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DECEMBER 1982

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Computing
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No. 4, Autumn 1982

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WORLD of RADIO & ELECTRONICS

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128 PAGES

70 p

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Weller/Cooper: Soldering Irons & Tools

You never regret buying the best!

- ★ TCP series
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- ★ Cutters/pliers
- ★ Toolkits

Motorola RF Power: Transformers for transmitting

- ★ 1W/30MHz to
- ★ 80W/150MHz
- ★ ..& beyond

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- ★ Auto DMMs
- ★ 'Scopes
- ★ Bananas (?)
- ★ Sig gens

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Coaxial relays

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WR&E

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Telephone (0277)230909, telex 995194 AMBITG, data RS232/300 baud (0277)230959*

- *Dial (0277)230959, hook in your low cost modem and terminal (most personal computers can be configured to access REWTEL, details are being published in R&EW over the next few months) and REWTEL will give you access to up to 5000 pages of background to the WR&E catalogue, equivalents, news, updates, hot off-the-press product news, information, jobs being advertised in the industry. It's computing at its most versatile and worthwhile: why be satisfied with a 64K MCU, when you can gain free access to the 70MByte+ of the REWTEL computer ??

Hobby Electronics

DECEMBER 1982
Vol 4 No 12

PROJECTS

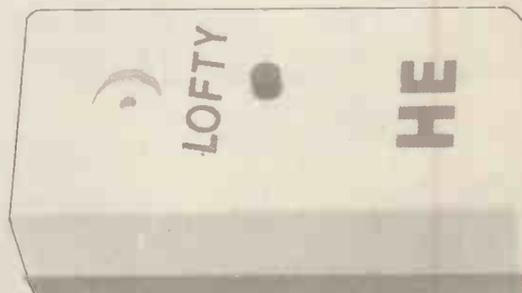
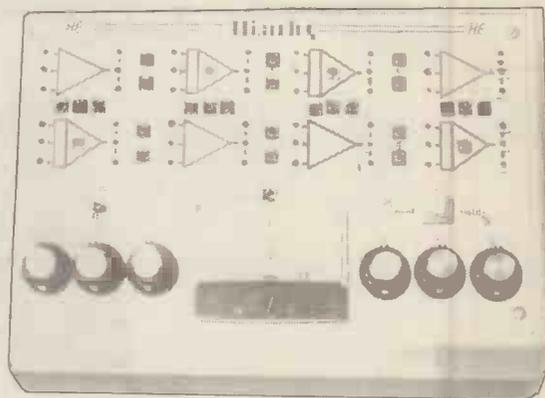
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An electronic eavsdropper for nature lovers.

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Ersin Multicore, solder contains 5 cores of non-corrosive flux, instantly cleaning heavily oxidised surfaces. No extra flux is required. Comes in handy dispensers and tool box reels in two different alloys 40/60 tin/lead for general purpose electrical soldering and 60/40 tin/lead ideal for small components and fine wire soldering.



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Size 3 40/60 tin/lead
£4.37 Per reel 1.6mm dia



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Multicore Savbit, solder increases the life of your soldering bit by 10 times, for better soldering efficiency and economy. Comes in two handy dispensers and tool box reels.



Size 5 Savbit
£1.15 Per pack 1.2mm dia



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£4.37 Per reel 1.2mm dia



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£1.73 Per pack 0.048mm dia

Multicore Alu-Sol

Multicore Alu-Sol, solder contains 4 cores of flux, suitable for most metals especially aluminium. Comes in handy dispensers on tool box reels.

Size AL150 Alu-Sol
£2.07 Per pack 0.048mm dia



Size 4 Alu-Sol
£7.82 Per reel 1.6mm dia



Multicore Solder Wick

Multicore Solder Wick, absorbs solder instantly from tags and printed circuits with the use of a 40 to 50 watt soldering iron. Quick and easy to use, desolders in seconds.

Size AB10 Solder Wick
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Size 9 Wire Strippers
£2.69 Per pair

Bib Audio/Video Products Limited
(Solder Division), Kelsey House,
Wood Lane End, Hemel Hempstead,
Hertfordshire, HP2 4RQ.
Telephone: (0442) 61291
Telex: 826437

All prices inclusive of VAT. Available from most electrical and DIYs stores. If you have difficulty in obtaining any of these products send direct with 50p for postage and packing. For free colour brochure send S.A.E.

WATFORD ELECTRONICS

35c CARDIFF ROAD, WATFORD, HERTS, ENGLAND

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POLYESTER CAPACITORS: Axial Lead Type
 400V: 1nF, 1.5n, 2n2, 3n3, 4n7, 6n8 11p, 10n, 15n, 18n, 22n 12p; 33n, 47n, 68n 16p; 100n, 150n 20p; 220n 30p; 330n 42p; 470n 52p; 680n 60p; 1µF 68p; 2µ2 82p; 4µ7 85p.
 160V: 10nF, 12n, 100n 11p; 150n, 220n 17p; 330n, 470n 30p; 680n, 38p; 1µF 42p; 1.5µ 46p; 2µ2 48p.
 1000V: 1nF 17p; 10nF 30p; 15n 40p; 22n 36p; 33n 42p; 47n 48p; 100n 50p; 150n 50p; 470n 99p.

POLYESTER RADIAL LEAD CAPACITORS: 250V:
 10nF, 15n, 22n, 27n 6p; 33n, 47n, 68n, 100n 7p; 150n, 220n 10p.
 330n, 470n 13p; 680n 19p; 1µF 23p; 1.5µ 40p; 2µ2 46p; 4µ7 60p.

ULTRASONIC TRANSDUCERS
 40kHz 325p/pr

ELECTROLYTIC CAPACITORS: (Values are in µF) 500V: 10 52p; 47 78p; 250V: 100 65p; 63V: 0.47, 1.0, 1.5, 2.2, 2.5, 3.3 8p; 6.8, 10, 10, 15, 22, 33 15p; 47 12p; 100, 15p; 100, 15p; 1000 70p; 50V: 47 7.8 22p; 100 10p; 220 24p; 470 32p; 2200 90p; 40V: 4.7, 1.5, 22p; 3300, 90p; 4700, 120p; 25V: 1.5, 6, 8, 10, 22, 33, 47 8p; 100 12p; 150 12p; 220, 15p; 330 22p; 470 25p; 680, 100p, 34p; 2200, 50p; 4700, 92p; 16V: 40, 47, 100 9p; 125, 12p; 220 13p; 470, 20p; 680 34p; 1000 27p; 1500, 31p; 2200 36p; 3300 74p; 4700 79p.

TANTALUM BEAD CAPACITORS
 35V: 0.1µF, 0.22, 0.33 15p; 0.47, 0.68, 1.0µF, 1.5 18p; 2.2, 3.3 18p; 4.7, 6.8 22p; 10µF 28p; 16V: 2.2, 3.3 16p; 4.7, 6.8, 10 18p; 15, 36p; 22 30p; 33, 47 40p; 100 75p; 220 88p; 10V: 1.5, 22p; 3.3, 47 36p; 100 50p; 6V: 100 42p.

POTENTIOMETERS: Rotary, Carbon, Track, 0.25W Log & 0.5W Lin.
 500Ω, 1KΩ & 2KΩ (Linear only) Single Gang 30p
 5KΩ-2MΩ Single Gang D/P Switch 78p
 5KΩ-2MΩ Double Gang 88p

SLIDER POTENTIOMETERS
 0.25W log and linear values 60mm
 5KΩ-500KΩ single gang 70p
 10KΩ-500KΩ dual gang 110p
 Self Stick graduated Bezel 40p

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

MINIATURE TYPE TRIMMERS
 2.8pF, 2-10pF, 2-25pF, 5-56pF 30p.

COMPRESSION TRIMMERS
 3-40pF; 10-80pF 20p; 20-250pF 28p; 100-580pF 38p; 400-1250pF 48p.

PRESET POTENTIOMETERS
 Vertical & Horizontal
 0.1W 50-M Ω Miniature 7p
 0.25W 100-M Ω 3-3 MΩ horiz. 10p
 0.25W 200-M Ω 4-7 MΩ vert. 10p

VOLTAGE REGULATORS
 1A TO3 +ve 7805 220p
 12V 7812 145p
 15V 7815 145p
 18V 7818 145p

100mA TO92 Plastic Casing
 5V 78L05 30p
 8V 78L08 30p
 9V 78L09 30p
 12V 78L12 30p
 15V 78L15 30p
 18V 78L18 30p

CA3085 95p LM317P 95p
 LM300H 170p LM323K 50p
 LM305H 140p LM337 175p
 LM309K 135p LM723 35p
 LM317K 350p TAA650 78p

DIL SOCKETS
 Low Wire Prof. wrap
 8 way 8p 25p
 14 pin 8p 35p
 16 pin 10p 42p
 18 pin 18p 52p
 20 pin 22p 60p
 22 pin 25p 70p
 24 pin 27p 70p
 28 pin 28p 80p
 40 pin 30p 99p

PROTO DEC
 Euroboard 650
 S Dec 520
 Bimbo I 500
 Veroblock 375

DENCO COILS
 DP VALVE TYPE
 Range 1 to 5 BL, RD, TL, Wh, 122p
 6-7 B-Y-R 110p
 1.5 Green 150p
 "T" type 1 to 5, Bl, Rd, Wh, Y, 150p
 BSA Valve Holder 142p

VERO BOARD
 0.1" Pitch clad plain
 21 x 31" 80p
 21 x 6" 91p
 31 x 3" 91p
 31 x 5" 105p 87p
 31 x 17" 360p 232p
 43 x 17" 470p
 Pkt of 100 pins 50p
 Spot face cutter 135p
 Pin insertion tool 178p

COPPER CLAD BOARDS
 Fiberglass
 6 x 6" 90p
 6 x 12" 150p
 6A/100V 40
 6A/400V 50
 6A/800V 65

S.R.B.P.
 9 x 8 95p
 Ferric Chloride
 1lb Anhyd. 195p

DIODES
 BY127 12
 BY127 12
 OA5 40
 OA47 12
 OA70 12
 OA79 15
 OA85 15
 OA90 8
 OA91 8
 OA95 8
 OA200 8
 OA202 8
 IN4001/2 5
 IN4003 6
 IN4004/5 6
 IN4006/7 7
 IN4148 4
 IN5401 15
 IN5404 16
 IN5408 17
 IS49 15
 IS521 9
 6A/100V 40
 6A/400V 50
 6A/800V 65

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

SCRs THYRISTORS
 5A/400V 40
 5A/600V 48
 8A/300V 60
 8A/600V 96
 12A/100V 78
 12A/400V 96
 12A/800V 188
 18A/100V 150
 18A/400V 150
 18A/800V 150
 25A/100V 240
 25A/400V 240
 25A/600V 240
 25A/800V 240

NOISE
 Diode 150p

BRIDGE RECTIFIERS
 1A/50V 18
 1A/100V 20
 1A/400V 25
 1A/600V 34
 2A/50V 36
 2A/200V 40
 2A/400V 45
 2A/600V 46
 6A/100V 83
 6A/400V 95
 6A/600V 125
 10A/200V 215
 10A/600V 298
 25A/200V 326
 25A/400V 326
 BY164 56
 VM18 50

TRIACS
 3A 100V 48
 3A 200V 54
 3A 400V 56
 8A 100V 60
 8A 400V 69
 8A 800V 115
 12A 100V 78
 12A 400V 82
 12A 800V 120
 16A 100V 115
 16A 400V 115
 16A 800V 120
 25A 800V 120
 25A 1000V 480
 25A 28000V 120

DIAC
 ST2 25

7400	11	74150	60	LS124	90	4050	25	AY-1-5051	160	MC1709G	90
7401	11	74151	60	LS125	24	4051	46	AY-3-8910	438	MC1710	79
7402	11	74153	40	LS126	35	4052	60	AY-5-1230	450	MC3302	90
7403	12	74154	50	LS132	85	4053	50	AY-6-1350	360	MC3340P	120
7404	13	74156	40	LS133	30	4054	86	CA3018	86	MC3360P	120
7405	15	74157	28	LS136	28	4055	86	CA3020	210	MC3401	66
7406	15	74158	30	LS138	29	4056	86	CA3025	250	MC3403	66
7407	20	74159	80	LS139	29	4057	1916	CA3035	250	MC68040	75
7408	20	74160	60	LS145	70	4059	435	CA3045	366	MK50398	636
7409	14	74161	48	LS147	100	4060	45	CA3046	70	ML24	276
7410	14	74162	40	LS148	70	4061	1195	CA3048	280	MM5303	636
7411	16	74164	40	LS151	40	4062	985	CA3059	225	MM5307	1275
7412	18	74165	40	LS153	40	4063	85	CA3075	340	MM5387	47
7413	18	74166	48	LS155	30	4066	24	CA3080E	70	NE59	225
7414	20	74168	48	LS157	27	4067	245	CA3081	190	NE531	140
7415	20	74169	150	LS158	30	4068	14	CA3085	95	NE543	225
7416	20	74170	125	LS160	32	4069	13	CA3089E	200	NE544	210
7417	20	74172	250	LS161	37	4070	13	CA3090A	375	NE555	160
7420	15	74173	54	LS162	37	4071	13	CA3123E	150	NE556	46
7421	20	174174	54	LS163	37	4072	13	CA3130	90	NE560	325
7422	20	74175	50	LS164	43	4073	13	CA3140	40	NE561	318
7425	18	74176	40	LS165	50	4075	13	CA3160	95	NE562	410
7426	18	74178	45	LS166	52	4076	50	CA3161	160	NE564	420
7427	18	74179	45	LS167	70	4077	13	CA3189	296	NE565	120
7428	25	74180	40	LS173	55	4078	16	HA1336V	240	NE566	156
7430	14	74181	50	LS174	50	4081	13	ICL106E	750	NE567	140
7432	22	74182	60	LS175	40	4082	13	ICL1710	975	NE570	410
7433	22	74184	90	LS180	90	4085	50	ICL8038CC	300	NE571	480
7437	25	74186	470	LS191	36	4088	125	ICM216A	1950	NE553	150
7438	22	74188	250	LS192	36	4093	20	ICM7224	785	RC4136	69
7439	15	74190	48	LS193	37	4094	70	ICM555	80	RC4136	69
7441	55	74191	46	LS194	33	4095	75	ICM556	150	SAB3209	425
7442	32	74193	45	LS195	33	4096	290	ICM557	250	SAB3210	325
7443	90	74194	45	LS196	45	4096	290	LAB0315	340	SAB3211	485
7444	55	74195	46	LS197	45	4097	190	LA4032	286	SAB4209	585
7445	55	74196	46	LS221	55	4098	75	LA4002	286	SN76013	360
7446	60	74196	46	LS240	55	4099	190	LC7120	300	SN76023	360
7447	35	74197	84	LS241	55	4160	75	LC7130	340	SN76477	420
7448	40	74199	84	LS244	55	4161	75	LC7137	385	SN76488	480
7450	18	74201	54	LS245	55	4162	99	LC7138	150	SN76489	480
7451	16	74221	54	LS257	30	4163	99	LF351	48	SL490	350
7453	16	74202	100	LS261	100	4175	105	LF353	50	SP6829	299

7454	18	74203	11	7456	10	4194	106	LF355	85	TA7120	150
7456	18	74204	11	7457	10	4195	106	LF356	95	TA7204	200
7457	18	74205	11	7458	10	4196	106	LF357	95	TA7205	200
7458	18	74206	11	7459	10	4197	106	LF358	95	TA7222	150
7459	18	74207	11	7460	10	4198	106	LF359	95	TA7223	150
7460	18	74208	11	7461	10	4199	106	LF360	95	TA7224	150
7461	18	74209	11	7462	10	4200	106	LF361	95	TA7225	150
7462	18	74210	11	7463	10	4201	106	LF362	95	TA7226	150
7463	18	74211	11	7464	10	4202	106	LF363	95	TA7227	150
7464	18	74212	11	7465	10	4203	106	LF364	95	TA7228	150
7465	18	74213	11	7466	10	4204	106	LF365	95	TA7229	150
7466	18	74214	11	7467	10	4205	106	LF366	95	TA7230	150
7467	18	74215	11	7468	10	4206	106	LF367	95	TA7231	150
7468	18	74216	11	7469	10	4207	106	LF368	95	TA7232	150
7469	18	74217	11	7470	10	4208	106	LF369	95	TA7233	150
7470	18	74218	11	7471	10	4209	106	LF370	95	TA7234	150
7471	18	74219	11	7472	10	4210	106	LF371	95	TA7235	150
7472	18	74220	11	7473	10	4211	106	LF372	95	TA7236	150
7473	18	74221	11	7474	10	4212	106	LF373	95	TA7237	150
7474	18	74222	11	7475	10	4213	106	LF374	95	TA7238	150
7475	18	74223	11	7476	10	4214	106	LF375	95	TA7239	150
7476	18	74224	11	7477	10	4215	106	LF376	95	TA7240	150
7477	18	74225	11	7478	10	4216	106	LF377	95	TA7241	150
7478	18	74226	11	7479	10	4217	106	LF378	95	TA7242	150
7479	18										

MONITOR

Directory Update

The response to our *Directory Of Electronic Component and Hardware Suppliers* has been tremendous, from both readers and the suppliers themselves. The reaction has been particularly strong from those suppliers who, for one reason or another, were either not included in our listings — or those whose address/telephone number got scrambled.

Naturally, they will all be listed (correctly) in our next Directory, here are some more companies operating on the supply side of our hobby . . .

**A.P.T. Radar Systems Limited,
Cybervox Language Laboratory
Division,**

Unit B, Sprint Industrial Estate, Chertsey Road, Byfleet, Surrey KT14 7LA. Tel. 09323 41331.

Specialists in the manufacture of tape recorders and related components together with headsets and spares.

Candis Electronics Ltd.

Highdown Works, Highdown Avenue, Worthing, West Sussex BN13 1PU. Tel. 0903 690750.

Specialists in temperature sensing components of all kinds.

Electronic Hobbies Ltd.,

17 Roxwell Road, Chelmsford, Essex CM1 2LY.

The correct telephone number is 0245 62149.

Garland Bros. Ltd.,

Chesham House, Deptford Broadway, London SE8 4QN. Tel. 01 692 4412.

"We are an established retail firm (20 years) dealing in electronic components, audio equipment, in-car entertainment, and we also do a very large range of CB equipment. A repair service for audio and CB is also available".

Garland Bros. carry all the lines mentioned in the charts, but do not operate a mail order service.

Roadrunner Electronic Products,

116 Blackdown Rural Industries, Haste Hill, Haslemere, Surrey GU27 3AY. Tel. 0428 53850.

"Developed and manufactured in Haslemere, our most well-known product is the Roadrunner prototype wiring system. This British product is already used extensively in industry and educational establishments, and is also ideal for the 'home engineer'.

Our hardware products range from packs of terminal pins to 19" subracks. We also handle computer and word-processing products, from typewriter ribbons through to microcomputer systems.

With a combination of the right product, a competitive pricing structure and excellent service, we make customer satisfaction our priority".

Roadrunner are moving to new, larger premises in Haslemere, with the intention of improving overall service to the professional and hobby markets. Orders using Access or Barclaycard are welcomed, either by phone or letter. There is no minimum order level, although a 50p handling charge is made on orders under £5. Carriage and pack-

ing charges are 5% of the total order before VAT is added.

TK Electronics,

11 Boston Road, London W7 3SJ.

The middle two numbers of TK's "easy to remember" telephone number were inadvertently transposed, rendering it 'not so easy'. The number should be, of course, 5-6-7-8-9-10.

The Vintage Wireless Company,

64 Broad Street, Staple Hill, Bristol BS16 5NL. Tel. 0272 565472.

"We are major stockists of obsolete electronic components, especially valves, and operate on a mail order business as well as personal calls to our premises. We try and offer a personal service, and also have a huge library of service data".

The range of services offered include: Sale of radio and television receivers, 1914 to 1954.

Sale of spare parts for the above.

Sale of radio, television and industrial valves.

Sale of service data, technical information, sales data, historical and other items of interest in vintage radio and TV. Restoration and overhaul (but not basic repairs of vintage equipment) of valve domestic and automobile radio of all types.

Sale of new and used books on the subject, plus second hand magazines, often dating back to the First World War!

Hire of radios and related props for theatrical purposes.

Sale of restored radios, with guarantee.

Sale of restored vintage car radios.

The full range of stock and vintage radio news can be found in The Antique Wireless Newsheet, published by the company from the above address — contact them directly for subscription rates.

Credit card sales are offered via Access and Barclaycard, and credit card orders are accepted by 'phone.

Flash Point Alarm

As if by magic, we have had replies to our request for suppliers of the difficult bits for this project.

First, the ICL7611 CMOS IC is readily available from Rapid Electronics, Hill Farm Industrial Estate, Boxted, Colchester, Essex CO4 5RD. The telephone number is 0206 36412.

The other tricky item was the thermocouple, without which the project had very little point; the exact thermocouple required is stocked in vast lengths by Candis Electronics Ltd., Highdown Works, Highdown Avenue, Worthing, West Sussex BN13 1PU. Tel. 0903 690750. Candis are specialists in the design and manufacture of temperature sensing equipment, and they carry a large stock of all kinds of thermal devices.

Add-Ons For The ZX Computers

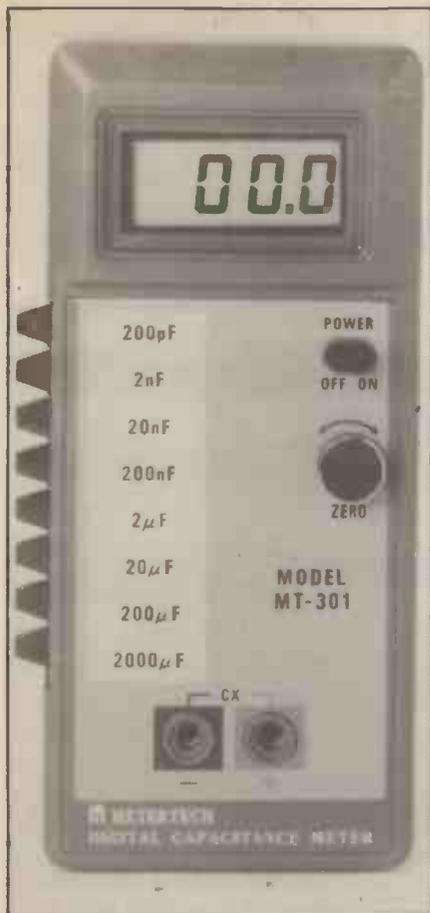
Thurnall Electronics have produced a range of accessories for Sinclair's ZX 80 and 81 computers, with an adaptor system to fit the ZX Spectrum.

The range is based on a 16-line I/O port, and the modular system allows different add-ons to be used simultaneously via an inexpensive motherboard.

Thurnall recommend their system as "... an ideal way of learning about inputting and outputting information ..." from the computers. An analogue-to-digital converter and an RS232 interface are also promised. For details contact Thurnall Electronics, 95 Liverpool Rd., Cadishead, Manchester M30 5BG. A catalogue is available — but send an SAE with your enquiry.



MONITOR



A Little Luxury

More advance builders, especially of radio equipment, may find Centemp Instrument's hand-held digital capacitance meter useful, provided they can spare £69. The little MT-301 is small and robust and designed to travel. It comes complete with battery, alligator test clips, spare fuse and instructions — all ready to go. A bold ½-inch, 3½ digit liquid crystal reads out from 0p1 to 200u across eight separate ranges; the controls are all push buttons for easy one-hand operation.

This is a slightly unusual piece of equipment, so anybody who feels the need of a digital capacitance meter could do worse than to start enquiring here. Incidentally, for the really rough rider, there's an optional "deluxe protective case" (fur-lined??) for an extra £6.00. Details from Centemp Instrument Co., 62 Curtis Rd., Hounslow, Middx. Tel. (01) 894 2723.

Hiding His Lights

Our apologies to Dr. D.L.H. Blomfield, who designed the *Three-Aspect Signal Lights Controller* project which appeared in our September '82 issue.

Dr. Blomfield has certainly earned our collective congratulations for his exceptional design, which has attracted high praise from several model rail enthusiasts.

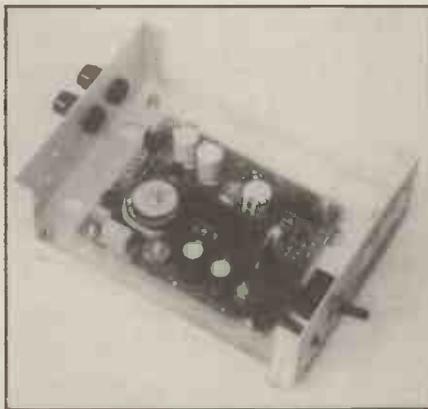
We generally credit our designers — where would we be without them — but due to an oversight in this case, Dr. Blomfield's name was omitted from the article.

Full Protection, But No Racket

Radio buffs going mobile should take a look at a low-noise 24 to 12 volt switched-mode voltage converter gives an output of 13.6V (±0.2V) at 6A continuous current, has a low noise rating of 2 mV RMS below 1 MHz and 1 mV RMS above 1 MHz, and is fully protected and operable up to 50°C.

The 6A version is priced at £39.95 and is supplied with M4 bolts for bulkhead mounting if required. The unit is also available in a 10A version. For further information contact Davtrend Ltd., 89 Kimbolton Rd., Portsmouth, Hants PO3 6DA.

And we'd better add that the unit is sold in a proper case, and not open to the air as our picture shows it!



Little Boxes

Things for putting other things in may not provide the total answer to how to run an orderly workshop, but they certainly do help, so SSI Fix Equipment have come up with a new system of component storage modules known as Portafix 6.

Each Portafix unit (sounds like something out of Asterix the Gaul, doesn't it?) has 12 bin-shaped drawers, each 2 x 4 x 3" deep. The overall size is 14 x 14 x 4", with a tray area on top, integral carrying handle and (an unusual feature) optional hooks, for carrying tools, at either end of the unit.

The whole thing seems to be designed for absolute minimum spillability and, for travelling, this principle can be taken even further — any two units can be hinged together face to face and securely locked shut — no more drawers sliding out every time the car tilts! Each little bin has a transparent dust-cover which opens upwards and the modules themselves can be stacked.

A very handy bit of storage equipment for any kind of craft which uses small components, from cake-decorating to woodworking to... well, electronics. At £7.40 for a single unit and £14.80 for a double (hinged) unit, this could knock a few of your Christmas present problems on the head!

At the moment Portafix 6 is only available from SSI Fix Equipment Ltd., Kingsclere Rd., Basingstoke, Hants RG21 2UJ, and prices don't include postage and packing, so you will have to enquire about that: telephone 0256 26511.

Rapid Electronics

MAIL ORDERS:
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TELEPHONE ORDERS:
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	4018 45	4039 280	4059 430	4085 48	4503 32	4532 60
4000 10	4019 25	4040 4060	42 4086 50	4507 38	4534 400	
4001 10	4020 42	4041 40	4063 80	4089 125	4508 128	4538 110
4002 12	4021 40	4042 38	4066 22	4093 18	4510 45	4543 70
4006 50	4022 45	4043 40	4067 225	4094 68	4511 45	4549 360
4007 14	4023 16	4044 40	4068 14	4095 65	4512 50	4553 245
4008 36	4024 33	4046 50	4069 13	4097 290	4514 120	4555 35
4009 24	4025 16	4047 45	4070 13	4098 70	4515 120	4556 35
4010 24	4026 75	4048 38	4071 45	4099 70	4516 85	4559 390
4011 11	4027 20	4049 21	4072 13	4106 40	4518 40	4560 175
4012 15	4028 40	4050 21	4073 13	4109 110	4520 50	4584 40
4013 20	4029 45	4051 42	4075 13	4163 60	4521 130	4585 60
4014 45	4030 14	4052 48	4076 45	4173 100	4526 60	4724 140
4015 40	4031 125	4053 48	4077 14	4175 75	4527 50	

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	LS21 12	LS76 17	LS124 24	LS161 35	LS221 60	LS366 28
	LS22 12	LS78 17	LS126 25	LS162 35	LS240 60	LS366 28
LS00 11	LS26 14	LS83 35	LS132 35	LS163 35	LS241 60	LS367 28
LS01 11	LS27 12	LS85 48	LS136 26	LS164 40	LS242 55	LS368 29
LS02 11	LS30 12	LS86 16	LS138 30	LS165 55	LS243 55	LS373 60
LS03 12	LS32 13	LS90 24	LS139 30	LS166 60	LS244 55	LS374 60
LS04 12	LS37 14	LS92 24	LS140 30	LS167 60	LS245 55	LS375 60
LS05 12	LS38 15	LS93 24	LS141 150	LS173 60	LS247 48	LS377 60
LS08 12	LS40 13	LS95 38	LS148 75	LS174 45	LS251 28	LS378 57
LS09 12	LS42 28	LS96 95	LS151 38	LS175 45	LS252 32	LS390 45
LS10 12	LS47 35	LS107 40	LS153 38	LS190 35	LS258 32	LS393 45
LS11 12	LS48 45	LS109 21	LS154 75	LS191 35	LS259 55	LS399 156
LS12 12	LS51 14	LS112 21	LS156 33	LS192 35	LS266 20	LS41 70
LS13 19	LS55 14	LS113 21	LS157 33	LS193 35	LS273 58	LS670 135
LS14 30	LS73 18	LS114 22	LS158 26	LS195 32	LS279 30	
LS15 12	LS74 17	LS122 35	LS158 29	LS196 45	LS283 38	

TTL	7413 17	7444 85	7483 30	74122 38	74161 46	74190 40
	7414 23	7446 58	7485 60	74123 38	74162 46	74191 40
	7416 19	7447 36	7486 19	74125 33	74163 46	74192 40
7400 11	7417 19	7448 43	7487 180	74126 33	74164 46	74193 40
7401 11	7420 14	7450 14	7490 19	74132 30	74165 46	74194 40
7402 11	7421 19	7451 14	7491 34	74141 54	74167 150	74195 40
7403 12	7422 19	7453 14	7492 24	74145 48	74170 115	74196 40
7404 12	7427 18	7454 14	7493 24	74147 75	74173 58	74197 40
7405 14	7428 25	7460 14	7494 33	74148 50	74174 53	74198 80
7406 19	7430 13	7472 22	7495 33	74150 48	74175 45	74199 80
7407 19	7432 20	7474 24	7496 38	74153 38	74176 35	74199 80
7408 13	7433 20	7474 19	7497 86	74154 47	74177 42	
7409 13	7437 23	7475 26	74100 78	74155 36	74179 75	
7410 13	7438 24	7476 25	74107 22	74156 36	74180 38	
7411 15	7440 14	7480 45	74109 24	74157 28	74181 100	
7412 17	7442 30	7482 65	74121 24	74160 55	74182 65	

LINEAR	LM339 45	LM3911 120	NE566 140	TL064 96
	LM348 60	LM3914 175	NE567 100	TL071 30
	LM348B 120	LM3915 195	NE570 370	TL072 30
555CMOS 80	ICL7106 700	LM377 170	LM3600 105	NE571 370
556CMOS 150	ICL7611 95	LM380 65	MC1496 68	RC4136 56
709 25	ICL7621 180	LM381 120	MC3340 135	RC4558 60
741 14	ICL7622 180	LM382 120	MF10CN 35	SL480 170
7400C 350	ICL8038 295	LM384 130	ML922 400	SL490 250
AY-31270 120	ICM722A 785	LM386 65	ML924 195	UA2240 120
AY-38910 370	ICM7551 85	LM393 100	ML926 140	SP829 250
AY-38912 625	LF355 45	LM709 25	ML927 140	TBA1205 70
CA3046 60	LF356 95	LM711 60	ML928 140	TBA800 96
CA3089 215	LM10 36	LM725 350	ML929 140	TBA810 96
CA3090A 375	LM301A 26	LM733 75	MM5387A 465	TBA820 70
CA3130E 85	LM311 70	LM741 14	NE529 225	TBA850 220
CA3140E 36	LM318 120	LM747 110	NE531 150	TDA1008 320
CA3161E 100	LM324 40	LM927 200	NE555 16	TDA1022 490
CA3189 290	LM3342 125	LM9900 45	NE556 45	TL061 40
CA3240E 110	LM3352 125	LM3909 70	NE565 110	TL062 60

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AC127 25	BC158 10	BC570 18	BFY50 25	TP130B 50	ZX103 17
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AD142 120	BC170 8	BD132 35	BFY50 23	TP132C 37	ZX503 18
AD149 80	BC171 10	BD133 50	BFY51 20	TP133A 50	ZX504 25
AD161 40	BC172 8	BD135 50	BFY52 23	TP133C 75	2N687 20
AD162 40	BC177 18	BD136 30	BFY53 32	TP134A 60	2N698 40
AF124 60	BC178 18	BD137 30	BFY55 30	TP134B 60	2N706 20
AF126 50	BC179 18	BD138 30	BFY56 32	TP135A 105	2N708 20
AF139 40	BC182 10	BD139 35	BRX39 40	TP135C 125	2N918 35
AF186 70	BC182L 8	BD140 35	BSY20 20	TP136A 125	2N1132 22
AF239 75	BC183 10	BD204 110	BSX29 35	TP136C 135	2N1613 30
BC107 10	BC183L 10	BD206 110	BSY95A 25	TP141A 45	2N2218A 45
BC107B 12	BC184 10	BD222 85	BU205 160	TP142A 45	2N218A 25
BC108 9	BC184L 10	BF100 35	BUX86 200	TP120 90	2N2214 25
BC108B 12	BC212 10	BF122 35	BU208 170	TP121 90	2N2222A 25
BC108C 12	BC212L 10	BF184 25	BU295 99	TP122 90	2N2368 25
BC109 9	BC213 10	BF185 25	MJE340 50	TP141 98	2N2369 16
BC109C 12	BC213L 10	BF194 12	MJE520 65	TP142 98	2N2484 25
BC114 22	BC214 10	BF195 12	MJE521 95	TP147 110	2N2646 45
BC115 22	BC214L 10	BF196 12	MJE305 70	TPP95B 60	2N2904 20
BC117 22	BC237 9	BF197 12	MPF105 200	TP1305 55	2N2904A 20
BC119 35	BC238 14	BF198 10	MJF104 40	TP143 40	2N2905 22
BC137 40	BC308 15	BF199 18	MPSA05 22	TP144 45	2N2905A 22
BC139 40	BC327 14	BF200 30	MPSA06 25	TP150 30	2N2906 25
BC140 30	BC328 14	BF248 22	MPSA12 30	TP191 30	2N2906A 25
BC141 30	BC337 14	BF245 25	MPSA55 30	VN10KM 45	2N2907 25
BC142 25	BC338 14	BF256 45	MPSA56 30	VN46AF 75	2N2907A 25
BC143 25	BC347 9	BF257 35	MPSU05 55	VN65AF 9	2N2908 25
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TLN877 45	Dual colour 60
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FND507	

HE Microlog

The return of the Analog Computer.

K. Manison

WITHOUT DOUBT we are living in a rapidly expanding digital world; *everything* is going digital. Clocks and watches, once precise mechanical instruments with analogue dials, now consist of tiny electronic circuits displaying the time in digits accurate to a tenth of a second. The acceptance of digital technology can be seen in the rapid increase in the availability of women's digital watches; it is no longer a symbol of male technology!

Digits are also appearing in other areas, long the exclusive domain of analogue indicators, but display methods are not the only field to fall to digital techniques. Our telephone conversations are digitised and transmitted as serial bit streams and who, today, hasn't heard of digital hi-fi? And with the recent release of video disc systems, digital video has finally arrived.

One of the reasons for the digital revolution, of course, is cost. With the rapid advances of digital integrated circuits — and that superstar the microprocessor — it has become much cheaper to produce a silicon circuit with an LED or LCD display, than to make a complicated mechanical indicator.

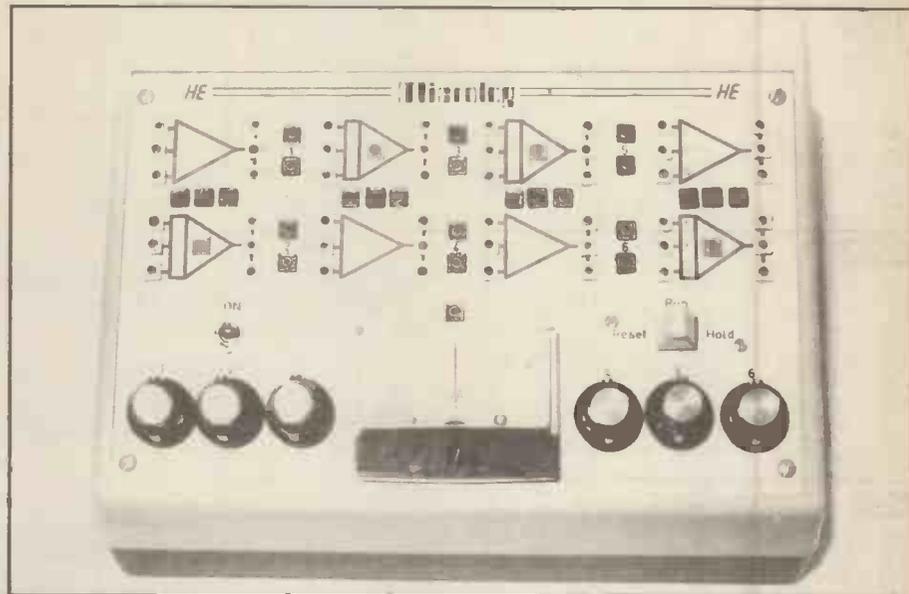
In many cases, the increased accuracy and resolution is definitely required and digital systems may be used to excellent effect. In other cases, however, the older analogue systems have many advantages, and that is true also of the analogue computer.

The Analogue Computer

Remarkable though it may seem, the analogue computer, which need not have a single TTL or CMOS logic chip in the whole of its circuit, manages to perform calculations that many digital machines would find difficult. Analogue computers have been around for decades in one form or another. In fact, many of us have used a slide rule without even being aware that it is an analogue computer.

Whereas a digital computer performs its calculations directly, using numbers, an analogue computer will use some physical parameter to represent the values it is to manipulate. The slide rule, for example, uses length; the length is considered to represent the log of a number so that adding two lengths together is *analogous* to adding logarithms which, of course, is a method of performing multiplication.

Until the cheap digital calculator became available, the slide rule was dexterously manipulated by



generations of engineers and scientists, and it has in no way hindered the advance of technology! In fact, entering experimental results accurate to two decimal places into a calculator and getting out a result with eight places of decimals can be meaningless. If the data is limited to two place accuracy so is the result, and we have to round off the answer anyway. The slide rule, being accurate to two places, can in many cases produce answers that are just as valid as a calculator, and it is not much slower either! To further illustrate the difference between analogue and digital computation, let us look at a common problem. When changing a note for coins, the bank teller can count the money in one of two ways. The most obvious way is to empty a heap of 10ps on to the table and count the required number. For small sums this is adequate, accurate and, for the experienced teller, remarkably fast. However, if a large sum has to be changed, the digital computing method becomes too slow and also increases the chance of error. So, the teller will weigh the coins and, the weight of a single 10p piece being known, the scale can be graduated in pounds and pence. This is an analogue method in which weight is the analogue of value. In this case, the analogue method will be faster than physically counting each coin and, with an accurate scale, just as precise.

It is obvious that different applications are better suited to either digital or to analogue computation. For example, analogue computers have long been used for solving differential equations of the type frequently encountered in control theory and

servo systems. While these equations can be solved by digital means, it is a time consuming process and often expensive as well. However, an electronic analogue of the system can be constructed on an analogue computer, the stimulus then fed in and the output viewed in real time on an oscilloscope or chart recorder. Variables of the system can be changed independently and the process run again and again.

It is the speed of computation, and the graphical output, that give the analogue computer the edge on this type of problem. So now let's look into an analogue computer and see what it consists of and how it can be used. For those that are interested in experimenting with these machines, the Microlog is a simple and cheap analogue computer that can be used to try out some of these concepts.

Analogue Computing

An analogue computer performs the functions of summation (adding), multiplication, integration and differentiation. While a digital computer can perform all these functions, it can only do them one at a time. So, even though it works very fast it has to perform a series of calculations. Particularly where integration is concerned, many simple calculations have to be made to solve one integral, and, if the step size is kept small to increase accuracy or resolution, then more calculations are required and the time taken is increased.

Say, for example, the solution to the problem $X = Y + (V + U)/2$ is required. A digital computer would tackle the problem like this: first, V and U would

Project

be added together and stored as a variable; second, that variable would be divided by 2; last, it would be added to Y to give the required answer. A program, written in BASIC, to handle the problem may look like this:

```

10 INPUT U
20 INPUT V
30 LET X = (U + V) / 2
40 INPUT Y
50 LET X = X + Y
60 PRINT X
70 END
    
```

For a simple problem like this these steps take very little time, but if a large complicated formula were being calculated you can see that this sequential type of process may take a very long time indeed.

The analogue computer, however, uses separate modules to simultaneously perform each function required in the calculation, and the manner in which the modules are interconnected determines the formula being calculated. If two additions have to be performed then two summers will be used, one for each.

For the problem $X = Y + (V + U)/2$, an electronic analogue computer would have modules connected together as shown in Figure 1. The triangle symbols are summers and produce the algebraic sum of the input voltages. The circle symbol is a coefficient multiplier, used to divide the sum of $V + U$ by 2 (multiplication by 0.5). You can see that as soon as the input voltages corresponding to Y, V and U are presented to the modules, X will be instantly available. Notice that the analogue computer is effectively performing all of its calculations in parallel, not one after the other. It is also performing an 'on-line' calculation in that the output X will continually follow the inputs. A digital machine would have to prompt for updated values, or interrogate I/O ports for them. This is what gives the analogue computer a speed advantage, in many cases. To find out how an analogue computer works, let us examine each of the building blocks; then we will determine how to put them together!

Computing Units

An analogue computer uses voltage and time to represent numeric values. For example, a voltage rising from 0 volts to 3 volts over a period of a minute could be used to represent the filling of a 300 gallon tank in the same time. In this case, 1 volt represents 100 gallons, and its variation with time shows the changing level in the tank. So, a plot of voltage against time will show the physical movement of the system we are simulating with the analogue computer. The analogue computer, therefore, needs devices that will sum, integrate and multiply electronic voltages. If we think of these devices as circuit elements, then we can connect them together as a circuit to produce the function we require.

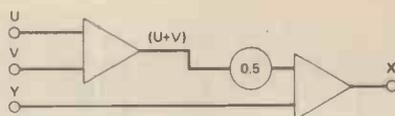


Figure 1. The analogue solution to the equation.

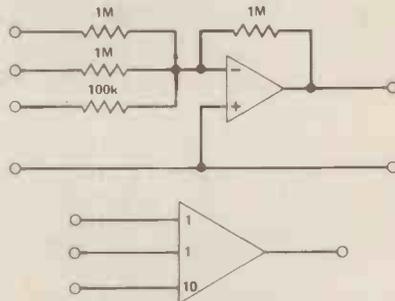


Figure 2(a). An analogue summing circuit (above); 2(b) the graphic symbol used for a summer (below).

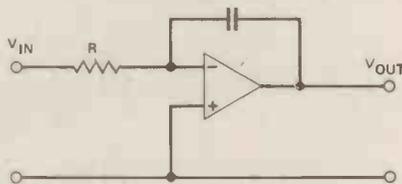


Figure 3. The circuit of an op-amp integrator.

Summers

If our computer is to use voltages to represent physical values then we need an electronic device to add two voltages together; it must produce a voltage which is the algebraic sum of two or more instantaneous voltages.

The simplest method is to use an op-amp; if we add several inputs through resistors, we get an output proportional to the sum of the input voltages. A typical circuit is shown in Figure 2a. The summer circuit module is usually shown by the symbol of Figure 2b. The gains, normally 1 and 10, are shown for each input.

Integrators

We stated at the beginning that analogue computers are used to produce solutions to differential equations, and this means that integration and differentiation are involved. Integration is essentially the sum of all the instantaneous values of a function. Normally it is performed between definite limits, say between the times $t = 0$ and $t = 100$. Some initial condition must also be specified if the integration is to be valid. For example, when integrating a voltage signal V , the starting condition may be $V = 2$ when $t = 0$. Therefore, the integrator must also have an "initial condition" input.

We can use an op-amp to integrate a voltage; consider the circuit shown in Figure 3. The output is given as:

$$V_o = -\frac{1}{RC} \int V_i dt$$

Of course, we can integrate multiple inputs in exactly the same way that we

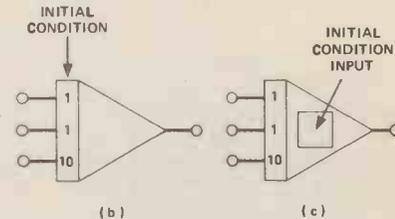
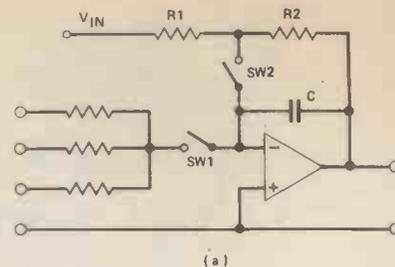


Figure 4. Above (a), the integrator circuit modified for initial condition input; (b) the usual graphic symbol; (c) the representation used on Microlog's panel.

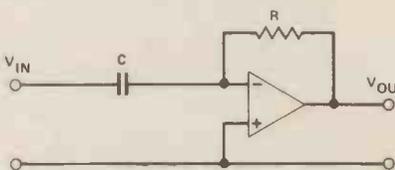


Figure 5. An op-amp differentiator.

summed several inputs, and it should also be clear that by changing the input resistors the integrator gains, expressed as $1/CR$, can be independently set for each input.

Now to set the initial conditions: we must be able to set the output (by setting the charge on the capacitor) to a desired value. In effect, the circuit must behave as a summer up to time $t = 0$, but operate as an integrator after that time. We achieve this by means of two switches, as shown in the circuit Figure 4a.

If switch SW2 is closed, you can see that you have a summer with only one input, $V_i \times R1/R2$. The capacitor will also have this voltage across it and will be charged to the desired initial condition.

If switch SW2 is opened and SW1 closed, we have an integrator with three inputs. When both switches are open, the circuit acts as a 'hold' circuit — the output will remain at whatever the voltage was when SW2 was opened. This is dependent, of course, on the capacitor remaining charged, but as the input impedance of the op-amp is very high, it can hold the voltage for an appreciable time.

In a large analogue computer, these switches are replaced by relays, which allows the machine to be switched from Reset to Compute repeatedly, and the response can be displayed on an oscilloscope. This mode of operation is called Rep-Op, short for Repetitive Operation.

Differentiators

We learn at school that integration is the opposite procedure to differentiation, so that the opposite

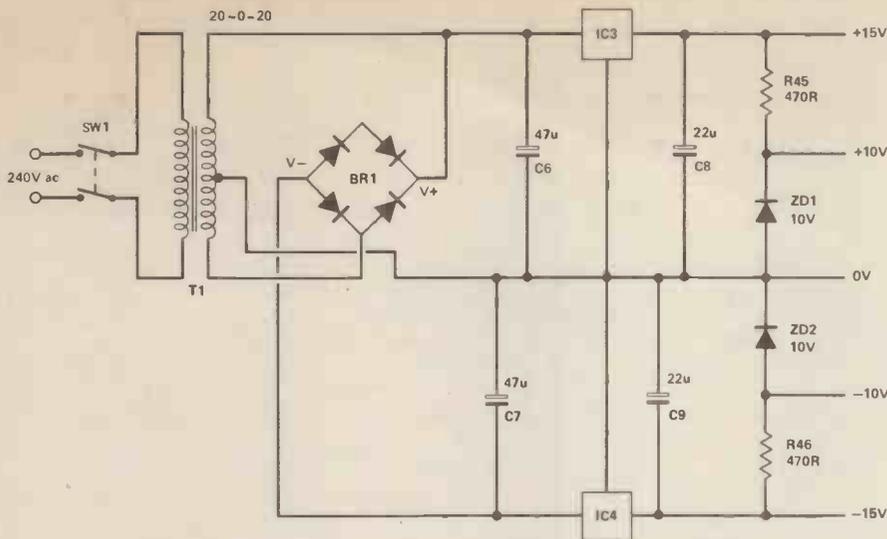
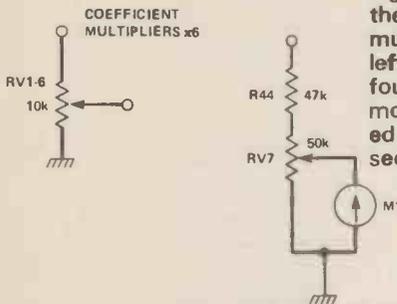
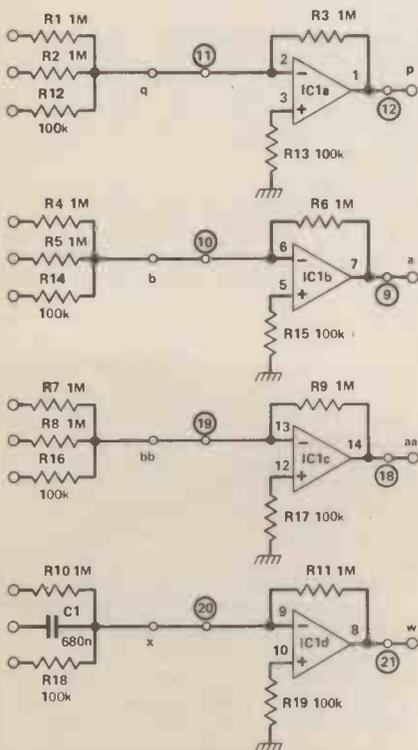


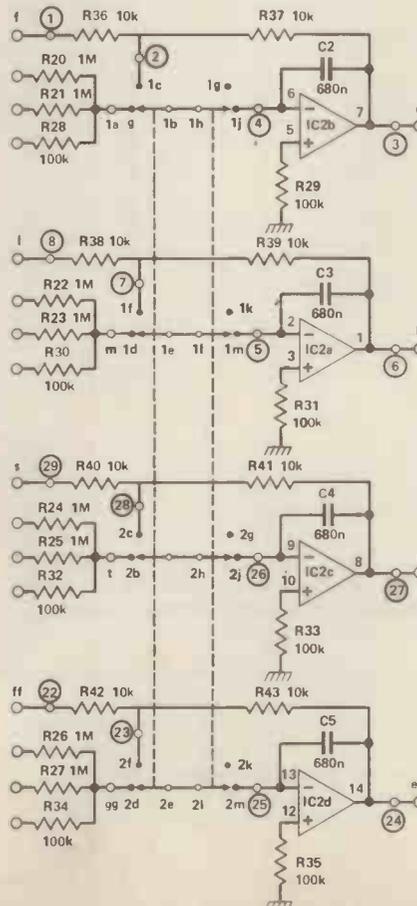
Figure 6. The complete Microlog circuit: (above) the power supply; (far left) the coefficient multipliers; (near left) the meter circuitry; (below left) the four summing circuits; (below right) the four integrators. Not all the components are mounted on the PCB; connection points are marked to aid wiring, which needs careful attention — see NOTE, below, and Figures 8 and 9.



NOTES:
IC1,2 ARE 348
IC3 IS 7815
IC4 IS 7915
M1 = 100µA CENTRE ZERO



NOTE:
CIRCLED NUMBERS = PCB CONNECTOR POINTS
LOWER CASE LETTERS = PATCH PANEL CONNECTOR POINTS
NUMBER AND LETTERS = LEVER SWITCH TERMINALS
LEVER SWITCH SHOWN IN "RUN"



configuration, in the op-amp circuit, will produce a differentiator. The circuit in Figure 5 produces the differential of the input voltage, and once again we can have several inputs with independent gains.

Coefficient Multipliers

So far we have shown our summers, integrators and differentiators with fixed gains of, eg., 1, 10, or 100. We could, of course, set them to any value required — 2.375 for example — but we lose flexibility if the gains are set to such 'strange' values, as they will only be useful for a calculation that needs that particular number! However, if we have a device that will divide a voltage by 11.2375 (ie. multiply by the coefficient, 0.2357) and then follow that by a summer with a gain of 10, we have achieved our required gain of 2.375. So we need a voltage, or potential, divider — which is nothing else but a potentiometer!

For analogue computers, the potentiometers have to be precise and stable. Also, there must be some means of setting them to the required value. The way this is achieved is to connect them across an accurate, known voltage and measure the output while adjusting the pot until the desired coefficient is reached. In large machines, this may be done automatically by small servo motors connected to the wiper mechanism. For small machines, such as the one described in this article, the pot has to be set manually. In the example above, the potentiometer could be connected across 10 volts and adjusted until the output at the wiper measured exactly 2.375 volts.

The HE Microlog

Microlog stands for Micrologue Computer (we can't have digital machines claiming sole rights to the term 'Micro'!). It has been designed as a conceptual trainer to give you a feel for analogue computing and, therefore, accuracy has been traded for low cost and simplicity.

Microlog's patch panel shown in Figure 7 and from it you can see that it has four integrators, four summers and six pots (coefficient multipliers). The Initialise-Integrate-Hold selection is performed by the keyswitch labelled Reset-Run-Hold; no rep-op mode is available as that would entail the use of relays, increasing the cost. The complete circuit is built on one PCB and fits in a type 104 Verobox, with 2 mm plugs used for the patch connectors. The most expensive item in the Microlog is the meter!

To keep everything simple, single chip voltage regulators are used for the 15 V power supplies and the reference supplies are simple zener diode regulators. Two 348 quad op-amps are used, one chip providing the four integrators and the other the four summers. One of the summers has a capacitor on one input to provide a differentiator function. The complete circuitry is shown in Figure 6.

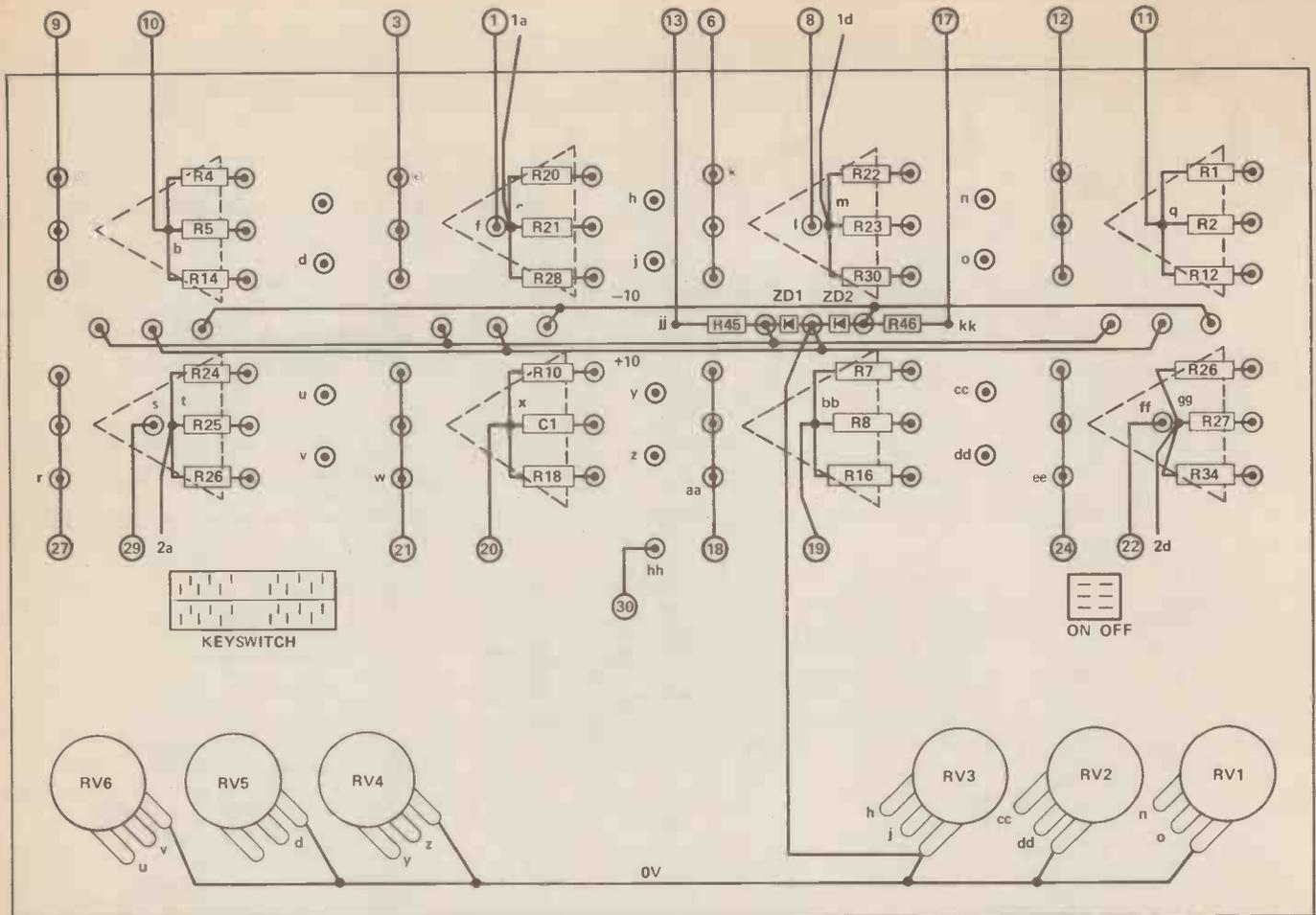


Figure 8. The front panel wiring diagram, showing the mounting positions of the components and the wiring points (eg, point 'f' goes to PCB point '1'; point 'g' goes to the leverswitch terminal '1a'). The switch terminal connections are shown in Figure 9.

The Patch Panel

Having designed the various computing elements that go to make up an analogue computer, we now require a method to interconnect them in order to solve problems. This is usually done by means of a patch panel. The inputs and outputs of each computing unit are brought out to sockets and jumper wires may then be used to connect the desired units to simulate a system or solve an equation.

Construction

The first thing is to drill the front panel of the Verobox for the 2mm sockets, pots, switches and the meter. Then, using Letraset or similar rub-down lettering, mark out the patch panel and spray with a clear polyurethane lacquer so that the markings will not rub off after a little use. The full-sized patch panel is reproduced on page xx for use as a template in this operation.

Next, mount all the sockets and pots. When tightening the nuts on the 2 mm sockets, take care not to overdo it or you may strip the thread. Using the wiring diagram, Figure 8, as a guide, connect up the pots to their respective sockets. Again, be very careful when soldering to the 2 mm sockets, as the plastic body melts very easily!

The next step is to mount the input resistors on the correct sockets for the summers and integrators (mounting

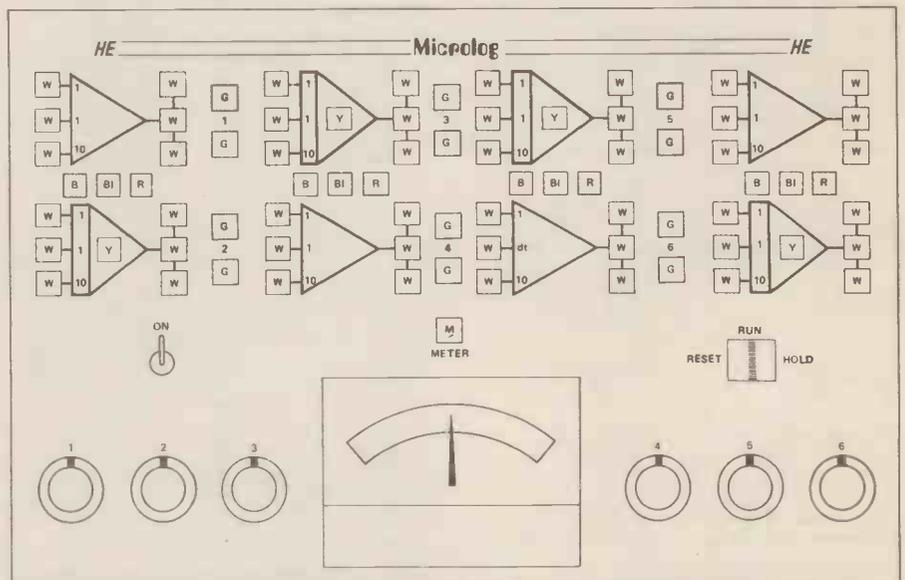


Figure 7. The front panel of Microlog.

□ 2mm SOCKETS
 B BLUE = -10V
 BI BLACK = 0V
 R RED = +10V
 G GREEN = POTENTIOMETERS
 Y YELLOW = INITIAL CONDITION INPUTS
 W WHITE = OP-AMP INPUTS AND OUTPUTS
 M = METER INPUT (BLUE)

them here, instead of on the PCB, reduces the amount of wiring from the patch panel to the PCB). Use the circuit diagram and the wiring diagram to determine the correct place for each resistor. Then mount the 10 volt Zener diodes, ensuring that you have put them in the right way round, and the 470R resistors.

The final front panel wiring is that from the keyswitch to the sockets. Take special care that this wiring is correct, as it is easy to get confused with the connections on the keyswitch. Use the circuit diagram and Figure 9 and double check it when you've finished. It is easier to change incorrect wires then, than at a later stage in the

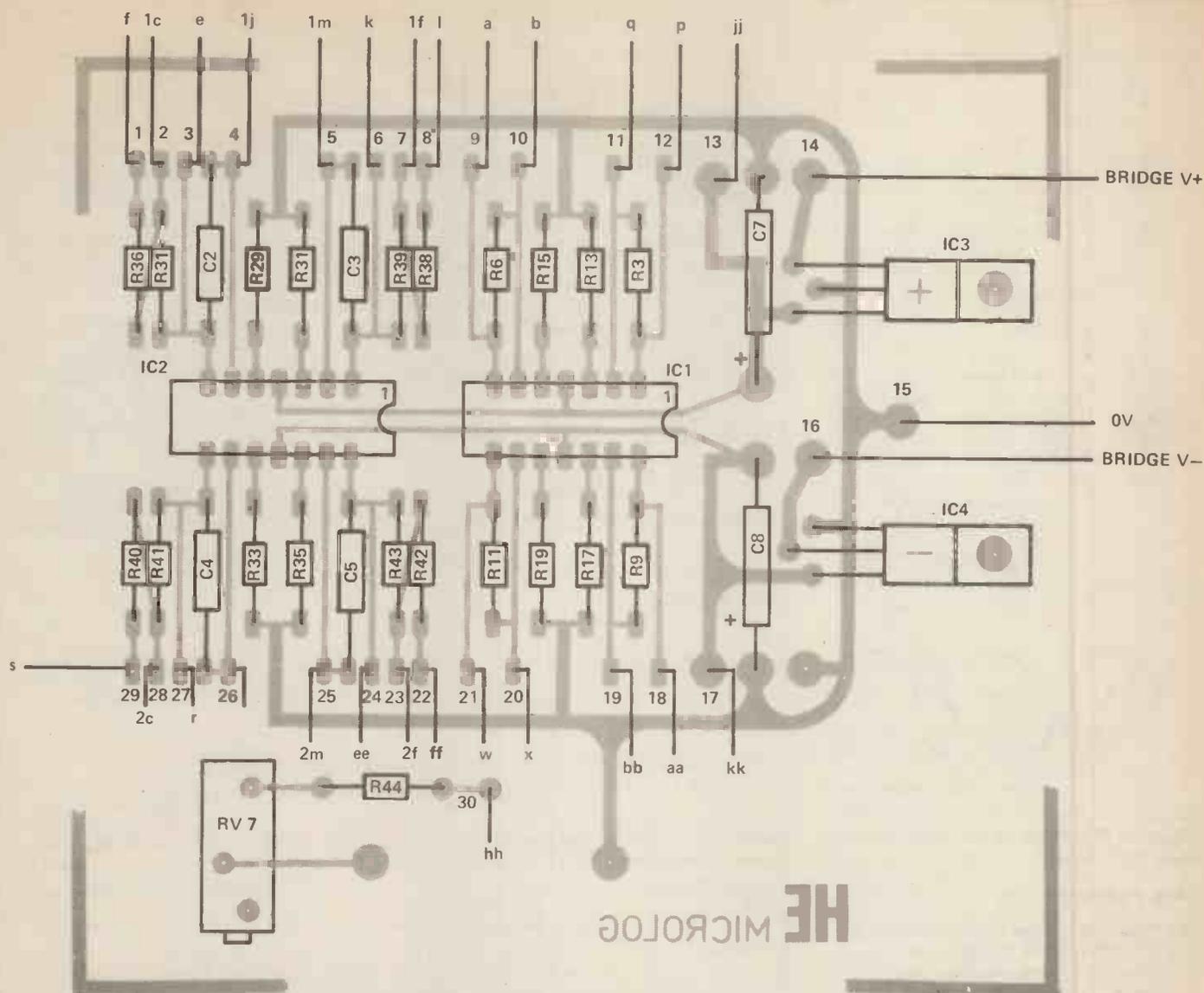


Figure 10. The PCB component overlay diagram; note the connection points.

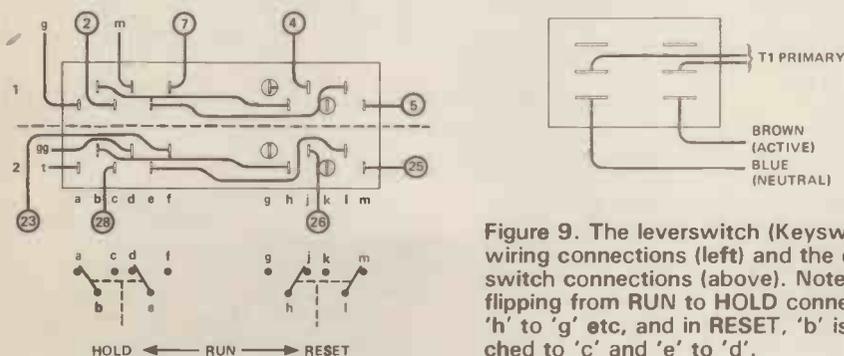


Figure 9. The lever switch (Keyswitch) wiring connections (left) and the on/off switch connections (above). Note that flipping from RUN to HOLD connects 'h' to 'g' etc, and in RESET, 'b' is switched to 'c' and 'e' to 'd'.

construction.

Before the panel can be put back on the Verobox, you will have to remove the central plastic strip that crosses the panel aperture. Don't worry — it doesn't weaken the box in any way. Some time before the testing stage, too, you will have to make up about 20 patch leads with 2 mm plugs on each end; it is best to make assorted lengths, say 3, 6 and 9 inches long.

Now you can start to mount the components on the PCB, using the Parts List and component layout Figure 10 to locate each part. First check the

tracks, to ensure there are no breaks or bridges, and then install the IC sockets and solder them in. Do not plug in the op-amps until the check-out procedure, later. Next, install the resistors on the board and once they are soldered, mount the capacitors. Ensure that the orientation of the electrolytic capacitors is correct; the layout diagram shows the way. Finally, install the two voltage regulator ICs; these are mounted with the metal face against the PCB and held in position with a small screw lockwasher and nut, and be sure the regulators are in the right

places. One is a positive voltage regulator and the other negative and if you accidentally swap them around, they won't last a second when you switch on! Bend the leads down into their respective holes and solder them in. Go over the board, then, checking for any solder bridges or dry joints, touching up where necessary.

Once the board is complete you can start wiring from the patch panel to the PCB connection points, using the wiring diagrams, Figures 8 and 9. This is where great care must be taken, as it is all too easy to get wires crossed. Give yourself enough length on the wires to be able to route them neatly, and to allow the panel or top of the box to be taken off without pulling the wires!

The wiring from the PCB to the keyswitch can be done next, again taking care that the correct connections are made. The PCB is then mounted to the panel, using the screw terminals of the panel meter, which also provides the electrical connections to the meter.

The last part of the construction is the power supply unit (PSU). This is extremely simple, consisting of the small transformer, a bridge rectifier

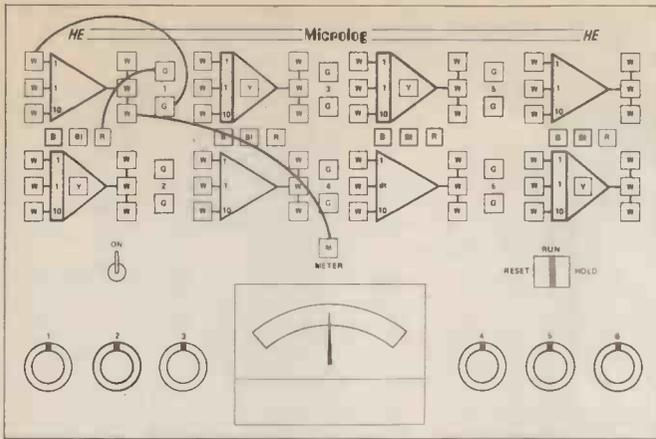


Figure 11. Patch diagram for testing the summing amps.

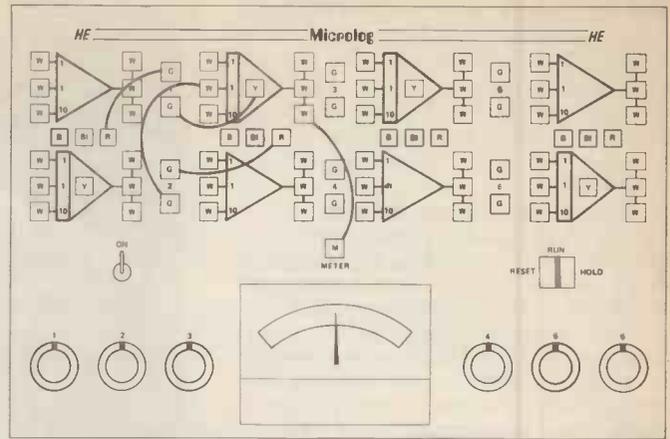


Figure 12. The patch for testing the integrators.

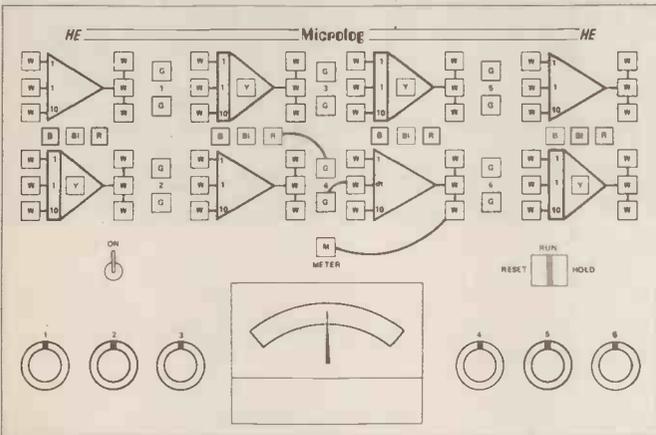


Figure 13. Testing the differentiator.

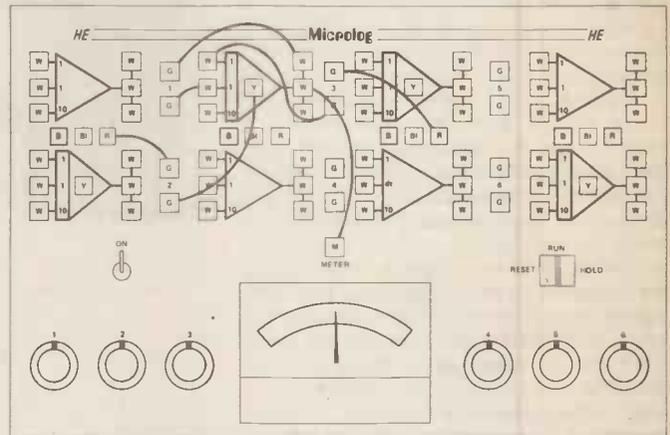


Figure 16. Patching the bathtub.

first seemed. First, then, we shall look at the filling problem with no outflow at all.

If we fill the bath from the tap the inflow will be a constant, 'K', determined by the setting of the tap and the water pressure. The quantity poured in, 'di', during time interval 'dt' is:

$$di = K \cdot dt$$

Now the rise in level 'dh' for quantity 'di' is:

$$dh = 1/A \cdot di$$

where 'A' is the area of the bath. Rearranging to make 'di' the subject we get:

$$di = A \cdot dh$$

Substituting this for 'di' and rearranging we get:

$$\frac{dh}{dt} = \frac{K}{A}$$

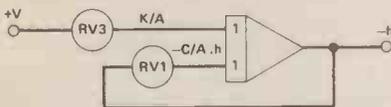


Figure 14. Developing the bathtub circuit.

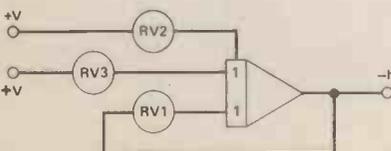


Figure 15. The bathtub completed.

So now we have a differential equation expressing the rise in level with time. The value 'K' represents the amount by which the tap is turned on and the main water supply pressure.

Now about the emptying part; the amount of water that will flow out in time interval 'dt' we shall call 'do'. Therefore, 'do' will be equal to the head 'h', multiplied by some constant 'C', where 'C' takes into account the size of the plug hole! Mathematically then:

$$do = C \cdot h \cdot dt$$

If the bath has a cross-sectional area of 'A' then the fall in head will be equal to:

$$dh = -\frac{1}{A} do$$

The sign is minus because the level is dropping. Rearranging we get:

$$do = -A \cdot dh$$

Substituting we get:

$$A \cdot dh = -C \cdot h \cdot dt$$

or:

$$\frac{dh}{dt} = -\frac{C}{A} h$$

This, too, is a differential equation showing the change of head with time, but this time it is due to the bath emptying. Therefore, the change in level at any instant in time will be the sum of the filling and emptying. So, finally, we can write:

$$\frac{dh}{dt} = \frac{K}{A} - \frac{C}{A} h$$

This is a differential equation of the type that Microlog can solve with ease; let's set up the circuit. First we will need an integrator, so that if we

put 'dh/dt' in we will get '-h' out (which is what we want). So, we have to put voltage signals corresponding to the right hand side of our equation into the integrator, and we will then get out a voltage that will be the analogue of the water level at any instant in time. The circuit, then, will look like Figure 14. Notice that each input does in fact represent a term on the right of our equation and that, as the inputs are summed, the terms are added, just as in the equation.

To complete the picture we have to set the initial conditions of the system; in this case the initial condition is the level of the bath water before we start the filling and emptying process. We can set it to zero (an empty bath) or at any level up to full. The complete circuit is shown in Figure 15 and the Microlog patch diagram is shown in Figure 16.

Now to run the program: first set Microlog to Reset and adjust RV2 to set the water level to full. That will be minus full scale deflection of the meter. Ensure that RV1 and 3 are turned fully off, anticlockwise, and switch to Run; the water level should remain constant. Now pull out the plug! You do that by turning up RV1; the value determines the size of the plug hole and thence the rate of outflow. Notice that the water level is dropping, as shown by the meter movement, and that the rate slows down as the bath empties. If we turn on the tap, RV3, you can fill the bath. Of course, the filling rate will have to

Project

be greater than the emptying rate or the level will slowly drop. It is interesting to start with an empty bath and start pouring water in. If the plug is open, the level will start to rise until the increased head causes the outflow to equal the inflow. At this point the level will remain constant. Turn down the inflow rate a little and after a while a new equilibrium level will be found. The time taken is the 'response time' of the system that we have just modeled on our analogue computer!

So instead of doing lengthy calculations, or getting wet running an experiment, Microlog has allowed you to set up an analogue of the system under test. You can try various settings for all the pots to see how the result changes.

Let's look at another application. You may remember that integrating SIN(X) gives -COS(X), and integrating COS(X) gives -SIN(X).

Again, this is a differential equation of the type easily set up on Microlog. Look at the circuit and patch diagram in Figures 17 and 20. If you patch this on Microlog, set the initial condition of integrator 1 to 10 volts and then switch to Run you will get out a sinewave or a 90 degree phase shifted sine wave (COS). Using pots RV1 and 2, you can slow down the frequency of oscillation (or by patching into the x10 inputs of the integrators you can speed it up). This makes quite a neat and simple very low frequency sinewave oscillator. Due to the tiny leakage of the capacitors and the small input currents of the op-amps the amplitude will decay eventually, but it will continue to oscillate for many minutes.

Loops and Bumps

Two areas in which analogue computers are often used are those of modeling dynamic systems and servo loops. These two problems require the solution of second order differential equations of the type:

$$A \frac{d^2x}{dt^2} + B \frac{dx}{dt} + Cx = 0$$

Let's take the front suspension of a car: what will happen if you hit a large pothole in the road and your shock absorbers are bad? Figure 19 is a simple representation of the type of system we are going to model, and the equation that describes the response of the system to a disturbance (a pothole) is:

$$M\ddot{X} + D\dot{X} + SX = 0$$

where $\ddot{X} = \frac{d^2x}{dt^2}$ and $\dot{X} = \frac{dx}{dt}$

$M\ddot{X}$ is the inertial force due to the mass of the car, $D\dot{X}$ is the viscous damping force produced by the shock absorber, and SX is the restoring force of your front spring. X , of course, is the displacement of the suspension system, and we want to see how quickly this will be restored to the original value.

To patch this on Microlog we first rearrange the equation so the \ddot{X} is the subject:

$$\ddot{X} = -\frac{DX}{M} - \frac{SX}{M}$$

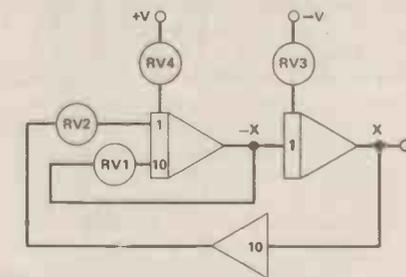
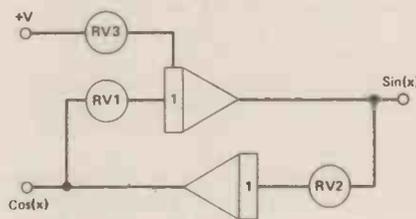
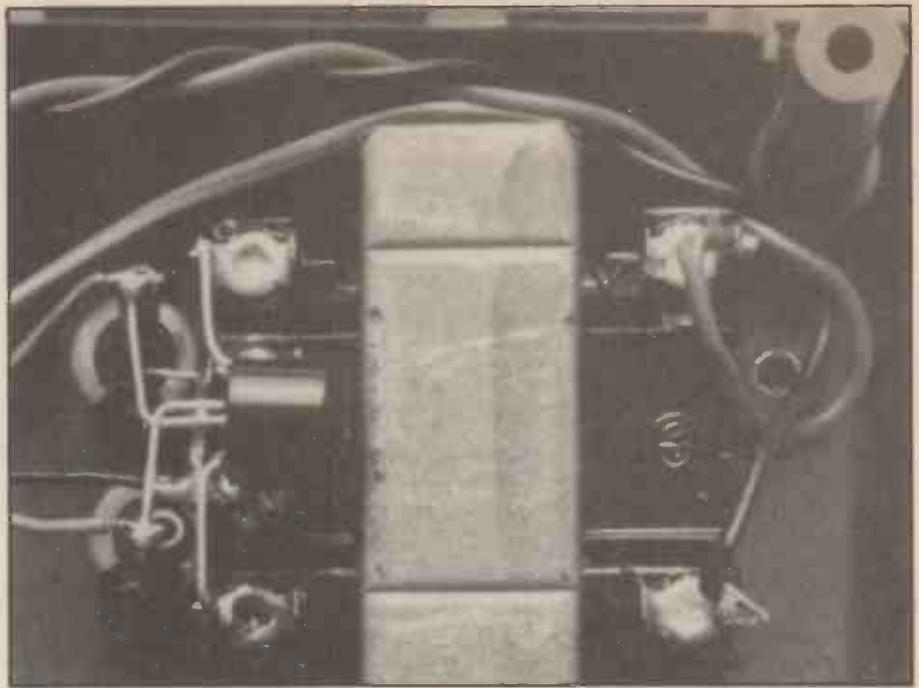


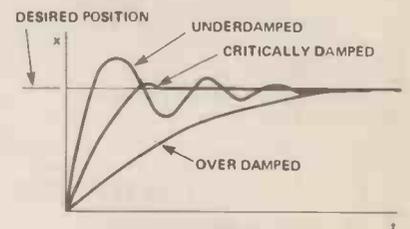
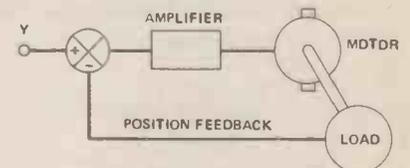
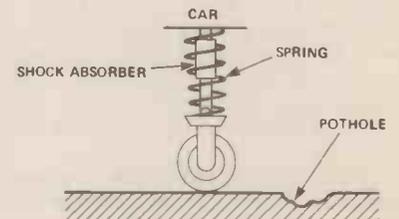
Figure 17 (top left). The Sin X/Cos X generator circuit.

Figure 18 (top right). A model suspension.

Figure 19 (middle left). Suspension circuitry.

Figure 22 (middle right). Model of a closed-loop servo system.

Figure 23 (right). Response curves of a closed-loop servo.



Integrating \ddot{X} gives \dot{X} , and integrating \dot{X} gives X . These can then be summed according to the formula to give \ddot{X} . The circuit and patch are shown in Figures 19 and 21. Pot RV1 is used to set the $D\dot{X}$ term and RV2 determines SX : Set them both to about mid range. But if we drive along a perfectly flat road the suspension will not move, so we have to simulate the bump. This is done by setting an initial condition into the integrators, to show that the suspension has been displaced.

Turn Microlog to Reset and set RV4

to about mid value and RV3 to give -50 on the meter - this is a medium sized pothole! Now switch to Run and watch the meter. It will return to zero (the original position) and then overshoot, then reverse direction but overshoot zero again, though not by so much this time. Eventually, it will settle down to a smooth ride again. Try playing around with RV1 and RV2; reducing RV2 reduces the effectiveness of the shock absorber and you will find the front end of your car bouncing up and down for the next few miles. Increase it, and it takes a

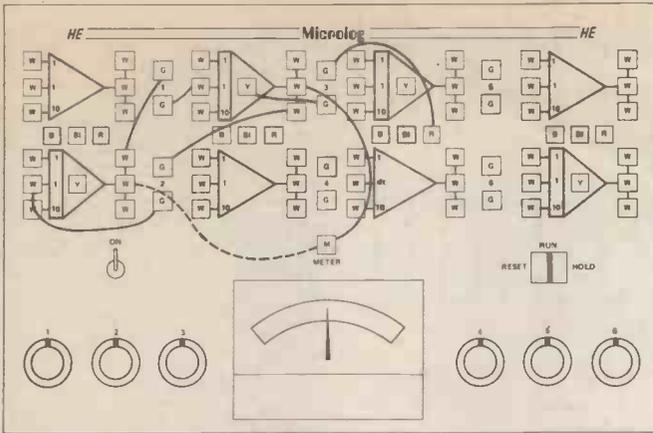


Figure 20. Sin X/Cos X patch.

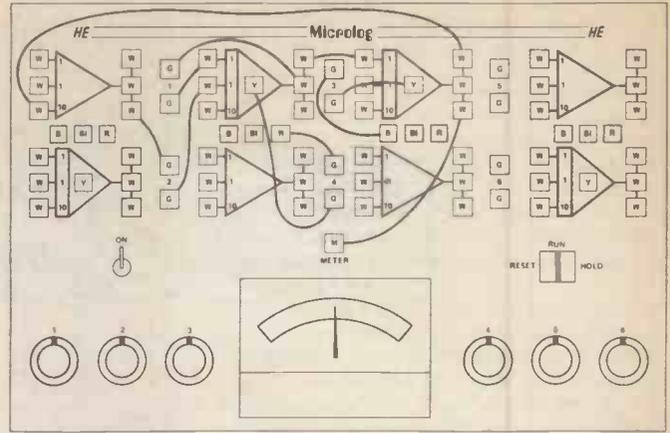


Figure 21. Pothole patch.

long time to return to the level condition again. If you increase RV1 you stiffen the spring. A high RV1 and RV2 setting simulates the rock hard suspension of a sports car, while a low setting for both (especially P1) gives you the ride of a big American Cadillac!

A closed loop servo system, of the type shown in Figure 22, also has a second order differential equation to describe its performance. In this case, instead of turning to the zero displacement position, the system must move to the position corresponding to the input signal Y.

Microlog can model this system too, and in fact it is very similar to the

car suspension problem. To change the patch to model the system shown in Figure 22, all you have to do is take the output of RV3 from the initial condition input of the integrator and plug it into the free summing input; this pot is now your position control. RV1 now sets the gain of the feedback loop and RV2 the inertia of the system. Switch Microlog from Reset to Run and then move RV3 to a new position; the meter output will follow but overshoot, and then come back. You can determine the best response by playing with the gain and inertia of the system, and if you have an oscilloscope you can plot the response and should be able to see the sort of

curves shown in Figure 23.

These are just a few of the possible systems and problems that can be solved with an analogue computer. Microlog is not designed to produce accurate numerical results; however, it can give a good idea of how a system will function, and give you a feel for analogue computing.

It can also be used to add signals, or the integrators can be set up to give you a very slow ramp. The differentiator input can be used to measure the slope of a ramp and it can also be used to detect drift in a circuit, so Microlog can be quite a useful lab instrument as well!

Go on. Build one!

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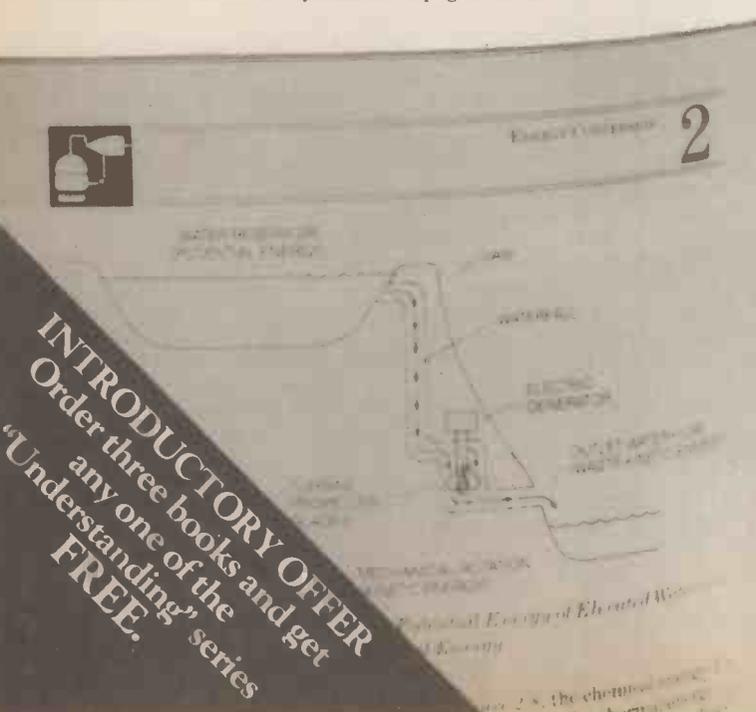
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Stereo Noise Gate

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Stereo Noise Gate

NOISE is present in every electronic circuit, and in audio circuits it results in the all too familiar background "hiss". Although modern electronics components have provided great improvements in noise performance in recent years, noise in audio circuits can still be very troublesome at times, and there can sometimes be a build-up of noise which results in a poor signal-to-noise ratio when using certain combinations of equipment. Re-recording material can also lead to a build-up of noise.

Two useful ways of combatting audio noise are to use either a noise gate or an expander. These two devices are very similar, but there is a very important distinction between them. A noise gate is rather like an automatic switch which normally allows the input signal to pass straight through, but cuts off the output when noise *only* is present at the input. Noise is most obtrusive during pauses in the main signal, and a noise gate can therefore give a large subjective improvement in performance.

An expander permits low level signals to pass normally but at medium and high signal levels, it gives a progressive boost to the processed signal. Thus the noise level remains the

same but the maximum volume level is increased; or, the noise level can be reduced with the maximum volume level remaining the same; or, a combination of the two, as desired. A simple volume expander was described in the January 1982 issue of *Hobby Electronics*.

Whether a noise gate or an expander is the best choice depends upon the particular circumstances in which the equipment will be used and, to some extent, on personal preferences. A disadvantage of an expander is that it alters the dynamic levels of the processed signal, whereas a noise gate simply cuts off the noise during breaks in the signal. A noise gate is therefore normally preferable for use where changes in dynamic level are undesirable. However, a gate is likely to be less satisfactory when the wanted signal may, at times, be almost lost in the noise, since it is then possible that the gate might cut off the signal. A noise gate is of most use when there is a fairly strong noise level, but the wanted signal is usually significantly above this level.

The unit described here is a stereo noise gate, although by using only one channel it can obviously be used in mono. Although expanders normally process each stereo channel separately

it is preferable for a stereo gate circuit to switch the two channels in unison, as it can be rather disturbing if one channel cuts out while the other is still present! This circuit therefore switches the two channels on and off simultaneously — see *How It Works* for an over-view of the system.

The Circuit

The full circuit diagram of the Stereo Noise Gate is shown in *Figure 1*. It is based on an LM13600N integrated circuit, which is a dual operational transconductance amplifier. An operational transconductance amplifier has features common with an ordinary operational amplifier, but there are also a number of important differences — a transconductance amplifier provides an output current (rather than an output voltage), governed by the differential input voltage, and it also has an additional input which enables the gain of the amplifier to be controlled over a wide range, from zero up to about 20 dB. Note that a gain of less than one is equivalent to attenuation!

In order to make a transconductance amplifier operate as a voltage amplifier, it is merely necessary to add a load resistor at the output; R20 is the load resistor for IC3a while R24 is the load for IC3b. The current flow into the

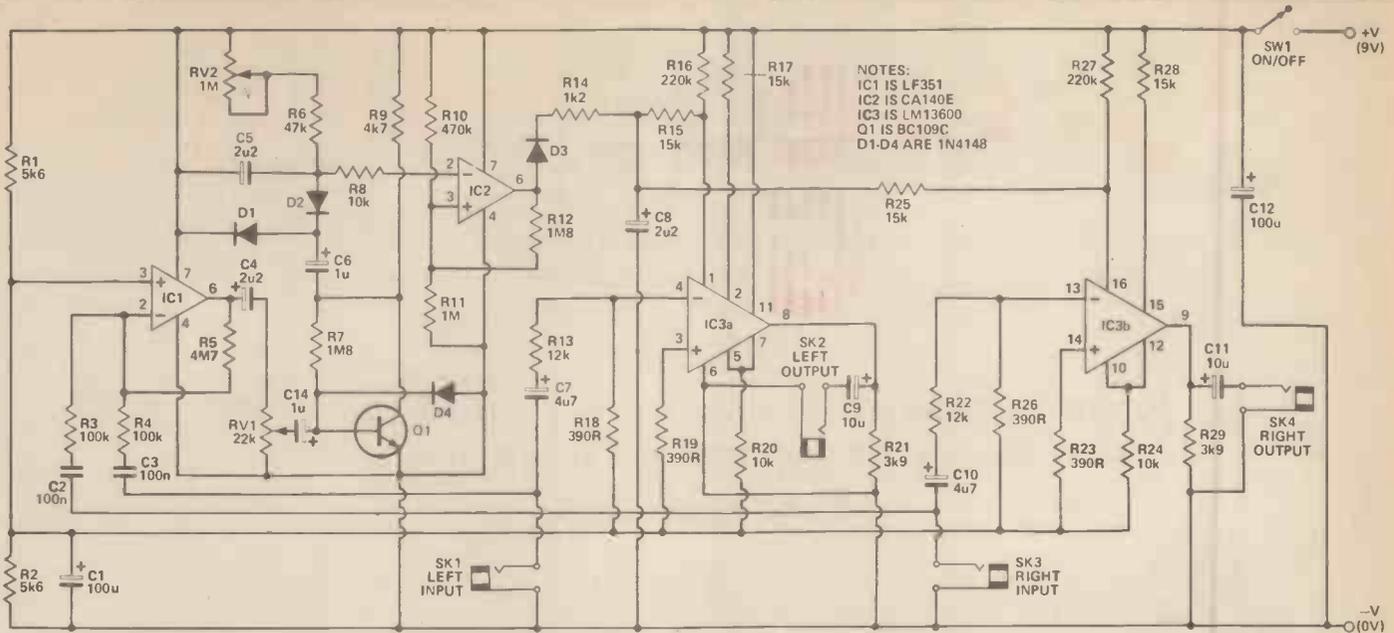


Figure 1. Circuit diagram of the Stereo Noise Gate. Note that both channels are included.

control input, rather than voltage, determines the gain of the amplifier. This is achieved by simply adding resistors (R15 and R25) in series with each control input so that the current flow is proportional to the applied voltage. Resistors R16 and R27 apply a small bias current to the control inputs; this gives the circuit about -20 dB of gain (ie, 20 dB attenuation) in the high attenuation mode, rather than completely cutting off the output signal, which usually gives more satisfactory results. The circuit can be made to operate as a true gate, if preferred, by simply omitting R16 and R27.

The LM13600N incorporates two Darlington Pair output stages which are used as emitter follower buffer stages, to give the VCAs a low output

Figure 2. Pin configuration for the LM13600 dual transconductance op-amp.

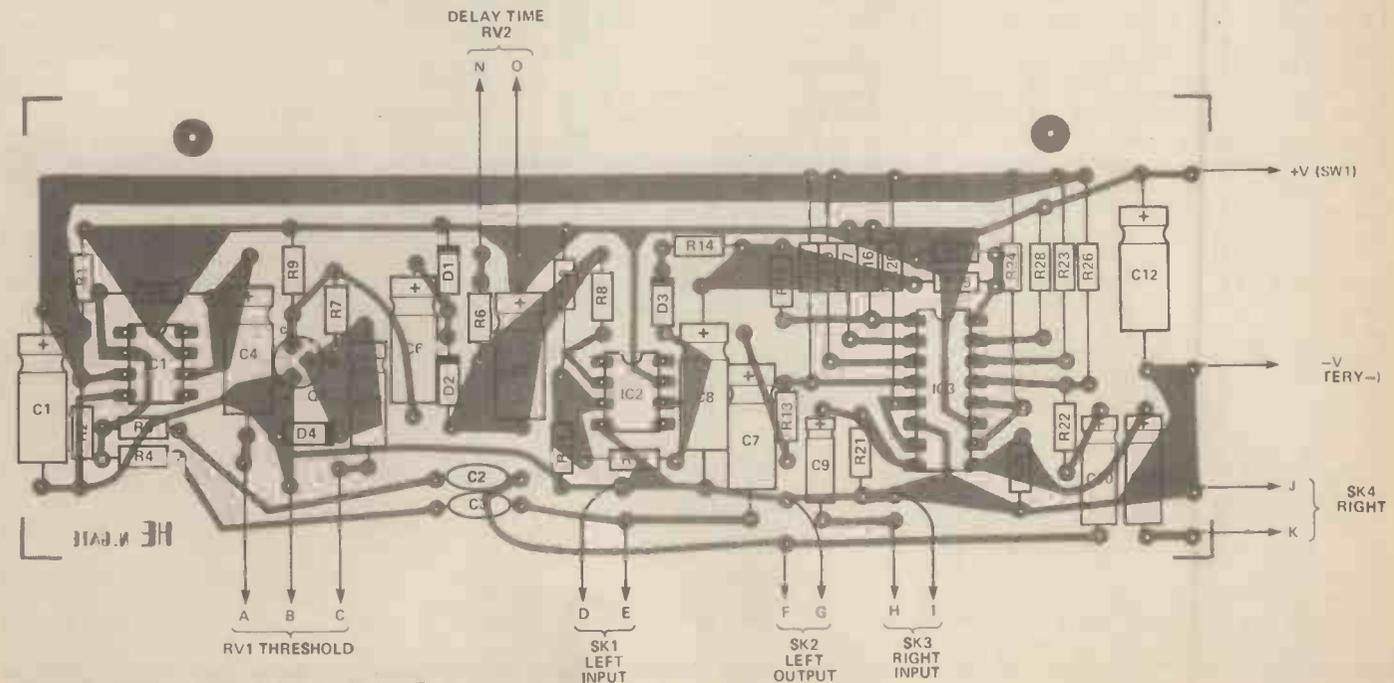
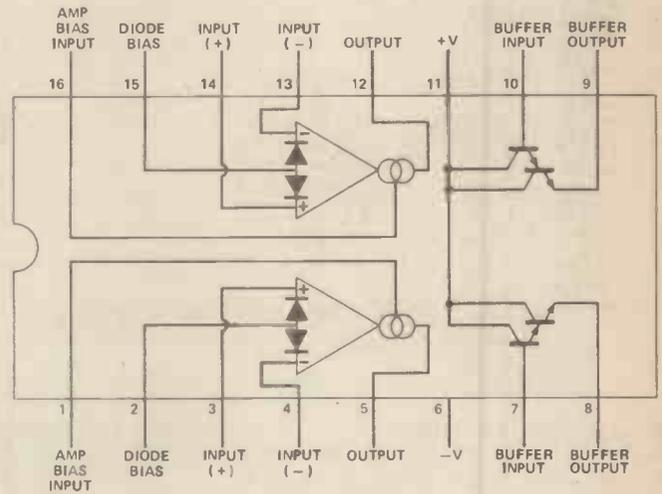


Figure 3. Overlay diagram for the Noise Gate.

Project

impedance. R21 and R29 are the discrete load resistors for these stages. The LM13600N has 'linearizing diodes', which enable a higher input signal level to be handled for a given distortion level, and these diodes are given the appropriate bias by R17 and R28.

In order to operate as a voltage controlled amplifier, a trans-conductance amplifier must be used open loop (ie, without any negative feedback). R1, R2, and C1 form a centre tap on the supply rails and the inputs of the two transconductance amplifiers IC3a, b, biased to this voltage by R18,19,23 and 26. R13 and R22 are used to reduce the voltage gain through each section of the unit to about unity (with a high control voltage), and also to boost the input impedance to a little over 12k.

The mixer stage is a conventional operational amplifier, IC1, and gives a voltage gain of about 47. Threshold control RV1 is a volume control type attenuator, and the output from this is coupled to a high gain common emitter amplifier based on Q1; the combined gain of Q1 and IC1 is needed in order to boost weak input signals to a high enough level to drive the subsequent circuitry.

The output of Q1 is coupled by C6 to a simple rectifier and smoothing circuit (D1, D2, C5 and R8) and RV2 controls the decay time of this circuit. Op-amp IC2 is used as a simple inverting trigger circuit, with positive feedback and hysteresis provided by R12;

'hysteresis' simply means that the input voltage at which the output triggers to the high state is lower than that at which it triggers back to the low state. This prevents instability when the input voltage is close to the switching threshold levels. D3 and R14 are used at the output of the trigger to very slightly slow the rise-time of the control

voltage, and to provide a slightly larger slowing of the fall-time. This prevents "clicks" from being introduced at the output as the gate changes state.

Construction

An aluminium and steel instrument case measuring about 152 x 114 x 44 mm is used to house this project — it is about

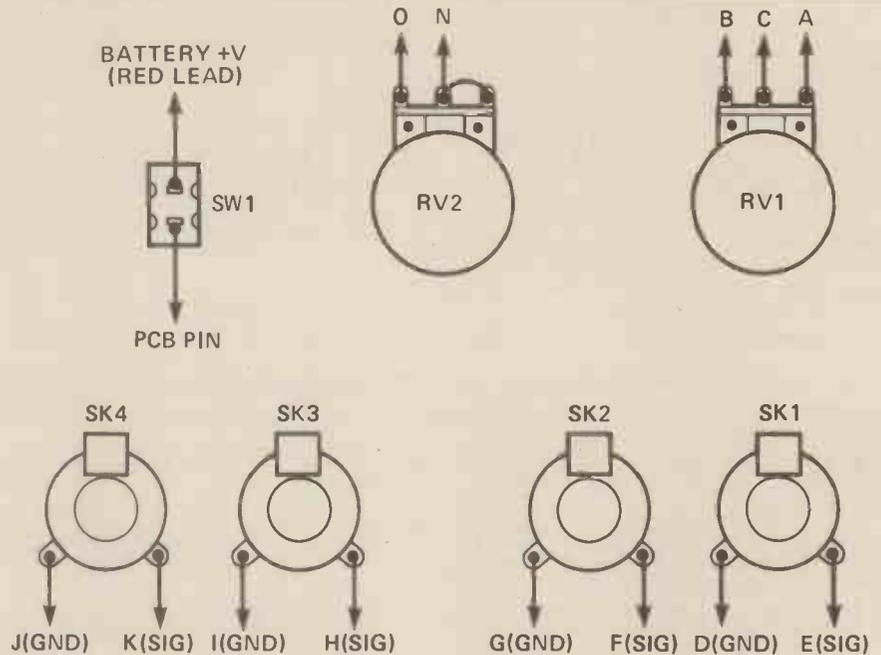
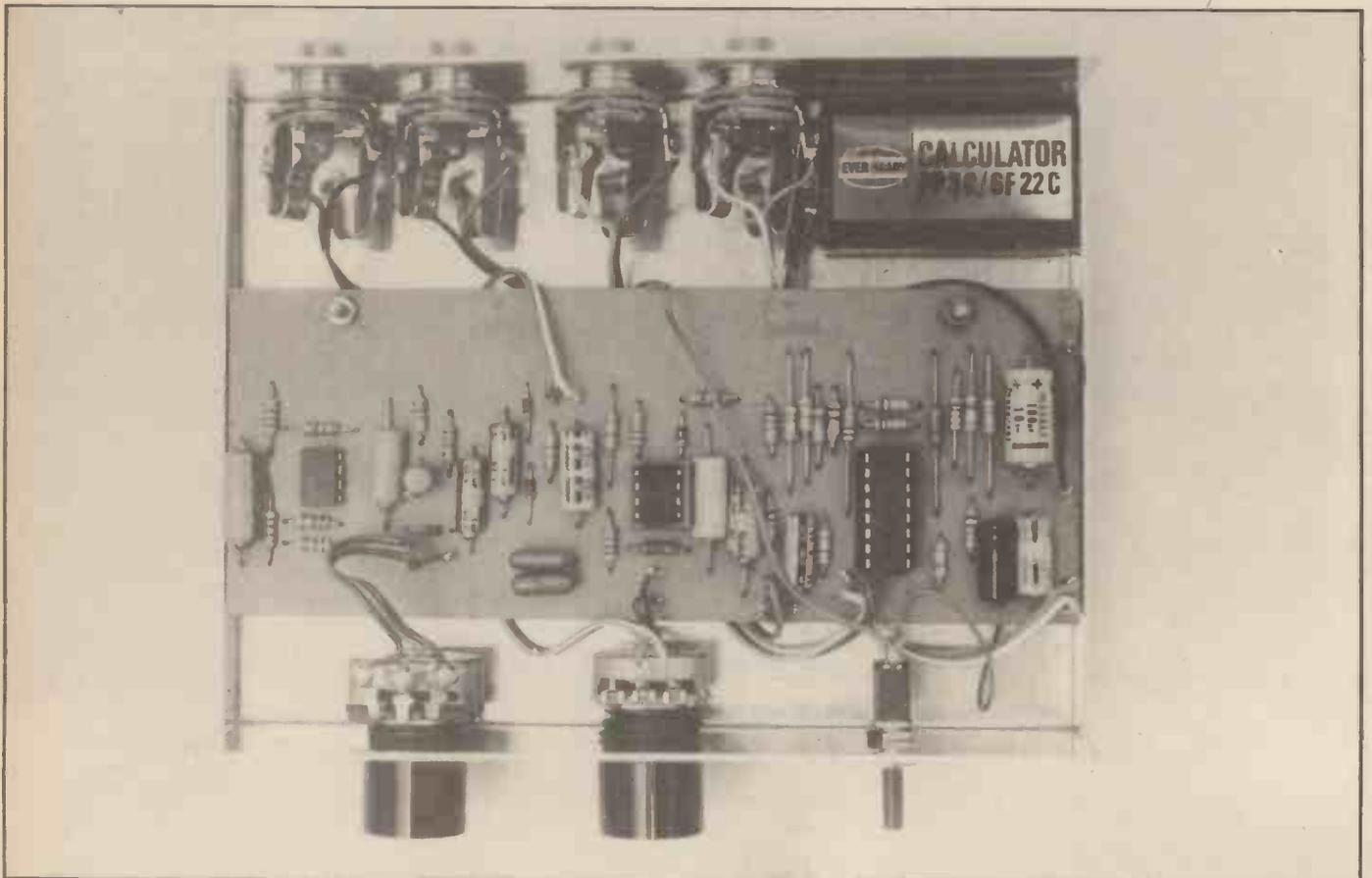


Figure 4. The internal wiring and connections inside the case of the Noise Gate.



the smallest case that could be used to accommodate all the parts. The three controls are mounted on the front panel and four sockets are fitted on the rear panel of the case.

Apart from the battery, all the other components are mounted on the printed circuit board, and this is detailed in Figure 3. As IC2 is a MOS device, it should be fitted in an 8 pin DIL IC socket and the normal MOS handling precautions should be observed. Use Veropins where connections to off-board components will eventually be made.

The completed board is mounted on the base panel of the case using 6BA fixings, including 6.3 mm spacers to hold the connections on the underside of the board clear of the metal case. The unit is then completed by adding the point-to-point wiring, illustrated in Figure 4. Ordinary PVC covered multistrand connecting wire is used here; it is not necessary to use screened leads.

In Use

The unit is intended for use with a high level signal and can take inputs of 2 volts RMS or so without serious distortion occurring. The threshold voltage at which the gate switches to the unity gain (zero attenuation) state can be varied from about 1 mV RMS (with RV1 set fully clockwise) to about 70 mV RMS. The best setting is likely to be such that the noise signal alone is not quite sufficient to trigger the circuit to the zero attenuation state, but it is worthwhile experimenting a little to find

the setting which gives the best subjective results.

The circuit will respond very rapidly to an input signal (fast attack), but the decay — the delay between the cessation of the main signal and the gate switching to the high attenuation state — can be varied from less than a

tenth of a second to more than two seconds. A fast decay time will often give best results, but it might sometimes be found that the gate tends to switch back and forth between the two states fairly rapidly; a slightly longer decay time should eliminate this problem.

Parts List

RESISTORS

(All 1/4 watt 5% carbon)

R1,2	.....	5k6
R3,4	.....	100k
R5	.....	4M7
R6	.....	47k
R7,12	.....	1M8
R8,20,24	.....	10k
R9	.....	4k7
R10	.....	470k
R11	.....	1M
R13,22	.....	12k
R14	.....	1k2
R15,17,25,28	.....	15k
R16,27	.....	220k
R18,19,23,26	.....	390R
R21,29	.....	3k9

POTENTIOMETERS

RV1	.....	22k
		log carbon
RV2	.....	1M
		linear carbon

CAPACITORS (All axial electrolytics unless noted)

C1,12	.....	100u 10V
C2,3	.....	100n
		C280 polyester

C4,5,8	.....	2u2 63V
C6	.....	1u 63V
C7,10	.....	4u7 63V
C9,11	.....	10u 25V

SEMICONDUCTORS

IC1	.....	LF351
		JFET op-amp
IC2	.....	3140E
		MOSFET op-amp
IC3	.....	LM13600N
		dual transconductance amp
Q1	.....	BC109C
		silicon NPN transistor
D1-4	.....	1N4148
		silicon signal diode

MISCELLANEOUS

SK1-4	.....	1/4" jack socket
		standard metal chassis type
SW1	.....	SPST
		miniature toggle switch
Case	(see Buylines); PCB; 6BA	nuts and bolts; Veropins; IC
		sockets; knobs (2); PP3 battery,
		clip, wire, solder etc.

BUYLINES page 34

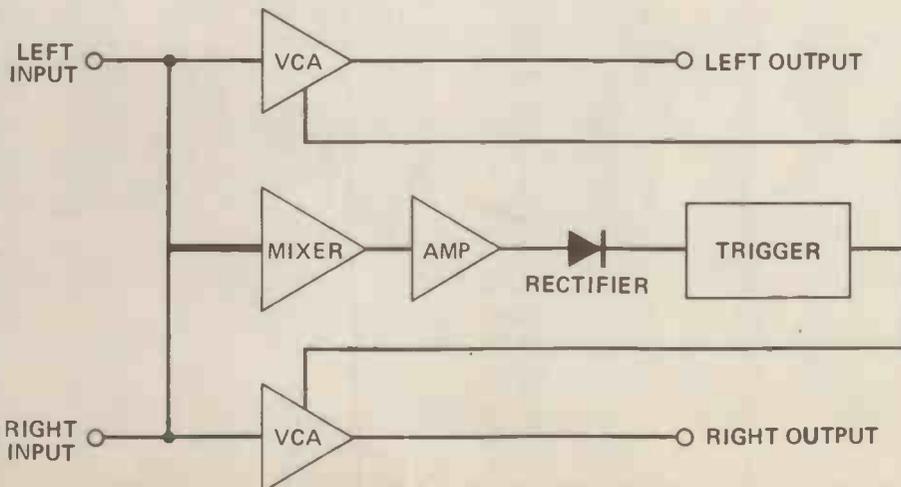
How It Works

THIS Noise Gate design is a stereo type which uses a separate VCA (voltage-controlled amplifier) to process each channel. With a low control voltage, each VCA gives a substantial amount of attenuation (about 20 dB — a 90% reduction in the signal voltage, in other words). A high control voltage gives unity gain (zero attenuation) through each VCA and the input signal is effectively allowed to pass straight through.

Automatic switching — to zero attenuation in the presence of a proper

input signal but high attenuation with only noise applied to the input — is achieved by first mixing the two input signals and then amplifying them. The amplified signal is then applied to a rectifier and smoothing circuit to produce a DC output level proportional to the strength of the combined input signals. this voltage is fed to a trigger circuit which has a high output voltage if the input voltage is above a certain threshold level, and a low voltage if it is not; this is the control voltage for the VCAs.

The circuit is adjusted so that with only background noise present at the input, the voltage fed to the trigger circuit is below the threshold voltage and the VCAs give a high attenuation level. With a high input signal, in addition to noise, the input voltage to the trigger circuit goes above the threshold level and the VCAs 'open' producing zero attenuation. Thus the required automatic attenuation of the noise-only input signal is obtained.



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METAL OXIDE/FILM RESISTORS	Chargers	TYPE H: Adjustable to 8	2N6130 30p 2N6131 30p 2N6132 30p 2N6133 30p 2N6134 30p 2N6135 30p 2N6136 30p 2N6137 30p 2N6138 30p 2N6139 30p 2N6140 30p 2N6141 30p 2N6142 30p 2N6143 30p 2N6144 30p 2N6145 30p 2N6146 30p 2N6147 30p 2N6148 30p 2N6149 30p 2N6150 30p 2N6151 30p 2N6152 30p 2N6153 30p 2N6154 30p 2N6155 30p 2N6156 30p 2N6157 30p 2N6158 30p 2N6159 30p 2N6160 30p 2N6161 30p 2N6162 30p 2N6163 30p 2N6164 30p 2N6165 30p 2N6166 30p 2N6167 30p 2N6168 30p 2N6169 30p 2N6170 30p 2N6171 30p 2N6172 30p 2N6173 30p 2N6174 30p 2N6175 30p 2N6176 30p 2N6177 30p 2N6178 30p 2N6179 30p 2N6180 30p 2N6181 30p 2N6182 30p 2N6183 30p 2N6184 30p 2N6185 30p 2N6186 30p 2N6187 30p 2N6188 30p 2N6189 30p 2N6190 30p 2N6191 30p 2N6192 30p 2N6193 30p 2N6194 30p 2N6195 30p 2N6196 30p 2N6197 30p 2N6198 30p 2N6199 30p 2N6200 30p	TYPE H: Adjustable to 8 of any HP type available for 55p	2N6201 30p 2N6202 30p 2N6203 30p 2N6204 30p 2N6205 30p 2N6206 30p 2N6207 30p 2N6208 30p 2N6209 30p 2N6210 30p 2N6211 30p 2N6212 30p 2N6213 30p 2N6214 30p 2N6215 30p 2N6216 30p 2N6217 30p 2N6218 30p 2N6219 30p 2N6220 30p 2N6221 30p 2N6222 30p 2N6223 30p 2N6224 30p 2N6225 30p 2N6226 30p 2N6227 30p 2N6228 30p 2N6229 30p 2N6230 30p 2N6231 30p 2N6232 30p 2N6233 30p 2N6234 30p 2N6235 30p 2N6236 30p 2N6237 30p 2N6238 30p 2N6239 30p 2N6240 30p 2N6241 30p 2N6242 30p 2N6243 30p 2N6244 30p 2N6245 30p 2N6246 30p 2N6247 30p 2N6248 30p 2N6249 30p 2N6250 30p 2N6251 30p 2N6252 30p 2N6253 30p 2N6254 30p 2N6255 30p 2N6256 30p 2N6257 30p 2N6258 30p 2N6259 30p 2N6260 30p 2N6261 30p 2N6262 30p 2N6263 30p 2N6264 30p 2N6265 30p 2N6266 30p 2N6267 30p 2N6268 30p 2N6269 30p 2N6270 30p 2N6271 30p 2N6272 30p 2N6273 30p 2N6274 30p 2N6275 30p 2N6276 30p 2N6277 30p 2N6278 30p 2N6279 30p 2N6280 30p 2N6281 30p 2N6282 30p 2N6283 30p 2N6284 30p 2N6285 30p 2N6286 30p 2N6287 30p 2N6288 30p 2N6289 30p 2N6290 30p 2N6291 30p 2N6292 30p 2N6293 30p 2N6294 30p 2N6295 30p 2N6296 30p 2N6297 30p 2N6298 30p 2N6299 30p 2N6300 30p
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LOW OHMIC VALUE RESISTORS	TYPE A: HP7 Up to 4 in a time! £5.85	TYPE B: GRAPHIC PROCESSORS	2N6301 30p 2N6302 30p 2N6303 30p 2N6304 30p 2N6305 30p 2N6306 30p 2N6307 30p 2N6308 30p 2N6309 30p 2N6310 30p 2N6311 30p 2N6312 30p 2N6313 30p 2N6314 30p 2N6315 30p 2N6316 30p 2N6317 30p 2N6318 30p 2N6319 30p 2N6320 30p 2N6321 30p 2N6322 30p 2N6323 30p 2N6324 30p 2N6325 30p 2N6326 30p 2N6327 30p 2N6328 30p 2N6329 30p 2N6330 30p 2N6331 30p 2N6332 30p 2N6333 30p 2N6334 30p 2N6335 30p 2N6336 30p 2N6337 30p 2N6338 30p 2N6339 30p 2N6340 30p 2N6341 30p 2N6342 30p 2N6343 30p 2N6344 30p 2N6345 30p 2N6346 30p 2N6347 30p 2N6348 30p 2N6349 30p 2N6350 30p 2N6351 30p 2N6352 30p 2N6353 30p 2N6354 30p 2N6355 30p 2N6356 30p 2N6357 30p 2N6358 30p 2N6359 30p 2N6360 30p 2N6361 30p 2N6362 30p 2N6363 30p 2N6364 30p 2N6365 30p 2N6366 30p 2N6367 30p 2N6368 30p 2N6369 30p 2N6370 30p 2N6371 30p 2N6372 30p 2N6373 30p 2N6374 30p 2N6375 30p 2N6376 30p 2N6377 30p 2N6378 30p 2N6379 30p 2N6380 30p 2N6381 30p 2N6382 30p 2N6383 30p 2N6384 30p 2N6385 30p 2N6386 30p 2N6387 30p 2N6388 30p 2N6389 30p 2N6390 30p 2N6391 30p 2N6392 30p 2N6393 30p 2N6394 30p 2N6395 30p 2N6396 30p 2N6397 30p 2N6398 30p 2N6399 30p 2N6400 30p	TYPE A: HP7 Up to 4 in a time! £5.85	2N6401 30p 2N6402 30p 2N6403 30p 2N6404 30p 2N6405 30p 2N6406 30p 2N6407 30p 2N6408 30p 2N6409 30p 2N6410 30p 2N6411 30p 2N6412 30p 2N6413 30p 2N6414 30p 2N6415 30p 2N6416 30p 2N6417 30p 2N6418 30p 2N6419 30p 2N6420 30p 2N6421 30p 2N6422 30p 2N6423 30p 2N6424 30p 2N6425 30p 2N6426 30p 2N6427 30p 2N6428 30p 2N6429 30p 2N6430 30p 2N6431 30p 2N6432 30p 2N6433 30p 2N6434 30p 2N6435 30p 2N6436 30p 2N6437 30p 2N6438 30p 2N6439 30p 2N6440 30p 2N6441 30p 2N6442 30p 2N6443 30p 2N6444 30p 2N6445 30p 2N6446 30p 2N6447 30p 2N6448 30p 2N6449 30p 2N6450 30p 2N6451 30p 2N6452 30p 2N6453 30p 2N6454 30p 2N6455 30p 2N6456 30p 2N6457 30p 2N6458 30p 2N6459 30p 2N6460 30p 2N6461 30p 2N6462 30p 2N6463 30p 2N6464 30p 2N6465 30p 2N6466 30p 2N6467 30p 2N6468 30p 2N6469 30p 2N6470 30p 2N6471 30p 2N6472 30p 2N6473 30p 2N6474 30p 2N6475 30p 2N6476 30p 2N6477 30p 2N6478 30p 2N6479 30p 2N6480 30p 2N6481 30p 2N6482 30p 2N6483 30p 2N6484 30p 2N6485 30p 2N6486 30p 2N6487 30p 2N6488 30p 2N6489 30p 2N6490 30p 2N6491 30p 2N6492 30p 2N6493 30p 2N6494 30p 2N6495 30p 2N6496 30p 2N6497 30p 2N6498 30p 2N6499 30p 2N6500 30p
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WIREWOUND RESISTORS 5%	TYPE A: HP7 Up to 4 in a time! £5.85	TYPE B: GRAPHIC PROCESSORS	2N6501 30p 2N6502 30p 2N6503 30p 2N6504 30p 2N6505 30p 2N6506 30p 2N6507 30p 2N6508 30p 2N6509 30p 2N6510 30p 2N6511 30p 2N6512 30p 2N6513 30p 2N6514 30p 2N6515 30p 2N6516 30p 2N6517 30p 2N6518 30p 2N6519 30p 2N6520 30p 2N6521 30p 2N6522 30p 2N6523 30p 2N6524 30p 2N6525 30p 2N6526 30p 2N6527 30p 2N6528 30p 2N6529 30p 2N6530 30p 2N6531 30p 2N6532 30p 2N6533 30p 2N6534 30p 2N6535 30p 2N6536 30p 2N6537 30p 2N6538 30p 2N6539 30p 2N6540 30p 2N6541 30p 2N6542 30p 2N6543 30p 2N6544 30p 2N6545 30p 2N6546 30p 2N6547 30p 2N6548 30p 2N6549 30p 2N6550 30p 2N6551 30p 2N6552 30p 2N6553 30p 2N6554 30p 2N6555 30p 2N6556 30p 2N6557 30p 2N6558 30p 2N6559 30p 2N6560 30p 2N6561 30p 2N6562 30p 2N6563 30p 2N6564 30p 2N6565 30p 2N6566 30p 2N6567 30p 2N6568 30p 2N6569 30p 2N6570 30p 2N6571 30p 2N6572 30p 2N6573 30p 2N6574 30p 2N6575 30p 2N6576 30p 2N6577 30p 2N6578 30p 2N6579 30p 2N6580 30p 2N6581 30p 2N6582 30p 2N6583 30p 2N6584 30p 2N6585 30p 2N6586 30p 2N6587 30p 2N6588 30p 2N6589 30p 2N6590 30p 2N6591 30p 2N6592 30p 2N6593 30p 2N6594 30p 2N6595 30p 2N6596 30p 2N6597 30p 2N6598 30p 2N6599 30p 2N6600 30p	TYPE A: HP7 Up to 4 in a time! £5.85	2N6601 30p 2N6602 30p 2N6603 30p 2N6604 30p 2N6605 30p 2N6606 30p 2N6607 30p 2N6608 30p 2N6609 30p 2N6610 30p 2N6611 30p 2N6612 30p 2N6613 30p 2N6614 30p 2N6615 30p 2N6616 30p 2N6617 30p 2N6618 30p 2N6619 30p 2N6620 30p 2N6621 30p 2N6622 30p 2N6623 30p 2N6624 30p 2N6625 30p 2N6626 30p 2N6627 30p 2N6628 30p 2N6629 30p 2N6630 30p 2N6631 30p 2N6632 30p 2N6633 30p 2N6634 30p 2N6635 30p 2N6636 30p 2N6637 30p 2N6638 30p 2N6639 30p 2N6640 30p 2N6641 30p 2N6642 30p 2N6643 30p 2N6644 30p 2N6645 30p 2N6646 30p 2N6647 30p 2N6648 30p 2N6649 30p 2N6650 30p 2N6651 30p 2N6652 30p 2N6653 30p 2N6654 30p 2N6655 30p 2N6656 30p 2N6657 30p 2N6658 30p 2N6659 30p 2N6660 30p 2N6661 30p 2N6662 30p 2N6663 30p 2N6664 30p 2N6665 30p 2N6666 30p 2N6667 30p 2N6668 30p 2N6669 30p 2N6670 30p 2N6671 30p 2N6672 30p 2N6673 30p 2N6674 30p 2N6675 30p 2N6676 30p 2N6677 30p 2N6678 30p 2N6679 30p 2N6680 30p 2N6681 30p 2N6682 30p 2N6683 30p 2N6684 30p 2N6685 30p 2N6686 30p 2N6687 30p 2N6688 30p 2N6689 30p 2N6690 30p 2N6691 30p 2N6692 30p 2N6693 30p 2N6694 30p 2N6695 30p 2N6696 30p 2N6697 30p 2N6698 30p 2N6699 30p 2N6700 30p
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LOW RESISTANCE ROTARY POTS	TYPE A: HP7 Up to 4 in a time! £5.85	TYPE B: GRAPHIC PROCESSORS	2N6701 30p 2N6702 30p 2N6703 30p 2N6704 30p 2N6705 30p 2N6706 30p 2N6707 30p 2N6708 30p 2N6709 30p 2N6710 30p 2N6711 30p 2N6712 30p 2N6713 30p 2N6714 30p 2N6715 30p 2N6716 30p 2N6717 30p 2N6718 30p 2N6719 30p 2N6720 30p 2N6721 30p 2N6722 30p 2N6723 30p 2N6724 30p 2N6725 30p 2N6726 30p 2N6727 30p 2N6728 30p 2N6729 30p 2N6730 30p 2N6731 30p 2N6732 30p 2N6733 30p 2N6734 30p 2N6735 30p 2N6736 30p 2N6737 30p 2N6738 30p 2N6739 30p 2N6740 30p 2N6741 30p 2N6742 30p 2N6743 30p 2N6744 30p 2N6745 30p 2N6746 30p 2N6747 30p 2N6748 30p 2N6749 30p 2N6750 30p 2N6751 30p 2N6752 30p 2N6753 30p 2N6754 30p 2N6755 30p 2N6756 30p 2N6757 30p 2N6758 30p 2N6759 30p 2N6760 30p 2N6761 30p 2N6762 30p 2N6763 30p 2N6764 30p 2N6765 30p 2N6766 30p 2N6767 30p 2N6768 30p 2N6769 30p 2N6770 30p 2N6771 30p 2N6772 30p 2N6773 30p 2N6774 30p 2N6775 30p 2N6776 30p 2N6777 30p 2N6778 30p 2N6779 30p 2N6780 30p 2N6781 30p 2N6782 30p 2N6783 30p 2N6784 30p 2N6785 30p 2N6786 30p 2N6787 30p 2N6788 30p 2N6789 30p 2N6790 30p 2N6791 30p 2N6792 30p 2N6793 30p 2N6794 30p 2N6795 30p 2N6796 30p 2N6797 30p 2N6798 30p 2N6799 30p 2N6800 30p	TYPE A: HP7 Up to 4 in a time! £5.85	2N6801 30p 2N6802 30p 2N6803 30p 2N6804 30p 2N6805 30p 2N6806 30p 2N6807 30p 2N6808 30p 2N6809 30p 2N6810 30p 2N6811 30p 2N6812 30p 2N6813 30p 2N6814 30p 2N6815 30p 2N6816 30p 2N6817 30p 2N6818 30p 2N6819 30p 2N6820 30p 2N6821 30p 2N6822 30p 2N6823 30p 2N6824 30p 2N6825 30p 2N6826 30p 2N6827 30p 2N6828 30p 2N6829 30p 2N6830 30p 2N6831 30p 2N6832 30p 2N6833 30p 2N6834 30p 2N6835 30p 2N6836 30p 2N6837 30p 2N6838 30p 2N6839 30p 2N6840 30p 2N6841 30p 2N6842 30p 2N6843 30p 2N6844 30p 2N6845 30p 2N6846 30p 2N6847 30p 2N6848 30p 2N6849 30p 2N6850 30p 2N6851 30p 2N6852 30p 2N6853 30p 2N6854 30p 2N6855 30p 2N6856 30p 2N6857 30p 2N6858 30p 2N6859 30p 2N6860 30p 2N6861 30p 2N6862 30p 2N6863 30p 2N6864 30p 2N6865 30p 2N6866 30p 2N6867 30p 2N6868 30p 2N6869 30p 2N6870 30p 2N6871 30p 2N6872 30p 2N6873 30p 2N6874 30p 2N6875 30p 2N6876 30p 2N6877 30p 2N6878 30p 2N6879 30p 2N6880 30p 2N6881 30p 2N6882 30p 2N6883 30p 2N6884 30p 2N6885 30p 2N6886 30p 2N6887 30p 2N6888 30p 2N6889 30p 2N6890 30p 2N6891 30p 2N6892 30p 2N6893 30p 2N6894 30p 2N6895 30p 2N6896 30p 2N6897 30p 2N6898 30p 2N6899 30p 2N6900 30p
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LOW RESISTANCE ROTARY POTS	TYPE A: HP7 Up to 4 in a time! £5.85	TYPE B: GRAPHIC PROCESSORS	2N6901 30p 2N6902 30p 2N6903 30p 2N6904 30p 2N6905 30p 2N6906 30p 2N6907 30p 2N6908 30p 2N6909 30p 2N6910 30p 2N6911 30p 2N6912 30p 2N6913 30p 2N6914 30p 2N6915 30p 2N6916 30p 2N6917 30p 2N6918 30p 2N6919 30p 2N6920 30p 2N6921 30p 2N6922 30p 2N6923 30p 2N6924 30p 2N6925 30p 2N6926 30p 2N6927 30p 2N6928 30p 2N6929 30p 2N6930 30p 2N6931 30p 2N6932 30p 2N6933 30p 2N6934 30p 2N6935 30p 2N6936 30p 2N6937 30p 2N6938 30p 2N6939 30p 2N6940 30p 2N6941 30p 2N6942 30p 2N6943 30p 2N6944 30p 2N6945 30p 2N6946 30p 2N6947 30p 2N6948 30p 2N6949 30p 2N6950 30p 2N6951 30p 2N6952 30p 2N6953 30p 2N6954 30p 2N6955 30p 2N6956 30p 2N6957 30p 2N6958 30p 2N6959 30p 2N6960 30p 2N6961 30p 2N6962 30p 2N6963 30p 2N6964 30p 2N6965 3
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HE TV Amp

N.D.N. Belham



Specially designed to let Grandad hear the telly clearly without annoying the rest of the household, it will also double-up as a general-purpose bench amplifier.

ALTHOUGH we loved the old man and owed him a lot, Grandad was becoming a pest with his complaints that he couldn't hear the TV sound. For a while we did our best, though the volume was painful, but something obviously had to be done about it — if not for ourselves, then certainly for the sake of the neighbours! Fortunately our TV set is a modern one, with two headphone sockets built in, so when we bought him a pair of 'phones, we thought the problem had been solved — but it wasn't long before he refused to wear them because he didn't like the voices "inside his head" when they should have been coming from the screen. Anyway they became too

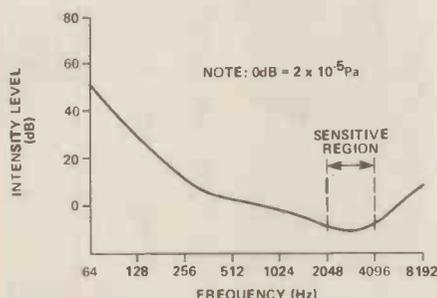
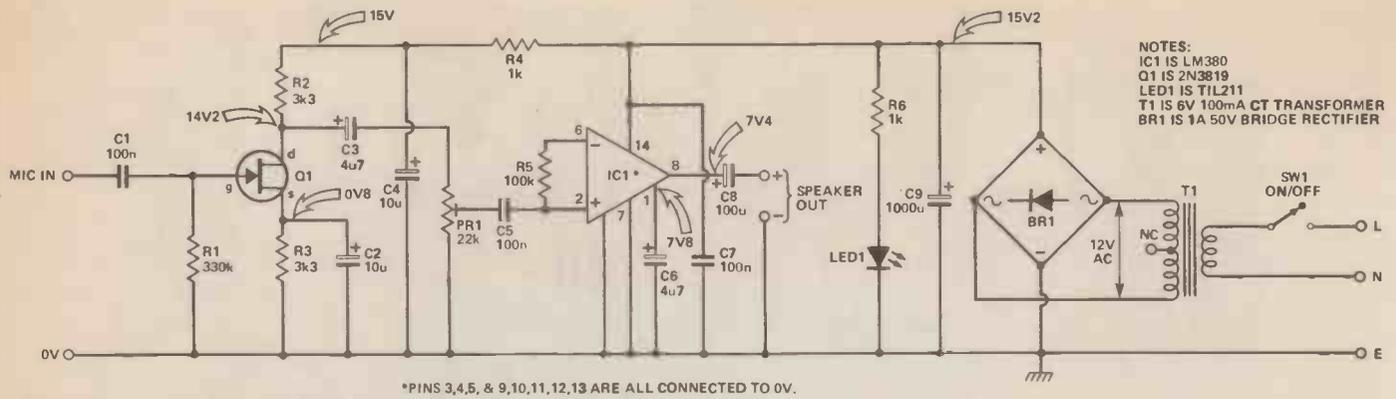


Figure 1. The response curve for the average person's sense of hearing (after Fletcher and Muson).

uncomfortable for him, after an hour or two. Another solution had to be found.

Grandad wasn't really deaf; he did not need a hearing aid, as he could carry on a normal conversation, but he did find it difficult to follow conversations on the telly. Strangely, it seemed to us, he preferred the sound from a small portable set to the one with full range hi-fi reproduction. Indeed, several factors seemed to be involved, some of a general nature and some peculiar to the elderly.

The diagram of Figure 1 shows the average frequency vs intensity response for an average person's hearing. Clearly, the energy required for a sound to be just audible varies greatly



NOTES:
 IC1 IS LM380
 Q1 IS 2N3819
 LED1 IS TIL211
 T1 IS 6V 100mA CT TRANSFORMER
 BR1 IS 1A 50V BRIDGE RECTIFIER

Figure 2. The circuit; the input is high impedance and will accept any audio input of around 10 to 50 mV.

Parts List

RESISTORS

(All 1/4 watt 5% carbon)

R1	330k
R2,3	3k3
R4,6	1k
R5	100k

POTENTIOMETERS

PR1	22k miniature cermet preset
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CAPACITORS

(All radial electrolytic unless stated)

C1,5,7	100n disc ceramic
C2,4	10u 16V
C3,6	4u7 35V
C8	100u 16V
C9	1000u 25V axial electrolytic

SEMICONDUCTORS

IC1	LM380 power amplifier
Q1	2N3819 FET transistor
BR1	50V 1A bridge rectifier
LED1	TIL211 0.2" green LED

MISCELLANEOUS

SW1	SPST mains toggle switch
T1	6-0-6 1.2VA Crystal microphone; centre-tapped transformer; speaker (see Buylines); Mains 'P' clip; mains lead and plug (2A fuse); case (see Buylines); 1/4" jack socket (plastic); LED bezel; PCB, wire, solder etc.

BUYLINES page 34

with frequency; very little sound energy is needed if it is at the right pitch, and the frequency range 2000 Hz to 4000 Hz is where the average ear is most sensitive.

Anyone who has worked in long range radio communication will know that restricting the audio bandwidth to between 500 Hz and 4000 Hz greatly improves the clarity of the transmission (especially in adverse atmospheric conditions), and this seems to indicate that, for speech, most of the essential information is contained in that frequency range.

Another factor, it seemed, was that the elderly find it difficult to concentrate on more than one sound at a time. They are easily put off by unwanted 'noise' — this is as much to do with the way in which sound is interpreted (psychoacoustics) as with

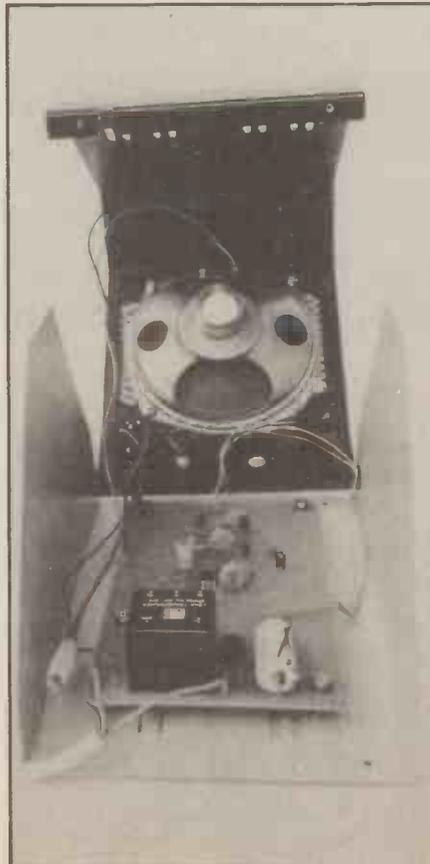
the sense of hearing. Hi-fi-quality sound, with its extended frequency range, produces too much 'noise' at the upper and lower limits of hearing which, for the elderly, masks the information in the mid-range frequencies. So, simply turning up the TV sound was not the solution because the unwanted frequencies are also boosted (this, also is why deaf aids are personally tailored to an individual's frequency response curve).

Grandad's Specifications

So, with these points in mind, we were able to write a specification for Grandad's TV amplifier:

- The output frequency must be tailored to peak at about 2000 Hz, with little response below 500 Hz or above 4000 Hz.
 - The output should be directional, so that it could be directed at Grandad, not at us!
 - The output level to be sufficient to allow it to be placed near the TV screen, to give it realistic 'TV sound'.
- The first step was to select a small loudspeaker, which automatically restricted the frequency response to the specified limits and also produced a degree of directivity. Unfortunately, the power available from a headphone socket is not sufficient to drive a loudspeaker, so an amplifier had to be designed and constructed. A single integrated amplifier, the LM380, proved adequate for the job, especially as it needs very few external components.

The price of batteries being what it is (expensive!), a simple mains power supply was built into the unit, together with an on/off switch and a LED power-on indicator. Since most TV sets do not have a headphone output, the circuit was adapted for general use by incorporating a microphone input. A crystal mic (use a short lead, because of its high impedance) is quite adequate, or a more expensive electret type can be used with a longer lead, if necessary. Dynamic microphones contain a coil which will respond to the varying magnetic field produced by the video scan, so they cannot be used here.



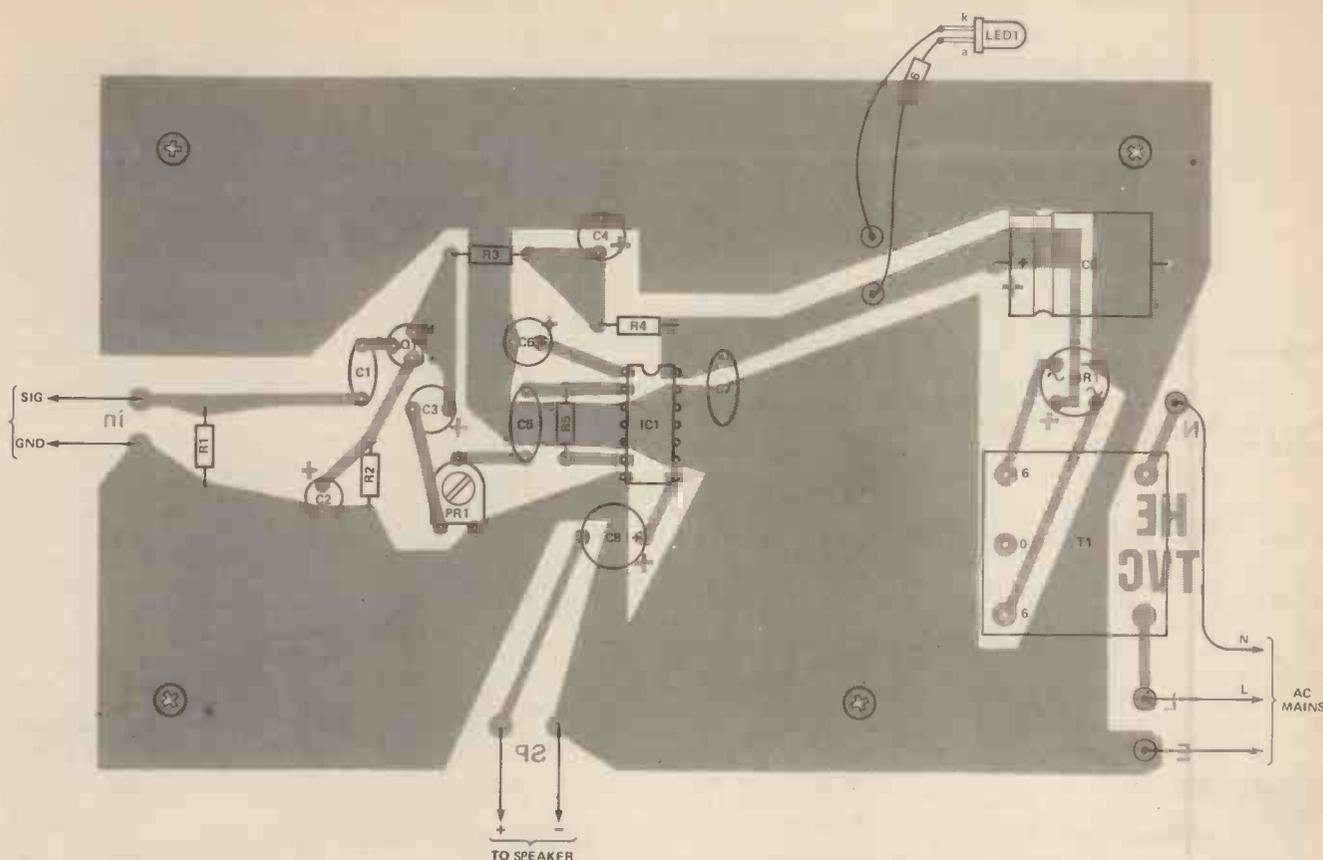


Figure 3. The PCB layout, viewed from the component side. Large areas of copper have been left to serve as a heatsink for the LM380 amplifier.

Granddad's Circuit

The microphone will give an output of a few tens of millivolts when placed fairly close to the loudspeaker with the volume control set for normal listening, and this is fed via coupling capacitor C1 to a FET amplifier, Q1. This provides the high impedance input required for the microphone and a voltage gain of between five and six.

A 4u7 capacitor, C3, couples the output of the FET stage to the preset volume control PR1, and C5 couples the signal to the inputs of IC1, the LM380 amplifier. This has an internally fixed gain of 34 dB (50Vout/Vin), but it is reduced to 20Vout/Vin by using a 'common mode' input, where part of the input voltage is coupled to the inverting input of the amplifier via the 100k resistor, R5.

Capacitor C6, connected to the bypass pin (pin 1) of IC1 de-couples the internal bias of the amp, preventing AC ripple on the output, while C7 performs the same function on the supply line.

The output is fed to the speaker via C8; together, C8 and the speaker voice coil impedance form a high pass filter, rolling off the response below 200 Hz when an 8R speaker is used. The speaker itself is the main factor in shaping the frequency response; by choosing a small 4" diameter unit and mounting it in an unsealed box, most of the lower frequencies are attenuated,

while the mechanical properties of the cone ensure that frequencies above about 4 kHz are also 'lost'.

Finally, the amp is powered from a simple DC supply derived from a 6V/100mA centre-tapped transformer and a diode bridge; the ripple voltage is filtered out by C9. LED 1 is included to provide 'power-on' indication, with R6 to limit the current through the LED.

Construction

In order to improve the stability of the amplifier (reducing the chance of it becoming an oscillator), it is mounted on a PCB which has a very large area of copper. The unused pins of the IC are soldered directly to these areas — do not use an IC socket in this project! This method also provides an effective heat sink.

The layout shown in Figure 3 is designed for a preset volume control to be mounted on the PCB; should a full-sized pot be required as a front panel volume control, leads must be taken from the PCB to the potentiometer solder tags. The choice of preset or variable volume control is left to the constructor — perhaps the solution depends on how many "knob-twiddlers" there are in the house!

Granddad's TV Amp can be built into any enclosure large enough to hold the components, including the speaker. Our prototype was cased in a rather

classy custom-built box from Newrad Instrument Cases Ltd (see Buylines for the ordering details); this also has a pre-drilled hole for a panel-mounted volume control.

Operation

The problem with any microphone-amplifying system is the risk of acoustic feedback, which will occur whenever the mic is picking up sound from the loudspeaker. Steps must be taken to prevent this from happening!

First, the best position for the TV Amp is on the floor, or on a low table in front of the TV set, so that the sound is coming from the same direction. Second, the mic should be placed as close to the TV speaker as possible, but without actually touching it. Then, the preset or volume control must be adjusted so that, at normal listening levels, there is no trace of whistling or "howl round" from the TV Amp.

In most cases, this arrangement will be quite satisfactory though for very deaf people, it may be necessary to place the Amp closer to the listener and to use a longer mic lead. If such is the case, a crystal microphone should not be used with a lead longer than about three feet.

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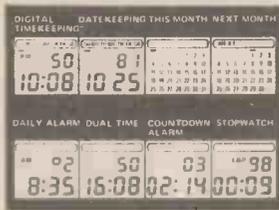
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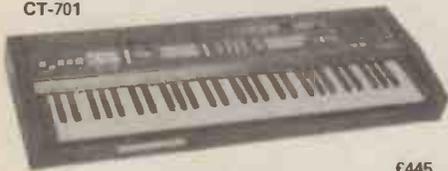
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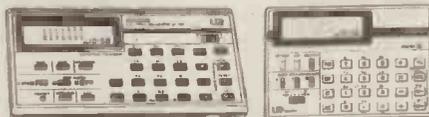
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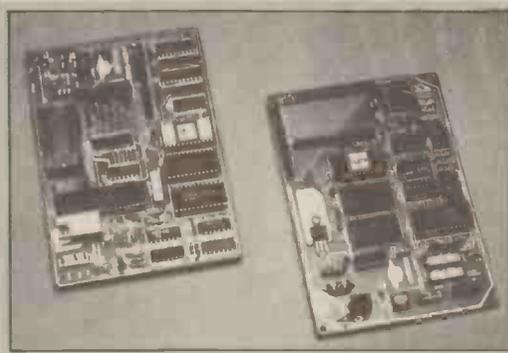
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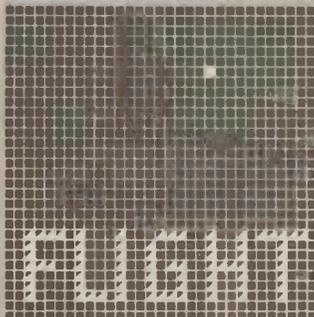
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(by phone or post)

POINTS OF VIEW

Feel like sounding off?
Then write to the Editor stating your Point Of View!

New Devices for Old Effects

Dear Sir,
With regard to your Fuzz-Box project in the February '82 HE, please could you inform me where I can obtain the BC650 transistors, as I have been unable to find them listed in any catalogue.
Graham Walsh,
Pudsey.

When the Noiseless Fuzz-box was designed, the BC650 transistor had only recently come on to the constructors' market. Consequently it was difficult to obtain (one source was, and still is, Magenta) and we had to do a lot of leg-work to seek out suitable suppliers. Now, however, it has proved to be quite popular and should be available from the larger semiconductor stockists. Incidentally, it does no harm to ask about a component that doesn't appear in a given advertiser's list. Once the enquiries start flooding in, most companies will obtain stocks from the distributors.

Echoes On The Line

Dear Sir,
I tried to 'phone you for clarification of the HE Echo-Reverb (May '82, pages 33-37) but apparently you are no longer on the phone (why not pay the bill?). Two points: the circuit and layout differ for the diodes, and the circuit and Parts List differ on the value of R15. Are there any other discrepancies?

Do pay the phone bill — it's such a long wait by Post Office Non Communications system.
H. W. Fletcher,
Marlow Bottom,
Bucks.

The HE Gremlins chose our Echo-Reverb unit for their *pièce de résistance* — and they really did a job on it. The full list of errors are given in the reply to the following letter. Our apologies to all concerned; the Gremlins have been dealt with!

Our phone bill has been paid, but it won't help you — we cannot take enquiries and produce a magazine every month, and if we didn't produce the magazine, you'd have nothing to enquire about, would you?

Designer on the Dole

Dear Sir,
For an eight month old dole freak like myself, the HE Echo-Reverb met a very real need.

Some months ago I had scraped up the pennies and lashed out on two

TDA1022 ICs with a view to designing my own phaser/flanger/chorus/echo/reverb. Needless to say I found myself hopelessly out of my depth (even with the Mullard spec sheet to hand)! To cut a long story short, my courage has been rewarded by the appearance of your design (heaven-sent!).

Thanks! I now hope to proceed with: switchable clock timing capacitors for phase/flange/chorus/echo and possibly a sine-wave modulator for the VCO input of the 4046 clock. (I fear a saw-tooth oscillator would be prone to spikes and hence 'clicks' in the output.

Please keep up the cost pruning!
Thanks again.
D.P. Allen,
Wembley,
Middlesex.

The Echo-Reverb (HE May '82) has been one of our more popular projects. For a modest outlay and with careful setting-up, the unit will produce varying degrees of reverberation and echo. However, as with some other projects of this standard, a few errors crept into the printed article. So, to all readers who've had a few problems, here's the list — exhaustive, we hope!

p. 34 Figure 1. RV2 wiper comes from pin 9 of IC 1.

D2 is shown inverted (ie. cathode goes to OV).

p. 36 Figure 2. The end tags of RV2 are connected to +15 and OV supply rails. Transformer should be 9-0-9 V.

p. 37 Parts List RV1 should be 47K log. RV4 should be 22K log. The transformer should be 9-0-9 V. R15 should be 27K.

A Better Building Block

Dear Sir,
I enjoyed the series of articles Into Electronic Components. As a now regular reader of your magazine, however, I must say the most interesting and informative articles to date are the "Building Blocks" — I would appreciate more of the same. Detailed information on ICs, etc. is of great value, too.
A. Easom (G4OPI),
Scarborough,
N. Yorkshire.

We are pleased that you appreciate the Building Blocks series. A great deal of work goes into researching the

information and presenting it in a form that is easy to understand. However, details of applications for ICs and general constructional info can also be found in our How It Works sections, and Breadboard pages. And in this issue we start a special Building Blocks series on ICs used in microcomputers, called Components for Computing.

A Better Class of Meter

Dear Sir,
Having read copies of various electronic magazines, may I say that yours is very enjoyable and you can be sure that I will buy HE every month in future.

Is it possible to construct a voltmeter of range 0-16 VDC with a digital LED seven segment display, calibrated to read to a tenth of a volt?

If so I would be grateful if you could supply me with any relevant information including circuit diagrams, etc.

Paul Humphries,
Newcastle upon Tyne,
Co. Durham.

Thanks for the compliment, although we'll answer your questions (usually) even if you're rude about us! It's not only possible to build this voltmeter, but we have just done one in the August '82 issue, and with a better specification, at that.

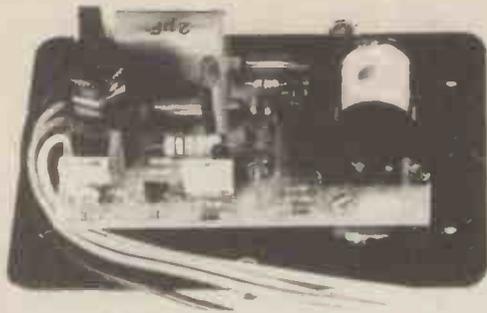
A Little Ingenuity

Dear Sir,
In the Three-Aspect Signal Lights project (September '82) you suggest fitting microswitches to the points to obtain the required switching. Those modellers who have PECO points can use the PECO "accessory switch". This clips to the point motor (if fitted). I see no reason why this neat unit cannot be fitted to other makes of points, with a little ingenuity. I think this project has been one of your best yet. It would be ideal for large club layouts where there is more than one operator.
Yours in electronics.
M. Wilkins,
Ipswich,
Suffolk.

A double thanks to Mr. Wilkins; first for the comments and second for the information on accessory switches. We are always happy to pass on tips from readers who can provide extra info about any of our projects! Thanks too, to Dr. D.L.H. Bloomfield, who designed that model project, but who was not properly credited in the article.

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ELECTRONICS TODAY INTERNATIONAL June '81 Issue
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The traditional capacitive discharge system has this high power spark but, due to its very short spark duration and consequential low spark energy, is incompatible with the weak air/fuel mixtures used in modern cars. Because of this most manufacturers have abandoned capacitive discharge in favour of the cheaper inductive system with its low power but very long duration spark which guarantees that sooner or later the fuel will ignite. However, a spark lasting 2000µs at 2000 rev/min. spans 24 degrees and 'later' could mean the actual fuel ignition point is retarded by this amount.

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SPARK DURATION	500 µs	160 µs
OUTPUT VOLTAGE (LOAD 50pF EQUIVALENT TO CLEAN PLUGS)	38 KV	26 KV
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TOTAL ENERGY DISCHARGE should not be confused with low power inductive systems or hybrid so called reactive systems.

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Jean Baudot

Ian Sinclair

BAUDOT — the name might ring a few bells if you are into computing: drop the last two letters and you get baud, which is a unit for the speed of transfer of information. The old-fashioned teleprinter, for example, operates at a rate of 110 baud, but a modern cathode-ray terminal may work at 2400 baud or higher. Having established the connection, let's look at the story of J. M. E. Baudot.

Jean Baudot was born in 1845 at Magneaux in France, and you will search in vain for details of his early life, unless you are prepared to look through a fairly large library. You won't find his name mentioned, often; it's the usual problem — a brilliant engineer whose name has entered our language hardly gets a mention, even in his own country.

He seems to have had the conventional schooling of the French middle classes at the time, which was, incidentally, one of considerable social unrest, with minor revolutions breaking out all over Europe. His firm interest, from the time that he left school, was the growing technology of the electric telegraph, and it was to this that he turned his attention when the time came to earn his own living.

Dots and Dashes

In these early days, the universal code for telegraph use was Morse code, which relies on the use of two types of electric impulse, a long (dash) and a short (dot) — the form of the code is shown in Figure 1. Now there is nothing wrong with this as a code, and it is used, to a limited extent, to this day, but it was devised in 1832, long before electrical communications began to evolve into the systems that were beginning to be commonly used in the 1870s. Baudot, in particular, thought that the use of Morse code was very restricting. In 1874, he was working on the development of what we now call time-multiplex telegraphy, which allowed one telegraph line to carry several sets of messages between different sets of transmitters and receivers, with no interference between the signals. The system that he was working with was a completely mechanical one; each signal source was connected to a separate contact of a group arranged in a circle, over which a revolving contact, like the brush of a dynamo, revolved at high speed, connecting each contact in turn to the single telegraph line. The current return was through the earth, which is why we use the term "earth" to mean current return path to this day. At the receiving end, a similar arrangement was used to connect the signals from the telegraph line to the different receivers but obviously, the system could operate correctly only if the motors driving the rotating contacts were synchronised.

Another of the problems of using this

system with Morse code was that each dash was liable to be broken up, by the action of the rotating brush, into a series of dots, on different channels; unless the speed of the brush was varied, so that it spent more time on a contact transmitting a dash than on one transmitting a dot, it inevitably scrambled the message. Many other people, at the time, were trying to synchronise the movement of the rotating brushes to the varying dots and dashes of Morse code, but Baudot came up with a completely different answer.

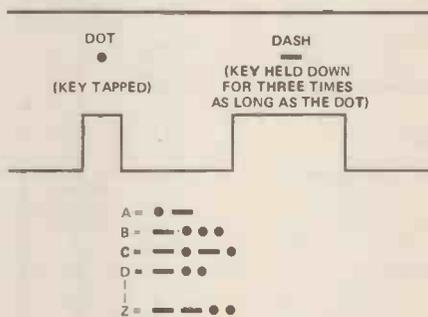


Figure 1. International Morse Code. The length of the pulse determines the meaning — dot or dash.

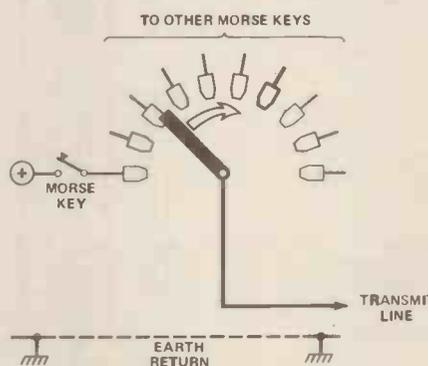


Figure 2. Early multiplex telegraphy.

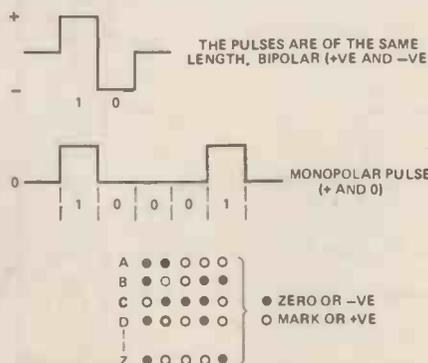


Figure 3. The modern 5-bit code. The bipolar version (top) is preferred because the difference between signal levels is easier to detect. This signal later became standardised as RS232.

A name to ring bells with.

Digital Codes

His approach was to use an entirely different code, one which used what we would now call digital signals — on and off — as distinct from the Morse code signals of 'long' and 'short'. The important point about Baudot's signals was that they were separated by *equal* time intervals. For example, if we take the two Morse signals, R (• — •) and S (• • •), the time between the first and last dots of each letter is not the same, because the middle dash of the R takes about three times as long as the middle dot of the S. Baudot devised a new 5-digit code, using pulses and spaces of equal length, so that the time needed to transmit a five-character message was always the same. This was the breakthrough that multiplex systems needed because the speed of the rotating contact (commutator) could now be synchronised to the pulse rate of the code.

Baudot patented his five-unit code in 1874. Five digits gave a choice of 32 characters, so that the early Baudot codes allowed the transmission of the letters of the alphabet (upper case) plus a few punctuation marks and operator signals (eg, BELL), but no digits. A later version of the code used seven digits and it is this version which has evolved into the ASCII seven-bit code that is used almost universally in computers.

The Baudot code was a major step forward in telegraphy because, as well as permitting more efficient multiplexing, it also permitted the faster development of the logical accompaniment to multiplexing — mechanical methods of sending and receiving telegraph signals.

The transmitter was primitive — if the operator released the key too soon, the wrong character would be sent — but it was a step forward from manual transmission. It was soon superseded by other methods.

Baudot's equally ingenious receiver used a method that was to remain current right up to the time when fully electronic printers were developed. It can still be seen, with some modern improvements, in some Telex terminals. It all looks like a mechanical nightmare — and anyone who has tried to get an old-style teleprinter going will agree that it is. Baudot's work vastly improved the rate at which data could be transmitted, and the principles which he established are in use to this day, although the methods have changed — for the better! Baudot code was not entirely logical and it was improved by Don Murray in 1903, so that the modern 5-bit code and its 7-bit successor are often known as Murray-codes rather than Baudot codes. The principles, nevertheless, are those of Baudot, and a good reason for immortalising his name in the term "baud rate".

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BC149	7p	BC159	12p	BC171	10p	BC173	10p	BC212	9p
BC212L	9p	BC213L	9p	BC237	12p	BC308	13p	BC327	18p
BC337	13p	BC558	14p	BF115	29p	BF194	13p	BF197	13p
BF198	13p	BF199	15p	BFR40	20p	BFX29	25p	BFY90	60p
2N706	15p	2N1131	20p	2N1132	20p	2N2222A	20p	2N2369A	15p
2N3702	10p	2N3705	10p	2N3711	10p	2N3904	15p	2N4061	10p
2N5172	15p	2N5179	30p						

VOLTAGE REGULATORS AND P.S.U. COMPONENTS

+ 5V	1A	TO220	.50p	-12V	1A	TO220	.50p
+ 5V	1.5A	TO3	1.50p	-12V	1.5A	TO3	2.00p
- 5V	1A	TO220	.50p	+15V	1A	TO220	.50p
- 5V	1.5	TO3	2.00p	+15V	0.5A	TO3	.90p
+ 6V	0.6A	TO220	.50p	-15V	1A	TO220	.50p
+12V	0.5A	TO220	.50p	-18V	1A	TO220	.50p
+12V	0.5A	TO3	.90p	-24V	1A	TO220	.80p
+12V	1.5A	TO3	1.50p				

2N3055 .35p, 2N4347 (120V) 1.50p, 2N6258 (250W) 1.80p, 400mW Zeners .05p
723 .30p

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EMOS

BUY LINE

HE Microlog

Our prototype was built into a standard Verocase, code 65-2523E, however because of the amount of drilling and marking involved, we had a chat with Newrad Instrument Cases, who have designed a suitable case for the Microlog. It is available from them (their address is printed elsewhere in this column) for £7.90 including VAT, p&p, complete with screen printed front panel and all holes drilled and punched. The lever switch is a Post Office type 1000.

Tape/Slide Synchronizer

There should be no problem obtaining the parts for this project; just remember that the relay is a 12V, 2-pole subminiature (ie PCB mounting) type, and choose the jack sockets to fit your sound system.

Phase Four

If your local supplier does not stock the TL064, it is always available from Technomatic, who also stock the 2N5457 FETs; a TL084 can be substituted for the TL064, if you are willing to accept increased battery usage. Once again, the custom case for our prototype was made by Newrad Instruments (see elsewhere in this column for their address).

Intruder Alarm

All the components contained on the PCB should be easy to obtain. The remainder will vary in availability according to the sort of system you envisage. However as a guide, suitable sirens can be bought from Greenweld.

A source for most of the other switches, mats and foils etc is Maplin.

Stereo Noise Gate

Most of the components are readily available and you should be able to get the thing working within a few hours.

The low voltage electrolytic is sold by Greenweld, who also stock a range of suitable cases. Other sources for a case are Lightning and West Hyde.

Big Ear

A complete list of parts for this project is available from Bewbush Audio, 26 Hastings Road, Pound Hill, Crawley, Sussex. The cost of the kit is £15.00, including VAT, post and packaging.

TV Amp

Newrad Instrument Cases have produced a case for our prototype, as shown in the photograph; this is available for £5.00, plus postage. Newrad Instrument Cases are at Tiptoe Rd., Wootton, New Milton, Hants BH25 5SJ.

Phase Four

Paul Coster

A Four-stage audio phaser unit, based on last month's Breadboards design.

AN AUDIO PHASER is simply a circuit designed to produce a 'comb filter' (Figure 1). When the notches of the 'comb' are swept up and down the audio spectrum, the musical effect known as 'phasing' occurs. One of the first times this trick was used on a recording was in 1968; the song was "Pictures of Matchstick Men" by a group called Status Quo. Another was "Itchycoo Park", by the Small Faces.

As a slightly more interesting (and relevant) diversion, it is worth mentioning that 'phasing' is not the same as a similar musical effect called 'flanging'. Flanging depends on a reasonably long time delay — as much as, oh, a millisecond or so; mixing the delayed signal with an undelayed signal also results in a comb filter, but now the notch frequencies are spaced at musical intervals — thirds, fifths, flattened ninths and so on — and the effect so produced has a more "musical" quality, so it is said. Flanging was discovered by the American record producer, Phil Spector...but that's another story!

Shifting Circuits

The HE Phase Four, however, is a phaser. It is based on the circuit of Figure 2, a single stage phase shifter producing 90° of phase shift from input to output.



At zero frequency (DC), the input to the non-inverting pin of the op-amp is blocked by the capacitor, C1, so the circuit acts as an inverter with a gain of one; this, of course, is equivalent to a phase shift of 180°. At very high frequencies, though, the capacitor becomes a short circuit and so the op-amp becomes a non-inverting amplifier, still with a gain of one; the phase shift now is 0°.

But at some intermediate frequency, set by the time constant (RC) of the

high-pass filter network on the non-inverting input, the phase shift will be exactly 90°; the gain is still one! Essentially, the op-amp is buffering the phase-shift produced by the high-pass network of C1 and R3, maintaining a constant gain of one.

If two of these units are cascaded — the input signal passing through one, then the other — the total phase shift will be 180° at the frequency set by the RC time constant, and if the phase-shifted signal is then added to an un-

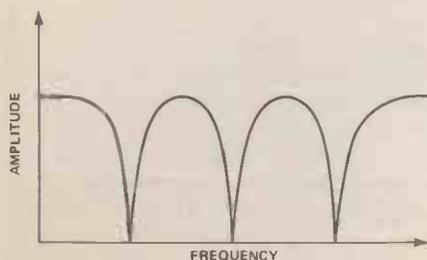


Figure 1. A comb filter forms a series of notches in the frequency response curve.

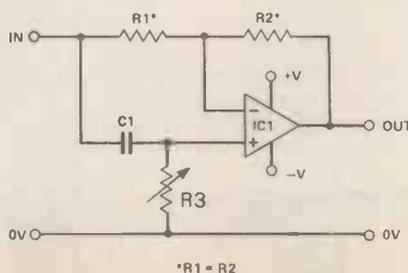


Figure 2. The basic phase shifting circuit.

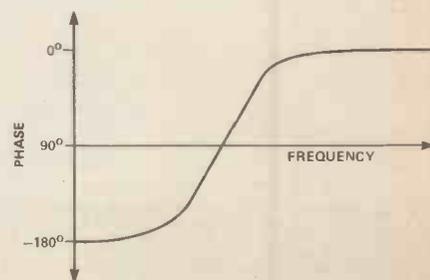
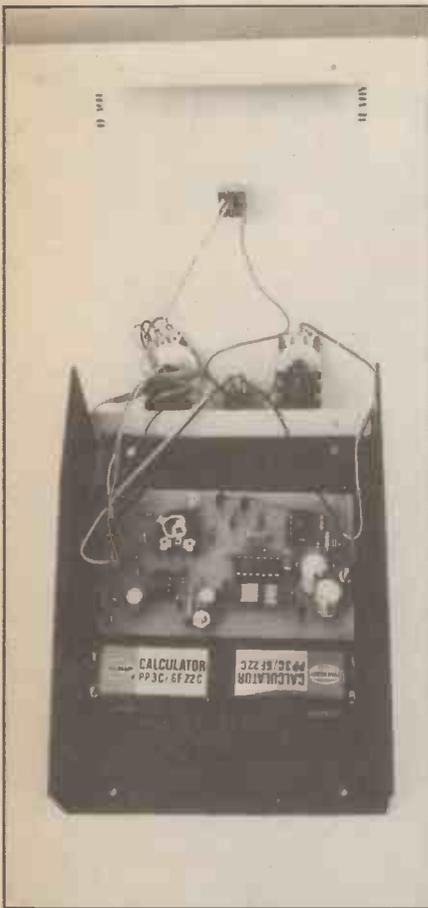


Figure 3. The frequency-phase response of the circuit in Figure 2. The crossover point is set by the values of R3 and C1.



shifted signal, the result will be a notch in the response, at the specified frequency.

In fact, there are easier ways to produce a notch filter. The reason why this circuit is used so often for phasing units is because it is quite easy to change the position of the notch. At its simplest, this is done by varying R3, thus changing the time constant which determines the corner frequency (the two are really equivalent). In a manually operated phaser, this would be achieved by using a potentiometer in place of R3 and varying it, by means of a foot pedal or something similar, to produce a manual sweep (ie, movement of the notch, up and down the response band).

It is just as easy to produce an automatic sweep; Figure 4 also shows a FET transistor connected across R3; by varying the voltage to the gate of the

FET, its resistance can be changed from a few hundred ohms to around a few hundred megohms. All we need now is a way of producing a varying voltage to control the resistance of the FET, and a summing amplifier to combine the phase-shifted and unshifted outputs.

Phase Four

All these elements are brought together in the HE Phase Four circuit, shown in Figure 5. It uses four stages to produce a total phase difference of 360° between input and output, producing two notches in the response.

The input to the unit is buffered by a unity gain stage, IC1a; the IC used in this position was chosen for its low noise specification. The phase shifters use all sections of a quad op-amp package, IC2 (elected for low power consumption).

The values of C3,6,7,8 are chosen somewhat arbitrarily, but they will affect the total quality of the output. Capacitors C1,2,4 and 5 are to decouple the supply rails, eliminating high frequency spikes from the output.

The phase shifted signal is fed to a standard virtual earth mixer. The amount of shifted signal added to the output is set by the depth control, RV1, which determines depth of the notches. A switch is also included which allows the effect to be bypassed; PR1 is used to adjust the output so that the gain is

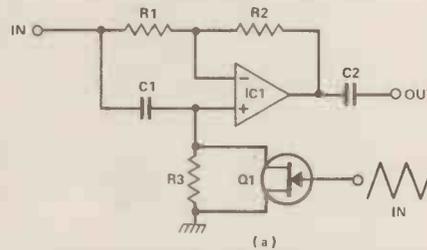


Figure 4. By putting an FET in parallel with R3, the effective resistance can be varied over a wide range.

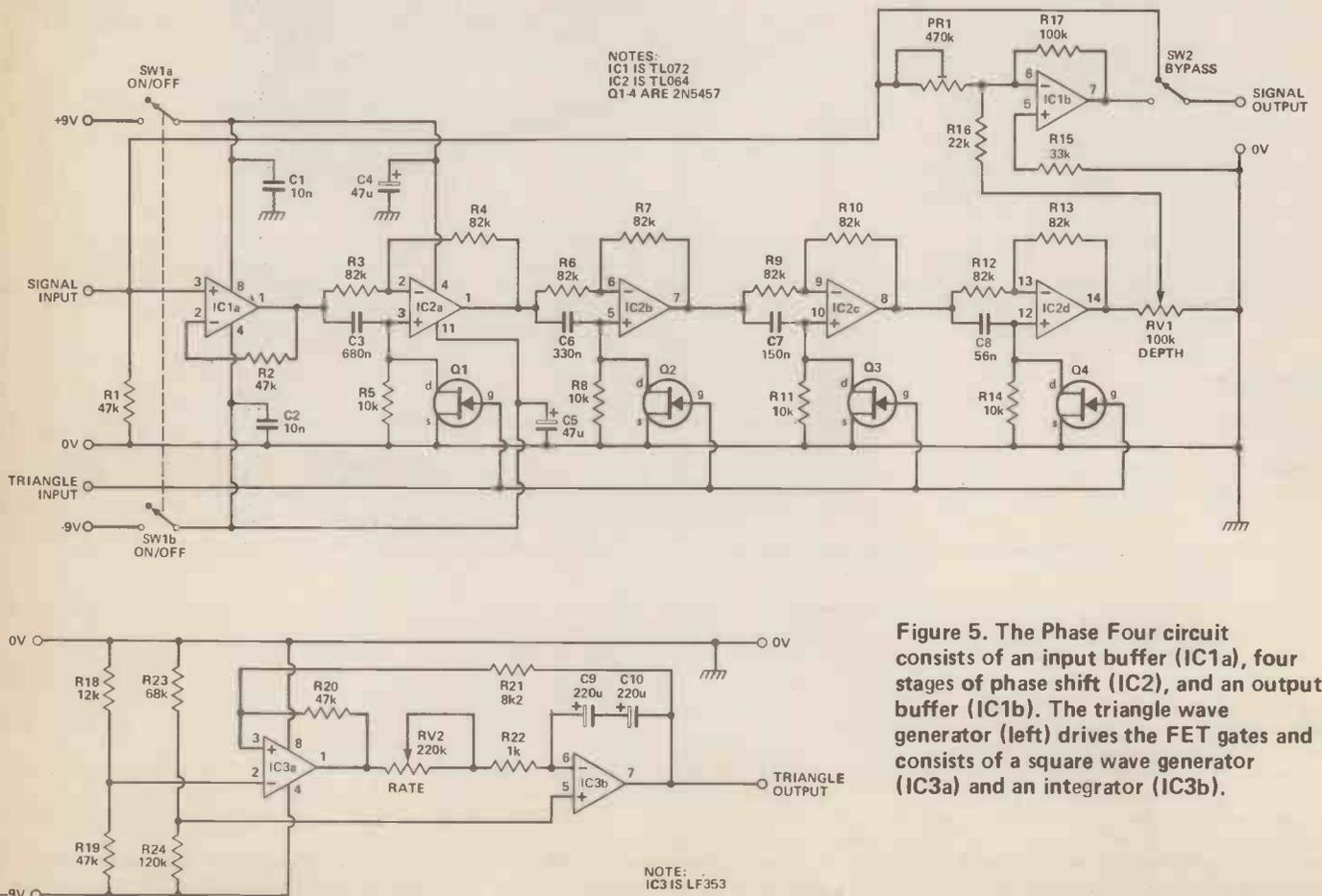


Figure 5. The Phase Four circuit consists of an input buffer (IC1a), four stages of phase shift (IC2), and an output buffer (IC1b). The triangle wave generator (left) drives the FET gates and consists of a square wave generator (IC3a) and an integrator (IC3b).

Parts List

RESISTORS

(All ¼ watt, 5% carbon)

R1,2,19,20	47k
R3,4,6,7,9,10,11,12	82k
R5,8,11,14	10k
R15	33k
R16	22k
R17	100k
R18	12k
R21	8k2
R22	1k
R23	68k
R24	120k

POTENTIOMETERS

PR1	470k
	horiz. carbon preset
RV1	100k
	log carbon
RV2	220k
	log carbon

CAPACITORS

(All metallised polycarbonate, unless noted)

C1,2	10n
	ceramic disc
C3	680n
C4,5	47u
	16V radio electro
C6	330n
C7	150n
C8	56n
C9,10	220u
	16V radio electro

SEMICONDUCTORS

IC1	TL072
	dual BIFET op-amp
IC2	TL064
	quad BIFET op-amp
IC3	LF353
	dual J-FET op-amp
Q1-4	2N5457
	N-Channel FET

MISCELLANEOUS

SW1	DPDT
	min. toggle
SW2	SPST
	footswitch
2 x ¼" jack sockets; 2 x PP3 battery clips; 2 x 8 pin, 1 x 14 pin DIL sockets; 2 x knobs; case (see Buylines); PCB; solder, wire etc.	

BUYLINES page 34

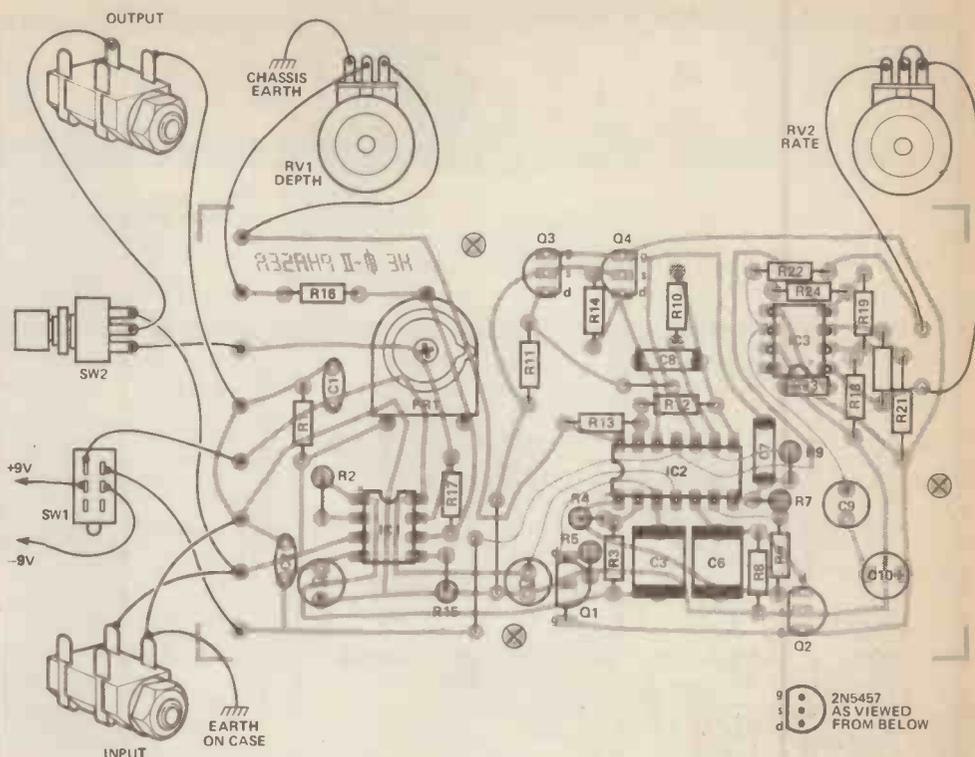
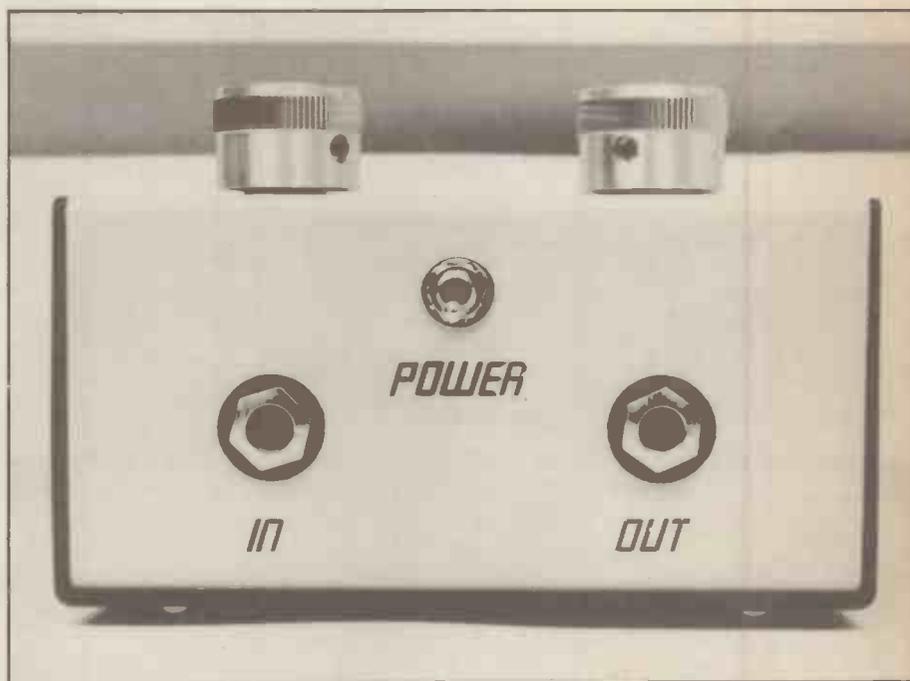


Figure 6. The PCB component overlay.



the same in either case.

The voltage sweep for the FETs is produced by ICs 3a,b, and LF353. The two op-amps are configured as a triangle-wave generator; in fact the sweep could be controlled by any slowly varying cyclic waveform, such as a sine wave or sawtooth, but the triangle shape works best in this application.

The circuit works in two stages: IC3a produces a square wave output and this is integrated by 3b to give the triangle shape. RV2 controls the frequency, ie the sweep rate, between the limits of about 0.1 and 10 Hz, with the values

chosen. The values of C9 and C10 are not critical, but they must be connected as shown, to form a simulated bi-polar capacitor.

Construction

Assembly of this project is not particularly difficult; simply follow the component overlay (Figure 6), taking care that the ICs and electrolytic capacitors are correctly positioned. One point to note is that RV2, a potentiometer with a logarithmic characteristic, must be connected the right way round; otherwise, the variation

in sweep speed will all come at one end of the rotation.

The ideal case for the Phase Four is the custom built job supplied by Newrad Instruments (see Buylines for details), though any case large enough to contain the PCB and batteries would do; it depends on how heavy-footed you are!

The only adjustment required is to set PR1 so that the gain through the phaser is the same as in the 'bypassed' condition. Simply set the depth control for minimum and adjust PR1, switching between effect and bypass, until the levels sound equal.

HE

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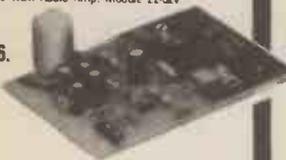
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SX19	100	Mixed Ceramics 68pF-0.5mF	£1
SX20	100	Assorted Polyester/Polystyrene Capacitors	£1
SX21	60	Mixed C280 type capacitors metal foil	£1
SX22	100	Electrolytics, all sorts	£1
SX23	50	Quality Electrolytics 50-1000mF	£1
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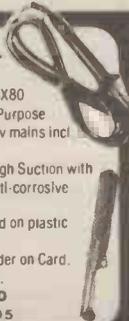
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Single Sideband

If you think back to amplitude modulation again, you may remember that business of sidebands. When a carrier is amplitude modulated, the output signal contains the carrier frequency and both sets of sidebands (sum and difference), all requiring power at the PA stage to transmit. All the information of the audio signal is carried in one sideband, however (either one), and none by the carrier, so that this well-worn double-sideband scheme is very wasteful of transmitter power. The solution is to use only one sideband, eliminating the other sideband and most of the carrier. This system is called single-sideband-suppressed-carrier, usually abbreviated to SSB, though this could also refer to systems that eliminate one sideband but retain most of the carrier.

Starting with transmitters this time, how do we achieve these two aims of removing one sideband and most of the carrier? Once again, there are several methods, but the most popular one consists of using a balanced modulator to remove the carrier, and filtering to remove the unwanted sideband. A balanced modulator is a circuit to which both carrier and audio signal can be applied. If there is no audio signal, then there is no output from the circuit, but adding an audio signal spoils the balance of the circuit and the sidebands of the modulated carrier form the output. There is very little trace of the carrier frequency in the output.

A simple type of balanced modulator is illustrated in Figure 1. This is a bridge or ring modulator and its action depends on the use of the audio signal to bias a set of diodes into conduction. Imagine that there is no audio signal, so that the audio input to the diode bridge at A is at earth voltage as far as signals are concerned. The carrier signal is injected at a point where the voltage lies exactly between the bridge outputs, so that the carrier signals to the transformer primary ends are in phase. In this condition, there is no output.

Now imagine that an audio signal is applied and that the audio voltage has reached its positive peak. Diodes D1, D2 will conduct when the carrier voltage is zero, putting a bias voltage onto the output line, at X. Now the carrier signal is no longer balanced because, when the carrier has its negative peak at X and its positive peak at Y, the diodes D1, D4 will conduct carrier signal, and D2, D3 will not conduct. This will cause some out-of-phase carrier signal to reach the transformer. The situation reverses when the audio signal at A goes to its negative peak. Now diodes D4, D3 conduct when the carrier voltage is zero, but when the carrier wave is positive at Y, negative at X, then D1, D4 don't conduct but D1, D2, D3 do, producing a signal to the transformer again. These signals to the transformer are of sidebands only because no carrier can pass, by itself.

The circuit works well, but needs careful setting up. An alternative is to use a balanced-modulator IC — the Motorola MC1496G is an old favourite for this task. Even so, these methods can never totally remove all traces of carrier, but suppression of 30 to 50 db can be easily achieved.

The next part of single sideband modulation is the filtering system which removes one sideband. Unless you can test and adjust crystal filters, the filter units just have to be bought — these can be quartz crystal types or surface wave types. The filter characteristic can be arranged so that it contributes to the suppression of the carrier, as well as removing the unwanted sideband.

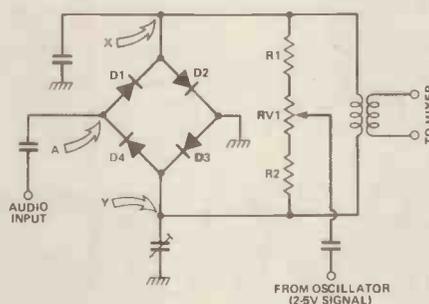


Figure 1. A bridge or Ring Modulator, which eliminates the carrier frequency from the output, is the first and most important stage in SSB transmission.

The combination of balanced modulator and filter is the complete single-sideband generator. The whole system can be designed around a low carrier frequency — 455 kHz is a favourite — or at high frequencies such as 9 MHz — the choice is fixed by the availability of commercially-built filters. You don't, of course, transmit at either of these frequencies. To reach the actual transmitting frequency, you would normally think of using multiplier stages, but this step is taboo with SSB transmitter circuits because multiplying up the carrier frequency means multiplying up the bandwidth of the sidebands. The alternative is 'frequency mixing', using another mixer stage to obtain a signal which is the sum of the modulated frequency and another crystal-controlled frequency.

Once the correct frequency has been reached (and several mixings may be needed, particularly if the original modulation was at 455 kHz and the final frequency is VHF), power amplification must use Class A or Class B circuits rather than Class C, to avoid distortion. This will make the efficiency of the output stage lower, but the effective power of the modulated signal, as com-

pared to a double-sideband signal with full carrier is so much greater that the loss is acceptable. As a guide, if we assume that the output stage is 66.7% efficient (meaning that 2/3 of the DC power fed to the output stage causes useful output), then the maximum allowed DC power of 150 W will cause an RF power of 100 W. This is all useful power however, so that the way in which we measure SSB power is in terms of what is called 'peak envelope power', which is four times the actual output power (100 W in this example). This is an approximation, but it implies that the SSB signal is equivalent in transmitted power to a conventional AM signal of four times its output power.

Problems, problems

Problems start when we want to receive a SSB signal. To start with, the demodulator must be a balanced type, operating like the modulator in reverse, and it has to be fed with a carrier signal of the correct frequency and phase. This is most easily arranged if transmitter and receiver share the same oscillator in the form of a transceiver, as the oscillator section of the transmitter can then provide a signal of exactly the correct frequency and phase to the demodulator. However, all of this makes a single-sideband rig a very complicated piece of goods, particularly if it is to be used at several frequencies, because there is a convention that the lower sideband is used at frequencies below 10 MHz while the upper sideband is used at frequencies above 10 MHz. Not many readers are likely to get involved in SSB as a do-it-yourself project! It's advantages, however, make impressive reading, and even more impressive listening. To start with, the bandwidth of the SSB signal is the same as that of the audio signal, no more. This means that a lot more SSB rigs can use a band than conventional AM rigs. There is also a gain in range, because all of the output power of the SSB transmitter is concentrated on the one sideband which the receiver uses. In addition, SSB is much less liable to atmospheric disturbance effects, such as fading and blasting, than conventional AM or even FM. The advantages of SSB can be increased by using speech-processing units which ensure that the modulation is always near the upper limit while you are speaking. SSB rigs of good quality are never cheap, but they represent just about the optimum in modern radio communications and a dream for every amateur licence holder to aspire to.

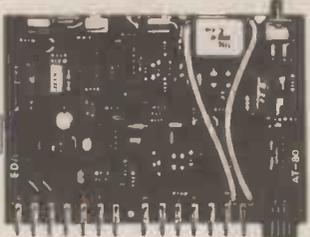
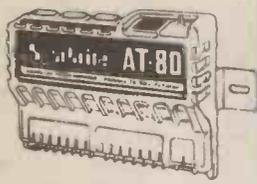
Due to space limitations in the November issue, this portion of Radio Rules was held over till December.

Next month we will back-track to examine AM Receivers.

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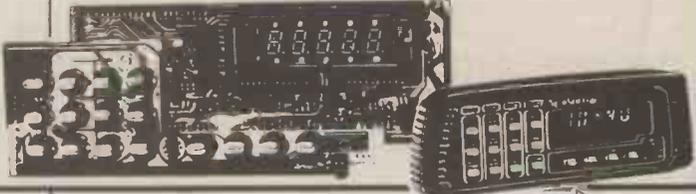


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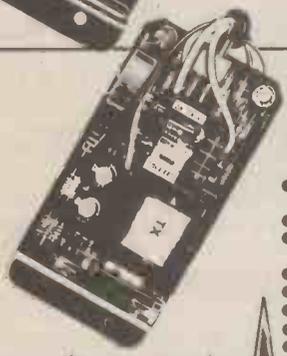


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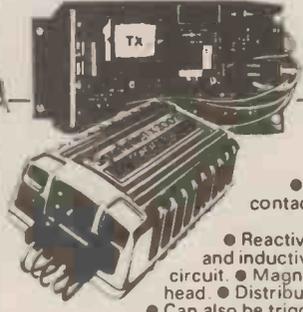
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COMPONENTS FOR COMPUTING

This is the first of a series of articles in which the components of microcomputer systems will be discussed. We will investigate the many aspects of each type of component, including general functions and areas of application, internal circuit operation, external circuits and the range of products on the market.

WE WILL START by describing Input/Output (I/O) port components. This may not seem entirely logical, but it follows from our Micro-Trainer series of earlier this year. Consequently, in this issue alone, there will be specific references to the Micro-Trainer when the programming of I/O ports is considered.

What Is An I/O Port?

A port, whether input or output, is a device that interfaces between the 'raw' hardware of a computer's central processing unit (CPU) and the external machinery of a control system. In its simplest form, a port consists of a data latch or register connected to the three busses (address, data and control) of the CPU. The diagram of Figure 1 shows an eight bit output port and an eight bit input port connected to a simple microprocessor system. The ports have an eight bit capacity simply because the microprocessor has an eight bit data bus, and can therefore transfer data eight bits at a time!

The output port has eight inputs connected to the data bus and eight separate outputs for connection to external circuits, and a strobe. The outputs follow the logic states of the inputs for as long as the strobe input is high; however when the strobe is taken low, the data at the outputs is frozen or 'latched' indefinitely. An IC of this sort is called an 'Octal Transparent Latch', and a 74LS373 is a typical example using TTL Technology in the microprocessor system of Figure 1, the strobe is derived from the \overline{WR} signal of the control bus and the decoded address bus. Data will be latched into the port only when the MPU attempts to write to a specific address, as determined by the address-decode logic. This configuration is called 'Memory-Mapped I/O' because the port appears to the MPU as a single byte of memory, in this case a write-only memory location. Using simple 'store' instructions, the MPU is able to control the state of eight logical outputs, each of which can be interfaced to anything from a LED to a large industrial machine,

using no more than a few transistors and relays.

The input port, as shown in Figure 1, is also an octal latch but this time the outputs are wired to the data bus and the inputs are taken from the external circuit. For an input port, the latch must have (like the 74LS373) a control which can 'tri-state' the outputs to the data bus; this means that the outputs can go to a high impedance state, and thus have no effect upon the data bus when it is being used by other devices, such as RAM or ROM. The output control signal is decoded from the address bus and the \overline{RD} signal so as to 'map' the port to the desired memory location. The strobe to an input latch is not synchronised with the MPU as with the output port; it has to be provided by the external circuit to synchronise with incoming data. In certain applications (A/D conversion being the best example) the data presented to the MPU's input port may not be valid (true) at all times, which explains the reason for an external synchronising pulse.

However, the MPU is often required

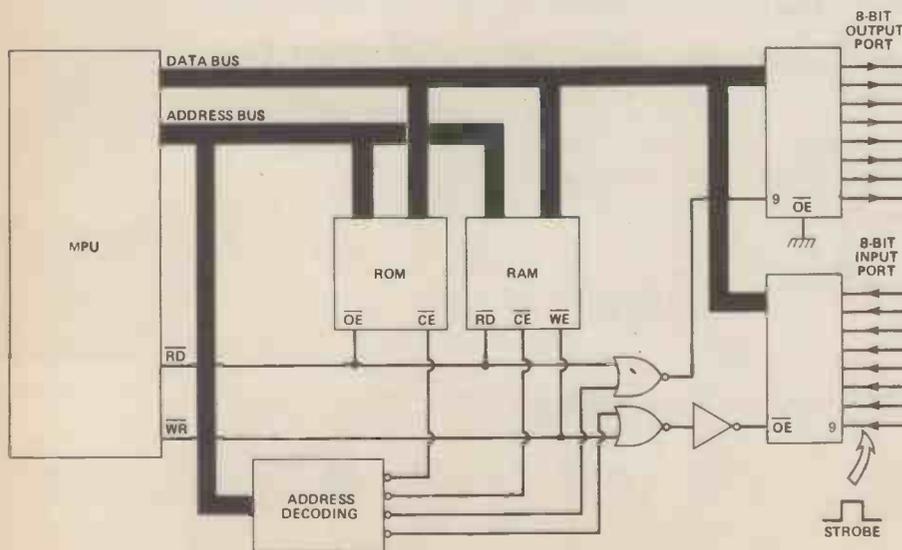


Figure 1. A simple microprocessor system with one output and one input port.

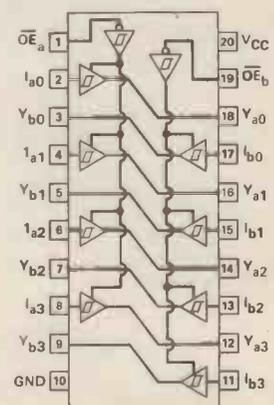


Figure 2. The logic diagram and pin outs of the 74LS244. The OE inputs latch the outputs to the high impedance (off) state.

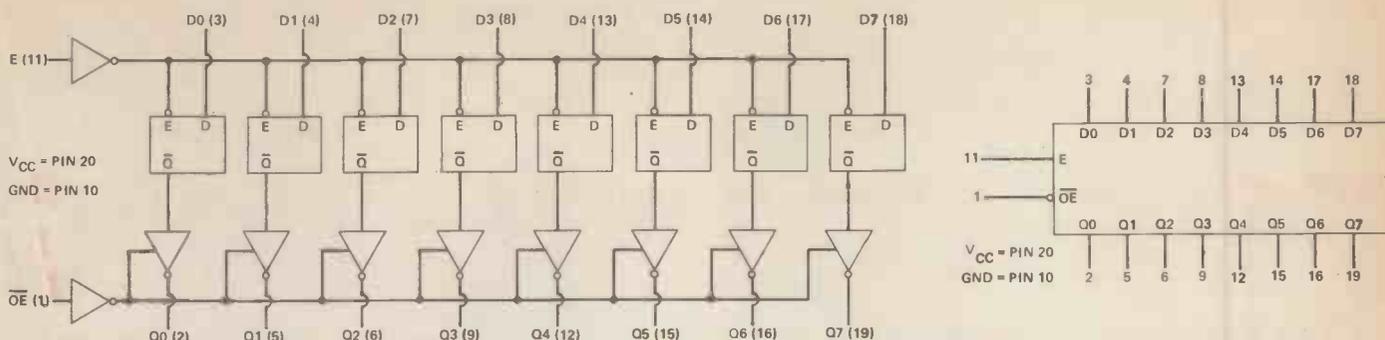


Figure 3. The logic diagram (above) and pin-outs (right) of the 74LS373. Data is latched by taking the E input low; a high on the OE input forces the outputs to the high impedance state.

only to sample the inputs periodically (if, for example, they connect to a set of logically independent switches) and in this case, latching of data is unnecessary; an "Octal Tri-State Buffer" (such as a 74LS244) will then be sufficient as an input port.

Memory mapped I/O is a system which can be readily applied to any microprocessor; yet there is a common alternative which is worth mentioning. "I/O Mapping" is a system which is unique for each type of microprocessor (some simply do not have the facility, eg. the 6800 and the 6502) because it requires specific sets of hardware and instructions. The 1802 has a three-bit address bus, separate from the normal address bus, which can be decoded to provide 'enables' for up to seven I/O devices; these addresses are generated only in response to special instructions (INP1 - INP7, OUT1 - OUT7).

Other processors (eg. the Z80 and many other Intel products) place I/O addresses (0-255) on the usual address bus and have a separate control line to indicate whether the instruction is to be executed on memory or on I/O.

I/O ports can easily be constructed from a few TTL chips, however the manufacturers of all microprocessor types offer more 'clever' devices designed for flexibility in applications, in a

single low cost package, with each device type intended for a particular microprocessor. Most of these contain several ports within a chip, and can be programmed to behave either as input or output devices; many have other interesting facilities, as we shall see.

The 8255

It is impossible, in these few pages, to describe every I/O device on the market so we shall concentrate on just one — the 8255. This device is intended to interface with the Intel 8080 and 8085 family of microprocessors; however, it can be used readily with the Z80 and, of course, the 1802, as in the Micro-Trainer. It is one of the most versatile PPIs (Programmable Peripheral Interface) available and has recently become very inexpensive.

Referring to the block diagram of Figure 4 and the pin diagram of Figure 5, you will see that the 8255 has three eight-bit ports within a 40 pin package. Port A (PA0-PA7) and Port B (PB0-PB7) can be separately programmed as either input or output, while Port C is logically divided into individually programmed upper (PC4-PC7) and lower (PC0-PC3) portions.

The 8255 possesses all the necessary signal inputs to interface directly to the CPU. Signals D0-D7 con-

nect directly onto the data bus, for bidirectional transfer of data between CPU and the ports and, likewise, the signals \overline{RD} and \overline{WR} connect directly to the corresponding signal lines of the CPU. The control signal \overline{CS} (Chip Select) is used to allow the CPU to use the 8255. For example, if \overline{CS} is provided with a logic low, decoded from the address bus (the Micro-Trainer uses an address in the range 2000H to 2003H) the device will be 'enabled'.

The signals A0 and A1, the two least significant bits (LSBs) of the address bus, will select one of the four internal registers, according to the address; three of these registers are, obviously, the ports A, B and C, while the fourth is a control register used for programming the device. These addresses (summaris-

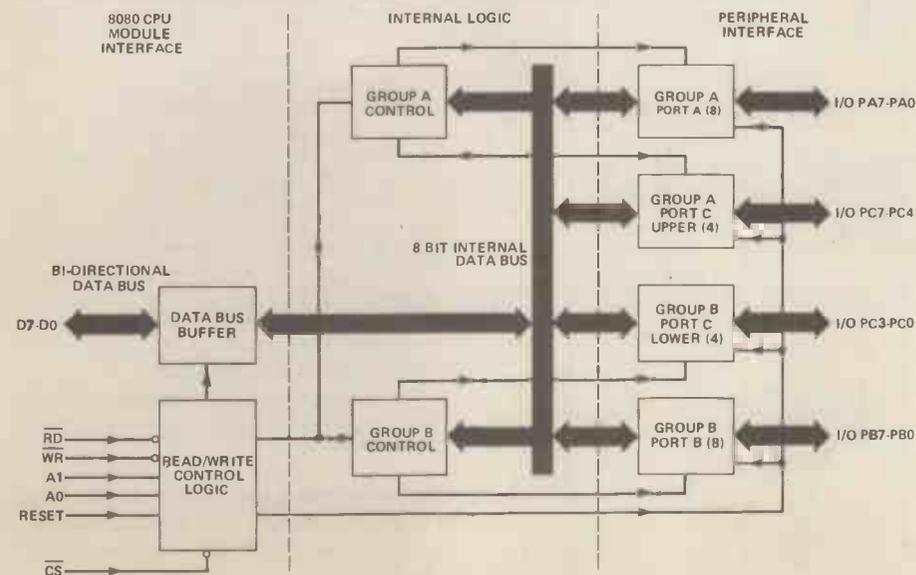
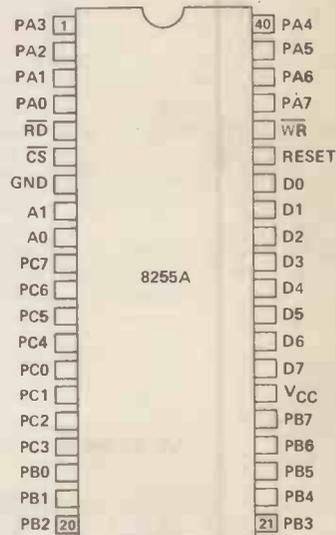


Figure 4. The logic diagram of the 8255 PPI; the ports are split into two groups for control purposes.



PIN NAMES

D7-D0	DATA BUS (BI-DIRECTIONAL)
RESET	RESET INPUT
\overline{CS}	CHIP SELECT
\overline{RD}	READ INPUT
\overline{WR}	WRITE INPUT
A0,A1	PORT ADDRESS
PA7-PA0	PORT A (BIT)
PB7-PB0	PORT B (BIT)
PC7-PC0	PORT C (BIT)
V _{CC}	+5 VOLTS
GND	0 VOLTS

Figure 5. The pin-outs of the 8255 (top) and their meaning (bottom).

A		B		GROUP A			GROUP B	
D4	D3	D1	D0	PORT A	PORT C (UPPER)	#	PORT B	PORT C (LOWER)
0	0	0	0	OUTPUT	OUTPUT	0	OUTPUT	OUTPUT
0	0	0	1	OUTPUT	OUTPUT	1	OUTPUT	INPUT
0	0	1	0	OUTPUT	OUTPUT	2	INPUT	OUTPUT
0	0	1	1	OUTPUT	OUTPUT	3	INPUT	INPUT
0	1	0	0	OUTPUT	INPUT	4	OUTPUT	OUTPUT
0	1	0	1	OUTPUT	INPUT	5	OUTPUT	INPUT
0	1	1	0	OUTPUT	INPUT	6	INPUT	OUTPUT
0	1	1	1	OUTPUT	INPUT	7	INPUT	INPUT
1	0	0	0	INPUT	OUTPUT	8	OUTPUT	OUTPUT
1	0	0	1	INPUT	OUTPUT	9	OUTPUT	INPUT
1	0	1	0	INPUT	OUTPUT	10	INPUT	OUTPUT
1	0	1	1	INPUT	OUTPUT	11	INPUT	INPUT
1	1	0	0	INPUT	INPUT	12	OUTPUT	OUTPUT
1	1	0	1	INPUT	INPUT	13	OUTPUT	INPUT
1	1	1	0	INPUT	INPUT	14	INPUT	OUTPUT
1	1	1	1	INPUT	INPUT	15	INPUT	INPUT

A1	A0	RD	WR	CS	INPUT OPERATION (READ)
0	0	0	1	0	PORT A = DATA BUS
0	1	0	1	0	PORT B = DATA BUS
1	0	0	1	0	PORT C = DATA BUS
					OUTPUT OPERATION (WRITE)
0	0	1	0	0	DATA BUS = PORT A
0	1	1	0	0	DATA BUS = PORT B
1	0	1	0	0	DATA BUS = PORT C
1	1	1	0	0	DATA BUS = CONTROL
					DISABLE FUNCTION
X	X	X	X	1	DATA BUS = 3-STATE
1	1	0	1	0	ILLEGAL CONDITION
X	X	1	1	0	DATA BUS = 3-STATE

X = DON'T CARE

Table 1 (right). The ports can be set up in any of 16 different ways.

Table 2 (above). Ports are addressed, as appropriate under program control. A WRITE instruction to a port set up for Input will be ignored.

ed in Table 3) are used in the Micro-Trainer to access the 8255.

In order to write data to a port, it is simply a matter of executing an 'STR' instruction to the appropriate address, eg:

```
LDI $20 PHI R3
LDI $01 PLO R3; R3 is pointer to Port B
LDI $0F STR (R3); data $0F appears on PBO-PB7
```

Data which has previously been written to an output port can also be read back from the same address — a feature which is not possible with the system of Figure 1.

We have not, so far, discussed how the ports are programmed — but there are no prizes for guessing that the control register is used for this. All the programming information is illustrated in Figures 7 and 8, but some explanation is also required.

The first step is to decide how the ports are to be configured (output or input) then, using the two diagrams, work out a control word on a bit by bit basis. You may be confused by the references to Modes 0, 1 and 2; just assume these bits are set to zeroes. Our description of the 8255's operation are all in Mode 0; the other modes configure certain bits of Port C as 'handshake' lines and as this facility is little used we will not discuss it here!

As an example, suppose we require PA0-PA7 as outputs, PC0-PC3 as outputs and PBO-7, PC4-PC7 all as inputs. Figure 7 tells us that the required data is 10001010 = 8AH so, simply by storing 8AH in the control register, our ports are set up as required. The contents of the control register may not be read back by the CPU. It is also well worth noting that each time a port is configured as an output, the contents are reset to zero.

During power-up, or reset of the MPU, it is normal to reset the 8255 also, using the hardware line RESET (pin 35). When this happens, all ports are configured as inputs in Mode 0, so that the machine's software must initialise the control register, as required, after reset. Figure 8, shows how Port C can be conveniently operated on bit by bit, when programmed as an output. Here, by storing the appropriate data in the control register, a single line of Port C may be set or reset. As an example, again, PC7 has been interfaced to a transistor (Figure 6).

This forms the cassette interface for the Micro-Trainer. It is controlled by a routine in ROM which recognises a LOAD or SAVE instruction, configures Port C (upper) as required, and then toggles bit 7 to transfer the data.

The other seven bits of Port C are all configured as outputs, buffered by a ULN2003 (IC7 in Figure 6), which provides open collector outputs suitable for driving LEDs, relays etc. Each output can sink up to 500mA.

Next month's installment will investigate the hidden depths of memory — RAMs, ROMs, and the multivariate degrees of PROMs.

A1	A0	MICROTRAINER ADDRESS	REGISTER ENABLE
0	0	2000H	PORT A
0	1	2001H	PORT B
1	0	2002H	PORT C
1	1	2003H	CONTROL

Table 3. The Micro-Trainer I/O addresses.

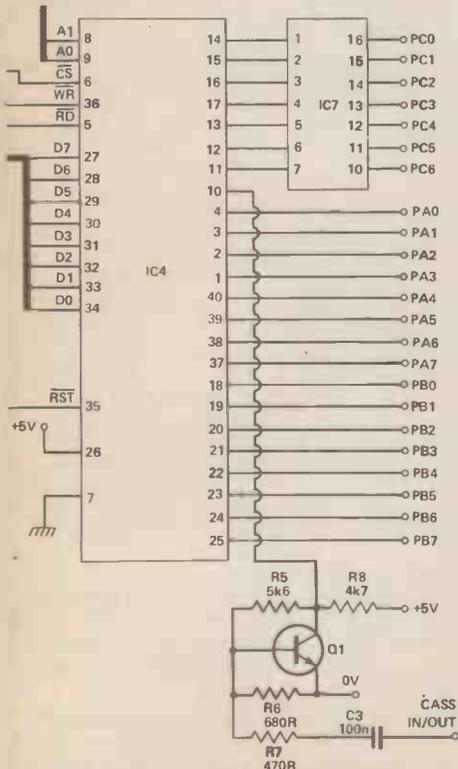


Figure 6. The I/O Port circuits of the Micro-Trainer; IC4 is an 8255.

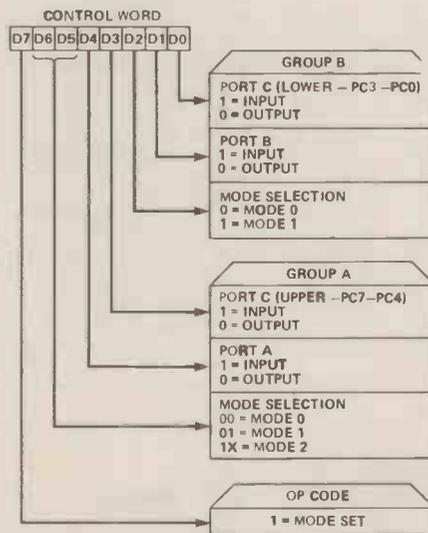


Figure 7. The mode control word can be constructed from this diagram.

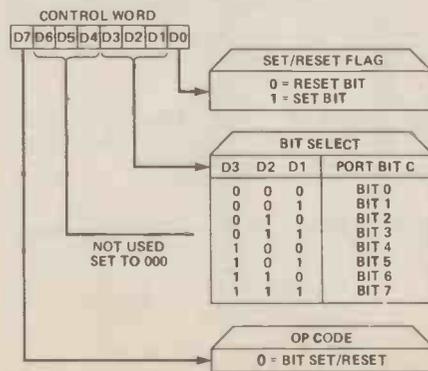


Figure 8. Deriving the control word to set or reset bits of Port C.

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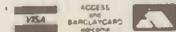
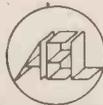
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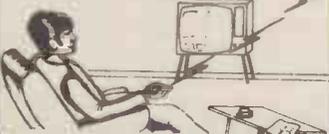
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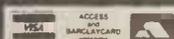
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CPR 1X	Pre-Amplifier Module	31.30	4.70	36.00	0.15	
MC 2	Moving Coil Pre-Pre-Amplifier Module	20.00	3.00	23.00	0.07	
REG 1	Regulated Power Supply	8.09	1.21	9.30	0.07	
TR 6	6VA Mains Transformer	2.87	0.43	3.30	0.21	
XO 2	2 Way Crossover Module	17.39	2.61	20.00	0.07	
XO 3	3 Way Crossover Module	26.09	3.91	30.00	0.07	
MU 1	Muting Circuit for XO 2 or XO 3	8.35	1.25	9.60	0.04	
CK 1010	Complete Pre-Amplifier Kit	78.26	11.74	90.00	2.50	
CK 1040	Complete 40 Watt Power Amplifier Kit	103.48	15.52	119.00	7.30	
CK 1100	Complete 100 Watt Power Amplifier Kit	129.56	19.44	149.00	7.30	
MC 2K	Add On Moving Coil Kit	21.74	3.26	25.00	0.12	
PSK	Pre-Amplifier Power Supply Kit	17.39	2.61	20.00	0.75	

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Clever Dick

A blast from the past

This seems to be a year for revivals — musicals in the West End, old pop songs from the 50s and 60s reappearing in the Charts, and now . . .

Dear Clever Dick, I have "Experimenter" and "S-Dec" boards and I am wondering if you could devise projects for these for future editions of HE. I find it very difficult to get anything suitable.

*P. Siddi,
Porthcawl,
Mid-Glam.*

. . . . "Short Circuits" have been brought back, in the shape of a new page called "Breadboards". Although these experimenter's circuits have been laid out and tested using Vero's Verobloc system, they can easily be adapted to any other breadboarding system.

*Dear CD, I have one short question; is there any errors in the shortwave Receivers veroboard diagram etc?
T Chapman
Fareham
Hants*

'Is there any errors' . . . it's enough to make you ask : is good grammar a thing of the past? Another question, which might be pertinent; which short wave receiver do you mean—we have published at least three?

However, passing over such minor considerations (it only took four times longer to sort things out), the receiver in question is probably that featured in September '81 issue. There were three errors discovered at the time; missing track cuts at F17 and G17, a missing link (not the . . . no it couldn't be) between F12 and G12 and no markings on D1—the cathode should go to F7.

*Dear CD, I am eleven years old, and have been alarmed to find a mistake on the "Intruder Confuser". Capacitor (C1) has been connected (not across) but in the same direction as the copper strips and there is no break between the two terminals. Also (according to the schematic diagram) the integrated circuit has been connected the wrong way round, there is also another problem. . . . I have, nowhere to store my Hobby Electronics magazine Yours Faithfully,
R Einstein
Ipswich
Suffolk*

(hint, hint). Life isn't all problems though, because I think your magazine's great

Correct on both points—though the issue was raised in a previous HE (June '82, I think). As for the mag, I also think it's great too (especially this page), but then I am a little biased!

Dear CD, I DO NOT WANT A BINDER!!! I would, however, like to pick your amazingly intelligent brain. Way back in January '79, HE published a Touch Switch project. I find it works fine if the OV level is connected to the mains earth, but if I try to run it off batteries (as you recommended, all those years ago) the operation becomes sporadic and unreliable.

So far as I can make out, the signal input level drops dramatically under certain conditions, depending on my posture (keep your remarks to yourself!).

Please could you suggest a circuit mod or, failing this, are there any ICs which I could use, preferably with several switches on one chip?

I am designing a piece of equipment for use by small children so that a single touch-control switch is important, as, of course is the electrical safety.

*Guy Incbald,
Burnage,
Manchester.*

The circuit is intended to be triggered by the 50 Hz hum voltage which we all carry around with us — effectively, the body acts as an antenna. Touching the contact transfers the voltage to the input of IC1, which amplifies it enormously. This is rectified by a diode and the resultant DC is used to switch another op-amp from low to high, thus turning on a LED, relay or whatever. Note, too, that this circuit does not latch up; it will turn off shortly after the finger is removed.

The unreliable operation is probably because the 50 Hz signal is being coupled to all parts of the circuit, (remember that a battery is a short circuit for AC, even at 50 Hz), so that the input op-amp is seeing similar 50 Hz voltages on both its inverting and non-inverting inputs. The easiest way to solve the problem is to physically isolate the touch plate from the circuitry; metal shielding may even be necessary. Alternatively, you could try increasing the sensitivity by increasing the gain of IC1; reduce R2 by stages until you find a value where the operation becomes reliable. However, you may find that the circuit becomes unstable if R2 is taken too low.

Dear Richard, I have had the HE watch dog intruder Alarm (Oct 80) working on a test basis for some months. But have found that it is triggered by an external source/s.

A 3 foot instant start fluorescent fitting and a portable TV that I know of, have, when switched off, bought on LED2 showing a short.

I don't know what electrical appliances my neighbours have but it has happened when I have only had a fridge working. Its only occasionally this happens, and after 2200 hrs, or the early hours of the morning.

The PB1 doesn't cancel LED2 and RV1 has to be re-adjusted to cancel it then adjusted back to its normal position, which may take five minutes or more of adjusting. The circuit board (its not a printed circuit, they were not available) is mounted in a metal box and the box is bonded to earth. The only alteration to the circuit is in the window, where the 22k resistor has been changed to 56k. resistor, to give a bigger window. But I find there is still only a small amount of movement of RV1, when adjusting, to equal door and window switches LED1 before LED2 comes on.

The value of my switch resistors are 470k. I have changed the ICs at different times but trouble always reappear's.

Have you had or heard of anyone having had this happen with the Intruder Alarm and how did you or they overcome it? My knowledge at the moment of electronics is limited so I'm hoping you can throw some light on to it for me.

*N. Kilbey
Ilford
Essex*

What can be deduced from this tale of woe? Gremlins in the alarm system . . . not likely . . . well, how about spikes in the mains . . . ah, that sounds more like it—mains borne interference.

What can be done about it? Well, first of all try putting the unit on a PCB—it's amazing the increased stability you'll get. There are also some other steps you can take. One is to wire a 100u capacitor across the supply rails; and try a 100n in parallel to cut out HF spikes. Another filter can be made by wiring a 10k resistor in series with the line from point X, followed by 4u7 capacitor down to earth (try different positions around the board). If you want to make RV1 more sensitive, change it to 1M and replace R2 with the original 22k value . . . and if all that fails, I hear Alsatians are also pretty effective!

POP-AMPS

Owen Bishop

Simple measuring circuits based on operational amplifiers.

No. 1: Microammeter

THIS circuit adapts any ordinary voltmeter to measure currents in the microamp range. You can also use it with a multimeter, switched to a voltage-measuring range. The lowest current range on a typical multimeter is 0 - 250 μ A, but with this circuit the range can be as small as 0 - 1 μ A. Of course, if you have an FET multimeter, you will probably not need this circuit, as it is likely to be built in to your meter already.

Measuring Currents

An ammeter is always connected in series with the circuit which is to be tested, and the current to be measured flows from the test circuit, through the meter and back to the test circuit. For this reason, the ammeter must have as low a resistance as possible, so that the flow of current in the test circuit is not reduced by the resistance of the meter. A typical microammeter has a coil resistance of around 750R, though some microammeters have coils of considerably higher resistance. However in this circuit, when it is used on its 100 μ A range, the resistance encountered by the current is only 100R, resulting in much greater accuracy. The improvement can be seen by taking a numerical example.

In Figure 1a, the current flowing through the 2k7 resistor is $0.2/2700 = 74\mu$ A. If we try to measure this using an ordinary microammeter (Figure 1b), with a coil resistance of 750R, the total resistance becomes 3450R and the current is reduced to 58 μ A. This is a 23% error!

Using the op-amp circuit (Figure 1c), the total resistance is much less affected. It becomes 2800R, reducing the current to 71 μ A, and the error is now only 4%.

Some reduction of current is inevitable, for we can not avoid using power to drive the measuring instrument. The advantage of using the op-amp microammeter then, is that it needs very little power and so has a relatively small effect on the current you are trying to measure.

The Circuit

We will assume that the circuit is being used on its 100 μ A range, when a current of 100 μ A flows through R5, the potential difference between its two ends is $[V = IR = 100 \times 10^{-6} \times$

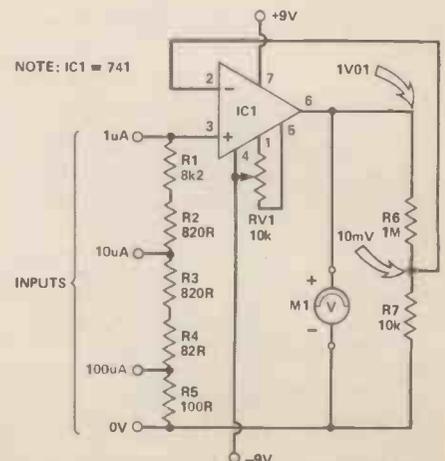
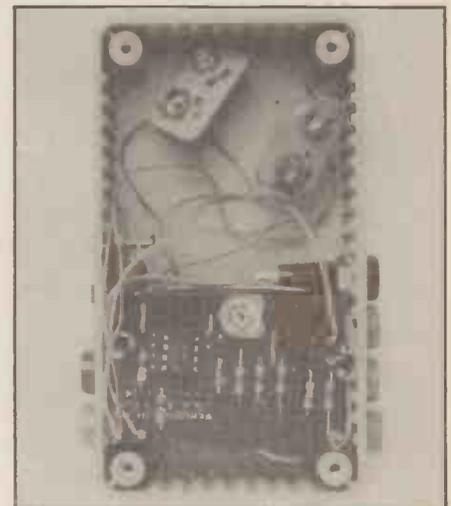
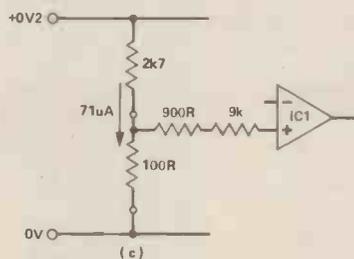
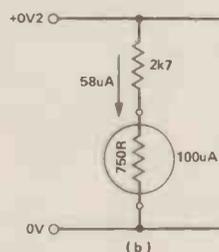
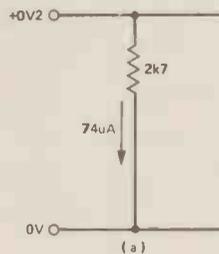
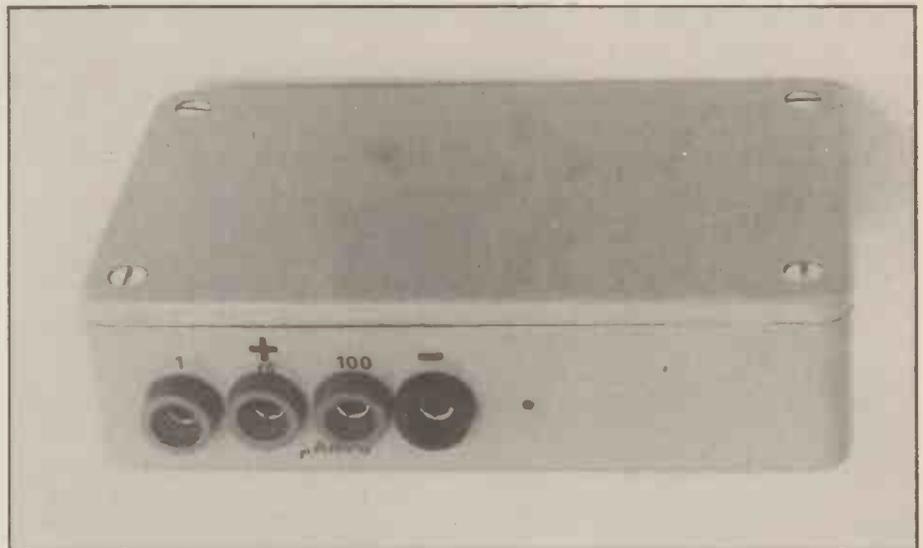


Figure 1. Measuring current (a) using a meter alone (b) results in a large error. The op-amp circuit (c) increases the accuracy of the measurement.

Figure 2. The Microammeter circuit.

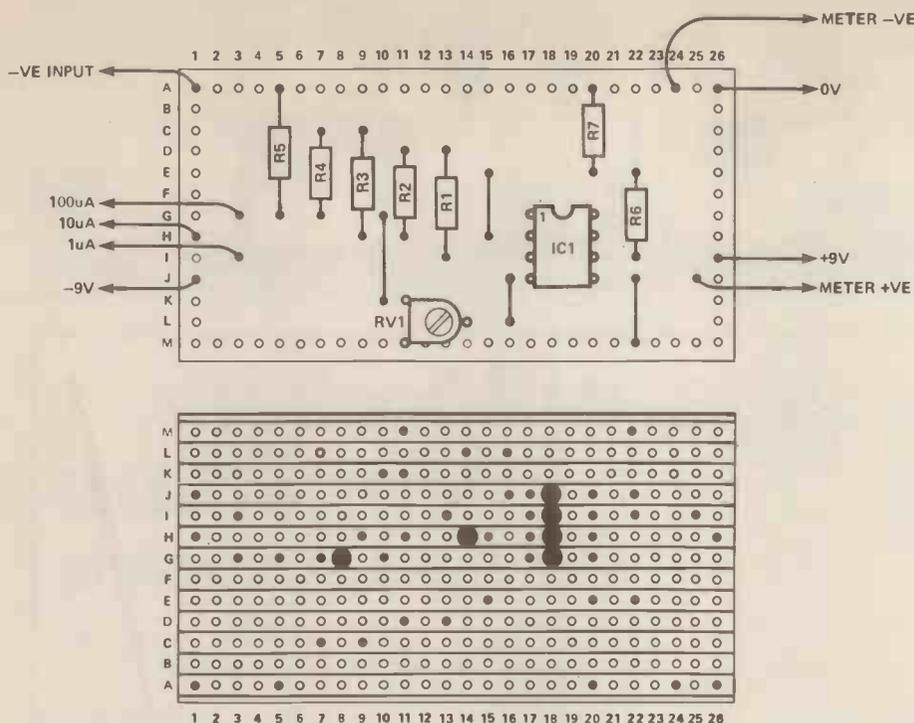


Figure 3. Veroboard component overlay and track-side view.

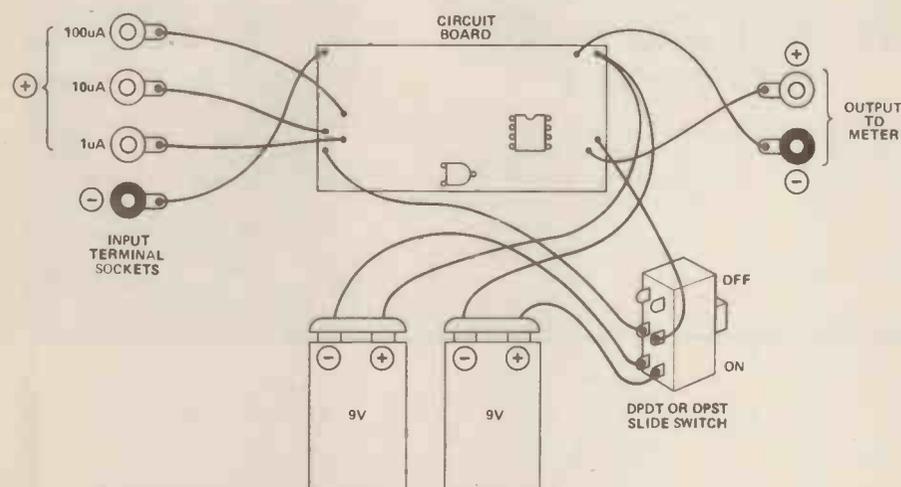


Figure 4. Wiring up the off-board components.

100 = 0.01 V [or 10 mV.] Thus, at full scale deflection (FSD), the non-inverting input (+ve) of the op-amp is at 10 mV compared with the 0 V line. We can ignore the effects of R1/R2 and R3/R4, since these are relatively small resistances compared with the input impedance of the op-amp (the input impedance of a 741 is typically 2M, so these resistors merely increase it to 2.0099M!). If the non-inverting input is at +10 mV, the amplifier adjusts its output to try to bring the inverting input (-ve) to the same potential. This is a special feature of op-amps, and one that is made use of in several other of the circuits we shall be describing.

If the inverting input is to be at +10 mV, the junction of R6 and R7 must be brought to +10 mV. Since R6 and R7 form a potential-divider network, the output voltage if the op-amp has to rise to +1.01 V to achieve this, and this is

the voltage which is measured by the voltmeter. When measuring a current of 100 uA, the voltage reading is 1.01 V; we can ignore the odd fraction of a volt and say that 1 V is equivalent to 100 uA. The currents equivalent to lower voltages are easy to calculate — 0V5 means 50 uA, 0V73 means 73 uA and so on, in proportion.

We work with a maximum potential difference of 10 mV on the other two ranges as well, so the reading obtained on the voltmeter is always between zero and 1 V. If the test circuit is connected to the 10 uA socket, the total resistance is 1k. With 10 uA flowing through this, the potential difference across R3/R4/R5 is 10 mV, as before. Now, a reading of 0V73 means a current of 7.3 uA. The 1 uA socket gives a total resistance of 10k, with a PD of 10 mV when 1uA flows. A reading of 0.73 V means a current of 0.73 uA.

Parts List

RESISTORS

(All 1/4 watt 1% carbon)

R1	.....	8k2
R2,3	.....	820R
R4	.....	82R
R5	.....	100R
R6	.....	1M
R7	.....	10k

POTENTIOMETERS

RV1	.....	10k
		min. horiz. preset

SEMICONDUCTORS

IC1	.....	741
		op-amp

MISCELLANEOUS

2.5 mm stripboard, 66 x 33 mm; 9 x 1 mm terminal pins; 2 x 4 mm red sockets, 2 x black; DPDT switch; 2 x PP3 battery clips; optional case; wire; solder etc.

BUYLINES page 34

Construction

Like all the circuits in this series, this one is built up on a single, small piece of stripboard (Figure 3). Whether you mount it in a case or not is a matter of preference. The circuit is powered by two PP3 batteries, giving the ±9 V supply required, though it is possible to operate on other balanced supplies, such as ±6 V or ±15 V.

Construction presents no problems but be sure to make the track cuts, and check the position of all components. Note that two pairs of resistors are wired in series (R1/R2 and R3/R4) to obtain the values 900R and 9kR, as nearly as possible.

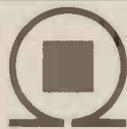
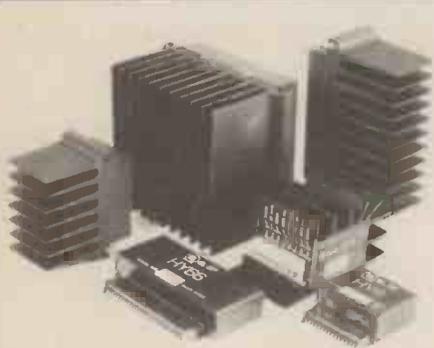
Setting Up

To set up the circuit, connect the voltmeter as shown in Figure 4. This should, preferably, be a 1 V FSD panel meter or a multimeter switched to the 1 V DC range, but a 2 V or 3 V meter will do almost as well.

It does not matter if it is a cheap meter, with low coil resistance, since the op-amp is capable of supplying all the current required. If you can afford a meter for the purpose, there is no reason why you should not wire it to this circuit and mount it permanently in a case.

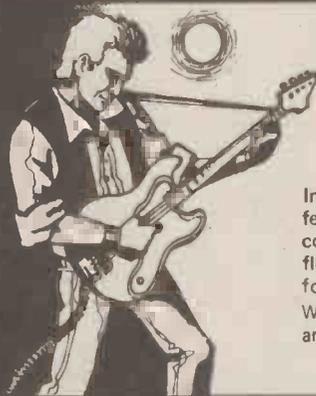
Now switch on the power; the meter will show a reading of some kind. Join the 1 uA input socket to the junction of R6 and R7, using a test-lead; this connects the two inputs of the op-amp together. The reading on the meter should be 0 V, but if not, adjust the offset null potentiometer (RV1) until the needle of the meter comes to rest at zero. The temporary lead may now be removed, and the circuit is ready for use. This is a simple circuit, with no provision for adjusting full-scale deflection or range; it is assumed that the use of 1% tolerance resistors will have ensured all the accuracy required.

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Module Number	Output Power Watts rms	Load Impedance Ω	DISTORTION		Supply Voltage Typ	Size mm	WT gms	Price inc. VAT
			T.H.D. Typ at 1KHz	I.M.D. 60Hz/7KHz 4:1				
HY30	15	4-8	0.015%	<0.006%	± 18	76 x 68 x 40	240	£8.40
HY60	30	4-8	0.015%	<0.006%	± 25	76 x 68 x 40	240	£9.55
HY60/90	30 + 30	4-8	0.015%	<0.006%	± 25	120 x 78 x 40	420	£18.69
HY124	60	4	0.01%	<0.006%	± 26	120 x 78 x 40	410	£20.75
HY128	60	4	0.01%	<0.006%	± 35	120 x 78 x 40	410	£20.75
HY244	120	4	0.01%	<0.006%	± 35	120 x 78 x 50	520	£25.47
HY248	120	8	0.01%	<0.006%	± 50	120 x 78 x 50	520	£25.47
HY264	180	4	0.01%	<0.006%	± 45	120 x 78 x 100	1030	£38.41
HY368	180	8	0.01%	<0.006%	± 60	120 x 78 x 100	1030	£38.41

Protection: Full load line, Slew Rate: 15V/ μ s. Rise time: 5 μ s. S/N ratio: 100db. Frequency response (-3dB) 15Hz - 50KHz. Input sensitivity: 500mV rms. Input Impedance: 100K Ω . Damping factor: 100Hz > 400.

MOSFET MODULES

Module Number	Output Power Watts rms	Load Impedance Ω	DISTORTION		Supply Voltage Typ	Size mm	WT gms	Price inc. VAT
			T.H.D. Typ at 1KHz	I.M.D. 60Hz/7KHz 4:1				
MOS 128	60	4-8	<0.005%	<0.006%	± 45	120 x 78 x 40	420	£30.41
MOS 248	120	4-8	<0.005%	<0.006%	± 55	120 x 78 x 80	850	£39.86
MOS 364	180	4	<0.005%	<0.006%	± 55	120 x 78 x 100	1025	£45.54

Protection: Able to cope with complex loads without the need for very special protection circuitry (fuses will suffice). Slew rate: 20V/ μ s. Rise time: 3 μ s. S/N ratio: 100db. Frequency response (-3dB): 15Hz - 100KHz. Input sensitivity: 500mV rms. Input impedance: 100K Ω . Damping factor: 100Hz > 400.

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PRE-AMP SYSTEMS

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HY6	Mono pre-amp	Mix/Mag. Cartridge/Tuner/Tape/Aux + Vol/Bass/Treble	10mA	£7.60
HY66	Stereo pre-amp	Mix/Mag. Cartridge/Tuner/Tape/Aux + Vol/Bass/Treble/Balance	20mA	£14.32
HY73	Guitar pre-amp	Two Guitar (Bass Lead) and Mic + separate Volume Bass Treble + Mix	20mA	£15.36
HY78	Stereo pre-amp	As HY66 less tone controls	20mA	£14.20

Most pre-amp modules can be driven by the PSU driving the main power amp.

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(inc. VAT) and the B66 for modules HY66-HY78 £1.29 (inc. VAT).

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PSU 41X	1 or 2 HY60, 1 x HY6060, 1 x HY124	£13.83	PSU 53X	2 x MOS128	£17.86	PSU 73X	1 x HY364	£22.54
PSU 42X	1 x HY128	£15.90	PSU 54X	1 x HY248	£17.86	PSU 74X	1 x HY368	£24.20
PSU 43X	1 x MOS128	£16.70	PSU 55X	1 x MOS248	£19.52	PSU 75X	2 x MOS248, 1 x MOS368	£24.20
PSU 51X	2 x HY128, 1 x HY244	£17.07	PSU 71X	2 x HY244	£21.75			

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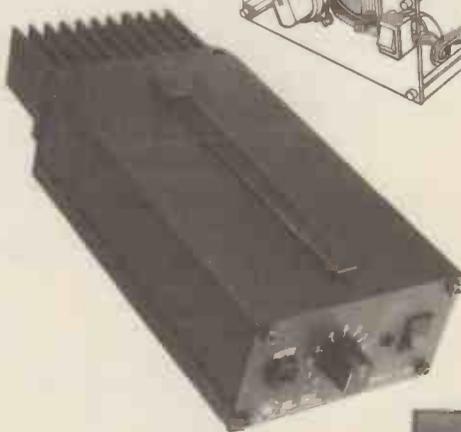
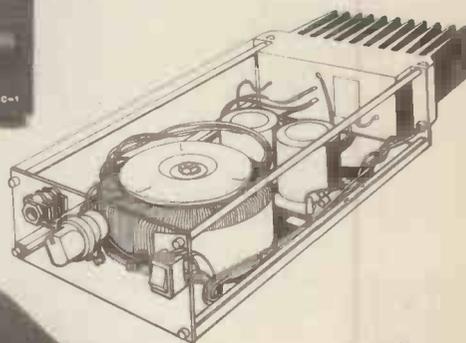
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UP7X	120W/4-8Ω	MOS	Mono	HiFi	£84.95
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TAPE/SLIDE SYNCHRONIZER

R. A. Penfold



Keep your audio in sync with your visuals!

THERE ARE several different types of slide/tape synchroniser, but the function they all perform is to record short "bleeps" of tone, on a cassette or tape recorder, and then use these tones on playback to automatically operate the slide-change mechanism of the projector. In its most basic form, a unit of this type is simply used with a monophonic cassette or tape recorder as a programmable slide timer, or in conjunction with stereo tape equipment the "bleeps" can be recorded on one channel while the other carries background music and (or) a commentary.

More sophisticated units enable the tone to be mixed with the music or commentary during records. Then, during playback, circuits in the unit operate the projector only when the "bleeps" of tone are detected and ignore other signals on the tape, so that spurious operations of the projector are avoided. This system has the advantage of enabling the slide show to have a monophonic accompaniment using a monophonic recorder, or a stereo accompaniment using a stereo recorder, but is not very satisfactory in practice since the "bleeps" are clearly audible to the audience, and are something of a distraction.

This problem can be overcome using the arrangement described above *plus* an additional stage which operates during playback to filter the "bleep"

signals from the output. The HE Slide/Tape Synchroniser is of this type, but it is reasonably simple and inexpensive and does not require any test equipment to enable it to be set up correctly for use. It would not be true to say that there is no loss of quality introduced by adding in the "bleeps" to one channel and then filtering them out again, but the loss of quality is not likely to be noticed, even if your slide shows are not quite as riveting as they

might be!

The bursts of tone are at quite a high frequency (about 5kHz) and when these are filtered out, any signals at around this frequency in the music or commentary are also removed. This obviously gives a certain loss of audio quality but, as only a very narrow band of frequencies are seriously affected and the fundamental frequencies in music are usually below 5kHz (so that only harmonics are attenuated by the

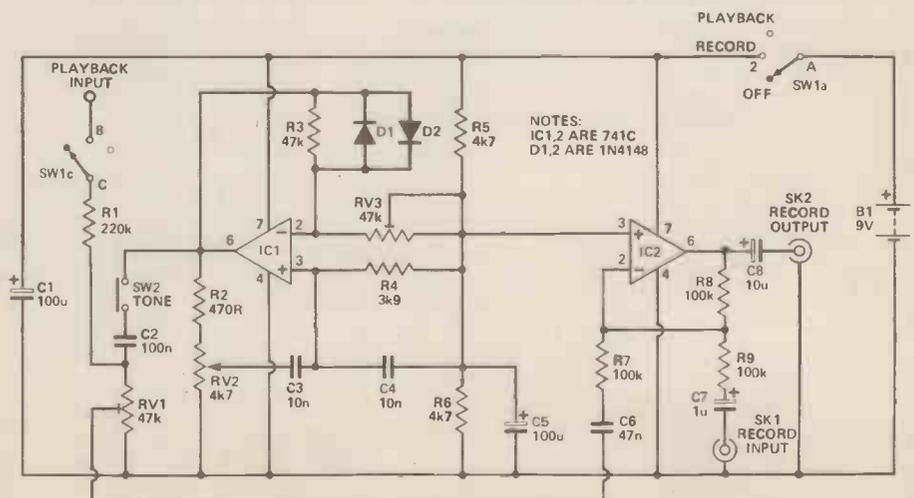


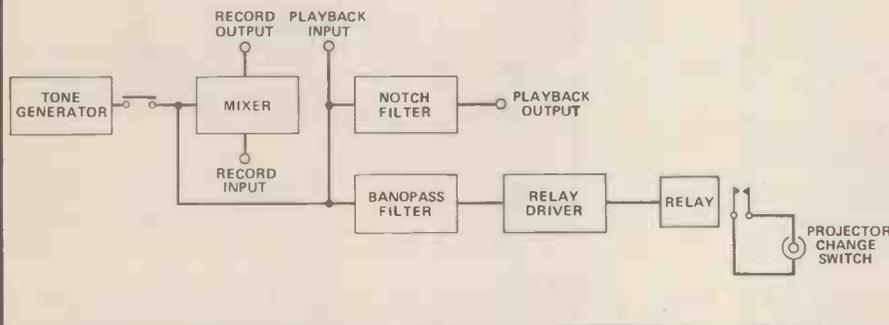
Figure 1. The Record section circuit.

How It Works

A MIXER and a tone generator are used to add bursts of high frequency tone to the input signal when a push button switch is briefly operated; the output is fed to the input of one channel of a tape recorder. Another circuit is used to process the signal when the tape is played back; the purpose of this circuit is to separate the bursts of tone and the main signal. The tone bursts are used to automatically operate the projector at the appropriate times, and this signal is filtered from the main signal using a bandpass filter tuned to the frequency of the tone signal. The output of the filter is fed to a driver circuit which pulses a relay when the tone bursts are detected; a pair of relay contacts are used to operate the slide change mechanism of the projector.

On playback the output from the tape recorder is also fed to a notch filter which gives very high attenuation at the frequency of tone bursts, and thus eliminates them, but enables other frequencies to pass unhindered. In practice, the notch filter will actually remove some of the wanted signal, while the bandpass filter permits some of the main signal to pass through to the relay driver. However, the loss of quality is not serious, and breakthrough to the relay driver should not cause spurious operation of the unit.

The "bleeps" of tone are also fed to the bandpass filter and the Record Output so that the projector is operated when the push button is operated, so that the tone burst is added to the sound track as the projector is operated.



filtering) there is no drastic loss of quality. There is also, inevitably, a reduction in the signal-to-noise ratio, but this is marginal and is of no practical consequence.

The unit is powered from an ordinary 9 volt (PP6 size) battery, and it should be compatible with any normal cassette or reel-to-reel tape deck or recorder. It has unity voltage gain in both the recording and playback modes and should not introduce any problems of incompatibility between

the tape machine used and other items of equipment such as the amplifier used during playback.

The Circuit

If we consider the recording circuit first, (shown in Figure 1), IC1 is used as the tone generator. The oscillator configuration is a form of the Wien Bridge which is capable of giving a good quality sinewave output. The operating frequency is determined by

R2, RV2, C3, C4 and R4; adjusting RV2 permits the operating frequency to be varied from around 2kHz to 10kHz. In use, RV2 is adjusted to adjust the output frequency to give maximum attenuation from the notch filter in the playback circuit; this is nominally at 5kHz.

R3, D1 and D2 form a negative feedback network, RV3 can be set to give gentle oscillation with a reasonably pure output. D1 and D2 help to stabilise the feedback at the correct level and make the adjustment of RV3 a little less critical.

IC2 is used as a standard operational amplifier mixed circuit having unity voltage gain. RV1 controls the volume of the tone signal fed through to the output socket, so that it can be set at a suitable level relative to the main signal; however the tone signal is only coupled through to RV1 when SW2 is operated.

The circuit diagram of the playback section of the unit is shown in Figure 2. C17 couples the input signal (from the recorder) to a notch filter, which is basically a twin-T type using C18, 19, 20, R17, 18, 19, and RV5. RV5 enables the attenuation of the filter to be peaked at a very high level (about 80 dB or more).

A problem with a simple, twin-T filter is that it tends, also, to significantly attenuate signals at frequencies well away from the centre frequency, and in this application the audio quality would be adversely affected. Typically, a twin-T filter gives about 10 dB attenuation at half and double the operating frequency. In this circuit, the response of the filter is improved by the negative feedback loop around IC4. The circuit may look a little confusing, due to the use of two negative feedback loops, but the effect of this is to stabilise the gain of the circuit at unity. This can only be achieved at frequencies where the losses through the twin-T network are fairly low, however, and at the operating frequency of the filter its losses are far too high to be significantly reduced by the negative

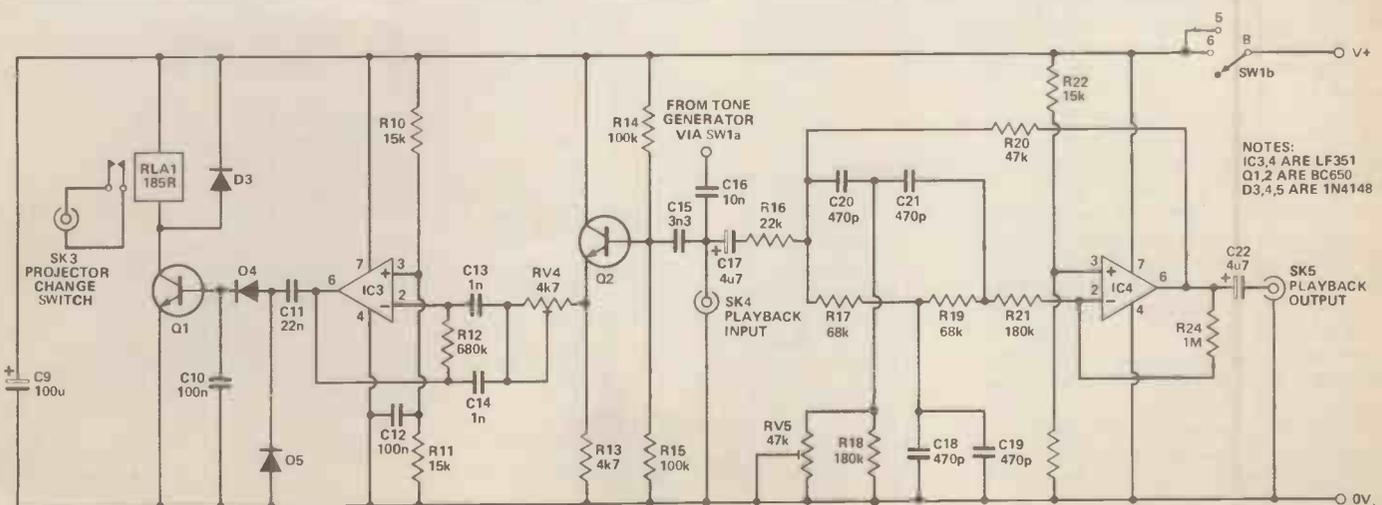


Figure 2. The Playback section; the tone filter circuit is on the right (IC4)

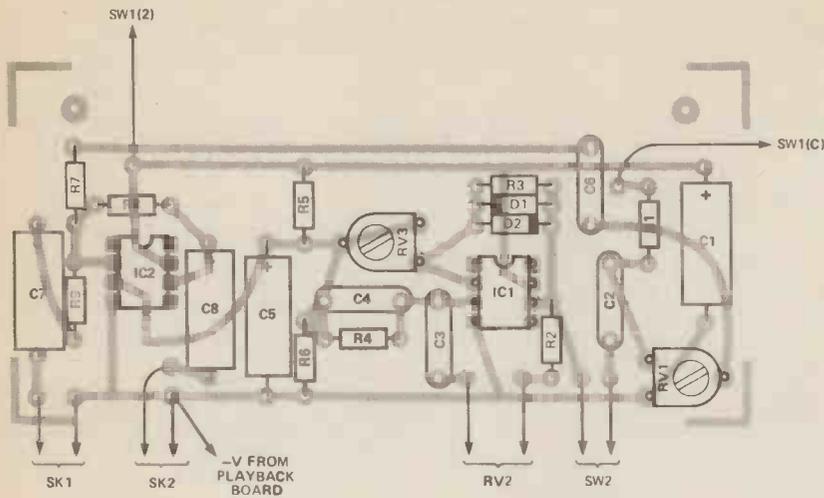


Figure 3. PCB overlay for the Record section circuit.

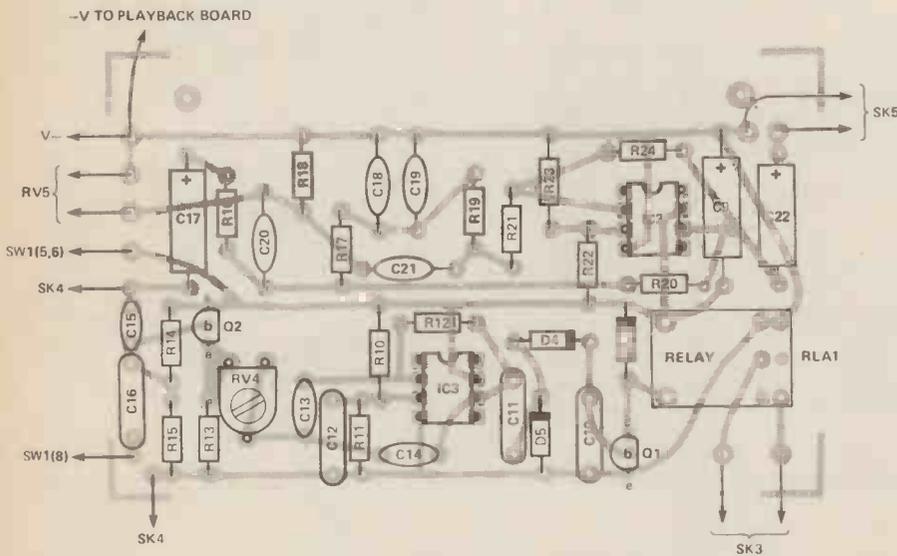
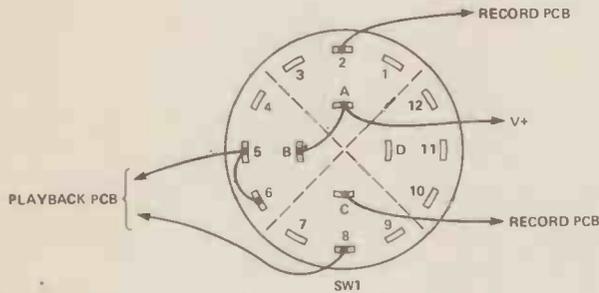


Figure 4. The PCB and component overlay of the Playback section.

feedback. Thus the response of the filter is improved, with reduced losses away from the operating frequency but with the deep attenuation notch being retained.

C15 couples the tape input signal to an emitter follower buffer stage which uses Q2, and this simply ensures that the next stage is fed from a suitably low source impedance. The next stage of the circuit is actually a standard operational amplifier bandpass filter using IC3, tuned by RV4 to peak the response of the circuit at the correct

frequency.

The output of IC3 is coupled to a smoothing and rectifier circuit which drives Q1 which, in turn, drives the relay coil. When the bursts of tone are present on the input signal, these produce a strong positive bias at the base of Q1, which is then switched on, activating the relay and the projector's slide change mechanism via a set of normally open relay contacts.

SW1 is the mode switch; this couples the output of the tone generator through to the playback

Parts List

RESISTORS

(All 1/4 W 5% Carbon)

R1	220k
R2	470R
R3,20	47k
R4	3k9
R5,6,13	4k7
R7,8,9,14,14	100k
R10,11,22,23	15k
R12	680k
R16	22k
R17,19	68k
R18,21	180k
R24	1M

POTENTIOMETERS

RV1,3	47k
	0.1W horizontal preset
RV2	4k7
	linear carbon
RV4	4k7
	0.1W horizontal preset
RV5	47k
	linear carbon

CAPACITORS

(All C280 polyester unless noted)

C1,5,9	100u 10V
	axial electrolytic
C2,10,12	100n
C3,4,16	10n
C6	47n
C8	10u
	25V axial electrolytic
C11	22n
C13,14	1n
	polycarbonate
C15	3n3
	ceramic
C17,22	4u7
	63V axial electrolytic
C18,19,20,21	470p
	polystyrene

SEMICONDUCTORS

IC1,2	741C
	op-amp
IC3,4	LF351
	bifet op-amp
Q1,2	BC650
D1,2,3,4,5	IN4148

MISCELLANEOUS

RLA1	12V 185n coil
	2 pole changeover contacts
SW1	3 way 4 pole rotary
SW2	Push to make non-locking type
B1	PP6, 9 volt
	Case, about 203 x 127 x 51 mm;
	battery clip (PP3 type); PCBs; three
	control knobs, wire, solder, etc.

BUYLINES page 34

circuit when the unit is in the record mode (it also provides on/off switching for both circuits). Note that power is applied to the playback circuit when the unit is in the recording mode, so that the relay activates the projector to synchronise the slide-change with the sound track.

Construction

An aluminium case measuring about 203 x 127 x 51 mm will comfortably accommodate all the components, including the battery. The four controls

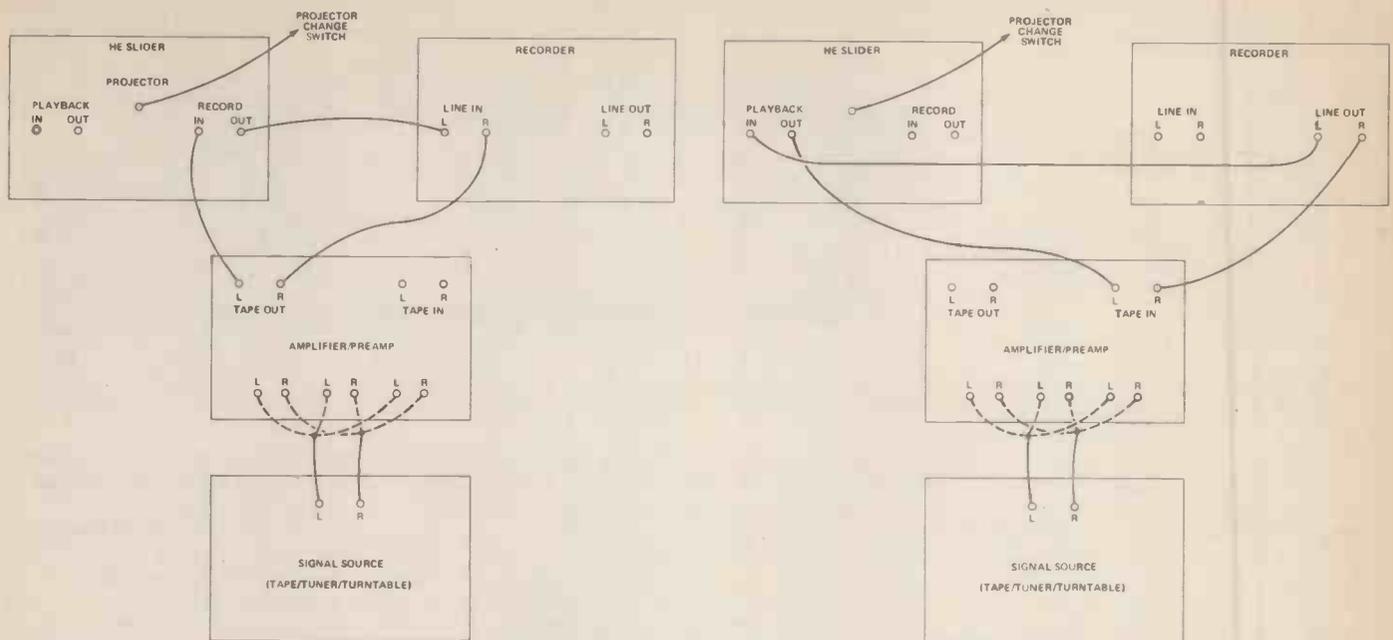
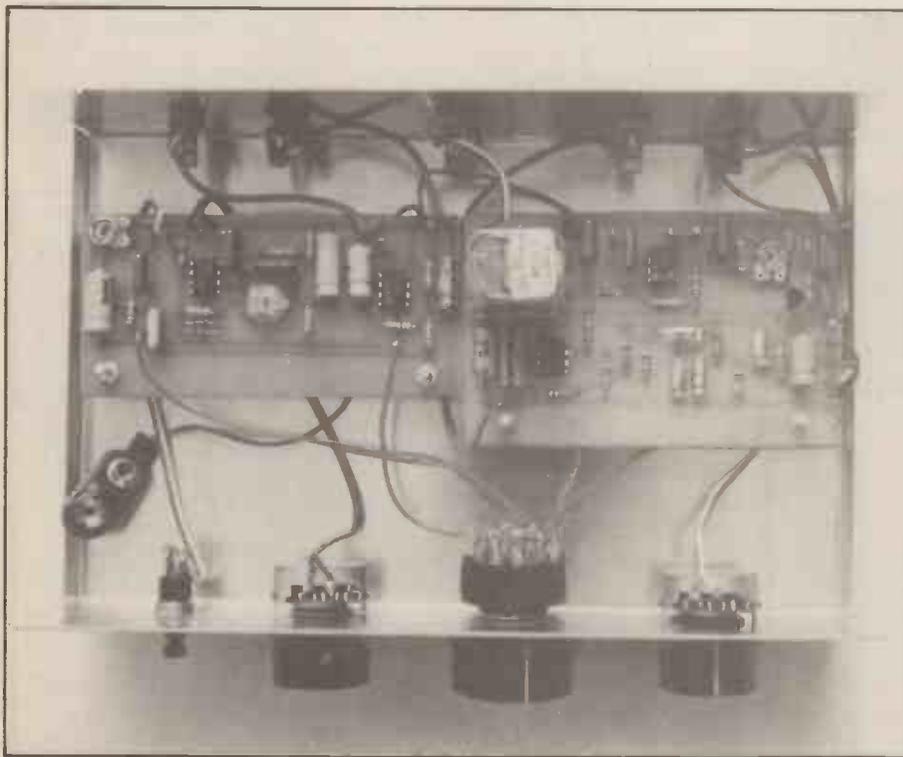


Figure 5. Connecting the unit for Record (left) or Playback (right).



are mounted on the front panel, although SW2 can be mounted in a separate small (hand held) case and connected to the main unit via a lead several feet long, if this will be more convenient in use. The lead would need to be terminated in a two way plug and SW2 would be replaced (on the front panel of the case) by a matching two way socket. Note that this socket should be a type which is insulated from the case, such as a plastic jack type or a two way DIN socket. SK1 to SK5 are mounted along the rear panel

of the case; these are all 3.5 mm jacks on the prototype, but can be changed to any other type of socket, if this will be more convenient in use.

The other components are mounted on two printed circuit boards, one for the recording circuit and the other for playback. The component layouts and wiring are shown in Figures 3 and 4 respectively; use Veropins at points where off-board connections will be made. The specified relay will fit directly onto the printed circuit board, but other types will work provided they

have a coil resistance of about 185 ohms or more, will operate from about 6 volts, and have at least one set of normally open contacts rated at about 2 amps (AC) or more. However, if an alternative relay is used it will be necessary to alter the PCB to suit, or mount the relay off-board. Incidentally, the specified relay has two sets of changeover contacts, with four of its pins unused.

Setting Up

A quick initial check of the unit can be made by switching the unit to the recording mode and operating SW2. If the output of SK2 is monitored using an amplifier and loudspeaker (or even just a crystal earphone), a tone should be produced when SW2 is operated, provided that RV3 is set well into the anticlockwise position. RV1 should control the volume of the tone, with RV2 giving pitch control.

The next stage is to set RV5 at about half way and monitor the output from SK5. By adjusting RV2, it should be found that the tone is greatly attenuated at some setting that gives a fairly high pitch and, by repeatedly adjusting RV2 and RV5, it should be possible to eliminate the fundamental frequency of the tone. With the tone generator oscillating strongly there will be quite strong harmonics (multiples of the fundamental frequency) at the output although, due to the high frequency of the tone, probably only two harmonics will be audible. Setting RV3 further in a clockwise direction will produce more gentle oscillation but will alter the pitch of the tone slightly, and RV2 will need to be readjusted. A little experimentation with the settings of RV1 to RV3 should produce a reasonably pure tone, with the filter attenuating this to an insignificant level.

POP-AMPS

Owen Bishop

Simple measuring circuits based on operational amplifiers

No. 2: Voltage follow-and-hold circuit

ONCE in a while, and probably more often, it is necessary to measure a voltage which is changing rapidly — but trying to follow the needle of the voltmeter by eye and read it at *just* the right instant is tension-generating, to say the least! And, if your eye cannot follow the needle, it is likely that the needle cannot follow the rapidly changing input voltage, either, so whatever reading you have struggled to obtain will be doubly in error. This circuit, however, gives your eye *and* the needle a breathing-space in which to catch up with the changing voltage. Pressing the button, it takes a sample of the input voltage at any instant; the circuit then holds the meter needle while the needle of the meter comes to rest, and your eye has time to take the scale reading with all the accuracy you need.

The Circuit

The output of the circuit (Figure 1) follows the input voltage as long as the button is held pressed. When the button is released, the output remains constant at whatever value it had at the instant of release. When the button is pressed again, the output immediately becomes the same as the input voltage. The operation of the circuit is diagrammed in Figure 2.

The op-amp is connected as an inverting amplifier with unity gain and with the button pressed, output follows input except that it is inverted.

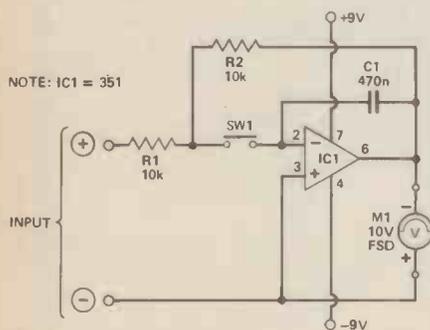
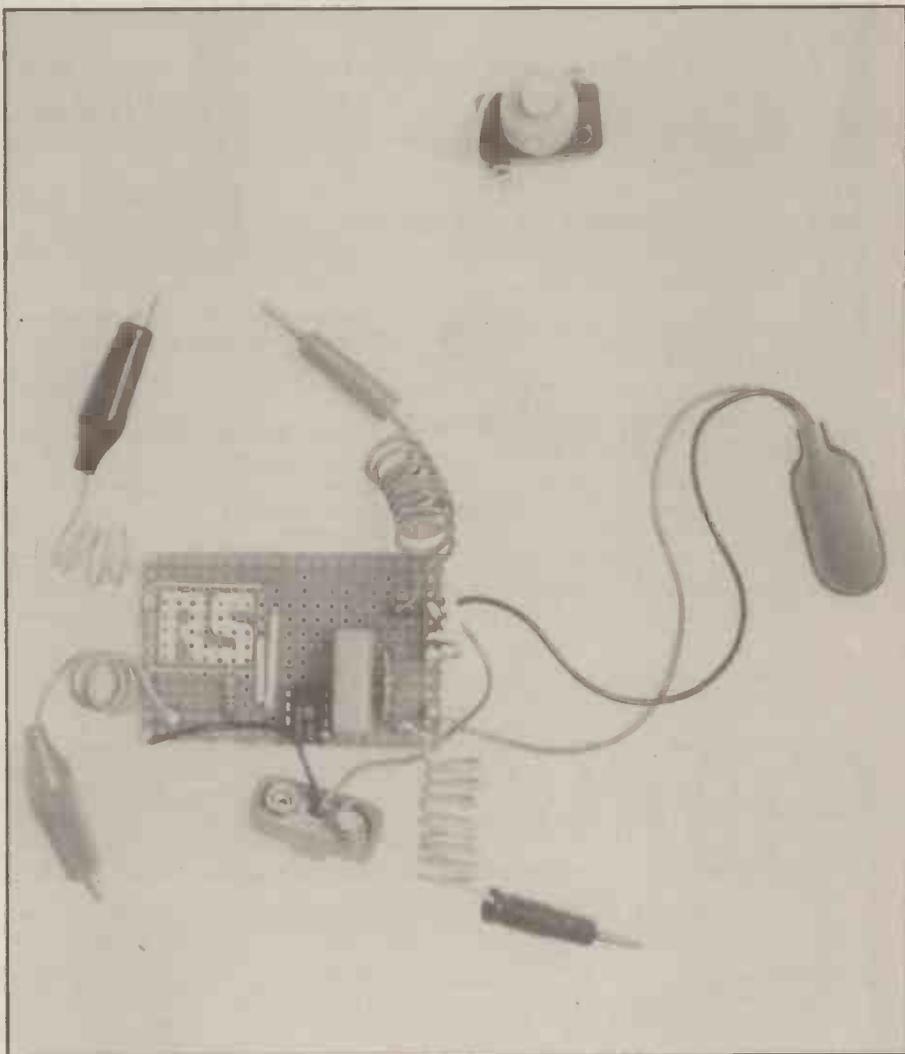


Figure 1. The Follow and Hold circuit.

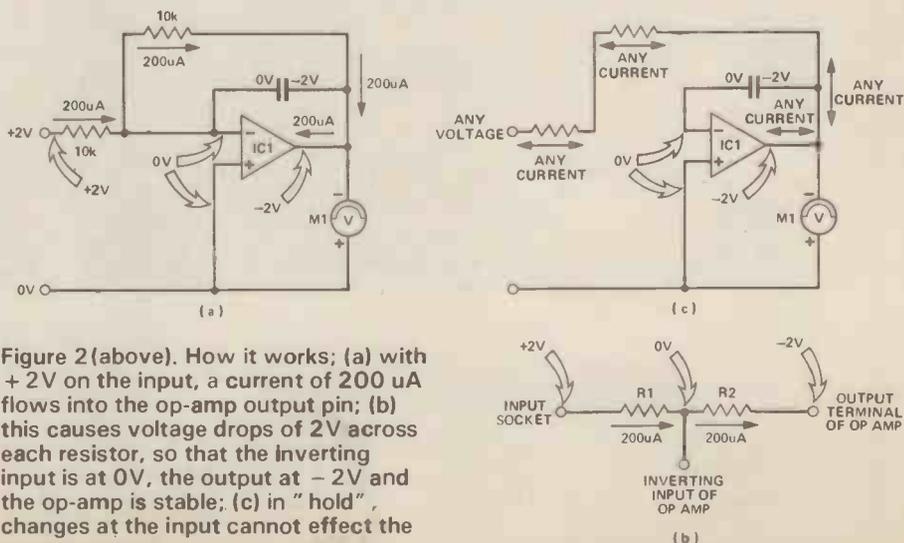


Figure 2 (above). How it works; (a) with +2V on the input, a current of 200 uA flows into the op-amp output pin; (b) this causes voltage drops of 2V across each resistor, so that the inverting input is at 0V, the output at -2V and the op-amp is stable; (c) in "hold", changes at the input cannot effect the op-amp output.

Now an op-amp is stable when there is no potential difference between its two input terminals. But since the non-inverting (+ve) input is wired to 0 V, the inverting input must also be at 0 V if the circuit is to be stable. So given an input of, say, +2 V, a current of 200 uA flows toward the inverting input, by way of the input resistor R1. The amplifier input has extremely high resistance, so almost no current enters it, but, instead, flows on through R2 and into pin 6 of the op-amp. Since R1 has the same value as R2, and the same current flows through each; the voltage difference across each resistor is the same (Figure 2b). Therefore, with a drop of 2 V across each resistor, the output potential is -2 V, the potential

at the inverting output is 0 V and the op-amp is stable. In this state, one side of capacitor C1 is at 0 V and the other is at -2 V; there is 2 V across it.

When the button is released, the circuit becomes as shown in Figure 2c. The input to the circuit may change, either increasing or decreasing in voltage, and a varying current may flow in either direction through R1, R2 and into or out of the output terminal of the op-amp — but the output of the op-amp is entirely unaffected by this! The potential at its inverting input is held at 0 V because of C1 and, since this is still the same as the potential at its non-inverting terminal, the amplifier is stable; it maintains an output potential of -2 V.

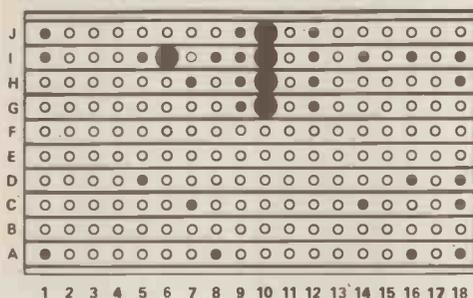
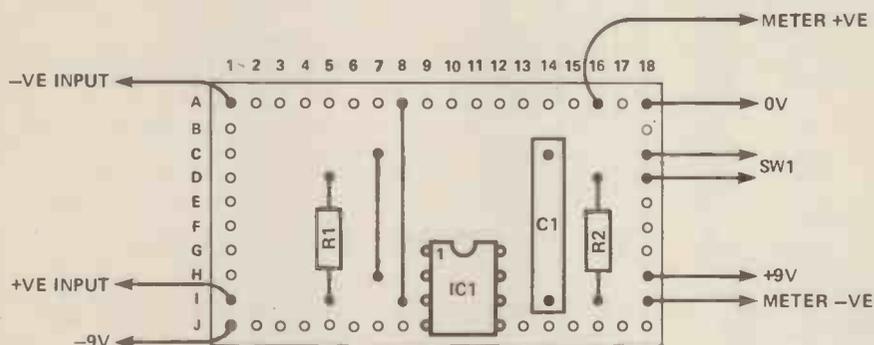


Figure 3. The Veroboard component overlay (top) and the track-side view (bottom), showing the positions where the strips are cut.

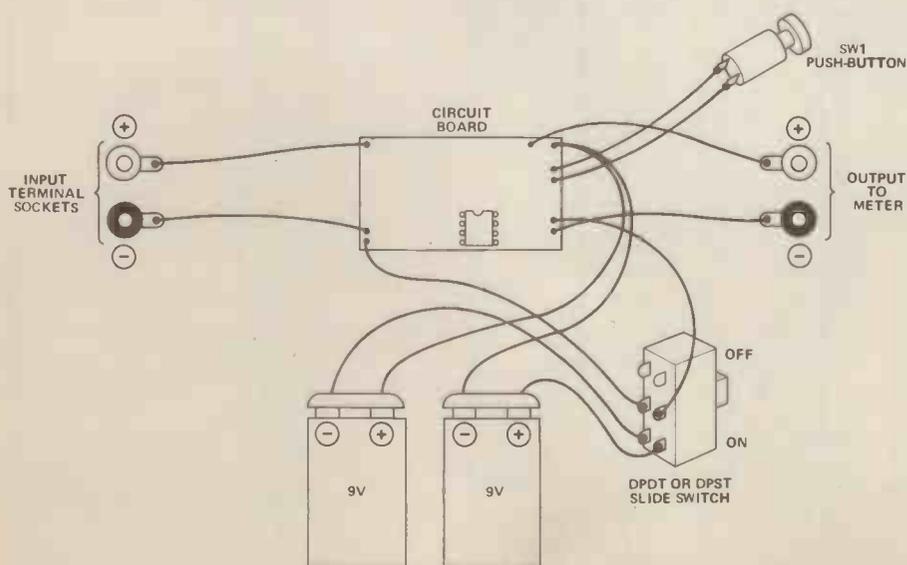


Figure 4. Wiring the external components to the Veroboard.

The capacitor retains its charge for a long time, since there is no way in which a large current can flow from one side of the capacitor to the other. The plates of C1 are effectively insulated from each other by the dielectric, which has a resistance of 20,000M or more, while leakage into the amplifier is very small too, since the input impedance is $10^{12}R$ — a million megohms! — and this high input impedance is the reason for choosing a JFET op-amp for the circuit. With such high resistances, a charge of 2 V on C1 takes 47 seconds to drop just a hundredth of a volt. This should give you (and the meter) plenty of time to cope!

The circuit described has unity gain, so meter readings are equal to input voltages, though increasing the value of R2, you can make the circuit amplify the voltages as well as hold them. The amplification is set by the ratio $R2/R1$; for example, if you replace R2 with 100k, the op-amp amplifies ten times.

The reason for choosing the 531 in preference to other JFET op-amps is that it has a very high slew rate (rate of change of output voltage) of 13V/us, which compared with the rate of 0V5/us for the 741, makes it a good device for sampling rapidly changing voltages.

Operating the multimeter on the 10 V range means that offset null adjustments (see *Pop Amps No. 1* in this issue) are less important and an offset potentiometer is not needed.

Construction

There are so few components that construction of the circuit takes only a few minutes. The component layout is shown in Figure 3. Whether you decide to mount it in a case is a matter of preference. If you have a 10 V meter to spare, you can mount this on the case; it does not need to have a high coil resistance, so a cheap one will do. Otherwise, plug your multimeter into the circuit, using the two sockets indicated. This circuit, like No. 1, can also be used with the LED Millivoltmeter featured in HE August 1982.

HE

Parts List

RESISTORS	
(All 1/4 Watt 1% carbon)	
R1,2	10k
CAPACITORS	
C1	470n polycarbonate
SEMICONDUCTORS	
IC1	7611 CMOS op-amp
MISCELLANEOUS	
2.5 mm stripboard, 48 x 25 mm; 6 x 1 mm terminal pins; 2 x 4 mm red sockets, 2 x black; push-to-make switch; DPDT switch; 2 x PP3 battery connectors; optional case; wire, solder etc.	
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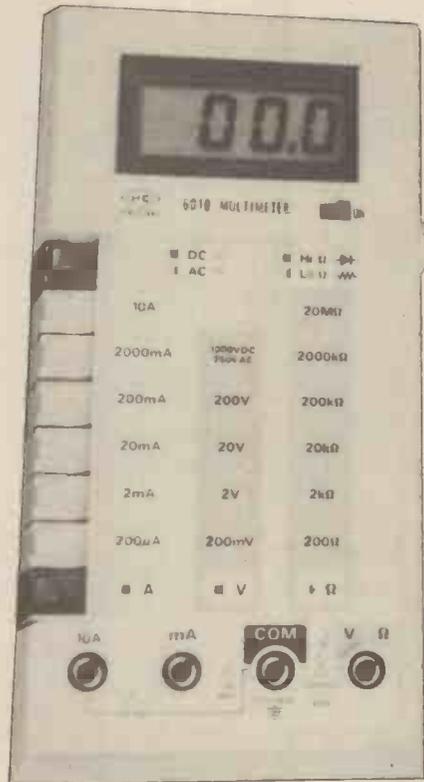
HC6010 DMM

Paul Coster

An accurate and reliable DMM with some outstanding features.

WHEN I unpacked the HC6010 from its mustard coloured box, I could tell I was in for a few surprises. Described by the manufacturers as accurate and reliable, it is a digital multimeter with all the usual AC/DC current and voltage ranges and some extra ones not common to meters in this price range — for example, a basic DC accuracy of 0.5%. In use it was very robust — of the highest electronic standards of construction — and well thought out. In fact, my only real criticism was of an aesthetic nature rather than due to any great failing of the meter.

The 6010 multimeter is made by Hung Chang Products and distributed by Armon Products Ltd. The basic ranges are AC/DC current and voltage (extending up to 1000 V and 10 A DC, and 750 V and 10 A DC) and two resistance — low and high output voltages. The display is 3½ digit LCD with auto-zero, auto-polarity and 'lo-bat' indicators. Range and scale selection is made via a series of push-buttons along the left-hand side of the instrument. There are eight buttons in all, two for selecting AC/DC (or hi/lo resistance) and voltage/current/resistance and six for setting up the correct full scale deflection (FSD). For instance, to measure up to 20 mA AC you would press the top button (conveniently coded dark grey) for AC and the fifth button to read up to 19.99 mA. However, there's no need to worry if the value is over range, since the meter is protected against overloads by sparkgap (voltage), inrush current limiter (current) and a 2A fuse (current). Also protected are the battery eliminator input and resistance ranges and as if that isn't enough, the test lead sockets are recessed — not to make plugging and unplugging the leads as difficult as possible as I first thought, but to ensure there is no bare metal to give you any nasty shocks — as part of an overall philosophy of 'safety first'.



Clearly A Better Meter

The voltage ranges are chosen by pressing the lowest of the (dark grey) buttons. Both AC and DC voltage scales have the same ranges (apart from maximum values of 750 V AC and 1000 V DC) and so AC or DC can be switched by a single button. Accuracy is quoted at $\pm 0.5\%$ (reading + 1 digit) DC and $\pm 1\%$ (reading + 5 digits) AC, which despite being a strange way of expressing the tolerances, is pretty good for a meter of this price range.

Sinusoidal voltages are measured with an averaging response, but the meter is calibrated to read RMS (though this is not as good as direct reading RMS) and resolution for both AC and DC is a very good 100 μ V.

To measure current, you have to plug the red test lead into a different socket (slightly tedious with the safety measures mentioned earlier), and the two dark grey buttons operate in a similar manner as when reading voltage — upper for AC/DC, lower remains 'out'. In addition to this, if you want to take readings up to 10 A you must plug the red lead into a third socket. This was again a chore, but when you consider that most other meters need a shunt to measure such large currents, perhaps it's forgivable.

Accuracy on the current ranges is not as high as on the voltage, but since the worst case (2 A and 10 A AC) is still fairly good at $\pm 3\%$ (reading + 5 digits), I do not feel the 6010 is any poorer than the competition (I was particularly impressed by the clear manner in which *all* the technical specifications were presented). Resolution on both AC and DC current is adequate at 100 nA; but this meter, like others I have reviewed, would have benefitted from a lower limit of 10 nA, say — after all, isn't everyone interested in the current consumption of their LCD calculator!

Resistance measurements are made by pressing the lowest button and then selecting either the 'hi' or 'lo' ohms scale. These two scales are present, as with other meters, to allow in-circuit readings to be made. However, unlike some other similar instruments, the lo output is low enough (280mV) to facilitate testing around *most* semiconductors. Both outputs (hi and lo) have six ranges from 200 ohms up to 20 megohms, with resolution down to 100 milli-ohms on the 200R. Accuracy is very good on the four lower ranges (0.5% nominal) and creditable on the 2M and 20M settings (better than 2% nominal). The high range (up to 20M) is quite rare for a unit of this type and I was pleased to see it included.

Specs And The Rest

The HC6010 DMM comes complete with an instruction leaflet, which is very clear but (sadly) not that well laid out — whatever happened to those neat pocket-sized manuals that used to accompany most of the better meters! Even so, operation is easy to grasp and the leaflet is only necessary as a source of reference information. What I do commend Hung Chang for, is the inclusion of a circuit diagram and parts list — it is always a good sign if a manufacturer is proud enough of his design work to want to make it public. However, it's a pity this pride doesn't extend to the fascia panel, on the front of the case, which has the lettering printed on it. Not only does this have a tendency to peel off, but it gives the meter a gimmicky appearance. A bit of time spent here (and on improving the shape of the case and buttons) would pay in the long run — designers of the 'Mark II' take note.

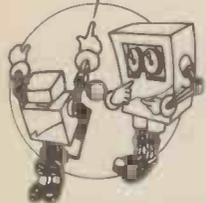
So, for those of you who are after a robust and accurate digital multimeter, that is easy to use and out-performs most others at the price, I can recommend the 6010. However, if you're after something to show off to your friends, then keep looking... and one final surprise, a price tag of £34.44. For further information contact Armon Products Ltd, 53-63 Wembley Hill Road, Wembley, Middlesex HA9 8BH.

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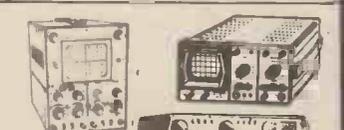
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Ready to use today, easy to expand tomorrow

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

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

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Key features of the Sinclair ZX Spectrum

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

Low Cost Alarm System

An easy-to-build security system that can be expanded to provide protection for any property.

Owen Bishop

THE COST of a professionally installed intruder detection system can be measured in hundreds of pounds so, with housebreaking on the increase, there is a lot to be said for a simple DIY system such as this. There are gains in the immediate savings on the considerable labour costs of installing the wiring, coupled with the fact that the commercially made 'box of electronic tricks' often seems to contain surprisingly little for the money. The electronic part of this system contains surprisingly little, too, but you will have to pay more than about £13 for all the components, including switches (but not including the case and battery). Perhaps this system does a little less than some of the more advanced of those commercially available, but it is straight forward in its action and there is virtually nothing to go wrong with it. Moreover it is not subject to false alarms caused by transients in the detector circuits, as are many of the simpler alarm systems. It has extremely low power consumption (only 0.75 mA) when quiescent, so it is ideally suited to battery power. A set of 'D' dry cells will last for many months of operation, 24 hours a day. A set of "AA" NiCad cells will last for 1 month on one charging. Thus, the system is independent of mains power failures or interruptions.

The noise generated by the solid state audible alarm is more than enough to wake the household or to rouse the attentions of neighbours. The alarm draws only 25mA, yet emits a piercing warbling tone with a power of 95 dB at 1m. Since its current requirements are low, it is feasible to wire two or more AWDs in parallel and site them in various parts of the house. But try using just one to begin with, for it is more than likely that you will find it does all that is needed.

The system has two kinds of detection circuit, the peripheral loop and the pressure mat system.

Peripheral Loop

This consists of normally closed switches mounted on all doors and windows, forming a loop which surrounds the area to be protected. The switches are in series so that, if any one switch is opened, the loop is broken and the alarm is sounded. It may be sufficient to protect ground-floor entry-points only, but upstairs windows should be protected too, if they are readily accessible from outside. Do not forget the less obvious points, such as coal-



shed doors, hatches and skylights.

It is best to use a magnetic switch specially made for the job. The switch consists of two parts (Figure 1). The reed switch itself is mounted on the frame of the door or window or may be concealed in a hole drilled in the frame. The other part contains a permanent magnet. This is mounted on or concealed in the door or window itself. When the door is shut, the magnet holds the reed switch closed. When the door is opened, even by only a centimetre or so, the switch opens and

the loop is broken.

The use of a normally-closed loop of this kind makes it difficult for an intruder to de-activate the system by cutting wires. A cut at any point on the loop sounds the alarm immediately. However, it is worth remembering that intruders do not always open doors or windows in the conventional way, in order to gain entry, especially if the door or window is securely locked or bolted. It may be easier for the intruder to quickly cut away the glass of a french door or picture

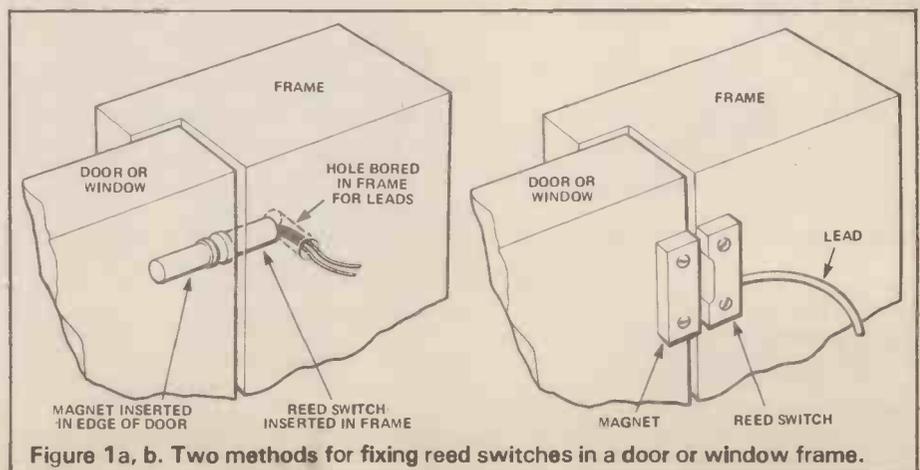


Figure 1a, b. Two methods for fixing reed switches in a door or window frame.

window, and enter through the hole. Another ploy is to cut an entry hole in the panel of a lightly-constructed door, or in the thin panelling which is often to be found alongside front-door units. Glass panes and thin panels may be protected by fixing strips of thin metal foil across them. Special window foil is sold for this purpose, together with terminal blocks for making connections to the end of the strip. These strips can be included as part of the peripheral loop.

Where the devices mentioned above are not suitable, it is usually easy to rig up a normally-closed microswitch which will be opened by an attempted break-in.

Pressure Mats

These are specially made mats which are placed beneath carpets or other floor coverings. They act as normally open switches, closing when stood on. If you have large pets loose in the house at night, or if any member of the family is a habitual sleep-walker, take care where you place them! Otherwise, they may be placed in strategic positions around the house, especially in areas such as the living room, where expensive equipment is likely to attract the intruder. The mats are wired in parallel, so that the circuit is completed when any one mat is stood on. This section of the system may also contain other normally-open switches. A valuable safety feature is to have a few push-buttons situated in the house where they can be used for sounding the alarm manually. This provides a quick and effective way of alerting the household in case of fire, for example. The wiring of this part of the system needs to be as carefully concealed as possible, for the system can easily be de-activated by cutting the wires, but since much of the wiring is beneath the carpets, this presents little difficulty. The wire used for the pressure mat system and the peripheral loop can be light-duty PVC covered wire (7/0.2 mm wire is cheap and perfectly satisfactory).

Circuit Details

The peripheral loop runs from the 12 V line, around the premises and back to the loop input terminal. If the loop is broken, the pull-down resistor, R2, causes the input voltage to IC1a to drop to 0V. The other input to IC1a is held high (at 12 V) by R1. If any one mat is stood on, the input voltage falls to 0 V (low). With two high inputs, the output of the NAND gate is low; this is the quiescent state. If the loop is broken, or if a mat is stood on, the output goes high.

A high output causes a current to flow through D1 and R3, charging C1. If the output remains high for long enough (about 0.5 seconds) the voltage rises above 6 V, which is effectively a high input to IC1b. The output then changes from high to low. If the output of IC1a is high for only a short time, as when a transient pulse appears on one of the inputs, C1 discharges through D2. Since there is no resistor in the return path, C1 discharges rather more rapidly than it charges, quickly eliminating the effect of the transient voltage. It would take an incredibly severe series of transients to break through this filter.

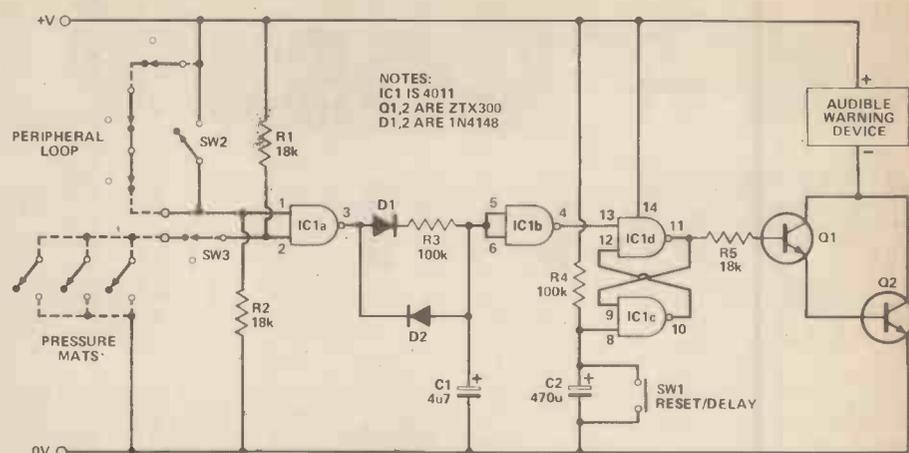


Figure 2. Circuit diagram of the alarm system.

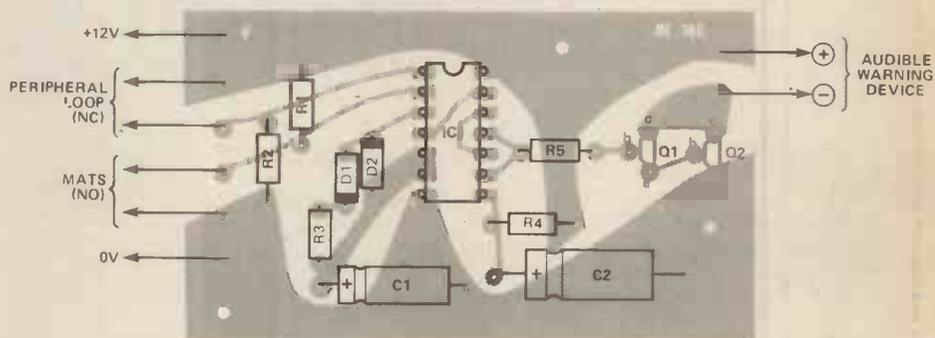


Figure 3. The component overlay.

Gates IC1c and d form a Set-Reset flip-flop. Its inputs are normally high and it is triggered to change state by a low pulse on one of the inputs. The Set input comes from IC1b. When this goes low, the flip-flop changes state, the output of IC1c changes from low to high and current flows to Q1, which is connected with Q2 as a Darlington pair to give sufficient current gain to operate the AWD.

The Reset input to the flip-flop comes from the junction of R4 and C2; it is held high by the pull-up action of R4, but when SW1 is pressed, the input falls immediately to low, thus resetting the flip-flop. While this input is low, a break in the loop or pressure on a mat can cause the input of the IC1c to go high and sound the alarm, but only for as long as the condition lasts, because the flip-flop does not change state permanently. The input to IC1c rises very slowly from 0 V as C2 charges through R4; it takes about 30 seconds to reach 6 V, providing the delay which allows the alarm to be set when the house is to be left unoccupied. After that, the flip-flop is ready to be triggered permanently by a low pulse from IC1b.

SW2 switches out the peripheral loop, by connecting the loop input directly to the 12 V line. This switch is not an essential part of the system, but it may be useful to de-activate the loop if, for example, a member of the household plans to return home late at night when the other members are in bed. This allows the mats to provide some kind of protection in the meantime. SW3 disconnects the mat system, and this too

is useful but not essential. During the evening, when all doors and windows are shut and the family is engrossed in the TV, the mat system is probably best kept inactivated. The peripheral loop gives adequate protection against intruders, many of whom prefer to break in when everyone is settled in one room with the sound from the TV to mask the noise of breaking glass or splintering timber.

Construction

There should be no problems in assembling the board and getting it to work straight away. As already mentioned, this circuit is ideally powered by a battery of 8 dry cells, or Ni-Cad cells. These may be contained in two 4-cell battery holders. Whether or not the circuit needs a case is a matter of opinion. It is preferable that the intruder should not be able to locate the circuit and cut off the power supply, so there is much to be said for hiding it away in a cupboard or drawer, eliminating the expense of a case.

The dead space below a table (Figure 5) is a good place to hide the circuit and batteries, though almost any other odd space will do; accessibility is not important, as you need renew the batteries so infrequently, provided that the switches can be reached easily. Concealed wiring should lead to the Reset/Delay button, hidden away in a convenient location fairly close to the door by which you normally enter the house. The AWD should be in some relatively inaccessible location, *not* beside the circuit itself. The wiring to it should be concealed as much as possible. The

Parts List

RESISTORS

(All 1/4 watt 5% carbon)
 R1, 2, 5 18k
 R3, 4 100k

CAPACITORS

(All electrolytic)
 C1 4u7 16V
 C2 470u 16V

SEMICONDUCTORS

Q1, 2 ZTX300
 silicon NPN transistor
 IC1 4011
 CMOS quad 2-input NAND
 D1, 2 1N4148
 signal diode

MISCELLANEOUS

SW1 Push-to-make
 push-button switch
 SW2, 3, 4 SPST
 standard toggle switches
 Siren (AWD), 12 V with optional
 multitone; battery holder (2); door
 and window switches; window foil
 and terminals; pressure mats; wire;
 solder etc.

BUYLINES page 34

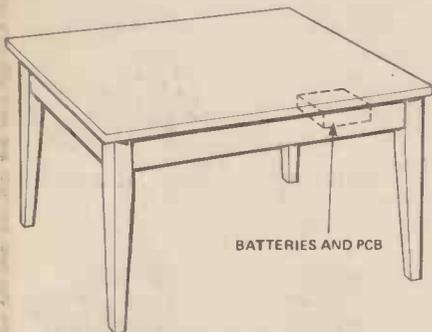
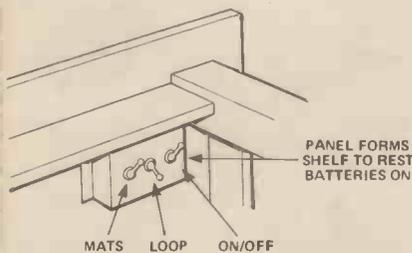


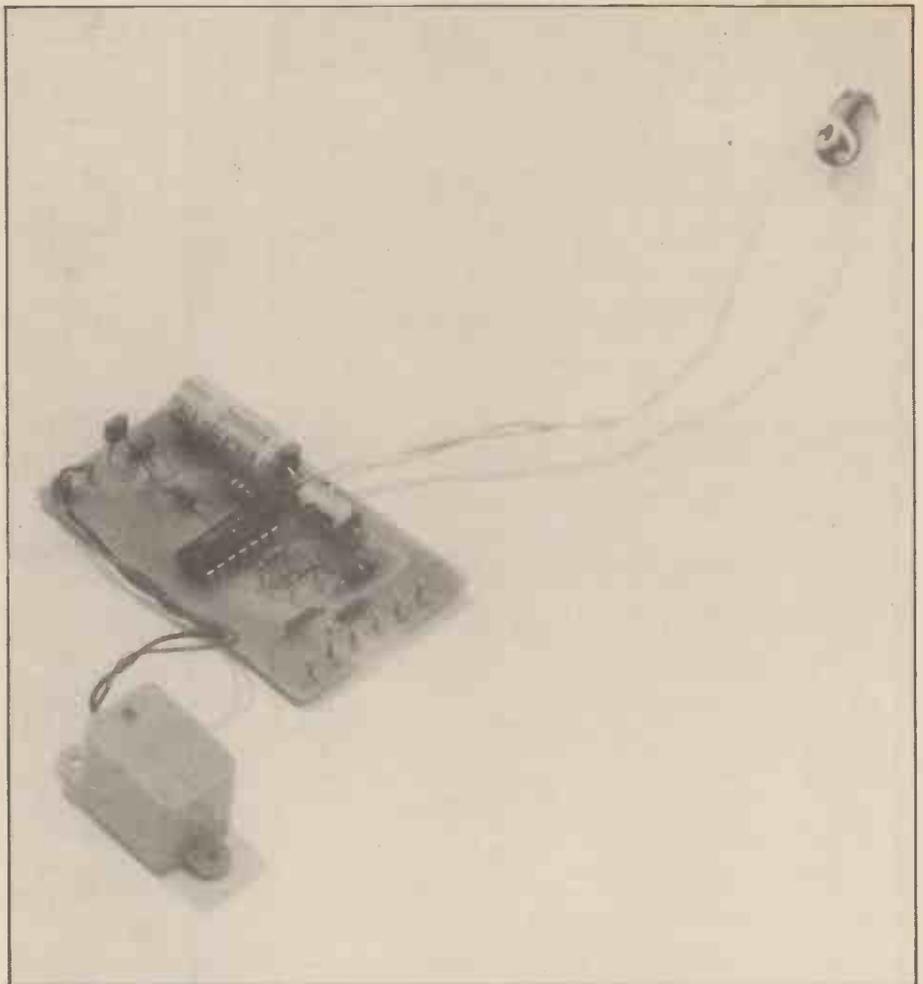
Figure 4. Top, the circuit board and power supply can be conveniently hidden underneath a table top — but make sure the switches are easily accessible (bottom) as well as being hidden.



AWD could be mounted in the loft, where its sounds will readily be heard both inside and outside the house.

Maintenance

A power-on lamp is not provided, since this would consume 25 times as much current as the quiescent circuit, so check the batteries regularly; remember that flat batteries will run the quiescent circuit well enough but may fail to provide enough power for the AWD. The check should include sounding the alarm; check each window and door switch every few months, and also each pressure-mat.

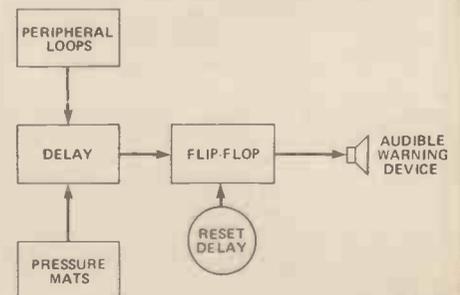


How It Works

THE TWO detecting systems, peripheral loop and pressure mats, provide inputs to the system which are normally high (12 V) but go low (0 V) when an intruder is detected. Since the wiring is many metres long and surrounds a houseful of electrical and electronic appliances, it frequently picks up transient electromagnetic signals. The switching on and off of equipment such as TV sets and refrigerators causes pulses to appear in the wires of detector systems, and these are often strong enough to trigger a flip-flop. The delay circuit filters out all these transients so that the alarm does not sound unless the detector circuit shows a low voltage for about half a second. It is not likely that an intruder could make an entry during so short a time, yet this is long enough for any transient to subside.

The action of the intruder triggers a flip-flop which sets off the alarm. This sounds continuously until the power supply is disconnected or the Reset/Delay button is pressed. Once the button is pressed, the flip-flop is inactive for a period of about 30 seconds. If the peripheral loop is broken during this period, the alarm sounds, but only for as long as the loop is broken. This delay is

essential if you are leaving the house empty, allowing the last person to remain in the house to press the Reset button and quickly leave by the front door. The alarm sounds very briefly as the door is opened and closed, but is silent after that. A few moments later the system becomes activated. On return to the house the alarm sounds but, if the first person in is prepared to act quickly and if the reset button is concealed not too far away from the door (on the inside, of course), it takes less than a second to silence the alarm. The delay operates similarly on the pressure-mat system, so there is no need to jump over the doormat on the way out.



HE

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Greenbank Electronics.
Dept E12H, 92 New Chester Road,
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(Tel: 051-645 3391)

READ THIS IF YOU VALUE YOUR JOB

I am writing to a worried man (or woman). I am writing to you. Are you scared of computers? Well not scared of the computers themselves, but scared of what they can do. Pretty well everywhere at work, on TV, these micro-things are being seen more and more all the time and you seem more and more to be getting left behind.

Do you have colleagues who are always spouting on and on about computers? Do you understand a word of what they're saying? Be honest, do you? Do they understand a word of what they're saying really, or are they just speaking words they've read out of a magazine or heard on T.V.?

What you need is a friend, an honest friend, who will try to help you. I will be your friend, I am your friend. My name is David Parkins, why not write to me or 'phone me? (my number is 051-645 3391).

I said I would be an honest friend so I'll begin now — I work for a firm which sells a computer in kit form, and I would like to sell you one. The name of the computer system is 'Interak 1'. I know you are going to buy a computer kit of some sort very soon, because you just can't let things go on as they are. 'Computing' is a club, and you're not a member yet. Worse still you may have bought a computer and found you still haven't a clue what goes on inside. Miracle chips they may be but it will be a miracle if you can understand what they do by just looking at them.

What I want to sell you is not just the pieces. I want to sell you 'the knowledge'. Then you'll know as much as I do, and you won't need me anymore. All I ask from you is that when you know what computing is really all about, that you treat others in the same way that you would like to be treated. Don't sneer at them because they don't know the difference between PASCAL and BASIC, they don't know what an RS232C interface is, or how a UART works, remember we all have to start somewhere.

Computers are bound to make our lives easier and happier (and richer) if they are used wisely, so it is vital that everyone be introduced to the 'Computer Club' as quickly as possible. Once everyone knows about computers we will be free to continue to make an honest living — at the moment there are all sorts of people who are uncropulously taking money from innocent people by taking advantage of their ignorance, and I for one just don't want to be a part of a business like that. Just read through a few advertisements, and think to yourself how can they all be the best?

When I said I am wanting to sell you 'the knowledge' please don't think I am offering a correspondence course. In my view that's not a suitable way to learn — a course has to proceed in simple logical steps — how an 'AND gate' works, and what is a 'flip-flop' and so on — microcomputers have left all that simple stuff behind long ago and you'll never catch up that way.

Learning computing is a bit like learning to swim, but you've got no time to waste. What I think you need is to be plunged in at the deep end — there's no time for splashing about in the paddling pool learning a bit at a time. But if you're going in at the deep end you'll need a friend to save you from drowning — that's what I'm here for.

Of course it's no swimming in a shallow end, but has to be replaced by the next model annually, before you can enter the water. Down at the shallow end this will cost you about £50 with a further £50 for the necessary RAM (memory). — at the deep end, where you'll find me, the cost is at least double.

I bet you're saying 'some friend this — he's already wanting me to spend twice as much as I thought'. Well it's true, I think you have got to, and here's why. The cheap systems are built down to a price — the 'chip count' (number of integrated circuits where all to be kept right down, preferably to four or five. There are two penalties to be paid. Firstly, no real expansion can be accommodated — the system will go so far then no further, secondly some special design 'tricks' have to be incorporated to make the chips do double duty and get the maximum performance out of the minimum resources. Don't get me wrong — some of the tricks are brilliant but the whole point in your buying a computer is so you can get an understanding yourself, not simply looking as a lump of silicon on (integrated circuit) where all the skill is buried. Once the design is 'encapsulated' in a master integrated circuit there's no way you'll ever find out what's inside unless the designer chooses to tell you, and he's hardly likely to tell you — he might want to use the same idea in the Mk II model next year.

Some people go into this with their 'eyes open' — but I think computing has come to a pretty poor state of affairs if you have to be prepared to throw away a hundred pounds or so on a system which cannot expand with you, but has to be replaced by the next model annually.

I would also say beware of committing the diametrically opposite mistake — a gimmick computer. This is one which is all things to all men. You name it, it's got it. This processor, that processor as an option. Level 1 expands to level 2 which has the optional what not interface which can easily be adapted for this or that.

Do you think the purchase of a computer is going to solve your problems?, of course not, learning is hard work. My computer (Interak 1) is ideal for your purposes I assume that you don't really know much about computers, you've probably got an interest in electronics, and with all the publicity that these micro chips are getting in magazines, TV, radio and newspapers you know that you've got to know all about them. Well I'll let you into a secret and give you some valuable information. There's too much going on for you to learn everything and new information is being created every day at such a rate that the longer you leave it to get started, the harder it will be to catch up.

Ask almost anyone what makes a good computer and they'll describe a monster. I'll show you the way to obtain sufficient knowledge to use computers for your pleasure, your work, and so that you can, if you want to, help others. It's all very well having a computer that has everything, but if you have too much hardware you'll be like the old woman who lived in the shoe — you won't know what to do.

I have a friend who has bought an Interak 1 System. (I say he's a friend but at the moment he thinks he's just a customer) and he's received a parcel, he's opened it and checked that he's got what we think we have sent him and I imagine he's ploughing his way through the manuals (yes one of the problems of being presented with a lot of information is having to read it all — carefully). He's got a lot of work ahead of him. Although he doesn't understand what it's all about, he'll learn from reading the manuals how to assemble the computer from its component parts, and then how to make it work.

I've put a lot of time and effort into this friendship, writing the words, and drawing what I think are helpful diagrams. I'm sure my friend will write to me with his problems and I'm also sure he will be delighted with his computer and any helpful remarks I may make.

I admit some of my answers to his problems may take the form of 'application notes', in fact most of them will, but that's just the way that I hope with helping lots of friends (when I get a letter with a problem or misunderstanding of something I've put in the manual, I write my answer in the form of an application note, then if I'm presented with the same problem again I can quickly give a well thought out answer in an application note with maybe just a covering letter.)

You've got a problem at the moment, you've either got a computer and not been able to learn all you need to know, or you haven't got one yet. Don't just go out and buy the first computer you see, or the biggest or the cheapest, buy the one that will help you to solve your problems. Remember that I'm here to help you, I've got a leaflet/data sheet set, that will probably tell you everything you need to know about my Interak 1 System. Write to me at Greenbank Electronics, using the above address and ask me to send you my Interak 1 leaflet. Now I warn you, there's quite a lot that I'll send you (about 36 sides of A4-size paper), it's type-written, with some hand drawn illustrations of the various kits. Of course it costs quite a bit to send through the post so an A4SAE would be appreciated but as you are my friend, if you don't enclose one I won't mind. By the way I'll probably enclose leaflets on some of the other things that my company sells but as I say to people I speak to, 'if I give you a leaflet you don't want please don't be offended'.

I'm being honest with you, I'm trying to make you into an Interak 1 user, because the more people who have this system, the more people I'll be able to exchange my programs with, and that's important.

You might not think that you are capable of building up a sophisticated computer system from component parts, but you need have no worries on that score. You do of course have to work carefully and patiently, but that's all you have to do. I haven't met anyone yet who was incapable of doing the job. Some people need a bit of help, some people need more help than others, but the way I look at it is that if you can't follow the instructions I have provided then it's my fault not yours. The same applies to testing the completed computer. If you make a board and you can't get it to work, I am here to help you — just pop the board into the post to me, and I'll plug it into my own system and will soon get it going for you.

Even if you don't buy the Interak 1 System then I do urge you to buy some sort of computer as soon as you can. If you have an children this is even more important. Children need computers almost as much as they need food and drink. There never was a more nutritious food for a young mind than a digital computer. Without a preconceived feeling that computers are somehow mystical, children are in a far better position to learn than we mere adults.

So far I have only let you think that the Interak 1 System will cost you money, but there are plenty of ways it will bring money in. Obviously if you have your own business you will know how much time and money a computer will save. And if you have brought yourself up to a standard where you can write your own programs and fix the system yourself (not that it will go wrong, you built it — remember) there won't be any hidden overheads to be paid. Other ways you can make money are writing programs that you can sell, or even writing a book. Don't think that you have to be particularly clever to do this. There may be thousands of people less fortunate than you who will be dying to hear of another's experiences. The last thing they will want will be some high faluting toms written by some lah-di-dah computer buff.

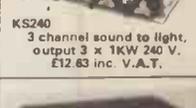
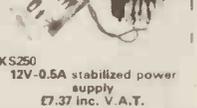
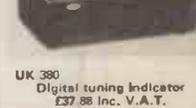
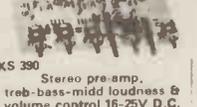
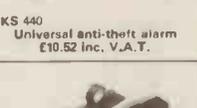
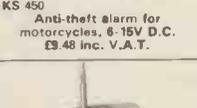
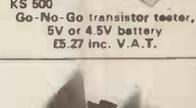
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Lofty

A handy loft-light alarm to build

RETURNING from a weekend away, not so long ago when the weather was still warm, we happened to meet our neighbours from across the street. The evening was balmy, though the light was fading fast as we exchanged pleasantries about the weather and Botham's batting while we unloaded the car; then our neighbour dropped his bombshell. "By the way", he said innocently, "did you know you left a light on in your loft? We can see it from our upstairs window". In fact, we could see it from across the street, shining brightly through narrow chinks between some of the tiles.

That rapidly put an end to the conversation as, feeling foolish, I hurried into the house thinking, as I climbed the ladder, of the electricity bill we were about to receive (without thanks, oh lord); those lights (two 150 watt bulbs) had been burning continuously for at least three weeks!

From that incident, Lofty was born — a simple device that could be connected across the light switch and which would sound an alarm after a preset period, unless the light had been turned off. As finally constructed, Lofty actually has two alarms; a winking LED for visual warning and a two-tone beeper which, although not particularly loud, generates a penetrating tone that will be audible throughout a quiet house.

Another aim, when we designed Lofty, was to keep the size of the unit as small as possible, and to keep the cost low.

For these reasons, we used a novel transformerless power supply. As a result of this design, though, *all parts of the circuit are at mains potential with respect to earth and are therefore possibly lethal to touch. No metallic parts must be exposed when the unit is operational, and particular attention must be taken in the construction to ensure that the unit is effectively insulated.*

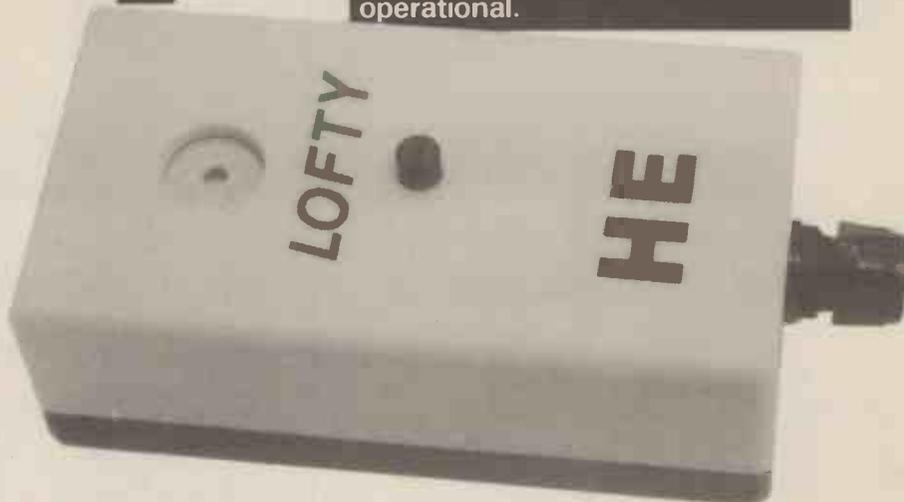
As an added precaution, it should be mounted in an inaccessible position, well out of the way of prying fingers! The method is perfectly safe provided these precautions are taken.

The Circuit

The transformerless power supply is based on C1; this has an impedance of 6k7 ohms at 50 Hz mains frequency. Therefore, the current through it at 240 VAC is 36 mA. Although it is acting as a 'dropping resistor' and is passing a fairly high current, C1 does not dissipate any power; that is, it does not get hot.

CAUTION

The 'Lofty' uses a transformerless power supply and, as a result, all parts of the circuit are at mains potential and are possibly lethal to touch. No metallic parts must be accessible when the unit is operational.



The AC current through C1 is then rectified by the diode bridge, BR1, and charges C2 to a maximum of 15V, determined by ZD1; this is the power rail for most of the circuit. Resistor R1 drops the supply voltage further before it is fed to the internal shunt regulator in IC1, and C3 provides some additional filtering.

IC1 is a ZN1034 precision timer IC made by Ferranti. It contains an oscillator, a 12-bit counter and a regulator circuit. When power is applied to the chip, the counter is reset; 4095 oscillator cycles later, the output at pin 2 goes high.

The time period is determined by the oscillator frequency; the higher the frequency, the longer the time period. The frequency is set by just two components — R2 and C4. The values used here give a period of around 45 minutes, but this can easily be altered, as described later.

While IC1 is still counting, the two sections of IC2, a dual 555 timer, are prevented from operating by the low output from pin 2 of IC1 on their reset inputs, pins 4 and 10. Then, when IC1 times out, its pin 2 goes high and enables both sections of IC2. It is now possible for LED1 to light, since its anode is no longer at OV.

IC2b will oscillate at a frequency of a few kilohertz, but the tone will be modulated from the output from IC1a, which is generating an asymmetrical waveform at 1 or 2 Hz. As well as modulating the output from IC2b, this waveform also causes LED1 to flash on and off. The output from IC2b is fed to the piezo-electric sounder, X1, which generates the audio tone.

Construction

Start by assembling the timer and tone generator components on the PCB; points to watch here are that the ICs

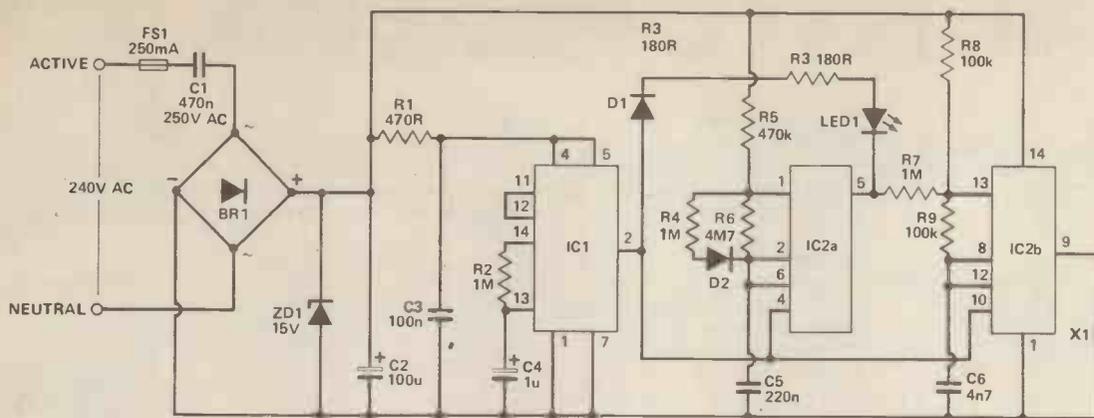
and the tantalum capacitor (C4) are correctly oriented. At this stage, the time period can be changed by altering the values of R2 and C4. The delay, in seconds, is equal to $0.7 \times 4095 \times R2 \times C4$, with R in megohms and C in microfarads; R2 should not be reduced below 10k and C4 must be between 10n and 100u.

Before proceeding with the power supply section (BR1, ZD1 and C2), test the timer and audio beeper by connecting a temporary 12-15 volt supply to the unit. Naturally, you will have to wait 45 minutes (or whatever period you have set) to find out if all is well! If the unit does fail to work for some reason, first carry out the usual checks for solder bridges, dry joints and so on. The operation of IC2 can be checked by first removing IC1, then applying about 3V to the IC1 pin 2 connection. This will enable both sections of IC2 and it should immediately burst into life unless there is a fault present. Testing IC1 will be more difficult, although there is very little that can go wrong here. If you do need to check the IC, it would be best to change R2 and C4 to give a short time delay — 39k and 10n give a one second delay — otherwise fault-finding could take a very long time!

When the timer and audio generator are working, the power supply can be wired up. Before proceeding with this, however, check that the LED is bright enough to be seen. If not, reduce the value of R3, but not below 100R.

Power Supplied

The vital component in the transformerless power supply is C1; this must be rated for 240V/50Hz operation ie, at least 250 VAC, 600 VDC working. When it has been soldered in place, make sure C1 cannot vibrate by tying it down with two cable ties passed



NOTES:
 IC1 IS ZN1034
 IC2 IS 555
 D1,2 ARE 1N4148 OR SIMILAR
 ZD1 IS 15V 1W3 ZENER
 BR1 IS 1A 800V (W08)
 LED1 IS LARGE RED LED (PLASTIC)
 FOR PANEL MOUNTING
 X1 IS PB2720 PIEZO BUZZER

Figure 1. The complete Lofty circuit — note that the mains earth lead is not connected.

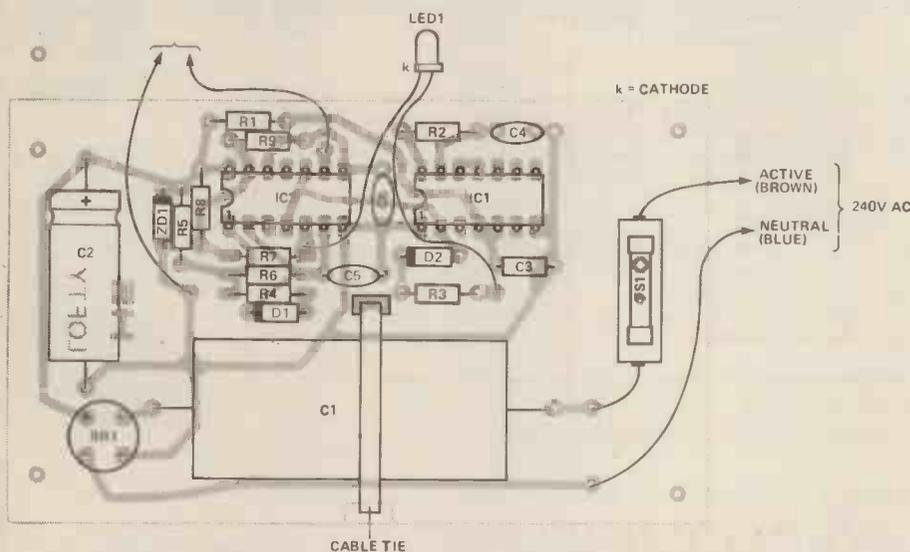


Figure 2. The PCB component overlay. Capacitor C1 takes up most of the board space!

through the holes in the PCB. Next, mount the diode bridge, C2 and the Zener diode, then the fuse, FS1. This is included to protect against the possible failure of C1; if it ever needs to be replaced, remember to *totally disconnect* the 'Lofty' before doing so!

Insulation

The last stage is to mount the piezo transducer and connect it to the appropriate points on the PCB. Use a stout piece of plastic film between X1 and the underside of the case to insulate the diaphragm of the transducer because, as explained earlier, this could be 'live' and thus potentially lethal to touch. Finally, mount the PCB in the case using M3 screws. It is now ready to be wired into the loft light circuit.

Wired Up

The unit should be placed near the loft opening, where it can easily be seen and the sound of the alarm will not be muffled. A length of ordinary two-core lighting flex is connected from the Lofty's mains input to the loft light, so that the unit is turned on with the lights. Forty five minutes later, the alarm will sound. If you are still working in the loft, reset the unit by briefly turning off the lights, initiating another timing period.



Parts List

RESISTORS

(All 1/4 watt 5% carbon)

R1	470R
R2,4,7	1M0
R3	180R
R6	4M7
R8,9	100k

CAPACITORS

(All polycarbonate unless noted)

C1	470n
	250 VAC/600 VDC minimum
C2	1000u
	25 V electrolytic
C3	100n
C4	1u
	35V tantalum
C5	220n
C6	4n7

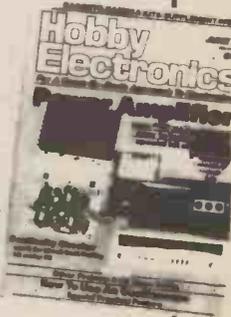
SEMICONDUCTORS

IC1	ZN1034
	precision timer
IC2	555
BR1	W08
	800V, 1A bridge rectifier
ZD1	BZX61C15
	15V, 1.3W Zener diode
D2,3	1N4148
LED1	panel mounting LED
	with plastic (not metal) bezel

MISCELLANEOUS

FS1	250mA
	20 mm fuse
X1	PB2720
	piezo-electric buzzer
	Chassis-type fuse holder; small cable gland; plastic LED bezel; Verobox enclosure (see Buylines); PCB; IC sockets; stout plastic film, 1" x 1"; M3 bolts; cable ties; wire, solder etc.

BUYLINES page 34



BACKNUMBERS

February 1980
Passion Meter, Win Indicator, Short Circuit Special, Kit Review Special, Into Electronics Construction Part 1.

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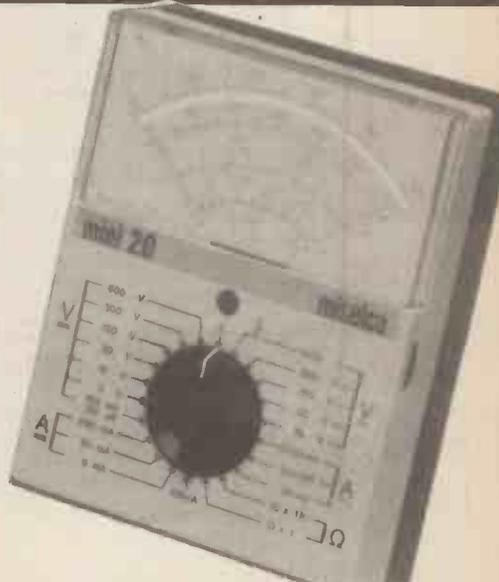
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Big Ear



A high gain, directional microphone, ideal for nature studies.

THIS is one project where the mechanical work is greater than the electronic! The Big Ear consists of an omnidirectional microphone insert mounted in a length of common, garden variety 2½" PVC pipe, and a simple two-stage amplifier circuit. It was originally designed for recording or listening to the sounds of wildlife; however, the prototype has also proved useful as a stethoscope, and for listening in to distant conversations (be warned — the listener may not always like what he hears!)

The length of pipe serves two purposes; first, it acts as a resonant cavity with many resonant frequencies extending from a few hundred Hertz right up to the top of the audio band. Any pipe or tube has a fundamental resonant frequency which is a function of its length, and it is also resonant at overtones (harmonics) of the fundamental frequency. In general, the fundamental frequency, f , of a pipe which is closed at one end is approximately equal to $c/4l$, where l is the length of the pipe and c is the velocity of sound (330 metres per second, for most purposes). Thus the fundamental frequency of a pipe 0.25m long will be at 330 Hz; the overtones produced by a closed pipe occur only at odd harmonics, therefore resonant peaks will also occur at 990 Hz (3f), 1650 Hz (5f), 2310 Hz (7f) and so on. The effect of these resonances is to accentuate any sound at those frequencies, increasing the gain of the system at specific points in the audio spectrum. The length of the

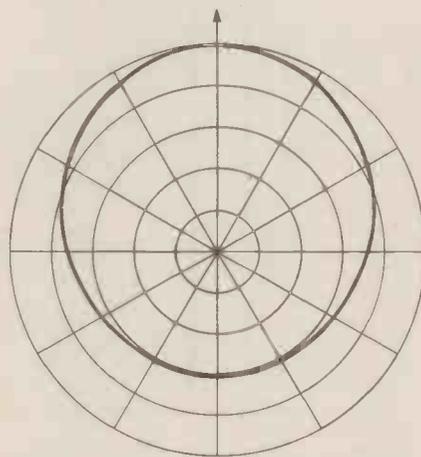


Figure 1. The directional response of the Big Ear.

pipe specified for this project has been arrived at after considerable experiment, and provides good results with minimum undesirable side-effects.

Second, the pipe provides a useful measure of directivity, due to diffraction effects. Diffraction is simply the change in direction of sound when it passes around an obstacle. The degree of bending depends on the ratio of the wavelength of the sound to the size of the obstacle and is greatest when the size of the object approaches the wavelength of the sound. In general, long wavelengths (bass frequencies) bend more easily because few everyday obstacles are more than about one metre long (the wavelength of a 100 Hz note, for example, is about 3.3m). The higher frequencies

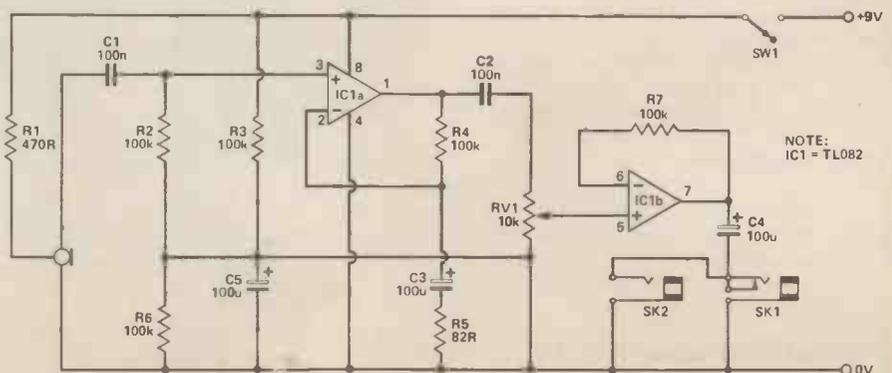


Figure 2. The internal circuitry of the Big Ear.

Parts List

RESISTORS

(All 1/4 watt 5% carbon)

R1 470R
 R2,3,4,6,7 100K
 R5 82R

POTENTIOMETERS

RV1 10K
 log carbon

CAPACITORS

C1,2 100n
 C352 * polyester
 C3,4,5 100u
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SEMICONDUCTORS

IC1 TL082
 dual op-amp

MISCELLANEOUS

SK1 3/4" stereo socket
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 microphone insert; 0.1" Veroboard,
 50 x 38 mm (20 holes x 15 strips);
 slide switch; PP3 battery clip; PVC
 pipe, 254 x 63 mm (10" x 2 1/2");
 wire, solder etc.

BUYLINES page 34

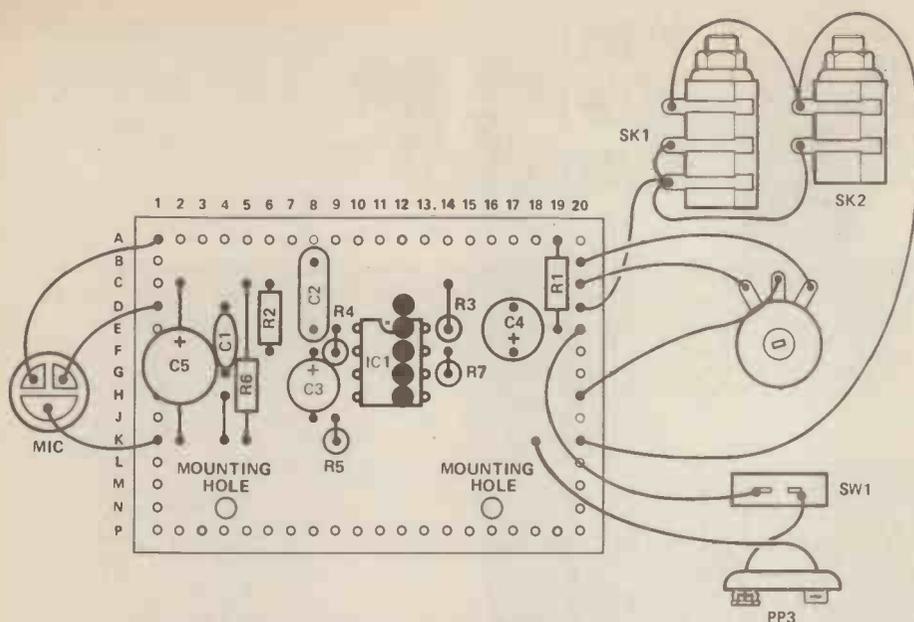
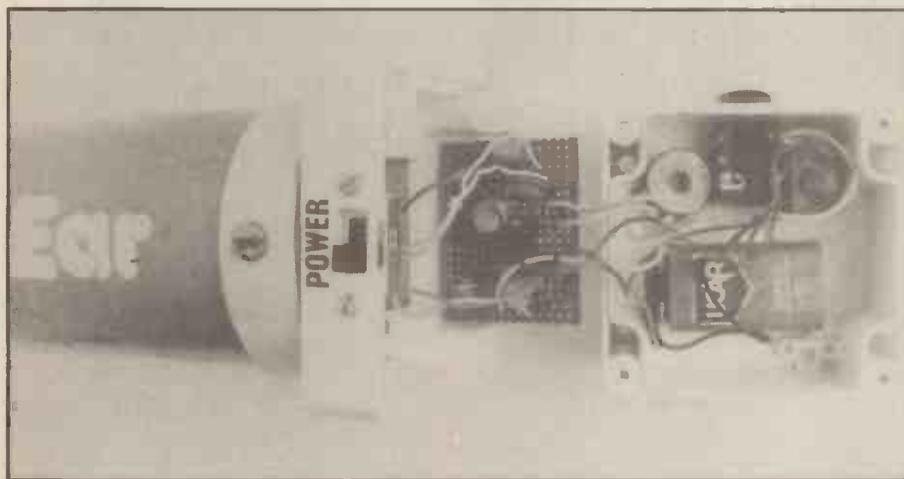


Figure 3. The project is simple enough to build on Veroboard. The diagram shows the component layout and the track cuts viewed from the top.



bend less easily and therefore are more directional, since they are reflected by common-sized obstacles rather than bending around them.

In the Big Ear, the pipe tends to 'hear' only those mid-range and high frequency sounds coming from directly in front, whereas sounds from the sides or rear will be rejected because they cannot bend around the edges of the opening. At low frequencies, however, the tube has no effect and so the response of the system reverts to that of the microphone insert, ie omnidirectional. To prevent these frequencies from being transmitted through to the output, the response of the amplifier is rolled off at the bass end. Overall, this combination of techniques gives a back-to-front ratio of 2:1 (see Figure 1).

The Big Ear is designed to be handheld, and for this purpose, a standard 2 1/2" pipe clip serves quite well as a handle in normal use; it will also do as a tripod mount, should that be required.

The amplifier section has two outputs: a headphone socket for monitoring purposes and a 1/4 jack

socket for connection to the line input of a tape recorder.

The Circuit.

The circuit (Figure 2) consists of two op-amps contained in a single TL082 IC package. The circuit can be split into two sections: a voltage amplifier and an output buffer.

Starting at the input (where else?), notice that the microphone has three connections to it. This is because it is an electret insert which contains a FET preamplifier to provide a low impedance drive from the high impedance microphone source. Thus, it must be connected to the supply rail via R1.

The input from the mic is fed to the non-inverting (-ve) input of IC1a. The value of the coupling capacitor, C1, is chosen to filter out the very low frequencies generated by handling the unit. Otherwise, these would create low rumbling sounds which would seriously interfere with the performance, especially at high gain settings! The voltage gain of this stage, set by the ratio of the values of R4 and R5, is x1000.

The Big Ear was intended to be

portable, and therefore a dual supply system, positive and negative rails, was not suitable because of the extra battery requirements. Instead, a half-supply voltage reference is created by the resistive divider network R3 and R6. The junction of the two resistors is bypassed to OV by C3 to remove any noise from the signal.

The full gain of the first stage is not always required (the results could be ear-splitting), so the output from IC1a is coupled to the buffer stage, IC1b, via a volume control, RV1; coupling capacitor C2 is chosen to roll-off the bass response. IC1b is set-up as a unity gain amplifier; its output is at a low impedance and is sufficient to drive an ordinary set of headphones or the input circuit of a tape recorder, via socket SK1. Blocking capacitor C4 is included to prevent the DC level at the output of IC1b from reaching the load.

Construction

As the circuit is so simple, it was decided to build it on Veroboard; the usual precautions concerning layout, track cuts and solder bridges apply! Pay particular attention to the correct orientation of the electrolytic capacitors and the IC.

When the board is assembled, attach flying leads about 9" long to each of the off-board connection points. Next comes the mechanical assembly.

Mark out and drill the mounting holes as shown in Figure 4. These are easily made — but the slot for the slide-switch will cause greater problems! Carefully drill 1/4" holes at each

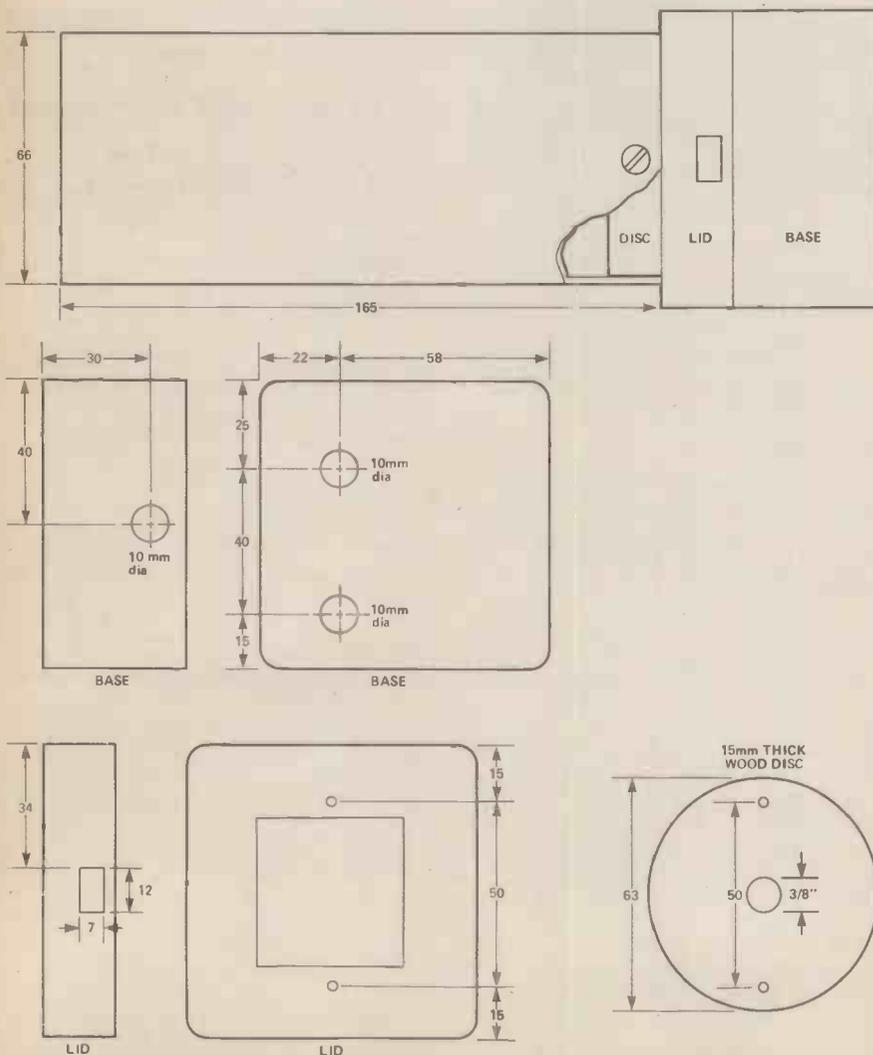
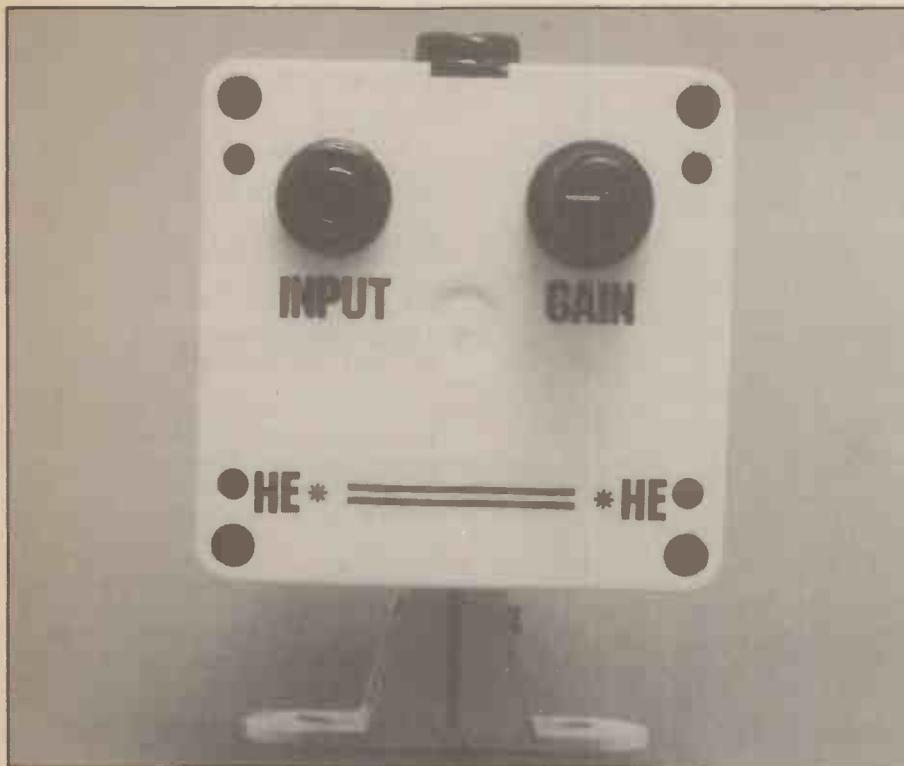


Figure 4. The mechanical details.

end of the slot, then file it to shape. A small flat file will be useful for finishing the task. Although the box cut-out for the microphone is shown as a square, this can be drilled out to 3/8" clearance, the size of the microphone insert.

Lastly, the wooden disc which holds the mic insert, and to which the length of 2 1/2" pipe attaches, must be cut out; the dimensions are shown in Figure 4. Preferably, the disc should be cut from a solid piece of wood; the pipe is held by screws into the sides of the disc, and chipboard has a tendency to fall apart if used in this fashion.

After the parts have been made, the Big Ear can be assembled. Mount the sockets, potentiometer and Veroboard; the mic insert should be a tight fit in the 3/8" hole through the centre of the wooden disc; glue it if you must, but the arrangement then becomes somewhat permanent! The disc itself is attached to the box by two small self-tapping screws, and the pipe can then be screwed onto the disc with three or four self-tappers. Finally, the flying leads should be connected as shown in Figure 3; the battery should be fixed to the base of the box with a piece of double-sided tape or Blu Tack, to prevent it rattling around inside.

At this point, the Big Ear is ready to use. Switch on and try it. There will be silence for a couple of seconds, then it should burst into life.

Why Not Experiment?

Although the final form of the Big Ear was arrived at after a considerable period of trial-and-error experiment, there are several other methods which could be used to improve the directional response.

The most effective would be to replace the omnidirectional mic insert with a directional type; however, these do not seem to be readily available and can probably only be had by dismantling a cheap directional electret mic of the type usually sold with cassette recorders.

The next most important factor determining the directivity is the aperture of the pipe; decreasing the diameter will increase the directional response to high frequencies, at the expense of less directivity at lower frequencies. Another trick is to form many small resonant cavities, rather than one large one, by filling the pipe with ordinary plastic drinking straws; the overall response can be 'tuned' by cutting the straws to different lengths. The directional response can also be improved by isolating the mic insert from the case and pipe, as some of the sound from the sides and rear will otherwise be conducted through the solid material to the microphone.

Finally, there are alternatives to the resonant tube system; one method worth trying is to use a parabolic or dish reflector; a simple plastic bowl would be adequate!



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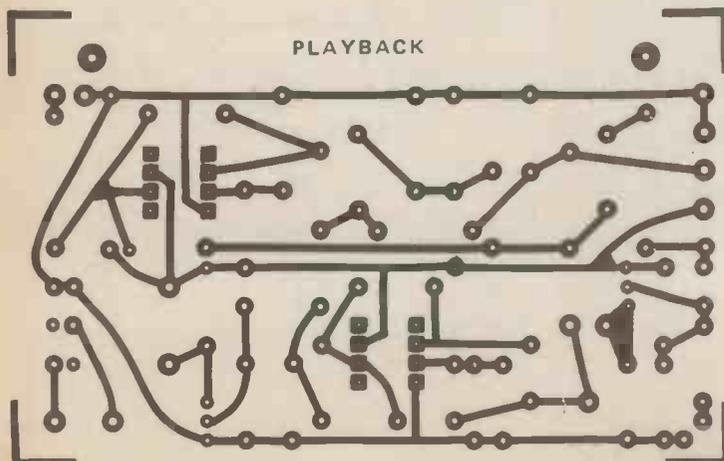
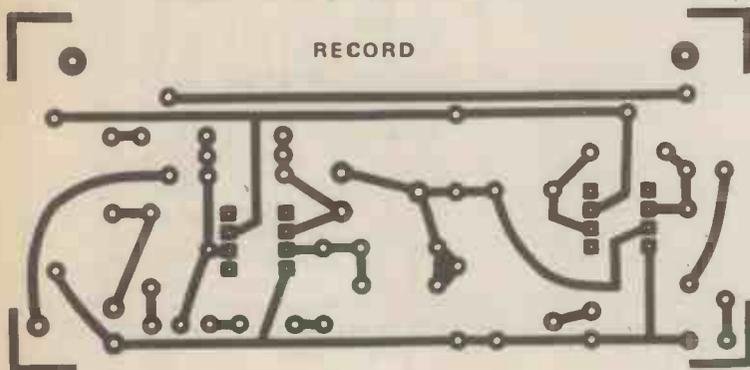
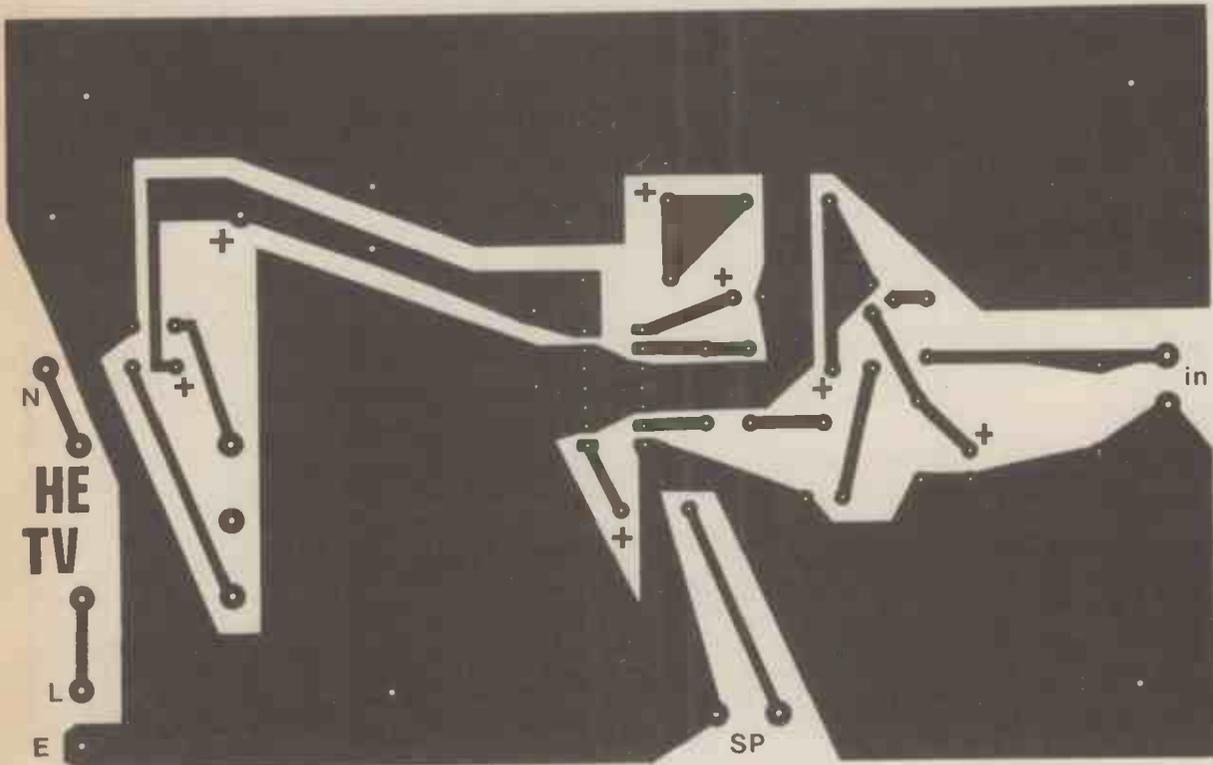
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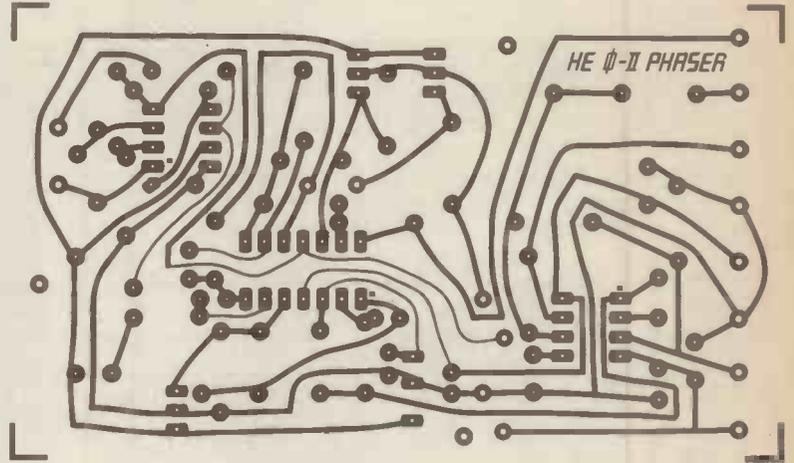
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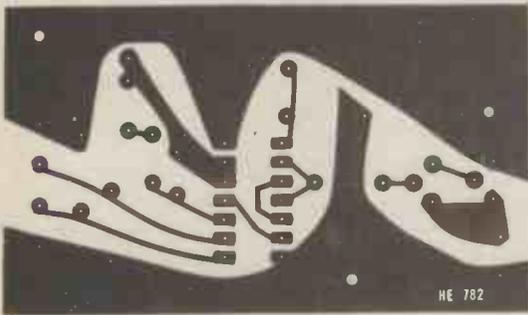


Left: Both PCB patterns for the Tape/Slide Synchroniser; top, the Recording board; bottom, the Playback board.

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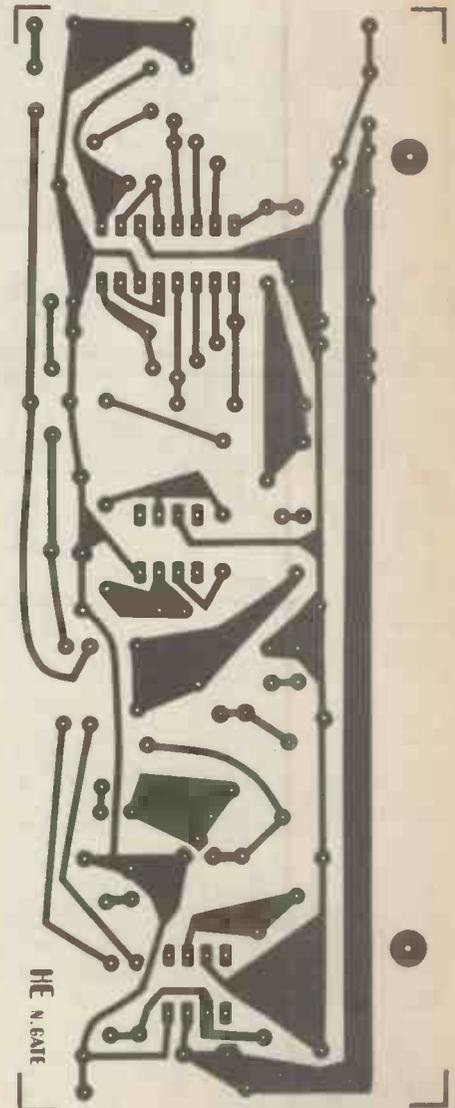


Right: The HE Phase Four PCB



The Stereo Noise Gate PCB pattern (right). Note that there are only two mounting holes.

Left: The PCB foil pattern for the Low Cost Alarm. The three large holes are for mounting bolts.



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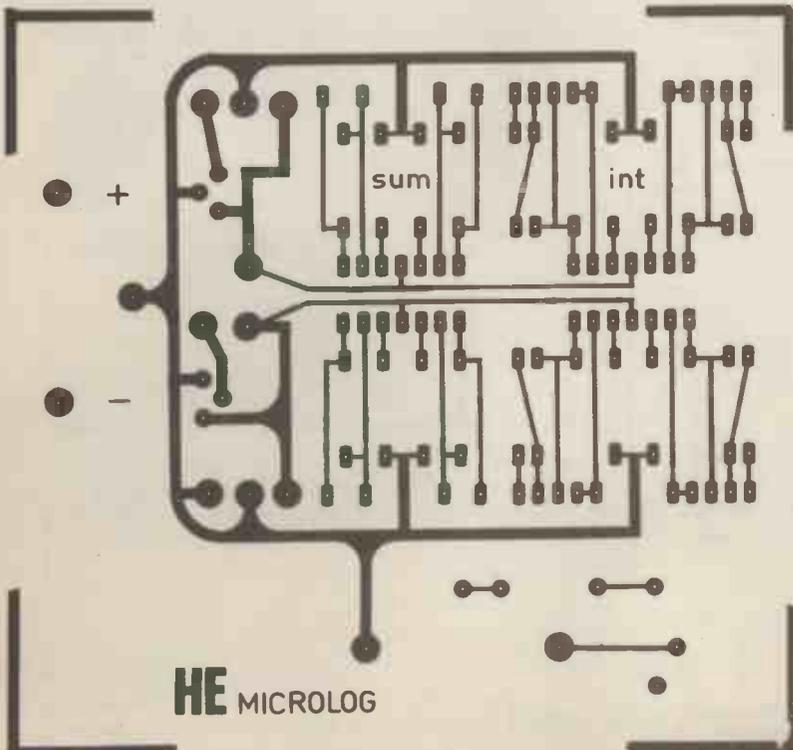


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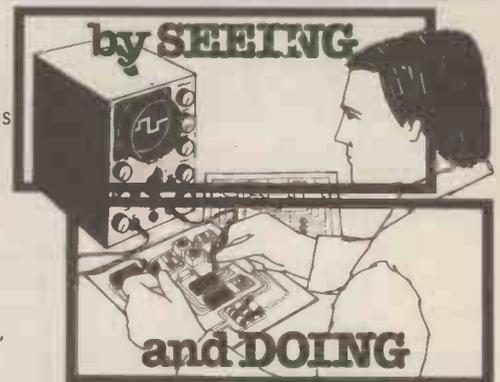
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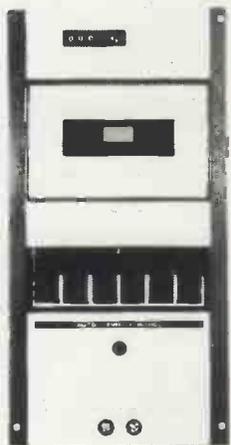
New 5" 30 watt mini version of above now available. Recommended cabinet size 180 x 155 x 295mm

Price £13.90 + £1.00 p&p per kit.

STEREO CASSETTE TAPE DECK MODULE. Comprising of a top panel and tape mechanism coupled to a record/play back printed board assembly. Supplied as one complete unit for horizontal installation into cabinet or console of own choice. These units are brand new, ready built and tested.

Features: Three digit tape counter. Auto-stop. Six piano type keys, record, rewind, fast forward, play, stop and eject. Automatic record level control. Main inputs plus secondary inputs for stereo microphones. **Input Sensitivity:** 100mV to 2V **Input Impedance:** 68K. **Output level:** 400mV to both left and right hand channels. **Output Impedance:** 10K. **Signal to noise ratio:** 45dB. **Wow and flutter:** 0.1%. **Power Supply requirements:** 18V DC at 300mA. **Connections:** The left and right hand stereo inputs and outputs are via individual screened leads, all terminated with phono plugs (phono sockets provided). **Dimensions:** Top panel 5 1/2" x 11 1/4". Clearance required under top panel 2 1/2". Supplied complete with circuit diagram and connecting diagram. Attractive black and silver finish.

Price £26.70 + £2.50 postage and packing. Supplementary parts for 18V D.C. power supply (transformer, bridge rectifier and smoothing capacitor) £3.50.



6 piano type keys

NEW RANGE QUALITY POWER LOUD-SPEAKERS (15", 12" and 8"). These loudspeakers are ideal for both hi-fi and disco applications. Both the 12" and 15" units have heavy duty die-cast chassis and aluminium centre domes. All three units have white speaker cones and are fitted with attractive cast aluminium (ground finish) fixing escutcheons. **Specification and Price:**

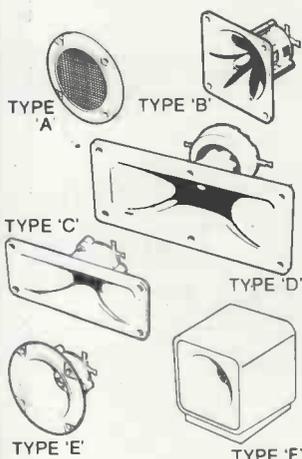
15" 100 watt R.M.S. Impedance 8ohm 59 oz. magnet, 2" aluminium voice coil. Resonant Frequency 20Hz. Frequency Response to 2.5KHz. Sensitivity 97dB. Price £32 each £3.00 Packing and Carriage each.

12" 100 watt R.M.S. Impedance 8 ohm, 50 oz magnet, 2" aluminium voice coil. Resonant Frequency 25Hz. Frequency Response to 4KHz. Sensitivity 95dB. Price £23.70 each. £3.00 Packing and Carriage each.

8" 50 watt R.M.S. Impedance 8 ohms, 20 oz. 1 1/2" aluminium voice coil, Resonant Frequency 40Hz, Frequency Response to 6KHz. Sensitivity 92dB. Also available with black cone fitted with black metal protective grill. Price: White cone £8.90 each. Black cone/grill £9.50 each. P & P £1.25 each.

PIEZO ELECTRIC TWEETERS - MOTOROLA

Join the Piezo revolution. The low dynamic mass (no voice coil) of a Piezo tweeter produces an improved transient response with a lower distortion level than ordinary dynamic tweeters. As a crossover is not required these units can be added to existing speaker systems of up to 100 watts (more if 2 put in series). **FREE EXPLANATORY LEAFLETS SUPPLIED WITH EACH TWEETER.**



TYPE 'A' (KSN2036A) 3" round with protective wire mesh, ideal for bookshelf and medium sized Hi-Fi speakers. Price £3.45 each.

TYPE 'B' (KSN1005A) 3 1/2" super horn. For general purpose speakers, disco and P.A. systems etc. Price £4.35 each.

TYPE 'C' (KSN6016A) 2" - 5" wide dispersion horn. For quality Hi-Fi systems and quality discos etc. Price £5.45 each.

TYPE 'D' (KSN1025A) 2" x 6" wide dispersion horn. Upper frequency response retained extending down to mid range (2KHz). Suitable for high quality Hi-Fi systems and quality discos. Price £6.90 each.

TYPE 'E' (KSN1038A) 3 1/2" horn tweeter with attractive silver finish trim. Suitable for Hi-Fi monitor systems etc. Price £4.35 each.

TYPE 'F' (KSN1057A) Cased version of type 'E'. Free standing satellite tweeter. Perfect add on tweeter for conventional loudspeaker systems. Price £10.75 each.

U.K. post free for SAE for Piezo leaflets.



1000 MONO DISCO MIXER

A superb fully built and tested mixer/pre-amp with integral power supply. 4 Inputs 2 turntables (ceramic cartridge). Aux. for tape deck etc., plus Mic. with override switch, all with individual level controls. Two sets of active tone controls (bass and treble) for Mic. and main inputs. Master volume control. Monitor output with select switch and volume control.

Outputs Main 750 mV Monitor 500 mV into 8 ohms. Supply 220/240V AC50/60Hz Size 22 1/2" x 4 1/2" x 2 1/2" price £39.99 + £2.50 P&P

1K.WATT SLIDE DIMMER



- Controls loads up to 1KW
- Compact size
- 4 1/4" x 1 3/8" x 2 1/2" 16
- Easy snap in fixing through panel/cabinet cut out
- Insulated plastic case
- Full wave control using 8amp triac
- Conforms to BS800
- Suitable for both resistance and inductive loads

Innumerable applications in industry, the home, and discos/theatres etc.

Price: £11.70 each + 50p P&P (Any quantity)

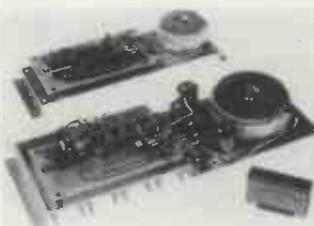
BSR P256 TURNTABLE

P256 turntable chassis • S shaped tone arm • Belt driven • Aluminium platter • Precision calibrated counter balance • Anti-skate (bias device) • Damped cueing lever • 240 volt AC operation (Hz) • Cut-out template supplied • Completely manual arm. This deck has a completely manual arm and is designed primarily for disco and studio use where all the advantages of a manual arm are required.

Price: £28.50 + £2.50 P&P



POWER AMPLIFIER MODULES



100 WATT R.M.S. AND 300 WATT R.M.S. MODULES

Power Amplifier Modules with Integral toroidal transformer power supply, and heat sink. Supplied as one complete built and tested unit. Can be fitted in minutes. An LED Vu meter is available as an optional extra.

SPECIFICATION:
Max Output Power: 110 watts R.M.S. (OMP 100) 310 watts R.M.S. (OMP 300)
Loads: Open and short circuit proof 4-16 ohms.
Frequency Response: 20Hz - 25KHz ±3dB.
Sensitivity for Max. Output: 500mV at 10K (OMP 100) 1V at 10K (OMP 300)
T.H.D.: Less than 0.1%
Supply: 240V 50Hz
Sizes: OMP 100 360 x 115 x 72mm
OMP 300 450 x 153 x 66mm
Prices: OMP 100 £31.50 each + £2.00 P&P
OMP 300 £89.00 each + £3.00 P&P
Vu Meter £8.50 each + 50p P&P

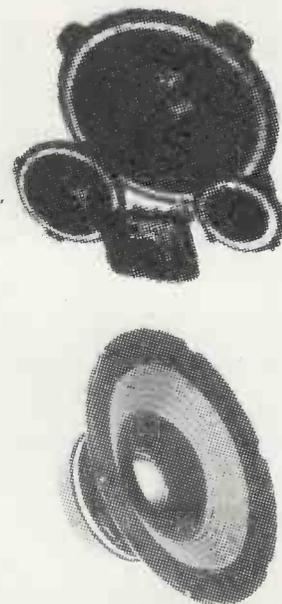
Matching 3-way loudspeakers and crossover

Build a quality 60watt RMS system 8ohms
Build a quality 60 watt R.M.S. system.

- ★ 10" Woofer 35Hz-4.5KHz
- ★ 3" Tweeter 2.5KHz-19KHz
- ★ 5" Mid Range 600Hz-8KHz
- ★ 3-way crossover 6dB/oct 1.3 and 6KHz

Recommended Cab-size 26" x 13" x 13"
Fitted with attractive cast aluminium fixing escutcheons and mesh protective grills which are removable enabling a unique choice of cabinet styling. Can be mounted directly on to baffle with or without conventional speaker fabrics. All three units have aluminium centre domes and rolled foam surround. Crossover combines spring loaded loudspeaker terminals and recessed mounting panel.
Price £22.00 per kit + £2.50 postage and packing. Available separately, prices on request.

12" 80 watt R.M.S. loudspeaker.
A superb general purpose twin cone loudspeaker. 50 oz magnet, 2 aluminium voice coil. Rolled surround. Resonant frequency 25Hz. Frequency response to 13KHz. Sensitivity 95dB. Impedance 8ohm. Attractive blue cone with aluminium centre dome.
Price £17.99 each + £3.00 P&P.



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MEMBRANE KEYBOARDS manufactured from a tough polycarbonate film mounted on 1mm glass fibre printed circuit board assembly incorporating silver plated contacts.
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Size: 100mm x 100mm x 2mm Price: £5.99 + 35p p&p
Alpha Numeric Keyboard Full size 55 key non encoded keyboard with the commonly required functions in a Qwerty array. Matrix output via a 16 pin DIL socket.
Size: 350mm x 100mm x 2mm Price: £13.99 + 50p p&p

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We at Silica Shop are pleased to announce some fantastic reductions in the prices of the Atari 400/800 personal computers. We believe that the Atari at its new price will become the U.K.'s most popular personal computer and have therefore set up the Silica Atari Users Club. This club already has a library of over 500 programs and with your purchase of a 400 or 800 computer we will give you the first 100 free of charge. There are also over 350 professionally written games and utility programs, some are listed below. Complete the reply coupon and we'll send you full details. Alternatively give us a ring on 01-301 1111 or 01-309 1111.

ATARI 400 with 16K	£199
ATARI 400 with 32K	£248
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400/800 SOFTWARE & PERIPHERALS

Don't buy a T.V. game! Buy an Atari 400 personal computer and a game cartridge and that's all you'll need. Later on you can buy the Basic Programming cartridge (£35) and try your hand at programming using the easy to learn BASIC language. Or if you are interested in business applications, you can buy the Atari 800 + Disk Drive + Printer together with a selection of business packages.

Silica Shop have put together a full catalogue and price list giving details of all the peripherals as well as the extensive range of software that is now available for the Atari 400/800. The Atari is now one of the best supported personal computers. Send NOW for Silica Shop's catalogue and price list as well as details on our users club.

THE FOLLOWING IS JUST A SMALL SELECTION FROM THE RANGE OF ITEMS AVAILABLE:

ACCESSORIES Cables Cassettes Diskettes Joysticks Le Stick - Joystick Misc Supplies Paddles	Mountain Shoot Rearguard Star Flite Sunday Golf	BUSINESS Calculator Database Managemt Decision Maker Graph-It Invoicing Librarian Mort & Loan Anal Nominal Ledger Payroll Personal Finl Mgmt Purchase Ledger Sales Ledger Statistics 1 Stock Control Teletink 1 Visicalc Weekly Planner Word Processor	DYNACOMP Alpha Fighter Chompelo Crystals Forest Fire Intruder Alert Monarch Moonprobe Moving Maze Nominoes Jigsaw Rings of The Emp Space Tilt Space Trap Stud Poker Triple Blockade	Maths-Tac-Toe Metric & Prob Solvg Mugwump Music Terms/Notarn Musical Computer My First Alphabet Number Blast Polycalc Presidents Of U.S. Quiz Master Starware Stereo 3D Graphics Three R Math Sys Video Math Flash Wordmaker	Scram States & Capitals Touch Typing	Castle Centurion Checker King Chinese Puzzle Codecracker Comedy Diskette Dice Poker Dog Daze Domination Downhill Eastern Front Galahad & Holy Grl Graphics/Sound Jax-O Jukebox Lookahead Memory Match Midas Touch Minotaur Outlaw/Mowitz Preschool Games Pro Bowling Pushover Rabbotz Reversi II Salmon Run 747 Landing Simul Seven Card Stud	Sleazy Adventure Solitaire Space Chase Space Trek Sultans Palace Tact Trek Tarry Wizards Gold Wizards Revenge	Jawbreaker Mission Asteroid Mouskattack Threshold Unvssrs/Golden Fl Wizard & Princess Terry Dog Daze Domination Downhill Eastern Front Galahad & Holy Grl Graphics/Sound Jax-O Jukebox Lookahead Memory Match Midas Touch Minotaur Outlaw/Mowitz Preschool Games Pro Bowling Pushover Rabbotz Reversi II Salmon Run 747 Landing Simul Seven Card Stud	PROGRAMMING AIDS from Atari Assembler Editor Dsembler (APX) Microsoft Basic Pascal (APX) Pilot (Consumer) Pilot (Educator) Programming Kit Disk Drive Epson Printers Program Recorder RS232 Interface Thermal Printer 16K Memory RAM 32K Memory RAM	PERIPHERALS Centronics Printers Epson Printers Program Recorder RS232 Interface Thermal Printer 16K Memory RAM 32K Memory RAM	ENTERTAINMENT from ATARI Asteroids Basketball Blackjack Centopede Chess Entertainment Kit Missile Command Pac Man Space Invaders Star Raiders Super Breakout Video Easel	PERSONAL INT from APX Adv Music System Banner Generator Blackjack Tutor Going To The Dogs Keyboard Organ Morse Code Tutor Personal Fitness Prg Player Piano Sketchpad	SANTA CRUZ Basics of Animation Bots Business Display Lists Graphics Machine Kids 1 & 2 Horizontal Scrolling Master Memory Map Mini Word Processor Page Flipping Player Missile Gr Player Piano Sounds Vertical Scrolling	SILICA CLUB Over 500 programs write for details
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