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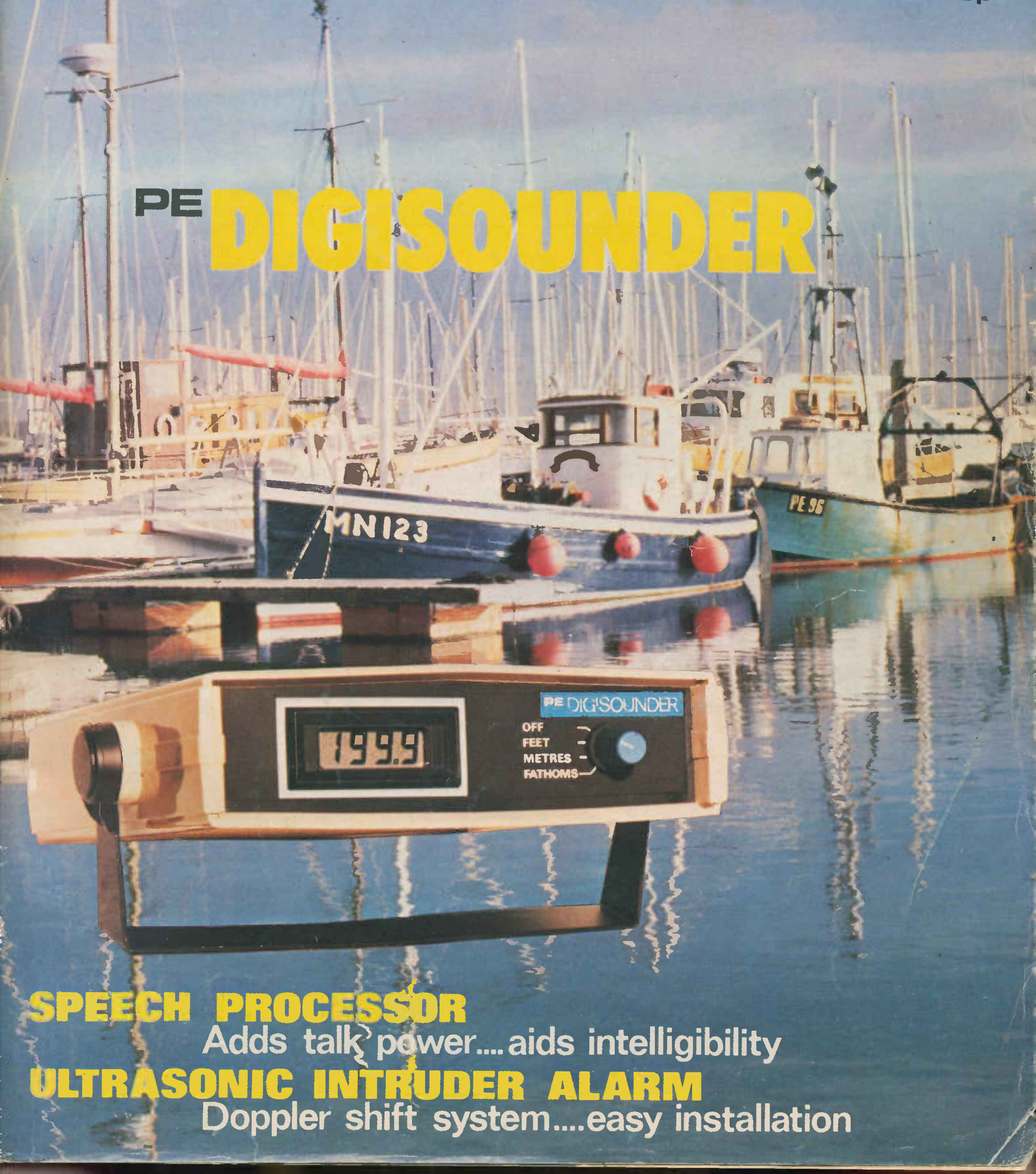

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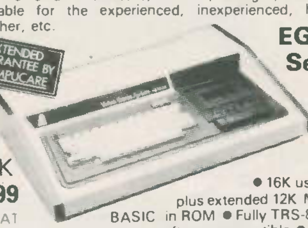

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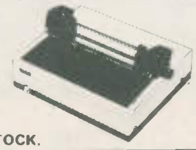

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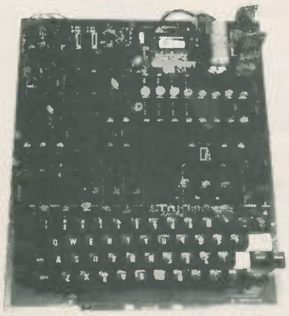

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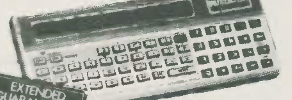

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ACY19	75
ACY20	75
ACY21	75
ACY22	60
ACY28	75
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BC107	10
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BC213L	10
BC214	10
BC214L	10
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BC307B	14
BC308B	16

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TIP32C	60
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2N3906	17
2N4037	46
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2N4061	10
2N4062	10
2N4069	45
2N4427	80
2N4859	78
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2N5138	18
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2N5485	36
2N5777	45
2N6027	32
2N6109	60
2SD234	75
3N128	112
3N140	112
40250	85
40251	97
40311	60
40313	130
40315	60
40316	95
40317	60
40320	60
40361	50
40362	50
40406	75
40407	60
40408	70
40411	285
40412	65
40467	130
40468	85
40594	105
40595	110
40603	110
40636	175
40673	95

ANTEX Soldering Irons

C15W	420
CX17W	420
CCN15W	430
X25W	430
Spare bits	50
Elements	190
Iron stand	160

DIL SOCKETS (TEXAS)

	Low profile	Wire wrap
8 pin	10p	25p
14 pin	10p	35p
16 pin	10p	46p
18 pin	16p	52p
20 pin	22p	65p
22 pin	25p	70p
24 pin	30p	78p
28 pin	35p	85p
36 pin	—	105p
40 pin	40p	109p

SPECIAL OFFER

2114-450ns	175p
2114-300ns	245p
2708	350p
2716-5V	450p
4116-16k	295p

Access

LINEAR IC's

702	75
709C 8 pin	35
710	67
741	17
747C 14 pin	78
748C 8 pin	36
753 8 pin	185
810	159
9400CJ	350
AY-1-0212	595
AY-1-1313A	660
AY-1-1320	225
AY-1-5050	99
AY-1-5051	160
AY-3-1270	840
AY-3-8500	390
AY-3-8910	850
AY-3-8912	850
AY-5-1224A	235
AY-5-1230	450
AY-5-1317A	630
AY-5-8100	775
CA3011	110
CA3012	175
CA3014	157
CA3018	68
CA3019	70
CA3020	186
CA3023	191
CA3028A	80
CA3035	235
CA3036	115
CA3043	275
CA3045	365
CA3046	70
CA3048	214
CA3059	195
CA3075	213
CA3080E	65
CA3081	190
CA3089E	215
CA3090AQ	375
CA3123	150
CA3130	90
CA3140	48
CA3160	95
ICL7106	795
ICL7107	975
ICL8038CC	340
ICL8211	150
ICM7205	1150
ICM7207	475
ICM7215	1050
ICM7216A	1950
ICM7216B	1950
ICM7217A	790
ICM7224	785
LD130	452
ICM7555	89
LF351	48

LF356	90
LM10	395
LM301A	26
LM308	95
LM311	70
LM318	200
LM324	50
LM339	68
LM348	90
LM349	115
LM379	415
LM380	80
LM381N	145
LM382	125
LM384	140
LM386	99
LM387	120
LM389	99
LM733	75
LM1458	45
LM2917	195
LM3900	60
LM3909	70
LM3911	125
LM3914	240
LM3915	240
LM3916	255
LM31600	135
M252AA	625
M253AA	1150
MC1303	88
MC1304P	260
MC1310P	150
MC1445	150
MC1458	45
MC1494	694
MC1495	350
MC1496L	92
MC1596	225
MC1648	290
MC1709G	90
MC1710	79
MC3302	150
MC3340P	120
MC3360P	120
MC3401	52
MC3403	135
MC3405	150
MFC6040	97
MK50398	635
MM5303	635
MM5307	1275
MM57160	520
MSM5526	820
NE515	275
NE529	225
NE543	210
NE544	185
NE555	22
NE556DB	55
NE560	325
NE561	395

NE5628	410
NE564	435
NE565A	120
NE566	180
NE567	170
NE570	450
NE571	420
RC4136D	110
S566B	275
SA83209	425
SA83210	275
SG3402	295
SN76003N	240
SN76013N	170
SN76018	148
SN76023N	170
SN76033N	195
SN76115N	215
SN76131	125
SN76227N	95
SN76477	175
SN76660	120
SP8629	299
TAA621AX1	250
TAA661A	155
TAD100	159
TBA120S	70
TBA540	220
TBA550Q	330
TBA641-A12/ 8X1 or 8X11	250
TBA651	190
TBA800	90
TBA810S	95
TBA820	70
TBA920Q	260
TBA990Q	270
TCA965	120
TDA1004	290
TDA1008	310
TDA1022	575
TDA1024	105
TDA2020	320
TDA2030	300
TL061	46
TL064CN	159
TL071CP	45
TL072CP	90
TL074CN	140
TL081CP	42
TL083CP	95
TL084CP	120
UAA170	170
UAA180	170
XR2206	350
XR2211	575
XR2266	750
ZN414	95
ZN423	195
ZN424E	130
ZN425E	415
ZN427	660

COMPUTER IC's

2114-450n	175
2114-300n	245
2532-32K	£16
2708	350
2716-5V	450
2732-450n	£16
4116	200
4315-4K	950
6502	675
6503	850
6505	795
6520	325
6522	570
6532	795
6545	1450
6551	785
6592	£27
6800	520
6802	670
6809	1550
6810	280
6821	315
6840	750
6850	315
6852	390
8080A	450
8085A	1100
81LS95	125
81LS96	125
81LS97	125
8212	210
8214	425
8216	200
8251	475
8253	999
8T26A	190
8T28A	195
8T31	350
8T95N	160
8T97N	150
AY-3-1015	395
AY-5-1013	325
AY-5-2376	750
MC1488	90
MC1489	90
MC14411	950
MC14412	1250
RO-3-2513U	600
SFF96364E	950
SFC71301	820
TMS2716-3V	1050
TMS4027	325
TMS6011	365
Z80CPU 2·5	650
Z80ACPU 4M	825
Z80 P10	440
Z80A P10	575
Z80 CTC	440
Z80A CTC	575
74L00	68
Z80S10	£19

Z80S10-9D1	£14
Z80AS10	£27
74S132	138
74S138	240
74S158	240
74S188	210
74S189	158
74S194	360
74S241	540
74S262	850
74S287	325
74S288	210
74S470	325
74S472	1150
74S475	825
75150	140
75154	150
75450	95
75451	70
75452	70
75454	225
75491/2	89

TTL 74 (TEXAS)

7400	11
7401	11
7402	11
7403	14
7404	14
7405	18
7406	36
7407	36
7408	17
7409	20
7410	17
7411	25
7412	20
7413	32
7414	38
7416	30
7417	30
7420	19
7421	38
7422	25
7423	28
7425	28
7426	43
7427	32
7428	35
7430	19
7432	27
7433	36
7437	35
7438	32
7440	20
7441	68
7442	58
7443	120
7444	116

7445	105
7446	132
7447	72
7448	75
7450	20
7451	20
7453	20
7454	20
7460	20
7470	40
7472	30
7473	35
7474	34
7475	56
7476	40
7480	52
7481	120
7482	75
7483	90
7484	99
7485	105
7486	33
7489	205
7490	42
7491	84
7492	50
7493	57
7494	85
7495	70
7496	80
7497	176
74100	130
74104	62
74105	62
74107	34
74109	60
74110	54
74111	68
74112	170
74116	170
74118	85
74119	120
74120	75
74121	35
74122	50
74123	65
74125	50
74126	45
74128	45
74132	55
74136	55
74141	75
74142	185
74143	250
74144	250
74145	90
74147	150
74148	125
74150	130
74151	70
74153	70
74154	120

74155	75
74156	75
74157	70
74159	165
74160	99
74161	99
74162	99
74163	99
74164	120
74165	120
74166	130
74167	205
74170	205
74172	375
74173	110
74174	100
74175	82
74176	80
74177	85
74178	110
74179	150
74180	90
74181	280
74182	85
74184	130
74185	130
74188	310
74190	130
74191	120
74192	120
74193	120
74194	102
74195	75
74196	99
74197	88
74198	160
74199	150
74221	150
74246	150
74247	151
74248	189
74249	189
74251	110
74265	66
74273	267
74278	249
74279	99
74283	149
74284	350
74285	350
74290	107
74293	135
74297	236
74298	185
74365	95
74366	95
74367	95
74368	95
74390	185
74393	185
74490	185

74LS

LS00	13
LS01	13
LS02	15
LS03	15
LS04	16
LS05	23
LS08	22
LS09	23
LS10	20
LS11	32
LS12	32
LS13	40
LS14	60
LS15	40
LS20	21
LS21	32
LS22	35
LS26	44
LS27	35
LS28	35
LS30	20
LS32	25
LS33	35
LS37	30
LS38	35
LS40	28
LS42	66
LS47	85
LS48	105
LS49	105
LS51	25
LS54	30
LS55	30
LS63	150
LS73	45
LS74	35
LS75	45
LS76	45
LS78	50
LS83	105
LS85	80
LS86	38
LS90	50
LS91	125
LS92	75
LS93	60
LS95	115
LS96	120
LS107	45
LS109	75
LS112	40
LS113	75
LS114	40
LS122	70
LS123	75
LS124	180
LS125	45
LS126	45
LS132	60

LS133	35
LS136	55
LS138	70
LS139	70
LS145	120
LS147	210
LS148	170
LS151	90
LS153	85
LS154	200
LS155	75
LS157	70
LS158	70
LS160	90
LS161	98
LS162	110
LS163	95
LS164	115
LS165	145
LS166	175
LS168	210
LS169	210
LS170	288
LS173	105
LS174	110
LS175	110
LS181	295
LS183	298
LS189	128
LS190	95
LS191	95
LS192	95
LS193	99
LS194	125
LS195	130
LS196	120
LS197	85
LS200	345
LS202	345
LS221	120
LS240	165
LS241	165
LS242	165
LS243	165
LS244	195
LS245	350
LS247	135
LS248	135
LS249	135
LS251	130
LS253	95
LS257	95
LS258	120
LS259	160
LS261	450
LS266	75
LS273	180
LS275	320
LS279	88
LS280	250

LS283	90
LS290	130
LS293	130
LS295	215
LS298	215
LS299	420
LS300	175
LS302	175
LS323	270
LS321	450
LS324	200
LS325	320
LS326	330
LS327	315
LS346	185
LS347	150
LS348	190
LS352	185
LS353	185
LS365	65
LS366	65
LS367	65
LS368	90
LS373	150
LS374	150
LS375	150
LS377	199
LS378	140
LS379	215
LS384	250
LS385	420
LS386	85
LS390	140
LS393	140
LS395	210
LS396	199
LS398	275
LS399	230
LS445	140
LS447	195
LS490	245
LS668	105
LS669	105
LS670	270
LS673	750
LS674	850

CMOS

4000	14
4001	14
4002	15
4006	86
4007	19
4008	76
4009	40
4010	48
4011	18

4012	24
4013	43
4014	80
4015	82
4016	35
4017	70
4018	76
4019	42
4020	85
4021	90
4022	85
4023	24
4024	60
4025	24
4026	170
4027	45
4028	92
4029	98
4030	55
4031	185
4032	125
4033	175
4034	213
4035	95
4036	275
4037	115
4038	110
4039	299
4040	85
4041	80
4042	70
4043	80
4044	80
4045	175
4046	96
4047	98
4048	65
4049	35
4050	38
4051	86
4052	86
4053	86
4054	130
4055	130
4056	135
4059	575
4060	110
4061	1225
4062	995
4063	120
4066	46
4067	430
4068	26
4069	22
4070	25
4071	25
4072	25
4073	25
4075	23
4076	85

CMOS (CONT.)

4077	30
4078	28
4081	26
4082	25
4085	90
4086	90
4089	150
4093	55
4094	210
4095	95
4096	95
4097	340
4098	115
4099	150
4160	115
4161	115
4162	115
4163	115
4174	110
4175	120
4194	115
4408	790
4409	790
4410	750
4411	950
4412F	1100
4415F	480
4419	280
4422	570
4432	1050
4433	995
4435	850
4440	999
4450	350
4451	350
4452	
4490	350
4500	750
4501	28
4502	105
4503	65
4506	75
4507	48
4508	280
4510	85
4511	98
4512	84
4513	225
4514	220
4515	250
4516	90
4517	415
4518	90
4519	80
4520	90
4521	210
4522	150
4526	98
4527	125
4528	100
4529	150
4530	90
4531	130
4532	120
4534	510
4536	310
4538	145
4539	120
4541	150
4543	150
4549	395
4553	399
4554	192
4555	85
4556	80
4557	425
4558	174
4559	450
4560	199
4561	104
4562	525
4566	195
4568	299
4569	195
4572	36
4580	495
4581	320
4582	135
4583	105
4584	55
4585	99
4599	275
40106	95
40174	160

PE VOLUME 17 No. 4 APRIL 1981

A GOOD CASE . . .

THOSE of you who have already looked further into your copy will by now be aware that our May issue is a very special one (others turn to page 36—when you have finished this piece please!) When planning our free case one of our intentions was to present as wide a variety of digital projects to fit in the case as possible. Another factor that influenced our decision to go ahead with this rather expensive gift, in the face of the present recession, was the relatively simple construction of each project.

The use of what is probably the first of a new generation of panel meters has resulted in very high performance projects which are not expensive, are readily constructed and neatly housed. The free case was designed especially for PE by Lascar Electronics and, as far as we know, is the only case of this type available in the UK at the present time. Because you will get one free you will save over £2·00 on the project cost and our *DPM Special Offer* will save you a further £3·00 on the normal price.

Taking all these factors into account we believe that we can appeal to the widest possible range of readership and thus make the most of our primary intention—to sell more copies. Yes, it's a hard world and we do publish to make money, although we can easily lose sight of that fact in our enthusiasm for electronics and for PE in particular. Of course we believe PE is excellent value for money anyway, but on this special occasion it will be even more attractive, so please make sure of your copy by ordering it now.

. . . LAID BEAR!

Having just worked our way through that lot of (hopefully) logical thinking and confidently believing we can introduce some new readers to PE, we received the following letter trusted to the tender care of a Paddington Bear envelope:

"Dear Sir or Madam,

In November 1974's Practical Electronics you published the "PE Minisonic" by G. D. Shaw.

My dad has a collection of your magazines, but unfortunately has not got all the parts. So could you please send me the circuit diagram for this very good battery operated synthesiser.

I enclose a stamped addressed envelope for your reply.

Yours sincerely,
Robert Brooks.

PS. I am twelve years old."

Thank you Robert for an excellent letter, unlike many older readers you have given your name and address clearly—you'd be surprised how many people forget all, or part of it—supplied a stamped addressed (Paddington) envelope—without any marmalade on it—set out your letter clearly, kept to one subject and even given us a little praise—all others please follow Robert's example.

The only thing that worries us is why do we bother about easy to build projects to interest new readers if you are building the *PE Minisonic* at the age of 12? You have just messed up all that logical thinking!

We would be interested in hearing from other young readers, we cannot promise to answer all the letters, but why not tell us how you first started reading PE and what type of projects and articles you like.

Mike Kenward

PS. I'm not telling you my age.

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We regret that lengthy technical enquiries cannot be answered over the telephone (see below).

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Technical Queries
We are unable to offer any advice on the use or purchase of commercial equipment or the incorporation or modification of designs published in Practical Electronics.

All letters requiring a reply should be accompanied by a stamped, self addressed envelope and each letter should relate to **one published project only.**

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

Back Numbers
Copies of some of our recent issues are available from: Post Sales Department (Practical Electronics), IPC Magazines Ltd., Lavington House, 25 Lavington Street, London SE1 0PF, at 95p each including Inland/Overseas p&p.

Binders
Binders for PE are available from the same address as back numbers at £4·30 each to UK or overseas addresses, including postage and packing, and VAT where appropriate. Orders should state the year and volume required.

Subscriptions
Copies of PE are available by post, inland or overseas, for £11·80 per 12 issues, from: Practical Electronics, Subscription Department, Oakfield House, Perrymount Road, Haywards Heath, West Sussex RH16 3DH. Cheques and postal orders should be made payable to IPC Magazines Limited.

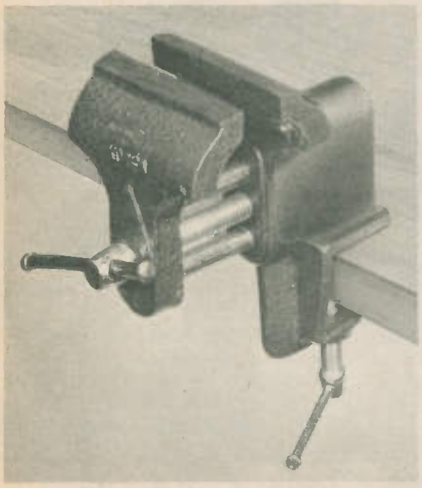
Market Place

Items mentioned are usually available from electronic equipment and component retailers advertising in this magazine. However, where a full address is given, enquiries and orders should then be made direct to the firm concerned. All quoted prices are those at the time of going to press.

by David Shortland and Jasper Scott

BUDGET VICE

This portable bench vice, pictured below, is now available from Home Radio. The jaws open to a maximum of 32mm and it can be fitted to benches up to 24mm thick, so it should be suitable for most light constructional work.



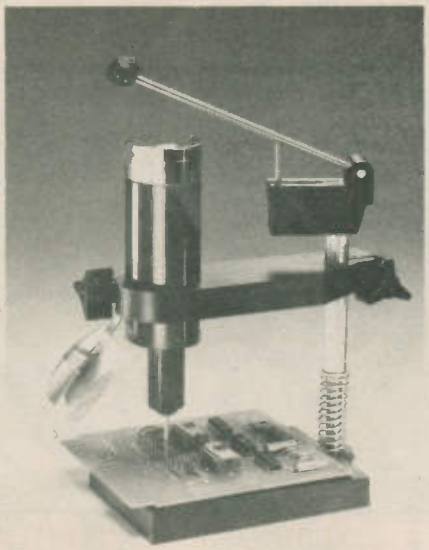
The price including VAT and p&p is £3·87.

Home Radio (Components) Ltd, PO Box 92, 215 London Road, Mitcham, Surrey (01-543 5659)

DRILLMASTER

Two new mini drills ideal for use with our minidrill p.s.u. are being marketed by Microflame together with a complete range of accessories which include a drill stand with a built in magnifying glass.

The junior model features a detachable chuck finger shield for close control and the chuck itself has four precision cut steel collets (0·6, 1·2, 1·8 and 2·4mm). An automatic 3-jaw chuck is available as an optional extra.



The senior model is supplied with an automatic 3-jaw chuck and a precision chuck with 5 collets is available as an optional extra (0·6, 1·2, 1·8, 2·4 and 3·2mm).

The price of the junior model is £10·00 and the senior model is £17·35. All prices exclude VAT and p&p.

Microflame (UK) Limited, Vinces Road, Diss, Norfolk (0379 4813).

SOAR DFM

Many people who consider digital frequency meters just too expensive to be considered for inclusion in their range of test equipment will be interested to hear about the Soar DFM. The importers of this Japanese instrument claim they have done so because of the non-availability of a low priced high quality UK meter.

The unit which measures only 100x32x120mm has a frequency range of 10Hz to 50MHz and can measure up to 500MHz with a prescaler. Powered by either 4 penlight batteries or an external d.c. supply (8 to 11V) the instrument has a 4 digit display and a resolution of 10Hz/10kHz with a maximum input of 20V.

The DFM is priced at £39·99 including VAT. For £43·58 the DFM is available with batteries, input lead carriage and insurance.

Holdings, Mincing Lane, Darwen Street, Blackburn BB2 2AF (0254 59595).

KITS FOR BEGINNERS

A range of simple chip-based hobby kits with step-by-step instructions has been introduced by OK Machine & Tool. OK say that the kits are suitable for 12 year olds upwards, with descriptions of the various terms and components used in electronics included in the instructions. Once assembled, the kits fit into their original plastic packaging containers.

Five kits are available, Quick Reaction (£5·80), Electronic Dice (£7·98), Digital Roulette (£8·60), Morse Code (£3·99) and Electronic Organ (£6·70). All prices include VAT and p&p and items are available by mail order or by placing a credit card order over the telephone. Prices do not cover batteries or tools.

OK Machine & Tool (UK) Ltd., Dutton Lane, Eastleigh, Hants SO5 4AA (0703 610944)

CATALOGUES

Howard Associates have just released a short form catalogue which covers a range of PE projects such as the Solid State Car Instruments, Speech Processor, 27/28MHz Converter, DFM, Sound Operated Switch and the Dynamic Semiconductor Tester.

Part kits are available and Howard can also provide individual component price lists.

The catalogue is available from **Howard Associates, 59 Oatlands Avenue, Weybridge, Surrey KT13 9SU.**

Another shortform catalogue just available is from Lascar Electronics. It contains their complete range of digital panel meters, counter timers and portable instruments. Also listed is a 12/24hr clock module and l.c.d. and l.e.d. thermometers which will measure temperatures between −55° to +150°C with a resolution of 0·1°C.

Lascar Electronics, Unit 1, Thomasin Road, Basildon, Essex (0268 727383)

KEYBOARD CONSOLES

Boss Industrial Mouldings have recently introduced three medium sized keyboard consoles into their BIM 7400 range. This range now consists of six case sizes from 355 to 508mm wide by either 178 or 254mm deep and with a rear panel depth of 102mm. The front panel is inclined by 10 to 15 degrees for easier key operation.

The consoles are of all aluminium construction and incorporate ventilation slots in both rear and bottom panels with a gasket fitted between the panels to reduce vibration.

Prices for the range are from £16·05 to £26·33 excluding VAT.

Boss Industrial Mouldings Ltd., 2 Herne Hill Road, London (01-737 2383).

DRAUGHTING AIDS

Constructors who like to produce their own p.c.b.s will be interested in the latest range of etch resistance transfers from Ace Mailtronix. The transfers which include straight or curved tracks, transistor, d.i.l. solid, oval, square and terminal pads are available either in sets of five sheets of a type or a mixed bag of six sheets including an introduction sheet. The transfers which are printed on 115×105mm sheets are available in a 1:1 scale for use directly onto copper clad boards or in a 2:1 scale for those with photograpic reduction facilities, Ace can also supply black crepe paper track tape in various widths for constructors with UV light boxes.

For a free catalogue of the complete range send a stamped addressed envelope (9×4ins).

Ace Mailtronix Ltd., 3A Commercial Street, Batley, West Yorkshire, WF17 5HJ.

AUDIO-SAFE

The latest protection system for cars is the audio-safe unit which the makers claim makes the unauthorised removal of an in-car entertainment system virtually impossible.

The unit is a two part system: a base plate which replaces the usual dashboard trim plate and a cast aluminium cover that fits over the equipment and is secured to the replacement

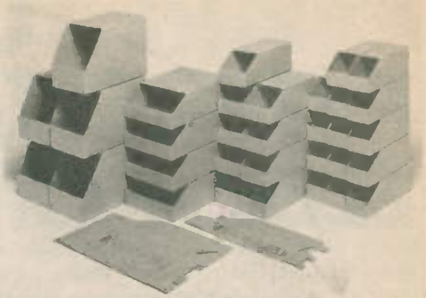
panel by means of an individual locking key.

When locked together access to the mounting nuts, securing the equipment, is prevented. In fact the equipment itself cannot be seen.

The audio-safe will sell for around £25·00 from retailers.

STORAGE CASES

A new range of component containers has been added to the large range already carried by Trade Aids. The containers which are made of laminated board are light, strong and easily folded flat for storage. They are available in four sizes from 380×100×133mm



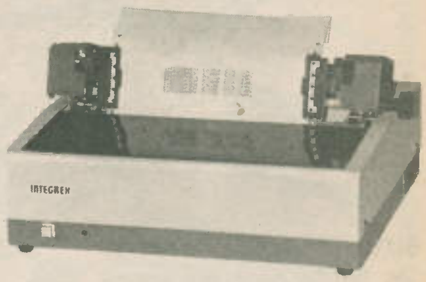
to 380×210×266mm with prices ranging from 24p to 50p ex. VAT and p&p.

Trade Aids, 54–56 Hawkes Road, Kingston upon Thames, Surrey, KT1 3FF. (01-549 2137)

COLOUR PRINTER

Integrex have recently announced the introduction of their new low cost impact Colour Matrix Printer, model CX80.

Printing in 7 colours (with simple control codes) and with 96 ASCII plus 64 graphics characters in ROM, the CX80 is fully dot ad-



dressable, has 15 user programmable characters together with double length and reverse character printing.

The retail price is £895 plus VAT, and further information is available from:

Integrex Ltd., Portwood Industrial Estate, Church Gresley, Burton on Trent, Staffs. (0283 215432)

FUELSTRETCHER

The latest in-car monitor is the Fuelstretcher Drive Computer which will give an instantaneous m.p.g. indication as well as helping with route planning, record keeping and trip scheduling.

The computer processes and stores information received from the fuel flow and speed sensors. This information which is given on a 4 digit l.e.d. display shows the driver how much fuel has been used, elapsed time and distance travelled on a particular trip or on a weekly or monthly basis.

The makers claim the unit is as easy to install as a car stereo and should take no more than two hours. All the motorist has to do is to fit the fuel sensor into the fuel line, speed sensor to the drive shaft and then connect both to the computer unit.

The computer, complete with wiring, optional mounting bracket, instruction manual, fuel flow and speed sensors can be obtained directly from EnviroSystems for just over £80·00.

EnviroSystems Ltd., Hampsfell Road, Grange-over-Sands, Cumbria, LA11 6BE (044 84 4233).

INDUSTRY NOTEBOOK

By Nexus

New Style Office

"- - - - - a transition to twentieth century from nineteenth century office technology is not easily or quickly achieved."

You might suppose the quotation above was taken from a text written, say, in 1905 and referring to then new-fangled ideas like the telephone. Actually, it was written in 1980 and published in January 1981 and is from a case history on the introduction of word processing. It implies that office methods haven't changed much in over 80 years and carries a stern warning of hazards ahead.

Word processing is now a boom area for manufacturers and equipment suppliers. But the potential user had better be wary. It is all too easy to stumble into the trap experienced by those bold enough to invest in data processing in the 1960s. In those days persuasive sales talk and extravagant claims for economy as well as efficiency only too frequently led to hasty installations, muddle, inefficiency and high costs. The jokes about computers all but disappeared as computer science attained maturity. Early hilarity has been supplanted by the menace of computer fraud—no laughing matter.

Now that we are all accustomed to, even conditioned to, data processing, a transition to word processing ought to be comparatively easy and painless. And, one would have thought, demonstrably so as an office has a well understood structure and purpose.

Not so, according to this case history. The authors went back to first principles and asked themselves what an office is and what it does. They found that in their own case that different departments organised their affairs quite differently and often to suit the personal needs of executives and secretaries as well as particular characteristics of the work undertaken.

There were more than 20 departments employing some 1,500 staff, half in London, originating over 1·2 million pages of text on A4 paper per year. When they looked at what people did they discovered that 150 person-years of time which should have been available for profit-earning professional tasks was being frittered away on internal administration. In fact the biggest savings would not be in reduction of secretarial costs but in gains of management time.

When it came to selecting a system it was found that over 30 suppliers offering over 50 different systems were available. Whittling these down to a short-list and final selection was no easy task.

The investment was eventually some £700,000 for the London office and an equal amount for the provincial offices, making a grand total of £1·4 million. The payback period was calculated as two years or less.

There is no space to describe all the development of software, training of staff, integration of the system with existing data processing facilities, or possible future expansion of the word processing system in terms of both size and newer technology as it becomes available. Or of how the system was progressively introduced, section by section, of 85 work stations without disruption of the daily work schedule.

The conclusion is that word processing is available now and is cost-effective. There is no mention of staff redundancy so that one assumes that payback in this case is added capacity for throughput which can only pay with an increase in business. In other words, while there are no immediate redundancies there should be no need to expand the staff for a long time ahead.

While this picture looks bleak for office workers, the other side of the coin is a huge new market for the electronics industry in manufacturing, installation, servicing and, eventually, a substantial replacement market, not to mention armies of software specialists.

Albert Einstein is recorded as having said: "If we look hopefully upon the shape of things to come, we can visualise automation as the greatest blessing mankind has ever known." I can only add that it seems a pity that the implementation of such a blessing is so painful.

Inertia

As a counterweight to the above an eminent engineer last year was remarking that although technology continues to advance it was slow in introduction and had had little real effect on our daily life pattern. As examples he quoted that people still commuted every day in great discomfort and read newspapers produced and distributed in the same manner as in the early part of the century.

How true! But he, too, is expecting big changes. What he was describing was that today there is practically no technical limitation to what can be achieved. The only real barrier to change is that people are conservative by nature.

Expansion

Ten years ago Aberdeen Airport was a busy terminal handling 30,000 aircraft movements per year of which 4,000 were helicopters. This year the projected movements are 130,000 including 53,000 helicopter movements. A new runway was laid down in 1977 and a new control tower added in 1979. Latest addition is a comprehensive CCTV system for monitoring apron parking, refuelling and baggage handling areas.

Such has been the impact of North Sea oil. The spin-off for the electronics industry is substantial and not only at Aberdeen.

Exploration, drilling, pumping, data logging, communications at sea are all huge markets benefiting the industry. It is interesting to note that in an analysis of the performance of the FT 30 Ordinary Share Index over the past three years that the oil giant BP is a notable high flyer with a gain of 90 per cent showing the strength of oils. But BP comes only third. Runaway winner is Plessey with a gain of 170 per cent since 1978 and GEC a creditable second-placer up 117 per cent.

There are some doubts on whether the government can maintain the promised level of defence spending and this could have an effect on both GEC and Plessey prospects with some major projects. But both these companies have a wide spread of activities and any programme reductions or delays are not likely to have a great effect.

In fact the outlook for electronics has never been brighter. One market analyst, Mackintosh, is forecasting an overall European growth rate of 12 per cent through to 1984 and that the UK will increase its market share.

The British Electrical and Allied Manufacturers' Association (BEAMA), which includes heavy electricals as well as electronics firms in membership, reported a 17 per cent rise in exports over the first nine months in 1980. In the same period, imports were up only 10 per cent.

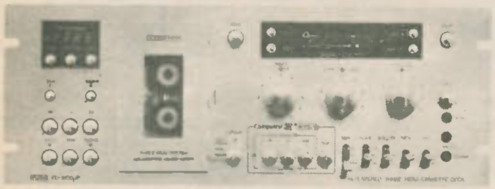
ATE.

Automatic test equipment (ATE) continues to thrive. Marconi Space and Defence Systems are supplying equipment for the Middle Eastern military base workshop. The contract is worth £2·5 million and the equipment supplied will be used to check out 150 p.c.b.s, sub-assemblies and other electronic units on main battle tanks.

On a more modest scale a Racal ATE worth £64,000 has gone into service with audio engineers Neve, who make sound mixing consoles for broadcasting and other high quality applications. Manual testing of a complex Neve p.c.b. takes as long as $3\frac{1}{2}$ hours. The Racal ATE does the same job in five minutes.

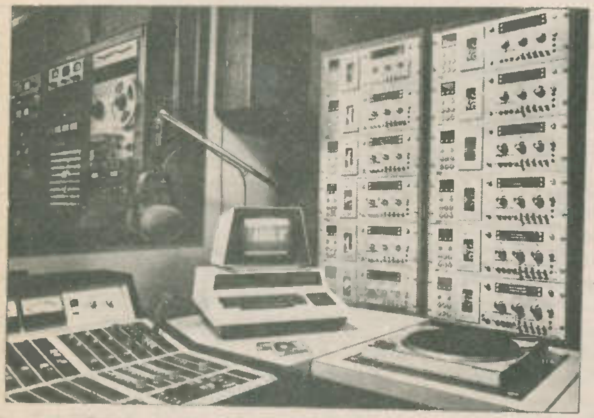
CONSUMER ELECTRONICS SHOW

A gallery of impressions from the Consumer Electronics Show held in Las Vegas, January 1981.



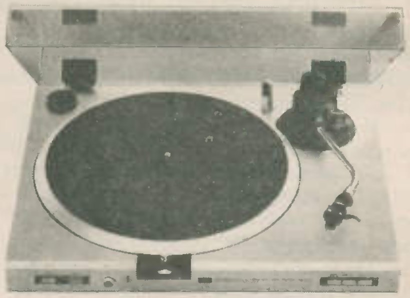
Claimed to be the world's first computer connectable cassette deck, the Eumig FL-100. Built-in microprocessor enables on-tape indexing of sound tracks.

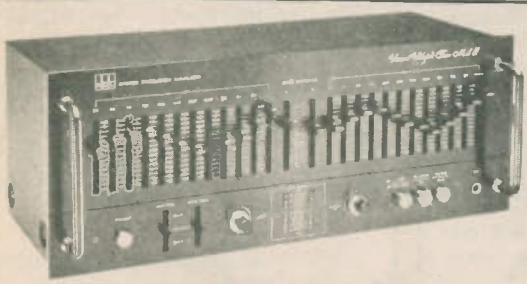
Twelve FL-1000s under computer control in an automated broadcast. *Photos courtesy of Eumig.*



New Revox B795 direct drive turntable with Linatrak tangential tracking system. Motors are controlled by Hall effect sensors via quartz-referenced phase locked loops. *Courtesy Studer Revox America Inc.*

More conventional than the deck shown above—or is it? All operations are computer supervised, and controlled entirely at the fascia so that the dust cover stays down. The new FR–D45 turntable, *courtesy of Sansui.*





BSR's ADC Sound Shaper Two Mark III, with l.e.d. slide controls, each with defeat switch for individual on/off. Unit includes 12 frequency controls of 24dB range per channel. *Courtesy BSR (USA) Ltd.*

Ultra-lightweight headphones by Mura. Weighing just 1·6 oz, the "Red Set" phones employ samarium-cobalt drivers. *Courtesy of Mura Corp.*

Not a two-faced grandfather clock, but the Revox Audio Rack. Galvanized steel to give strength, oak veneer to give finish. *Courtesy of Studer Revox.*

The world's most expensive stereo receiver, or so it is claimed, is the Revox B780. Incorporating a 70W per channel amplifier and quartz-controlled synthesizer FM tuner, the entire system is based on advanced technology. The unit also uses a microprocessor to manage the 18-station recall memory (with back-up battery). Specification is top line, and a Dolby FM circuit card can be user-installed. Suggested list: $2699.

The Akai mini-component system, UC–3. The amplifier produces 45W of power per channel. *Courtesy of Akai America Ltd.*

Dimensions
UC-U3 mini-amp:
11 in. wide, 4 in. high, 10 in. deep
Cassette deck:
11 in. wide, 4 in. high, 10 in. deep
UC-S4 AM/FM
digital tuner:
11 in. wide, 2 in. high, 10 in. deep

Put a tape of any oxide formulation into this cassette deck, and the on-board computer will have adjusted to correct bias, equalisation and sensitivity within seconds. Functions are solenoid (logic) controlled. The fluorescent bar meter allows for peak hold, and Dolby noise reduction is included in the GX-F95. *Akai America Ltd.*

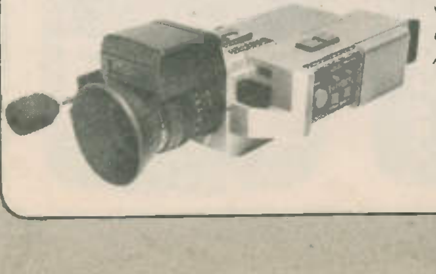
Selling the concept of psychoacoustics, "Doc" Cavalier of Omnisonix Ltd. says of his Imager . . . "far more dramatic than the performance of a dynamic range expander". Shown here is the 801-A, intended for automobile hi-fi. *Courtesy of Omnisonix Ltd.*

The Bearcat 150 synthesised scanner, featuring 10-channel memory, fluorescent display and membrane keypad operation. Frequency ranges from 30 to 512MHz, covering 5 bands.

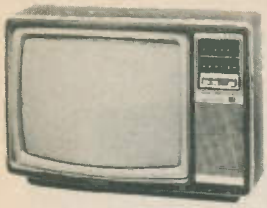
Magnavox 14-day programmable touch-tune VHS VCR, model 8340 portable. Features frame by frame advance, variable slow motion, stop action, fast motion and picture search; fascia or remote control.

Leading edge technology concealed in a "Mediterranean" styled colour TV. Model 5056 in Pecan, by *Magnavox*.

Described as the *unconventional* colour video camera, Akai's VC-X1 features auto-focus, whereby the camera adjusts itself relative to the main subject matter. The equipment can handle close-up and low light level work. *Photo courtesy of Akai.*

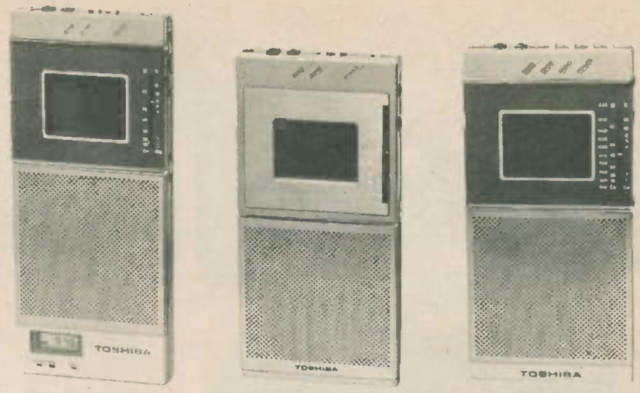


Magnavision laser-optical videodisc player. Forward, reverse, speed and search facilities, plus choice of bi-lingual-or-stereo, are built in. Video discs are immune to dust and scratches. *Courtesy of Magnavox.*



Today's look in television. The CB–954 is one of the latest family of 19 inch sets from Toshiba. Picture improvement results from the following: Electronic Noise Cancellor, Automatic Dark Picture Intensifier, and a White Detail Purifier. *Photo courtesy of Toshiba America Inc.*

POCKET TELEVISION WITH LIQUID CRYSTAL SCREEN

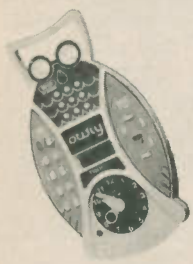


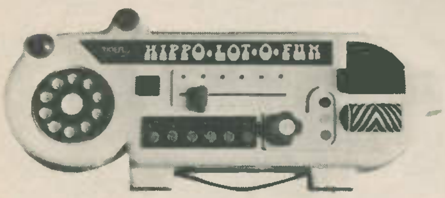
The star revelation at Las Vegas was undoubtedly three hand-held UHF–VHF TVs, whose monochrome pictures are produced on flat-screen l.c.d.s. Each unit measures an amazing 6·8 × 3·2 × 0·7 inches thick, and weighs just 10·5 ounces. The screen system used measures 1·2 × 1·6 inches (2 in. diagonal). One model incorporates a digital clock, and another, a radio. All three televisions can double the image size by zooming in on the centre area of the screen.

This is the way Toshiba describe the operation of their breakthrough: "The screen comprises a liquid crystal matrix panel filled with liquid crystal in a gap between the integrated circuit and the front glass. A picture is the end result of brightness differences on the crystal created by voltage differentials."

Photographs courtesy of Toshiba Consumer Electronics Divn.

Computers disguised as animals aid development in thinking and co-ordination in the very young.

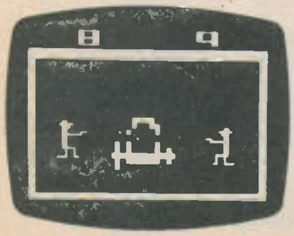




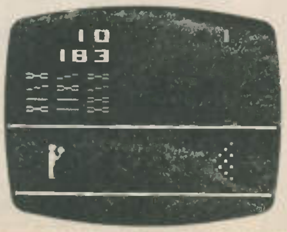
A unique three-dimensional game called Cosmos. In addition to what are described as "Holoptic" images, this sophisticated l.e.d. game incorporates novel sound effects.

Mattel Electronics, a pioneer of hand-held electronic games, is expanding in the computerised video games field. Some of these games are shown below.

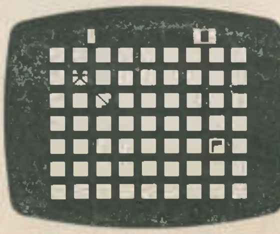
OUTLAW



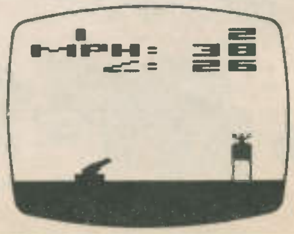
BOWLING



FLAG CAPTURE



HUMAN CANNONBALL



The EL-7001 Memowriter is an alphanumeric typewriter/calculator with 40 word-memories, by *Sharp.*

The Imagination Machine II with 27K RAM, 14K ROM, is a small business system with r.r.p. $1,199. It features up to eight video colours, sound synthesiser, BASIC or 6800 m/c, object orientated and point resolution graphics. Photo shows floppy interface module inserted. *Courtesy of APF Electronics.*

Praxis 35 portable electronic typewriter. Automatic correction of last ten characters via memory. *Courtesy of Olivetti.*

The "jewelry look" has come to calculators. This charcoal grey case with raised chrome numeral keys and l.c.d. display should suit some executives.

Mura claim this is one of the lowest priced digital VOMs. The LCD–200 features easy-to-read $\frac{1}{2}$ inch high digits, and is intended for hobbyists and engineers.

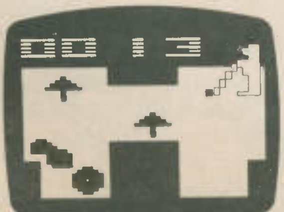
Banana plugs are used in preference to pin contacts, and *all* ranges are switched, obviating the need to change the probe leads from one socket to another, as is often the case with cheaper units. *Photo courtesy of Mura Corporation.*

The Kosmos biorhythm unit and world time clock will display data on six people. It also has a stopwatch. *Courtesy of Kosmos International of Atlanta.*

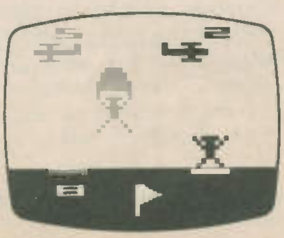
Fuzzbuster's radar detector for cars. The remote portion, utilising dielectrically coupled waveguide technology, fits behind the radiator grill. *Electrolert Inc.*

A few of the very many Atari games on offer. *Pictures courtesy of Atari Consumer Divn.*

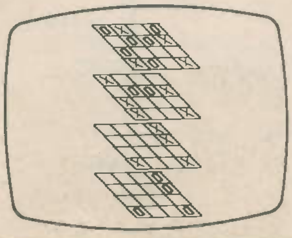
GOLF



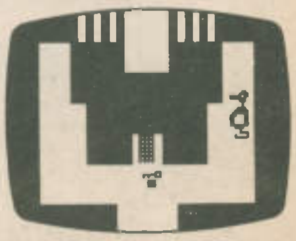
SKYDIVER



TIC–TAC–TOE

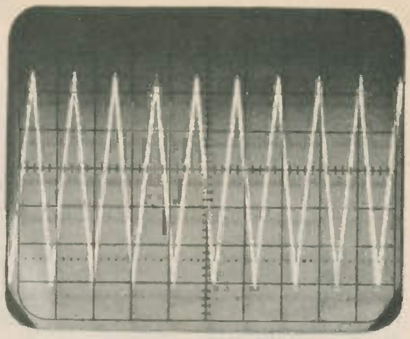


ADVENTURE



CONSUMER ELECTRONICS SHOW

Oscilloscopes



....HOW THEY WORK

Part One...The Cathode Ray Tube... by Ian Hickman

This two-part feature is taken from the last two chapters of a new book by this well-known author. Published by Newnes Technical Books the paperback is entitled *Oscilloscopes. How to use them. How they work.*

THE cathode-ray tube is the main component of an oscilloscope. A cathode-ray tube consists basically of an electrode assembly mounted in an evacuated glass vessel (Fig. 1). The electrodes perform the following functions:

1. A triode assembly generates the electron beam, originally called the "cathode ray". It consists of a cathode K heated by a filament F, a control grid G and the first beam-acceleration electrode (2).
2. An electrode (1) focuses the beam.
3. The beam is then further accelerated before reaching the deflection plates.
4. The vertical deflection plates change the direction of the beam in proportion to the potential difference between them. When this is zero, i.e. the two plates are at the same potential, the beam passes through undeflected. The vertical deflection plates are so called because they can deflect the beam in the vertical direction, so that it hits the screen at a higher or a lower point; they are actually mounted horizontally above and below the beam, as shown in Fig. 1. Similarly the horizontal deflection plates permit the beam to be deflected to left or to right.
5. The deflected beam then hits the fluorescent coating on the inner surface of the glass screen of the c.r.t. The coating consists of a thin layer of "phosphor", a preparation of very fine crystals of metallic salts deposited on the glass. The "spot" or point of impact of the beam glows, emitting light in all directions including forwards. Modern c.r.t.s are aluminised, i.e. a thin layer of aluminium is evaporated on to the rear of the coated screen. The electrons pass through this with little retardation, causing the phosphor to glow as before, but now the light emitted rearwards is reflected forwards, almost doubling the useful light output.

The potential at the focus electrode is adjusted to obtain a very small round spot on the end of the tube. Unfortunately, if no other control were provided, it would often be found that the focus control setting for minimum spot widths was different from that for minimum spot height. This is avoided by providing an astigmatism control. In the case of a simple cathode-ray tube this consists of a potentiometer that adjusts the voltage on the final anode and screen relative to the deflection plate voltages. Alternate adjustments of the focus and astigmatism controls then permit the smallest possible spot size to be achieved. With more complicated tubes using a high "post-deflection acceleration ratio" another electrode is often needed. This is a "geometry" electrode and is connected to another preset potentiometer, which is adjusted for minimum "pincushion" or "barrel" distortion of the display.

When an electron beam passes between two horizontal plates

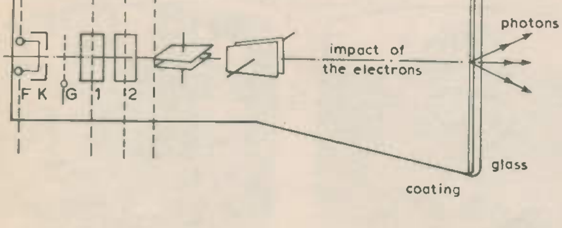


Fig. 1. Basic oscilloscope (electrostatic) cathode-ray tube *(courtesy Enertec Instrumentation Ltd.)*

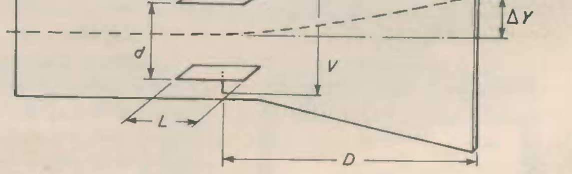


Fig. 2. Y-deflection sensitivity: see text *(courtesy Enertec Instrumentation Ltd.)*

that have a potential difference of V volts between them (Fig. 2) it is deflected vertically by an amount:

$$\Delta Y = \frac{KVLD}{2V_a d}$$

where L = length of the plates
D = distance between the plates and the point on the axis where the deflection is measured
d = distance between the plates
V_a = acceleration voltage applied to the beam at the level of the plates
K = a constant relating the charge of an electron to its mass.

The Y deflection sensitivity of a c.r.t. is defined by $\Delta Y/V$ and is expressed in cm/V. However, in practice the inverse relationship is normally used: $V/\Delta Y$, in V/cm, i.e. the differential deflection-plate voltage necessary to achieve a spot deflection of 1cm.

Brilliance or intensity modulation (also called Z modulation) is obtained by the action of a potential applied to the cathode or grid that controls the intensity of the beam. Generally, a change of 5V will produce a noticeable change of brightness, while a swing of about 50V will extinguish a maximum-intensity trace. The beam is normally extinguished during "flyback" or "retrace"; see Part 2. This may alternatively be achieved in some c.r.t.s by means of an auxiliary "blanking" electrode, which can deflect the beam so that it no longer passes through the deflection plates and hence does not reach the screen.

TUBE SENSITIVITY

The deflection plates of a c.r.t. are connected to amplifiers, which can be of relatively simple design when the required output amplitude is low; it is therefore desirable for the tube sensitivity to be as high as possible. To enable the amplifier to have a wide bandwidth, the capacity between the plates must be kept low, so they must be small and well separated. On the other hand, in order to obtain a suitably clear trace of a signal with low repetition frequency (or single-shot) the energy of the beam must be high. But the ideal tube must be:

1. Short (not cumbersome): D small
2. Bright (high acceleration voltage): V_a large
3. And with low deflection-plate capacity: L small, d large

This gives a tube with very low sensitivity, considering the formula:

$$\text{Sensitivity} = \frac{\Delta Y}{V} = \frac{KLD}{2V_a d}$$

The requirements for high sensitivity contradict the terms of the equation. Practical cathode-ray tubes are therefore the result of a compromise. However, techniques have been developed to improve a selected parameter without prejudice to the others. Post-deflection acceleration (p.d.a.) is one of these; see Fig. 3. To improve the trace brightness while retaining good sensitivity, it is arranged that the beam passes through the deflection system in a low energy condition (relatively low initial acceleration); post-deflection acceleration is then applied to the electrons. This is achieved by applying a voltage of several kilovolts to the screen of the c.r.t.

Spiral p.d.a., Fig. 4, is a development of the basic p.d.a. technique, and consists of the application of the p.d.a. voltage to a resistive spiral (500MΩ) deposited on the inner tube surface between the screen and the deflection system. The uniformity of the electric field is improved, which reduces distortion. In addition the effect of the p.d.a. field between the deflection plates is weaker, so the loss is sensitivity caused by this field is reduced.

The use of a field grid—Fig. 5a—avoids any reduction in sensitivity caused by the effect of the post-deflection accleration field. A screen is interposed between the deflection system and the p.d.a.; this makes the tube sensitivity independent of the p.d.a., a significant benefit. The screen must, of course, be transparent to the electrons and is formed from a very fine metallic grid. With this system we reach the domain of modern cathode-ray tubes.

The next development is the electrostatic expansion lens—Fig. 5b. By modifying the shape of the field grid (e.g. a convex grid) it is possible to create, with respect to the other electrodes, an electric field that acts on the electron beam in the same way as a lens acts on a light beam. It is therefore possible to increase the beam deflection angle, for example by a factor of two, which improves the sensitivity by the same amount.

The field can also be formed by quadripolar lenses. So, for example, if the sensitivity of a spiral tube is 30V/cm in the X axis and 10V/cm in the Y axis, then the sensitivity of a lens-fitted tube, for the same trace brightness, may be 8V/cm in X and 2V/cm in Y or even better.

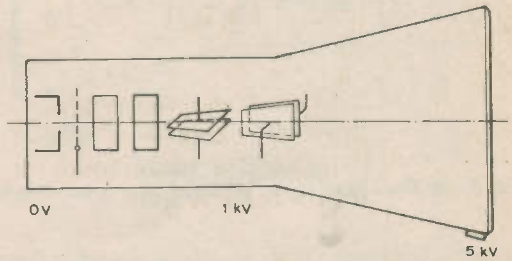


Fig. 3. Single-stage post-deflection acceleration *(courtesy Enertec Instrumentation Ltd.)*

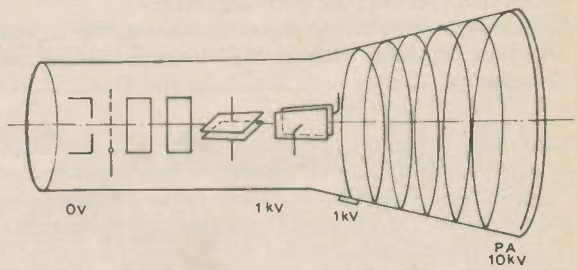


Fig. 4. Spiral p.d.a. *(courtesy Enertec Instrumentation Ltd.)*

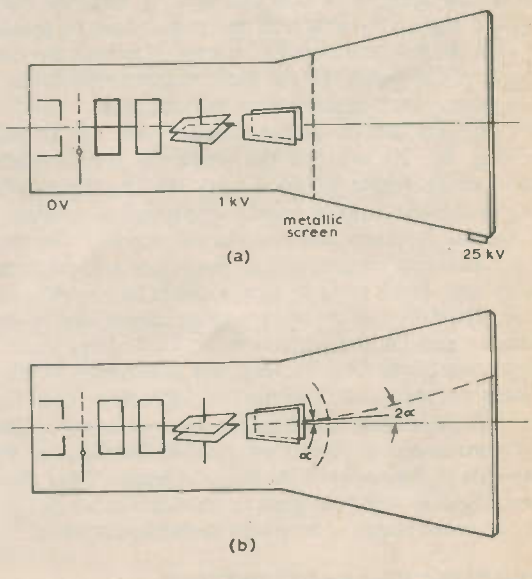


Fig. 5. (a) Mesh p.d.a.; (b) As (a) combined with expansion lens *(courtesy Enertec Instrumentation Ltd.)*

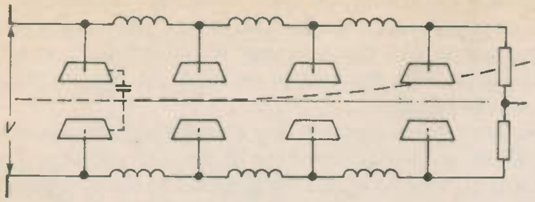


Fig. 6. Delay-line Y-deflection plates ***(courtesy Enertec Instrumentation Ltd.)***

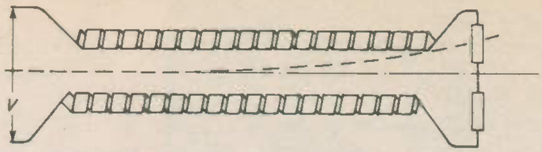
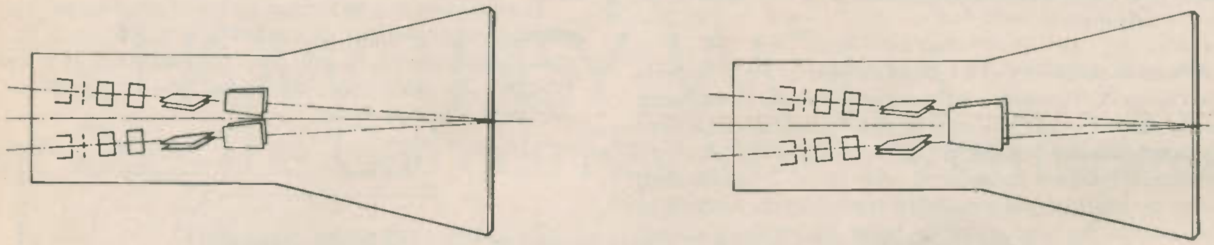


Fig. 7. Travelling-wave Y-deflection plates ***(courtesy Enertec Instrumentation Ltd.)***



(a) (b)

Fig. 8. (a) Dual-gun tube; (b) Dual-gun tube with common X- deflection plates ***(courtesy Enertec Instrumentation Ltd.)***

To improve the sensitivity by modifying the deflection system it is necessary to do one of two things:

1. Reduce the distance between the plates, increasing the capacity between them; in addition it must be possible to deflect the beam without it striking them.
2. Lengthen the plates, again increasing the capacity; however, the transit time involved limits the application of this idea.

The transit time is the time taken for an electron to pass through the deflection system: $t_0 = L$/electron speed. Suppose that a sinusoidal voltage of period t_0 is applied to the deflection plates. An electron leaving the plates will be in the same position as one entering the system, because the instantaneous value of the voltage applied to the plates will be the same (one period between the input and the output) and there will be no deflection. To enable the beam to be deflected so as to trace the outline of the applied signal, the length of the plates must be small compared with the distance the electrons travel during the period of one cycle of the signal. So for high-frequency work the plates must be short, which again reduces the sensitivity.

This problem can be circumvented by the use of sectional plates (Fig. 6). To improve the sensitivity several plates are placed in series, connected by a delay line. As the propagation velocity of the line is made equal to the speed of the electrons in the beam, the deviation accumulates successively. On the other hand the parasitic capacitance of the plates is incorporated in the delay line, which must be terminated in its characteristic impedance. The design of the line is entirely determined by its stray capacitance and the propagation time. This brings us to delay-line deflection plates (Fig. 7). Here, the dimensions of the plates have been reduced and their number increased. Two flattened helices are used, each spiral acting as a deflection plate. The helix is constructed in such a way that its propagation velocity corresponds to the speed of the electron beam. These deflection systems, together with field grids or quadripolar lenses (or both), permit the construction of very high-performance tubes.

OTHER TUBE CHARACTERISTICS

To be suitable for use at high frequencies a c.r.t. must, as already discussed, have a highly developed deflection system. But this alone is not sufficient when it is required to observe and photograph fast pulses with low repetition rates or single-shot phenomena. The brilliance of the display must also be adequate. This is why "writing speed" is an important feature in these conditions. Writing speed is defined as the maximum speed at which a spot, passing once across the tube face, can be photographed under specified conditions (camera, aperture, image/object, film sensitivity).

On the occasions when it is necessary to compare several fast, single-shot phenomena occurring simultaneously, the only solution is to use an oscilloscope equipped with a c.r.t. with several beams. There are a number of different types available:

1. Multi-gun tubes. Fig. 8a shows a c.r.t. with several cathode-ray assemblies mounted in a single tube. Fig. 8b shows a tube where each gun or triode assembly has its own vertical deflection system but shares common horizontal deflection plates. All phenomena are displayed with the same sweep speed.

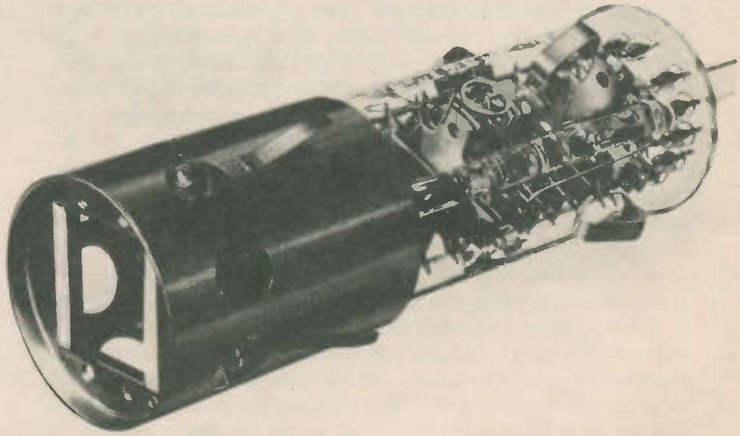


Fig. 9. Electrode assembly of Brimar mesh p.d.a. c.r.t. type D13–51GH ***(courtesy Thorn Brimar Ltd.)***

2. Multi-beam tubes. There is a single electron gun for the different deflection systems, typically two. The beam is shared between each deflection system by means of a splitter plate. This type of tube is more economical because there is a single gun assembly. However, there is reaction between the two systems, and the brilliance of the displays cannot be adjusted separately.

CONSTRUCTION

The construction of the electrode assembly of a mesh p.d.a. cathode-ray tube is shown in Fig. 9. The deflection plates are within the cylindrical shield and the mesh covers the square opening at the end. The wires of which the mesh is woven are so fine that it is invisible; this also ensures that it is transparent to the beam of electrons. Fig. 10 shows a high-performance oscilloscope c.r.t. with side connectors to the deflection plates for minimum capacitance, spiral p.d.a., internal graticule, bonded implosion guard and light guide for graticule illumination.

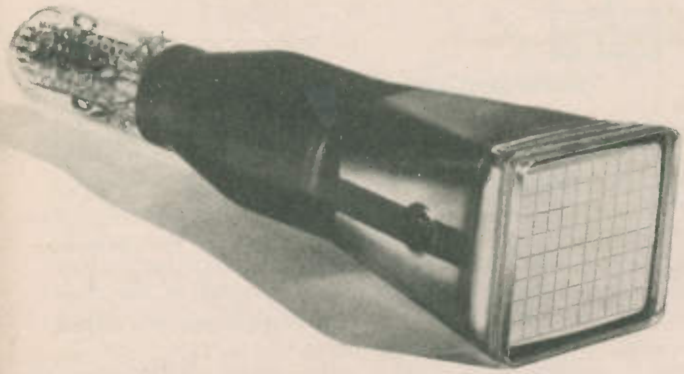


Fig. 10. Brimar spiral p.d.a. c.r.t. type D14–210GH/82 with internal graticule *(courtesy Thorn Brimar Ltd.)*

All the measures to maximise the bandwidth of a c.r.t. mentioned previously—p.d.a., delay-line deflection plates, scan expansion lenses—have been put together in the cathode-ray tube used in the Tektronix type 7104 oscilloscope. This instrument boasts a 1GHz real-time bandwidth, this limit being set by the Y amplifier rather than the c.r.t. itself. The latter could display signals up to 2·5GHz, were it possible to design suitable wideband drive circuitry. Also, notwithstanding the conflict, explained earlier, between tube design parameters for optimum bandwidth and maximum writing speed, this tube achieves the remarkable writing speed of 20,000cm/µs, using ASA 3000 film without fogging. (In fact, single-shot events at that speed can also be seen comfortably with the naked eye.) The secret is revealed in Fig. 11, which shows that in addition to the measures already mentioned, the c.r.t. incorporates a microchannel electron multiplier plate. This consists of thousands of short parallel tubes, each coated internally with a high-resistance film. Each individual tube acts as an electron multiplier by virtue of secondary emission, resulting in 10,000 electrons hitting the phosphor for each electron in the beam. Owing to the small spacing between the microchannel plate output side and the aluminised phosphor, together with the high potential difference between them, there is negligible spreading of the output of each microchannel tube, maintaining a small sharp spot size.

NEXT MONTH: the oscilloscope circuitry.

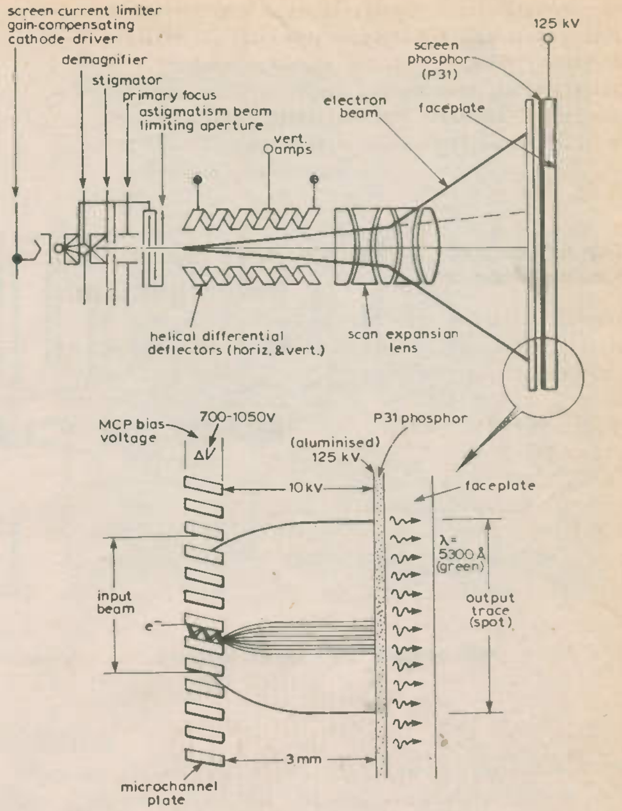


Fig. 11. Cathode-ray tube used in Tektronix oscilloscope type 7104 *(courtesy Tektronix UK Ltd.)*

PE DIGISOUNDER PART 1

BRIAN CURRIE

THE PE Digisounder is a digital depth gauge suitable for all types of small vessels. The l.c.d. read-out gives a clear unambiguous display, drawing only a small operating current. This makes it particularly suitable for sailing boats where power is often at a premium. The 'Digisounder' also includes an internally pre-settable alarm which gives an audible warning if the depth of water below the hull drops under a certain level.

Assuming sufficient interest a synthesised speech board will be featured in a future issue. This will utilise a small loudspeaker and actually call out the depth indicated on the Digisounder. This facility will be particularly useful to single-handed sailors or when sailing at night. It will fit inside the 'Digisounder' case and outputs are provided ready for it.

The 'Digisounder' can be constructed at a fraction of the cost of similar commercial equipment and will replace the 'Seafarer' type fitted in many boats, as it utilises the same ultrasonic transducer.

'DIGISOUNDER' BASICS

The principle is similar to radar in that a pulse is transmitted, and the time taken for the reflection to return is proportional to the distance the pulse has travelled. With radar the pulse is electromagnetic and travels at 300,000km per second approximately. The Digisounder uses an ultrasonic pulse of usually 150kHz, which travels approximately 1·5Km per second in water. So typically, we will expect time durations in the order of tens of milliseconds.

Conventional depth sounders usually have a rotor with an l.e.d. or neon, which flashes as the pulse is transmitted and flashes again when it is received. By this time, the rotor has moved further round the clock face scale, giving an approximate indication of depth. This system, besides being sometimes hard to read, is very wasteful of power as the rotor consumes power as it turns, and to give an apparently continuous display, the pulse must be transmitted and l.e.d. flashed several times a second.

The Digisounder only transmits one pulse of 500 microseconds duration per second and the l.c.d. display consumes negligible power, so the overall consumption from a 9V battery is around 7mA, compared with 250mA for the conventional type.

The overall operation can be seen from the block diagram, in Fig. 1.1. Although the circuit contains certain extra

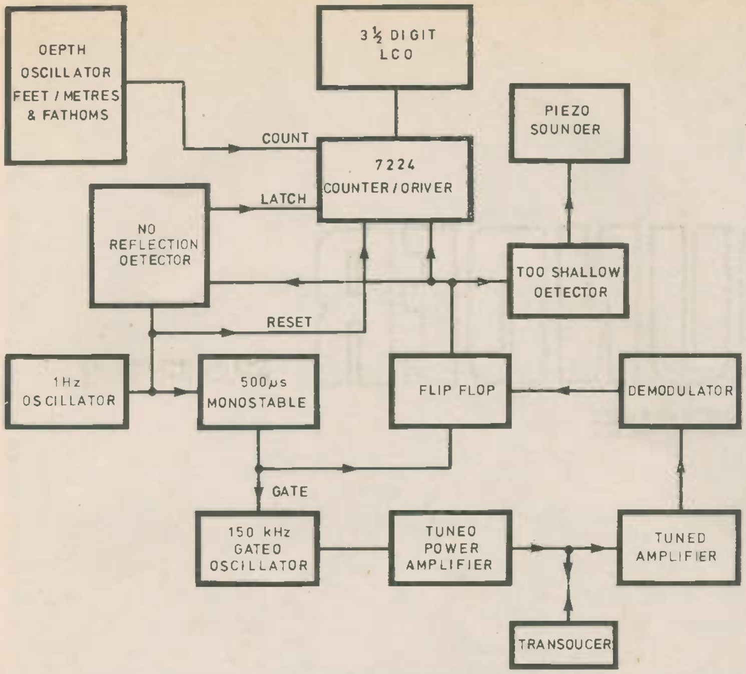
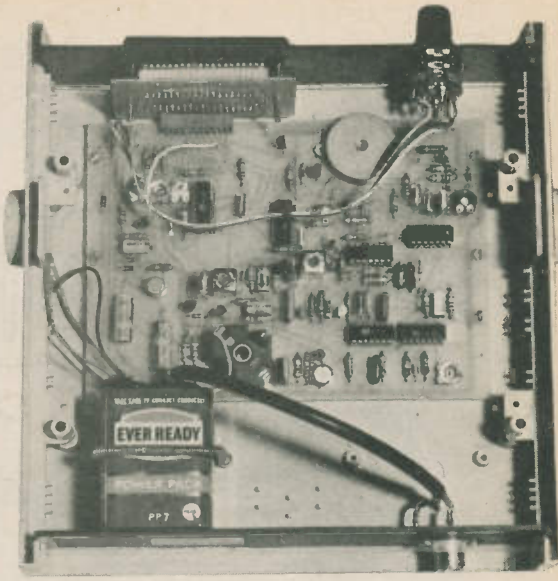


Fig. 1.1. Block diagram of the Digisounder



Internal view of the Digisounder

features, the basic operation is to pulse an electronic transducer. At the same time, a counter is reset to zero and the counter input is held open. An oscillator input is fed into the counter, which will commence to count. The counter is stopped and the resultant count displayed on receipt of the transmitted pulse. This count is dependant on the depth of water below the transducer. Varying the oscillator frequency means that the read-out can be in feet, metres or fathoms.

CIRCUIT DESCRIPTION

The complete circuit diagram of the Digisounder is shown in Fig. 1.2. The 1Hz oscillator IC1d, e, f controls the timing of the circuit. It initiates the cycle of firing the 500µs monostable IC2e, IC2f which gates the 150kHz oscillator IC1a, IC1b, IC1c, "on" (for 500µs). The tuned power amplifier TR3, TR4, TR5 amplifies this 9V pk-pk square wave to about 400V pk-pk. The waveform at this stage is approximately sinusoidal because of the tuning. When this 400V signal is applied to the transducer, the crystal turns the electrical signal into an acoustic one, which travels down to the seabed where it is reflected. On returning to the transducer, it is converted back to an electrical signal (typically tens of microvolts).

The tuned amplifier TR8, TR10 has a time dependant automatic gain control TR6, TR7. The 1Hz oscillator turns the gain down during transmission and raises it again over the following 30 milliseconds. As the transducer is fired, a positive going pulse appears at the output of IC3b, switching on TR7, discharging C9. Which then charges exponentially through R15, R16 and this changing level is fed via emitter follower TR6 to supply the first tuned stage of the receiver, TR9. The purpose of this is to reduce the risk of a false reflection from air bubbles or debris, which if they are near the transducer can cause large receiver signals and hence an incorrect depth reading. As the gain of the tuned amplifier is very high, it is susceptible to all sorts of interference, hence the need to turn the 150kHz oscillator off by D2 when it is not driving the transducer (if it were not turned off, some small amount of 150kHz might get through and saturate the amplifier).

COUNTER

The heart of the unit is the main counter, which receives pulses from the oscillator. The gate of the counter is held open from the moment the transmitter is fired until the returned pulse 'disables' the counter, and operates the latch, updating the display. The time the gate is held open is proportional to depth of water and the frequency of pulses fed in during this time determines the ultimate displayed figure. Therefore, by feeding in different frequencies, the counter will display feet, metres or fathoms. As an example, the 'feet' oscillator is exactly six times the frequency of the 'fathoms' input. This automatically converts the reading into fathoms.

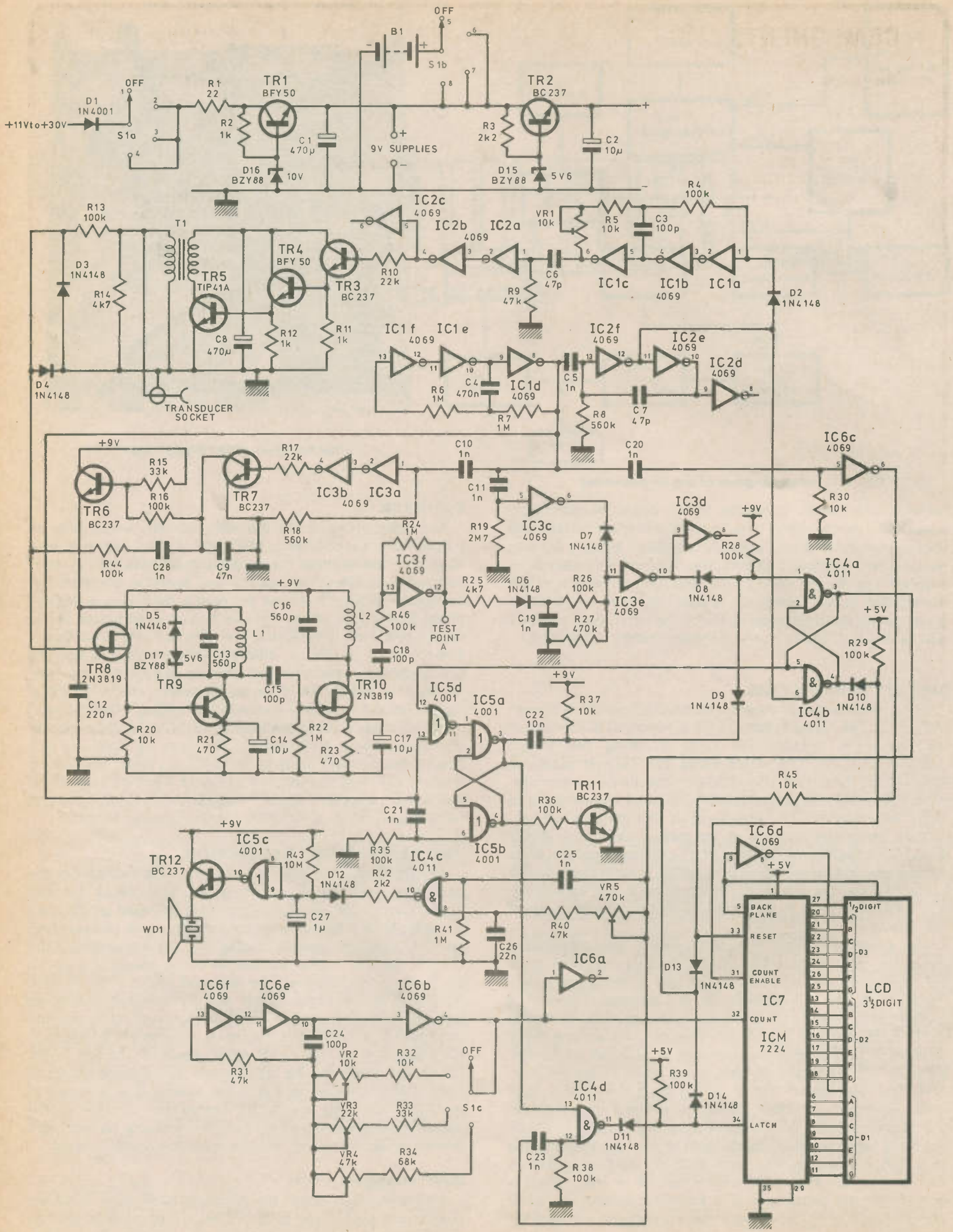
The counter used is the Intersil 7224, a 4½ digit counter that will drive an l.c.d. directly. Although 3½ digits are sufficient, this i.c. was chosen as being the most convenient method of implementing the required function. It features low power operation, direct 7-segment l.c.d. drive, latch and reset inputs and a count inhibit (enable/disable) control.

"NO REFLECTION" DEFLECTION

The flip-flop IC4a, IC4b is set by the 1Hz oscillator at the beginning of the transmit pulse and reset by the demodulator IC3e when a reflection is detected (so the output is high for a time proportional to the depth of the water, and this signal is used to 'enable' the 7224 counter). If the bottom has soft mud or substantial weed growth, it is possible that no reflection will be detected. IC5a, IC5b another flip-flop is set on transmission, and stays in this position as long as reflections are received. If, however, after approximately 0·5 seconds, no reflection is received, IC5d resets it. IC5a output goes low, which resets the main flip-flop (IC4a, IC4b) and prevents the latch pulse being transmitted by IC4d. TR11 turns on, and pulls the reset and latch inputs of the 7224 low. This makes the display show a zero reading indicating that no reflection has been received. As soon as a correct reflection arrives, normal operation recommences.

DEPTH OSCILLATOR

By varying the rate of the oscillator IC6b, IC6e, IC6f applied to the count input of the 7224, it is possible to arrange the display to show the depth in any desired unit — feet,



+11V to +30V
D1 1N4001
S1a
OFF
R1 22
R2 1k
TR1 BFY50
D16 BZY88 10V
C1 470µ
B1
S1b
9V SUPPLIES
TR2 BC237
R3 2k2
D15 BZY88 5V6
C2 10µ
R13 100k
T1
D3 1N4148
R14 4k7
TR5 TIP41A
C8 470µ
TR4 BFY50
R12 1k
TR3 BC237
R11 1k
R10 22k
IC2c 4069
IC2b 4069
IC2a
C6 47p
R9 47k
VR1 10k
R5 10k
C3 100p
R4 100k
IC1c
IC1b 4069
IC1a
D2 1N4148
D4 1N4148
TRANSDUCER SOCKET
IC1f 4069
IC1e
R6 1M
C4 470n
IC1d 4069
R7 1M
C5 1n
IC2f 4069
IC2e 4069
IC2d 4069
C7 47p
R8 560k
+9V
TR6 BC237
R15 33k
R16 100k
TR7 BC237
R17 22k
IC3b 4069
IC3a
R18 560k
R44 100k
C28 1n
C9 47n
C10 1n
C11 1n
R19 2M7
IC3c 4069
C20 1n
IC6c 4069
R30 10k
D7 1N4148
IC3d 4069
R28 100k
R24 1M
IC3f 4069
R46 100k
TEST POINT A
R25 4k7
D6 1N4148
C19 1n
R26 100k
R27 470k
IC3e 4069
D8 1N4148
IC4a 4011
+5V
R29 100k
IC4b 4011
D10 1N4148
D9 1N4148
D5 1N4148
D17 BZY88 5V6
C13 560p
L1
C16 560p
L2
C18 100p
TR8 2N3819
C12 220n
TR9
C15 100p
TR10 2N3819
R20 10k
R21 470
C14 10µ
R22 1M
R23 470
C17 10µ
IC5d 4001
IC5a 4001
C22 10n
R37 10k
C21 1n
IC5b 4001
R35 100k
TR11 BC237
R36 100k
R45 10k
IC6d 4069
TR12 BC237
IC5c 4001
R43 10M
WD1
C27 1µ
D12 1N4148
R42 2k2
IC4c 4011
C25 1n
VR5 470k
R41 1M
C26 22n
R40 47k
IC6a
IC6f 4069
IC6e 4069
IC6b 4069
C24 100p
R31 47k
VR2 10k
R32 10k
VR3 22k
R33 33k
VR4 47k
R34 68k
S1c
D13 1N4148
+5V
R39 100k
D14 1N4148
IC4d 4011
D11 1N4148
C23 1n
R38 100k
BACK PLANE
RESET
COUNT ENABLE
IC7
COUNT
ICM 7224
LATCH
LCD 3½ DIGIT
½DIGIT
D3
D2
D1

COMPONENTS . . .

Resistors

R1	22
R2, R11, R12	1k (3 off)
R3, R42	2k2 (2 off)
R4, R13, R16, R26, R28, R29, R35, R36, R38, R39, R44, R46	100k (12 off)
R5, R20, R30, R32, R37, R45	10k (6 off)
R6, R7, R22, R24, R41	1M (5 off)
R8, R18	560k (2 off)
R9, R31, R40	47k (3 off)
R10, R17	22k (2 off)
R14, R25	4k7 (2 off)
R15, R33	33k (2 off)
R19	2M7
R21, R23	470 (2 off)
R27	470k
R34	68k
R43	10M

All resistors $\frac{1}{2}$W 5% carbon

Potentiometers

VR1, VR2	10k per min. (2 off)
VR3	22k per min.
VR4	47k per min.
VR5	470k per min.

Capacitors

C1, C8	470μ 16V (2 off)
C2, C14, C17	10μ 16V (3 off)
C3, C15, C18, C24	100p (4 off)
C4	470n
C5, C10, C11, C19, C20, C21, C23, C25, C28	1n (9 off)
C6, C7	47p (2 off)
C9	47n
C12	220n
C13, C16	560p (2 off)
C22	10n
C26	22n
C27	1μ

Semiconductors

D1	IN4001
D2–D14	1N4148 (13 off)
D16	BZY88 10V Zener
D15, D17	BZY88 5V6 Zener (3 off)
TR1, TR4	BFY50 (2 off)
TR2, TR3, TR6, TR7, TR9, TR11, TR12	BC237 (7 off)
TR5	TIP41A
TR8, TR10	2N3819 (2 off)
IC1, IC2, IC3, IC6	4069 (4 off)
IC4	4011
IC5	4001
IC7	ICM7224

Miscellanous

3 pole 4 way switch
$3\frac{1}{2}$ digit l.c.d.
PP7 battery and connector
15 way p.c.b. plug and socket
Case Pac Tec 60119-1
UHF socket
Rm10 (AL250) pot core kit (RS228–242)
YXNS 30450NK 2mH choke (2 off)
22 s.w.g. enamelled wire
36 s.w.g. enamelled wire
Ultrasonic transducer
Soldercon pins
WD1 Piezo-Electric Sounder

Constructor's Note

A complete set of parts for the Digisounder is available from **Lascar Electronics, Unit 1, Thomasin Road, Basildon, Essex (0268 727383).** Price £69·80 (transducer extra)

metres, fathoms, inches etc. For the purpose of this design, the first three are used.

Those who know the ICM 7224 will, no doubt, realise that it is a $4\frac{1}{2}$ digit counter, but here it is only being used to drive a $3\frac{1}{2}$ digit display. This is because there is little point in measuring to an accuracy of 0·01 feet ($\frac{1}{8}$th of an inch) when the boat will be moving up and down substantially more than that, due to the movement of the water. A $3\frac{1}{2}$ digit display is easier and cheaper to obtain with larger digits for the same glass size.

"TOO SHALLOW" DETECTOR

As the current consumption is so low, there is no reason why the instrument should not be left on all the time, in which case the shallow water detector IC4c comes into its' own. If there are three consecutive readings below a preset level (adjustable by altering resistor VR5 on the p.c.b.) an alarm sounds, so you can sleep in confidence that if the tide goes out, you will be woken up before it is too late! Three consecutive readings are required, as you might get an occasional low reading from a fish or piece of debris near the transducer. The output from IC4a is taken low when the transmitter fires and stays low until the flip-flop is reset by the returning signal. When the output first goes low, C26 discharges at a rate set by VR5. If the main flip-flop is reset before the voltage on C26 is below the CMOS threshold (approximately 4·5V) due to shallow water, then a negative going pulse on the output of IC4c partially discharges C27. This is normally being charged via R43. However, the circuit is arranged so that three consecutive 'low level' readings discharge C24 to the point where IC5c switches on TR12, activating the alarm. VR5 allows setting of any depth between 2–3 feet and 25 feet.

If the depth sounder is to be used on a boat with an engine, it is imperative that the engine is properly suppressed, otherwise it will produce interference, giving random depth indications.

POWER SUPPLY

The instrument operates from a 9V supply, from which is derived a 5V supply for the logic circuitry. The 9V supply can be from the internal PP7 battery, or external in the range 12V to 30V. The external input is regulated down to approximately 9V by D16, TR1. D15 and TR2 regulate the 9V input down to 5V. Diode D1 protects against reverse polarity connection of external supply.

The instrument can be powered from either a supply in the range 12V to 30V or an internal 9V battery, but not both at the same time, because the 9V battery may leak corrosive chemicals as a result of having charge pushed into it. If external supply is used, the internal 9V battery should be removed.

NEXT MONTH: Construction, Testing and Installation

FRANK W. HYDE

THE NEXT DECADE

The Calendar for the next decade is a very full one. It is hoped that it will begin with the first trials of the Space Shuttle, Columbia. This issue of *Spacewatch* should be in your hands for the date set for the launch, which is the 17th of March 1981.

At the present time of writing Columbia is set up on its launch platform at the Kennedy Space Centre in Florida. The vehicle was powered up from the ground using ground based power. Engineers have since January 5th been making the final inspections and the exhaustive check of the systems.

On January 6th the prime team of astronauts, John Young and Robert Crippen together with the back-up crew practised the escape routines. The back-up team are Joe Engel and Richard Truly. There are complete safeguards for the crew from the moment of count-down. A quick exit is possible during the final hours of count-down if an emergency should arise.

The first orbital flight will last for 54 hours. During this flight the crew will test all the systems including the opening and the closing of the 59 feet long doors which cover the payload bay (where the spacecraft to be launched will be carried) and the space which is provided for other instruments.

The Shuttle with its boosters will be launched vertically and will later re-enter the atmosphere to glide in an un-powered condition to the NASA Dryden Flight Research centre in Edwards, California. If an emergency should arise the crew can also land in Florida or at the White Sands Missile Base near Las Cruces, Mexico.

PROSPECTS FOR THE NEXT DECADE

August 1981 will see the encounter with Saturn by Voyager 2. Plans are already being finalised for this event. The success or otherwise is dependent on the state of the vehicle when it arrives in the area of Saturn, before going on to Uranus.

The Soviet Union have a planetary programme which will involve four Venus probes. Venera Nos. 13 and 14 will be launched in November this year with an encounter date in the spring of 1982. Two more Venera craft nos. 15 and 16 will be launched around June or July 1985.

The missions will be "landers" and will very likely be similar to the Viking landers used by NASA on Mars. The two vehicles 13 and 14 will land March/April 1982 to examine the surface of Venus and, no doubt will be making the details of the project available. The 1984 mission will be a joint mission with France. Venera 15 and 16 will carry two balloons and two landers. These balloons at present being developed will carry instruments for the study of the Venusian atmosphere at a height of 56 km over a period of about six days. The landers will be carrying out observations from the surface at the same time. It is not known at present whether the vehicles themselves will orbit or flyby, but one will leave for an encounter with Halley's comet. This will be in 1986. This vehicle will be equipped with a specially developed camera supplied by the French.

The European Space Agency is preparing the Exosat which will be an additional satellite to cover the X-ray spectrum. At the moment this is the province of the Einstein satellite of NASA. An additional booster will be added to the Ariane launcher in order to get the required power to lift the Exosat to its eccentric orbit, taking it some 200,000km above the North Pole. The vehicle is equipped to study the position, structure and spectra of the sources emitting X-rays in the energy range up to 1·5keV. This satellite will operate as an observatory so that the groups of observers can share the time. The date set for the launch is November 1981.

A joint European/United States venture for the launching of an astronomical Satellite in August 1982 will go ahead, but at a higher cost due to certain technical problems. Its task is to study the infra-red wavelengths, which cannot be done satisfactorily from ground based telescopes, because of the carbon dioxide and water in the Earth's atmosphere. This satellite is the IRAS.

Another joint NASA/ESA venture will be the Space Telescope. This is due to be launched by the Space Shuttle in December 1983. The exact date of launch will of course depend on the progress and time table of the Shuttle programme. The telescope will have a primary mirror of 2·4m diameter, and will carry a number of instruments for the task to be undertaken. The benefit of this telescope will be that it will be some 500km above the atmosphere and will in consequence produce results of the order of 10 times greater than the largest of the earth based instruments.

In 1984, during March, the Galileo probe is due to be launched. This vehicle has also had a number of difficulties due to the financial troubles that have beset NASA. The plan is to send a probe deep into the atmosphere of Jupiter and an orbiter to go round the planet. The orbiter would be sent ahead of the probe and will circle the the planet for 20 months make close observations of the conditions of the atmosphere. The probe will study the atmosphere down to a level where the pressure is more than 10 times that of the Earth. Both vehicles will encounter the planet in July 1987.

Still another joint mission is the International Solar Polar Mission. The object of this mission is to explore that part of the solar system away from the ecliptic. It will be the first time that any spacecraft explore that part of the solar system about which we know nothing. The orbit will be over the poles of the Sun. Two spacecraft will be despatched toward Jupiter and "flicked" round in the planet's gravitational field toward the Sun. They will be launched in such a way that they pass over each of the solar poles, that is, they will travel in opposite directions.

Their task is to study the high energy particles of the solar wind and study the solar magnetic field. This is a most important mission to which the European space agency has already allocated £30 million.

In 1986 the Venus Orbiting Imaging Radar mission will be launched from the Space Shuttle. The object, as its name implies, will be to obtain radar pictures of the surface of Venus. The system of imaging that has been successfully developed will enable distances down to 150m to be resolved through the thick cloud cover. This vehicle will be dispatched in May or August depending on which trajectory is chosen. It will arrive at Venus in December of the same year.

Another special mission is that of Giotto. This is to be launched by an Ariane vehicle in July 1985 on a trajectory to intercept Halley's comet in March 1986. Attempts will be made to obtain imaging of the nucleus and measure the gas and dust of the coma. There is a great deal at stake in this mission, for an accurate knowledge of the composition of comets is very necessary to qualify present theories of cosmology.

The United States will carry out a plan to extend Gamma-Ray astronomy. The observatory will be launched in August 1985. The Shuttle will also be the vehicle for this mission. The observatory will examine, from an orbit 400–500km above the Earth, the very short wavelengths below 10^{-13}m. It is hoped that these observations will help to provide clues as to the nature of Pulsars, Quasars and Supernova.

To make a new map of the sky a special satellite, Hipparcos, is to be launched in 1986/1987. This was put back in favour of Giotto to ensure that at least one spacecraft was able to rendezvous with Halley's comet. Hipparcos' mission is an extremely important one for the same reasons that Giotto was important: further accurate knowledge of the universe.

Hipparcos will measure the positions and motions of 100,000 stars with an accuracy that is not possible from Earth. The measurements will also provide better evidence of the quasars and sources near the edge of the observable universe.

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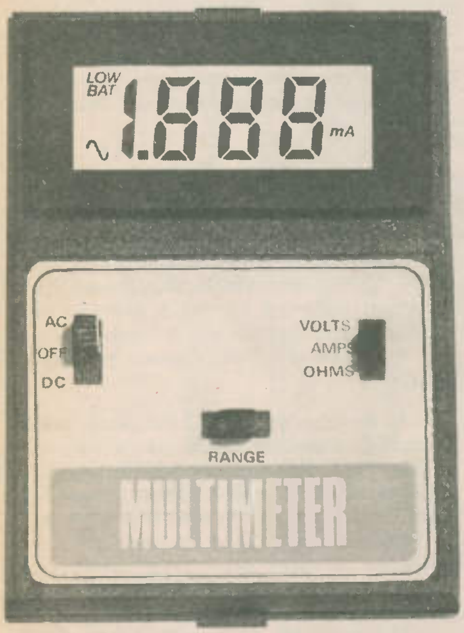

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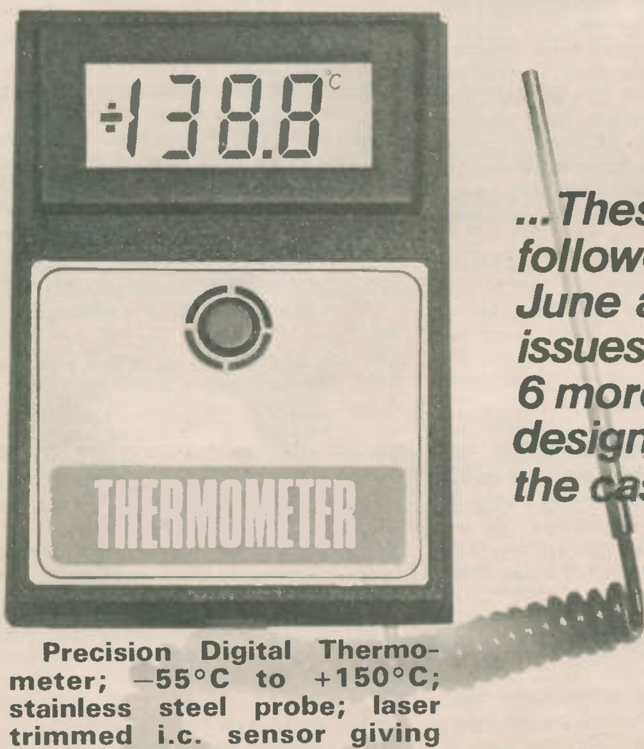

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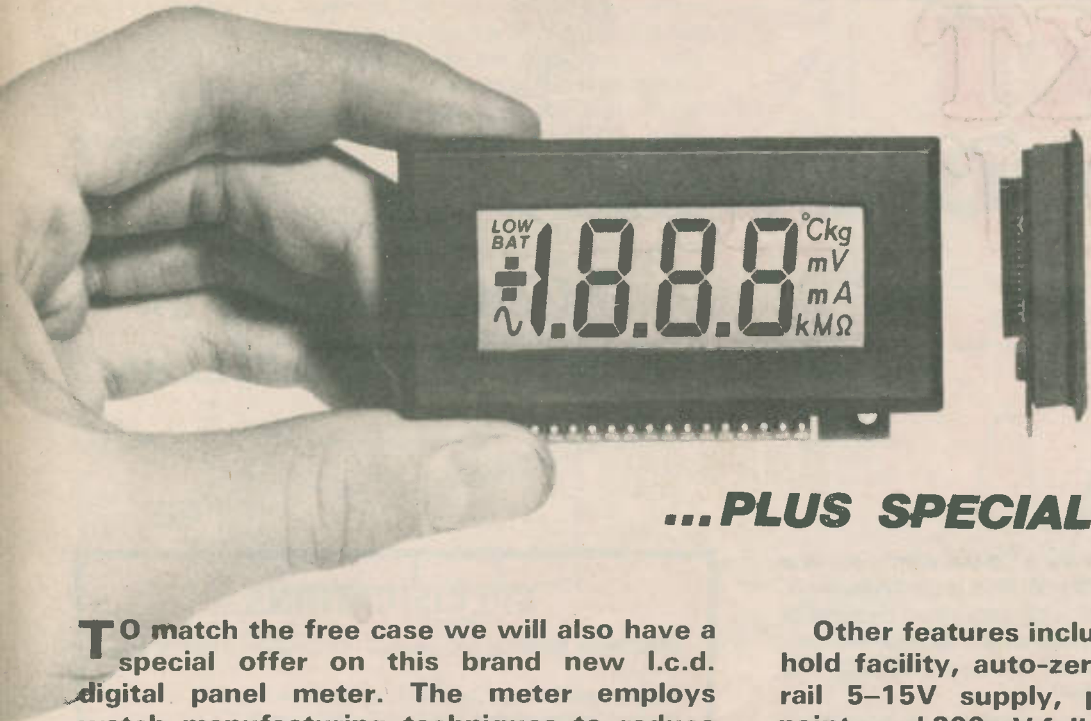

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PRACTICAL
ELECTRONICS
MAY ISSUE ON SALE FRIDAY 10 APRIL 1981

Simple Speech Processor

Michael Tooley B.A.
David Whitfield B.A.M.Sc.

A SPEECH processor is essentially a device which improves the intelligibility of a voice signal. This is particularly important where the wanted signal is contaminated by noise or where the signal varies over a wide range. Several different types of processor are possible and these vary considerably in complexity and effectiveness.

The unit to be described not only provides an increase in signal level but also reduces the dynamic range of the signal. It is therefore eminently suited to applications where a consistently high level of output is required from a signal which varies in amplitude. The unit employs an active limiter and therefore avoids some of the time constant problems associated with dynamic speech compressors. Active filter techniques further enhance the output signal by reducing noise and harmonic distortion.

The circuit uses only one integrated circuit, a FET input quad operational amplifier, and may be readily inserted in the signal path of such equipment as public address amplifiers, tape recorders, transmitters and transceivers.

CHARACTERISTICS OF SPEECH

Very large variations in instantaneous signal are present in speech waveforms. This can often be an important consideration in the design of equipment for use with voice signals including public address amplifiers, transceivers etc. The 'peak factor' is defined as the ratio of peak to RMS sound pressure over a specified bandwidth. For unfiltered speech the peak values exceed the RMS values by typically some 10dB or more over a time which is equivalent to the length of an average syllable. Over a longer period of time, however, this value is greatly increased and the peak factor is typically some 20dB. Thus, if a public address amplifier is producing, for example, an average power of 1W from a given source it must be capable of a peak power of around 100W if the signal is to be reproduced faithfully.

In many applications, however, the important consideration is intelligibility rather than accuracy of reproduction. Here we are concerned not with the absolute signal power but more with the ratio of signal to noise power. This can be increased by either reducing the transmission channel bandwidth or by raising the average level of the signal whilst the noise in the transmission medium or recording system remains constant. The latter technique has the effect of reducing the dynamic range of the signal or, to put it in simple terms, making the quieter sounds louder whilst the louder sounds stay loud!

A further consideration is that, for a given system, there *is* often a maximum signal level that should not be exceeded. This is important in, for example, such applications as broadcast transmitters where overmodulation of the carrier results in a signal having an excessive bandwidth.

SPECIFICATIONS

Maximum limiting 3dB change in output for 20dB change in input
Input signal range 2mV to 2V peak-peak
Output signal range 20mV to 6V peak-peak
Minimum input signal for onset of limiting 6mV peak-peak
Input impedance 10k typical
Output impedance 150R typical
Supply 6 to 9V at 12 to 20mA

SPEECH PROCESSING TECHNIQUES

The two principal methods for restricting the dynamic range of a signal are amplitude limiting or clipping and dynamic compression. The former method has the advantage that it is simple and fast to act, but has the disadvantage that harmonic distortion is introduced by the limiting action. Dynamic compressors are relatively distortion free but are somewhat more complex. They also have considerable drawbacks associated with attack and decay time constants of the AGC system employed; the compressor may not operate quickly enough to respond to a rapid transient and, furthermore, may be slow to recover once the compression action has been started. Fig. 1a shows the general block schematic of an amplitude limiter whilst, for comparison, Fig. 1b shows the arrangement of a dynamic compressor.

The circuit described in this article uses an active limiting arrangement. As with all limiters some distortion is inevitable. This is primarily due to the generation of harmonics caused by the non-linearity of the transfer characteristic. Harmonics of the lower frequency components (say below 1kHz) of the input signal are more significant because they fall within the frequency range of the speech signal. At middle and high frequencies (say above 2kHz) the harmonics generated fall outside the speech signal frequency range and can be attenuated by means of a suitably designed filter.

The transfer characteristics for various degress of amplitude limiting are shown in Fig. 2. 'Hard-limiting' occurs very abruptly, there being no perceptible increase in the output signal amplitude beyond a certain input level. 'Soft-limiting', as its name implies, is somewhat more gentle and the slope of the transfer characteristic is made to fall progressively as the input signal amplitude increases above

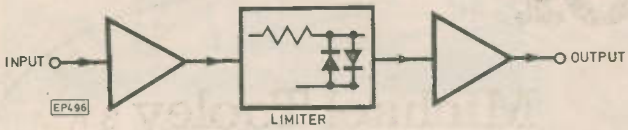


Fig. 1a Amplitude limiter block schematic

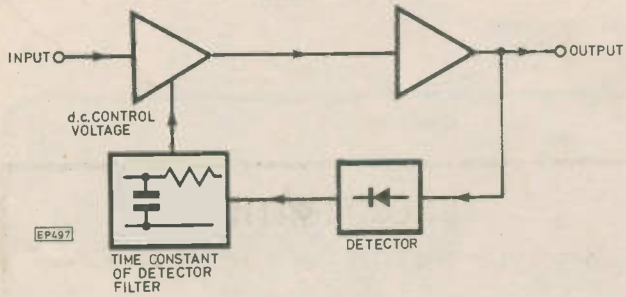


Fig. 1b Dynamic compressor block

a certain threshold level. 'Soft-limiting' offers some advantages over 'hard-limiting' as regards the generation of unwanted harmonics of the input signal. These are considerably reduced with the result that the output signal is less harsh and consequently more pleasant to listen to. Also, due to the reduction in harmonic content, less stringent requirements are imposed on the subsequent filter stage. Typical signal waveforms obtained with 'hard' and 'soft-limiting' are shown in Fig. 3.

The degree of limiting employed depends largely upon the particular application. A change in output of, say, 3dB for a change in input of 20dB may be eminently suitable for voice communications over a noisy radio channel, however, for public address and tape recording of speech signals a somewhat less severe 6dB change in output for a 12dB change in input will be more suitable. An essential requirement, therefore, of a general purpose speech processor employing amplitude limiting techniques is that the degree of limiting should be adjustable over a wide range. In practice, and since the input signal level may vary from one source to another, this means that the signal level both preceeding and following the limiter stage must be made variable. By careful adjustment a wide range of limiting can be achieved and a variety of input and output signal levels can be catered for.

The block schematic of the speech processor is shown in Fig. 4. The first stage is an amplifier with a voltage gain which is adjustable from approximately 1 to 100. The limiter stage which follows has a fixed voltage gain of 2 for small signals and this falls dramatically as the signal level increases. The active low pass filter has an upper cut-off frequency of approximately 4kHz and significantly reduces the harmonic content of the output signal from the limiter. The final stage is another amplifier, the gain of which may be adjusted over the range of 0·05 to 4·5.

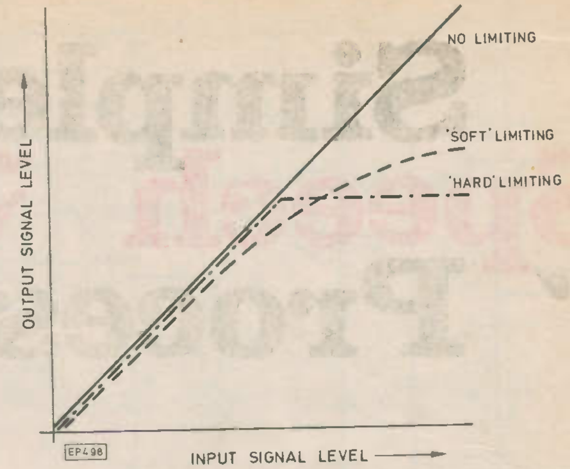


Fig. 2 Transfer characteristics for various degrees of amplitude limiting

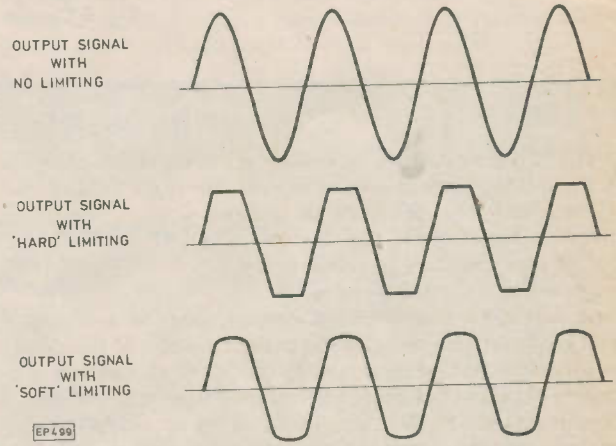


Fig. 3 Effect upon signal waveforms of the limiting characteristics depicted in Fig. 2

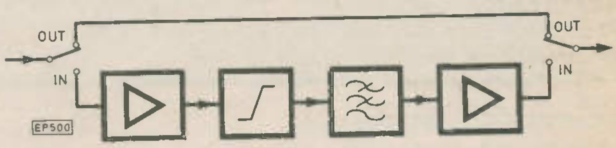
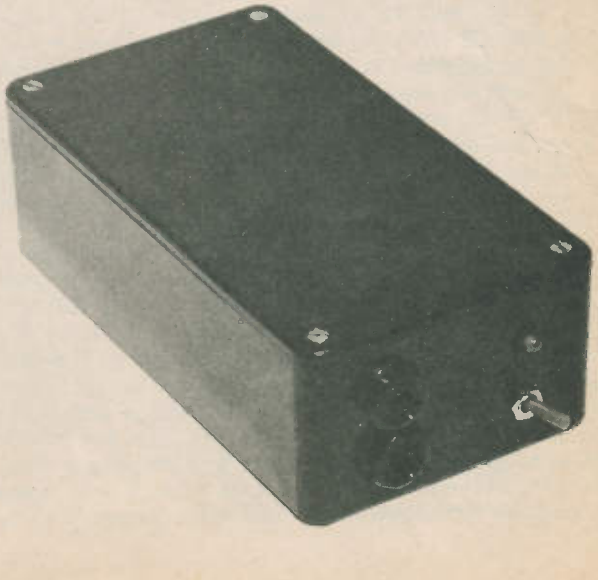


Fig. 4 Block schematic of the Speech Processor



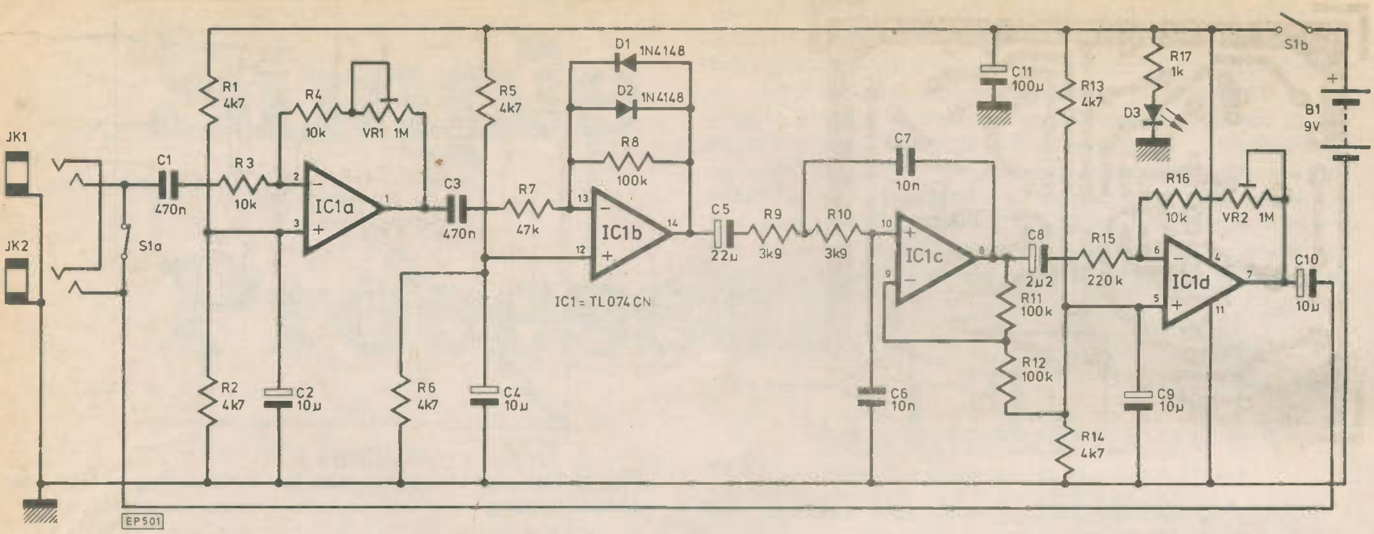


Fig. 5 Circuit of Speech Processor

COMPONENTS.

Resistors

R1	4k7
R2	4k7
R3	10k
R4	10k
R5	4k7
R6	4k7
R7	47k
R8	100k
R9	3k9
R10	3k9
R11	100k
R12	100k
R13	4k7
R14	4k7
R15	220k
R16	10k
R17	1k

All fixed resistors $\frac{1}{4}$W 5% carbon

Potentiometers

VR1	1M miniature horizontal preset
VR2	1M miniature horizontal preset

Semiconductors

IC1	TL074CN
D1	1N4148
D2	1N4148
D3	l.e.d.

Capacitors

C1	470n polyester
C2	10µ 16V tantalum
C3	470n polyester
C4	10µ 16V tantalum
C5	22µ 25V tubular
C6	10n polyester
C7	10n polyester
C8	2µ2 35V tantalum
C9	10µ 16V tantalum
C10	10µ 16V tantalum
C11	100µ 16V p.s. mounting tubular

Miscellaneous

Printed circuit board plastic case measuring approx. 150 × 80 × 50 mm DPDT miniature toggle switch, sockets (2 off) 3-pole jack or similar, battery connector—snap fit to PP3 battery, low profile 14-pin DIL socket

Components and p.c.b. available from **Howard Associates, 59, Oatlands Avenue, Weybridge, Surrey.**

CIRCUIT DESCRIPTION

IC1a operates as a conventional inverting voltage amplifier, the gain of which is controlled by the negative feedback resistor, VR1. The voltage at the non-inverting input is set by means of R1 and R2 at approximately half the supply voltage with C2 providing decoupling at signal frequencies. A similar arrangement is used for setting the non-inverting input on each subsequent stage. The active limiter is formed by IC1b, D1, D2 and associated components. Since D1 and D2 are silicon devices, a peak-peak voltage of approximately 1·2V at pin 14 of IC1 will cause D1 and D2 to conduct on alternate half-cycles and this will, in turn, provide a low impedance shunt path across the feedback component, R8.

IC1c and associated entry circuit forms a low-pass Sallen and Key filter. This is a simple, yet effective, second order filter, and cut-off frequency being determined by R9, R10 and C6, C7. The ratio of R9 to R10 and C6 to C7 being kept constant to provide fixed filter characteristics. The final stage, IC1d, is an inverting voltage amplifier, similar in configuration to IC1a. VR2 and R16 set the voltage gain of this stage, the values being chosen so that the stage can provide attenuation as well as amplification. S1a provides a direct signal path between input and output when S1b is in the 'off' position. A conventional LED and current limiting resistor is used to provide visual indication that the processor is in use.

CONSTRUCTION

The speech processor is built on a single sided p.c.b., the copper foil layout of which is shown in Fig. 6. The components are arranged on the top side of the p.c.b., as shown in Fig. 7.

It is recommended that IC1 be mounted in a low-profile 14-pin DIL socket and that, as far as possible only miniature components are used. The completed p.c.b. should be carefully checked and then mounted in a small plastic case using stand-off pillars. The layout of the input and output sockets, on/off switch and l.e.d. being entirely a matter for the individual constructor's preference. The connections to the p.c.b. together with associated wiring are shown in Fig. 8.

INITIAL TESTS AND ADJUSTMENTS

Connect a suitable battery (PP3, PP6 or similar) and check the supply current. This should be in the region of 12 to 20 mA. Set VR1 and VR2 to mid-position and connect a microphone to SK1. The output signal should then be checked using an amplifier or tape recorder connected to

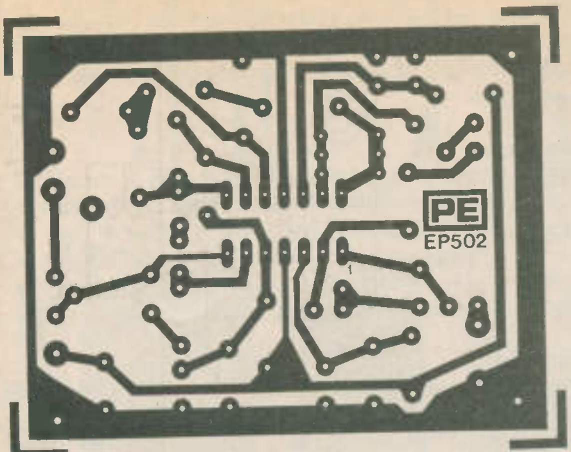


Fig. 6 Printed circuit

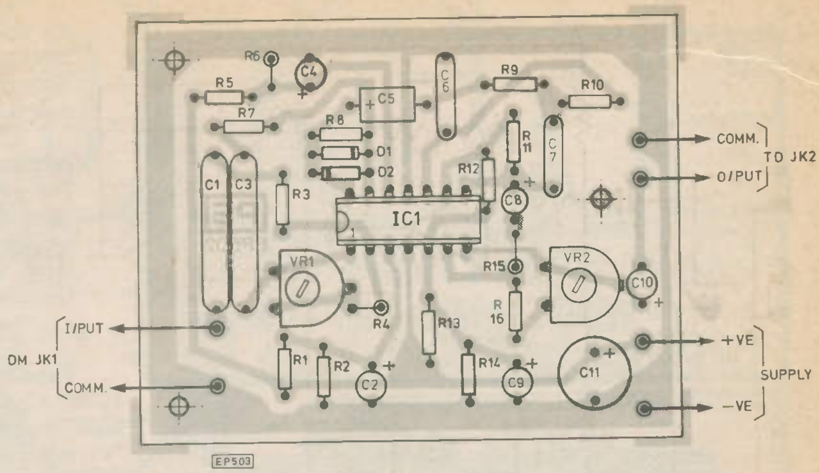


Fig. 7 Component layout

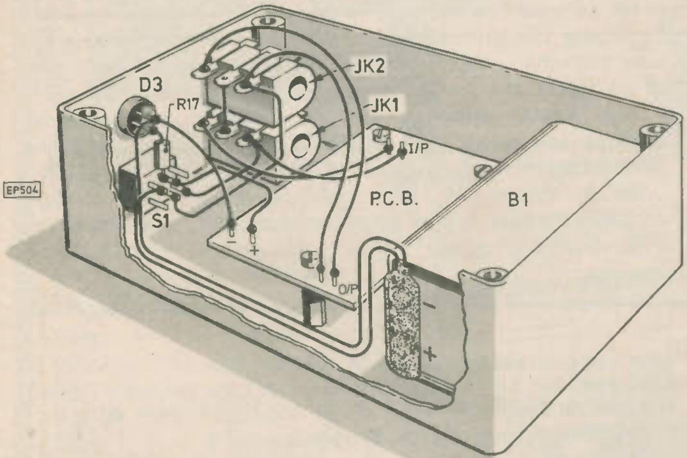


Fig. 8 Interior layout and wiring

SK2. The effect of varying the settings of VR1 and VR2 should be noted. If VR1 and VR2 fail to have any effect, or if the output signal is not obtained, the p.c.b. should again be carefully checked and, if this does not reveal any errors, d.c. voltages should be measured and reference made to the table of test voltages.

When experimenting initially with the speech processor it is recommended that VR1 and VR2 be set almost fully clockwise. This will produce similar input and output levels when using a low impedance dynamic microphone and limiting should occur when 'close-talking' into the microphone. Where an appreciable amount of gain is required, as would be the case when speaking at some distance from the microphone, the settings of both VR1 and VR2 may be increased to around mid-position.

Note that this may have the undesirable side-effect of amplifying unwanted extraneous noises to such a level that their presence is annoying. The settings of VR1 and VR2 are best determined by experiment in conjunction with the actual microphone or signal source which is to be used. It is then a fairly easy matter to determine the optimum settings for any particular application.

APPLICATIONS

Radio transmitters/transceivers

The addition of a speech processor will enhance the performance of most transmitters and transceivers. The extra "talk-power" often making the difference between a signal which is readable and one which is lost in noise. Air tests under marginal conditions show an effective 3 to 4dB increase over a signal without speech processing. The device is suitable for use with most types of transmitter and transceiver and, being merely inserted in the microphone connection, requires no internal modifications whatsoever. The processor may be switched in and out as required; a direct path from microphone to transceiver being provided in the latter case. Since processed speech tends to be somewhat less pleasant to the ear this facility is useful for restoring normal operation for local contacts; the speech processor being primarily intended for chasing DX! When used with mobile equipment the speech processor will allow

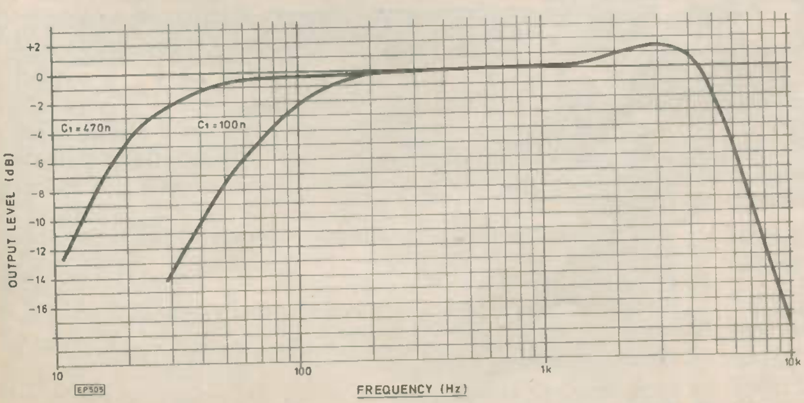


Fig. 9 Frequency response of the Speech Processor with C1 = 470n and 'rolled-off' at LF below 200Hz with C1 = 100n

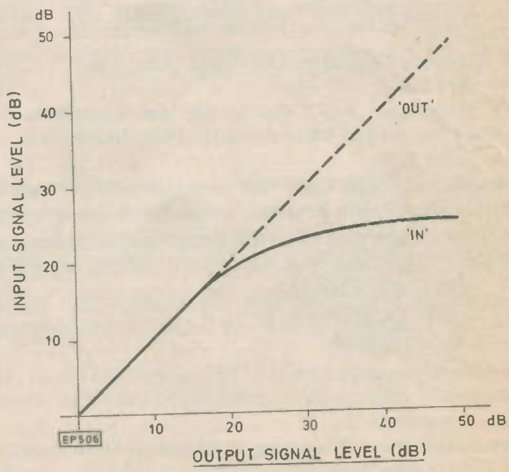
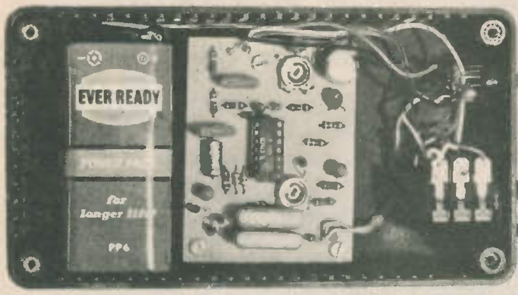


Fig. 10 Transfer characteristic

Test voltages

IC1 pin	1 4·5V	8 4·5V
	2 4·5V	9 4·5V
	3 4·5V	10 4·5V
	4 9·0V	11 0V
	5 4·5V	12 4·5V
	6 4·5V	13 4·5V
	7 4·5V	14 4·5V

All the above voltages were measured with a 10mΩ input d.c. voltmeter. The d.c. supply was 9V.



the operator to talk at some distance from the microphone thus permitting the use of a gooseneck or tie-clip microphone. This is much safer in use than the usual hand-held microphone!

Public address

The speech processor is particularly useful as a means of compensating for the variation in signal level which is often experienced when a fixed microphone (on either a floor or table stand) is employed. The processor then allows the speaker to vary his position relative to the microphone without appreciable loss of amplification.

Tape recording

The speech processor may be used to replace the AGC system used on some cassette tape recorders when recording speech. There is no annoying 'recovery time' and the processor is useful in clarifying signals contaminated by noise as would be the case when recording from short wave receivers. The unit is also suitable for dictation, freeing the user from the need to hold the microphone and allowing him or her to talk at some distance from the recording machine.

And finally, although the processor is not generally suitable for music (the distortion introduced being quite noticeable) it may prove to be of some interest to those who wish to experiment with musical effects. The speech processor makes a very effective "fuzz-box" with VR1 and VR2 suitably adjusted! ★

Countdown

BEX March 25-26. Metropole, Brighton. **K**
The Northern Electronic Test & Measurement Exhibition March 31–April 2. Wythenshawe Forum, Manchester. **T**
Laboratory April 1–2. Glasgow. **I**
BEX April 8–9. Centre Hotel, Liverpool. **K**
Laboratory April 8–9. Manchester. **I**
London Computer Fair April 14–16. North London Polytechnic **B5**
All Electronics Show April 22–24. Grosvenor House, Park Lane, London. **F1**
Computer Graphics April 28–30. The Barbican Centre, London. **O**
BEX April 29–30. Dragonara Hotel, Leeds. **K**
Entertainment May 9–17 (weekday mornings trade only). NEC, Birmingham. **B2**
The European Consumer Electronics Show May 10–13. Nuremberg, West Germany. **I**
BEX Train May 11–22. Calling at: Cambridge, Norwich, Leicester, Sheffield, Newcastle, Middlesbrough, Hull, Nottingham, Reading and Portsmouth. **K**
Defence Components Expo May 12–14. Brighton Metropole. **I**
East Suffolk Wireless Revival May 24. Sports ground of Ipswich Civil Service Sports Association, Straight Road, Ipswich. **V1**
Scotelex June 2–4, Royal Highland Exhibition Hall, Ingliston, Edinburgh. **A1**
Semlab June 2–5, Grand Hall, Olympia, London. The international scientific educational, medical and industrial laboratory equipment exhibition. (Trade). **I**
Transducer Tempcon June 9–11. Wembley Conf. Centre, London. **T**
Components (Electronics Components Industry Fair) June 9–12. Earls Court, London. **I**
International Word Processing Exhibition & Conf. June 23–26. Wembley Conf. Centre. London. **Z**
BEX—Portsmouth June 24–25. Centre Hotel. **K**
Solar Energy Exhibition Aug. 23–28, 1981. Brighton. **M**
Laboratory Sept 8–10. Grosvenor House, Park Lane, London. **I**
International Business Show Oct. 20–29. NEC. Birmingham. **A2**
BEX—Southampton Nov. 4–5. Polygon Hotel. **K**
Electronics 82 (Sub-titled International Electronics Control and Instruments Exhibition) May 24–28, 1982. NEC. **I**

I Industrial Trade Fairs. ✆ 021-705 6707
K Douglas Temple Studios, 1046 Old Christchurch Road, Bournemouth
M Montbuild. ✆ 01-486 1951
O Online Conference. ✆ 0895 39262
T Trident International Exhibitions. ✆ 0822 4671
A1 Institute of Electronics. ✆ 0706 43661
V1 Jack Tootill, Ipswich. ✆ 0473 44047
A2 Hart Browne & Curtis Ltd., 29 Sackville Street, Piccadilly, London W1X 1DR. ✆ 01-439 8556
B2 Brintex Exhibitions Ltd., 178–202 Great Portland Street, London W1N 6NH. ✆ 01-637 2400
B5 Dept. Electronic & Communication Eng., Polytechnic of N. London.

POINTS ARISING

27/28MHz CONVERTER *(March '81)*

The following coil winding details were omitted from Fig. 6:
L1 3 turns 26 s.w.g. wound over L2.
L2 15 turns 30 s.w.g. close wound.
L3 & L4 12 turns 30 s.w.g. close wound.
L5 18 turns 30 s.w.g. close wound.
In Fig. 5, D5 Anode should be connected to C21 which is non elect.

MICROBUS *(Feb '81)*

There was an error in one of the ZX80 programs. See *Readout* on page 64.

P.s.u. and controller design for mini-drills employing p.w.m. to vary the speed

mini drill P.S.U.

CHRIS LARE

NEARLY everyone who regularly produces printed circuit boards at home will own a miniature drill of some sort. These drills normally require a power supply of 14 volts, capable of giving 2–3 amps. The supply will allow the drill to give a better performance if it is regulated, since the 14 volts will be maintained when the drill is under load. Also, if the drill is to be used for other purposes than drilling (which should always be done at the fastest possible speed) a variable speed power supply/controller is desirable. The most notable time when a slower speed is required is when using a burr bit to scratch out a p.c.b. track, at full speed the burr tends to skid or bite making the job very difficult. The design presented here is for a suitable power supply and controller, employing pulse width modulation to give the variable speed capability.

PULSE WIDTH MODULATION

The easiest way to control the speed of a small d.c. motor (as are most drills) is to vary the power supply voltage. However, the torque developed by the motor falls off very quickly as the supply is reduced, making the slower speeds useless. This problem can be overcome by using a square wave drive with variable 'on' and 'off' time. (Fig. 1). When the 'on' time is a small percentage of the 'off' time the motor will obviously run more slowly since less energy is supplied, but since the motor is pulsed by a full power surge the torque remains fairly high. Obviously the speed is increased by increasing 'on' time. It is usual to keep the frequency of the system constant and vary the width of the 'on' pulse, hence the name of pulse width modulation.

THE CIRCUIT

The circuit is shown in Fig. 2. The power supply is fairly conventional, except that a great deal of decoupling is employed. This should not be omitted because the drill generates a lot of spikes which will cause faulty operation of the timing circuit. It is important that all the power supply components are rated to sufficient current.

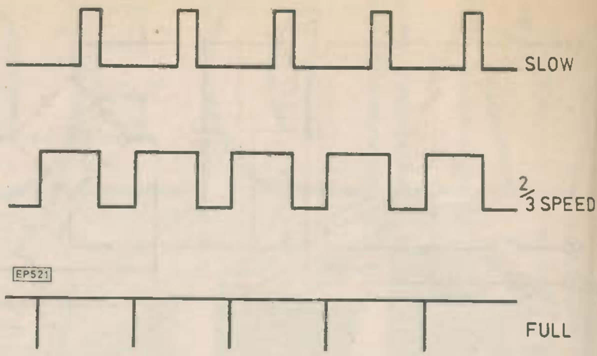


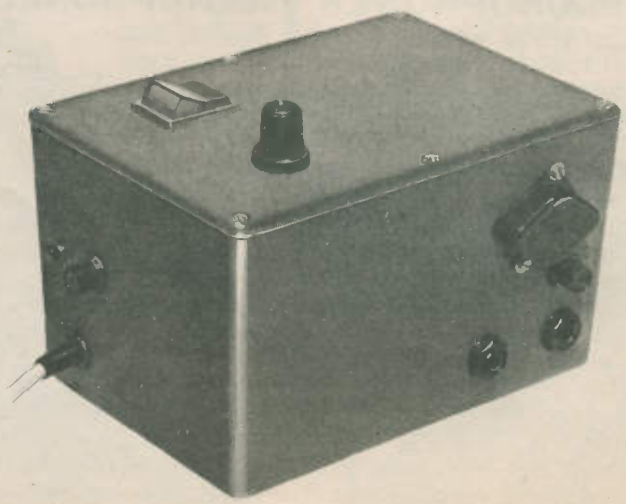
Fig. 1. Pulse width speed control

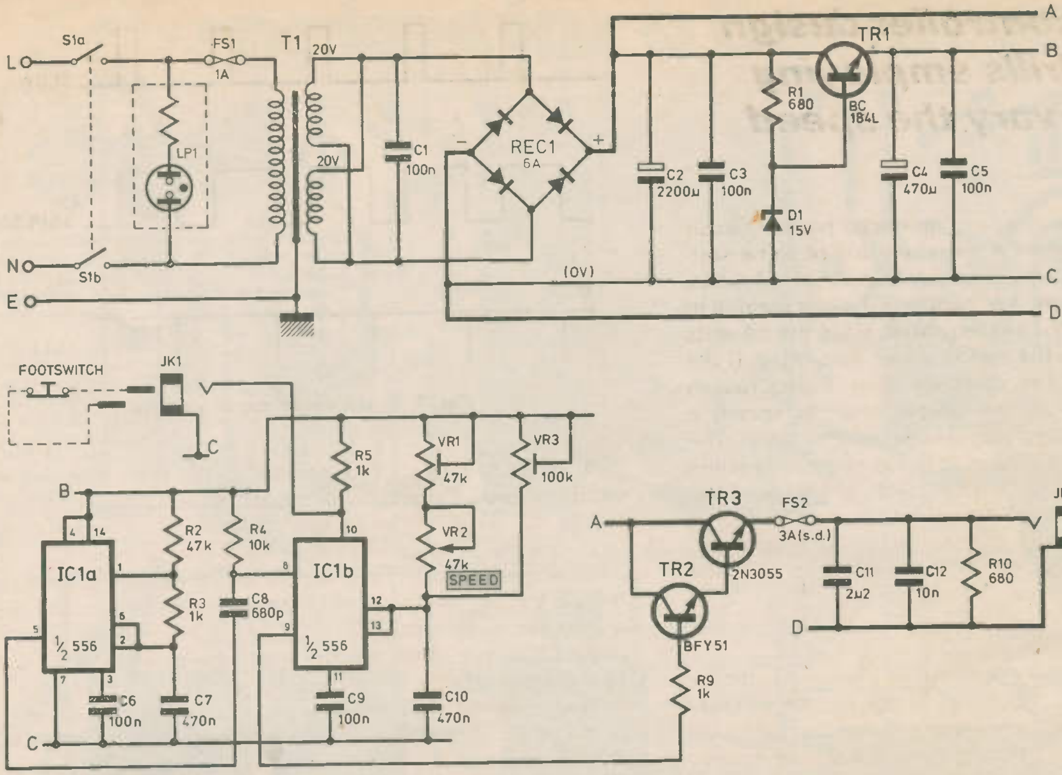
A 20 volt transformer was used in the prototype to give plenty of spare capacity. The output from this transformer is fed to C2 via a 6 amp bridge. Transistor TR1 and R1, D1 form a simple series regulator for the timing circuit. The voltage generated by this supply also determines the final output voltage and thus should be chosen to suit the drill concerned. A 15 volt Zener was used in the prototype, when reduced by three base/emitter drops the resultant 13·2 volt final drive is ideal for a 14 volt drill.

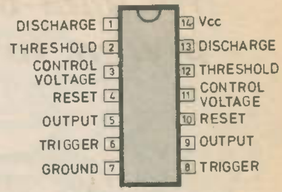
The timing is generated by two 555 timers in a double package (556). The first timer is connected as an astable, of 60Hz frequency. However, the output from this is in the form of a short pulse, this being ensured by making R2 much greater than R3. The pulse output is used to trigger the second 555, which is connected in monostable mode. C8 and R4 act as a pulse differentiater which increases the noise immunity of the circuit.

The monostable period can be varied by VR2, between short and long periods. Since the maximum period required is just less than the frequency of the first 555 VR3 is included to allow this period to be accurately set; similarly VR1 sets the shortest time available—or the slowest speed. A footswitch facility is provided by using the reset of the monostable; this simply inhibits its operation.

The output from the monostable is fed to a Darlington pair, of which the 2N3055 should be mounted on a heatsink. The output from the 2N3055 is fed directly to the drill, although considerable decoupling in the form of C11, C12 and R10 should be added.







CONNECTIONS TO 556

Fig. 2. Circuit diagram

COMPONENTS . . .

Resistors

R1, 10	680R
R2	47k
R3, 5, 9	1k
R4	10k
VR1	47k miniature preset
VR2	47k potentiometer
VR3	100k miniature preset

Capacitors

C1, 3, 5, 6, 9, 12	0·1µ Mullard C280
C2	2200µ 63 Volt electrolytic
C4	470µ 25 Volt electrolytic
C7, 10	0·47µ Mullard C280
C8	680p polystyrene
C11	2·2µ Mullard C280
C12	0·01 disc ceramic 750V

Semiconductors

D1	15V 400mW Zener
TR1	BC184L
TR2	BFY51
TR3	2N3055
IC1	556

Miscellaneous

REC1–6A bridge; T1–20V transformer 2·4A; double pole single throw illuminated switch; 1A fuse & holder; 3A fuse & holder (optional); 2 mono jack sockets; plugs; die cast aluminium box; p.c.b.; footswitch (Watford PB12); insulation kit for 2N3055; cover for 2N3055; nuts, bolts etc.; sticky feet; mains supply neon (optional).

CONSTRUCTION

The physical construction is not critical, but the wiring diagram should be closely adhered to so as to avoid noise problems.

The prototype circuit was built on a printed circuit board, produced with an etch-resist pen. Veroboard is not recommended due to the possible noise problems. The circuit board, together with the other parts was housed on a large die-cast aluminium box, chosen for its good heatsink properties. The 2N3055 transistor was mounted on the box part and fitted with a cover to prevent accidents with wandering screwdrivers. A double pole illuminated switch for the mains supply and the speed control were mounted on the lid of the box.

Standard quarter inch jack sockets were used to connect the drill and footswitch. Note that the footswitch should have closed contacts when released. Most footswitches are connected the other way round, but the one used in the prototype had a standard changeover micro switch inside,

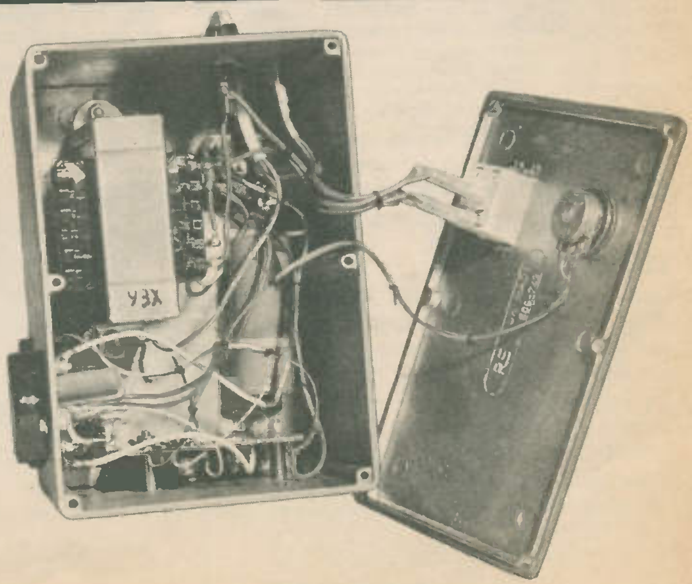
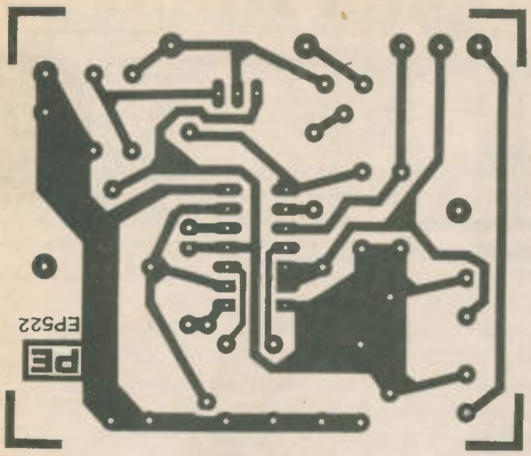
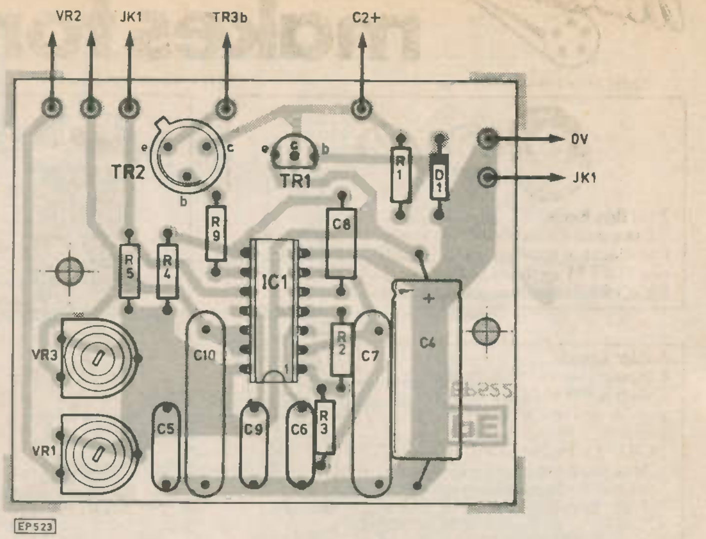


Fig. 3. P.c.b. and assembly details





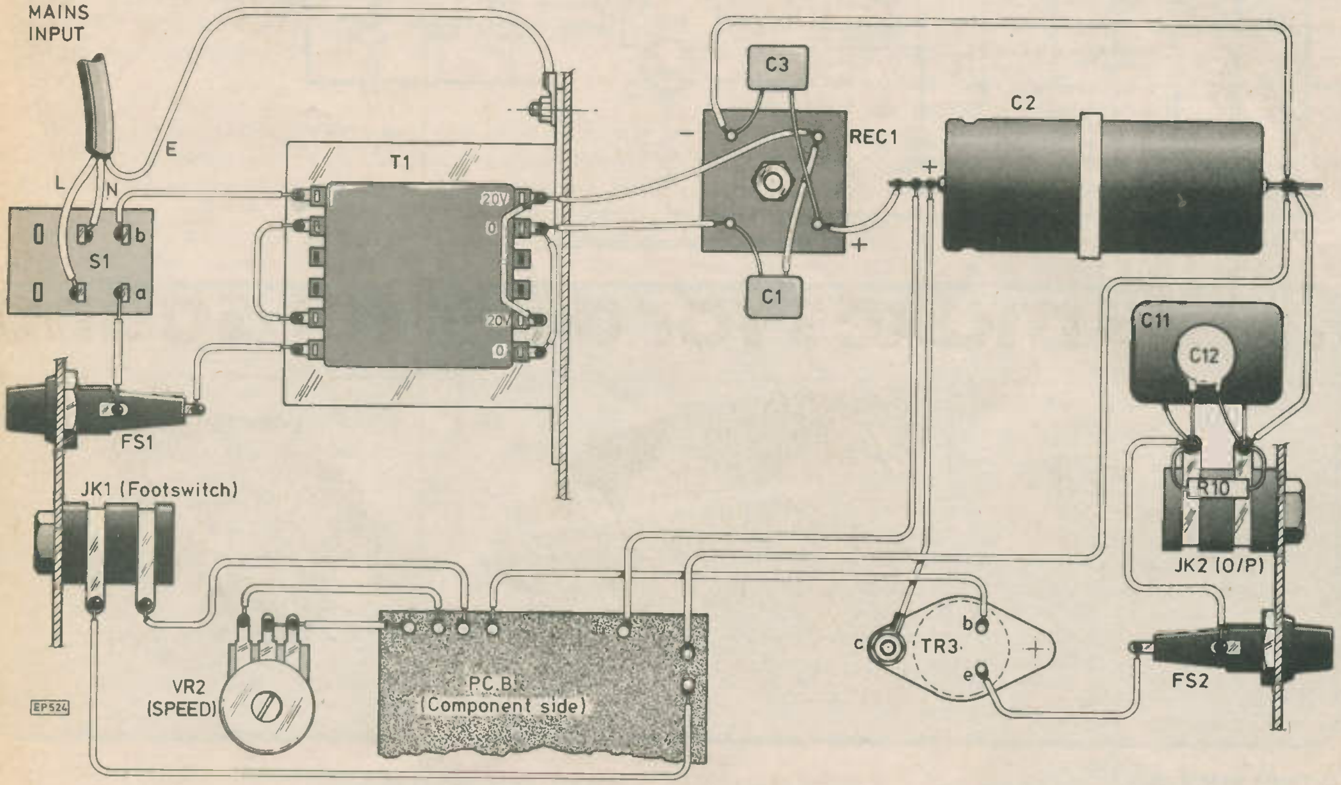


Fig. 4. Interwiring detail

and it was a simple matter to alter the connections. The main capacitor and bridge were mounted on the bottom of the box, and the output decoupling components were mounted directly on the output jack socket.

Four stick on plastic feet completed the unit.

TESTING

If an alternative current limited supply is available it is a good idea to test the board with that, since a major failure will almost certainly destroy TR1 and probably D1 as well. Set the supply for about 17 volts. After re-checking the wiring switch on. Check the regulator works. Check that a pulse output is present on pin 5, and also on pin 9. Set both presets to half travel and connect a drill up and it should run. Increase the speed control to full, and the drill should speed up. If it starts to run roughly, and slows down, do not worry—it is simply the monostable over running. Adjust VR3 with the speed control at maximum until the motor runs at its fastest. Turn the speed control to minimum and adjust VR1 until a suitable speed is obtained, then re-adjust VR3 with the speed control at maximum.

IN USE

All drilling should be performed with the speed control at maximum. Slow drilling will wear the drill bits out more quickly, as well as taking longer. For other uses, burring, polishing, etc. the best advice is trial and error, but around half speed seems to be the best.

The footswitch is a definite improvement. It is particularly useful if the drill stalls because the drive can be released quickly, and when drilling over a centre point because the drill can be positioned and then started. ★

Semiconductor UPDATE...

FEATURING ICM 7242 L290, 1 & 2 4118, 4801 & 4802 R. W. Coles

DIGITAL 555

Probably the most universally useful and successful integrated circuit ever made is the ubiquitous 555 timer. You find them in the most unlikely places, often doing unlikely jobs which the manufacturers never dreamed of when they introduced the design back in the early 'seventies. First came useful dual and quad versions in 14 and 16 pin packages, and more recently came the CMOS versions, all helping to expand the area of application, but never really eclipsing the original design with its cheap, simple and robust reputation. All of the "improved" 555 devices have been covered in this column over the years, and this month I am able to report on yet another device intended to replace 555s in certain timing applications.

One area where all previous 555 circuits have run out of steam has been in the construction of simple timers capable of long delay periods of seconds or even minutes duration. The trouble is that the 555 relies on a single CR period to set time duration, and this means going to large electrolytic capacitors when long time-outs are needed. The use of electrolytic capacitors brings the usual bogies of poor tolerance, high leakage, and temperature sensitivity, and for critical applications the solution has been to run the 555 as a higher frequency astable and follow it with a multi stage binary counter such as the CMOS 4040.

To make the job of constructing long duration timers and low frequency oscillators easier, Intersil have introduced the ICM 7242 which puts the oscillator and the counter all in one 555-like 8 pin package. A single external resistor and capacitor set the basic oscillator frequency, and the oscillator output is fed to the internal 8 stage binary divider chain whose final stage therefore gives an output frequency 1/256th that of the oscillator. Also in the package is a control flip-flop which is set by a TRIGGER input, and starts the count sequence, and reset by a RESET input which stops the count and zeroes the counter chain. With the RESET line disconnected the 7242 can be used as an LF oscillator, with the RESET line connected to the final count stage output the 7242 works like a monostable or timer.

For additional flexibility the basic RC oscillator output is brought out, as is the first stage of the count chain which gives a symmetrical square wave at half the oscillator frequency. This is a very useful device for those occasional long time/low frequency applications, but it won't replace the 555, take my word for it!

ROBOT MUSCLE

Robots, like people, need muscles to enable them to move their "arms". Animal muscles can be precisely controlled, are efficient, and are very complex. The poor old robot, on the other hand, has to rely on electric motors, gears, and drive belts, not to mention feedback pots, servo amplifiers, and power supplies.

Really useful muscle analogues seem as far away as ever, but perhaps a new chip set from SGS-ATES can at least help to streamline existing d.c. servomotor "muscle" technology to make it more efficient and compact. With the addition of a d.c. motor and an optical position encoder, and under the control of a microprocessor, the L290, L291 and L292 trio make up a compact and powerful servo system for position control in robots or any other industrial machine. The L290 comes in a 16 pin plastic d.i.p. and contains the circuitry to interface the optical position encoder to the microprocessor by means of derived position and velocity signals. This chip also provides a compensated reference for the L291, which accepts parallel binary data from the microprocessor and converts this into an analogue servo demand signal using a D to A converter. This chip also contains a position amplifier, mode/direction switches, and is housed in another 16 pin d.i.p. The L292 is the motor driver, able to handle up to 2 amps at 36 volts using an overload protected bridge circuit. The L292 operates in the "switched" mode, and in keeping with the application, it is housed in a 15 lead Multiwatt power package.

When interconnected, the servo components operate in two modes. In order to slew rapidly to a new demanded position the servo loop can initially employ velocity control only, but as the target position is approached, a change to precise position control is made.

PUTTING THE BYTE ON

If you are shovelling together a new microprocessor system and can't make up your mind what to do about memory, it's probably time you had a look at the "Bytewyde" concept championed by Mostek.

Bytewyde is not a reference to a single memory device, but is the name given to a whole family of devices, including some you will already be very familiar with, like the 2716 EPROM. What makes the concept special is the plug-in interchangeability of ROM and RAM memory devices in the same socket by utilising the pin configuration made standard by 24 pin UV erasable EPROMs and compatible masked ROMs. To launch the concept, Mostek introduced the 4118, a 1K × 8 static RAM in a 24 pin package which would have been a useful hunk of memory even *without* EPROM compatibility! Things didn't stop there however, and now there are bigger chips and several new manufacturers joining in. Mostek have introduced another 1K × 8, the 4801 which is faster than the 4118, and are now offering the 4802 which is faster and has a 2K × 8 capacity to boot. The Mostek chips are all NMOS, but in the land of the rising sun they are turning out CMOS memories in the Bytewyde mould, such as the MSM 2128-1 from OKI Semiconductor, another 2K × 8 device.

If you adopt Bytewyde, you can lay your boards out with standard 24 pin sockets and then by changing links to just two of the pins, you can plug in your choice of 1K × 8, 2K × 8 or 4K × 8 EPROMs, or 1K × 8 or 2K × 8 RAMs. If you use 28 pin sockets instead, you will be ready for all of the above plus the new generation of 8K × 8 EPROMs and those giant RAM chips which are just around the corner!

MICRO-BUS

Compiled by DJD.

Appearing every two months, Micro-Bus presents ideas, applications, and programs for the most popular microprocessors; ones that you are unlikely to find in the manufacturers' data. The most original ideas often come from readers working on their own systems; payment will be made for any contribution featured.

THIS month's Micro-Bus presents an automatic program loader for the ZX80, and a three-dimensional plotting program for the Acorn ATOM. But first here are three ingenious programs for the ZX80 devised by *Lars Silen* of Finland. They provide ways of concatenating strings, transferring the last character from one string to another, and reading from the ZX80's keyboard.

CONCATENATING STRINGS

The ZX80 has no built-in function for concatenating two strings; so you cannot, for example, add the two strings A$="STUV" and B$="WXYZ" by writing A$=A$+B$ as you can on some BASICs. The routine shown in Fig. 1 overcomes this limitation by providing a way of concatenating any two different string variables, and it is called as follows:
LET A$=A$
LET B$=B$
GO SUB 1000

With the examples given above A$ would end up with the value "STUVWXYZ" and B$ would have the value " " (the null string). The references to A$ and B$ in the two seemingly redundant LET statements may be changed to any two different string variables that are to be concatenated. Note that no variables should be used between these two LET statements and the subroutine call, as this may cause the interpreter to hang up.

```
1000 REM STRING ADDER
1010 LET AD=PEEK(16394)+256*PEEK
(16395)-3
1020 LET AD=AD-1
1030 IF NOT PEEK(AD)=1 THEN GO T
O 1020
1035 LET TP=PEEK(AD+1)
1040 POKE AD,0
1050 POKE AD,PEEK(AD+2)
1060 LET AD=AD+1
1070 IF NOT PEEK(AD+2)=1 THEN GO
 TO 1050
1080 POKE AD+1,TP
1090 POKE AD,1
1100 RETURN
```

Fig. 1. Program to concatenate two strings on the ZX80

PROGRAM OPERATION

The program depends, for its operation, on the way strings are assigned in the ZX80; when a string variable is assigned to, the old version is deleted and a new version is created at the end of the list of variables. The two LET statements above have the effect of moving the strings A$ and B$ to the end of the list of variables, so that they are positioned in memory as shown in Fig. 2 (a).

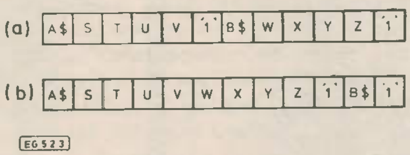


Fig. 2. Diagram showing two strings (a) before and (b) after running the String Adder program of Fig. 1

Locations 16394 and 16395 contain the address of the top of the list of variables; the program reads backwards from this address, through string B$, until the terminating byte '1' is found at the end of A$ (lines 1020 to 1030). Then the characters of B$ are shuffled down onto the end of A$ (lines 1050 to 1070), and finally B$ is recreated as a null string (lines 1080 to 1090). The result is shown in Fig. 2 (b).

TR$ FOR THE ZX80

The following routine is very much like the ZX80's TL$ function, but instead of cutting off the leftmost character from a string, it cuts off the rightmost character; it could therefore be called TR$. The routine is shown in Fig. 3, and uses much the same technique as the program to concatenate strings. Again, the routine is called by executing:
LET A$=A$
LET B$=B$
GO SUB 1000
The effect is to cut off the last character from A$ and add it as the first character of B$. Thus if initially A$="STUV" and B$="WXYZ" the result would be A$="STU" and B$="VWXYZ". B$ may initially be a null string.

```
1000 REM TR$
1010 LET AD=PEEK(16394)+256*PEEK
(16395)-3
1030 LET AD=AD-1
1040 IF NOT PEEK(AD)=1 THEN GO T
O 1030
1050 POKE AD,PEEK(AD+1)
1060 POKE AD+1,PEEK(AD-1)
1070 POKE AD-1,1
1080 RETURN
```

Fig. 3. Program for the ZX80 moves the last character from one string to another

ZX80 KEYBOARD ROUTINE

One shortcoming of the ZX80 is that the keyboard and display are effectively dead during execution of a program. However, with the help of the following simple machine-code routine it is relatively easy to read keys at any desired time:

```
IN A, 0   ; read port 0 into accumulator
LD L,A    : save result in LSB of HL
LD H, 0   : zero MSB of HL
RET :       return to BASIC, result in HL
```

Since there is always a risk that a machine-code routine located in the ZX80's RAM will be overwritten by the display file, the routine is written into a string which must not therefore be used elsewhere in the program. The program of Fig. 4 sets up the machine-code routine, and is called using the USR function:

LET K=USR(O)

where K is given the value of the key pressed. Note that this function, and lines 20 to 90 in the program, refer to the variable "O", *not* the digit zero.

```
 10 REM READER
 20 LET O$="XXXXXX"
 30 LET O=PEEK(16392)+256*PEEK(
16393)+1
 40 POKE O,219
 50 POKE O+1,0
 60 POKE O+2,111
 70 POKE O+3,38
 80 POKE O+4,0
 90 POKE O+5,201
```

Fig. 4. Program sets up a machine-code routine to read the ZX80's keyboard

AUTOMATIC PROGRAM LOADER

It is often convenient to record a large number of seldom-used programs onto one cassette, but then it can be a lengthy business retrieving the particular one you want. The following system automatically searches a tape for the correct program, by skipping the correct number of earlier programs on the tape. It was developed by *Trevor Toms* of Phipps Associates, for use with the cassettes of programs that accompany their excellent "ZX80 Pocket Book", and they have kindly given permission for it to be included in Micro-Bus.

The automatic loading is performed by a header program, stored at the beginning of each tape. This is loaded first, and it prints out a list of all the other programs on that tape. All you need to do is type the number of the program you want, and the header program will locate it and load it.

MACHINE-CODE ROUTINE

The first stage in writing the header program is to create a machine-code routine that will skip past a program on the tape. This is best done using a BASIC program, as in Fig. 5. First, line 2 reserves 100 bytes for the machine-code by dimensioning an array C, and the address of this array is calculated and stored in the variable C (line 10). To avoid having to write the entire cassette routine from scratch, the ZX80's LOAD subroutine is copied out of the relevant part of the monitor ROM in lines 30 to 70, and then "patched" to do the required task by modifying certain bytes. The patches are as follows:

Lines 110 to 230 converts the routine into a subroutine, rather than part of the main command-entry loop, and make it read program bytes from tape until a byte containing 128 (or 80 in hex) is detected. This byte denotes the end of the program and program variables. Lines 240 to 260 make the routine ignore the system variables, which are stored as 40 bytes before the program text and program variables. Finally, the routine is patched so that if the BREAK key is pressed the USR function will return a value of −1 (lines 330 to 390). Any other value returned indicates that a program has been successfully skipped over.

```
  1 REM CREATE CASSETTE HEADER
  2 DIM C(50)
 10 LET C=PEEK(16392)+PEEK(1639
3)*256+2
 20 LET Y=C+1
 40 FOR X=504 TO 597
 50 POKE Y,PEEK(X)
 60 LET Y=Y+1
 70 NEXT X
100 REM PATCH LOAD SUBROUTINE
110 POKE C+1,21
120 POKE C+2,32
130 POKE C+3,5
140 POKE C+4,126
150 POKE C+5,254
160 POKE C+6,128
170 POKE C+7,22
180 POKE C+8,1
190 POKE C+9,0
200 POKE C+10,0
210 POKE C+11,32
220 POKE C+12,28
230 POKE C+13,201
240 POKE C+14,6
250 POKE C+15,40
260 POKE C+25,57
270 POKE C+35,42
280 POKE C+36,8
290 POKE C+37,64
300 POKE C+38,35
310 POKE C+39,35
320 POKE C+40,80
330 POKE C+49,33
340 POKE C+81,24
350 POKE C+82,174
360 POKE C+83,33
370 POKE C+84,255
380 POKE C+85,255
390 POKE C+86,201
400 STOP
```

Fig. 5. Program to set up a machine-code routine to skip a program on tape

Having typed in the program of Fig. 5, and saved it on tape in case it crashes, run it to create the machine code in array C. Now delete every line in the program, being extremely careful to avoid pressing RUN or CLEAR which would destroy the contents of array C. Now type in the header program of Fig. 6; this contains, in lines 100 to 200, a list of the programs to be saved on the tape, and these lines should obviously be altered to suit the programs to be stored. Line 20 calculates the address of the skip subroutine created earlier, which still exists in memory although there is no longer any reference to it. The subroutine is called by the function USR(C+14).

```
   1 REM ***    "GOTO 1"    ***
   2 REM *** DO NOT "RUN" ***
  10 LET MAXPROGS=3
  20 LET C=PEEK(16392)+PEEK(1639
3)*256+2
  30 PRINT "PROGRAM SELECTION:"
  40 PRINT
 100 PRINT "1. MASTERMIND",,"1K"
 100 PRINT "2. HANGMAN",,"1K"
 120 PRINT "3. HUNT THE WUMPUS",
"3K"
 200 PRINT
 210 PRINT "REWIND TAPE, ENTER S
ELECTION"
 220 PRINT "PRESS PLAY/NEWLINE T
OGETHER"
 300 INPUT N
 310 IF N<1 OR N>MAXPROGS THEN G
OTO 1
 320 IF N=0 THEN LOAD
 330 IF USR(C+14)=-1 THEN GO TO
400
 340 LET N=N-1
 350 FOR Y=1 TO 400
 360 NEXT Y
 370 REM SMALL SETTLE LOOP 4 SEC
S
 380 GO TO 320
 400 PRINT "BREAK..."
9999 STOP
```

Fig. 6. Header program for the ZX80 loads a specified file from a tape

Having entered the header program, save it at the start of the tape, and you are then ready to fill up the tape with programs you wished to archive. Note that about 10 seconds of blank should be allowed after recording the header program, so that it can be updated and re-recorded if more programs are added to the end of the tape at a later stage.

USING THE PROGRAM

In use, the header program is first loaded from the start of the cassette, and executed using "GOTO 1" since RUN would destroy array C containing the machine-code routine. Having selected a program from the menu, and entered its number, the tape is rewound and played again, while typing NEWLINE. The automatic loader will then skip the header program, and all the intermediate programs, finally loading the program that was chosen.

3-D PLOTTING

The simple program in Fig. 7 plots a three-dimensional curve using high-resolution graphics. It is designed for an Acorn Atom with a floating-point extension. The program avoids plotting lines that would be hidden by the perspective from which the curve is being viewed; see Fig. 8.

The program uses a mixture of integer and floating-point variables; the floating-point variables are prefixed by a "%" sign, and are

```
  5 REM 3-D PLOT
 10 CLEAR4
 20 A=128;B=A*A;C=96;D=96
 30 FOR X=0 TO A
 40 S=X*X
 50 %P=SQR(B-S)
 60 %I=-%P
 65 DO
 70 %R=SQR(S+%I*%I)/A
 80 %Q=(%R-1)*SIN(24*%R)
 90 %Y=%I/3+%Q*D
 95 FIF %I=-%P %M=%Y;GOTOb
100 FIF %Y>%M %M=%Y;GOTOa
105 FIF %Y>=%N GOTOc
110b%N=%Y
115a%Y=C+%Y
120 PLOT13,(A-X),%Y
130 PLOT13,(A+X),%Y
135c%I=%I+4
140 FUNTIL %I>=%P
145 NEXT X
150 END
```

Fig. 7. Three-dimensional plotting program for Atom BASIC with floating-point

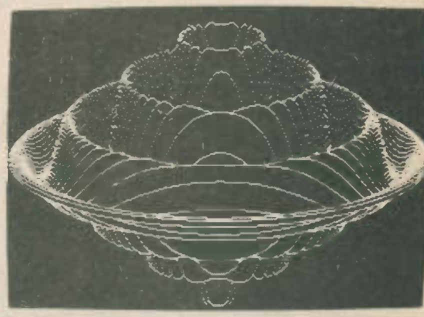


Fig. 8. High-resolution graphics curve produced by 3-D Plot program

totally separate from the normal integer variables. A second version of the IF statement, FIF, is provided for floating-point comparisons; similarly the integer DO . . . UNTIL loop, which gives repeated execution of a section of statements until the condition in the UNTIL statement is satisfied, has as its counterpart the floating-point DO . . . FUNTIL loop. The lower-case letters are labels, used by the GOTO statements instead of line numbers.

The graphics command 'CLEAR 4' sets up the display for 256 x 192 points, and the statement 'PLOT 13,X,Y' plots a point at coordinates X,Y. Hidden-line removal is performed by keeping a record of the highest point plotted, in %M, and the lowest point plotted, in %N; only points greater than %M and less than %N are plotted. Line 90 determines the perspective at which the curve is viewed. The function for evaluation is given in line 80, as the height %Q in terms of the radius %R, and this line can be changed to give plots of other functions.

ULTRASONIC INTRUDER ALARM

GILBERT DAVIES

THIS Ultrasonic Intruder Alarm is an updated version of the design published in *PE December 1979*. Modifications to the original circuit include the use of a sensitivity control which will also preset the detection range and a steady alarm output. The complete unit has been redesigned to fit onto a single p.c.b.

CIRCUIT DESCRIPTION

The complete circuit diagram of the Intruder Alarm is shown in Fig.1. The 555 timer (IC2) is connected as a 40kHz square wave generator which can be fine tuned by VR1. The square wave output is filtered by R22 and C16 before being used to drive the ultrasonic transmitter X1. The 40kHz signal sets up a sound pattern in the protected room and if an object moves within the field a frequency shift occurs (due to the Doppler effect) to the waves which are reflected from the moving object. The transducer X2 will receive two different frequencies (40kHz and the shifted frequency which can be higher or lower than 40kHz); these will combine to produce a beat note. The frequency of this audio or sub-audio beat note will be the difference between the two ultrasonic frequencies. This beat frequency is then amplified filtered and used to operate the alarm. The received sound from X1 feeds the 40kHz amplifier IC3 the gain being determined by VR2, R6 and C6. VR2 adjusts the voltage gain from 1 to X100.

The output of this stage is fed to the envelope detector to remove the 40kHz signal and detect the Doppler frequencies from the received signal. IC4 forms a Doppler frequency amplifier the gain being set by R10, R9, and C8 this increases the signal sufficiently to drive the diode pump detector C9, D7, D8, C10 and R11 to convert the Doppler frequency into a d.c. level.

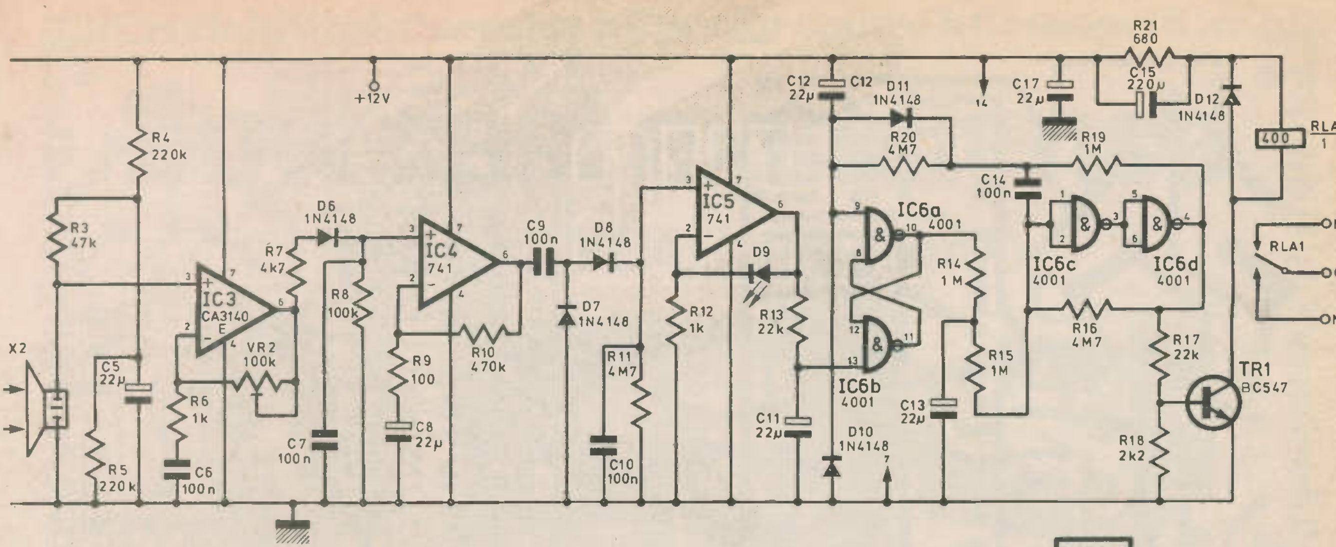
This d.c. level feeds the unit 'on' and 'movement' indicator formed by IC5, D9 and R12. The diode D9 glows when the unit is on and increases in brightness as a movement is detected, the brightness being dependent upon the voltage at the output of IC5 which causes current to flow though D9 and R12. The diode D9 also acts as a 1·2V level shifter for better matching to the next stage.

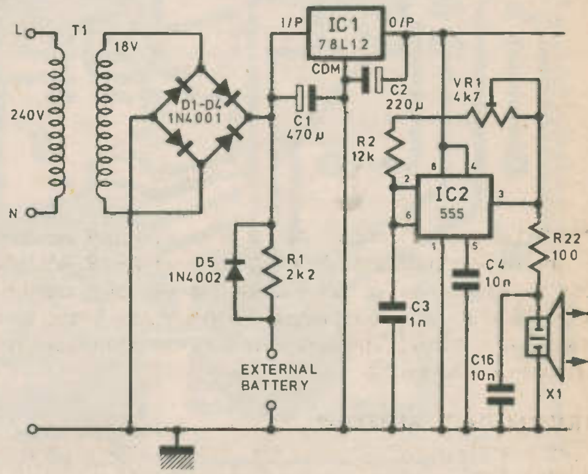
The d.c. level from IC5 is filtered by R13 and C11 (to form a 1 second invalid movement delay to prevent false triggering) before feeding IC6a and b which form a bistable reset at switch on by C12, D11 and R19 (D10 forms a discharge path at switch off for C12). When the bistable is triggered by pin 13 going high the output of pin 10 goes high charging C13 via R14. When the voltage across C13 reaches the upper threshold of the Schmitt trigger formed by IC6c and d, R15 and R16 the output of pin 4 goes high driving TR1 via resistor chain R17 and R18, the collector of TR1 drives RLA and D12. Resistor R21 and C15 provide sufficient current to energise the relay with a low holding current to minimise the power taken by the relay. When pin 4 is high C12 is discharged by R19 and R20 causing the voltage at pin 9 to rise, which resets the bistable causing pin 10 to go low discharg-

FEATURES

(1) Screw connections for 240V a.c. supply and remote alarm sounder.
(2) 18V battery back up option in case of mains failure. Ni-cads can provide up to 5 hours of protection.
(3) Internally preset detection range (normally preset to 15 feet with built and tested alarms)
(4) Half second system test at switch on—acts as an alarm on reminder for the user
(5) Twenty seconds delay at switch on—to allow the building to be left without sounding the alarm.
(6) Twenty second delay on entry—to allow the alarm to be cancelled without sounding.
(7) One second invalid movement delay—to prevent false alarms by plants etc.
(8) Two minute self cancelling alarm—to provide repeated protection whilst away for long periods.

The alarm is most sensitive to moving objects in front of the unit and towards the unit. A red lamp glows on the front of the unit when power is connected and increases in brightness as movement is detected.





ing C13 via R14 and when the lower threshold of the Schmitt trigger is reached pin 4 goes low turning off TR1 and de-energising RLA. If relay RLA is removed and R21 linked TR1 can drive a low power high efficient piezo sounder such as the ITT U250-RHA which requires 12V d.c. at 18mA to produce a 105dB 2·7kHz at 1 metre.

R1 and D5 form a suitable charging circuit for ni-cad battery back up. If dry cells are used the charge resistor R1 should be removed. The mains power to the unit and battery feed should both be switched.

The power supply consists of T1, D1, D2, D3, D4, smoothing capacitor C1 i.c. regulator IC1 and decoupling capacitors C2 and C17.

The switch on test is provided by C14 causing pins 1 and 2 of IC6 to go high whilst charging through path C12. D11, R15 and C13 causing pin 4 to go high turning on TRI and energising RLA.

Fig. 1. Complete circuit diagram of the Intruder Alarm

COMPONENTS . . .

Resistors

R1, R18	2k2 (2 off)
R2	12k
R3	47k
R4, R5	220k (2 off)
R6, R12	1k (2 off)
R7	4k7
R8	100k
R9, R22	100 (2 off)
R10	470k
R11, R16, R20	4M7 (3 off)
R13, R17	22k (2 off)
R14, R15, R19	1M (3 off)
R21	680

All resistors ¼W 5% carbon

Potentiometers

VR1	4k7 min. hor.
VR2	100k min. hor.

Capacitors

C1	470µ 25V elect.
C2, C15	220µ 16V elect. (2 off)
C3	1n polyester
C4, C16	10n ceramic (2 off)
C5, C8, C11, C12, C13, C17	22µ 16V elect. (6 off)
C6, C7, C9, C10, C14	100n polyester (5 off)

Semiconductors

D1–D4	1N4001 (4 off)
D5	1N4002
D6, D7, D8, D10, D11, D12	1N4148 (6 off)
D9	Red l.e.d.
TR1	BC547
IC1	78L12
IC2	NE555
IC3	CA3140E
IC4, IC5	741 (2 off)
IC6	4001

Miscellaneous

T1	Mains transformer 18V sec
X1	MA40LIS
X2	MA40LIR

20mm grommets (2 off)
9mm grommets (2 off)
ABS box 115 × 95 × 45mm
Relay Omron LC1N-E
Piezo sounder ITT 250 RHA, p.c.b.
3-way terminal block p.c.b. type (2 off)

Constructor's Note

A complete kit of parts for the Intruder Alarm is available from **GJD Electronics, 105 Harper Fold Road, Radcliffe, Manchester M26 0RQ.**

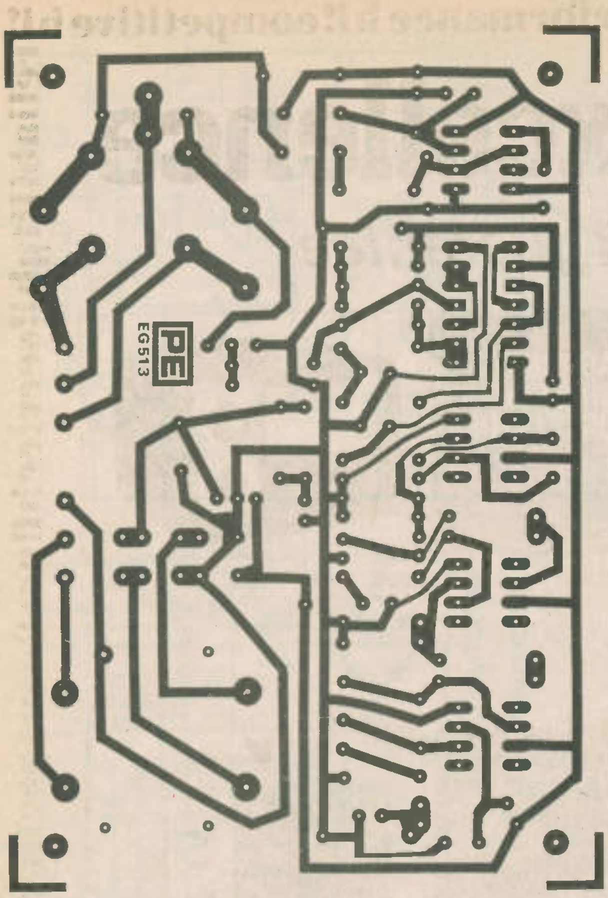


Fig. 2. P.c.b. design

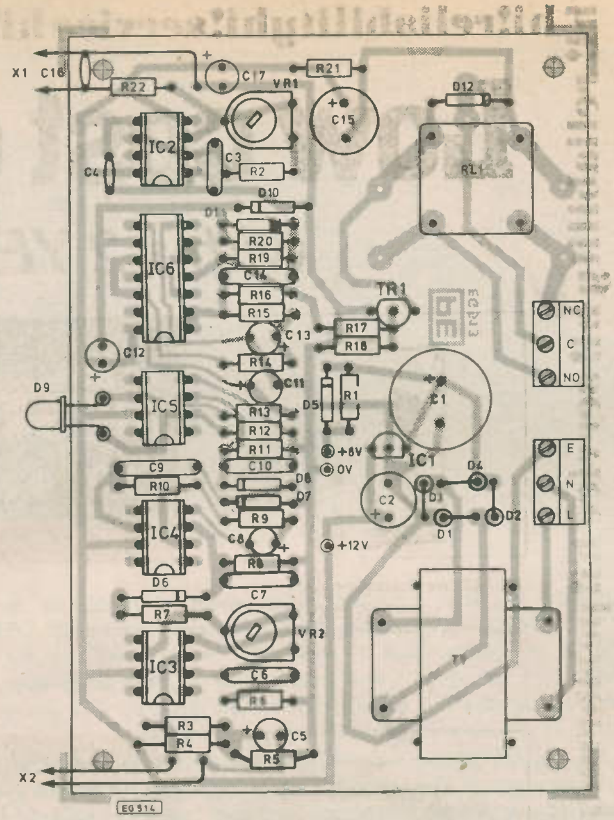


Fig. 3. Component layout

CONSTRUCTION

The p.c.b. design for the alarm unit is shown in Fig. 2 with the component layout shown in Fig. 3. After all the components have been soldered onto the p.c.b. and checked then the case can be drilled. On the prototype the two transducers were fitted into 20mm grommets. The front panel should also be drilled for the movement detector l.e.d. Grommets should also be fitted to the two holes at the rear of the case used for the mains lead and relay connections.

With the transducers fitted into the case and the p.c.b. mounted, then C16 and the other end of R22 should be soldered onto the ultrasonic transducer X1.

SETTING UP

Point the alarm into the room. Turn VR2 fully clockwise and measure the voltage at IC4 pin 3 which should be at around 5·5V d.c. Adjust VR1 until the maximum voltage is obtained, reduce this setting of VR2 for the required sensing range. It is always best to use the minimum range required to reduce the possibility of a false alarm.

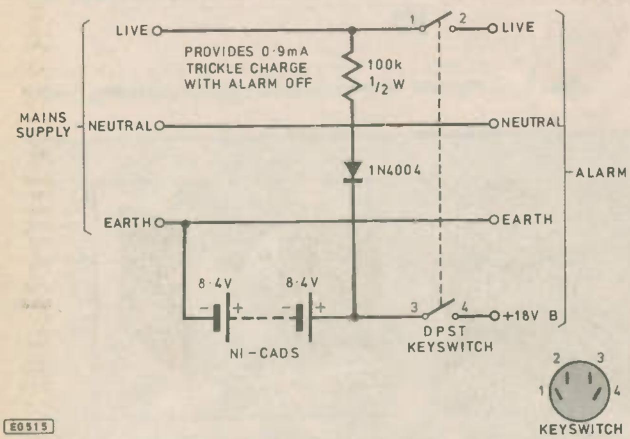
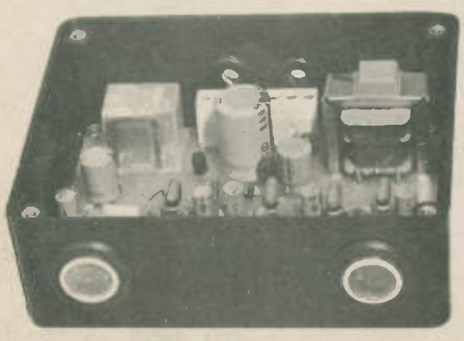


Fig. 4. Circuit for ni-cad conversion



Internal view of the alarm

INSTALLATION

The alarm is prone to both vibration and air currents therefore the points below should be observed to avoid false triggering of the alarm.

(1) Do not place the alarm on a vibrating surface.
(2) Close all doors and windows.
(3) Do not point the alarm at a radiator or convector heater.
(4) Cats, dogs and large insects should be considered.
(5) If more than one alarm is to be used ensure that the ultrasonic sound emitted by one alarm does not interact with the second alarm.
(6) Try to install away from telephones as some bells can produce high frequency sound similar to that of the alarm ★

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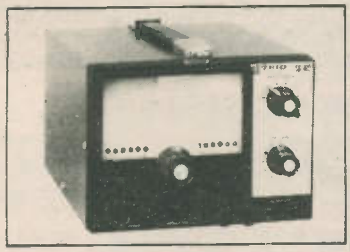
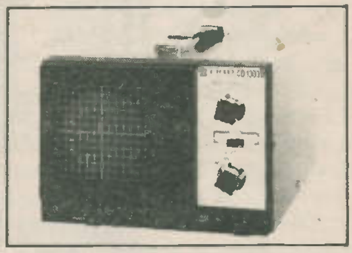


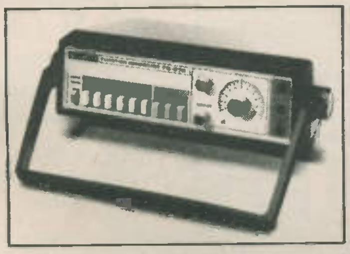
SG 402 30 MHz A.M. SIG. GEN. £59

SG402 A.M. Signal Generator — 100KHz to 30MHz in 6 bands — 100mV of O/P with variable attenuator — Int. and Ex. A.M. — Solid State — Lightweight and portable — Large clear easy to read frequency dial.

CO 1303D 5 MHz OSCILLOSCOPE £100



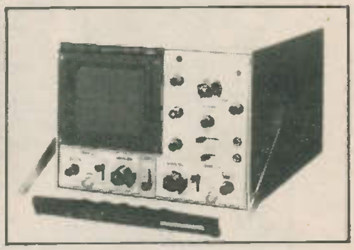
CO1303D, DC to 5MHz Oscilloscope — 10mV/div sensitivity with variable atten. — Int. variable sweep frequency in 4 ranges from 10Hz to 100KHz — Int. and Ext. sync. — Direct deflection terminals can monitor R.F. up to 450MHz. CO1303G as above, plus 1:8 to 54MHz monitor freq. range from 1 to 500W direct coupling — Two Tone gen. 1KHz and 1.575KHz — ideal for SSB, A.M. C.W. etc.



FG 270 FUNCTION GEN. £146

FG270, Function Generator — 0.1Hz to 1MHz in 6 ranges — sine, square and triangle — 20V p-p open circuit output — < 1% distortion — D.C. offset — TTL O/P — Ext. VCO for sweep tests. FG271 as above plus 0.02Hz to 2MHz in 7 ranges — Int. sweep — Pulse, Tone Burst and A.M.

CS 1562A 10 MHz DUAL TRACE £224



CS1562A Dual Trace 10MHz Oscilloscope — 10mV to 20V/div sensitivity in 1-2-5 sequence with fine control — 1μs to 0.5 s/div. sweep time plus X5 Mag. — Auto, Manual and T.V. triggering — Z mod and X-Y operation. A single trace version CS1559A is available at even lower cost.

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Interfacing COMPUKIT

Part 4 D.E.Graham

THIS MONTH we introduce a second companion board to the Decoding Module, and examine the implementation of analogue output from the Compukit.

ANALOGUE, TIMING AND AUDIO BOARD

This is a double sided p.c.b. of the same dimensions as the Decoding Module, which connects directly to it via a single edge connector to provide the Compukit with a range of facilities. The board is powered by the Decoding Module's dual 5 volt power supply, and, as may be seen from Fig. 4.1, contains four separate sections: A D/A converter and operational amplifier taken out to SK7; an 8 channel A/D converter accessed through SK6; an AY-3-8910 Programmable Sound Generator and audio amplifier whose output is taken to a number of pads at the edge of the board, and whose two 8 bit ports are accessed through SK2 and 3; and a 6522 Versatile Interface Adaptor providing a number of counting and timing facilities, as well as a further 16 bits of parallel port. Connections to the 6522 are made via SK4 and 5. Sockets SK2, 3, 4, 5, 6 and 7 are all of the 16-pin d.i.l. variety.

CONSTRUCTION

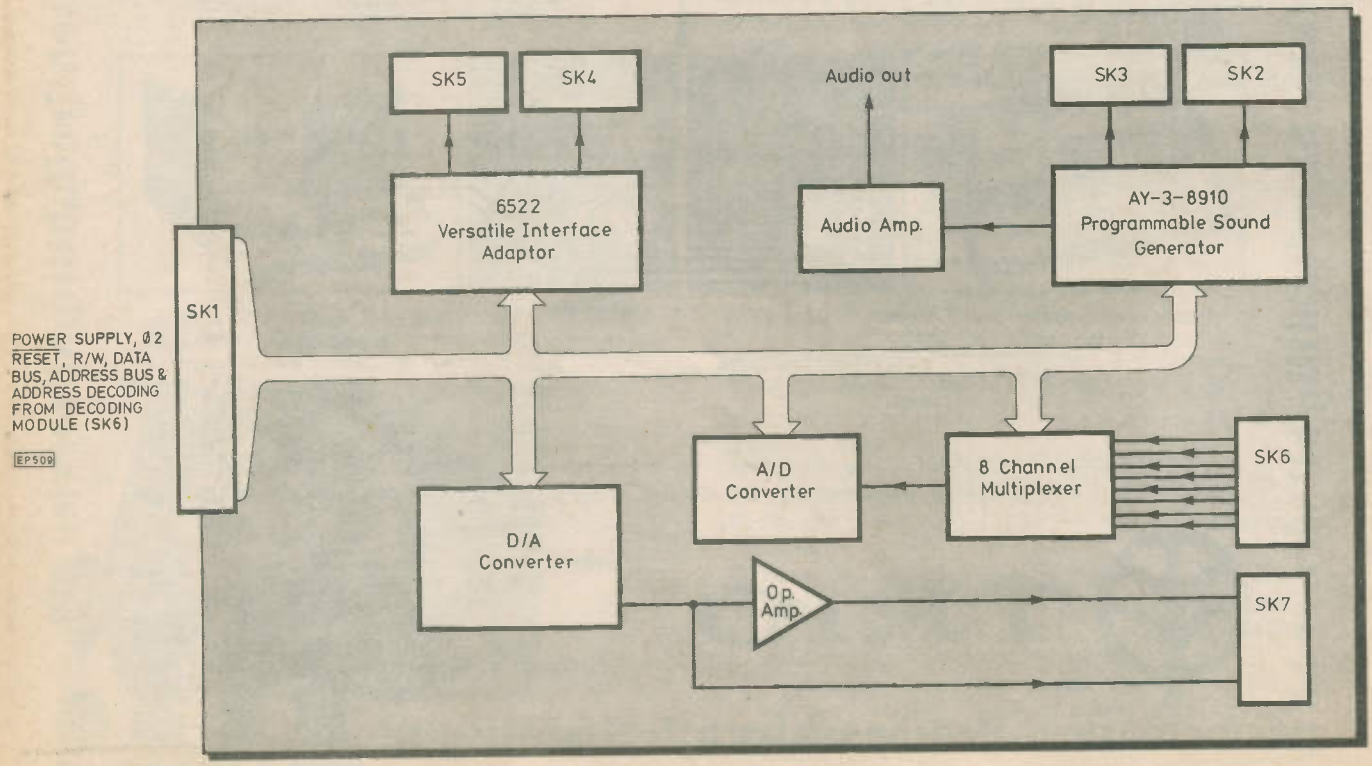
This should prove to be fairly straightforward. It is probably easiest to solder in i.c. sockets first, followed by discrete components, and finally the through-pins (as indicated on the component overlay in Fig. 4.4). Before inserting the i.c.s, test that the correct supply voltage appears at the appropriate pins of all i.c. sockets. The Analogue Board connects to the Decoding Module via a 2 × 25-pin 0·1 inch edge connector SK1. This is wired to SK6 on the Decoding Module as shown in Table 4.1. This wiring should be kept to a few inches in length. Precautions against static damage must be exercised when dealing with i.c.s 1, 2, 6, 8 and 10 since these devices may be easily damaged by static charges.

We will cover the testing of the four parts of the board in the particular sections dealing with each functional unit. Details of the PSG, 6522 and A/D converter will be given in forthcoming issues. Now we deal with D/A conversion.

D/A TECHNIQUES

In its simplest form a D/A converter may consist of a chain of resistors joined to a parallel output port. Fig. 4.5 shows a 4 bit D/A converter that could be connected directly to the

4.1. Block diagram of Analogue Board

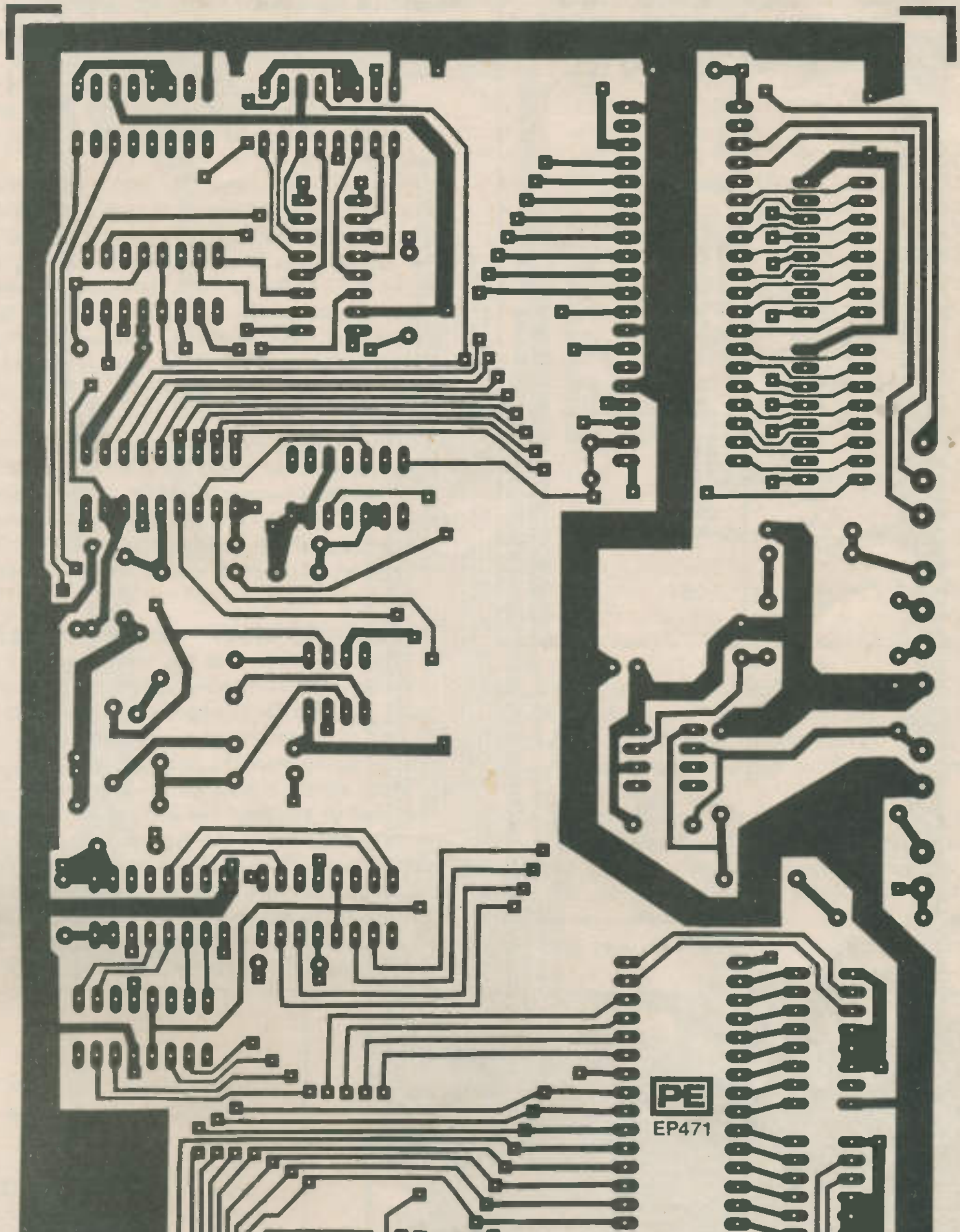


outputs of a 7475 quad latch. The output voltage would range from a fraction of a volt for zero data to about 4 volts for the decimal value 15. The resistors would need to be one per cent tolerance types to avoid abrupt changes in voltage occurring when different sections of the chain are brought into play, as in the major transition which occurs from 7 to 8 for example.

The configuration could be doubled up to produce an 8 bit converter, but resistor tolerances would become more critical. Also, if a PIA port was to be used with such a converter, higher value resistors would be required because of the relatively low drive capability of its output. This would further necessitate the use of a d.c. amplifier to produce a usable analogue output.

ZN425 MONOLITHIC CONVERTER

It is of course possible to get around these problems, and particularly the problem of conversion accuracy, by using a



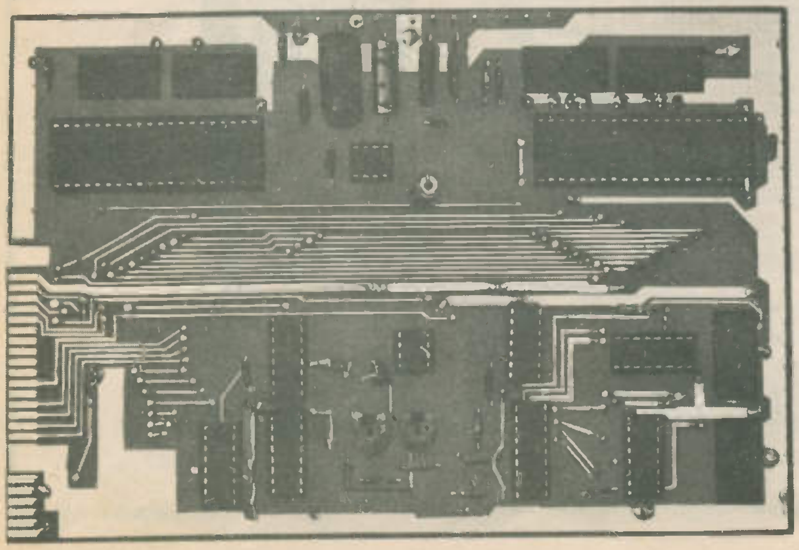
4.2. P.c.b. for Analogue Board (actual size)

Table 4.1 Connections Between SK1 of Analogue board and SK6 of Decoding Module.

	Upper		Lower	
SK1 pin number	SK6 pin number (upper)	Function	SK6 pin number (lower)	Function
1	1	Vgg(−5V)	1	RESET
2	2	Ø2	2	W7
3	3	1RQ	3	W8
4	4	BC1	4	R7
5	5	BDIR	—	NC
6	—	NC	—	NC
7	—	NC	7	R/W
8	—	NC	8	GND
9	—	NC	9	GND
10	—	NC	10	D7
11	11	W7	11	D6
12	—	NC	12	D5
13	13	A3	13	D4
14	14	A2	14	D0
15	15	A1	15	D1
16	16	A0	16	D2
17	17	GND	17	D3
18	18	GND	18	Vcc
19	19	GND	19	Vcc
20	—	NC	20	GND
21	—	NC	21	GND
22	—	NC	22	GND
23	—	NC	—	NC
24	—	NC	—	NC
25	25	NMI	25	BL2

monolithic D/A converter i.c. From the variety of such devices on the market we have chosen to use the Ferranti ZN425 for a number of reasons. In particular it is readily available at a reasonable price, and operates from a 5 volt supply.

Fig. 4.6 gives a block diagram of the sections of the 425 used in D/A conversion. Essentially it consists of 8 data switches which are activated by an external port or latches. These switch a precision R-2R network to an on-chip 2·5 volt reference source to produce an analogue output on pin 14. This is typically 2·555 volts for all bits on, and 3mV for all bits off.



PRACTICAL D/A CIRCUIT

Fig. 4.7 gives the full circuit of the D/A section of the Analogue Board. This consists of a pair of 74LS75s wired to form an 8 bit data latch. The latch enables are taken to the W line on the Decoding Module, which corresponds to an address of 61320. The 8 parallel outputs of the latch are connected directly to the ZN425, which performs the conversion of the latched data within 1µ sec. The analogue output (DA) appears at pin 14 of the 425, and is fed to the non-inverting input of IC11, a 741 operational amplifier. Both DA, and the output of the op. amp. (DAA) are taken out to SK7, which also carries both polarity supply connections and ground.

The op. amp. circuit has two associated variable resistors. VR1 is used for zeroing, and has been given an extended offset capability, and VR2, which controls the gain between about 1 and 2.

To test the converter, connect a voltmeter between pin 14 of SK7 and earth (pins 1, 5 or 6 of SK7). Execute the command **POKE 61320, 0,** and adjust VR1 to give zero volts on the meter. Now execute **POKE 61320, 255.** This should cause the meter to read somewhere between 2·5 and 4 volts, depending on the setting of VR2. The system is now operational, and POKEing intermediate values to 61320 should yield intermediate voltage readings with a linear correspondence (providing the gain has not been set too high).

If the voltage does not vary with differing data, a voltage check should be made on the DA output of the converter (pin 14 of IC6, or pin 16 of SK7). If this does not alter when data is POKEd to 61320, then checks should be made on the outputs of the two latches IC4 and 5. These should also change when different values are POKEd to 61320.

APPLICATIONS OF THE D/A CONVERTER

The DAA output of the converter unit at pin 14 of SK7 may be used in a wide variety of different applications. It could be used for example to feed a servo amplifier controlling a d.c. motor which could variously drive a graph plotter, a steering mechanism, or a robot's left leg.

More simply it may be used to drive power controllers of one kind or another. For low power d.c. operation, a simple current amplifier of the type shown in Fig. 4·8 may be connected to the DAA output of the converter unit. This will vary the brightness of a 2·5V lamp according to the data POKEd to 61320. To set this up, first execute POKE 61320, 0, and adjust the zero offset (VR1) so that the bulb is just extinguished. Then execute POKE 61320, 255. This should

CONSTRUCTOR'S NOTE: NEW MONITOR IN EPROM

During the development of this series the screen editor written by Nigel Climpson and published in PE was found to be extremely useful. This editor is now available as the CE1 monitor in a 2716 EPROM for £12·50 + VAT and p&p, from **Technomatic Ltd.** It replaces the UK101 2K monitor ROM, and also contains useful routines such as a rapid screen clear.

illuminate the lamp brightly, and VR2 may then be adjusted to achieve best control over the full range of data.

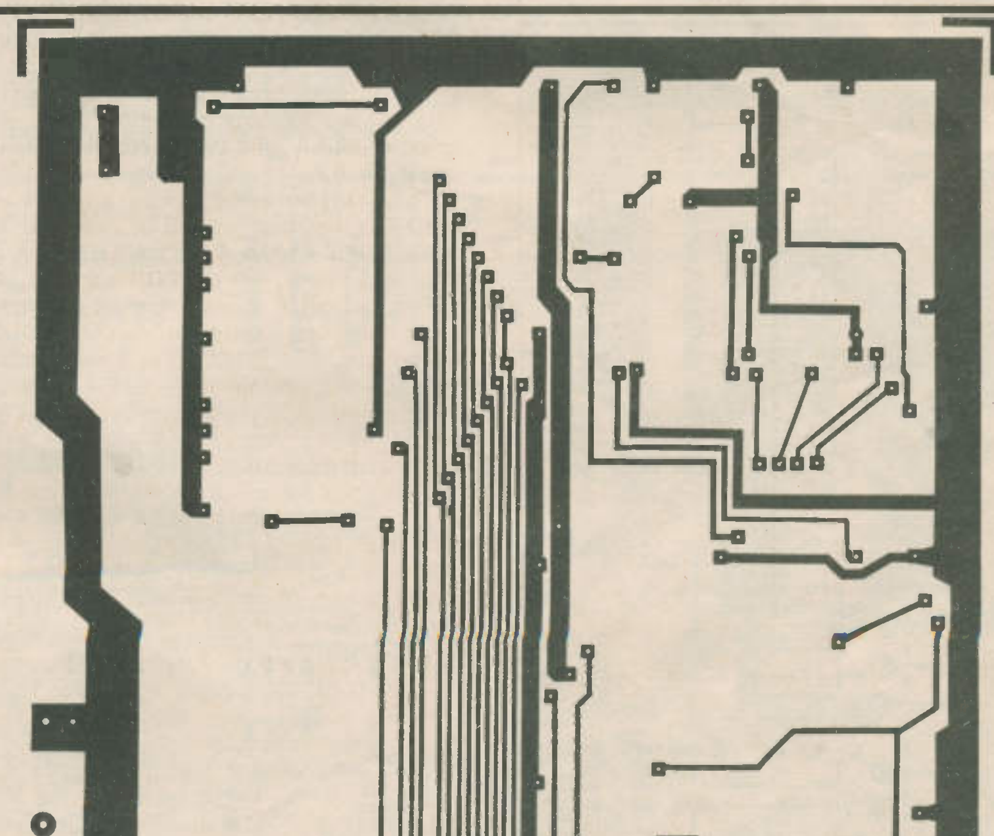
A program of the type listed below will be found useful in setting up the converter for the above, and for other applications:

```
80 REM TEST ROUTINE FOR A/D CONVERTER
100 A=61320
120 INPUTX
140 POKEA,X
160 GOTO100
```

It simply requests a number, which should be an integer between zero and 255, and POKEs this to the converter.

TRIAC CONTROLLER

If a.c. or pulsed d.c. control is required, then the converter may be used to drive a Triac or Thyristor. There are many ways in which this may be achieved, but perhaps the most straightforward is to use the DAA output of the converter to vary the brightness of a l.e.d. indicator, which itself illuminates a light dependent resistor placed at a strategic



EP472 **Fig. 4.3. Analogue Board p.c.b. component side**

point in a triac or thyristor controller circuit. This has the great advantage of completely isolating the computer system from the mains. Alternatively, a patent opto-isolator such as the TIL112 may be used. In either case the l.e.d. may be directly driven by the DAA output of the converter as in Fig. 4.9.

Fig. 4.10 gives an experimental circuit for a power controller using the l.d.r. method. The phase shift for the triac is produced by the R1/C1 network, with the l.d.r. altering the charge time of C1. R2, R3, and C2 help to reduce hysteresis and flicker, common diseases of this type of controller, though the latter is *not* completely eliminated. L1 and L2 are inductors each formed by winding about 100 turns of wire of a half inch former. Perhaps the most vital part of the circuit is the R4/C3 network. This prevents spikes in the supply line from destroying the triac.

The l.e.d. and series resistor are connected between the DAA output of the converter and Vcc. The l.e.d. should be

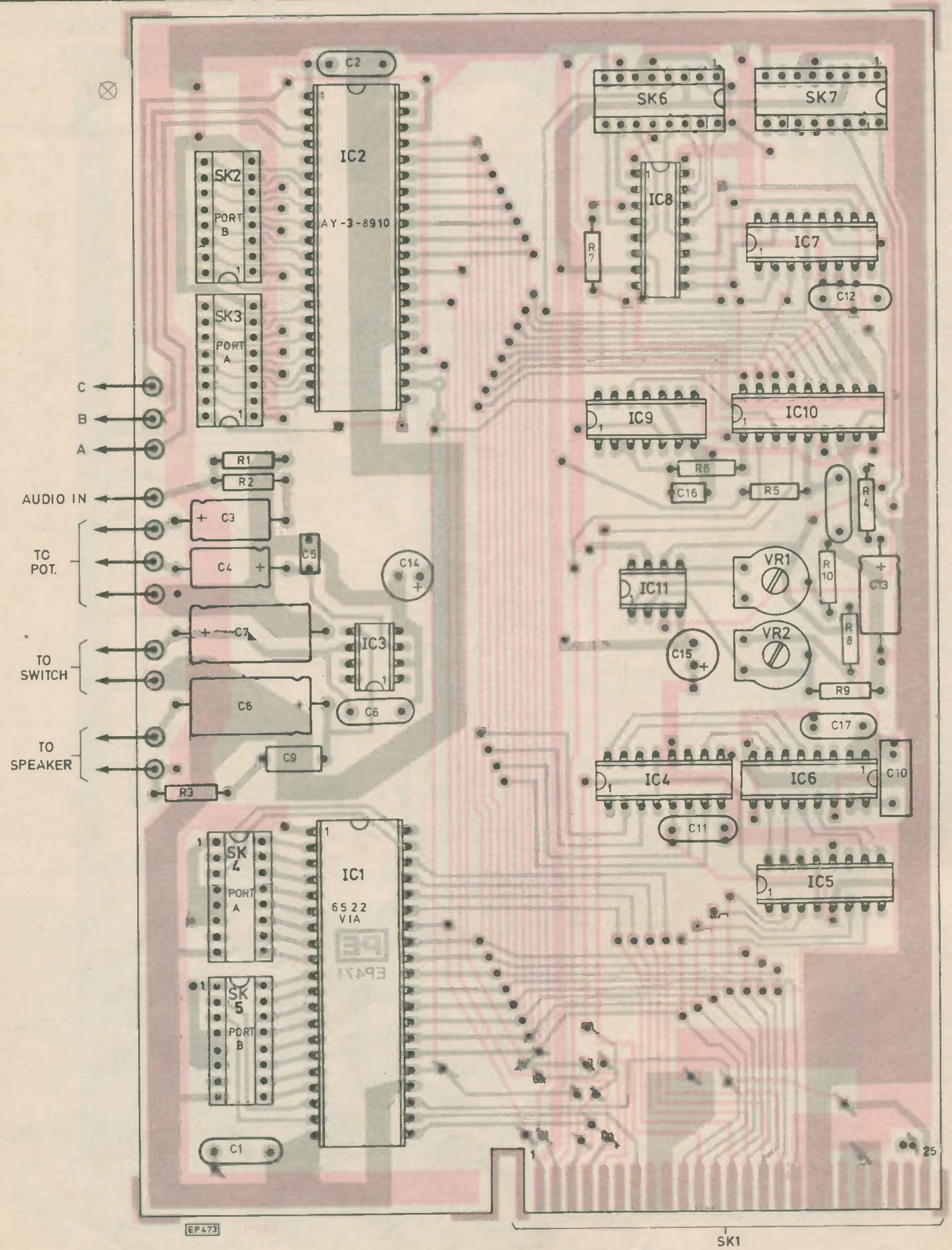


Fig. 4.4. Component overlay for Analogue Board

taped to the l.d.r., and the pair mounted in a *completely* light-tight container.

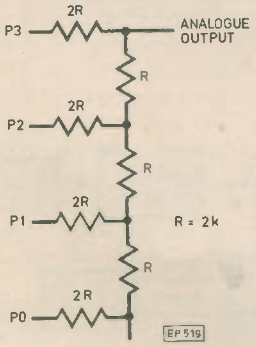
To set up the circuit, VR1 of the converter should be set to give zero volts between DAA and ground on execution of POKE 61320, 0. VR2 should then be adjusted to give a smooth range of control. Some adjustment of R1, 2 and 3 may be necessary to effect this.

THYRISTOR CONTROLLER

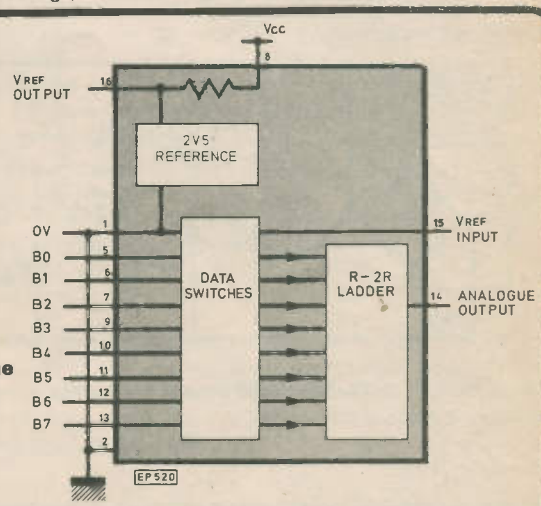
In the author's experience, far more satisfactory power control is achieved using thyristors rather than triacs. One advantage of the thyristor is the ease with which unijunction transistor delay circuits may be used with them; and secondly they cannot suffer from asynchronous firing in the two directions of current flow, as may occur with the triac, and which is indeed one of the factors causing flicker in the controller of Fig. 4.10.

Fig. 4.11 gives the circuit of a thyristor controller which may be used to vary the power to some 12 volt d.c. device for currents up to two or three amperes. Control using the 500k resistor is smooth and flicker-free. An l.d.r. driven by an l.e.d. from the D/A converter may be introduced in a number of ways into this circuit. About the simplest is to take the l.d.r. from point X to earth via a resistor in the range 20 to 100k. To obtain smooth control it will be necessary to adjust the 500k pot in conjunction with VR1 and VR2 on the Analogue Board. Again, however, it should be stressed that this is an experimental circuit, and some adjustment of values may be necessary to obtain the best performance.

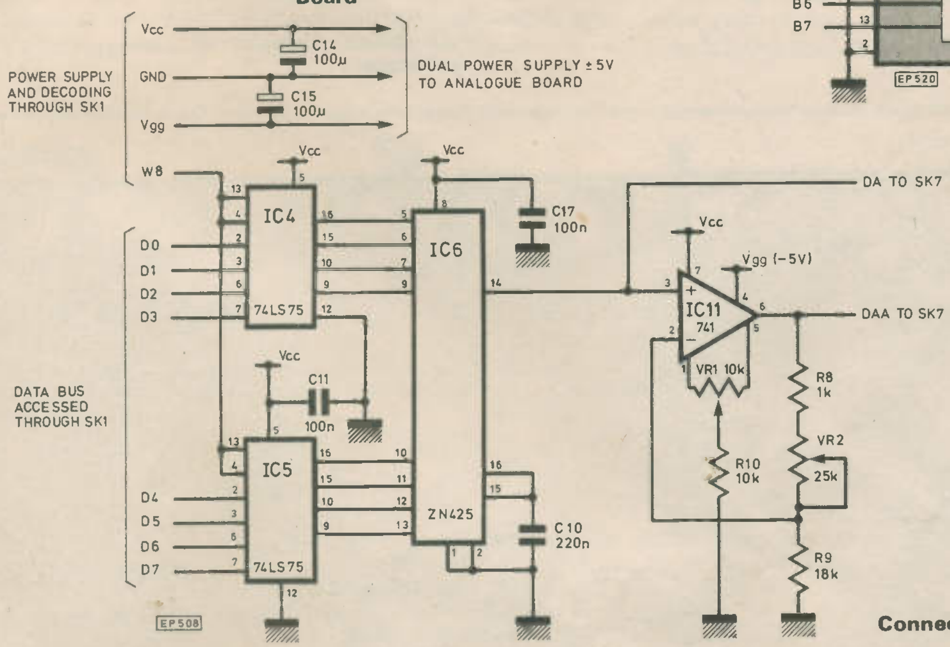
If it is desired to use this circuit for power control at a higher voltage, then it should be possible to increase the supply voltage, and adjust the Zener diode dropper resistor R1 accordingly. If a.c. control is required, then the load



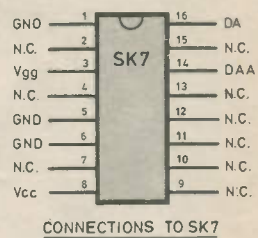
4.5. R/2R D/A converter

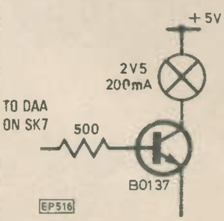


4.6. ZN425 block diagram

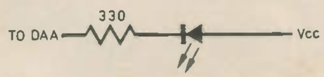


4.7. D/A Converter section of Analogue Board

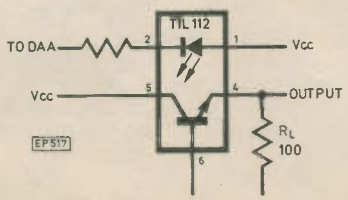




4.8. BD137 Current Amplifier

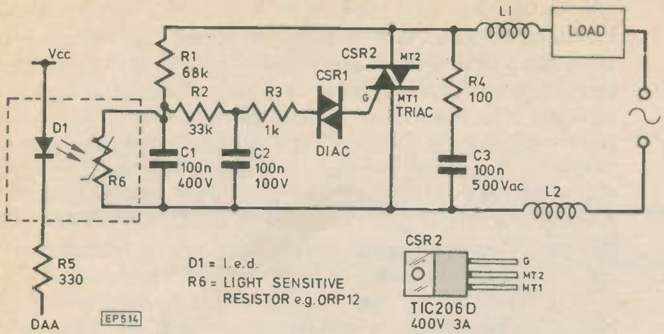


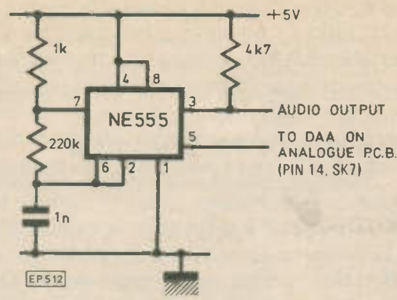
Connection of l.e.d. to D/A converter



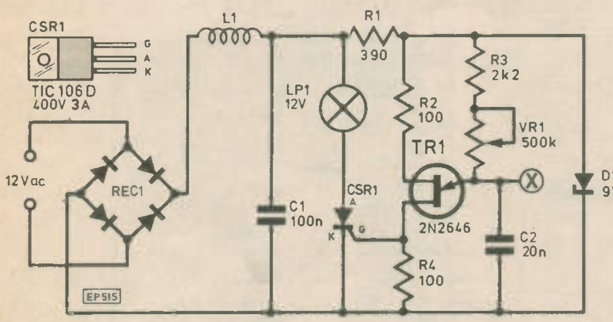
4.9. L.e.d. and Resistor (to opto-isolator)

4.10. Triac Power Controller. All resistors are 1 Watt

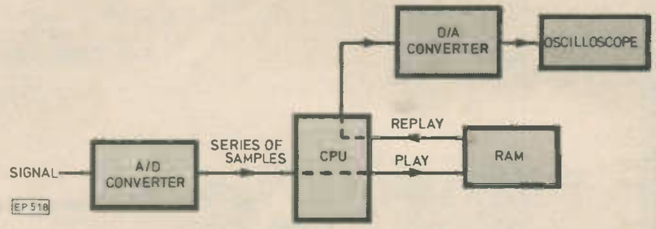




4.12. NE555 signal generator



4.11. Thyristor Power Controller



4.13. Block diagram of storage oscillocope

COMPONENTS . . .

Resistors

R1, R6, R8	1k (3 off)
R2	100k
R3	10
R4	390
R5	82k
R7	3k9
R9	18k
R10	~~10k~~ 47K.

Potentiometers

VR1	10k preset
VR2	25k preset
VR3	100k log + switch

Capacitors

C1, C2, C6, C11, C12, C17	100n disc ceramic (6 off)
C3, C4, C13	10μ/10V (3 off)
C5	1n
C7, C14, C15	100μ/10V (3 off)
C8	200μ/10V
C9	47n mylar
C10	220n mylar
C16	50n mylar

Integrated Circuits

IC1	6522
IC2	AY-3-8910
IC3	LM386
IC4, IC5, IC7	74LS75 (3 off)
IC6	ZN425
IC8	4051
IC9	74LS90
IC10	ZN427
IC11	741

Miscellaneous

P.c.b.
SK1 2 x 25 0·1in. edge connector
SK2–SK7 16-pin d.i.l. sockets (6 off)
40-pin d.i.l. sockets (2 off)
16-pin d.i.l. sockets(5 off)
8-pin d.i.l. sockets (2 off)
14-pin d.i.l. sockets
14-pin d.i.l. sockets
length of 40 strand ribbon cable

Constructors' Note

A complete kit of parts, excluding loudspeaker, is obtainable from **Technomatic Ltd., 17 Burnley Road, London NW10** should be placed in series with the a.c. supply feeding the bridge rectifier. Additionally the reader is referred to the many power control circuits that have appeared in *P.E.* in the past, and to the useful book on the subject by *D. Marsden*, entitled *110 Thyristor Projects.* The use of one of these with a controlling l.d.r. or opto-isolator should meet most individual requirements; though it should be noted that the recently published circuit for the *Slave Light Dimmer (P.E. Feb. 1981)* is not suitable for this purpose.

AUDIO OUTPUT

For some purposes it may be found useful to run an audio generator from the Analogue Board D/A converter, or from a R-2R converter running from an unused port, and buffered with an operational amplifier similar to that used on the Analogue Board. In either case the DAA output (or similar) may be used directly with i.c.s such as the NE566 function generator or the NE555 timer. Fig 4.12 gives a circuit for audio production using the 555. The DAA line from pin 14 of SK7 is used to directly drive the control pin (pin 5) of the 555. With the components specified this will give outputs in the range 5 to 10kHz. VR1 should be set to null output for zero data, and VR2 to maximum gain. This will result in outputs of about 10kHz for 255, and about 5kHz for data of around 80. If zero is POKEd to the converter, the generator ceases to oscillate, so providing a convenient means of switching off audio output.

FURTHER APPLICATIONS

The D/A converter on the Analogue Board may also be used for directly handling audio and other waveforms. It can, for example, be used in the direct generation of virtually any conceivable waveform. The program below produces a staircase output at the DA and DAA pins of the converter:

```
100 A=61320
110 INPUT "SAMPLE RATE: TRY 5"; C
120 FOR B=1 TO 255 STEP C
130 POKE A, B
140 NEXT
150 GOTO 120
```

Using BASIC for this purpose limits the output frequency of any waveform generated to a few Hz or so. For higher frequency outputs, the program would have to be executed in 6502 code. It would be a relatively simple matter to write a short routine in 6502 code that successively output the contents of a block of memory to the D/A converter. The block could then be filled beforehand, using a POKE routine in BASIC, with any desired waveform, e.g. sin, square, triangular step, etc. The short 6502 code program could then be accessed via the USR(X) call to output the data at any given speed.

Using similar techniques in conjunction with an A/D converter it would be possible to write software for a storage facility for an oscilloscope. The A/D converter would sample a given waveform, and store the data in a given block of RAM. The D/A converter could then be used to output the sequence repeatedly, and at any frequency and repetition rate, so as to provide a permanent display, with the option of recall facilities, etc. See Fig. 4.13.

Next month we will look at the use of the PSG on the Analogue Board, and discuss applications such as a 14-note organ operated from the UK101 keyboard. Details will also be given on the use of the Programmable Sound Generator as a 3-channel D to A converter

Readout...

A selection from our Postbag

Readers requiring a reply to any letter must include a stamped addressed envelope.
Opinions expressed in Readout are not necessarily endorsed by the publishers of Practical Electronics.

Excellent Combination

Sir—I have recently constructed a *PE* Congress amplifier from a kit supplied by Wicca, as a re-introduction to electronics after a fifteen year break. Apart from bridging two tracks in the phono stage, the unit worked first time. I must congratulate the designer(s) on the performance of this design—it really is incredibly good to listen to, and is capable of 'demolishing' a number of commercial units with a higher 'paper' performance.

I have only two small points of criticism. Firstly, the effectiveness of the balance control can only be described as minimal. I can find no fault in the construction, so can you advise? The second problem (about which I intend to speak to Wicca) is transformer hum, which, in an amplifier that generates so little noise internally, is very noticeable. Perhaps a toroidal unit would have been worthwhile?

My second reason for writing is to give a pat on the back to a company which has given me superb service. Some six months ago, I purchased a pair of Videotone GB3 speakers through the *PE* Special Offer. These were used a few times on an old stereo record player which at best could be described as poor, but did play old records, so I took little notice of the poor sound. When I had completed the Congress, I connected the GB3 units, and with a decent input to them, it was immediately obvious that one tweeter was inoperative.

I telephoned Videotone and explained the problem, which they suggested may have been caused by clipping on the old amplifier (which I doubt as I treated the unit very carefully in deference to its meagre output), but they took my address and offered to supply a new tweeter under warranty. It duly arrived and was installed, and the speakers were connected. The performance of those tiny (and cheap) boxes is a revelation. There is ample bass during the day with a little boost, but the real beauty is at night. With the bass rolled off a little, the sound quality is retained without annoying the neighbours. Try doing that with the bus-sized speakers that so many people seem to think necessary. In any normal residence, the Congress and GB3 pairing will be found capable of generating excrutiating volume without distortion, even to those with 'disco-ears'.

To any reader who may have built a Congress, I would say without hesitation, "hang on a pair of GB3s, you will not believe your ears". I bought the GB3s on the strength of an earlier auditioning of the older 'Minimax', which was very good, but not, I believe, in the same class as the GB3. As for the service from Videotone, what can I say except "thank you".

S. G. West,
Northampton.

Noddy Radio

Sir—As a reader of your magazine I would be quite content if the sickeningly over-exposed letters "CB" appeared never again. I have no enthusiasm for citizens band radio, and I suspect that 99% of the population of this country is similarly disinterested.

What we have is a verbose minority creating a furore over what is, after all, Noddy radio. I am prepared to tolerate occasional breakthrough on my domestic equipment when it is the police going discreetly about their business—or even a local taxi firm.

However. I see no reason why I should endure prolonged breakdowns when I am trying to take in the news, just so that an immature "citizen" can tell the world he is called Rubber Duck and he doesn't like "bears".

I have no doubt that should this band be allowed, every ten years or so it will become involved in some small way with a murder hunt, and then we shall hear of the wonderful contribution CB makes to society. Why should a respectable magazine like *Practical Electronics* jump on this bandwagon?

As far as I'm concerned, CB should be allowed only on microwave at 1mW so that nobody can use it!

Peter Bleck,
London.

Sir—I see that you have published a CB converter in your March issue. I already have a converter and I see from your editorial in the February issue that I need a licence to listen to it. As I cannot obtain a licence to listen to CB, *how* can I be prosecuted for not having something I cannot obtain anyway?

It is also illegal to transmit on CB, so therefore there is nothing to listen to. So how can I be prosecuted for listening to something that is not there in the first place?

This seems to me to be a ridiculous situation and the sooner the government comes up with some *sensible* licensing ideas, the sooner it will be getting more money to help with the running of the country.

Little T,
Leicester.

Sir—Your editorial seeking views on listening to—for example—CB on 27 MHz raises a wider question. Has any government the moral right to forbid us to listen to any available radio transmission? There may be perfectly justifiable reasons for restricting *transmission* (e.g. CB) but it must surely be a fundamental right to *listen* to any broadcast information in an intelligible form.

The obvious exception is on security grounds, e.g. police radio—but the enterprising criminal is hardly likely to be deterred by the Wireless Telegraphy Acts more than, say, the Theft Act!

If the originator of a message chooses an inherently public medium such as radio the onus is on him to adopt a cryptic method of transmission. If an illicit broadcaster gets on the air it is the business of the authorities to stop him, not to tell us not to listen, as do totalitarian regimes. Even those who practice press censorship tend to go for the publisher rather than the reader!

D. B. Lyall,
Cheltenham.

Alive and Kicking

Sir—As the new chairman of the Amateur Computer Club I would like to clarify the current position of the ACC, and in particular its future. I feel that your readers, many of whom are interested in home computing will be interested to learn of the current position of the ACC.

I am pleased to announce that the ACC is now very much alive and kicking following a somewhat dormant period last year. The ACC is a national organisation to promote interest in amateur computers and computing, to facilitate the exchange of information and ideas, and to help members with their home computer systems. Annual membership is £4·50.

I would also like to mention a few other points. Firstly, last year the ACC year was extended to September '80. The new year started on October 1st and runs until 30th September '81. Secondly, it is hoped to set up regular contact with the journals and to keep them informed of the activities of the ACC.

Peter Whittle,
Chairman—ACC,
1 Blinco Road,
Urmston,
Manchester.

Micro Bus Error

Sir—Congratulations for your excellent 'Micro Bus' series, but why not every month? Having tried the *Draughts Board* game in *February 81* issue (for the ZX80) I would like to point out a couple of small (but very important) errors (probably printing errors!):

Line 30 should read: **PRINT "12345678"** *Space after the eight*, and Line 300 . . . **OR (X=13 AND TL$ (A$)="R") OR NOT...** *Bracket close after "R"*

Having just spent a Sunday afternoon finding the missing space, I hope this might save someone else the trouble. There has been some gain though, at least I now know how the program works, which I admit I wouldn't have if it had worked straight away!

P. Holton,
Upper Norwood,
London.

PE Microtune

Sir—I have read with interest your project Microtune, in the Dec-Jan editions of your magazine, and was impressed by the technical specifications and useful functions available on what is quite a reasonably priced machine.

It is good to note that your magazine is aware of the importance of the correct adjustments to the ignition system of the modern motor car and that this equipment makes such adjustments an easy task. Using this equipment carefully should enable the builder to recover the cost of it in improved fuel consumption and smoother running in a very short time.

On reading the section "USING THE MICROTUNE", I would like to comment on a few points that I feel may cause confusion with an operator who is not fully conversant with car electrical systems and I hope that my comments may be of use.

In the section "Battery Checking" the test that is suggested is a good test but I feel that the duration of the test should be limited to 15 seconds as the time of 30 seconds quoted I consider too long and could result in the premature condemning of a serviceable battery. An extra check that could be incorporated into this section is a check on coil SW voltage. On a 12 volt coil system the voltage at the SW terminal should be no more than 0·5 volt lower than the battery voltage. A higher volt loss could be due to a faulty ignition switch or connections in the coil feed. On a ballast system the voltage should be between 5 and 8 volts; a reading higher or lower could indicate a wrong coil fitted or a high resistance in ballast resistor or wiring. These checks are carried out with the contacts closed and ignition on. With the engine being cranked over, this voltage at the SW terminal should be a minimum of 9 volts. With a ballast system a voltage of, say, 5 volts would indicate a fault in the boost circuit between solenoid and coil.

Coil resistance tests are extremely useful, particularly when trying to find out if a car has the right coil fitted. The most usual figures are 3 to 3·5 ohms for a 12 volt coil and 1·5 ohms for a ballast coil. Most ballast resistors are 1·5 ohms and on some cars it is possible to check this also.

The section on points resistance is perhaps the most useful section, and it is important to get this figure down as low as possible. The figures quoted by distributor manufacturers vary between 0·1 volt and 0·4 volt. The Lucas figure of 0·2 volt can be considered as one to aim for. Good starting and coil output depend on a low volt loss here and to some extent condenser performance can also be affected. Things to look for are faults in plug-in connectors in the wiring, burnt or dirty contacts and distributor base plate earth faults.

Dwell angle on modern cars is around 50° and typical figures quoted are Motorcraft 48 to 52° on Ford vehicles, 46 to 56° by Lucas on most Leyland vehicles and 49 to 51° by Delco fitted to Vauxhall cars. These figures are all for 4 cylinder engines. Owing to the fact that altering the dwell angle by 5° alters the ignition timing by 5°, it is important to check and adjust the ignition timing after any distributor adjustments.

M. J. Stacey,
TI Transport,
PO Box 8,
High March,
Daventry,
Northants.

Going too far?

Sir—In view of the recent interest in CB, I think you may be interested to learn of an article which appeared in a recent issue of the medical newspaper *Doctor*.

The article concerns an incident in Preston, when a CB group donated £560 to the intensive care unit of a local hospital to buy some urgently needed equipment. The doctor who had accepted the donation was shocked when the hospital management refused the gift and ordered inquiries into the donors.

The article states: "An embarrassed Dr Saltpepper said 'After the DMT's final decision I was informed that it is not advisable for members of staff to associate with unlawful organisations.' He had not realised that the CB group—many of whom are ambulancemen—was unrecognised as a charitable body because CB radio is illegal."

D. M. Broughton,
Leeds.

PATENTS REVIEW...

Copies of Patents can be obtained from:
the Patent Office Sales, St. Mary Cray, Orpington, Kent. Price £1·25 each.

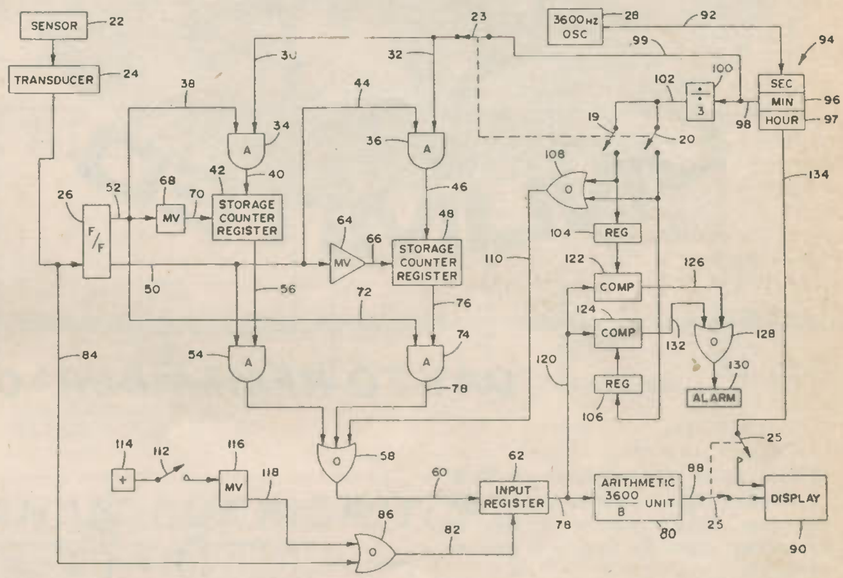


Figure 3

FINGER ON THE PULSE

The national obsession with jogging, and the health risks involved, is producing a spate of patents for gadgets which monitor the wearer's pulse rate and heart beat. The latest, British patent application 2 039 434, from Patrick Wright of Woking, Surrey and Julian Lynn-Evans of Chichester, Sussex, describes a sophisticated monitor which is worn like a watch on the wrist to give a constant digital readout of heart beat and sound an alarm if a dangerously high rate is reached.

The unit shown in Figures 1 & 2 has a transducer 16 and pressure sensor 13 on the rear face which lies over the wrist pulse point. Normal pulse rate is around 72 pulses per minute and the inventors suggests that in general, exercise should be controlled to keep the rate down to below 120ppm.

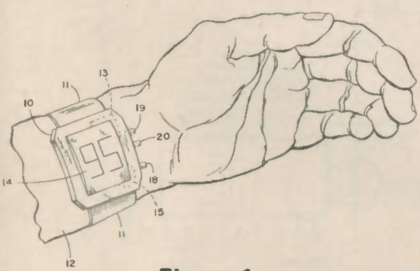


Figure 1

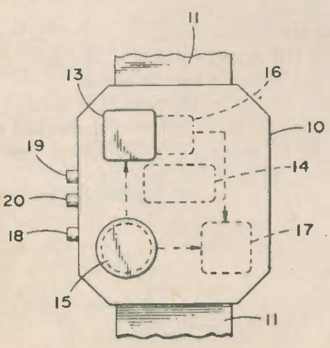


Figure 2

Figure 3 shows the basic circuit for utilising the pressure sensor output. Oscillator 28 produces a 3600Hz signal on line 92 coupled to clock 94. Heart beat rate is determined by the formula

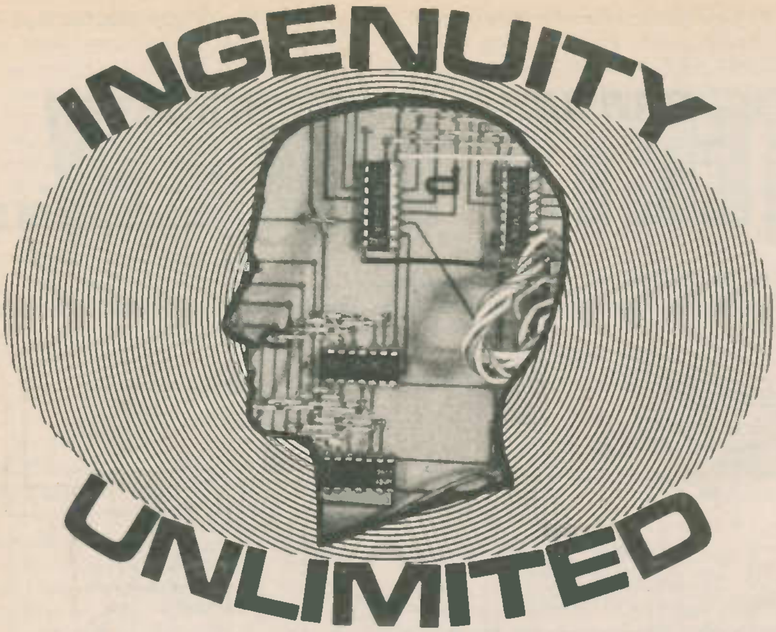
$$H = \frac{3600}{B}$$

where H = heartbeat rate and B = the number of oscillator pulses stored between heart beats. So if 60 pulses are stored between heart beats, a rate H, of 60 beats per minute is represented and if 120 are stored between beats a rate H, of 30 beats per minute, is represented. Clock circuit 94 is a conventional second, minute, hour, clock and its 60 pulse per second output on line 98 is fed to AND gates 34, 36. These gates are enabled by a signal from flip-flop 26 which changes state each time a pulse is received from transducer 24. When the sensor 13 is in contact with the wearer's pulse pressure point it produces a pulse each time a heart beat is detected so flip-flop 26 changes state with the wearer's heart beat.

With the appearance of each heart beat one of two counters 42, 48 begins to store pulses from oscillator 28 until the next heart beat is sensed. At that instant the 60Hz pulses from clock 94 are transferred from the first counter to the second counter, while the output of the first counter is coupled to input register 62. So the number of pulses occurring between heart beats is stored alternately in counters 42, 48 and transferred alternately to input register 62. Arithmetic unit 80 is programmed to divide 3600 by whatever count is stored in register 62. The output of unit 80 is coupled to numerical display 90. So the wrist watch unit provides a constant monitor of heart beat rate.

To sound the alarm for an excessively high rate, a pre-set number of oscillator pulses is stored in a register for comparison with the sensed rate. Switches 19, 20 couple the output of divider circuit 100 to storage register 104 and 106. As these switches are held closed, pulses are fed into the registers at 20 pulses per second and until required upper and lower limit heart beat rates are stored. Switch 19 is depressed to store the upper rate and switch 20 is depressed to store the lower rate.

Comparators 122, 124 receive the same input signals as arithmetic unit 80 from input register 16. Comparator 122 produces an output for OR gate 128 if the monitored heart beat is greater than the number of pulses stored in register 104. Likewise if the monitored number of pulses is less than the number stored in register 106, comparator 124 produces an output for OR gate 128. In each case an alarm 130 is activated to warn the wearer.



A selection of readers' original circuit ideas. It should be emphasised that these designs have not been proven by us. They will at any rate stimulate further thought.

Each idea submitted must be accompanied by a declaration to the effect that it has been tried and tested, is the original work of the undersigned, and that it has not been offered or accepted for publication elsewhere.

Why not submit *your* idea? Any idea published will be awarded payment according to its merits.

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

'DAY TO REMEMBER' CLOCK

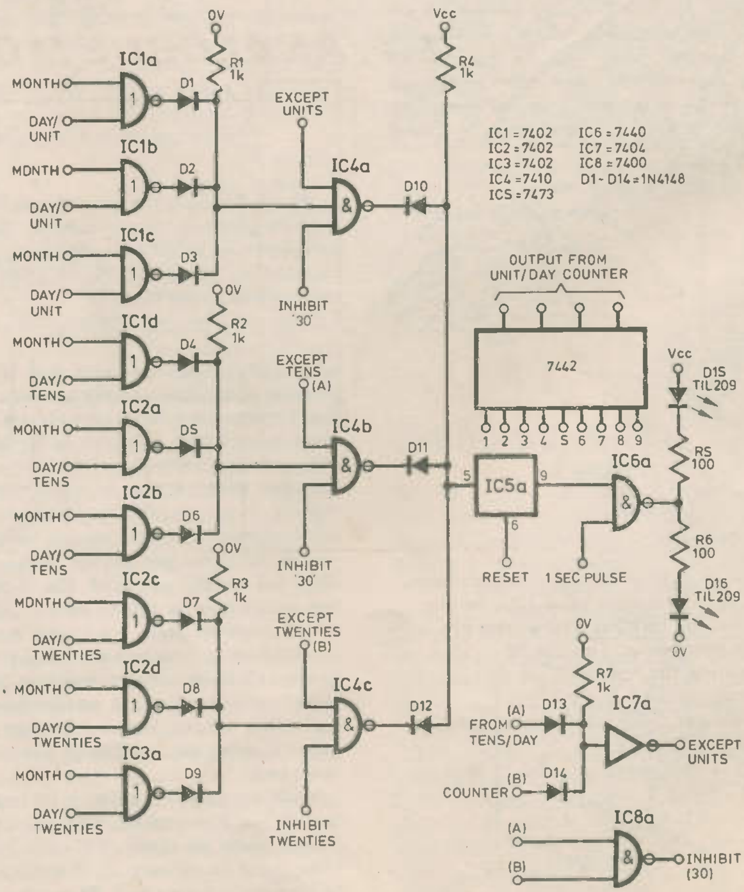
THIS circuit is an add on unit to D. E. Clarke's Digital Calendar published in *PE* June 1976. It provides a 'Day To Remember' alarm for birthdays, anniversaries, etc.

The NOR gates inputs are wired up to the required outputs from the 74154 on the digital calendar and the 7442. I have divided the unit up into three groups of three NOR gates, DAY/UNIT/MONTH, DAY/TENS/MONTH, DAY/TWENTIES/MONTH. If the day to remember is the 16th March, then the middle set of gates would have one of its inputs connected to the 3rd output on the 74154 and the other input connected to the 6 output on the 7442.

When the clock indicates this date both inputs would go to '0', feeding a '1' to the 7410 gate, as the date is the 16th, and not the 6th, or the 26th, 'except tens' will be at '1' and the 'inhibit 30' will also be at '1', then a '0' will be fed through and trigger the 7473. This will remove the inhibit from the 7440 and let the 1 sec. pulse through to switch the l.e.d.s on and off. The 7473 is reset by a '0' on pin 6; this will cause pin 9 to restore the inhibit and stop the l.e.d.s switch on and off.

Obviously it would be of no point in setting up the clock to indicate the day on which the birthday or anniversary falls, therefore I have set my clock up for the alarm to come on 5 days before the event.

C. T. Chantler,
Grimsby,
South Humberside.



BARGRAPH THERMOMETER

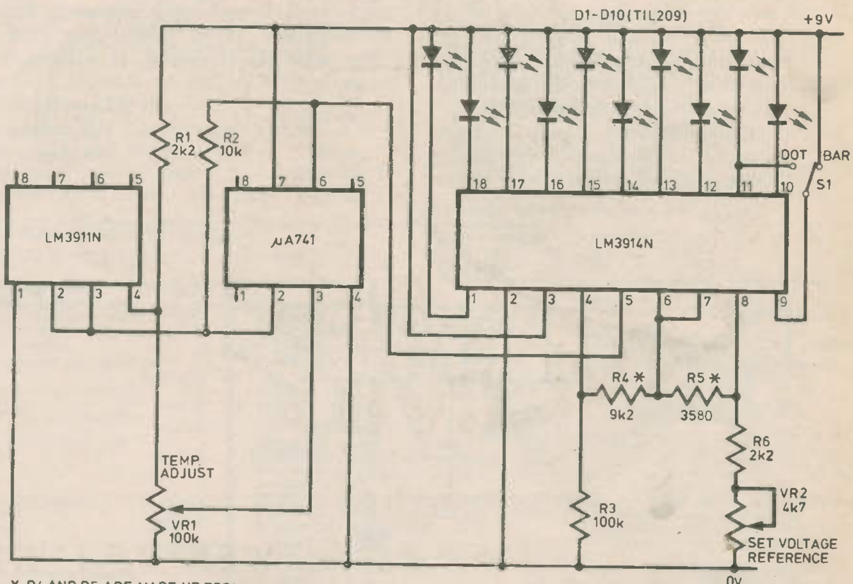
THE thermometer circuit shown will measure temperature in the range −25°C to +85°C. The LM3911 is used to sense the temperature and provides an output of 10mV/°k (10mV/°C). Therefore at −25°C (248°k) the output is 2·48V and at +85°C (358°k) 3·58V.

This output, though, goes negative on temperature increase, and is so inverted by the 741 op-amp. VR1 can be used to adjust the final reading on the display.

The LM3914 is an i.c. that senses analogue voltage levels and drives to l.e.d.s, providing a linear analogue display. The current for each l.e.d. is programmable and in this case is set at approximately 10mA. The i.c. uses a resistive divider network, one end of which is set to the high reference, the other end to the low reference. For this application they are set to 3·58V and 2·48V respectively. These being adjustable by VR2. The divider therefore has 1·1V across it which means that another l.e.d. will light for every 110mV input, which corresponds to an 11°C temp. rise. The first l.e.d. will switch on at −14°C, the second at −30°C and so on up to +85°C.

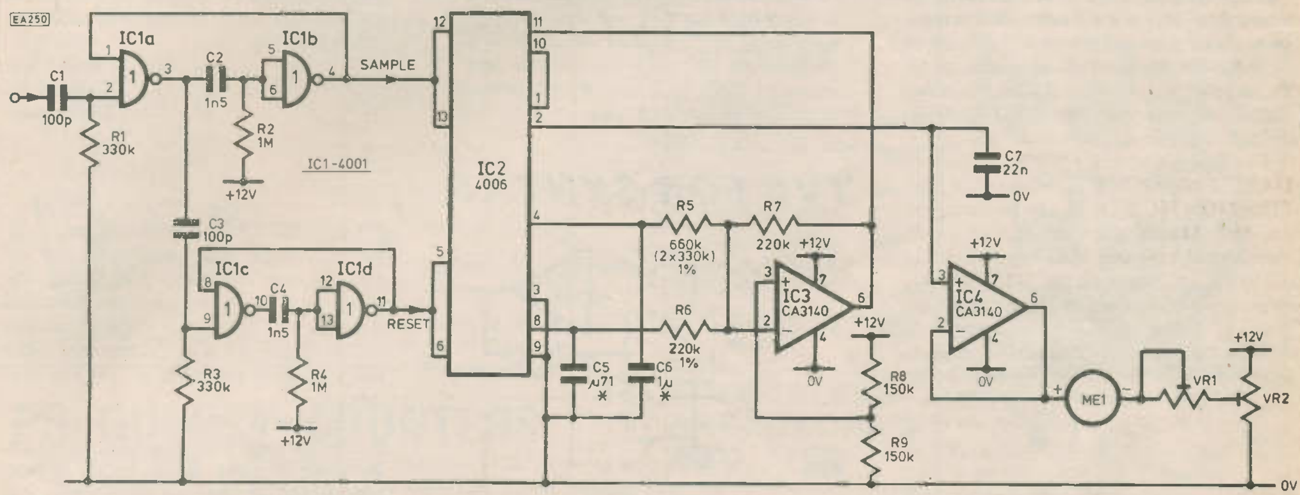
The mode switch selects whether previously lit l.e.d.s remain on as temp. increases, or whether only one l.e.d. remains on.

R. Eley,
Keynsham,
Bristol.



* R4 AND R5 ARE MADE UP FROM 8k2 AND 1k (R4) AND 3k3, 270, 10, (R5) FOR DIFFERENT SUPPLY VOLTAGES R1=(V⁺ −6·8)k

L.F. ANALOGUE MONITOR



MOST low frequency measurements, e.g. the human pulse rate, involve a compromise between a slow response and a pulsating output. This can be avoided by calculating the reciprocal of the interval between pulses. Done digitally, this is elegant, but costly enough in itself to increase the pulse rate!

My simple analogue circuit gives excellent linearity over a 4:1 or more frequency range. It relies on the fact that a CR charge will approximate a reciprocal. Combining two charge currents of different time constants in the right ratio gives a good approximation to linearity.

Here, R5 R6, C5 and C6 form the two RC networks, C5 and C6 charging towards an aiming potential $V_{DD} \times R9/(R8 + R9)$.

IC3 produces an output voltage proportional to the sum of the currents in R5 and R6. This is sampled and held, to drive the meter via IC4, each time a positive going pulse appears at the input to IC1a. Each such input pulse develops, via IC1a to d, a sample pulse for this purpose, followed by a reset pulse to discharge C5 and C6 and recommence the cycle.

The 4 channel switch IC2 performs the discharge and sampling. Sampling is via two gates in series to maximise leakage resistance. C8, which provides a double integrator in the open gate condition via the gate leakage resistances, is not needed at pulse rates higher than 30 per minute.

VR1 and 2, which control sensitivity and zeroing, can with many meter scales be set up for a direct indication of frequency.

The ratios R5/R6 and R5C5/R6C6 should ideally to correct within about 1%.

The supply voltage is not critical but should be reasonably stable since it affects sensitivity to some extent.

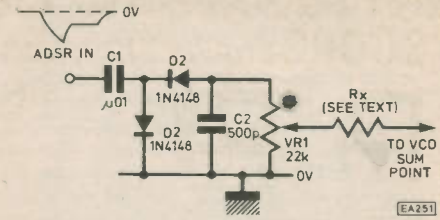
C. J. Collins,
Letchworth,
Herts.

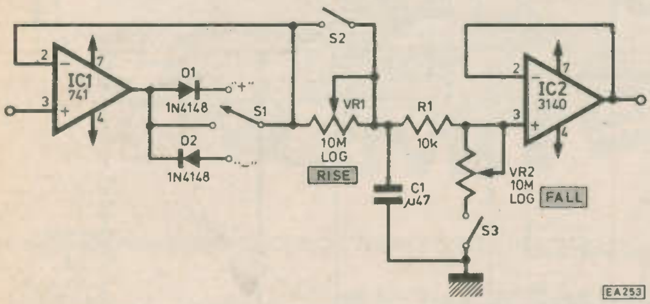
ENVELOPE DIFFERENTIATOR

MOST monophonic lead line synthesisers have provision for modulation of the VCOs by other oscillators to give vibratos and trills, but few use the ADSR envelope output because of the difficulty in tuning caused by sustained portions of the envelope. The circuit described here converts an ADSR envelope into an AD envelope, giving a 'chirp' at the beginning of every new envelope.

Capacitor C1 'differentiates' the changing envelope voltages, whilst diodes D1 and D2 ensure that only negative going AD envelopes reach the VCOs. VR1 controls the depth of VCO modulation. Rx is a resistor chosen to give acceptable maximum levels of modulation. For use in the *PE* Minisonic suitable values range from 100k to 470k, depending on individual tastes.

Martin Russ,
Fallowfield,
Manchester.





SYNTH PROCESSOR

THIS circuit was originally designed for use in a voltage-controlled synthesiser as a multi-purpose voltage processor, but it can be applied to many other uses.

The circuit consists of a peak detector made up of IC1 and the associated components, and a memory circuit made up of IC2 and the associated components.

Switches S2 and S3 are used to control the operation mode of the circuit. Controls VR1 and VR2 control the rate of change of the output voltage. Switch S1 controls the direction in which the circuit holds the peaks of the input voltage.

With S2 open the rise time of the circuit is determined by VR1 and the circuit now behaves as 'lag' circuit or integrator. If S3 is closed the fall time of the circuit is determined by VR2, S3 is opened for a memory hold or peak detector function. If S2 and S3 are closed and VR2 is set to its minimum value, the circuit acts as a voltage follower.

There are many applications of this circuit. In a voltage-controlled synthesiser, the lag processor and voltage follower are useful control-voltage modifiers, using the peak hold with a keyboard voltage can give unusual effects such as unidirectional portamento, where the glide speed varies with the direction of playing on the keyboard. For low frequency a.c. applications the circuit can be used as a rectifier and filter unit with the output being proportional to the 'average' of the input in a similar manner to the operation of an envelope follower.

Martin Russ,
Fallowfield,
Manchester.

TVC FOR SYNTHS

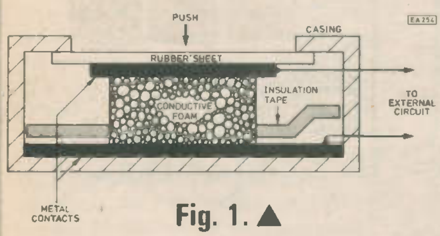


Fig. 1. ▲

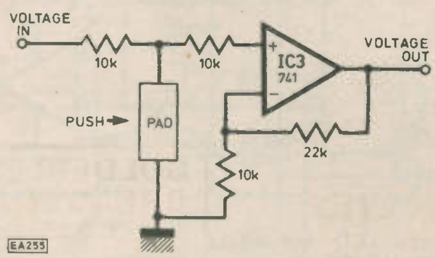


Fig. 2. ▲

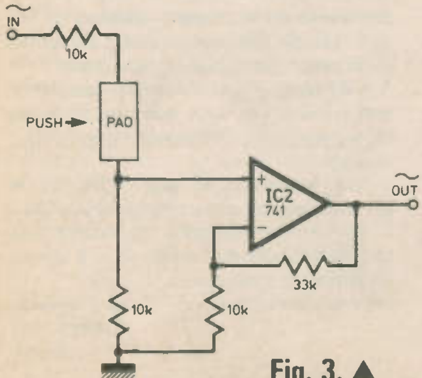


Fig. 3. ▲

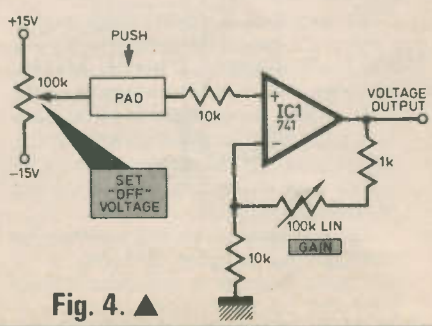


Fig. 4. ▲

COMMERCIAL performance synthesisers use many forms of man/machine interface. Of these, the pitch-pad is rarely seen on home produced synthesisers. The touch voltage control (TVC) described here enables the pitch pad idea to be applied to almost any synthesiser.

The basis of the circuit is the 'conductive' black foam used to pack CMOS i.c.s. By using a piece about 3 cms square, sandwiched between two metal sheets, it is possible to make a resistor whose value changes with pressure, from about 100k or more down to about 200 ohms.

Mechanical and electrical construction of the TVC pad is shown in Fig. 1. The prototype was constructed in a PP3 battery case from which the insides were removed and a rectangular hole cut in the side.

The pad can be used to replace any resistor in the control circuitry of the synthesiser, a few ideas are given in Figs. 2, 3 and 4. These are a voltage controller, volume control and attenuator respectively.

Martin Russ,
Manchester.

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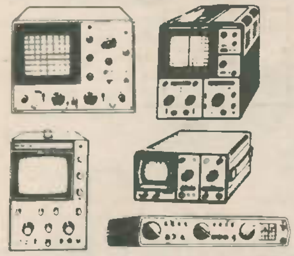
SCOPES

A range of Scopes in stock from 5mHZ Single Trace to 50mHZ Dual Trace. Mains and Battery/Mains Portables. Many on demonstration.



HAMEG ● TRIO ● LEADER ● SINCLAIR ● HITACHI

SINGLE TRACE (UK c/p etc £2·50)

Hm 307-3 10mHZ, 5mV, 6 × 7cm display plus component Test	£158·78
C01303D 5mHZ, 10mHZ, 7 × 7cm display	£109·25
SC110 10mHZ Battery portable, 10mV, 3·2 × 2·6cm display (Optional case £8·86, Nicads £8·63, Mains unit £4·00)	£158·95
*LB0512A 10mHZ, 10mV, 5" display	£195·50
CS1559A 10mHZ, 10mV, 5" display	£232·00
*V151 15mHZ, 1mV, 5" display	£241·50

OPTIONAL PROBES (ALL MODELS)

X1 £6·50, X10 £8·50, X100 £12·95, X1-X10 £10·95

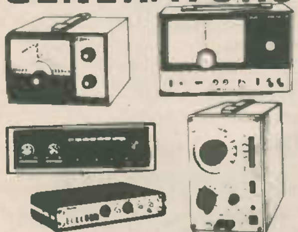
*PRICES INCLUDE FREE PROBE(S)

DUAL TRACE (UK c/p etc £3·50)

CS1562A 10mHZ, 10mV, 5" display	£267·00
CS1575 5mHZ, 1mV, 5" display	£284·00
Hm 312-8 20mHZ, 5mV, 8 × 10cm display	£253·00
CS1566A 20mHZ, 5mV, 5" display	£339·00
*LBO3085 70mHZ, 2mV, 5 × 6·3cm display, Battery/Mains portable, built in Nicads	£482·00
Hm 412-4 20mHZ, 5mV, 8 × 10cm display plus Sweep Delay	£399·50
CS1577A 35mHZ, 2mV, 5" display	£478·00
CS1830 30mHZ, 2mV, 5" display plus Sweep Delay Line/New Model	£569·00
Hm 512-8 50mHZ, 5mV, 10 × 8cm display, Delay Sweep	£667·00
*LB0514 10mHZ, 1mV (5mV), 5" display	£294·00
*V152 15mHZ 1mV 5" display	£326·60
*V302 30mHZ 1mV 5" display	£447·35
*V550 50mHZ 1mV 10 × 8cm Delay sweep + 3 channel display	£799·25

(UK C-P £1.75)

GENERATORS



TRIO ● LEADER ● CSC
SINCLAIR ● LEVELL

RF

A range of signal generators to cover audio RF and pulsing. Mains operated (TG series battery).

SG402 100KHZ-30mHZ with AM modulation	£68·00
LSG16 100KHZ-100mHZ (300mHZ on Harmonics)	£63·25
SG2030 250KHZ-100mHZ low cost range	£46·95
ARF300 18HZ-200mHZ Low cost range	£76·95

PULSE

2001 1HZ-100KHZ (Function)	£89.70
TG105 5HZ-5mHZ	£92.50
4001 0·5HZ-5mHZ	£109.25
TT100 (Function 10KHZ)	£90·85

AUDIO (All sine/square)

AG202A 20HZ-200KHZ	£69.00
LAG26 20HZ-200KHZ	£73.60
AG203 10HZ-1mHZ Sine/Square	£126.75
LAG120A 10HZ-1mHZ	£146.00

LOGIC PROBES/ MONITORS

Logic probes indicating high/low, etc, states that scopes can miss. All circuit powered for all IC's.

LP3 50 mHZ logic probe	£55·95
LP1 10 mHZ logic probe	£35·50
LP2 1½ mHZ logic probe	£19·95
LM1 Logic monitor	£33·00
LDP 50 mHZ Logic probe with case	£51·00

Also in stock range of Protoboard kits and breadboards.

PRO MULTIMETERS

M1200 100K/Volt 30 range plus AC/DC 15 amp	£67·00
K1400 20K/Volt 23 range large scale	£79·95
M1500 20K/Volt 42 range plus AC/DC 10 amp (UK c/p £1·20)	£53·50
K200 38 range FET 10m ohm input 20Hz to 30 MHz (UK c/p £1·50)	£95·00

SWR/FS AND POWER METERS

Range in stock covering up to 150mHZ and up to 1K watt power. PL259 sockets. 250UHZ Grid Dip.

SWR9 SWR/S 3-150mHZ	£9·50
SWR50 SWR/Power meter 3½-150mHZ 0-1000 watts	£13·95
110 SWR/Power 1½-144mHZ 0/10/100 watts	£11·50
171 As 110 Twin meter plus F/S	£14·50

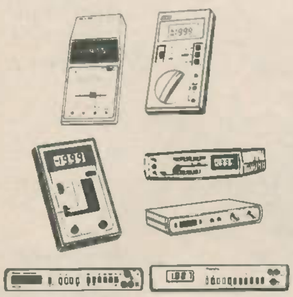
Plus large range of BNC/PL259/etc leads / plugs / adaptors / connectors always in stock.

176 SWR Power FS 1½-144mHZ, 5-50 watt	£16·60
KDM6 Grid Dip 1½-250mHZ	£38·50

DIGITAL MULTIMETERS

A range of LED and LCD Bench and Hand DMM's battery operated with optional Mains Adaptors—some with optional Nicads. All supplied with batteries and leads.

KAISE ● SINCLAIR ● LASCAR ● THURLBY



HAND HELD (UK post etc 85p)

TM352 3½ Digit LCD plus 10ADC and Hfe checker	£54·95
TM354 3½ digit LCD 2A AC/DC	£45·94
ME502 3½ Digit LED plus 10A DC and Hfe checker	£43·95
LM2001 3½ Digit LCD 2 amp AC/DC 0·1%	£51·70
6200 3½ Digit LCD 0·2A AC/DC, Auto range	£45·95
6220 As 6200 plus 10A AC/DC	£55·95
6100 As 6200 plus Cont. test/range hold	£69·95
6110 As 6100 plus 10A AC/DC	£85·95
GL35C 3½ digit LCD 1A AC/DC with case	£37·50

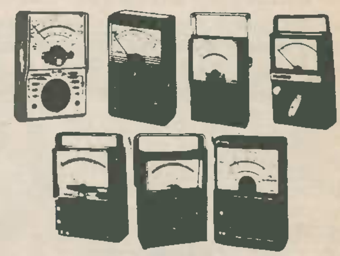
BENCH PORTABLES (UK c/p £1·00)

DM235 3½ Digit LED 21 ranges, 0·5% AC/DC 2A	£60·38
DM350 3½ Digit LED 34 ranges, AC/DC 10A	£83.38
TM353 3½ Digit LCD AC/DC 2 amp	£96·60
TM351 3½ Digit LCD AC/DC 10 amp	£113·85
LM100 3½ Digit LCD AC/DC 2 amp	£86·50
DM450 4½ Digit LED 34 ranges, AC/DC 10 amp	£113·85

(DM series options: Carry case £8·86, Nicads £8·63, Mains adaptor £4·00.)

MULTIMETERS

(UK post etc 75p)



KRT101 1K/Volt 10 range pocket	£4·60
ATM1/LT1 1K/Volt 12 range pocket	£5·98
NH55 2K/Volt 10 range pocket	£6·50
AT1 2K/Volt 12 range pocket de luxe	£7·75
NH56 20K/Volt 22 range pocket	£11·95
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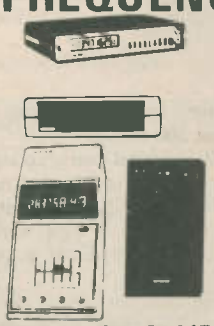
AT1020 20K/Volt 19 range de luxe plus hfe test	£16·95
7081 50K/Volt 36 range plus 10 amp DC	£20·80
TR303TR 20K/Volt + 12A DC + HFE test	£18·95
AT20 20K/Volt 21 range de luxe plus 10A DC and 5KV DC	£21.95
AT205 50K/Volt 21 range de luxe plus 10A DC	£24·95
7080 20K/Volt 26 range large scale, 10A DC plus 5KV AC/DC	£26·95
AT2050 50K/Volt 18 range de luxe plus hfe test	£28·50
AT210 100K/Volt 21 range de luxe 12A AC/DC	£29·95
360TR 100K/Volt 23 range plus hfe checker and AC/DC 10 amps	£34·95

FREQUENCY COUNTERS



Portable and Bench LCD and LED Counters up to 600mHZ. Prices include batteries and leads.

HAND HELD (UK post etc 85p)

PFM200 20HZ to 200mHZ 8 Digit LED	£52·27
MAX50 100HZ to 50mHZ 6 Digit LED	£61·00
MAX550 30KHZ to 550mHZ 6 Digit LED	£106·00

BENCH PORTABLES

(UK c/p £1·00)

MAX100 8 Digit LED 5 HZ to 100mHZ	£89·00
TF200 8 Digit LCD 10HZ to 200mHZ	£166·75
7010A 9 Digit LED 10HZ to 600mHZ	£169·00
200SPC 6 Digit 100mHZ LED built into 0·002HZ to 5·5mHZ pulse generator	£437·00
TP600 600mHZ Prescaler for TF200	£43·13
TF040 8 digit LCD 20 MHz	£126·50

CSC ● SINCLAIR ● SPC ● OPTO ELECTRONICS

SOLDERLESS BREADBOARD AND KITS

EXP350	£3·45
EXP300	£5·95
EXP650	£3·95
EXP600	£6.50

KITS

PB6	£9·95
PB100	£12·95
PB101	£17.95

(UK c/p – EXP's 30p. KITS 55p)

MINI DRILLS AND KITS

(9-12 Volt ⅛" chucks)

Small Drill plus 3 collets	£7·25
Medium Drill plus 3 collets	£10·50
Small Drill plus 20 tools	£14·95
Medium Drill plus 20 tools	£17·95
Mains Drill	£13·95
Mains Drill plus 20 tools	£21·50

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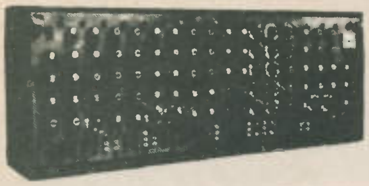
D.I.Y. KITS FOR SYNTHESISERS, SOUND EFFECTS



BASIC COMPONENTS SETS include all necessary resistors, capacitors, semiconductors, potentiometers and transformers. Hardware such as cases, sockets, knobs, keyboards, etc. are not included but most of these may be bought separately. Fuller details of kits PCBs and parts are shown in our lists.

LAYOUT DIAGRAMS are supplied free with all PCBs unless "as published".

PHONOSONICS

MAIL ORDER SUPPLIERS OF QUALITY PRINTED CIRCUIT BOARDS, KITS AND COMPONENTS TO A WORLD-WIDE MARKET

P.E. MINISONIC MK2 SYNTHESISER

A portable mains operated miniature sound synthesiser with keyboard circuits. Although having slightly fewer facilities than the large Formant and P.E. synthesisers the functions offered by this design give it great scope and versatility.

Set of basic component kits (excl. KBD R's & tuning pots – see list for options available) and PCBs (incl. layout charts) — KIT 38-25 **£80.14**
"Sound Design" booklet — **£1.00**

P.E. 128-NOTE SEQUENCER

Enables a voltage controlled synthesiser to automatically play pre-programmed tunes of up to 32 pitches and 128 notes long. Programs are keyboard initiated and note length and rhythmic pattern are externally variable.

Set of basic comps, PCBs and charts — KIT76-7 **£35.56**
Set of text photocopies — **£1.36**

P.E. 16-NOTE SEQUENCER

Sequences of up to 16 notes may be programmed by the use of external panel controls and fed into most voltage controlled synthesisers.

Set of basic comps, PCBs and charts — KIT 86-5 **£32.10**
Set text photocopies — **£1.84**

P.E. STRING ENSEMBLE

A multivoiced polyphonic string instrument synthesiser.

Set of basic comps, PCBs & charts — KIT 77-8 **£109.72**

ELEKTOR PHASING & VIBRATO

Includes manual and automatic control over the rate of phasing & vibrato, and has been slightly modified to also include a 2-input mixer stage.

Set of basic comps, PCB & chart — KIT 70-2 **£21.67**
Text photocopy — **67p**

ELEKTOR FORMANT SYNTHESISER

A very sophisticatged synthesiser for the advanced constructor who puts performance before price.

Set of basic comps, PCBs (as publ.) — KIT 66-14 **£255.45**
Set of text photocopies — **£7.83**

ELEKTOR DIGITAL REVERB UNIT

A very advanced unit using sophisticated i.c. techniques instead of mechanical spring lines. The basic delay range of 24 to 90mS can be extended up to 450mS using the extension unit. Further delays can be obtained using more extensions.

Main unit basic comps and PCB (as publ.) — KIT 78-3 **£49.95**
Extension unit basic comps and PCB (as publ.) — KIT 78-4 **£39.95**
Text photocopy — **86p**

ELEKTOR SEWAR

For use with Elektor Analogue Reverb to give greater flexibility to the reverb effects.

Basic comps, PCB (as publ.) — KIT 101-1 **£18.19**
Text photocopy — **60p**

ELEKTOR RING MODULATOR

Compatible with the Formant & most other synthesisers.

Set of basic comps & PCB (as publ.) — KIT 87-2 **£6.84**
Text photocopy — **38p**

ELEKTOR CHOROSYNTH

A 2½-octave Chorus synthesiser with an amazing variety of sounds ranging from violin to cello and flute to clarinet amongst many others. Experienced constructors can readily extend the octave coverage.

Basic comps, PCBs and charts but excl. sw's — KIT 100-8 **£44.39**
Text photocopy — **70p**

ELEKTOR ANALOGUE REVERB

Using i.c.s instead of spring-lines the main unit has a maximum delay of up to 100mS, and the additional set extends this up to 200mS. May be used in either mono or stereo mode.

Main unit basic component set — KIT 83-4 **£29.23**
Additional Delay basic components — KIT 83-2 **£20.07**
PCB (as publ.) to hold both kits included in Kit 83-4
Text photocopy — **67p**

ELEKTOR FUNNY TALKER

Incorporates a ring modulator, chopper & frequency modulator to produce fascinating sounds when used with speech & music signals.

Basic comps, PCB (as publ.) — KIT 99-1 **£9.60**
Text photocopy — **40p**

ELEKTOR FREQUENCY DOUBLER

For use with guitars & other electronic instruments to produce an output one octave higher than the input. Inputs and outputs may be mixed to give greater depth.

Basic comps, PCB (as publ.) — KIT 98-1 **£5.48**
Text photocopy — **20p**

P.E. SPLIT-PHASE TREMOLO

A simple but effective substitute for a rotary cabinet. The output of an internal generator is phase-split and modulated by an input signal from an electronic guitar or other instrument. Output amplitudes, depth & rate are variable. May be fed to one or two amplifiers.

Basic comps, PCB & chart — KIT 102-3 **£17.68**
Text photocopy — **65p**

P.E. MINISONIC WAVEFORM CONVERTER

A simple converter that modifies the Minisonic sawtooth waveform to produce triangle and sine outputs. Ideally one should be used with each Minisonic VCO.

Basic comps, PCB & chart — KIT 96-1 **£3.98**

P.E. GUITAR MULTIPROCESSOR

An extremely versatile sound processing unit capable of producing, for example, flanging, vibrato, reverb, fuzz and tremolo as well as other fascinating sounds. May be used with most electronic instruments.

Set of basic comps, PCBs & charts (excl. SWs) — KIT 85-5 **£49.23**
Set of text photocopies — **£2.52**

P.E. PHASER

An automatically controlled 6-stage phasing unit with Integral oscillator.

Basic components, PCB & chart — KIT 88-1 **£10.91**
2-Notch extension, PCB & chart — KIT 88-2 **£6.36**
Text photocopy — **68p**

ELEKTOR ELECTRONIC PIANO

A touch-sensitive multiple-voicing piano using the latest integrated circuit techniques for the keying and envelope shaping, and virtually eliminating "bee-hive" noise hitherto inherent in previous electronic pianos.

5-octave set of basic comps and PCBs (as publ.) — KIT 80-9 **£149.42**
Additional 3-octave extension and basic parts and PCBs (as published) — KIT 80-10 **£58.32**
Set of text photocopies — **£1.81**

P.E. GUITAR EFFECTS UNIT

Modulates the attack, decay and filter characteristics of a signal from most audio sources, producing 8 different switchable effects that can be further modified by manual controls.

Basic comps, PCB & chart — KIT 42-3 **£10.60**
Text photocopy — **28p**

P.E. GUITAR OVERDRIVE

Sophisticated versatile fuzz unit incl. variable controls affecting the fuzz quality whilst retaining attack and decay, and also providing filtering. Usable with most electronic instruments.

Basic components, PCB & chart — KIT 56-3 **£11.22**
Text photocopy — **68p**

P.E. SMOOTH FUZZ

Basic components, PCB & chart — KIT 91-1 **£6.52**
Text photocopy — **56p**

TREMOLO UNIT

A slightly modified version of the simple P.E. unit.

Basic components, PCB & chart — KIT 54-1 **£3.74**

GUITAR FREQUENCY DOUBLER

A slightly modified and extended version of the P.E. unit.

Basic components, PCB & chart — KIT 74-1 **£5.19**
Text photocopy — **39p**

P.E. GUITAR SUSTAIN

Maintains the natural attack whilst extending note duration.

Basic components, PCB & chart — KIT 75-1 **£6.99**
Text photocopy — **38p**

P.E. AUTO-WAH UNIT

Automatically gives Wah or Swell sounds with each note played.

Basic components, PCB & chart — KIT 58-1 **£10.11**
Text photocopy — **58p**

ELEKTOR WAVEFORM CONVERTER

Converts a saw-tooth waveform into sinewave, mark-space saw-tooth, regular triangle, or square-wave with variable mark-space.

Basic comps, PCB & chart, but excl. sw's — KIT 67-1 **£9.24**

P.E. SWITCHED TONE TREBLE BOOST

Provides switched selection of 4 preset tonal responses.

Basic components, PCB & chart — KIT 89-1 **£4.34**
Text photocopy — **78p**

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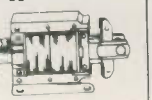

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Short Lever type 16amp. rating (Grouzet) **£4.00** (**£4.60** incl VAT)
Roller Type (Bonnella) 10 for **£3.50.** (**£4.03** incl. VAT). N.M.S.
D.P. C/O lever m/switch mfg. by Cherry Co. USA. Precious metal low resistance contacts. 10 for **£2.25** P. & P. 30p. Total inc. VAT **£2.93** (min. 10). N.M.S.

SOLID STATE EHT UNIT

Input 230V ac. Fully isolated output 10mm spark. Approx. 15Kv. Built in 10 sec. Timer. Easily modified for 20 sec, 30 sec, to a continuous operation.
Designed for boiler ignition. Dozens of uses in the field of physics and electronics, eg. supplying neon or argon tubes etc., EHT, starter or laser xenons csr lamps VAN de GRAFF generator, loss of vacuum detector, OUDINI coils etc.
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A.E.G. CONTACTOR

Type LS6/L11. Coil 240V 50 Rs. Contacts – 3 make: 600V: 20amp. 1 break: 600V: 20 amp. Price: **£5·50** + 50p P. & P. (**£6·90** inc. VAT & P.). N.M.S.

ARROW-HART MAINS CONTRACTOR, Cat. No. 130A30. Coil 250V. or 500V. A.C. Contacts. 3 make 50 amp up to 660V. A.C. 20 h.p. at 440V. 3 phase 50 Hz. Price: **£7.75** + p. & p. £1.00 (incl. VAT. total: **£10.06**). N.M.S.

SMITH BLOWER

Type FF8. 1706. Small, quiet, smooth running. 240V. A.C. operation. Output aperture 45×40cm. Overall size 135×165 cm. Flange mounting. Price: **£4.25.** P.&P. 75p. (Total: **£5.75** inc. P. & VAT. N.M.S.
Other types available. S.A.E. for details

CENTRIFUGAL BLOWER UNIT

Powered by GEC 230/250V, 2850 r.p.m. motor producing approx. 120 c.f.m. Aperture 65x90mm. Overall size 222×225 ×195mm. Incl: Starter Capac. Price: **£16.00** + £2.00 p. & p. (Total incl: VAT **£20.70**) N.M.S.

24 volt. D.C. BLOWER UNIT

Precision 24 volt. D.C. 0·8 amp Blower that works well on 12V 0·4 amp D.C. Producing 30 cu.ft. min at normal air pressure. **£4.50** P. & P.75p (inc. VAT £6·04). N.M.S.

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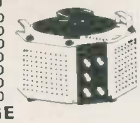
Test to I E E Spec Rugged metal construction suitable for bench or field work constant speed clutch Size L 8in W 4in H 6in weight 6lb. 500V. 500 megohms, £49.Post 80p (£57·27 Inc. VAT & P.). 1,000V 1,000MΩ, £55. Post 80p (£64·17 Inc. VAT & P. SAE for leaflet.

Yet another outstanding offer.

IMFD 600V Dubilier wire ended capacitors. N.M.S
10 for **£1·50** p&p 50p. (**£2·30** inc VAT + p&p) (Min 10)

VARIABLE VOLTAGE TRANSFORMERS

INPUT 230/240V a.c. 50/60 OUTPUT 0-260V



200 watt (1 amp inc. a.c. voltmeter	£14.50
0.5 KVA (2½ amp (MAX)	£18.00
1 KVA (5 amp MAX)	£24.00
2 KVA (10 amp MAX)	£39.00
3 KVA (15 amp MAX)	£47.00
5 KVA (25 amp MAX)	£76.00
10 KVA (50 amp MAX)	£168.00
15 KVA (75 amp MAX)	£260.00

3-PHASE VARIABLE VOLTAGE TRANSFORMERS

Dual Input 200-240V, or 380-415V. Star connected.

3KVA 5 amp per phase max.	£106.43	Carriage, packing & VAT extra.
6KVA 10 amp per phase max.	£159.37	
10KVA 16 amp per phase max.	£327.43	

LT TRANSFORMERS

13-0-13V at 1 amp £2.50 P. & P. 50p (**£3.45** inc. VAT)
0-15V 24 amp 0-30 at 12 amp £20.40. plus P. & P. £2.30. Total Incl. VAT £26.11.
0-6V/12V at 20 amp £16.20 P. & P. £1.00 (**£19.78** inc. VAT)
0-12V at 20 amp or 0-24V at 10 amp £14.90 P. & P. £1.50 (**£18.86** inc. VAT & P.)
0-6V/12V at 10 amp **£9.10** P. & P. £1.50 (**£12.19** inc. VAT)
0-6V/12V/17V/18V/20V at 20 amp **£20.90** P. & P. £2.00 (**£26.34** inc. VAT & P.).
0-10V/17V/18V at 10 amp **£11.55** P. & P. £1.80 (**£15.35** inc. VAT)
Other types in stock; phone for enquiries or send sae for leaflet.

HY-LIGHT STROBE KIT MK IV

Latest type Xenon white light flash tube. Solid state timing and triggering circuit 230/240V a.c. operation. Designed for larger rooms, halls, etc. Speed adjustable 1–20 f.p.s. Light output greater than many (so called 4 Joule) strobes. Hy-Light Strobe Kit Mk IV. **£22.00** + £1.50 P & P (incl. VAT total **£27.03**). Specially designed case and reflector for Hy-Light **£9.00.** Post £1.50 (**£12.08** incl. VAT & P.). Super Hy-Light Strobe (approx. 16 joules) Price **£33.** P & P £1.50 (incl. VAT total **£39.68**).
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Super Hy Light Strobe Kit, details on receipt of foolscap sae.

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Range available from stock. S.A.E. for details.

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4ft. 40 Watt £8.70 inc. VAT **£10.00** (callers only).
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(For use in stan bi-pin fittings).
12in. 8 watt £2.80. Post 35p. (**£3.62** inc. VAT + P).
9in. 6 watt £2.25. Post 35p. (**£2.99** inc. VAT + P).
6in. 4 watt £2.25. Post 35p. (**£2.99** inc. VAT + P.
Complete ballast unit, for either 6", 9" or 12" tube 230V AC op **£4.50.** Post 45p. (**£5.69** inc. VAT +P). Also available for 12V DC op **£4.50.** Post 45p. (**£5.69** inc VAT + P).
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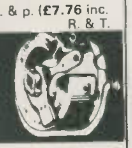
240V A.C. operation. 12 individually adjustable cams. **£7.50** + 75p P. & P. (**£9.49** inc. VAT). R.T.
6 adjustable 6 fixed cams. Price **£6.00** + 75p p. & p. (**£7.76** inc. VAT) R. & T.

Superior Quality Precision Made NEW POWER RHEOSTATS



New ceramic construction, embedded winding heavy duty brush assembly, continuously rated.
25 WATT 10/25/50/100/250/500/1kΩ/1·5kΩ, **£2.80.** Post 20p (**£3.45** inc. VAT & P.).
50 WATT 250Ω £2·90. Post 25p (**£3·62** inc. VAT & P.).
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Black, Silver, Skirted knob calibrated in Nos. 1-9 1½in. dia. brass bush. Ideal for above Rheostats **24p** each.

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Wide range of AC and DC relays available from stock. Phone or write in your enquiries.

Other types available — phone for details. N.M.S.

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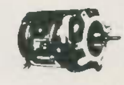
Open type 3 c/o. 10 amp £1.10 (£1.50 incl. VAT & P).
230/240V A.C. 3CO. 11 pin base. Sealed. 5 amp contacts £1.35 plus P. & P. 20p. Total incl. VAT £1.78.
D.C. Relay. sealed 6/12V. D.C. 2CO. 10 amp contacts. Single hole fixing. Push on contacts. **£1.30** plus P. & P. 20p. Total incl. VAT £1.73.
12V D.C. 2Co. open type 10 amp contacts **£1.25** plus P. & P. 20p. Total incl. VAT £1.67.
24V D.C. 2Co 7 amp contacts. Sealed, octal base. **£1.30** plus P. & P. 20p. Total incl. VAT £1.73.
Mercury Wetted contact relay mfg. by Clare. Type HGSM 1003. 18/24V D.C. Ico. **£2.00** plus P. & P. 20p. Total incl. VAT £2.53.
Reed Relay mfg. by Alma. Type CPR1/D 6/9V D.C. 700 ohm. coil. 5 for £2.50 plus P. & P. 50p. Total incl. VAT £3.45.
D.C. Relays: Sealed 12V 1 c/o 7 amp octal base **£1.00** (**£1·38** inc. VAT & P). Sealed 12V 3 c/o 7 amp 11-pin **£1.35** (**£1·78** inc. VAT & P). 24V. Sealed 3 c/o 7 amp 11-pin **£1.35** (**£1·78** inc. VAT & P). (amps = contact rating). P&P on any Relay 20p.
KMKI Relay. 230V. A.C. 1 c/o. open type 10 amp contact, mf. by "Keyswitch" 80p. + 20p. p. & p. (**£1.15** incl. VAT). 5 for **£3·75** postpaid (**£4·32** incl. VAT).
Hellermann Deutsch. Hermetically sealed sub-min. Relay. 12-24V. D.C. 2 c/o. 850 ohm coil. 0.2 pitch. P.C. mounting. L. 20 mm. W. 10mm. H. 12mm. Fraction of maker's price: **£2.50** postpaid (**£2.88** incl. VAT). N.M.S.

GEARED MOTORS



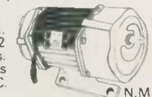
7½rpm KLAXON motors approx. 25lb inch
28rpm WYNSCALE motors approx. 20lb inch
71rpm WYNSCALE motor approx. 10lb inch
Above three motors are designed for 110V. A.C. supplied with auto transformer 240V. A.C. operation, **£9.25** p. & p. 75p. Total incl. VAT **£11.50.** N.M.S.

56 rpm. 240V. a.c. 50lb. in. 50Hz 0.7 amp. Shaft length 35mm. Dia. 16mm. Wt. 6kg. 600g. mf. **FRACMO.** Price: **£15·00** + £1·50 P. & P. (**£18·98** inclus. VAT). N.M.S.

100 rpm. 110V. a.c. 115lb. in. 50Hz. 2.8 amp. single phase split capacitor. Immense power.
Totally enclosed. In-line gearbox. Length 250mm. Dia. 135mm. Spindle dia. 15.5mm, length 145mm. Tested. Price: **£12.00** + £1.50 P. & P. (**£15.53** inclus. VAT). R. & T. Suitable Transformer for 230/240V operation. Price **£8.00** + 75p. P. & P. (**£10.06** inc. VAT).

200 rpm. 35 lbs. in. 115V. 50Hz.
Price: **£16·00** + £1·50 P. & P. (**£20·13** inclus. VAT). N.M.S.
Suitable Transformer for 230/240V. a.c.
Price: **£8·00** + £1·00 P. & P. (**£10·35** inclus. VAT). N.M.S.

1rpm 230/240V. a.c. Synchronous geared Motor, mf. **HAYDON.** **2 rpm** 230/240V. a.c. Synchronous geared Motor, mf. **CROUZET.** Either type **£3.90** + 30p. P. & P. (**£4.83** inc. VAT).



N.E.C. geared Motor 152 R.P.M. **200lb. inch.** 230 A.C. 50hz. Ratio 9.2 to 1. Non reverse. Incl. capacitors. Fraction of makers Price **£35.00** plus carriage and VAT. Also available 230A.C. 60hz. 182.R.P.M. 20lb in. as above. N.M.S.
42 R.P.M. 110 A.C. 50hz. 100lb incl. reversible will operate on 230A.C. Speed remains at 42R.P.M. but torque reduces by 50%. Price **£16.00.** P. & P. £1.00. (total incl. VAT & p. **£19.55**) N.M.S.

INCREDIBLE OFFER

Geared Motor. 120 rpm approx. 15 lb.in. 230V. A.C. Cont. Rating. Non-reversible. Size 150mm×90mm×85mm spindle 8mm dia × 30 mm long. Complete with capacitor and relay for max. load starting. Offered at mere fraction of mfrs. price – **£11.50 incl.** of p. & p. & V.A.T.

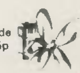
24V. D.C. GEARED MOTOR

24V. D.C. 200 rpm 10lbs/ins. continuously rated geared Motor mfg. by either Parvalux or Carter. Easily removable from heavy ali. chassis containing **9**×24V. D.C. Solenoids, microswitches, friction clutch, precision gearing etc. etc. Ex-equipment London Transport Ticket Printer. Price: **£11.00** + £2.00 p. & p. (total incl. VAT **£14.95**).

24V. D.C. REVERSIBLE MOTOR

Parvalux type SD12L, 24 D.C. shunt wound Motor, either 133 rpm 65lbs in Gearbox ratio 30:1. Current 6.8 amp. Rating continuous. Will operate on reduced power and speed at 9V D.C. or less. Size Dia. 16mm, Width 150mm, Shaft dia. 16mm. Price **£16.00** + £2.00 p. & p. (**£20.70** incl. VAT). N.M.S. or 60 rpm 100lb in rating. Price as above. N.M.S.
100W Rheostat 1 ohm speed control available **£6.90** (**£7.94** incl. VAT).

230V a.c. FAN ASSEMBLY.



Powerful continuously rated a.c. motor complete with 5 blade 6½in. or 4 blade 3in. aluminium fan. Price **£3.50.** P & P. 65p (**£4.77** incl. VAT & P.).

ROTARY CARBON VANE VACUUM & COMPRESSOR.

Direct coupled to 1/3 h.p. 110/115V. A.C. Motor 4.2 amp. 1380 rpm. Motor manuf. by A.E.I. or G.E.C. Pump by Williams. Max. Vac. 25" H.G. Max. pressure cont. 10 p.s.i. Int. 15 p.s.i. Max. air-flow 3 c.f.m. at "0" H.G. Price: **£30.00** + £3.00 P. & P. (**£37.95** incl. VAT). N.M.S.

Suitable transformer for 240V. op. **£10.00** P. & P. £2.00 (**£13.80** incl. VAT). N.M.S.

A.C. Wkg. TUBULAR CAPACITORS.

Fraction of makers price. Motor start etc.

1.5 mfd.	440V. A.C.	60p	5.4 mfd.	280V. A.C.	75p
2 mfd.	250V. A.C.	60p	6.5 mfd.	280V. A.C.	£1·00
2 mfd.	450V. A.C.	75p	7.5 mfd.	200V. A.C.	£1·00
2.2 mfd.	440V. A.C.	75p	10 mfd.	250V. A.C.	£1·00
3 mfd.	440V. A.C.	£1·00	19 mfd.	280V. A.C.	£2·00
4.1 mfd.	440V. A.C.	£1·00	20 mfd.	250V. A.C.	£2·25
5 mfd.	400V. A.C.	£1·25			
5.3 mfd.	160V. A.C.	60p			

P. & P., up to 2.5 mfd. 25p. 3 mfd tp 20 mfd. 50p. All plus V.A.T. N.M.S.

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ERD Time switch 200/250V a.c. 30 amp contact 2 on/2 off every 24 hrs. at any manually pre-set time. 36 hour Spring Reserve and day omitting device. Built to highest Electricity Board specification. Price **£9·00.** P. & P. 75p (£11.21). R. & T.

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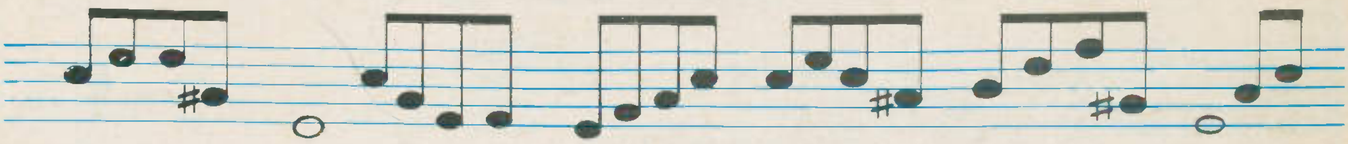

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