Australia $1.75 New Zealand $1.95 Malaysia $4.95

PRACTICAL

AUGUST 1985 · £1·00

ELECTRONICS

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Semiconductor Circuits - Universal Timer

Computer Envelope Shaper

Automatic Fish Feeder

MODEMS - Getting started

SAVE EVEN MORE!

THE PRACTICAL ELECTRONICS FILM SERVICE

So many satisfied customers have been delighted with this award-winning film service that the economies made are now being passed on to you in the form of substantial price reductions. You can now save up to 75p on last year's prices. For 36 successful Superprints you pay only £2.95 inc. VAT. Compare this with last year's £3.70 and with the prices in the shops. Postage and packing is 30p extra as before. Here is the new price range—and remember, Superprints give you 30 per cent more picture area than standard prints at no extra charge.

No. of Superprints	Price (inc. VAT)	
12-15	£1.65	PLUS P/P 30p extra
24	£2.20	
36	£2.95	

RELIABILITY AND QUALITY

All our colour prints are made on Kodak Luxury Lustre paper. Prints have square corners and are borderless to give you maximum picture area. All prints are checked at every processing stage for accurate colour reproduction in a laboratory which is the winner of five recent successive Kodak Gold Awards for Quality. No other processing laboratory has been able to match this record. After allowing for postal and peak-period delays, you should normally expect your prints after seven to ten days.

ALL YOU HAVE TO DO

Send any make of colour print film together with your cheque or postal order inside the Freepost envelope enclosed with this issue. Or fill in the coupon below and send together with your film and remittance in a strong envelope to: Practical Electronics Film Service, FREEPOST, Watford WD1 8FP. Half-frame films are welcome, and these are charged at double the full-frame price.

PERSONALISED SERVICE

Readers know we care for their prints. If you have any queries, contact our service's ten-line switchboard: (01) 953 9911.

SPECIAL FILM OFFER

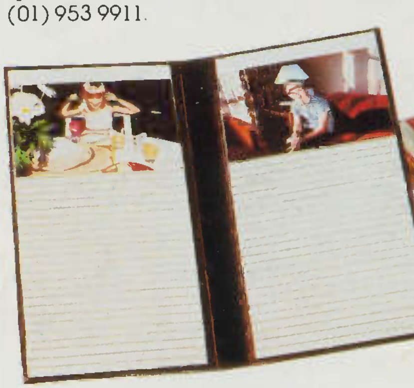
Films from the high-resolution emulsion 'ColorFast' range are available to all readers at highly competitive prices. And when you order three, you get another FREE.

110/24, 126/24, 135/24 £1.40 each OR 4 for price of 3—£4.20. Konica disc £1.60 OR 4 for price of 3—£4.80. 135/36 £1.80 OR 4 for price of 3—£5.40.

SPECIAL ALBUM OFFER

An attractive flip-type album, padded in black with gold embossing and holding 100 Supersize prints (in the shops £5.75) is offered to readers for only £3.99 inc. p&p.

All prices are correct at the time of going to press and are for UK readers only.



Approx. sizes of Superprints: 6"x4" (35mm) 5¼"x4" (110, Disc and 135 Half Frame) 4"x4" (126).

USE THIS LABEL IF YOU HAVE NO ENVELOPE, OR PASS TO A FRIEND.

To: Practical Electronics Film Service, FREEPOST, Watford WD1 8FP.

From: Practical Electronics Film Service, FREEPOST, Watford WD1 8FP.

Name__________

Address__________

Post Code__________

*Print my enclosed film _____

*Rush me_____of 110/24,_____of 126/24,

_____of 135/24,_____of 135/36,_____of Disc/15 film_____

*Rush me_____album(s)

for which I enclose cheque/PO payable to Practical Electronics Film Service. £_____

PES

UNLESS YOU MAKE PRIOR ARRANGEMENTS WITH US we will only accept your film on the strict understanding that our liability in the case of loss or damage will not exceed the replacement cost of the unexposed film and the processing charges paid. NO CREDITS GIVEN FOR FAILURE PRINTS. This offer is limited to the U.K. Choice of materials at our discretion. The Practical Electronics Film Service is operated in association with MFS Photographic Ltd., registered England 1835748. Registered Office: Stirling Way, Borehamwood, Herts. WD6 2AZ. Offer expires 31/3/86.

PE ROBOTICS MICROS ELECTRONICS INTERFACING

ISSN 0032-6372

VOLUME 21 Nº8 AUGUST 1985

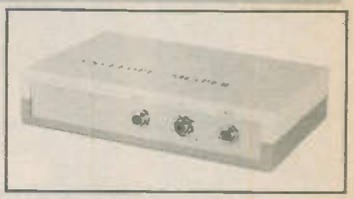
CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

NEWS & COMMENT

This month's cover is a photographic abstract of various components supplied by Mullard Ltd.

CALLING CLIFFORD HONES
The Editor would very much like to contact Mr Clifford Hones (Harlow) who was pictured in the first issue of PE (Nov '64) at the age of 13 receiving a prize from Harry Secombe.



OUR SEPTEMBER ISSUE WILL BE ON SALE FRIDAY, AUGUST 2nd, 1985 ***(see page 33)***

WATFORD ELECTRONICS

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VAT Export orders no VAT. U.K. customers please add 15% VAT to total cost incl. p&p. We stock thousands more items. It pays to visit us. Nearest underground/British Rail Station: Watford High Street. Open Monday to Saturday, 9.00am to 6.00pm. Ample FREE Car parking.

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

ELECTROLYTIC CAPACITORS (Values in µF). **500V:** 10µF **52p;** 47 **78p;** **63V:** 0·47, 1·0, 1·5, 2·2, 3·3, **8p;** 4·7 **9p;** 10 **10p;** 15, 22 **12p;** 33 **15p;** 47 **12p;** 68 **18p;** 100 **19p;** 220 **26p;** 1000 **70p;** 2200 **99p;** **50V:** 68 **20p;** 100 **17p;** 220 **24p;** **40V:** 6·8 **15p;** 22 **9p;** 33 **12p;** 330, 470 **32p;** 1000 **48p;** 2200 **90p;** **25V:** 4·7, 10, 22, 47 **8p;** 100 **11p;** 150 **12p;** 220 **15p;** 330 **22p;** 470 **25p;** 680, 1000 **34p;** 1500 **42p;** 2200 **50p;** 3300 **76p;** 4700 **92p;** **16V:** 2·5, 40 **8p;** 47, 68, 100 **9p;** 125 **12p;** 220 **13p;** 330 **16p;** 470 **20p;** 680 **34p;** 1000 **27p;** 1500 **31p;** 2200 **36p;** 4700 **79p.**

TAG-END TYPE: 64V: 4700 **245p;** 3300 **145p;** 2200 **120p;** **50V:** 3300 **155p;** 2200 **95p;** **40V:** 4700 **160p;** 2200 **70p;** 3300 **85p;** 4000, 4700 **75p;** 10,000 **250p;** 15,000 **270p;** **18V:** 2200 **200p;** **25V:** 4700 **98p;** 10,000 **320p;** 15,000 **345p.**

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

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

SIEMENS mulitlayer miniature capacitors.
250V: 1nF, 1n5, 2n2, 3n3, 4n7, 6n8, 8n2, 10n, 15n, 22n **7p;** 18n, 27n, 33n, 47n **8p;** 39n, 56n, 68n **9p,** 100nF **11p.**
100V: 100n, 120n, **10p;** 150n **11p;** 220n **13p;** 330n **18p;** 470n **23p;** 680n **30p;** 1MF **34p;** 2M2 **50p.**

POTENTIOMETERS: Carbon Track, 0·25W Log & Linear Values.

500W, 1K & 2K (LIN ONLY) Single	**35p**
5KΩ-2MΩ single gang	**35p**
5KΩ-2MΩ single gang D/P switch	**95p**
5KΩ-2MΩ dual gang stereo	**99p**

SLIDER POTENTIOMETERS
0·25W log and linear values 60mm track

5KΩ-500KΩ Single gang	**80p**

PRESET POTENTIOMETERS

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

RESISTORS Hi-stab, Miniature, 5% Carbon.

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

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

POLYSTYRENE Caps:

10pF to 1nF	**8p**
1n5 to 12nF	**10p**

RESISTORS S.I.L. Package: 7 Commoned, 100Ω, 470Ω, 680Ω, 1K, 2K2, 4K7, 10K, 47K, 100K **24p.**
8 Commoned: (9 pins) 150Ω, 180Ω, 270Ω, 330Ω, 330Ω, 1K, 2K2, 4K7, 6K8, 10K, 22K, 47K, 100K **26p.**

TRANSISTORS

AC127/8	35	BC308B	16
AC141/2	35	BC327/8	15
AC176	35	BC337/8	15
AC187/8	35	BC441	34
AC188	35	BC461	34
AD142	120	BC477/8	40
AD149	79	BC516/7	40
AD161/2	42	BC547/8	12
AF118	95	BC549C	15
AF139	40	BC556/7	15
AF239	55	BC558/9	15
BC107/8	12	BCY41/42	30
BC107B	14	BCY70	18
BC108B	14	BCY71	20
BC108C	14	BCY72	25
BC109	12	BCY78	30
BC109B	14	BD131/2	65
BC109C	14	BD133	60
BC114/5	30	BD135	45
BC117/8	25	BD136/7	40
BC140	38	BD138/9	40
BC142/3	38	BD140	40
BC147/8	12	BD158	68
BC147B	15	BD245	65
BC148C	10	BD434	70
BC149	12	BD695A	150
BC149C	15	BD696A	150
BC153/4	30	BF115	45
BC157/8	12	BF154/8	30
BC159	11	BF167	35
BC167A	14	BF173	35
BC168C	12	BF177	35
BC169C	12	BF178	35
BC171/2	12	BF179	40
BC173	15	BF194/5	12
BC177/8	16	BF198/9	18
BC179/81	20	BF200	30
BC181	30	BF224	40
BC182/3	10	BF244A	28
BC184	10	BF244B	29
BC182L	10	BF245	50
BC183L	10	BF256B	50
BC184L	10	BF257/8	32
BC186/7	28	BF259	40
BC212/3	12	BF394	40
BC212L	10	BF451	40
BC213L	12	BF494/5	40
BC214	10	BF594/5	30
BC214L	12	BFR39/40	25
BC237/8	15	BFR41/79	25
BC307B	15	BFR80/81	25

BFR98	105	TIP30C	37	2N914/5	32	2N5458/9	30
BFX29/84	35	TIP31A	38	2N918	40	2N5485	36
BFX84	35	TIP31C	45	2N930	20	2N5777	45
BFX85/86	35	TIP32A	43	2N1131/2	40	2N6027	32
BFX87/88	28	TIP32C	45	2N1303/4/5		2N6109	60
BFY50/51	30	TIP33A	70	2N1307	70	2N6290	70
BFY52	30	TIP33C	75	2N1613	30	2SA636	250
BFY53	35	TIP34A	85	2N1671B	160	2SA671	250
BFY55	35	TIP34C	105	2N2160	325	2SA715	75
BFY56	35	TIP35A	120	2N2219A/20A/		2SC495/6	85
BFY64	40	TIP35C	130	21A/22A	25	2SC1061	250
BFY90	80	TIP36A	130	2N2369A	18	2SC1096	85
BRY39	50	TIP36C	140	2N2646	45	2SC1162	45
BSX20	30	TIP41A	50	2N2846	80	2SC1172/3	125
BSX29	45	TIP41B	52	2N2904A/05A/		2SC1306	100
BSY26	35	TIP42A	55	06A/07A	26	2SC1307	150
BSY95	35	TIP42B	58	2N2926G	10	2SC1449	95
BU105	180	TIP120	70	2N3053	25	2SC1679	190
BU205	190	TIP121	73	2N3054	55	2SC1678	140
BU206	200	TIP141	120	2N3055	50	2SC1923	65
BU208	200	TIP142	120	2N3442	140	2SC1945	225
MJ2955	90	TIP147	120	2N3615	199	2SC1953	90
MJE340	54	TIP2955	70	2N3663	20	2SC1957	90
MJE371	100	TIP3055	70	2N3702/3	10	2SC1969	165
MJE2955	99	TIS43	50	2N3704/5	10	2SC2028	85
MJE3055	70	TIS44	45	2N3706/7	10	2SC2029	200
MPF102	40	TIS88A	50	2N3708/9	10	2SC2078	170
MPF103/4	30	TIS90	30	2N3710	10	2SC2091	85
MPF105	30	TIS91/93	32	2N3771	179	2SC2166	165
MPSA05	30	VK1010	99	2N3772	195	2SC2314	85
MPSA06	25	VN10KM	70	2N3773	210	2SC2335	200
MPSA08	30	VN46AF	95	2N3819	35	2SC2465	125
MPSA12	32	VN66AF	110	2N3820	60	2SC2547	40
MPSA55	30	VN88AF	120	2N3822/3	60	2SC2612	200
MPSA56	30	VN89AF	120	2N3866	90	2SD234	75
MPSA70	40	ZTX107/8	12	2N3903/4	15	2SK45	90
MPSU02	58	ZTX109	12	2N3906/5	15	2SK288	225
MPSU05	60	ZTX212	28	2N4037	60	2SJ83	225
MPSU06	60	ZTX300	13	2N4058	15	2SJ85	225
MPSU52	65	ZTX301/2	16	2N4061/2	15	3N128	115
MPSU55	60	ZTX303	25	2N4264	30	3N140	115
MPSU56	60	ZTX304	17	2N4286	25	40251	150
OC23	170	ZTX320/26	30	2N4289	25	40311	60
OC28/36	220	ZTX500/1	14	2N4400	25	40313	130
OC41/42	75	ZTX502/3	18	2N4427	80	40361/62	70
OC70	40	ZTX504	25	2N4859	78	40408	76
OC72	50	ZTX531	25	2N5135	30	40412	90
OC75/76	55	ZTX550	25	2N5138	25	40467	130
OC76	50	2N696	30	2N5172	25	40468	85
OC81/82	50	2N697	23	2N5180	45	40594	105
OC83/84	70	2N698	40	2N5191	75	40595	110
TIP29A	32	2N699	48	2N5194	80	40603	110
TIP29C	38	2N706A	25	2N5305	24	40673	70
TIP30A	35	2N708	25	2N5457	30	40871/2	90

LINEAR IC's

555 CMOS	80	LM349	125	TA7205	90
702	75	LM358	50	TA7222	150
709C 8 pin	35	LM377	210	TA7310	120
710	50	LM379	495	TAA900	395
741	15	LM380	120	TAA661	190
747C 14 pin	70	LM381N	175	TAA700	275
748C 8 pin	30	LM382	190	TAD100	159
753 8 pin	185	LM384	225	TBA120S	70
810	160	LM386	90	TBA540	275
9400CJ	375	LM387	200	TBA550Q	330
ADC0808	£10	LM389	160	TBA641	290
AY-1-1320	225	LM393	85	TBA651	190
AY-1-5050	99	LM394CH	380	TBA800	80
AY-1-6720	210	LM558	170	TBA810S	95
AY-3-8910	390	LM725CN	300	TBA820	80
AY-3-8912	450	LM733	65	TBA920Q	200
AY-5-1317A	630	LM1871	300	TBA990	350
CA3011	130	LM1889	400	TCA270	350
CA3012	175	LM2907	395	TCA280A	220
CA3014	275	LM3900	70	TCA940	175
CA3018	86	LM3909	85	TCA950	00
CA3019	90	LM3911	185	TCA965	180
CA3020	210	LM3914	300	TDA1008	310
CA3023	210	LM3915	345	TDA1010	220
CA3028A	110	LM3916	300	TDA1022	400
CA3035	255	LM13600	150	TDA1024	110
CA3036	270	LS7220	270	TDA1034	350
CA3043	275	M51513L	230	TDA1054	00
CA3045	365	M51515L	320	TDA1490	350
CA3046	70	M51516L	475	TDA2002	325
CA3059	25	MB3712	200	TDA2003	190
CA3075	215	MB3756	440	TDA2006	320
CA3080E	70	MC1204	250	TDA2020	320
CA3081	190	MC1301	90	TDA2030	190
CA3085	160	MC1310P	150	TDB0791	420
CA3086	60	MC1445	250	TL061CP	40
CA3090AQ	375	MC1458	35	TL062CP	60
CA3123	185	MC1469	300	TL064CN	95
CA3130	90	MC1494	695	TL071CP	40
CA3140	45	MC1495	300	TL072CP	70
CA3160	90	MC1496L	70	TL074CN	110
CA3161E	180	MC1596	225	TL081CP	35
CA3162	540	MC3302	75	TL082CP	55
CA3189	270	MC3401	50	TL083CP	75
CA3240	110	MC3403	65	TL084CP	100
HA1366	175	MC3404	85	TL091CP	60
HA1388	235	MC3405	150	TL170	50
ICL7106	675	MC3423P	80	TL430C	90
ICL7107	975	MC4016	00	TL497A	185
ICL7611	95	MF10	300	TL507	110
ICL7660	250	MFC6040	75	TL509	110
ICL8038CC	300	ML924	275	UA2240	120
ICL8211	225	NE515	275	UA78S40	225
ICM7215	1050	NE529	225	UAA170	180
ICM7216A	£22	NE531	120	UAA180	180
ICM7217A	£11	NE543	225	ULN2003	75
ICM7224	£11	NE544	190	ULN2004	75
ICM7240	300	NE555	20	ULN2283	150
ICM7555	80	NE556DB	60	ULN2803	190
ICM7556	140	NE558	170	UPC556	00
LA3350	250	NE560	350	UPC575	275
LA4031P	340	NE562B	410	UPC1025H	375
LA4032	295	NE564	420	UPC1156H	295
LA4400	350	NE565A	120	UPC1181	00
LA4422	320	NE566	150	UPC1182	425
LC7120	300	NE567	140	UPC1366	195
LC7130	320	NE570	400	XR2206	375
LC7137	350	NE571	300	XR2207	400
LF347	120	NE5532	150	XR2211	575
LF351	60	NE5534	120	XR2216	675
LF353	90	OM335	650	XR2266	360
LF355	90	RC4136D	55	ZN414	80
LF356	90	RC4558	55	ZN423E	130
LF357	100	S556B	210	ZN424E	130
LF398	495	SAB3209	425	ZN425E-8	345
LM10	325	SAB3271	485	ZN426E-8	200
LM301A	30	SAB4209	295	ZN427E-8	600
LM307	45	SG3402	295	ZN428E	450
LM308	75	SL490	300	ZN429E-8	240
LM311	60	SL924	00	ZN459	245
LM318	150	SL6270	150	ZN1034E	200
LM319	180	SN76033	350	ZN1040E	685
LM324	45	SN76488	525	ZNA234E	925
LM334Z	110	SN76489	400		
LM335Z	130	SP0256AL	425		
LM337	250	TA7120	120		
LM339	40	TA7130	125		
LM348	60	TA7204	150		

COMPUTER IC's

2102L	160	8224	£3	TMS9914	895
2114	275	8226	£3	TMS9927	£14
2147-3	£3	8228	310	TMS9928	£16
2516	300	8243	290	TMS9929	£16
2532-4	350	8250	£11	TMS9995	£12
25L32	450	8251	350	ULN2003	75
2564	£6	8253	370	UPD7002	550
27L08	450	8255	400	UPD7007	725
2716-5V	300	8256A	£15	WD1691	£14
2732	350	8257A	400	WD1770	£19
2764-250	399	8259	400	WD2143	850
27C64	£10	8271	£49	Z80CPU 2·5	295
26501	75	8272	£15	Z80ACPU4M	380
27128/250n	875	8279	750	Z80ACTC	310
256K DRAM	£10	8282	450	Z80B	£8
3242	675	8283	450	Z80DART	650
4027	95	8284	550	Z80ADART	800
4116	140	8288	£11	Z80ADMA	900
4164-150	255	8748	£33	Z80DMA	795
4416-2	355	8T26A	99	Z80P10	250
4532-3	250	8T27	150	Z80AP10	315
4816-100ns	125	8T31	350	Z80S10-1	850
4864-15	255	8T95N	90	Z80AS10	900
5514	250	8T97N	90	Z80AS10-2	£9
6116-150	295	9364AP	550	Z8002CPU	00
6116L-120ns	300	9602	220		
6117-100n	575	AM26LS31C	125		
6167-6	795	AM26LS32A	125		
6264L-15	895	AM26LS33	150		
63A03	£14	AM7910	£30		
6402	350	AY-3-1015	300		
6464L-15	750	AY-5-1013	300		
65C02	850	AY-5-1350	388		
6502 CPU	325	AY-5-3600	750		
6502A	545	CD4724	150		
6503	650	COM8017	275		
6504	600	DM8131	275		
6505	650	DP8303	450		
6520	175	DP8304BN	350		
6522A	545	DS3647	600		
6522 VIA	340	DS3691N	350		
6532 RRIOT	£11	DS8820	110		
6532 RIOT	650	DS8830	140		
6545 CRTC	899	DS8831	125		
6551 ACIA	650	DS8832	200		
6592	00	DS88LS120	300		
6800	220	E9364	800		
6802	275	E9365	£28		
6803	850	FD1691	£15		
6805	670	FD1771	£15		
6808	520	FD1791	£22		
6809E	680	FD1793	£23		
6810	150	FD1795	£28		
68A02	345	FD1797	£28		
6820	150	HD26501	75		
68B21	220	HD4315	250		
6821	150	HD6301	225		
6840	375	HM6845	755		
6843	800	IM6402	350		
6845	650	INS8060N	1250		
6845SP	750	M58174	825		
6846	625	MC1488	100		
6847	650	MC1489	100		
6850	120	MC14411	675		
6852	250	MC14412	725		
6854	625	MC3242	590		
68B54	750	MC3446	250		
68000	£25	MC3447P	315		
8017	275	MC3486	175		
8035	350	MC3487	175		
8080A	400	MK3886-2M	£7		
8085A	600	MM5280D	695		
8088	£15	MM5303	635		
81LS95	140	MM5307	1275		
81LS96	170	MM5387A	865		
81LS97/98	140	MM58174	875		
8123	160	RO-3-2513L	700		
8131	475	RO-3-2513U	650		
8150	800	SAA5050	875		
8154	750	SFF96364E	800		
8155	400	SP0256AL2	475		
8156	400	TCM3101J	£13		
8202	£25	TMS2716-3	725		
8212	220	TMS4047	100		
8214	495	TMS4164-15	255		
8216	150	TMS4416-2	355		
		TMS4500A	£12		
		TMS4532-3	350		
		TMS5100	600		
		TMS6011	500		

74S

74S00	40	74S262	£10
74S02	40	74S274	00
74S03	40	74S275	00
74S04	40	74S280	00
74S05	40	74S281	00
74S08	40	74S283	00
74S09	40	74S287	200
74S10	40	74S288	180
74S11	50	74S289	200
74S15	60	74S299	540
74S20	40	74S301	350
74S30	60	74S365	250
74S22	60	74S373	375
74S30	50	74S374	375
74S32	50	74S412	380
74S37	50	74S470	325
74S38	70	74S471	600
74S40	40	74S472	400
74S51	40	74S473	00
74S64	40	74S474	400
74S65	40	74S475	425
74S74	70	74S571	300
74S85	295	74S573	450
74S86	100		
74S112	150		
74S113	120		
74S114	120		
74S124	300		
74S132	90		
74S133	50		
74S134	60		
74S135	110		
74S138	170		
74S139	170		
74S140	75		
74S151	140		
74S153	140		
74S157	200		
74S158	190		
74S162	300		
74S163	300		
74S168	300		
74S169	300		
74S174	250		
74S175	300		
74S181	£11		
74S182	250		
74S188	180		
74S189	225		
74S194	280		
74S195	275		
74S196	350		
74S197	300		
74S201	250		
74S225	500		
74S226	500		
74S240	375		
74S241	375		
74S244	475		
74S251	225		
74S257	225		
74S258	225		
74S260	70		

75

75107/8/9	95
75110	90
75121	00
75150	125
75154	195
75158	150
75159	140
75160	420
75162	650
75182/3	99
75188/9	100
75322	140
75353	00
75361	00
75365	00
75376	00
75450	88
75451/2	52
75454	70
75491/2	65

TTL 74

7400	25	7454	35	74197	100
7401	25	7460	30	74198	200
7402	25	7470	50	74199	200
7403	25	7472	50	74221	150
7404	30	7473	50	74246	130
7405	30	7474	45	74247	120
7406	40	7475	55	74248	145
7407	40	7476	45	74249	175
7408	25	7480	60	74251	90
7409	25	7481	175	74259	150
7410	25	7482	100	74265	260
7411	25	7483	100	74273	180
7412	25	7484	110	74276	130
7413	40	7485	100	74278	160
7414	60	7486	40	74279	80
7416	25	7489	200	74283	100
7417	35	7490	55	74284	440
7420	25	7491	70	74285	300
7421	50	7492	110	74290	80
7422	35	7493	50	74293	80
7423	35	7494	100	74297	175
7425	35	7495	60	74351	180
7426	40	7496	75	74365	70
7427	35	7497	200	74366	70
7428	35	74100	60	74367	70
7430	25	74104	70	74368	70
7432	30	74105	70	74376	120
7433	30	74107	45	74390	100
7437	30	74109	70	74393	100
7438	40	74110	55	74425	60
7440	30	74111	55	74426	60
7441	90	74112	170	74490	100
7442	65	74116	160		
7443	100	74118	100		
7444	100	74119	160		
7445	110	74120	90		
7446	110	74121	45		
7447	95	74122	65		
7448	110	74123	75		
7450	30	74125	60		
7451	30	74126	55		
7453	35	74128	55		
		74132	70		
		74136	65		
		74141	85		
		74142	235		
		74143	250		
		74144	250		
		74145	100		
		74147	160		
		74148	130		
		74150	170		
		74151	60		
		74153	70		
		74154	130		
		74155	75		
		74156	90		
		74157	75		
		74159	170		
		74160	100		
		74161	100		
		74162	100		
		74163	100		
		74164	100		
		74165	100		
		74166	130		
		74167	300		
		74170	190		
		74172	400		
		74173	130		
		74174	100		
		74175	100		
		74176	100		
		74177	110		
		74178	130		
		74179	130		
		74180	100		
		74181	300		
		74182	130		
		74184	170		
		74185	170		
		74186	70		
		74188	75		
		74190	120		
		74191	120		
		74192	120		
		74193	120		
		74194	100		
		74195	75		
		74196	120		

74C

C244	150
C245	150
C373	180
C374	425
C922	550
C923	600
C925	650

74LS

LS00	25	LS85	70	LS323	400
LS01	25	LS86	35	LS324	150
LS02	25	LS90	50	LS325	150
LS03	25	LS91	90	LS326	290
LS04	25	LS92	55	LS327	290
LS05	25	LS93	55	LS347	120
LS08	25	LS95	70	LS348	140
LS09	25	LS96	90	LS352	110
LS10	25	LS107	40	LS353	110
LS11	25	LS109	45	LS355	220
LS12	25	LS112	45	LS356	200
LS13	35	LS113	40	LS363	150
LS14	50	LS114	40	LS364	150
LS15	25	LS122	70	LS365	50
LS19	45	LS123	80	LS366	50
LS20	25	LS124	125	LS367	50
LS21	25	LS125	50	LS368	50
LS22	25	LS126	50	LS373	100
LS24	50	LS132	60	LS374	100
LS26	26	LS133	50	LS375	70
LS27	25	LS135	28	LS377	130
LS28	25	LS136	45	LS378	95
LS30	25	LS138	60	LS379	130
LS32	25	LS139	60	LS380	310
LS33	25	LS145	95	LS382	310
LS37	25	LS147	165	LS384	460
LS38	25	LS148	130	LS385	330
LS40	25	LS151	70	LS386	50
LS42	50	LS153	70	LS390	60
LS47	80	LS154	155	LS393	100
LS48	90	LS155	70	LS395	110
LS49	100	LS156	70	LS396	300
LS51	25	LS157	60	LS398	195
LS52	25	LS158	60	LS399	140
LS54	25	LS160	70	LS445	125
LS55	25	LS161	70	LS447	80
LS63	55	LS162	70	LS465	140
LS73	30	LS163	70	LS467	120
LS74	35	LS164	75	LS490	150
LS75	45	LS165	110	LS540	100
LS76	40	LS166	150	LS541	100
LS78	40	LS168	140	LS624	155
LS83	70	LS169	100	LS629	130
		LS170	140	LS640	200
		LS173	100	LS641	150
		LS174	75	LS645	195
		LS175	70	LS668	90
		LS181	190	LS669	90
		LS183	190	LS670	170
		LS190	85	LS673	890
		LS191	85	LS674	800
		LS192	80	LS682	250
		LS193	85	LS684	350
		LS194	75	LS687	350
		LS195	75		
		LS196	85		
		LS197	85		
		LS221	85		
		LS240	80		
		LS241	80		
		LS242	95		
		LS243	95		
		LS244	80		
		LS245	100		
		LS247	105		
		LS248	105		
		LS249	105		
		LS251	75		
		LS253	75		
		LS256	90		
		LS257	75		
		LS258	75		
		LS259	125		
		LS260	70		
		LS261	100		
		LS266	60		
		LS273	120		
		LS275	350		
		LS279	70		
		LS280	180		
		LS283	80		
		LS290	80		
		LS293	80		
		LS294	999		
		LS295	140		
		LS297	850		
		LS298	100		
		LS299	225		
		LS320	210		
		LS322	360		

CMOS

4000	20	4036	250	4520	55
4001	25	4037	115	4521	115
4002	25	4038	75	4522	125
4006	70	4039	280	4526	60
4007	25	4040	60	4527	65
4008	60	4041	60	4528	70
4009	45	4042	50	4529	145
4010	40	4043	45	4530	90
4011	25	4044	50	4531	120
4012	25	4045	110	4532	65
4013	35	4046	60	4534	365
4014	60	4047	60	4536	250
4015	60	4048	55	4538	80
4016	40	4049	40	4539	80
4017	55	4050	35	4541	95
4018	60	4051	70	4543	70
4019	40	4052	60	4544	150
4020	80	4053	60	4549	400
4021	60	4054	85	4553	245
4022	70	4055	85	4554	180
4023	30	4056	85	4555	35
4024	50	4057	£10	4556	55
4025	25	4059	420	4557	250
4026	90	4060	70	4558	120
4027	45	4061	£5	4559	395
4028	45	4062	995	4560	150
4029	75	4063	90	4561	104
4030	35	4066	45	4562	350
4031	130	4067	245	4566	160
4032	65	4068	25	4568	250
4033	130	4069	25	4569	175
4034	140	4070	25	4572	45
4035	70	4071	25	4580	255
		4072	25	4581	125
		4073	25	4582	99
		4075	25	4583	100
		4076	70	4584	55
		4077	25	4585	55
		4078	25	4599	155
		4081	25	40097	45
		4082	25	40098	42
		4085	60	40100	215
		4086	60	40101	130
		4089	125	40102	140
		4093	40	40103	412
		4094	70	40104	120
		4095	85	40105	220
		4096	100	40106	60
		4097	275	40107	55
		4098	80	40108	325
		4099	75	40109	100
		4160	95	40110	235
		4161	99	40114	240
		4162	99	40161	194
		4163	99	40163	75
		4174	99	40174	75
		4175	105	40175	75
		4194	105	40181	220
		4408	850	40192	75
		4409	850	40193	95
		4410	725	40194	90
		4411	750	40195	80
		4412	805	40244	195
		4415	590	40245	195
		4419	280	40257	198
		4422	770	40373	220
		4433	770	40374	220
		4435	850		
		4440	999		
		4450	350		
		4490	450		
		4500	395		
		4501	40		
		4502	60		
		4503	40		
		4504	100		
		4505	350		
		4506	100		
		4507	45		
		4508	130		
		4510	55		
		4511	55		
		4512	55		
		4513	150		
		4514	115		
		4515	125		
		4516	65		
		4517	275		
		4518	50		
		4519	35		

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

SUPER HY-LIGHT STROBE KIT
Designed for Disco, theatrical uses, etc.

Approx. 16 joules. Adjustable speed. Price £45 + £2 p&p (Total inc. VAT £54.05; Case and reflector price £15 + £2 p&p (total inc. VAT £19.55); Foolscap SAE for further details including Hy-Light and Industrial Strobe Kits.

ULTRA VIOLET BLACK LIGHT FLUORESCENT TUBES

4ft 40 watt £10.44 (£12.00 inc. VAT)
2ft 20 watt £7.44 + £1.25 p&p (£9.99 inc. VAT)
18in. 15 watt £5.00 + 75p p&p (£6.61 inc. VAT)
13in. 10 watt £4.00 + 75p p&p (£5.46 inc. VAT)
12in. 8 watt £3.60 + 50p p&p (£4.71 inc. VAT)
9in. 6 watt £3.00 + 50p p&p (£4.02 inc. VAT)
6in. 4 watt £3.00 + 50p p&p (£4.02 inc. VAT)

230V AC Ballast Kit for either 6in, 9in or 12in tubes £5.50 p&p 55p (£6.96 inc. VAT).
For 13in. & 18in. Tubes £6 p&p 75p (£7.76 inc. VAT).
For 12V DC op. 12in. & 13in. tubes only £5.50 p&p 75p (£7.18 Inc. VAT).
175 WATT SELF-BALLASTED BLACK LIGHT MERCURY BULBS. Available for either B.C. or E.S. fitting, price £10.80 + p&p £1.25 (total inc. VAT £13.85).
400W UV LAMP & BALLAST complete — £48.80 + p&p £3.50 (£60.15 incl. VAT).
400W UV LAMP only, £20.00 + p&p £2.50 (£25.88 incl. VAT).

ROBOT ENTHUSIASTS
1. ESCAP precision Swiss-made ironless rotor, 6V DC geared Motor with 70-1 gearbox. 6V DC – 16 r.p.m. 3V – 8 r.p.m. amazing power; no load current; only 10 ma. approx. Size: 4 x 2½ cm. Ex-equipment, tested and guaranteed. ONLY £4.50 + 50p p&p (total inc. VAT £5.75).

MICRO SWITCHES
Type 1. Heavy duty 10A c/o contacts. Type 2. V3 c/o contacts. Type 3. Sub-miniature c/o contacts. All button type. Price £6.90 inc. VAT for 10, any type. Post paid. N.M.S.

VORTEX BLOWER & SUCTION UNIT
Powerful multi-stage dynamically balanced totally enclosed rotors. 1½in. inlet and outlet. 110V AC. £22.00. Switchable transformer for 240V AC £8.00 p&p £3.00 – total £37.95 inc. VAT.

VBL4 CENTRIFUGAL BLOWER
240V AC powerful 1/50 h.p. .23A motor. £18.00 + £2.00 p&p (Total inc. VAT £23.00). N.M.S.

CENTRIFUGAL BLOWER
Smith Type FFB 1706. 240V A.C. Aperture 45-40mm £6.50 p&p £1 (inc. VAT £8.62).

12/24V DC CENTRIFUGAL BLOWER
0.4A producing 30 cu.ft. £7.50 + £1.00 p&p – total inc. VAT £9.78. N.M.S.
METER 90mm dia. 0/300V A.C. M/C rect. £5.00 p&p £1 inc. VAT £6.90.

COOLING or EXTRACTOR FAN
Quiet smooth running. Size 4¾×4¾×1½. Supplied for 240V a.c. operation. Price £4.75 + £1 p&p (Total inc. VAT £6.62) N.M.S.

HEAVY DUTY SOLENOID
Mf. by Magnetic Devices 230V AC. Intermitten operation. Approx. 20lb pull at 1.25in. Ex-equip. Tested £10.00 + £1.50 p&p – total inc. VAT £13.23.

VARIABLE VOLTAGE TRANSFORMERS
INPUT 230, 240V a.c. 50/60 OUTPUT 0-260V.

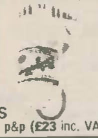
200W, 1A Max.	£18.50
0.5KVA 2½A Max.	£21.00
1KVA 5A Max.	£29.00
2KVA 10A Max.	£41.00
3KVA 15A Max.	£56.00
5KVA 25A Max.	£99.00
10KVA 50A Max.	£181.00
15KVA 75A Max.	£275.00

3-PHASE VARIABLE VOLTAGE TRANSFORMERS
Dual input 200-240V or 380-415V. Star connected

3KVA 5amp per phase max.	£113.40	All V.V.Ts
6KVA 10amp per phase max.	£170.10	plus carriage
10KVA 16amp per phase max.	£345.45	and VAT

Comprehensive range of TRANSFORMERS L.T. ISOLATION & AUTO (110-240V). Either cased with American socket and mains lead or open frame type available for immediate delivery. Leaflet on request.

12V D.C. BILGE PUMPS



400 G.P.H. 15ft. head, 3amp, £8.00 + £1.00 p&p (£10.35 inc. VAT).
700 G.P.H. 10ft. head, 3.5amp, £11.50 + £1.50 p&p (£14.95 inc. VAT).
1750 G.P.H. 15ft. head, 9amp, £15.00. + £1.75 p&p (£19.26 inc. VAT).

SINGLE DIAPHRAGM COMPRESSOR NMS
Max. 20 PSI. One CFM approx. 240 volts A.C. £18 + £2 p&p (£23 inc. VAT).

EPROM ERASURE KIT
Why waste money? Build your own EPROM ERASURE for a fraction of the price of a made-up unit. Complete kit of parts less case to include 12, 8 watt 2537 Angst. Tube. Ballast unit, pair of bi-pin leads, Neon indicator, safety microswitch, on/off switch and circuit.
LESS CASE: Price £13.60 + 75p p&p (Total inc. VAT £16.50)
Warning: Tube used in this circuit is highly dangerous to the eyes. Unit must be fitted in suitable case.

SOLID STATE E.H.T. UNIT
Input 230V A.C. Approx. 15KV. Producing 10mm spark. Built-in 10 sec timer. Easily modified for 20 sec, 30 sec, to continuous. Designed for boiler ignition. Dozens of uses in the field of physics and electronics, e.g. supplying neon or argon tubes etc. £6.50 + 90p p&p (Total Inc. VAT £8.50) N.M.S.

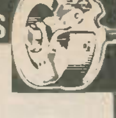
A.C. CAPACITOR
16 UF 900V. A.C. 50/60 Hz. Ideal power factor correction etc. 9¼×6×4¾ ins. Wt. 7½ Kg. Price £12.00 + £3.00 p&p (Total inc. VAT £17.25). N.M.S.

FROM STOCK AT PRICES THAT DEFY COMPETITION

AC GEARED MOTORS	C.F. BLOWERS
DC MOTORS SMALL	AC CAPACITORS
MICROSWITCHES	STROBE KITS
RELAYS	FLASHTUBES
REED SWITCHES	CONTACTORS
SOLENOIDS A.C. or D.C.	SYNCHRONOUS
PROGRAMME TIMERS	MOTORS

WIDE RANGE OF XENON TUBES
WRITE/PHONE IN YOUR ENQUIRIES

Superior Quality Precision Made NEW POWER RHEOSTATS



New ceramic construction, heavy duty brush assembly, continuously rated.
25 WATT 5/10/25/50/100/150/250/300/500/1kΩ
1.5kΩ £4.25 + 30p p&p (£5.23 inc. VAT).
50 WATT 250Ω £6.50 + 50p p&p (£8.05 inc. VAT).
100 WATT .1/5/10/25/50/100/250/500/1kΩ/1.5kΩ/2.5kΩ/3.5kΩ
£10.25 + 75p p&p (£12.65 inc. VAT).
Black Silver Skirted Knob calibrated in Nos 1-9, 1½in. dia. brass bush. Ideal for above Rheostats 30p ea. + VAT.

INSULATED TESTERS *NEW!*

Test to I.E.E. Spec. Rugged metal construction suitable for bench or field work constant speed clutch. Size L 8in., W 4in., H 6in. weight 6lb. 500V. 300 megohms. £49 p&p £2 (£58.65 incl. VAT). 1000V 1000MΩ £55 + p&p £2 (£65.55 incl. VAT) SAE for leaflet.

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"Special Offer" 0-6.3V-0-6.3V at 10 Amp (12V 0-10 Amp or 6V at 20 Amp) Price £9.00 p&p £2.00 – inclusive of VAT £12.65 N.M.S.

GEARED MOTORS
5 rpm 240V AC Mf. by Carter, £6.05 £1 p&p (£8.11 inc. VAT). N.M.S.
20 rpm 115V AC Synchronous, torque approx. 80lb/in. £20.00 + £4 p&p (Total inc. VAT £27.60). N.M.S.
TRANSFORMER 240V operation, £9.15 + £2.00 p&p (Total inc. VAT £12.82).
28 rpm Torque 20lb.in. reversible 1/80th h.p. 110V AC. Price: £9.50 + p&p £1.80 (Total inc. VAT £12.99).
Suitable TRANSFORMER for 230-240V AC operation. Price: £5.20 + p&p £1.40 (Total inc. VAT £7.59). N.M.S.
38.3 rpm GEARED MOTOR. Torque 35lb.in. reversible 115V AC inc. start capacity. Price: £11.55 + £2.00 p&p (Total inc. VAT £15.58). N.M.S.
Suitable TRANSFORMER 230V AC operation. Price: £5.20 + 50p p&p (£6.56 inc. VAT).
CROWN 37 rpm 2000lb.in. approx. 110V AC, reversible geated motor. Price: £35 p&p £4.50 (£45.42 inc. VAT). N.M.S.
Suitable TRANSFORMER for above £10 p&p £1.50 (£13.22 inc. VAT).

57 rpm 240V 1/22 h.p. continuously rated REVERSIBLE 50lb.in. manuf. by Wynstruments. New. Ideal for garage doors, curtains etc. ONLY £12.00 + £2.00 p&p (incl. VAT £16.10), inclusive capacitor.

71 rpm Torque 10lb.in. reversible 1/70th h.p. 110V AC motor. Price: £9.50 + £1.80 p&p (Total inc. VAT £12.99).
Suitable TRANSFORMER for 230-240V AC operation. Price: £5.20 + p&p £1.40 (Total inc. VAT £7.59). N.M.S.
24V DC 200 rpm 10lb/in. Mf. by either Parvalux or Cater. Ex-equip. tested. £8.00 + £1.50 p&p (Total inc. VAT £10.93).
230/240V AC SYNCHRONOUS, 2 rpm, 6 rpm, 6 rev per day. Any type. £4.80 + 50p p&p (Total inc. VAT £6.10).

CHECK METER
200-240V A.C. 50amp, fully reconditioned. £7.50 + £1.75 p&p (Total inc. VAT £10.64).

SANGAMO WESTON TIME SWITCH
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75 -	20	2 watt carbon resistors 10 values
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PE VOLUME 21 Nº8 AUGUST 1985

HOLIDAY HELP

YOU HAVE all seen the reports in your local paper of burglaries or the scare style advertisements placed by those selling alarm systems. While we would not wish to frighten anyone it does seem that crime figures are not encouraging. With this in mind and more particularly with the thought of summer holidays coming up we felt a review of the d.i.y. alarm market was in order.

Rather than just look at what is available we have delved into the various systems explaining in basic terms what they are, how they work and their various uses—everything from reed switches to radar and seismic detectors! We have also gone on to look at discussing the set up with your local crime prevention officer, false alarms and the various governing bodies and specifications. All this plus a buyer's guide on d.i.y. systems should ensure you can be at ease in the sun on holiday.

Another "holiday" project is the *Automatic Fish Feeder*. While this sounds very specialised it could easily be adapted to water the house plants or tomatoes while you are away, or for that matter with a little ingenuity perform any task that is required once or twice a day.

RUR

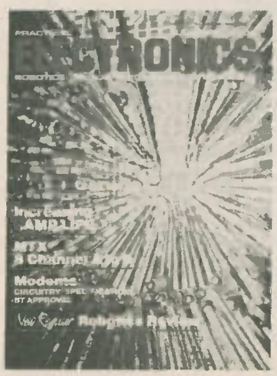
Both the above items will no doubt set readers thinking about just how they might help themselves. One project that should also get the inventive moving is *'RUR' Hobby Robot*. The control electronics published this month would form an excellent basis for any project. Incidentally, we should apologise for the delay in publishing the second part which was unfortunate but unavoidable (part one was in June—for those who missed it).

While on the subject of "experimenting with robots", those very words form the title of a short series aimed at the hobbyist who does not want to spend a small fortune. The series should get you started in developing your own ideas and inventing robots and other electronically controlled mechanical items. *Experimenting With Robots* is in next month's issue.

While we are getting you interested in the subject, we have some copies of our November '84 Robotics supplement to spare. This 16-page booklet carried two feature articles on Robots and their Technology plus a Buyer's Guide showing more than 25 small robots and giving basic information on them. Anyone wanting a free copy of this booklet should send an A4 size stamped self-addressed envelope to the editorial office with a note requesting a copy of *"Robotics"*.

Mike Kenward

BACK NUMBERS and BINDERS . . .



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

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

Components are usually available from advertisers; where we anticipate difficulties a source will be suggested.

Old Projects

We advise readers to check that all parts are still available before commencing any project in a back-dated issue, as we cannot guarantee the indefinite availability of components used. **We are unable to answer letters relating to articles more than five years old.**

Technical *and* **editorial** *queries and letters to:*
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We regret that lengthy technical enquiries cannot be answered over the telephone.

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

...NEWS &

SIR CLIVE'S BRAVE FACE

As the Hoover factory at Merthyr Tydfil in South Wales was drastically cutting back its production of the Sinclair C5 electric trike, Sir Clive himself was putting on a brave face to the retailers who he hopes will help him sell it. Speaking at the annual Radio, Electrical and Television Retailers Association (RETRA) conference at Bournemouth, in April, Sir Clive raised cynical smiles and silent laughter from High Street dealers when he told them they could sell as many C5 trikes as video recorders.

They were equally unimpressed when Sir Clive went on to suggest that his pocket TV set would sell at a rate of over 2 million a year, like portable stereo systems.

Production of the TV has now been shifted back to the Timex factory in Dundee, after the temporary involvement of Thorn-EMI-Ferguson. The Enfield factory made a few sets, and said no thank you, telling Sinclair that it needed extensive re-design for successful mass production. According to Sinclair the Timex factory in Dundee is now mass producing and there are certainly sets in the shops.

Sinclair admitted at Bournemouth, that the home computer market has gone flat. He promised dealers that he will launch a "no compromise" portable computer next year. "The next big, vital step is a portable with a real TV screen, and no compromise over battery power and memory storage. Liquid crystal displays are totally unsatisfactory. We are confident that we can be ahead of everyone else. The Japanese will fail because they have continued to back l.c.d.s. We shall launch the new portable in 1986".

Sinclair reiterated his previously reported promise, of a real electric car with "300 mile range and 80 mile per hour top speed" by 1990. He acknowledges that his promised vehicle depends on completely new technology.

More recently, rumours suggest that the C5 company is up for sale in an attempt to provide cash for his computer business commitments. Debts to Thorn EMI and Timex amount to around £10 million, with an additional overdraft estimated at £5 million. Over £30 million worth of equipment is said to be held in stock—directly reflecting the disappointing sales of the QL.

City of York exhibit

EXHIBIT, the prestigious high technology exhibition will be staged in the centre of the City of York by IBM, in the gardens of the Yorkshire Museum, from Monday, July 1st to Sunday, July 28th.

Designed to stand in a natural parkland setting, IBM's pavilion is a light, flexible structure incorporating advanced architectural features and was itself developed with the aid of a computer.

An arcade, with 34 arches, is the framework for the large, covered pavilion (48 metres long, 12 metres wide and 7 metres high). The polycarbonate pyramids which make up the pavilion are completely transparent.

Entirely free of charge, the exhibition will feature a wide range of information technology demonstrations aimed at informing and stimulating young people's interest in creative computer applications of the future.

Up to 45 temporary summer jobs, with specialist IBM training, will be created for local students, acting as demonstration staff.

ELECTROSAFE LIFESAVER

The 'Powerbreaker-H20' from Electrosafe, a division of Featmarks Ltd, is designed to prevent death or injury from an electrical accident.

Frayed or cut wires on garden or DIY power tools, etc., can be lethal, either through electric shocks or through causing fires. The H20 senses any small leak of current to earth—perhaps through a person. It cuts off the electricity supply in a split second when this happens.

Made in the UK to BS4293 and BS1363, the H20 has a durable, tamper-proof plastic casing. The fuse can be changed in seconds without the use of a tool. The device can be used on all standard 13 amp sockets. A foolproof and abuse-proof reset mechanism has been incorporated. There is a red "flag" on its side which indicates "on/off" and it has a test button so that you know it is working properly.

Finally, the H20 has a neon light which will indicate a dangerous, incorrectly-wired socket, and it will trip automatically if plugged into one of these sockets. It can also be used with extension cables, even a four-in-line trailing socket, so you can use up to four appliances at once.

The Powerbreaker-H20 costs £19.95 inc. VAT and p&p. It is available from Electrosafe, P.O. Box 16F, Chessington, Surrey KT9 2DA (01-391 0985).

MARKET PLACE

Software directory

In part with the aid of central government, computers have now been acquired by virtually every primary and secondary school, and further and higher educational establishments in Britain.

The last two years have seen an explosion in the amount of educational software commercially available—quite apart from that produced within the educational sector, and quite apart from pure "games".

With more than 1,000 entries, the M & E Educational Software Directory will be a reference for teachers, students and home computer owners alike. The software is classified under subject and specialist headings. Each entry includes a short description of what the software will do, specifies the machines for which versions of the software are available, and gives the name of the supplier and a price guide.

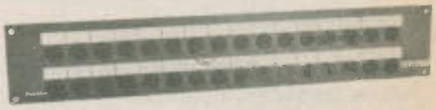
Compiled and written by J. Arthur and T. Russell, the directory is published by Macdonald and Evans and retails at £12.50.

MUSIC MAKERS TRIO

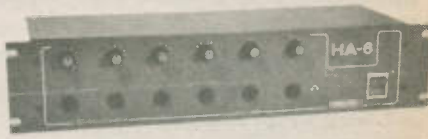
The following three kits, from Powertran Cybernetics, should be of interest to our musically orientated readers.

Specially designed to meet the unique demands of keyboard players, the Synth Mix (SM-6) features three auxiliary sends on each of its six channels. External effects units can thus be utilised properly. All connections are made via the back panel to keep the front of the rack mounting (4U) unit clear. A stereo headphone output is incorporated for private practice or pre-gig tuning. Price £194.35.

Avoid cable tangles with the 'patchbox' which will enable you to make all your connections on one panel. 16 Pairs of jack sockets are presented in a neat 19-inch rack mounting panel with spaces for labelling. Contacts between pairs of sockets can be normalised if required. Phono sockets at the rear connect to your instruments, effects, mixer, etc. Price £40.25.



For studio work and for practice this amplifier enables up to six pairs of stereo headphones to be used from a single input source. Alternatively, two input signals can be used, each being fed to a group of three pairs of headphones (HA-6). Price £102.35.



All prices include VAT and p. & p. From Powertran Cybernetics Ltd., Portway Industrial Estate, Andover, Hants SP10 3NN (0264) 64455.

Source for valves

T.O. Supplies (Export) Ltd., has joined the Selectron Group of companies at their new headquarters at Gravesend in Kent. They have been a major exporter of electronic components for over 25 years, and will be working with P. M. Components, the Selectron Group main distributor, to provide a comprehensive range of electronic tubes, valves, integrated circuits, semiconductors. A wide range of video and TV products will also be available.

Peter Watson and Mike Leeper of the Selectron Group have also announced that the Meopham Green warehouse, home of P.M. Components for the last few years, will shortly be re-opening as a surplus superstore in conjunction with Bernard Welling, formerly of B & T Electronics.

Further information and lists of surplus electronic goods will be published later this year. Details from P.M. Components Ltd., Selectron House, Wrotham Road, Meopham Green, Meopham, Kent DA13 0QY (0474 813225).

Countdown . . .

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

Video Software Sept. 1–3, Olympia, **G3**
Personal Computer World Show Sept. 18–22. Olympia **2 2**
Leeds Electronics Show Sept. 24–26. University **E**
Electron & BBC User Sept 27–29. UMIST, Manchester **L**
Cellular Communications Iut. Nov. 5–7. Wembley Conf. Cntr. **O**
Electronic Publishing Nov. 5–7 Wembley Conf. Cntr. **O**
Compec Nov. 12–15. Olympia **K2**
Electron and BBC User Nov 14–17. New Horticultural Hall, London **L**
Computers In The City Nov 19–21. Barbican Conf. Cntr. **O**
Computer Graphics Oct. 16–18. Wembley Conf. Cntr. **O**

A1	Inst. Electronics ☎ 0706 43661
E	Evan Steadman ☎ 0799 26699
G3	Link House Video ☎ 01-686 2599
K2	Reed Exhibitions, Surrey Ho., 1 Throwley Way, Sutton, Surrey.
L	Database ☎ 061-420 8157
M	Montbuild ☎ 01-486 1951
O	Online ☎ 01-868 4466
T1	Cahners ☎ 0483 38085

Computer Envelope Shaper

R.A. Penfold

CONVENTIONAL synthesisers use an ADSR envelope shaper, or in the case of the more simple instruments an attack/decay type might be fitted. A wide range of envelope shapes and effects can be obtained from an ADSR envelope shaper, including envelope shapes that enable good simulations of many "real" sounds to be produced. Nevertheless, just four stages of shaping plus the restrictions on the way in which the volume can be altered during each of these stages makes it impossible to produce really intricate envelope shapes.

DIGITAL SHAPING

Digital techniques are being applied to electronic music in more and more ways, including digital systems of envelope shaping. These enable practically any desired envelope to be generated. For instance, shapes such as a "backwards" ADSR or one having several peaks and troughs can be generated just as easily as the classic ADSR shape.

It is perfectly feasible to use an external digital envelope shaper with an ordinary analogue synthesiser provided the instrument has a gate output socket. Building an add-on of this type from scratch would be quite a costly business, but with the aid of a suitable home computer a fairly simple circuit will suffice, with the computer providing the complex control and memory circuits.

The unit described in this article has been designed for use with the VIC-20, Commodore 64, and BBC model B computers, together with a synthesiser which has a gate output signal at normal 0–5V logic levels. It should in fact be possible to use it with any computer that can provide 7 digital outputs and one digital input (the Memotech MTX computers for example). The way in which the unit is used is largely dependent on the software. A simple routine for the Commodore machines is provided, and with this the envelope shape is controlled by placing a series of numbers in a data statement. The program for the BBC machine is a little more sophisticated, and it operates by entering the required envelope shape via a joystick, with the shape being displayed on-screen. There is plenty of scope for users to develop software to precisely match their needs, and the advantage of a digital approach is the almost unlimited scope for customising that it provides.

SYSTEM OPERATION

The block diagram of Fig. 1 shows the way in which the system functions. The audio output from the synthesiser is processed by a VCA and buffer stage in the add-on envelope shaper. It is not possible to utilize the internal VCA of the synthesiser due to a lack of an input socket to provide access to the control input of the VCA. Any CV inputs are usually for the VCOs and the VCF. The buffer amplifier is merely needed to give the circuit a low output impedance.

The gate output is fed to a digital input of the computer. This input monitors the state of the gate output, and with the aid of a software routine it starts a new envelope each time a low-to-high transition is detected. The leading edge of the gate pulse is then effectively used as a trigger signal rather than a true gate pulse. However, with suitable software the length of the gate pulse could be used to control the envelope shape in some way, and it would be perfectly feasible to provide more sophisticated control than is possible with an ADSR envelope shaper. The signal could be made to slowly decay during the gate period rather than just hold on indefinitely at a certain level, or a sort of tremolo effect could be used during this period. With digital envelope shaping it is possible to obtain any type of envelope shaping you desire.

The control voltage for the VCA is obtained from a digital-to-analogue converter. This is actually an 8-bit type, but here it functions as a 7-bit converter as the least significant input is just connected to earth. This leaves the least significant line of an 8-bit input/output port free to act as the input to monitor the gate signal. This gives 128 gain levels in theory, but in practice the VCA cuts off at low output values and not just zero. Even so, this gives over 100 different gain levels, enabling a very wide dynamic range to be covered with an average increment of under 1dB. Unlike most computer sound generators (which have only sixteen volume levels) this enables the volume to be varied without the stepping action being apparent.

The digital-to-analogue converter is a standard R-2R type which consists of a resistor network, eight electronic switches that are controlled by the input signals, and a 2·55V precision reference source. The reference source sets the full scale output voltage of the converter, since the maximum output voltage is equal to this reference potential. An amplifier is used to boost the output to just over 5V in order to give a better drive level for the VCA, and this stage also provides buffering.

A supply voltage of 5V is needed for the digital-to-analogue converter, but the other stages of the unit require a supply potential of about 9 to 12V. This higher potential is not available at

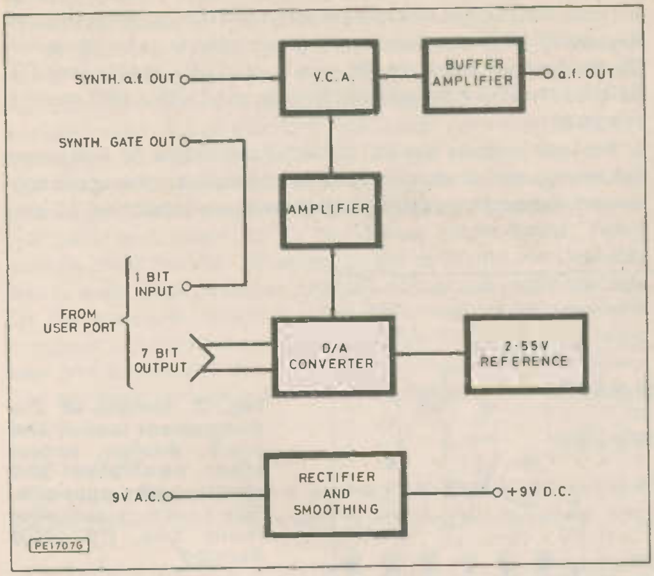


Fig. 1. Block diagram of the Computer Envelope Shaper

the user port of the VIC-20, Commodore 64, or the BBC model B. In the case of the BBC model B the +12V output of the power port is utilised. The user port of both the Commodore 64 and VIC-20 computers has two 9V a.c. outputs, and one of these is fed to a rectifier and smoothing circuit which provides a supply of about +9 to 10V.

CIRCUIT OPERATION

The full circuit diagram of the Computer Envelope Shaper appears in Fig. 2.

IC1 is the digital-to-analogue converter, and this is a Ferranti ZN426E low current consumption type. It does not have a built-in data latch and must be driven from latching outputs, but the user ports of all three machines provide suitable outputs. The only discrete components required by IC1 are R1 and C1 which are respectively the load resistor and decoupling capacitor for the integral 2·55V precision reference source.

Operational amplifier IC2 is used as the output amplifier and buffer stage for the converter. IC2 is used in the standard non-inverting mode and the negative feedback network formed by R2 and R3 set the nominal voltage gain at two times. The CA3140E device used in the IC2 position is a type which can operate with its output at virtually the negative supply potential. This is advantageous in this application since it avoids the need for a negative supply for IC2. Devices such as the 741C and LF351 do not have suitable output stages and are ***not*** suitable substitutes for the CA3140E in this circuit.

The voltage controlled amplifier uses one section of an LM13600N (or the almost identical LM13700N) dual transconductance operational amplifier. The other section of the device is not needed and is totally ignored. Even though only one section of IC3 is utilized, the LM13600N is still competitive with the alternatives in terms of both cost and performance.

Transconductance operational amplifiers are very different to ordinary operational amplifiers, the main difference being that they are current- rather than voltage-operated devices. It is the differential input current that determines the output current, and not the differential input voltage that determines the output voltage. In practice this is not very convenient, and it is normal for the input signal to be applied to the device via a series resistor so that the input current is proportional to the input voltage. Also, the output is given a load resistor so that the output voltage is proportional to the output current. This effectively converts the device to voltage operation. In this circuit R10 is the resistor in series with the input and R9 is the output load resistor.

The output voltage of the circuit is a function of the input voltage and the bias current fed to the "amplifier bias" input at pin 1. The gain of the amplifier can therefore be controlled by means of this bias current. R4 is connected in series with the bias input so that the current flow is roughly proportional to the applied voltage, and the required voltage control is obtained. C3 prevents any large and very rapid changes in control current. This smoothes out the steps in the control signal and prevents relatively high frequencies from being modulated onto the output signal (which would produce "clicking" sounds). This is not absolutely necessary if the gain is being incremented and decremented one step at a time, but it can give much better results if the unit is used with fairly simple software which gives relatively coarse control of the envelope shape.

R5, R6, and C4 provide a centre tapping on the supply lines which is used to bias the inputs of IC3 via R7 and R8. The output load resistor (R9) must also be returned to this point in the circuit. The output from the transconductance amplifier is at a fairly high impedance, but the LM13600N has a Darlington Pair emitter follower buffer stage for each amplifier. This provides the unit with a low output impedance. R12 is the load for the output buffer.

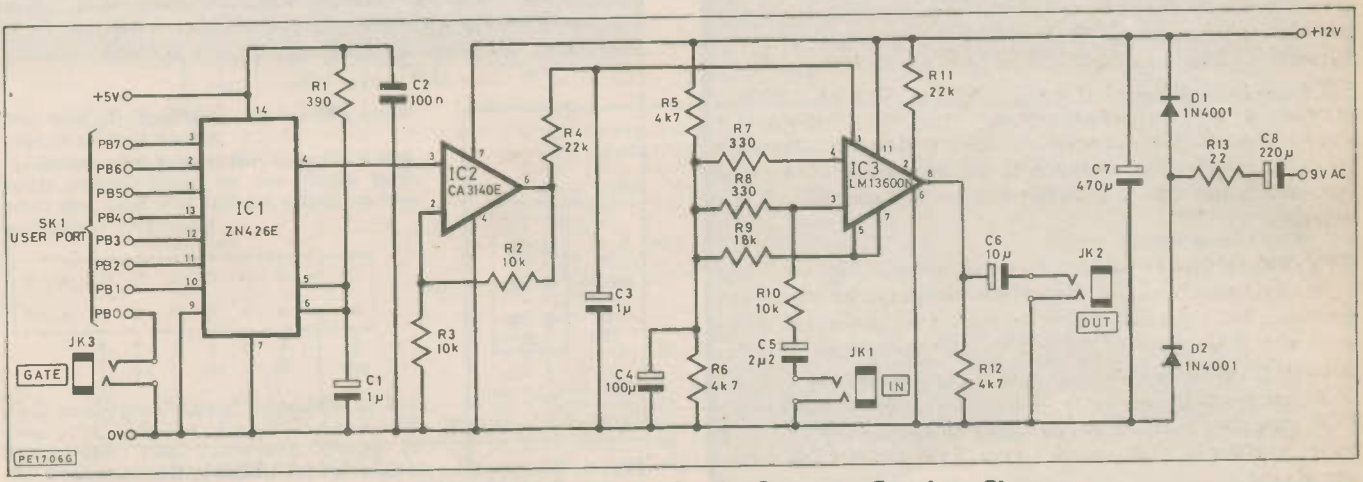


Fig. 2. Complete circuit diagram for the Computer Envelope Shaper

The amplifiers of the LM13600N feature linearising diodes at the inputs, and by feeding a bias current to these it is possible to obtain improved distortion performance and dynamic range. R11 is used to supply a suitable bias current to the linearising diodes.

For the Commodore 64 and VIC-20 computers one 9V a.c. output of the user port is rectified by C8, R13, D1 and D2, and then smoothed by C7. This is a quite crude way of obtaining a 9 to 10V supply, but it gives an adequately smoothed supply with no significant hum or noise detectable at the output of the unit. Of course, if the unit is used with the BBC model B computer and its 12V d.c. output the rectifier circuit is not needed.

CONSTRUCTION

Details of the printed circuit design are reproduced in Fig. 3.

In general, construction of the board is quite straight forward, but note that IC2 has a MOS input stage and consequently requires the normal MOS antistatic handling precautions to be observed. Do not overlook the single link-wire next to C2 and IC1. Omit C8, R13, D1, and D2 if the unit is only to be used with a BBC model B computer.

The user ports of the VIC-20 and Commodore 64 computers can be regarded as identical as far as connection to this unit is concerned. Connection to either machine is via a piece of 11-way ribbon cable up to about one metre or so in length, and a 2 by 12-way 0·156 inch edge connector. Fig. 4(a) shows the correct method of connection for this. It is unlikely that the edge connector will be fitted with a polarising key, and care must therefore be taken to ensure that it is always fitted to the user port the right way round. It is advisable to clearly label the top and bottom edges of the connector as such.

Connection to the user port of the BBC machine is by way of an 8-way ribbon cable and 20-way IDC header socket. Probably the easiest way of making these connections is to use a ready-assembled 20-way socket and lead, ignoring the 12 leads that are

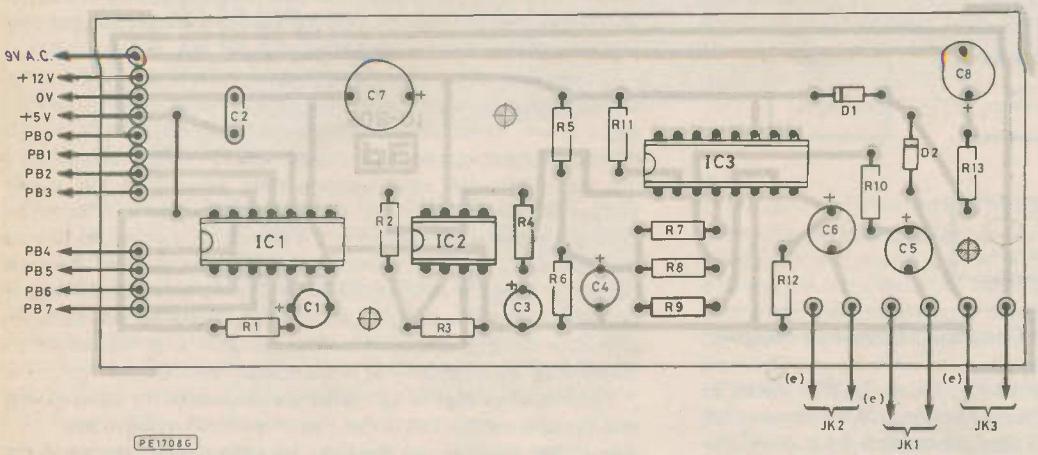


Fig. 3. Details of the component layout and p.c.b. design, actual size: see also the photographs opposite. The board is available from the *PE PCB Service*

COMPONENTS . . .

Resistors

R1	390
R2, R3, R10	10k (3 off)
R4, R11	22k (2 off)
R5, R6, R12	4k7 (3 off)
R7, R8	330 (2 off)
R9	18k
R13	22

All ¼W ±5% carbon

Capacitors

C1, C3	1µ 63V radial elect. (2 off)
C2	100n ceramic
C4	100µ 10V radial elect.
C5	2µ2 63V radial elect.
C6	10µ 25V radial elect.
C7	470µ 16V radial elect.
C8	220µ 25V radial elect.

Semiconductors

D1, D2	1N4001 (2 off)
IC1	ZN426E
IC2	CA3140E
IC3	LM13600N or LM13700N

Miscellaneous

SK1	20-way IDC header socket or 2 by 12-way 0·156 inch edge connector
JK1, JK2, JK3	Standard jacks (3 off)

Case about 180 × 120 × 39mm; Printed circuit board—available from the *PE PCB Service*, order code 508-01; BBC power connection plug; 8 pin d.i.l. i.c. holder; 14 pin d.i.l. i.c. holder; 16 pin d.i.l. i.c. holder; wire, pins, solder, 6BA fixings, etc.

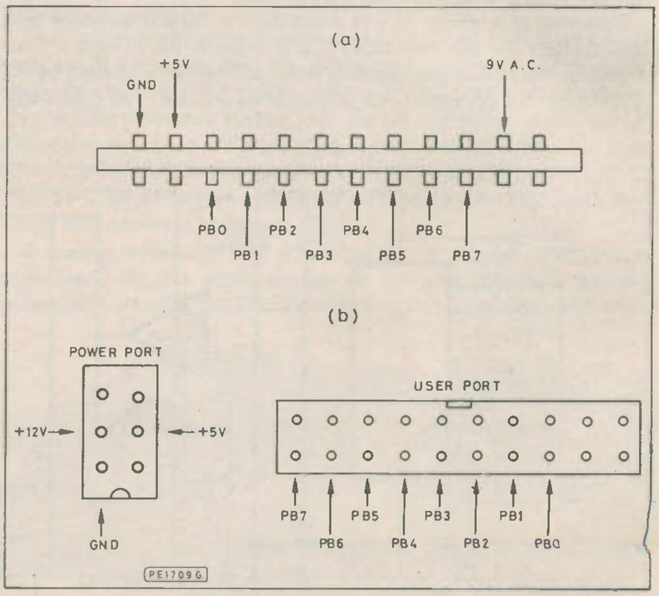


Fig. 4. Connection details for (a) VIC-20/Commodore 64, and (b) BBC Model B, also showing the power port

not required in this case. The +12, +5, and 0V signals are taken from the power port of the computer using a three way cable terminated with the appropriate type of plug. Fig. 4(b) gives connection details for both the user and power ports.

The case for the prototype is a Verocase having dimensions of 180 × 120 × 39 millimetres. This is a neat and practical case, but is admittedly somewhat larger than is really necessary. The three sockets, which are all standard jack types, are mounted on the front panel. A notch must be filed in the rear panel of the case to provide an exit point for the lead or leads to the computer. Alternatively, a multiway socket or sockets could be fitted on the rear panel and connected to the printed circuit board. These sockets could then be connected to the computer via a suitable lead or leads. This is a neater but more difficult and costly solution. On the prototype, which is used mainly with a BBC model B computer, a compromise was adopted with the connections to the user port being made direct while the connections to the power port are made through a 3-way DIN socket mounted on the rear panel.

SOFTWARE

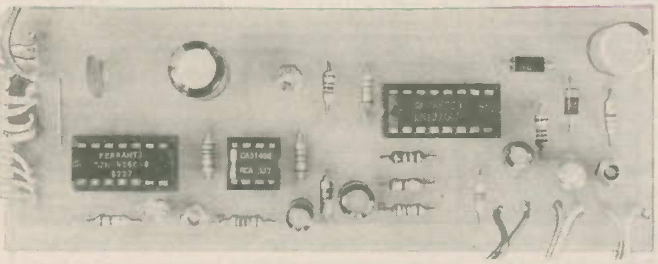
All three computers have a user port which has each input/output line individually programmable to provide the required function. This is accomplished by writing the appropriate value to the data direction register. Setting a bit to 1 designates the corresponding input/output line as an output—setting a bit to 0 designates the corresponding line as an input. In this case the least significant bit must be an input while the other seven bits are all outputs. A value of 254 must therefore be written to the data direction register which is at address &FE62 in the BBC model B, 56579 in the Commodore 64, and 37138 in the VIC-20. Data is then written to and read from addresses &FE60, 56577, or 37136 respectively.

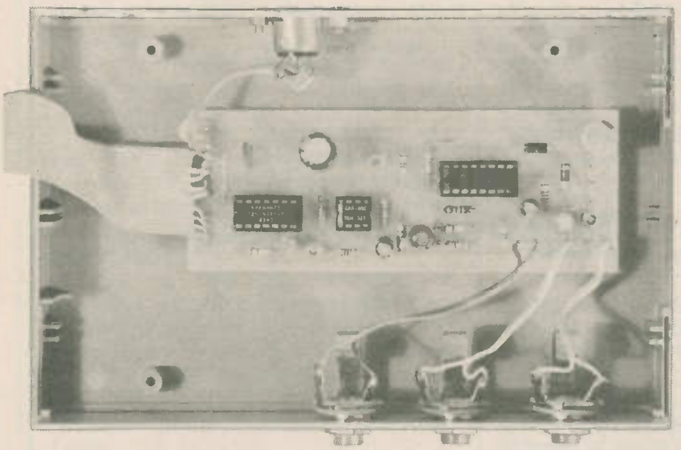
The basic action of the software is to read the input line and loop until this goes high (indicating the start of a note and an envelope). The series of values are then written to the user port to generate the required envelope shape. However, there is a slight complication in that the program must continue to monitor the input line, and must go back to the beginning of the envelope if the input line goes through a low to high transition before the end of the envelope.

COMMODORE 64 AND BBC ROUTINES

In the routine for the Commodore 64 the envelope shape is controlled by the values in the DATA statements. The same routine will operate with the VIC-20 if the two user port addresses are changed to suit. The program will only output about 30 values per second which limits the precision with which the required envelope shape can be obtained, although quite good results are still obtained. The speed of a machine code program would be needed to fully utilize the capabilities of the unit with the Commodore computers. Envelope shapes can be saved simply by saving the whole program including the DATA statements.

The BBC program is more sophisticated and has envelope shapes entered using a joystick. If you do not have a BBC joystick an alternative is to connect a potentiometer to the analogue port in the manner shown in Fig. 5. The trace is automatically swept across the screen and the joystick is used to control the trace





The top photograph shows the completed circuit board.

Above, the board fixed in its case, with connections to the three jack sockets, and the ribbon cable to the computer user port

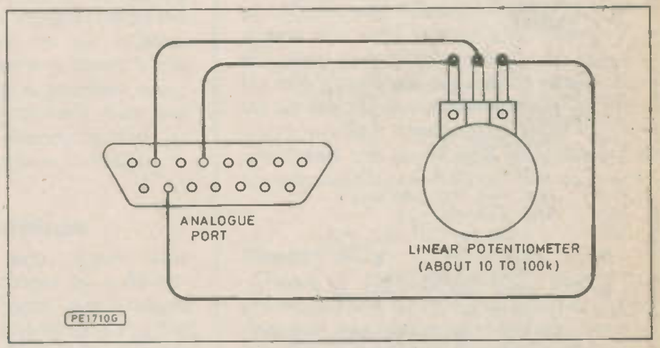


Fig. 5. Connecting a potentiometer to the BBC computer's analogue port

The program listing opposite is for the VIC-20 or Commodore 64 machines. The envelope shape is determined by the values in the DATA statements

```
5 REM COMMODORE 64 PROGRAM
8 REM CHANGE PORT ADDRESSES FOR VIC-20
9 REM DATA STATEMENTS GIVE EXAMPLE ENVELOPE SHAPE
10 POKE 56579,254
20 IF (PEEK(56577) AND 1) = 0 THEN GOTO 20
30 READ A
40 IF A = 0 THEN GOTO 100
50 POKE 56577,A
60 IF (PEEK(56577) AND 1) = 1 THEN GOTO 30
70 RESTORE
80 GOTO 20
100 RESTORE
110 IF (PEEK(56577) AND 1) = 1 THEN GOTO 110
120 GOTO 20
1000 DATA 255,245,235,225,215,205,195,185
1010 DATA 175,165,155,155,165,175,185,195
1020 DATA 205,215,225,215,205,195,185,175,165,155,150,150,150,150
1030 DATA 150,150,140,130,120,110,100,95,90,85,80,75,70,65,60,55,50,45,40,35
1040 DATA 30,25,20,15,10,5,0
```

```
  10 REM ENVELOPE SHAPER PROGRAM
  20 REM FOR BBC MODEL B
  30 REM J.W.P. 10/84
  40 MODE 1
  50 ?&FE62=254
  60 C%=FALSE
  70 DIM STORE 127
  80 VDU 24,5;500;1275;1020;29,5;500;
  90 ON ERROR GOTO 240
 100
 110
 120 CLS
 130 PROClabels
 140 REPEAT
 150   choice$=GET$
 160   IF choice$="E" OR choice$="e" THEN PROCenvelope
 170   IF choice$="P" OR choice$="p" THEN PROCplay
 180   IF choice$="L" OR choice$="l" THEN PROClong
 190   CLS
 200   VDU 28,0,28,19,18,31,X%,Y%
 210   UNTIL FALSE
 220
 230
 240 IF ERR<>17 THEN REPORT:PRINT" at line ";ERL:STOP
 250 CLS
 260 GOTO 130
 270
 280
 290 DEF PROClabels
 300 VDU 28,0,28,19,18
 310 COLOUR 3
 320 PRINT "Please select:-"
 330 PRINT
 340 COLOUR 1
 350 COLOUR 1:PRINT"E";
 360 COLOUR 3:PRINT"nvelope"
 370 PRINT
 380 COLOUR 1:PRINT"P";
 390 COLOUR 3:PRINT"lay"
 400 PRINT
 410 PRINT"Play ";
 420 COLOUR 1:PRINT"L";
 430 COLOUR 3:PRINT"ong"
 440 PRINT
 450 COLOUR 1
 460 PRINT"Press letter key";
 470 COLOUR 3
 480 ENDPROC
 490
 500
 510 DEF PROCenvelope
 520 PROCmessage_e
 530 REPEAT
 540   CLG:GCOL 0,3
 550   MOVE 0,0
 560   VDU7
 570   FOR T=0 TO 100:NEXT
 580   FOR X=0 TO 127
 590     Y=ADVAL(2) DIV 256
 600     STORE?X=Y
 610     DRAW X*10,Y*2
 620     FOR T=0 TO 100:NEXT
 630     NEXT X
 640   UNTIL (ADVAL(0) AND 3)<>0
 650 SOUND 1,-15,110,20
 660 PROCconfirm
 670 ENDPROC
 680
 690
```

Complete listing for the BBC Model B. The envelope shape is drawn by means of a joystick, or alternatively by making use of a potentiometer, as explained in the text

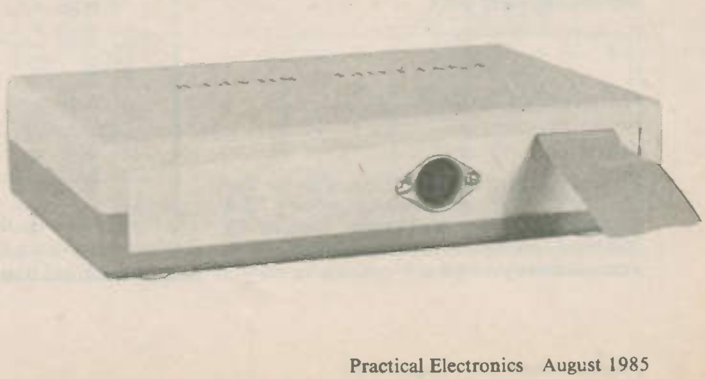
```
 700 DEF PROCconfirm
 710 CLG
 720 GCOL 0,2
 730 MOVE 0,0
 740 FOR X=0 TO 127
 750   DRAW X*10,STORE?X*2
 760   NEXT X
 770 GCOL 0,3
 780 ENDPROC
 790
 800
 810 DEF PROCplay
 820 PROCmessage_p
 830 C%=FALSE
 840 REPEAT
 850   REPEAT UNTIL (?&FE60 AND 1)=1
 860   FOR V=0 TO 127
 870     ?&FE60=STORE?V
 880     IF (?&FE60 AND 1)=0 THEN C%=TRUE
 890     IF (?&FE60 AND 1)=1 AND C% THEN V=0:C%=FALSE
 900     NEXT V
 910   REPEAT UNTIL (?&FE60 AND 1)=0
 920   UNTIL INKEY$(0)<>""
 930 ENDPROC
 940
 950
 960 DEF PROClong
 970 PROCmessage_p
 980 C%=FALSE
 990 REPEAT
1000   REPEAT UNTIL (?&FE60 AND 1)=1
1010   FOR V=0 TO 127
1020     ?&FE60=STORE?V
1030     FOR T=1 TO 10:NEXT
1040     IF (?&FE60 AND 1)=0 THEN C%=TRUE
1050     IF (?&FE60 AND 1)=1 AND C%  THEN V=0:C%=FALSE
1060     NEXT V
1070   REPEAT UNTIL (?&FE60 AND 1)=0
1080   UNTIL INKEY$(0)<>""
1090 ENDPROC
1100
1110
1120 DEF PROCmessage_e
1130 X%=POS:Y%=VPOS
1140 VDU 28,20,28,39,18
1150 PRINT"Draw envelope shape"'"with joystick."
1160 PRINT
1170 PRINT"Press fire button"'"when satisfactory."
1180 ENDPROC
1190
1200
1210 DEF PROCmessage_p
1220 X%=POS:Y%=VPOS
1230 VDU 28,20,28,39,18
1240 PRINT"Press any key to"'"return to command"'"mode."
1250 PRINT
1260 PRINT"(ESCAPE for instant"'"return.)"
1270 ENDPROC
```

vertically and draw out the required shape. This process will repeat automatically, but when exactly the required shape has been obtained the program can be halted by pressing the firebutton. If you are using a potentiometer to control the trace the following line should be substituted at line 640.

640 UNTIL INKEY$(0)<>""

The program can then be halted by pressing any key on the computer's keyboard. The envelope can be reproduced at two speeds. Operating instructions are included in the program.

The routines provided are really only intended as starting points, and there is ample scope for the user to develop software to exactly suit his or her needs. ★



INDUSTRY NOTEBOOK

By Nexus

Forty Years On

The VE-Day and VJ-Day anniversaries were given saturation coverage this year, reviving memories of sadness and of joy, of terror and triumph.

The war years, tragic as they were on all sides, were also years of invention and innovation with an industry founded on communications (the wireless and, by the mid-thirties, the new-fangled television) emerging in 1945 as electronics. This much broader-based activity was soon to penetrate industrial production and testing, the office, medicine until, today, it is everywhere.

Next year we shall see the 30th anniversary of nuclear power but I doubt any celebration of Calder Hall coming on stream in 1956. That year seemed like a new dawn. The frightful energy released on two Japanese cities which abruptly terminated the war in the Far East had now been successfully harnessed in peace for the benefit of humanity.

It could not have been done but for electronics and the industry benefited accordingly. First with instrumentation and control systems for the nuclear power stations and subsequently in the many new fields such as medical diagnosis and treatment and industrial applications of nuclear physics.

By 1970, with newer and larger power stations in operation, Britain had produced more electricity by nuclear power than the rest of the world added together. But with abundant coal and, in those days, cheap oil there was no need to expand nuclear energy, particularly as the cost of generation was still higher than either oil or coal fired stations. The oil crisis of the mid-70s changed the economic structure of the power supply industry and today nuclear power is much less costly than oil and comparable with coal.

But while our own nuclear programme lost momentum the rest of the world started catching up. The International Atomic Energy Agency lists 26 countries with nuclear power capacity and the present state of play reveals some surprising statistics. The yardstick is the percentage share of nuclear to total generating capacity.

France is world leader with 58.7 percent of all its capacity being nuclear with Belgium (50.8 percent) and Finland (41.4 percent) second and third. Bulgaria, not generally regarded as a high-tech country is sixth (28.6 percent) while the Soviet Union generally regarded as high-tech rates a lowly 14th spot with a modest 9 percent.

The United Kingdom is running 11th (17.3 percent) but ahead of the United States (13.5 percent) and Canada (11.6 percent). Of course not too much should be read into the figures because each country has different needs in respect of availability and cost of indigenous fuels, electricity demand and economic development.

Our own future programme is seriously obstructed by a noisy anti-nuclear lobby which has already delayed the planned Sizewell installation by at least two years. Nonetheless, for obvious reasons of reliability of supply, the Central Electricity Generating Board is dedicated to reducing dependence on coal and expects to expand nuclear capacity to 40 percent or more of the total by the end of the century.

But France, already world leader, expects to achieve 75 percent nuclear power by 1990. French tariffs, largely due to nuclear power, are some 20 percent lower than in Britain and the large industrial users in France are claimed to have a 30 percent cost advantage in energy over their competitors in the UK. It leaves one wondering whether the anti-nuclear groups realise the economic damage they do or, indeed, whether the 'greens' among them know that burning coal and oil is infinitely more damaging to the environment than the 3,500 operating years already clocked up by the world's nuclear power stations.

Japanese Connections

When, forty years ago, Japan was forced into military surrender by a devastating atomic left and right, the inherent militancy of the nation re-emerged in a bid for world domination with results which are plain to see.

Perhaps from a sense of guilt over Hiroshima and Nagasaki the west has been tolerant of some of the worst excesses of Japanese trading practices. Today there is a hardening of attitude that Japan should fall into line and stop blocking imports while still free to export her own products worldwide. If and how this problem will be resolved only the next few months will tell.

Meantime, we perhaps need Japan more than she needs us. ICL's new super-fast Series 39 mainframe computer would not have been possible without cooperation with Fujitsu on chip manufacture. BL has made good use of cooperation with Honda. Nissan at Sunderland is already recruiting in anticipation of starting car production in the UK. And Trade and Industry Minister Norman Tebbit was recently in Japan and is reported to have a list of over 300 Japanese firms interested in establishing subsidiary companies in Europe. Mr Tebbit hopes a good proportion will choose the UK as a base and he has some good examples to influence them in their choice.

Good Relations

When looking at the Japanese electronic companies already established in the UK one sees instantly why Japan succeeds so consistently while we so often fail. It is often thought that the Japanese do well in the UK only if starting fresh on a green field site recruiting only those untainted by old-fashioned, inefficient work practices. But Hitachi and Toshiba both took over existing factories and turned loss into profit. Albeit at a price in jobs. But when Toshiba, for example after a period of five years is now producing the same number of TV sets with only one fifth of the staff of the previous British employers and turned huge losses into profit it demonstrates that there are no bad troops, only bad officers.

We have here a fine paradox. When I was at social occasions in Japan I found it somewhat embarrasing to find the polite introductory bow between the Japanese prolonged while, by careful hedging, it was discovered which person was the more senior and therefore the one to be deferred to. Yet in industry everyone is equal though mutual respect is encouraged, in fact mandatory. One works restaurant, one worker status, one trade union, one standard for all in clocking on, holidays and sick pay.

Naturally there are differentials in pay and managers will still manage. But the concept of officers and troops, of directors dining rooms and staff canteens is absent, as is the shop steward constantly on the alert for any grievance capable of exploitation. He or she is now a representative, has a good working relationship with management and the workforce and differences are resolved by discussion, not walk-outs.

Smart Buy

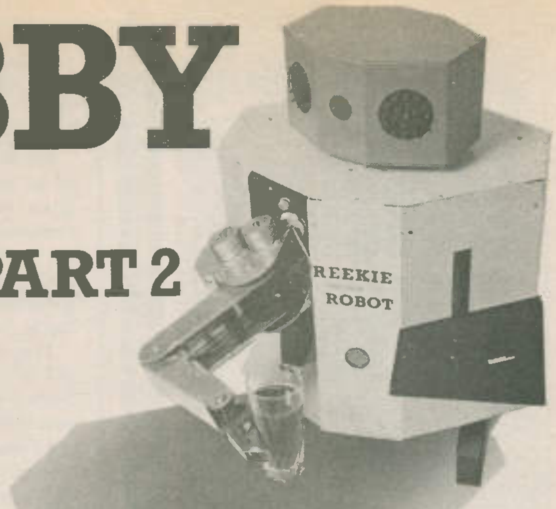
There is little doubt that, during the period leading up to privatisation, British Telecom was keeping a sharp eye on Cable and Wireless whose liberation from Government restraint came much earlier. And now BT has followed C & W's example of expansion with the acquisition of 51 percent of the Canadian Mitel Corporation.

This brings two great assets to BT. First it brings to BT a large scale manufacturing operation. Second, perhaps even more important, it gives BT an opening in the North American as well as other world markets.

Mitel, whose UK manufacturing base is in South Wales, also has factories in the USA, Germany, Hong Kong, Mexico, New Zealand and Puerto Rico and sells microprocessor controlled PABXs to 80 countries. Mitel was in financial difficulties but over a medium term it looks a smart buy for BT. Mitels' founders, Terry Matthews and Mike Copeland are, in effect, 'coming home' as they were both ex-BT employees before seeking a fortune in Canada.

'RUR' HOBBY ROBOT PART 2

Ralph P. Magee



Continued from the June issue

IN this, the final part of the *R.U.R. (Reekie Universal Robot)* we look at the electronics (designed by James Chisholm) and the Tiny BASIC software.

The control card for the R.U.R. is based around the Z8671 single chip Microcomputer from Zilog. It is an industrial micro controller in the Z8 range. It was chosen as it has a 2K Tiny BASIC internally held in ROM. Two fully programmable timer counters, full duplex USART/RS232/432 as well as I/O ports and addressing capabilities up to 62K, enough for most control, vision, speech recognition, speech synthesis, and enough internal registers for any machine code programs.

The basic electronics supplied with the robot has 2K RAM and 4K EPROM containing programs described later. An 8255 I/O post giving another 24 lines of I/O. A TTL to RS232/432 (almost) converter. A clock running at 7·37MHz and a Polaroid ultrasonic range finder which is connected to timer T1 and used as object and path sensing system. Two Darlington drivers are connected to the output lines to the 8255 that provide for the direction relays, motors and l.e.d. eyes.

The Address Range is decoded from 0000 HEX to 3FFF HEX into 2K blocks. These can be set-up as either ROM or RAM by changing the links so that as much or as little RAM can be used. However, with an all ROM system there are only about a 100 usable registers inside the CPU and the stack grows down from the top of memory and takes up most of the registers. With RAM in place the stack sits on top of external RAM and grows down. The bottom 4K of this area is taken up with the internal ROM and I/O ports. Also two 8-bit bi-directional I/O ports have been set aside for experimental use, One port, the individual lines of the byte can be set to be input or open-drain, and under software control can be set-up to be of type active input or open-drain. The other port is set-up to be input or output and is a byte wide.

THE ELECTRONICS

On reset the Z8 (Fig. 4) non-destructively tests the memory to find areas occupied by RAM. The micro-processor sets up the output port and prints a colon (:) and then jumps to % 1020 where it starts the software held in EPROM. If the EPROM is removed and replaced by 6116 the whole system, without any of the Reekie software, is available to the user. With the Reekie EPROM it auto-runs the software as described later.

DECODING

The Z8 has a multiplex data/address bus and to decode it AS and DS are required. The data is valid when DS is at logic 1 and address bus bits 0 to 7 are valid when AS is logic 1. The address bus is latched by the 74LS373 and brought out to the edge. Bits 8 to 15 are valid throughout both cycles. These feed into 74LS138 3-to-8 decoder which decodes address range 0000 HEX to 3FFF into 2K blocks suitable for the 6116 and 2716 2K by 8 RAMs and EPROMs. To decode for 2732 two of these bits are ANDed together to form a 4K chip select suitable for the 2732. And line A11 must also be exchanged for the read write R/W for the signal. This can be achieved by changing the links.

PORT 2

Port 2 is available for the user. It can split into individual bits of either input or output type by setting the internal register @246 to 1 for input, and 0 for output, on each individual bit, then writing the data to be sent out by using @2 = data, e.g.:

```
10 @246 = 0      : REM sets port 2 to output
20 @2 = 255      : REM output 255 to port 2
```

And the ports as follows:

```
@%800 = Port A
@%801 = Port B
@%802 = Port C
```

This echoed through the block % 0800 to % OFFF.

Port A drives into a Darlington driver i.c. which can sink 500mA as long as the whole package does not dissipate more than 1·8 watts. This is used to drive the eye l.e.d.s on lines 0 to 5 and the head motor *on* and *off* on bit 6, and *direction* on bit 7.

Port B is brought to the edge of the printed circuit board and is free for users use.

Port C is split, the lower bits are set-up as mainly inputs to monitor switches on the head position (if fitted) and a demonstration button. Bits 4 to 7 are set as outputs and control the direction of the main motors. Bit 4 controls the left motor, bit 5 controls the direction of the left motor: 1 = forward. Bit 6 controls the right motor on logic 1, and bit 7 controls the direction of the right motor: 1 = forward. See Table 1 for guidance of driving the motors.

INTERRUPTS

The Z8 has 6 interrupts, 4 internal and 4 external, i.e. two both internal and external. Of these, two are taken by the USART INT 3 and 4, and a further two are taken by the ultrasonic range-finder system, these being INT5 and INT2, leaving 0 and INT1 for the user. These are vectored by 16-bit addresses stored in RAM, and should point to the start of service routines. All these interrupts can be prioritised and enabled by very powerful interrupts system. See Table 2.

INT0 and INT1 are negative edge-triggered and brought out on port 3,2 and 3,3. These can also be set-up as input and output lines by changing the port 3 register 247 % F7.

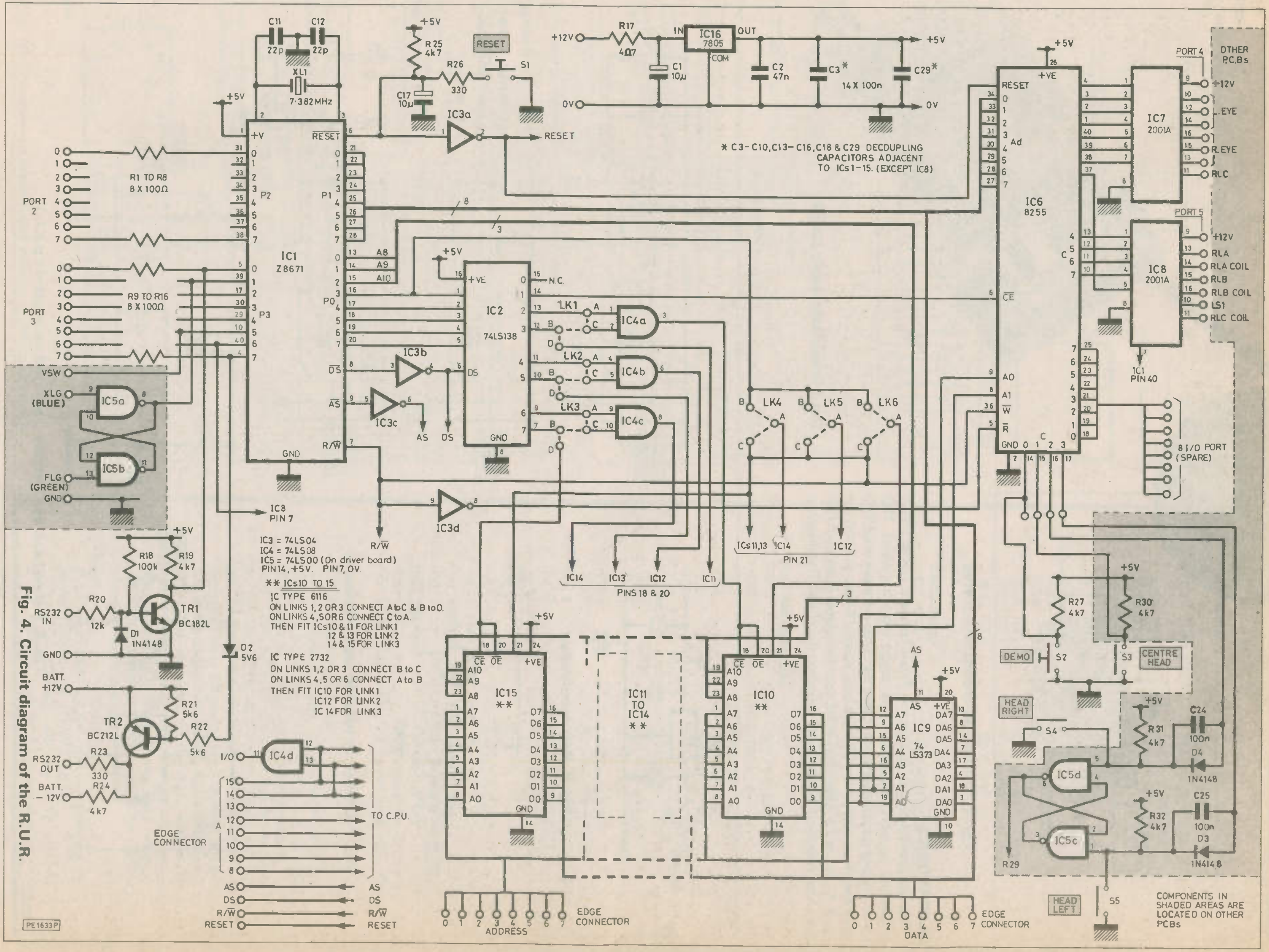


Fig. 4. Circuit diagram of the R.U.R.

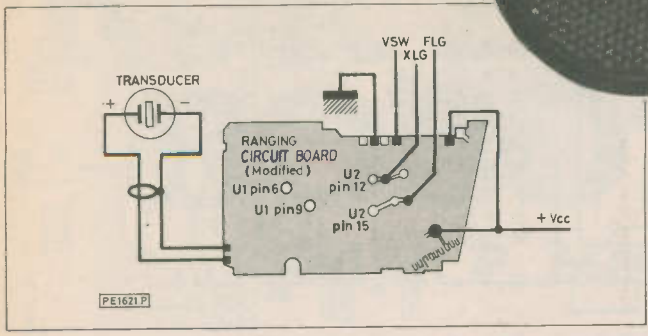
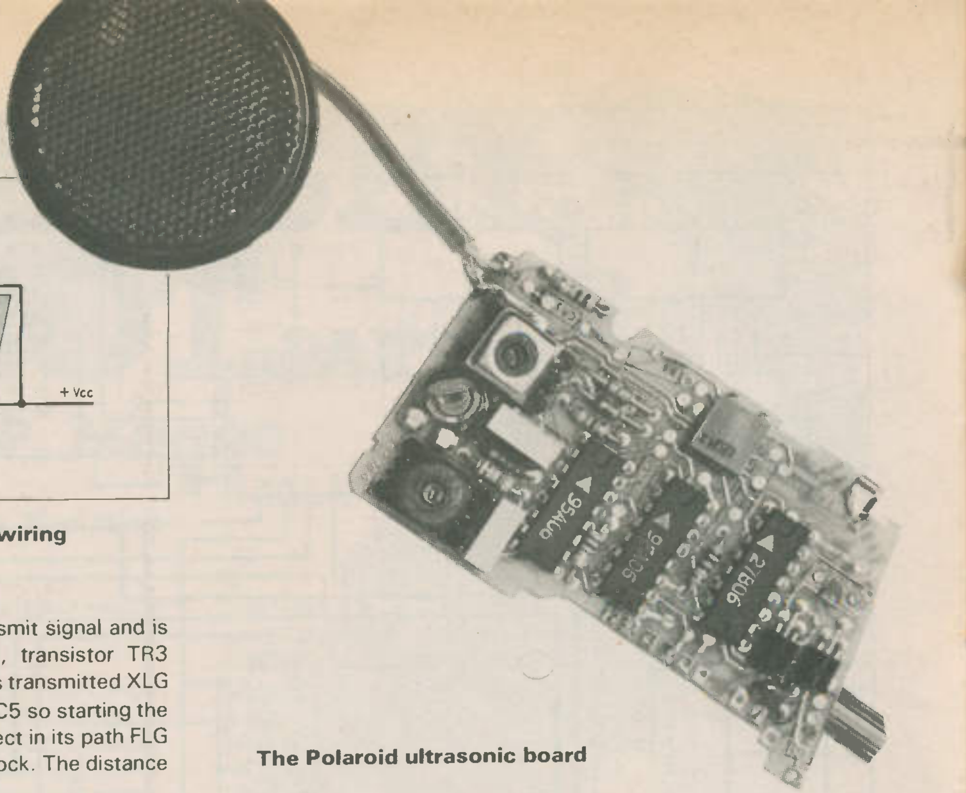


Fig. 5. Ultrasonic ranging unit wiring



The Polaroid ultrasonic board

ULTRASONICS

The ultrasonics signal VSW is the Pulse Transmit signal and is connected to port 3,5 when it is taken low, transistor TR3 conducts and transmits a pulse. Once the pulse is transmitted XLG goes low, thus setting the RS latch built around IC5 so starting the clock T1 in the Z8. Upon first echo from the object in its path FLG goes low, resetting the latch and stopping the clock. The distance

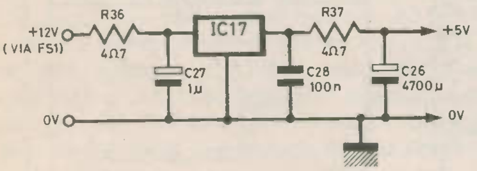


Fig. 6. Regulator circuit

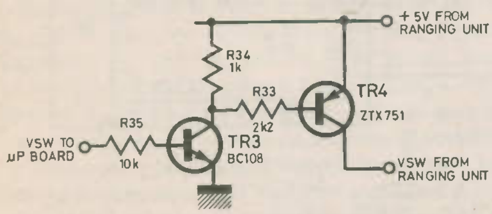


Fig. 7. Ultrasonic ranging unit interface

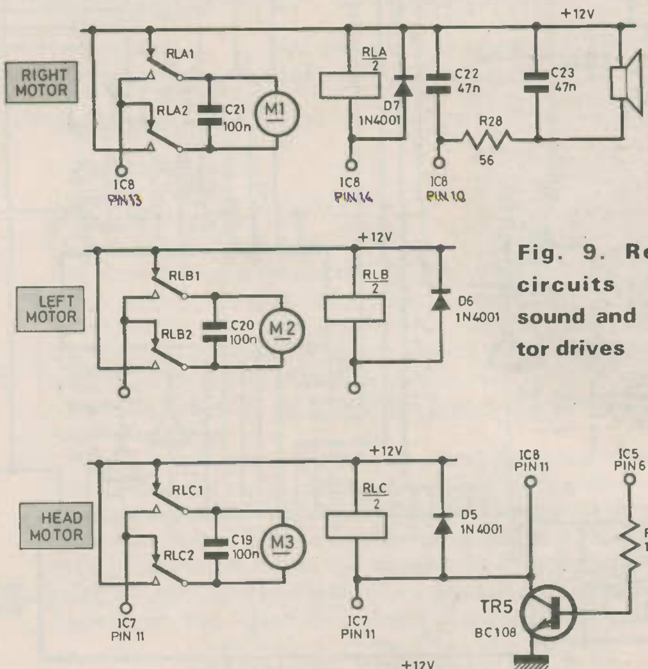


Fig. 9. Relay circuits for sound and motor drives

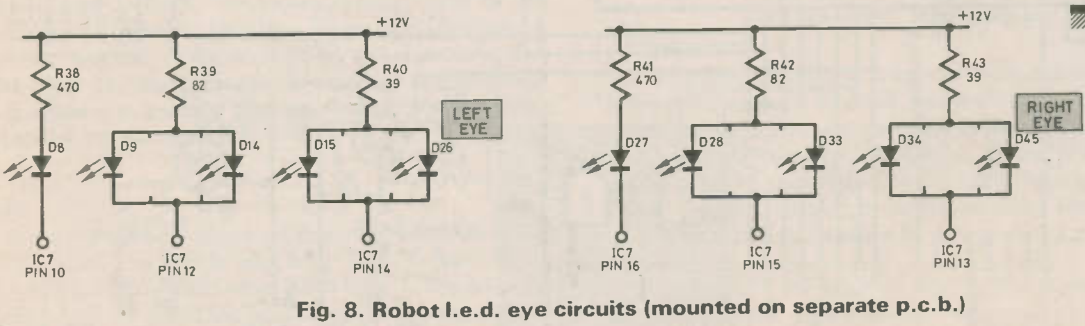


Fig. 8. Robot l.e.d. eye circuits (mounted on separate p.c.b.)

PE1634P

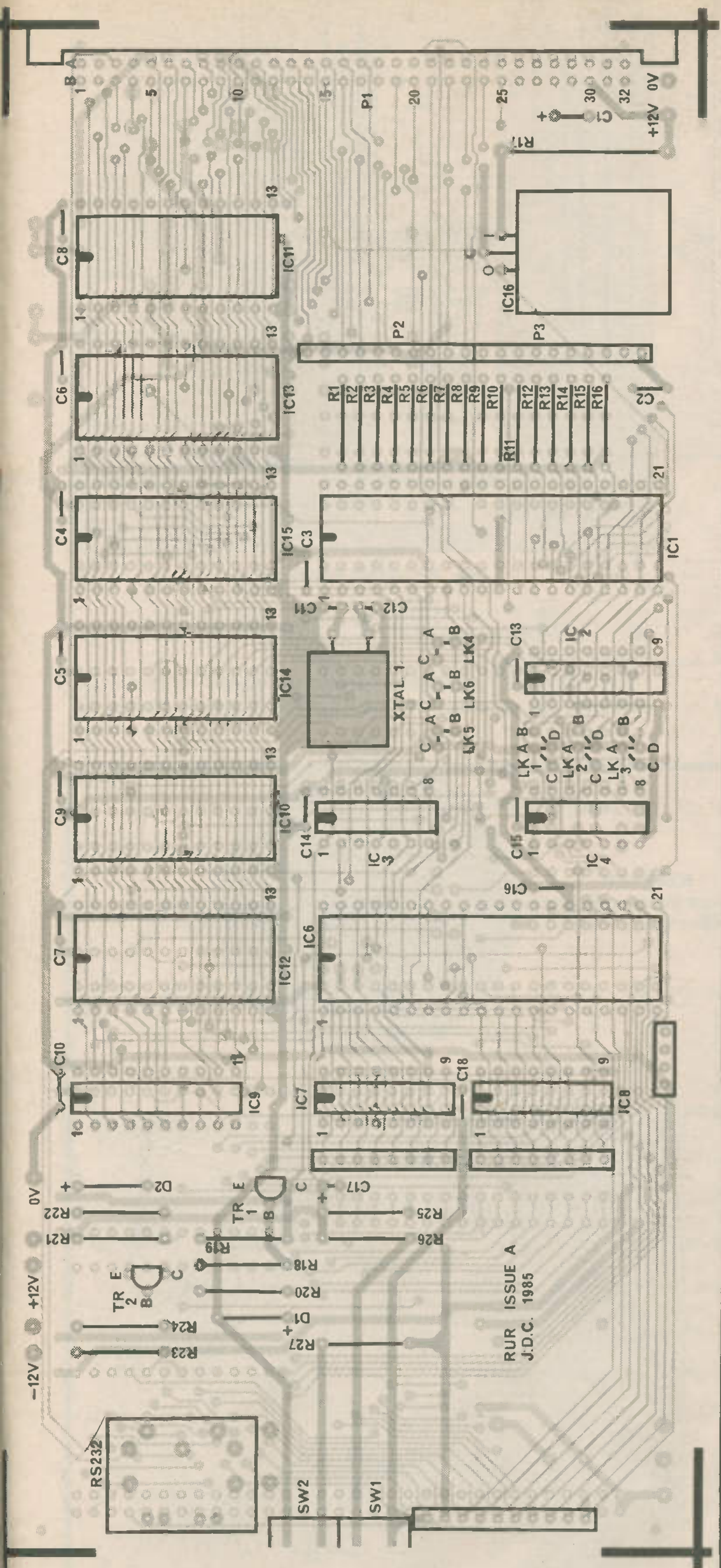


Fig. 10. Component layout and wiring of the main p.c.b.

COMPONENTS . . .

Resistors

R1–R16	100 (16 off)
R17, R36, R37	4Ω7, 4W (3 off)
R18	100k
R19, R24, R25, R27, R30–R32	4k7 (7 off)
R20	12k
R21, R22	5k6 (2 off)
R23, R26	330 (2 off)
R29, R35	10k (2 off)
R33	2k2
R34	1k
R38, R41	470 (2 off)
R39, R42	82 (2 off)
R40, R43	39 (2 off)

All resistors ¼W 5% unless otherwise specified

Capacitors

C1, C17	10µ, 63V tant. bead (2 off)
C2, C22, C23	47n disc cer. (3 off)
C3–C10, C13–C16, C18–C21	100 disc cer. (16 off)
C11, C12	22p (2 off)
C19–C21	100n (3 off)

Semiconductors

IC1	Z8671 micro
IC2	74LS138
IC3	74LS04
IC4	74LS08
IC5	74LS00
IC6	8255
IC7, IC8	2001A (2 off)
IC9	74LS373
IC10	2732 or 6116
IC11	6116
IC12	2732 or 6116
IC13	6116
IC14	2732 or 6116
IC15	6116
IC16, IC17	7805 (2 off)
TR1	BC182L
TR2	BC212L
TR3, TR5	BC108 (2 off)
TR4	ZTX751
D1, D3, D4	1N4148 (3 off)
D2	5V6 Zener
D5, D6, D7	1N4001 (3 off)
D8, D27	0·2 in. green l.e.d. (2 off)
D9–D26, D28–D45	0·2 in. red l.e.d. (36 off)

Miscellaneous

LS1 2in. 8Ω loudspeaker
S1, S2 keyboard type "click" switches (2 off)
Main p.c.b., Relay p.c.b., Eye p.c.b. (2 off), RLA, RLB, RLC 12V two-pole changeover relays (3 off), 3A fuse plus p.c.b. holder, heatsink for regulator IC16, XL1 7·382MHz crystal, 24-pin d.i.l. i.c. socket (6 off), 16-pin d.i.l. i.c. socket (3 off), 20-pin d.i.l. i.c. socket, 14-pin d.i.l. i.c. socket (4 off), 40-pin d.i.l. i.c. socket (2 off), p.c.b. mounting 5-way d.i.n. socket for RS232, 5-way p.c.b. plug, 4-way p.c.b. plug (4 off), 6-way p.c.b. plug, 8-way p.c.b. plug (3 off), PP3 battery lead with studs, 12V battery lead with spare connector.

Note

A full kit of parts for the RUR is available from Reekie Robots. Tel: 01-892 2877.

The kit is supplied with one 6116 and one 2732. Ports 2, 3 are for future expansion.

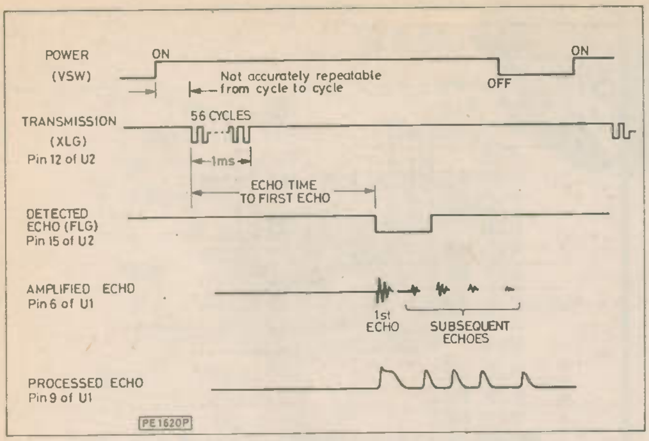


Fig. 11. Ultrasonic unit timing and operation diagram

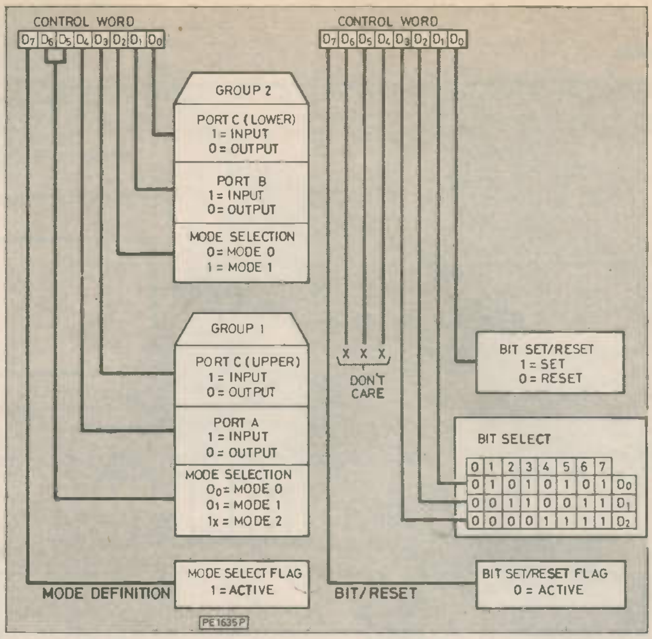


Fig. 12. 8255 addressing

in front of the transducer is given by the formula:

$$D = 331{\cdot}4 \times (K/273)^{0.5} \times \frac{t}{2}$$

D is in metres
K is the air temp. in Kelvin
t is time in seconds
This can be simplified to D=170·2*t at 15 deg. C. If there is no object in the path, i.e. the distance to any wall which is over 35 feet after 62ms, then FLG automatically goes low.

The internal software routine returns the distance in cm at 15 deg. C and makes use of INT 5 to increment the count in the register overflows.

Port 3,0 and 3,7 are used to connect the USART to the outside world and are fed directly to the RS232/432 driver and receiver

Table 1. Motor control logic

	SIDE A		SIDE B
1	5V on A + B		left free
2	left free		left free
3	DS		AS
4	A14 and A15		reset
5	A0		A1
6	A2		A3
7	A4		A5
8	A6		A7
9	A8		A9
10	A10		A11
11	A12		A13
12	A14		A15
13	3, 3	in	3, 2
14	3, 1	in	3, 0
15	3, 7	00	3, 6
16	3, 5	00	3, 4
17	R/W		SP
18	SP		SP
19	D0		2, 0
20	D1		2, 1
21	D2		2, 2
22	D3		2, 3
23	D4		2, 4
24	D5		2, 5
25	D6		2, 6
26	D7		2, 7
27	SP		SP
28	SP		SP
29	SP		SP
30	SP		SP
31			+12V
32	0V		0V

Table 2. Interrupt priorities

R249 IPR
Interrupt Priority Register
(F9H: Write Only)

D7 D6 D5 D4 D3 D2 D1 D0

RESERVED

IRQ3,IRQ5 PRIORITY (GROUP A)
0 = IRQ5>IRQ3
1 = IRQ3>IRQ5

RQ4,IRQ2 PRIORITY (GROUP B)
0 = IRQ2>IRQ4
1 = IRQ4>IRQ2

IRQ1,IRQ4 PRIORITY (GROUP C)
0 = IRQ1>IRQ4
1 = IRQ4>IRQ1

INTERRUPT GROUP PRIORITY
RESERVED = 000
C>A>B = 001
A>B>C = 010
A>C>B = 011
B>C>A = 100
C>B>A = 101
B>A>C = 110
RESERVED = 111

R251 IMR
Interrupt Mask Register
(FBH: Read/write)

D7 D6 D5 D4 D3 D2 D1 D0

1 ENABLES IRQ0–IRQ5
(D5 = IRQ0)

RESERVED

1 ENABLES INTERRUPT

R250 IRQ
Interrupt Request Register
(FAH: Read/write)

D7 D6 D5 D4 D3 D2 D1 D0

RESERVED

IRQ0 = P33 INPUT (D5 = IRQ0)
IRQ1 = P32 INPUT
IRQ2 = P31 INPUT
IRQ3 = P30 INPUT, SERIAL INPUT
IRQ4 = T0 SERIAL OUTPUT
IRQ5 = T1

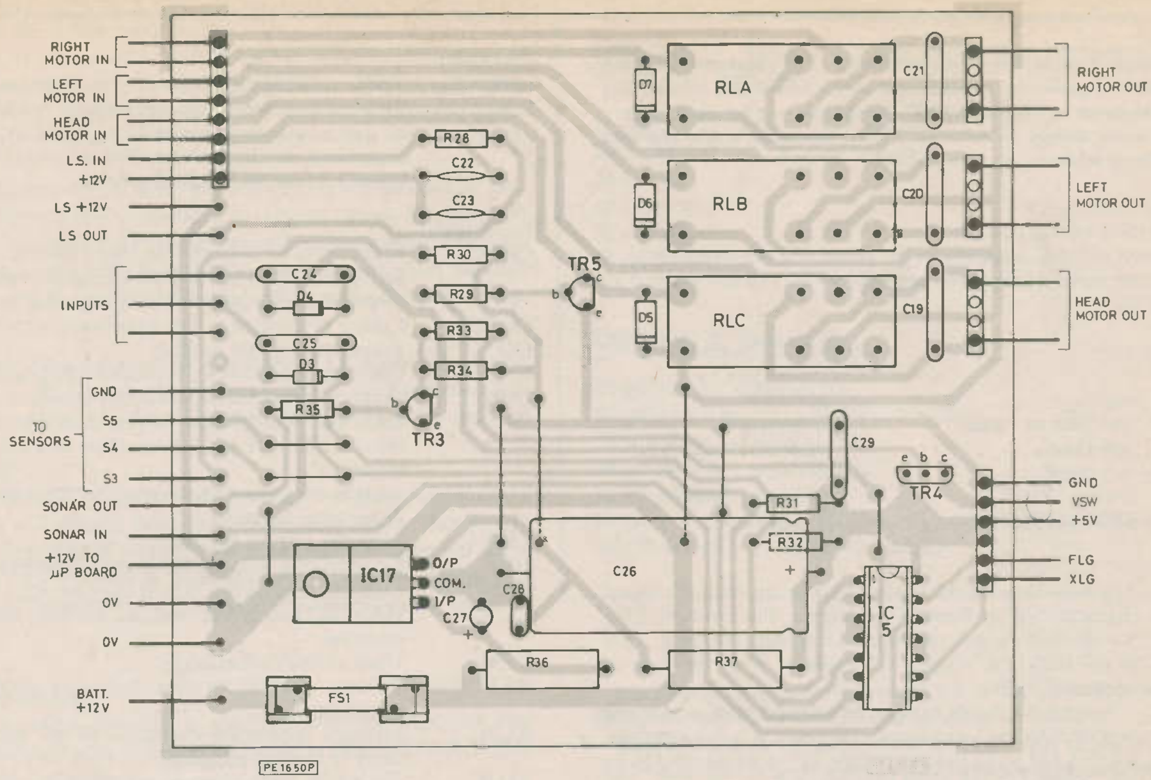
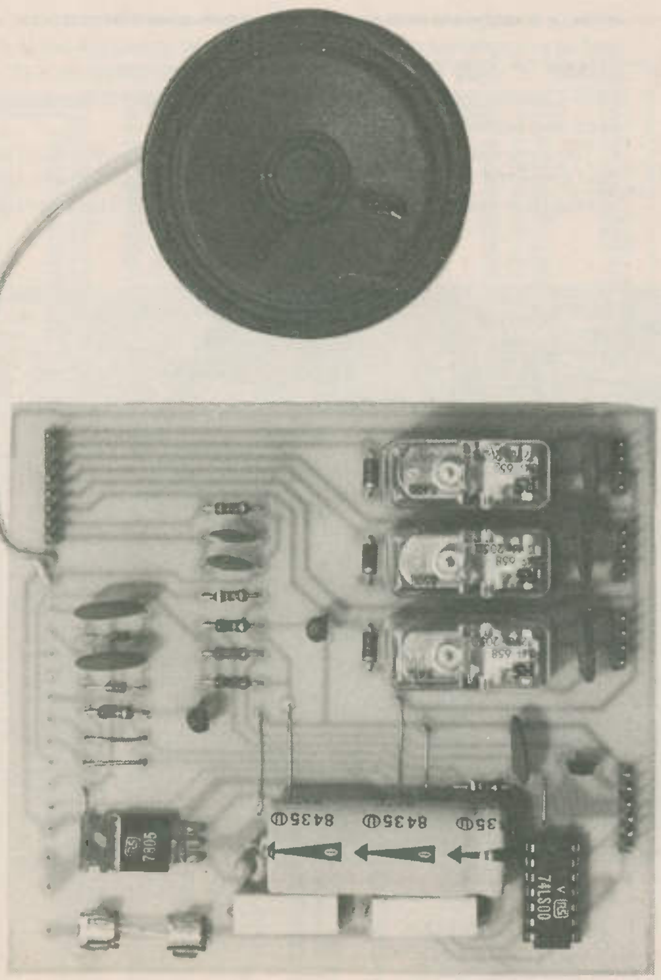


Fig. 13. Component layout and wiring for the relay p.c.b.



circuits built around transistors TR1 and TR2, and various other associated components. This circuitry is powered by two PP3 batteries giving a voltage swing of 18 volts, enough for quite long lengths but this can easily be modified to give a potential of 24V for standard RS232 interfaces.

PORT 3

Port 3,6 is connected directly to a Darlington and drives a speaker which enables beeps to be created from timer T1.

The internal UART in the Z8 is set-up to transmit the 8 bits with no parity and 2 stop bits. It is fully interrupt driven using interrupts 3 and 4 so is fully duplex (repeating everything sent to it), employing the timer TO for the generation for its Baud rates.

THE 8255

This is an Intel chip which happens to work with the Z8. To control it, it has a Data Direction Register (DDR) addressed by @%803HEX as shown in Fig. 12.

ASSEMBLY AND CHECKING

To construct the relay board the passive components should be inserted first, then the d.i.l. sockets, and then the relays and transistors etc. Power up and check the +5V rail from the regulator before plugging in the i.c. When everything is found to be satisfactory, power down again and plug in IC5.

Assemble the main board to the same general rules and, again, check the supply voltages throughout before plugging in the i.c.s.

When ready, connect the relay board with the main board. Plug in IC1 and power up. Do not yet plug in the ROM. Using the terminal, check that a colon (:) appears on the screen. If the colon does not appear, the fault is almost certainly in the power, clock, RS232 or reset circuit. Check these areas and rectify.

Table 3. This is only a minor selection of what can be done with this powerful system and some novel and interesting extensions to normal BASIC keywords can be used allowing such things as relative, index, immediate and indirect register addressing from BASIC.

Expressions:
Variable names A–Z
Signed decimal numbers in the range –32768 to +32767.
Hexadecimal numbers (preceded by "%") in the range 0 to 65535.

Operators:		*Arithmetic Operators:*	
=	equal.	+	addition.
<=	less than or equal.	–	subtraction.
<	less than.	*	multiplication.
<>	not equal.	/	division.
>	greater than.	\	unsigned division.
>=	greater than or equal.		

Memory Operators:
@ Any byte may be referenced by placing the byte signal character "@" in front of the address. For example, LET X = @ 1000 assigns the value at address 1000 to X; LET @ (C*100) = A assigns the value of A to the byte at address (C*100).

Sixteen-bit words may be referenced with an address preceded by the word signal character "↑". For example, PRINT ↑↑8 will print the sixteen-bit value pointed to by the contents of the word at location 8.

Functions:

AND (a,b)	Performs a logical AND of the expressions a,b.
USR (a,b,c)	Calls an assembly language routine at address a. The expressions b,c may be used to pass arguments to the routine. The assembly language routine must return a value.

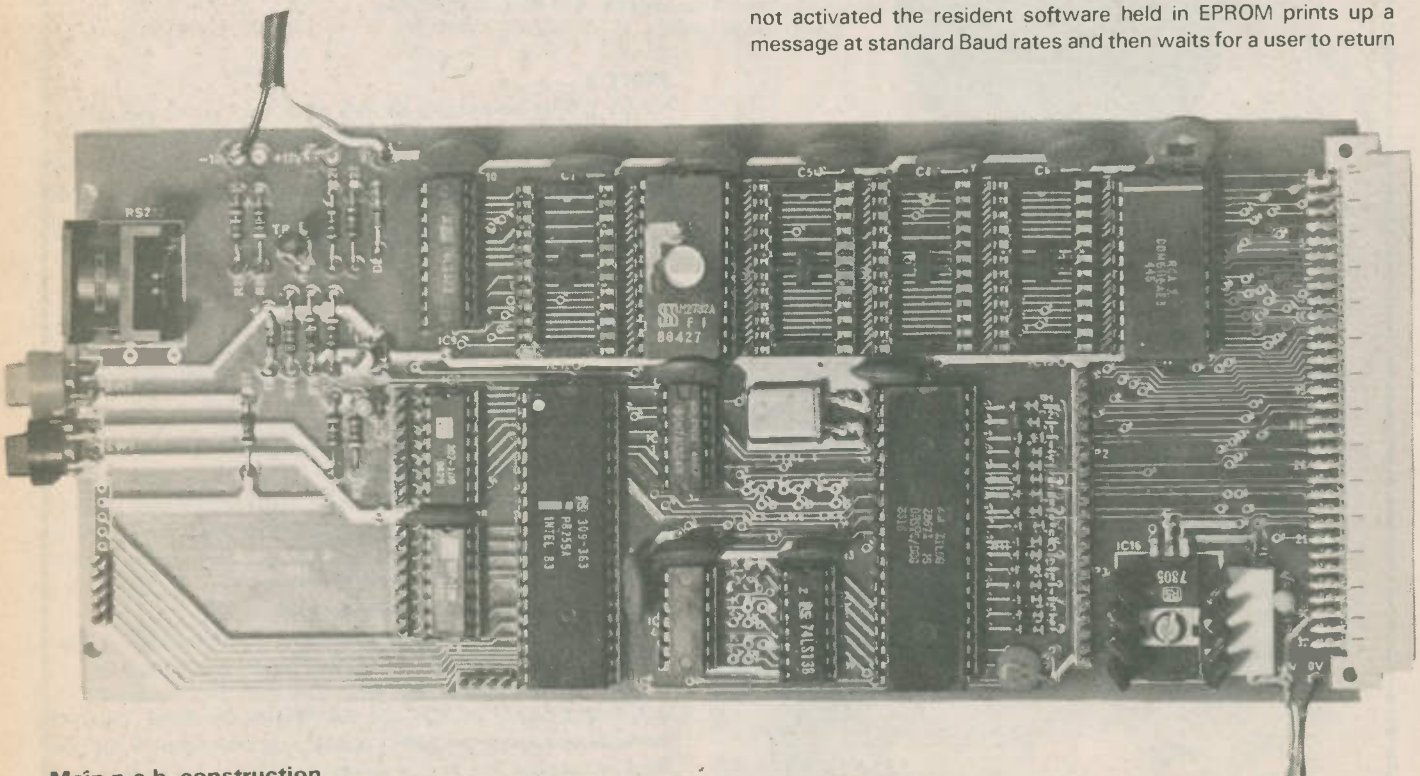
Statements:

GO@	Branches to an assembly language routine. This statement is similar to USR except no value is returned by the assembly language routine.
GOSUB	Calls a subroutine at line number.
GOTO	Branches to a line number.
IF/THEN	Used for conditional operations and branches.
INPUT	Inputs expressions separated by commas.
IN	Same as INPUT except values remaining in the input buffer are used first, then new data is requested.
LET	Assigns the value of an expression to a variable or memory location.
LIST	Lists the current program.
NEW	Establishes a new start-of-program address.
PRINT	Lists its arguments, which may be text messages or numerical values, on the output terminal.
REM	Used to insert comments.
RETURN	Returns control to line following GOSUB statement.
RUN	Initiates sequential execution of all instructions in current program.
STOP	Gracefully ends program execution.

SOFTWARE

Software for the RUR initially consists of a learning and then repeat routine. A demonstration program is activated upon power-up and press of the Demo button, so the robot can be used without a keyboard with the auto-Baud rate selection program, as well as a program to return the distance to any object in front of the SONAR. A delay routine is included to set-up delays as well as other routines for forward, backward, left and right chasing of the eyes and scanning the head.

The auto-Baud rate selection. After reset, if the Demo routine is not activated the resident software held in EPROM prints up a message at standard Baud rates and then waits for a user to return



Main p.c.b. construction

a Carriage Return (%OD). It then counts the number of 0s received and sets the Baud rate accordingly.

The Demo routine sends the robot off to do a demonstration of its skills, and ends up with a short random walk under sonar control. If the demo button is repressed three times in quick succession it will keep repeating the demo routine until it is reset, *or worse!*

The Learn program is a simple learn program written in Tiny BASIC machine code with sections to outputs. Some of it is stored in RAM so the user can supply actual routines and extend and tailor the program to any individual robot, or any modification the user might have added. Options also exist to load and save sequences, EDIT LIST the program.

COMMANDS: FD = forward, BK = backward, LT = left, RT = Right, JP = jump, PA = pause, GO = go/execute, CL = clear, LI = list, LD = load, SA = save, ST = stop.

THE BASIC

On existing to BASIC the program stops. The choice can then be made to list and change the teach program, or reset. This allows access to Tiny BASIC and excellent language developed from Dartmough BASIC which is modified specifically for control and debugging of programs. A summary of Commands is listed in Table 3.

DEMO PROGRAM

A demonstration program is supplied with the RUR. At this stage the demo program should be typed in (See LISTING 1) and the functions checked.

LISTING 1. Demo A. To stop the program press RESET or ESCAPE

```
10 REM PROGRAM TO CHASE
20 @246 = 0        Port 2 outputs
30 A = 0
40 @2 = A
50 A = A + 1
60 GOTO 40
```

LISTING 2. Demo B.

```
10 REM EYE CHASING
20 @803 = 128          SET DDR 8255
30 A = 0          INITIALISE
40 @800 = A          OUTPUT TO 8255
50 A = A*R
60 IF A > 256 THEN GOTO 30          CHECK IF TOO LARGE
70 GOTO 40          LOOP ROUND
```

It is after conducting these checks that the motors, sonar rangefinder and eye l.e.d.s should be wired up.

Now is the time to plug in the ROM (with the power off), press the DEMO button and with any luck, see the RUR in action. ★

modems

M. TOOLEY BA and D. WHITFIELD MA MSc CEng MIEE

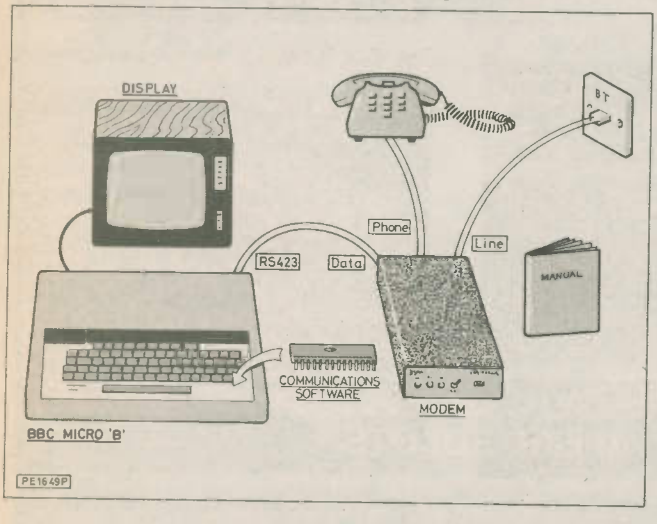
THIS month sees the conclusion of the modem series, and looks at what is involved in getting started 'on-line'. The objective here is to give an idea of what to expect once you've taken the plunge and decided to go on-line. The approach we have taken is to provide a number of illustrated examples of modem usage in conjunction with a BBC Micro. As described in previous articles, you will need to extend your computer configuration to include the following items in order to put your decision into practice: a BABT approved modem, a power supply/mains lead, a communications software package, a computer-to-modem lead, and a modem-to-BT socket lead or an acoustic coupler. To assist in choosing a modem, details of a selection of currently available (BABT approved) modems are given overleaf, together with a list of contact telephone numbers to get you started.

SETTING UP

The details of setting up your system to include a modem will depend very much on the computer involved. In the case of the BBC Micro model B, however, it is fairly straightforward because the serial port is already fitted, and the majority of modem software for the BBC Micro is provided on ROM. The Modem 84 package from Watford Electronics has been used in the examples of modem applications. This comes complete with the following items: a basic Prestel-type direct-connect modem (1200/75 and 1200/1200 baud rates) with integral mains power supply, modem manual, software in ROM, software manual, and leads for mains power, computer-to-modem and modem-to-BT connection. The configuration is illustrated in Fig. 1.

Installation is simplified by the provision of a socket on the back of the modem to allow connection of an existing telephone. This avoids the need for an additional telephone socket or a two-way adaptor by allowing the modem and telephone to share a single BT outlet. The software is installed by inserting the ROM into a convenient socket, and a function key overlay is added to identify the additional functions supported by the package. The two signal leads from the modem (to the computer and the BT socket), and the mains supply complete the installation. Once the installation is established, the next step is to try it out in action.

Fig. 1. Basic modem configuration



LOGGING ON TO PRESTEL

Once the system is set up, the inevitable question arises: "What next?", The easiest first step is probably to try out one of the ready-made demonstration facilities available on an on-line database. Depending on your interests, you may then choose to take a subscription with, say, Prestel, but initially a demonstration will help you get the feel of this type of system. What follows, therefore, is a step-by-step guide to using the Prestel demonstration with the BBC Micro and Watford Modem 84. This is only a simple demonstration, and for clarity it does not make use of many of the software facilities.

Assuming that the system is configured as shown in Fig. 1, the first step is to switch on the system and activate the software package. This is done using the *PRESTEL command provided by the ROM. This causes the introductory display shown in Fig. 2 to be produced. The next step is to obtain legal access to the Prestel computer for a free demonstration of its capabilities. This, for example is available on the London 'Enterprise' computer, but is also available on a number of other Prestel computers. The telephone number of the Enterprise computer is 01-618 1111, and ringing this number should result in a continuous tone being heard. When this occurs, switch the modem on-line, and replace the telephone handset; the modem will then hold the connection until you 'log off' the computer.

After a short pause, the Prestel computer will respond with the display in Fig. 3, which requests you to enter your customer identity. For the demonstration database you should type in 4444444444 (10 fours); anything you type will be echoed as a '—' for security reasons. After the last '4', the computer will automatically move on to the display in Fig. 4, and request your password. Entering a code of 4444 gives access to the demonstration database, and the welcome page in Fig. 5 is then displayed. Pressing any number moves on to the second welcome page, Fig. 6. Pressing any number then displays the top level 'menu' of choices, as shown in Fig. 7; you are now in the database proper. All of the subsequent pages are accessed from menus like this, all with accompanying messages to help you find your way around. The menu approach allows you to move down and back up the tree-structure of menus. Thus, for example, selecting 1 from the menu in Fig. 7 moves you into the Micronet 800 demonstration area of the database.

For further details of Prestel and Micronet 800, you can apply directly from your terminal. Although there is a charge for many Prestel pages when viewed, the demonstration is free, other than your telephone call costs. Various choices allow you to be shown the whole demonstration one page at a time, or just see the highlights.

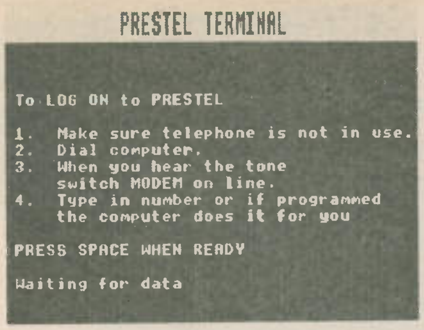


Fig. 2. WE Prestel ROM display

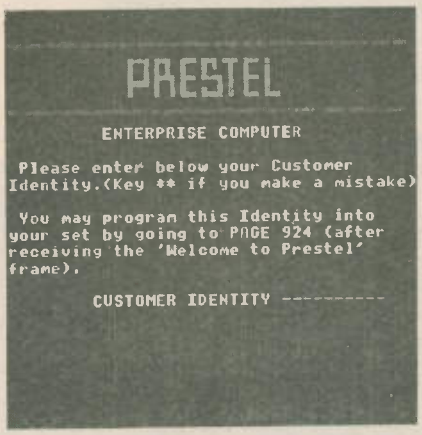


Fig. 3. customer identification

Fig. 4. password request

Fig. 5. Prestel—welcome

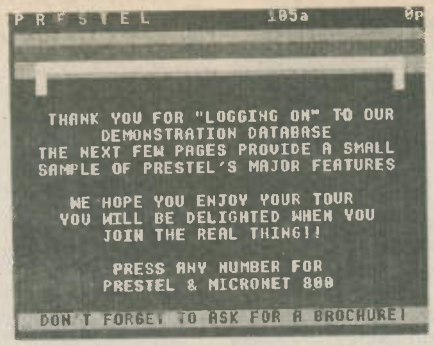


Fig. 6. Prestel—'logged on'

APPROVED for use with telecommunication systems run by British Telecommunications in accordance with the conditions in the instructions for use.

The above symbol is the BABT green circle of approval. It is illegal to connect to the public network any piece of apparatus showing the red triangle (below).

Guides for suppliers and users covering the Marking Orders and advertising of telecommunications apparatus, including extension telephones—'What you need to know before you buy' can be obtained free of charge from, Mr. R. Smith, D. P. Mailing Ltd., Streatham Road, Mitcham, Surrey, CR4 2AA. (01-640 7418).

The Department of Trade and Industry also issue a free leaflet educating users in the importance of the Marking Order. Available from, Ringing the Changes, Marketing Solutions Ltd., 70 Salusbury Road, Queen's Park, London, NW6 6NU.

PROHIBITED from direct or indirect connection to any telecommunication system run by British Telecommunications. Action may be taken against anyone so connecting this apparatus.

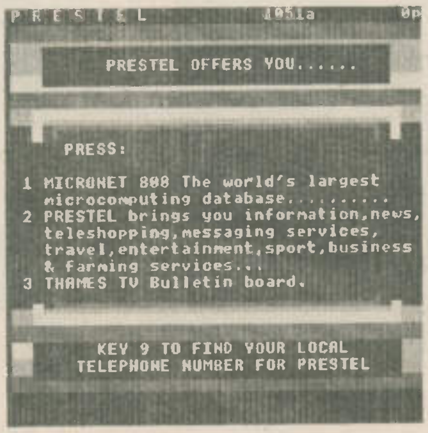


Fig. 7. Prestel—options

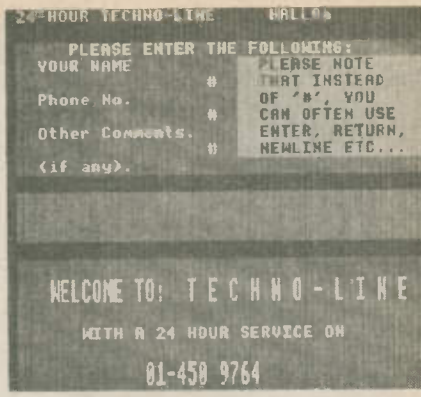


Fig. 8. Techno-Line—welcome

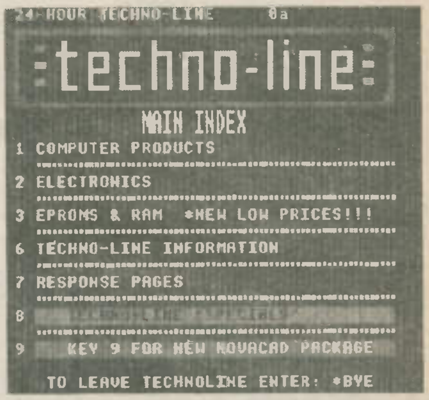


Fig. 9. Techno-Line—main index

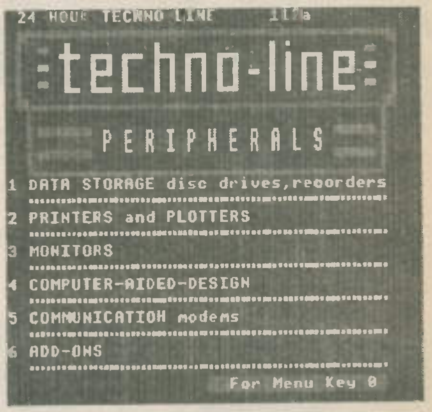


Fig. 10. Techno-Line—peripherals

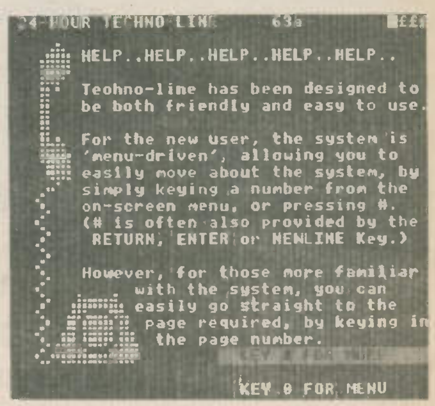
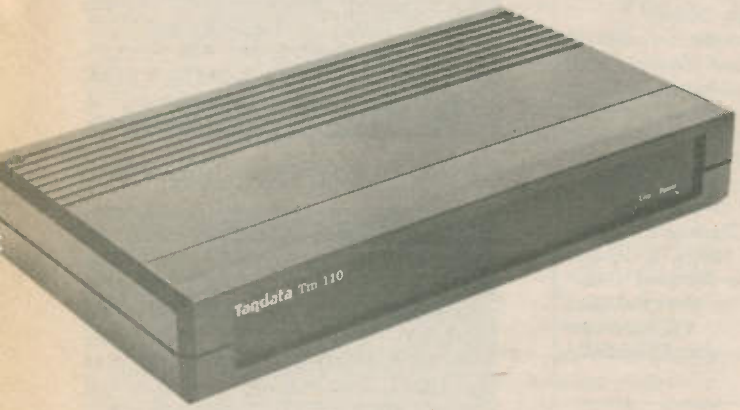


Fig. 11. Techno-Line—information

EPSON 'CX-21 ACOUSTIC'

WATFORD 'MODEM-84'

MIRACLE TECHNOLOGY 'WS 2000'



TANDATA MARKETING 'TM 110'

SCICON 'BUZZBOX-AA'

PACE SOFTWARE 'NIGHTINGALE'

	CX-21	MODEM-84	TM-110	WS 2000	BUZZBOX-AA	NIGHTINGALE
BAUD RATES	300	1200/75	1200/75	300, 600, 1200/75	300	300 1200/75
INTERFACE	RS 232	RS 232 (BBC)	RS 232	RS 232	RS 232	RS 423/232
OTHER FEATURES	Self-check Test & Answer Facility.	Auto-log-on. *Price Includes BBC Software.	Autodial. Autorecall. Autotransmit. 8 Number Memory	Autodial. Autoanswer. Many Baud Rate Options.	Power Supply Included. Also Modular Jack Adaptor.	Self-check Facility. BBC Lead Included.
PRICE	£187.45	£71.00*	£119.60	£149.00	£127.50	£136.85
SUPPLIER	STC Electronic Services, Edinburgh Way, Harlow, Essex, CM20 2DE. (0279 26777)	Watford Electronics 250 High St., Watford, WD1 2AN. (0923 40588)	Tandata Marketing Ltd., Albert Road North, Malvern Works, WR14 2TL. (06845 68421)	Technomatic Ltd., 17 Burnley Rd., London, NW10 1ED. (01-452 1500)	Scicon Ltd., 44 Berners St., London, W1P 4AQ. (01-580 5599)	Pace Software Supplies Ltd., 42 New Cross St., Bradford, BD5 8BS. (0274 729306)

All prices were correct at time of going to press, they include VAT and p&p.

As software requirements and prices are so varied they have been omitted from this brief guide (unless an all-inclusive price has been quoted). Further software information can be gleaned from the addresses given in the table.

All the modems featured in this guide are BABT approved. Full specifications are obtainable from the addresses given in the table.

STOP PRESS The Watford 'Modem-84' is shortly to be superseded by a superior model. 'The Modem' (for the BBC) will be a 75/1200 and 300 baud machine with autodial, autoanswer and a ten number memory. It will retail at around £100 including software. (BABT approval applied for).

All-in-all it is well worth browsing through the pages on offer, but suggest you do so in off-peak periods to avoid large telephone bills.

One final point is the answer to a question which often causes a momentary panic: "How do you log off?". This is quite easy, if not exactly obvious; in reply to a request for a page selection, simply type "*90#". This will cause Prestel to display the log-off page and drop the carrier tone. The modem software should then drop the call, and you should return the mode switch to the off-line position.

ELECTRONIC MAIL ORDER

Returning to the theme of the first article, our second example is Techno-Line, which includes facilities for ordering components electronically. Techno-Line is a 24 hour service offered by Technomatic Limited on 01-450 9764. It provides a range of news and information services, in addition to telephone ordering facilities. Techno-Line operates with Viewdata/Prestel protocols on 300/300 or 1200/75 baud (automatic recognition). In the same way as Prestel, Techno-Line is organised around menus which allow you to get rapidly to what you are looking for. To give an impression of the facilities offered by Techno-Line, Figs. 8 to 11 provide examples of screen displays. Techno-Line provides a good example of the way in which suppliers are taking the new technology on board. Is this the shape of things to come?

CONTACTS

The following listing is a necessarily brief selection of contact telephone numbers for electronic bulletin boards and databases. The information was correct at the time of going to press.

Microweb
(The Micro User)
061-456 4157
Daily 24 hours
300 8-bit no parity/1 stop

Mailbox-80, Liverpool
051-428 8924
Daily 24 hours
300 8-bit no parity/1 stop

Micro Live
01-579 2288
Daily 24 hours
300 8-bit no parity/1 stop

Computer Answers Bulletin Board
01-636 3076
Daily 24 hours:
300 8-bit no parity/1 stop
Weekdays:
1200/75 Viewdata

C-View
(Rochford District Council, Essex)
0702 546373
Daily 24 hours
1200/75 Viewdata

Hackney B.C.
(Hackney Borough Council, London)
01-985 3322
Daily 24 hours
1200/75 Viewdata

Techno-Line
(Technomatic Limited)
01-450 9764
Daily 24 hours
1200/75 & 300/300 Viewdata

Distel
(Display Electronics)
01-679 1888
Daily 24 hours

CBBS Surrey
04862 25174
Daily 24 hours
300 8-bit no parity/1 stop

North Birmingham Bulletin Board
0827 288810
Daily 24 hours
300 8-bit no parity/1 stop

South-West Bulletin Board
0626 890014
Daily 24 hours
300 8-bit no parity/1 stop

Aberdeen ITEC
0224 641585
Daily 24 hours 1200/75 Viewdata

Micronet 800,
155 Farringdon Road,
London, EC1 3AD

THE TIMER was designed to be the brains of an automatic pond fish feeder that performs dutifully whilst I stretch my toes in the sand at a holiday resort each year. In fact, because I am forgetful, and *it* isn't, I let the fish feeder operate all summer long.

The circuit has many other uses, however, and so my particular application of it occupies only a section of this article.

The 9 volt battery-powered circuit uses CMOS technology to minimise power consumption, which is considerably less than one milliamp (worst case) in quiescent condition. The timing period may be selected by switch for either 12 or 24 hours, and at the end of each time-out a pulse is delivered to the reed relay. With the values given, the period of this pulse is adjustable from a fraction of a second to several seconds, but component values may be altered to suit individual requirements. In my application the potentiometer controlling this period called for the label *Dispense Quantity*. Equally, the circuit could control a water valve (via a suitably rated relay) which enables your tomatoes to enjoy a regular sprinkling.

CIRCUIT DESCRIPTION

A block diagram is shown in Fig. 1, and a circuit diagram in Fig. 2. The heart of the timer is a 4020 divider/counter i.c. This divides by 16384, and by clocking it with a slow multivibrator running at a period of 5·27 seconds a 24 hour period is obtained. IC1a forms the required clock multivibrator. A dual 555 timer was chosen because the other half conveniently provides the monostable function required at the system output.

In essence, the 4020's fully divided output, and its halfway output are taken to switch S2 for 12/24 hour selection. The chosen signal is routed from there to the trigger input of the output monostable.

The circuit's operation is that simple, but there is a subtlety. Whilst designing the circuit I decided that before I could head for the sun with any peace of mind I would need proof that the electronics are working. What is more, I did not wish to stand over the unit for twelve hours to find out. So, I designed a test function that accelerates the clock to the point where the whole system counts through in a minute or so.

Take a look at the multivibrator IC1a. It can be seen that the timing has *two* resistor chains feeding C3. Accelerated oscillation is achieved when R4 is selected by the bistable IC3a and b.

Accelerated test is automatically selected at switch-on because C9 acts as a momentary closure switch to 0V until it is charged up by R7. Once the system has cycled through, the output from the monostable IC5a and b is also used to reset the bistable IC3a and b and return the circuit to normal operation. It is the negative pulse that achieves this, bringing VR2 and R2 back into the timing network with C3. VR2 provides the multivibrator with a trimming function to allow the unit to be adjusted to exactly 24 hours. Really, VR2 goes beyond being a mere trimmer, as its value would imply. Quite a range of periods can be squeezed out of the 1M preset.

The other gates, IC3c and d, and IC4a and d form a 1ms monostable which generates a short reset pulse for the divider-/counter IC2. This ensures that the very first time-out period after the switch-on is of full duration.

Finally, the remaining gates IC5a and b, and IC4b form another monostable to limit the output pulse from IC2 to 1ms to trigger the main output monostable IC1b.

There is one other subtlety, and this is the line (inverted by IC4c) between IC2's output and the reset input of IC1b. If r.f. noise from a nearby lawnmower is excessive, corruption of the counting circuit will not be avoided unless the electronics are housed in a metal case, however, *that much* interference is unlikely, and we can at least stabilise the output monostable during the count period. The line in question does this by holding the monostable in reset mode right up to the moment it is to be triggered. A sparky lawn mower cannot now bury the fish in pellets or flood the tomatoes.

Note that spare gates are wired input-to-ground to prevent them oscillating.

BENDING IT

The output monostable period may be varied if its range as published does not suit you. You may alter the value of C1 or the values of VR1 and R1. The most likely alteration will be to increase the period, in which case increasing these component values will do the trick.

Capacitor C10 is included to decouple noise from the supply rail and may not actually be necessary; it depends upon what you connect to the timer that is also powered by the battery. If you include C10 then use a high working voltage capacitor or a good low leakage type.

The reed relay contacts are rated at about 500mA and should not be used to switch mains under any circumstances. Neither should they be used to switch an unsuppressed inductive load.

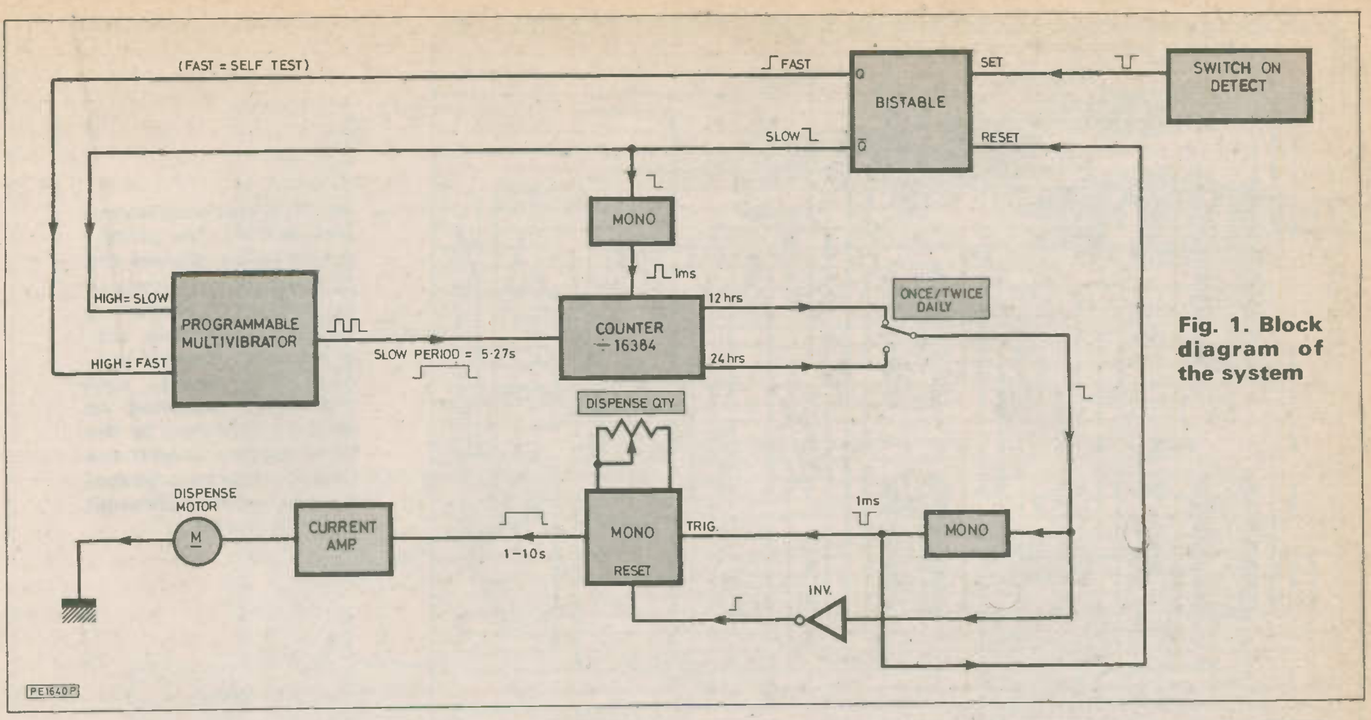


Fig. 1. Block diagram of the system

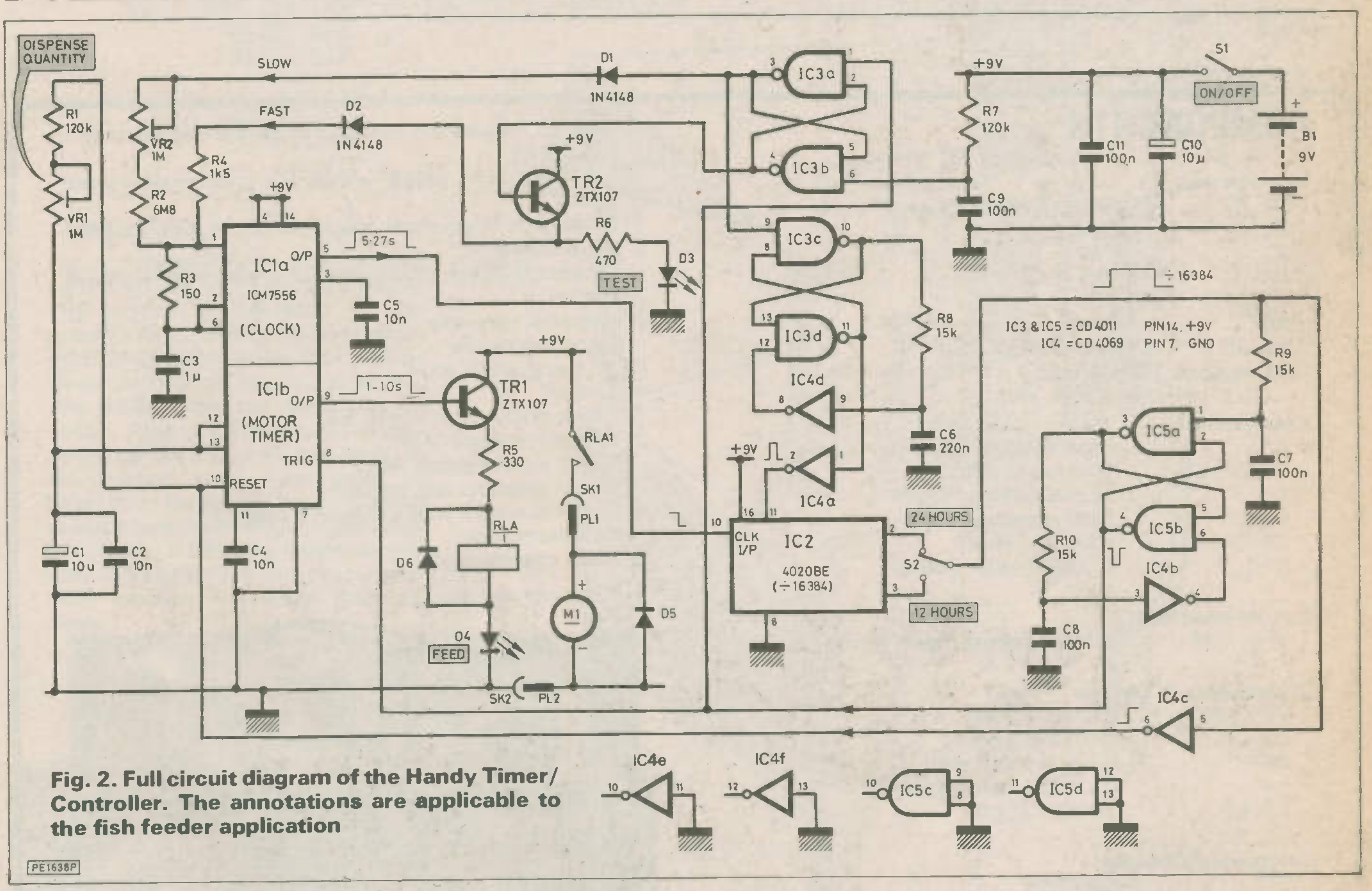


Fig. 2. Full circuit diagram of the Handy Timer/Controller. The annotations are applicable to the fish feeder application

. . . OR HANDY TIMER/CONTROLLER

FEATURES:

Auto self-test for applications which demand reliability.
12 or 24 hour cycle selection.
Variable output pulse duration.
Very low current consumption (PP9 life 3 months typical).

APPLICATIONS:

Automatic fish feeding station.
Daily reminder alarm.
Greenhouse sprinkler control.
Process timer or controller.

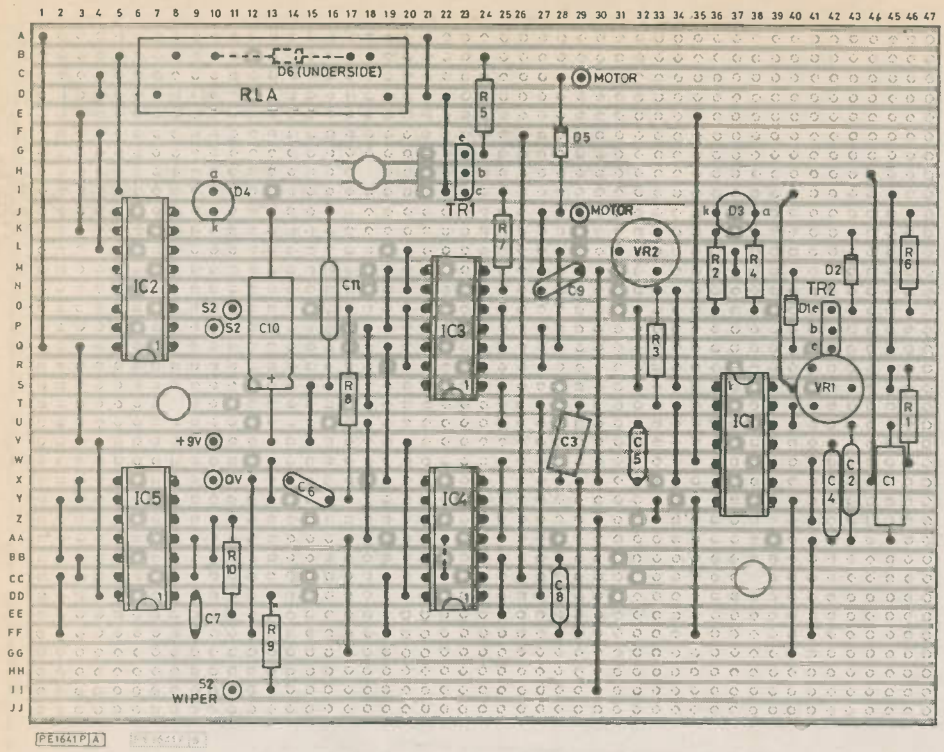


Fig. 3. Stripboard layout (actual size). The photograph below shows the *prototype* stripboard layout, and therefore differs from this diagram. If horizontal presets are used, and the board mounted on spacers attached to the lid of the box, then these presets may be adjusted by screwdriver through holes in the lid

COMPONENTS . . .

Resistors

R1, R7	120k (2 off)
R2	6M8
R3	150
R4	1k5
R5	330
R6	470
R8–10	15k (3 off)

All resistors ¼W 5%

Capacitors

C1	10μ/16V tant. bead
C2, C4, C5	10n disc (3 off)
C3	1μ metallised polyester
C6	220n polyester
C7–C9, C11	100n disc (4 off)
C10	10μ/63V elect. (radial)

Potentiometers

VR1, VR2	1M hor. cermet preset (2 off)

Transistors & Diodes

TR1, TR2	ZTX107 (2 off)
D1, D2	1N4148 (2 off)
D3	L.e.d. 0·1 inch red
D4	L.e.d. 0·1 inch yellow
D5, D6	1N4001 (2 off)

Integrated Circuits

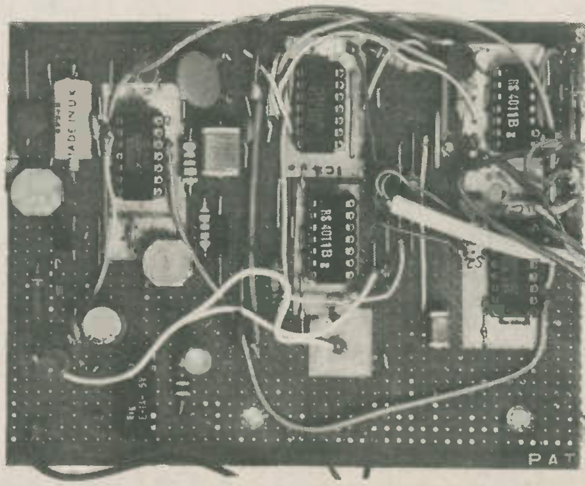
IC1	ICM7556
IC2	4020BE Counter
IC3, IC5	CD4011BE (2 off)
IC4	CD4069UBE

Miscellaneous

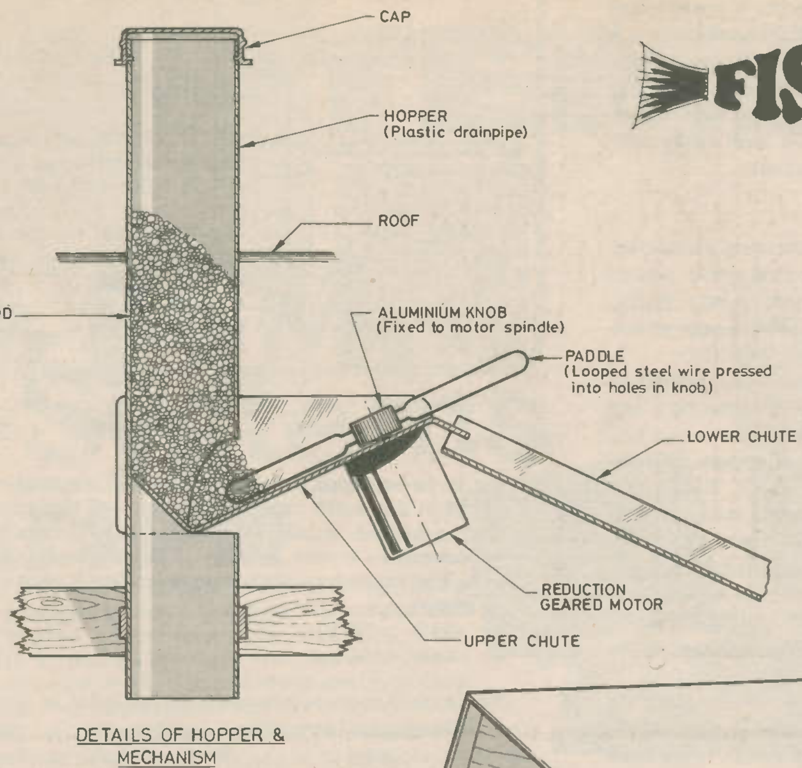
RLA 5V d.i.l. reed relay (Maplin FX88V)
PP9 battery
PP9 battery studs

Snap-lid Tupperware container or case (weatherproof)
Stripboard
Single-pole c/o toggle switch S2 (plus weatherproof boot?)
Single-pole single-throw toggle switch S1 (plus weatherproof boot?)
6V electric motor, mains relay, or whatever is required at output
Veropins, wire, etc
Dispenser paddle*
16 s.w.g. sheet alloy*
Timber*
Plastic drainpipe of 70mm dia.
Drainpipe clamps (2 off)
Wood screws (brass pref.)
Wood preserver and lacquer
Plastic sheet (for roof and base if desired)
Instrument wire
P.c.b. mounting pillars

* See text and diagrams



AUTOMATIC FISH FEEDER



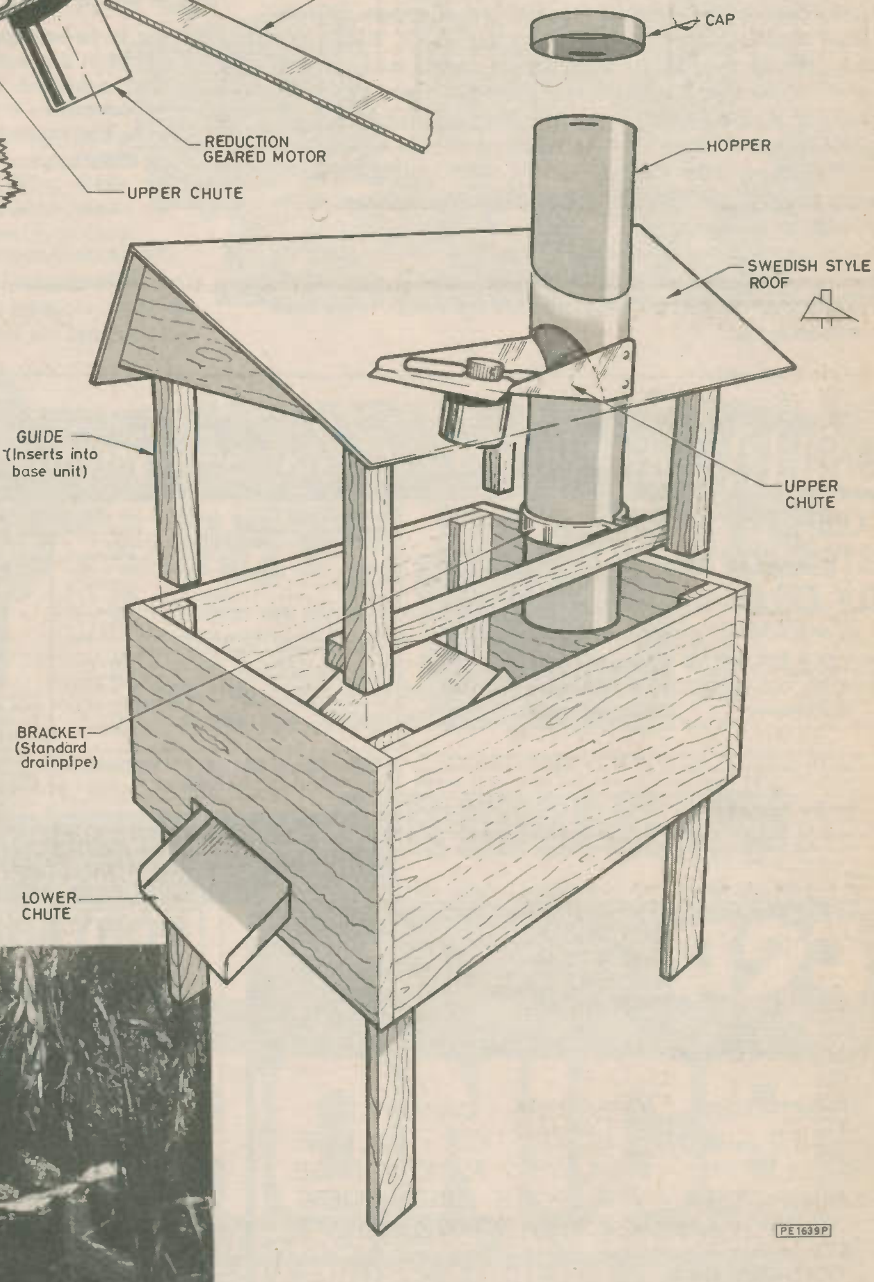


Fig. 4. A few hints on how to build an automatic fish feeding station. The system is intended to dispense pellets, and would not work with powdered food (the pellets illustrated above are not to scale). The paddle can be made from a solid spun aluminium knob screwed on the motor spindle in the normal way. Two pairs of holes may be drilled into the knob to accommodate loops of springy steel wire. If the wire loops are not fully formed before insertion, their own tension will keep them in place

CONSTRUCTION

The circuit may be constructed on stripboard as shown in Fig. 3. If the unit is to be operated whilst exposed to the elements then the circuit board must be housed in a watertight case. This is a worthwhile precaution anyway when using CMOS devices, particularly if mounted on stripboard, because whilst condensation may look like water to *you*, to CMOS it looks like a lot of resistors soldered randomly across the circuit board. At least spray both sides of the finished *and tested* board with lacquer.

FISH FEEDER

A few hints on the construction of a fish feeding station are given graphically in Fig. 4. A motor and gearbox assembly, which I think came from a car electric window winder, was found to be ideal. A reduction gearchain giving considerable mechanical advantage is necessary, so use a motor incorporating a gearbox.

The house comprises two parts; the wooden base mounted on stilts, and which incorporates the chute and electronics box, and the roof which has its own legs to act as guides which insert into the base. The roof incorporates the chimney, or hopper, and the dispenser which is a motorised paddle arrangement. The hopper chimney passes through the roof and is sealed with a liberal quantity. of Cow Gum. The roof is fabricated from treated plywood covered with stippled cement (now complete with lichen), and the hopper is a piece of 70mm diameter plastic drainpipe. An excellent cap for the hopper is the end cap from the cardboard tube in which a leading brand of fish pellets is sold. The hopper is slotted at the top in order to locate the cap.

The paddle dispenser is not mechanically linked to the chute; the pellets drop from the first stage to the second by gravity, which means that the roof can be lifted off once the motor wires have been disconnected.

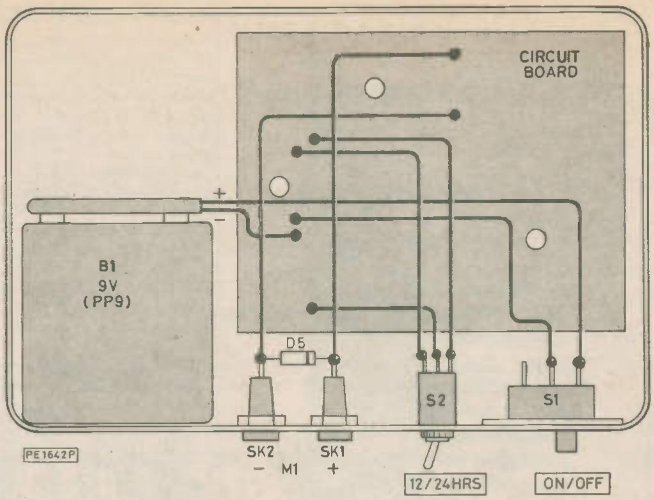


Fig. 5. In any application the timer/controller may be fitted in a plastic "sandwich box" of the type that can be sealed, if costs are to be kept down. Where appearances count, any good quality case will suffice. The prototype (*in a sandwich box!*) was laid out as above

The paddle dispenser principle is shown in Fig. 4, and it is made from sheet alloy (as is the chute). A pop rivet gun is essential, and I advise the mocking up of your metalwork using cardboard first so that you start out with a reliable template. ★

all in your

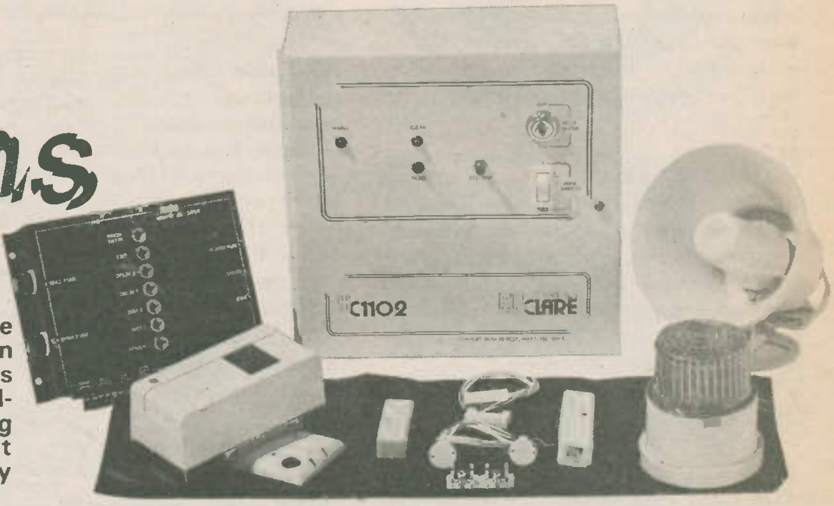
SEPTEMBER

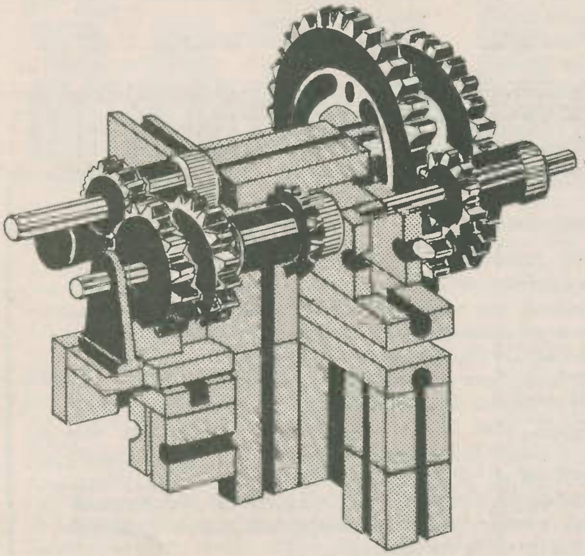
issue!

ALARM Systems

BUYER'S GUIDE

The constant media coverage of soaring crime rates has brought about a boom in the production of DIY intruder alarm products and kits. This guide looks at the elementary functions of available detection devices, control units and warning devices and their relevance within a system. It goes on to cover a good number of currently available kits and products.





EXPERIMENTING WITH ROBOTS

Robots are fun to use, but even more fun to invent, along with other kinds of servo machinery. This can be a cheaper hobby than buying a ready-built machine to use; *and a lot more fun.* We hope this new series will provide a platform for what is a whole new playground for the imagination.

CAR BOOT ALARM

Once the alarm is armed, the action of light falling on a hidden sensor will cause the car horn to sound continuously if the boot is opened by an intruder.

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SEPTEMBER ISSUE ON SALE FRIDAY, AUGUST 2

SPACEWATCH

By Dr. PATRICK MOORE O.B.E.

SPACE PROBES

Two important events take place this month. The new Observatory on La Palma is being opened, and the European space-probe *Giotto* is due to be launched towards Halley's Comet. Inevitably I am writing these notes ahead of time, but by publication we ought to know whether or not *Giotto* has been sent safely on its way.

If not, then we must resign ourselves to waiting 76 years for another chance, since the Russian and Japanese probes are designed merely to by-pass the comet, whereas *Giotto* should penetrate its coma and—we hope—send back close-range information about the nucleus. The encounter date is the night of March 13–14, 1986. By then Halley will have passed perihelion, and will have begun its journey back into the far reaches of the Solar System.

The *Spacelab-2* is scheduled for launching this month from Cape Canaveral, on the Space Shuttle. Two British experiments will be carried. One is an X-ray telescope, which will detect X-ray images of interesting regions in the Milky Way; actually there are two telescopes mounted side by side, carried on their own mounting which means that they can be aimed at targets independently of the attitude of the Spacelab itself. The other, a joint project of the SERC, the Rutherford-Appleton Laboratory, and the Mullard Space Science Laboratory, is CHASE (Coronal Helium Abundance Spacelab Experiment).

At the moment we are by no means sure how much helium is contained in the Sun's corona, and estimates range between 5 per cent and as much as 25 per cent. It is usually thought that the amount of helium in the corona will be much the same as that in the Sun as a whole, and that this in turn will be linked to the helium abundance in the universe as a whole—which is cosmologically very important indeed. CHASE should give a value accurate to within 10 per cent of the true figure. It consists of a two-metre grazing incidence spectrometer covering the wavelength range from 140 to 1350 Ångstroms, illuminated by a two-reflection grazing incidence telescope. Studies will also be made of the temperatures and densities of other regions of the Sun.

In my May article I referred to the forthcoming mutual occultations of Pluto and Charon. These have now been fully confirmed—and we are lucky, since from Earth the phenomena takes place for only limited period once ever 124 years, or half Pluto's revolution period. Spectroscopic work has already indicated that Pluto's surface is partly covered with methane ice, with less reflective regions whose composition is not known.

It is now thought that as Charon's shadow sweeps over Pluto during the next few years, we may even be able to define these dark regions. It would indeed be a major feat to draw up even a rough map of a world which from Earth looks like nothing more than a speck of light!

PHAETHON

Asteriod 1983 TB, discovered by instruments on board *IRAS* (the Infra-Red Astronomical Satellite) has now been given a number, 3200, and the name Phaethon has been suggested for it. This would be appropriate. Phaethon was the mythological youth who was allowed to drive the Sun-chariot for one day, and almost set the world on fire before Jupiter toppled him with a thunderbolt: Asteriod 3200 goes much closer to the Sun than any other known body apart from comets.

It has been suggested that it is a dead comet—that is to say, a comet which has lost all its volatiles—and could even be the parent comet of the Geminid meteor stream. True, the orbits are very similar, but very recent work indicates that Phaethon is "stony" rather than icy, in which case it can hardly have been a comet. I will have more to say about it in December, when the Geminid meteors are on view.

TOP OBSERVATORY

The observatory in La Palma, in the Canary Islands—officially opened this month by the King of Spain—is known

THE SKY THIS MONTH

The Moon is full on 2 July, so that for the first few nights of the month there will be no real darkness; but even the Moon cannot drown Venus, which is now of magnitude −3·7, and is a brilliant object in the east before dawn. It is now gibbous—that is to say, between half and full—and by the end of July it will be almost 70 per cent illuminated. On July 15 it will be just north of Aldebaran, in Taurus.

Of the other planets, Jupiter is in Capricornus, and is approaching opposition, due on August 4. It too is very brilliant, with a magnitude of −2·3, so that even small telescopes will show the main belts; and, of course, the four Galilean satellites which have proved to be such fascinating worlds.

Saturn, magnitude 0·6, is in Libra, and visible in the south-west during evenings. Mars and Mercury are to all intents and purposes out of view. Mars completely so, since it is in conjunction with the Sun on July 18.

The Perseid meteor shower begins around July 27, though the first part of it will be partly hidden by moonlight. However, during the maximum of the shower, around August 12, the Moon will be out of the way.

The Perseids are associated with Comet Swift-Tuttle of 1862, which has a somewhat uncertain period; it was expected back before now, but has yet to put in an appearance. Halley's Comet is brightening, but is still beyond the range of modest telescopes, though it will start to become more accessible during August.

SUMMER TRIANGLE

In the absence of strong moonlight, the unofficial "Summer Triangle" of Vega, Deneb and Altair continues to dominate the evening sky, with Vega more or less overhead after sunset. Ursa Major, the Great Bear (often nicknamed the Plough) is low in the north-west, though it never sets from anywhere in the British Isles; we can still see Arcturus, in Boötes, for some time after sunset.

Arcturus, that lovely orange star, is actually the brightest star in the northern hemisphere of the sky, with a magnitude of −0·04. Its only superiors—Sirius, Canopus and Alpha Centauri—are all south of the celestial equator, and of course Canopus and Alpha Centauri never rise at all in our latitudes.

Cassiopeia, with its characteristic W-form, is high in the north-east. Below it is the Square of Pegasus, which is distinctive even though maps tend to make it look smaller and brighter than it really is. In the south, not far above the horizon, look for the constellation of Sagittarius, the Archer; it has no particular shape, though it has several bright stars. (Some people have likened its pattern to that of a teapot, though I have never been able to understand why!)

If you have binoculars, or a rich-field telescope, it is fascinating to sweep among the lovely Sagittarius star-clouds which indicate the direction of the centre of the Galaxy. We can never see the actual centre, which lies around 30,000 light-years from us, because there is too much intervening dust; we are not at all sure precisely what lies in that decidedly mysterious region.

officially as El Observatorio del Roque de los Muchachos. Los Muchachos, or "the Boys", are rocks on the summit of the ancient volcano upon which the observatory has been built; I am sure that there must be a local legend about them, though I have never been able to find out what it is!

The island is Spanish, but the observatory is international, and the Royal Greenwich Observatory has played a very major role throughout; Dr. Paul Murdin, who is in charge of the British telescopes there, is a Greenwich astronomer. The first major British telescopes were the 40-inch Kapteyn reflector (named in honour of the famous Dutch astronomer) and of course the I.N.T. or Isaac Newton reflector.

The I.N.T. was originally set up at Herstmonceux in Sussex, the present headquarters of the Royal Greenwich Observatory, and had a 98-inch mirror (officially, at least; the usable aperture was slightly less). However, Sussex skies are not suited to astronomical work, and the decision was made to transfer the I.N.T. to La Palma, giving it a new mirror with an aperture of just over 100 inches.

The I.N.T. has been in use there for some time; I will not forget a night when I took part in a "commissioning run", and we managed to obtain a colour video of the Ring Nebula in Lyra—the first time that this had been achieved for an object beyond the Solar System. At present the even larger William Herschel Telescope is being made ready, and the dome is almost complete, though it is likely to be some months yet before the W.H.T. can be brought into operation.

There are other telescopes, too. The Swedes have a large solar tower, for instance, and the Danes have set up an 'automatic transit instrument' which takes star transits all by itself—with a somewhat uncanny effect if you happen to be present when a transit is due! Also planned is the Nordic Telescope, which will be a 100-inch reflector and is a joint project from Norway, Sweden, Denmark and Finland. The Dutch are deeply involved, too, and before long La Palma will be recognized as one of the major observatories of the world.

THE SKY FROM LA PALMA

What is the sky really like? Well, the high altitude means that seeing conditions are usually excellent (which is why the site was chosen, of course), and one often finds that the cloud-layers lie below the summit. There is also the question of latitude. Though La Palma is well north of the celestial equator, so that features such as the Clouds of Magellan are inaccessible, the difference between their skies and ours is quite striking.

When I was there, a few weeks ago, I was surprised to see how high up the grand globular cluster of Omega Centauri was. You can also have superb views of the Sagittarius star-clouds, which are always inconveniently low from Britain. I was just able to see Canopus, though it skirts the horizon even when at its greatest altitude.

Of course, the telescopes are fully automatic, and today the observer is not even in the dome which contains the telescope itself during observing runs; everything is done from a comfortable control room, and the results come up on a television screen. Gone are the times when the observer had to spend long hours at the eyepiece, guiding the telescope during photography. Moreover, it will be possible to operate the telescopes from afar, so that the observer need not even be in the Canary Islands. Things have changed; La Palma is the most modern of all observatories, and we may confidently expect great developments there in the near future.

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PE BAZAAR AUGUST '8

THE LEADING EDGE

CLIVE'S PUZZLE

There is some little known background to the decision by Sir Clive Sinclair now to use wafer scale integration (WSI) techniques proposed and patented by Ivor Catt, ten years ago. When Sinclair first announced the decision, last August, the word soon went round that Catt had previously failed to sell his idea to Plessey, STC and ICL.

This seemed puzzling, because Sinclair had teamed with Robb Wilmot, Chairman of ICL. At around the same time, Trilogy, the US company formed by Gene Amdahl to make wafer scale i.c.s, ditched the idea. The big question, which Sir Clive Sinclair's company will have to pay millions to answer, is this: was Ivor Catt's idea feasible but ahead of its time, or an armchair theory that can never be put into practice.

The public records at the British Patent Office tell an interesting tale on this. Ivor Catt filed a patent application on the WSI idea in August 1972. This was issued as British patent 1 377 859 in the mid-70s. Annual renewal fees have been paid ever since, to keep it in force, even though a string of UK companies has reputedly turned down the chance of a licence. If Sinclair now manages to exploit the Catt patent, he will embarrass not only these companies, but the Government's Department of Trade and Industry and its Ministry of Defence as well.

In June 1975 Ivor Catt signed an agreement with the Department of Industry (or more accurately, the Secretary of State for Industry). The DI then authorised the Ministry of Defence to sign a contract with Middlesex Polytechnic, as part of the Advanced Computer Technology Project. The contract was for a feasibility study on Computer Associative Memory. Catt was given £500 to act as a consultant.

Under the terms of the agreement, the rights to any know-how which emerged as a result of the research project were to become the property of the Department of Industry. But the DI had to agree to grant Catt licence to use any such know-how. In return Catt agreed to pay back a share of any proceeds. He also had to promise to licence only UK companies, unless special permission were granted to deal with foreign firms.

Clearly Middlesex Poly, the MOD and the DI did not think the invention was worth exploiting. It was not until ten years later that Sinclair took the patent on board. The interesting question now is whether Catt and Sinclair will have to pay the Government a share of any proceeds if the Sinclair Research WSI project proves successful!

SELF TESTING

The patent, readily available for anyone to read or buy for a couple of pounds, explains the usual procedure for making individual microchips. Several hundred at a time are formed on a single slice or wafer of silicon. Each i.c. area is then automatically tested and marked good or bad. The wafer is diced into individual chips, the good ones saved and the bad ones thrown away.

Catt's idea, back in 1972, was that all the circuits on the silicon slice should incorporate a flip-flop logic switch and the wafer be left intact instead of diced. A test-signal is fed into one circuit near the centre of the wafer. If the test is positive its switch flips over to connect it to the next adjacent i.c. The test is run over and over again, with the connections spiralling out from the wafer centre, and the chips by-passed whenever the test fails. So the final result is a single silicon slice, with a large total memory capacity. This is doubtless how Sinclair plans to provide its first WSI product, a large plug-in memory for the QL.

The Catt patent suggests that chips made this way can be self-repairing. If one of the circuit areas fails in use, it is by-passed by the routing switches of the chips around it. Another advantage is that a memory made this way should be cheaper than a batch of separate i.c.s of comparable total capacity, because no time is spent dicing the wafer. Also the chip can operate faster, because there is no need for an external web of connecting wires.

SOUND SENSE

No-one has yet cracked the anti-sound problem. In theory it sounds such a simple idea. Use a microphone to listen to an unwanted noise, generate a replica in opposite phase and of equal volume, and hey presto the original is cancelled out.

In practice it's nowhere near that easy. If the sound to be cancelled is not constant, the anti-phase sound has to track it without any time delay.

This is obviously impossible. Every circuit has a finite response time. Room reflections, standing waves and absorption by people and furnishings mean that the sound in any environment will vary with listening position. Accurate cancellation in one area may even increase the sound in other areas.

But still inventors press on. Several universities have anti-sound research contracts and a recent British Aerospace patent (BP 2 126 837) explores another approach.

The aim here is to cut background noise in an aircraft, especially a prop plane, where the noise is particularly loud and annoying through beat effects caused by different engines running at slightly different speeds. British Aerospace have previously patented a system which relies on giving everyone a pair of headphones with a built-in microphone and amplifier that produces an anti-phase signal that is fed through the headphones. But if aircraft passengers must wear headphones, why not simply give them headphone ear muffs?

The new patent doesn't answer this simple question. Presumably British Aerospace have found that passengers don't want to wear anything over their ears anyway, because the new patent takes a different tack.

Inside the passenger cabin there is a microphone which picks up soundwaves coming in from the engines and produces a corresponding output signal. A notched wheel on the drive shaft of one of the engines spins past a magnetic pickup to produce a train of reference pulses which gives a firm tell tale of engine speed. These pulses are impressed on the microphone output and the mixed signal fed to a synchroniser which delays it before inversion and amplification.

The synchroniser calculates the interval between successive engine pulses and then delays the signal from the microphone by an interval equivalent to one full period. In this way the inverted and amplified noise signal, which is fed to a loudspeaker replica irrespective of the propeller speed.

British Aerospace suggest that the same basic idea could be adopted for use in an airport building or bus terminal, by replacing the engine pulse train sensor with a variable frequency oscillator which impresses a series of notional reference pulses on the signal. The interval between the pulses is altered by trial and error until the noise is suppressed, either manually or automatically.

It's an interesting idea, but if it works why are airports all still so noisy?

BARRY FOX

Digital Delay & Sound Sampler
WITH COMPUTER INTERFACE
John M.H. Becker — Part 3

THIS month we will take a further look at the constructional details and begin the various testing procedures for the Digital Delay line. To help with testing, a simple l.e.d. test board has been made as shown in Figs. 10 and 11.

BEWARE OF MAINS VOLTAGES!

From this point onwards you will be dealing with a unit that is coupled to the mains. Although there is a transformer, a switch and a fuse, it is still possible to be careless and accidentally touch a mains connection. Until the unit is completely assembled and fully tested, I suggest that the transformer be kept well away from the unit, in an insulated box for example, and bring out long 6 volt leads from it to the PSU connection on the p.c.b. If you are in any doubt or inexperienced, seek authoritative advice.

FIRST TEST

If you haven't yet checked all your joins with a magnifying glass do so now! Then connect the 6V a.c. leads between the transformer and the PSU. Switch on and check that approximately 8 volts or so is at the positive end of C47, and that 5 volts is present on p.c.b. pin 23. If it isn't in either case, switch off and check what you have done wrong. It is permissible for the voltages to be slightly higher, but any large difference is wrong, especially if the readings are too low. As you progressively bring in more circuitry during the testing, the voltage at C47 will drop, but the 5V line should remain about the same. This should be checked for at each stage of testing. IC36 is short circuit protected, so if a short occurs on the 5V line, correct the fault and leave IC36 to cool for ten minutes.

ANALOGUE TESTING

Until the unit is fully operational, keep any connecting wires slightly longer than they need to be. At the end of testing they can all be tidied up into neat harnesses and trimmed to a better length. Refer to the wiring diagram (next month) and connect VR1, 2, 3, 4, 10, 11, 12, the input and output sockets, S2 and S3. Insert IC1 and IC4. Plug in a cassette recorder to the input, and plug the output into your normal amplifier. Set VR1, 4 and 12 fully up, VR2 min, S2, S3 open.

Check that the signal passes through at about the same strength as it goes in, and that the level can be varied by any of VR1, 2, 4 or 12. Temporarily take p.c.b. pin wire 11 to point 9 instead of to the centre of VR4, check that the signal still passes through. Return wire 11 to VR4. Take the second p.c.b., connect it to the power points designated, and insert IC2 and IC3. Connect points 9 to 42, and 5 to 45. Temporarily take a short length of wire and solder it carefully to the negative ends of C11 and C15. The signal is now routed through the preamp stages, compressor, expander, filter and the output. Set VR6 to VR9 midway, VR1, 10, 11, 12 max, VR2, 4 min, S2 open, S3 closed.

Check that the signal still passes through to the amplifier, that S3 switches it off and on, that VR11 controls its level, and that VR10 acts as a treble control. The fine setting of the presets can be left until later. Disconnect the wire between C11 and C15. The analogue circuits can now be ignored for a while.

TIMING BOARD

Connect up the designated power line connections of the timing p.c.b. plus VR18, 19, 20, S4, S5, S6, and insert all of the i.c.s. With a meter or scope check that with S4 closed and VR19 max a varying slow speed voltage change occurs on pin 9 of IC26, and that VR18 varies the rate of change. Temporarily take point 88 to any of points 19 to 22 (0V line). Next, S4 and S5 open, S6 closed. If a scope is used, check that h.f. oscillation occurs at the outputs of IC26 and IC23b, and that each output pin of IC27 goes up and down at one tenth of the rate of its input.

Alternatively if you don't have a scope and have built up the optional l.e.d. test board, this is connected to the 8V (136 or 138) p.s.u. line and to the p.c.b. output pins 74, 75, 76, 77, 78, 87, 89. Check that the l.e.d.s light in the correct sequence. If the flashing rate is too fast at the slowest clock setting, put a larger capacitor temporarily across C38 to reduce the rate. A scope can be synchronised to the test point on this p.c.b. and all outputs checked in turn. Additionally check that VR20 varies the clock rate, that S6 raises and lowers the range, and that S5 affects the control range of VR20. Then check that with S4 closed VR19 varies the depth of clock modulation. Disconnect point 88 from the 0V line.

ADDRESSING BOARD

Connect up the addressing and memory boards, complete all the remaining wiring, and insert the remaining i.c.s except for the memory chips IC15 to IC22. Switch S7 down and S8 up. Check that a negative voltage of about −3·5V is present at pin 36 of the first p.c.b., and that a bias voltage of about 2·5V is present at C30 and R45, and at C33 and R51. If using the l.e.d. test p.c.b. connect the board so that the l.e.d.s will flash in sequence when connected to p.c.b. pins 110, 107, 109, 106, 114, 113, 111, 112, in that order. Temporarily connect pin 108 to +5V (any of pins 23 to 25) instead of 74, connect 97 to +5V instead of S8, take 95 temporarily to 0V instead of 76. These three temporary connections put the multiplexer in Column mode, hold IC8 and IC9 at reset, and open IC7. Temporarily take 17 and solder directly to the track connected to pin 3 of IC23a instead of to 86, so bypassing this part of the IC. The l.e.d.s should now be monitoring the output of IC7 while it converts the voltage data from VR15 to binary. Set VR14 to min, and sweep VR15 from one end to the other and back again at a slow rate. The l.e.d.s should flash in a binary sequence. Now rotate VR15 to its zero end and VR16 to maximum resistance. Adjust VR17 until only the l.e.d. connected to pin 110

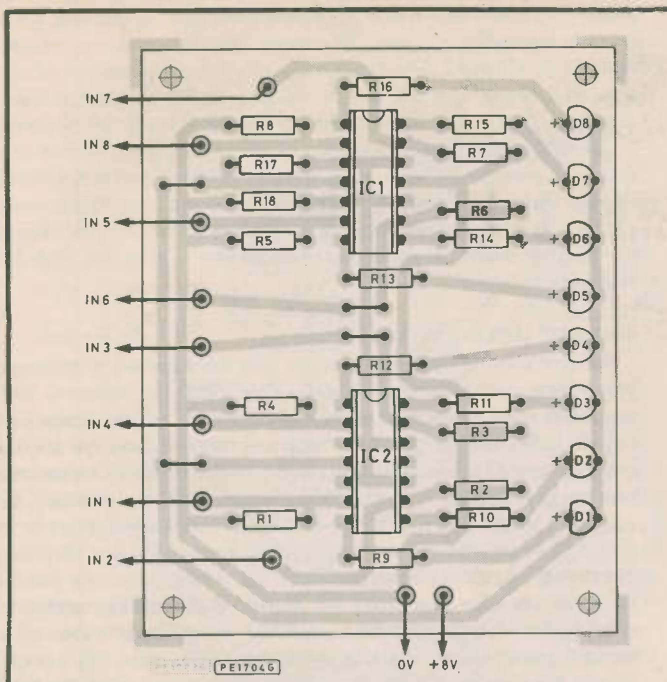


Fig. 11. P.c.b. construction of the optional L.e.d. Test Board

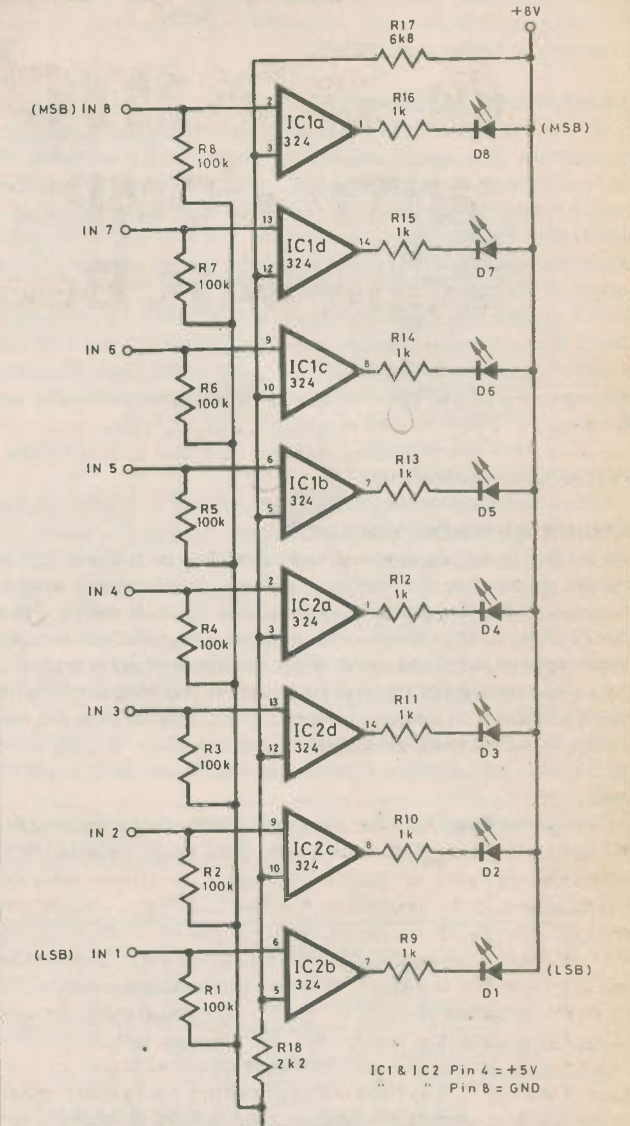


Fig. 10. Circuit diagram of the optional L.e.d. Test Board

Components . . .

Resistors

R1–R8	100k (8 off)
R9–R16	1k (8 off)
R17	6k8
R18	2k2

Semiconductors

D1—D8	0·2″ l.e.d. (8 off)
IC1, IC2	LM324 (2 off)

Miscellaneous

P.c.b.; sockets; p.c.b. clips.

is on, if necessary reducing VR16. Swing VR15 fully the other way to the full positive end, and adjust VR16 until all l.e.d.s are just on, if necessary readjusting VR17. Repeat this procedure until the displacement range is set from 1 to 255 decimal, but allow the minimum end to favour 2 rather than zero. Remake all temporary connections back to their correct points, except for the 108 connection. Leave the l.e.d.s connected. They will now monitor the main column address numbering. Temporarily take 95 to +5V instead of 76, so disabling the IC7 outputs. This ensures that nothing is added to the column address. Set VR20 to maximum frequency, open S4, S6, and close S5. IC8 and IC9 will now be counting up in sequence, the column addresses will be seen to change in binary order, and varying VR20 will vary the rate of counting.

Now take point 108 to 0V so that you can monitor and check the row addresses. The clock oscillator will probably need to be set to its slowest rate for the binary counting sequence to be individually seen on the l.e.d.s. Again remake all temporary connections to their correct points. Out of interest you can watch the various binary sequences taking shape whilst varying VR15, but it probably won't be too meaningful because of the rates of change.

A TO D SETTING UP

Connect the l.e.d. test board to points 55 to 62 in that order. Set VR1, 2, 3 to minimum. Adjust VR13 around its midway point until a binary reading of 10000000 (decimal 128) is shown. This is the midway point in the absence of a signal. It is not too critical, and a place or two to either side is acceptable.

MEMORY BOARD

Until you are sure that all is well with your connection of the memory board, only insert 4 memory chips to begin with, IC17, 18, 19 and 20. This covers the mid binary range, and thus lower level signals. Plug in the cassette recorder again, check that the signal still reaches the amplifier via VR4, then turn down VR4, close S3, and bring up VR11. Set the clock oscillator to its fastest rate, and set the address displacement controls VR14 and VR15 to minimum. An approximate representation of the original signal should now be heard, having been sampled, stored, and reconstituted again. It will probably be distorted at this point, for only 4 memory chips are used and some presets have yet to be set. Switch off, insert the other remaining chips IC15, 16, 21, 22. Switch on again and an improvement in quality should be apparent, especially at higher signal levels.

COMPANDER ALIGNMENT

VR6 to VR9 control the accuracy of the waveforms through the compander. If a scope and signal generator are available the correct setting will be obvious with a triangle wave. If you don't have a scope they can be readily set while listening to the ouput, in which case monitor the wipers of VR6 and VR8 with a voltmeter and adjust each until the voltage reads half the line voltage. In other words, if the line is 7·8V then set them for 3·9V. Feed in a signal from a cassette or signal generator, and increase the signal level until a little distortion is just heard, then adjust VR7 and VR9 until this is minimal, at which point both phases of the signal should be balanced. If you can hear no difference leave them midway and ignore.

FEEDBACK ALIGNMENT

For effects such as reverberation, repeating echo and flanging, feedback of the delayed signal is required, so that it is mixed with the original. In any delay unit the amount of signal fed back is fairly critical, particularly for flanging, where the effect can only be produced when feedback is close to the point at which 'howl' occurs. This point, though, only holds true for particular frequencies related to the phase of the original and processed waveforms. If the delay between the two is such that the waveforms of the frequency are out of phase with each other, then adding the two results in subtraction! One cancels out the other. If they are in phase, then full repetitive addition can occur each time round the loop.

Change the delay, and the phase relationships change and thus the howl point level. With such a wide delay range variable from a few milliseconds to well over a minute, virtually any frequency can at some point be in the correct phase for successive enhancement in feedback. A compromise has thus to be struck between the need to prevent howl, and sufficient feedback to allow a good number of repeating echoes to develop, plus adequate reverb and flanging enrichment. The compander circuits give a degree of self limiting to the howl effect even under some quite severe feedback situations, but an average amount of feedback must still be found by experimenting with the setting of VR5. Start off with this at a midway setting, turn VR3 up full with S2 closed. Feed in signals of various strengths, and give different delay settings, particularly around the shorter delay regions. Adjust VR5 until the best reverb or flanging effect is produced without the unit going into full feedback howl.

PHRASE HOLD SWITCH

At any time a particular phrase can be retained in memory indefinitely by switching off S7. This puts the memory into perpetual read mode, and data already stored will be repeatedly looped back. The length of the loop will depend upon the original delay setting of the sampling rate control VR20. Having frozen that phrase in memory, its pitch and duration can be changed by adjusting VR20. Varying VR14 and VR15 will have a short term effect while you move them, but nothing permanent. For very long loops with speech or special effects, the address counter can be reset to zero by switching S8 down. Switch it up again to commence recording, then switch S7 up to Hold mode at a suitable point before the end of the address sequence. S8, though, should only be used in the knowledge of its effect upon the RAS line.

MEMORY REFRESH

Each time RAS is strobed during the timing cycle, the data in all 256 locations associated with that Row is refreshed. Without this strobe, the data eventually decays to a level below which it cannot be retrieved. When S8 is switched down to the reset and external

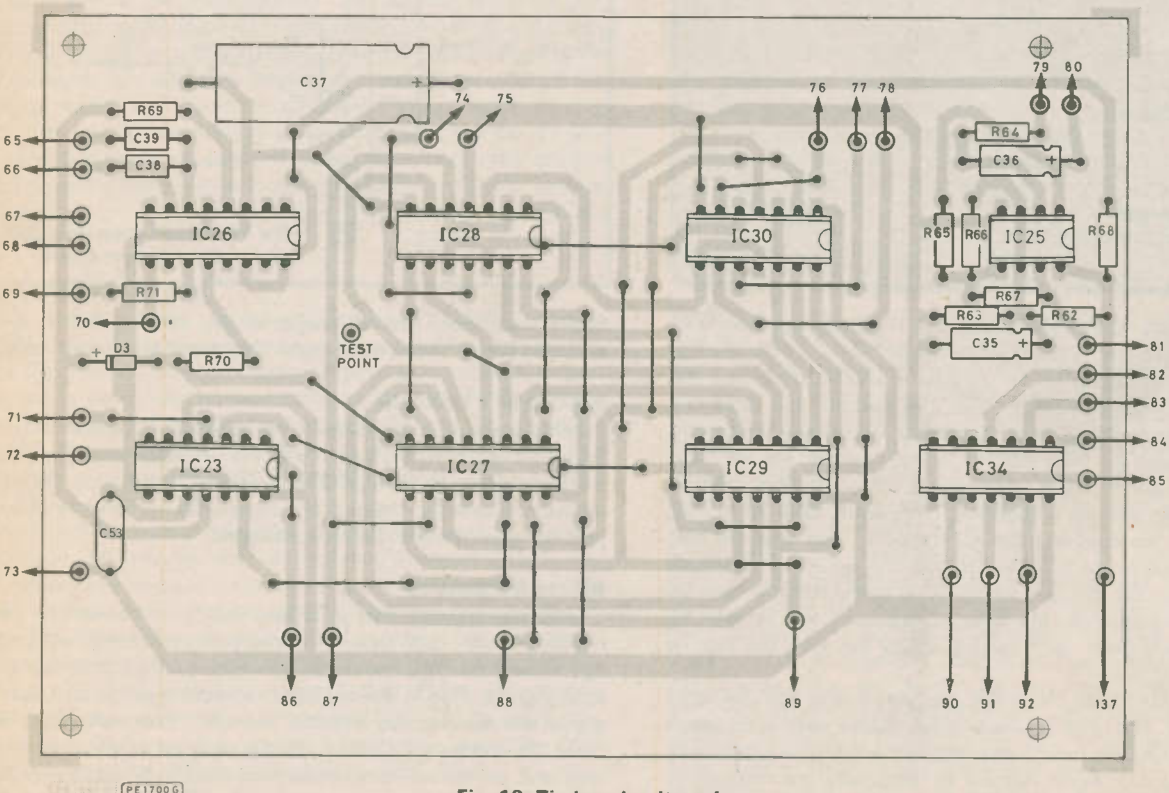


Fig. 12. Timing circuit p.c.b.

The p.c.b. layouts for the Digital Delay are shown as follows: (left) the timing circuit p.c.b. (top right) the compander and A to D/D to A circuits (bottom right) addressing circuit p.c.b.

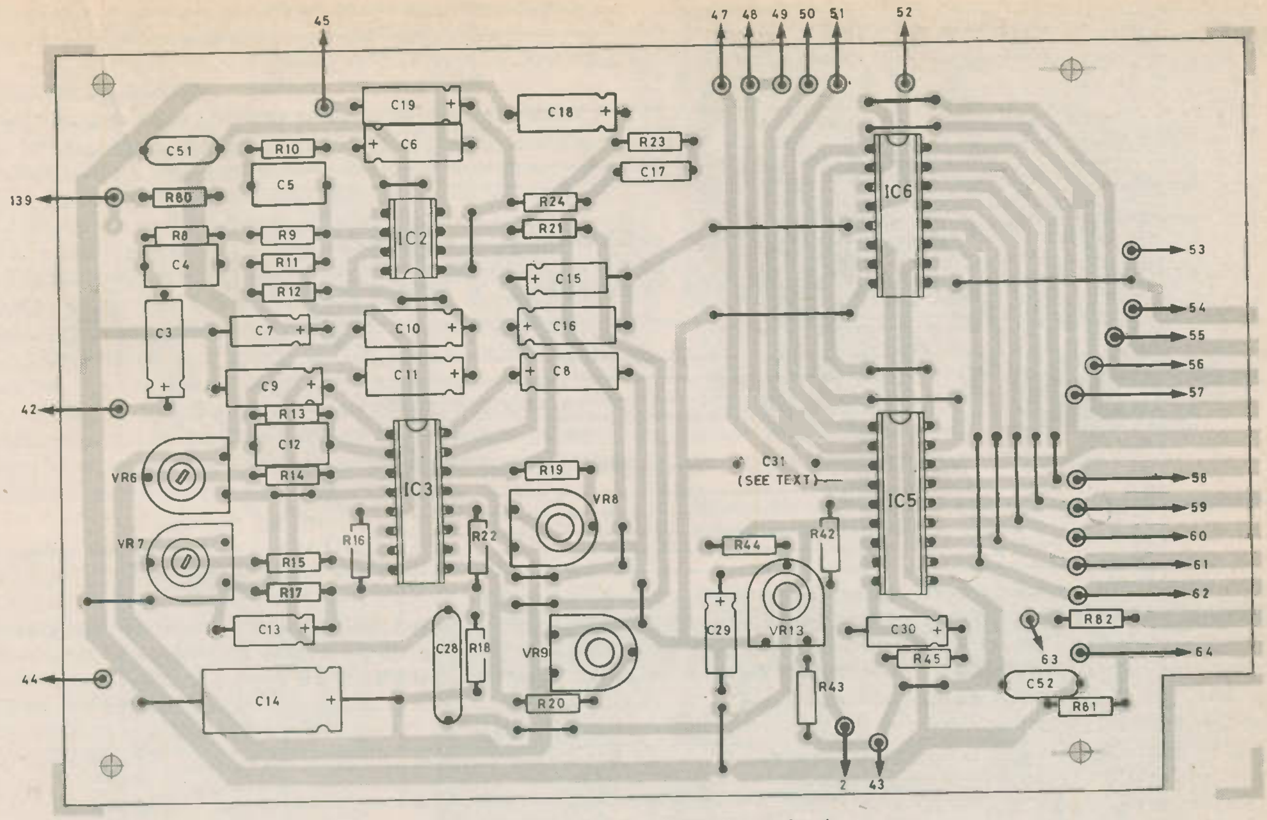
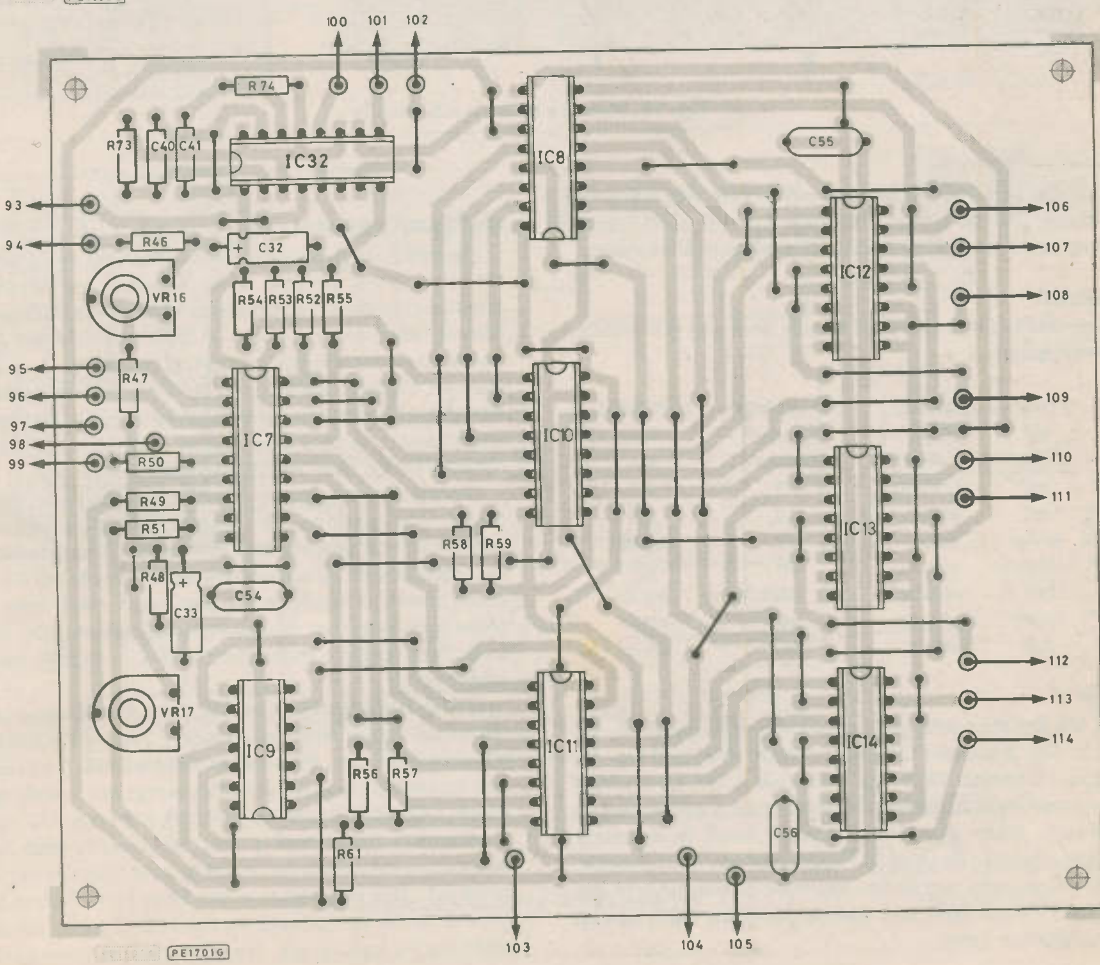


Fig. 13 (above) and Fig. 14 (below)



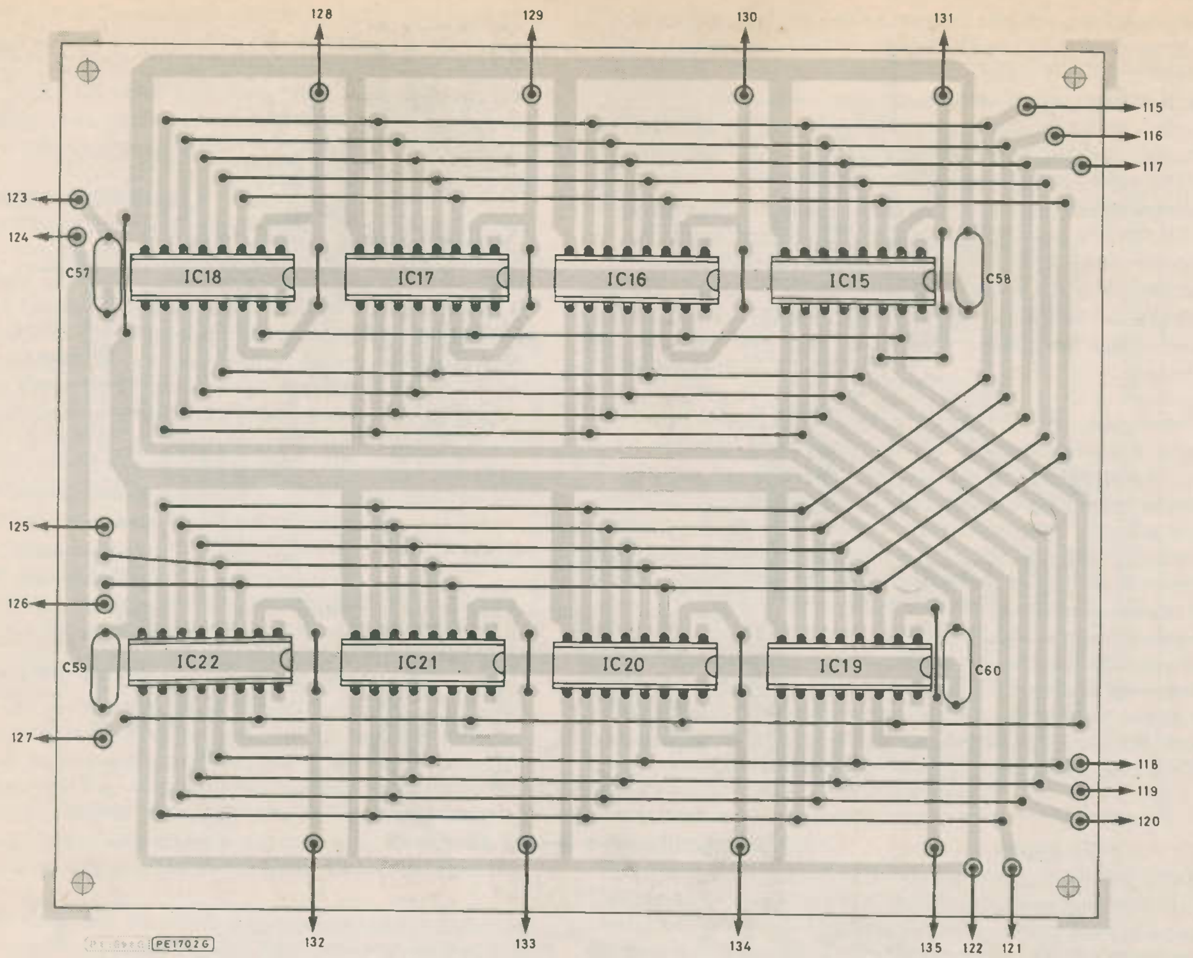


Fig. 15. Memory board p.c.b. details

modes, the timing sequence stops, refresh ceases and a gradual data decay starts, though on the prototype it remains accessible for several minutes before deterioration becomes unacceptable.

EFFECTS GUIDE

The ultimate setting of controls is largely personal preference, but as a general guide:—

EFFECT	LFO	DELAY	FEEDBACK	ORIGINAL
Echo	off	any	plenty	full
Reverb	off	v. short	plenty	full
Double track	off	shortish	off	full
Flanging	on	short	full	off
Phasing	slow	short	off	equal
Vibrato	fast	short	off	off
Chorus	fast	shortish	off	equal
Unnamed 1	some	short	full	equal
Unnamed 2	full	short	full	equal

TIDYING UP

When you are satisfied with your assembly, the boards can be stacked, p.c.b. Fig. 8 bottom LHS, Fig. 13 above it, and Fig. 12 above that, Fig. 15 bottom RHS, Fig. 14 above it. Now the wiring can be drawn into neat harnesses, trimming to a better length where necessary. Keep signal and control leads in separate harnesses. Cable ties can be used to ensure harness permanence. Finally mount the transformer at the top right of the back of the box, as looking from the front, and secure the mains earth lead to one of the transformer bolts.

EXTERNAL SAMPLING

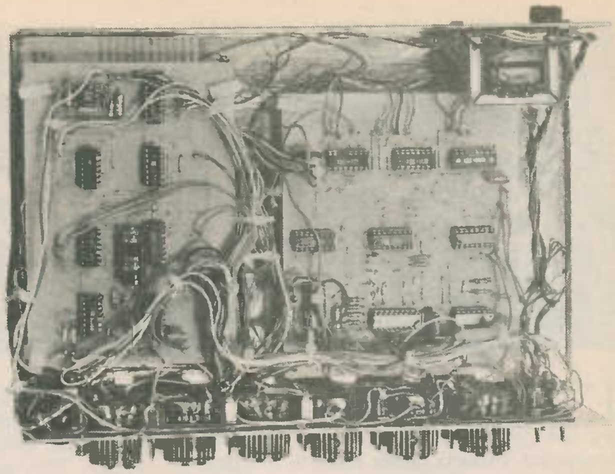
The internal memory can be switched off by S8 which then puts the unit under control from external equipment such as a computer. In switching off S8, the timing and address counters are held at reset, and the gates of IC33 and IC34 act as changeover switches, rerouting the control of the signal A to D Enable and Convert triggers, the D to A Latch trigger, and additionally opens an output Ready command line. In this mode the internal memory chips have their data lines held at a high impedance state and so have no effect upon the signal data conversion.

The signal conversion p.c.b. has been given an edge connection facility, configured to suit the User Port of my Commodore 3032, and has a track spacing of 0·156 inches. The external connections can alternatively be soldered direct to pins 53 to 64. The order of these tracks is unimportant and could have been any random order, providing that the ultimate destination order is correct. The track notations are those for the 3032 and their functions are as follows:-

GND (53)=Digital Ground (0V). CA1 (54)=Output to computer to tell it that data is ready to be taken. PA0 to PA7 (55 to 62)=data bits 0 to 7 in order. PA0 is LSB, PA7 is MSB. CA2 (63)=Line to tell unit to convert signal data from computer, needs to go up then down. GND (64) Digital Ground (0V), but via a 10Ω resistor. On the prototype I found that a low level earth loop existed when connecting the computer digital ground direct to the unit ground at point 53. This resulted in a low level hum. Taking the computer ground to the unit ground via the 10Ω resistor cured this without affecting the logic levels. Try your unit first connected to point 53, then if hum exists, use point 64 instead. All of these lines also have their equivalents on the usual IEEE computer connections.

AUXILIARY TRIGGERS

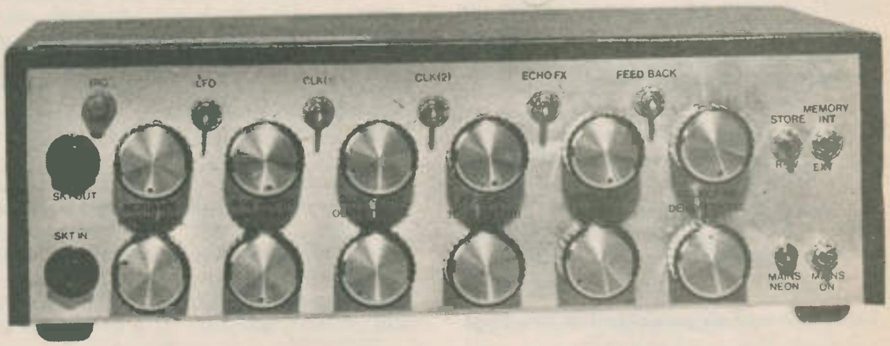
When the unit receives a positive going trigger pulse on the CB2 line, a faster pulse is developed by IC24b which triggers the conversion process of the signal A to D IC5. At this point the computer should have its output data ready on the data lines PA0 to PA7. The pulse from IC24b triggers IC35A to send a pulse to the D to A converter IC6 which reads and latches in the data from the computer. IC6 is only open to the computer for the duration of the pulse. Whilst this is happening the A to D is doing its conversion, and when complete the Ready output of IC5 goes high, is inverted by IC31c, passes through the gate IC33b and enables the output of IC5. Simultaneously a positive going pulse is sent by IC35b, via gate IC34d back to the computer on the CA1 line. Upon receipt of the pulse the computer knows that it can take and latch in the data from IC5. It can then do what it wants with the data before commencing the next cycle.



Photos illustrating the internal and external constructional details of the Digital Delay Line.

Constructors' note:–
A complete kit of parts or separate p.c.b.s are available from:
Becker Phonosonics, Dept. DDL, 8 Finucane Drive, Orpington, Kent, BR5 4ED (send s.a.e. for details).

NEXT MONTH: Final points and wiring



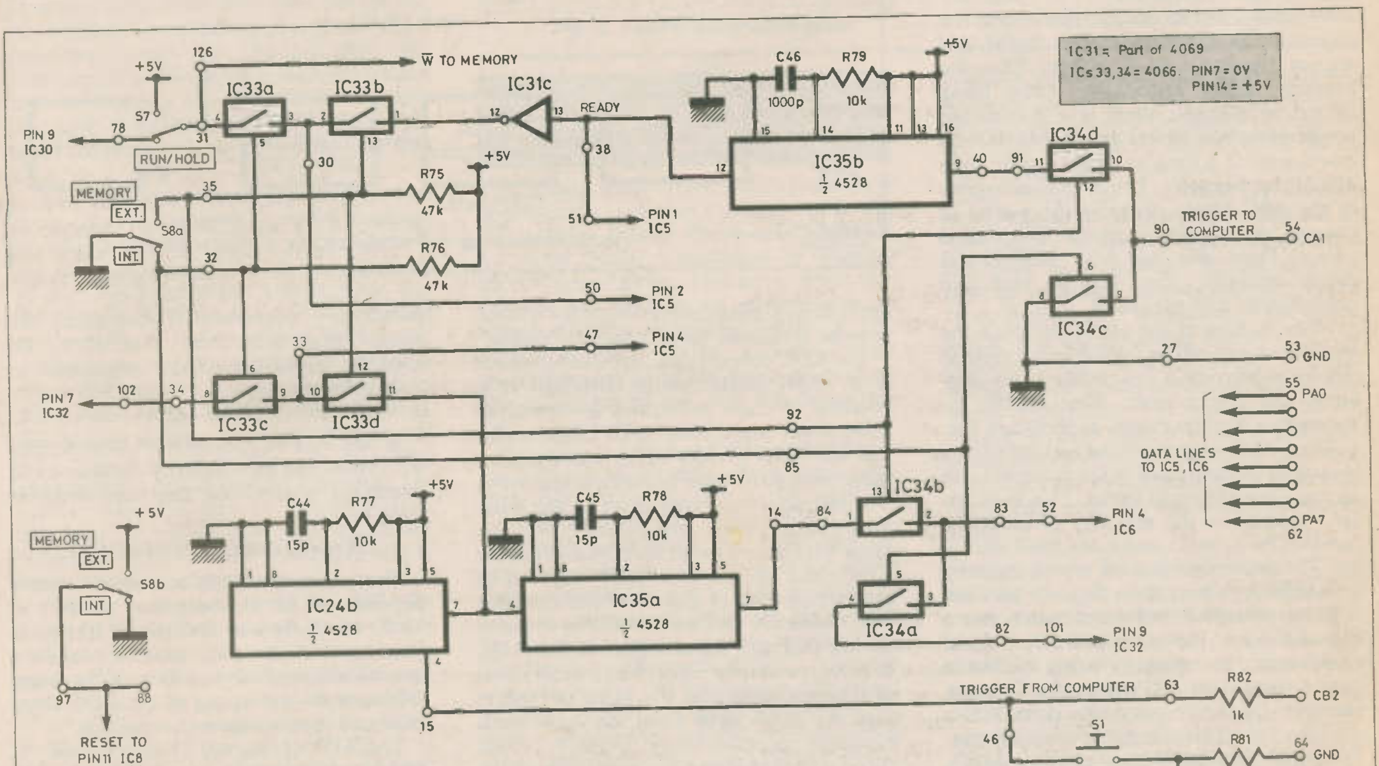


Fig. 16. Auxilliary triggering circuit diagram

BBC Micro Forum...

David Whitfield MA MSc CEng MIEE

LAST month in this column I started to look at the BBC Micro's analogue port. As we saw just by looking at the electrical connector, there is rather more to this port than its name might at first suggest. Essentially, the port is a connector which is shared by the analogue-to-digital (A-to-D) converter, the CRT controller, and the system VIA. For convenience, the destination(s) of these various input signals are summarised in Table 1. This month I will be starting to explore the A-to-D section of the analogue port in greater detail.

Pin	Signal	Destination
4,7,12,15	ADC channels 0–3	ADC
5,8	Analogue ground	ADC
11,14	Reference volts	ADC
10,13	Push buttons	System VIA
9	Lightpen strobe	System VIA and CRTC

Table 1. Analogue port signal destinations

A-to-D CONVERSION

Typically, signals in the real world are essentially analogue rather than digital, and are not usually electrical in form. Thus, for example, when considering water being heated in a kettle, there is a continuous temperature rise, rather than jumps of (say) one degree at a time as might appear on a digital thermometer. The A-to-D converter in the BBC Micro provides the means to convert such analogue signals into digital values. Once this has been done, these digital quantities can then be read and processed by user programs.

When looking at the use of micros in the real world, one of the fundamental tasks is clearly to provide a link between the analogue and digital areas. This usually involves two distinct stages, as shown in Fig. 1. The first is to convert the quantity to be measured (temperature in the example) into an analogue electrical signal. This is necessary because in the majority of cases the quantity being measured is not itself electrical. The conversion process is performed by a transducer, whose form depends on what is to be measured, but which rarely has a digital output. Having produced a signal representing the quantity being measured (e.g. a number of mV per degree Celsius), the next step is to convert this signal into a digital value. This process is normally performed by an A-to-D converter i.c. (ADC), which in the case of the BBC Micro is built into the analogue port and connected to the main system bus.

BBC MICRO'S ADC

The ADC device in the BBC Micro is a μPD7002, which is a 4-channel 12-bit converter. This means that it is capable of measuring up to four different analogue signals, one at a time. When the ADC is measuring the signal on one of these channels, each measurement takes a finite amount of time to complete. For example, when a 12-bit reading is required, each measurement takes approximately 10ms. Since only one of the input channels can be read at a time, this means that when all four channels are in operation, the measurements on each channel will be 40ms apart. One effect of this measurement interval is to limit the maximum frequencies which can be handled in signals being measured. At 10ms per sample, this maximum is around 50Hz, and falls to around 12Hz if all four channels are being used. Although this effect imposes a number of limitations, it is still perfectly adequate for a wide range of applications, particularly where the quantity to be measured varies relatively slowly.

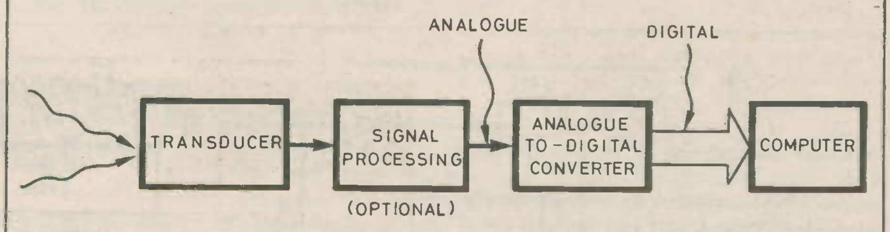


Fig. 1. Measuring real world values

The ADC output from each measurement is a 12-bit digital value (although it is possible to trade resolution for speed by using fewer bits). This 12-bit range means that the ADC divides up its measurement range into 4096 steps between 0 and 4095. The measurement range is set by the reference voltage (Vref) used by the ADC. The same Vref is used on all four channels of the ADC, and is approximately 1·8V. Vref appears on pins 11 and 14 of the analogue port connector, and care should be taken to ensure that any input signal to the ADC does not exceed its value. The overall effect of the resolution and the value of Vref is that the 4096 steps from the ADC each represent approximately 0·44mV. From this it is clear that any electrical noise on the input signal will easily affect the ADC output. Typically, therefore, the usable range of the ADC will be limited to 9 or 10 bits, unless some special precautions are taken. This resolution will, however, be more than adequate for many applications, and gives a resolution of 0·2% or 0·1% respectively. The ADC may be configured to give 8, 10 or 12-bit resolution, but by default gives 12 bits.

SOFTWARE FACILITIES

Unlike the user port, the analogue port is quite well provided with software facilities which can be used from BASIC. These are primarily ADVAL, *FX16 and *FX17. ADVAL(n) numbers the ADC channels from 1 to 4, and when called it returns the latest value read for channel n. In normal operation the ADC is continually measuring the signal on each channel in turn, and the MOS stores these latest values from each channel. The values returned are all multiplied by 16 to allow for future expansion, and thus the ADC steps appear to be 16 apart (rather than 1) as far as the program is concerned. To establish the latest value read from channel 1, for example, a BASIC statement might be:

```
X = ADVAL(1) DIV 16
```

If you wish to convert the value directly into volts, and have already measured and stored the value of Vref, then the alternative form is:

```
X = ADVAL(1)*VREF/65520
```

The accuracy of this conversion clearly depends on the accuracy and stability of Vref, which is not too good. If this is important, it is a good idea to connect a known reference voltage (e.g. a band gap reference device) to one of the ADC channels, and then compare the readings.

The ADVAL keyword has a number of other functions which are not related to the ADC channels, and these will be found described in Chapter 33 of the *User Manual*. One function which does relate to the

ADC, however, is ADVAL(0). This call allows the identity of the latest ADC channel read (multiplied by 256) to be determined. Thus, this will identify the latest channel:

PRINT "Current channel = ";ADVAL(0) DIV 256

The *FX16 command allows the default situation of the four ADC channels each being measured in turn to be altered. As shown in Table 2, the sequence can be limited to any number of channels from 0 to 4. This can be explored by using the method above to check that the range is limited.

In order to obtain the latest value from any given channel, the *FX17,n command (where n is the channel number) will start a measurement on the selected channel. The measurement will be available 10ms later. When using the *FX16/17 commands, do remember not to use them in multi-statement lines with BASIC commands *after* them; the remainder of the line is passed to the MOS for action.

Command	Channel Measuring Sequence
*FX16,0	No channels measured
*FX16,1	Channel 1 only
*FX16,2	Channels 1, 2 alternately
*FX16,3	Channels 1, 2, 3 in turn
*FX16,4	Each channel in turn

Table 2. ADC measurement sequence control

DIGITAL THERMOMETER

After the theory, it is now time to see how some of these ADC facilities can be put to work. Fig. 2 shows the circuit for a digital thermometer which can be connected to the analogue port. As is clear from the circuit, the number of components involved is best described as 'minimal'. The most important component in the circuit is the temperature sensor. This is a type 590kH, which is also available from RS as 308–809. The complete thermometer may be built for less than £10.

The 590kH semiconductor temperature sensor is a two-terminal i.c. which produces an output current which is proportional to the absolute temperature. If, like me, your physics has become just a little rusty, you may like to be reminded that the absolute temperature in degrees Kelvin is the temperature in Celsius plus 273·2 degrees. Thus, for example, a room temperature of 20° Celsius is equivalent to 293·2° Kelvin. For supply voltages between +4 volts and +30 volts d.c. the 590kH acts as a high impedance constant current regulator. The current passed is 1µA per degree Kelvin, and thus the voltage developed across any resistance wired in series with the sensor is proportional to temperature.

With a series resistance of 1kΩ, for example, the output from the thermometer will be 1mV/deg. The rated temperature range of the sensor is −55°C to +150°C, and over this range a maximum error of ±5·5°C is specified if no compensation is included in the circuit. If the preset in Fig. 2 is adjusted to give the correct output at 25°C (298·2µA), this maximum error over the range is reduced to ±2°C; the effect is illustrated in Fig. 3.

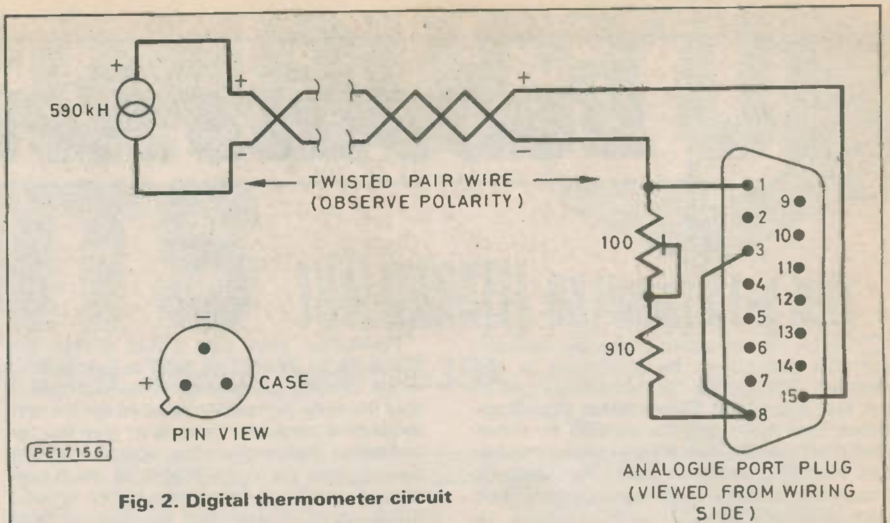


Fig. 2. Digital thermometer circuit

Construction of the thermometer is a straightforward matter. The resistors are most conveniently mounted on the rear of the 15-pin D-type plug used for the analogue port. The temperature sensor should be connected by a convenient length of a twisted pair of insulated wires. The circuit shows channel 0 (ADVAL channel 1) being used, but any of the other channels could equally well have been used. The leads on the sensor should also be sleeved to avoid accidental short circuits. If the sensor is to be immersed in liquid, the electrical connections will need to be totally encapsulated to avoid current leakage through the liquid, and hence false (high) readings. The sensor can be calibrated conveniently by using another thermometer, or by using a known standard such as the fact that melting ice in its own water will be at 0°C.

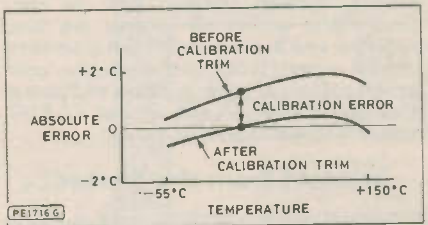


Fig. 3. Sensor calibration error

NEXT MONTH: *BBC Micro Forum* will be listing some suitable software for the digital thermometer, and then looking at some other uses of the basic temperature sensor.

Book Corner

This month a new book which could have been written with your scribe in mind. The **Epson/Kaga Printer Commands Revealed,** by *David Smith,* is published by Watford Electronics at £5.95. This book caters specifically for BBC Micro owners with an Epson FX-80 compatible printer. If you have a Wordwise ROM, it is even more useful because all of the examples include the commands to use with Wordwise (the OC. . . . strings).

But what, I hear some ask, is wrong with the substantial manuals which come complete with these printers; surely they are detailed enough? The real problem is not that they lack detail, but that they are written (or should I say "loosely translated from Japanese"?) for a wide market. As such, the commands (of which the printers in question support a great number) are illustrated in Microsoft BASIC. Although this has become an international standard of sorts, it does not help the BBC Micro owner who cannot get any response other than "Mistake" when the LPRINT examples given in the manuals are tried.

The introduction makes the point that this book is really a supplement for a standard printer manual, and not a replacement for it. To this end, every command description includes references to pages in the *Kaga, FX80* and *RX80* manuals, where full definitions of the commands will be found. Within the book there are 90 pages describing all of the commands available on the printers mentioned. Each command is described in a standard format, showing how to issue the necessary control codes from BASIC and Wordwise. This is followed by a description of the action of the command, and then a BBC BASIC example listing, with illustrations of the results where appropriate. The commands are arranged in eight logical groups, and each command description starts on a new page. The command described is indicated at the top of each page, and the book includes an index.

Verdict: *If you have already mastered your existing manual, this book may well be a more convenient reference, but do not expect to learn anything new. However, if Microsoft BASIC is a mystery to you, and you have a new FX-80 compatible printer, this book could save you many hours of "manual-gazing". The choice of whether this is a book for you depends very much on your needs, but I would have been happy to have had a copy by my side when my printer first arrived.*

Robotics Review

Nigel Clark

SCARA robots seem to be the fashionable devices to be producing at the moment. No sooner had we announced in the last issue that **Cybernetic Applications** was launching its version at Automan than we discovered that two competitors also had plans for using Automan as the event at which they would unveil their own SCARAS.

For the uninitiated SCARA is an acronym for selective compliance assembly robot arm and apparently they are finding increasing favour in industry.

Powertran Cybernetics, those close neighbours and rivals of Cybernetic Applications have a version called IVAX. It has four axes plus a gripper, three with rotational movement and the fourth vertical movement on the central pillar.

It is powered by d.c. motors with feedback provided by optical encoders. Constant torque springs have been used to eliminate the effect of backlash and it is strong enough to lift 1kg.

All the rotational axes, the two limbs of the arm and the wrist, can move through 270 degrees and it has a 40mm range of vertical movement. IVAX can work within an arc with radii of between 108mm and 280mm.

. . give the co-ordinates . .

On board it has a Z80A processor with options for either 2K or 8K of RAM, which allows storage of three or 15 sequences. Extra storage is available of either 512 or 2K bytes.

Powertran says that it has written the software to make it as easy as possible to write control programs. One example is that the only instruction needed for the arm to reach a particular point is to give the co-ordinates, rather than the operator having to calculate the movements of each section. A graphical simulation of the robot's movements is provided so that routines can be run and tested on screen before being passed to IVAX.

All of the software is written in BASIC and versions are at present available for the BBC B and the Apple. IVAX has been designed to work in a restricted area or cell and a work cell has been developed to illustrate some of the robot's abilities.

The company says that it has been working on the SCARA for about six months. Further add-ons such as conveyors and go/no go gauges are also available. IVAX will be sold both in kit form for just under £2,000 (for the robot, controller, software, teach pendant and power unit) and ready-built, at almost £2,500, mainly to the educational market.

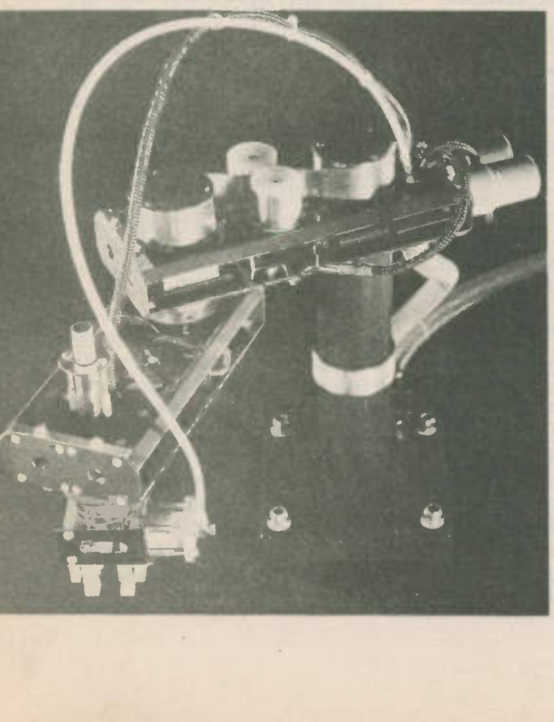
. . interest from the States . .

The other entrant in the SCARA stakes is a new company, **Universal Machine Intelligence** of London. UMI hit the headlines last year with the news that the company's products were attracting great interest from the States where two were having extensive trials.

The first device to result from that work is the RTX, which has a modified SCARA design. It is a little more sophisticated than IVAX having six axes plus a gripper and the strength to lift 4kg. While having the same two limb axes and vertical movement, the wrist has three axes, pitch, yaw and roll.

Although its vertical travel, at 920mm, is much greater than the IVAX, the angular movements are more limited. The shoulder can move through 180 degrees, elbow 160 degrees, yaw 180 degrees, roll 165 degrees in either direction and pitch 110 degrees.

But the two machines are not comparable. The RTX at a price which has yet to be fixed but is thought to be in the region of £3,000, is intended for light industrial as well as educational and health care use.



Powertran's IVAX SCARA robot

Power is provided by d.c. motors with optical encoders giving feedback. The controller is based on two Intel 8031 chips. It has to be hooked up to a micro via the RS232 port and software is available for the IBM PC.

For the future UMI is looking to include two RTX arms on a mobile base on a mobile robot called R-Theta. Details are not being given at the moment but it is known that it will be intended for industry rather than education.

Powertran, meanwhile, has been upgrading its existing Genesis hydraulically-powered arms. While retaining the same basic design and capabilities, the overall quality and reliability of the P101 and P102 have been improved. In particular the company says that the tendency of the oil to leak from the hydraulic cylinders has been reduced.

The major change has been the addition of a parallel I/O port.

L. W. Staines is also on the up-grade. Celebrating getting one of its sturdy Ogres in Oxford University it is bringing out two new versions. It is now possible to get the basic for £240, the Super Ogre at £295 and the Ogre Supreme at £350.

The company says that it has been surprised by the reaction to its arm, particulary from industry and higher education so it was decided to provide machines which would better suit their requirements.

It has another robot at the development stage. Called Troll it will have two arms, one similar to the Ogre and the other an extending arm. Details are limited at the moment but it is hoped to have it ready in the next few months with a price of less than £1,000.

. . good future for the toy market . .

Finally the toy market is still proving popular. **Tomy Toys** is planning an autumn launch for a new top of the range robot. Peter Brown, sales and marketing manager, was reluctant to give away too many details, because of worries about the competition, but he did reveal that it would probably cost about £400 and be a much more manipulative machine than the present top of the range, Omnibot, and be radio controlled.

He added that Omnibot had been very successful and Tomy saw a very good future for the toy market.

For £150 you can now push a robot around. Cybernetic Applications has produced a set of touch sensors for its Neptune arm which allows operators to guide it by hand. The kit comes complete with the necessary software and the ability to store routines.

SEMICONDUCTOR CIRCUITS

TOM GASKELL BA (Hons) CEng MIEE

UNIVERSAL TIMER (HEF4753B)

THE '4000' series of CMOS logic i.c.s. is a popular and widely used logic family. Many of the i.c.s. in the series have become industry standards, cropping up in thousands of different applications, and most of these are produced by a considerable number of different semiconductor manufacturers. Occasionally, though, it is possible to find a device in the 4000 series which is only made by one or two companies, and is rarley seen, yet which may have many useful attributes.

The 4753 by Mullard is just such a device. It is known as a universal timer, which is a little anomalous since it has no timing components as such (ie, no on-chip oscillator circuitry), but it does have a very comprehensive set of counting circuits which make it a very interesting and useful i.c. for inclusion in timing and counting circuitry.

The pinout and specifications of the 4753 i.c. is shown in Fig. 1. The specifications are a little unusual in that they miss out many parameters such as input current, etc., but since this i.c. is one of the standard 4000 CMOS series of devices all the normal family specifications apply. Fig. 2 shows the block diagram.

The clock input is used to synchronise all circuit activity, and can be divided by 1, 16, 256, or 4096 to provide the clock input to a programmable counter. This counter in turn can divide the clock by any number from 1 to 255, as defined by the programming inputs on pins 1 to 8. The output is

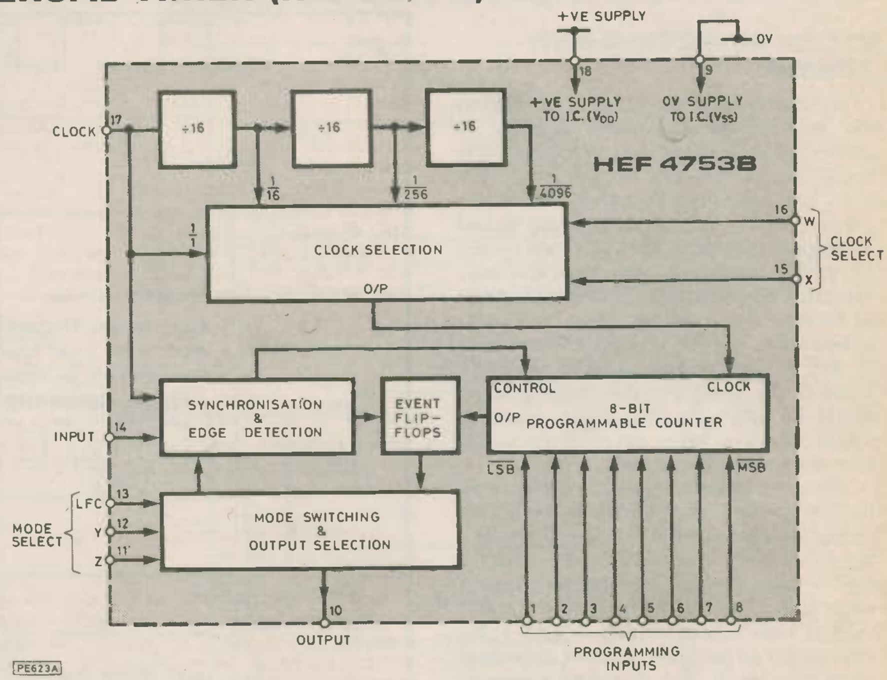


Fig. 2. Block diagram for the HEF 4753B i.c.

Characteristic	Notes	At Supply Voltage of	Minimum Value	Typically	Maximum Value	Units
Supply voltage		—	3·0		18·0	V
Maximum clock Frequency	(At Pin 17)	5	3·0	6		MHz
	Square wave clock—	10	7·0	14		MHz
	50/50 mark space ratio	15	8·0	17		MHz
Output sink Current, maximum (Pin 10 = low)	o/p voltage = 0·4V	4·75	2·3			mA
	o/p voltage = 0·5V	10	8·0			mA
	o/p voltage = 1·5V	15	20			mA
Output source current, maximum (Pin 10 = high)	o/p voltage = 4·6V	5	0·5			mA
	o/p voltage = 9·5V	10	1·5			mA
	o/p voltage = 13·5V	15	5·0			mA
PROPOGATION DELAY (Delay between clock changing and output changing state) (Load capacitance = 50pf)	High to low transition	5		420	850	ns
		10		180	360	ns
		15		120	250	ns
	Low to high transition	5		450	900	ns
		10		200	400	ns
		15		140	280	ns
OUTPUT TRANSITION TIMES (Load capacitance = 50pf)	High to low transition	5		30	60	ns
		10		15	30	ns
		15		10	20	ns
	Low to high transition	5		60	120	ns
		10		30	60	ns
		15		20	40	ns
Other specifications follow typical spec's for the CMOS '4000B' series						

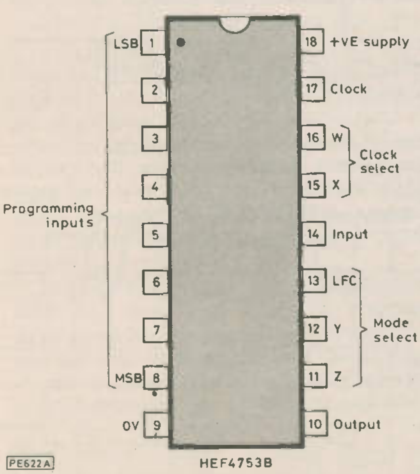


Fig. 1. Pinout and specifications

Inputs		Clock to programmable counter is clock input to pin 17 divided by:
W	X	
Pin 16	Pin 15	
0	0	1
0	1	16
1	0	256
1	1	4096

Fig. 3. Clock selection

Inputs			Operating Mode	
LFC	Y	Z	Mode	Description
PIN 13	PIN 12	PIN 11	No.	
0	0	1	1	Counter
0	1	0	2	Divider
1	1	0	3	Delayed low to high edge
1	0	1	4	Delayed high to low edge
1	1	1	5	Transient pulse suppression
0	1	1	6	Frequency recognition
SEE FIG. 11	0	0	7	Digital 'filter'

Fig. 4. Mode selection

controlled by 'event flip-flops' and three mode select inputs, which arrange for the different timing modes to be implemented.

CLOCK SELECTION AND TIMING

The method of selecting the clock input to the internal programmable counter is shown in Fig. 3. (In all descriptions of logic levels, logic 0 is a low level, ie. near to 0 volts, and logic 1 is a high level, near to the positive supply voltage.) If both the W and X inputs are at logic 0, the clock input to pin 17 is fed directly to the programmable divider. Otherwise, it is divided by a factor as shown. For example, if an 8·192kHz square wave was fed into pin 17, and both W and X were at logic 1, then the clock input of the 8-bit programmable counter would be fed with 2Hz square wave; it would therefore begin counting up at the rate of 2 counts per second.

The programming inputs determine how far the counter must count up before its output changes state. These inputs act as a binary number, but with inverse logic; a logic 0 turns that bit on, whereas a logic 1 turns it off. For example, if pins 1 and 2 were at logic 0, and the rest at logic 1, the counter would reach three before the output changed state. If pins 2, 3, and 4 were at logic 0, and the rest at logic 1, the counter would reach 14 before the output changed.

The counter has a range of 1 to 255; an input of zero (pins 1 to 8 all at logic 1) is not allowed. Note that unlike some i.c.s. featured in *Semiconductor Circuits,* no inputs have internal pull-up or pull-down resistors, so if switches are to be used resistors must be provided externally. (See Fig. 12.)

OPERATING MODES

The seven different operating modes are selected by applying the appropriate logic signals to the LFC, Y, and Z inputs as shown in Fig. 4. The counter mode is shown in Fig. 5. Here, the input is synchronised with the first positive going clock transition after it goes high, and at the next negative clock transition the timing interval starts. After a period T_3 (determined by the clock select and programming inputs) the output goes to logic 0 for 1 clock cycle, then returns to logic 1 again. The divider mode shown in Fig. 6 is similar, but in this case the output stays low after the time period has ended, until the input drops to logic 0, causing the output to go high again after a period $T_1 + T_2 + T_3$.

In both the counter and divider modes it is normally intended that the output should be connected back to the input to make the

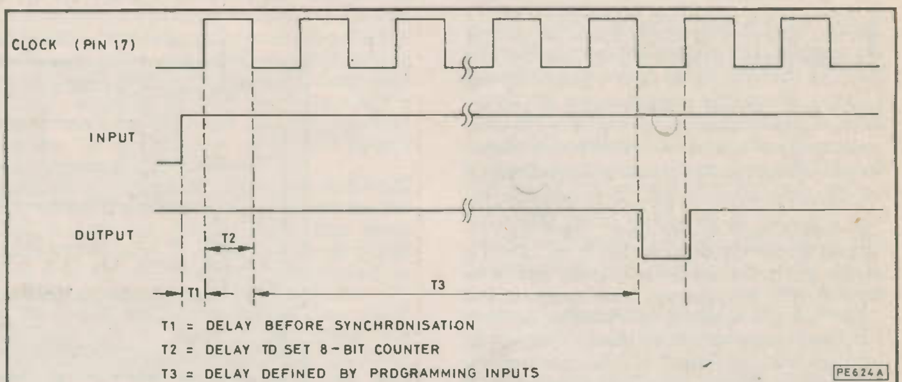


Fig. 5. Operating mode one—Counter

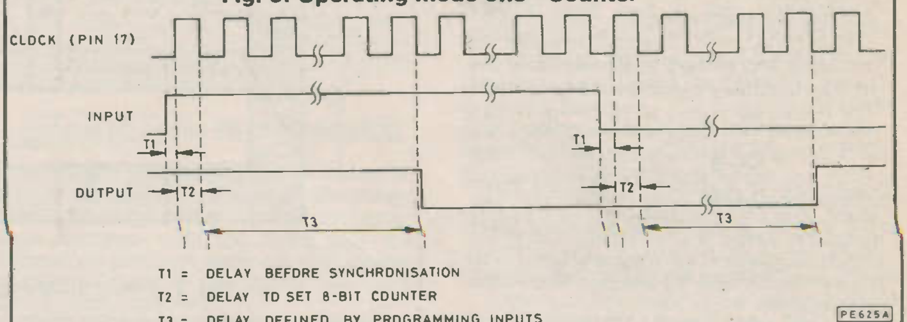


Fig. 6. Operating mode two—Divider

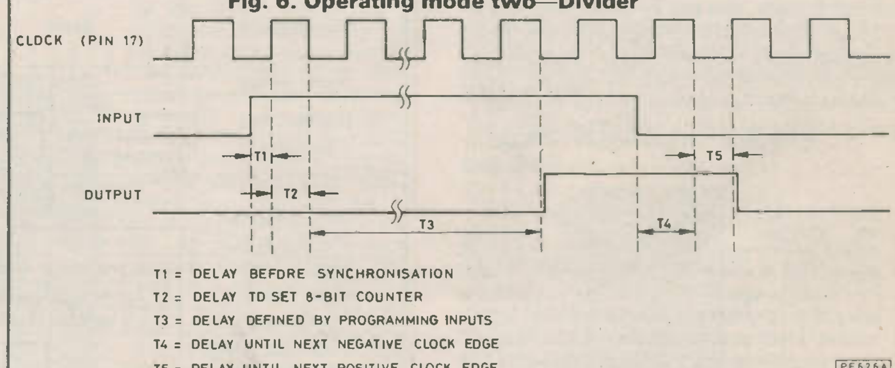


Fig. 7. Operating mode three—Delayed Low to High Edge

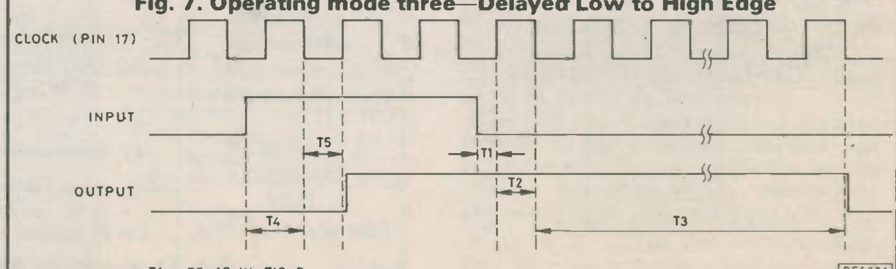


Fig. 8. Operating mode four—Delayed High to Low Edge

i.c. self-triggering. The output will then be a square or rectangular waveform with a frequency dependent on the clock rate and the value of T_3. If this feedback is not implemented then only one cycle of the counter occurs after the input changes state, but then the output will change at a very slow rate (1/4096 of the clock at pin 17) irrespective of the settings of the programming inputs or the clock select pins.

The delayed low to high edge mode is shown in Fig. 7. When the input goes to logic 1, the output goes to logic 1 after a time $T_1 + T_2 + T_3$. When the input changes back to a logic 0 level, the output changes back much faster, however; it waits for the first negative going clock edge, then the next positive going clock edge, then the output changes back to logic 0. Fig. 8 is the opposite of this—a 0 to 1 change at the input gets passed through to the output fairly rapidly, whereas a 1 to 0 change is delayed by $T_1 + T_2 + T_3$.

A representation of the transient pulse suppression mode is shown in Fig. 9. For input pulses wider than $T_1 + T_2 + T_3$, the output is merely delayed by $T_1 + T_2 + T_3$. However, if the input pulse is shorter than $T_1 + T_2 + T_3$ it is ignored—no changes take place as a result of it. This circuit is therefore acting as a sort of digital low-pass filter. Short pulses are eliminated, but longer pulses (ie. low frequencies) are merely delayed, not suppressed.

This principle is taken further in the frequency recognition mode shown in Fig. 10. The incoming signal should be symmetrical (ie. a square wave of 50/50 mark/space ratio). If the input pulse width T_7 is shorter than the programmed period $T_3 + T_1 + T_2$, then the output goes to logic 1, whereas if the input period is longer than $T_1 + T_2 + T_3$, the output goes to logic 0.

This allows us to recognise incoming frequencies as being above or below the frequency:

$$f = \frac{1}{2(T_1 + T_2 + T_3)}$$

In this mode it is important to note that the minimum programmed count number is 3.

Finally, in Fig. 11, two 4753s are used to provide a "digital filter" function. The two i.c.s have different programmed time periods, T_a being greater than T_b. The output stays at logic 0 unless the incoming pulses (again the input should be a 50/50 square wave) are longer than T_b but shorter than T_a (plus the appropriate synchronising delays in each case, as appropriate) at which point the output becomes a delayed version of the input wave form. As with the previous mode, the minimum programmed count should be 3.

The HEF4753B is an extraordinarily versatile i.c. capable of extremely complex timing and counting operations. It's subtleties shouldn't disguise the fact that it is an excellent general purpose timer/counter with as many simple applications as complex ones. To illustrate this point, the applications project this month shows an economical timer design which uses both mode and clock selection facilities.

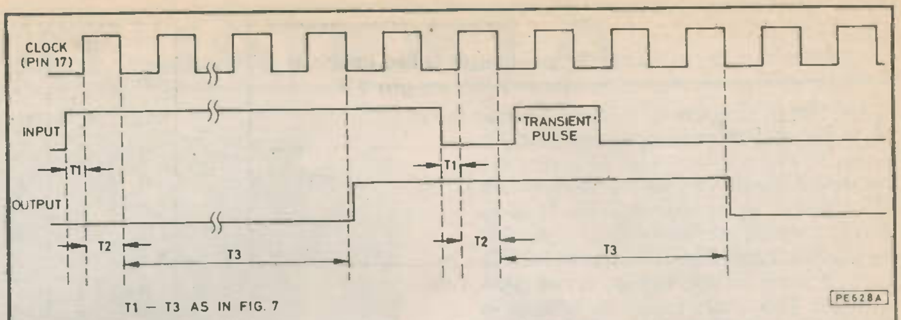


Fig. 9. Operating mode five—Transient Pulse Suppression

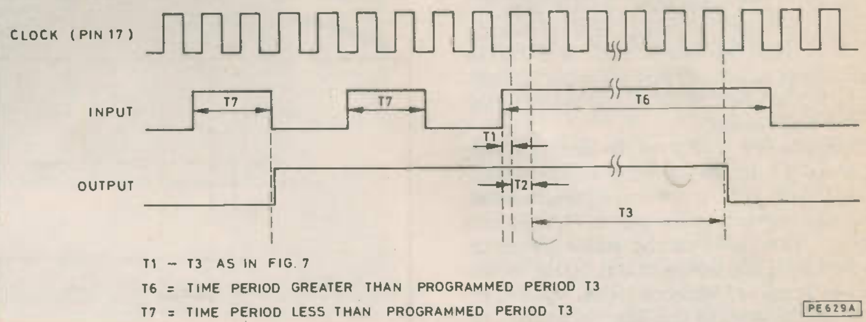


Fig. 10. Operating mode six—Frequency Recognition

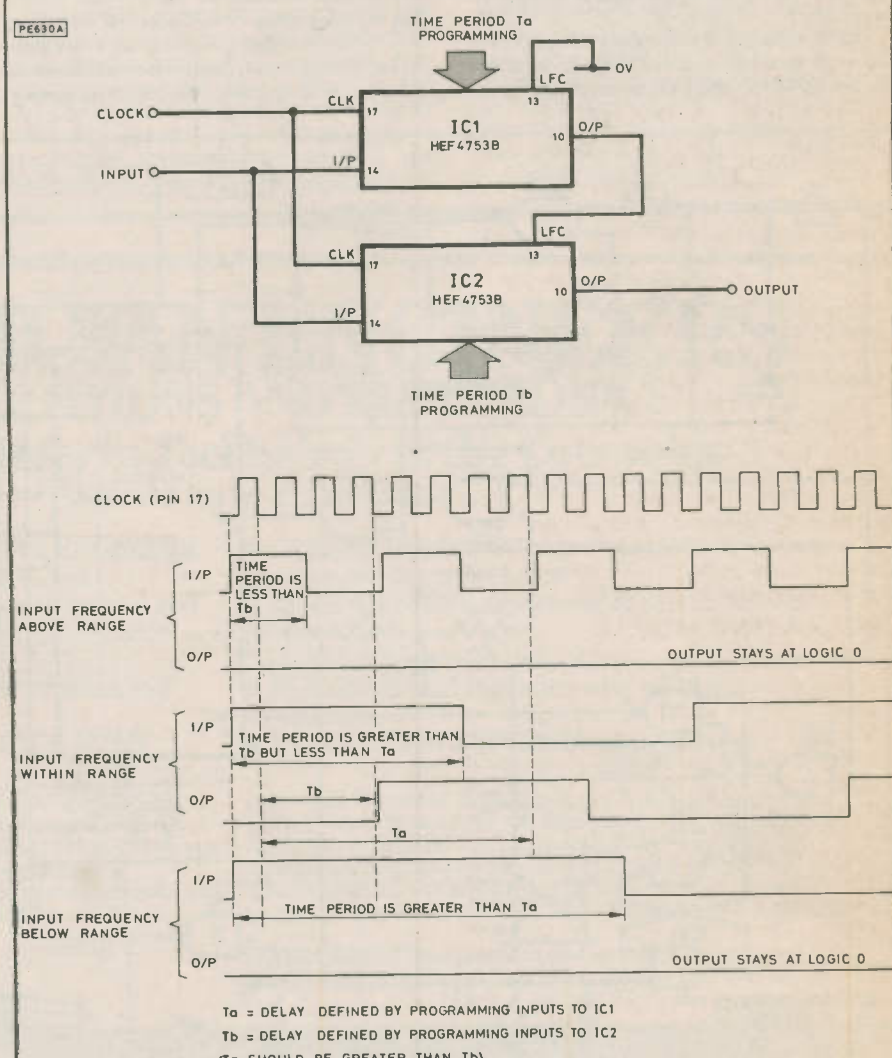
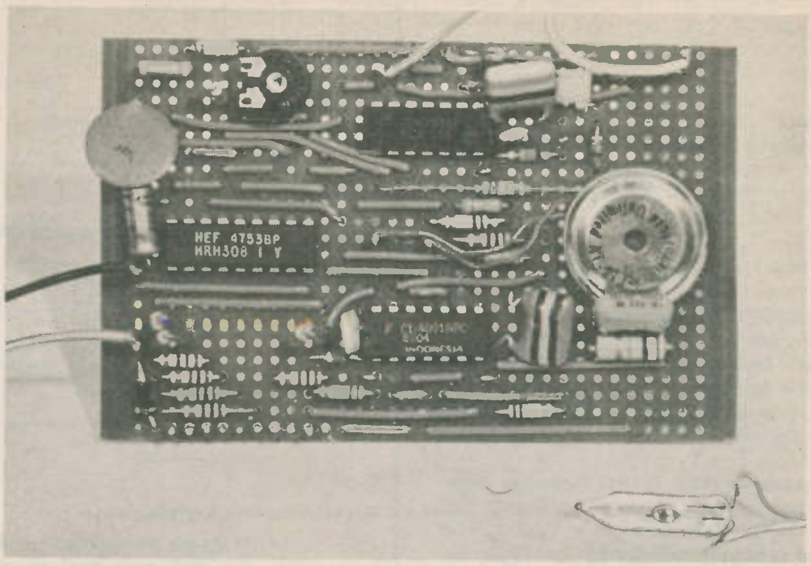


Fig. 11. Operating mode seven—Digital Filter

A DIGITAL TIMER



THE circuit diagram of a Digital Timer (which can be used as an egg timer) is shown in Fig. 12, with Fig. 13 giving the Veroboard layout. To start the timer, switch S9 is opened. This causes IC2c pin 10 to go to logic 1, which provides a pulse to pin 5 of the flip-flop formed by IC3a and IC3b. Pin 3 of IC3 therefore goes to logic 1, and pin 4 to logic 0. This in turn causes the W input to IC1 to go to logic 1, and the LFC input to go to logic 1. (The main input to IC1 (pin 14) also goes to logic 1.) Hence, the 4753 has it's clock divided by 4096. With a 546·1Hz clock input to pin 17, this provides 1 count every 7·5 seconds, with IC1 in the delayed low to high mode.

Switches S1 to S8, with their pull-up resistors R1 to R8, provide the programming inputs to IC1. After the programmed time has elapsed, the output of IC1 goes to logic 1. This turns on the audio oscillator formed by IC2b, which causes X1 to sound a tone. It also produces a pulse, via C6, to reset the IC3a/IC3b flip-flop. As a result of this, pin 3 of IC3 is now at logic 0, and pin 4 is at logic 1.

The W input of IC1 also goes to logic 0, so the 4753 now has its clock only divided by 16, not by 4096. The LFC goes to logic 0, so IC1 is now working in the divider mode. Via the time delay of R15 and C4, and IC3c and IC3d, the output of IC1 is now connected back to its input. It therefore oscillates at a very low frequency (the exact frequency depending on the settings of S1 to S8), causing the piezo sounder X1 to send out bursts of tone. Closing the switch S9's contacts against forces IC1 back into the delayed low to high mode, and turns off the

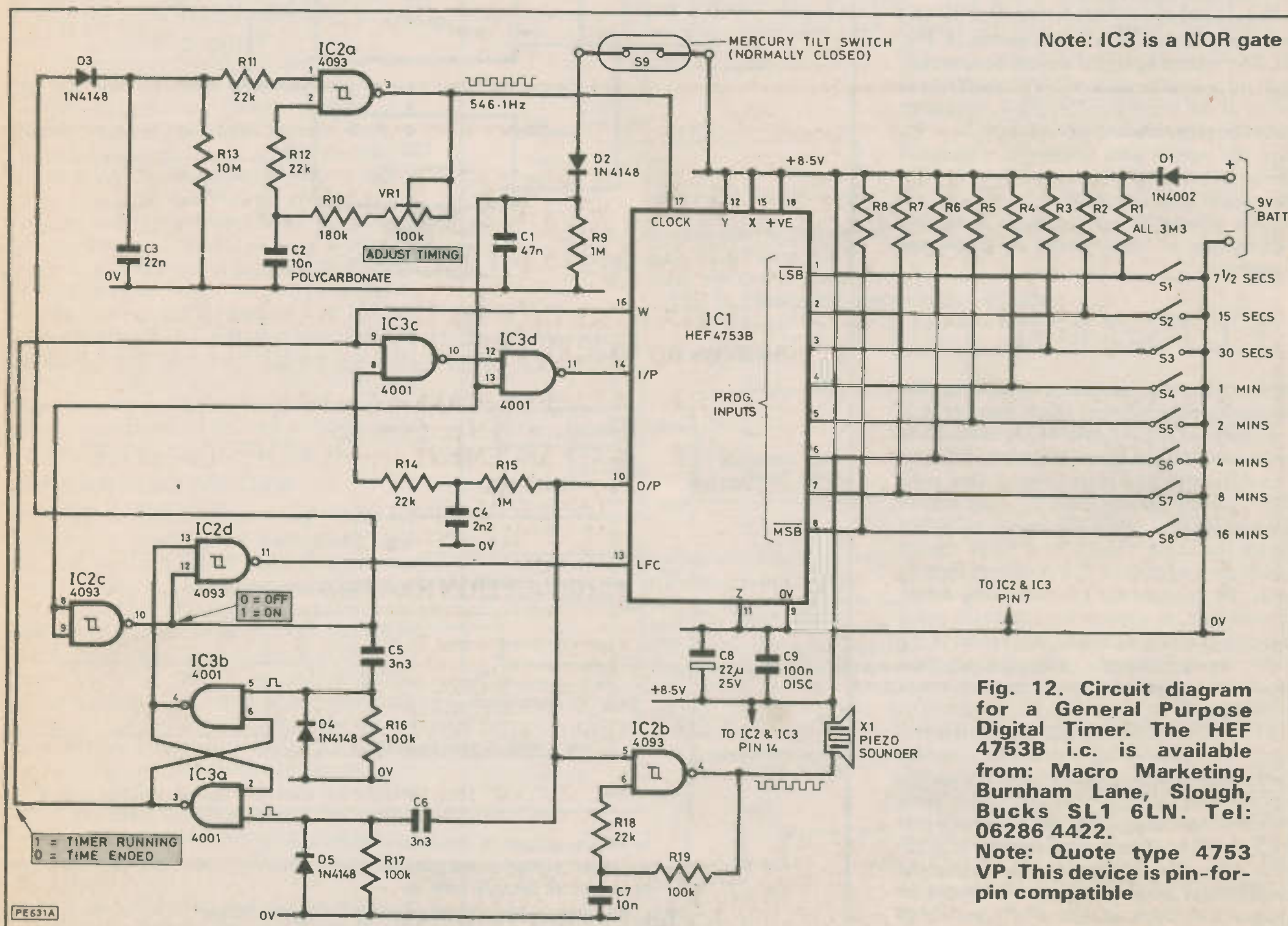


Fig. 12. Circuit diagram for a General Purpose Digital Timer. The HEF 4753B i.c. is available from: Macro Marketing, Burnham Lane, Slough, Bucks SL1 6LN. Tel: 06286 4422.
Note: Quote type 4753 VP. This device is pin-for-pin compatible

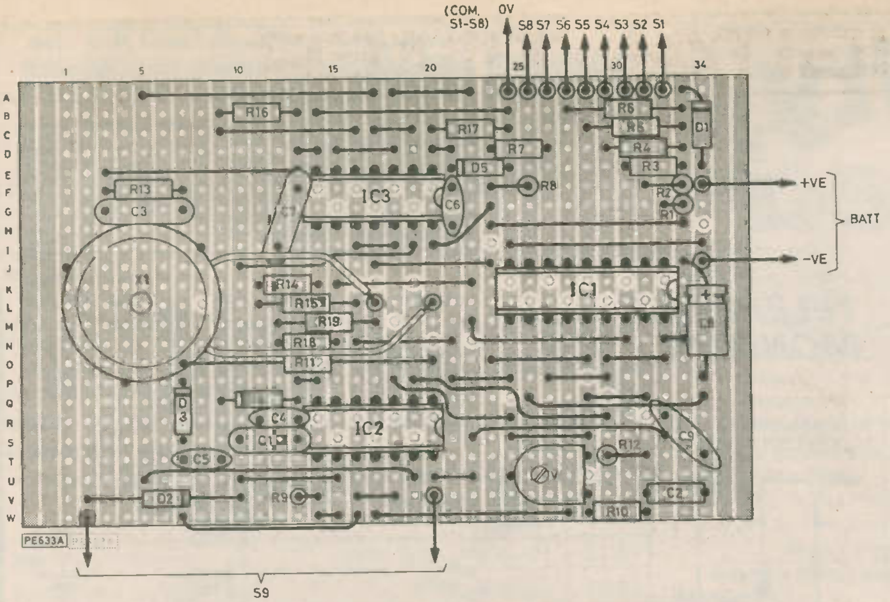


Fig. 13. Veroboard component layout for the Digital Timer

clock oscillator formed by IC2a, with associated components.

PRACTICAL CONSIDERATONS

There are several small but important areas of circuitry incorporated into this design. D2, C1, and R9 form a switch de-bouncing network for S9. Without this, the multiple triggers feeding into IC3b due to switch bouncing could cause mis-operation. The clock oscillator, IC2a, is turned off when the timer is not in use to lower the power consumption. However, it was found that this should not be done immediately after changing the mode of IC1, or, again, mis-operation occurred. Hence D3, C3, and R13 delay the turning off of the oscillator after S9 is closed, to allow IC1 to complete its internal synchronisation, etc. R15 and C4 delay the output of IC1 reaching IC3c pin 8 until after the IC3a/IC3b flip-flop has changed state. Finally, D1 helps to protect against reverse connection of the battery, C8 and C9 decouple the supply, and R11, R12, R14, and R18 protect the CMOS gate inputs when power is turned off.

In use, the switches S1 to S8 set the timing interval. Several of these can be turned on at once, of course, to add up the required time period. VR1 should be adjusted to give the correct clock frequency, or the correct time intervals if no frequency counter is available.

No on/off switch as such is required, as the circuit only draws typically 17μA in the 'off' state with no programming switches turned on. In the 'on' state, the current drawn is approximately 130μA, and with the tone sounding it averages 300μA.

If the circuit is to be used for fixed time periods only, then S1 to S8 can be replaced by wire links or a d.i.l. switch. S9 was made to be a mercury tilt switch (salvaged from an old digital alarm clock!) so that the timer could be started by turning it up-side down, and stopped by turning it the right way up again. If you do decide to use such a switch, be very careful not to break it, as mercury is a very toxic substance. As an alternative, an ordinary switch can be used, of course.

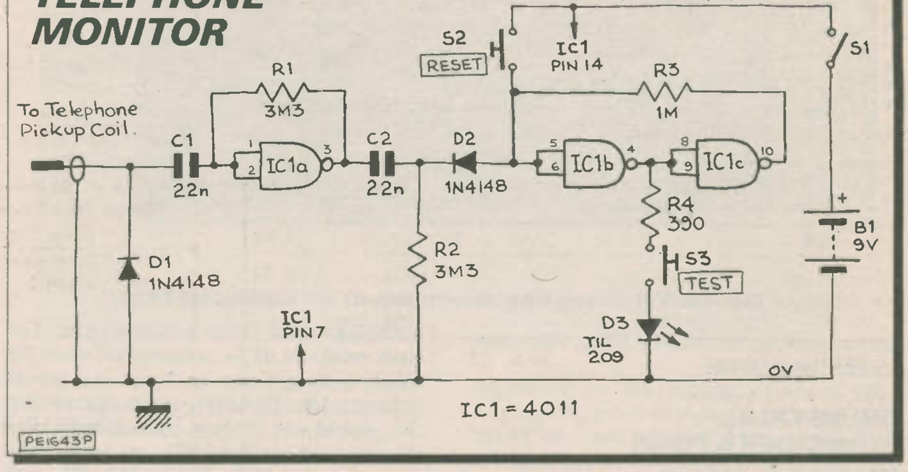
The Veroboard layout has been made as small as possible to enable it to fit into a small case, so care must be taken with its assembly. The use of a 4753 in this circuit provides us with a compact and economical way of implementing what is actually quite a complex timing system.

Ingenuity Unlimited

Why not submit *your* idea? Any idea published will be awarded payment at £40 per magazine page.

Each idea submitted must be accompanied by a declaration to the effect that it has been tried and tested, is the original work of the undersigned, and that it has not been offered or accepted for publication elsewhere. It should be emphasised that these designs have not been proven by us. They will at any rate stimulate further thought.

TELEPHONE MONITOR



A NUMBER of friends of mine have said that they have had difficulty in telephoning me. This Telephone Monitor enables the user to check if there have been any calls in his absence.

A standard pick-up coil is stuck to the side of the telephone and connected to the circuit shown. IC1a is biased into the linear mode by R1 and gives very high gain. C2 and D2 send the input of IC1b low when a signal is received; R2 provides a path for charge to escape from the capacitor-diode junction.

IC1b and c form a latch, which can be reset by pressing S2. S3 causes D3 to light if the telephone has rung.

On the prototype, S1 was incorporated into a jack socket, although the current consumption of the unit on standby renders this strictly unnecessary. The circuit was also found to work on the doorbell!

K. Jones,
Fairhaven,
Lancs.

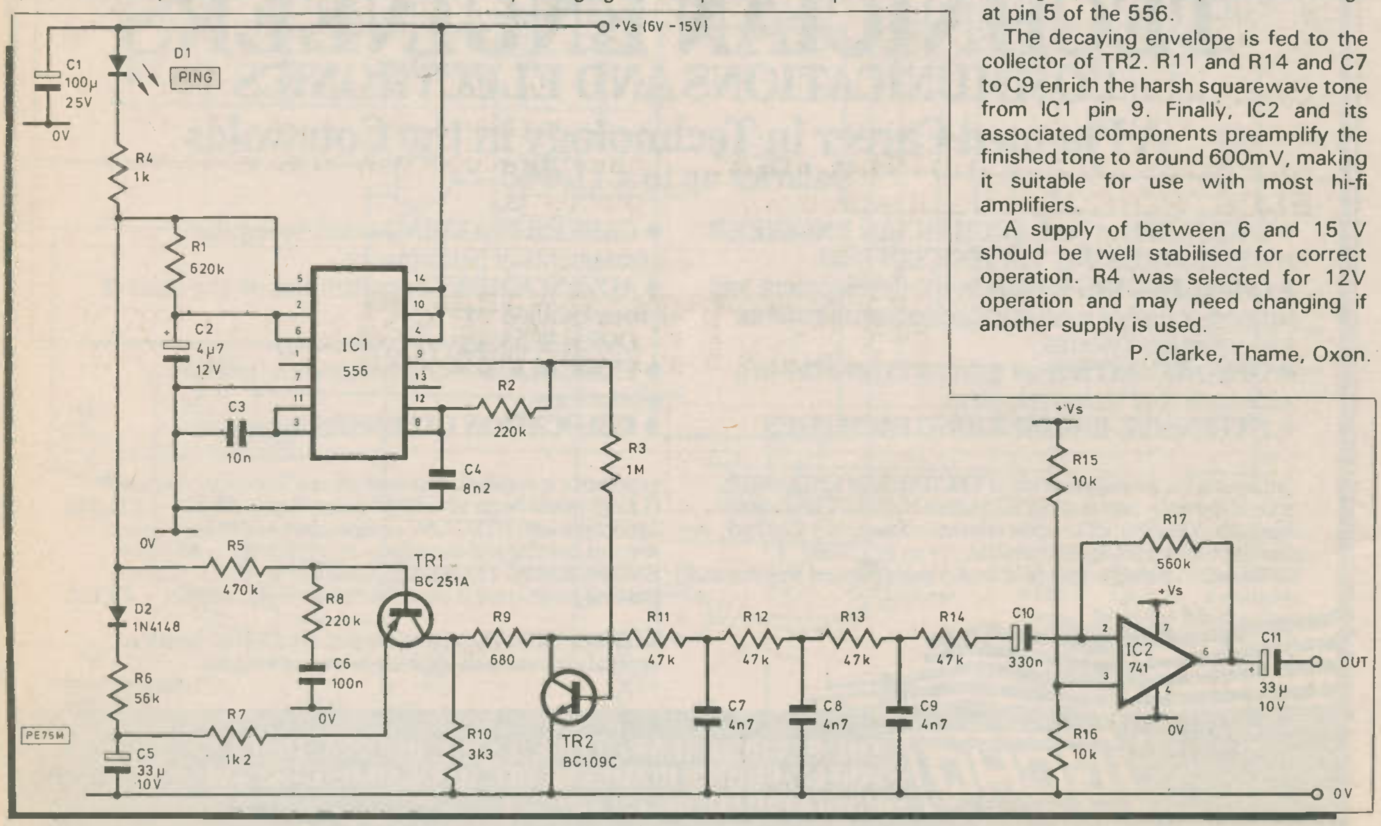
EVERYONE who has visited the Royal Festival Hall in London could not have failed to notice the gentle electronic 'pinging' sound used to indicate the end-of-interval, at concerts. The circuit shown here will emulate this sound and has been used with great success at various 'home-grown' productions.

IC1 is a dual monostable with equal mark/space ratio: the output at pin 5 oscillates at around 0·2Hz and pin 9 at around 400Hz. The latter can be tuned by changing R2 if required. When pin 5 is at a high voltage C5 is charged and TR1 is off. When pin 5 goes low, TR1 is turned on and C5 is discharged causing a decaying waveform across R10. D2 prevents C5 discharging into the 556 whilst R8 and C6 soften the attack by making the voltage at the base of TR2 fall slightly more slowly than the voltage at pin 5 of the 556.

The decaying envelope is fed to the collector of TR2. R11 and R14 and C7 to C9 enrich the harsh squarewave tone from IC1 pin 9. Finally, IC2 and its associated components preamplify the finished tone to around 600mV, making it suitable for use with most hi-fi amplifiers.

A supply of between 6 and 15 V should be well stabilised for correct operation. R4 was selected for 12V operation and may need changing if another supply is used.

P. Clarke, Thame, Oxon.



PRACTICAL ELECTRONICS
PRINTED CIRCUIT BOARD SERVICE

Printed circuit boards for certain PE constructional projects are now available from the PE PCB Service, see list. They are fully drilled and roller tinned. All prices include VAT and postage and packing. Add £1 per board for overseas airmail. Remittances should be sent to: ***PE PCB Service, Practical Electronics Editorial Offices, Westover House, West Quay Road; Poole, Dorset BH15 1JG.*** Cheques should be crossed and made payable to IPC Magazines Ltd.

Please note that when ordering it is important to give project title, order code and the quantity. Please print name and address in Block Caps. Do not send any other correspondence with your order.

Readers are advised to check with prices appearing in the current issue before ordering.

NOTE: Please allow 28 days for delivery. We can only supply boards listed here.

PROJECT TITLE		Order Code	Cost
Spectrum Autosave	MAR '84	403–01	£1.83
Sustain Unit		405–02	£2.82
Audio Signal Generator	MAY '84	405–03	£4.28
,,		405–04	£2.51
Cross Hatch Generator	JUNE '84	406–01	£3.52
Simple Logic Analyser I		407–01	£7.73
EPROM Duplicator	JULY '84	407–02	£3.74
Alarm System		407–03	£3.19
Oscilloscope Calibrator		407–04	£4.23
Comm. 64 RS232C Interface		408–01	£3.02
Field Measurement	AUG '84	408–02	£3.19
,,		408–03	£2.76
Simple Logic Analyser II		408–05	£2.93
Parallel to Serial Converter		409–01	£2.92
Through the Mains Controller	SEPT '84	409–02	£2.88
,,		409–03	£2.71
Logic Probe	OCT '84	410–01	£1.90
Computer DFM Adaptor	NOV '84	411–01	£2.76
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Pt-1: Power Amp Board	FEB '85	502–01	£4.19
Spectrum DAC/ADC Board		502–02	£3.69
Modular Audio Power System			
Pt-2: Pre-Amp/Line Driver		503–01	£5.00
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Rugby Clock Pt-2		504–03	£24.22
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60 watt Mobile 240v AC and 12v DC. *4-8-16 ohm+100v line* ***£89***
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BAKER LOUDSPEAKERS Post £2 each

Type	Model	Size	Watts	Ohms	Price
P.A./Disco/Group	DG50/10	10in	50	8/16	**£20.00**
Midrange	Mid 100/10	10in	100	8	**£25.00**
Hi-Fi	Major	12in	30	4/8/16	**£18.00**
Hi-Fi	Superb	12in	30	8/16	**£26.00**
P.A./Disco/Group	DG45	12in	45	4/8/16	**£18.00**
Hi-Fi	Woofer	12in	80	8	**£25.00**
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P.A./Disco/Group	DG75	12in	75	4/8/16	**£22.00**
P.A./Disco/Group	DG100	12in	100	8/16	**£28.00**
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OUTDOOR HORNS 8 ohms. 25 watt **£22.** 30 watt £25. 40 watt **£33.** 20W plus 100 volt line **£38.** Post £2.
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Make	Model	Size	Watts	Ohms	Price	Post
AUDAX	WOOFER	5½in.	25	8	£10.50	£1
GOODMANS	HIFAX	7½×4¼in	100	8	£34	£2
GOODMANS	HB WOOFER	8in.	60	8	£13.50	£1
WHARFEDALE	WOOFER	8in.	30	8	£9.50	£2
CELESTION	DISCO/Group	10in	50	8/16	£21	£2
SEAS	WOOFER	10in.	50	8	£19.50	£2
WEM	WOOFER	10in.	300	8	£36.00	£2
GOODMANS	HPG/GROUP	12in.	120	8/15	£35.00	£2
GOODMANS	HPD/DISCO	12in.	120	8/15	£33.00	£2
H+H	DISCO/GROUP	15in.	100	4/8/16	£49	£4
GOODMANS	HP/BASS	15in.	250	8	£74	£4
GOODMANS	HPD/BASS	18in.	230	8	£87	£4
PEERLESS	TWEETER	3¼in.	60	8	£7.50	£1
AUDAX	TWEETER	2½in.	30	8	£4	£1

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DISCO "PARTY LITE", Sound Flashing, Light Show, 4 lamps, self contained unit 240v A.C. No other connections needed **£34.95.** PP **£2.**

MAINS TRANSFORMERS	Price	Post
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350-0-350V 250mA. 6.3V 6A CT £12.00 Shrouded	£14.00	£2
220V 25mA. 6V 1 Amp £3.00 220V 45mA. 6V 2 Amp	£4.00	£1
250V 60mA. 6.3V 2A.	£5.00	£1
Low voltage tapped outputs available		
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ditto 2 amp £10.50 3 amp £12.50 5 amp	£16.00	£2
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£8.50 **post 50p MINI-MULTI TESTER**
Pocket size instrument. DC volts 15, 150, 500, 1000. AC volts 15, 150, 500, 1000. DC 0.1ma, 0-150ma. Resistance 0 to 100K. De-Luxe Range Doubler Meter, **50,000** o.p.v. 7 × 5 × 2in. Resistance 20 meg in 5 ranges. Current 50μA to 10A. 0-25V to 1000V DC. 10V to 1000V AC. **£25.00** post **£1**

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4 × 2½ × 2¼in. £2.50; 6 × 4 × 1½in. £3.60; 8 × 5 × 2in. **£4.00**; 11 × 6 × 3in. **£5.50**; 11¾ × 6 × 5in. **£9.00**; 15 × 8 × 4in. **£12.00.**

ALUMINIUM PANELS 18 s.w.g. 12 × 12in. **£1.80**; 14 × 9in. **£1.75**; 6 × 4in. 55p; 12 × 8in. £1.30; 10 × 7in. 96p; 8 × 6in. 90p; 14 × 3in. 72p; 12 × 5in. 90p; 16 × 10in. **£2.10**; 16 × 6in. £1.30.
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16/450V	50p	220/400V	£2	20+20/350V	75p
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32/350V	45p	8+16/450V	75p	32+32/350V	50p
32/500V	95p	16+16/350V	75p	32+32+32/450V	£1.50
				16+32+32/500V	£2

SINGLE PLAY RECORD DECKS. Post £2.

Make	Drive	Model	Cartridge	Price
BSR	Belt	12 Volt	Ceramic	£20
BSR	Rim	P207	Ceramic	£20
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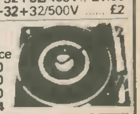
AUTOCHANGER		GARRARD	Ceramic	£24



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Post 65p Minimum. Callers Welcome.
Same day despatch. Closed Wed. Lists 34p.
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INDEX TO ADVERTISERS

MAIL ORDER ADVERTISING

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Advertisements in this publication are required to conform to the British Code of Advertising Practice. In respect of mail order advertisments where money is paid in advance, the code requires advertisers to fulfil orders within 28 days, unless a longer delivery period is stated. Where goods are returned undamaged within seven days, the purchaser's money must be refunded. Please retain proof of postage/despatch, as this may be needed.

Mail Order Protection Scheme

If you order goods from Mail Order advertisements in this magazine and pay by post in advance of delivery, PRACTICAL ELECTRONICS will consider you for compensation if the Advertiser should become insolvent or bankrupt, provided:

(1) You have not received the goods or had your money returned; and
(2) You write to the Publisher of PRACTICAL ELECTRONICS summarising the situation not earlier than 28 days from the day you sent your order and not later than two months from that day.

Please do not wait until the last moment to inform us. When you write, we will tell you how to make your claim and what evidence of payment is required.

We guarantee to meet claims from readers made in accordance with the above procedure as soon as possible after the Advertiser has been declared bankrupt or insolvent.

This guarantee covers only advance payment sent in direct response to an advertisement in this magazine not, for example, payment made in response to catalogues etc, received as a result of answering such advertisements. Classified advertisements are excluded.

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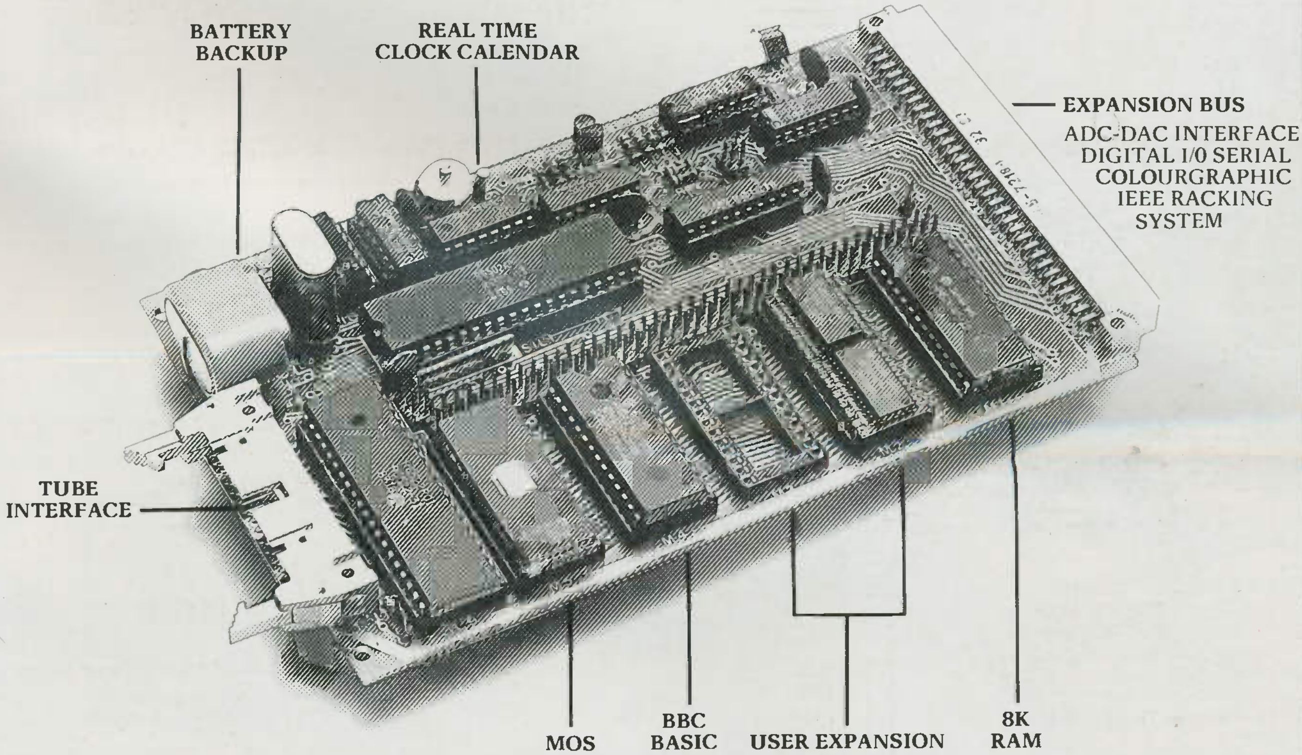
PUT BBC BASIC IN CONTROL
USE THE 6502 2ND PROCESSOR
WITH BIG CONNECTIONS



- Single Eurocard – can stand alone and run BBC BASIC programs.
- Program your control applications in BBC BASIC . . .
  . . . FORTH, PASCAL or any other language ROM.
- Adds I/O expansion to your BBC via the 6502 bus connector.
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