AN ARGUS SPECIALIST PUBLICATION

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JAN 1986 £1.20

INTERMAG

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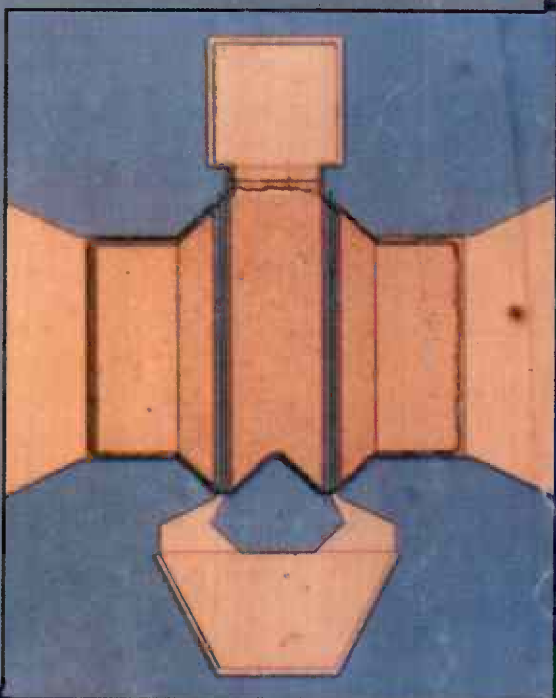
WALKMATE
AUTOWIPE
BUILD THEM AND USE THEM

Gallium Arsenide – The fast one



BOOK ROUND-UP

LINSLEY HOOD'S SEASONAL YARN

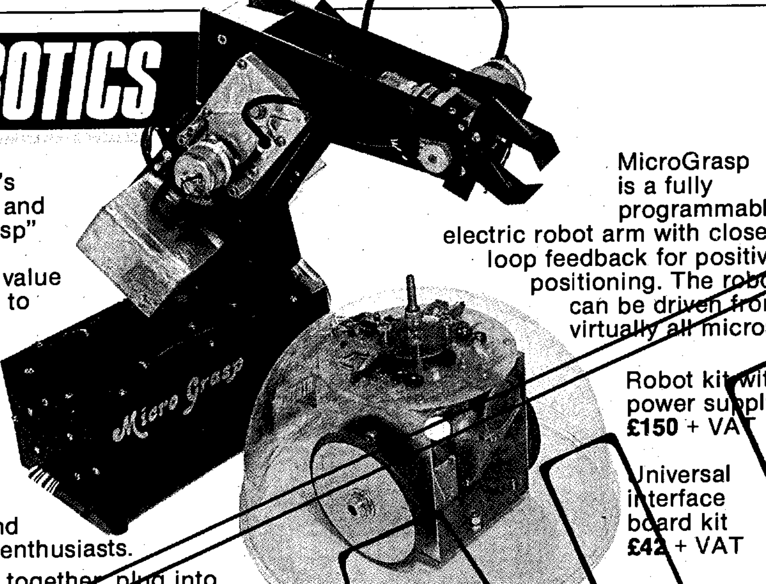
BARRY PORTER TELLS A PCB'S TALE

FANTASTIC DISC DRIVE OFFER FROM ETI AND WATFORD

AUDIO....COMPUTING....MUSIC....RADIO....ROBOTICS

TOP KITS FROM POWERTRAN
CYBERNETICS LIMITED

ROBOTICS



Powertran's "Hebot II" and "MicroGrasp" kits offer unrivalled value for money to colleges, schools and individual enthusiasts.

Put the kit together, plug into your micro and off you go!

Hebot II can perform a bewildering variety of actions under the control of a simple BASIC program. Features include independent control of two wheels, flashing "eyes" two-tone hooter and a retractable pen.

Complete kit **£39.95** + VAT
Universal computer interface board kit **£5.50** + VAT

MicroGrasp is a fully programmable electric robot arm with closed loop feedback for positive positioning. The robot can be driven from virtually all micros.

Robot kit with power supply **£150** + VAT

Universal interface board kit **£42** + VAT

Powertran kits are complete down to the last nut and bolt, with easy-to-follow assembly instructions.

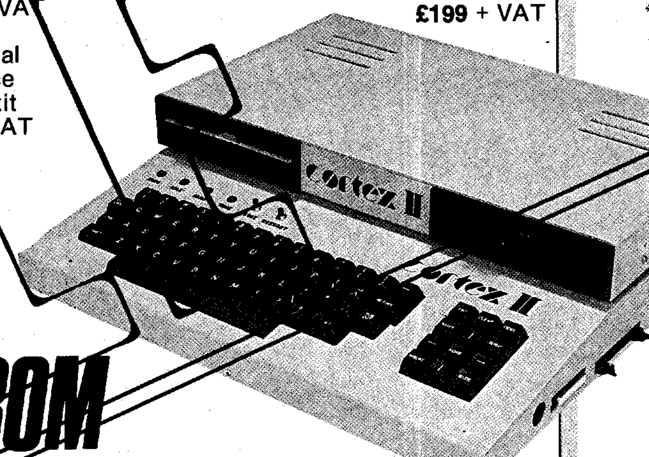
COMPUTING

Cortex II. 16 Bit. 16 Colour.

Cortex II offers the speed and power of true 16-bit processing at the same price that you might pay for some of the 8-bit games machines on the market.

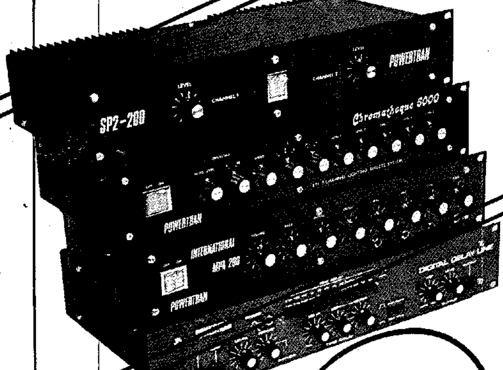
The standard kit has interfaces for TV, cassette and RS232 – others are available as optional extras. Add disc drives, printer and a monitor for a fully-fledged business system.

£199 + VAT



MUSIC

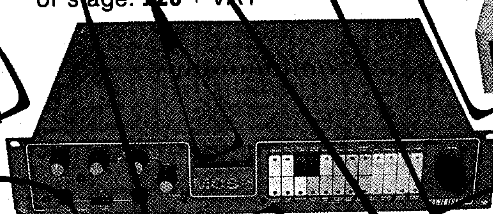
Powertran's range of quality audio products offers top quality at low, low prices. All the products are finished in rugged metal cabinets suitable for 19" rack mounting or as free-standing units.



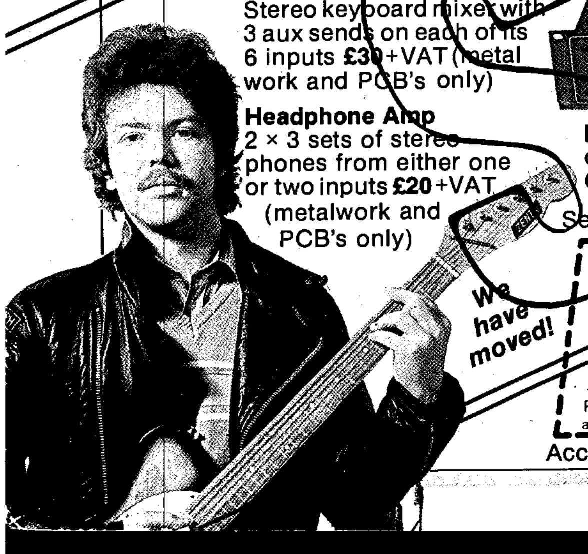
MPA 200 100 watt mixer-amplifier
Complete kit **£40** + VAT
SP2 200 2-channel 100 watt amplifier.
Complete kit **£50** + VAT
Chromatheque 5000
5-channel light show controller.
Complete kit **£40** + VAT
Digital Delay Line Studio quality effects – up to 1.6s delay **£95** + VAT
Patchbay 16 pairs of jacks – for studio or stage. **£20** + VAT

Synth Mix
Stereo keyboard mixer with 3 aux sends on each of its 6 inputs **£30**+VAT (metal work and PCB's only)

Headphone Amp
2 × 3 sets of stereo phones from either one or two inputs **£20**+VAT (metalwork and PCB's only)

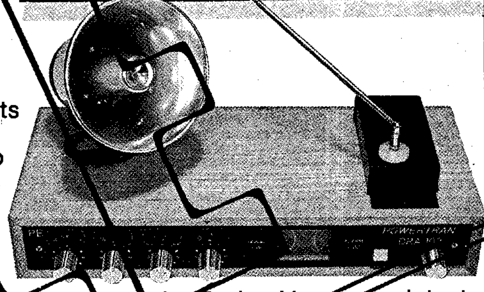


MCS-1 MIDI-controlled sampling unit – doubles as a high quality effects unit.
Complete kit **£290** + VAT



We have moved!

HOME SECURITY



Our Doppler Radar Alarm can detect intruders early enough (and loud enough) to offer your home *real* protection. Standard kit including two transmitters **£70** + VAT
Pair of extra transmitters **£23** + VAT
Special offer: extended kit including four transmitters **£84** + VAT

Send for demonstration tape to sample some of the sounds available **£2.50** + VAT

To Powertran Cybernetics Limited, Park Road, Crowborough, Sussex.

Please send me the following kits ______
I enclose Cheque/Postal Order, value £ ______ (Don't forget to add V.A.T.)
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Please allow 21 days for delivery. Offers subject to availability. Prices are exclusive of V.A.T. and correct at time of going to press. Overseas customers - please contact our Export Department.

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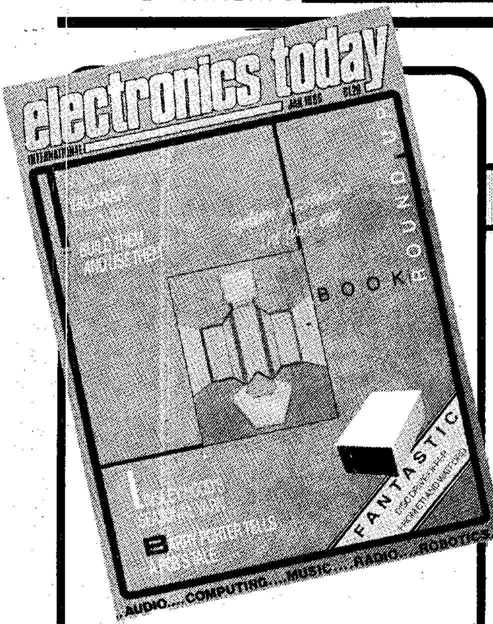
JANUARY 1986 VOL 15 NO 1



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FEATURES

Due to the pressure on space, we have had to hold over the scheduled parts of our series on Transistor Stage Design and Automatic Test Equipment until next month. Our apologies to readers.

PROJECTS

ETCETERA

INFORMATION

WATFORD ELECTRONICS

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ELECTROLYTIC CAPACITORS: (Values in uF) **500v**; 10uf 52; 47 **78p**; **63V**: 0.47, 1.0, 1.5, 2.2, 3.3, 4.7 **8p** 10 **10p**; 15, 22 **12p**; 33 **15p**; 47 **12p**; 68 **20p**; 100 **19p**; 220 **26p**; 1000 **70p**; 2200 **99p**; **50V**: 68 **20p**; 100 **17p**; 220 **24p**; **40V**: 22 **9p**; 33 **12p**; 330, 470 **32p**; 1000 **48p**; 2200 **90p**; **25V**: 1.5, 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**: 47, 68, 100 **9p**; 125 **12p**; 330 **18p**; 470 **20p**; 680 **34p**; 1000 **27p**; 1500 **31p**; 2200 **28p**; 4700 **72p**.

TAG-END CAPACITORS: 64V: 2200 **120p**; 3300 **145p**; 4700 **245p**; **50V**: 2200 **95p**; 3300 **155p**; **40V**: 4700 **160p**; **25V**: 2200 **70p**; 3300 **85p**; 4000, 4700 **75p**; 10,000 **250p**; 15,000 **270p**; **16V**: 22,000 **200p**.

POLYESTER CAPACITORS: Axial Lead Type
400V: 1nF, 1n5, 2n2, 3n3, 4n7, 6n8 **11p**; 10n, 15n, 18n, 22n **12p**; 33n, 47n, 68n **16p**; 150n **20p**; 220n **30p**; 330n **42**; 470n **52p**; 680n 1uF **88p**; 2u2 **82p**.
1000V: 1nF **17p**; 10nF **30p**; 15n **40p**; 22n **36p**; 33n **42p**; 47n, 100n **42p**.

SIEMENS pcb Type Miniature poly Capacitors
250V
1nF, 1n5, 2n2, 3n3, 4n7, 6n8, 10n, 15n **7p**
18n, 22n, 27n, 33n, 39n, 47n **8p**
39n, 56n **12p**
82n, 100n **11p**
100V
100n, 120n **10p**
150n, 180n **12p**
220n, 270n **15p**
330n, 390n **20p**
470n, 560n **26p**
680n **30p** 1uF **34p** 2u2 **50p**

POLYESTER RADIAL LEAD CAPACITORS: 250V
10n, 15n, 22n, 27n **8p**; 33n, 47n, 68n, 100n **8p**; 150n, 220n **10p**; 330n, 470n **15p**; 680n **19p**; 1u5 **40p**; 2u2 **48p**.

FEED-THROUGH CAPACITORS
1000pF/450V **10p**

TANTALUM BEAD CAPACITORS
35V: 0.1uF, 0.22, 0.33 **15p** 0.47, 0.68, 1.0, 1.5 **18p**; 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 **45p**; 33, 47 **50p**; 100 **95p**; **10V**: 15, 22, **28p**; 33, 47 **50p**; 100 **80p**; **6V**: 100 **55p**.

POTENTIOMETERS: Carbon Track, Rotary 0.25W Log & LIN Values, 470R; 1K & 2K (Linear only)
Single Gang **35p**
5K—2M Single Gang Log & Lin **35p** 5K—2M Single Gang DP Switch **95p** 5K—2M Double Gang **99p**

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

SLIDER POTENTIOMETERS
0.25W log and linear values 60mm
5K — 500K single gang **60p**
Graduated Bezels for above **45p**

CERAMIC CAPACITORS 50V:
Range: 0.5pF to 10nF **4p**
15nF, 22nF 33nF; 47nF **5p**
100nF/20V **7p** 200nF/6V **8p**

PRESET POTENTIOMETERS
0.1W Miniature Vertical or Horizontal, 100R to 4M7 **8p**
0.25W Larger 100R to 3M3 Horz **12p**
0.25W Larger 200R to 4M7 Vertical **12p**
¾" cermet multiturn preset 100 to 500K **89p**

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POLYSTYRENE CAPACITORS:
10pF to 1nF **8p**; 1.5nF to 12nF **10p**.

SILVER MICA (Values in pF)
2, 3.3, 4.7, 6.8, 8.2, 10, 12, 15, 18, 22, 27, 33, 39, 47, 50, 56, 68, 75, 82, 85, 100, 120, 150, 180pF **15p each**
200, 220, 250, 270, 300, 330, 360, 390, 470, 800, 800, 820 **21p each**
1000, 1200, 1800, 2200 **30p each**
3300, 4700pF **80p**

MINIATURE TRIMMERS Capacitors
2-6pF 2-10pF **22p**
2-25pF; 5-65pF **30p**
10-88pF **38p**

RESISTORS Carbon Film, miniature, Hi-Stab, 5%.

	RANGE	Val	1-99	100 +
0.25W	2Ω2 — 10M	E12	3p	1p
0.5W	2Ω2 — 4M7	E12	3p	1p
1W	2Ω2 — 10M	E12	6p	4p
2% Metal Film	51Ω — 1M	E24	6p	4p
1% Metal Film	51Ω — 1M	E24	5p	4p

100+ price applies to Resistors of each type not mixed.

RESISTORS NETWORK S.I.L.
7 Commoned: (8 pins) 100Ω, 680Ω, 1K 2k2, 4K7, 10K 47K, 100K **18p**
8 Commoned: (9 pins) 150Ω, 180Ω, 270Ω, 330Ω, 1K, 2K2, 4K7, 6K8, 10K, 22K, 47K & 100K **20p.**

DIODES

AA119	8
AA129	10
AAY30	8
BA100	10
BY100	15
BY126	12
BY127	11
CRO33	198
OA9	10
OA47	10
OA70	9
OA79	10
OA81	10
OA85	10
OA90	8
OA91	8
OA95	8
OA200	8
OA202	8
1N914	4
1N916	5
1N4001/2	5
1N4003	6
1N4004/5	6
1N4006/7	7
1N4148	4
1N5401	12
1N5404	16
1N5406	1
1N5408	19
1S44	9
1S921	9
6A/100V	40
6A/400V	50
6A/800V	60

BRIDGE RECTIFIERS

1A/50V	18
1A/100V	20
1A/400V	25
1A/600V	30
2A/50V	26
2A/200V	40
2A/400V	42
2A/600V	50
6A/100V	83
6A/400V	96
10A/200V	215
10A/600V	298
25A/200V	240
25A/600V	398
BY164	56

ZENERS

Range: 2V7 to 39V 400mW **8p each**
Range: 3V3 to 33V 1.3W **15p each**

TRIACS

3A200V	56
3A400V	58
8A100V	60
8A400V	69
8A800V	115
12A100V	78
12A400V	82
12A800V	136
16A100V	103
16A400V	106
16A800V	220
25A500V	220
25A800V	296
T2800	125

VARICAPS

BB105B	40
BB106	40

75 SERIES

75107/8	95
75110	90
75114/5	150
75121/2	130
75150	125
75154	125
75158	150
75159	195
75160	420
75162	650
75182/4	99
75188/9	100
75322	140
75324	360
75325	00
75361/3	150
75365	00
75450	85
75451/2	50
75454	70
75491/2	65

SCR THYRISTORS

5A/40V	32
5A400V	40
5A600V	48
8A300V	60
8A600V	90
12A100V	78
12A400V	96
12A800V	188
BT106	150
BT116	180
C106D	36
TIC44	24
TIC45	29
TIC47	36
2N5062	32
2N5064	38
2N4444	130

DIAC

ST2	25

COMPUTER ICs

2102L	160	8123	160	MK3886-2M	£7
2114	275	8131	475	MM5280D	696
2147	300	8150	800	MM5303	636
2516	300	8154	750	MM5307	1275
2532	350	8155	400	MM5387A	865
25L32	450	8156	400	MM58174	875
2564	600	81LS95	175	MM74C922	420
256KDram	495	81LS96	175	RO-3-2513L	700
26501	75	81LS97	175	RO-3-2513U	650
2716-5V	350	81LS98	175	SAA5050	875
2732-4	350	8202	£25	SFF9364	800
2764-250	225	8205	225	SP0256	475
27C64	1000	8212	220	TCJ3101J	£13
27128-250	325	8214	495	TMS2716-3V	725
3242	675	8216	150	TMS4047	100
4027	95	8224	300	TMS4164	200
4116-200n	125	8226	300	TMS4416-2	355
4164-150n	200	8228	310	TMS4500	£12
4416-2	335	8236	00	TMS4532-3	350
4816-100ns	100	8243	290	TMS6011	500
4864-15	200	8250	£11	TMS9914	895
5514	250	8251A	350	TMS9927	£14
6116-150	150	8253	1370	TMS9928	£16
6116L-120	300	8255	400	TMS9929	£16
6117-100n	575	8256AC	£15	ULN2003	75
6167-6	795	8257-5	400	UPD7002	440
6264L-15	420	8259	400	WD1691	£14
63A03	£14	8271	£45	WD1770	£14
6402	350	8272	£45	WD2143	850
65C02	850	8279	750	Z80CPU 2.5	295
6502CPU	325	8282	450	Z80ACPU 4M	380
6502A	545	8283	450	Z80 CTC	285
6503	650	8284	550	Z80A CTC	310
6504	600	8288	£11	Z80BCPU	£11
6504 250	550	8748	£55	Z80 DART	650
6505	650	8T26A	99	Z80A DART	800
6520PIA	175	8T27	150	Z80B	£8
6522A	545	8T31	350	Z80 DMA	795
6522VIA	340	8T95	90	Z80ADMA	925
6530	£11	8T97N	90	Z80 PIO	250
6532RRIOT	650	9602	220	Z80A PIO	315
6545RTC	899	9637A	250	Z80 SIO-1	850
6551ACIA	650	AM26LS31C	125	Z80A SIO	£9
6592PC	£20	AM26LS32A	125	Z80ASIO-2	£9
6800	220	AM26LS33	150		
6802	275	AM7910	£30		
68A02	345	AY-3-1015	300		
6803	850	AY-5-1013	300		
6805	670	CD4724	150		
6808	520	COM8017	275		
6809E	680	D8748	£33		
6810	150	DM8131	275		
6820	150	DP8303	450		
6821	150	DP8304	350		
68B21	220	DS3647	600		
6840	375	DS3691N	350		
6843	800	DS88LS120	300		
6845	650	DS8820	110		
6845SP	750	DS8830	140		
6847	650	DS8831	125		
6850	120	DS8832	200		
6852	250	E9364	800		
6854	625	E9365	£28		
68B54	750	FD1691	£15		
6859	£4	FD1771	£15		
68000	£30	FD1791	£22		
8017	275	FD1795	£28		
8035	350	HD26501	75		
8080A	425	HD4315	250		
8085A	950	HD6301	225		
8088	995	HD63AO3RP	700		
		HM6645SP	755		
		IM6402	380		
		INS8060N	1250		
		MC1488	70		
		MC1489	70		
		MC14411	675		
		MC14412	725		
		MC3242	590		
		MC3446	250		
		MC3447P	315		
		MC3486	225		
		MC3487	225		
		IM6402	350		
		MC6845	625		
		MC6846	625		

LINEAR ICs

555Cmos	80	CA3081	190	MC1469	300	TL091CP	60
702	50	CA3085	160	MC1488	70	UA2240	120
709C 8 pin	35	CA3086	60	MC1489	70	UA78S40	225
710	50	CA3090AQ	250	MC1494	695	ULN2003	75
741 8 pin	16	CA3123E	165	MC1495	300	ULN2004	75
747C 14 pin	60	CA3130	85	MC1496L	70	ULN2283	150
748C 8 pin	35	CA3140	40	MC1596	225	ULN2803	190
735 8 pin	185	CA3160	95	MC1709G	90	UPC575	275
810	160	CA3161	180	MC3302	75	UPC1025H	375
9400CJ	375	CA3162	540	MC3401	50	UPC1156H	295
ADC0808	1000	CA3189	260	MC3403	65	UPC1182	425
AY-1-1320	225	CA3240E	100	MC3404	85	UPC1366	195
AY-1-5050	99	HA1336W	175	MC3405	150	XR2206	375
AY-1-5051	160	HA1388	235	MC3423	80	XR2207	400
AY-1-6720	210	ICL7106	675	MF10	300	XR2211	575
AY-3-1270	720	ICL7107	975	MFC6040	75	XR2216	675
AY-3-1350	350	ICL7611	95	ML924	275	XR2266	360
AY-3-8910	390	ICL7660	250	NE515	275	ZN409	160
Booklet for		ICL8038CC	300	NE529	225	ZN414	80
AY-3-8910	150	ICL8211	225	NE531	120	ZN423E	130
AY-3-8912	430	ICM7216C	£22	NE543K	225	ZN424E	130
AY-5-1317A	630	ICM7217A	£11	NE544	190	ZN425E	595
AY-5-1350	366	ICM7224	785	NE555	20	ZN426E	200
CA3011	130	ICM7240	300	NE556	60	ZN427E	600
CA3012	175	ICM7555	80	NE558	170	ZN428E	450
CA3014	275	ICM7556	140	NE560	350	ZN429E	240
CA3018	85	LA3550	250	NE564	420	ZN459	615
CA3019	90	LA4031P	340	NE565A	120	ZN1034E	200
CA3020	210	LA4032	295	NE566	150	ZN1040E	665
CA3023	210	LA4400	350	NE567V	140	ZNA234E	925
CA3028A	110	LA4422	320	NE570	400		
CA3035	255	LC7130	300	NE571	300		
CA3036	270	LC7120	300	NE5532	150		
CA3043	275	LC7137	350	NE5534A	120		
CA3045	365	LF347	120	OM335	650		
CA3046	70	LF351	60	RC4136D	55		
CA3059	325	LF353	90	RC4558	55		
CA3075	215	LF355	90	SAB3209	425		
CA3080E	65	LF356	90	SAB3271	485		
		LF357	100	SAB4209	295		
		LF398	495	SG3402	295		
		LM10	325	SL490	300		
		LM301A	30	SL6270CD	150		
		LM307	45	SN76227N	95		
		LM308T	75	SN76477	380		
		LM311	60	SN76488	525		
		LM318N	150	SN76489	400		
		LM319	180	SP8629	350		
		LM324A	45	SP0256AL	425		
		LM334Z	125	TA7120	120		
		LM335Z	130	TA7204	150		
		LM337	250	TA7205	90		
		LM339	40	TA7222	150		
		LM348	60	TA7310	120		
		LM349	125	TAA661A	190		
		LM358	50	TAA700	275		
		LM377	210	TAA900	395		
		LM379	495	TAB1042	110		
		LM380	80	TAD100	159		
		LM381N	175	TBA120S	70		
		LM382	190	TBA920Q	200		
		LM384	225	TBA990Q	350		
		LM386	90	TCA220	350		
		LM387	200	TCA270Q	350		
		LM389	160	TCA280A	220		
		LM393	85	TCA940	175		
		LM394CH	380	TCA965	180		
		LM558	170	TDA1004	350		
		LM725CN	300	TDA1008	310		
		LM733	65	TDA1010	220		
		LM1458	35	TDA1022	400		
		LM1871	300	TDA1024	110		
		LM1889	400	TDA1034	350		
		LM2907	395	TDA1490	350		
		LM2917	300	TDA2002	325		
		LM3900	70	TDA2003	190		
		LM3909N	85	TDA2004	230		
		LM3911	185	TDA2006	320		
		LM3914	300	TDA2020	320		
		LM3915	345	TDA2030	190		
		LM3916	300	TDB0791	420		
		LM13600	110	TL170	50		
		LS7220	280	TL497A	185		
		M70681	150	TL507	110		
		M51513L	230	TL509	110		
		M51515L	320	TL061CP	40		
		M51516L	475	TL062CP	60		
		MB3712	200	TL064CN	95		
		MB3756	440	TLO71CP	40		
		MC1204	250	TLO72CP	70		
		MC1301	90	TL074CN	110		
		MC1310	135	TL081CP	30		
		MC145106	695	TL082CP	55		
		MC1455	50	TL083CP	75		
		MC1458	35	TL084CN	100		

TRANSISTORS

AC126/7	30	BC441/61	34	BFR39/40	30	OC26	170	ZTX300	13	2N3866	90	2SC2547	40
AC141/2	35	BC477	22	BFR41/79	25	OC28	220	ZTX302	16	2N3903/4	18	2SC2612	200
AC176	25	BC516/7	30	BFR80/81	25	OC35	50	ZTX303	25	2N3905/6	15	2SD234	74
AC187	25	BC547/8	12	BFR98	105	OC36/41	75	ZTX304	17	2N3906	17	2SK45	80
AC188	25	BC549C	12	BFX29	28	OC42/75	75	ZTX326	30	2N4037	60	2SK288	225
ACY19/21	75	BC556/7	15	BFX81	45	OC71/72	50	ZTX451	23	2N4058	15	2SJ83	225
ACY22/41	75	BC558/9	15	BFX84	35	OC75/76	55	ZTX500	14	2N4061/2	15	2SJ85	225
AD142	120	BCY39/40	85	BFX85/6	35	OC81/82	50	ZTX501/2	15	2N4284	30	3N128	115
AD149	79	BCY41/42	30	BFY50/51	30	OC83/84	70	ZTX503	18	2N4286	25	3N140	115
AD161	42	BCY45	50	BFY52	30	OC170/71	75	ZTX504	25	2N4289	25	40315	90
AD162	42	BCY58/59	35	BFY53	35	OC70	40	ZTX531	125	2N4314	78	40316	95
AF115/6	80	BCY70/71	18	BFY55/56	56	OC200	75	ZTX550	25	2N4400	25	40324	100
AF188	80	BCY72	18	BFY64	40	TIP29A	32	2N697	23	2N4427	80	40326/7	70
AF124/26	60	BCY78	30	BFY81	120	TIP29C	38	2N698	40	2N4871	55	40347	90
AF139	40	BD114	190	BFY90	80	TIP30A	35	2N699	48	2N5135/6	30	40348	120
AF178	75	BD121	95	BRY39	50	TIP30C	37	2N706A	25	2N5138	25	40360	60
AF186	70	BD124	115	BSX20	28	TIP31A	38	2N708	25	2N5172	25	40361/2	70
AF239	55	BD131/32	55	BSX26/29	32	TIP31B	39	2N918	40	2N5179	45	40407/8	75
BC107	12	BD133	50	BSY26	35	TIP31C	45	2N1131/2	40	2N5180	45	40411	285
BC107B	14	BD135	45	BSY95	35	TIP32A	43	2N1302	45	2N5190/1	75	40412	90
BC108	12	BD136/37	35	BU105	180	TIP32C	45	2N1307	70	2N5194	80	40467A	130
BC108B	14	BD138/39	35	BU205	180	TIP33A	70	2N1671B	160	2N5305/8	30	40468	85
BC108C	14	BD140	40	BU206	200	TIP33C	75	2N2160	325	2N5457/8	30	40594	105
BC109	12	BD144/45	198	BU208	170	TIP34A	85	2N2219A	28	2N5459	30	40603	110
BC109B	14	BD158	68	BUY69C	225	TIP34C	105	2N2220A	28	2N5485	36	40673	75
BC109C	14	BD184	35	MD8001	250	TIP35A	120	2N2221A	25	2N5777	45	40871/2	90
BC114/5	25	BD205/6	110	MJ2955	90	TIP35C	130	2N2222A	25	2N5879	180		
BC117/8	25	BD245	65	MJE170	150	TIP36A	130	2N2368	25	2N6027	32		
BC119	35	BD378	70	MJE180	150	TIP36C	140	2N2369A	18	2SA671	250		
BC137/9	40	BD434	70	MJE340	54	TIP41A	54	2N2483/4	27	2SA715	75		
BC140	30	BD517	75	MJE370	100	TIP41B	52	2N2646	46	2SC495	85		
BC142/3	28	BD645	80	MJE371	100	TIP42A	55	2N2904/5	28	2SC496	85		
BC147	12	BD695A	150	MJE520	50	TIP42B	58	2N2906/7	28	2SC1061	250		
BC147B	15	BD696A	150	MJE521	90	TIP120	70	2N2907A	28	2SC1096	85		
BC148	12	BF115	45	MJE2955	98	TIP121/2	73	2N2926G	10	2SC1162	45		
BC148B	15	BF154/8	30	MJE3055	70	TIP141/2	120	2N3053	25	2SC1173	125		
BC149	12	BF167	35	MPF102	40	TIP147	120	2N3054	55	2SC1306	100		
BC149C	15	BF173	35	MPF103	30	TIP2955	70	2N3055	50	2SC1307	150		
BC182L	10	BF177	35	MPF104	30	TIP3055	70	2N3252	46	2SC1449	95		
BC183L	10	BF178	35	MPF105	30	TIS43	50	2N3441/2	140	2SC1678	140		
BC184	10	BF179	40	MPF106	40	TIS44/5	45	2N3614/5	180	2SC1679	180		
BC184L	10	BF184/5	38	MPSA05	23	TIS88A	50	2N3663	20	2SC1923	85		
BC186 6/7	25	BF194/5	12	MPSA08	30	TIS90/91	30	2N3702/3	10	2SC1945	225		
BC188	10	BF198/9	15	MPSA12	29	UC734	99	2N3704/5	10	2SC1953	80		
BC212	10	BF200	35	MPSA55	30	VK1010	99	2N3706/7	10	2SC1957	80		
BC212L	12	BF224A	40	MPSA56	30	VN10KM	65	2N3708/9	10	2SC1969	180		
BC213	10	BF224B	40	MPSA70	40	VN46AF	90	2N3713	140	2SC2028	85		
BC213L	12	BF245	38	MPSU02	58	VN66AF	110	2N3771	179	2SC2029	200		
BC214	10	BF256A	45	MPSU05	50	VN88AF	220	2N3772	195	2SC2078	170		
BC214L	12	BF256B	50	MPSU06	55	VN89AF	120	2N3773	210	2SC2091	85		
BC237/8	10	BF257/8	32	MPSU52	65	ZTX107/8	12	2N3819	35	2SC2314	86		
BC238	10	BF259	30	MPSU55	60	ZTX109	12	2N3820	60	2SC2166	105		
BC256B	35	BF275	55	MPSU56	55	ZTX212	28	2N3822/3	60	2SC2335	200		
BC307B	15	BF336/7	35										
BC308	12	BF394	40										
BC318	80	BF451	40										
BC327/8	12	BF494/5	40										
BC337/8	12	BF594/5	30										

RF Chokes Miniature PCB type
1uH, 2u2, 4u7, 10u, 22u, 33u, 47u, 100u, 220u, 330u, 470u ...**35p**
1mH, 1m5, 2m2, 4m7, 10mH ...**40p**
22mH, 33mH, 43mH, 47mH ...**60p**
100mH, 220mH ...**75p**

74HC

HC00	55
HC02	55
HC08	55
HC10	55
HC20	55
HC32	55
HC42	135
HC51	55
HC74	70
HC86	60
HC107	70
HC109	75
HC139	120
HC153	35
HC160	35
HC161	135
HC164	135
HC165	270
HC173	120
HC174	120
HC175	120
HC240	195
HC249	195
HC241	195
HC242	135
HC244	195
HC245	195
HC259	270
HC373	225
HC374	225
HC393	225
HC640	240
HC645	240

TTL74

7400	22	74105	68
7401	22	74107	40
7402	22	74109	80
7403	25	74110	55
7404	25	74111	55
7405	25	74112	160
7406	38	74116	160
7407	38	74118	100
7408	25	74119	150
7409	25	74120	90
7410	25	74121	45
7411	25	74122	50
7412	25	74123	73
7413	35	74125	50
7414	50	74126	50
7416	35	74128	55
7417	35	74132	60
7420	25	74136	63
7421	30	74141	80
7422	30	74142	230
7423	32	74143	250
7425	32	74144	225
7426	36	74145	85
7427	30	74147	130
7428	30	74148	105
7430	22	74150	130
7432	29	74151	60
7433	35	74153	70
7437	29	74154	135
7438	39	74155	75
7440	25	74156	90
7441	85	74157	75
7442	65	74159	175
7443	95	74160	90
7444	100	74161	90
7445	100	74162	90
7446	100	74163	90
7447	95	74164	110
7448	98	74165	90
7450	25	74166	130
7451	30	74167	200
7453	25	74170	160
7454	25	74172	390
7460	25	74173	100
7470	48	74174	100
7472	35	74175	80
7473	40	74176	80
7474	36	74177	80
7475	48	74178	120
7476	40	74179	90
7480	50	74180	85
7481	175	74181	230
7482	90	74182	85
7483	85	74184	160
7484	100	74185	160
7485	100	74190	117
7486	35	74191	140
7489	170	74192	191
7490	55	74193	110
7491	65	74194	80
7492	55	74195	90
7493	50	74196	63
7494	90	74197	85
7495	65	74198	190
7496	72	74199	190
7497	170	74221	95
74100	195	74246	125
74104	68	74247	120
		74248	145
		74249	172
		74251	90
		74259	140
		74263	75
		74265	60
		74273	150
		74276	150
		74278	150
		74279	75
		74283	110
		74284	300
		74285	310
		74286	90
		74290	85
		74293	85
		74297	165
		74298	156
		74351	175
		74365	68
		74366	68
		74367	68
		74368	65
		74376	117
		74390	100
		74393	103
		74426	65
		74490	89

74C

74C244	150
74C245	150
74C373	180
74C374	425
74C922	550
74C923	800
74C925	650

74S

S00	45
S02	40
S03	40
S04	40
S05	40
S08	40
S09	40
S10	40
S11	50
S15	60
S20	40
S22	60
S30	50
S32	50
S37	50
S38	70
S40	40
S51	40
S64	40
S65	40
S74	70
S85	295
S86	100
S112	150
S113	120
S114	120
S124	300
S132	90
S133	50
S134	60
S135	110
S138	170
S139	170
S140	75
S151	140
S153	140
S157	200
S158	190
S162	300
S163	300
S174	250
S175	300
S188	180
S189	225
S194	280
S197	300
S201	250
S225	500
S226	350
S240	375
S241	375
S244	475
S251	225
S257	225
S258	225
S260	70
S262	£10
S287	200
S288	180
S289	200
S301	350
S365	250
S373	375
S374	375
S412	380
S470	325
S471	600
S472	400
S474	400
S475	425
S571	300
S573	450

74LS

LS00	22	LS19	45	LS259	90
LS01	22	LS20	22	LS260	70
LS02	22	LS21	22	LS261	100
LS03	22	LS22	22	LS266	25
LS04	22	LS24	50	LS273	80
LS05	22	LS26	22	LS275	350
LS08	25	LS27	22	LS279	55
LS09	22	LS28	24	LS280	180
LS10	22	LS30	22	LS283	70
LS11	22	LS32	22	LS290	80
LS12	22	LS33	23	LS292	850
LS13	30	LS37	22	LS293	75
LS14	50	LS38	25	LS294	999
LS15	22	LS40	22	LS295	130
		LS42	50	LS297	850
		LS47	75	LS298	100
		LS48	75	LS299	220
		LS49	95	LS320	210
		LS51	22	LS322	380
		LS52	25	LS323	300
		LS54	22	LS324	140
		LS55	22	LS325	150
		LS63	52	LS326	290
		LS73	28	LS327	290
		LS74	28	LS347	120
		LS75	38	LS348	140
		LS76	28	LS352	115
		LS78	34	LS353	85
		LS83	65	LS355	220
		LS85	70	LS356	200
		LS86	35	LS363	140
		LS90	40	LS264	150
		LS91	86	LS365	42
		LS92	50	LS366	42
		LS93	45	LS367	42
		LS95	58	LS368	42
		LS96	90	LS373	80
		LS107	40	LS374	80
		LS109	45	LS375	55
		LS112	40	LS377	100
		LS113	38	LS378	85
		LS114	36	LS379	127
		LS122	55	LS380	310
		LS123	60	LS382	310
		LS124	120	LS384	457
		LS125	37	LS385	310
		LS126	37	LS386	50
		LS132	52	LS390	60
		LS133	44	LS393	48
		LS135	28	LS395	100
		LS136	35	LS396	195
		LS138	48	LS398	185
		LS139	48	LS399	115
		LS145	90	LS445	125
		LS147	130	LS447	75
		LS148	115	LS465	130
		LS151	55	LS490	148
		LS153	65	LS540	100
		LS154	120	LS541	98
		LS155	55	LS624	155
		LS156	55	LS629	120
		LS157	47	LS640	150
		LS158	48	LS641	140
		LS160	60	LS645	195
		LS161	60	LS668	87
		LS162	60	LS669	85
		LS163	60	LS670	150
		LS164	70	LS673	850
		LS165	95	LS674	850
		LS166	88	LS678	275
		LS168	138	LS684	300
		LS169	90	LS687	300
		LS170	120		
		LS173	80		
		LS174	60		
		LS175	60		
		LS181	190		
		LS183	186		
		LS190	75		
		LS191	55		
		LS192	75		
		LS193	75		
		LS194	70		
		LS195	60		
		LS196	75		
		LS197	75		
		LS221	65		
		LS240	80		
		LS241	80		
		LS242	80		
		LS243	80		
		LS244	70		
		LS245	88		
		LS247	75		
		LS248	100		
		LS249	100		
		LS251	55		
		LS253	70		
		LS256	90		
		LS257	55		
		LS258	55		

SWITCHES

TOGGLE: 2A, 250V
SPST 35p DPDT 48p

SUB-MIN TOGGLE

SPST on/off	58p
SPDT c/over	64p
SPDT centre off	85p
SPDT biased both ways	105p
DPDT 6 tags	80p
DPDT centre off	88p
DPDT biased both ways	145p
DPDT 3 positions on/or/on	185p
4-pole 2 way	220p

SLIDE 250V:

DPDT 1A	14p
DPDT 1A c/off	15p
DPDT ½A	13p

PUSHBUTTON 6A
with 10mm Button

SPDT latching	150p
DPDT latching	200p
DPDT moment	200p

Mini Non Locking

Push to Make	15p
Push to Break	25p

DIGITAST Switch
Assorted Colours
75p each

DIP SWITCHES

(SPST) 4 way **65p**; 6 way **80p**; 8 way **85p**; 10 way **125p** (SPDT) 4 way **190p**

ROTARY SWITCHES

(Adjustable Stop type)
1 pole/2 to 12 way; 2 pole/2 to 6 way; 3 pole/2 to 4 way; 4 pole/2 to 3 way **48p**

ROTARY: Mains DP 250V 4 Amp on/off **88p**

ROTARY: (Make-a-switch)
Make a multiway switch. Shafting assembly has adjustable stop. Accommodates up to 6 wafers (max. 6 pole/12 way + DP switch). Mechanism only **90p**

WAFERS: (make before break) to fit the above switch mechanism. 1 pole/12 way; 2 pole/6 way; 3 pole/4 way; 4 pole/3 way; 6p/2 Way **65p**
Mains DP 4A Switch to fit **45p**
Spacers **4p.** Screen **6p.**

ROCKER SWITCHES

ROCKER: 5A/250V SPST	28p
ROCKER: 10A/250V SPDT	38p
ROCKER: 10A/250V DPDT c/off	95p
ROCKER: 10A/250V DPST with neon	85p

THUMBWHEEL Mini front mounting switches

Decade Switch Module	275p
B.C.D. Switch Module	298p
Mounting Cheeks (per pair)	75p

GAS/SMOKE DETECTORS

TGS812 or TGS813
£6 each
Holders for above **40p**

JUMPER LEADS (Ribbon Cable Assembly)

Length	14 pin	16 pin	24 pin	40 pin
Single ended DIP (Header Plug) Jumper				
24 inches	145p	185p	240p	380p
Double ended DIP (Header Plug) Jumper				
12 inches	198p	215p	315p	480p
24 inches	210p	235p	345p	540p
36 inches	290p	370p	480p	525p

IDC Female Header Socket Jumper Leads 36

	20pin	26 pin	34 pin	40 pin
Single ended	180p	200p	260p	300p
Double ended	290p	370p	480p	525p

VEROBOARD 0.1in

2½ x 3¼	95p
2½ x 5	110p
3¾ x 3¾	110p
3¾ x 5	125p
3¾ x 17	420p
4¾ x 17	590p
VQ Board	195p
DIP Board	395p
Vero Strip	95p

VERO PINS per 100

Single ended	55p
Double ended	60p
Wire wrape S/E	155p
Wire wrape D/E	255p

VERO WIRING PEN
VERO WIRING

Pen + Spool	380p
Spare spool	75p
Combs	8p
Pen + Spools + combs	599p

Combs	8p
Pen + Spools + Combs	599p

PROTO DECs

Veroblock	480p
S-Dec	395p
Eurobreadboard	590p
Bimboard 1	575p
Superstrip SS2	1350p

VERO TOOLS
Spot face cutters **150p**
Pin Insertion Tool **185p**

FERRIC CHLORIDE
1 lb bag Anhydrous
125p + 50p p&p

DALO ETCH RESIST PEN
Plus spare tip **100p**

COPPER CLAD BOARDS

Fibre glass	Single-sided	Double sided
6" x 6"	100p	125p
6" x 12"	175p	225p

DIL SOCKETS

	Low Prof	Wire Wrap
8 pin	8p	25p
14 pin	10p	35p
16 pin	10p	42p
18 pin	16p	52p
20 pin	20p	60p
22 pin	22p	65p
24 pin	25p	70p
28 pin	28p	80p
40 pin	30p	90p

EDGE CONNECTORS

	.1"	.156"
2x6 way	—	75p
2x12 way	—	160p
2x15 way	—	165p
2x18 way	175p	160p
2x22 way	200p	170p
2x23 way	150p	—
2x25 way	250p	245p
2x28 way	180p	—
2x30 way	280p	—
2x36 way	300p	—
2x40 way	320p	—
2x43 way	400p	—
2x75 way	600p	—

SIL SOCKET 0.1" Pitch 20 way **65p**

ANTEX SOLDERING IRONS

C15W	525p;	CS17W	545p
C18W	550p;	XS25W	570p
Spare Bits	85p;	Elements	230p
Iron Stand	175p;	Heat Shunt	30p

IDC CONNECTORS

	PCB with Pins Strt	Plugs latch Pins Angle	Female Header Plug	Female Card Edge Conct
10 way	65p	85p	85p	100p
16 way	75p	75p	80p	—
20 way	90p	90p	95p	185p
26 way	105p	110p	115p	230p
34 way	115p	130p	135p	320p
40 way	140p	145p	150p	335p
50 way	165p	170p	175p	350p
60 way	195p	210p	225p	495p

EURO CONNECTORS

Gold Flashed Contacts	Female Strt. Pins	Socket Angle Pins	Male Strt. Pins	Plug Angle Pins
DIN41617 31 way	125p	—	—	175p
DIN41612 2 x 32 A + B	200p	—	175p	185p
DIN41612 2 x 32 A + C	225p	—	185p	210p
DIN41612 3 x 32 A + B + C	280p	290p	295p	300p

DIL PLUG (Header)

	Solder	IDC
14 pin	40p	95p
16 pin	45p	100p
24 pin	85p	135p
28 pin	150p	200p
40 pin	200p	255p

RIBBON CABLE

price per foot

	Grey	Color
10 way	15p	28p
16 way	25p	40p
20 way	30p	50p
24 way	40p	65p
28 way	55p	80p
34 way	60p	85p
40 way	70p	90p
50 way	100p	135p
64 way	120p	160p

ZIF TEXTOOL DIL SOCKETS

24 pin	550p
28 pin	650p
40 pin	800p

'D' CONNECTORS

	9 way	15 way	25 way	37 way
Male				
Solder lugs	55p	80p	120p	150p
Angle pins	110p	175p	225p	300p
PCB pins	100p	100p	160p	250p
Female				
Solder lugs	90p	125p	180p	275p
Angle pins	150p	200p	260p	390p
PCB pins	100p	125p	195p	355p
Covers	75p	70p	70p	85p

IDC 25 way 'D' Plug **385p**; Socket **450p**

PANEL METERS

FSD
60 x 46 x 35mm
0–50μA
0–100μA
0–500μA
0–1mA
0–5mA
0–10mA
0–50mA
0–100mA
0–500mA
0–1A
0–2A
0–25V
0–50V
0–300V AC **465p**

CRYSTALS

32.768KHz	100
100KHz	400
200KHz	370
455KH	370
1MHz	265
1.008M	275
1.28MHz	450
1.6MHz	200
1.8MHz	545
1.8432M	2)0
2.0MHz	225
2.4576M	200
3.12MHz	240
3.278M	150
3.5794M	95
3.6864M	300
4.0MHz	140
4.032MHz	290
4.19430M	150
4.433619M	100
4.608MHZ	200
4.80MHz	200
5.0MHz	150
5.185MHz	300
5.24288M	390
6.0MHz	140
6.144MHz	140
6.5536MHz	225
7.0MHz	150
7.168MHz	175
7.7328MHz	250
7.68MHz	200
8.0MHx	140
8.089333M	395
8.86723M	175
9.00MHz	200
10.0MHz	170
10.24MHz	200
10.5MHz	250
10.7MHz	150
12.0MHz	150
12.528M	300
14.31814M	170
15.0MHz	155
16.0MHz	200
18.0MHz	150
18.432M	150
19.968MHz	150
20.0MHz	150
24.0MHz	150
24.930MHz	325
26.69M	150
27.648M	170
27.145M	180
38.6667M	240
48.0MHz	240
100.0MHz	295

RELAYS

Miniature, enclosed, PCB mount.

SINGLE POLE Changeover
RL-91 205R Coil; 12V DC, (10V5 to 19.5V), 10A at 30V DC or 250V AC **195p**

DOUBLE POLE Changeover, 6A 30V DC or 250V AC
RL-113 53R Coil, 6V DC (5V4 to 9V9) **190p**
RL6-111 205R Coil, 12V DC (10V7 to 19V5) **195p**
RL6-114 740R Coil, 24V DC (22V to 37V) **200p**

ASTEC UHF MODULATORS

Standard 6MHz	375p
Wideband 8MHz	550p

BUZZERS

miniature, solid-state 6V; 9V & 12V	70p
PIEZO TRANSDUCERS PB2720	70p

LOUDSPEAKERS

Miniature, 0.3W- 8

2in, 3¼in, 2½in, 3in	80p
2½in 40Ω, 64Ω or 80Ω	80p
6" x 4" 8Ω	200p
7" x 5" 8Ω	225p
8" x 5" 8Ω	250p

MONITORS

- ZENITH — 12" Green, Hi-Resolution Popular **£70**
- MICROVITEC 1431. Standard Res, Colour RGB input 14" incl cable **£185**
- MICROVITEC 1451. 14" Medium resolution **£229**
- KAGA 12". Med-res. RGB Colour. Has flicker-free characters. Ideal for BBC, Apple, VIC, etc **£225** (car £7)
- KAGA 12". As above but Hi-Resolution **£310** (car £7)
- Connecting Lead for KAGA **£3**

Carriage £7 Securicor

TRANSFORMERS

3-0-3V; 6-0-6V; 9-0-9V; 12-0-12V; 15-0-15V @ 100mA **130p**
PCB mounting. Miniature, Split bobbin
3VA: 2x6V/0.25A; 2x9V/0.15A; 2x12V/0.12A; 2x15V/0.2A **235p**
6VA: 2x6V/0.5A; 2x9V/0.3A; 2x12V/0.25A; 2x15V/0.2A **280p**
Standard Split Bobbin type:
6VA: 2x6V/0.5A; 2x9V/0.4A; 2x12V/0.3A; 2x15V/0.25A **250p**
12VA: 2x4.5V/1A3; 2x5V-1A; 2x9V/0.6A; 2x12V/0.5A; 2x15V-0.4A; 2x20V/0.3A **345p** (35p p&p)
24VA: 2x6V/1.5A; 2x9V/1.2A; 2x12V/1A; 2x15V/0.8A; 2x20V/0.6A **385p** (60p p&p)
50VA: 2x6V/4A; 2x9V/2.5A; 2x12V/2A; 2x15V/1.5A; 2x20V/1.2A; 2x25V/1A; 2x30V/0.8A **520p** (60p p&p)
50VA: Outputs +5V/5A; +12V, +25V, −5V, −12V at 1A **620p** (60p p&p)
100VA: 2x12V/4A; 2x15V/3A; 2x20V/2.5A; 2x25V/2A; 2x30V/1.5A; 2x50V/1A **855p** (75p)
P&P charge to be added over and above our normal postal charge

VOLTAGE REGULATORS

1A TO220 Plastic Casing

	+ ve		− ve	
5V	7805	45p	7905	50p
12V	7812	45p	7908	50p
15V	7815	45p	7912	50p
18V	7818	45p	7915	50p
24V	7824	45p	7918	50p
			7924	50p

100mA TO92 Plastic package

5V	78LO5	30p	79LO5	45p
6V	78LO6	30p	—	—
8V	78LO8	30p	—	—
12V	78L12	30p	79L12	45p
15V	78L15	50p	79L15	45p

ICL7660	245p	TAA550	50p
RC4194	375p	TDA1412	150p
RC4195	160p	78H05 +5V/5V	550p
LM309K	135p	78H12+12V/5A	695p
LM317K	250p	78HG+5V to+25V/5V 5A	550p
LM317KP	450p	79HG-5V to-24V/5A	785p
LM323K	450p		
LM337	175p		
LM723 Var	30p		
78S40	225p		

SOLDERCON PINS

Ideal for making SIL or DIL Sockets

100 pins	45p
500 pins	195p

ALUM BOXES

3 x 2 x 1"	85p
4 x 2½ x 2"	100p
4 x 2½ x 2½"	103p
4 x 4 x 2"	105p
4 x 4 x 2½"	120p
5 x 4 x 1½"	99p
5 x 4 x 2½"	120p
5 x 2¾ x 1½"	90p
5 x 2¾ x 2½"	130p
6 x 4 x 2"	120p
6 x 4 x 3"	150p
7 x 5 x 3"	180p
8 x 6 x 3"	210p
10 x 4 x 3"	240p
10 x 7 x 3"	275p
12 x 5 x 3"	280p
12 x 8 x 3"	295p

25 way 'D' CONNECTOR (RS232)

Jumper Lead Cable Assembly

18" long, Single end, Male	475p
18" long, Single end, Female	510p
36" long, Double Ended, M/M	995p
36" long, Double Ended, F/F	£10
36" long, Double Ended, M/F	995p

AMPHENOL CONNECTORS

	IDC	SOLDER
24 way IEEE plug	465p	460p
24 way IEEE skt	485p	480p
36 way Centronics plug	375p	390p
36 way Centronics skt	480p	450p

BT TELEPHONE CONNECTOR

LJU 1/4A	Mini Line Master	435p
LJU 1/6A	Mini Line Slave	295p
LJU 2/4A	Line Master	370p
LJU 2/6A	Line Slave	250p
LJU 3/4A	Flush Master	370p
LJU 3/6A	Flush Slave	240p
LJU 10/3A	Dual Splitter	550p
4 WAYBT Plug		65p

CMOS

4000	20	4075	25	4543	70
4001	25	4076	70	4548	40
4002	25	4077	25	4549	400
4006	70	4078	25	4553	245
4007	25	4081	25	4554	180
4008	60	4082	25	4555	35
4009	45	4085	60	4556	55
4010	40	4086	60	4557	250
4011	25	4089	125	4558	120
4012	25	4093	40	4559	395
4013	35	4094	70	4560	150
4014	60	4095	85	4561	104
4015	60	4096	100	4562	350
4016	40	4097	275	4566	160
4017	55	4098	80	4568	250
4018	60	4099	110	4569	175
4019	60	4160	95	4572	45
4020	80	4161	96	4580	255
4021	80	4162	96	4581	125
4022	70	4163	96	4582	99
4023	30	4174	96	4583	100
4024	50	4175	105	4584	55
4025	25	4194	105	4585	55
4026	90	4408	850	4597	330
4027	45	4409	850	4599	155
4028	45	4410	725	40085	90
4029	75	4411	750	40097	45
4030	35	4412	805	40098	42
4031	130	4415	590	40100	215
4032	65	4419	280	40101	130
4033	130	4422	770	40102	140
4034	146	4435	850	40103	412
4035	70	4440	900	40104	120
4036	250	4450	360	40105	220
4037	115	4451	350	40106	80
4038	75	4490	450	40107	55
4039	280	4500	395	40108	325
4040	60	4501	40	40109	100
4041	60	4502	60	40110	235
4042	50	4503	40	40114	240
4043	45	4504	100	40161	194
4044	50	4505	350	40163	75
4045	110	4506	100	40174	75
4046	60	4507	45	40175	75
4047	60	4508	130	40181	220
4048	55	4510	55	40182	80
4049	40	4511	55	40192	75
4050	35	4512	55	40193	95
4051	70	4513	150	40194	70
4052	60	4514	115	40195	75
4053	60	4515	115	40244	196
4054	85	4516	55	40245	198
4055	85	4517	275	40257	196
4056	85	4518	50	40373	220
4057	1000	4519	35	40374	220
4059	420	4520	55	45106	586
4060	70	4521	115		
4061	500	4522	125	**OPTO**	
4062	988	4526	60	OCP71	120
4063	90	4527	65	ORP12	85
4066	45	4528	70	ORP61	86
4067	245	4529	145	BPX25	250
4068	25	4530	90	BPW21	320
4069	25	4531	120	TIL139	225
4070	25	4532	65		
4071	25	4534	365		
4072	25	4536	250		
4073	25	4538	80		
		4539	80		
		4541	95		

OPTO ELECTRONICS

LEDs with clips

TIL209	10
TIL211 GRN	14
TIL212 Yel.	14
TIL220 2" Red	12
2" Green, Yellow or Amber	14
0.2" Bi colour Red/Green	100p
Green/Yellow	115p
0.2" Tri colour Red/Green/Yellow	85
Hi-Brightness Red	58
High-Bri Green or Yel	68
Flashing red 0.2" red	55
Square LEDs, Red, Green, Yellow	30
Rectangle Stackable LEDs Red, Green or Yellow	18
Triangular LEDs Red	18
Green or yellow	22
LD271 Infra Red	48
SFH205 Detector	118
TIL32 Infra Red	52
TIL78 Detector	55
TIL38	50
TIL100	75
BARGRAPH. Red 10 segments	275

ISOLATORS

IL74	75
ILD74	145
ILQ74	275
TIL111/2/4	70
ILCT6 Darlington	135
TIL117	125
4N33 Photo Darlington	136

7 Segment Displays

TIL312 .3" CA	120
TIL313 .3" CC	120
TIL321 .5" CA	140
TIL322 .5" CC	140
TIL729/730	140
DL704 .3" CC	125
DL707 .3" CA	125
FND357 Red	120
FND500	130
.3" Green CA	150
.6" Green CA	215
.3" ± 1 Red CA	150
.3" ± 1 Green CA	150
LCD 3½ Digits	496
LCD 4 Digits	530
LCD 6 Digits	625
Reflective Switch	225
SLOTTED Optical Switch similar to RS Comp.'s	295

TURNED PIN Low Profile

Professional DIL SOCKETS

8 pin	20p
14 pin	25p
16 pin	30p
18 pin	35p
20 pin	40p
22 pin	40p
24 pin	45p
28 pin	55p
40 pin	75p

SPECIAL OFFER

	1+	10+
2764-250nS	220p	205p
27128-250nS	325p	300p
6116LP-3	185p	150p
6264LP-150nS	420p	405p

COMPUTER CORNER

- EPSON FX80 Printer £315
- EPSON FX100 Printer £429
- EPSON LX80 Printer £225
- CENTRONICS (NLQ) Printer £110
- KAGA/TAXAN KP810 Printer £235
- KAGA/TAXAN KP910 Printer £339
- BROTHER HR15 Daisywheel £318

Cable for above printers to interface with BBC Micro £7

- TEX EPROM ERASER — Erases up to 25 Eproms. Has a built.in safety switch £30
- SPARE 'UV' Lamp Bulb £8
- C12 Computer CASSETTES in Library cases 32p
- 8½" & 9½" Fan Fold paper (1000 sheets) .... £7 (Carr. 150p)

(Securicor Carriage charge on printers is £7)

CALL IN AT OUR SHOP FOR A DEMONSTRATION ON ANY OF THE ABOVE ITEMS. BE SATISFIED BEFORE YOU BUY OR WRITE IN FOR OUR DESCRIPTIVE MICRO PERIPHERALS LEAFLET.

5¼" DRIVES for the BBC Micro

(All Drives are supplied cased with Power Supply and Utilities Disc

- **CS200** — Epson Single 200K, 40 track Double sided £107
- **CS400S** — Mitsubishi Single 400K, 80T, Double sided 40 track switchable £130
- **CD400** — Epdon Yein 400K, 40 track, Double sided £175
- **CD800S** — Mitsubishi Twin 800K, 80T, 40/80 track switchable £230
- **TWIN Disc drive case** with Power supply and Cables to house your own drives £35
- All Single Drives with Power supply are supplied in a twin case for later inclusion of a second drive.
  (Securicor Carriage on Drives £7)
- **DISC INTERFACE KIT** complete £75
- **DFS Manual** (comprehensive) (NO VAT) £7

SPDOS

The only professional Disc Interface for the Spectrum Micro.

SPECIAL OFFER THIS MONTH for ONLY £75

£18

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A complete wordprocessing package (which can be heavily modified to your requirements, maintaining large discount). We supply everything you need to get a BBC Micro running as a word-processor. Please call in for a demonstration.
Example Package:
BBC Micro, with DFS Interface, Wordwise, Twin 800K Disc Drives, 12" High-res green monitor, Brother HR15 Daisywheel printer, Beebcalc & Database software on Disc, 10 3M Discs, 500 sheets of paper, 4way mains trailing socket, manuals and all cables.

Only: £999

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Rapid Electronics

Fast component distribution

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Hill Farm Industrial Estate
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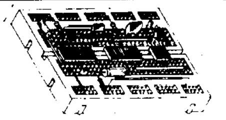
LINEAR

		ICM7555	55	LM386	85	ML924	290	SL486	240	TL084	90
		LF347	90	LM387	90	ML925	290	SL490	280	TL170	50
555 CMOS	55	LF351	40	LM393	45	ML926	275	SN76477	380	TL170	50
556 CMOS	150	LF353	70	LM710	48	ML927	275	SPO256AL2	425	ULN20003	80
709	35	LF356	90	LM711	48	ML928	275	Data on above	50	ULN2004	80
741	16	LM301A	30	LM725	270	ML929	275	TBA800	70	ULN2803	130
748	35	LM311	45	LM741	16	NE531	135	TBA810	65	XR2206	395
AY-3-8910	390	LM318	110	LM747	60	NE555	20	TBA820M	60	ZN414	75
AY-3-8912	430	LM324	40	LM1458	35	NE556	45	TCA940	65	ZN423	100
CA3046	60	LM334Z	85	LM2917	170	NE565	95	TDA1022	270	ZN424	70
CA3080E	65	LM335Z	130	LM3909	85	NE566	95	TL061	40	ZN425E	340
CA3130E	75	LM339	40	LM3914	190	NE567	100	TL062	65	ZN426E	200
CA3140E	38	LM348	60	LM3915	190	NE570	230	TL064	05	ZN427E	580
CA3240E	100	LM358	40	LM13600	100	NE571	195	TL071	32	ZN428E	435
ICL7106	680	LM377	210	MC3302	75	NE5532	160	TL072	55	ZN435E	360
ICL7611	100	LM380	80	MC3340	130	NE5534	105	TL074	105	ZN448E	525
ICL8038	395	LM381	130	MF10CN	330	RC4136	65	TL081	28	ZN459	190
ICL8211A	200	LM382	130	ML922	415	RC4558	45	TL082	45	ZN1034E	190

BREADBOARDS



Protobloc breadboards are extremely useful for quick construction of electronic circuits without soldering. All sockets are on a 2.54mm pitch enabling DIL circuits and a wide range of components to be plugged in to the board. The contact pattern contains two separate contact groups each of rows of 5 interconnected contact sockets. Bus strips are provised for power use. All contact positions are clearly marked on an alphanumeric grid. Supplied complete with approx. 20 layout sheets. Two sizes are available:

length	width	tie points	rows	max no.16 pin devices	prices
80mm	60mm	390	29	3	395p
172mm	65mm	840	64	7	695p

CAPACITORS

Mini polyester 63V DC type.
1n, 2n2, 4n7, 10n, 22n, **5p**; 47n, 100n, **6p**; 220n, **9p**; 470n, **13p**.

Electrolytic. Radial head type.
1u, 2u2, 4u7 @ 63V **5p**; 100u, 22u @ 25V **5p**; 47u 25V **7p**; 100u 25V **8p**; 220u 25V **13p**; 470u 16V **14p**; 1000u 16V **20p**; 1000u 25V **30p**; 2200u 16V **34p**; 2200u 25V **42p**.

Tantalum bead.
0.1u, 0.47u, 1u @@ 35V **6p**; 2u2 @ 25V **6p**; 4u7 @ 25V **8p**; 10u @ 25V **14p**; 22u @ 16V **18p**; 47u @ 16V **40p**.

Ceramic disc 50V.
100p-10n **3p each**; 100n 25V **6p**.

TRANSISTORS

				BC214L	10	BD131	40	MPF102	40	TIP42A	45	2N2904A	28
				BC237	5	BD132	40	MPSA12	29	TIP120	60	2N2905	28
				BC238	5	BD139	35	TIP29A	35	TIP121	60	2N2905A	28
AC127	30	BC148	10	BC327	6	BD140	35	TIP29C	35	TIP122	60	2N2907	24
AC128	30	BC169C	10	BC328	6	BF180	35	TIP30A	35	TIP2955	70	2N2907A	24
AC176	25	BC171	10	BC337	6	BF244B	35	TIP30C	40	TIP3055	60	2N2926	10
AC187	25	BC178	16	BC338	14	BF337	35	TIP31A	35	VN10KM	65	2N3053	28
AC188	25	BC179	18	BC477	22	BFR80	23	TIP31C	40	VN46AF	94	2N3054	55
BC107	10	BC182	10	BC478	22	BFX85	30	TIP32A	35	VN66AF	110	2N3055	50
BC107B	12	BC182L	10	BC479	22	BFX88	30	TIP32C	40	VN88AF	120	2N3702	9
BC108	10	BC183	10	BC517	30	BFY50	25	TIP33A	65	ZTX109	11	2N3703	10
BC108C	12	BC183L	10	BC547	5	BFY51	25	TIP33C	75	ZTX300	14	2N3704	9
BC109	10	BC184	10	BC548	5	BFY52	27	TIP34A	70	ZTX500	13	2N3705	10
BC109C	12	BC184L	10	BC549	10	BRY39	50	TIP34C	80	ZTX502	18	2N3773	195
BC140	29	BC212	10	BC557	5	BSY95A	30	TIP35A	105	2N2221A	25	2N3819	32
BC141	30	BC212L	10	BC558	5	BU208	170	TIP35C	125	2N2222A	20	2N3866	90
BC142	28	BC213	10	BcY70	16	MJ2955	99	TIP36A	115	2N2369	18	2N3904	10
BC143	30	BC213L	10	BCY71	16	MJE340	50	TIP36C	130	2N2646	60	2N3906	10
BC147	10	BC214	10	BCY72	16	MJE3055	70	TIP41A	45	2N2904	28	2N5457	30

MICRO

		27128-250	320	6800	200	6522	330
		27256-250	480	6802	280	6532	520
		6116LP3	150	6809	600	6551	540
2716	310	6264LP15	320	6810	140	8085A	320
2532	380	4164-15	160	6821	140	8156	380
2732 one time programmable	280	41256-15	320	6840	360	8251	350
		Z80A CPU	270	6850	165	8253	370
2732	280	Z80A PIO	270	6852	240	8255	320
2764-250	240	Z80A CTC	270	6875	500	8259	400
2764-BBC	240	Z80A SIO	700	6880	100	MC1488	60
		Z80A DMA	700	6502	370	MC1489	60

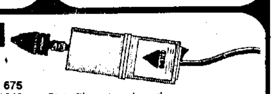
IDC CONNECTORS

	PCB plug st.	PCB plug rt.ang.	skt.	Edge conn.
16 way	80	85	90	—
20 way	90	95	90	—
26 way	110	110	105	—
34 way	120	130	130	165
40 way	140	150	145	—

HARDWARE

PP3 battery clips	6
Red or black crocodile clips	5
Pair ultrasonic transducers	396
20mm panel fuseholder	25
6 or 12V electronic buzzer	65
66mm 8 ohm min. speaker	70
66mm 64 ohm min. speaker	75
12 way 'chocolate block'	21
Red or amber panel neon	28

PCB EQUIPMENT



We offer a comprehensive range of equipment.

Expo Reliant 12V PCB drill	675
Expo Titan 12V PCB drill	1040
Drill stand to suit	1250
Variable speed power supply	1440
0.8, 1.0 or 1.4mm drills	60

Photo-etch PCB (Professional quality)

	single sided	double sided
100 x 160mm	180	200
233.4 x 220mm	560	640
305 x 457mm	1180	1320

Plain fibre glass board

	single sided	double sided
100 x 160mm	70	75
233.4 x 220	160	175
203 x 95	80	90
203 x 306	200	220

Etch resist pen **70p**
Full range of PCB transfers also available — see catalogue

RESISTORS

	1+	25+
Carbon film		
1/4W 5% 4.7ohm-10M	2p	1p
1/2W 5% 4.7ohm-4M7	3p	2p
Metal film		
1/4W 1% 10ohm-1M	3p	3p

25+ price applies to 25+ per value.
SIL resistor networks
8 resistor 9 pin type 20p

COMPONENT KITS

Our component kits offer a considerable saving when buying a complete range of components. Ideally suited for re-stocking etc.

0.25W Resistor kit. Contains 1000 0.25W 5% resistors from 4.7ohms thru to 10M. Quantities depend upon popularity i.e. 10×10r, 30×470r, 30×10K, 25×470K. **Just £7.90 each**

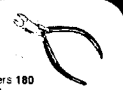
Ceramic capacitor kit. Total of 240 miniature ceramic capacitors from 22pF thru to 0.1uF. **Just £6.90 each**

Polyester capacitor kit. Total of 110 miniature polyester capacitors from 0.01u to 0.47uF. **Just £6.90 each**

Radial electolytic kit. Total of 93 miniature radial electrolytics from 1u 63V thru to 2200u 16V. **Just £7.50 each**

Preset kit. Total of 110 miniature horizontal mounting presets from 100R thru to 1M. **Just £6.90 each**

TOOLS



Low cost side cutters	180
Low cost pliers	180

Both the above represent exceptional value. We have seen similar tools advertised at £5!!!

Bib wire stripper	180
Automatic wire stripper	590
Light duty cutters	380

VERO

Veroboard. Size 0.1in matrix

2.5 x 1	26	2.5 x 3.75	95
3.75 x 5	120	3.75 x 17	390
4.75 x 17	495	VQ board	190

Veropins per 100 single sided 55 double sided 65
Spot face cutter 150

RIBBON CABLE

Grey	per foot	100ft reel
10 way	14	650
16 way	25	1050
20 way	28	1310
26 way	38	1720
34 way	58	1950
40 way	68	2650
50 way	90	3320

BRIDGE RECTIFIERS

1A 50V	20	2A 200V	40
1A 200V	25	2A 400V	45
1A 400V	30	6A 100V	80
1A 800V	38	6A 400V	85

CABLES

20 metre pack single core connecting cable ten different colours.	75p
Speaker cable	10p/M
Standard screened	16p/M
Twin screened	24p/M
3 core 2.5A mains cable	23p/M
Four core screened	35p/M

REGULATORS

78L05	30	LM338K	680
78L12	30	LM723	40
78L15	30	79L05	50
7805	40	79L12	50
7812	45	79L15	50
7815	45	7905	45
LM317K	230	7912	45
LM317T	90	7915	45
LM323K	420	78H05	550

RELAYS

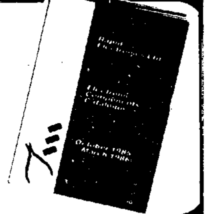
Ultraminiature SPDT relay rated 2A 6 or 12V	105
Ultraminiature DPDT relay rated 2A 6 or 12V	160
Miniature relay SPDT rated 10A 6 or 12V	160
Miniature relay DPDT rated 5A 6 or 12V	180

SOCKETS

	Low profile	Wire wrap
8 pin	4p	28p
14 pin	7p	48p
16 pin	8p	55p
18 pin	9p	65p
20 pin	10p	75p
22 pin	12p	80p
24 pin	13p	85p
28 pin	14p	100p
40 pin	18p	140p

NEW CATALOGUE

Our new fully illustrated 84 page catalogue is now available. Contains over 3400 stock lines at the most competitive prices in the market. We now sell more components that all the other mail order companies put together! When you receive our new catalogue it's easy to see why! Price just £1 including postage (includes £1 discount voucher) or free with orders over £20 in value. Send for your copy now!



AVAILABLE NOW

OPTO

3 or 5mm red	8		
3 or 5mm green	11		
3 or 5mm yellow	11		
3 or 5mm clips	3		
5mm superbright	30	TIL32	40
5mm tricolour	30	TIL38	35
ILD74	95	TIL78	40
ILQ74	185	TIL100	75
MOC3020	180	ORP12	85

Seven segment displays

0.3in common anode or cathode	95
0.5in common anode or cathode	100
0.56in common anode or cathode	105
10 bar DIL LED array (20pin DIL) High efficiency red	140

DIODES

BY127	12	1N4001	4
DA47	10	1N4002	5
OA90	8	1N4006	7
OA91	7	1N5401	12
OA200	8	1N5404	14
OA202	8	1N5406	15
1N914	4	400mW zeners	8
1N4148	3	1.3W zeners	13

AUDIO CONNECTORS

DIN	Plug	Skt	Jack	Plug	Skt
2 pin	8	8	2.5mm	10	9
3 pin	13	13	3.5mm	10	9
5 pin	14	13	.25in	17	20
Phono	10	14	Stereo	25	25

4mm plugs and sockets red or black
Plugs 12 Sockets 12
4mm terminals 36

D CONNECTORS

	9 way	15 way	25 way	37 way
Plug solder lugs	35	40	55	100
Rt. angle PCB plug	85	130	200	260
Socket solder lugs	45	50	65	120
Rt.angle PCB skt.	115	170	290	350
Cover	70	80	80	95

BOXES

Black ABS with lid and screws

71×46×22mm	50
95×71×35mm	93
140×90×55mm	150

LS00

		LS13	25	LS47	60	LS95	50	LS157	35	LS193	55	LS273	55
		LS14	35	LS48	65	LS96	75	LS158	35	LS195	55	LS279	50
		LS15	20	LS73	33	LS122	45	LS161	55	LS221	70	LS283	60
LS00	18	LS20	20	LS74	25	LS123	45	LS163	55	LS240	65	LS365	40
LS01	20	LS21	20	LS75	30	LS125	38	LS164	55	LS241	65	LS366	40
LS02	20	LS26	20	LS76	30	LS126	38	LS166	85	LS242	60	LS367	40
LS04	18	LS27	20	LS78	28	LS132	45	LS170	100	LS244	55	LS373	60
LS05	20	LS30	20	LS83	45	LS138	38	LS173	45	LS245	55	LS374	60
LS08	20	LS32	20	LS85	60	LS139	38	LS174	45	LS247	60	LS375	40
LS09	20	LS37	20	LS86	22	LS148	100	LS175	45	LS251	45	LS390	55
LS10	20	LS38	20	LS90	25	LS151	35	LS190	60	LS257	45	LS393	55
LS11	20	LS40	20	LS92	35	LS154	120	LS191	55	LS259	70	LS541	95
LS12	20	LS42	35	LS93	30	LS155	45	LS192	55	LS266	32	LS670	110

DIN 41612

Gold flashed contacts	Rt ang plug	wirewrap socket
64 way A+B	110	170
64 way A+C	115	175
96 way A+B+C	150	245

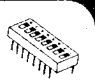
CONNECTORS

ZX81 23 way edge connector	150
Spectrum 28 way edge conn	200
24 way IEEE male	350
36 way Centronix male	330

CRYSTALS

		5.008MHz	100
1MHz	275	6.0MHz	85
1.008M	270	6.144MHz	110
1.8432M	180	8.0MHz	85
2.0M	180	10.0MHz	85
2.4576	85	12.0MHz	85
3.276	85	16.0MHz	85
4.0MHz	90	18.0MHz	100

SWITCHES



Low cost DIL switch

4 way 8 pin	70
6 way 12 pin	80
8 way 16 pin	90

Submin toggle switches
SPST 55 SPDT 60 DPDT 65

Miniature toggle
SPDT 60 SPDT centre off 65
DPDT 70 DPDT centre off 75

Standard toggle
SPST 35 DPDT 48

Miniature push to make 15
Miniature push to break 25

Slide switches DPDT
Miniature 14 Standard 16

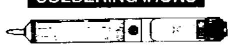
CMOS

		4012	15	4025	18	4046	48	4070	20	40106	35	4526	45
		4013	24	4026	90	4047	50	4071	18	4502	50	4528	40
		4015	40	4027	22	4049	23	4072	18	4507	45	4532	50
4000	15	4016	20	4028	35	4050	23	4073	18	4508	95	4538	40
4001	15	4017	35	4029	40	4051	45	4076	50	4510	45	4543	40
4002	15	4018	40	4030	20	4052	45	4077	30	4511	50	4553	215
4006	40	4020	40	4040	40	4060	45	4081	15	4514	85	4555	35
4007	15	4022	40	4042	30	4066	25	4082	15	4516	45	4566	35
4009	25	4023	15	4043	45	4068	18	4093	22	4518	45	4584	35
4011	15	4024	30	4044	45	4069	15	4098	50	4520	45	4585	50

POTENTIOMETERS

Single pots 470ohms-2M2	38
Stero pots 1K-2M2	110
Switched pots 1K-2M2	105
Slider pots 5K-500K (60mm)	70
Min. hor. presets 100-1M	8
Single turn cermet 100-1M	30
20 turn cermet 100ohms-500K	65

SOLDERING IRONS



High quality desolder tool	480
Antex CS 17W soldering iron	480
Antex XS 25W soldering iron	500
Iron stand to suit CS or XS	170
10 metres 22 swg solder	75
0.5Kg reel 22 swg solder	750

TTL

		7408	28	7430	28	7448	80	7476	40	7495	60	74163	80
		7413	38	7432	30	7450	28	7483	48	7496	80	74175	80
		7414	48	7433	38	7451	28	7485	80	7497	150	74177	80
7400	25	7416	38	7437	30	7453	28	7486	38	74121	40	74190	70
7401	28	7417	38	7438	35	7454	28	7489	140	74123	50	74191	75
7402	25	7420	28	7440	28	7460	28	7490	40	74132	50	74192	75
7404	25	7421	50	7442	70	7472	35	7491	70	74150	135	74193	70
7405	28	7422	28	7444	105	7473	35	7492	55	74154	135	74194	75
7406	40	7427	30	7446	130	7474	35	7493	45	74157	70	74195	75
7407	40	7428	30	7447	88	7475	45	7494	80	74161	80	74196	75

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★ Same day despatch ★ Lowest prices
★ Brand new components ★ In-depth stocks

ORDERING INFO. All components brand new and to full spec. All prices exclude VAT — please add to total order. Please add 70p carriage to all orders under £20 in value. Minimum order value £5. Send cheque/PO or Access/Visa number with order. Our new 84 page catalogue is given free with orders over £20. Telephone orders welcome with Access or Visa. Official orders welcome from colleges, schools, public companies, etc. Export orders no VAT but please add for carriage (payment in Sterling please). We are open Monday–Friday from 8.00 a.m.–6.00 p.m.

DIGEST

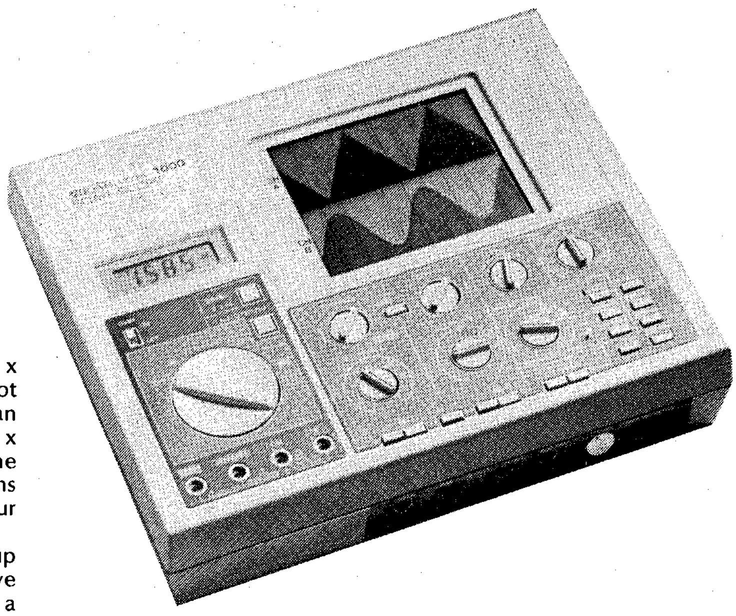
Handheld Dual Trace DSO with DMM

Advance House of Instruments are distributing the Soaar 1000, a battery operated digital storage oscilloscope which uses a liquid crystal display and has a built-in digital multimeter.

The Soar 1000 has a bandwidth of 3.2MHz and nine ranges of sensitivity from 10mV/division to 5V/division. The Y-amplifier frequency characteristic is ±3dB or less from DC to 200kHz. The timebase has twenty ranges from 5us/division to 5s/division and features continuous-sweep and single-sweep measurement modes and positive, negative and switcheable trigger slopes.

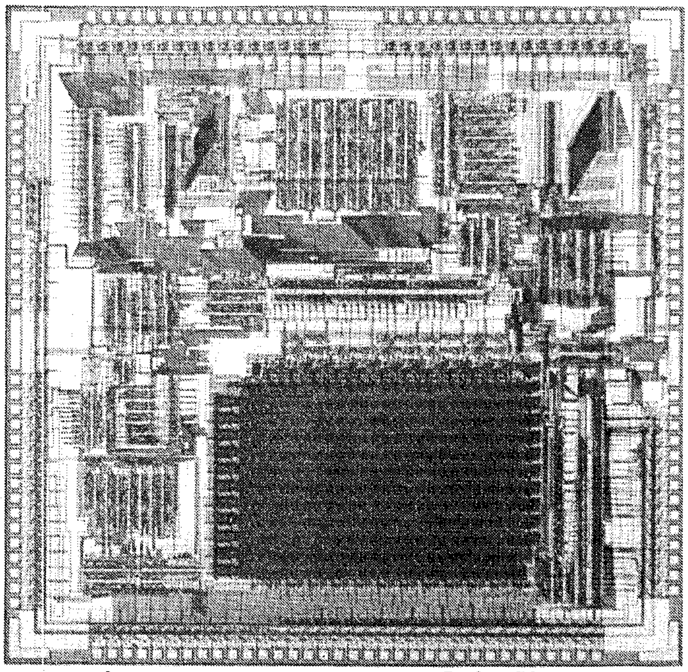
The display unit is a 128 x 160 dot-matrix LCD with a dot size of 0.55 x 0.55 mm and an effective display area of 76 x 95mm. A graticule divides the display area into ten divisions on the horizontal axis and four vertically on each trace.

A built-in battery backed-up memory allows storage of wave forms for later analysis and a waveform alarm function ensures correct operation. The rechargeable NiCad battery pack provides six hours of operation and the unit can also be powered by means of a mains adaptor.



The Soar model 1000 includes a seven function, 27-range digital multimeter which offers both automatic and manual ranging. The unit comes complete with oscilloscope probes, multimeter probes, batteries, rechargeable battery pack and an AC adaptor and costs £995.00 plus VAT.

Advance House of Instrument Raynham Road, Bishop's Stortford Hertfordshire CM23 5PF, 0279 — 55155.



32-Bit Processor Multiplies In One Cycle

Advanced Micro Devices claim their single chip 32-bit floating point processor (FPP) is the first in the world and can perform floating-point addition, subtraction and multiplication in a single 150ns clock cycle.

The Am29325 FPP features a three-bus flow-through architecture, using two 32-bit input buses and one 32-bit output bus. The cycle time is 150ns in the flow-through mode and 135ns in the clocked mode. It can also be used in two other I/O configurations, a 32-bit two-bus architecture and a 16-bit, three-bus format for use with 16-bit processors.

The device can perform arithmetic in either IEEE floating-point format standard P754 or DEC single-precision floating-point format. It can also perform conversions between the IEE and DEC formats and between 32-bit integer format and floating-point format.

There are six flags to provide additional information on the status of the computation. These are invalid operation, inexact result, zero, not-a-number, overflow, and underflow. For maximum design flexibility, the input and output registers can be made independently transparent. This allows the designer to choose either the on-chip or external registers with no loss of system speed.

The Am29325 is manufactured using AMD's IMOX-S™ bipolar process, and comes in a 144pin pin-grid array package. It is the first member of their Am29300 32-bit microprocessor family to become available and is designed for use both with members of that family or with other microprocessors. AMD say the device will be in full production by the end of 1985. They expect it to find applications as a floating-point accelerator for workstations, array and digital signal processors, high-end graphics, supercomputers, super minicomputers, spectrum analysers, radar and sonar equipment, image-processing and in guidance systems for military use.

Advanced Micro Devices (UK) Ltd, AMD House, Goldsworth Road, Woking, Surrey GU21 1JT, tel 048 62 — 22121.

ETI PCB Service

At long, long last we are happy to announce that this service has re-started. The contract with the new suppliers was signed in mid-November and by the time you read this, work should have begun on clearing the backlog of orders.

A new pricing structure has been agreed and there will be a number of price changes as a result. We are hopeful that not all will be in an upward direction! We have also made use of the opportunity afforded by the change to revise the list of boards offered. Many boards which sold in small quantities or not at all have now been removed, and we hope this will enable us to offer an improved service on those that remain.

Because of all these changes, we were not able to prepare a full list of prices in time for them to be included in this issue. Readers who wish to obtain un-priced boards listed in the PCB Service page will have to contact us in order to find out the price. We hope to have the fill list prepared and checked in time for it to be included in the February issue.

Once again, we would like to thank out readers for their remarkable tolerance and understanding during this period of difficulties. We look forward to offering you a better service in the future.

Cirkit wishes all Electronics Today International readers a very happy Christmas

Ni-Cad Batteries

High quality Uni Ross nickel cadmium rechargeable batteries in sizes equivalent to the popular dry cell range; eg, HP7=AA, HP11=C, HP2=D. They can replace dry cell types in applications drawing medium to high current, but are not suitable for low current drain applications.

type	size (mm)	nom. volts	capacity (Ahrs)	charge rate
AA	14.5x50	1.2	0.5	50mA
C	26x49	1.2	1.2	120mA
D	33x61	1.2	1.2	120mA
PP3	50x27x16	8.4	0.11	11mA

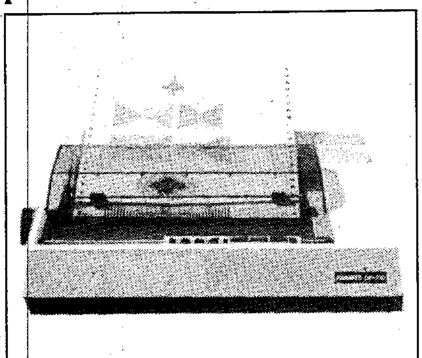
type	Stock No.	Price
AA	01-12004	£0.80
C	01-12024	£2.35
D	01-12044	£3.05
PP3	01-84054	£3.70

WM12D

12 watt miniature lightweight pencil thin soldering iron, with a break-resistant stay cool handle. Designed for soldering where precision touch is essential, the WM12D weighs 7 ounces and measures 7" less tip. It develops tip temperature of 800°F and acommodates a choice of 3 Weller slide-in tips.

Stock No. 54-22911 Price £6.02

Admate DP100 NLQ dot matrix printer



Newly imported, it is a compact Centronics interface dot matrix printer designed to suit the requirements of office, personal or home use. As well as NLQ print mode it supports normal (Pica) and Elite characters, plus enlarged and condensed printing, superscript and subscript. Italic fonts are available for most print modes, as is underline. The character sets are among the most extensive available; along with 192 ASCII characters (96 normal, 96 italic) and JIS characters the DP-100 supports 103 semi-graphic symbols and has US, UK, German, French, Swedish, Italian, Spanish, Danish and Greek character sets, the latter making this printer extremely useful for printing out mathematical text without fuss.
The DP100 is Epson compatible and printer control is by means of standard ESCAPE codes.
Print width is 80 columns in normal characters and the print speed is 100 characters per second, bi-directional and logic seeking. High resolution bit-image dot graphics are supported at 640 dots/line and the vertical resolution is far better than that of many other printers - line spacing is programamable in increments of 0.118mm (1/216in), 0.35mm (1/72in), 3.18mm (1/8in) or 4.23mm (1/6in).
The printer accepts either fanfold, single sheet or roll paper, with adjustable sprocket and friction feed, a self-stacking paper basket is included. The Admate DP-100 is exceptionally good value for money, a printer with features worth much more than its price.

Stock No. 40-90100 Price £155.00

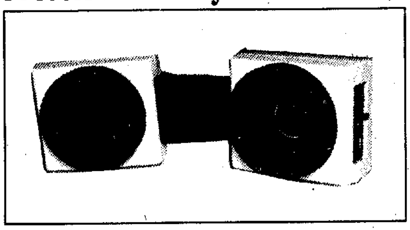
Type CX4/Multi Battery Charger

This unit will recharge AA, C, D and PP3 size cells with automatic voltage selection: it will also recharge the following combinations of cells: 4xD, 4xAA, 4xC, 2xPP3, 2xC + 2xD, 2xAA + 2xD, 2xAA + 2xC, 2xD + 1xPP3, 2xC + 1xPP3, 2xAA + 1xPP3. Power supply 240V 50Hz; weight 0.475kg; dimensions 199x109x55mm.

battery type	output (V)	charge rate	charge time (hrs)
AA	2.9	45	16
C	2.9	120	16
D	2.9	120	16
PP3	11	11	

Stock No. 01-02205 Price £7.49

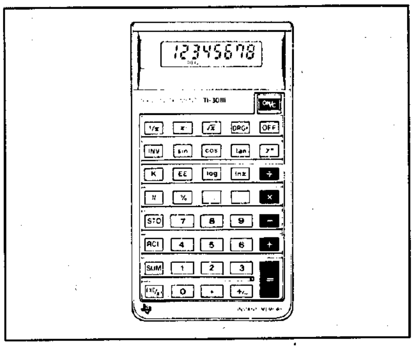
Prestel Link for your Amstrad



The Modem
British designed Acoustic Modem, flexible coupling fits all standard and Herald telephones.
More reliable in operation than some direct connect Modems.
1200/75 Baud operation allows access to PRESTEL, MICRONET, BT GOLD,etc.
1200 baud half duplex operation to swap programs and data over the telephone network with other users.
Supplied with connection details and user manual.
Modem signals are RS323 compatible, allowing use with other computers and terminals.
Earpiece allows call monitoring.
Battery power, and LED battery state monitor for trouble free portable operation.
Batteries (4xAA cells) give 40 hours of operation.
The Interface
Plugs into Disk Drive, through Bus Connector for Disk Drives and other peripherals.
Can be used to interface to other RS232 devices, such as Modems, Plotters and Printers. Baud rates supported 75/1200, 1200/1200 and 300/300*.
INPUTS:- Data, one handshake - RS232 compatible.
OUTPUTS:- Data, one handshake - +5 volt positive going.
Works with all TTL level inputs and most RS232 devices.
All interface features are software addressable, uses 8251 UART.
Supplied with full RSX drivers, which may be used in your own programs.
Not directly compatible with Amstrad CPM.
Extensive documentation about interface and RSX's supplied on the cassette.
*Cannot be used with Modem.
Link Software
Full PRESTEL support, including up to 16 onscreen colours and dynamic frames. Information is displayed in real time, allowing page exit as soon as header details have been seen.
Available on tape or disk.
Terminal Emulation Mode, allows the Amstrad computer to act as a glass Teletype.
Allows access to BT GOLD and similar services.
File transfer allows data transfer from user-to-user over the telephone network.
Interface Configure Mode allows changing of interface Baud rate and data format.
RSX drivers for all features, can be incorporated into other programs.
Supplied with extensive documentation.

41-50200 £26.00 +VAT Contents: modem, interface & software on tape
41-90150 £ 8.00 +VAT Disk only

TI-30 III Calculator



A calculator with basic scientific functions, for general use. Stock No. 40-90002 Price £9.55

TI-56 Calculator

A more advanced programmable scientific calculator with 122 different scientific and statistical functions, including two-variable statistics and eight data memories or 56 programming steps. Supplied with hard carrying case.

Stock No. 40-90007 Price £24.99

Programmer II Calculator

Specifically designed for computer programmers, this versatile electronic abacus features calculations in hex, octal and decimal as well as base conversions and logical operations. Supplied with hard carrying case.

Stock No. 40-90006 Price £38.50

HT-320 multimeter

A high quality, high specification but reasonably priced meter. In addition to the usual functions, facilities are provided for measuring transistor parameters. The meter movement is fully protected against overloads, and has a 3-colour mirrored scale. Supplied with comprehsnive instructions, test probes, transistor test leads and batteries. Sensitivity: 20k/V dc, 18k/V ac. dc volts: 0.1, 0.5, 2.5, 10, 50, 250V, 1kV. ac volts: 10, 50, 250V, 1kV. dc current: 50uA, 2.5, 25, 250mA. resistance: 2,20k, 20, 20Mohms. audio output: transistor parameters: Iceo 150uA, 15, 150mA; hfe 0-1000 decibels: -10dB to +22dB weight: 410g

Stock No. 56-83201 Price £17.70

HC5010 Digital Multimeter

High quality, high accuracy digital multimeter. Accuracy on all DC volt ranges ±0.25% + 1 digit. Ranges: DC volts 200mV to 1000V. DC currents: 20μA to 10 amps. AC voltage 200mV-750V. AC currents 20μA to 10 amps. Resistance 20Ω-20MΩ and continuity and diode test.
Complete with battery and test leads.

Stock No. 56-5018 Price £48.00

Please add 15% VAT to all advertised prices and 60p post and packing. Minimum order value £5 please. We reserve the right to vary prices in accordance with market fluctuation.
Just send for our catalogue or visit one of our three outlets at:

200 North Service Road, Brentwood, Essex. CM14 4SG - (0277) 211490;
53 Burrfields Road, Portsmouth, Hampshire. PO3 5EE - (0705) 669021;

Cirkit, Park Lane, Broxbourne, Hertfordshire. EN10 7NQ - (0992) 444111.

Two new signal generators from MS Components cover the frequency spectrum from 10Hz to 450MHz in overlapping ranges. The AF model generates sine waves from 10Hz to 1MHz and square waves from 10Hz to 100kHz, with a variable 0-5V, 600 ohm output. An external sync input is provided. The RF model covers 100kHz to 150MHz in fundamentals, extending to 450MHz on harmonics. The output is variable from 0 to 0.1V (RMS) and modulation is provided by an internal 1kHz tone or an external tone of 50Hz to 20kHz. Further details from MS Components, Zephyr House, Waring Street, West Norwood, London SE27 9LH, tel 01-670 4466.

The results of the Thandar Frequency meter competition held in ETI, November 1985, will be announced next month.

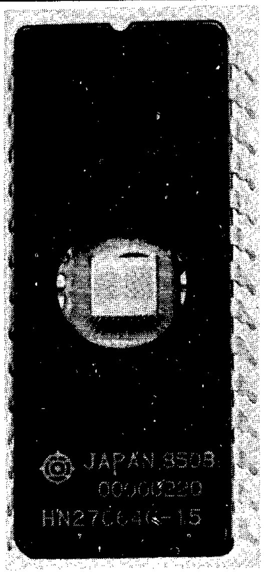
As we go to press, the Comdex show in Las Vegas should be hearing about Optimem's eraseable optical disc drive. We will be bringing you further details of this development as soon as possible.

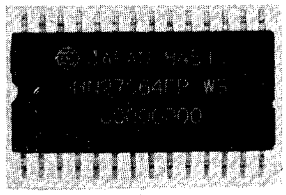
Lack Of Application

The disappointing sales of microcomputers in the last year were blamed on a lack of training in applications packages at a recent seminar on the state of the UK micro market sponsored by Barclays Bank. The accusation came from Philip Virgo, the Information Technology Manager of the National Computing Centre in Manchester.

Virgo pointed out the training was unevenly distributed about the country, with 69% of all public courses being held in London and the South-East. The availability of software, Virgo said, massively outstripped the availability of relevant training. For example, only two courses were run last year covering CAD packages, while 175 such packages were on the market.

The previously buoyant computer market in the UK will continue to sink, suggested Virgo, if the quality of applications training and instructional manuals did not improve.





WeePROM

Hitachi, who claim to be Europe's leading supplier of memory products (with support for this contention from market researchers Dataquest), have introduced a miniature 64K CMOS PROM with a maximum response time of 2ns and power consumption of 40mW/MHz in active mode and 55μW in standby. The HN27C64FP is configured as an 8Kx8 memory, is TTL compatible in both read and write modes and is a 28-pin device. It is distinctly unlike more conventional PROMs in other respects, being a surface-mounted chip just half the size of other 64K devices in every dimension. It is plastic-packaged and lacks a window since, Hitachi argue, many manufacturers fail to utilize the eraseability of EPROMs for reasons of cost and convenience. The HN27C64FP is, therefore, one-time programmable for use with fully debugged systems.

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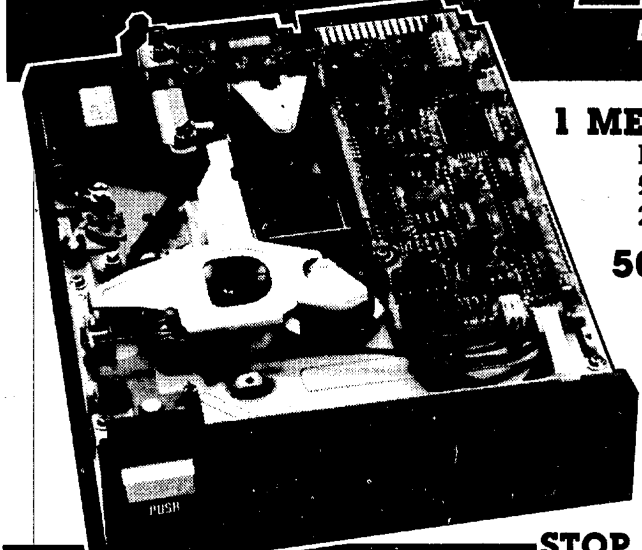
Electro-Mech Industries

EMI



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74LS08	0.12
74LS10	0.13
74LS14	0.50
74LS20	0.13
74LS27	0.12
74LS30	0.13
74LS32	0.13
74LS74A	0.15
74LS86	0.35
74LS93	0.35
74LS22	0.45
74LS123	0.45
74LS125	0.45
74LS138	0.25
74LS157	0.25
74LS161A	0.50
74LS163A	0.50
74LS166	0.75
74LS175	0.50
74LS191	0.50
74LS193	0.40
74LS241	0.50
74LS242	0.50
74LS243	0.50
74LS244	0.50
74LS245	0.75
74LS257	0.75
74LS273	0.30
74LS365	0.50
74LS367	0.50
74LS373	0.45
74LS374	0.45
74LS393	0.50
74LS465	0.75
74S04	0.25
74S734	2.00

C MOS

4013	0.25
4016	0.25
4049	0.25
4066	0.30
4070	0.20

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2716	2.50
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2764–25	3.00
27128–25	3.50
3764–20	2.50
4116–3N	0.40
4864–2	2.00
6116–4	2.00
8264–2	3.00
81256–15	5.00

VARIOUS I.C.s

14L4–2CN	1.00
1691	8.00
1793	9.00
2143	8.00
9216	8.00
6301–1N	1.00
63S141	1.50
82S23	1.00
82S123	1.50
6845	5.00
LM1889	1.25
SN76489	2.00
SY6551A	2.50
TMS9928	5.00
TMS9929	3.00
HAI4625–5	2.00
HEF4011	0.15
Z80ACPU	1.50
Z80ACTC	1.40

INDUCTORS – AXIAL

4.7MH	0.05
22MH	0.05
33MH	0.05
100MH	0.05

CRYSTALS

1.8432MHz	2.00
3.579545MHz	0.50
4.00MHz	0.50
4.433619MHz	0.50
10.6875MHz	0.50
10.738635MHz	0.50
15.00MHz	0.50
10.00MHzOSC	4.50

I.C. SOCKETS – STD

20 PIN	0.15
24 PIN	0.15
28 PIN	0.15
40 PIN	0.25

I.C. SOCKETS – LOW PROFILE T.I.

16 PIN	0.10
18 PIN	0.10
28 PIN	0.20
40 PIN	0.25

MODULATORS – ASTEC

UM1286(8MHz)	1.50
UM1285–8(USA)	2.50

REGULATORS

UA7805CKC	0.25
UA7812CKC	0.25

TRANSISTORS

2N3904	0.12
2N3906	0.12
BC107	0.15
TIP2955	0.50
TL081CP	0.35

DIODES

IN4004	0.05
IN4148	0.02
IN5402	0.10
BZX79C4V7	0.05
BZX79C5V1	0.05
BZX79C5V6	0.05
BZX79C12	0.05
BZX79C7V5	0.05

POTENTIOMETERS

1K HOR PRESET	0.10
1K CERMET	0.25
22K HOR PRESET	0.12

SWITCHES

ML3KEYTOP	0.10
2 WAY ON–OFF DIP	0.15
NEON MAINS	0.75
4 POL DIL	0.25
8 POL DIL	0.55
TV TO COMPUTOR	0.75
MINI-SLIDE	0.15
C+K 8631 PUSH	0.25

RESISTORS 0.25W c/f

Measured in OHMs.
All 0.01 each.

1.0	180	33K	27	4.3K	820K
1.1	200	36K	30	4.7K	910K
1.2	220	39K	33	5.1K	1M
1.3	240	43K	36	5.6K	1.2M
1.5	270	47K	39	6.2K	1.3M
1.6	300	51K	43	6.8K	1.8M
1.8	330	56K	47	7.5K	2M
2.0	360	62K	51	8.2K	2.2M
2.2	390	68K	56	9.1K	2.4M
2.4	430	75K	62	10K	3M
2.5	430 M/F	82K	68	11K	3.6M
2.7	470	91K	75	12K	4.3M
3.0	510	100K	82	13K	4.7M
3.3	560	110K	91	15K	5.1M
3.6	620	120K	100	16K	5.6M
3.9	680	130K	110	18K	6.2M
4.3	750	150K	120	20K	6.8M
4.7	820	160K	130	22K	7.5M
5.1	910	180K	150	24K	8.2M
5.6	1K	200K	160	27K	9.1M
6.2	1KM/F	220K		30K	10M
6.8	1.1K	240K			
7.5	1.2K	270K			
8.2	1.3K	300K			
9.1	1.5K	330K			
10	1.6K	360K			
11	1.8K	390K			
12	2K	430K			
13	2.2K	470K			
15	2.4K	470K ½W			
16	2.7K	510K			
18	3K	560K			
20	3.3K	620K			
22	3.6K	680K			
24	3.9K	750K			

CAPACITORS

CERAMIC PLATE

All 0.03 each

10NF	47 PF
22NF	68 PF
22NF DISC	100 PF
47NF DISC	150 PF
8.2 PF	220 PF
15 PF	560 PF
27 PF	1000 PF
33 PF	1500 PF
39 PF	4700 PF

ELECTROLYTICS – AXIAL

470 MF/25V	0.07
4700 MF/16V	0.35

ELECTROLYTICS – RADIAL

10MF/16V	0.05
10MF/63V	0.05
22MF/35V	0.08
47MF/16V	0.08
100MF/25V	0.10
470MF/10V	0.12
470MF/16V	0.12
2200MF/25V	0.20
4700MF/16V	0.25

POLYESTERS

22NF	0.06
100NF	0.06
047MF	0.06

SIBITATS

47NF	0.06
100NF	0.06

TANTLUMS

1MF35V	0.10
10MF35V	0.15
22MF16V	0.18

TRIMMERS

5.5–40PF	0.15

MISCELLANEOUS

3.5MM PCB MTG JACK SOCKET	0.12
PHONO SOCKET – NUT FIXING	0.14
BNC SOCKET – CHASSIS MTG	0.40
20 × 5MM PCB MTG FUSEHOLDER	0.10
20 × 5MM PCB MTG FUSEHOLDER COVER	0.10
20 × 5MM 3.15A QUICK BLOW FUSE	0.10
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7 PIN DIN R/A PCB MTG SOCKET	0.35
9 WAY 'D' TYPE R/A PLUG	0.25
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PHONO TO COAX PLUG CABLE ASSY 1.4M LG	0.30

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5 WAY R/A S.I.L. HEADER	0.10
5 WAY S.I.L. HEADER	0.07
6 WAY WAFER	0.10
6 WAY S.I.L. HEADER	0.10
8 WAY S.I.L. HEADER	0.10
10 WAY R/A S.I.L. HEADER	0.15
15 WAY S.I.L. HEADER	0.18
15 WAY S.I.L. R/A HEADER	0.25
20 WAY WAFER	0.25
20 WAY R/A WAFER	0.30
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CIRCLE 96 FOR FURTHER DETAILS.

IEE and IERE To Merge?

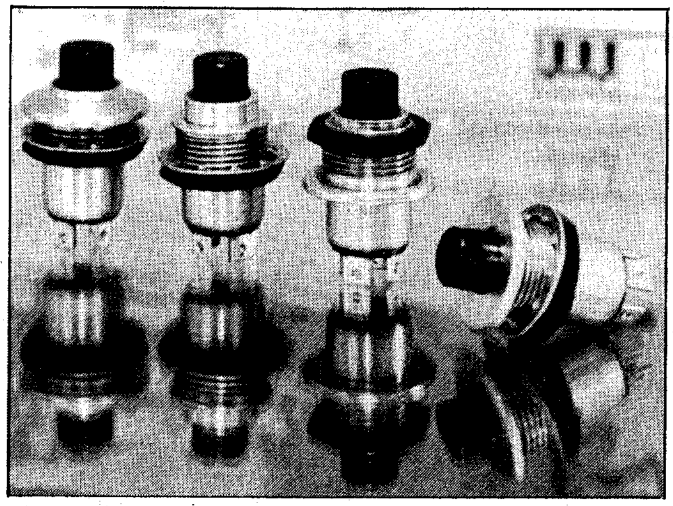
The Insitution of Electrical Engineers and the Institution of Electronic and Radio Engineers may eventually be merged into one body. The proposal has been welcomed by the councils of both Institutions and their members will debate the merger at Special General Meetings to be held late in 1986.

The proposal was put forward by a joint IEE/IERE working party which felt that the combined body would speak with greater authority and would enhance the reputation of electrical and electronic engineering among the public. Other advantages include a rationalisation of the publishing and other services offered by the two bodies and the achievement of a common standard for Chartered Engineering status amongst electrical and electronic engineers. The existence of a single body would also simplify the accreditation of courses and training programmes in those fields.

For further details contact the Institution of Electrical Engineers, Savoy Place, London WC2R 0BL, tel 01-240 1871, or the Institution of Electronic and Radio Engineers, 99 Gower Street, London WC1E 6AZ, tel 01-388 3071.

○ The latest volume of the TTL Data Book, Volume 3, is now available from Texas Instruments. It covers bipolar programmable logic (PAL and FPLA devices) and schottky TTL memories (PROMs, RAMs and memory-based code converters). It includes general information and a functional index and costs £8.00 inclusive from Texas Instruments Ltd, PO Box 50, Market Harborough, Leicestershire.

○ **Marston Palmer have published a 14-page brochure which describes their force cooled heat sinks. Full technical details are included and there is a guide to designing force cooled assemblies for particular applications. Copies of the brochure are available free-of-charge from Marston Palmer Ltd, Wobaston, Road, Fordhouse, Wolverhampton, West Midlands WV10 6QJ, 0902-783361.**



Sealed Push-Button Switches

Diamond H Controls have introduced a range of push-button switches which are sealed against dust and moisture and which are suitable for both low-level and power switching use.

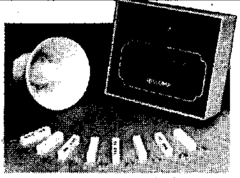
The Otto P3 series are double pole and come in four different case styles. The maximum current rating is 10A and the contact resistance is 25m. The mechanical life claimed is 250 000 cycles and the minimum electrical life is 25 000 cycles at full load.

The switches are made from aluminium alloy with nylon buttons and are sealed with epoxy. A fully waterproof version is also available which can withstand up to three feet of water pressure. The terminals are suitable for both screw and solder connection.

Diamond H Controls Ltd, Vulcan Road North, Norwich NR6 6AH, tel 0603-45291.

Intruder Alarms and Accessories

A COMPLETE SECURITY SYSTEM FOR ONLY £39.95 + V.A.T.



contains:

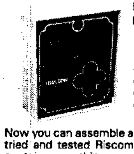
Control Unit	CA 1250
Enclosure & mechanical fixings	HW 1250
Key Switch & 2 keys	KS 3901
L.E.D's	LED 1
5½" Horn Speaker	HS 588
4 high quality surface mounting Magnetic Switches	MS 1025

With only a few hours of your time it is possible to assemble and install an effective security system to protect your family and property, at the amazingly low cost of £39.95+V.A.T. No compromises have been made and no corners have been cut. The outstanding value results from volume production and direct supply. Assembly is straightforward with the detailed instructions provided. When installed you can enjoy the peace of mind that results from a secure home. Should you wish to increase the level of security, the system may be extended at any time with additional magnetic switches, pressure pads or ultrasonic sensors. Don't wait until it's too late – order today.
Order Code: CS 1370.

EXTENDED SYSTEM CS 1480 Price £62.50 + V.A.T.

This system contains, in addition to the CS 1370, an ultrasonic detector type US 5063 + its enclosure, an additional hom speaker and a further 2 magnetic switches. This system represents outstanding value for money for the high level of security provided.
Order Code: CS 1480.

SELF-CONTAINED ULTRASONIC ALARM UNIT CK 5063 only £37.00 + V.A.T.



Requires no installation. Easily assembled using our professionally built and tested modules.
- Adjustable range up to 25ft
- Built-in entrance and exit delay
- Built-in timed alarm
- Key operated switch – Off, Test and Operate
- Provision for an extension speaker
- Fully self-contained
- Uses US 5063, PSL 1865 Key Switch 3901. 3" Speaker 3515

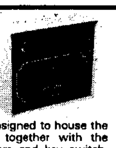
Now you can assemble a really effective intruder alarm at this low price using tried and tested Riscomp modules. Supplied with full instructions, the kit contains everything necessary to provide an effective warning system for your house or flat. With a built-in LED indicator and test position the unit is easily set-up requiring no installation. It may simply be placed on a cupboard or desk. Movement within its range will then cause the built-in siren to produce a penetrating 90dbs of sound or even 110dbs with an additional speaker. All parts included and supplied with full instructions for ease of assembly. Size 200 x 180 x 70mm. Order as CK 5063.

ALARM CONTROL UNIT CA 1250

Price £19.95+V.A.T.

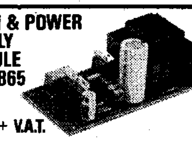
The heart of any alarm system is the control unit. The CA 1250 offers every possible feature that is likely to be required when constructing a system whether a highly sophisticated installation or simply controlling a single magnetic switch on the front door.
- Built-in electronic siren drives 2 loud speakers
- Provides exit and entrance delays together with fixed alarm time
- Battery back-up with trickle charge facility
- Operates with magnetic switches, pressure pads, ultrasonic or I.R. units
- Anti-tamper and panic facility
- Stabilised output voltage
- 2 operating modes full alarm/anti tamper and panic facility
- Screw connections for ease of installation
- Separate relay contacts for external loads
- Test loop facility

HARDWARE KIT HW 1250 only £9.50 + V.A.T.



This attractive case is designed to house the control unit CA 1250, together with the appropriate LED indicators and key switch. Supplied with the necessary mounting pillars and punched front panel, the unit is given a professional appearance by an adhesive silk screened label. Size 200 x 180 x 700m

SIREN & POWER SUPPLY MODULE PSL 1865 only £9.95 + V.A.T.



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

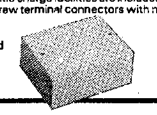
NEW

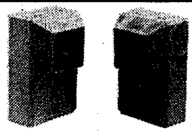
TIMER SWITCH & POWER SUPPLY MODULE DP 3570 Price £13.95 + V.A.T.

The DP 3570 consists of an adjustable timer switch and stabilised 12V power supply for use in a wide range of applications including security, lighting control and automatic switching.
The timer section of the module provides switching of loads up to 3A for pre-set times, the duration of which may be set by the user to between 10 secs and 5 mins. The timed period may be triggered by the opening of a loop or the closing of external contacts, with the timed period commencing instantaneously or delayed to provide a form of entrance delay.
The power supply section of the module provides a 12V output of up to 250mA which is sufficient for most applications. The module operates from either 240V a/c supply or a 12V battery for which trickle charge facilities are included. Connections to the module are by means of screw terminal connectors with no soldering needed.

For mounting the unit an attractive moulded enclosure is available.

ME 357 only £2.85 + V.A.T.

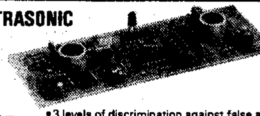




INFRA-RED SYSTEM IR 1470 only £25.61+V.A.T.

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

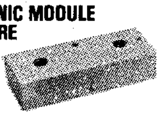
DIGITAL ULTRASONIC DETECTOR US 5063 only £13.95 + V.A.T.



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

This advanced module uses digital signal processing to provide the highest level of sensitivity whilst discriminating against potential false alarm conditions.

ULTRASONIC MODULE ENCLOSURE only £2.95 + V.A.T.



Suitable metal enclosure for housing an individual ultrasonic module type US 5063 or US 4012. Supplied with the necessary mounting pillars and screws etc. For US 5063 order SC 5063, for US 4012 order SC 4012.

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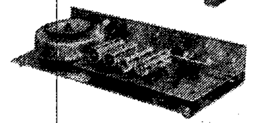
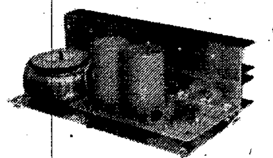
Now enjoy a world-wide reputation for quality, reliability and performance at a realistic price. Four models available to suit the needs of the professional and hobby market. i.e., Industry, Leisure, Instrumental and Hi-Fi. etc. When comparing prices, NOTE all models include Toroidal power supply, Integral heat sink, Glass fibre P.C.B., and Drive circuits to power compatible Vu meter. Open and short circuit proof. **Supplied ready built and tested.**

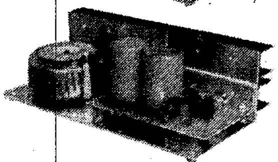
OMP100 Mk II Bi-Polar Output power 110 watts R.M.S. into 4 ohms, Frequency Response 15Hz - 30KHz —3dB, T.H.D. 0.01%, S.N.R. —118dB, Sens. for Max. output 500mV at 10K, Size 355 × 115 × 65mm.
PRICE £33.99 + £3.00 P&P.



OMP/MF100 Mos-Fet Output power 110 watts R.M.S. into 4 ohms, Frequency Response 1Hz - 100KHz —3dB, Damping Factor 80, Slew Rate 45V/uS, T.H.D. Typical 0.002%, Input Sensitivity 500mV, S.N.R. —125dB. Size 300 × 123 × 60mm. PRICE
PRICE £39.99 + £3.00 P&P.

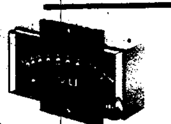


OMP/MF200 Mos-Fet Output power 200 watts R.M.S. into 4 ohms, Frequency Response 1Hz - 100KHz —3dB, Damping Factor 250, Slew Rate 50V/uS, T.H.D. Typical 0.001%, Input Sensitivity 500mV, S.N.R. —130dB, Size 300 × 150 × 100mm. PRICE
PRICE £62.99 + £3.50 P&P.



OMP/MF300 Mos-Fet Output power 300 watts R.M.S. into 4 ohms, Frequency Response 1Hz - 100KHz —3dB, Damping Factor 350, Slew Rate 60V/uS, T.H.D. Typical 0.0008%, Input Sensitivity 500mV, S.N.R. —130dB, Size 330 × 147 × 102mm. PRICE
PRICE £79.99 + £4.50 P&P.

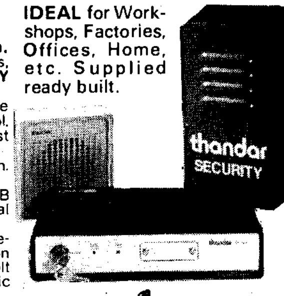
NOTE: Mos-Fets are supplied as standard (100KHz bandwidth & Input Sensitivity 500mV). If required, P.A. version (50KHz bandwidth & Input Sensitivity 775mV). Order — Standard or P.A.



Vu METER Compatible with our four amplifiers detailed above. A very accurate visual display employing 11 L.E.D. diodes (7 green, 4 red) plus an additional on/off indicator. Sophisticated logic control circuits for very fast rise and decay times. Tough moulded plastic case, with tinted acrylic front. Size 84 × 27 × 45mm.
PRICE £8.50 + 50p P&P.

BURGLAR ALARM

IDEAL for Workshops, Factories, Offices, Home, etc. Supplied ready built.



Better to be **'Alarmed'** then terrified.
Thandar's famous 'Minder' Burglar Alarm System. Superior microwave principle. Supplied as three units, complete with interconnection cable. **FULLY GUARANTEED.**
Control Unit — Houses microwave radar unit, range up to 15 metres adjustable by sensitivity control. Three position, key operated facia switch — off — test — armed. 30 second exit and entry delay.
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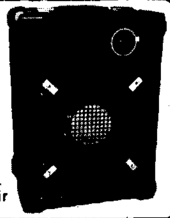
Both the control unit and outdoor alarm contain rechargeable batteries which provide full protection during mains failure. Power requirement 200/260 Volt AC 50/60Hz. Expandable with door sensors, panic buttons etc. Complete with instructions.

SAVE £138.00 Usual Price £228.85
BKE's PRICE £89.99 + £4.00 P&P
? Why buy a collection of self-assembly boards!

OMP LINNET LOUDSPEAKERS



The very best in quality and value. Made specially to suit todays need for compactness with high sound output levels. Finished in hard wearing black vynide with protective corners, grille and carry handle. All models 8 ohms. Full range 45Hz - 20KHz. Size 20" × 15" × 12". Watts R.M.S. per cabinet. Sensitivity 1W. 1mtr. dB.

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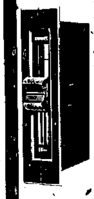
OMP 12-200 Watts 102dB. Price £199.99 per pair. Delivery: Securicor £8.00 per pair

OMP 19" STEREO RACK AMPS

Professional 19" cased **Mos-Fet** stereo amps. Used the **World** over in clubs, pubs, discos etc. With twin Vu meters, twin toroidal power supplies, XLR connections. MF600 Fan cooled. **Three models** (Ratings R.M.S. into 4ohms). Input Sensitivity 775mV

MF200 (100 + 100)W. £169.00 **Securicor**
MF400 (200 + 200)W. £228.85 **Delivery**
MF600 (300 + 300)W. £274.85 **£10.00**

1 K-WATT SLIDE DIMMER



★ Control loads up to 1Kw
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★ Easy snap in fixing through panel/cabinet cut out
★ Insulated plastic case
★ Full wave control using 8 amp triac
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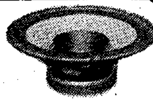
★ Suitable for both resistance and inductive loads. Innumerable applications in industry, the home, and disco's, theatres etc.

PRICE £13.99 + 75p P&P

LOUDSPEAKERS 5" to 15" up to 400 WATTS R.M.S.



Cabinet Fixing in stock. Huge selection of **McKenzie Loudspeakers** available including Cabinet Plans. Large S.A.E. (28p) for free details.

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8" 50 WATT R.M.S. Hi-Fi/Disco.
20 oz. magnet. 1½" ally voice coil. Ground ally fixing escutcheon. Res. Freq. 40Hz. Freq. Resp. to 6KHz. Sens. 92dB. PRICE £10.99 Available with black grille £11.99 P&P £1.50 ea.
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50 oz. magnet. 2" ally voice coil. Ground ally fixing escutcheon. Die-cast chassis. White cone. Res. Freq. 25Hz. Freq. Resp. to 4KHz. Sens. 95dB. PRICE £28.60 + £3.00 P&P ea.

McKENZIE
12" 85 WATT R.M.S. C1285GP Lead guitar/keyboard/Disco.
2" ally voice coil. Ally centre dome. Res. Freq. 45Hz. Freq. Resp. to 6.5KHz. Sens. 98dB. PRICE £28.76 + £3.00 P&P ea.
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Res. Freq. 45Hz. Freq. Resp. to 14KHz. PRICE £29.80 + £3.00 P&P ea.
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3" ally voice coil. Die-cast chassis. Res. Freq. 40Hz. Freq. Resp. to 4KHz. PRICE £54.99 + £4.00 P&P ea.
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Res. Freq. 40Hz. Freq. Resp. to 5KHz. Sens 101dB. PRICE £59.45 + £4.00 P&P.
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5" 70 WATT R.M.S. Multiple Array Disco etc.
1" voice coil. Res. Freq. 52Hz. Freq. Resp. to 5KHz. Sens. 89dB. PRICE £19.99 + £1.50 P&P ea.
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1" voice coil. Res. Freq. 48Hz. Freq. Resp. to 5KHz. Sens. 92dB. PRICE £29.49 + £1.50 P&P ea.
10" 300 WATT R.M.S. Disco/Sound re-enforcement etc.
1½" voice coil. Res. Freq. 35Hz. Freq. Resp. to 4KHz. Sens. 92dB. PRICE £33.49 + £2.00 P&P ea.
12" 300 WATT R.M.S. Disco/Sound re-enforcement etc.
1½" voice coil. Res. Freq. 35Hz. Freq. Resp. to 4KHz. Sens. 94dB. PRICE £41.49 + £3.00 P&P ea.

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5" 60 WATT R.M.S. Hi-Fi/Multiple Array Disco etc.
1" voice coil. Res. Freq. 63Hz. Freq. Resp. to 20KHz. Sens. 86dB. PRICE £9.99 + £1.00 P&P ea.
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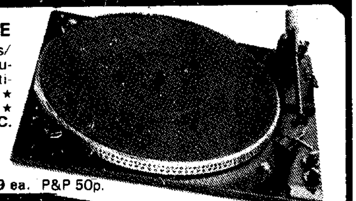
1" voice coil. Res. Freq. 56Hz. Freq. Resp. to 20KHz. Sens. 89dB. PRICE £10.99 + £1.50 P&P ea.
8" 60 WATT R.M.S. Hi-Fi/Multiple Array Disco etc.
1¼" voice coil. Res. Freq. 38Hz. Freq. Resp. to 20KHz. Sens. 89dB. PRICE £12.99 + £1.50 P&P ea.
10" 60 WATT R.M.S. Hi-Fi/Disco etc.
1¼" voice coil. Res. Freq. 35Hz. Freq. Resp. to 15KHz. Sens. 89dB. PRICE £16.49 + £2.00 P&P

BSR P295 ELECTRONIC TURNTABLE



★ Electronic speed control 45 & 33⅓ r.p.m. ★ Plus/Minus variable pitch control ★ Belt driven ★ Aluminium platter with strobed rim ★ Cue lever ★ Anti-skate (bias device) ★ Adjustable counter balance ★ Manual arm ★ Standard ½" cartrige fixings ★ Supplied complete with cut out template ★ D.C. Operation 9-14v D.C. 65mA
Price £36.99 — £3.00 P&P.

ADC Q4 mag. cartridge for above. Price £4.99 ea. P&P 50p.

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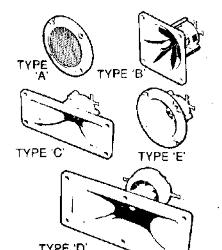
Join the Piezo revolution. The low dynamic mass (no voice coil) of a Piezo tweeter produces an improved transient response with a lower distortion level than ordinary dynamic tweeters. As a crossover is not required these units can be added to existing speaker systems of up to 100 watts (more if 2 put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



TYPE 'A' (KSN2036A) 3" round with protective wire mesh, ideal for bookshelf and medium sized Hi-fi speakers. **Price £4.90 each** + 40p P&P.
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TYPE 'C' (KSN6016A) 2" × 5" wide dispersion horn. For quality Hi-fi systems and quality discos etc. **Price £6.99 each** + 40p P&P.
TYPE 'D' (KSN1025A) 2" × 6" wide dispersion horn. Upper frequency response retained extending down to mid range (2KHz). Suitable for high quality Hi-fi systems and quality discos. **Price £9.99 each** + 40p P&P.
TYPE 'E' (KSN1038A) 3¾" horn tweeter with attractive silver finish trim. Suitable for Hi-fi monitor systems etc. **Price £5.99 each** + 40p P&P.
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PANTEC HOBBY KITS.

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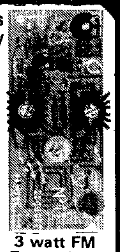

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FM MICROTRANSMITTER (BUG) 90/105MHz with very sensitive microphone. Range 100/300 metres. 57 × 46 × 14mm (9 volt) **Price: £8.62 + 75p P&P.**
3 WATT FM TRANSMITTER 3 WATT 85/115MHz varicap controlled professional performance. Range up to 3 miles 35 × 84 × 12mm (12 volt) **Price: £14.49 + 75p P&P.**
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STEREO DISCO MIXER with 2 × 5 band L. & R. graphic equalisers and twin 10 segment L.E.D. Vu Meters. Many outstanding features 5 Inputs with individual faders providing a useful combination of the following:— 3 Turntables (Mag), 3 Mics, 4 Line plus Mic with talk over switch. Headphone Monitor. Pan Pot. L. & R. Master Output controls. Output 775mV. Size 360 × 280 × 90mm.
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NEWS: NEWS: NEWS

DIARY

Satellite Communications — December 3/4th
Tara Hotel, London. See November '85 ETI or contact Online at the address below.

The History of Sound Broadcasting — December 5th
IEE, London. Lecture by Dr. G.J. Phillips, formerly of the BBC. For details contact the Secretary at the address below.

Robots Can See — Dec 18th & 19th
Institution of Electrical Engineers. Christmas Holiday Lecture by Professor A. Pugh of Hull University at 2.30 p.m. on each day. Free admission by ticket only, available from the IEE at the address below.

The Which Computer? Show — January 14-17th
NEC, Birmingham. Contact Cahners at the address below.

Electronics In Oil and Gas — February 4-6th
Barbican, London. See November '85 ETI or contact Cahners at the address below.

Power UK '86 — March 4-6th
Kensington Exhbition Centre, London. Exhibition and conference devoted to power supplies and alternative power sources. Organised by the Power Supply Manufacturers Association. For details contact TCM Expositions Ltd, Exchange House, 33 Station Road, Liphook, Hampshire GU30 7DN, tel 0428-724 660.

Electronic Production Efficiency Exposition — March 11-13th
Olympia, London. See November '85 ETI or contact Cahners at the address below.

Electro-Optics/Laser International — March 18-20th
Metropole Convention Centre, Brighton. Exhbition and conference on optics and lasers which includes a special focus on fibre optics. For details contact Cahners at the address below.

Low Energy Ion Beams — April 7-10th
University of Sussex, Falmer, Brighton. Conference on the production and use of ion beams, covering such areas as semiconductor processing and machining and material modification in metals and insulators. There will also be an exhibition of related equipment. For details contact the Meetings Officer, The Institute of Physics, 47 Belgrave Square, London SW1X 8QX, tel 01-235 6111.

Electrical Insulation Conference — May 19-22nd.
Brighton. International conference described by the organisers as the premier event in its field. For details contact the British Electrotechnical and Allied Manufacturers Association, Leicester House, 8 Leicester Street, London WC2H 7BN, tel 01-437 0678.

Advanced Infrared Detectors And Systems — June 3-5th
Institution of Electrical Engineers, London. Conference which aims to cover the developments in infrared detectors, systems and techniques and their relationship to developments in the field of millimetre waves. For details contact the IEE at the address below.

Networks '86 — June 10-12th
Wembley Conference Centre, London. Exhibition and conference devoted to all aspects of data exchange networks. For details contact Online at the address below.

Northern Computer Show — June 24-26th
G-MEX Exhibition Centre, Manchester. Exhibition aimed at professional computer users, from professionals in user departments to computing specialists. For details contact Reed Exhibitions, Surrey House, 1 Throwley Way, Sutton, Surrey SM1 4QQ, tel 01-643 8040.

Addresses:
Cahners Exhibitions Ltd, Chatsworth House, 59 London Road, Twickenham, Middlesex TW1 3SZ, tel 01-891 5051.
Institution of Electrical Engineers, Savoy Place, London WC2R 0BL, tel 01-240 1871.
Online Conferences Ltd, Pinner Green House, Ash Hill Drive, Pinner, Middlesex HA5 2AE, tel 01-868 4466.

ETI

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- Graphic extensions	£35
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PENGO, BLUE-BIRD, GOLF	£13
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CDOS WORD PROCESSOR (DISC ONLY)	£13
DRAWTECH (DISC ONLY)	£43
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	Built	£175
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Happy Memories

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6116 150ns	1.99	1.80	1.65
6264 150ns Low Power	3.75	3.45	3.20
2716 450ns 5 volt	3.85	3.45	3.30
2732 450ns Intel type	4.75	4.25	4.10
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27128 300ns Suit BBC	2.95	2.65	2.40
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Low profile IC sockets: Pins	8	14	16	18	20	24	28	40
Pence	12	13	14	16	18	24	27	38

Available now — The ROAM BOARD for the BBC Micro. Reads Roms via a Low Insertion Force Socket and saves their contents as files, then reloads a file into its sideways Ram as required.
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74LS series TTL, wide stocks at low prices with DIY discounts starting at a mix of just 25 pieces. Write or 'phone for list.

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BBC Micro Computer System

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VIEW STORE/VIEW SHEET .... £52 ea (c)
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ACCELERATOR (BASIC Compiler) .... £56 (c)

COMMUNICATION ROM
Termi II .... £26 (d)
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TORCH UNICORN products including the IBM Compatible GRADUATE in stock
For detailed specification on any of the BBC Firmware/Peripherals listed here or information on our complete range please write to us.

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These are fully cases and wired drives with slim line high quality mechanisms. Drives supplied with cables manuals and formatting disc suitable for the BBC computer. All 80 track drives are supplied with 40/80 track switching as standard. All drives can operate in single or dual density format.

Single Drives:
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1 x 400K 40/80T DS :T400 .... £99 (b)

Dual Drives: (with integral psu)
Stacked Version:
PD800 2 x 400K 80/40T DS .... £199 (a)

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FLOPPICLENE Disc Head Cleaning Kit with 20 disposable cleaning discs ensures continued optimum performance of the drives .... £14.50 (c)
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KP810 **£235** (a) KP910 **£339** (a)

DAISY WHEELS:
JUKI 6100 **£295** (a)
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2000 Sheets Fanfold:
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ACCESSORIES

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FX80 Tractor attachment .... £37.00 (c)
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8148 RS232 + 2K .... £57.00 (c)
8132 Apple II .... £60.00 (c)
8165 IEEE + cable .... £65.00 (c)
Serial & Parallel Interfaces with larger buffers available.
Ribbons: RX/FX/MX80 .... £5.00 (d)
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Spare pens for H180 .... £7.50/set (d)
FX80 Tractor Attachment £37 (c)

KAGA TAXAN
RS232 Interface + 2K Buffer .... £85 (c)
Ribbon KP810/910 .... £6.00 (d)

JUKI:
RS232 Interface .... £65 (c)
Spare Daisy Wheel .... £14.00 (d)
Ribbon .... £2.50 (d)
Sheet Feeder .... £182 (a)
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BROTHER HR15:
Sheet Feeder .... £189 (a)
Tractor Feeder .... £99 (a)
Ribbons Carbon or Nylon .... £4.50 (d)
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BBC Printer Lead:
Parallel (42") .... £7.00 (d)
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Printer Leads can be supplied to any length.

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1431 Standard Resolution .... £185 (a)
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1441 Hi Resolution .... £388 (a)
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KAGA Vision II .... £225 (a)
Vision III .... £330 (a)
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MONOCHROME MONITORS 12":
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MODEMS
— All modems listed below are BT approved

MIRACLE 3000:
A new range of microprocessor based modems offering of upto 2400 baud, full duplex. Features include 'HAYES' protocol compatibility, auto answer, auto dial, speed buffering, printer port, data security option etc. Mains powered.
WS3000 V2123 (V21 & V23) .... £295 (b)
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WS3000 V22bis2400 (as above plus 2400 baud full duplex) .... £650 (b)

MIRACLE 2000
A world standard modem covering V21, V23 (Bell 103/113/108 outside UK) and including 75, 300, 600, 1200 baud ratings. Optional Auto dial, auto answer cards, complete control from computer keyboard. **WS2000 £129** (b)

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SKI Software Control Kit .... £10 (d)

BUZZ BOX:
Pocket size, direct connect 300/300 half and full duplex with originate and answer modes .... £62 (c)

Data Cables for above modems available for most computers.

SPECIAL OFFER

2764-25 .... £2.00
27128-25 .... £3.00
6264LP-15 .... £4.00

ATTENTION

All prices in this double page advertisement are subject to change without notice.
ALL PRICES EXCLUDE VAT
Please add carriage 50p unless indicated as follows:
(a) £8 (b) £2.50 (c) £1.50 (d) £1.00

Serial Test Cable
Serial Cable switchable at both ends allowing pin options to be re-routed or linked at either end — making it possible to produce almost any cable configuration on site.
Available as M/M or M/F .... £24.75 (d)

Serial Mini Patch Box
Allows an easy method to reconfigure pin functions without rewiring the cable assy.
Jumpers can be used and reused. .... £22 (d)

Serial Mini Test
Minitors RS232C and CCITT V24 Transmissions, indicating status with dual colour LEDs on 7 most significant lines.
Connects in Line. .... £22.50 (d)

GANG OF EIGHT
INTELLIGENT FAST EPROM COPIER

Copies up to eight eproms at a time and accepts all single rail eproms up to 27256. Can reduce programming time by 80% by using manufacturer's suggested algorithms. Fixed Vpp of 21 & 25 volts and variable Vpp factory set at 12.5 volts. LCD display with alpha moving message. **£395 (b).**

SOFTY II

This low cost intelligent eprom programmer can program 2716, 2516, 2532, 2732, and with an adaptor, 2564 and 2764. Displays 512 byte page on TV — has a serial and parallel I/O routines. Can be used as an emulator, cassette interface.
Softy II .... **£195 (b)**
Adaptor for 2764/2564. **£25.00 (c)**

UV ERASERS

All erasers with built in safety switch and mains indicator.
UV1B erases up to 6 eproms at a time .... **£47 (c)**
UV1T as above but with a timer .... **£59 (c)**
UV140 erases up to 14 eproms at a time .... **£71 (b)**
UV141 as above but with a timer .... **£88 (b)**

CONNECTOR SYSTEMS

I.D. CONNECTORS
(Speedblock Type)

No of ways	Header Plug	Receptacle	Edge Conn.
10	90p	85p	120p
20	145p	125p	195p
26	175p	150p	240p
34	200p	160p	320p
40	220p	190p	340p
50	235p	200p	390p

EDGE CONNECTORS

	0.1"	0.156"
2 x 6-way (commodore)	—	300p
2 x 10-way	150p	—
2 x 12-way (vic 20)	—	350p
2 x 18-way	—	140p
2 x 23-way (ZX81)	175p	220p
2 x 25-way	225p	220p
2 x 28-way (Spectrum)	200p	—
2 x 36-way	250p	—
1 x 43-way	260p	—
2 x 22-way	190p	—
2 x 43-way	395p	—
1 x 77-way	400p	500p
2 x 50-way (S100conn)	600p	—

AMPHENOL CONNECTORS

	Solder	ZDC
36 way plug	500p	475p
36 way skt	550p	500p
24 way plug IEEE	475p	475p
24 way skt IEEE	500p	500p

PCB Mtg Skt Ang Pin
24 way 700p 36way 750p

RIBBON
(grey/metre)

10-way	40p	34-way	160p
16-way	60p	40-way	180p
20-way	85p	50-way	200p
26-way	120p	64-way	280p

D CONNECTORS

No of Ways	9	15	25	37
MALE:				
Ang.Pins	120	180	230	350
Solder	60	85	125	170
IDC	175	275	325	-
FEMALE:				
St Pin	100	140	210	380
Ang.pins	160	210	275	440
Solder	90	130	195	290
IDC	195	325	375	-
St Hood	90	95	100	120
Screw Lock	130	150	175	-

EURO CONNECTORS

DIN 41612	Plug	Socket
2 x 32 way St Pin	230p	275p
2 x 32 way Ang Pin	275p	320p
3 x 32 way St Pin	260p	300p
3 x 32 way Ang Pin	375p	400p
IDC Skt A + 8		400p
IDC Skt A + C		400p

For 2 x 32 way please specify spacing (A + B, A + C).

GENDER CHANGERS
25 way D type
Male to Male £10
Male to Female £10
Female to Female £10

RS 232 JUMPERS
(25 way D)

24" Single end Male	£5.00
24" Single end Female	£5.25
24" Female Female	£10.00
24" Male Male	£9.50
24" Male Female	£9.50

DIL HEADERS

	Solder	IDC
14 pin	40p	100p
16 pin	50p	110p
18 pin	60p	-
20 pin	75p	-
24 pin	100p	150p
28 pin	160p	200p
40 pin	200p	225p

TEXTOOL ZIF
SOCKETS 24-pin £7.50
28-pin £9.00 40-pin £12

MISC CONNS
21 pin Scart Connector 200p
8 pin Video Connector 200p

DIL SWITCHES
4-way 90p 6-way 105p
8-way 120p 10-way 150p

TECHNOLINE VIEWDATA SYSTEM

Using 'Prestel' type protocols for information and orders phone 01-450 9764. 24 hour service, 7 days a week.

74 SERIES

7400	30p
7401	33p
7402	33p
7403	33p
7404	31p
7405	31p
7406	41p
7407	41p
7408	31p
7409	31p
7410	31p
7411	34p
7412	30p
7413	50p
7414	70p
7416	36p
7417	40p
7420	30p
7421	60p
7422	34p
7423	34p
7425	40p
7426	40p
7427	40p
7428	43p
7430	30p
7432	38p
7433	30p
7437	30p
7438	40p
7439	40p
7440	40p
7441	90p
7442A	70p
7443A	100p
7444	110p
7445	100p
7446A	100p
7447A	100p
7448	120p
7450	36p
7451	35p
7453	38p
7454	38p
7460	55p
7470	50p
7472	55p
7473	55p
7474	50p
7475	60p
7476	45p
7480	65p
7481	180p
7483A	105p
7484A	125p
7485	110p
7486	42p
7489	210p
7490A	55p
7491	70p
7492A	70p
7493A	55p
7494	110p
7495A	60p
7496	80p
7497	210p
74100	190p
74107	50p
74109	75p
74110	75p
74111	55p
74116	170p
74118	110p
74119	170p
74120	100p
74121	55p
74122	70p
74123	80p
74125	65p
74126	55p
74128	55p
74132	75p
74136	75p
74141	90p
74142	250p
74143	270p
74144	270p
74145	110p
74147	170p
74148	140p
74150	175p
74151A	70p
74153	80p
74154	140p
74155	80p
74156	100p
74157	80p
74159	175p
74160	110p
74161	80p
74162	110p
74163	110p
74164	120p
74165	110p
74166	140p
74167	400p
74170	200p
74172	420p
74173	140p
74174	110p
74175	105p
74176	100p
74178	150p
74179	150p
74180	100p
74181	340p
74182	140p
74184	180p
74185A	180p
74190	130p
74191	130p
74192	110p
74193	115p
74194	110p
74195	80p
74196	130p
74197	110p
74198	220p
74199	220p
74221	110p
74251	100p
74259	150p
74265	380p
74273	200p
74276	140p
74278	170p
74279	90p
74283	105p
74285	320p
74290	90p
74293	90p
74298	180p
74351	200p
74365A	80p
74366A	80p
7436A	80p
74367A	80p
74368A	70p
74376	160p
74390	110p
74393	112p
74490	140p

74LS SERIES

74LS00	24p
74LS01	24p
74LS02	24p
74LS03	24p
74LS04	24p
74LS05	24p
74LS08	24p
74LS09	24p
74LS10	24p
74LS11	24p
74LS12	24p
74LS13	34p
74LS14	50p
74LS15	24p
74LS20	24p
74LS21	24p
74LS22	24p
74LS24	50p
74LS26	24p
74LS27	24p
74LS28	24p
74LS30	24p
74LS32	24p
74LS33	24p
74LS37	24p
74LS38	24p
74LS40	24p
74LS42	50p
74LS43	150p
74LS47	80p
74LS48	90p
74LS49	100p
74LS51	24p
74LS54	24p
74LS55	24p
74LS73A	30p
74LS74A	35p
74LS75	45p
74LS76A	36p
74LS83A	70p
74LS85	75p
74LS86	35p
74LS90	46p
74LS91	90p
74LS92	58p
74LS93	54p
74LS95B	75p
74LS96	90p
74LS107	40p
74LS109	40p
74LS112	45p
74LS113	45p
74LS114	45p
74LS122	70p
74LS123	80p
74LS124/629	140p
74LS125	50p
74LS126	50p
74LS132	65p
74LS133	50p
74LS136	45p
74LS138	55p
74LS139	55p
74LS145	95p
74LS147	175p
74LS148	140p
74LS151	65p
74LS152	200p
74LS153	65p
74LS154	160p
74LS155	65p
74LS156	65p
74LS157	50p
74LS158	65p
74LS160A	75p
74LS161A	75p
74LS162A	75p
74LS163A	75p
74LS164	75p
74LS165A	110p
74LS166A	150p
74LS168	130p
74LS169	100p
74LS170	140p
74LS173A	100p
74LS174	75p
74LS175	75p
74LS181	200p
74LS183	190p
74LS190	75p
74LS191	75p
74LS192	80p
74LS193	80p
74LS194A	75p
74LS195A	75p
74LS196	80p
74LS197	80p
74LS221	90p
74LS240	80p
74LS241	80p
74LS242	90p
74LS243	90p
74LS244	80p
74LS245	110p
74LS247	110p
74LS248	110p
74LS249	110p
74LS251	75p
74LS253	75p
74LS256	90p
74LS257A	70p
74LS258A	70p
74LS259	120p
74LS260	75p
74LS261	120p
74LS266	60p
74LS273	125p
74LS279	70p
74LS280	190p
74LS283	80p
74LS290	80p
74LS292	900p
74LS293	80p
74LS295	140p
74LS297	£9
74LS298	100p
74LS299	220p
74LS321	370p
74LS323	300p
74LS324	320p
74LS348	200p
74LS352	120p
74LS353	120p
74LS356	210p
74LS363	180p
74LS364	180p
74LS365	50p
74LS366	50p
74LS367	50p
74LS368A	50p
74LS373	90p
74LS374	90p
74LS375	75p
74LS377	130p
74LS378	95p
74LS379	130p
74LS381	450p
74LS365	325p
74LS390	60p
74LS393	100p
74LS395A	100p
74LS399	140p
74LS445	180p
74LS465	120p
74LS467	120p
74LS490	150p
74LS540	100p
74LS541	100p
74LS608	700p
74LS610	1900p
74LS612	1900p
74LS624	350p
74LS626	225p
74LS628	225p
74LS629	125p
74LS640	200p
74LS640-1	300p
74LS641	150p
74LS642-1	300p
74LS643	250p
74LS643-1	300p
74LS644	350p
74LS645	200p
74LS645-1	400p
74LS668	90p
74LS669	90p
74LS670	170p
74LS682	250p
74LS684	350p
74LS687	350p
74LS688	350p
74LS783	£21

74S SERIES

74S00	50p
74S02	50p
74S04	50p
74S05	60p
74S08	50p
74S10	50p
74S11	75p
74S20	50p
74S22	50p
74S30	50p
74S32	60p
74S37	60p
74S38	60p
74S40	50p
74S51	45p
74S64	45p
74S74	70p
74S85	300p
74S86	100p
74S112	150p
74S113	120p
74S114	120p
74S124	300p
74S132	100p
74S133	60p
74S138	180p
74S138	180p
74S139	180p
74S140	100p
74S151	150p
74S153	150p
74S157	200p
74S158	200p
74S163	300p
74S169	550p
74S174	300p
74S175	320p
74S188	180p
74S189	180p
74S194	300p
74S195	300p
74S196	350p
74S200	300p
74S201	320p
74S225	520p
74S240	400p
74S241	400p
74S244	500p
74S251	250p
74S257	250p
74S258	250p
74S260	100p
74S261	100p
74S283	300p
74S287	225p
74S289	225p
74S299	550p
74S373	400p
74S374	400p
74S387	225p

4000 SERIES

4000	20p
4001	24p
4002	25p
4006	70p
4007	25p
4008	60p
4009	45p
4010	45p
4011	24p
4012	25p
4013	36p
4014	60p
4015	70p
4016	36p
4017	55p
4018	60p
4019	60p
4020	80p
4021	60p
4022	70p
4023	30p
4024	48p
4025	24p
4026	90p
4027	40p
4028	60p
4029	75p
4030	35p
4031	125p
4032	100p
4033	125p
4034	250p
4035	70p
4036	70p
4037	110p
4038	100p
4039	250p
4040	60p
4041	55p
4042	50p
4043	60p
4044	60p
4045	100p
4046	60p
4047	60p
4048	55p
4049	38p
4050	35p
4051	65p
4052	60p
4053	80p
4504	60p
4055	80p
4056	85p
4059	400p
4060	70p
4063	85p
4066	40p
4067	230p
4068	25p
4069	24p
4070	24p
4071	24p
4072	24p
4073	24p
4075	24p
4076	65p
4077	25p
4078	25p
4081	24p
4082	25p
4085	60p
4086	75p
4089	120p
4093	35p
4094	90p
4095	90p
4096	90p
4097	270p
4098	75p
4099	90p
4501	38p
4502	55p
4503	38p
4504	95p
4505	380p
4506	90p
4507/4030	35p
4508	120p
4510	55p
4511	55p
4512	65p
4513	150p
4514	110p
4515	110p
4516	65p
4517	220p
4518	45p
4519	32p
4520	80p
4521	115p
4522	80p
4526	70p
4527	80p
4528	65p
4529	100p
4531	75p
4532	65p
4534	380p
4536	250p
4538	75p
4539	75p
4541	90p
4543	70p
4551	100p
4553	240p
4555	38p
4556	50p
4557	240p
4560	140p
4566	140p
4568	240p
4569	170p
4572	45p
4583	90p
4584	48p
4585	60p
4724	150p
14411	750p
14412	750p
14416	300p
14419	260p
14490	420p
14495	450p
14500	650p
14599	200p
22100	350p
22101	700p
22102	700p
40014/4584	
40106	48p
40085	120p
40097	36p
40098	40p
40100	150p
40101	125p
40102	130p
40103	200p
40104	120p
40105	150p
40106	48p
40107	55p
40108	320p
40109	20p
40110	225p
40114	225p
40147	280p
40163	100p
40173/4067	
40174	120p
40175	100p
40192	100p
40244	150p
40245	150p
40257	180p
40373	180p
40374	180p
80C95	75p
80C97	75p
80C98	75p

LINEAR ICs

AD7581	£15
ADC0808	1190p
AM7910DC	£25
AN103	320p
AY-1-5050	100p
AY-3-1350	350p
AY-3-8010	450p
AY-3-8912	500p
CA3019A	100p
CA3028A	110p
CA3046	70p
CA3059	325p
CA3080	90p
CA3080E	70p
CA3086	60p
CA3089E	210p
CA3090AQ	375p
CA3130E	90p
CA3130T	130p
CA3140E	45p
CA3140T	100p
CA3160E	100p
CA3161E	200p
CA3162E	600p
CA3189E	270p
CA3240E	150p
CA3280G	270p
D7002	£8
DAC1408-8	300p
DAC0800	300p
DAC0808	300p
DG308	300p
HA1366	190p
ICL7106	675p
ICL7611	95p
ICL7650	400p
ICL7660	250p
ICL8038	400p
ICM7216B	£22
ICM7217	750p
ICM7555	80p
ICM7556	140p
LC7120	300p
LC7130	300p
LC7137	350p
LF347	120p
LF351	60p
LF353	80p
LF355	90p
LF356N	110p
LF357	100p
LM10C	450p
LM301A	30p
LM307	45p
LM308CN	75p
LM310	225p
LM311	90p
LM318	150p
LM319	180p
LM324	45p
LM334Z	115p
LM335Z	130p
LM336	180p
LM339	40p
LM348	80p
LM358P	50p
LM377	300p
LM380N-8	150p
LM380	150p
LM381AN	170p
LM382	200p
LM383	325
LM384	220
LM386N-1	100p
LM387	270p
LM389	180p
LM391	180p
LM392N	110p
LM393	385p
LM394CH	380p
LM709	36p
LM710	48p
LM711	100p
LM723	60p
LM725CN	300p
LM733	85p
LM741	22p
LM747	70p
LM748	30p
LM1011	480p
LM1014	150p
LM1801	300p
LM1830	280p
LM1871	300p
LM1872	300p
LM1886	580p
LM1889	480p
LM2917	300p
LM3302	80p
LM3900	60p
LM3909	100p
LM3911	100p
LM3914	380p
LM3915	380p
LM3916	340p
LM13600	150p
M51513L	230p
M51516L	480p
MB3712	200p
MC1310P	150p
MC1413	75p
MC1458	45p
MC1495L	300p
MC1496	70p
MC3340P	120p
MC3401	70p
MC3403	65p
MF10CN	300p
MK50240	900p
MK50398	790p
ML920	500p
ML922	400p
MM6221A	300p
NE531	120p
NE544	190p
NE555	22p
NE556	60p
NE564	400p
NE565	120p
NE566	160p
NE567	125p
NE570	400p
NE571	400p
NE592	90p
NE5532P	150p
NE5533P	180p
NE5534P	100p
NE5534AP	150p
OP-07EP	500p
PLL02A	500p
RC4136	90p
RC4151	200p
RC4558	55p
S566B	220p
SAA1900	£16
SFF96364	800p
SL490	300p
SN76033N	300p
SN76489	400p
SN76495	400p
SP0256AL2	700p
TA7120	120p
TA7130	140p
TA7204	150p
TA7205	80p
TA7222	150p
TA7310	150p
TBA231	130p
TBA800	90p
TBA810	90p
TBA820	80p
TBA820M	75p
TBA920	200p
TBA950	225p
TC9109	500p
TCA210	350p
TCA220	350p
TCA940	175p
TDA1010	225p
TDA1022	400p
TDA1024	110p
TDA1170S	300p
TDA2002	325p
TDA2003	180p
TDA2004	240p
TDA2006	320p
TDA2020	320p
TDA2030	280p
TDA2593	280p
TDA3810	750p
TDA7000	350p
TEA1002	700p
TL061CP	40p
TL062	60p
TL064	90p
TL071	40p
TL072	70p
TL074	110p
TL081	35p
TL082	50p
TL083	75p
TL084	100p
TL094	180p
TL170	50p
UAA1003-3	935p
UA759	320p
UA2240	120p
UAA170	170p
UCN4801A	550p
ULN2003A	75p
ULN2004A	75p
ULN2068	290p
ULN2802	190p
ULN2803	190p
ULN2804	190p
UPC575	275p
UPC592H	200p
UPC1156H	300p
UPC1185H	300p
XR210	400p
XR2206	400p
XR2207	375p
XR2211	575p
XR2216	675p
XR2240	120p
ZN409	190p
ZN414	80p
ZN419P	175p
ZN423E	130p
ZN424E	130p
ZN425E8	350p
ZN426E	300p
ZN427E	900p
ZN428E	450p
ZN429E8	225p
ZN447E	£9.50
ZN449E	300p
ZN450E	750p
ZN459CP	300p
ZN1034E	200p
ZN1040E	680p
ZNA134J	£23
ZNA234E	950p

COMPUTER COMPONENTS

CPU

1802CE	650p
2650A	1050p
6502	450p
6502A	450p
65C02A	£15
6502B	800p
6800	250p
6802	300p
6803-2	£12
6809	650p
6809E	£8
68B09	£10
68B09E	£12
68000-LB	£36
8035	350p
8039	420p
80C39	700p
8080A	420p
8085A	300p
80C85A	750p
8086	£22
8088	1750p
8741	£12
8748	£16
TMS9980	£14.50
TMS9995	£12
Z80	250p
Z80A	290p
Z80B	550p
Z80CMOS (CMOS Z80)	750p

SUPPORT DEVICES

2651	£12
3242	800p
3245	450p
6520	300p
6522	350p
6522A	550p
6532	480p
16551	650p
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DS8838	225p
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MC1489	60p
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MC3480	900p
MC3418L	900p
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MC3487	250p
MC4024	550p
MC4044	550p
MC14411	950p
MC14412	750p
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ULN2068	280p
ULN2802	190p
ULN2803	180p
ULN2804	190p
75107	80p
75108	80p
75109	120p
75110	90p
75112	180p
75113	120p
75114	140p
75115	140p
75121	140p
75122	140p
75150P	120p
75154	120p
75159	220p
75160	500p
75161	500p
75162	400p
75172	400p
75182	80p
75188	80p
75189	80p
75365	150p
75450	50p
75451	50p
75452	50p
75453	70p
75454	70p
75480	150p
75491	65p
75492	65p
8T26	120p
8T28	120p
8T95	120p
8T96	120p
8T97	120p
8T98	120p
81LS95	140p
81LS96	140p
81LS97	140p
81LS98	140p
88LS120	300p
9602	300p
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9638	180p
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2.45760	200p
2.5	225p
2.662	250p
3.12MHz	175p
10.00MHz	175p
3.276	150p
3.5795	100p
4.00	140p
4.194	150p
4.43	100p
4.608	250p
4.9152	200p
5.000	150p
6.00	140p
17.734	200p
7.00	150p
7.168	175p
8.00	150p
8.867	175p
10.50	250p
10.70	180p
11.00	200p
12.00	150p
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15V		7815	50p	7915	50p
18V		7818	50p	7918	50p
24V		7824	50p	7924	50p
5V	100mA	78L05	30p	79L05	45p
8V	100mA	78L08	30p		
12V	100mA	78L12	30p	79L12	50p
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READ/WRITE

Unbalanced

Dear Sir,

There is no way that a practical, well-balanced, rational, non-controversial answer can be given to Anna Paczuska (ETI, October 1985).

To attempt it, in detail, would take several thousand words and would lay open to every kind of accusation, from MCP to fascist.

It is probably the biggest red-herring ever strewn in the path of an unsuspecting, largely male(?) readership.

Whichever way her problem is examined, a serious train of thought inevitably arrives at the starting point.

One way of achieving her aims — in part, at least, is to campaign for sexual equality. Then I can retire next year, together with all those hale and hearty sixty-year-old ladies who, the statisticians say, will be going strong when I am fertilizing the daisies.

Yours faithfully,
(Name and address witheld)

I'm not quite sure what your objection is to an article that takes a cool look at a topic of public interest — unless, that is, you're opposed to the idea that electronics and related technologies should be as open to women as they are to men. As it happens, this idea — in the form of the Equal Opportunities Act — is a matter of law and public policy in this country. While the vast majority of our readers are indeed male, that is no reason why they should not be concerned about the issues of sexual discrimination, as you yourself imply, nor is it a reason to discourage women from reading or contributing to ETI. — Ed.

Unbiased

Dear Sir,

Thank you for producing an electronics magazine that has been enjoyed for many years. However, recently articles such as "electronic weapons being used against us" — Greenham women claim' (ETI, December 1985), 'Electronics for Peace?' (ETI, April 1985), etc, were included in ETI. But note that a politician may voice his opinions such as 'The Greenham women are liars,' 'The Greenham women recently visited Russia,' or 'What you said is all true — so what?' It may surprise you to know, that to be fair, whatever politicans think is equally valid and has to be published (rightly or wrongly).

Such politics has little to do with electronics. It does not tell me how to bias my transistors. It does not tell me why Gallium Arsenide works faster than silicon. It does not tell me who has developed the latest high-speed op-amp. Many hours of politics are screened on television each day. Most daily newspapers publish enormous amounts of rubbish — all of which I may or may not wish to review. ETI is a safe haven from all these. Please don't turn it into a political battlefield.

Thank you,
Yours faithfully,
Joseph Michael BSc.
London.

Dear Sir,

I would like to cancel my subscription to Electronics Today International forthwith and my money's reamining owed to me to be refunded. I have enclosed the label from my last issue.

Yours faithfully,
Sgt. R. Hailstones
School of Signals
Blandford Camp
Dorset.

Nuff said! — Ed.

I Got Rhythm

Dear Sir,

I read Mr. Phillips article entitled 'The Rhythm Chip' in ETI, November 1985, with interest. Unfortunately I think that the designer has failed to fully exploit the potential of the 'look-up table' technique. His meter has a very limited range and resolution, requiring the necessity of a scale change to accommodate a modest selection of rates. In addition the power consumption of this device is probably about 250mA making battery operation of this system unsatisfactory. A mains power supply can be seen in the photograph accompanying the article although this is not described in the text. From the arguments presented it would be an advantage if a truly portable, low-power system could be designed.

Fortunately this has already been done! I have previously published such a design using the ROM look-up table conversion technique. This device was built using CMOS chips, has a three digit LCD display and a single range of 30 - 300 pulses per minute with 1% or better resolution. It was intended for battery operation and using a CMOS ROM (27C16) consumes only 20mA while having similar circuit complexity to Mr Philips' design but few discrete components and no presets! The only function that my rate meter fails to achieve is audible tone generation, although this is simple to add.

I am surprised that editorial review has allowed the wheel to be re-invented in an apparently inferior way.

Yours faithfully,
P.D. Coleridge Smith
Dept. of Surgical Studies
The Middlesex Hospital
London.

Suppress your surprise and produce a project for us. Our contributors are our greatest asset and our readers our greatest inspiration and safeguard. — Ed.

Back To Front

Dear Sir,

I would like to compliment and thank KIA for the special accordion amplifier AX68. The results are excellent, just as I had hoped for, and I consider it very good value for money.

I thank Mr. Lawrence at KIA for his interest and great patience in constructing my special order.

May I recommend KIA to any reader with amplifier problems and wish them continuing success in the future.

Yours gratefully,
J.T. Cormack
Suffolk.

The news has finally reached me after journeying all the way from the Classifieds at the back of ETI that KIA advertise with us. My apologies to them. Their address, for anyone interested, is 8 Cunliffe Road, Ilkley, West Yorks, LS29 9DZ. — Ed. ETI

NEXT MONTH

AN ARGUS SPECIALIST PUBLICATION

electronics today INTERNATIONAL

The Microamp

The third ETI sound processor is a high-performance bridgeable amplifier giving 20W per channel stereo and 40W per channel mono output. Uniform with the compressor-noise gate in the December issue and this month's Activator, the Microamp is the last link in a basic sound system of small proportions and great quality.

Digibaro

Using a pressure sensor, analogue-to-digital converter and data stored in EPROM, this digital barometer is a model of environmental measuring techniques. The circuit includes full compensation for temperature drift and altitude and the neatly packaged unit will prove a boon to amateur meteorologists and anyone who suspects that the pressure is getting too much for them.

PLUS

All our regular features, circuit ideas galore, Tech Tips, Read/write, Digest and more.

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ALL ON BOARD

The PCB has come to dominate contemporary electronics. If you still find it difficult to design your own, Barry Porter shows you how to cope with tracks and pads and all the paraphernalia. We might say, 'New readers, start here ...'

In basic terms, a printed circuit board is nothing more than a support for the component of a circuit, which happens to have built-in interconnections that enable the circuit to operate. In reality, it is something more than that. A well-designed board can have considerable aesthetic appeal, although most examples are guaranteed to send the average crow rushing out for a copy of 'The Nest Builders' Cookbook'. It also assists in keeping the blood pressure of anyone called upon to carry out repairs within tolerable limits, and provides additional boozing time by accelerating the construction of your latest masterpiece.

The only difference between bad and good circuit board layouts is care. There is no excuse for boards in manufactured products being second rate, but there is even less reason for one-offs produced by home constructors to resemble a windy night at a spaghetti factory. Time is money to the manufacturer, but the DIY enthusiast should not suffer from this constraint. Providing you were not short changed at birth in the patience department, and with a gentle nudge in the right direction from this Pulitzer prize-worthy epistle, you will soon be producing layouts that will be the envy of your sewing circle, and you could soon find yourself giving demonstrations to your local WI and Rose Pruning Society.

The Birth Of The Board

The object of the exercise is to guide you through the design and preparation of the necessary artwork to send to a PCB manufacturer. Although it is possible to make your own boards, the expenditure of time and the amount of mess generated are unlikely to be justified by the end result, so unless you are prepared to invest a considerable amount of the folding stuff in specialised equipment, it is best to leave the difficult bit to a professional.

Circuit boards usually start their careers as circuit diagrams, and the stages necessary to translate a familiar schematic into a finished board begin as a number of very rough layouts, followed by one or more attempts to transfer these to graph paper at a defined scale. The successful graph paper layout is used as a master from which the various artwork layouts are generated. These consist of plastic drafting film masters for the copper tracks, a solder resist mask and the component identification screen. If the board is to be double sided, a separate artwork is normally provided for each side. The artwork will normally be produced at 2:1 scale with linear dimensions which are twice those of the final board — although for very large boards, it may be necessary to work 'same size', and for very small layouts, a 4:1 scale is sometimes preferable.

To illustrate the various steps in the production of a set of artworks, we will start with a circuit for a high quality tape record amplifier (Fig. 1), and attempt to design a layout which fits a circuit board with the dimensions shown in Fig. 2. Any layout is made easier if you are free to choose the overall board size and the points at

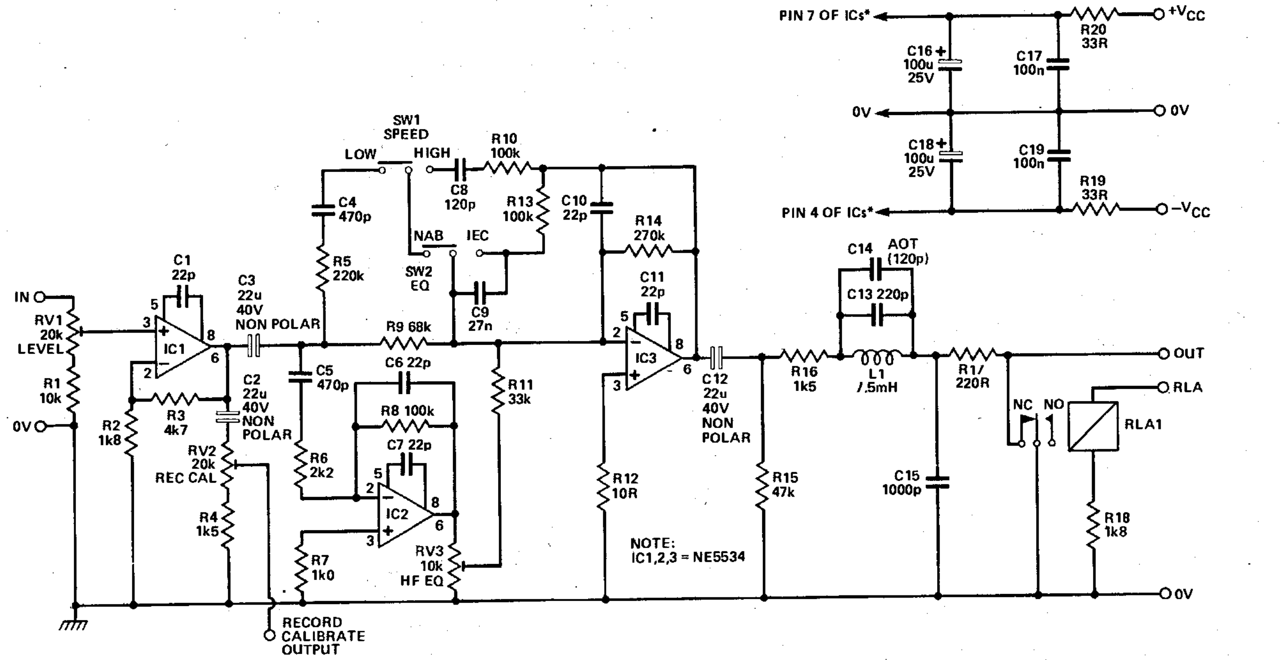


Fig. 1 Circuit used for layout exercise.

which connections to the outside world are made. The most difficult tasks involve fixed board dimensions, such as the design of a replacement board for an existing piece of equipment. Life is further complicated if the external connections are made via an edge connector with pre-determined locations. Just to ensure that life retains some enjoyment, this is the situation that will be tackled during the course of this article.

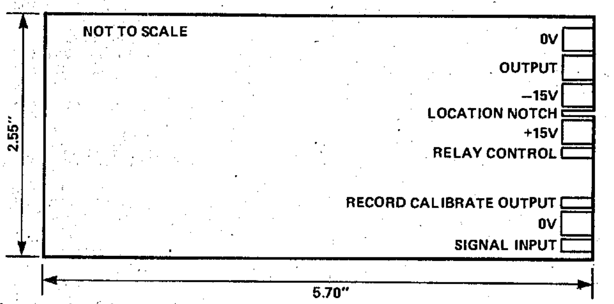


Fig. 2 Circuit board dimensions and edge connections.

Before getting too involved with the design of a specific board, a few basic rules may not go amiss. Circuit diagrams are usually drawn in a way that can almost be taken as a worldwide standard. Signal normally progresses from an input at the left hand side, through various transistor or op-amp stages, to emerge at the right hand side. It is usually good practice to lay out a circuit board so that it bears a close resemblance to the original schematic.

Inexperienced PCB designers usually fall into one of two main traps — running low level inputs and high level outputs too close together, so that a circuit that worked in breadboard form becomes unstable, and getting the earthing arrangements in a cobble, which can result in so many nasty effects that there is a good chance that if alien beings ever pay this world a visit their first words will be 'Hum loop'. (My wife, who assures me that our 2½-year-old is an alien, has just pointed out that his opening statement sounded more like 'Bo Derek').

Where possible, input and output signal paths should be well separated, particularly when there is more than about 15dB difference in their levels. Providing the operating impedances are low, it is normally quite safe to allow the inputs and outputs of low level circuitry to be within 0.5" of each other. If an area of track at earth potential can be placed between them, it is quite possible to reduce the spacing to 0.25". Power amplifiers are a different ball game, and a minimum input to output spacing of 3.0" should be allowed, but 6.0" or even more is to be preferred.

Bad earthing practice can cause problems beyond your wildest imagination, yet perfectly good earthing can be achieved very easily by ensuring that the input to output earth path of any circuit simply follows the signal through the various stages. The impedance of all earth connections must be kept as low as possible, which means using large areas of copper track wherever space allows.

One very popular way of introducing instability is to place a continuous strip of copper track at earth potential around the outer edge of a board. This is often the most convenient place for the earth track to be positioned, but it is essential that the circle is broken at one point so that as far as possible, the earth path follows that of the signal.

In designing a printed circuit board, the aim should be to arrive at a layout where the components are neatly positioned without compromising the performance of the circuit. As far as possible, the components should be placed in rows with correct spacing between the mounting holes. Before laying out any board, it is essential to have some examples of the components which will be used or obtain accurate dimensions from a data sheet. The appearance of many a board has been ruined because of an incorrect guess at the length of a capacitor, so pay special attention to your component sizes, as plenty of eager gremlins lie in wait for the unwary.

Some complicated circuits can only be laid out by using double sided boards, but the additional cost of these — about 25% for a small quantity — is usually a sufficient incentive to extract the necessary effort to achieve a single sided layout. Whenever possible, the use of wire links should be avoided, more as a matter of designers' pride than because of their effect on circuit operation. (With Herculean effort, author fights off desire to make rude comments about people who listen to bits of wire, and can tell the direction of the molecular structure at ten paces on a foggy night in a force 9 gale.)

Getting Down To It

Instead of rambling on randomly, let's get on with the job in hand — a layout of the circuit in Fig. 1. Before starting any design work, it is wise to make sure that certain items are at hand:

1. One each of the various circuit components, or accurate details of their dimensions.
2. Lots of scrap paper for the initial rough design. (Goodbye to another Norwegian Pine.)
3. Supply of graph paper, slightly larger than the finished artwork, with scale markings at 1.00" and 0.1". (None of yer metric stuff here — components invariably fit a 0.1" grid.)
4. Matt surfaced plastic drafting film, same size as graph paper.
5. Drawing instruments — pencils, pens, stencils, compasses, rule scaled in tenths of an inch.
6. Talcum power (fragrance unimportant).
7. Supply of circuit layout materials (details later).
8. Roll of red transparent adhesive tape.
9. Scalpel with selection of blades.
10. Pair of good quality 6" engineers tweezers with undamaged points.

Having collected together these 'tools of the trade', the time has arrived to leave the world for a few hours. Find somewhere where your concentration will not be disturbed, even if you have to send the family to Disneyland and gag the budgie.

It is a rewarding experience to turn out a good, well-planned circuit board ...

The first step is to produce a very rough sketch of where the different parts of the circuit will fit onto the circuit board. If there are no constraints brought about by board dimensions or edge connectors, it is quite easy to arrange the circuit parts in a reasonably compact and symmetrical manner. Working to pre-determined dimensions, it is necessary to decide where various circuit elements should be placed to fit within the confines of the board, and if the external connections have been specified, these should be taken into consideration.

Figure 3 shows the first attempt to fit the Fig. 1 circuit on to the designated board. At this stage, the main consideration has been given to establishing a route for the signal input and output tracks, the placing of the three integrated circuits and connections to the multi-turn potentiometers.

At first sight, getting a direct connection from the edge connector to the wiper of RV2 is likely to be a problem, but one that can be noted and dealt with as the design progresses.

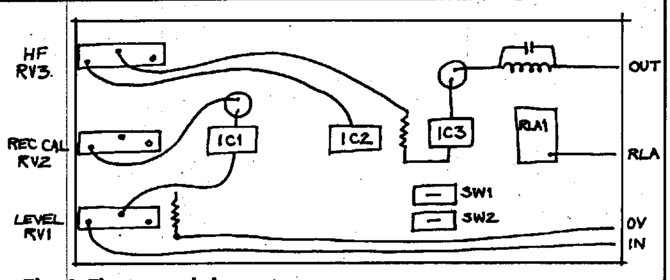
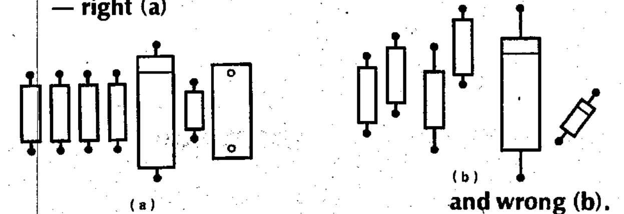


Fig. 3 First rough layout.

The next task is to produce some rough layouts of separate parts of the circuit, this time putting in all components and the interconnecting tracks. At this point, it should be mentioned that most PCB designers produce their layouts and artwork as it is viewed from the component side of the board. Some people prefer to work as though they are looking at the copper side, but this method can lead to problems, the most popular being ICs with reversed connections — easily idenitifed by the emission of grey smoke if not discovered before the board is built and tested. Throughout this article it will be assumed that all views are from the component side.

Fig. 4 Component spacing and layout — right (a)



and wrong (b).

As the next layout rough is prepared, account should be taken of the component sizes and spacing, especially with regard to resistors and capacitors. In order that the final result is as neat as possible, one aim should be to keep the ICs and their associated components in straight rows, and not staggered as shown in Fig. 4b. The spacing between normal 0.25 or 0.5 W resistors is likely to be 0.15", and this does not leave sufficient space between the solder pads for the passage of a piece of track without the track becoming too narrow for comfort or the pads requiring modification with a scalpel.

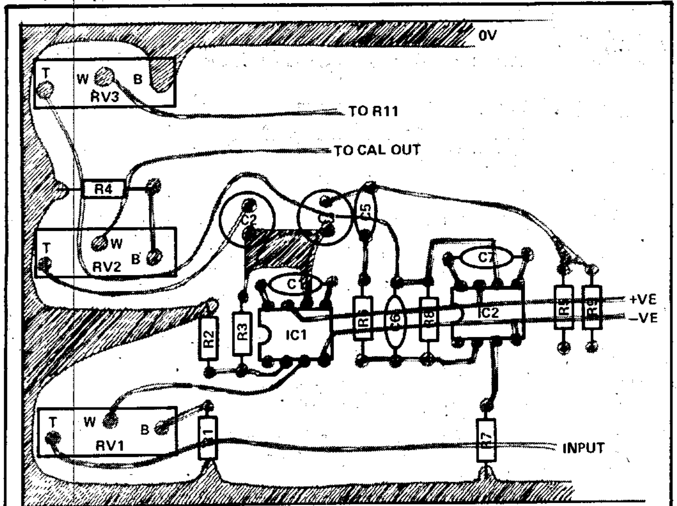


Fig. 5 First attempt at input stage layout.

Without getting too involved in pad and track sizes at this stage, while doing the rough layouts, keep in mind that tracks passing between 0.15" spaced pads may cause problems at a later stage, so avoid the practice if possible without damaging the appearance of the layout.

The first rough layout of the record amplifier board is shown in Fig. 5. Although this has several areas which need correcting — for example the input and 0V tracks will have to be reversed, and the output of RV2 is in danger of being trapped by the track going to R11 — it is at least a starting point, and as such it forms a foundation of sorts on which to build.

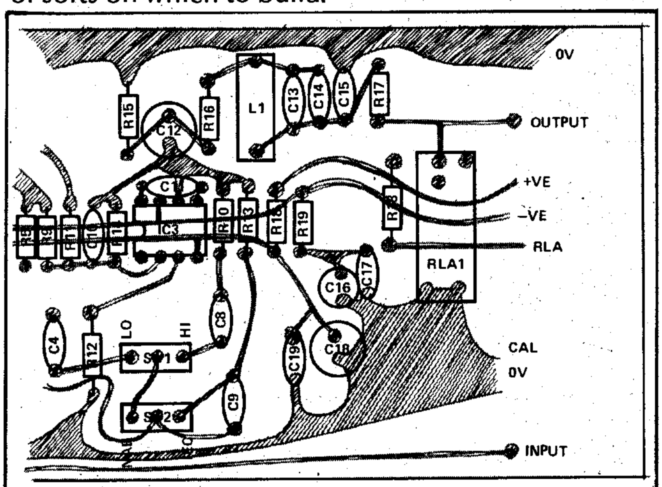


Fig 6. First attempt at output stage layout.

The remaining circuitry is shown in Fig. 6. Again, it contains a few problem areas, such as the non-appearance of the 'Record Cal' track and the rather tortuous path from the bottom of C9 to pin 2 of IC3, but these can be sorted out at the next stage.

Slow On The Draw

Having produced a satisfactory *rough* layout with sufficient accuracy to establish that it is not necessary to use a double sided board, and that wire links will probably not be needed, it is possible to attempt a correctly scaled layout on graph paper.

> *In designing a printed circuit board, the aim should be to arrive at a layout where the components are neatly positioned without compromising the performance of the circuit ...*

From now on, everything must be related to the scale of the artwork — in our case, 2:1 — so care must be taken to double every dimension. Experience has shown that this is not always as easy as it sounds. It is quite easy to draw small components with correct dimensions, simply by counting squares on the graph paper, but with larger items such as electrolytic capacitors, it is very easy to make a mistake, and the distance between mounting holes should always be checked by measuring them with a rule calibrated in tenths of an inch. The time spent doing this should not be considered as wasted, especially if you have ever suffered the sinking feeling when you realize that a component will not fit a board because of your own lack of care.

If your board dimensions are not fixed, you should be able to estimate an approximate size, which will give you an idea of the size of graph paper you need. With an established board size, an outline of the board should be drawn — in ink — to the correct scale and any fixed components, mounting holes or edge connector details added using a fine felt tipped pen or similar.

In our example, the only restraint apart from the overall board size and edge connector positions is the placing of the three pre-set potentiometers which are required to line up with similar controls on other boards in the recorder. The outlines and mounting holes of these are therefore drawn in ink, and then using a soft pencil, an attempt is made to transfer the rough layouts of Figs. 5 and 6 on to the double sized graph paper grid.

Although this may be done freehand, keep everything as neat as possible. This is the best way to ensure accuracy. It's worth repeating that, unless absolutely necessary, all components should be in neat rows and not scattered haphazardly round the board. If your circuit uses ICs, these should lie along the same line, and should be placed in the same direction — which normally happens automatically if the power rails are run between the rows of IC mounting pads, and don't approach each device from a different direction. The sign of ultimate neatness is when groups of polarized components, such as diodes or electrolytic capacitors, all have their positive ends facing the same direction. Figure 7 shows some examples of how electrolytics and diode bridges may be laid out, (d) and (f) illustrating how they should be positioned for the best appearance.

If you are having a good day, you will achieve a satisfactory layout before your local graph paper factory has to start working overtime. Do not be surprised if it takes three or four attempts before you are happy. It can often be beneficial to get an electronically inclined colleague to give your layout the once-over, as this can often result in the discovery of glaring mistakes which would prove expensive if not corrected.

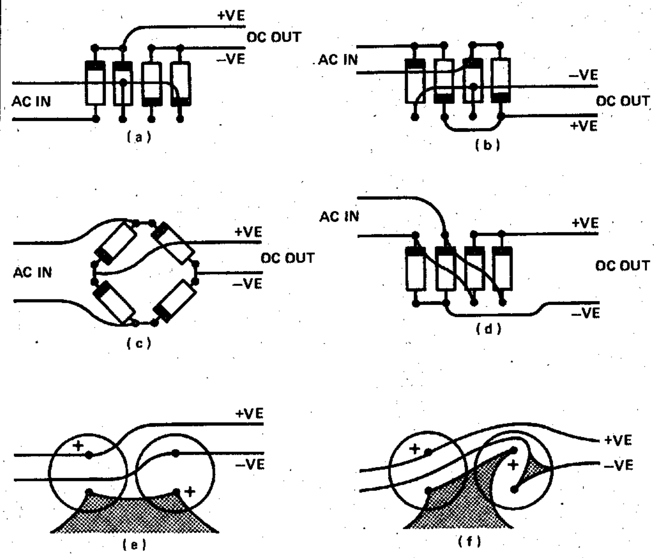


Fig. 7 Examples of diode bridge and electrolytic capacitor layout.

To be continued.

ETI

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THE PRESENT AND FUTURE MACHINE

A short story for Christmas by John Linsley Hood

In my experience, inventors all have one thing in common — they all think their latest idea is going to make them rich and famous, and that a life basking on the sands of the Bahamas or wherever is just round the corner.

Having said that, they come in two very different kinds. The first just have a bright idea ...... in principle, and they would like someone with the right kind of technical knowledge to put their invention into practical shape, and make it work. This, they feel sure, will be quite a simple job. The other kind, and they are vastly preferable, get the idea... and then become immensely secretive while they put it into practical form.

My old friend Fred, of the electronics components shop, happily came into the latter category. I call him 'my old friend', because I've known him for years, well, practically as long as I have been interested in electronics, and he lets me come behind the counter of his shop, and up to his little workshop in the attic. Also, Peggy, his kindly and long-suffering wife, has brought us up innumerable cups of coffee while we have been busy tinkering with electronics - or simply setting the world to rights.

However, I also reflect that, in all the years I've known him, he's never knowingly let me have anything in the way of electronic gear at less than the full retail price! Still, I suppose that's just because he's a very good businessman: certainly his little shop is a treasure trove of bits and pieces of electronic kit, including quite a lot of fairly scarce components.

At the time I am thinking about, which was a very wet and dismal day in early November a few years ago, I had called at his shop on my way home from work, and Peggy had sent me up to his attic with the comment that he had hardly stirred from there all day and was busy on some project or other. The task on which he was engaged turned out to be the conversion of a rather grotty old 14 inch TV into an oscilloscope, and he'd got as far as getting a single line timebase scan across the centre of the screen, with a whopping great kink in the middle of the trace.

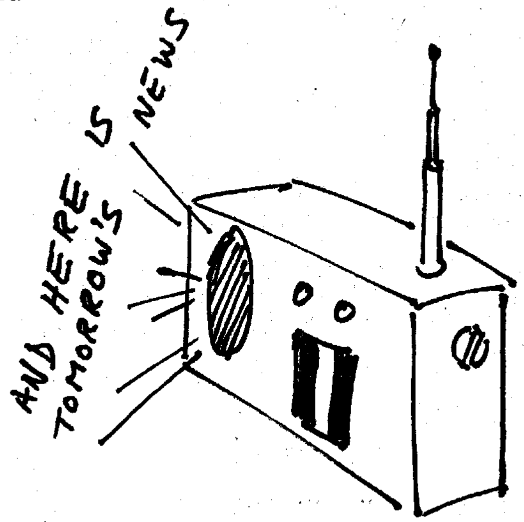
'You've got a problem there,' I observed, 'looks as though you are getting some breakthrough from your timebase into your 'Y' axis.' At this Fred turned round to me with a seraphic smile. 'Your problem,' he remarked, 'is that you've got no imagination. What you see here is the beginning of a great technical discovery - the sort of thing which great brains have laboured to uncover for generations, and I've been the one to do it!'

'That loop in the trace is due to electrons travelling backwards in time. Time is linear across the screen, so any kink in the trace across the screen must be time going backwards.' He turned back to his brainchild with a look of triumph. 'Don't you see what that means?'

'Well, yes,' I said, 'I would agree with you if that was what was really happening, but I'd be prepared to bet that your scanning waveform has also got a kink in it. After all, trying to get a linear timebase out of inductive deflection coils is a pretty tricky task.'

'I did think of that' admitted Fred, 'but I checked on my other 'scope' and he indicated his old standby, a 1940's portable job with a screen fully one inch across. 'As you can see, the waveform is perfectly OK, without a trace of kinkiness.'

'Whereabouts are you looking', I asked, thinking that a good magnifying glass would be a useful accessory. 'Is that the waveform at your timebase generator or actually on the deflection coils - because these probably interact.' 'No,' said Fred, 'I've checked, and the timebase waveform is quite clean. That's a real negative time effect.'



'Don't you see the implications of this? When I've modified the circuit a bit, to slow everything down, I can get from a millisecond, to a second, to a minute, and maybe to hours. Then all sorts of things will be possible, from TV cameras at airports or railway stations to record accidents before they actually happen so that they can be prevented, to letting me, before I tell anyone else about it, make a few millions on the pools or the stock exchange. Meanwhile, I'm afraid that I shall have to keep the details of my actual circuit pretty confidential. After all, we wouldn't want details to get out before I'd finished the design, would we.' And with that, he took me by the elbow, and gently, but firmly, piloted me out of the room.

★ ★ ★

Downstairs, over a cup of coffee, I explained Fred's latest scheme to Peggy, and apologised for my unsympathetic attitude to Fred's discoveries. 'I'm afraid,' I added, 'that there are much more plausible explanations than time travel for the knots he has got in his timebase.'

'You know, he's made things much more difficult for himself by starting with an old TV with a magnetic deflection system, simply because he happened to have one in his junk pile. In any case, if he wants a better 'scope than that old museum piece of his, why doesn't he buy himself one. It isn't as though he can't afford it. Especially since I'm sure his accountant would allow it as a legitimate business expense.'

Peggy agreed, but gave me a thoughful look. 'Never mind,' she said, 'it's keeping him busy, and he's happier than he's been for months.'

I called at the shop, from time to time over the next few weeks, so that Peggy could give me periodic progress reports on the development of Fred's invention. 'He's got his time advance up to several seconds now' she observed, a week or two later. 'He's organised it so that photocells stuck on the TV screen trigger relays as the spot passes by them, and he's got them connected so that they can switch on other things, one before the other'.

'I don't really understand the technical bits, but I think that what he is now trying to do is to connect up another TV, with the same kind of electronics, so that the first will switch on the timebase of the other before it has itself started, and that then switches on the first, and so on, building up quite a big time advance.'

'Then', she continued, 'you close a contact to get the first one going, and you choose whichever of the relays you want, depending on how far into the future you want to go. Fred says that if you had enough TVs you could get as big a jump into the future as you wanted.'

'Of course,' she said, 'he's only got two TVs to play with at the moment - I've refused to let him have our colour telly in the living room - and so, until he gets things organised, he can't make his time jump get very far. Do you think we could help him a bit?'

'I'm afraid that my problem here, ' I commented, 'is that I think that the whole scheme is just a load of eyewash, which means that I wouldn't be very enthusiastic as a collaborator. Besides which,' I added, 'I don't really think he'd let me in his workshop at the moment'.

'Neither do I,' grinned Peggy, 'that wasn't what was in my mind. I don't honestly have any more faith in Fred's latest invention than you do, after all, we've been this way before, but it keeps him happy, and I'd like it to last till Christmas';.

'What he was telling me, last night, was that he was going to fix his gadget in series with the shop door bell, so that he can see on the closed circuit TV system who is going to come into the shop before they actually do. Then if he can get that working properly, he'll try getting a bit more ambitious.'

'Well, yes, that seems a fair enough test, so far, but where do I come in?' I asked. Peggy gave me a conspiratorial grin, and continued. 'At the moment, as you know, we don't actually have a contact on the door. Fred got fed up with the bell ringing continually if someone left the door ajar, and so what we have is a pressure switch under the door mat, which works when someone stands on it. What I'm wondering is whether we couldn't move it forward a bit, or perhaps have some kind of photocell system which I could move along, forwards or backwards, depending on whether Fred thinks he is making progress.'

★ ★ ★

I looked at Peggy with new eyes. This was a degree of skullduggery of which I had never previously thought her capable. 'All right', I said, 'I'll help, but what's the long term intention?' — at which Peggy explained.

The necessary electronics for a reflex photocell system, which was not too conspicuous; and which Peggy could slide along a side window, which looked out on the passage leading to the shop door, were not too difficult to organise, and, on occasions over the following week or so, you might have noted Peggy and me in the kitchen poring over catalogues and specification sheets.

For a while, Peggy's plan to keep Fred happy, even if his progress was more illusory than actual, worked quite well, but about a week before Christmas she reported that he was beginning to have doubts about his invention, and to feel that, perhaps, he might be on a wild goose chase. Still, she thought he might not give up quite yet, since he had, last night, thought of yet another scheme for organising his TV timebases which might just do the trick.

On Christmas Eve, which was a Saturday, Fred was feeling particularly optimistic, and happily accepted the suggestion that he should fix his closed circuit TV camera so that it would look right down the street. A mid-morning phone call alerted Peggy, and I, as look-out, signalled to Peggy when to ring the door bell. 'It works, it really works,' shouted Fred, as he dashed down the stairs — just in time to see the delivery man make his pre-arranged, second walk up the street, and hand Fred a fairly heavy parcel.

'Happy Christmas' said Peggy, and pointed to the photocell system in the window, and to her fellow conspirators. 'I'm afraid that they had to give a bit of help to your 'future machine' but I think that the 'present' looks OK.' -and watched as Fred, with a mixture of astonishment and delight, unwrapped a shiny, new, twin beam, DC to 20 MHz, 1 mV sensitivity, storage oscilloscope.

'Now you'll really be able to sort out the kinks in your timebase waveforms ..... that is if you still want to continue in the DIY oscilloscope trade.' said Peggy, as Fred poked buttons and twiddled knobs with a grin like a Cheshire Cat.

You know there are times when I wonder whether I have misjudged the old codger. As I said, all of this happened some years ago, and had largely passed out of my mind.

What reminded me was the occasion, just a few days ago, when I'd called in his shop to pick up some transistors he'd ordered for me, and Fred said that since it was coming up to Christmas, if I could find anyone interested in buying a 14 inch Black and White telly, partially converted for use as an oscilloscope, I could have another one, as a present.

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THE FAST ONE

It could be a GaAs, man, but we're not likely to see much gallium arsenide around outside of LEDs for quite a while yet. Stuart Smith investigates the wonder semiconductor.

To appreciate how Gallium Arsenide (GaAs) devices work, and why they are superior in many respects to silicon-based devices, it is necessary to understand some of the fundamental physical properties of semiconductors. At the risk of covering already well-known territory, the next few sections will cover some of this ground.

Energy Bonds

It's a fact of life that electrons in an atom can have only certain energies. When the atoms are bonded together to make a crystal, the electrons can have energies within certain allowed bands, which may overlap. The 'band structure' (Fig.1) of solids determines whether they are conductors, semiconductors or insulators.

Electrons with energies within the valence band are attached to particular atoms in the crystal. They cannot move through the crystal and contribute to conduction. Electrons in the conduction band have sufficient energy to escape the attraction of the nucleus and can move through the crystal under the influence of an applied electric field.

Band Gap

The basic difference between insulators, semiconductors and conductors is the *size* of the energy gap between the valence and conduction bands, because this governs how easy it is for an electron to enter the conduction band. In metals the bands overlap - there are always conduction band electrons available, so metals are good conductors.

In insulators the gap is so wide (over 3 or 4eV) that virtually no electrons enter the conduction band at reasonable temperatures.

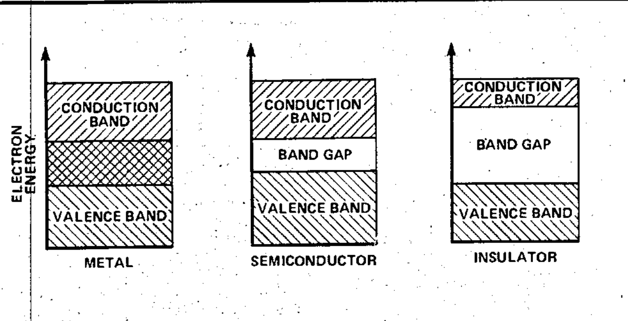


Fig.1 Energy band diagrams.

In a semiconductor the band gap is about 1 eV, which leads to a resistivity midway between insulator and conductor. At absolute zero temperature (-273°C) the valence band is completely filled and the conduction band empty. At higher temperatures some electrons gain sufficient energy from the thermal vibrations of the crystal to leave the valence band and jump into the conduction band. The number of conduction band electrons is exponentially related to temperature.

There are several elements and alloys with band gaps in the 1 eV region but for various reasons not all of them are suitable for electronic devices. Table 1 shows the important electronic properties of Germanium (Ge), Silicon (Si) and GaAs. Some of these properties are discussed below.

Excitation And Recombination

It's possible to raise the energy of an electron in a crystal by several methods: heating it, shining a light on it or applying an electric field to it. When an electron is excited from valence to conduction band it leaves behind a vacant energy level (or state) called a hole. The hole behaves like a positive charge.

Electrons do not stay in the conduction band for ever: they naturally 'fall back' into the valence band - but they must fall into a hole. This process is called recombination, and it releases energy, the energy the electron originally gained to enter the conduction band. The energy may be released as heat, light or both, depending on the type of material.

Doping

To make useful electronic devices, it's usually necessary to control the conductivity of the materials by altering the number of holes and electrons in the material which are available for conduction. This can be done by adding small quantities of other materials called 'dopants' to the pure (intrinsic) semiconductor. If the dopant adds electrons, it is a donor and the resulting semiconductor is called n-type. If it adds holes it is an acceptor and the semiconductor is p-type.

Temperature

The relatively high bandgap of GaAs means that at normal temperatures (-20°C to 100°C or so) the amount of free carriers (electrons or holes) is minimal compared with those introduced by doping. This is still true at high temperatures. Some GaAs devices are usable at up to 400°C and most will work at temperatures between -200°C and 200°C. The range is much wider than for silicon devices.

Mobility

When subjected to an electric field, electrons accelerate towards the most positive point. In a crystal this does not continue forever, as the electrons eventually collide with the crystal atoms. Collisons may even cause the electrons to reverse direction. Overall the electrons can be said to reach a mean or drift velocity which is constant and proportional to the applied field. The ratio of electron speed to applied field is called the electron mobility, and it is much higher in GaAs than in silicon. Electron mobility governs the switching speed of transistors and GaAs devices are therefore much faster than their silicon counterparts. There is a limit to the drift velocity attained as the applied field is increased, but this limit is higher in GaAs than in silicon.

Photoconduction And Photoemission

A quantum of light energy (a photon) can, if it has the right frequency, transfer all it's energy to an electron and cause it to jump into the conduction band. The relationship between photon frequency and energy is:

E=hv, where
E is energy in Joules (J) ($1 eV = 1.6x10^{-19}$J),
h is Planck's constant, $6.63x10^{-34}$Js,
v is light frequency in Hertz.

Below a threshold frequency, $v_{th} = E_{gap}/h$, the electrons cannot gain sufficient energy to cross the band gap and will not be excited. At a frequency greater than v_{th} the light will cause excitation and generate electron-hole pairs, so the conductivity of the material will increase with light level. Cadmium Sulphide (CdS) has a band gap of 2.42eV which gives it a response to light similar to that of the human eye. Other semiconductors respond well to infrared or lower frequency electromagnetic radiation.

Light Emitting Diodes

As we have seen, electrons eventually recombine with holes, giving up their energy as heat or light. Recombination in Si produces mostly heat. In GaAs, recombination gives off light in the infrared. By adding Phosphorus (P) to the GaAs the band gap is increased and the emission moves towards the blue end of the spectrum. GaP LED's emit green light.

An LED is a junction between p and n type GaAs (or GaAsP, or GaP). In the bulk of the diode, away from the junction, there are a lot of free carriers (Fig.2a). Application of a forward bias voltage (Fig.2b) makes it easy for electrons to leave the n region, cross the junction and enter the p region. Here there are many holes, which recombine with the electrons. The holes are continually replaced by fresh ones at the diode anode so the current flow, recombination and light emission continue as long as the forward bias is applied.

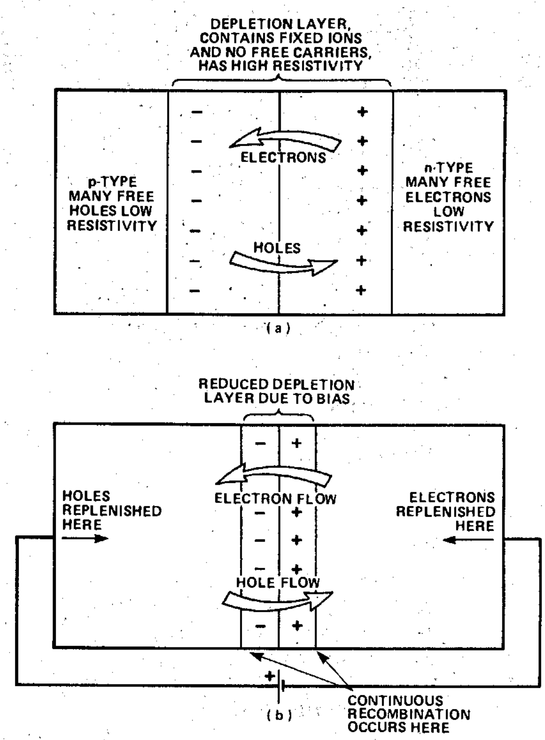
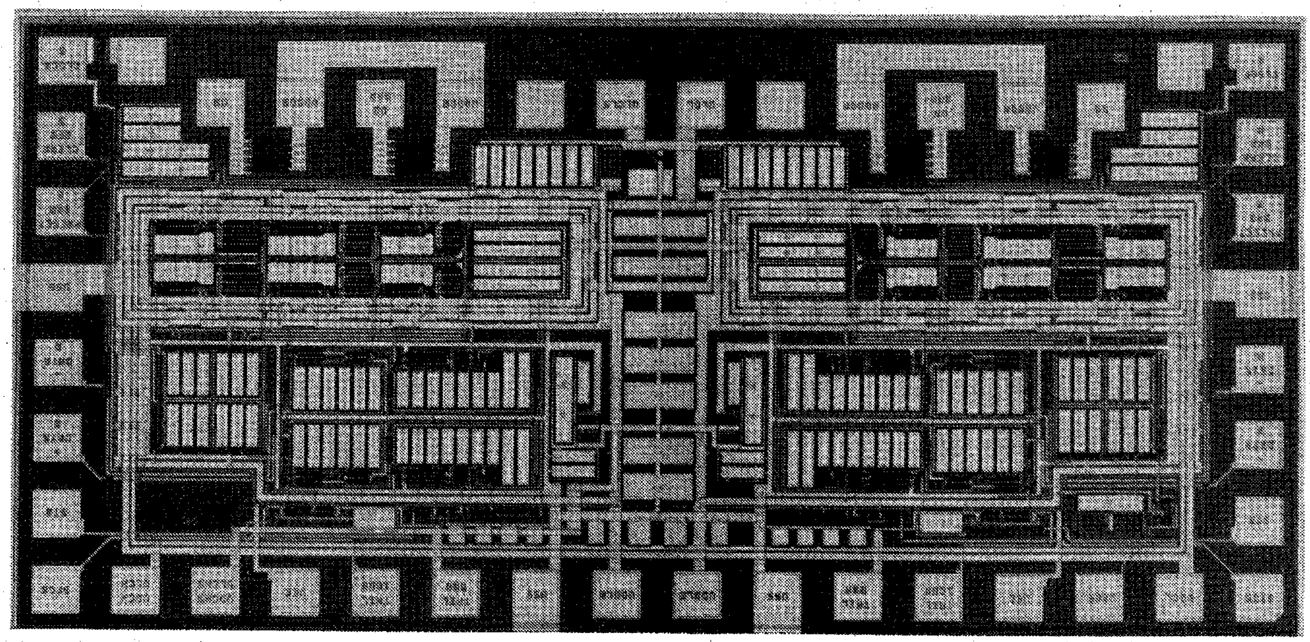


Fig.2 PN junction with no bias applied (a) and with forward bias (b).

Semiconductor Lasers

The semiconductor laser is a device of great importance in modern communications. Fiber-optic data transmission using a semiconductor laser as the light source allows the transfer of huge quantities of information over large distances at great speed.

To use an optical fiber at high speed over an appreci-



Gigabit logic — a dual precision D-Latch operating at 1GHz (Pronto Electronic Systems Ltd. Ilford).

able distance (say several kilometers), a number of conditions must be satisfied:

1. The laser light must be capable of being modulated at a high rate;
2. The light must be of a single frequency to avoid spreading of pulse edges;
3. The light must be very intense to allow large spacings between repeaters (which pick up weak signals, amplify and retransmit them);
4. The light source must be very efficient, for low cost and power consumption.

Semiconductor lasers fulfil all these requirements.

The basic principle of the laser is quite simple. We have already seen that electron-hole recombination releases energy. In most cases recombination occurs randomly and spontaneously. Any photons given off in the process are in random phase with one another. The light so produced is said to be incoherent.

The presence of photons of the wavelength corresponding to the band gap energy can cause recombination, accompanied by emission of light. This 'stimulated emission' is in phase with the photon which caused the emission. The light amplitudes add in phase and the resulting light is very intense and coherent (Fig. 3).

We also know that photons can be absorbed by the material, causing the electrons within it to be excited into the conduction band. In order for there to be a continuous output of coherent light, two conditions must prevail.

1. There must be a high density of photons in the material, so that more stimulated than random emission occurs;

2. There has to be an electron 'population inversion' — a greater number of electrons in a high-energy state than a low-energy state. This ensures that more emission than absorption takes place.

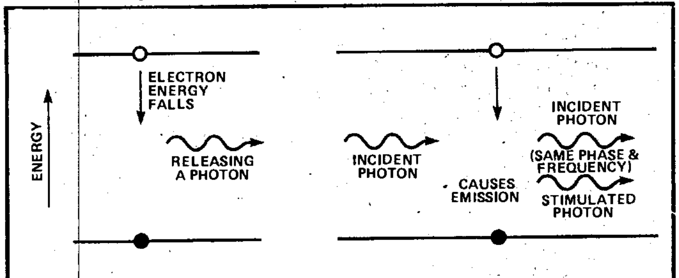


Fig.3 Spontaneous and stimulated emission of radiation.

The first requirement is met by creating an optical resonant cavity — simply a bar of material with mirrored faces so that the light intensity builds up within the cavity by repeated reflections.

Population inversion occurs in the semiconductor junction's depletion layer. It is called the depletion layer because it usually lacks carriers (holes or electrons). At high currents, however, it is far from depleted. There is a continual stream of high-energy carriers being injected into the junction and swept away. Over a short distance in the junction there can be more conduction than valence band electrons.

The basic structure of a GaAs/GaAlAs injection diode laser is shown in Fig. 4. The laser action takes place at the junction between the p'GaAs and the n-GaAlAs (gallium aluminium arsenide). The regions immediately adjacent to these perform two functions:

1. They confine the light to a narrow region because they have different refractive indices to the junction materials;

2. They keep the volume within which population inversion takes place small, so reducing the threshold current at which laser action begins. The effect occurs because the band structure of the materials forces the carriers to recombine in the narrow region near the junction.

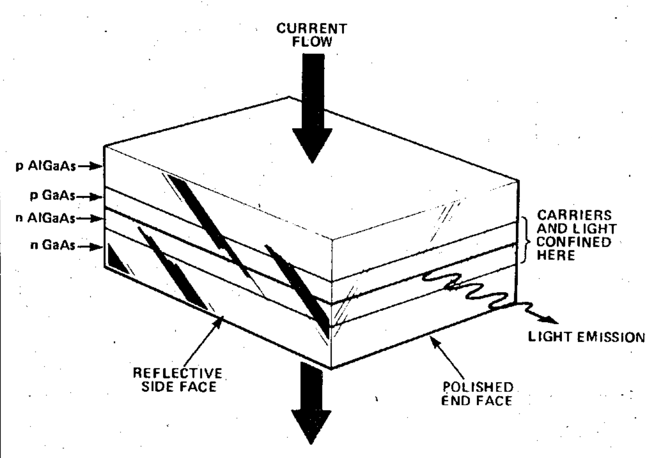


Fig. 4 Simplified diagram of GaAs/GaAlAs diode laser.

For optical fiber communications the GaAs/GaAlAs laser is being replaced by a GaInAsp (gallium-indium-arsenic-phosphide) diode on an InP substrate. By adjusting the relative quantities of Ga, In, As and P in the diode it is possible to adjust the band gap so that the emitted light has the wavelength at which the fiber is most transparent. By the same means the lattice constant (the distance by which atoms are separated) can be adjusted independently of the band gap. This allows the growth of diodes directly matched to the InP substrate.

The present aim is for systems using 1.5 to 1.65 μm radiation modulated at 2 Gigabits/sec. With the latest optical fibers signals may be sent up to 100km without repeaters.

The Gunn Diode

The Gunn diode is a two-terminal device used in microwave oscillator circuits. It has a variety of different modes of operation, but its basic principles can be understood with reference to resonant circuits.

A common LC circuit, when stimulated by step input voltage, will oscillate at a frequency $f=1/(2\pi\sqrt{LC}$.) The oscillations will die away exponentially, however, because of resistive losses (damping) in the circuit, (Fig. 5a).

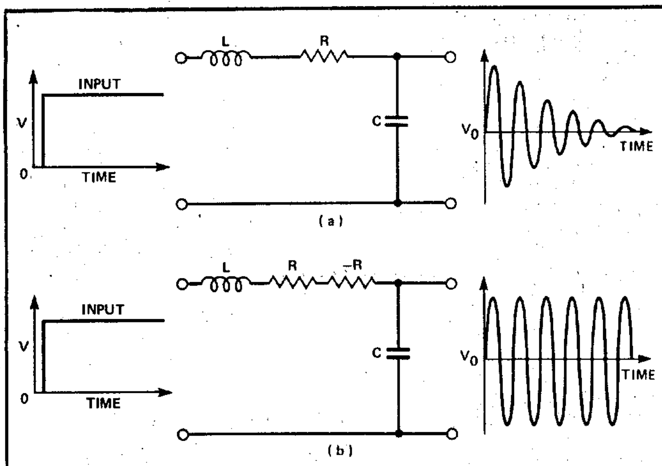


Fig.5 LC oscillator with damping (a) and with negative resistance applied (b).

In most oscillators, these resistive losses are compensated for by feeding back an amplified version of the output to the input in such a way as to sustain the oscillation. Another approach is to use a device which exhibits negative resistance over part of its I-V charactersitic (Fig. 5b).

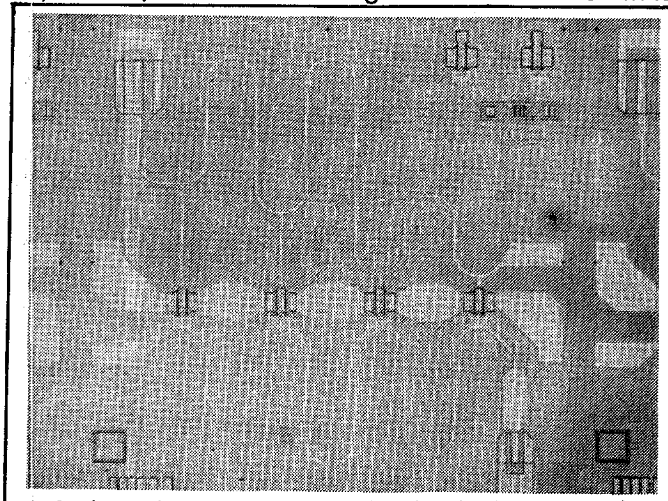
A real negative resistance would be very valuable! In practice, we find some devices for which a small increase in applied voltage causes a small decrease in current flow (Fig. 6). Strictly speaking, they have negative differential resistance and a suitably doped piece of GaAs exhibits this property due to its band structure.

Electrons in GaAs can be excited into the conduction band by an applied field. Up to a certain threshold field (about 3kV/cm) the electron drift velocity increases with field strength, since the mobility is constant. Above the threshold field the electrons gain sufficient energy to reach part of the conduction band where their mobility is much smaller because of the increased probability of collisions. The conductivity of the GaAs drops. Small increases in field cause more electrons to enter the low-mobility region and the current falls — this is the negative-resistance region. This property is utilised in Gunn diodes and makes the devices useful for circuits of the form shown in Fig. 5.

The Gunn diode (named after J.B. Gunn who discovered the principle of producing microwaves by the application of a steady voltage in 1963) is formed from a single section of n-type GaAs. The GaAs is unevenly doped so that, with the application of a suitable voltage, both high and low mobility electrons are liberated. The crystal becomes partitioned into areas of different-intensity electric field. In the negative-resistance region of operation, the existence of a highest-intensity area, in which electron density is greatest, will cause an increase in current flowing into the area and a decrease flowing out of it. The domain of high-intensity charge builds-up and is eventually attracted to the anode end of the GaAs crystal. It travels through the crystal, a packet of charge not altogether unlike a spark bridging two electrodes in the air, producing a spike of current at the anode. The process repeats itself, generating a microwave output which has reached 65mw at 2GHz continuous and up to 200w pulsed.

Transistors And ICs

Although GaAs transistors for microwave applications have been available for some time, the development and production of integrated circuits is still in its



Surface of microwave GaAs chip (GEC Hirst Research Centre).

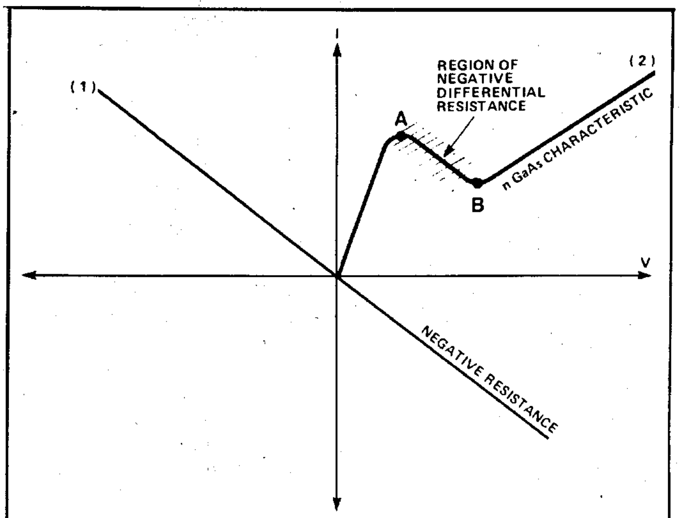


Fig.6 Negative resistance characteristic of doped GaAs.

infancy — commercial ICs have only been on the market since early 1984.

GaAs integrated circuits are difficult to make: the raw material cost is high, defect-free wafers (circular slices of single-crystal semiconductor) are hard to obtain and the processing of them is difficult (Fig. 7). To take full advantage of the speed of GaAs, the devices need to be very small, stretching the limits of current technology. In addition, the wafers are brittle and have to be handled more carefully than silicon.

On the other hand, GaAs devices promise higher speed than silicon at lower power levels, which should allow higher levels of integration before heat dissipation becomes a problem. As yet only MSI devices have been produced in commercial quantities.

Most of the work currently being done on GaAs integrated circuits concentrates on ultra-high speed digital circuitry. Results so far indicate that GaAs devices may rival superconductor Josephson junction devices for speed — and, more importantly, they are available now and developing quickly. Current commercially available logic circuits feature gate delays of around 300ps and maximum counter clock rates of around 2 to 3GHz.

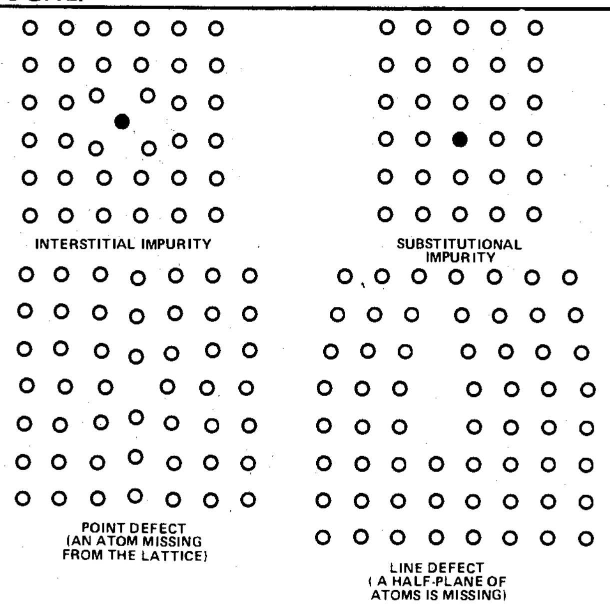


Fig.7 Some defects in crystal structure capable of causing device deterioration.

It is useful to look at what makes an ideal transistor switch for digital integrated circuits. It should be small, so that large circuits can be fabricated in a small space. This reduces the likelihood of encountering a wafer defect and so increases the yield. It should consume very little power, so that heat dissipation at high circuit densities does not become a problem. It should require very little voltage change between the on and off condition. This reduces the switching time as less charge has to be put on to or removed from internal capacitances during switching. Finally, its control input should have low capacitance, again to reduce switching time.

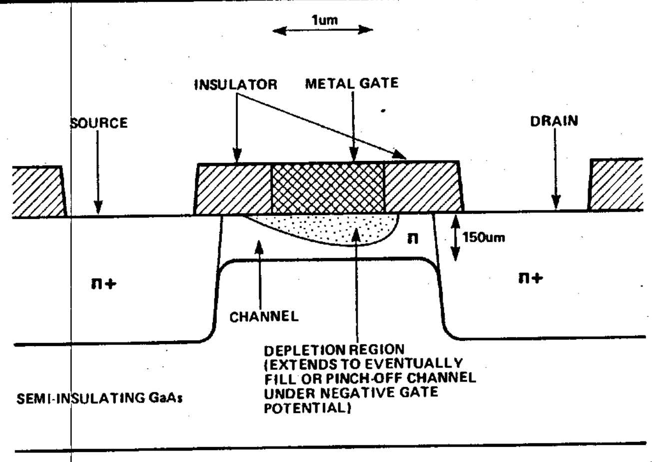


Fig.8 Cross-section of D-MESFET (not to scale).

Most current GaAs integrated circuits use depletion-mode metal-semiconductor field effect transistors (D-MESFETS), as these are the easiest devices to produce (Fig. 8). Unfortunately a negative gate voltage is required to turn these devices off, while the output is positive (Fig. 9). They require two power supplies (plus earth), and level shifting circuitry between circuits (Figs. 11, 12 and 13).

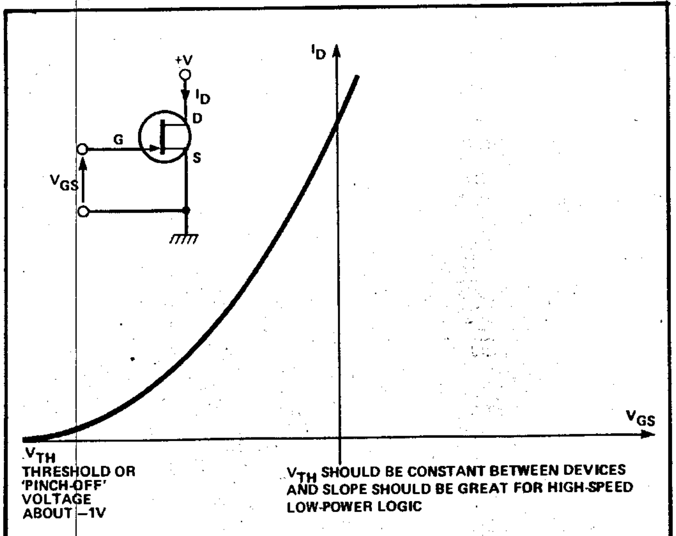


Fig. 9 Id against Vgs for a D-MESFET.

Enhancement-mode FETs (E-MESFETs) have been produced, but they are not yet at the mass production stage. Their construction is similar to that of the D-MESFET but the channel is very shallow and lightly doped so that the built-in potential of the metal-semiconductor junction keeps the channel pinched off with no external gate bias. Thus the E-MESFET is normally off. It requires only about 0.1V gate potential to turn on. This is a definite advantage for high speed and low power circuits, but requires very tight control over processing in order to keep the threshold voltages within a very narrow range, or else the devices become overly susceptible to noise. E-MESFETs are also difficult to fabricate as the channel is very lightly doped and surface defects can easily pinch off the channel — various structures and geometrics are being tried to avoid this.

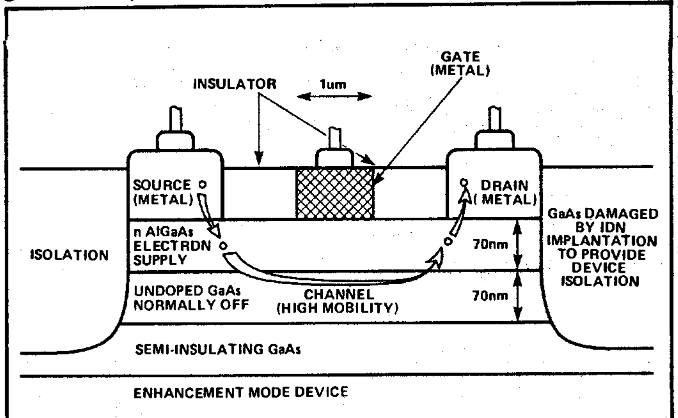


Fig.10 Cross section of High Electron Mobility Transistor (not to scale).

Other devices under development include the high-electron mobility transistor (HEMT) (Fig. 10) and the heterojunction bipolar transistor (HJBT). Up till now I have only mentioned field effect (unipolar) transistors. An NPN sandwich made entirely from GaAs does not work well as a transistor, partly because holes, which are the dominant carriers between base contact and active base region, travel rather slowly in GaAs. A much better transistor can be made with an n-GaAas emitter and a p-GaAs base. Work on the HJBT is not as far advanced as on the various FETs, but it could be the best device for very high speed VLSI. Single-transistor switching speeds of 1ps and logic swings of 250mV have been predicted.

The current dominant technology is the D-MESFET. Several logic structures are in use, just as silicon bipolar circuits are available in TTL, LSTTL, I²L and ECL. Buffered FET Logic, Schottky-Diode FET Logic and Capacitor-Diode FET logic gates are illustrated in Figs. 11. 12 and 13.

Even after a GaAs circuit has been produced, the problems are not yet over. To preserve reasonable pulse-shapes at, say, 1GHz, circuits have to deal with frequency

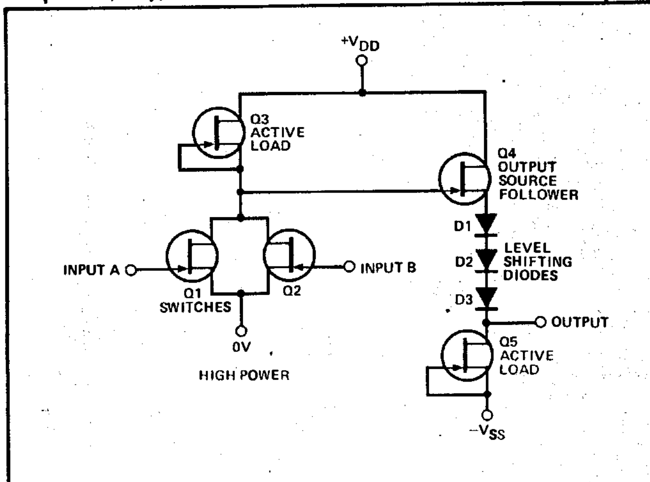


Fig.11 Buffered FET logic (BFL) NOR gate.

components up to 3GHz. The digital designer will have to utilise microwave design techniques such as impedance matching of chips to interconnections to avoid pulse reflections. Supply decoupling becomes vastly important, and the capacitors used have to behave properly at GHz frequencies. Testing is likely to become another large (and expensive) headache.

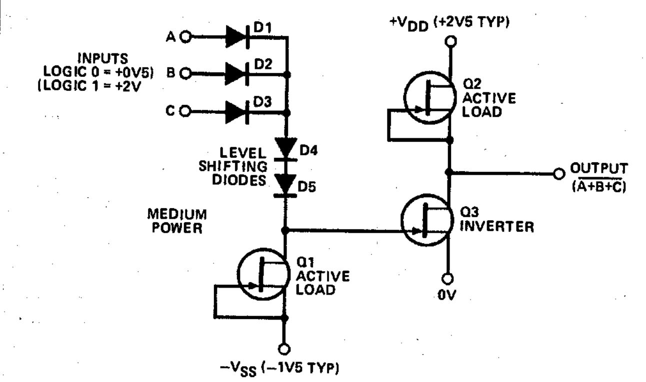


Fig.12 Schottky-Diode FET logic (SDFL) NOR gate.

The Market

The major semiconductor manufacturers have, on the whole, stood back and waited to see where GaAs is going — after all, the market for high speed bipolar and MOS devices is not going to go away just yet. Also, there is a world shortage of engineers qualified to develop GaAs devices. This is probably a good reason for not spreading them too thin on the ground.

In this country there are only a few suppliers of commercial GaAs integrated circuits. GEC's Hirst Research Centre has produced several microwave amplifier chips with DC-12GHz response, and they are developing higher frequency and higher power circuits.

The two major UK suppliers of GaAs logic circuits are Harris Semiconductors and Gigabit Logic. Both have a range of small scale integrated circuits (NOR gates, D-types, dividers and, for example, shift registers), which work at around 1 to 4GHz clock rates. Harris also market a range of discrete GaAs FETs for use at up to about 18GHz. They have also released preliminary data on a 170-gate array. Both companies sell an evaluation kit for their ICs.

The Future

Future markets for GaAs integrated circuit include the Direct Broadcast by Satellite system, very high speed computers, optical communication and phased array radar. As for the future of the technology itself, researchers at Glasgow University have produced tiny MESFETs with only 75nm wide gates, while Sheffield University has demonstrated an all-optical switch in GaAs/GaAlAs which holds promise for all-optical logic (which may be very fast, indeed). Inevitably GaAs development will be largely determined by the military value attached to high-speed temperature and radiation resilient devices. The rest of us will have to wait to savour the benefits of this remarkable material.

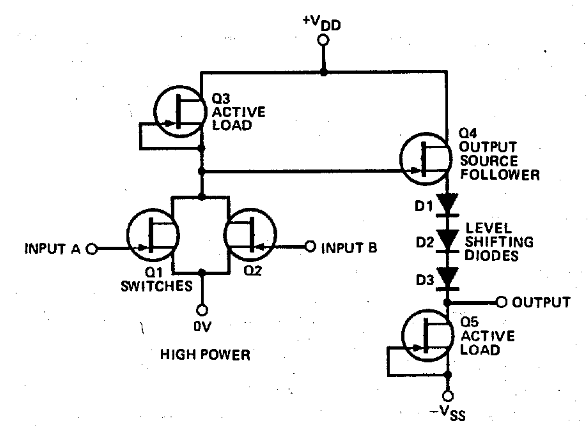
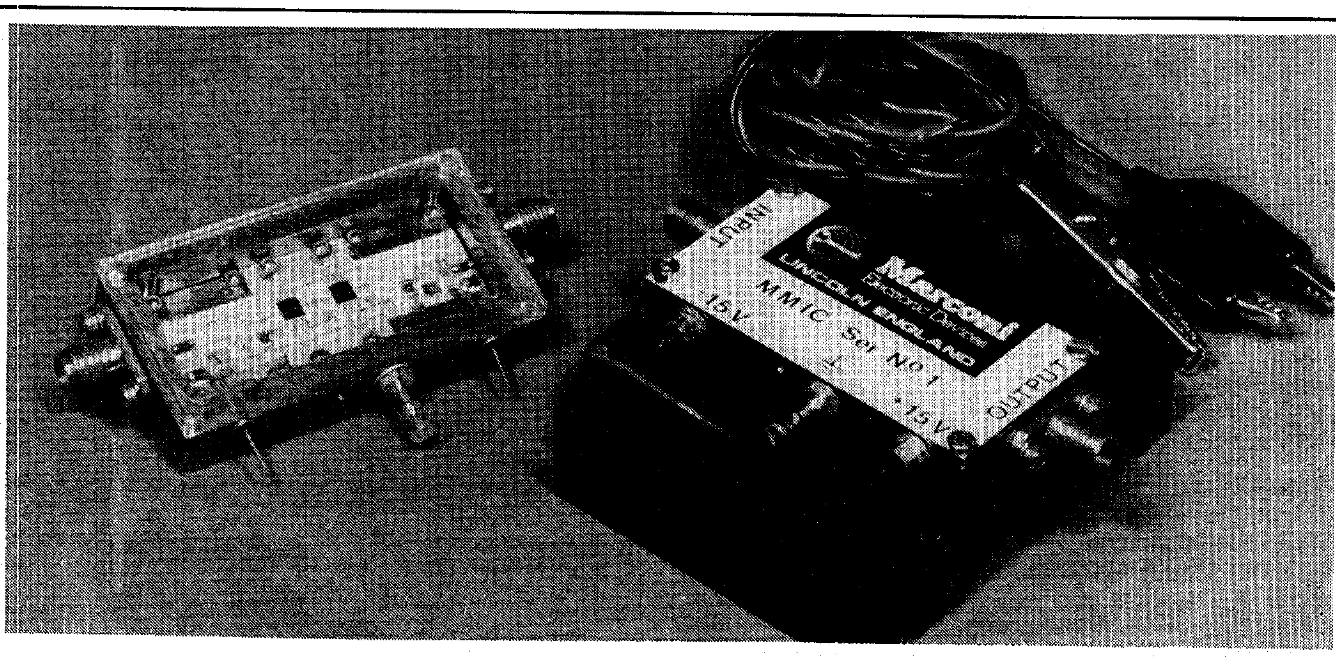


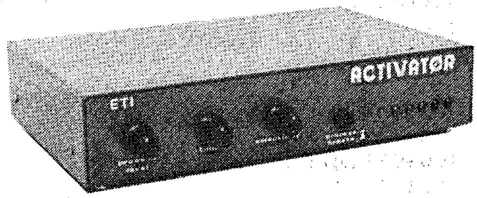
Fig.13 Capacitor Diode FET logic (CDFL) NOR gate.



Microwave amplifier device (GEC Hirst Research Centre).

ETI

THE ETI ACTIVATOR



Ultra-fi buffs should be prepared to have their illusions if not their best crystal glass-ware shattered as the second in our series of sound-processing units excites the airwaves and the eardrums, courtesy of Allan Bradford of Time Machine Sound Engineering.

Aural 'Exciters' have been around for some ten years. They have been used almost universally by up-market recording studios to improve the perceived clarity of recordings, giving an extra edge to their products. Since the idea of aural enhancement was first promoted by Aphex, much mystique has grown to shroud the technique — not surprisingly, because the promoters knew they were on to a good thing. In fact, this technique, which 'miraculously' cleans up dodgy recordings and adds sparkle to good ones, is astonishingly simple.

The Sound In Your Head

Psychoacoustics is the study of the perception of sound. The brain seems to rely on high order harmonics for much of our perception of detail in complex sound structures. These harmonics, being of low amplitude, are the first to be lost in recording due to noise and poor high frequency response.

If there was a way of restoring these low level, high order harmonics, then much of the original clarity and detail of the recorded sounds would be recaptured. Improbable? Right. So let's cheat, and — surprise, surprise — we have the technology!

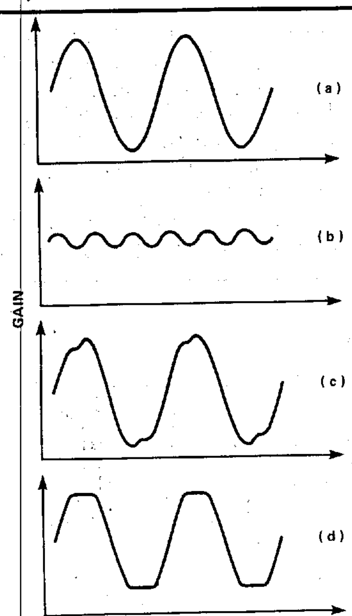


Fig. 1 Harmonic generation.

Harmonic Generation

Imagine that the sine wave of Fig. 1a is mixed with a small amount of third order harmonic (Fig. 1b). The result is shown in Fig. 1c. Fourier symmetry tells us (as we physicists say) that we could bend a pure sine wave using some non-linear network to resemble the waveform of Fig. 1c, in effect creating a third order harmonic component added to the fundamental. There is no theoretical problem with complex sounds, since any waveform can in principle be reduced by Fourier analysis to component sine waves.

Now, we can bend a sine wave quite easily. Simply clipping it as in Fig. 1d will generate harmonics — the heavier the clipping, the more harmonics are produced (the more it approximates a square wave). The amount of clipping and consequent harmonic generation are very much dependent on signal level. In the Activator, a sophisticated system is used so that the 'bending' is like that of Fig. 1c and is independent of signal amplitude.

Doing it With Frequency

But wait a minute. What we are talking about is severe distortion, isn't it? And distortion is the last thing we want in quality audio.

Well, yes and no. The difference between aural enhancement and mere distortion is one of degree and frequency, to coin a phrase. Firstly, clipping a sine wave is rather severe and generates very large amounts of harmonics. Secondly, the effect we seek only works at high frequencies. Thus the signal must be high pass filtered so that only frequencies above a few kilohertz are 'bent'. If you apply harmonic generation to the whole spectrum, the result just sounds like distortion. Also, the amount of harmonic generation must be kept low. Only then does the whole effect come to life.

This may all sound very strange on paper and if you aren't convinced, the only answer is to hear a unit in action. When an Activator is switched out, the result of suddenly hearing the original recording in an unmodified state is like putting a bag over your head. Once you've heard the difference you won't be able to live without it. It will do wonders for all your records and tapes, revealing details you never knew existed.

When recording individual instruments or voices the Activator will create a sense of presence in a way that old fashioned presence controls never could. The frequencies which are 'activated' also happen to be those which carry most stereo information — so a stereo unit like the Activator enhances the stereo effect, too.

Dolby And Son

It's worth mentioning the beneficial effects the Activator will have on muddy sounding cassette tapes. If there is no treble in the recording, then boosting the treble band with a graphic equaliser will achieve nothing but the amplification of tape hiss. Aural enhancement, however, does not require treble to be prêsent since it uses upper mid-frequencies to synthesize new high frequencies. This basic difference sets aural enhancement apart from any simple form of equalisation.

Dolby B was invented when the quality of cassette tape was very poor. The noise reduction it afforded made listening acceptable. Now cassette tapes are very good indeed and Dolby is (arguably) redundant since all it seems to do is kill the top treble end of your recordings. In fact, many people record tapes with the Dolby on to act as a treble boost and then play them back with the Dolby switched off. If you play tapes back through the Activator you can leave the Dolby on, taking advantage of the noise reduction without sacrificing prized high frequencies.

Active Design

A practical system is shown in block diagram form in Fig. 2. Notice that after the harmonic generator the resulting signal is mixed in antiphase with the signal emerging from the filter so as to cancel out the fundamental, leaving only the newly synthsized harmonics to be added in the desired proportion to the output. There is very little change in overall signal amplitude when the harmonics are added. In the Activator, there is also a very slight reduction in high frequency level as the PROCESS control is advanced, which keeps the subjective volume constant.

The high pass filter used in the ACTIVATOR is voltage controlled with a 12dB per octave roll off below a centre frequency which is variable between 2kHz and 8kHz. It also has variable resonance or SELECTIVITY. It is possible to tune and emphasize particular frequencies within the signal to be processed.

The Activator is designed so that whatever size signal you put in, the same size signal is output. Harmonic enrichment maintains the correct proportions. The relative level of different order harmonics is determined by a time constant rather than by signal amplitude, avoiding the use of separate 'Drive' and 'Mix' controls as on most existing designs. These interact and their combined effect is largely to make the display function correctly.

The Activator display is designed to indicate the proportion of harmonics added to the original signal, independent of overall signal level. The display will not respond very much to signals peaking much below −10dBm but, since −10dBm is the standard domestic recording level, no problems are envisaged. The unit is equally happy with 0dBm signals.

The Ins and Outs

Line level, balanced and unbalanced inputs and outputs are standard in this family of units. Phono sockets have been added to the Activator with the domestic hi-fi owner in mind. The unit will handle signals well in excess of +10dBm before clipping, unlike some of its more prestigious and expensive cousins.

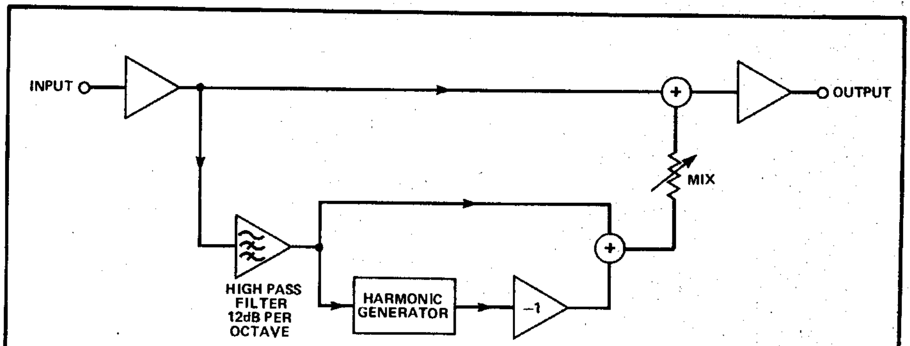


Fig. 2 Block diagram of practical enhancement arrangement.

Construction

Few problems should be encountered in using the double sided PCB. The most important thing is to ensure that all the track-linking pins are soldered on both sides of the board! Enough said. Assemble components in order of height, ensuring correct orientation of diodes, LEDs and, where appropriate, capacitors. It is a good idea to bench-test the completed board prior to bolting it into the case and wiring it to the sockets (Fig. 3).

Use

With the Activator processing a signal (left-hand LED green) adjust the PROCESS LEVEL control so that the display peaks at about half full scale. The ultimate decision must be based on your listening judgement, but remember that excessive high frequency is very easy to get used to and you only find out about it when you come back to your recordings after a break. Suffice to say that if the display is constantly in the red, you are overdoing it!

The Activator will impart an up-market, up-front quality to live sounds. In recording almost anything will benefit — dull guitars, lifeless pianos, drums and, in particular, vocals can be given a breathy and intimate quality.

The unit will also be found indispensible for cassette duplication, helping overcome the inevitable loss of quality.

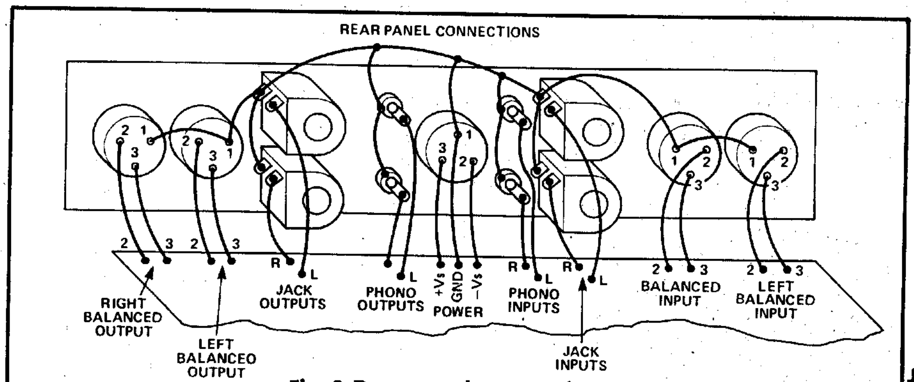


Fig. 3 Rear-panel connections.

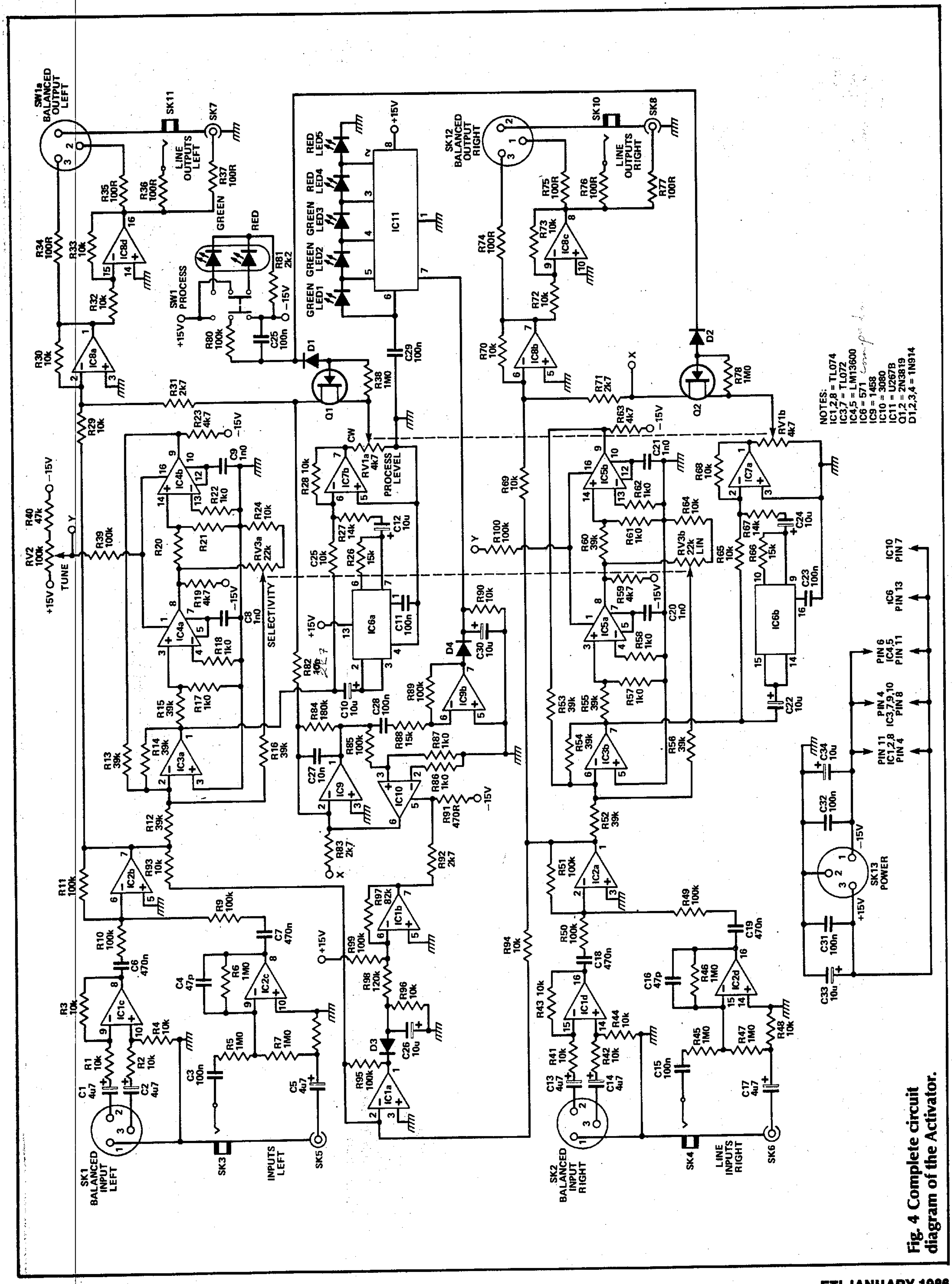


Fig. 4 Complete circuit diagram of the Activator.

HOW IT WORKS

Figure 4 is the complete diagram of the stereo circuit. Balanced, line level inputs are debalanced by IC1c and d, while unbalanced inputs are buffered by IC2c and d. The resulting signals are mixed by IC2b and a. From this point the signal is split, and is fed directly to the output drivers, IC8, and the harmonics-generating side chain circuitry.

IC3a and b are dual operational transconductance amplifiers (OTAs), IC4 and IC5, form a voltage controlled high pass filter with a 12dB per octave roll off below the centre frequency, which can be swept between 2kHz and 8kHz by the TUNE control, RV2. The SELECTIVITY control, RV3, enables the negative feedback from the bandpass output at IC4 and IC5 pin 8 to be reduced, thus peaking up the response by about 12dB around the centre frequency.

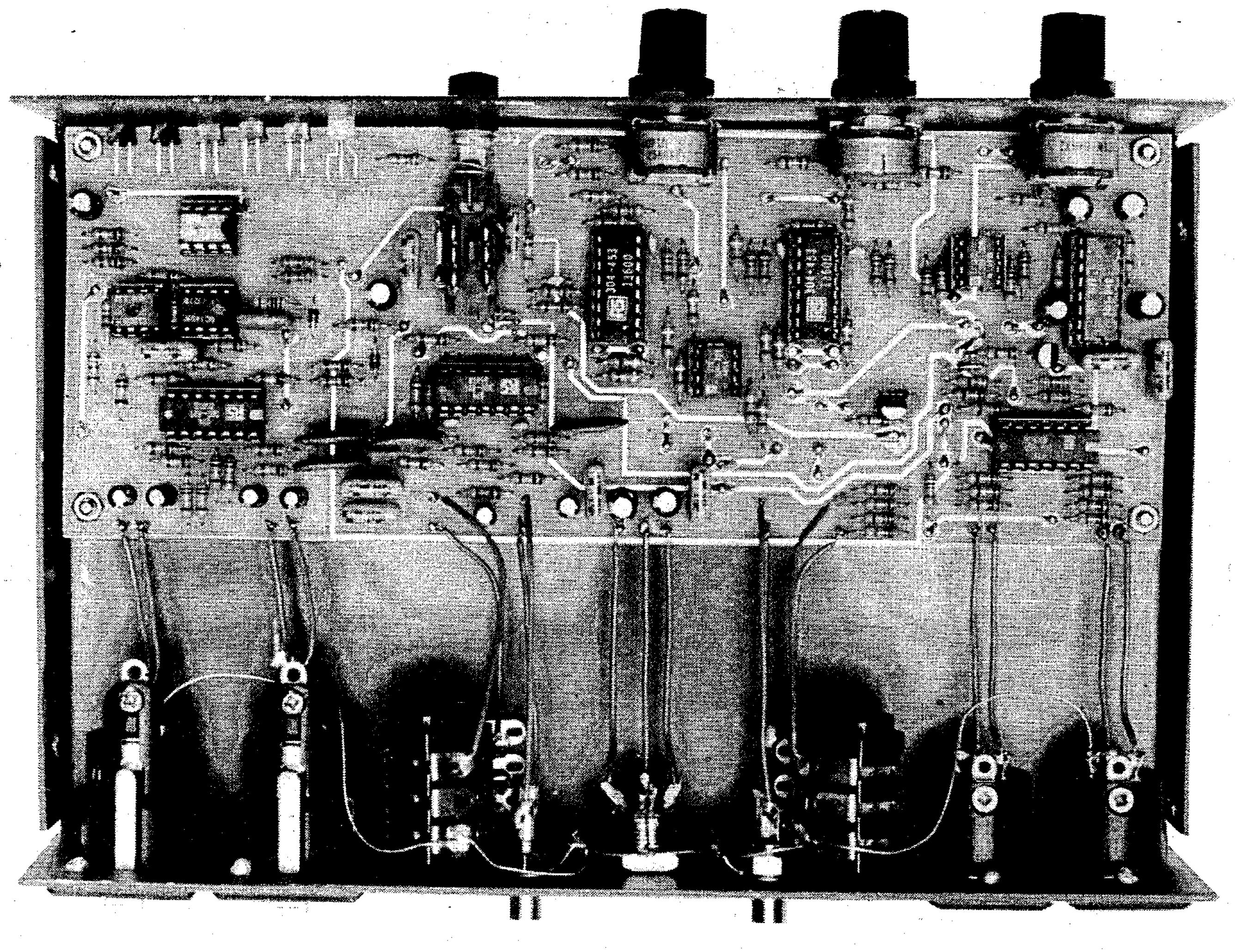
The high pass filter output at IC3 pins 1 and 7 passes to the non-linear harmonic generation circuitry. In this design the harmonics are generated by abusing a 571 compandor chip, IC6. It is provided with time constant capacitors C11 and C23 which are ten times too small. This method provides symmetrical 'bending' of the waveform which is fairly independent of signal level and is superior to other methods employing diode networks or the non-linear characteristics of OTAs, say.

The output of IC6 is inverted. Mixing it back with the filter output in the correct proportions (set by R25 and R27 and by R65 and R67) through IC7 cancels out the fundamental and leaves the harmonics which have been generated. It is these which are added to the original, unprocessed signal via the PROCESS LEVEL pot RV1.

SW1a, R80, C25, Q1 and Q2 provide silent switching to prevent clicks when the effect is switched in and out, which it will be frequently in order to make 'before and after' comparisons. The other half of SW1 switches the bottom led of the bargraph (LED6) from red (bypass) to green (process).

The rest of the circuitry concerns the display. The object of the exercise is to make the bargraph respond only to the level of the generated harmonics, rather than to the overall signal level. To achieve this an analogue divider is built around IC9a and OTA IC10. The left and right harmonics signals emerging from Q1 and Q2 are summed by IC9a but the gain of IC9a is controlled by IC10, which is in turn controlled by the level of the input signal. In other words as the input signal level increases the gain applied to the harmonics signal is reduced.

The input signal is rectified by IC1a, D3, C26 and R96 and level shifted by IC1b in order to produce the control voltage which sets the gain of the OTA. The output of IC9a is amplified and rectified by IC9b, D4, C30 and R90 and the resulting DC control voltage is fed to the bar driver chip, IC11.



Inside the ETI Activator

BUYLINES

A complete kit of parts including the fully finished steel case and associated hardware is available from TIME MACHINE Sound Engineering for £74.00 including VAT, postage and packing. The double sided, legended PCB is available separately at £9.00 and the case at £14.00. The ready built power supply in a plug costs £24.00. All prices include VAT, postage and packing. Contact: TIME MACHINE Sound Engineering, Abbotsford, Deer Park Avenue, Teignmouth, Devon TQ14 9LJ. Telephone 06267 2353.

PARTS LIST

RESISTORS (all 1% metal oxide)

R1, 2, 3, 4, 8, 24, 25, 28, 29, 30, 32, 41, 42, 43, 44, 48, 64, 65, 68, 69, 70, 72, 73, 90, 96	10k
R5, 6, 38, 78	1M0
R9, 10, 11, 39, 49, 50, 51, 85, 89, 95 99, 100	100k
R12, 13, 14, 15, 16, 20, 52, 53, 54, 55, 56, 60	39k
R17, 18, 21, 22, 57, 58, 61, 62, 86, 87	1k0
R19, 23, 59, 63	4k7
R27, 67	14k
R26, 66, 68	15k
R31, 71, 82, 83, 92	2k7
R34, 35, 36, 37, 74, 75, 76, 77	100R
R81	2k2
R84	180k
R91	470R
R97	82k
R98	120k

RV1	4k7 log pot dual
RV2	100k lin pot
RV3	22k lin pot dual

CAPACITORS

C1, 2, 5, 13, 14,	4u7 40V minelect
C3, 11, 15, 23, 25, 28, 29, 31, 32	100n polyester
C4, 16	47p ceramic
C6, 7, 18, 19	470n polycarb
C8, 9, 20, 21	1n0 ceramic
C10, 12, 22, 24, 26, 30, 33, 34	10u 40V minelect
C27	10n polyester

SEMICONDUCTORS

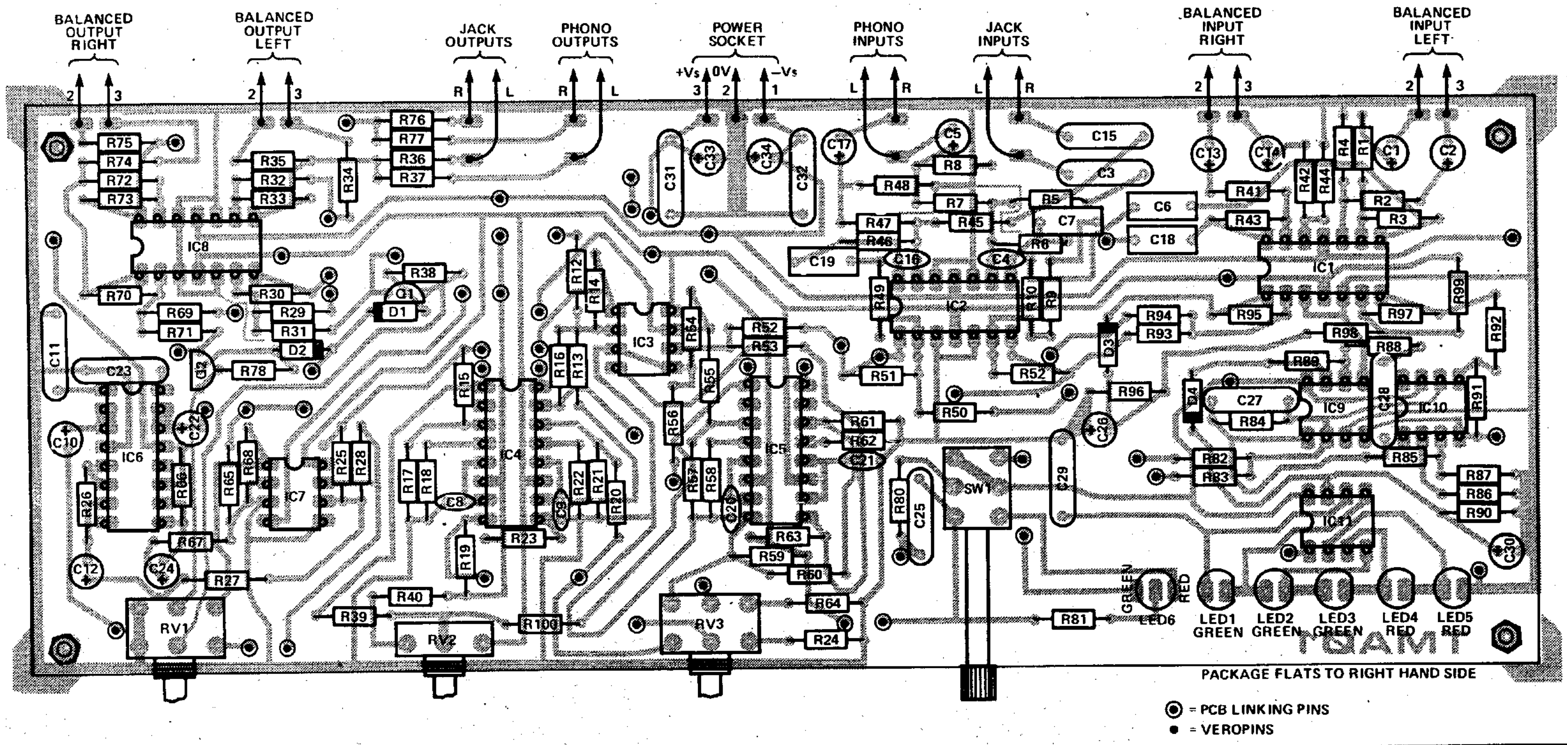
IC1, 2, 8	TLO74
IC3, 7	TLO72
IC4, 5	LM13600N
IC6	NE571
IC9	1458
IC10	CA3080E
IC11	U267B
D1, 2, 3, 4	1N914
Q1, 2	2N3819
LED 1, 2, 3	Green LED
LED 4, 5	Red LED
LED 6	Tricolour LED

MISCELLANEOUS

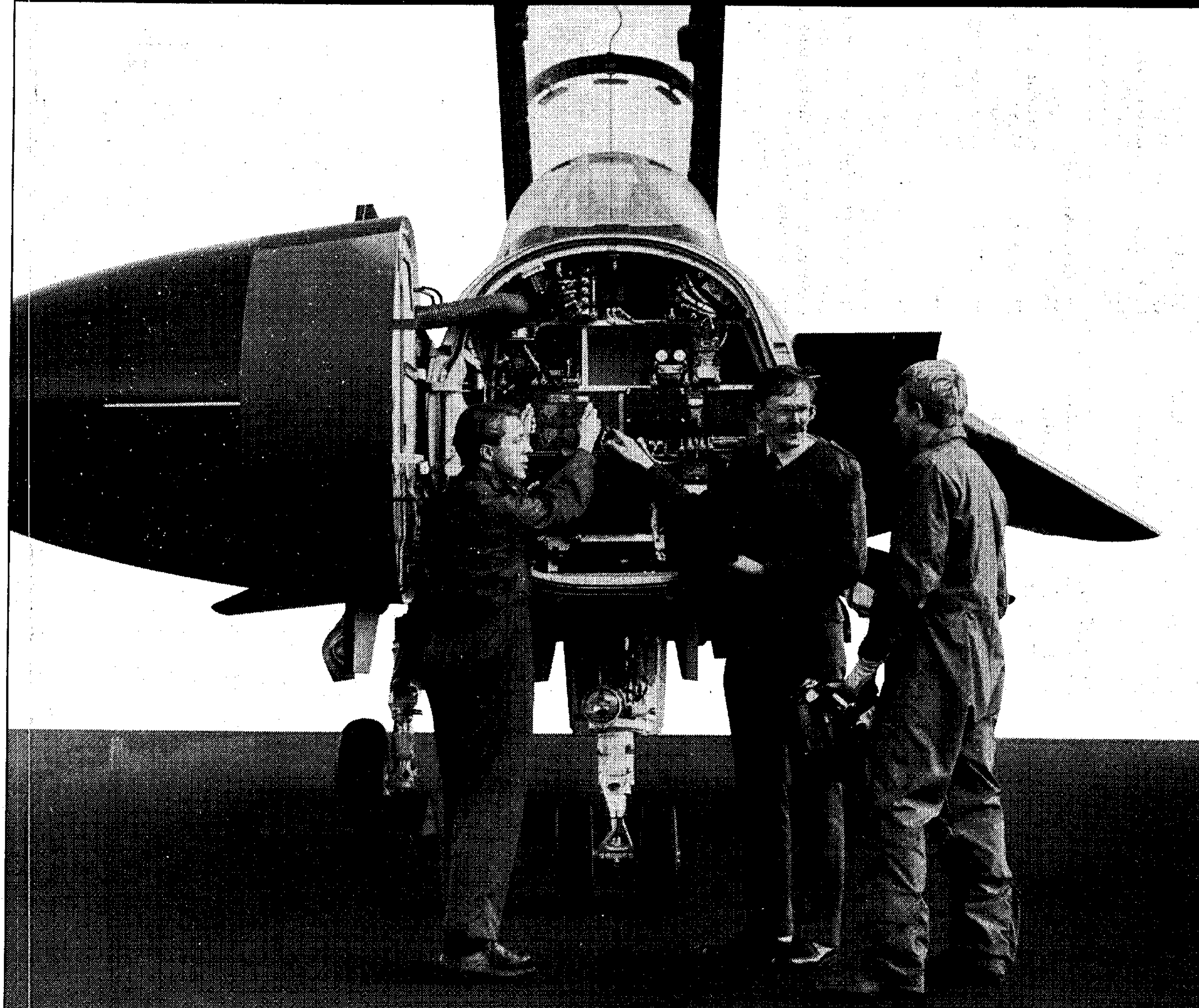
SK1, 2	female panel mounting XLR
SK3, 4, 9, 10	Mono ¼" jack socket
SK5, 6, 7, 8	Panel mounting phono sockets
SK11, 12	Male panel mounting XLR
SK13	Prof 3-pin DIN panel socket

Knobs (collet or grub-screw, 3 off); PCB; case; PC pillars (tapped and studded plus nuts bolts and locking washers, 4 off); PCB linking pins (61 off); veropins (19 off); 6BA nuts, bolts and locking washers (4 off); power supply ± 15V @ 100ma per rail regulated.

Fig. 5 Component overlay of the activator.



Isn't it time you traded your micro for one of our home computers?



This is the RAF Tornado GR1, one of the world's most sophisticated fighting machines. And, naturally, it's packed with computer hardware and software. Everything from the weapons-aiming systems to the low-level, terrain-following radar and the advanced fly-by-wire control techniques relies on on-board computers to deliver an accurate response at 1,400 mph.

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RAF Apprentice

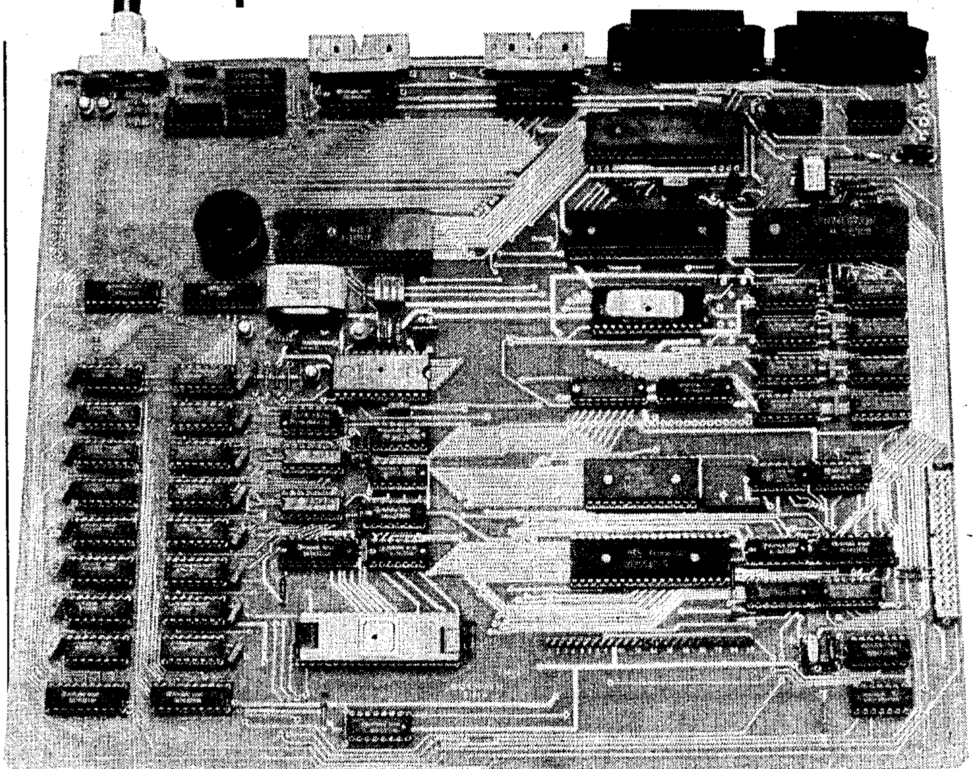
ENGINEERING TECHNICIAN

6809-BASED MICROCOMPUTER

Designer Dave Rumball takes us chip-by-chip through the circuitry of his single board computer.

This is the second in a series of articles which describe the design, construction and use of a powerful, 8-bit, single-board microcomputer based upon the 6809 microprocessor. The board uses the Flex operating system, giving access to a wide range of cross-assemblers and making it particularly suited to software development work. As well as having all the features usually found on a Flex standard machine, this design also offers very high resolution monochrome graphics, 128K of graphics RAM, a RAMdisc system which uses a variable amount of the 128K graphic RAM and appears to an operating system exactly as though it were a floppy disc, and an EPROMdisc system which consists of a small, plug-in board and again appears to the operating system as a floppy disc. Other features include a battery backed-up real time clock and an on-board EPROM programmer, and the complete package is available in kit form from Micro Concepts.

In this article we will look at the workings of the microcomputer section by section. In subsequent articles we will be describing the construction of the board and how to use it.



The CPU, Memory, Buffers And Decoding

The 'core' of the Microbox II is formed by the processor IC1, the SAM chip IC2 and the memory IC3-IC12. IC2 has several functions. First, it takes the master 16MHz clock from IC15 and generates the 1-2MHz processor clocks. The processor address is converted to the multiplexed eight-bit buss and control strobes necessary for the eight 64K DRAMs, IC5-IC12. 22 ohm resistors in these lines damp any signal reflections or undershoots which would disturb the DRAM operation. It also defines a three-bit decoding buss which is used by the decoding logic. An 8K EPROM, IC3 holds the monitor program and system service. IC4 buffers the DRAM read data onto the processor data buss, whilst IC13 is a bi-directional buffer between the processor and the peripheral data busses.

The low order address lines, the control strobes E and R/W, and the reset signal are buffered by IC18, which has its two enable signals grounded. The reset signal from SW2 triggers two time constants, the shorter of which resets the SAM chip by pulling VCLK low, whilst the longer resets the processor so that the SAM chip comes out of reset before the processor. Note that no use is made of the SAM chip's video capabilities in this design.

The HS pin is tied low on the SAM chip. This frees up an extra RAM cycle per CPU cycle allowing operation at 2MHz. However the SAM chip stops refreshing the DRAM at 2MHz, so operation at this speed can only be for periods of less than 2ms, or longer if the operation itself refreshes the memory as would a transfer of 256 bytes during a disc operation.

The memory system map is defined by IC65 and parts of IC14 and IC16. The memory map is filled with the 64K RAM, except for the top 8K section which is the monitor EPROM. This 8K section is split into two, and the bottom 4K may be switched between EPROM and RAM with the MAP signal from the system PIA. This is used in the current software to

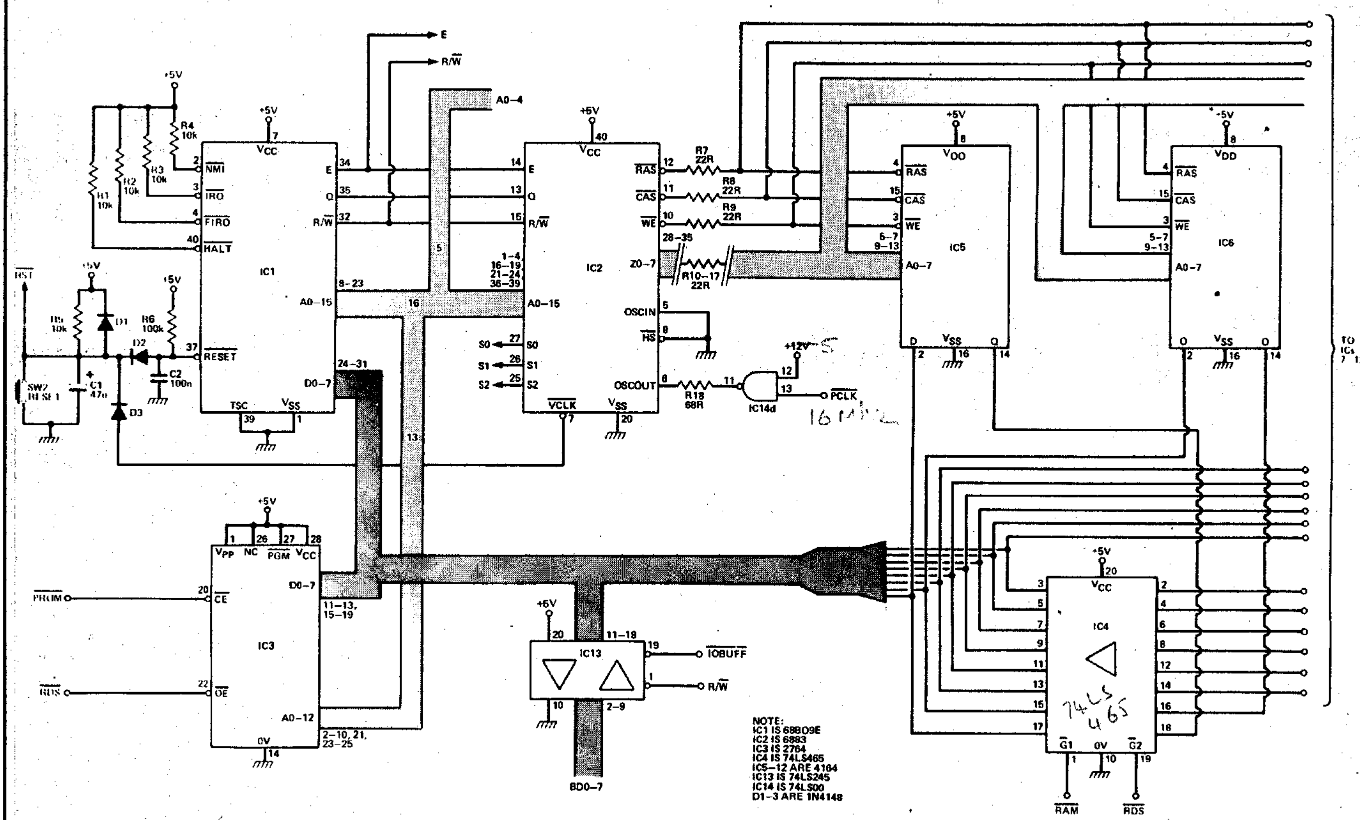


Fig. 1 Circuit diagram of the CPU and memory stages.

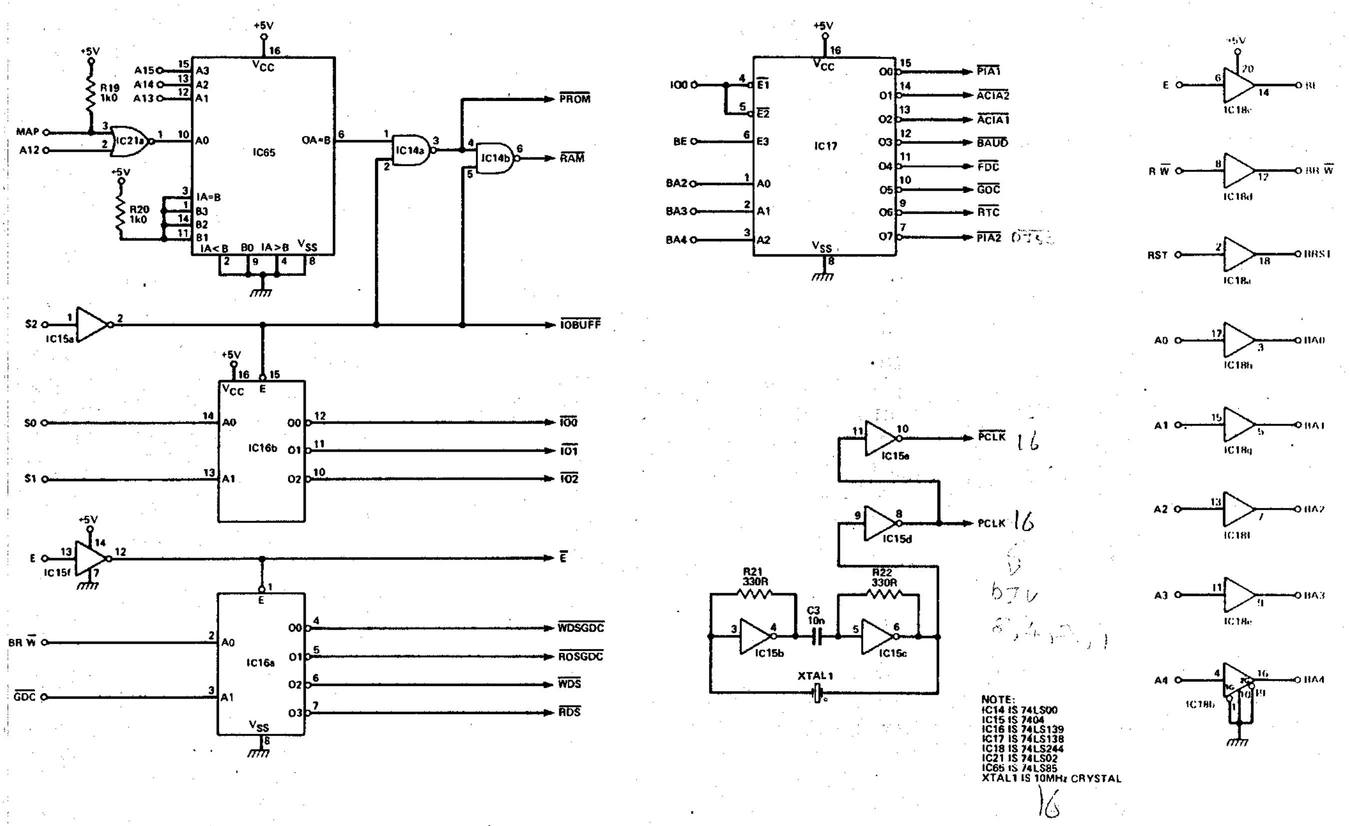


Fig. 2 Circuit diagram of the decoding, buffers and master clock.

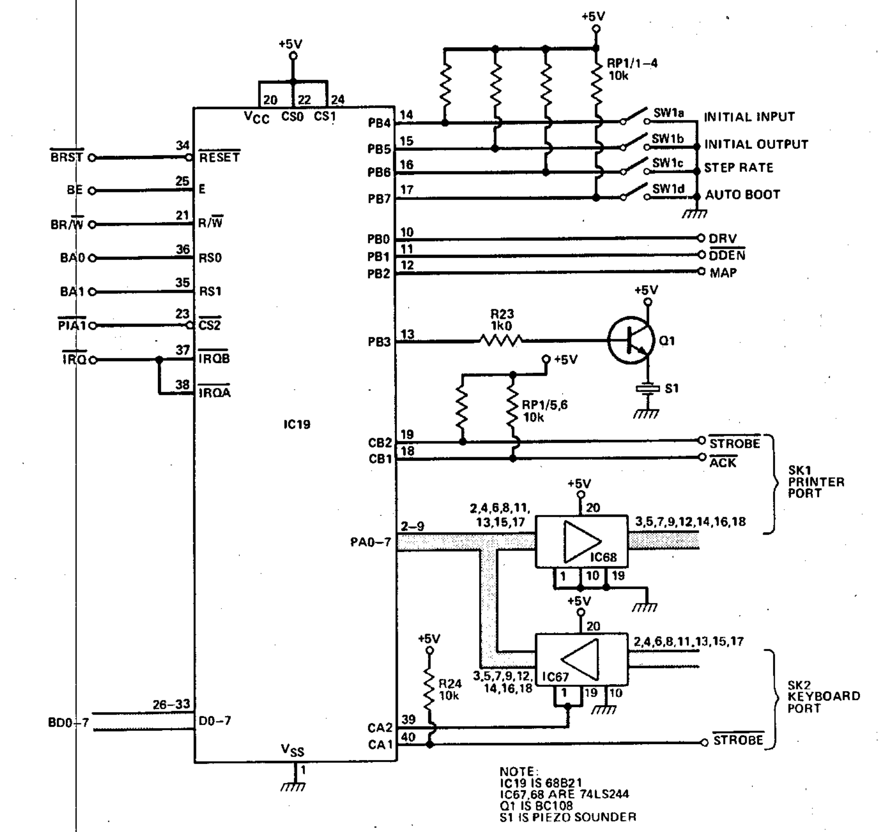


Fig. 3 Circuit diagram of the system interface.

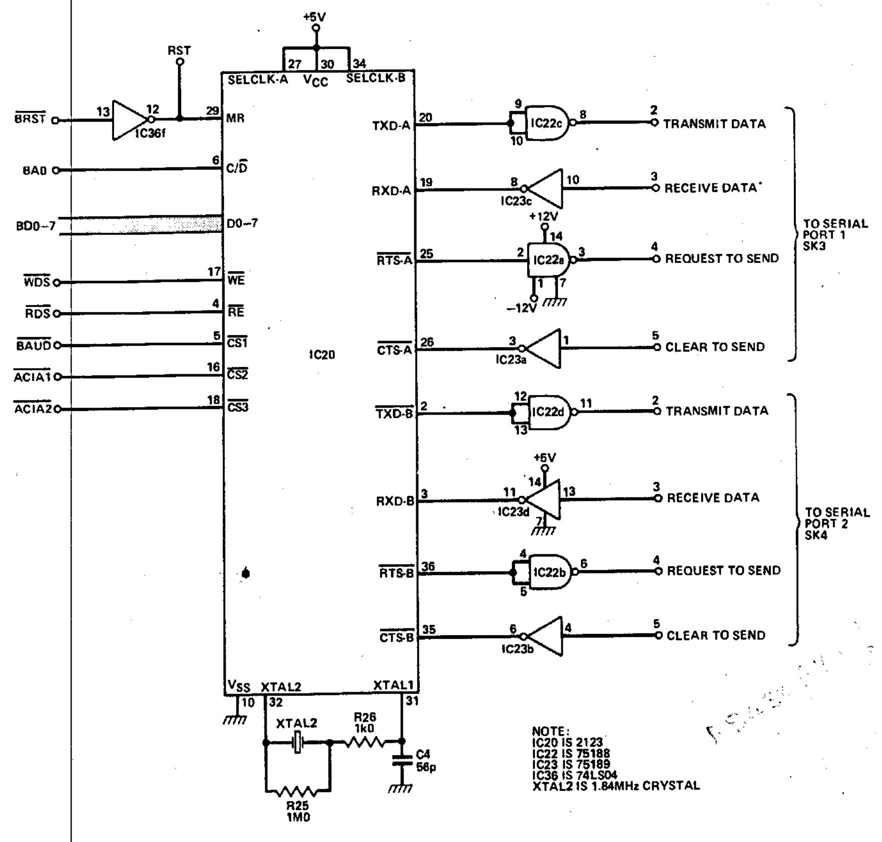


Fig. 4 Circuit diagram of the serial ports.

switch out the diagnostics section of the monitor when Flex is loaded, freeing up an extra block of memory which is used for text drivers and character sets.

The top 256 bytes of memory (as defined by the SAM chip) are given over to three 32 byte I/O slots and the addresses used to set the SAM chip control registers. The first of these I/O slots is used for on-board devices, and is further decoded to eight, four-byte slots by IC17. IC16a generates the RDS and WDS control strobes used by the non-Motorola peripheral devices. Because the NEC720 graphics controller does not have a separate CE line, there are separate strobe signals for this device. Finally, IC15 forms a standard crystal oscillator which generates the master 16MHz clock.

The System I/O And Serial Ports

The keyboard and printer ports, together with a number of control signals, connect to the two parallel ports of a single 6821 type PIA, IC19. The centronics printer and parallel keyboard share the first port via two tristate buffers IC67 and IC68. The PIA port is normally set for input from the keyboard, with the keyboard strobe going to the CA1 line. When printing is in progress, the port is turned from input to output and a strobe signal is sent on the CB2 line. This operation is performed for each character sent to the printer — in between each character, the keyboard is examined so that keyboard characters are not lost whilst printing is in progress.

The other port of the PIA is given over to various system signals. There are four inputs from four switches which the software uses to set certain parameters when the computer is first switched on. The remaining four lines are four outputs, the MAP line for the decode section, the DRV select bit and DDEN line for the floppy disc interface, and a signal which enables a sounder to give a 'beep'.

The serial ports are provided by a single IC, a WD2123 DUART (IC20). The internal baud rate generators derive their timing from a 1.84 MHz crystal oscillator. The data and handshaking lines are buffered from TTL to RS-232 levels and back again by the obligatory 75188/75189 pair.

The Floppy Disc Interface and PROMdisc

The floppy disc controller is refreshingly simple: it consists of just three ICs, two of which are SSI buffers! The work is done by IC24, a WD1770 floppy disc controller, which connects directly to the peripheral data buss. Input signals from the drives are buffered by IC25, whilst output signals are buffered by IC26. The two drive select lines are derived from a single signal. This means that one drive or the other will be selected all of the time, and its drive select light will be on. This causes no harm if the drive is set up to load its head with the MOTOR ON signal. The drive motor timing is set by the 1770 by counting index pulses. It will stop the drive nine index pulses after the last operation, and will delay any operation until six index pulses have occurred.

The EPROM disc is formed from an 8255 PIA, four EPROMs and an eight bit counter. The data lines from the EPROMs are connected to one of the ports of the PIA, IC28, and the high eight address lines for the EPROMs to another. Chip enables for the four EPROMs, the program line for one of them, and clear and count lines for the counter are connected to the last port. Because Flex only reads data from discs in chunks of 256 bytes, not every address line is needed and the low eight address lines can come from an eight bit counter. To read a 'sector', the processor selects the correct EPROM as a function of the 'track' and 'sector' numbers, then clears the counter and clocks it 256 times, moving each byte for the port to RAM as it goes.

EPROMS may be programmed by applying 21V to the VPP pin, setting the address lines and data, and then pulsing the program line for 50ms.

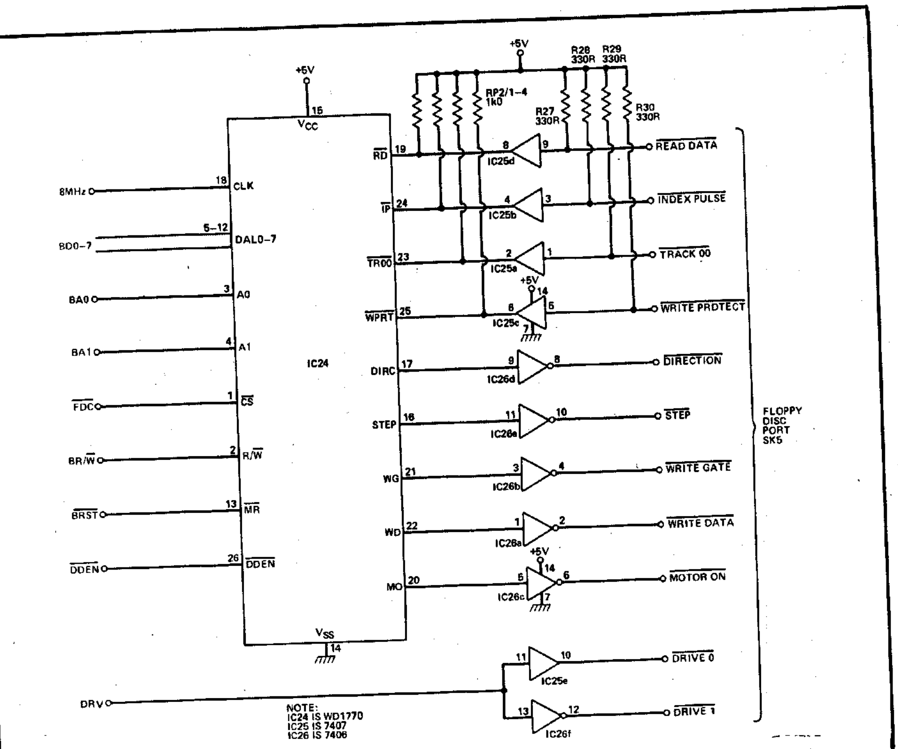


Fig. 5 Circuit diagram of the floppy disc controller.

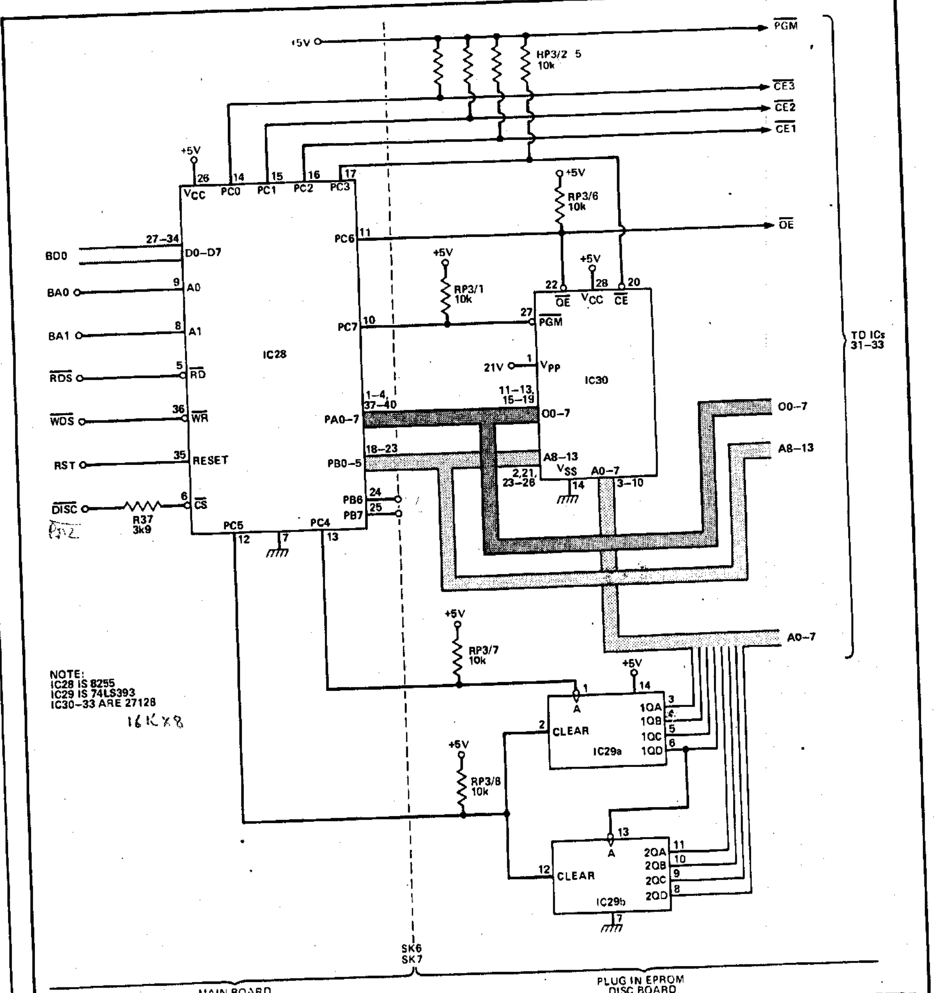
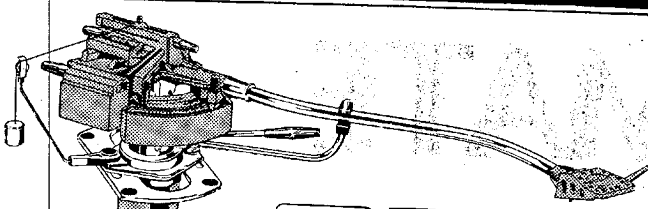


Fig. 6 Circuit diagram of the EPROM disc interface and board.

The operation of the remainder of the board will be described next month, when we also hope to bring you complete constructional details including board overlay and parts list. If you'd rather not wait that long, a kit of parts complete with full constructional details is available from Micro Concepts, 2 St. Stephens Road, Cheltenham, Gloucestershire GL51 5AA, tel 0242-510 525.



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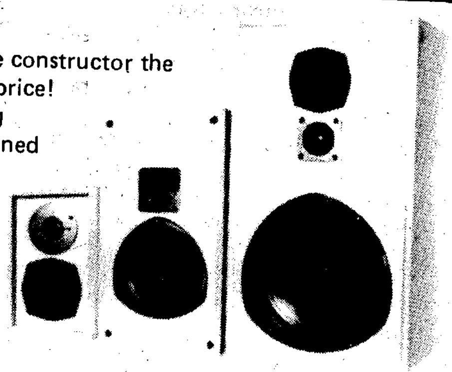

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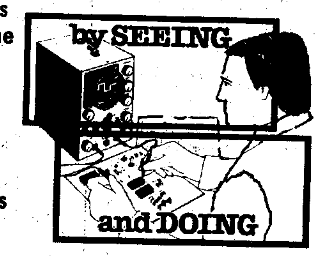

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ETI WALKMATE

Do you have a personal (hi-fi) problem? Ram Chandru has a battery of suggestions to help you overcome it.

In recent years, a new generation of miniature tape players and radios has appeared on the market. Popularly known as Walkmans, they are battery operated, have miniature headphones rather than loudspeakers and are designed for use anywhere at any time. The quality of the sound reproduction is usually pretty good and they have proved immensely popular.

They are not without their drawbacks, however. As anyone who has used one of these machines will know, the current consumption tends to be fairly high and a set of batteries doesn't last very long. Also, whilst at first sight they may seem ideal for use as the basis of a 'second' music system in the bedroom or elsewhere, in practice it is not easy to use them in this way. The output level is not suited to the inputs on most amplifiers, the problem of battery consumtpion remains, and while purpose-built miniature amplifiers and loudspeakers are available these too are battery-operated, pushing the overall running costs very high indeed.

SPECIFICATIONS

AMPLIFIER	
Output power	2W RMS per channel into 8R (mains operation) 1W RMS per channel into 8R (12V DC operation) 1.5W RMS Per channel into 4R (12V DC operation)
Input sensitivity	80mV RMS for full output
THD	typically 0.2% (from IC manufacturers data — not measured)
Bass control	±16dB at 50Hz
Treble control	±14dB at 10kHz
DC SUPPLY	
Output voltage	adjustable over the range 1.5-9V
Overload protection	current limiting at 500mA (at 25°C heatsink temperature; reduces by 2mA/°C above 25°C) LED indication of overload condition
BATTERY CHARGER	
Constant current output	50mA
Overcharge protection	charging ceases when terminal voltage exceeds a preset figure, adjustable between 1.5 and 9V LED indication of charging

The Walkmate has been designed to overcome these problems and allows a miniature tape player or radio to be used indoors with standard loudspeakers at minimum cost. It consists of a regulated DC supply, a constant current battery charger and a stereo amplifier with tone controls. The regulated supply is overload protected and offers 500mA at between 1.5 and 9 volts, a range which accommodates every type of personal stereo we have come across. The constant current charger can only be used with rechargeable batteries, of course, but offers the convenience of recharging whilst the unit is being used, ready for later use elsewhere. The stereo amplifier delivers up to 2 watts RMS per channel into 8R, and the complete system operates either from the mains or from a 12v car battery.

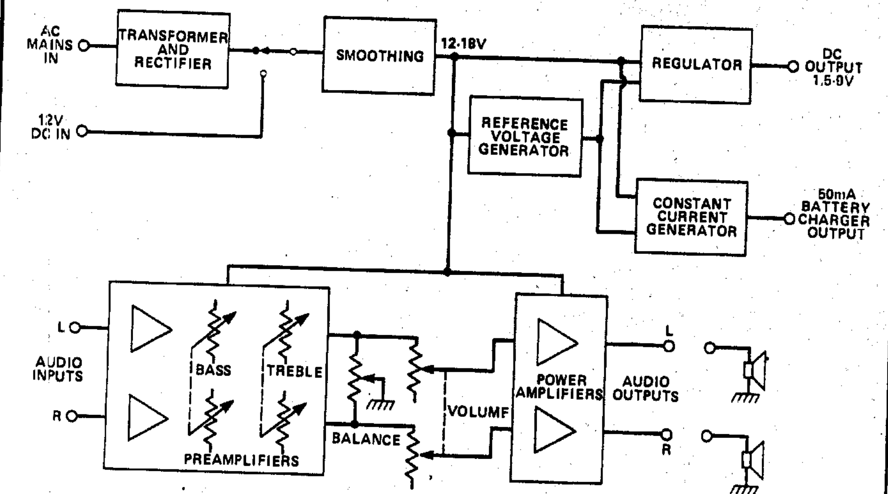


Fig. 1 Block diagram of the Walkmate circuit.

The Circuit

The circuit of the Walkmate is shown in block form in Fig. 1. The incoming mains is passed through the transformer and rectifier to produce an output with an average value of about 18V. This is passed to the smoothing network via a switch on the 12V DC input socket. Inserting a 2.5mm power jack into this socket will disconnect the transformer and rectifier from the rest of the circuit.

A reference voltage is derived from the main smoothed supply to feed the regulator and the constant current generator. The reference is provided by a 1.22V band-gap IC, but several stages of dropping and filtering are used to ensure as ripple-free an output as possible. This is important because

HOW IT WORKS

IC2b, Q6 and Q8 form the basic power supply circuit. Q6 and Q8 are connected as a darlington pair in order to supply a relatively large load current (500mA) with only a small bias from IC2b. The short circuit protection consists of R13, Q5 and Q7. When the load current through R13 reaches a value such that their product reaches a diode drop, (in this case 500mA), Q5 conducts and turns Q7 on to divert the base current of Q6 to earth, thus limiting the power dissipated in Q8. Q4 turns on LED2 indicating a current limiting condition. The output voltage can be adjusted by varying RV2. C8 is included to reduce the ripple present at the output. The impedance through C8 is very small compared to the value of R16, so the ripple is bypassed to the op-amp input. C9 reduces the high frequency impedance of the power supply and C6 and C7 are there to suppress any loop instability.

One point to notice is that Q8 and Q4 are thermally coupled. This ensures that the short circuit current will decrease as Q8's junction temperature increases so that thermal runaway will never occur. As

$$I_{short\ circuit} = \frac{V_{be}\ (of\ Q4)}{R13}$$

and V_{be} is approximately 0.6V at room temperature, the short circuit current will be about 500mA. However V_{be} has a temperature coefficient of -2.1mV/°C, (the negative sign indicates that it decreases with temperature), so the short circuit current will decrease with increasing heatsink temperature at about

$2mA/°C\ (-\frac{2.1}{1.2}mA)$.

The maximum power dissipation in Q8 is roughly 9.0W (0.5A x 18V). In order to maintian a junction temperature below 150°C a 7.8° C/W heatsink is required giving a safety margin of about 60°C ambient temperature.

The IC used in this circuit is an LM358N dual op-amp. Other common dual op-amps such as LM1458 will not do the job because the reference voltage is too near to the earth potential. The common-mode input voltage range of the LM1458 is typically ±12V with a ±15V supply. That means the input voltage must be 3V above the negative supply. In this case, the negative supply to the op-amp is 0V and the reference must therefore be a minimum of 3V in order for the op-amp to function correctly. However, since the design strategy is to provide voltages as low as 1.5V, a small reference voltage must be used. The LM358N has a common mode input voltage range including the negative supply which suits our design.

The battery charger is basically a constant current sink. IC2a, Q3, R7 and R8 form the basic constant current sink circuit with the addition of Q1 and Q2 as the cut-off monitor circuit. The charging current is determined by the value of R7 and R8 in series. Since the reference voltage is 1V22, the current is therefore 1.22/24 which is approximately 50mA. Q1 and ZD2 monitor the voltage across the battery under charge. When the battery voltage brings the potential at the wiper of RV1 to the zener voltage of ZD2 plus a diode drop below the supply voltage, Q1 will conduct and turn Q2 on to divert the base current of Q3 to earth. The cutoff is 'soft' since the zener voltage is current dependent, and this will enable the batteries to maintain their fully charged state. In practice, there will be a small current of around 4-5mA still flowing through batteries when the cut-off circuitry is in action. D6 prevents the battery discharging into the circuit if the Walkmate is disconnected from the mains. The circuit loop formed by Q1 and Q2 will tend to oscillate when the battery terminal is left open circuit, and C3 and C4 are there to prevent this and maintain unconditional stability.

The charger has been designed to charge four AA size rechargeable batteries. However, the charging current can be altered by varying the values of R7 and R8. At 50mA charging current, no heatsink is required by Q3. Its power dissipation will be at a maximum when the battery terminal is short circuit, which is 50mA x 18V = 0.90W. If the charging current is increased to 100mA or above, a small heatsink should be fitted to Q3. The cut-off circuitry can be adjusted to monitor from a minimum of one battery up to a maxixum of six batteries. If less than three batteries are being charged ZD2 should be replaced by a single diode (installed so that it has the opposite polarity to ZD2, of course).

LED1 will light up when the batteries are placed in the charger and will switch off when the batteries are fully charged, indicating that the process is complete. With the cut-off circuit correctly adjusted, batteries could be left in the charger indefinitely without being damaged.

In order to generate a constant current sink and a constant voltage supply, a reference voltage is needed. The easiest way of generating a reference voltage is by means of a zener diode. The arrangement is adequate provided there is not much ripple in the supply voltage, but in our case the rectifier output will contain 100Hz ripple of up to 4V.

An improvement is to use a diode and capacitor as a peak detector which captures the peak value of the ripple according to the current drawn by the diode. Since the zener current is very small, typically 5mA, the ripple seen across the capacitor is very small. Another improvement is to use two zener diodes. The output of the first zener contains a small amount of ripple voltage which is then further reduced by the second zener.

The circuit used in this project is a combination of both improvements. The average current into ZD1 is about 4mA and the current into IC1 is about 1mA. The circuit provides a reference voltage of 1.22V. The dynamic resistance of ZD1 is a maximum of 30R and the bandgap reference IC1 has a maximum dynamic resistance of 2R. The ripple seen across C2 is approximately 0.25V (with I=5mA, neglecting the leakage of D5). The ripple appearing on the V ref line is therefore estimated to be about 2μV. C3 is present to reduce the high frequency impedance of V ref.

The first stage in the audio section is the tone control. There are two basic types of control, the negative feedback type and the RC passive type. The RC passive type has been used here because it introduces less distortion. However, because of the insertion loss of this type of control, a voltage amplifier is needed to provide a gain equal to the maximum boost, in this case 20dB (10 times). The amplifier is usually placed before the tone control if the input signal is small, so that the signal is amplified before being attenuated and is less likely to pick up noise and hum. Looking at the right channel (the left channel is identical, of course), IC3a is connected as an inverting amplifier with an input impedance of 100k. Since the op-amp is powered from a single supply, the non-inverting input is biased to the mid-point of the supply by C13, R20 and R27. D7 and C12 form a peak detector to filter most of the ripple present at the supply voltage. C10 and C14 isolate the DC level at the input and output of the op-amp.

The power amplifiers use LM380N ICs which have a fixed voltage gain of 50. The output DC voltage is set internally to approximately half the supply voltage. C28 and R34 bypass any high frequency oscillation which might occur. C26 is included to improve the PSRR (Power Supply Rejection Ratio) of the amplifier. RV7 provides the trimming of the output DC voltage in order to obtain the maximum symmetric voltage swings. C30 is the output capacitor, and its value determines the low frequency roll-off of the circuit. With an 8R load and a 2200μ capacitor, the -3dB low frequency point occurs at about 9Hz.

The two LM380Ns share a high power twisted vane 10.5°C/W heatsink. When the walkmate is powered from the mains, a 4R load is not recommended because the ICs will be operating in the current limiting mode and power dissipation will become excessive.

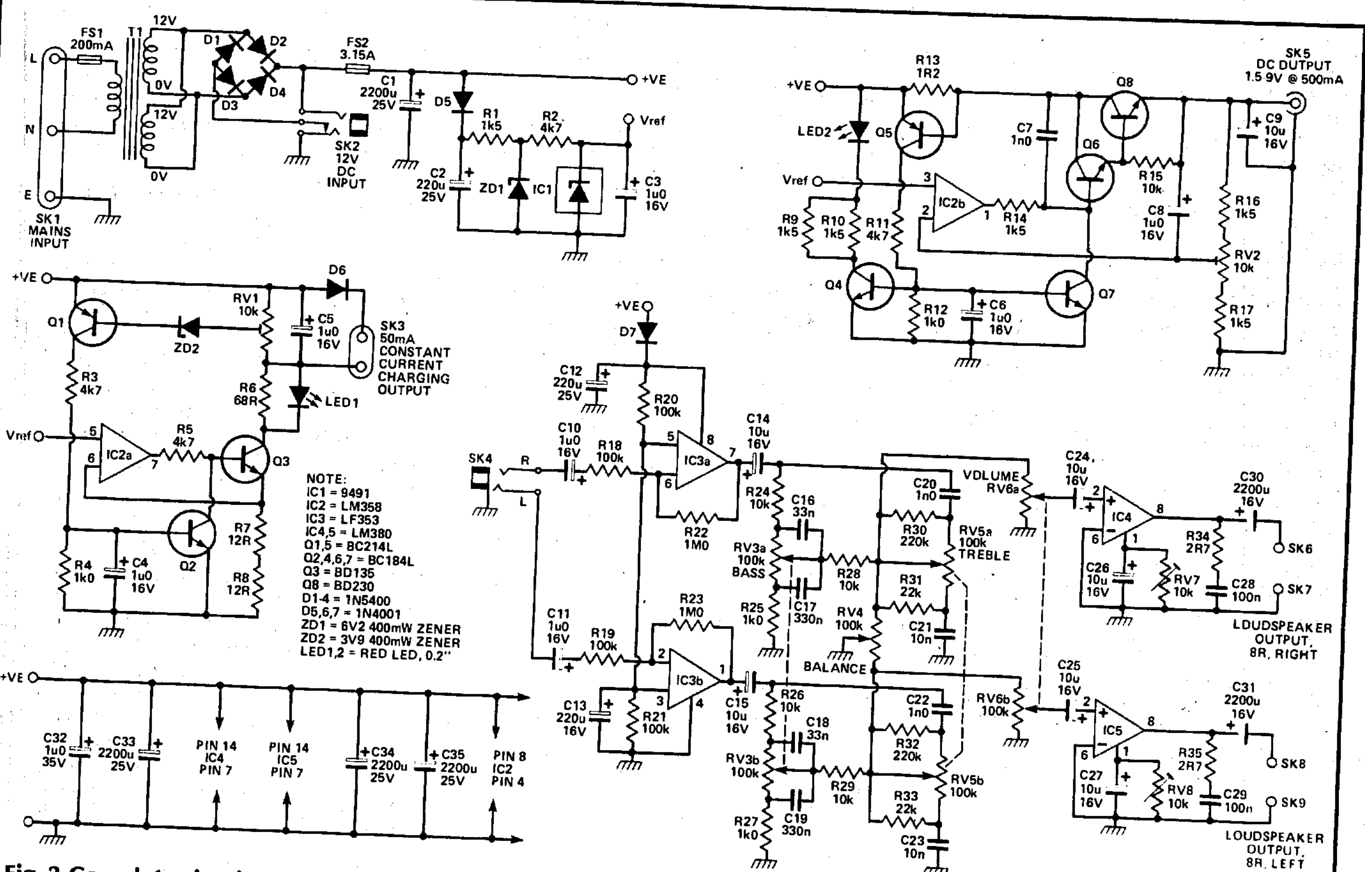


Fig. 2 Complete circuit diagram of the Walkmate

any imperfections in the reference supply will be amplified in the regulator.

The constant current charger provides an output of 50mA which is suitable for the AA-size cells used in most personal stereos. A circuit is included which monitors the voltage across the batteries under charge and removes the current when a pre-set terminal voltage is reached. An LED indicates when charging is taking place.

When the audio output of a tape player is connected to the Walkmate, the signal is first passed to a tone control stage built around anLF 353 dual op-amp. One half of the LF353 is used in each channel. Separate bass and treble controls are provided along with balance and volume controls. The outputs from this stage feed two LM380 power amplifier ICs each capable of delivering 2 watts RMS into an 8R load when the unit is being operated from the mains. When operated from a 12V DC supply, the outputs can deliver 1W RMS into 8R or 1.5W RMS into 4R.

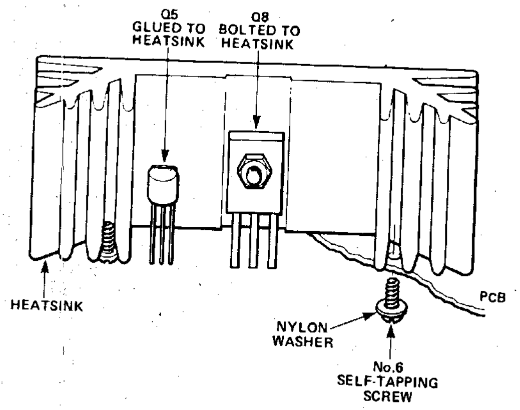


Fig. 3 Details of the regulator heatsink assembly.

Construction

All of the major components mount directly onto the printed circuit board including the mains transformer, the heatsinks, the potentiometers and most of the sockets. The fuse in the DC line (FS2) is mounted on the board but the mains fuse and socket are mounted into the back panel of the case along with the loudspeaker connectors, SK6-9. Connections to these and to the battery charging socket can be taken directly from the board or via standard 0.1" pitch PCB connectors if preferred.

Before soldering anything to the board, Q5 has to be glued to the 7.8°C/W heatsink. Attach Q8 to the heatsink with an M3.5 nut and bolt and then position the heatsink on the PCB with the transistor pins inserted through the appropriate holes. Secure the heatsink temporarily with the two self-tapping screws, then place Q5 into position with its flat side towards the heatsink. Put a dab of Superglue or something similar on the transistor and hold it against the heatsink for a few moments until the glue dries.

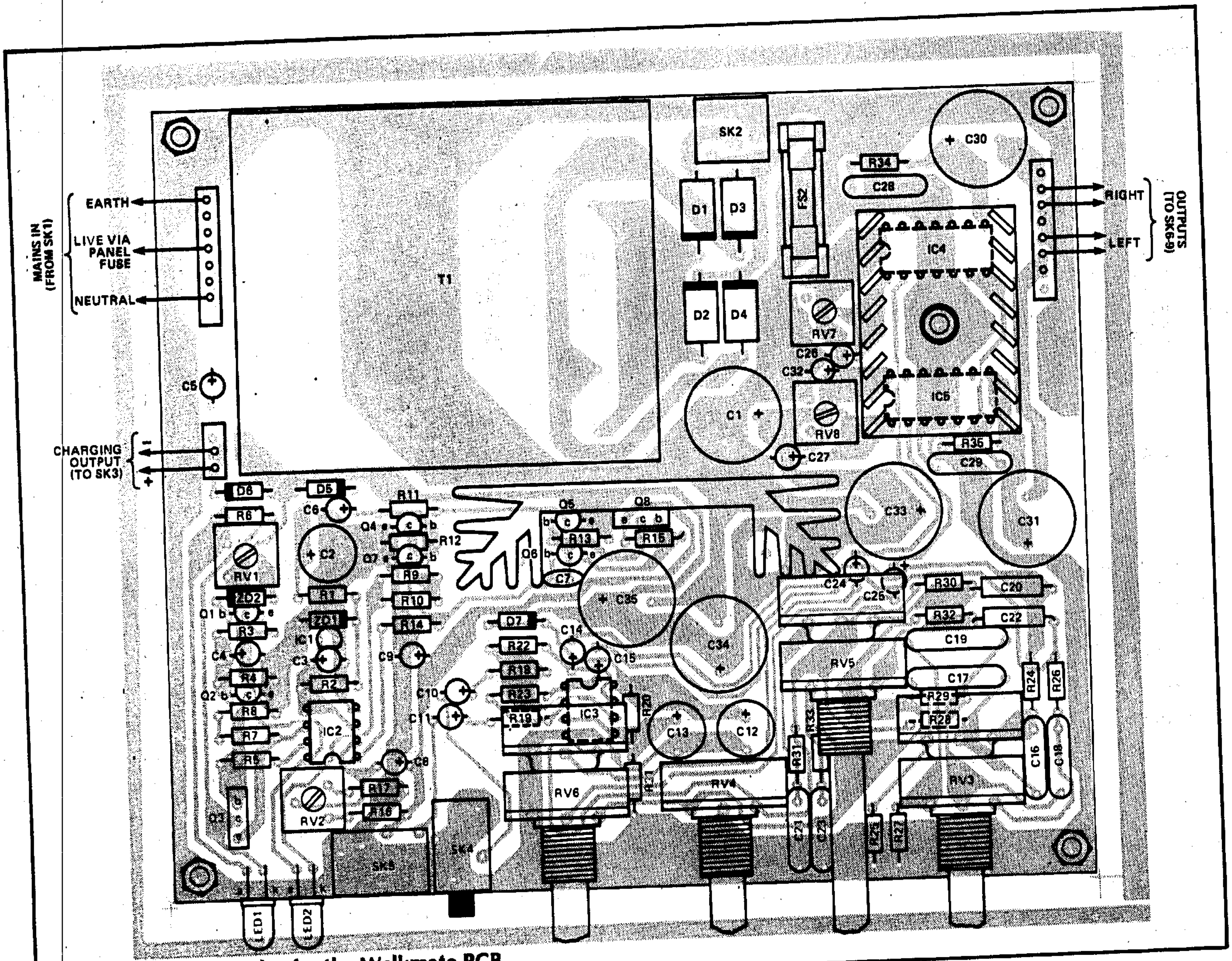


Fig. 4 Component overlay for the Walkmate PCB.

The glue should be allowed an hour or so to develop its full strength, so carefully dismantle the assembly from the board and put it to one side while the rest of the components are installed. Begin with the resistors, the preset potentiometers and the sockets and also the smaller capacitors. The large smoothing and output capacitors should not be installed at this stage. The fuse holder should also be soldered into place now, along with the PCB connectors if these are to be used for the mains, loudspeaker and charging output connections.

Next install the diodes and the transistors (except Q5 and Q8, of course) and then IC2 1, 2 and 3. Sockets should not be used for any of the ICs because there is very little room on such a densely-populated board. The LEDs can be installed at this stage if desired but you may prefer to wait until the board is ready for installation in the case so that they can be lined up with the front panel holes. Solder the potentiometers into place, taking care that they do not interfere with any of the components already installed.

Loosely re-assemble the 7.8°C/W heatsink on the board, placing nylon insulating washers on the two self-tapping screws so that there is no connection to the copper track. This removes the need for a mica washer on Q8, although a smear of thermal compound here will not go amiss. Position the transformer and C1 on the board and make sure they clear one another and the heatsink. Tighten down the self-tapping screws, solder the transformer pins and the transistor and capacitor leads and then install C34 and C35.

Loosely insert ICs 4 and 5 into the holes provided and place the 10.5°C/W heatsink on top of them. Secure the heatsink with an M3.5 nut, bolt and shakeproof washer taking care not to overtighten the bolt so as not to damage anything. The pins of the ICs can now be soldered on the underside of the board. With the heatsink in place, capacitors C30, C31 and C33 can be installed and the board is then complete.

The prototype was built into a 203 x 127 x 51mm vinyl-covered steel box and the PCB dimensions were chosen to suit it. This is important since the edges of the PCB must be very close to the

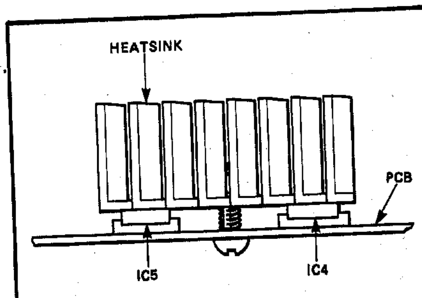


Fig. 5 The twisted vane heatsink shown in position over IC4 and 5.

PARTS LIST

RESISTORS (all ¼W, 5%)

R1, 9, 10, 14, 16, 17	1k5
R2, 3, 5, 11	4k7
R4, 12, 25, 27	1k0
R6	68R
R7, 8	12R
R13	1R2
R15, 24, 26, 28, 29	10k
R18, 19, 20, 21	100k
R22, 23	1M0
R30, 32	220k
R31, 33	22k
R34, 35	2R7
RV1, 2, 7, 8	10k linear enclosed horizontal preset
RV3, 5, 6	100k logarithmic dual-gang PCB-mounting potentiometer
RV4	100k linear single-gang PCB-mounting potentiometer

CAPACITORS

C1, 33, 34, 35	2200u 25V radial electrolytic
C2, 12	220u 25V radial electrolytic
C3, 4, 5, 6, 8, 10, 11	1u0 16v radial electrolytic (or 1u0 35V tantalum)
C7	1n0 ceramic
C9, 14, 15, 24, 25, 26, 27	10u 16V tantalum or radial electrolytic
C13	220u 16V radial electrolytic
C16, 18	33n polyester
C17, 19	330n polyester
C20, 23	10n polystyrene
C21, 23	10n polyester
C28, 29	100n polyester
C30, 21	2200u 16V radial electrolytic
C32	1u0 35V tantalum

SEMICONDUCTORS

IC1	9491 (1V22 bandgap ref.)
IC2	LM358
IC3	LF353
IC4, 5	LM380
Q1, 5	BC214L
Q2, 4, 6, 7	BC184L
Q3	BD135
Q8	BD230
D1-4	1N5400
D5, 6, 7	1N4001
ZD1	BZY88C 6V2
ZD2	BZY88C 3V9
LED1, 2	red 0.2" LED

MISCELLANEOUS

FS1	200ma fuse and panel-mounting holder
FS2	3.15A 20mm fuse and PCB-mounting holder
SK1	IEC three-pin mains chassis plug
SK2, 5	2.5mm DC power socket with break contact, PCB-mounting
SK3	PP3-type battery connector
SK4	3.5mm stereo jack socket, PCB-mounting
SK6, 8	red spring-loaded press terminal
SK7, 9	black spring-loaded press terminal
T1	0-12 + 0-12V, 24VA mains transformer, PCB-mounting

PCB; case; knobs, 4 off; heatsinks, 7.8°C/W finned T0220, 60 x 32 x 16mm and 10.5°C/W twisted vane, 38 x 28 x 22mm; battery holder and clip-in battery compartment; PCB transition connectors if desired, 2 off 8-way and 1 off 3-way; two no. 6 self-tapping screws (for 7.8°C/W heatsink); 10mm high spacers, 4 off; nuts, bolts, etc.

front and back panels if the on-board sockets and controls are to be accessible. This would have to be taken into account if a different size of case were used for any reason.

Drilling details are given in Fig. 6. The battery compartment, mains fuse, mains socket and loudspeaker terminals are not too critical in their positioning, and the potentiometer holes will be hidden by the knobs so it won't matter if they are a fraction off centre. The holes for the sockets, on the other hand, must be accurately positioned if they are to be accessible and the unit is to look good. If you have any doubts about your metalworking skills, try drilling a small hole first and then place the board in position to check it. If necessary, the hole can be centred with a small round file before final drilling out to the correct diameter.

Before installing the PCB in the case, carefully check it against the overlay diagram (Fig. 4) and pay particular attention to the orientation of transistors, ICs, diodes and electrolytic capacitors. Check carefully too that there are no breaks in the PCB tracks or solder bridges between adjacent tracks. In my experience, it is usually a good idea to go away and do something completely different for some time after a board has been completed. The mind is then much cleared when it comes to checking the board and potentially expensive mistakes are easier to spot.

When you are convinced that all is well, loosely install the board in the case and then bend and fit the LEDs so that they line up with the front panel holes. Remove the PCB, solder the LEDs into place and attach any flying lead connections to the underside of the board. These will not be needed if you have chosen to use PCB transition connectors for the mains, output and battery charger

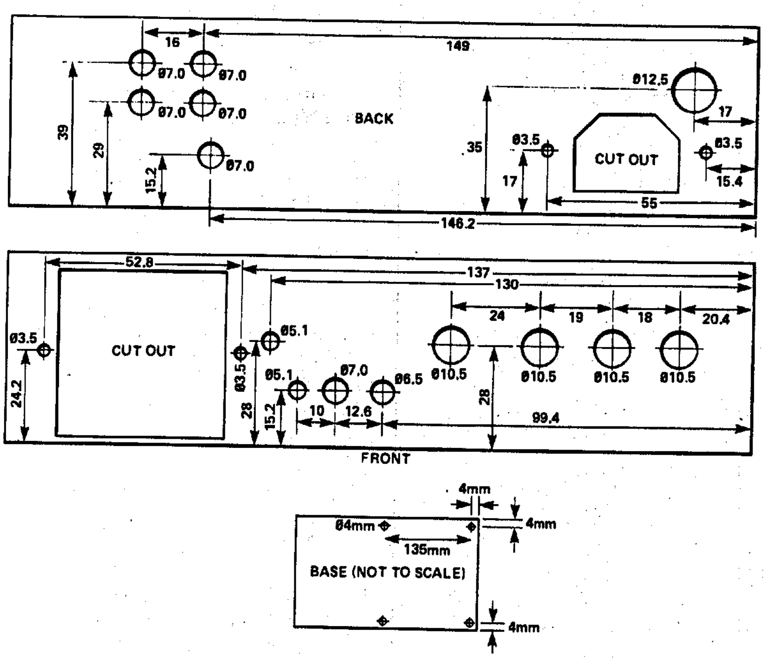
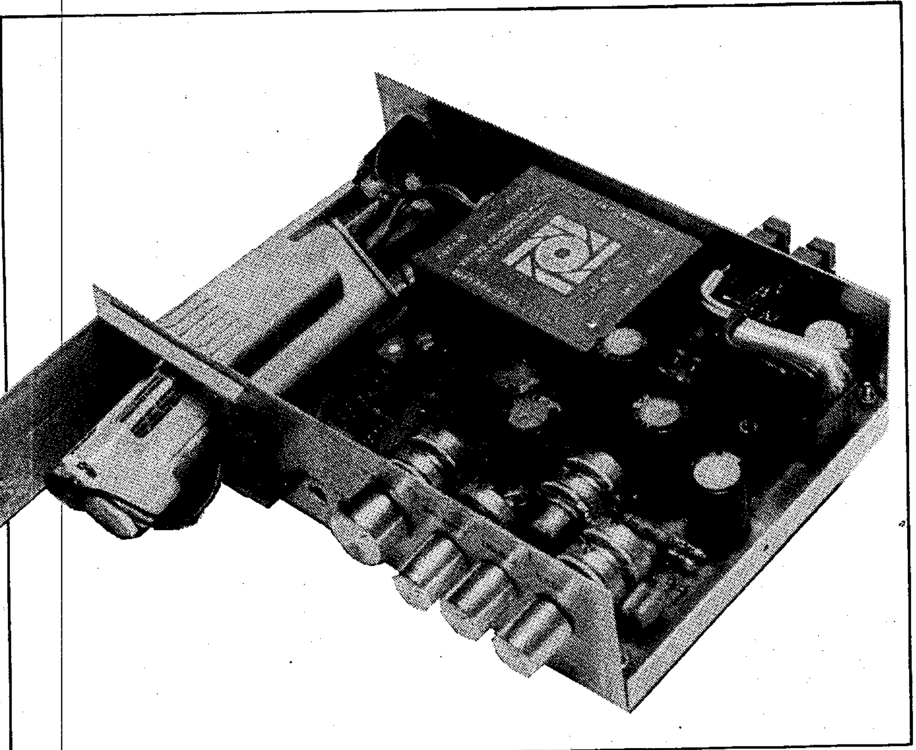


Fig. 6 Drilling details for the metal case.



connections. When all soldering is complete, install the board in the case using four 10mm metal pillars and connect up the mains socket and fuse, the loudspeaker output sockets and the battery connector. Don't forget to earth the metal case.

Testing And Setting-Up

Carefully check all the connections to the PCB, especially the mains wiring, and then set all the presets to their mid positions. Connect a voltmeter between FS2 and ground and plug in the mains. The voltmeter should show around 18-20 volts. If the voltage is significantly lower than this, check the polarity of the rectifiers and the smoothing capacitors. If either of the fuses blows, switch off immediately and check everything again.

When the voltage on FS2 is correct, remove the voltmeter and connect it across pins 4 and 5 of IC2 or some other point where the reference voltage is available. The reading here should be between 1.2 and 1.26V. If the voltage lies outside of this range, check the orientation of IC1 and ZD1 and the components around them.

Connect a milliammeter across the battery charging terminals. LED1 should light up as soon as the meter is connected and a reading of 48-50mA should be obtained. Remove the milliameter and connect in its place a set of fully-charged or nearly fully-charged Nickel Cadmium cells and a voltmeter. The voltage across the cells should rise slowly. When it reaches the full terminal voltage (1.45V for each cell), carefully turn RV1 until LED1 extinguishes. Remove the cells, discharge them slightly and then connect them as before along with the voltmeter. Check that LED1 goes out when the intended voltage is reached, and if not, re-adjust RV1. This exercise may take a little time but you can leave the batteries charging or discharging while you carry on with the rest of the setting-up.

Connect a voltmeter across the regulated DC Output. A reading of about 2.5 should be obtained and this should increase and decrease if RV2 is rotated. Set the voltage to suit the personal stereo you plan to use and then connect an ammeter directly across the output. LED2 should light up and the ammeter should show a current which slowly decreases from an initial value of around 500mA. If a much larger current is present, disconnect the ammeter immediately and check the circuit carefully, paying particular attention to the circuitry around Q5 and R13. Check also that there is no connection between the heatsink and the copper earth track via one of the fixing screws.

With the power supply and charger circuitry working correctly, all that remains is to test and set-up the audio stages. Check that the DC level across R21/C13 is around 9V and that a similar voltage is present on the outputs of the two halves of IC3 (pins 1 and 7). Next, check that about 8V DC is present on the output pins of ICs 4 and 5 (pin 8). Connect an 8R dummy load across one of the loudspeaker outputs and inject a 1kHz signal into the corresponding input. Connect an oscilloscope across the dummy load and adjust RV7 or RV8 as appropriate until the output swings are symmetrical above and below 0V. It is advisable to turn the preset very slowly whilst making this adjustment. When the output symmetry is correctly set, transfer the dummy load, oscilloscope and signal generator to the other channel and repeat the procedure.

If you want to be particularly thorough you can check the operation of the bass and treble controls using signal frequencies of 50Hz and 10kHz. Those who do not have an oscilloscope will have to be content with setting the output DC level at 8V as described above and using their ears to evaluate the operation of the tone controls.

BUYLINES

The fixed resistors, the capacitors and most of the semiconductors are available from a number of our regular advertisers and from the usual mail-order suppliers. The PCB-mounting potentiometers are available from Maplin, who can also supply the battery holder and clip-in compartment, the 10.5°C/W twisted-vane heatsink and the PCB-mounting jack socket and DC Power sockets. The vinyl-covered metal case used for the prototype also came from Maplin and is known as type WB3. The mains transformer, enclosed horizontal presets, PCB-mounting fuse holder and the BD230 can be obtained from STC Electronic Services, Edinburgh Way, Harlow, Essex CM20 2DT, tel 0279 26777. The 9491 bandgap reference and the 7.8°C/W finned heatsink are available from RS Components who will only accept orders from trade and professional customers. However, most electronic dealers can order RS parts or you can obtain them by mail order from Crewe-Allan & Co., 51 Scrutton Street, London EC2 or Trilogic, 29 Holme Lane, Bradford, BD4 0QA, tel 0274 684289. The printed circuit board will be available from our PCB Service, for details of which see page 59. ETI

DIGITAL SOUND SAMPLER

In this (slightly delayed) article in our series on the construction of a sound sampler for use with the Spectrum, Paul Chappell finally gets around to describing the analogue circuitry.

The analogue signal path is the critical area in determining the quality of sound reproduction that a sampler will achieve. Although it is possible to sample sounds with little more than an ADC, a DAC and a home computer, for reasons discussed in an earlier issue (ETI, September 1985) the sound will not be very pleasant. Refinements such as a sample and hold circuit before the ADC will help, but the most spectacular improvements are achieved by the inclusion of suitable low-pass filters before and after the conversion.

Figures 1 and 2 show the complete audio path of the project. The input filtering is incorporated in the circuitry around IC2 and IC5 and the output filtering is carried out by IC12, IC13 and IC16. It seems, at first sight, that the filtering should be the most precise and academic part of the circuit design: apply the correct formulae, use the right set of design tables and you've got a filter. As is often the case with circuit design, it's far from being so clear cut, and some of the considerations involved are worth a closer look.

Filter Considerations

Let's suppose that we are sampling at 30kHz and so would like to remove any components of the input signal above 15kHz. The most obvious compromise is that we can't have a filter that passes everything up to 15kHz and nothing thereafter, so let's choose the -3dB point to be 12kHz and see where it leads us. We could live with a bandwidth of 12kHz — it may not be quite hi-fi but, in comparison with TV sets, radios and walkpersons it's not too bad. We will also recognise that the signal above 15kHz will not be zero, but if it was below -50dB it would be pretty well inaudible, so we'll take that as a starting point.

The first shock comes when we see the size of filter needed to meet this specification. For a Butterworth filter response (one without ripple in the passband) we are going to need 11 Sallen and Key type filter sections (like the circuitry around IC2) all cascaded together. That is, 11 op-amps, 22 capacitors and 44 resistors. Some filter! With a Chebyshev response we are a bit better off — with a little over 1dB passband ripple, we could manage with only 5 sections and still get to -50dB at 15kHz; with a little more ripple, we could get it down to four sections, but for reasons I'll come back to later we can't allow too much ripple.

Switching To Capacitors

Because we want the filters to track the sampling and playback frequencies, switched capacitor types have been chosen (IC5 and IC13). These, in effect, sample the signal and hand it back at the output in the form of discrete steps. For this reason they are just as prone to 'alias' distortion as the A-D, D-A conversion process. It may sound odd, but we need to filter the input and output of the filters! As the clock rate, or sampling frequency, of the mobile filters is 50 times the cut-off frequency, the filtering requirements are not too stringent. If the filters are set for 12kHz, this means a sample rate of 600kHz, and if we only attempt to remove signals that could give rise to beat products falling within the range up to 40kHz, we are only asking that the fixed frequency filter should produce an insignificant output above 560kHz. As it can begin to roll off anywhere above 12kHz without interfering with the bandwidth of the sampler, a steep slope is not called for. Even allowing for the fact that we may wish to sample at rates below 30kHz — maybe even as low as 10kHz — we are still looking for a good attenuation at 160kHz.

As we are expecting the best performance at a sample rate of 30kHz, it makes sense to choose a cut-off frequency for the fixed filters that will assist in attenuating frequencies of 15kHz and above. On the other hand, they can't have a cut-off frequncy of 12kHz to match the mobile filters at this sample rate. If they were all independently designed to cut off at 12kHz, that is to say the -3dB point for each was 12kHz, the consequence of cascading all five would be that the attenuation at 12kHz would be -3dB x 5 = -15dB. Not quite what we are aiming for! A similar consideration applies to the passband ripple that can be tolerated — it can add from one filter to the next and there could be a good deal more at the output than was intended.

A third consideration is the desirability of applying a certain

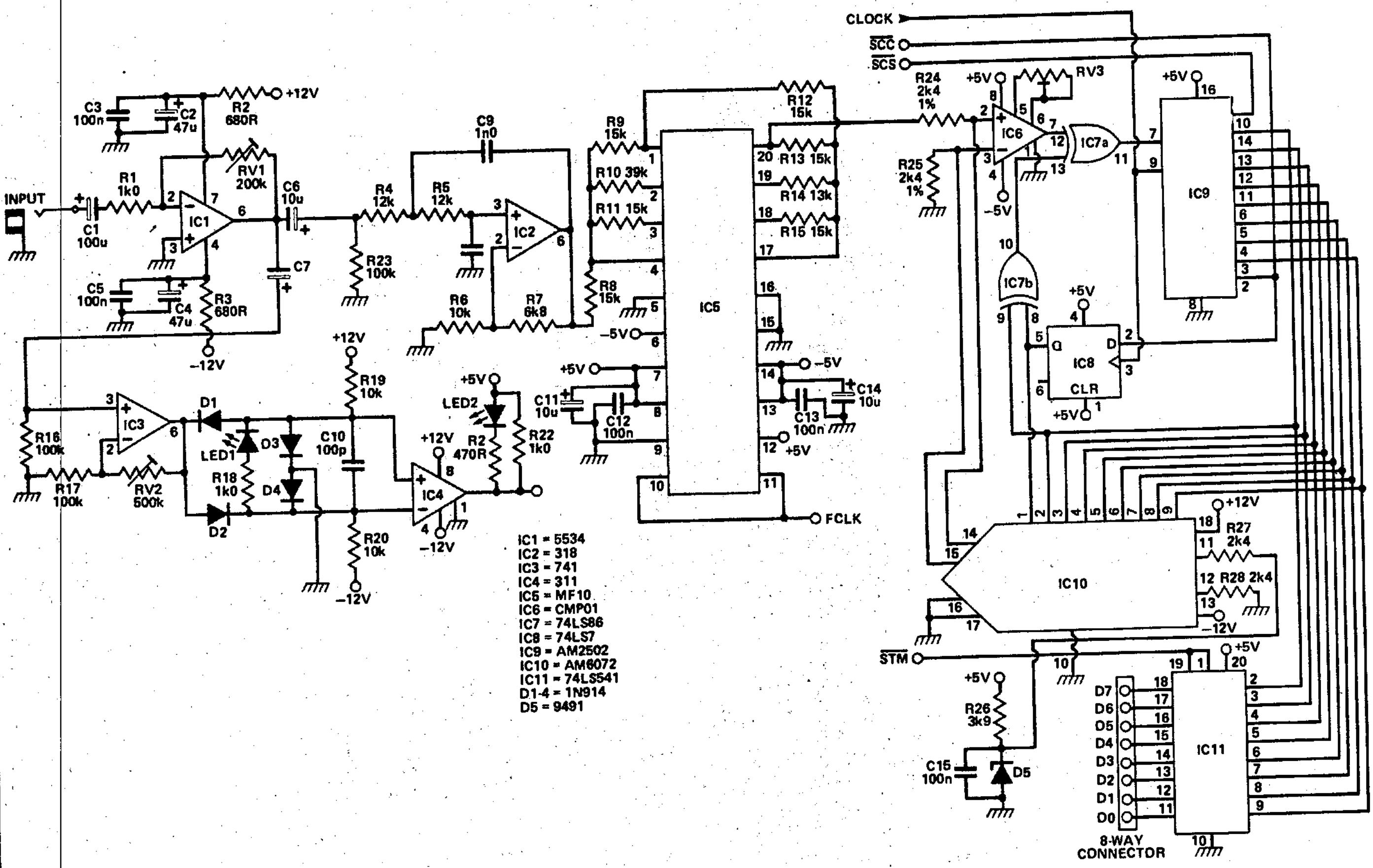


Fig. 1 Analogue input circuit of the sampler.

The input signal from the microphone is first amplified by IC1. From the output of IC1 the amplified signal passes to IC2 and to IC3. Taking the main signal path first, IC2 and IC5 are lowpass filters included to prevent 'alias' distortion in the sampling process. IC5 is a switched capacitor filter with a cutoff frequency determined by the frequency of FCLK. FCLK is generated by the sample rate circuit (to appear in a later issue) and is proportional to the selected sampling frequency, so the cutoff frequency of IC5 tracks the sample rate. IC2 is a lowpass filter with a fixed cut-off frequency to prevent signals with a frequency above ½FCLK from reaching IC5.

The output from IC1 is also fed to IC3 where it is further amplified by an amount set by RV2. The function of IC4 is to provide a signal SOUND to the control circuit when an input of a suitable level is detected. When no input is present the +ve input of IC4 is held at 0.7V by R19 and D3, the −ve input is at +0.7V by the action of R20 and D4, so the open collector output of IC4 will be held high by R22. If the output of IC3 goes low, the +ve input of IC4 will be pulled low by D1 but the −ve input will remain at −0.7V, and allowing for the drop across D1 this means the output of IC3 must go below −1.4V. If IC3 output goes high, IC4 will similarly be switched by D2 at +1.4V or above. A signal of 2.8V p-p at the output of IC3 will begin to switch IC4 on and off. LED2 indicates that this is happening and means that an audio signal large enough to trigger the sampler is present at the input. Adjustment of the signal level needed to trigger the sampler is made by RV2.

Overload indication is provided by LED1. If the output of IC3 goes high enough, current will eventually flow through D2, R18, LED1 and D3. If it goes low enough, current will flow through D1, LED1, R18 and D4. The voltage level needed to begin to light LED1 is roughly 0.7V (for D2) plus 2V (for LED1) plus 1V (for R2, assuming that LED1 will just become visible at 1mA) plus 0.7V (for D3), equals 4.4V. Similarly, −4.4V will be needed to begin to illuminate LED1 on negative peaks, so a signal of around 8.8V p-p will begin to give an indication. The LED will get brighter as the signal increases above this level, and can thus be used to give a rough measure of higher signal levels.

To return to the main signal path, the output of IC5 is fed to the ADC circuit consisting of ICs 6, 7, 8, 9, 10. The action of this circuit has been described in ETI, November 1985. The output of the ADC will be in a companded sign and magnitude format. IC11 buffers the output of the converter and drives the data lines D7 to D0 when STM is low.

There is no need for a sample and hold circuit prior to the ADC because this function is one of the duties of IC5. If the clock of IC5 is stopped, its internal state will effectively be frozen and the ouput will remain steady for several ms before the leakage of internal charges cause it to droop. The conversion time of only a few μs is more than enough for a very effective sample and hold. When the control circuit issues the START CONVERSION signal (SCS) to the ADC, it simultaneously turns off the clock to IC5 and will not re-start it until the conversion has finished.

The circuitry to retrieve the sound

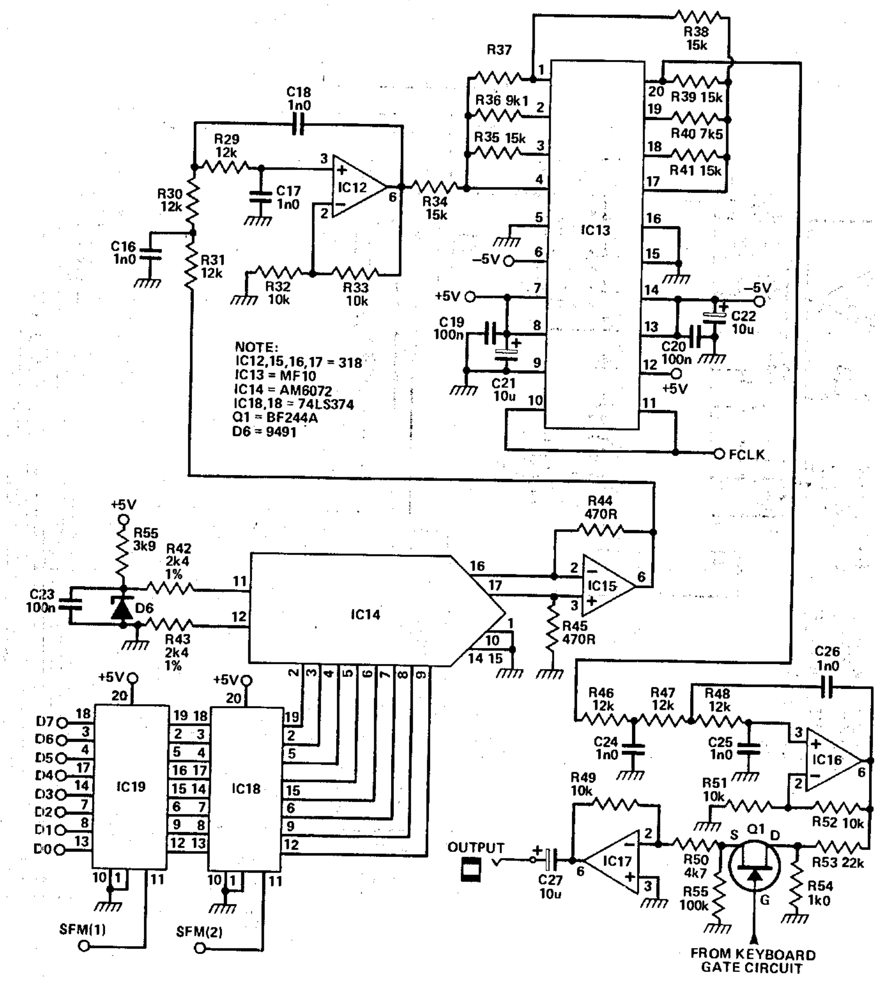


Fig. 2 Analogue output circuit of the sampler.

code from the data lines and turn it back to analogue form begins with IC19. This is an 8-bit latch which captures the data when it is clocked by SFM(1). The control circuit (to appear in a later issue) sends interrupts to the computer at regular intervals. The time between the computer receiving an interrupt and the digital sound code appearing on the data lines will depend on the point the computer has reached in its current instruction cycle when the interrupt is received. Unfortunately, this time is variable and unpredictable. If the output of IC19 was fed directly to the DAC, the irregular updating of the data would give rise to distortion of the audio signal. IC18 is included to even out the update rate and set it to match the sampler's requirements, not the computer's.

From IC18, the digital sound codes are sent to the DAC, IC14. This IC produces differential current ouputs which are translated into a voltage level by IC15. From the ouput of IC15, the sound is filtered by IC12 prior to the output tracking filter IC13. Once again, IC13 has a low-pass cutoff point set to suit the playback frequency by variations in FCLK. This is, in fact, the same signal that clocks CI5 — if the sound is passed straight through the circuit for test purposes, we want IC5 and IC13 to cut off at the same frequency. If IC13 is being used to filter sound from the computer's memory, it doesn't matter what frequency IC5 is clocked at, so the same signal can be used for both.

IC16 provides the final low-pass filter to restore the step output from IC13 to a continuous audio signal. At the output of IC16 is a FET Q1, to turn the output signal on and off. Q1 is driven from the gate signal from the keyboard, and besides allowing the sound to be turned on and off when a key is depressed and released, it also allows some control over the attack and decay rates of the sound.

From Q1 the signal passes to the amplifier IC17 which provides a suitable output level.

amount of pre-emphasis to the higher frequency components of the signal before sampling and de-emphasising it afterwards. It's not good enough to tack an RC circuit to one of the op-amps to give a 6dB per octave lift at the input and corresponding circuit for a 6dB per octave cut at the output. Considerations of making life more difficult for the input LP filters aside, the more important point is that when the sampled sound is played back at a different pitch, the entire frequency spectrum will be shifted. The result is that the emphasised part no longer matches the de-emphasis profile, so the upper frequencies will be amplified or attenuated in a way that was not intended. On the other hand, it does seem rather extravagent to use extra tracking filters just for the emphasis.

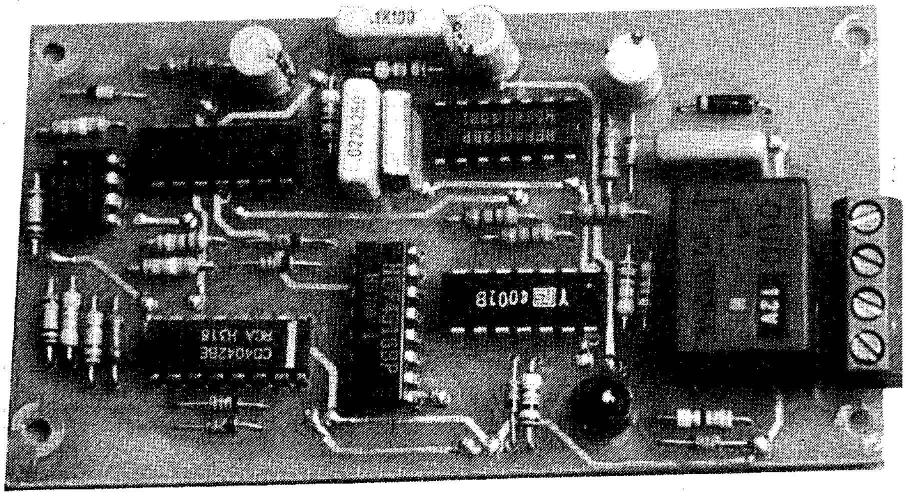
The Final Circuit

In the circuit presented here, the two mobile filters, IC5 and IC13, are considered as part of the same filter and component values chosen accordingly. This avoids the adding of the -3dB attenuation, at least as far as these filters are concerned, and has one or two other advantages. The two high-Q sections are placed before the ADC which means that there will be a rise in the gain at frequencies approaching the cut-off point: pre-emphasis. The two-Q sections after the DAC, besides completing the filter profile, in effect provide de-emphasis. The hypothetical requirement for very steep filter slopes has been relaxed since it was based on the implicit assumption that the spectrum of an audio signal is flat, whereas the amplitued of higher frequency components will generally be very much less than that of lower frequencies. The filter requirements to achieve good sound quality are therefore not as strict as it would seem. There is the additional factor that filters with very steep cut-off slopes tend to have poor transient response and are prone to ringing, so it's a matter of choosing the best compromise.

To complete the sound sampler, the articles to follow will describe the keyboard interface and the digital control circuit.

AUTOWIPE

Andrew Armstrong sets the pace with a digitally-controlled variable delay unit for windscreen wipers.



You are trundling along the road in your car. A light drizzle starts. You switch on the windscreen wipers. SCRAPE-SCRAPE-SCRAPE. The rain is heavy enough to obscure your vision but not heavy enough to lubricate the wipers. You switch on the fixed rate intermittent wipe. SCRAPE-SCRAPE-SCRAPE. Not slow enough! Until now, your only solution was to turn up the radio very loud to drown out the sound of wipers on (almost) dry glass. Now you have an alternative.

The Autowipe is quick and simple to install. It requires just four connections to the motor wiring and no bodged holes in the dashboard — especially useful on the rear wiper of estate cars and hatchbacks. Installation typically takes 15 minutes. The connections are 0V, the +12V motor supply, and the normal speed motor wire, cut in two with both ends joined to the gadget.

The time period is set by triggering a single wipe of the screen, and another after the desired interval has elapsed. The unit remembers the interval and keeps on working at this rhythm (give or take 10%) until cancelled or reset.

The circuit described here is suitable only for negative earth cars, in which the switching to the wiper motor is in the supply side rather than the ground side. This includes the vast majority of cars on the road now. The circuit may be modified to cope with other arrangements, and some notes are supplied to help the experienced constructor who may wish to modify the design for different applications.

BUYLINES

The resistors, capacitors and semiconductors are all widely available and should not present any problems, but note that Q1 should be a BC212 and not a BC212L. The relay is available from Cirkit. The PCB is available from our PCB Service, for details of which see page 59.

Principles

A timer starts when the switch is turned on briefly for the first time, and its state is stored on the second switch operation. The timer is then cycled repeatedly — the windscreen wipers being operated once in each cycle. A third switch operation, if it occurs when the wipers are stationary, resets and restarts the timer. A fourth operation of the wiper switch stores the new time period (between third and fourth switch operations). If no fourth operation is received, the unit times out after about 30 seconds.

The timing is digital in nature, and uses a four bit binary counter. This provides 14 usable time periods, since both zero and terminal count are not valid time settings. In order that this quantisation of available timings is not a nuisance, the speed of the clock oscillator is controlled by the state of the counter. The clock starts off fast when the time period is being set and slows as the period lengthens. In this way, the accuracy of the timer (expressed as a percentage of the required time period) remains constant. A limit is placed on the oscillator speed so that it does not use up too many possible states while the wipers are crossing the screen the first time the switch is operated.

Earlier designs used an analogue timer, but in damp weather leakage currents caused a significant timing drift over a period of five minutes. The digital design is much less susceptible to this, though condensation on bare tracks can cause problems.

Construction

The first job is to link the top and bottom sets of tracks on the PCB. The board is laid out so that none of the pads on the top of the board connect to components — they are all simply links to the bottom. This simplifies both assembly and repair. The preferred method of joining the two sides is to use track pins. If these are unavailable, wire links may be used.

It's a good idea to spray the component side of the PCB with lacquer once the track pins are soldered on both sides. This will ensure that even the tracks which run underneath components are coated. This can prove to be

HOW IT WORKS

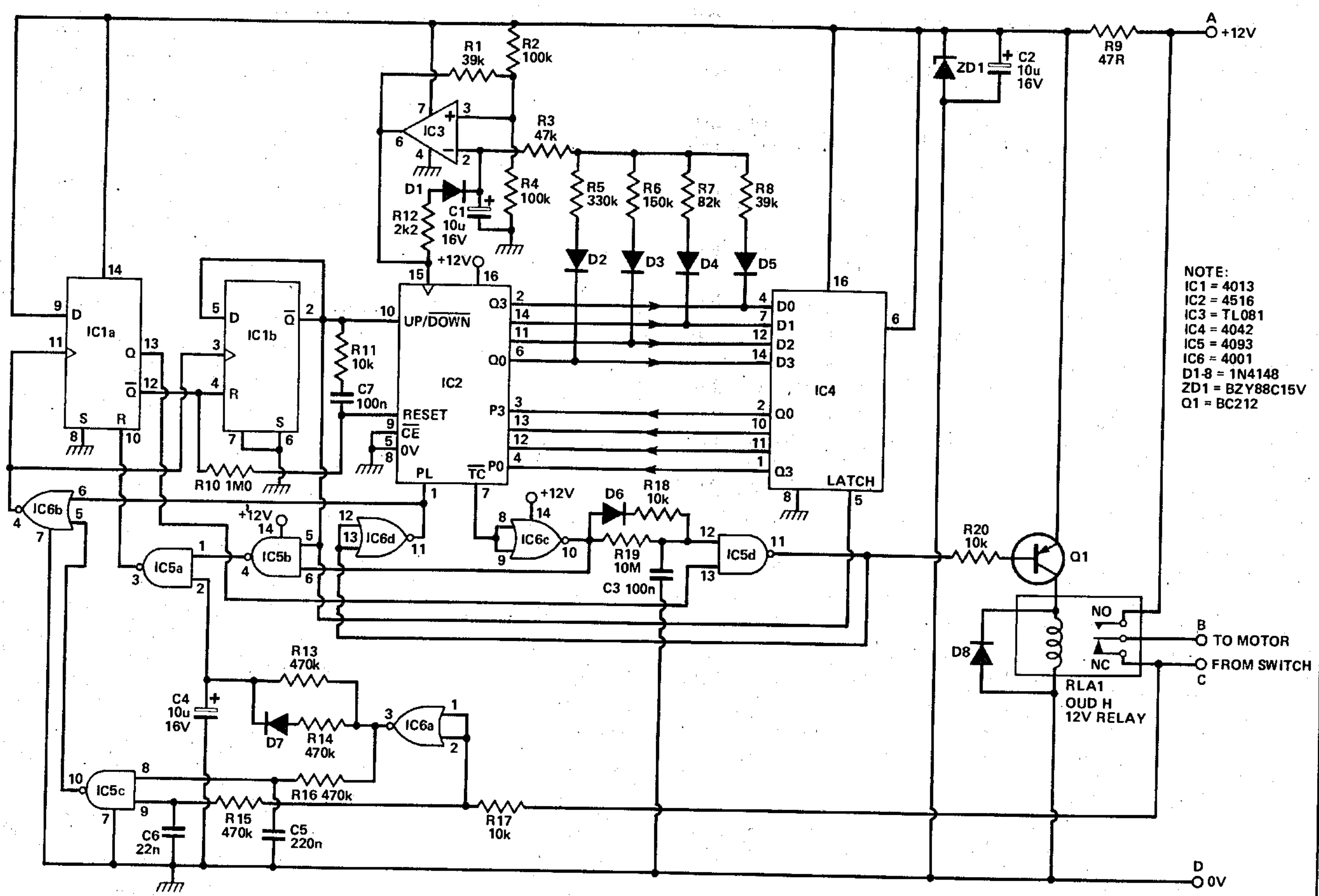


Fig. 1 Circuit diagram of the Autowipe.

When the wiper switch is switched on, a logic 1 is applied to the input of IC6a via R17 (which is there to protect the input). Because of the inequality of the time constants of R15/C6 and R16/C5, there is a brief period when both of the inputs of IC5c are at logic 1. This results in a brief negative going output pulse, which is inverted by IC6b and which then clocks the flip-flop, IC1a. The inequality of the time constants ensures that a transition from logic 1 to logic 0 on R17 will not cause a clock pulse.

The fact that both inputs to IC5c have RC time constants means that electrical noise is rejected to a large extent. Should electrical noise or switch bounce prove to be a problem in use, then both time constants may be increased in proportion.

The first clock pulse switches IC1a so that its Q output goes to logic 1. This enables the relay drive, via IC5d. The $\overline{Q}$ output goes to the reset inputs of IC1b, and the counter, IC2, via R10. The counter is therefore allowed to start counting up as soon as C7 has discharged to logic 0 via R10. We shall come to the purpose of C7 later.

The oscillator which clocks the binary counter is derived from a standard configuration, but it has been designed so that the discharge path of C1 is separate from the charge path, and is connected externally to the oscillator part of the circuit. This means that the cycle time of the oscillator can be controlled by the voltages applied to the discharge resistors.

These resistors, R5 to R8, are approximately binary weighted, and connected to the outputs of the binary counter. To limit the maximum oscillator speed to something useful, while leaving the slower speeds almost the same, an extra fixed discharge resistor, R3, is placed in series with the discharge path.

Clearly, if the counter is allowed to reach state 15 (1111) then there will be no discharge path for C1, and the oscillator will stop. This does not matter because when the counter reaches this state, the terminal (or carry) output, IC2, pin 17, switches to logic 0. This resets the first flip-flop, IC1a, via IC6c, IC5b, and IC5a, which means that the unit has timed out.

There is only one further point to make about the oscillator and counter. IC3 must have a sufficient slew rate to clock the CMOS counter used. A 741, for example, will not work. Having tried one, out of curiosity, I can report that the counter will count up for a while, but normally stops when it is time for the third most significant bit to switch. TL081s and LF351s with a 13V/microsecond slew rate are perfectly adequate.

Back to the main sequence of operation. If a second clock pulse is applied (the wiper switch is operated again) before the counter reaches terminal count, then IC1b is clocked. This has the effect of latching the counter output in the transparent latch, IC4. The counter up/down input is switched to down, and the counter now counts down from whatever number it has reached until the terminal count bar output switches over. This now occurs at zero, because the counter is in the down mode. The down count takes the same period of real time as the up count took, since the oscillator is progressively speeding up rather than slowing down. When terminal count is reached, the relay is energised for a period set by the time constant of R19 and C3. This starts a wipe of the windscreen, which is then completed by the park switch in the motor.

While the relay is energised, the counter is parallel loaded with the latched count data, so that a new down count can be started from the same number. Any clock pulse generated on the output of IC5c as a result of the wipe, is prevented from reaching IC1a by IC6b during this period.

The terminal count output is prevented from resetting the flip flops by IC5b as long as IC1b is set.

If the wiper switch is operated when the wipers are stationary, the resulting clock pulse from IC5c is allowed through to the flip-flops, and it switches over IC1b. A reset pulse is applied to IC2 via C7, with R11 in series to limit the peak current in the input protection diodes when it switches back the other way. IC2 is now allowed to count up, and the circuit is in the state it was in after the first operation of the wiper switch. It is waiting for a new time setting.

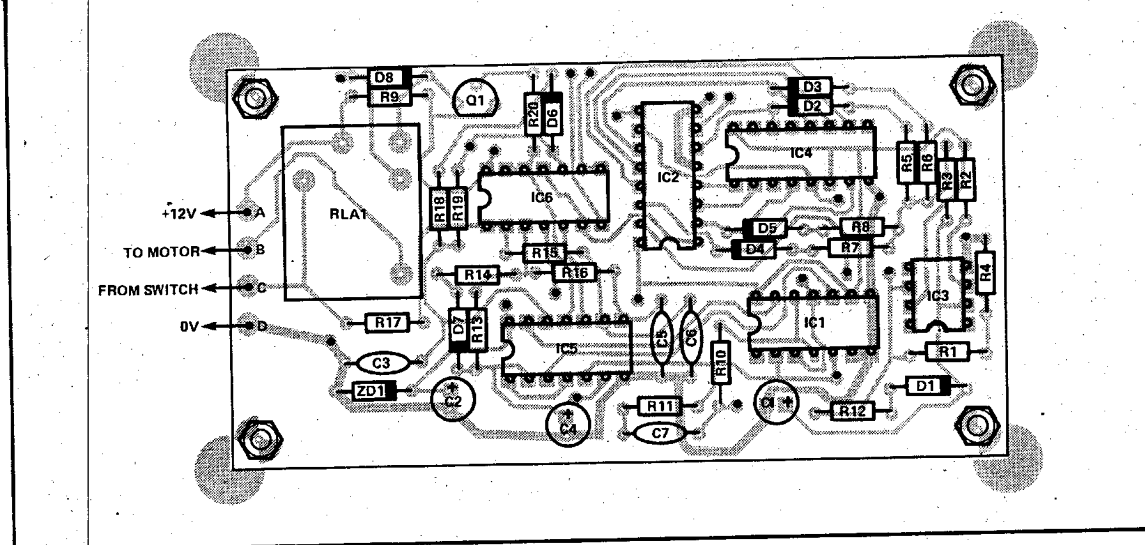


Fig. 2 Component overlay for the Autowipe PCB.

PARTS LIST

RESISTORS (all ¼W 5%)	
R1, 8	39k
R2, 4	100k
R3	47k
R5	330k
R6	150k
R7	82k
R9	47R
R10	1M0
R11, 17, 18, 20	10k
R12	2k2
R13, 14, 15, 16	470k
R19	10M
CAPACITORS	
C1, 2, 4	10µ, 16V
C3, 7	100n
C5	220n
C6	22n
SEMICONDUCTORS	
IC1	4013
IC2	4516
IC3	TL081
IC4	4042
IC5	4093
IC6	4001
D1-8	1N4148
ZD1	BZY88C 15V
Q1	BC212
MISCELLANEOUS	
RLA1	OUD 12V RELAY

PCB; 4 way 0.2"-pitch screw connector block; track pins for through-board connections (see text).

important if the PCB is to be mounted in the engine compartment of a car, because condensation can sometimes occur under these circumstances.

The components may then be mounted on the PCB, starting with the passive components. The only one likely to be difficult is the relay, as some samples of these have pins which are very resistant to soldering. The most effective method of persuading them to

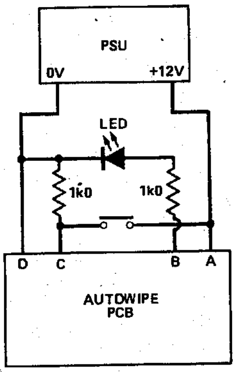


Fig. 3 Test harness circuit.

solder is to clean them up with a glass fibre brush. Another solution which has worked is to pre-tin the pins with the aid of a corrosive flux. The flux must then be cleaned off the pins very thoroughly, or else the board will fail due to the tracks being eaten through after a few months.

When all the components are correctly fitted, a bench test is in order. The best way to do this is with a test harness (Fig. 3). Switch on the supply, and wait ten seconds for C4 to charge up. With the aid of a digital watch operate the switch twice, at a ten second interval. Time the flashing of the LED, and check that its period is between nine and eleven seconds.

If it is far out, then check that R5 to R8 and D2 to D5 are properly fitted. If nothing happens, or if the relay just switched on, check that both parts of the flip-flop switch over as appropriate, and then move on to checking that the clock oscillator works, and that a pulse appears on IC5 pin 10 when the switch is turned on. It might also be worth checking whether Q1 is switching but failing to operate the relay — such faults have been known.

Once the board is shown to be in good working order, a liberal coat of lacquer should be applied to the underside, and allowed to dry thoroughly.

Installation

There are two points requiring careful consideration. The first is to find a place to mount the PCB, within reach of the wiring of the windscreen wiper motor. The second is to discover which of the wires going to the motor is which.

The first of these depends on the individual car, so only general advice can be given. Any flat surface, at whatever angle, near to the motor, may be suitable. It should not be in direct line with any spray which may come in through the radiator grill, nor should it be somewhere where corrosion is obviously occurring. If there is a convenient access to the wiring inside the car, then this is a preferable mounting place, especially if there is also a convenient plastic panel to fix the PCB to.

The photographs of the board in situ show it on a removable plastic panel inside a Maestro, close to the position of the fixed slow wipe unit supplied with the car. I found the place by listening to the clicking when the slow wipe was in operation.

The only way to identify the wires non-destructively is to find a connector somewhere in the windscreen wiper motor wiring.

The positive connection can be found with the aid of a meter first of all, and then it should be possible to identify the standard speed connection to the motor by finding which one receives a continuous supply only when the wiper switch is in the standard speed position. This wire should be cut and connected to the unit (Fig. 4).

The positive supply may be obtained via a tap-in connector, and the 0V connection may be

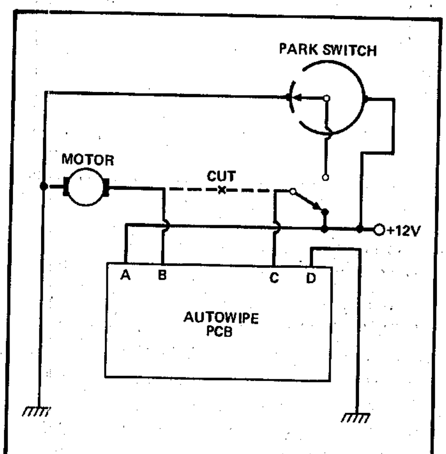


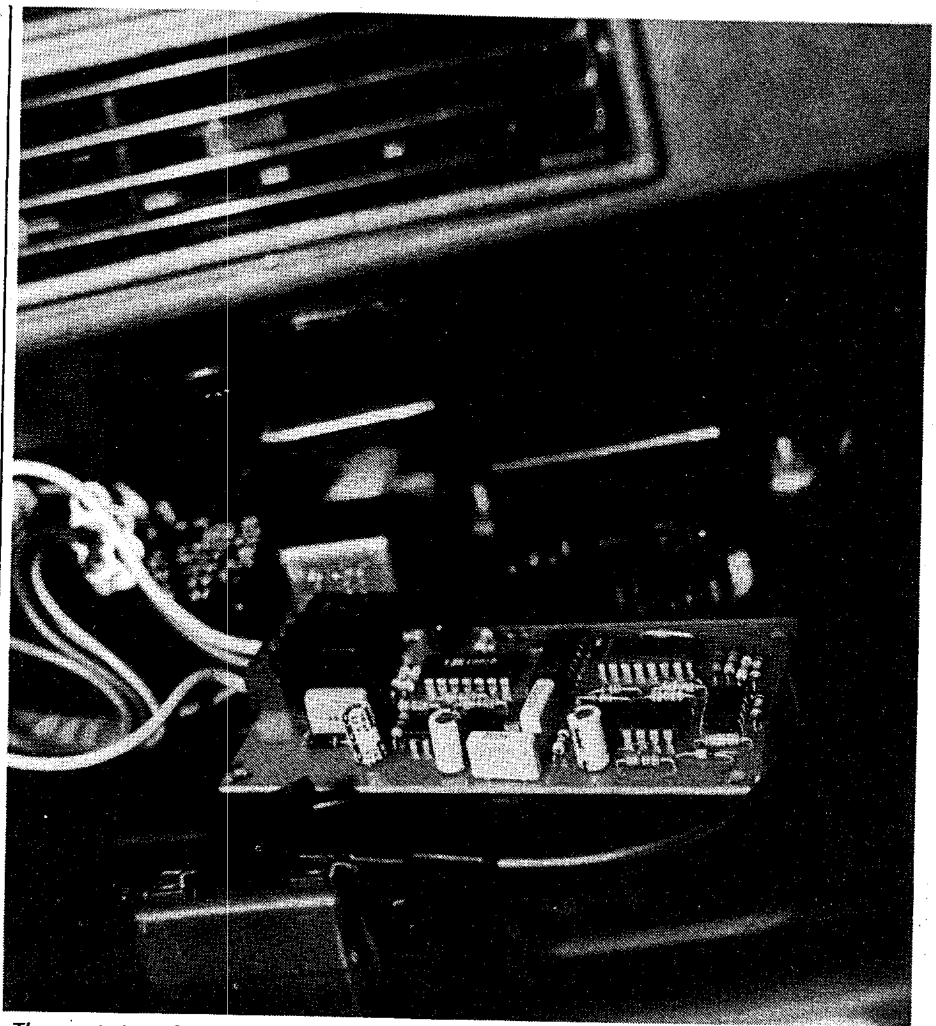
Fig. 4 Simplified wiring diagram.

taken to any convenient bolt which passes through the metallic structure of the car. A quick final test is now all that is needed before the unit is ready for use.

It has been used on a number of different cars, including an Austin Maxi, Austin Maestro, Morris Marina, Morris Ital, Jaguar XJS, Hillman Hunter and Triumph Herald. This last one was positive earth, and the design was modified accordingly.

Should the unit be used on any car in which the switch wire is not grounded by the park switch in the motor, then an external pulldown resistor may have to be connected to the terminals, as shown in the test circuit (Fig. 3).

The operation sequence is: operate wiper switch to wipe screen once. Repeat after a delay of x. The intermittent switch will now operate at a period of x (±10%), with the switch in the off position, until a third manual wipe is carried out, or the switch is turned on for several seconds continuously, or the ignition is turned off. It is always possible to switch the wipers on continuously (even if the accessory should malfunction), so there is no safety hazard.



The prototype installed in an Austin Maestro.

In the event of a fault which causes the wipers to operate continuously (for example, the relay remaining on all the time), it is possible to return to normal wiper operation by disconnecting just the positive supply to the unit, pending a proper repair.

Sniggles And Contrivances

There is one more important detail to mention. It is possible that, by mistake, a time period may be set which leaves the wiper stationary for only a small fraction of a second. If this happens, it is very difficult to flick the wiper switch during the stationary period to reset the circuit. If the circuit is allowed to run for a few seconds C4 will, on average, discharge rather than charge, and after a while IC1a will be reset via IC5a. This part of the device has been nicknamed the 'anti-knickers-in-a-twist' circuit.

To improve reliability, the power supply connections to the ICs are protected from spikes and reverse polarity connection by R9, ZD1, and C2. If the circuit should accidentally be connected to the power the wrong way round, the only damage likely is that R9 may smoke mightily.

If the unit is to be used on a positive earth car, the circuit can be modified to work, provided that the wiper switch is in the power rather than ground side of the motor. Here are the steps required:

1) Exchange C5 and C6.
2) Replace R9 with a wire link.
3) Cut the negative track (labelled 0V) and insert a 47R resistor.
4) Cut the track connecting the relay NO contact to +ve and reconnect it to the −ve where it enters the board before the 47R resistor.
5) Make sure that the power is connected so that the +ve is connected to chassis, and the 0V board connection to the −12V supply.

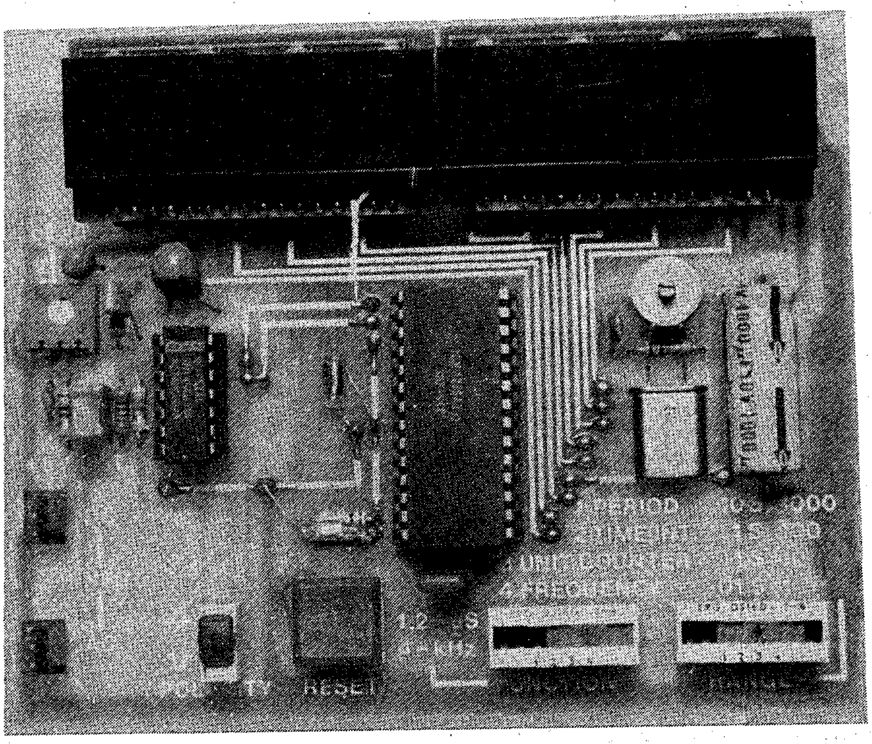
ETI

MODULAR TEST EQUIPMENT

Continuing his series on low-cost test equipment modules, Mike Meakin describes an un-enclosed counter of the 8-digit kind.

This module measures frequency, period and time intervals and can also be used as a totalizing event counter. In common with the other instruments in our Modular Test Equipment series, it is designed for use as a free-standing board and thus avoids the hardware costs associated with cased equipment. To further reduce costs, the module is not equipped with a power supply but draws its current from the bench power supply module described in our October issue. Readers who do not wish to construct the bench supply should be able to find an alternative power source without too much difficulty.

The basic module has a sensitivity of 250mV RMS and a maximum input frequency of 10MHz. A plug-in prescalar module extends frequency measurements up to 150MHz. Gate times of 10ms, 100ms, 1s and 10s can be selected in the frequency mode and either 1, 10, 100 or 1000 cycles can be averaged in the period and time interval modes. The reading displayed is in kilohertz in the frequency mode and in microseconds for period and time interval modes. With a 10s gate time, the frequency can be measured to 0.1Hz resolution whilst in period and time interval mode the resolution is 0.1us. Leading zero blanking and decimal points are automatically selected and overflow is indicated by the left-most decimal point being illuminated.



Simplicity is the keynote of this design and not all of the available functions of the IC are utilized. No provision has been made for frequency ratio measurements and the circuitry requires that time interval measurements are repetitive. Single shot events can only be measured by resetting the counter and initiating the event twice. The first pulse 'primes' the counter and the second pulse is measured and displayed. The polarity of the measured pulse can be selected by SW1 so that either negative or positive going pulses can be measured. In the event-counting mode this switch determines the polarity of the edge on which the counter is incremented.

Both AC and DC coupled inputs are provided. The DC input

OOPS!

On the pulse generator circuit diagram which appeared on page 38 of the December 1985 issue, R8 is shown as a 100R resistance. Its value should be 100k as stated in the parts list.

It has been pointed out that the switch function labelling is not clearly visible on the photograph of the waveform generator (November 1985 issue) and the pulse generator (December 1985 issue). Readers who require details of the labelling can obtain photocopies of the twice-up screen-print masters from us by sending a stamped, self-addressed envelope. We have included a flat-on view of the counter module in this month's article to forestall further complaints!

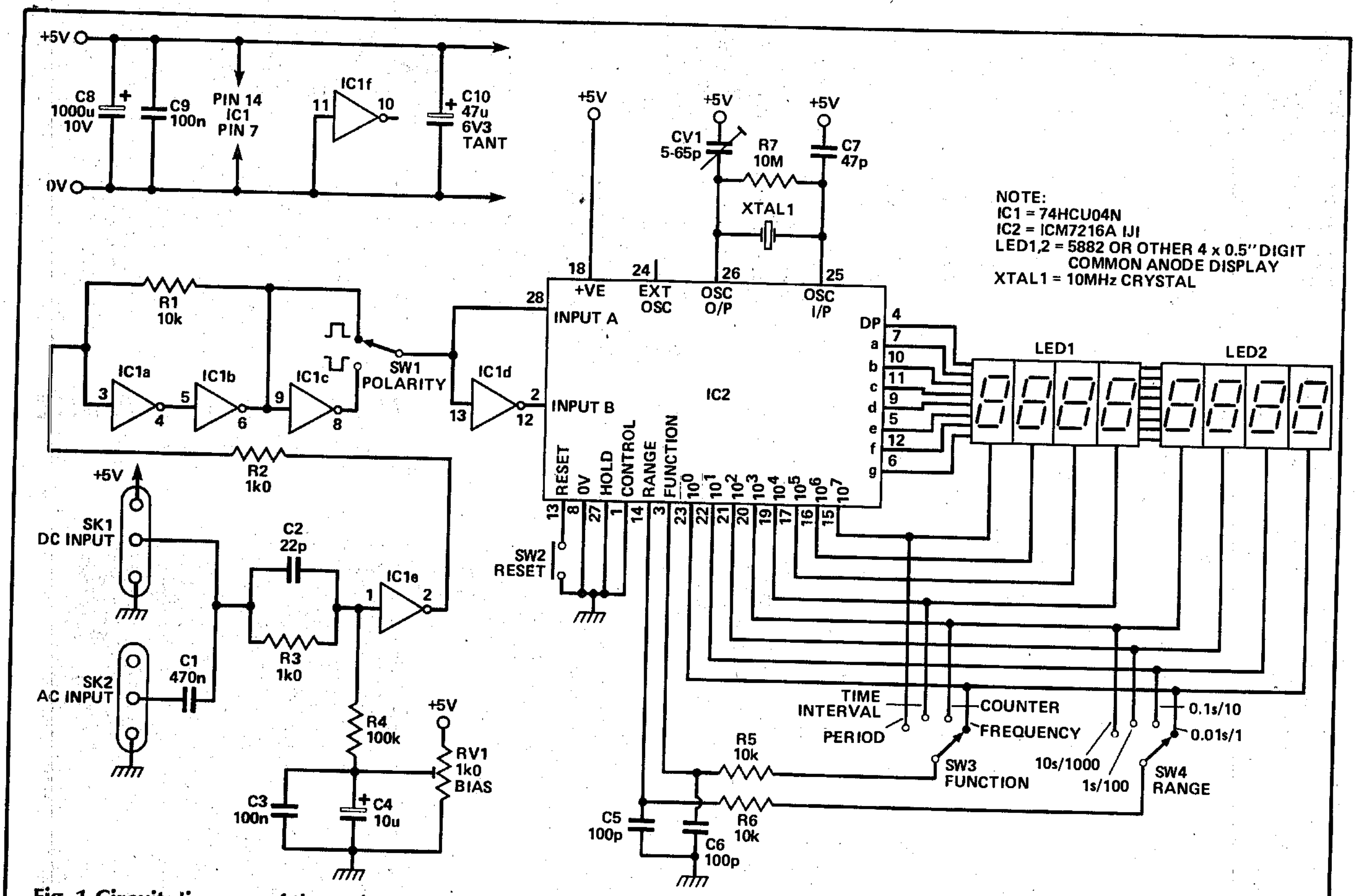


Fig. 1 Circuit diagram of the universal counter/timer.

HOW IT WORKS

The clever bits are taken care of by IC2. The Intersil application note provides comprehensive information on this device and readers who wish to know more about its operation are advised to obtain a copy. IC1 amplifies and squares the input signal to provide the necessary digital signals for IC2.

It is unusual to use a digital CMOS IC as a linear amplifer and it is important that a National 74HCUO4N is used in this position. This is an unbuffered high speed CMOS hex inverter and no other type will function correctly in this position. It is biased by RV1 and R4 to its linear operating region giving an input impedance of 100k. R3 together with the internal clamp diodes of IC1e protect the input up to ±25V. If input signals greater than this are anticipated then a suitable input attenuator should be constructed. IC1e amplifies the signal and IC1a and b form a Schmitt trigger to square it. IC1c and SW1 select the polarity of the pulse to be measured in time interval mode and the edge on which the counter is incremented in the event-totalizing mode. The position of SW1 is unimportant for the other modes. SW2 is used in the event-totalizing mode to reset the counter.

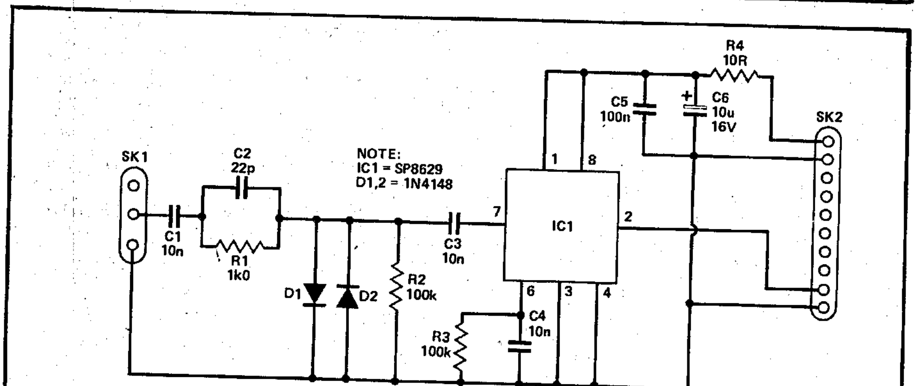


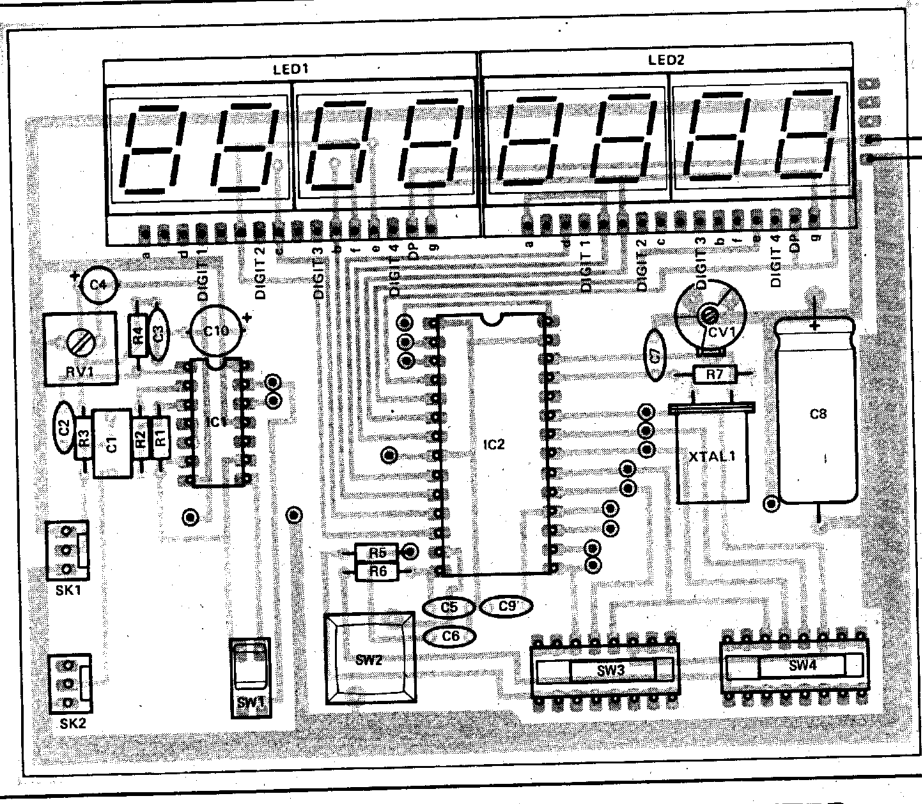
Fig. 2 Circuit diagram of the prescalar.

is mainly used for frequencies below 20Hz and measurements of pulses from logic circuitry. The logic threshold levels and AC sensitivity are controlled by a bias preset allowing inputs from both TTL and and CMOS circuitry to be accepted.

An SP8629 is used as a high frequency prescalar. It operates with input frequencies between 10MHz and 150MHz and has a typical sensitivity of 100mV RMS. The prescalar plugs into the main board from which it derives its power via the top pin of SK1. The manufacturers standard application circuitry has been used with extra input protection provided by R1, D1 and D2. As the device operates at high frequencies, the prescalar PCB has a ground plane on the upper side which is connected to 0V via a track pin.

Because it is intended that the module be used without a case, all labelling of switch functions, sockets and so on will have to be done on the PCB itself. Various methods were described in the Modular Test Equipment article in the November issue, including the

Fig. 3 Component overlay for the counter/timer PCB.



use of rub-down lettering which can give a very neat end result. Another method which has since been suggested is to mark the necessary legends on by hand using drawing ink. The board would have to be thoroughly cleaned before starting, preferably with a suitable solvent, and when finished the lettering could be protected with a coat of clear lacquer. Whichever method you use, the lettering will almost certainly need to be completed before you assemble any of the components onto the board.

Construction

The board is double sided and for reasons of economy the holes are not plated through. The connections are made by track

PARTS LIST — COUNTER

RESISTORS (all ¼W, ±5%)	
R1, 5, 6	10k
R2, 3	1k0
R4	100k
R7	10M
RV1	1k0 enclosed horizontal preset
CAPACITORS	
C1	470n 100V polyester layer
C2	22p sub-miniature plate ceramic
C3, 9	100n ceramic
C4	10u 16V tantalum
C5, 6	100p sub-miniature plate ceramic
C7	47p sub-miniature plate ceramic
C8	1000u 10V radial electrolytic
C10	47u 6V3 tantalum
CV1	5-65p trimmer
SEMICONDUCTORS	
IC1	74HCUO4N
IC2	ICM 7216A IJI
LED1, 2	5882 or other 4 x 0.5" digit common anode display
MISCELLANEOUS	
SK1, 2	3-way Molex PCB plug with polarising post
SW1	single-pole DIL switch
SW2	PCB-mounting keyboard switch
SW3, 4	1-pole 4-way DIL slide switch
XTAL1	10MHz crystal

PCB; 2 x 16-way 0.1" pitch PCB plugs (for mounting LED displays); IC sockets if desired, 1 off 14-pin and 1 off 24-pin DIL; track pins or wire links for through-board connections; double-sided sticky foam pad for XTAL1.

PARTS LIST — PRESCALAR

RESISTORS (all ¼W, ±5%)	
R1	1k0
R2, 3	100k
R4	10R
CAPACITORS	
C1	10n polyester layer
C2	22p sub-miniature plate ceramic
C3, 4	10n ceramic
C5	100n ceramic
C6	10u 16V tantalum
SEMICONDUCTORS	
IC1	SP8629 (÷100 prescalar)
D1, 2	1N4148
MISCELLANEOUS	
SK1	3-way Molex PCB plug with polarising post
SK2	10-way Molex PCB socket
PCB	

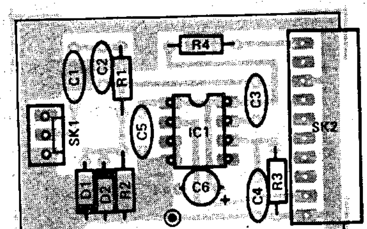


Fig. 4 Component overlay for the prescalar board.

pins. These should be inserted in the board and carefully soldered on both sides.

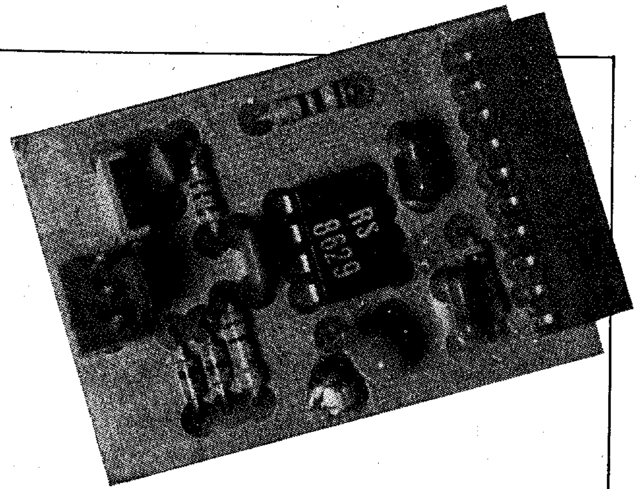
Molex PCB plugs are used to mount the display and provide some of the throughboard connections. Prepare two sets of 16-way connectors made up from one ten way and another ten way cut down to six ways. Insert the longer side of the connectors into the board so that about 2mm of each pin protrudes from the underside of the board. Turn the board over and solder the top connections. Use plenty of heat and allow the solder to flow around the pad.

Inspect the board for solder splashes and good clean joints. The two displays should then be mounted on the pints and gently tilted at an angle of about 15 degrees above the horizontal. The holes on the displays are plated through and the pads need only be soldered on the top side. Care is needed to ensure that no shorts occur and again the board should be visually inspected after soldering.

The remaining components can now be soldered onto the board. Note that one end of R5 is used as a throughboard connection and make sure that it is soldered on both sides. A socket should be used for IC2 and although the device is static protected the usual precautions should be taken. The crystal is attached to the board by a double sided adhesive foam pad. As with any PCB it is a good idea to clean the board with a suitable organic solvent to remove the flux residue. Do remember that these solvents can attack the plastic of the DIL switches and the displays!

Construction of the prescalar module is very straightforward. A track pin must be inserted in the position indicated on the overlay and soldered on both sides so as to connect the ground plane to 0V. The only other point to note is that no IC socket should be used for the SP8629. Using a socket would probably upset the high frequency performance.

The plug-in prescalar module: note the use of a ground plane on the component side of the board.



Testing

This module requires only a single 5V supply capable of providing up to 250mA. Adjust RV1 and CV1 to their mid-positions, select the frequency mode and the 1s gate time, then switch on the power. The right most LED should display zero. Apply an input signal of about 1V peak to peak to the AC input and check that you get sensible readings on the display. CV1 should be adjusted to give a display of 10000.000 kHz when connected to a 10MHz frequency standard, but for most uses can be left in its mid-position. The other functions and ranges should then be checked. A 555 connected as an astable can provide a signal suitable for checking the period, time interval and event totalizing modes. RV1 can be set to its optimum position by gradually reducing the amplitude of an AC input signal and adjusting the position of RV1 to obtain consistent readings

The prescalar module is tested by simply plugging it into the main board and connecting a suitable input signal. A short wire aerial can often pick up sufficient signal from low power transmitters or even the stray radiation from FM tuner local oscillators. Don't forget to multiply the display readings by one hundred to obtain the correct frequency!

ETI

BUYLINES

The ICM 7216A IJI and the 74HCUO4N are both available from Farnell Electronic Components Ltd of Leeds and the 74HCUO4N is also available from Maplin. Farnell will only accept orders from trade and professional customers but Trilogic Ltd of 29 Holme Lane, Bradford BD4 0QZ will obtain parts from them on payment of a small handling charge. The 74HCUO4n is an unbuffered version of the standard high-speed CMOS (HC) device and offers a higher impedance and even higher speed. A 74HCO4 device would not perform as well in this circuit. The ICM 7216 is available in four versions, all of which are stocked by Farnell but only one of which, the 7216A, will work in this circut. (The 7216B is a common-cathode version of the 7216A and the 7216C and D are respectively common-anode and common-cathode versions of a reduced function device which does not include the counter-timer facilities). Incidentally, you should be prepared to pay quite a high price for this IC. As befits something which contains almost the entire circuitry of an 8-digit, 10MHz timer/counter/frequency meter, the 7216A will probably cost you in the region of £30.00 by the time VAT and all the other extras have been added on.

The other IC, the SP8629, is available from a number of regular suppliers and none of the resistors or capacitors should present any problems. The enclosed horizontal presets are available from Verospeed and Cricklewood Electronics and trimmer capacitors suitable for use in the CV1 position are sold by Maplin and Cirkit among others. Bradley Marshall stock the 5882 displays, although you may prefer to obtain these from Farnell if you are ordering from them anyway.

The DIL switches used for SW3 and SW4 in the prototype were obtained from ERG and are known as type DS16D 1-4. ERG are another company who will only deal with trade and professional customers, and we do not know of a dealer who can obtain parts from them. Farnell stock a 1-pole, 8-way DIL switch (type DS16C 1-8) which will fit the board. In operation, the two outer positions at each end would have to be ignored and only the middle four positions used. An alternative is the DS16C 2-4, also available from Farnell, which has four ways and two poles. It will fit the board, but the two spare pads at either end of the top row of contacts on each switch would have to be separated from the adjacent pads to which they are presently connected. The switch will then have only four positions as required, but the switching sequence would be altered. On the range switch, for example, the sequence would then be 10, 1, 1000, 100 instead of 1000, 100, 10, 1.

The PCB will be available from our PCB Service, for details of which see page 59.

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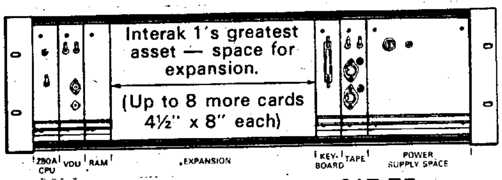

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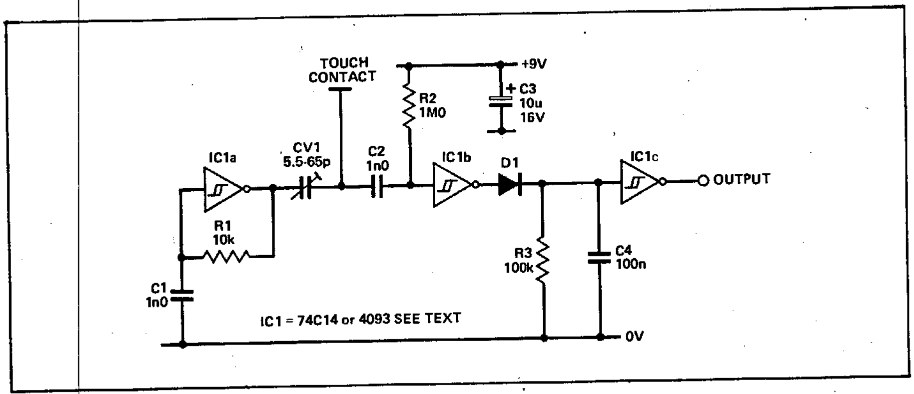
TECH TIPS



Touch Switch

Ali Taalf
Ringwood

This is a reliable touch switch design with wide application, which uses only common or garden components. In the basic circuit, the output is normally at logic 0. When the contact is touched, the output smartly switches to logic 1.

IC1a is used in an oscillator circuit which produces a frequency of approximately 200kHz. All the time that the contact is not being touched this high frequency signal passes via CV1 and C2 to the input of IC1b. This Schmitt inverter switches at the signal frequency and keeps C4 charged.

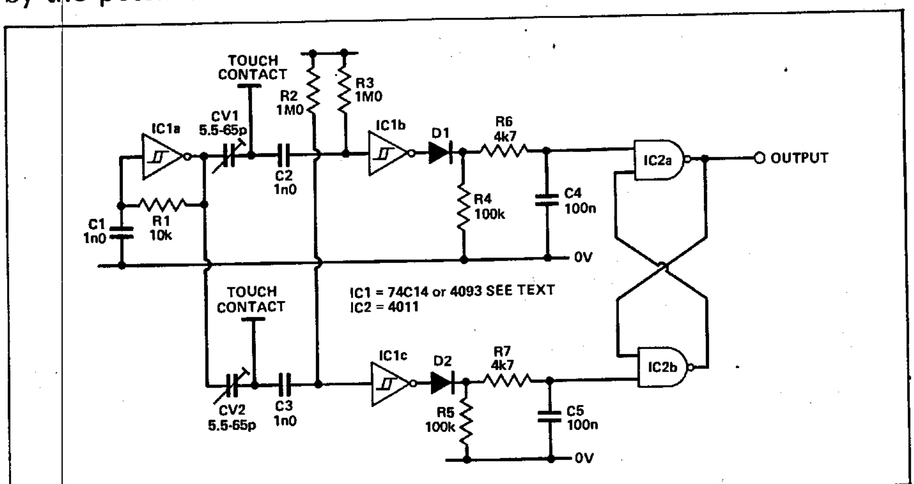
When a finger is placed on the touch plate, the signal reaching the input of IC1b is substantially reduced by the potential divider action of CV1 and the capacitance of the finger. This in turn causes the output of IC1b to stop switching and remain at logic 0. C4 discharges through R3 and the output of IC1c switches to logic 1.

CV1 should be adjusted for optimum sensitivity. Some units may require a different value of C1 from that shown owing to the tolerance on the Schmitt levels of the 74C14 — the approximate operating frequency is

$$f = \frac{2}{R1 \times C1}$$

C2 prevents hum pickup from causing IC1b to switch. If preferred, 4093s wired as inverters may be used instead of the 74C14s.

The second figure shows two touch switches used to set and reset a latch. Obviously the principle could be extended to many more ways, but still only one oscillator would be needed.



Analogue Opto-Isolator

P. Cuthbertson,
Inverurie.

This circuit accepts an analogue input and transfers it to the output faithfully without any electrical connection, the link being optical. It is more usual to see V to f convertors being used for this, but they demand more cumbersome circuitry and unless a train of pulses is required, the linear approach should be considered. Additionally, V to f convertors integrate or smooth out the incoming waveforms, which may or may not be desirable. With slight modifications (changing a few resistor values) this circuit will feed the A/D convertors of, for example, a BBC without introducing loops.

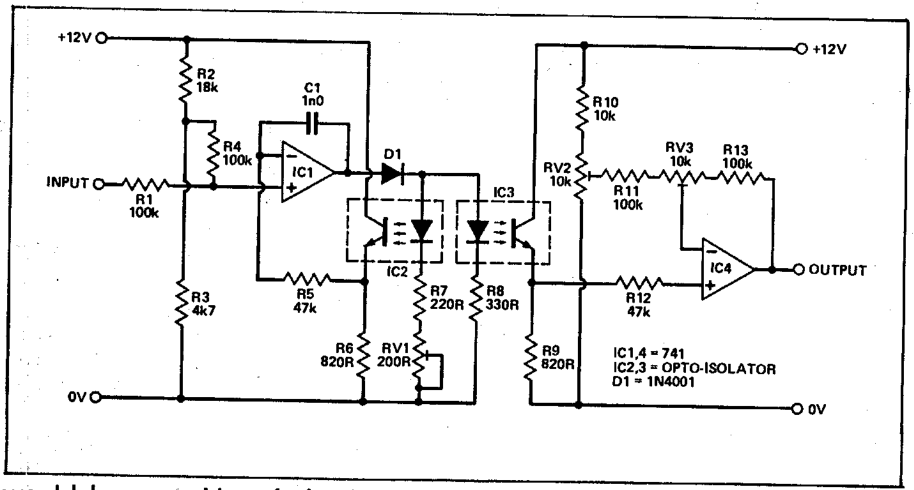
Linearity is maintained by using two optoisolators; these are both non-linear, but equally so, and the effect can be made to cancel out. Although not done on the original, a dual type could be used to obtain the benefits of equal temperatures. I don't think this is as important as it

Multi-Channel Electronic Signal Switching

A. Armstrong,
Leighton Buzzard

This tech-tip shows how to use electronically latched switching of up to 8 signals. It is intended for use in home audio systems. Unlike many electronically latched systems, it can be made to remember which position it was in when last used. Indicator driving is no problem either.

The NAND gates shown in the first figure are arranged so that, as any switch is pressed, the outputs of the latches take up the binary number corresponding to the switch pressed. Five-input NAND gates are needed for eight way switching, so one can either use 4068s and connect the extra inputs to logic 1, or five-input gates can be constructed from inverters and diodes as shown in the lower figure. In this case, the only pull-up resistors required will



would be on a V to f circuit, and besides, the isolators are dissipating approximately equal power.

The two halves of the circuit are powered from separate supplies. The network R1, 2, 3, 4 attenuates the incoming voltage and offsets it. This ensures that the LEDs always have a certain amount of current flowing in them. IC1 drives both LEDs and the voltages on its inputs are nearly equal. Current flows in R9, the offset is removed and the gain adjusted in the output circuit, IC4.

To get the best linearity, adjust RV1 to the centre of its travel and take two pairs of measurements of output versus input, one pair near the more positive end of the range of interest, the other pair near the more negative end of the range. Divide the differences between the adjacent pairs of inputs by the difference between the adjacent pairs of output values, giving two ratios which should be approximately equal. Adjust RV1, making a note of how far it has been adjusted, and repeat the measurements and calculation. Compare this new set of ratios with the previous lot. There are three possibilities: the error will have diminished, in which case adjust further in that direction; it will have increased, in which case reverse the adjustment direction; or you may have adjusted past the point of linearity in which case you will note that the ratio which was the larger is now the smaller. In this last case reverse the direction of adjustment but don't adjust too far back again. Repeat until the linearity is acceptable.

In fact, the linearity is only a few per cent out with a 330 ohm resistor in place of R7 and RV1. If you can stand a certain amount of non-linearity substitute the resistor. If you possess a ramp generator and scope capable of XY display then you will be able to adjust the linearity by eye.

Adjust the gain and offset once the linearity is satisfactory. Do not be afraid to alter resistor values to suit other input values. C1 is not usually necessary but I have included it as it stops any tendency to oscillation. The power supplies are simple 3 terminal regulators. The original circuit runs IC1 at ±15V but one may get away with just plus 15V, connecting pin 4 to ground. D1 would no longer be needed then since it only serves to protect the optoisolator LEDs from polarity reversal.

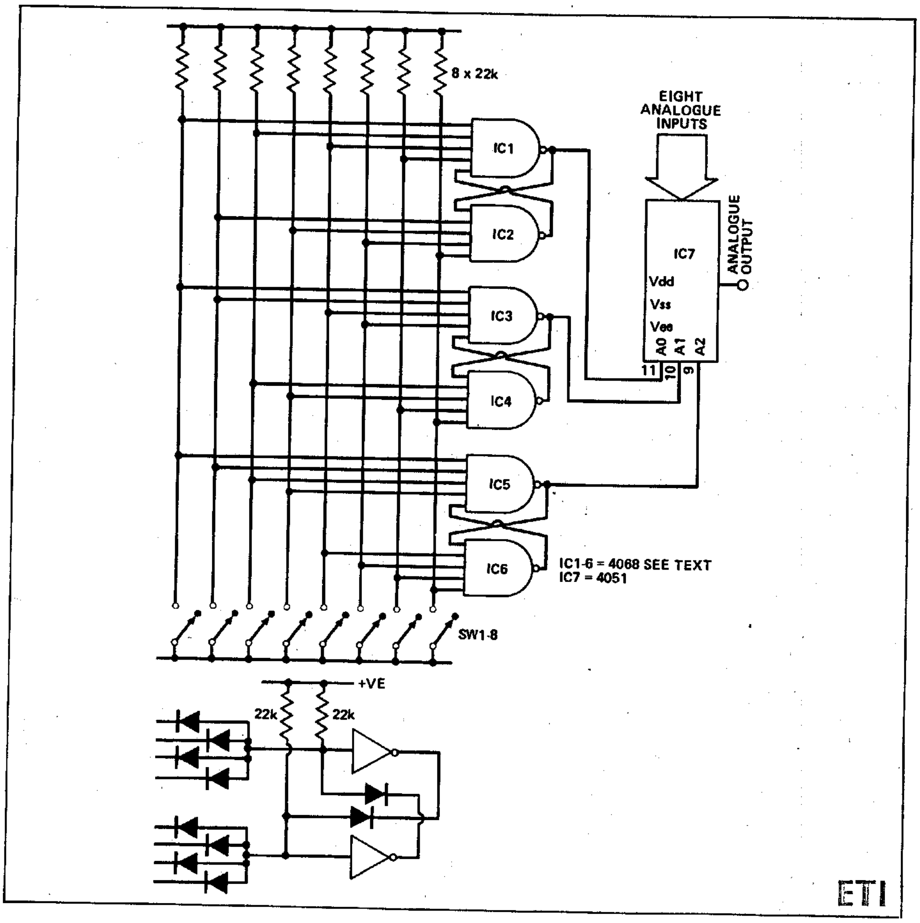
---

be the ones directly connected to the gates, a total of six instead of eight.

This scheme can be carried out using one hex inverter rather than six 4068s, but it is untidy with all those diodes hanging on the board. If you only want four way switching, two triple, three-input gates can be used, leaving two gates spare. A 4052 would then be used to switch both channels of the stereo source.

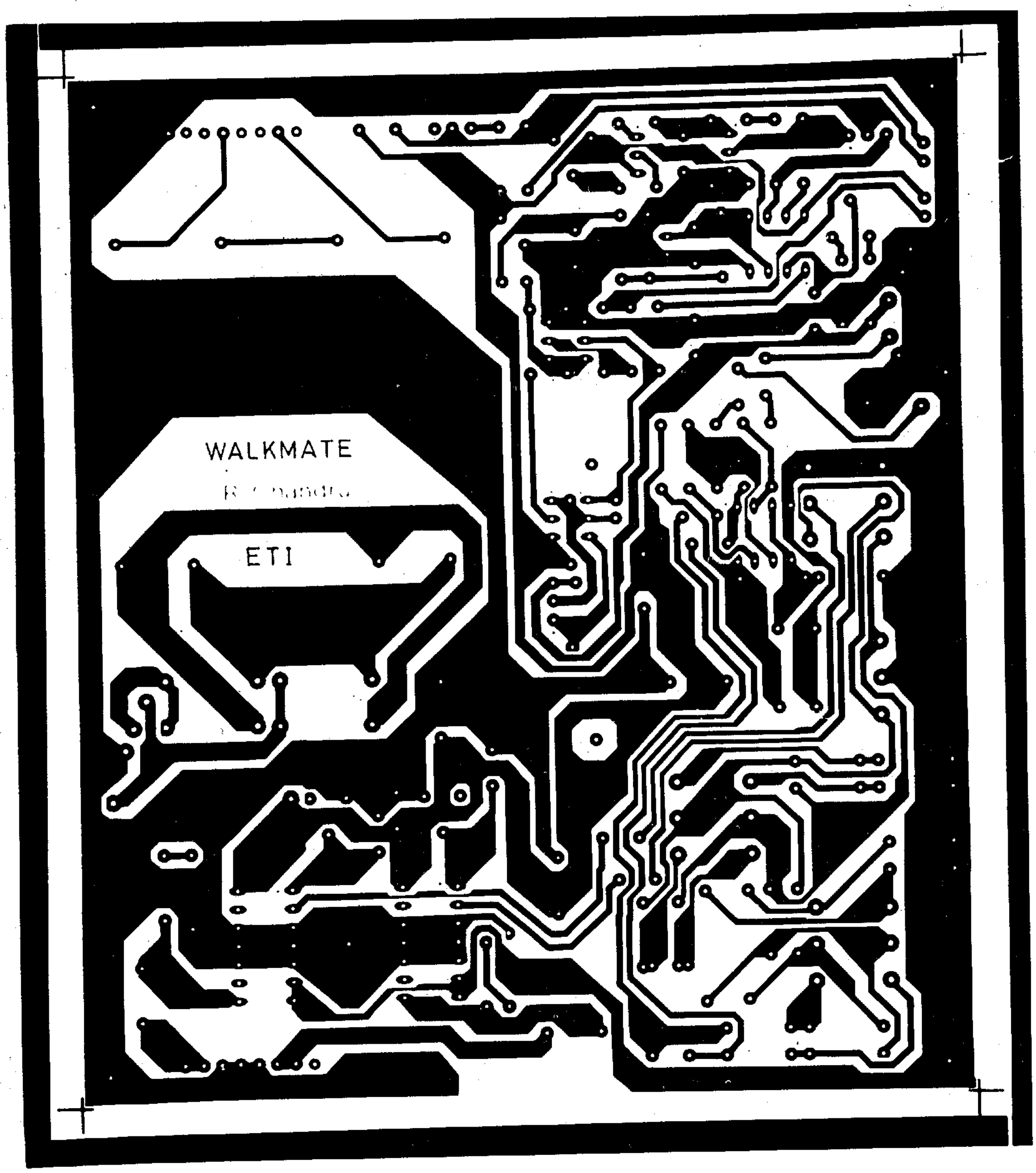
Only one 4051 is shown in the diagram here, but in practice three would be used, with the address lines in parallel. Two of them would switch the signal and the third the indicator LEDs. It is quite safe to put 5mA through this type of device, so the common input/output pin is connected to +7.5V via about 1k2 and the LEDs are connected to the switched terminals. Then one LED will illuminate at a time, corresponding with the channel selected.

Battery backup can easily be added. The positive connections to all the CMOS gates and pullup resistors should be connected to the battery supply, but nothing else should be. The only thing to remember is that it is possible to change the state of the latch while only the battery supply is present. This circuit has been tested and is in use.

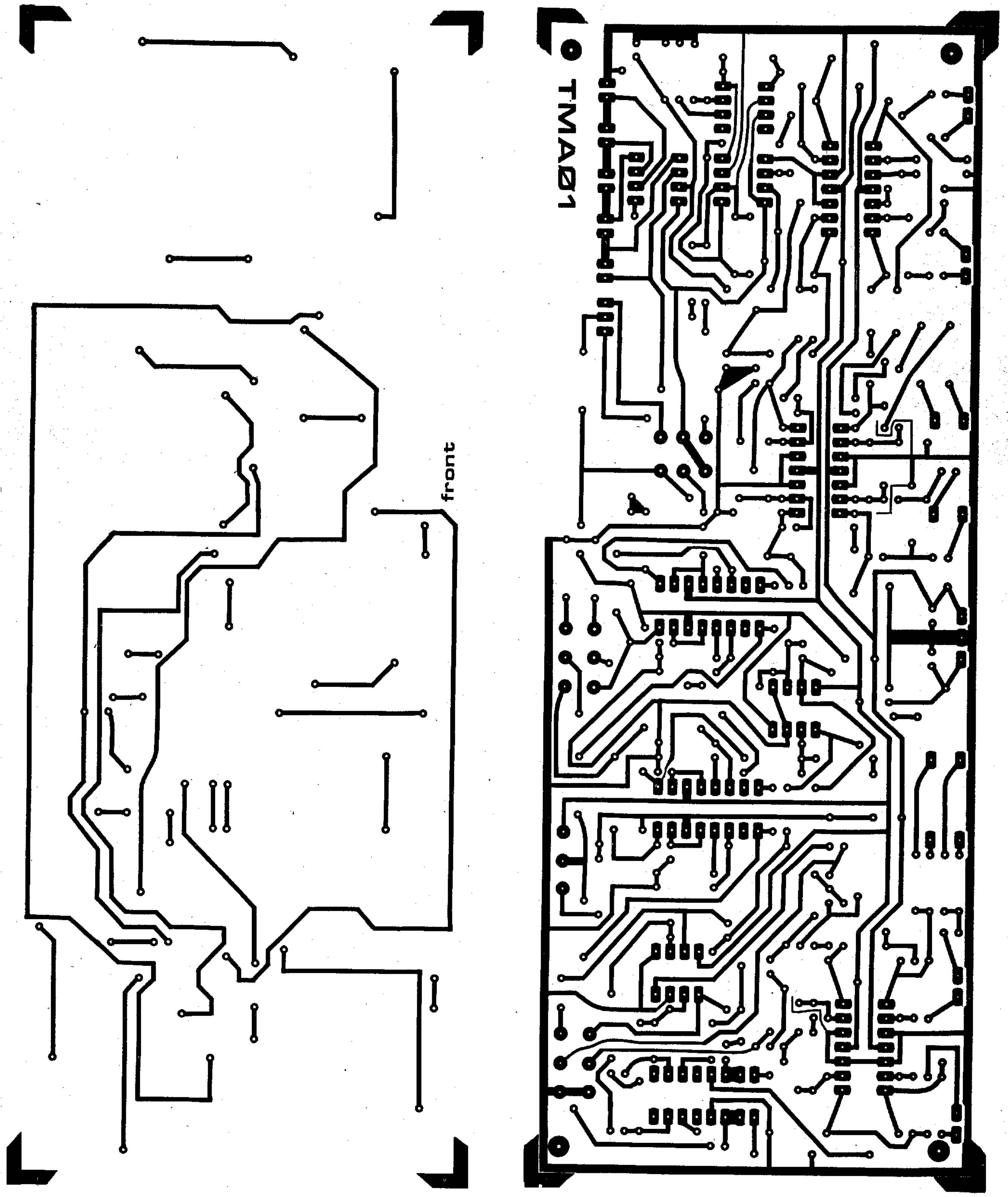


ETI

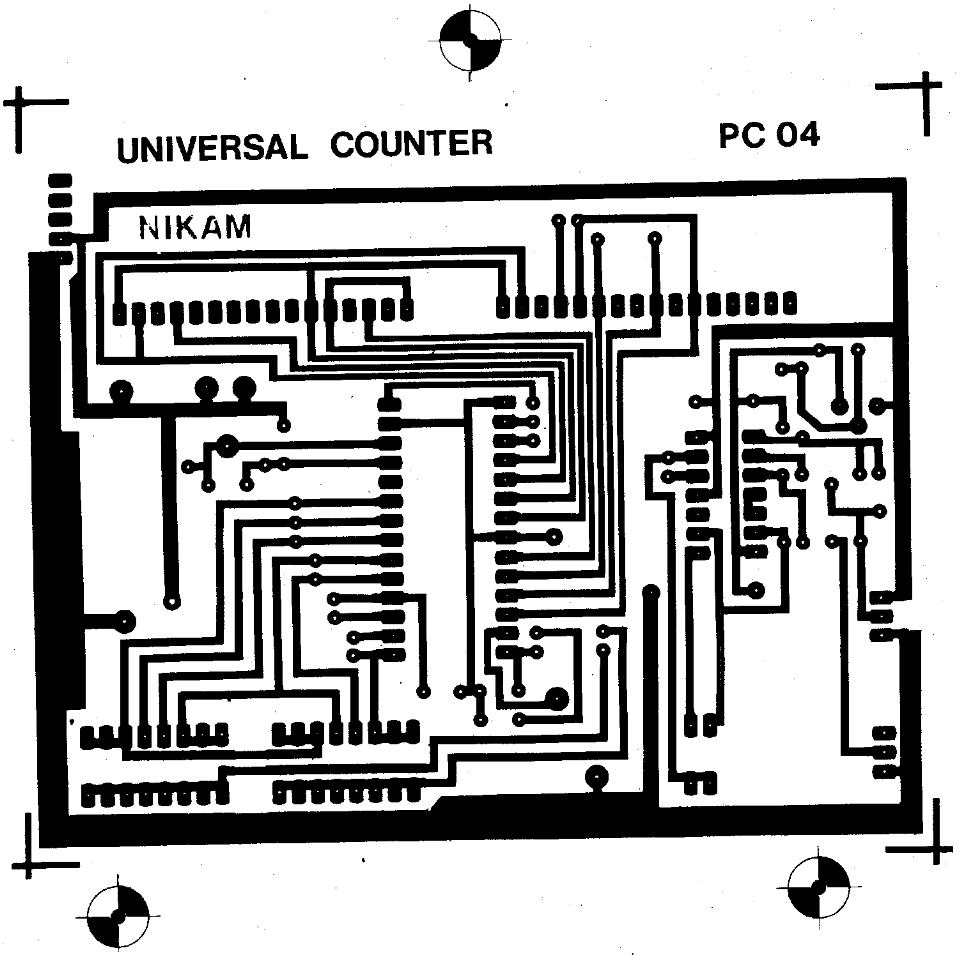
PCB FOIL PATTERNS



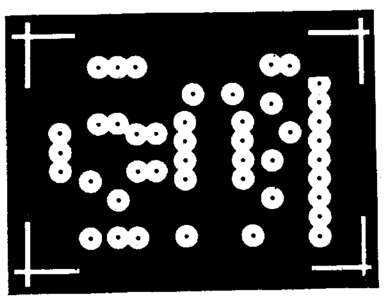
The foil pattern for the Walkmate board.

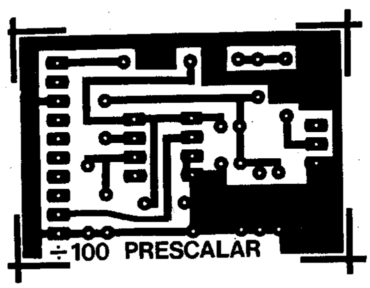


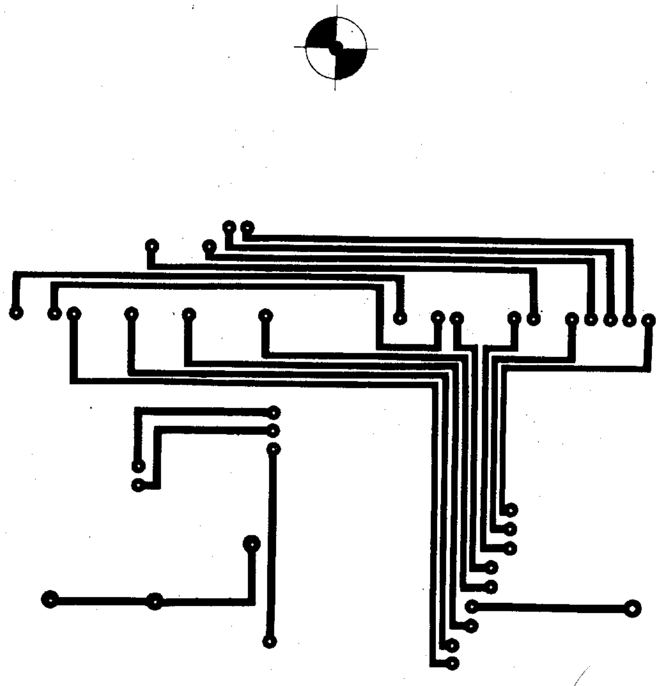
The top and bottom foils for the Sound Activator board.

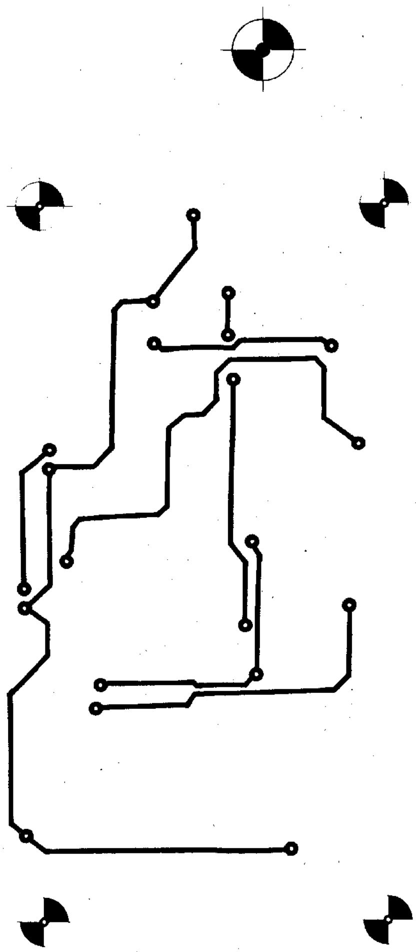


The foil patterns for the Modular Test Equipment Universal Counter: above and above right, the top and bottom foils for the main board and below, the underside foil and the upper side groundplane foil for the prescaler module.

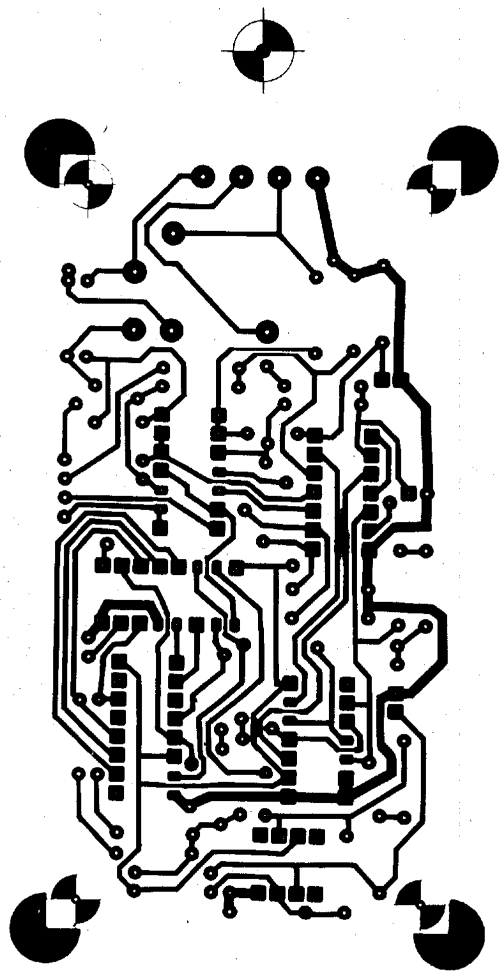








The top and bottom foils for the Autowipe board.



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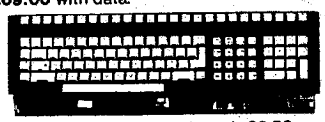

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OPEN CHANNEL

There have been a number of developments in the telecommunications arena since I last wrote. First, it looks as though British Telecom's bid to buy a 51% stake in Mitel is to be cleared by the Monopolies and Mergers Commission. The original £180 million bid — yes £180 million — was made in May of this year, and consequently referred to the Commission as many telephone equipment manufacturers like Plessey and GEC believe the acquisition would be harmful to them. And wouldn't it?

Let's think of the possibilities. If BT is allowed to buy the controlling share of Mitel, it can then press ahead with the manufacturer of small private automatic branch exchanges (PABXs) of the sort Mitel already makes. It currently buys these exchanges from Mitel, of course, as well as buying similar exchanges from other manufacturers (such as Plessey and GEC) — the difference being that as BT will, in effect, be manufacturing its own exchanges, a greater profit will be made from the equipment than that from other manufacturer's equipment. In the long term, BT is bound to increase its manufacturing capabilities to reduce the intake from other manufacturers — that is an inescapable fact. So on the face of it, yes, the other manufacturers have the right to grumble.

On the other hand, BT is now committed, since privatisation, to providing the best service for its customers (theoretically, it was before privatisation, too, but that's another issue). It stands to reason, therefore, that BT would be entering the manufacturing side of the industry, anyway. And if it doesn't purchase the capabilities in one swoop, by buying a controlling stake in a company such as Mitel, it will inevitably set up its own manufacturing organisation in stages over the coming years. The difference between these two alternatives is simply the timespan, of course. Plessey, GEC et al, have no reason to assume they are the rightful suppliers of equipment to BT — if they can supply suitable equipment to BT at an economic price then I am sure BT will not wish to make the equipment itself.

The best outcome of the affair must be a recommendation from the Monopolies and Mergers Commission that BT can buy Mitel if it wants, but that for a limited timespan it cannot increase its market share because of the manufacturing advantage. This will give other manufacturers a chance to get their houses in order.

Wire We Waiting

In an unprecedented attempt to awaken public interest in the possibilities of cable television systems, the Department of Trade and Industry is allocating £5 million in the form of grants, to companies involved in interactive cable television demonstrations. Since the first rumblings of the cable television revolution were first heard, back in 1982, less than £2 million has been given in support — so the new sum represents quite a step forward.

Through the Support for Innovation scheme run by the DTI, those eligible will receive up to 50% of the costs of providing the demonstration equipment. Equipment funded from this magnificent sum will, I am sure, persuade Joe Public that interactive cable television is all that it was originally cracked up to be and better! In reality, Mr Public probably feels, and still will feel, that interactive cable television is just another gimmick to make him part with his money.

Wire-less Are We Waiting

The selection procedure to determine the organisers of proposed community radio stations is now underway.

Community radio is planned to go on-air in the Spring, initially as part of an experiment lasting two years but eventually, it is hoped, on a full-time basis. If concluded and introduced satisfactorily community radio will provide an important new service not performed by existing radio broadcasters — ie, the BBC and the IBA. Rumours abound, however, that there are certain personnel on the advisory selection panel who (having very close links with these very same existing radio broadcasters) would not want community radio to take off without problems, or more importantly, would not want community radio to take off at all. I am convinced that the Home Office will look at all viewpoints most sympathetically and weigh up the situation thoroughly before allocating the franchises for the community radio station. Watch this space...

Why ARE We Waiting?

At the time of writing I've had no news from the CCIR meeting regarding the future of European television — ie, whether we're to go to the Japanese HDTV route, or the European extended C-MAC route. These things take time, I'm sure. It's taken us 50 years to get this far — we'll be damned if a few Japs can get us into a flap over what's best for our telly.

Keith Brindley

ALF'S PUZZLE

To save a few pennies on our projects at ETI, we often buy cheap bags of mixed components. Last week we received a pack of assorted CMOS ICs from BI-A-BAG and set about testing and sorting them out. All went well until we came across an IC with no markings on at all. 'Don't throw it away,' said Alf. 'It's just what I need to test my new IC identifying machine.' He trotted off to his workshop and returned a few minutes later, proudly showing us the printout from his machine. This is what it said:

IC TYPE: MASK PROGRAMMED ROM, 256 x 1

PIN 1	NC
PIN 2	Address line
PIN 3	Address line
PIN 4	Address line
PIN 5	Address line
PIN 6	NC
PIN 7	OV
PIN 8	NC
PIN 9	Address line
PIN 10	Address line
PIN 11	Address line
PIN 12	Adress line
PIN 13	Data out
PIN 14	+V

CONTENTS:
Locations 0 to 254 contain 1
Location 255 contains 0

We were most impressed until it occurred to us that there was a much more likely identity for the IC.

To test our idea, we gave Alf a certain 4000-series CMOS IC to test on his machine. He soon returned with a puzzled look on his face and a printout exactly the same as the one above. Which IC did we give him?

The answer to last month's puzzle.

Let's suppose you actually tried to build an infinite resistor network. You could start off with a single section of two 4R resistors and a 5R, giving a resistance for the first section of 13R. Working from left to right, you could then add another pair of 4R resistors and a 5R. The resistance at the terminals would have dropped slightly because the 4R resistor of the first section is now in parallel with the second section. Adding a third section would reduce the resistance yet again, but by a much smaller amount than before. By the time you had 100 or so sections connected, you'd be hard pressed to measure any change in resistance at all from adding another section, and when you reached a billion sections, even your ultra sensitive meter with one single electron resolution would have given up long ago. For an infinitely long resistor network, you would not have any change in resistance at all by adding another section, not even in theory.

Instead of adding another section to the right hand side, I want you to add one to the left. I know that means an infinitely long walk to the other end of the resistor chain, but it's all in a good cause. Let's call the resistance of the infinitely long resistor chain 'Alf', after its inventor. Adding another section at the left hand side gives a resistance at the new terminals of:

(9R +4R)//Alf

Since the resistance of the new chain will be just the same as that of the old one, we have:

Alf = (9R + 4R)//Alf

This is an equation that we can easily solve for Alf, and we find that the resistance of the network is 12R.

ETI

MERRY XMAS
AND
A HAPPY 1986
FROM
ALF AND ALL
OF US AT ETI

REVIEWS — 1985 BOOKS

CIARCIA's CIRCUIT CELLAR Vol IV
Steve Ciarcia. Price: £18
McGraw Hill Books Co. (UK) Ltd., Shoppenhangers Road, Maidenhead, Berkshire SL6 2QL.

ELECTRONIC AND MICROPROCESSOR CONTROLLED SECURITY PROJECTS
Vaughn Martin and Dean Davis. Price £14
BUILD A PERSONAL EARTH STATION FOR WORLDWIDE SATELLITE TV RECEPTION
Robert J Traister. Price: £12
EXPLORING LIGHT, RADIO AND SOUND ENERGY, WITH PROJECTS
Calvin R Graf. Price £9.45
John Wiley & Sons Ltd., Baffins Lane, Chichester, West Sussex PO19 1UD

THE EXPERIMENTER'S GUIDE TO INTEGRATED CIRCUITS
Robert J Traister. Price: £12.70
THE EXPERIMENTER'S GUIDE TO SOLID STATE DIODES
Robert J Traister. Price: £11.80
Prentice-Hall International, 66 Wood Lane End, Hemel Hempstead, Herts HP2 4RG

EASY ADD-ON PROJECTS FOR THE COMMODORE 64, VIC-20, BBC MICRO AND ACORN ELECTRON
Owen Bishop. Price: £2.95
Bernard Babani (Publishing) Ltd., The Grampians, Shepherds Bush Road, London W6 7NF.

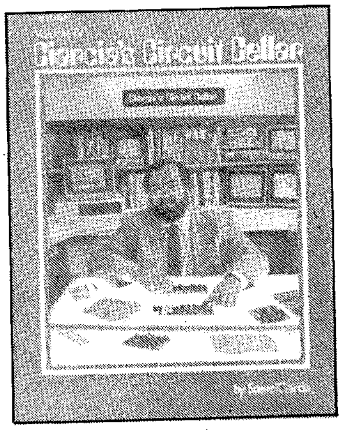
COST-EFFECTIVE ELECTRONIC CONSTRUCTION
John Watson. Price: £5.95
MacMillan Education, Houndmills, Basingstoke, Hants RG21 2XS

Not long ago I spent some time working on a journal for the British and Australian market which, to a large extent, was intended to be an editorial translation from American initiated text. I quickly realised that this idea wasn't possible. The American and British markets in electronics publications are quite different — it's not simply a matter of re-styling American text to a British manner, because the actual language used is very different, too. The outcome was that a virtual re-write of the journal was necessary before we dare publish it.

The same differences exist between American and British books on electronics: and are indeed amplified when the books are about electronics projects — not only is the language different, but components which are commonplace in America are sometimes difficult to obtain here. True, you can still find a large number of American books about electronic projects on the bookstalls — look for yourself — but that's not because they're particularly good; it's just that the British counterparts are generally bad!

New books are continuously appearing and it's to some of these that I'm now going to turn my attention. Six of these are American imports but two are British thoroughbreds. I'll deal with the American books first.

Ciarcia's Circuit Cellar



Steve Ciarcia is a well-known and respected columnist and writer in America. In fact, this book is simply a collection of his columns published under this title in Byte magazine, so it will not be new to those who read the magazine.

There are 18 chapters in the book corresponding to those columns in the January 1982 to June 1983 editions of Byte. The subject matter is therefore not quite up-to-the-minute, but it is nevertheless quite interesting. Among projects described by Ciarcia are a computerised weather station, a simple speech recognition circuit, an infra-red remote controller, a real-time clock, a laser-disc controller, a computer-controlled sound effects generator and a build-it-yourself IBM compatible computer.

Most of the projects are reasonably simple (with the notable exception of the IBM-compatible computer) and are generally based around one new, main IC with a handful of peripheral devices. Programs are included where required. In America, at least, the circuit boards and components for most projects are available mail-order, although this may not be true for the British reader.

Each project is accompanied by a chatty but fairly detailed explanation of operation which allows the reader to get to know the project before building it — rather similar to the 'How It Works' section in ETI projects. Where necessary, the author also gives any background information regarding the electronic principles. His long experience as a project designer for magazines throughout the USA gives him a great insight into what readers want from do-it-yourself electronic projects, and although the book is written in Americanese, even British readers may find it a good buy.

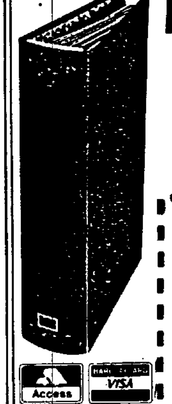
Finally, although I wouldn't particularly recommend the book as being the best example of electronics project books (it *is* American, remember), you should remember that most of the projects described are designed with computer interfacing in mind, so those readers with computers who go in for interface projects should find the book useful, if only for the ideas discussed. It is certainly one of the best written American books on electronic projects I have seen.

Electronic And Microprocessor Controlled Security Projects

This book is all about home security systems — burglar alarms and such like — so it's specific in nature, which of course limits its own potential market. Some of the principles discussed, however, are general ones, so readers shouldn't rule it out before looking at it. And, although specific security projects are discussed, a large part of the book is given to discussing general security principles, so it could form part of a reference library on security topics. In content, the information is not particularly in-depth, but it does present an overview which may interest those readers who have never built security projects before and who require an easy introduction.

The first part of the book deals with security projects which are not microprocessor-controlled, while the second part describes those which are. Rather than using a home-computer-and-interface-type of arrangement for the microprocessor controlled projects (which most other writers would have done) the authors have designed and built their own dedicated microprocessor controller board, details of which are given in chapter 4.

Each project (bar one) is designed on a printed circuit board (all patterns are given, same size), although this won't prevent the dedicated electronics enthusiast from designing his own or even building the project on breadboard. Some of the more complex projects in the book are accompanied by board layout diagrams, timing diagrams and fault-finding charts.



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Build a Personal Earth Station

Chapter 1 of this book starts (and I quote) "Most of us on planet Earth have several things in common. One of these is the television age." and from then on the book gets worse.

Despite its title, the book gives no information at all on building your own satellite television receiving station, so it's a pity the UK's Trades Description Act doesn't apply to American books. The book only gives details on *siting* commercially available receiving equipment. In this respect it's a bit like a 'Blue Peter' guide to making your own interplanetary spaceship!

The Experimenter's Guide to Integrated Circuits

Another book from the pen of Robert J Traister, this one provides much more meat for the electronics builder, albeit a little basic in parts. Mr Traister describes the fundamentals of integrated circuits: how they are made, how they are packaged, how they are used, as well as some simple information regarding other components. General circuit and project building practices are also discussed, along with some of the author's views on safety in the electronics lab.

The differences between analogue and digital ICs are adequately covered and some of the many types of digital families are described. One area which is sadly lacking, however, is a description of CMOS ICs. The author doesn't even mention them let alone use them in circuits! All regular ETI readers will know that CMOS ICs are an integral part (yes, a pun!) of the electronics scene nowadays so no electronics book of this nature should dare ignore them. However, this is an American book, and from it we can only presume that CMOS devices have not achieved the popularity in America which they have here.

A good selection of circuits for experimentation and project building are included in the book, but they are a little biased in favour of analogue ICs.

The Experimenter's Guide to Solid-state Diodes

What Robert J Traister did for ICs in the previous book, he now does for diodes in this book. The same major areas: manufacture, packaging, use, safety, construction techniques etc, are covered, this time in relation to the various forms of semiconductor diodes available to the electronics enthusiast. With the ICs of the previous book, discussions of these areas can only be general because there are so many different types, but with diodes, on the other hand, much more specific information can be given. There are, after all, only a limited number of available types of diode. Mr Traister takes advantage of this and supplies some high quality and in-depth information. For example, Chapter 2 gives all the important specifications which will be needed by the average builder when choosing a diode for a particular circuit. It's not possible to give this type of information in a similar book on ICs.

A wide variety of projects is given in the book, ranging from simple diode protection and power supply rectification circuits to thyristor and triac control and LED meter applications.

This really is a most unusual book. It is packed with information about many aspects of electronic communications and transducers, but it's written in such a way as to confuse the reader into thinking that this is not what it's really about at all! And if you're not confused by that description of the book, then you'd better read the book itself.

The bulk of the book is about electromagnetic and sound phenomena. Via experiments the author takes the reader through some fascinating ideas that would normally be presented in more orthodox ways.

For instance, the reader is told how to use transducers and amplifiers to listen to a variety of things including LEDs and LCDs, heart pacemakers(!), and various sounds not normally heard from car engines such as the alternator turning, the distributor and the fuel gauge. Thunderstorms, aircraft vibration and fish are also covered.

Along the way, however, the principles involved in these experiments and projects are described, so that just by working through the book from start to finish you should pick-up (excuse the pun) a great deal of knowledge. It's an unusual book, and it's only a pity more can't be written like it. Other authors take note!

Easy Add-on Projects

At last, I feel I'm on home ground with the first British book, written in English. There's bit of a difference in price, too, from the American offerings.

Owen Bishop, as you may know, is a respected author in the electronics world, and has written many other books of projects as well as several magazine articles. Recently, his attention has turned, like that of many electronics writers, to projects which interface to home computers. The home computer market has taken off nowhere as strongly as it has in the UK, so it seems only natural that UK authors could write about it well. Owen tackles the problem with his book in an authoritative way, describing projects which can be used with any of the home computers listed in the title.

The projects include a pulse detector, picture digisiter, model controller, bleeper, lamp flasher, light pen, magnetic catch, photo-flash, and a weather station. All projects are fairly simple and inexpensive to build, so beginners as well as the more experienced constructers will find the book a useful source of ideas. Sample programs are included to get the projects up and running.

Cost-effective Electronic Construction

Where the American books I have reviewed so far fell down was in their presentation of the projects to be built by the reader. The Americans view the construction of the project as being a boring, almost secondary concern; they are mainly concerned with blowing their own trumpets and singing the project's praises. The better books deal as much with the nitty-gritty topics such as how to actually build the projects in the first place.

This book is one of the best. It describes some simple but effective and useful projects in a step-by-step manner. Like those in Owen Bishop's book, reviewed above, each project's operation is described together with methods of construction and use. Photographs and illustrations are used to advantage. Where Bishop gives a considerable amount of background information on the principles involved in his projects, however, John Watson doesn't. This is the only area which could have been expanded.

Projects include an automatic porch light, a drill-speed controller, a stereo simulator, an xenon strobe, a freezer temperature alarm, a computer input/output port and a model radio-control system

Keith Brindley

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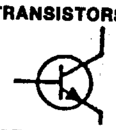

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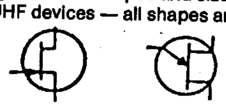

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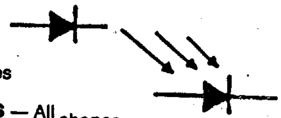

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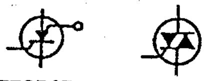

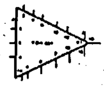

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SCRATCHPAD

by Flea-Byte

The trick with this puzzle is not in doing the sums, but in deciding which sums to do in the first place. It would no doubt be possible to form a series of partial sums beginning with the first resistor section and progressively adding more sections, and to show that the series tends to a limit. Alf is much too lazy for the complicated mathematical manipulations involved with this approach.

* * *

Here in the gloomy recesses of ETI Towers it dawned on us suddenly with the force of revelation that what the world really needed at this time of the year was another award ceremony. Well, all of us make mistakes.

Undaunted, Flea-byte set about the task of drawing all the necessary threads together with a will. Sir Richard Attenborough was engaged to weep volubly; Princess Alexandra (or maybe it was Princess Michael of Kent, or even Princess David of SW7) was engaged to smile condescendingly; even David Puttnam agreed to come and tell the guests how British Electronics is the best electronics in the world. We booked the Café Royale and invited everyone we could think of. Only at this point did it occur to Flea-byte or any of the toiling minions working on the project that nobody had been considered to receive an award.

Let me tell you, there was panic. A team of expert judges was hastily recruited and supplied with a year's back-copies of ETI, Electronics News and the Beano. They were locked in a room and told not to come out until the awards had all been agreed or they had all killed each other. In the event, only our very own Alf emerged unscathed to present what he said was a unanimously agreed list of award-winers. Of course, Flea-byte had no way of knowing whether Alf was bending the truth a little or not, since all the other judges were by now assuming postures of extreme stillness and silence. Alf said they were practising a new form of Korean meditation called Be-Ing-Ded, but Flea-byte was not convinced.

As it turned out, we really needn't have bothered since due to a proof-reading error the invitations had all gone out inviting people to attend 'An Away Ceremony To Present The ETI Draws for 1985, to be held at the Café Royale, Bremerhaven, on December 31st, 1984. Needless to say, nobody accepted.

However, Flea-byte couldn't let all his hard work go to waste, to say nothing of the efforts made by Alf, the minions and the judges. So Scratchpad is proud to present the first annual ETI awards for 1985 on this page.

The Walt Disney award for contributions to artificial intelligence: Ronald Reagan.

The Joan Collins award for optimism in the face of overwhelming odds: Sir Clive Sinclair.

The Clive Sinclair award for promotion: Halley's Comet.

The Isaac Newton award for contributions to the study of gravitational effects: Boeing Aircraft.

The Most Promising Newcomer award (for the third year running): Gallium Arsenide.

The TINA (an award instituted by Margaret Thatcher to encourage resistance to change): TTL.

The Input-Output award for services to amplification: Sara Keays.

The General Motors award for services to the British Economy: jointly awarded to Olivetti, IBM, Ian McGregor and Japan.

The Clark Kent award for the most original idea about telephone boxes: Cellnet.

* * *

Phone Phun

Some of the more amusing stores of 1985 centre on the new telephone services designed to create a demand-fuelled expansion in the current vogue arena of electronic development — communications. One may dispute the rights and wrongs of deregulation, privatisation and the break-up of monopolies like BT and AT&T in America, but there is no arguing that we are not prepared for the new freedoms we are being offered. In Bristol, for example, an experiment in itemised telephone accounts ran into near disaster when bills started arriving at private households featuring numerous calls to telephone numbers unrecognized by one or other member of the household. Curious wives or husbands were not slow in discovering that their partners were, often as not, hiding illicit relationships behind the unemotional front of a simple six-digit number. As a result, it was said that for the duration of the experiment divorce and separation statistics in the Bristol area rocketed.

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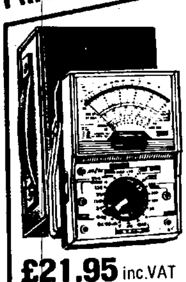

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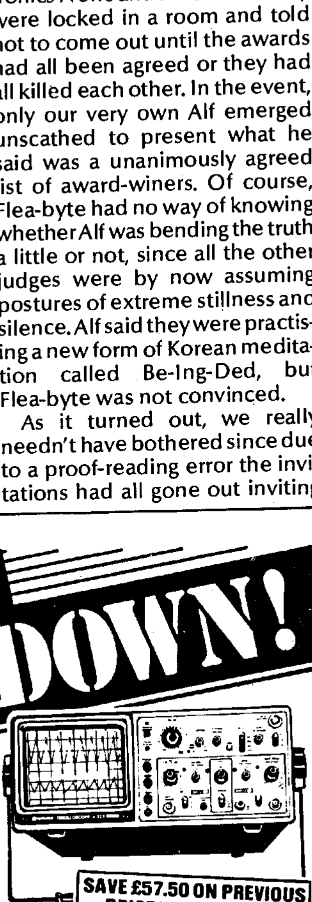

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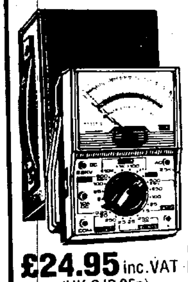

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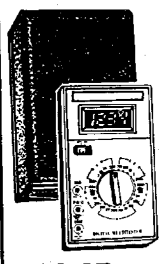

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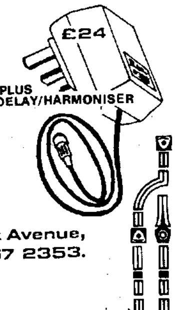

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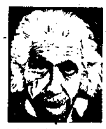

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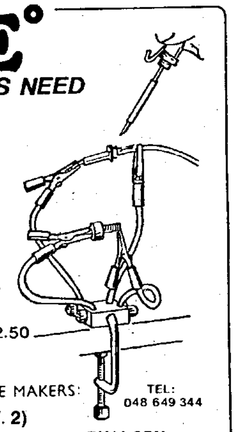

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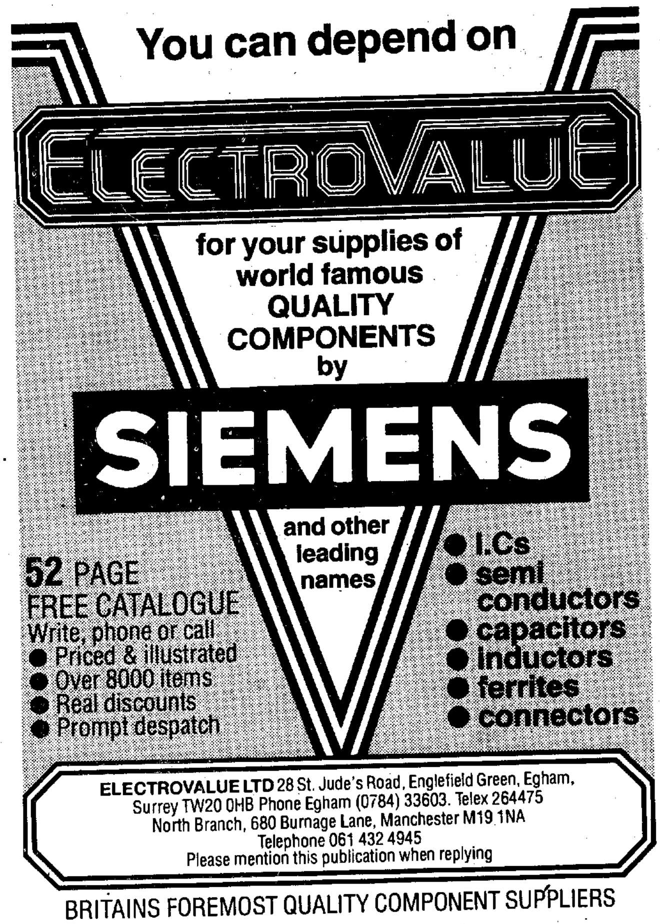

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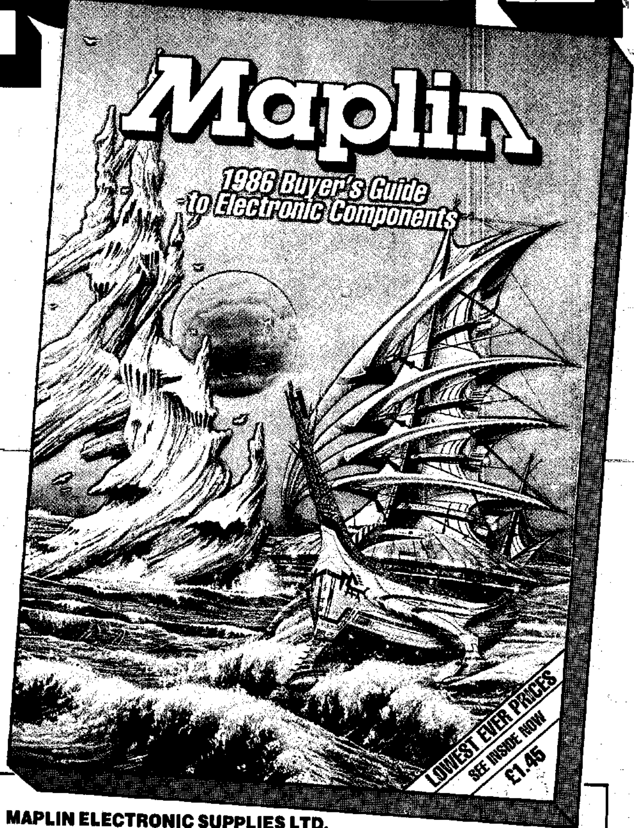

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