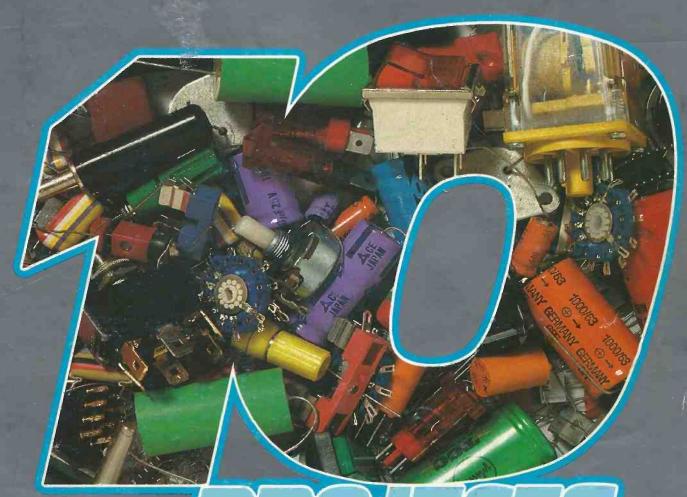
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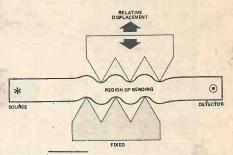
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2u2, u, 22u, 47u, 220u, 470u 30p 1m5, 4m7, 35p 33m, 60p 75p 1mH, 2m2, 10mH 22m, 43m 100m

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4019 75 4161 99 4569 175 4020 42 4162 99 4569 175 4021 40 4162 99 4587 460 4021 40 4174 99 4581 280 4022 13 4175 105 4582 99 4024 32 4194 105 4583 90 4025 13 4408 796 4585 60 4027 20 4410 725 4585 60 4027 20 4410 725 4585 60 4027 30 4410 725 4587 330 4028 39 4411 676 4589 290 4028 39 4411 676 4599 290 4029 45 4412 776 40085 90 4030 15 4415 280 40085 90 4031 125 4419 280 40085 90 4031 125 4419 280 40081 90 4033 125 4435 80 40100 115 4031 125 4435 80 40100 15 4031 125 4436 998 40100 15 4031 125 4436 998 40100 15 4031 125 4436 998 40100 15 4031 125 4436 998 40100 15 4031 125 4436 998 40100 15 4031 140 4440 998 40100 15 4031 150 456 675 40103 376 4033 125 4451 350 40101 398 4036 576 4010 998 40100 350 4039 110 4490 350 40105 105 4039 110 450 675 40107 80 40401 40 450 28 40109 198	Square LEDs, Red, Green, Yellow Rottangle Stackable LEDs Red, Green or Yell Triangular LEDs Red Green or Yellow 22 Common or Y	height Char. RS232 and Printer Cable for our print SOFTY-2: The complication of the co	Centronics Intrf. standa tetrs and BBC MICRO ete Microprocessor dev ROM.  Erases up to 32 ICs in 1 with a safety switch plus our Solid State, 15-30 min. ts your expensive Chips in no time lated with Overload pr 1 A. Professionally finish IE CASSETTES in librat.	rd £235 (£7 carr). £12 elopment system. £169 5-30 minutes £ 33 £ £ 35 te ELECTRONIC £44 Connects directly from overcooking, £15 otection. Variable hed £38 ry case 40p	12 K of fig - RS232 and 3 tronics and 0 from BASIC	I FORTH — I/O Unit  - FORTH in ROM, Full 24 Bits of I/O for Cen- Control use. Can be used or FORTH. Will work on 3 Spectrum. Many other only: £59 r full details)
4042 40 4504 476 40110 225 4044 404 40 4506 35 46114 4018 20 4046 46 4507 35 40101 46 4046 46 4508 35 4016 35 4018 20 40176 50 4048 40 4510 46 4018 20	TIL1312.3" CA 105 TIL1312.3" CC 105 TIL1312.5" CC 115 TIL132.5" CC 115 TIL132.5" CC 115 DL704.3" CC 99 D707.7 CA 99 D707.7 CA 99 D707.7 CA 15 TO 15	CD50A — Twin Cased CS50E — Single Cased CD50E — Twin Cased 10 Verbatim Diskettes 10 Verbatim Diskettes 10 Wabash Diskettes, 5 10 Wabash Diskettes, 5 10 Wabash Diskettes, 5 WITSUBISHI DISC DR Track, 5½" Slim line, 01 Track to track access tim MITSUBISHI Single Megabyte, (400 K with MITSUBISHI Twin S	with PSU, 40 track, 5% with PSU, 40 trach, 5% with PSU, 80 track, 5% with PSU, 80 track, 5% with PSU, 80 track, 5% %% S.S.D. (5 yrs warr 5% D.D. (5 yrs warr 5% D.D. (5 yrs warr 5% D.D. (5 yrs war 7% S.S.D.D. (5 years wa %", S/S. WES: Uncased, Double VES: Uncased Winself Smsec.  Stimline, 5% Cased win BBC)	"S/S 100K £170 "S/S 200K £330 "S/S 200K £245 "S/S 400K £475 soft 400 £20 rranty) £20 rranty) £28 rranty) £28 . £15 . £25 . Density, Double ck Density, 96TPI only: £225 th PSU. DSDD. 1 . £275 th PSU. DSDD, 2	Model A	EROCOMPUTER & CESSORIES  £299 Model B £399 (incl VAT) range of BBC Micro peripherals, rare like, Disc Drivers (Top quality pishi), Diskettes, Printers, printer Zable, Dust Covers, Cassette Rees, Monitors, Connectors (Ready gs & Sockets), Plotter (Graphic Programmer, Lightpen Kit, Joy-ROM Board, EPROM Eraser, OM, The highly sophisticated IEEB DFS, WORDWISE, BEEB. Eductional Application & Games), Please send SAE for our descrip-

	C		VIT	ECI		LEC		RO	NIC	5
	TRANSISTORS	1	2			THYRISTORS	CMOS		CPU IC's	VOLTAGE
	BC 107B 12p BC 108C 12p BC 109C 10p BC 113/4 16p BC 115/6 17p BC 119 28p BC 139 32p BC 140 28p	BC 546 10p BC 546B 10p BC 547B 9p BC 548B 9p BC 548C 9p BC 549C 9p BC 550C 10p BC 556 10p	BF 196 12p BF 197 12p BF 198 10p BF 199 12p BF 200 40p BF 224 15p	MPSA 55 20p MPSA 56 22p MPSA 63 22p MPSA 64 22p MPSA 92 24p MPSA 93 24p TIP 29A 30p TIP 29B 33p	2N2907A 25p 2N3053 23p 2N3054 56p 2N3055 50p 2N3055H 75p 2N3440 58p 2N3441 120p 2N3442 120p	C 106D C 116D 70, C 126D 90, C 126M 98, MCR 101 30, MCR 102 34, T 2800D 110, T 2800M 165,	4000 4001 4002 4006 4007 4008 4011	14p 40162 14p 40163 14p 4501 50p 4502 16p 4503 50p 4504 14p 4506 15p 4508	52p 6800 395p 52p 6802 550p 16p 6808 520p 55p 6810 250p 34p 6820 250p 98p 6821 190p 70p 6840 595p 145p 6850 180p	REGULATORS Positive 100mA 78L05 30p 78L12 30p 78L15 30p 78L18 45p 78L24 45p
	BC 141 29p BC 142 27p BC 143 27p BC 160 30p BC 161 32p BC 169C 8p BC 171B 9p BC 172C 9p BC 173C 9p BC 173C 15p	BC 556B 10p BC 557B 9p BC 557C 9p BC 558C 9p BC 558C 9p BC 559C 10p BC 637 20p BC 637 20p BC 638 20p BC 638 20p	BF 245 25p BF 256C 32p BF 256C 35p BF 257 32p BF 258 32p BF 259 35p BF 336 36p BF 337 39p BF 338 40p	TIP 29C 33p TIP 30A 30p TIP 30B 33p TIP 30C 36p TIP 31A 33p TIP 31B 35p TIP 31C 37p TIP 32A 33p TIP 32B 35p	2N 3702 10p	2N4443 120p 2N4444 130p 2N5060 23p 2N5061 24p 2N5062 29p 2N5064 32p —TRIACS — C 206 55p C 225D 60p C 226D 70p	4013 4014 4015 4016 4017 4018 4019 4020 4021 4021	24p 4510 54p 4511 16p 4512 24p 4513 24p 4514 17p 4516 10p 4517 16p 4518 12p 4520 16p 4522	50p 6852 360p 52p 6880 140p 48p 6885 130p 98p 6889 140p 110p 68900 POA 55p 8T26A 140p 52p 8T26 120p 55p 8T95 140p 55p 8T97 140p 65p 8T98 140p	7805 36p 7808 55p 7812 36p 7815 36p 7815 36p 7816 36p 7824 40p 5 A TO3 78HO5 540p Negative
	BC 17/BC 15p BC 179C 15p BC 179 15p BC 182 9p BC 182B 9p BC 183B 9p BC 183C 9p BC 184C 9p BC 184C 9p BC 212 9p	BC 639 22p BC 640 24p BC 770 18p BC 771 18p BC 772 17p BD 115 50p BD 131 45p BD 132 48p BD 132 48p BD 133 30p BD 135 30p BD 136 30p	BF 458 32p BF 459 37p BF 494 12p BF 595 16p BF 596 20p BFX 29 28p BFX 30 28p BFX 84 28p BFX 85 28p	7 19 33A 55p 7 19 33A 60p 7 19 41A 60p 7 19 41C 60p 7 19 42A 46p 7 19 42C 60p 7 19 110 45p 7 19 115 45p 7 19 120 70p 7 19 121 70p	2N3773 190p 2N3819 20p 2N3823 50p 2N3866 95p 2N3903 10p 2N3904 10p 2N3905 10p 2N3906 10p 2N4030 30p	C 226M 90F C 236 90F C 236M 120F C 246D 98F C 246M 140F BR 100 30F BRIDGE RECTIFIERS W 005 18F W 01 20F	4023 4024 4025 4026 4026 4027 4028 4029 4030 4035	4526 48p 4528 44p 4528 44p 4529 34p 4530 99p 4531 12p 4532 18p 4541 8p 4544 8p 4553	64p 8080A 400p 56p 8085A 500p 72p 8156C 600p 92p 8216C 198p 70p 8216C 200 88p 8224C 220p 70p 8228C 450p 120p 8251AC 495p 88p 825AC 800p 180p 825AC 800p	Negative 100 mA 79L05 50p 79L12 50p 79L15 50p 1 A TO220 7905 45p 7906 65p 7908 65p 7912 55p 7915 55p
	BC 213B 9p BC 213C 9p BC 214G 9p BC 214C 9p BC 237 7p BC 238 9p BC 239 9p BC 239 9p BC 251 9p BC 300 36p BC 301 32p	BD 137 30p BD 138 35p BD 139 35p BD 140 35p BD 203 70p BD 204 70p BD 205 70p BD 239A 40p BD 239A 40p BD 239C 50p	BFX 88 23p BFY 50 23p BFY 51 22p BFY 52 22p BSY 95A 23p BU 205 140p BU 206 150p BU 208 140p MJ 2500 230p MJ 2501 245p	TIP 122 70p TIP 126 70p TIP 127 70p TIP 2955 70p TIP 3055 70p TIS 3055 70p TIS 90 24p TIS 90 24p TIS 92 20p 2N 1613 30p 2N 1711 30p	2N4033 30p 2N4037 40p 2N4058 10p 2N4059 10p 2N4060 10p 2N4061 10p 2N4062 10p 2N4062 15p 2N4401 15p 2N4401 15p 2N4403 15p	W 02 22F W 04 24F W 06 28F W 08 32F 3A/50V 40F 3A/100V 44F 3A/200V 46F 6A/50V 75F 6A/100V 80F 6A/200V 88B	4042 4043 4044 4044 4046 4048 4049 4049 4050 4051 4052	4554 4555 44p 4555 44p 4557 55p 4558 80p 4559 4560 25p 4566 52p 4568 62p 4569	148p 8259C 900p 48p 8288 £16 140p TMS9980A£22 110p TMS9901N590p 390p TMS9902N550p 170p Z80A P10500p 270p Z80A DMA£16 140p 2101-4A 350p	7924 65p - Variable- LM 309K 120p LM 317K 250p LM 317T 98p LM 337T 180p LM 350T 395p LM 723CN 35p 78H05 540p
	BC 302 32p BC 303 32p BC 304 32p BC 307 10p BC 308 10p BC 309 10p BC 327 12p BC 328 12p BC 328 12p BC 333 12p	BD 240A 42p BD 240C 50p BD 241C 54p BD 241C 54p BD 242A 42p BD 242C 54p BD 243C 55p BD 243C 68p BD 243C 68p BD 244C 78p	MJ 3000 210p MJ 3001 225p MJE 340 48p MJE 350 70p MJE 370 80p MJE 371 84p MJE 520 60p MJE 521 68p MJE 521 68p	2N1893 30p 2N2218 24p 2N2218A 25p 2N2219 24p 2N2219A 25p 2N2221A 20p 2N2222 18p 2N2222A 20p 2N2328B 25p 2N2369A 15p	2N5400 18p 2N5401 20p 2N5457 28p 2N5458 27p 2N5458 25p 2N5450 38p 2N5550 18p 2N5551 20p 2N6027 23p 2N6028 23p	6A/400V 94p 25A/100V185p 25A/200V198p 25A/400V220p LEDS 3mm red 7p 5mm red 7p 3mm green 10p 5mm green 10p	4066 44068 4069 4070 4071 4072 4073 4074 4074 4075	28p 4573 5p 4574 4575 5p 4580 5p 4584 5p 4584 5p 4585 5p 4599 5p 1C SOCK		TIL 32 55p TIL 38 40p TIL 78 50p TIL 100 100p TIL 111 85p 2N5777 50p 4N25 80p 4N26 70p 4N33 128p
	BC 413C 10p BC 414C 10p BC 415C 10p BC 416C 10p BC 477 25p BC 478 23p BC 479 24p	BF 180 30p BF 181 30p BF 182 30p BF 183 30p BF 184 30p BF-185 30p BF-185 194 12p	MPSA 05 20p MPSA 06 20p MPSA 12 22p MPSA 13 22p MPSA 42 23p	2N2484 24p 2N2646 48p 2N2904 22p 2N2904A 23p 2N2905 23p 2N2906A 22p 2N2907 23p	ZENERS -400 mW 2V7-36V 6p 1.3 W 4V7-51 V 10p	3mm yellow10p 5mm yellow10p clips 3p rectangular Red 10p Green 14p Yellow 14p	4078 4081 4082 4093 3 4098 7 40161	18 pm   18 p	7P 28 pin 16p 8p 40 pin 20p 9p SPECIAL OFFERS 11p 25 x 22 pin 270p 14p 25 x 28 pin 340p 14p 10 x 40 pin 185p 16p 25 x 40 pin 440p	4N35 150p 4N37 100p BPX 38 390p BPX 43 340p TIL 221 20p (high output clear red)
	CA 3046 72p CA 3065 190p CA 3080 72p CA 3080 56p CA 3089 170p CA 3090AQ 300p CA 31305 905	LM 565 100p LM 567 150p LM 709 35p LM 710 70p LM 711 60p LM 733 75p LM 741 14p LM 747 50p	SAA5041 £25 SAA5050 £10 SAA5052 £10 SL490 300p SN76115 98p SN76660 90p TBA120S 70p	0.47 25 5p 0.47 63 6p	Tantalum bead. B. B. O O O O O O O O O O O O O O O O	A 119 9p AX 13 5p AX 16 6p A 47 9p A 90 7p A 91 7p A 95 8p	RESISTORS  Watt Carbon film 5% E 24 series 4.7 R. 2M2 1p each. Watt Carbon film 5% E 12 series 18-10M	4xTO3 mour 4xTO66 mour 5 xTO126 bus 10xTO220 bus 5 xTO3P bush 20mm panel f 4mm plugs 1; minals 30p. 3.	nting kits 20p 64 mm Lou nting kits 20p 64R 78peas shes/washers 14p PP3 batte shes/washers 22p 4xHP7 b nes/washers 14p 6xHP7 b useholder 32p 20mm chas 2p, 4mm sockets 20p, 4n 5mm jack socket 15p, 3,5i	ch. 300mW rating. ery snaps 6p each, attery holder 22p attery holder 32p siss fuseholder 7p nm insulated ter- nm jack plug 15p
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		300p	LIVI	141	14P	ł
CA	31308	95p	LM	747	50p	ł
CA	3140	44p	LM	748	35p	ŀ
CA	31608		LM	1458	36p	ì
	31618		LM	3900	47p	ı
	3240		-			1
٠, ١	J2407	165p		1455	16p	ı
C A	32408			1458	34p	ł
	32608			1496	70p	I
	810Q			1748	35p	1
CA	8100	250p		3302	72p	ı
		250p		3401	68p	ı
	347	160p	MC	3403	65p	l
	351	45p	NE	529	220p	ı
	353	80p	NE	531	160p	ı
	355	85p		532	56p	ı
	356	88p		544	200p	ı
LF	357	110p		550	160p	ı
				555	16p	ł
	301A	26p		556	45p	L
	307	54p		558	170p	L
	311	60p		565	140p	İ
	318	120p		560	150p	ı
	324	46p		567	110p	ı
	339	46p		570	350p	ı
	348	60p		571	320p	İ
	358	48p		644	POA	1
	380	68p		645	POA	1
	380.8	80p				1
	381	140p		45 <b>5</b> 8		1
	381	120p		41027		ļ
	384	125p		41056		ì
	386	68p		<b>450</b> 00		ı
	387	135p		45010		1
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40p

available these values, radial available on all of above.

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CAPACITORS		DIODES	ı
Electrolytic		AA 119	ç
radial/axial.	Tantalum bead.	BAX 13	Ę
		BAX 16	6
Value/ V price	Value/ V price	OA 47 OA 90	9
0.47 25 5p		OA 90	-
0.47 63 6p	0.22 35 12p	OA 95	έ
1 μF 63° 6p	0.33 35 12p	OA 200	7
2.2 16 5p	0.47 35 12p	OA 202	έ
2.2 63* <b>6p</b> 4.7 25 <b>6p</b>	0.68 35 12p	1544	€
4.7 63* 6p	1 μF 35 <b>12p</b> 2.2 μF 35 <b>16p</b>	15921	ç
10 µF 10 5p	3.3 µF35 18p	1N914	3
10 F 16 6p	4.7 µF 25 20p	1N916	4
10 µF 25* 6p	6.8 µF 25 20p	1N4148 1N4149	3
10 µF 63* 7p	10 µF 16 20p	1N4001	3
22 µF 16 . 6p	15 μF 16 28p	1N4002	4
22 µF 25 '6p	22 μF 16 <b>35</b> p	1N4003	4
22 μF 63* 9p	33 µF 16 60p	1N4004	5
47 μF 10 7p 47 μF 25 8p	33 μF 10 <b>36</b> p	1N4005	5
47 µF 63 12p	47 μF 10 60p 68 μF 10 80p	1N4006	6
100 10° 6p	60 µF 6.3 60p	1N4007	6
100 16 8p	100µF 6.3 70p	1N5401	11
100 25 10p	100µF3 38p	1N5402 1N5403	12
100 63 18p	150µF6.3 90p	1N5404	13
220 10* 8p	·	1N5405	14
220 16 10p		1N 5406	14
220 25° 14p	Ceramic Plate	1N5407	15
220 63 24p 470 10 14p	63/100 V	1N5408	16
470 25* 20p	1.8 pF to 4N7	6A/100V	25
1000 10 18p	5p.	6A/200V	28
1000 25 28p	Polystyrene 5%	6A/400V	30
2200 10 32p	63 V: 10 pF to		
2200 25* 45p	1 nF 9p each.	HEATSIN	iks

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TO5 push on 6mm (80°C/W) 16p each. 12mm(60°C/W) each 2.5 X1 25p 2.5 X3.75" 90p 2.5"X5" 110p 3.75"X3.75" 110p 3.75"X3.75" 110p 3.75"X5" 115p pak of 100 pins 55p spot face cutte

Slide switch 1A/250V DPDT (22 x 12 x 8 mm) 16p	
BRAND NEW COMPONENT PACK	S
CP100 60 IC sockets, 8, 14, and 16 pin 20 of each	440r
CP101 20 BC182/BC212 transistors, 10 of each	130g
CP102 20 BC183/BC213 transistors, 10 of each	100c
CP103 20 BC184/BC214 transistors, 10 of each	130
CP104 20 BC549C/BC559C transistors, 10 of each	130

CP103 20 BC184/BC214 transistors, 10 of each 130p CP104 20 BC549C/BC559C transistors, 10 of each 130p CP105 20 BC559C/BC559C transistors, 10 of each 160p CP105 20 BC559C/BC560C transistors, 10 of each 160p CP107 100 1N916 switching diodes, 75-100V/75mA 280p CP109 100 1N916 switching diodes, 75-100V/75mA 60p CP109 500 1N4148 switching diodes, 75-100V/75mA 60p CP109 500 1N4148 switching diodes, 75-100V/75mA 60p CP110 30 1N41002 1A/400V rectifiers 100p CP111 30 1N4002 1A/400V rectifiers 100p CP112 100 400mW zeners, 4 of each 2V7 to 33V 450p CP112 100 13W zeners, 4 of each 2V7 to 33V 450p CP113 100 1:3W zeners, 4 of each 2V7 to 33V 450p CP114 4 LF351 JFET op amps, Low noise 170p CP115 4 LF353 JFET op amps, Low noise 170p CP115 6 Dmixed LED's 3mm/5mm/rect/red/green/yellow 400p CP121 100 1N4002 1A/100V rectifiers 270p CP120 10 C106D 400V/4A thy ristors 250p CP121 10 NE556 dual timer IC's 40p CP121 10 NE556 dual timer IC's 40p CP125 LM317T IA/TO220 variable regulators 440p SPECIAL BULK PURCHASE

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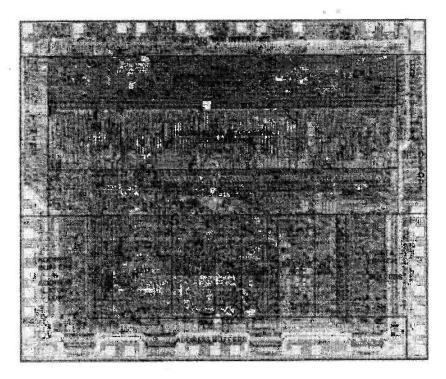


Photo of the CMOS 6502 processor courtesy of Rockwell International.

#### 16 Channel A-to-D Board

Following on in our series of projects aimed at but not exclusively for the Mircotan, here is an A-to-D board to help you connect your computer to the outside world. If you built the D-to-A board of some months ago or would like to use your computer for control or monitoring, here is the project for you, as it will be suitable for 6502 and Z80 systems.

#### **ZX** Controlled Burglar Alarm

The idea of using a home computer to control a burglar alarm would have seemed crazy a few years ago. Laterly, however, the ZX81 seems to have become so common that many are languishing on shelves gathering dust. Well here's a job for them — controlling a buglar alarm system. The system can also be used with the Spectrum.

#### **Modular Preamplifier**

Just so that the computer freaks don't get it all their own way, here's a top-quality preamplifier that is modular in construction. The author himself describes the design as an Audio Leggo Kit, and that's just what it is. The basic unit is a motherboard into which you slot the modules that you want — so if you don't want tone controls, you don't have to have them. But unlike other preamps, you can change your mind at a later date.

### Lightsaver

Problem: when light-bult filaments are cold, their resistances are very low, so when you turn on the light a very heavy current will flow momentarially: this problem is exacerbated if you just happen to turn on when the mains cycle is near its maximum voltage. Solution: buy next month's ETI and find out!

# ALL THIS AND MORE IN THE DECEMBER ETI! RESERVE YOUR COPY NOW OR RISK MISSING OUT!

Articles described here are in an advanced state of preparation. However, circumstances may dictate changes to the final contents.

Now's the time to catch up with out on Breadboard. 179, 80, 81 and



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<sup>\*</sup>see next page

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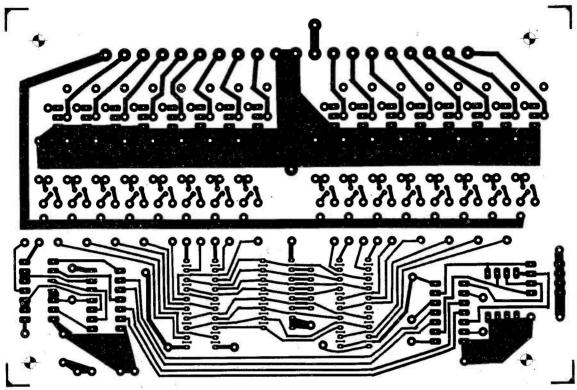
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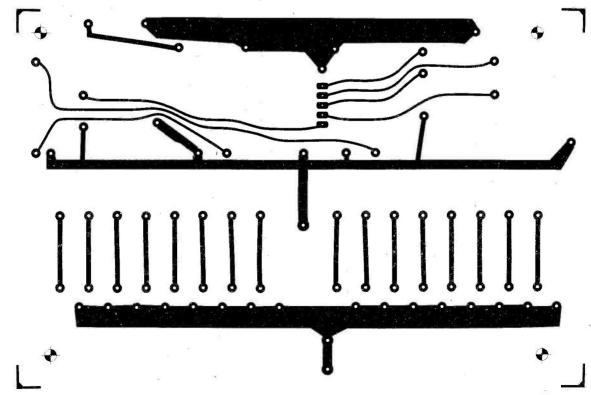
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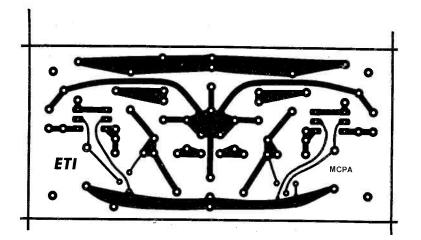
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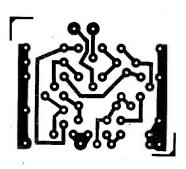


Sorry! These two are foil patterns for the Output Driver, published way back in July (we've only just had space for them now).

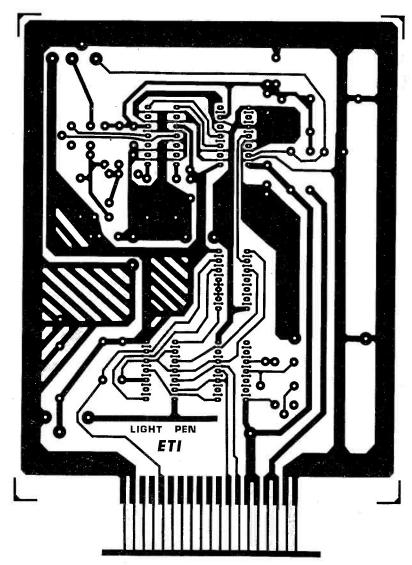




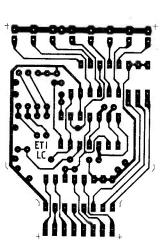
The Moving Coil Head Amplifier.

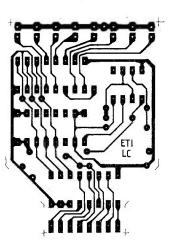


The Gain Block from Audio Design; note that this will not be available through the PCB service.

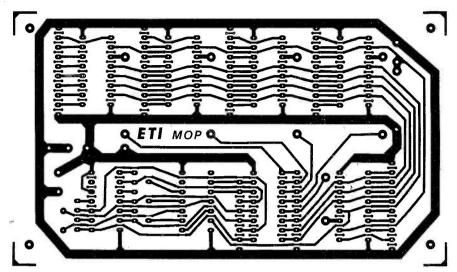


The Fast Light Pen.

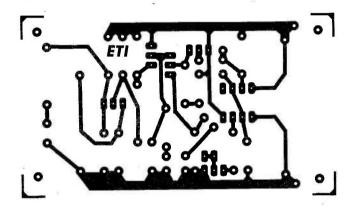




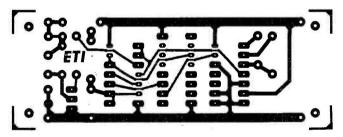
The Logic Clip.



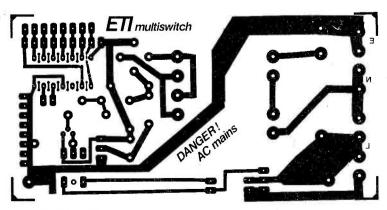
The Multiple Output Port.



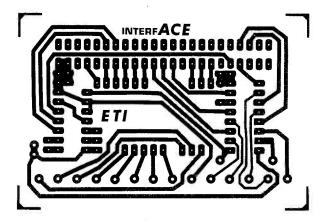
The Mini Drum Synth Module.



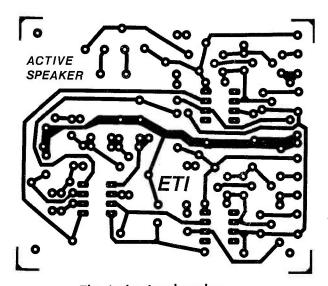
The Alarm Extender.



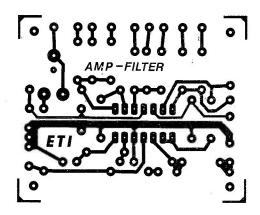
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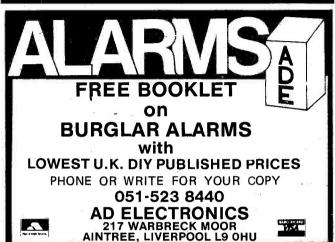
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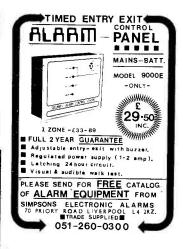
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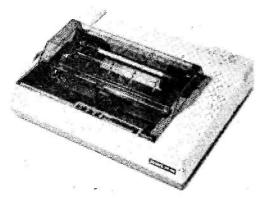
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B K Electronics	
Black Star	
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Electrovalue	30
Europa Electronics	9
Frei Ltd	6
Greenbank Electronics	35
Greenweld6	2
G.S.C	1
Happy Memories	6
Horizon Electronics	7
House of Instruments	2
ICS8	0
ILP 38,7	9
Kelan Engineering	1
L B Electronics	1
Magenta Electronics	5
MaplinOB	C
Marco Trading	6
Mawson Assocs	6
Microtanic	2
Midwich Computers	1
MJL Systems	0
Musicraft	5
Pantechnic	0
Parnden Electronics	5
Phonosonics	Ô
Positronics10	6
Powertran IFC,10,IB	č
Qauntum Jump	5
Rapid Electronics	2
Riscomp5	ñ
R.T.V.C	1
Sparkrite	3
Stuarts of Reading	1
Tape Soft8	_
Technomatic	0
T K Electronics	J
Netford Electronics	4
Natford Electronics4,	C

# Low-price robots from **POWERTRAN**

- -hydraulically powered
- microprocessor controlled

The UK-designed and manufactured range of Genesis general purpose robots provides a first-rate introduction to robotics for both education and industry. With prices from as low as £425, even the home enthusiast can aspire to his or her own robot.

Each robot in the Genesis range has a self-contained hydraulic power source operated from single phase 240 or 120v AC or from a 12v DC supply. Up to 6 independent axes are capable of simultaneous operation with positional control being provided by means of a closed-loop feedback system based on a dedicated microprocessor. Movement sequences can be programmed by means of a hand-held controller or the systems can be interfaced with an external computer via a standard RS232C link. Benesis idiol

GENESIS

S101

The top-of-the-range P102 has dual speed control, enhanced memory and double acting cylinders for increased torque on the wrist and arm joints. There is position interrogation via the RS232C interface, increasing the versatility of computer control and inputs are provided for machine tool interfacing.

All Genesis robots are available either ready-built or in kit





For under £100, Hebot II takes programming off the VDU and into the real world. Each wheel is independently controlled by a computer, enabling the robot to perform an almost infinite number of moves. It has blinking eyes, a two-tone bleep and a solenoidoperated pen to chart its moves. Touch sensors coupled to its shell return data about its environment to the computer enabling evasive or exploratory action to be calculated.

The robot connects directly to an I/O port or, via the interface board, to the expansion bus of a ZX81 or other microcomputer.

#### HEBOT II



A real, programmable robot for under £200! Micrograsp has an articulated arm jointed at shoulder, elbow and wrist positions. The entire arm rotates about its base and there is a motor driven gripper. All five axes are motor driven and servo controlled, giving positive positioning. The robot can be controlled by any microcomputer with an expansion bus – the Sinclair ZX81 being particularly suitable.

£425

#### MICROGRASP

Weight 8.7kg, lifting capacity 100g Robot kit with power supply

Universal computer interface board kit 23 way edge connector £2.50 AX81 peripheral/RAM pack £145.00 splitter board £3.00

#### **GENESIS S101**

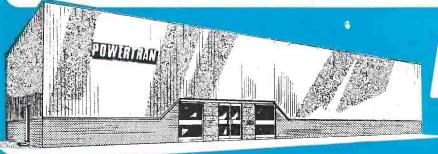
Weight 29kg, lifting capacity 1.5kg 4-axis model (kit form) 5-axis model (kit form) 5-axis complete system £475 (kit form) 5-axis complete system (ready built) £1,450

#### **GENESIS P101**

Weight 34kg, lifting capacity 6-axis model (kit form) £675 6-axis complete system £945 (kit form) 6-axis complete system (ready built) £1,650

#### **GENESIS P102**

Weight 36kg, lifting capacity 2kg 6-axis system £1175.00 (kit form) 6-axis system (ready built) Powertran Cortex £1950.00 microcomputer self-assembly kit £295.00



POWERTRAN cybernetics

# THE NEW MAPLIN CATALOGUE FOR 84

# NOW WITH PRICES ON THE PAGE

More data, more circuits, more pictures, in the brand new 480 page Maplin catalogue. Take a look at the completely revised Semiconductor section or the new Heathkit section with descriptions and pictures of dozens of kits and educational products from digital clocks to 16-bit business computers. The much expanded computer section itself, gives details of hundreds of pieces of software for Atari, BBC, Commodore 64, Dragon, Spectrum and VIC20. In addition to all this you'll find hundreds of fascinating new items spread through the rest of the catalogue.

As always, the Maplin catalogue is tremendous value for money and now has prices on the page!

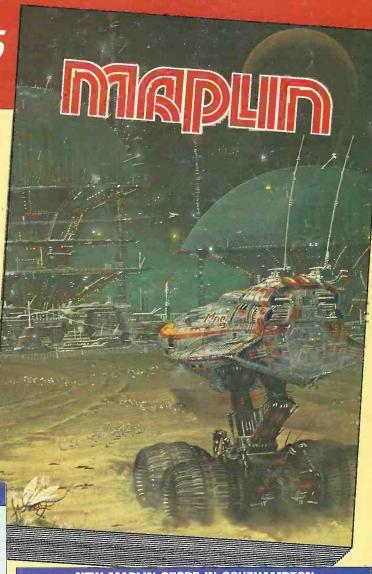
Pick up a copy at any branch of W.H. Smith or in one of our shops for just £1.35 or send £1.65 including postage to our Rayleigh address. On sale from 1st Nov 1983.

#### PROJECTS FOR THE HOME CONSTRUCTOR

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on kits. Full construction details in our Project Books and brief specifications in our new catalogue. Dozens of fascinating new projects coming soon including a Keyboard for the ZX Spectrum with electronics to make all shifts, single-key operations. Full details in Project Book 9 on sale 11th November 1983. Order As XA09K. Price 70p.



#### **NEW MAPLIN STORE IN SOUTHAMPTON**

Opening on 1st November 1983, our new south coast store is at 46-48 Bevois Valley Road, Southampton (Tel: 0703 25831). You will find our full range of components, projects and computers on sale. We are within easy reach of the city centre with good parking close by. Call in and see us soon.



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Mail Order: P.O. Box 3, Rayleigh, Essex SS6 8LR. Tel: Southend (0702) 552911 ♠ Shops at: 159–161 King Street, Hammersmith, London W6. Tel: 01-748-0926 ♠ 8 Oxford Road, Manchester. Tel: 061-236-0281 ♠ Lynton Square, Perry Barr, Birmingham. Tel: 021-356-7292 ♠ 282-284 London Road, Westcliff-on-Sea Essex. Tel: 0702 554000 ♠ \*46-48 Bevois Valley Road, Southampton. Tel: 0703 25831. \*Opens 1st November 1983. All shops closed Mondays. All prices include VAT and carriage. Please add 50p handling charge to orders under £5 total value (except catalogue).

# DIGEST

# Holophony — The Continuing Saga

We received a great deal of interested enquiries over our item on Holophony back in July. At the same time, elsewhere in the press a certain amount of cynicism was expressed over the system. Well now you can judge for yourself because a record of holophonic sound effects is available.

Out on CBS (CBS recording number TA3278), the record is a 12' 45 RPM and seems to be titled Zuccarelli Holophonic by Zuccarelli Labs Ltd, and your very own intrepid editor has been giving it a listen! He writes: "I must say I was somewhat disappointed at the quality of the effects, they were nothing like as good as when played through Hugo Zuccarelli's own equipment. Also the sleeve notes are far from complete - they fail to mention that you should use single-driver speakers small-cone or headphones".

Readers will also be interested to note that the Sennheiser dummy head recordings mentioned in September's READ/WRITE are available from Havden Laboratories Ltd, Hayden House, Chiltern Hill, Chalfont St Peter, Gerrards Cross, Bucks SL9 9UG, tel 0753 888447, at £1.15 each plus 57p postage and packing. There are just two recordings, both on 7' 45s; one is just a straight demonstration of the dummy head in a room with a commentator walking around and talking to you; the other has various sound effects, such as a jet aircraft passing overhead and a choir surrounding the dummy head.

# **IEEE Interface For The BBC**

ambridge Technology, a new specialist computer company, has produced the first, fully operational IEEE interface for the BBC microcomputer. The CST Procyon allows users to communicate with the range of instruments operating to the IEEE-488 international standard, and is particularly valuable in educational or scientific establishments. enables a BBC micro to be interfaced with high quality plotters and printers, frequency counters, voltmeters or disc drives, but may also be used to connect the "Beeb" to CBM equipment via a specially written Commodore filing system. It responds to any high level language including LISP, FORTRAN, FORTH, BASIC

The PROCYON is supplied with an 8k EPROM which fits a vacant sideways ROM socket in the BBC micro and supplies an IEEE filing system which can cope with up to 16 connected devices, accepting standard operating system file commands as well as special instructions or userdefined options. Data is transferred at up to 70k bytes of information per second, and the system is helpful and virtually fool-proof with extensive user advice facilities, error checking and visual indications of operating status.

A straightforward but comprehensive manual is supplied with the system, containing tutorials for beginners and advice on maximising the PROCYON's effectiveness. Cambridge Systems Technology, 30 Regent Street, Cambridge CB2 1DB, Tel (0223) 323302





Slipped Disc?
A couple of months ago we

Couple of months ago we featured two so-called portable audio units in Digest and wondered, in view of their ever increasing complexity and weight, just how long it would be before someone fitted wheels to one. Panasonic's SG-J500 does indeed have a revolving addition, but instead of being there to ease the load it just adds to it, for this truly monstrous beastie comes complete with a push-button, slide out turntable.

Part of a new range of portable audio units called 'RX Sound', the SG-J500 features an auto stop cassette deck and a three band tuner as well as the turntable and delivers four watts (whether RMS or peak is not specified) through its 'full range' speaker system. Weight is not specified, Panasonic being content to describe it as 'lightweight', and price is £133.50.

The RX-F32L from the same range does not have a turntable, presumably because they didn't have room for one after including the four, full range speakers, sur-

round effect ambience stereo, Dolby noise reduction, loudness switch, and automatic tape search system. However, for those who simply must have everything, Panasonic have produced an add-on turntable unit, the SL-N15. This is described as-'jacket sized' (we think they/mean record jacket sized) but is in reality rather thicker and features linear tracking.

Last, but presumably not least since it is the most expensive item in the range, the RX-C45L. This features a five-band graphic equaliser, ten watts per channel output, Dolby noise reduction, metal tape compatibility, full auto stop, and again it can be used in conjunction with the SL-N15 turntable. There is also something in the press release about 'soft touch', but apparently this refers to the machine rather than to potential purchasers.

The RX-F32L costs £144.50 and the RX-C45L costs £177.50. Price of the SL-N15 is not given. All items should be available through Panasonic's authorised dealers nationwide.

## Electronic Typewriters with RS232

National Panasonic recently launched a new range of electronic typewriters in the USA and now plan to market them in the UK from about the middle of next year. The two new machines, designated KX-E701 and KX-E708, are both available with an optional RS232C interface, thus enabling them to be used as letter quality printers.

The KX-E701 is described as an economically priced, standard electronic typewriter, while the KX-E708 is a full-feature model with a forty character display. Just what is meant by economical is not clear since no prices have been announced; indeed, when we telephoned panasonic UK to quiz them about it, they seemed unaware that the machines were due here at all! So perhaps you'll just have to make our typewriter interface after all . . .

Panasonic Business Equipment (UK) Ltd, 107-109 Whitby Road, Slough, Berkshire SL1 3DR, tel Slough 75841.

# ₹Rapid ₹Electronics

MAIL ORDERS: Unit 1, Hill Farm Industrial Estate, Boxted, Colchester, Essex CO4 5RD. **TELEPHONE ORDERS:** Colchester (0206) 36412.



CAPACITORS



#### **ACCESS AND BARCLAYCARD** WELCOME

CAPACH ORS

Polyester, radial leads. 250v. C280
type: 0.01, 0.015, 0.022, 0.033 69; 0.047, 0.068, 0.1 - 79; 0.15,
0.22 - 99; 0.33, 0.47 - 139, 0.66 209; 1u - 239.
Electrolytic, radial or axial leads:
0.47/63V, 1/63V, 22/63V, 43/63V,
10/25V - 79; 22/25V, 47/25V - 89;
10/25V - 29; 22/25V - 149;
40/25V - 250; 100/25V - 149;
40/25V - 500; 20/25V - 149;
40/25V - 500; 20/25V - 149;
40/25V - 250; 100/25V - 309;
220/63V - 1409; 470/63V - 309
Polyester, ministure Semens PCB:
1n, 2n, 2, 3n, 4n, 6n, 10n, 15n, 7p;
22n, 3n, 47, 6n, 81, 0n, 15n, 7p;
150n, 11p; 220n, 13p; 330n, 20e;
470n, 26p; 880n, 29p; 1u 33p; 2u, 20e;

50p.

Tantalum bead:
0,1 0,22,0,33,0,47,1,0 @ 35V - 12p. 2,2,4,7,1,0 @ 25V - 20p;
15/16V - 30p; 22/16V - 27p; 33/
16V - 45p; 47/6V - 27p; 47/16V - 97p;
68/6V - 40p; 100/10V - 90p,
Cer. disc, 22p-0.01u 50V, 3p each,
Mullard ministure ceremic plate:
1.8p F to 100p F 6p each.

Polystyrene, 5% tol: 10p-1000p, 6p; 1500-4700, 8p;6800 0.012u, 10p. Trimmers. Mullard 808 series: 2-10 pF, 22p; 2-22pF, 30p; 5.5-65pF, 35p

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LIMITATE		17141		LM339	45	LM3911	120	NE566	140	TL064	96
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555CMOS	80	ICL7106	790	LM377	170	LM13600	105	NE571	370	T.L074	95
556CMOS	150	ICL7611	95	▶LM380	65	MC1496	68	▶RC4136	55	▶TL081	25
709	25	ICL7621	180	►LM381	120	MC3340	135	▶RC4558	60	TL082	45
▶741	14	ICL7622	180	LM382	120	►MF10CN	350	SL480	170	TL084	95
748	35	ICL8038	295	LM384	130	ML922	400	SL490	250	TL170	50
9400CJ :	350	ICL8211A	200	LM386	65	ML924	195	SL76018	150	UA2240	120
AY-3-1270	720	ICM7224	785	LM387	120	ML925	210	▶SN76477	380	ULN2003	85
AY-3-8910	370	ICM7555	80	LM393	100	ML926	140	SP8629	250	ULN2004	90
AY-3-8912	540	▶LF351	45	LM709	25	ML927	140	TBA120S	70	XB2206	290
CA3046	60	LF353	85	LM711	60	ML928	140	TBA800	75	ZN414	100
▶CA3080	65	'LF356	90	LM725	350	ML929	140	TBA810	96	ZN423	135
CA3089	190	LM10	360	LM733	75	MM5387A	465	TBA820	70	ZN424	135
CA3090AQ	375	LM301A	25	LM741	14	NE529	225	TBA950	220	ZN425E	350
CA3130E	85	LM311	70	LM747	60	NE531	150	TDA1008-	320	ZN426E	330
▶CA3140E	36	LM318	120	LM1458	40	NE544	205	▶TDA102		ZN427E	650
	100	LM324	40	LM2917	200	NE555	16	TDA1024	125	ZN428E	480
	290	LM334Z	100	LM3900	45	NE556	45	TL061	40	ZN459	285
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				BC548	10	BFR80		TIP29B	55	ZTX300	14	▶ 2N3702	
AC125	35	BC149	9	BC549	10	▶BFR8		TIP29C	37	ZTX301	16	2N3703	9
AC126		BC157	8	BC558	"10 ·	BFX29		TIP30A	35	ZTX302	15	►2N3704	
AC127	25	BC158	10	BCY70		BF X84		TIP30B	-50	ZTX304	17	2N3705	9
► AC128		BC159	8	BCY71		BFX85		TIP30C	37		30	2N3706	9
AC176	25	BC160	45	BCY72		BFX86		TIP31A	35	ZTX500	15	2N3707	10
AC187	22	BC168C	10	BD115		BFX87		TIP31C	37	ZTX501	15	2N3708	10
AC188	22	BC169C	10	BD131		BFX88		TIP32A	35	ZTX502	15	2N3709	10
	120	BC170	8	BD132		BFY50		TIP32C	37	ZTX503	18	2N3772	170
AD149	80	BC171	10	BD133		BFY51	20	TIP33A	50		25	▶2N3773	
AD161	40	BC172	8	BD135		BFY52		TIP33C	75	2N697	20	▶2N3819	
AD162	40	BC177	18	BD136		BFY53		TIP34A	60	2N698	40	2N3820	40
AF124	60	BC178	18	BD137		BFY55		TIP34C	85	2N706A	20	2N3823	65
AF126	50	BC179	18	BD138		BFY56		TIP35A	105	2N708	20	2N3866	90
AF139	40	BC182	10	►BD13		BRY39		TIP35C	125	2N918	35	2N3903	10
AF186	70	▶BC1821		▶BD14		BSX20		TIP36A	125	2N1132	22	2N3904 2N3905	10
AF 239	75	BC183	10	BD204		BSX29	35	TIP36C	135 45	2N1613	30	2N3905 2N3906	6
BC107	10	BC183L	10	BD206		BSY95		TIP41A		2N2218A		2N3906 2N4037	10 45
BC107B	12	BC184	10	BD222		BU205	160	TIP42A	45	2N2219A		2N4037 2N4058	10
▶BC108		BC1841		BF180		BU206	180	TIP120	90 90	2N2221A		2N4068 2N4060	10
BC108B	12	BC212	10	BF182		BU 208	170	TIP121	90	2N2222A		2N4060 2N4061	10
BC108C	12	BC212L	10	BF184		MJ2955		TIP122 TIP141	98	2N2368	25	2N4061	10
▶BC109		BC213	10	BF 185	25	MJE340		TIP141	98	2N2369 2N2484	16 25	2N5457	36
BC109C	12	BC213L	10	BF194		MJE520		TIP 142	110	2N2484 2N2646	45	2N5458	36
BC114	18	BC214	10	BF195		MJE52		TIP2955	60	2N2646 2N2904	20	2N5458	30
BC115	22	▶BC2141		BF196		MJE305		TIP2955	55	2N2904 2N2904A		2N5485	36
BC117	18	BC237	8	BF197		MPF10		TIS43	40	2N2904A 2N2905	20	2N5777	45
BC119	35	BC238	14	BF198		MPF10		TIS43	45	2N2905 2N2905A		2N6027	30
BC137	40	BC308	12	BF 199		MPSA0		TIS90	30	2N2905A 2N2906	25	40360	40
BC139	40	BC327	14	BF200		MPSAO		TIS90	30			40361	50
BC140	28	BC328	14	▶BF2		MPSA1		VN10KN		2N2906A	25	40362	50
BC141	30	BC337	14	BF245		MPSA5		VN10KN		2N2907 2N2907A		40408	70
BC142	25	BC338	14	- BF256		MPSA5		VN46AF			25	70400	/0
BC143	25	BC477	30	BF257		MPSU0				2N2926 ▶2N3053			
BC147	8	BC478	30	BF258		MPSU0		VN8BAF	95				
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MIN. D CON	NECT	ORS		<b>A</b>
Plugs solder lugs Right angle Sockets lugs Right angle Covers	9 way 60p 120p 90p 160p 100p	15 way 85p 180p 130p 210p 90p	25 way 125p 240p 195p 290p 100p	37 way 170p 350p 290p 440p 110p

	OIMIM	ĘŲI	ons		
DIN	Plug	Skt	Jack	Plug	Skt
2 pin	9p	9p	2.5mm	10p	10p
3 pin	12p	10p	3.5mm	9p	9p
5 pin	13p	11p	Standa	d16p	20p
Phone	10p	12p	Stereo	24p	25p
1mm	12p	13p	4mm	18p	17p
UHF :	(CB)	Conn	ectors:		
PL259	9 Plug	40p	. Reduc	er 14	D.
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OWNTOWNED
Submin toggle:
SPST 55p. SPDT 60p. DPDT 65p.
Miniature toggle:
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DPDT 90p. DPDT centre off 100p.
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Push to make 14p.
Push to break 22p.
Rotary type adjustable stop.
1P12W, 2P6W, 3P4W all 55p each.
DIL switches:
4SPST 80p 6 SPST 80p. 8SPST
100p.

SMITCHES

SOCKETS	Low	Wire
8 pin	6p	25p
14 pin	8p -	35p
16 pin	9р	42p
18 pin	12p	52p
20 pin	13p	60p
22 pin	16p	70p
24 pm	18p	.70p
28 pin	23p	80p
40 pin	25p s 60P/100	98p

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		1

SCRs

▶C106D	.30
400 V 8A	70
400V 12A	95

SOLDERING IRONS

VERO

Antex CS 17W Soldering iron 495
2.3 and 4.7mm bits to suit . 85
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nals are used to select the allo-	

	. 770	VERO				
Now your com The G1 SP0256	speech processor stored program to	VEROBLOC < Size 0.1 matri 2.5 × 1		* ·		350 22 75 85 95
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KETS	Low	Wire- wrap	4
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in .	18p	.70p	6
in	23p	80p	N

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Resistor kit. Contain	s 10 of each value f	rom 4	1.7	ohm	s to	1 M	l (to	tal	
of 650 resistors) .									530
Ceramic Cap, kit. 5 c						œi.		•	370
Polvester Cap, kit. 5	of each value from	0 01	**	1E	165	020	10	•	575
									9/3
Preset kit, Contains 5	o of each value from	100	on	ms to	2 14	ηţt	ota		
65 presets									425
Nut and Bolt kit (tot	(al 300 items): 180p	1							
25 68A ¼" bolts	50 6BA washers			50 68	ЗА і	nuts	5		

# 50 6BA washers

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#### REGULATORS

78L05	30	79L05	65
78L12	30	79L12	65
78L15	30	79L15	65
7805	35	7905	40
7812	35	7912	40
7815	35	7915	40
LM309K	130	LM723	35
LM317K	270	SPECIAL O	OFFER!
LM317T	120	78PO5 10A	\ +5V
LM3 23 K	350	only 390n	each

#### DIODES

DIOUE	•			
BY127	12	▶1N4001	3	
OA47	10	1N4002	5	
OA90	8	1 N4006	7	
OA91	7	1N4007	7	
OA200	8	1N5401	12	
OA202	8	1N5404	16	
1N914	4	1N5406	17	
▶1N4148	3	400mWzen	6	

#### OPTO

▶3mm red	7	▶5mm red	
▶3mm green	10	▶5mm green	1
▶3mm yello	w10	▶5mm yello	w
Clips to suit	- 3p		
Rectangular		TIL32	•
▶red	12	TIL78	4
green		▶TIL111	(
yellow	17		1
▶TIL38	40	TIL100	1
2N5777	45	Dual colour	•
Sevan segme	nt di	splays:	

# Seven segment displays: Com cathode DL704 0.3" 95 PFND500 DFND507 0.5" 100 0.5" 100 TIL313 0.3"15 TIL3220.5"115 TIL322 0.5"115 LCD: 3% digit 580p. 4 digit 620p.

#### RESISTORS

%W 5% Carbon film £12 series 4.7 ohm - 10M 1p each.
%W 5% Carbon film E12 series 4.7 ohm to 4M7 2p each.
½W 1% metal film E24 series 10 ohm - 1M 6p each.

ohm to	Carboi 4M7 metal		12 series 2p each series 1 6p each	4.7 1. 0	F
СМО	s ·	4016 4017	20 30	403 403	
CIVIC	<b>.</b>	4017	45	403	
4000	10	4019	25	404	
4001	10	4020	42	404	1
4002	12	4021	40	404	
4006	50	4022	45	404	
4007	14	4023	16	404	
4008	36	4024	33	404	
4009	24	4025	12	404	
4010	24	4026	75	404	
4011	10	4027	20	404	
4012	15	4028	40	405	
4013	20	4029	45	405	51

# 4017 4018 4019 4020 4021 4022 4023 4024 4025 4026 4027 4028 4029

4014	45	4030	14	4052
4015	40	4031	125	4053
LS T	TL	LS20 LS21	12 12	LS75 LS76
LS00 LS01	11	LS22 LS26 LS27	12 14 12	LS78 LS83 LS85
LS02	12	LS30	15	LS86
LS03	12	LS32		LS90
LS04 LS05	14 12	LS37 LS38	14 15	LS92 LS93 LS95
LS08	14	LS40	13	LS96
LS09	12	LS42	28	

L315	12	L374	20	LUIZZ
=		7413	17	7444
TTL		7414	23	7446
_	-	7416	19	7447
7400	11	7417	19	7448
7401	11	7420	14	7450
7402	11	7421	19	7451

7405	14	7428	25	7460
7406	19	7430	13	. 7472
7407	19	7432	20	7473
7408	13	7433	20	7474
7409	13	7437	23	7475
7410	13	7438	24	7476
7411	15	7440	14	7480

Alkinonikano	
PP3 battery clips	
Red or black crocodile clips	
Black pointer control knob	. 1
Pr Ultrasonic transducers	35
▶6V Electronic buzzer .	6
▶12V Electronic buzzer .	6
▶PB2720 Piezo transducer .	7
▶64mm 64 ohm speaker .	7
▶64mm 8 ohm speaker .	7
20mm panel fuseholder .	2

#### POTENTIOMETERS

Rotary, Carbon track Log or Lin
1K - 2M2, Single 32p, Stereo 85p.
Single switched 80p. Slide 60mm
travel single Log or Lin 5K - 500K
63p each.
Preset submin. hor. 100 ohms -1M

7p each. Cermet precision multiturn, 0.75W %" 100 ohms to 100K - 88p each.

TRIACS	400 V 8A 400 V 16A	65 95
400V 4A	50 BR100	25

#### JUMPER LEADS

COME ZX81 2

Length	14pin			
Sgle end				umper
24 ins.		165		380
Dble end				
6 ins.				
12 ins.	195	215	315	490
24 ins.	210	235	345	
36ins.	230	250	375	595
25 way				
18ins. le				
18ins.lo	ng singl	e ende	d f/mal	e 525p

# BRIDGE 2A 400V 45 8A 400V 80 8A 400V 95 95 91 A 400V 35 200V 5 50 ONNECTORS

COMPUTER CONNECTORS	IDC CC
ZX81 2 x 23 way edge connector wire wrap suitable for ZX81 add-ons	10 way
RIBBON CABLE Grey Ribbon cable. Price per metre	16 way 20 way 26 way 34 way
10 way . 38 34 way . 150	40 way

way	55	:40 way	4	
way	80	50 way		
WAV	110	60 way		

PCB MATERIALS	
Alfac transfer sheets - please	state
type (e.g. DIL pads etc.)	45
Dalo etch resistant pen	100
Fibra glass board 3.75 x 8"	80
Fibre glass board 8 x 12"	200
Ferric Chloride crystals	100

. 05			
pe (e.g. alo etch bre glas bre glas	sfer sheet DIL pads resistant ( s board 3. s board 8 oride crys	etc.) pen 75 x 8" x 12"	se state 45 100 80 200 100
140 249 280 40 40 38 40 40 40 35 38 21	4054 4055 4059 4060 4063 4066 4067 4068 4069 4070 4071 4072 4073	78 80 430 42 80 22 225 14 13 13 13	4081 4082 4085 4086 4089 4093 4094 4095 4097 4098 40106 40106
42 48 48	4075 4076 4077	13 45 14	40163 40173 40175

ts — pleas		PI
s etc.) : pen 3.75 x 8''	100 80	& 3
3 × 12" /stals	200 100	7
78	4081	

	& scri 3 x 2 4½ x	x 1" 3 x 1%	55 " 88	3 × 4 × 6 × 7 ×		1 %' 2"	1
ı	7 × 4	x 2"	160	8 x	6 x 3	•	2
_	12	4019	3 6	35	4528		4

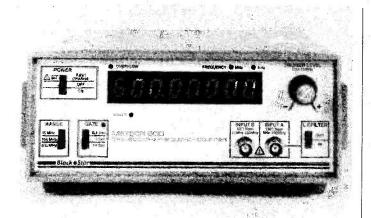
Edge Conn

1000					
1081	12	40193	65	4528	45
1082	12	4502	60	4529	150
1085	48	4503	32	4532	60
1086	50	4507	35	4534	400
1089	125	4508	110	4538	60
1093	18	4510	45	4543	50
1094	68	4511	40	4549	360
1095	65	4512	40	4553	215
1097	290	4514	115	4555	35
1098	70	4515	115	4556	35
099	70	4516	55	4559	390
10106	40	4518	40	4560	140
0109	110	4520	50	4584	35
0163	60	4521	130	4585	60
10173	100	4526	60	4724	140
0175	75	4527	50		
S160	35	LS197	45	1 5353	60

	_	7413	17	7444	85	7483	30	74122	38	74161	46	74190	40
TTL		7414	23	7446	58	7485	60	74123	38	74162	46	74191	40
	_	7416	19	7447	36	7486	19	74125	33	74163	46	74192	40
7400	11	7417	19	7448	43	7489	180	74126	33	74164	46	74193	40
7401	11	7420	14	7450	٠14	7490	19	74132	30	74165	46	74194	40
7402	11	7421	19	7451	14	7491	34	74141	54	74167	150	74195	40
7403	12	7422	19	7453	14	7492	24	74145	48	74170	115	74196	40
7404	12	7427	18	7454	14	7493	24	74147	75	74173	58	74197	40
7405	14	7428	25	7460	14	7494	33	74148	60	74174	53	74198	80
7406	19	7430	13	7472	22	7495	33	74150	48	74175	45	74199	80
7407	19	7432	20	7473	24	7496	38	74153	38	74176	35		
7408	13	7433	20	7474	19	7497	86	74154	47	74177	42		
7409	13	7437	23	7475	26	74100	78	74155	36	74179	75		
7410	13	7438	24	7476	25	74107	22	74156	36	74180	38		
7411	15	7440	14	7480	45	74109	24	74157	28	74181	100		
7412	17	7442	30	7482	65	74121	24	74160	55	74182	55		

ORDERING INFO. All components brand new and full specification. All prices exclude VAT. Please add to total order. Please add 50p carriage to all orders under £15 invalue. Send cheque/P.O. or Access/Visa number with order. Our detailed catalogue costs 45p (free with orders over £10). Callers most welcome. Flelphone orders welcome with Access or Visa. Official orders accepted from colleges, Schools, etc. . . Callers most welcome, we are open Monday to Friday.

# NEWS:NEWS:NEWS:NEWS:NEWS:NEWS



#### **Low Cost DFM**

The Meteor 600 is the first in a series of digital frequency counters announced by Black Star Ltd. It has a frequency measurement range of 2 Hz-700 MHz, sensitivity of 25mV at 600 MHz and resolution down to 0.1 Hz, and also features  $8 \times \frac{1}{2}$ " bright LED displays, 3 gate times, 2 inputs, a trigger level control and an integral low pass filter. The counter is housed in an attractive,

sturdy, custom-moulded A.B.S. case with tilt stand. It can be operated from rechargeable batteries or mains and is supplied complete with a mains adaptor/charger and a comprehensive instruction manual. A wide range of optional accessories is also available.

The Meteor 600 costs £115 plus VAT and is available from Black Star Ltd, 9A Crown Street, St. Ives, Huntingdon, Cambs. PE17 4EB, tel. 0480-62440.

# **Shorts**

- ITT Cannon have introduced the AXR audio connector range, a successor to their industry standard XLR range, which features easier assembly, greater RFI protection, improved cable clamping, and lower cost. The AXR has from three to seven contacts plus a mains version, comes in sixteen shell styles, and is available from PSP Electronics Ltd, Unit 2, 2 Bilton Road, Perivale, Greenford, Middlesex UB6 7DX.
- 3M have introduced a new Scotchlok connector which may be attached to an existing cable in one action using a pair of pliers and which provides a fully insulated tapping point for a standard ¼" blade connector. Also new is an inline fuseholder which assembles onto wire ends without prior stripping, again with only one action. Electro-Products Group, 3M United Kingdom PLC, 3M House, PO Box 1, Bracknell, Berkshire RG12 1JU, tel 0344 58755.
- Data I/O has published a thirty-two page booklet entitled 'Programmable Logic A Basic Guide for the Designer'. It covers all aspects of design, programming and testing including a worked example, and is available free-of-charge from Microsystem Services, PO Box 37, Lincoln Road, Cressex Industrial Estate, High Wycombe, Bucks HP12 3XJ, tel 0494 41661.

- Och Aye, hoots mon, and the rest! Scottish ETI readers should note that the first Scottish Home Computer and Electronics Show is coming and will feature micros, software, CB, ham, hi-fi and video equipment. Venue is the Anderston Centre in Glasgow and the whole caledonian caboodle runs from the 11th to the 13th November. Details from Ann Trade **Exhibitions** 53/55 Commissioner Scotland, Street, Crieff, Perthshire PH7 4DA, tel 0764 - 4204.
- CHO-JAC is a bonded foil and polymer sheath designed to protect ribbon cables against electromagnetic and radio frequency interference. Available in sizes to fit 16, 26, 34, 40, 50, and 60 way cables, it is claimed to give a shielding effectiveness of up to 65 db and is supplied in 100 ft rolls. Chomerics Europe, Chomerics House, 14-18 Church Street, Slough, Berkshire SL1 1PZ, tel. (0753) 822242.
- The EX 110 is a new, plunger type, electrically heated desoldering tool which weighs four ounces and is designed to be operated for extended periods without tiring the operator. It features a cassette system which eases removal of the accumulated solder, operates from the mains, has a bit temperature of 420°C, and costs about £18 plus VAT. Nietronix Ltd, West End Trading Estate, Blackfriars Road, Nailsea, Bristol BS19 2DI, tel 0272 856697.

# Hello, Computer Speaking . . .

f your micro is feeling lonely, why not introduce it to a wider circle of friends with the new UDS V.21 LP modem from Codex (UK) Ltd? This 300 baud stand alone machine comes in either manual or automatic answering versions and is approved for connection to the Public Switched Telephone Network, from which it draws its power. It stands only one inch high and is designed to fit neatly underneath the telephone. With a selling price of around £200 for the manual version and £250 for the automatic model, Codex anticipate a lot of interest from the small business and hobbyist markets, and are currently seeking distributors for the product to whom they are prepared to offer generous quantity discounts. Codex (UK) Ltd. 114/116 Thornton Road, Surrey CR4 6XB, tel. 01-689 2101.

- We are often asked by readers to recommend someone who will repair and re-calibrate test meters, etc, and usually have to admit defeat. PIL will not, as far as we know, repair meters but they will re-calibrate them and whats more they'll do it to Defence Standard 05-24. Ring 01-639 0155 for details.
- Cambridge Microelectronics have introduced a 2516, 2532, 2716 and 2732 EPROM programmer for the ZX81. ROM-81 provides all the standard programming functions, requires four PP3 batteries, is housed in a neat ABS case which plugs into the back of the ZX81 and has a further expansion adaptor, and comes complete with a taped control program and user notes. Price is £19.95 plus VAT from Cambridge Microelectronics Ltd, 1 Milton Road, Cambridge CB4 1UY, tel 0223 - 314814.
- They may not be giving computers away with breakfast cereals yet but they are giving them with courses. Prophet Systems Ltd are running one and two day training courses in computer assisted business modelling at their Jacobean manor at Polebrook, Peterborough, and are giving away a Prophet II microcomputer to each participant. Polebrook Management Systems Ltd, Polebrook Hall, Peterborough PE8 5LN, tel 0832 72052.

Sculptured Circuits

owty Circuits Ltd have signed an agreement with Advanced Circuit Technology of America giving them exclusive rights to manufacture what they call sculptured circuits in this country. This patented technology permits the physical carving of copper into various shapes by a chemical milling process, allowing the thickness of a piece of copper to be varied along its length. In this way, connector systems can be fabricated in which each conductor has both its terminal pins and flexible lead made from a single continuous piece of copper, thereby increasing reliability, reducing series resistance, and reducing assembly costs, time, etc. Dowty anticipate the production of a wide range of standard and custom designs with various conductor diameters, pin densities, finishes and terminations. Dowty Circuits Ltd, Industrial Estate. **Terminus** Road. Chichester, West Sussex PO19 2UA, Tel 0234 784516.

- The TG-3 is a hand-held, battery operated television test generator with a direct UHF output to suit a standard 625 line set. It provides 2 MHz lines for focus check, grating pattern, dot pattern, and plain white raster, and costs £46 inclusive from Video Techniques, 101 Derby Street, Bolton, Lancashire BL3 6HH, tel 0204 26916.
- OK Industries new FG-201 function generator provides highly accurate sine, square and triangle waveforms from 1 Hz to 1 MHz into 50 ohms and offers both AM and FM modulation. There is also a 5 ohm output for sine and triangle while square wave may be used simultaneously with either as a trigger. The FG201 costs £230 plus VAT and is manufacturered by OK Industries UK Ltd, Dutton Lane, Eastleigh, Hampshire, tel 0703-610944.
- Industrialists and Researchers are invited to the First International Conference on Lasers in Manufacturing to be held at the Brighton Metropole from 1st-3rd November. Hewlett-Packard, Rolls-Royce, and BL will be among those contributing to the conference, which aims both to highlight recent experience and to consider the future of the laser in industry. Details from The Conference Director, LIM-1, IFS (Conferences) Ltd, 35-39 High Street, Kempston, Bedford MK42 7BT, tel 0234 853605.

#### **HOME LIGHTING KITS**

These kits contain all necessary components and full instructions & are designed to replace a standard wall switch and control up to 300%, of lighting.

TDR300K Remote Control £14.30 Dimmer Transmitterfor above £4.20 TD300K Touchdimmer £ 7.00 Touchswitch £7.00

TDE/K Extension kit for 2-way switching for TD300K £ 2.50



#### **ELECTRONIC LOCK KIT XK101**

This KiT contains a purpose designed lock IC, 10-way keyboard, PCBs and all components to construct a Digital Lock, requiring a 4-key sequence to open and providing over 5000 different combinations. The open sequence may be easily changed by means of a prewired plug. Size:  $7 \times 6 \times 3$  cms. Supply: 5V to 15 V d.c. at 40uA. Ouput: 750mA max. Hundreds of uses for doors and garages, car anti-theft device, electronic equipment, etc. Will drive most relays direct. Full instructions supplied. **ONLY £10.50** 

Flectric lock mechanism for use with latch locks and above kit £13.50

#### "OPEN-SESAME"

"OPEN-SESAME"

The XK103 is a general purpose infra-red transmitter/
receiver with one momentary Inormally open relay contact and two latched transistor outputs. Designed primarily for controlling motorised garage doors and two auxiliary outputs for divergarage lights at a range of up to 40 ft. The unit also has numerous applications in the home for switching lights, TV, closing curtains, etc. Ideal for aged or disabled persons.

The Kit comprises a mains powered receiver, a four button transmitter, complete with prachilled box, requiring a 9V battery and one opto-isolated solid state switch kit for inter-facing the receiver to mains appliances. As with all our kits, full instructions are supplied.

**ONLY £23.75** 

#### XK113 MW RADIO KIT

Based on ZN414 IC, kit includes PCB, wound aerial and crystal earpiece and all components to make a sensitive miniature radio. Size:  $5.5 \times 2.7 \times 2$ cms. Requires PP3 9V battery. IDEAL FOR BEGINNERS. £5.00

#### 3-NOTE DOOR CHIME #

Based on the SAB0600 IC the kit is supplied

#### Have you got our FREE GREEN CATALOGUE yet?

NO2! Send S.A.E. b. 9" TODAY:

It is packed with details of all the KTS one make range to SEMICONDUCTORS including CMOS, LS TTL, fatear, microphomessors and mentories, full range of LEDs, capacitors, resistors, hardware, relays, switches at: We also stock VERO and Antex grounds as well as broks from Texas Instruments. Babani and Elektor.

ALLAT VERY COMPETITIVE PRICES.

ORDERING IS EVEN EASIER — JUST RING THE NUMBER YOU CAN'T FORGET FOR PRICES YOU CAN I PRESIST.

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#### MINI KITS

LM3911

MK1 ELECTRONIC THERMOSTAT Uses LM3911 IC to sense temperature (80°C max) and triac to switch heater (1KW). Mains powered. £4.00

Government and triac to switch heater (1KW) Mains powered. £4.00 MK2 SOLID STATE RELAY Switches 240V as motors, lights, heaters from logic/computer circuits. Zero voltage switching, opto-isolated. Supplied without triac £2.50 MK4 PROPORTIONAL TEMPERATURE CONTROLLER Uses "burst lire" technique to maintain temperature to within 0.5°C. Ideal for photography, incubators, wine making, stc. Max. load 3KW (240V ac). Temp. range up to 90°C. £5.55 MK5 MAINS TIMER Mains powered timer enabling a load up to 1KW at 240V ac to be switched on (or off) for a variable time from 20 mins. to 35 hrs. Longer or shorter periods possible with minor component changes. £5.00 MK15 DUAL LATCHED SOLID STATE RELAY Comprises two MK2s with larch circuit controllands. MK12 bit it controllands.

STATE RELAY
Comprises two MK2s with latch circuit
enabling the MK12 kit to control two
mains loads independently. Two
output triacs not supplied (See
remote control kits.)

£4.50

NEW! MK19 DC CONTROLLED
AUDIO AMPLIFIER
May be used with virtually any stereo
audio amplifier to control bass,
volume, treble and balance remotely
either using a wire link or the MK11
infra red receiver. A 1 of 10 decoder
with LEDS is also included for remote
input selection/display. (See remote selection/display. ... control kits.) £10.70

NOW OPEN

#### COMPONENTS a wide range in stock including:

TD4 1024

LINEAR	1.20	1.20	REGU
ICs	LM3914	TDA2020	LATORS
	2.10	2.85	
555 .17	LM3915	TDA4290	781.05.12.
556 .40	2.20	1.98	15 .26
741 15	LM13600	TL061 .40	79L05: 12
748 .35	1.10	TL062 .60	15 .60 7805.12
AD590 3.30	LS7220	TL064 .98	15 35
AY-3-1270	2.75	TL071 .30	7905 40
7.20 CA3080 .72	LS7225	TL072 50	LM3177
CA3130 .75	2.60	TL074 .95	1.80
CA3140 .43	MF10C 3.30	TL081 .25	LM338K
ICL7106	ML922 4 10	TL082 .45	4.60
7.00	ML924 1.95	TL084 .95	LM723 .40
ICL7107	ML 925 2,10	TL170 .50	C-V(723 .40
9.00	ML926 1.40	TL507C	CMOS
ICL7126	ML927 1.40	1.80	
8.00	ML928 1.40	UA2240	4000 11
ICL8038	ML929 1.40	1.20	4001 .11
3 10	MM74C911	ULN2003	4002 .11
CMOS555	6.50	.80	4007 .12
79	MM74C915	ULN2004	4012 12
LF351 44	.96 MM74C922	.85	4013 .20
LF353 80	2.90	ZN414 .98	4015 .39
LF356 .90	MM74C926	ZN425 3.40	4016 .20
LM324 .35	4.50	ZN4275.70	4017 .29
LM334Z .90	NE566 1.40	ZN428 4,10	4019 .24
LM335Z	NE567 .97	ZN1034E 1.80	4023 .15
1.20	S566B 2.15	1.80	4025 .15
LM339 .50	S576D 2.15	TRIACS	4026 .72
LM348 .63	SABOSCO		4027 20
LM358 .45	2.50	400V	4028 .38
LM377 1.45	SL440 1.75	Plastic	4040 .39
LM380 .80	SL441 1.35	1 6A 42	4043 .38
· LM381 1.15	SL480 1.70	4A- 49	4046 .46
LM382 1.00	SL490 2.40	8A .58	4049 .21
LM386 .75	TBA800	12A .85	4050 21
LM1458.35	.68	16A .95	4060 .42
LM1830	TBA810AS	25A 1 90	4069 .13
1.50	1.00	Q4006LT	4070 13
LM2917	TMS1121	MOC3020	4071 13
1.60			1077 16

1.00 TMS1121 8 50 TMS1601 10.00

Hours: Mon-Fri 10am

SPECTRUM

MEM ORIES 2114 .80 6810 1.25 2716 2.00 2732 4.80 MICROS Z80A cpu 2.85

Z80A ctc 2.60 Z80A pro 2.50 8035L 5.50 LED's 3mm & 5mm

Red 9p Green or Yellow 12p Flashing Red 49p Red 49p Flashing Continuous Red 52p Red TrrCalour 5mm Round 50p Rectangular 55p

3" cc Red 75p

#### Order as XK112. £42.00 Additional Receivers XK111 £10.00

**DISCO LIGHTING KITS** 

This value for money kit fea-tures a bi-directional se-quence, speed of sequence and frequency of direction change, being variable by means of poten-tiometers and incorporates a master dimming control.

A lower cost version of the above, featuring

Optional opto input DLA1
Allowing audio ("beat") – light response.
DL3000K

DL3000K
This 3 channel sound to light kit features zero voltage switching, automatic level control and built in mic. No connections to speaker or amp required. No knobs to adjust — simply connect to mains supply and lamps, (IKw channel) Only £11.95

LCD 31/2 DIGIT MULTIMETER

6 ranges including DC voltage (200 mv-100) and AC voltage, DC current (200 mA-10 A nd resistance (0-2 M) + NPN & PNP transisto ain and diode check. Input impedance 10M ize 155x88x31 mm. Requires PP3 9v battery.

HOME CONTROL CENTRE

This kit enables you to control up to 16 different appliances anywhere in the house from the comfort of your armchair. The transmitter injects coded pulses into the mains which are decoded pulses into the mains which have a compared to the state of the

£14.60

JO TO

£8.00

ONLY £29.00

DL 1000K This value for money kit fea-

DLZ1000K

**REMOTE CONTROL KITS** 

FOR A DETAILED BOOKLET ON REMOTE CONTROL — send 30p ~ 6" × 3" S.4" MK6 SIMPLE INFRA RED TRANSMITTER Supplied with hand-held plastic box. Requires 9V [P93] batter £4.20

Supplied with hand-held place (PP3) battery
MK7 INFRA RED RECEIVER MK7 INFRA RED RECEIVER

Mains powered with triac output to switch up to 
500W at 240V ac. Range approx. 20 ft. chroff or 
momentary control. £9.00

monthly a Dead we make approx. 20 11: 29.00

1RC 500K — special price for MK6 MK7

MK9 4-WAY KEYBOARD

For use with MK 18/MK 12 transmitter receiver where only 4 channels are required

1.190

MK10 16-WAY KEYBOARD

MK11 10 Channels 3 analogue oly racelver

A mains powered LR receiver providing control signals to 10 onnof and 3 analogue circuits. Maye signals to 10 onnof and 3 analogue circuits. Maye MK11 10 channels 4 analogue oly racelver

A mains powered LR Receiver providing up to 16 on topic of the signals o

with all components, including loudspeaker, printed circuit board, a pre-drilled box (95 × 71 × 35mm) and full instructions. Requires only a PP3 9V battery and push-switch to complete. AN IDEAL PROJECT FOR BEGINNERS. Order as XK 102. £5.00

# ALL PRICES EXCLUDE VAT

#### MICROPROCESSOR CONTROLLED MULTI-PURPOSE TIMER

Now you can run your central heating, lighting, hi-fi system and lots more with just one programmable timer. At your selection it is designed to control four mains outputs independently, switching on and off at pre-set times over a 7 day cycle, e.g. to control your central heating (including different switching times for weekends), just connect it to your system programme and set it and forget it—the clock will do the rest.

#### FEATURES INCLUDE:-

- EATURES INCLUDE:

  7mm LED 12 hour display
  Day of week, am pm and output status indicators
  4 open collector outputs for driving relays, triacs, etc.
  50:60Hz mans operation
  Battery and the programmes and continues time keeping
  Battery and the programmes and continues time keeping
  Display blanking during power failure to conserve battery power
  18 programme time sets
  Powerful Everyday\* function enabling output to switch every day but
  use only one time set
  Useful' sleep' function turns on output for one hour
  Direct switch control enabling output to be turned on immediately or
  after a specified time interval man entry
  Programme verification at the touch of a button
  Plastic box with attractive screen printed front panel 15 10 5 5cm

# 10:00

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(Kit includes all components, PCB, assembly and programming Order as CT6000

XK114 OPTIONAL RELAY KIT Kit includes one relay, PCB to accommodate up to four relays, terminal blocks, etc... to fit inside. CT6000 box, Provides up to four 3amp 240V AC changeover contacts

£3.90

Additional relays £1.65 each

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PACK 6 25 Red LEDs (5mm dia.) £1.25

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Switches any appliance up to IkW on and off at preset times once per day. Kit contains: AY-5-1230 IC, 0.5° LED display, mains supply, display drivers, switches, LEDs, triacs, PCBs and full instructions.

CT1000KBasicKit £14.90 CT1000K with white box (56-131 x 71mm)...£17-40 (Ready Built)......£22.50



#### **DVM/ULTRA SENSITIVE** THERMOMETER KIT

This new design is based on the ICL7126 (a lower power version of the ICL7106 chip) and a 372 digit liquid crystal display. This kit will form the basis of a digital multimeter (only a few additional resistors and switches



(only a few additional resistors and switches are required—details supplied), or a sensitive digital thermometer (-50°C to +150°C) reading to 0.1°C. The basic kit has a sensitivity of 200mV for a full scale reading, automatic polarity indication and an ultra low power requirement—giving a 2 year typical battery life from a standard 9V PP3 when used 8 hours a day, 7 days a week.

#### Price £15.50

Add 65p postage & packing + 15% VAT to total Overseas Customers; Add £2.50 (Europe), £6.00 (elsewhere) for

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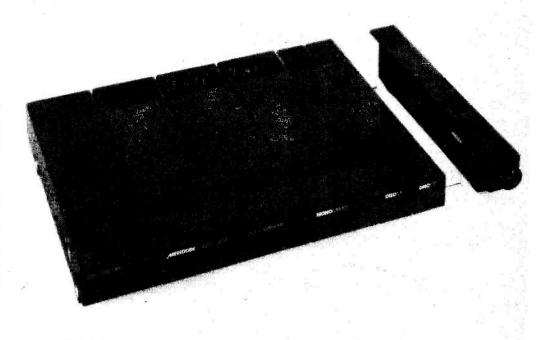
# **NEWS:NEWS:NEWS:NEWS:NEWS:NEWS**

# Plug-Together Amplifier System

If building a hi-fi amplifier from scratch sounds a bit too much like hard work, why not cheat and buy a new Boothroyd Stuart Meridian Component Amplifier? With this system you can buy just those modules you want and simply plug them together to produce an amplifier system tailored precisely to your requirements.

The Meridian Component Amplifier System consists of a number of modules of matching appearance which plug together to form a neat, slimline unit. Two coin-slot headed screws further secure the units to ensure a good connection and to prevent bits falling off when you move it around! The basic unit is a stereo power amplifier with a switchmode power supply operating at 40 kHz. The amplifiers are conservatively rated at thirty-five watts RMS each and the power supply ensures that high power transients are accommodated without straining. Although built and sold as a single unit, this block is visually divided into four adjacent modules so as to match the appearance of the rest of the system. A slim module, half the width of the apparent power modules, contains the stereo preamplifier and volume control, and this plugs onto the right hand end of the basic block. Up to twenty (yes, twenty) input modules can be added between the power and preamp modules catering for magnetic and moving coil pickups, tape, etc, and just in case this leaves you with a monster several feet long there is also a splitter module which allows you to stack one row of modules on top of another. Other modules either already available or soon to be introduced include tone controls, an FM stereo tuner, and a power supply for the preamp alone which allows you to dispense with the main power block when driving active loudspeakers or a separate power amplifier.

Although no specifications were included in the press release, Boothroyd Stuart assure us that performance in all areas is to a very high standard and that distortion in particular is so low as to be almost immeasurable. The basic unit with preamplifier and one (disc) input should sell for about £375 including VAT. Boothroyd Stuart Ltd, 13 Clifton Road, Huntingdon, Cambridge PE18 7EJ, tel 0480 57339.



### Cool, Calm and Connected

Pye Electro Devices (PED) Ltd have introduced a series of fans which use a piezoelectric system rather than the conventional magnetic system. The Series 13 module A and B cooling fans have almost no moving parts and are intended for use as spot cooling devices in solid state systems.

Piezoelectric materials can be made to change shape when a voltage is applied to them. In the new fans, two flexible piezo ceramic elements are laminated to a flexible metal strip such that, when a voltage is applied, one side expands and the other contracts, causing the metal strip to bend. Two such fan blades, matched and fed with alternating voltages such that they move in phase quadrature, produce a highly focussed stream of air. PED claim that such a system offers near infinite life since there are so few moving parts. Other advantages include very low noise output, a complete absence of electro-magnetic and radiofrequency interference, no starting surge, and very low power consumption. Versions available for use on 115 V AC 60 Hz, 220/240 V AC 50 Hz, and DC supplies from 5 to 12 V and maximum dimensions are 71 mm x 55 mm x 17mm. Pye Electro Devices Ltd, Relay and Solénoid Division, Exning Road, Newmarket, Suffolk CB8 0AX. Tel (0638) 665161.

# Microtan And Microtutor Are Alive And Well . . .

And living in Dulwich. Microtanic, formerly purely a software house, have bought all rights to the Microtan and to the Microtutor. Not only that but they've launched a magazine for Microtan owners, Microtan World (Why are we advertising competitors? — Ed).

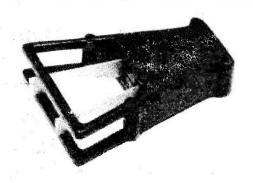
To do this, Microtanic have had to overcome enormous problems and they seem to be coping admirably despite it all. To ETI, it comes as a relief to see this excellent computer being kept alive, as it is truly an experimenter's system, as a casual perusal of some of the recent issues of ETI will testify.

Readers should direct their enquiries to Microtanic Computer Systems Ltd, 16 Upland Road, Dulwich, London SE22, tel 01-693 1137.

# Hi-Fi VHS Announced

Ten Japanese companies have collaborated to produce a common standard for a hi-fi VHS video cassette recorder. Akai, Canon, Clarion, Hitachi, JVC, Matsushita, Mitsubishi, Orion, Sharp, and Tokyo Sanyo will produce machines to the new standard and a number of companies are expected to produce compatible videotapes with hi-fi stereo sound.

In the existing VHS video system, video signals are recorded and played back by rotary heads while fixed heads are used for audio signals. In the new system, two additional rotary heads are provided exclusively for the audio signals. It is claimed that this, plus the use of frequency modulated 1.3 and 1.7 MHz carriers, produces a marked improvement in dynamic range, distortion level, and wow and flutter. Other features include a newly-developed noise reduction system and the ability to use existing software on the new machines and vice-versa, although no details are given on how this is achieved.





#### MULLARD SPEAKER KITS

Purposefully designed 40 watt R.M.S. and 30 watt R.M.S. 8 ohm speaker systems recently developed by MULLARD'S specialist team in Belgium. Kits comprise Mullard woofer (8" or Belgium. Kits comprise Mullard woofer (8" or 5") with foam surround and aluminium voice coil. Mullard 3" high power domed tweeter. B.K.E. built and tested crossover based on Mullard circuit, combining low loss components, glass fibre board and recessed loudspeaker terminals, SUPERB SOUNDS AT LOW COST. Kits supplied in polystyrene packs complete with instructions. 8" 40W system — recommended cabinet size 240

5" 30W system — recommended cabinet size 160 × 175 × 295mm Price £13.90 each + £1.50 P 8 P.

Designer approved flat pack cabinet kits, including grill fabric. Can be finished with iron on neer or self adhesive vinyl etc.

8" system cabinet kit £8.00 each + £2.50 P'& P.
5" system cabinet kit £7.00 each + £2,00 P & P.

Comprising of a top panel and tape mechanism coupled to a record/play back printed board assembly. Supplied as one complete unit for horizontal installation into estimate console of own choice. These units are brand new, ready builts and tested.

STEREO CASSETTE TAPE

**DECK MODULE** 



# 1000 LOUDSPEAKER

The very best in quality and value.

Ported tuned cabinet in hardwearing black vynide with protective corners and carry handle. Built and tested, employing 10in British driver and Piezo tweeter. Spec: 80 watts RMS; 8 ohms; 45Hz-20KHz; Size: 20in x 15in x 12in; Weight: 30 pounds.

Price: £49.00 each £90 per pair Carriage: £5 each £7 per pair

# **BK ELECTRONICS**

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HOBBY KITS. Proven designs including glass fibre printed circuit board and high quality components complete with instructions.

FM MICROTRANSMITTER (BUG) 90/105MHz with very sensitive microphone. Range 100/300 metres. 57 x 46 x 14mm (9 volt) Price: £7.99p

DIGITAL THERMOMETER -9.9°C to +99.9°C. LED display. Complete with sensor 70 x 70 mm (9 volt) Price: £27.60p 3 WATT FM TRANSMITTER 3 WATT 85/115MHz varicap con-

trolled, professional performance. Range up to 3 miles 35 x 84 x 12 mm (12 volt) Price: £12.49p

SINGLE CHANNEL RADIO CONTROLLED TRANSMITTER/ RECEIVER 27MHZ Range up to 500 metres. Double coded modulation. Receiver output operates relay with 2amp/240 volt contacts. Ideal for many applications. Receiver 90 x 70 x 22 mm 9/ 12 volt) Price: £16.49 Transmitter 80 x 50 x 15 mm (9/12 volt) Price £10.29 P&P All Kits +50p. S.A.E. for complete list.



3 watt FM

#### **BSR P256 TURNTABLE**

P256 turntable chassis ● S shaped tone arm • Belt driven • Aluminium platter • Page turntable chassis ● S shaped tone arm

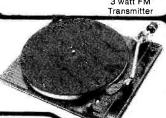
Belt driven ● Aluminium platter ●

Precision calibrated counter balance ● Antiskate (bias device) ● Damped cueing lever

• 240 volt AC operation (Hz) ● Cut-out
template supplied ● Completely manual arm.

This deck has a completely manual arm and is
designed primarily for disco and studio use
where all the advantages of a manual arm are

Price £31.35.each, £2.50 P&P



#### LOUDSPEAKERS POWER RANGE

LOUDSPEAKERS POWER RANGE
THREE QUALITY POWER LOUDSPEAKERS (15" 12" and B" See 'Photo). Ideal for both HI-Fi and Disco applications. All units have attractive cast aluminium (ground finish) fixing escutcheons.
Specification and Prices.
15" 100 watt R.M.S. Impedance 8 ohms.
50 oz. magnet. 2" aluminium voice coil. Res.
Freq. 20 Hz. Freq. Resp. to 2.5KHz. Sens.
97dB. Price: C34.00 each + C3.00 P&P
12" 100 watt R.M.S. Impedance 8 ohms.
50 oz. magnet. 2" aluminium voice coil. Res.
Freq. 25Hz. Freq. Resp. to 4 KHz. Sens.
95dB. Price: C34.50 each + C3.00 P&P
8" 50 watt R.M.S. Impedance 8 ohms. 20
oz. magnet. 1½" aluminium voice coil. Res.
Freq. 40Hz. Freq. Resp. to 6 KHz. Sens.
92dB. Black Cone. Price: C9.50 each. Also
available with black protective grille Price:
9.99 each. P&P £1.50.



£9.99 each. PGP £1.50.

12" 85 watt R.M.S. McKENZIE C1285GP (LEAD GUITAR, KEYBOARD, DISCO) 2" aluminium voice coil, aluminium centre dome, 8 ohm imp., Res. Freq. 45Hz., Freq. Resp. to 6.5KHz., Sens, 98dB. Price: £23.00 + £3 carriage.

12" 85 watt R.M.S. McKENZIE C128Tc (P.A., DISCO) 2" aluminium voice coil. Twin cone. 8 ohm. imp., Res. Freq. 45HZ., Freq. Resp. to 14KHz. Price £23 + £3 carriage.

15" 150 watt R.M.S. McKENZIE C15 (BASS GUITAR, P.A.) 3" aluminium voice coil. Die cast chassis. 8 ohm imp., Res. Freq. 40Hz., Freq. Resp. to 4KHz. Price: £47 + £4 carriage.

#### **POWER AMPLIFIER** MODULE



New model. Improved-specification NEW OMP100 Mk.II POWER AMPLIFIER MODULE Power Amplifier Module complete with integral heat sink, toroidal transformer power supply and glass fibre p.c.b. assembly incorporates drive circuit to power a compatible LED Vu meter. New improved specification makes this amplifier ideal for P.A., Instrumental and Hi-Fi applications.

and Hi-Fi applications.

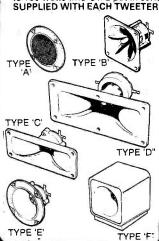
SPECIFICATION
Output Power:— 110 watts R.M.S.
Loads:— Open and short circuit proof 4/16
ohms.

omms. Frequency Response:--- 15Hz - 30KHz -3dB. T.H.D.:-- 0.01%. .H.D.:— 0.01%. .N.R. (Unweighted):— -118dB ±3.5dB. Sensitivity for Max Output: -- 500mV @ 10K. Size: -- 360 x 115 x 72 mm Price: -- £31.99 + £2.00 P&P. Vu Meter Price: -- £7.00 + 50p P&P.

MOSFET versions available up to 300W. R.M.S.

#### PIEZO ELECTRIC TWEETERS - MOTOROLA

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



TYPE 'A' (KSN2036A) 3" round with protective wire mesh, ideal for bookshelf and medium sized Hi-fi speakers. Price £4.29 each.

TYPE 'B' (KSN1005A) 3 %" super horn. For general purpose speakers, disco and P.A. systems etc. Price £4.99 each.

TYPE 'C' (KSN6016A) 2" × 5" wide dispersion horn. For quality Hi-fi systems and quality discos etc. Price £5.99 each.

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 £7.99 each.

TYPE 'E' (KSN1038A) 3%" horn tweeter with attractive silver finish trim. Suitable for Hi-fi monitor systems etc. Price £4.99 each.

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

P&P 20p es. (or SAE for Piezo leaflets).

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104dB output.

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Active bass and treble tone conts.
Individual level controls plus master volume. Monitor output (head-phone) for all inputs, Output:775W Supply 240Vac. Size:19" x 5\mathref{x}' x 2\frac{1}{2}". pnone) for all inputs.
Output:775mV Supply 240Vac.
Size:19" x 5" x 2" x
Price: £49,99 + £2.00 Pep

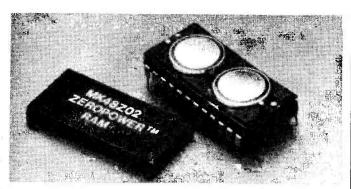
ASO STEERED DISCO MIXER with
7 band graphic. Vu display, All
facilities. £99,99 + £2.00 Pep

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# NEWS:NEWS:NEWS:NEWS:NEWS:NEWS



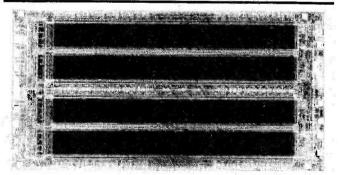
### Non-Volatile Static RAM

It seems such an obvious idea that we are amazed no one has tried it before! In order to give their new 16K static RAM the retention characteristics of a ROM, Mostek Corporation have included a lithium energy source within the IC package itself.

Designated the MK48Z02 Zeropower RAM, the new device uses HCMOS technology to ensure low current drain, resulting in a minimum operating life of five years (at 25°C) on its internal lithium cell. It is organised as 8 × 2K, comes in a standard 24-pin DIP package, and has the same pin-out as, for example, the

2716 EPROM, allowing it to directly replace 16K static RAMs in many applications. No additional circuitry is required for interfacing to microprocessors since access time, read cycle, and write cycle are all below 250 nS and require only a single +5V supply. Features include an automatic write protection circuit which comes into operation whenever Vcc drops below 4.5 volts, thus preventing inadvertent loss of data on power up and power down, and, as with other static RAMs, there is no limit on the number of write cycles that can be performed.

The MK48Z02 Zeropower RAM is available in 200 nS and 250 nS access time versions, and one-off prices are around £43 and £39 respectively. Mostek UK Ltd, 1 Valley Drive, Kingsbury Road, London NW9, tel. 01-204 9322.



## Third-Generation 64K RAM

Jnited Technologies' Mostek Corporation claim to have produced a third-generation 64K dynamic RAM which provides access times of 80 ns to 120 ns. The MK45H64 uses the latest Mostek scaled NMOS process technology known as the LD3 process, featuring silicon gate, doublelevel poly interconnect, 1.5u 200 A channel lengths and capacitor oxide for maximum critical charge. It can be used in virtually on-line storge anv memory system, including mainframe computers, minicommicrocomputers, puters. and with microprocessors, and in applications such as video and

graphics memory, buffer memory and terminal memory.

Multiplexed address inputs allow the MK45H64 64K dynamic RAM to be packaged in a standard 16-pin DIP with only 15 pins required for basic functionality. It is designed to be compatible with the JEDEC standards for 64K x 1 dynamic RAMs, and features very fast page mode cycle times (equal to RAS access) and has TRAS (max) specified at 40 uS, allowing an entire page of 256 bits to be accessed within a single RAS cycle. The device also features a hidden refresh cycle which enables the component's output to be held valid for up to 40uS by holding CAS active low, allowing refresh cycles to be performed while holding data valid from a previous cycle.

Mostek U.K. Ltd, 1 Valley Drive, Kingsbury Road, London NW9, tel 01-204 9322.

# Stepper Motor Control/Drive IC

New from RIFA is a monolithic IC designed for controlling and driving bipolar stepper motors, or the direct control of d.c. motors, solenoids or relays.

The PBL 3717 is a 16-pin

The PBL 3717 is a 16-pin monolithic bipolar IC that includes LS-TTL-microprocessor compatible logic inputs, three addressable current comparators, and a full H-bridge output stage with built-in protection diodes. Configured with one winding of a bipolar stepper motor, the PBL 3717 requires very few external components to form a complete control and drive stage within LS-TTL or microprocessor-based stepper motor systems. It is

capable of either half- or full-step modes, and offers a range of current control from 5mA to 500mA continuous without a heat sink, up to 800mA with a heat sink, and 1.0 A peak. Current levels may be either selected in steps or continuously varied, and supply voltage range is from 10V to 45V with a 15V reference input. It will accept analogue or digital logic inputs of 6V at 10mA, for which the ideal rise and fall times are stated as 2.0vs.

Though designed principally for stepper motor applications, the PBL 3717 may alternatively be used to drive conventional d.c. motors by the appropriate adjustment of its input signals.

The operational temperature range of the PBL 3717 is 0 to +70°C, and it is produced in the industry standard 16-pin plastic DIL package. RIFA AB, Market Chambers, Shelton Square, Coventry, Tel (0203 27259

### **IGT** Is Here

The General Electric Company of the USA has announced the commercial availability of a new type of power semiconductor device called the Insulated Gate Transistor or IGT. It is a gate turn on-turn off device in which, it is claimed, the advantages of power MOSFETs and bipolar transistors are combined. The result is a device which has a high input impedance like a MOSFET but a low on-state conduction loss like bipolar transistors.

The cell design and MOS gate structure of the IGT are similar to that of power MOSFETs. The major difference is that the resistance of the epitaxial drain region is modulated to a low value when the gate is turned on, resulting in very low on-state voltage drops and a forward con-

duction characteristic similar to a PIN rectifier. This allows devices rated at 500 V to operate at current densities twenty times greater than power MOSFETs and five times greater than bipolar transistors, giving a significant reduction in both chip size and cost.

IGTs either already available or soon to be introduced include a 10 A, 500 V device in a TO-220 package and a 25 A, 500 V device in a TO-218 package. They are available with a range of gate turn off times from about four micro seconds down to less than 1 microsecond. General Electric say that IGTs will cost much less than equivalent power MOSFETs and will compare favourably with bipolar transistors and darlingtons. International General Electric Company of New York, Demesne, Dundalk, Ireland, tel 010-35342 32371.

# High-Performance Sample-and-Hold Amplifier

Zeltex have introduced a new sample-and-hold amplifier known as the ZMP-241 which, when used in front of 16-bit converters, has demonstrated an error contribution so small as to be impossible to discern at the output of the ADC.

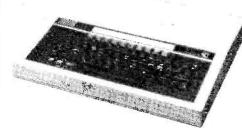
The amplifier has been optimised for use with 16-bit A-Ds where it allows sampled data rates of over 58 kHz to be achieved. Data sheet figures include a settling time of  $10\mu \text{sec}$  for a 20V step, a slew rate of 5V per  $\mu \text{sec}$  and a small signal bandwidth of 700 kHz. Peak-to-peak noise over the 10 Hz to 100 kHz frequency range is only  $75\mu V$ , and the droop rate, a measure of how long a sample-and-hold amplifier maintains its accuracy after a sample has been taken, is 5mV per second.

100-off price of the ZMP-241 is £64 and it comes in a 50 × 50 × 10 mm metal case which provides a very high level of radio frequency interference screening. Data Beta Limited, 23A Buckingham Avenue, Slough, Berkshire, SL1 4QA. Tel: (0753) 75933/4.

# 01-452 1500 Technomatic Ltd 01-450 6597

# **BBC Micro Computer System** OFFICIAL DEALER

Please phone for availability



BBC Model B £399 (incl. VAT) Carr £8/unit Model A to Model B upgrade kit £50 Fitting charge £15 Individual upgrades also available

**TELETEXT ADAPTOR £195** WORDWISE 8K ROM £39 **TORCH Z80 DISC PACK £825** 

WORD PROCESSOR 'VIEW' 16K ROM £52

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Double Drive 51/41′ 800K £699+£8 carr.
BBC COMPATIBLE 51/41′ DISC DRIVES

These drives are supplied in BBC matching colour cases and with necessary cables.

SINGLE DRIVES: 100K £150; 200K £215 400K £265 SINGLE DRIVES: with PSU 100K £185; 200K £260\*; 400K.

DUAL DRIVES: with PSU 2 × 100K £355; 2 × 200K £475\*;  $2 \times 400 \text{K}$  £595

\*These drives are provided with a switch to change between 40 and 80 tracks.

DRIVE CABLES: SINGLE £8, DUAL £12,

DISC MANUAL & FORMATTING DISKETTE £12.50

#### Phone or send for our BBC leaflet

#### CASSETTE RECORDER

SANYO Data Recorder DR101

A superior quality data recorder with dedicated computer output and monitoring facility on computer output and monitoring facility on both record and play £39.50 + £1.50 carr.

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Computer Grade Cassettes £0.50 each. £4.50 for 10 + £1 carr

Cassette lead £3.50.

#### **MONITORS**

MICROVITEC 1431 14in Colour Monitor £230+£8 carr MICROVITEC 2031 20in Colour Monitor £319+£8 carr KAGA 12in RGB Monitor £255+£8 carr Lead for KAGA/SANYO RGB £10 SANYO HI RES GREEN MONITOR £99+£6 carr SANYO HI RES RGB MONITOR £445+£8 carr.

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120 CPS, 80 cols Logic Seeking, Bidirectional Forward and Reverse Line Feed. Proportional Spacing, Auto Underline, Hi-Res and Block

Graphics, Greek Char. Only £320 + £8 carr.



**PRINTERS** SEIKOSHA GP 100A £175.00 GP 250X £235.00

GP 700A £425.00 Silver Reed EX44 Daisy Wheel with Serial Interface £365, with Parallel Interface £385 Carriage/Printer £8.00

Parallel Printer lead for BBC/Atom to most printers £13.50 Variety of interfaces, ribbons in stock. 2,000 fan fold sheets 9½"×11" £13.50+£3 p&p



EPSON RX80 and FX80

RX 80 100CPS 80 col Tractor Feed £270

FX80 160CPS 80 col F&TFeed £380

> MX100 F/T3 £425 (Carr./printer £8)

NEW RX 80 FT £319 Carriage/Printer £8

#### SIDEWAYS ROM **EXPANSION BOARD**

EXPANSION BOARD

This board provides 8 high quality 28 pin sockets for expanding the computer's sideways ROM capacity by a further 128K. (As 8K Eproms consume about 40mA on standby and 16K much higher, in our opinion addition of 8 extra ROMS will not overload the computer psu nor cause internal overheating). All ROM sockets are of turned pin type gold contacts to ensure that numerous insertions and extractions will not wear out or deform them. The board is fully buffered and also dimensioned to ensure non interference with other on board components. Full fitting instructions supplied. £25 + £2 p&p.

#### **TORCH Z-80 PACK**

For little more than the cost of an 800K disc drive, you can now considerably extend your BBCs capabilities. The twin drives, together with the Z80 card, gives you 64K of memory and includes a database, word processor etc. Comes complete with manuals, CP/N Operating System, Demonstration and Utility programs etc. The system is fully compatible with CP/M\* thus allowing the use of professional business software. £825 + £8 p&p. Special offer from Torch: free software worth £1,000, for a limited period only and subject to availability.

availability.
\*CP/M is a trademark of Digital Research.

### I.D. CONNECTORS

(Speedblock Type) Conn 120p 195p 240p 320p 340p 390p

#### **D CONNECTORS**

No. of ways 9 15 25 37

80p 105p 160p 250p 150p 210p 250p 365p Angled 180p 210p 250p 365p FEMALE 105p 160p 200p 335p 165p 215p 290p 440p 90p 85p 90p 100p ay plug 385p. Socket 450p

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#### JUMPER LEADS

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24" Ribbon Cable with Headers 14-pin 16-pin 24-pin 40-pir 145p 165p 240p 350p 210p 230p 345p 540p

24" Ribbon Cable with Sockets 20-pin 26-pin 34-pin 40-pin 160p 200p 280p 300p 290p 370p 480p 525p

Ribbon Cable with D. Conn 25-way Male 500p Female 550p

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Solder £5.50 24-way plug IEEE Solder £5 IDC £4.75 24-way socket IEEE Solder £5

#### RIBBON CABLE

(Grey/meter)

10-way 16-way

### **RS 232 JUMPERS**

(25-way D)
24" Single end Male....
24" Single end Female...
24" Female-Female...
24" Male-Male...
24" Male-Female...

#### **DIL HEADERS**

#### **FURO** CONNECTORS

DIN 41617 21-way 31-way Plug 160p 170p 31-way
DIN 4161Z
2×32-way St. Pin
2×32-way Ang. Pin
3×32-way Ang. Pin
3×32-way Ang. Pin
3×32-way Ang. Pin 275p 320p 300p 350p

**TEST CLIPS** 14-pin 275p 40-pin £6

# **EDGE**

600p

**CONNECTORS** 0.1" 0.156 2×18-way 140p 240p 2×18-way 2×22-way 2×23-way 2×25-way 2×28-way 1×43-way 2×43-way

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Bare: £135; Cased: £155

2 × FD55A 40 track SSDD 500kbytes unformatted Cased x psu £350 FD55E 80 track SSDD 500kbytes unformatted

Bare: £180; Cased: £205 2 × FD55E 80 track SSDD 1 Mbyte unformatted

Cased + psu £475 51/4" Mitsubishi M4853 Slim Line mechanism 80 track DSDD 1 Mbyte unformatted 2 × M4853 2 Mbytes Bare: £225; Cased: £245 Cased + psu £590

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7402 18 7403 18 7404 22	74278 100p 74279 55p	74LS283 50p 74LS290 55p 74LS292 900p	74C20 20p 74C32 25p 74C42 80p	4096 70p 4097 290p 4098 90p	4539 70p 4543 75p 4553 245p	40257 160p 40373 160p 40374 160p	CPUs 1802CE 650p	8279 440p 8284 350p 8288 £11	CRT CONTROLLER	8T97/98 90p 81LS95/96 120p	375p 8MHz UHF 450p
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7407 90; 7408 18; 7409 18;	74290 75p 74293 90p	74LS298 65p 74LS299 200p 74LS321 240p	74C76 50p 74C83 120p 74C85 120p	4503 45p 4504 75p 4505 400p	4560 120p 4566 160p	14419 280p 14490 350p	6800 <b>225p</b> 6802 <b>250p</b>	TMS4500 £14 TMS5220 £12 TMS9909 £9	EF9365 £36 EF9366 £36	9602 <b>220p</b> 9637AP <b>160p</b>	32.768KHz 100p 100KHz 250p
7410 18 7411 18 7412 18	74351 150p 74365A 48p	74LS323 200p 74LS324/	74C86 30p 74C90 70p	4506 35p 4507 35p	4568 250p 4569 170p 4572 30p	14495 300p 14500 700p 14599 290p	6809 650p 68705P35 £25 68809E £16	TMS9911 £16 Z80P10 250p	MC6845 650p MC6845SP £12 MC6847 650p	ZN425E-8 350p ZN426E-8 350p ZN427E £6	200KHz 280p Freq in MHz
7413 27 7414 42 7416 38	74366A 48p	624 150p 74LS348 140p 74LS352 70p	74C93 70p 74C95 106p 74C107 70p	4508 130p 4510 45p 4511 45p	4583 90p 4584 40p 4585 75p	COUNTERS 74C925 £4	8035 350p 8039 300p 8080A 250p	Z80AP10 280p Z80CTC 250p Z80ACTC 280p	SFF96364 £8 TMS9918 £60 TMS9927 £14	ZN428E-8 450p	1.0 290p 1.008 275p 1.8432 210p
7417 38 7420 18	74370 90p	74LS353 70p 74LS356 175p 74LS363 180p	74C150 300p 74C151 100p 74C154 300p	4512 48p 4514 120p 4515 110p	40014 40p 40085 90p 40097 45p	74C926 £5 74C928 £6 72168 £22	8085A 350p 8086 £22 8088 £18	Z80ADART 700p Z80ADMA £9	TMS9928 £20 TMS9929 £16	CONTROL ICs	2.00 225p 2.45760 210p 2.5 250p
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7483A 48p 7484A 90p	74LS73A 20p 74LS74A 30p	74LS642-1 250p 74LS643 200p	74ALS74 50p 74ALS138	375p CA3130E 90p CA3130T 110p	MB3712 200p MB3730 400p MC1310P 150p	ULN2803 150p ULN2804 150p	6875 570p 8154 950p 8155 350p	PROMs 74S188 140p	MC4024 325p MC4044 325p	COM 8116 800p 47028 750p	55.5 400p 116 300p 145.80 250p
7485 90p 7486 30p 7489 170p	74LS76A 27p 74LS83A 46p	74LS643-1 250p 74LS644 200p	74ALS139 150p	CA3140E 40p CA3140T 90p	MC1413 75p MC1458 36p	UPC592H 200p UPC1156H	8156 350p 8205 225p 8212 110p	74S287 200p 74S288 140p 74S387 225p	MC14411 675p MC14412 750p 75107 90p	UARTs AY-3-1015P	REAL TIME
7490A 32p 7491 48p 7492A 36p	74LS85 60p	74LS645 200p 74LS645-1	74ALS573 200p 74ALS574 400	CA3161E 150p CA3162E 450p	MC1493 100p MC1495L 350p MC1496 70p	XR210 400p	8215 100p 8224 110p 8226 250p	74S473 850p 74S474 650p	75110/12 160p 75114/15 160p 75121/22 140p	<b>300p</b> AY-5-1013P	MK3805 £TBA MM58174 700p
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7496 50p 7497 120p 74100 120p	74LS95B 50p 74LS96 90p	74LS670 120p 74LS674 550p 74LS682 250p	4002 12p 4006 50p	D7002 390p DAC0800 £2 DAC0808 £2	MF10CN 320p MK50240 900p MK50398 700p	ZN414 80p ZN419C 190p	8251 250p 8253 390p	2564 £6 2708 300p	75365 150p 75451/2 72p 75453/4 72p	ZIF SKTS	TELETEXT DECODER
74104 50p 74105 55p 74107 27p	74LS107 33p 74LS109 33p 74LS112 33p	74LS684 400p 74LS687 450p 74S SERIES	4007 14p 4008 36p 4009 24p	DG308 300p HA1366 190p HA1388 250p	ML920 800p MM57160 620p MN6221A 600p	ZN424E 130p ZN425E 340p	8255 250p 8256 £36 8257 400p		75491/2 65p 8T26 120p 8T28 120p	(TEXTOOL) 24 pin 575p 28 pin 800p	SAA5020 600p SAA5030 700p
74109 27p 74110 45p 74111 55p	74LS113 30p 74LS114 32p 74LS122 60p	74S00 30p 74S02 30p	4010 24p 4011 11p 4012 16p	ICL7106 700p ICL7650 400p ICL7660 250p	NE531 140p NE544 150p NE555 16p	7NI427E EDO-	8259 400p 8271 £36	27128-25 £22	8T95/96 90p	40 pin 975p	SAA5041 £16 SAA5050 900p
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74119 75p 74120 75p	74LS125 36p 74LS126 36p 74LS132 42p	74S10 40p. 74S11 50p 74S20 40p	4016 20p 4017 32p 4018 45p	ICM7555 80p ICM7556 140p LC7120 300p	NE566 155p NE567 140p NE570 410p	ZN1040E 670p ZNA134 £23 ZNA234 850p	14 pin 10p 20	pin 18p 28 pin pin 22p 40 pin	26p 14 pin	42p 20 pin 66 45p 22 pin 75	p 28 pin 100p
74121 32p 74122 36p 74123 45p	74LS133 30p 74LS136 30p 74LS138 42p	74S21 50p 74S22 50p 74S30 40p	4019 25p 4020 48p 4021 40p	LC7130 325p LC7137 270p LF347 150p	NE571 400p NE592 60p NE5532 130p	TRANSISTORS	BFY50 24p BFY51/2 24p BFY56 33p	TIP36C 150p TIP41A 50p TIP41C 55p	2N3773 200p 2N3819 20p 2N3823 30p	DIODES	TRIACS PLASTIC
74125. 34p 74126 36p 74128 45p	74LS139 42p 74LS145 75p 74LS147 120p	74\$32 70p 74\$37 60p 74\$51 75p	4022 45p 4023 13p 4024 32p	LF351 48p LF353 95p	NE5533 140p NE5534P 110p	BC107/8 13p BC109C 14p	BFY90 80p BRY39 45p	TIP42A 60p TIP42C 65p	2N3866 90p 2N3902 700p	BY127 12p BYX36300 20p OA47 8p	3A 400V 60p
74132 43p 74136 38p 74141 55p	74LS148 120p 74LS151 50p	74S74 75p 74S85 300p 74S86 90p	4025 13p 4026 80p 4027 20p	LF356P 95p LF357 110p LF13331 350p	NE5534AP 125p PLL02A 500p RC4136 60p	BC172 12p BC177/8 17p	5U104 225p 8U105 190p	TIP120 75p	2N3906 16p 2N4037 65p	OA90/91 9p OA95 9p OA200 9p	6A 500V 88p 8A 400V 75p
74142 175p 74143 200p 74144 200p	74LS154 150p 74LS155 40p	74S112 90p 74S113 90p 74S114 90p	4028 40p 4029 45p	LM10C 325p LM301A 25p LM307 50p	SAA1900 £16 SAD1024A	BC182/3 10p BC184 11p	8U126 150p	TIP142 120p	2N4056 65p 2N4123/4 27p 2N4125/6 27p	OA202 10p 1N914 4p 1N916 7p	8A 500V 95p 12A 400V 85p 12A 500V 105p
74145 75p 74147 90p 74148 75p	74LS157 40p 74LS158 35p	74S124 300p 74S132 110p 74S133 60p	4031 125p 4032 80p	LM308N 75p LM310 120p LM311 70p	1150p SFF96364 800p SN76488 450p	BC212/3 11p   BC214 12p	BU180A 120p BU205 200p BU208 200p	TIP4055 70p	2N4401/3 25p 2N4427 90p 2N4871 50p	1N4148 4p 1N4001/2 5p 1N4003/4 6p	16A 400V 110p 16A 500V 130p T2800D 130p
74150 120p 74151A 40p 74153 40p	74LS161A 50p 74LS162A 45p	74S138 110p 74S139 120p	4033 125p 4034 140p 4035 45p	LM318 150p LM319 215p LM319N 160p	SN76489 480p SN76495 400p SP0256AL £10	BC327 16p   BC337 16p	BU406 145p BUX80 600p BUY69C 350p	VN66AF 90p VN88AF £1	2N5087 27p 2N5089 27p 2N5172 27p	1N4005 6p 1N4006/7 7p 1N5401/2 12p	TIC 206D 60p TIC 226D 75p TIC 246D 110p
74154 120p 74155 45p 74156 48p	74LS163A 45p 74LS164 48p 74LS165A 60p	74S140 60p 74S151 180p 74S153 180p	4036 <b>275p</b> 4037 <b>110p</b> 4038 <b>110p</b>	LM324 30p LM334Z 90p LM335Z 140p	TA7120 150p TA7130 160p TA7204 150p	BC338 16p 8 BC461 25p 8 BC477/8 30p 8	MJ2501 225p	ZTX300 13p ZTX452 45p	2N5191 90p 2N5245 40p 2N5401 60p	1N5403/4 14p 1N5404/5 14p	THYRISTORS
74157 45p 74159 150p	74LS166A 90p 74LS168 140p 74LS169 110p	74S157 250p 74S158 195p 74S163 300p	4039 290p 4040 40p 4041 40p	LM339 40p LM348 65p LM358P 60p	TA7205 90p TA7222 150p TA7310 150p	BC5478 14p 1 BC548C 12p 1	MJ2955 90p MJ3001 225p MJ4502 400p	ZTX502 16p ZTX504 18p	2N5459 30p 2N5460 60p 2N5485 36p	1N5404/7 19p IS920 9p	3A 400V 45p 8A 600V 180p 12A 400V 160p
74161 55p 74162 55p	74LS170 100p 74LS173A 90p 74LS174 45p	74S174 250p 74S175 320p 74S188 150p	4042 40p 4043 40p 4044 40p	LM377 175p LM380 75p LM381AN 180p	TBA231 120p TBA800 80p	BC549C 16p 1 BC557B 14p 1	MJE340 60p MJE2955 100p	ZTX552 55p ZTX652 60p	2N5875 250p 2N6027 30p 2N6052 300p		16A 100V 180p 16A 400V 180p C106D 45p
74163 55p 74164 60p 74165 75p	74LS175 45p 74LS181 120p 74LS183 120p	74S194 300p 74S195 300p 74S196 300p	4045 105p 4046 50p 4047 45p	LM382 120p LM386 90p	TBA950 225p	BCY70 18p 1 BCY71 22p 1	MPF102 40p MPF103/4 30p	2N697 25p 2N698 45p	2N6059 325p 2N6107 65p 2N6247 190p		MCR101 36p 2N3525 130p 2N4444 180p
74166 90p 74167 200p 74170 150p	74LS190 60p 74LS191 60p 74LS192 60p	74S200 450p 74S201 320p 74S225 650p	4048 50p 4049 24p 4050 24p	LM387 120p LM389 95p LM391 150p	TC9109 750p TCA210 250p TCA220 350p	BD132 80p N	MPSA06 30p	2N708 30p 2N918 45p	2N6254 130p 2N6290 65p		2N5060 30p 2N5061 32p 2N5064 35p
74172 250p 74173 65p 74174 55p	74LS193 60p 74LS194A 50p 74LS195A 50p	74S240 250p 74S241 300p 74S244 300p	4051 45p 4052 60p	LM392N 60p LM393 100p LM394CH 300p	TCA270 350p TCA940 175p TCA965 120p	BD189 60p N	MPSA20 50p	2N1131/2 36p 2N1613 25p	2SC1306 100p 2SC1307 150p 2SC1957 90p		PCB
74175 50p 74176 55p 74177 50p	74LS196 60p 74LS197 54p 74LS221 80p	74S251 250p	4054 <b>90p</b> 4055 <b>90p</b>	LM709 36p LM710 50p LM711 70p	TDA1008 320p   TDA1010 200p	8D233 75p M BD235 85p M	MPSA56 32p	2N2102 70p 2N2160 350p	2SC1969 150p, 2SC2028 80p 2SC2029 200p	BRIDGE RECTIFIERS	MOUNTING RELAYS
74178 90p 74179 90p 74180 55p	74LS240 70p	74S260 70p 74S261 300p	4046 90p 4059 450p 4060 55p	LM725 300p LM733 60p	TDA1022 500p TDA1024 120p TDA1170 300p	BD241 60p N BD242 60p N BD379 60p N	MPSA93 40p MPSU06 63p MPSU07 60p	2N2219A 25p 2N2222A 25p 2N2369A 17p	2SC2078 160p   2SC2335 200p   2SC2612 200p	1A 50V 19p 1A 100V 20p	6 or 12V DC
74181 140p 74182 50p	74LS242 60p 74LS243 60p 74LS244 70p	74S262 850p 74S283 300p 74S287 225p	4063 90p 4066 27p 4067 225p	<b>VOLTAGE RE</b>	<b>GULATORS</b>	BD380 60p M BD677 40p M BF2448 35p T	MPSU45 90p   MPSU65 78p   MPSU6	2N2484 25p 2N2646 40p 2N2904/5 25p	3N128 120p 3N140 120p 3N141 110p	1A 400V 25p 1A 600V 30p 2A 50V 30p	Coil SPDT 2A 24V DC 160p 6 or 12V DC Coil DPDT 5A
74184 120p 74185A 120p 74190 60p	74LS245 140p 74LS247 70p 74LS248 70p	74S288 150p 74S299 550p 74S373 400p	4068 14p 4069 14p 4070 14p	1A +ve 5V 7805	-ve 40p 7905 45p	BF256B 50p 7 BF257/8 32p T	1P29C 40p 1P30A 35p	2N2906A 25p 2N2907A 25p	3N201 110p 3N204 200p 10290 250p	2A 100V 35p 2A 400V 45p 3A 200V 60p	24V DC 240V AC 200p
74191 60p 74192 60p 74193 60p	74LS249 70p 74LS251 45p 74LS253 45p	74S374 400p 74S387 250p 74S472 1150p	4071 <b>14p</b> 4072 <b>14p</b>	6V 7806	40p 7906 45p 40p 7908 45p	BFR39 25p T BFR40/1 25p T	1P31A 40p	2N3053 25p 2 2N3054 55p 2 2N3055 35p	10361/2 75p 10408 90p	3A 600V 72p 4A 100V 95p	6 or 12V DC Coil SPDT 10A 24V DC
74194 50p 74195 50p 74196 48p	74LS256 200p 74LS257A 45p 74LS258A 45p	74S474 400p 74S475 825p 74S571 620p	4075 14p 1 4076 48p 1	5V 7815 8V 7818	40p 7915 45p	8FR80/1 25p T BFR96 180p T	IP32C 40p	2N3442 140p 2N3553 240p	10410 100p 10594 120p	4A 400V 100p 6A 50V 80p 6A 100V 100p	240V AC 225p ZENERS
74197 48p 74198 120p 74199 120p	74LS259 80p 74LS260 35p 74LS261 80p	74S573 900p 74C SERIES	4078 16p	5V 100mA 78L05 6V 100mA 78L06 8V 100mA 78L08	30n 791 05 45n l	BFX30 27p T BFX84/5 40p T	1P34A 90p	2N3643/4 48p / 2N3702/3 10p /	10595 120p 10673 75p 10871/2 100p	6A 400V 120p 10A 400V 200p 25A 400V 400p	2.7V-33V 400mW 9p
7 <b>42</b> 21 <b>80</b> p 7 <b>42</b> 51 <b>60</b> p	74LS266 25p 74LS273 75p	74C00 20p 74C04 20p	4086 55p   1	2V 100mA 78L12 2V 100mA 78L12 5V 100mA 78L15	30p 79L12 50p	BFX88 27p T	IP35C 140p 2	2N3704/5 10p 2N3706/7 10p 2N3708 10p			1W 15p WW-5
								SE ADD 4			أفسال حدد

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# **ACE INTERFACE**

Game playing and typing in should be fast and furious on the Jupiter Ace because of the use of FORTH. But with a membrane keyboard? Doug Bollen shows how to get round the rubber.

It is strange that something as simple as a set of keys and a joystick should pose such a problem for both makers and users of low cost computers. Beneath that intractable rubber keyboard, in an unassuming plastic box, lies many a good computer, spoilt by the lack of a real human interface. Of course, the reason for this is a price differential of at least twenty-five quid.

A typewriter-style keyboard can reduce frustration, and more than double program and test entering speed if the key-scan plus display routine in the computer ROM is fast enough to cope with fleeting fingers. Old mini and mainframe keyboards can be picked up now

and then quite cheaply, and some of them have excellent magnetic switches. Alternatively, a good low-cost keyboard may be built with readily available switches mounted on a piece of Veroboard.

Video games are great fun, but can you imagine piloting an airliner or spacecraft with four keypresses? There is no standard for games software direction keys so a programmable joystick is an absolute necessity for the dedicated games-player.

Once you've acquired a keyboard and a joystick, you need an interface to connect them to the computer. At this rate of expenditure you could have bought a 'Flash MK IIB' computer, but

never mind, it is all part of the learning process, and those plug-in-add-ons can be very versatile.

The Jupiter Ace has a fast keyscan routine which is capable of electric typewriter performance. The space key is a trifle slower than normal, but all other keys respond well, particularly when aided by a software or hardware key beep. If the relatively large user memory (51K expanded) of this compact language machine is taken into account along with its other features, an Ace with full-travel keyboard is capable of serious work in areas of text and data handling, as well as super-speed gaming.

This project allows a full-travel keyboard and a joystick, acting on

# HOW IT WORKS — INTERFACE \_

The Ace rubber keyboard uses an input port which occupies eight addresses, but all even addresses (AØ low) are reserved for internal use. Data lines DØ-D4, and address lines A8-A15 are used for keyscan, while D5 is reserved for tape load. The remaining three data bits may be ignored here. Because the five Ace data lines are up with no keypress, and the Ace TTL keyboard buffers have a relatively high output impedance for logic 1, it is possible to pull down the data lines externally during keyscan, and this saves on hardware and software.

Ace keys are positioned in a matrix of 5 data lines by 8 address lines. In normal inputting key-scan mode, no keypress and multiple keypresses (other than shifts) return a zero; this is also the case with INKEY. If the keyboard is read by 'address IN' (refer to Fig. 3), a combination of any five keys on each matrix line Y8-Y7 will give a multiple keypress code. For example, F7FE IN (keys 1-5) is binary 11111 with no keypress, five keys at once 100000, key '1' on XØ 11111Ø, and key '5' on X4 101111. The MSB is the tape port which toggles between 1 and Ø only when you input a tape signal.

There is nothing very mysterious about the interface circuit of Fig. 1, it is merely a six-bit input port running in tandem with the Ace's own keyboard port, and addressed by AØ low. Two three input NORs (IC1) are configured to give an active low enable to buffer/driver IC2 during an input request. Diodes D1-D8 serve to isolate each address line. Spare input T is the alternative LOAD port. XØ-X4 and YØ-Y7 form the interface input lines.

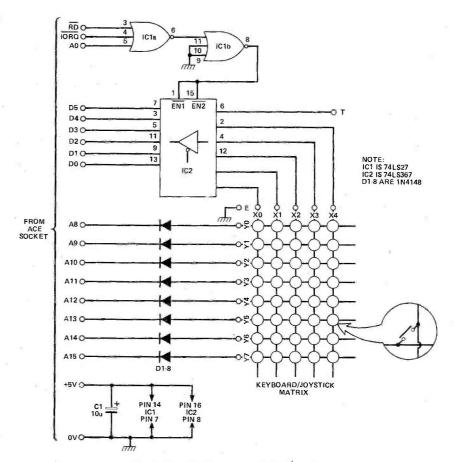


Fig. 1 Circuit diagram of the interface.

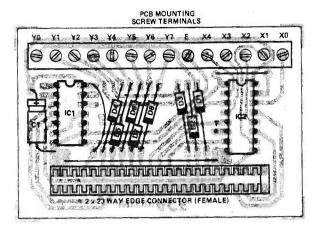
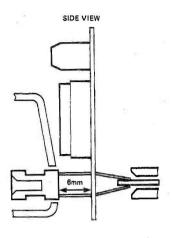


Fig. 2 (a) Overlay diagram of the PCB.



(b) detail of assembly of edge connector.

any pre-selected group of five keys, to be plugged into the back of the Ace, which will not invalidate the manufacturer's guarantee or require additional software. The interface circuit mimics the Ace's internal hardware so that dual keyboards and joystick effectively operate in parallel and simultaneously. An additional input provides DC access to the internal tape-load port of the Ace for experimental purposes.

The ability to simulate key-press with a switch (without a mess of wires soldered to the computer mainboard) can provide a range of useful facilities. Allowing for shift functions and unprintable codes, there are 106 individual codes which may be obtained using INKEY during program execution, and each represents a discrete input channel. Multiple key-presses of up to forty keys are also possible with the IN word, or a compact machine code routine, and this will yield 255 key combinations or channels.

A three-octave monophonic music keyboard, fitted with suitable contacts, can make use of the readymade and debounced key-scan routine in Ace ROM, and leave 70 additional channels free for other functions. Multi-key-press offers three octave polyphonic operation.

A small panel of insulated material, with forty 3.5mm jack sockets, will serve as a general purpose patch-panel for switch interfacing, and is handy for quick, softwareless joystick programming. With the switch combinations available, and an equal number of possible computer responses, many other applications should spring to mind.

#### Construction

Ace edge connectors are not widely available, but you can use a cut-down ZX Spectrum connector, a

modified ZX81 connector, or one cut from a long block. Make sure that the edge connector wire length is at least 14mm. Some, but not all, ZX81 connectors can be modified by carefully pushing out two contacts at the end of each block with a small pair of pliers and reinserting them in the ZX blanking key position, then fitting the blanking key at the end of the row to suit the Ace.

Insert the edge connector halfway into the plain side of the PCB with the blanking key to the right.

#### PARTS LIST.

CAPACITOR

10uF 10V tubular electrolytic

**SEMICONDUCTORS** 

IC1 74LS27 IC2 74LS367 D1-D8 1N4148

**MISCELLANEOUS** 

Double sided 23-way edge connector (see text); 14-way PCB mounting screw terminals (see text); 14-pin IC socket; 16-pin IC socket; PCB (see Buylines); keyboard; joystick (see text).

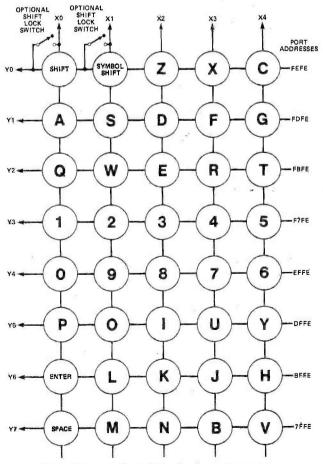


Fig. 3 The coding of the keyboard matrix

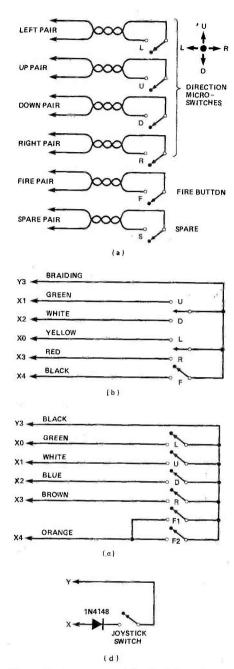


Fig. 4 Different Joystick configurations: a. a microswitch joystick rewired for the Ace and multipress on any six keys; b. pot switch joystick (Voltmace) shown for multi-press on keys 1 to 5; c. diaphragm switch joystick (Spectrovideo Quickshot) shown for multipress on keys 1 to 5; d. use of isolating diodes to avoid ghosting.

Lay a pencil along the top row of wires, on the foil side of the PCB, and apply pressure to the pencil to bend the wires inwards (see Fig. 2). Now bend the remaining row of wires inwards and adjust until the a suitable male edge connector strip into position between the wires, making sure that there is plenty of contact area free for the Rampack, and solder the wires to the strip. Position the edge connector parallel

to the PCB in all planes, 6mm away from the board, and solder to the PCB.

Now check all solder joints with a magnifying glass (even if you do have good eyesight!) and look for whiskers or blobs of solder which may cause a short between adjacent strips. Clean minute blobs of flux from the extender strip with a brass wire brush. Plug the interface into the Ace and remove it, with power supplies OFF, several times, to remove oxidisation from the computer board. If you have a Rampack, push it on and off the interface rear extender strip too. Now switch on and check that the Ace behaves normally. With clean contacts, it should be possible to rock the Rampack slightly without crashing. Look for dry joints or dirty contacts if there is malfunctioning.

Insert the remaining components and link wires on the PCB, but leave out the longest link for the time being. Observe capacitor and diode polarities and DIL socket orientation. The screw terminal block can be made up of 8 + 4 + 2, 8 + 3 + 3, or 4 + 4 + 4 + 2 assemblies. It may be necessary to sandpaper the end of the blocks for a good fit on the PCB. You can insert and solder the long link wire after the diodes have been soldered.

Before inserting the ICs, check that the Ace works normally with the interface in position. Switch off, insert ICs the correct way up, and test again. The interface should have no effect on the Ace. Just to make sure, try a LOAD from a trusty tape and check all key-presses on the rubber keyboard.

Wire up the underside of your add-on keyboard according to the keyboard layout in Fig. 3, and fit optional shift lock switches if required. Try to keep switch interconnecting wiring as short as possible, to minimise circuit strays.

Your keyboard can be wired straight to the PCB terminal block, with about ½ metre of ribbon cable, and all key-presses then tested. If some keys work erratically, or are slow on repeat, try earthing the computer via the negative side of the power supply jack plug. A joystick can also be wired to the PCB terminal block, but cannot be reconfigured without switching the computer off because of edge connector wobble. It is a good idea to run a flexible length of ribbon cable from the PCB to two 2 A terminal blocks for the joystick, which can then be reconfigured while the computer is running.

#### **Joysticks**

There are many weird and wonderful joysticks now on the market. Analogue joysticks with pots are not suitable for this

```
: LEFT
    left"
  JIP
    UP "
: DOMN
    down"
  RIGHT
  " right"
  FIRE
 " fire"
: MULTIPRESS
 Ø IN 31 AND ( get keypress and
mask off unwanted bits)
 DUP 1 AND Ø=
 ΙF
  ( is DØ low?)
  LEFT
 THEN
 DUP 2 AND 0=
 IF
  ( is D1 low?)
  UP
 THEN
 DUP 4 AND 0=
 IF
  ( is D2 low?)
  DOWN
 THEN
 DUP 8 AND 0=
  ( is D3 low?)
  RIGHT
 THEN
 DUP 16 AND Ø=
 IF
  ( is D4 low?)
 FIRE
 THEN
 DROP ( discard keypress)
: TEST
BEGIN
  CLS MULTIPRESS 500 0
   ( slow routine down for displ
ay)
  LOOP
  a
UNTIL
```

Fig. 5 Five-key FORTH multi-press routine.

# HOW IT WORKS — MULTIPLE \_ KEY ROUTINE \_

READ is a table containing a  $5 \times 8$  byte array of ASCII codes relating directly to the logical layout of the Ace keyboard. At the end of this table is an 8 byte array, which is a table of keyboard port addresses (high byte only).

The word KEY picks up from the stack the start address of the READ table and the ASCII key value to be tested. It searches the table until it finds a match to the key value. If there is no match the routine is aborted with ERROR & as an invalid key code has been used.

By the time a valid match is found, the Z80's B and D registers contain an indirect pointer to the relevant port address for the key which is to be tested (B register), and the key's position within that port as a data bit (D register). If the bit is reset  $(=\theta)$ , then the key is being pressed and a 1 is placed on the stack, otherwise a  $\emptyset$  is stacked, thus giving a true or false flag for testing with IF . . . THEN.

interface. There are 'floppy-stick' joysticks which do not 'click' but use switches which look like pots. Then there are diaphragm switch joysticks, and microswitch joysticks which 'click'. Leaving aside personal styling preferences and magnetic switch joysticks, the microswitch type is preferred for this interface, but diaphragm switch joysticks (Atari, Quickshot) will work over a limited range of keys and can be rewired (with some difficulty) for all keys.

If you can find or make a microswitch joystick it should be wired as in Fig. 4a. The pot type switch (Fig. 4b) cannot be rewired for all key positions, but will multipress a five key row. The diaphragm switch joystick, Fig. 4c, can be rewired for all keys by cutting the tracks on the switch PCB and rewiring as in Fig. 4a, but make sure there are no solder joints under the switch actuator plastic ring. Unmodified, the diaphragm switch type will multipress five keys as in Fig. 4b.

If you rewire the joystick according to Fig. 4a, use pairs of twisted insulated wire about ½ metrelong. If you are also making a patch panel (which has a socket for each key), the joystick pairs can be terminated with 3.5mm insulated jack plugs. To configure the joystick for a program, merely insert the appropriate plug in the socket position corresponding to the keypress, or clamp the wire pairs in the terminal blocks by following the key/matrix diagram of Fig. 3.

Certain key combinations of diagonal plus fire button could

conceivably produce unwanted responses with a few examples of commercial software. To avoid keypress 'ghosting', place an isolating diode in each joystick 'x' wire, as in Fig 4d.

# **Programming For The Interface**

Good games software must be responsive and easy to control, not to be confused with difficult to play. There is nothing worse than a

```
CREATE READ 48 ALLOT
  16 BASE C! 48 Ø
  RETYPE NUMBER DROP OVER I
  + C9
 LOOP
 DECIMAL
® HEX
 16 BASE CT
READ IN
43 53 7A 78 63 61 73 64
66 67 71 77 65 72 74 31
32 33 34 35 30 39 38 37
36 70 6F 69 75 79 D 6C
6B 6A 68 20 6D 6E 62 76
FE FD FB F7 EF DF BF 7F
DEFINER MC
 UIS CR ." BYTES:"
 RETYPE NUMBER DROP'CR BASE
 C@ HEX SWAP . " ENTER"
  RETYPE NUMBER DROP C,
 LOOP
 CR BASE C!
DOES>
CALL
REDEFINE IN
MC KEY (NOTE:on bytes prompt
enter 52)
DF D5 DF E1 E5 6 8 E
5 16 1 7E BB 28 B CB
22 D 23 20 F6 10 F0 E1
E7 0 3E 8 90 E1 1 28
0 9 85 6F 46 E FE ED
78 2F A2 11 0 0 28 1
13 D7 FD E9
DEFINER MC
DOFS>
 CALL
```

REDEFINE MC

sluggish 'thing' which hesitantly jerks in four directions and freezes (together with the whole scenario) during a zap. It takes all the fun out of what might otherwise be an excellent game.

Multipress action is not difficult to achieve on the Ace, if INKEY is discarded in favour of IN. Up to five simultaneous keys (those in the vertical groups X0-X4 in Fig. 3 combined with other vertical groups) will give a total of 31 keypress combinations. Apart from the eight directions plus zap, pressing right plus left (or up plus down) could produce a tenth and eleventh response, but this is not possible on a joystick alone.

In the five key multipress routine Fig. 5, you supply the direction and zap definitions, in place of the demo definitions inside the dot quotes. All five-key groups are operative because MULTIPRESS uses Ø IN. If you want to employ only one group of keys, change number base to HEX, edit MULTIPRESS, and replace Ø with an address from Fig. 3, then redefine

					4, 2		
	3FAE	DF				RST	18
1	3FAF	<b>D</b> 5				PUSH	DE
	3FB0	DF			- des	RST	18
1	3FB1	E1			2011	POP	HL
	3FB2	E5				PUSH	HL
1	3FB3	06	08			LD	8,08
١	3FB5	ØE	05			LD	C,05
1	3FB7		01			LD	0,01
1	3FB9	2E				LD	A, (HL)
ı	<b>3FBA</b>	BB				'CP	E
ı	3FBB	28	ØB			JR	Z,3FC8
ı	3FBD	CB	22			SLA	D
	3FBF	ØD				DEC	C
ı	3FCØ					INC	HL
1	3FC1	20	F6			JR	NZ, 3FB9
ı	3FC3	10	FØ			SNLD	3FB5
1	3FC5	E 1				POP	HL
Į	3FC6	E7	00			RST	20,00
-	3FC8	3E	08	4		LD	A,08
	3FCA	90					В
	3FCB	El			, in	POP	HL
ı	3FCC	01	28	00		LD	BC,0028
100	3FCF	09				ADD	HL,BC
2	3FD0	85				ADD	L
100	3FD1	6F				LD	L,A
l	3FD2	46				LD	B, (HL)
Į	3FD3	ØE	FE			LD	C,FE
ı	3FD5	ED	78			IN	A,(C)
ı	3FD7	2F				CPL	Į.
DE MEDICA	3FD8	A2				AND	D
ı	3FD9		00	00		LD	DE,0000
ı	3FDC	28	01			JR	₹,3FDF
ı	3FDE					INC	DE
	3FDF					RST	10
L	3FE0	FÞ	E9	Į.	40.5	JP	(IY)

Fig. 6a. All-keys multiple-key read program listing; b. assembler listing for the program (relative addressing).

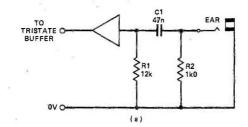
the MULTIPRESS and return to decimal. The word TEST places MULTIPRESS inside a BEĞIN UNTIL loop and slows it down to allow time for a screen display. MULTIPRESS would normally be inside your program loop.

#### All Keys Multiple Key **Read Routine**

Gary Knight has kindly consented to the publication of his own forty key machine code routine.

To use the multiple key read routine you need to place on the stack the ASCII code of the lowercase letter or the number which appears on that key. So, to execute the word LEFT if the 'l' key is being pressed you would use: ASCILL READ KEY IF LEFT THEN You can test for the ENTER, SPACE, CAPS SHIFT and SYMBOL SHIFT keys by placing on the stack decimal 13, decimal 32, ASCII C or ASCII S (note the last two are in upper-case). See the 'How It Works' section for this routine.

Type in everything in the listing (Fig. 6a) exactly as it stands. There are two tables of numbers (after READ IN and after MC KEY). Type



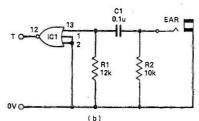


Fig. 7a. Standard Ace tape input port circuit; b. alternative tape port using spare gate on interface.

each hex number and press ENTER after each.

#### Tape Port and Keybeep

The standard Ace tape port input circuit is shown in Fig. 7a. R1 biases the gate input to about 2V, and R2 acts as a tape recorder output load resistor. If the gate is omitted, it is possible to feed straight into the interface T

connection from the circuit of Fig. 7a, but gate buffering is desirable.

A suggested circuit for an alternative tape port is given in Fig. 7b. The spare three input NOR in IC1 is pressed into service (the inverted signal works) and C1 is increased in value to improve sensitivity. A higher value for R2 makes it possible to feed from DIN plugs on some tape recorders. With DC access to the tape port, you can experiment with input filtering, etc.

#### BUYLINES.

The following are available from I.T.M. KJ Interface PCBs £4.45 per set. KJ Interface Kits with PCBs £11.50 each (including full documentation). Assembled and tested KJ Interfaces (uncased) with applications documentation £14.50 each. All prices inclusive of VAT and postage. SAE for further details of KJ interfaces, patchboards etc. I.T.M. 119a Culverley Road, Catford, London SE6. (01-698 5351).

Long wire ZX81 or Spectrum edge connectors are available from Technomatic (see text). PCB mounting screw terminals (0.2" pitch) and keyboard switches from Maplin or Ambit International (see text). Other components are not difficult to obtain.

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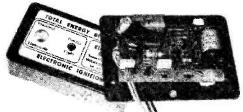
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# AUDIO DESIGN

Enough of this theoretical agonising over distortion and noise! John Linsley Hood shows us what is to be actually done about these problems — following up with a practical example, a project for a moving coil PU head-amp.

In the preceding parts of this series I have taken a, necessarily brief, look at the basic techniques of small-signal audio circuit design, and mentioned some of the problems. However, I haven't so far talked much about distortion, or looked at how these design techniques would be employed to produce a technically advanced piece of circuitry, such as is now expected in up-market hifi gear. I will now remedy this deficiency.

#### Distortion

In its most general context, this refers to the way in which the output signal from some part of the signal handling chain differs from that present at its input, excepting that due solely to uniform and frequency independent amplification or attenuation. In normal use, this term is taken to refer to the waveform distortion of a continuous uniform (steady state) sinusoidal waveform, either as a result of regularly occurring kinks or bends in this waveform (harmonic distortion — so called because the distortion products occur at frequencies which are harmonically related to the fundamental frequency) or as a result of the inadvertent interaction, due to imperfections in the signal handling channel, of two — or more — frequencies simultaneously present (intermodulation distortion).

Harmonic distortion can be measured by a simple test instrument of the kind shown in Fig. 1, known as a **total harmonic distortion** or **THD** meter, in which the incoming signal is measured by an AC millivoltmeter, either directly, or through a sharply tuned 'notch' filter. If the meter is set to read full scale with the filter shorted out, and then this reading is compared with the smaller reading obtained after the notch filter is used to remove the fundamental, what will be left, as a fraction of the original, is the total harmonic distortion, plus, alas, the noise and hum accompanying the original signal.

A better, but more complicated, way of measuring harmonic distortion is to use a **harmonic analyser** — shown in Fig. 2. In this the AC millivoltmeter is fed by a sharply-tuned variable-frequency filter having a narrow passband. This allows the magnitude of signals present at

SET TUNABLE NOTCH FILTER

OVO

OVO

Fig. 1 Total harmonic distortion measuring instrument.

any frequency to be compared with the magnitude of the signal at the fundamental frequency, and allows the user to avoid spurious results due to hum and noise. The magnitude of individual harmonics can then be identified, which gives a more significant assessment of what has happened to the signal on its passage through the unit under test. In the particular case of intermodulation distortion, this relates to the way in which two signals may combine within the signal handling stage to produce the so-called 'sum and difference' frequencies of the two components.

Although there were different standards employed, a fairly typical intermodulation distortion test would have used, for example, two frequencies at 70 Hz and 3 kHz, in a 10:1 ratio, and the Harmonic Analyser would then have been used to measure the amount of 2930 Hz and 3070 Hz present as a result of the non-linearity of the unit under test. More modern tests, of a similar kind, would use two identical magnitude signals at, say 19 kHz and 20 kHz and a simple low-pass filter could then be used to isolate for measurement the spurious 1 kHz (difference) frequency.

It has been claimed that this particular test gives results which correlate very significantly with the way in which an audio amplifier sounds. I am sceptical about this, if only because I know I could design an amplifier which would do well in this test and yet would sound awful.

The snag, of course, in all these tests is that they relate only to 'steady state' continuous sinewave tones, which really have very little to do with the sort of signals which audio equipment has to handle — with the occasional exception of the lovers of very slow-moving organ or flute music. Most of the sounds which inform or delight the listener are random, transitory and irregular in waveform. There is a relationship between the way in which an amplifier, say, will handle a steady state signal and the way in which it will sound on real life signals such as speech or music, but this is neither a simple nor a complete one; distortion measurements, though they relate to an important aspect of the behaviour of the system are not, of themselves, as meaningful as the advertisers of hi-fi goodies would have us believe. They need to be inter-

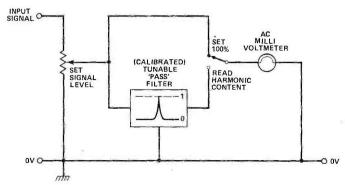


Fig. 2 Harmonic analyser arrangement,

preted, and weighted, in the light of experience and with

an eye to their applicability.

So, in addition to knowing how to design for low distortion, we also need to have some understanding about the relative importance of the various types, so that if there is some need for compromise, the right decisions can be made. Happily, this isn't too difficult.

#### **Harmonic Distortion**

If a sinewave is asymmetrically distorted, as shown in Fig 3a this will give rise to even harmonics (2nd, 4th, 6th etc.). If the distortion is fairly smooth, as would be the case in most simple low-level signal stages without negative feedback, the main harmonic produced would be the 2nd. This is simply the same note, but one octave higher, and is therefore consonant, as would be the 4th, 8th and 16th harmonics, which would give the same note two, three and four octaves higher. Small amounts of such low-order harmonics — up to, say, 0.5-1.0% are musically quite tolerable, and may give an apparent richness to the sound quality — much liked by the devotees of old valve amps.

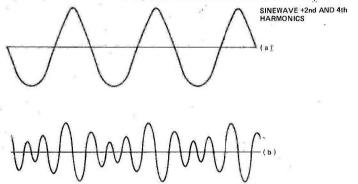


Fig. 3 Harmonic (a) and intermodulation (b) distortion.

The reason why one doesn't want even musically innocuous harmonics is shown in Fig. 3b. If a smaller signal at a different frequency were present, along with this bigger sinewave, its amplitude would vary with the excursion of output voltage — simply because the waveform distortion implies a variation in stage gain as a function of output voltage. This is what is known as **intermodulation distortion.** 

Higher order even harmonics, such as the 6th, 10th, 12th, 14th, are dissonant (if 256 Hz is middle C, its third harmonic would be 768 Hz which is somewhere near G in the octave above, and the 6th harmonic would be near the G in the octave above that), as are all the 'odd' harmonics, to an extent which increases rapidly as their

'order' increases.

The odd harmonics are due to symmetrical bending of the waveform, as shown in Figs. 4a and 4b, the latter case being that due to crossover defects in push-pull systems. As an invariable rule, the smaller the proportion of the waveform which is bent the higher the harmonic, and probably the worse it will sound. In the particular case of crossover distortion in push-pull stages, in addition to making nasty sounds, it also removes low magnitude signals from the output, which makes the system have a 'thin' sound. The same sort of kinks at the tips of the waveform, as in Fig. 4c, due to symmetrical clipping, would just make the sound rather hard and 'edgy' - yet both of these could be the same harmonics, present in a numerically identical quantity, but merely shifted in phase. As a kind of working rule, 0.1% of third harmonic would not be musically objectionable (though the equipment would sound 'cleaner' without it). 5th, 7th and above should not be present above some 0.02% for a plea-

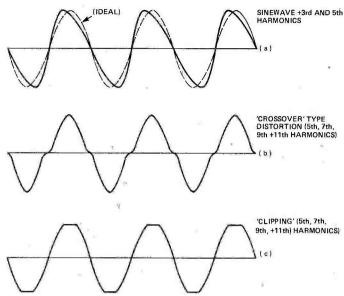


Fig. 4 Waveforms containing odd harmonic distortion.

sant sounding result.

Since these are the kinds of harmonic produced by class AB (low quiescent current) push-pull transistor output stages, it is easy to see why very low orders of THD are demanded nowadays from such amplifiers, while the old valve jobs could get away with ten times as much as this, and still be applauded.

#### Intermodulation Distortions (IMD)

If an incoming sinewave signal is 'bent', this implies that, for that amount of signal swing, the gain of the system varies as a function of the output voltage. It follows from this that any other signals present at the same time will be modulated in amplitude, as I've already shown in Fig. 3b. This has the effect of muddling up the sound, and making it more difficult to separate the individual components.

If an amplifier limits, either because it has been driven into clipping through too big an input signal, or because it has been made to try to follow a transient which is too fast for it, it is obvious that other signals present while it has been driven into a limit condition will be lost. This second condition is known as slew rate limiting or, more fancifully, as transient intermodulation distortion (TID). Both of these problems are shown in Fig. 5 (over page).

Although a lot of technical capital has been made from TID, both in relation to its description and in relation to its cure, it is, in reality, rather less pervasive than normal IM distortion, if only because it only happens on transients, and it is rather more simple for the user to avoid—just drive it a little less hard!

#### **Reducing Distortion**

Harmonic distortions usually arise from one or other of three causes: non-linearity of device voltage/current transfer characteristics; intrusion of unwanted signals (which could be distorted versions of the wanted ones) from supply lines, or by capacitive coupling from later stages (which will tend to exaggerate the higher frequency components); and by coupling of unwanted components into the signal line by poorly arranged earth line return paths.

The first of these, and part of the second, is a question of circuit design, the rest is a matter of care in layout. Being aware, for example, of the need to prevent capacitive coupling of output signals back to earlier stages

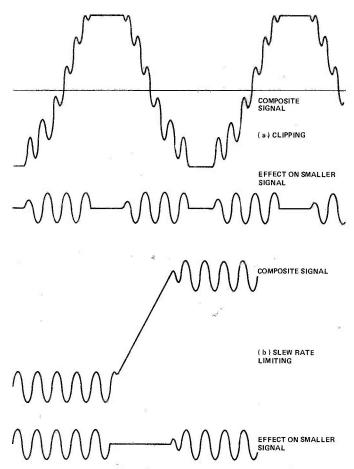


Fig. 5 Intermodulation distortion types due to (a) clipping and (b) slew rate limiting.

leads quite naturally to the thought that these parts of the circuit should be kept as far apart physically as practicable (or necessary). Being conscious of the undesirability of output circuit currents flowing in input signal paths can, without much mental stress, lead one to more elegant wiring layouts — so this isn't difficult to do adequately. It is the knowing (and remembering) which is the hard bit.

# The Use Of Negative Feedback

Designing for low distortion is more demanding of thought. The major implement in this task is the use of **negative feedback (NFB)**, in which a proportion of the outpur signal is — effectively — subtracted from the input signal. If the output signal contains components which are not present in the input, these components will be amplified in an inverted phase, as shown in Fig. 6, and will tend to cancel the distortion components present in the output.

This technique does work, and works well, but there are snags! The first of these is that the distortion components will themselves be distorted, so that an amplifier, without feedback, having 2nd and 3rd harmonics, will, with feedback, also contain 4th, 6th and 9th — and could well sound less pleasant. Also, the use of NFB is likely to make the amplifier much less stable at HF, with the possibility of continuous or incipient oscillation. This also is ruinous for sound quality, and gave rise, some years ago, to a vogue among the less inspired circuit designers for circuits without any NFB at all. The real answer to these problems is to have enough gain in the amplifier for a decent amount of NFB to be used, and to design it with an adequate stability margin, which means mainly not having too many stages within the NFB loop.

Because the final distortion figure of any feedback

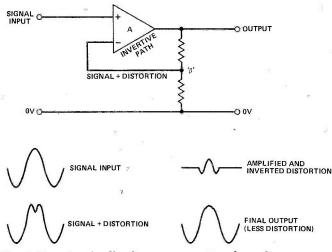


Fig. 6 Negative feedback arrangement and results.

amplifier (by this we normally mean an amplifier with negative feedback) depends on the initial distortion, then we need to make the amplifier as linear as possible in its open-loop condition. The formulae for calculating the effect of feedback (negative or positive) are:

$$A' = \frac{A}{(1 - \beta A)}$$

$$D_f = \frac{D}{(1 - \beta A)}$$

where A is the gain without feedback (negative for an inverting amplifier) A' is the gain after feedback is applied (if A is large enough, then we can use the approximation  $A' = -1/\beta$ ),  $\beta$  is the proportion of the signal fed back, D is the distortion without feedback and  $D_f$  the distortion with feedback.

The expression  $(1 - \beta A)$  is known as the **feedback factor**, and it reduces the gain and distortion equally in simple systems. It is normally expressed in decibels, for example 20dB of feedback which implies that the gain has been reduced by a factor of 10. If A and  $\beta$  are both positive, then the feedback factor will be less than one and both the gain and distortion will be increased, up to the point where  $\beta A = 1$ , where the gain becomes infinite and the amplifier will oscillate.

# A High Quality, Low-Distortion Gain Block

So, how does one design, say, a low-distortion smallsignal amplifier. The distortion arises because of bending in the input characteristics of the device, as shown in Fig. 7. Here I have illustrated the input voltage/output current characteristics of a small-signal silicon junction transistor and a junction FET. The bipolar transistor is obviously much more bent, and will therefore give a more distorted output, but because the upward slope of the graph is much steeper it will also give much more gain. An important point to remember, though, is that the smaller the signal which is applied to the input, the less the distortion - simply because any curve becomes a straight line if a small enough part of it is used. This means that if, by some means, we can get a high enough gain from the stage, the waveform distortion due to the input characteristic curvature will be made very small. So, one must design to get the best stage gain.

Another useful point is that push-pull circuits, because they are symmetrical, cause asymmetrical distortions to cancel out, largely. The bending of a transistor V<sub>base</sub> vs. I<sub>c</sub>

# FEATURE: Audio Design

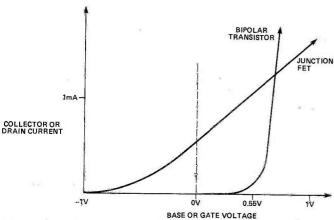


Fig. 7 Input characteristics of bipolar and field-effect transistors.

characteristic is asymmetrical, therefore a push-pull input system, such as a long-tailed pair discussed in part 1 of this series, would have less distortion — by a factor of perhaps 10 — than the equivalent single-ended input stage.

To simplify the problems of stability when negative feedback is applied, it is preferable to limit the loop, around which the feedback is applied, to two gain stages. Probably the best of the possible circuit configurations is the one in which an input long-tailed pair is followed by another push-pull amplifier stage, which is, in turn, loaded by a **current mirror** of the kind shown in Fig. 8a. A working stage of this kind is shown in Fig. 8b. I have shown this in a standard op-amp form, with a + and – DC supply, two inputs (one inverting, one non-inverting) and an output, so we can use this exactly as if it were an IC op-amp in any appropriate circuit. However, it has the advantage that it will, with suitable transistors, be usable up to DC supply voltages of 50 V or so, allowing an output voltage swing of some 96 V P-P, or an RMS output of some 34 V, which would give good headroom.

In this circuit Q3, Q4 and R1 and R4 act as a constant-current source, in which, if the current through R1 produces a voltage greater than 0.55 V, Q4 will turn on and steal the base current from Q3, to prevent Q3's emitter current from increasing any further. With the values shown this holds the current through Q1 and Q2 to  $100\mu$ A each, which gives a satisfactorily high input impedance to this stage. For example, if Q1 and Q2 have current gains of 200, the base currents required will only be  $0.5\mu$ A.

The best input noise figure in this stage will be given if the input transistors (Q1, Q2) are PNP types — because they have N-type base regions — and for the sort of DC supply voltages which I envisage in this application ( $\pm 15$  V, so that we can also use ICs) BC214Cs are ideal. In order to get a good output drive capability from this gainblock, I have chosen to make Q5 and Q8 pass 5 mA each, which is 10 mA through R6. If this is 100R, the potential drop across it will be 1 V. So, to provide 0.55 V across the base-emitter junctions of Q5 and Q8, the voltage drop across R2 and R3 must be 1.55 V. Since Q1 and Q2 each pass 100  $\mu$ A, then R2 and R3 must each be 15.5k — the preferred value of 15k is near enough, in practice. This defines the component values, with the exception of R4, which isn't really critical in value, and R5C1 which is a phase correcting circuit.

The gain/bandwidth, noise and THD figures for this circuit block are quite excellent (see Table 1), and allow it to be used in a very high quality audio preamp to obtain a standard of performance which would not be bettered by an commercial unit on the market, though some of the more astronomically priced ones might equal it. If one restricts the ± DC supplies to 15 V, one could substitute

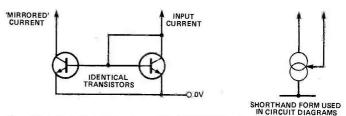


Fig. 8(a) Current mirror circuit arrangement.

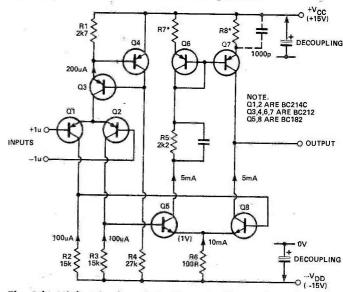


Fig. 8(b) High gain, low distortion gain block. R7 and R8 (marked with \*) are optonal 100R resistors which lessen the need to match the characteristics of Q6 and Q7 — they could be replaced with links.

any commercial unit on the market, though some of the the LF351 or the TL071, for this gain block with only a small lowering of audio performance, though, as mentioned above, the gain block is not so restricted in DC supply potentials.

# The Passive Components

There are a few further points which are worthy of comment, at this stage, concerning components. Quite a lot of thought has been given to the sound quality changes imparted to audio circuitry by the components used. So far here, we have only considered the way in which the circuit will work, and what values of components we should employ. However, when we actually get down to the detailed design of audio stages, we can no longer simply say a resistor is a resistor is a resistor . . .! There are two main problems with real resistors, excess noise due to random variations in the path current will actually take through the resistance track and voltage dependence of resistance (even at power levels too low to wam it up significantly).

The consensus of opinion here is that metal film types are the best, with metal oxide types comparable in performance, followed by carbon film, and with carbon

Gain. (without NFB) 30,000x

Bandwidth. 300KHz

Distortion: Less than 0.003% at 1KHz

at x100 gain

Square wave performance. No overshoot.

IMD. Not measurable.

Input noise resistance. 1k5

**Note.** The circuit is stable, as it stands, for gains (set by NFB) down to 5. For unity gain use, an output Zobel network of 1000pF and 180 ohms should be added.

Table 1 Performance of the gain block.

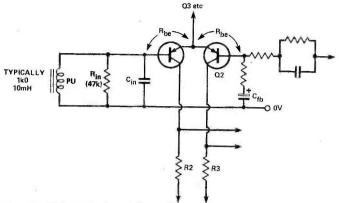


Fig. 9 RIAA stage input impedances.

composition, a long way down the list. For low values of resistance, wirewound types are excellent, but for higher values the inductive effects are troublesome. In the case of capacitors, non-polar types are always better, with polypropylene, polystyrene, polycarbonate and polyester film types shown in descending order of preference. (This is largely a function of dielectric loss and hysteresis.) In the polar types (electrolytics), low equivalent series resistance (low ESR) capacitors are preferable, but in the absence of these, supply line bypass capacitors should always be bypassed with a smaller non-polar film type. If you are really fussy you can bypass this again by a smaller monolithic ceramic type. For low signal levels, if large capacitance values are necessary, in the audio path, use one of the new low-leakage miniature aluminium types. Tantalum bead types, in addition to being very dear, are now thought to spoil the clarity of the signal.

Returning to our gain block of Fig. 8b, for the best sound quality, the DC supply lines should always be stabilised — in addition to being bypassed to the 0 volt line by an adequately large low ESR capacitor. Up to  $\pm 24$  V we can use IC voltage regulators for this purpose, which is

the most economical solution.

# **RIAA Equalisation Stage**

At the conclusion of this series, I propose to describe a high quality audio amplifier and preamp as a 'proof of the pudding'. The gain block just described will make an excellent RIAA input stage for this, though there are a few other considerations in the way it is used. In the last part of this series, I referred to resistor noise, a thing which is present in all low level circuitry as a measurable background. In the case of Fig. 8b, the important part, in relation to resistor noise, is the input circuit, shown in Fig. 9 in the way it would be connected for an RIAA equalisation stage.

Here we have two input transistors, each with their

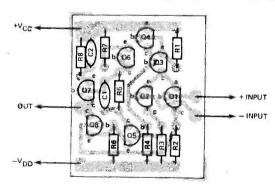
own internal input resistance ( $R_{be}$ ), and with external impedances between their bases and the 0 V line, which are effectively in series with  $R_{be}$  so far as the noise resistance is concerned. Since the noise components due to these add as the root of the squares, and this gives the same result as if all the resistors were added together as a lump noise resistance, the task, for minimum noise, is to try to make the total  $-R_{in}$  (in parallel with the pick-up impedance)  $+R_{be}(Q1)+R_{be}(Q2)+R_{be}$  (in series with  $C_{fb}$ ) - as small as practicable. Here is a snag. For any sensible value of collector current for Q1 and Q2 this will be larger than likely values for  $R_{fb}$  and  $Z_{pu}$ , and limits the lower value of noise resistance to some 1k5, at low frequencies. (At higher frequencies the inductive impedance of the 10 mH or so of the PU coil will be the dominant factor anyway).

This compares with noise resistance of 4 to 5k for the better third generation audio op-amps now available. From the noise figure graph shown in the last part of this series, 1k5 will give a noise output of 0.7 µV at room temperature and 20 kHz bandwidth. This would give a signal to noise ratio of some 73dB, with reference to a typical 3 mV/5cm/sec output signal from a low output PU. However, in practice, the shape of the RIAA correction curve, which slopes down with increasing frequency, limits the effective bandwidth to about 2 kHz, and allows a practical S/N ratio of about 83dB from this sort of input noise resistance. (The TL071/LF353 would give an S/N figure, under the same conditions, of around 79 dB, which

is still good).

It should be remembered, however, in order not to get lost in the wild and woolly world of specifications, that the average LP disc, when new and played on a good turntable, can manage only about 65dB S/N. Moreover, when one has had it for a little while and played it a few times, this S/N ratio is likely only to be about 55-60dB, due to surface noise.

In the last part of this series, when talking about opamp ICs, I described a good quality, simple, two stage RIAA equalisation module, using a passive RC second



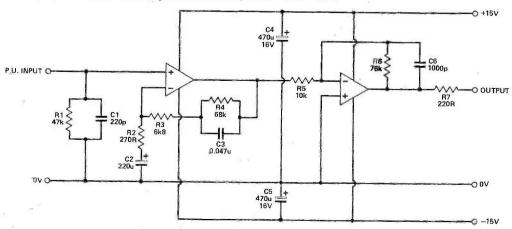


Fig. 10 (left) High quality RIAA equalisation stage, based on the gain block of Fig. 8(b) or a high-quality op-amp.

Fig 11. (above) Component overlay for gain block of Fig. 8(b).

stage to cope with the 1 kHz-21 kHz part of the response curve. One can get a bigger output signal before overload (ie, more 'headroom') if one uses an active RC stage for the second part. A complete circuit for one channel is shown in Fig. 10.

For any readers who would like to experiment with the gain block, a suitable PCB layout for a single unit is shown in Fig. 11. However, I would like to postpone further discussion of the use of the gain block (and the design of the PCB) until I describe the complete preamp later in this series.

# **Moving Coil Head Amps**

To the great sorrow of those companies who had been making a good living from the manufacture of precision, light-weight PU arms, aimed at the increasingly light and free tracking moving magnet or variable reluctance PU cartridges, the more massive low-output moving coil units (which are more ideally mounted on the end of a short length of crowbar) have swept the ultimate-fi scene. This is mainly, I think, because of their more vivid and dramatic stereo presentation — though the MM brigade are fighting back on this score and are narrowing the audio gap.

For the moment, MC cartridges are the choice of the critical users, and these mainly have a very low output

which is typically in the range  $50-500\mu V$  for a 1 cm/sec recorded velocity. This level of output is too low for it to be used directly with a normal RIAA input stage, so a head amplifier is needed. This has to work with an input load impedance of typically 50 ohms, and must be designed for the lowest possible transistor and input circuit noise if it is to compete satisfactorily with the rather more mundane step-up transformer.

When head amps of this type were first employed, the low effective input noise resistance was achieved by putting a lot of small signal transistor stages in parallel, so as to reduce the overall input resistance. This was a bit inelegant as an approach, and now it is more common to choose an input transistor which has an adequately low base-emitter effective resistance on its own (these are often to be found among the plastic encapsulated small power transistors, in the 3-4 A l<sub>c</sub>, 30-40V V<sub>ce</sub> range). The actual device type must be chosen with some care, from a manufacturer of known quality. I prefer Motorola, ITT or National Semiconductors, though this is not an exhaustive list. The device should also be tested before use, under the actual operating conditions.

The circuit should then be chosen to make the gain of the first stage sufficiently high that the noise contributed by later stage transistors can be neglected in comparison

# **Moving Coil PU Head Amp**

The theoretical background for this circuit has been discussed in the main section of Audio Design, so all that remains to be done here is to give the practical details necessary to construct the project.

There are only two points that need to be made: firstly, the electrolytic capacitors used should be low ESR types; if you don't find these easy to obtain, then you could get away with using ordinary or tantalum types (whatever your convictions are) suitably bypassed

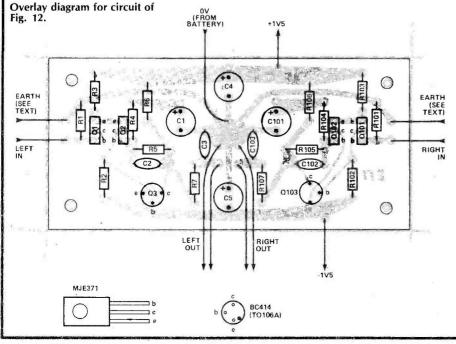
with unpolarised capacitors.

The second point concerns the earthing. We've shown an earthing point near the input. However, there are bound to be cartridges and/or systems for which use of this particular earthing point will cause massive hum loop problems, so we recommend that you tread very carefully on your choice of earthing. Remember that you are dealing with a very small signal!

The unit should be small enough to mount in the base of

most record decks. However, the magnetic field of the motor may just manage to cause problems too . . . In any case, be very careful not to obstruct the suspension of the turntable and arm.

One final point is that you will need an on-off switch: to save the bind of having to switch the head amp, you could use a relay driven from the PSU of the pre- or power amplifier. Using a relay means that you isolate the head amp from the earth system on the main amp.



RESISTORS (all m	etal film, 5% or
better) -	
R1, 101	47R
R2, 102	2k2
R3, 103	1k8
R4, 104	15R
R5, 105	680R
R6, 106	470R
R7, 107	330R
CAPACITORS	·
C1, C101	470μ, 4V7 min, low
	ESR electrolytic
C2, 3, 102, 103	1n0 polypropylene
	or polystyrene
C4, 5, 104, 105	470μ low ESR electrolytic
SEMICONDUCTO	ORS
Q1, 2, 101, 102	MJE371
Q3, 103	BC414
MISCELLANEOU!	S
PCB, case to suit, switch.	battery holders,

# FEATURE: Audio Design

with the amplified signal. Additionally, the values of the resistors used in the circuitry should be kept as low as the circuit design can allow, and the transistors, especially the input one(s), should be operated at collector currents which will minimise R<sub>be</sub> and 'shot' noise.

On the other hand, because the signal levels are so low, the harmonic distortion from such a stage can usually be ignored. This situation does not apply, however, to transient performance, so the stability margin of the negative feedback loop, if one is used, should be high. Also, perversely, the tonal characteristics of the components used, especially the capacitors in the signal line, seem to grow more important as the signal levels are reduced. So, the moral is to use the best quality com-

ponents one can afford at this stage.

Having laid down these general guide-lines, the actual design of a good quality low-noise MC head amplifier is not too difficult, and I have shown a suitable circuit in Fig. 12, with a PCB layout for this in Fig. 13. Because of the very low signal levels involved, hum pick up is likely to be a problem in an 'integrated' system, so it makes life a lot simpler if one can design it so that the whole unit can be housed in a small screened box, separate from the main preamp, and isolated apart from the input and output signal connections. 'Single-point' earthing of the head amp circuitry is also very desirable.

The actual circuit in Fig. 12 is a very straightforward two stage voltage amplifier, using an input long-tailed pair of suitable PNP input transisotrs, biased to operate a 250uA, which is near the optimum value for the devices chosen. The second stage amplifier transistor (Q3) is a very low noise small-signal type operated at 3mA collector current (determined by R6). The overall gain is controlled to

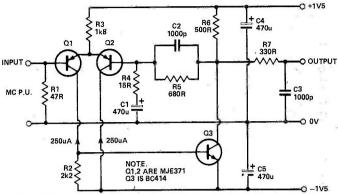


Fig. 12 Moving coil cartridge head amplifier.

45 by the feedback resistors R5 and R4. The -3dB point is set to 20 Hz (a very suitable value for record replay use) by C1. In order to avoid the possibly deleterious characteristics of capacitors in the signal path, the head amp uses a direct-coupled circuit, where the DC NFB also holds the output DC value to 0V, plus or minus a few millivolts.

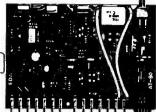
Metal film resistors, and appropriately chosen capacitors (low ESR types for C1, C3 and C4, and polystyrene foil types for C2 and C5) should be employed. Because the supply voltages for which the unit has been designed are ±1.5 V, it is possible to run the unit from a pair of alkaline manganese cells, or ordinary 1.5 V 'HP' series batteries, of AA, C or D sizes (the bigger sizes will make for more economical running) which allows the unit to be separately powered and eases the task of getting a hum-free system.



Step-by-step fully illustrated assembly and fitting instructions are included together ith circuit descriptions. Highest quality components are used throughout.

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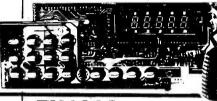
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# NEW! OUT SOON

ETI NOVEMBER 1983

# MINI DRUM SYNTH

Why beat about the bush when you could be beating upon our latest up-beat offering? Design by A.G. Atkins; development by Phil Walker.

ince commercial drum machines first appeared in the late '70s there have been numerous designs published for the home constructor. Some of them were very good, some were not too bad, and some appeared in magazines other than ETI, but almost without exception they were comparatively complex and cost guite a lot to build. Whilst the little unit described here cannot claim as many facilities as some of its illustrious forbears, it does offer good performance at a very low price, and it is very easy to build.

The circuit is that of a manually operated, single channel drum synthesiser. The input sensor consists of a small loudspeaker operating as a microphone, the circuit being arranged so that a light tap on the loudspeaker will cause the synthesiser to produce a drum beat. The circuit includes controls for the adjustment of pitch, decay

time and output level and features two basic pitch modulation envelopes. With SW1 open, the pitch remains constant throughout the drum beat, while with SW1 closed, the pitch falls sharply as the beat decays. With short decay times this latter effect produces a very natural sound, while with longer decay times the sound becomes less drum-like but if anything more interesting, opening up lots of possibilities for off-beat effects.

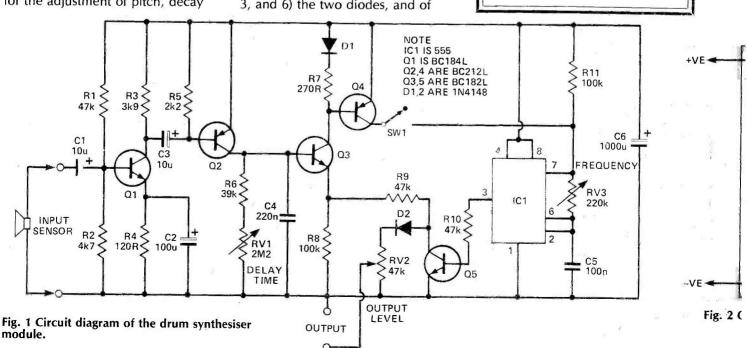
# Construction

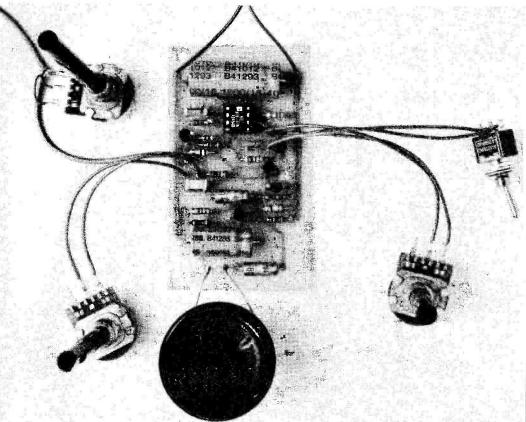
Construction is pretty straightforward since everything except the potentiometers, the switch, the input sensor, the battery, and the output connector is mounted on the PCB. The IC can, if desired, be fitted into a socket, but however you do it make sure it's the right way round. The same goes for the electrolytic capacitors (C1, 2, 3, and 6) the two diodes, and of

# HOW IT WORKS\_

The input sensor can be almost any small loudspeaker. Its output is fed to the amplifier formed by Q1 and its associated components. The amplified signal is converted into pulses by Q2 which then charge up C4. This charge leaks away via R6 and RV1, the latter setting the decay time. Q3 acts as a buffer, passing the voltage on C4 to Q5 via R9. IC1, the 555 timer is connected to form a free-running oscillator whose frequency is controlled by RV3. The oscillator output is fed via R10 to the base of Q5. Q5 acts as a crude modulator, the output from its collector taking the form of a series of pulses whose amplitude is determined by the voltage on C4. These pulses are then fed to the output via D2 and RV2.

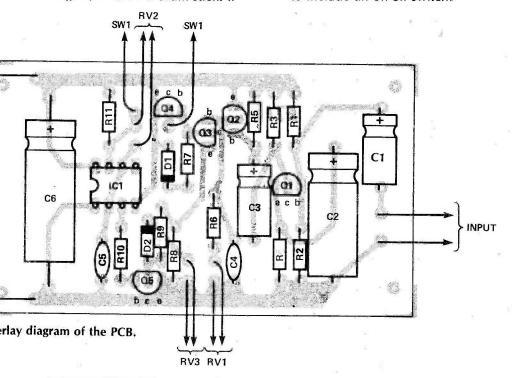
If SW1 is closed, current flows from the collector of Q4 into the oscillator circuit. The magnitude of this current is roughly proportional to the voltage on C4, and causes the oscillator frequency to increase as C4's voltage increases and to decrease when it falls. Thus, as the charge on C4 leaks away after each trigger pulse, the oscillator frequency will drop from its initial value.





course all the transistors. No case has been described since there are no real layout problems and almost anything you can come up with should be suitable. One possibility, however, is to mount all the bits in a drum-shaped container with the sensor held against the underside of the upper surface. The instrument can then be 'played' by tapping on this surface with a pencil, or your fingers, or even a drum-stick! If

preferred, the electronics can be mounted in a more conventional case and the sensor connected via a suitable length of lead. Ordinary twisted flex should be fine; since the sensor has a very low impedance there should be no problems with noise pick-up. SW1 can be any single pole switch, and if the battery is to be permanently installed in the case you may wish to include an on-off switch.



# Going Modular

For the ambitious constructor, this simple circuit offers plenty of scope for development. Several units could be built and set to produce different sounds, allowing a comprehensive mini drum kit to be built up. Taking the idea a stage further, some of our more experienced readers might feel able and inclined to produce a multichannel drum synthesiser to their own requirements. By dispensing with the input sensor and modifying the input amplifier, the circuit could be adapted to trigger from logic pulses, whereupon any number of units might be controlled from a fairly simple digital timing circuit. From there on, the sky's the limit.

PARTS LIST.

	AKIS LISI
RESISTORS	(all ¼W, 5%)
R1, 9, 10	47k
R2	4k7
R3	3k9
R4	120R
R5	2k2
.R6	39k
R7	270R
R8, 11	100k
RV1	2M2 linear
RV2	47k log
RV3	220k linear
1	

<b>CAPACITORS (10V</b>	working min)
C1, 3	10u electrolytic
C2	100u electrolytic
C4	220n polyester
C5 .	100n polyester
C6 `	1000u electrolytic

# **SEMICONDUCTORS**

IC1	555
Q1	BC184L
Q2, 4	BC212L
Q3, 5	BC182L
D1, 2	1N4148

# MISCELLANEOUS

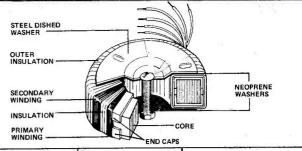
single pole switch PCB (see Buylines); 9V battery (any size); small loudspeaker of between 8 and 80 ohms; battery connector; output connector; case; on-off switch, IC socket, knobs, etc. as desired.

# BUYLINES.

Absolutely no problems at all with this one. All of the components, semiconductors included, are available from any number of regular advertisers, and the PCB is, as always, available through our PCB service (see page 89).

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15 VA 62 x 34mm 0.35Kg Regulation 19%	50 VA 80 x 35mm 0.9Kg Regulation 13%	120 VA 90 x 40mm 1,2Kg Regulation 11%	225 VA 110 x 45mm 2.2Kg Regulation 7%	500 VA 140 x 60mm 4Kg Regulation 4%
SERIES SECONDARY No Volts Current	2x010 6+6 4.16 2x011 9+9 277 2x012 15+12 268 2x013 15+15 1.66 2x013 15+15 1.66 2x014 8.15 1.66 2x014 25+25 1.00 2x017 30+30 0.83 2x028 110 0.45 2x028 110 0.45 2x028 220 0.22 2x030 240 0.20 8x0 VA 90 x 30mm 12% Regulation 12% 1Kg 3x010 9+9 4.44 3x011 9+9 4.44 3x011 12+12 3.33 3x013 15+15 2.66 3x014 18+18 22 3x015 22+22 1.81 3x016 25+25 1.60 3x017 30+30 1.33 3x028 110 0.72 3x029 220 0.36 3x030 240 0.33	4×010 6+6 10,00 4×011 9+9 6,66 4×012 12+12 5 00 4×013 15+15 4 00 4×013 15+15 4 00 4×014 18+18 3,33 4×015 22+22 2,72 4×016 25+25 2 40 4×017 30+30 2.00 4×018 35+35 1.71 4×028 110 1.09 4×029 220 0.54 4×039 240 0.50 160 VA 110 x 40mm 1.8Kg Regulation 8% 5×011 9+9 8.89 5×012 12+12 6.66 5×013 15+15 5.33 5×014 12+12 6.66 5×013 15+15 5.33 5×014 35+35 1.29 5×015 25+25 3.20 5×016 35+35 2.28 5×017 30+30 2.66 5×018 35+35 2.28 5×018 35+35 2.28 5×018 35+35 2.28 5×028 40+40 2.00 5×028 110 1.45 5×028 20 0.72 5×030 240 0.66	6x012 12-12 9 38 6x012 15+15 7 50 6x014 18+18 6.25 5x014 18+18 6.25 5x11 6x016 25+25 4.50 6x015 22+22 5x11 6x016 25+25 4.50 6x017 30+30 3.75 6x018 35+35 3.21 6x025 45+45 2.50 6x028 110 2.04 6x029 220 1.02 6x029 200 1.02 6x029 300 VA 110 x 50mm 2.6Kg Regulation 6% 7x013 15+15 10.00 7x014 18+18 8.33 7x015 22+22 6.00 7x016 25+25 6.00 7x018 15+45 4.28 7x016 25+25 6.00 7x018 35-45 4.28 7x016 35+45 4.3 33 7x025 45+45 3.33 7x025 10.27 7x029 220 1.36 7x029 220 1.36 7x029 220 1.36 7x029 220 1.36 7x029 220 1.36 7x029 220 1.36 7x029 220 1.36 7x029 220 1.36 7x029 220 1.36 7x029 220 1.36 7x029 220 1.36 7x029 220 1.36 7x029 220 1.36 7x029 220 1.36 7x029 220 1.36 7x029 220 1.36 7x029 220 1.36 7x029 220 1.36 7x039 240 1.25	8x016 25+25 10.00 8x017 30+30 8.33 8x018 35+35 7.14 8x026 40+40 6.25 8x025 45+45 5.55 8x033 50+50 5.00 8x042 55+55 4.54 8x029 220 2.27 8x030 240 2.08 9x017 30+30 10.41 9x018 35+35 8.92 9x026 40+40 7 81 9x027 45+45 8.92 9x028 110 6.25 9x028 15 55+55 6.84 9x028 20 2.27 8x030 26 26 26 26 26 26 26 26 26 26 26 26 26

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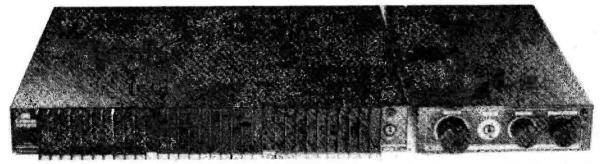




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# ALARM EXTENDER

Is your alarm system the talk of the neighbourhood? Fit ETIs simple add-on unit and protect your social conscience. Design by S.W. Terry.

any of the alarm systems currently in use, whether commercial designs or home-made units, have an ouput that remains on continuously once triggered, stopping only when reset. There is obviously a danger with such alarms that they will be triggered when you are absent for a long period, initially drawing attention as desired but going on to cause considerable anoyance to the neighbours. At its worst, this could result in your facing a little legal unpleasantness. One way of overcoming the problem is to have an alarm which sounds only for a pre-determined time, long enough to attract attention but not so long that it becomes a nuisance to those nearby.

The ETI Alarm Extender provides this facility and is designed so that it may be easily fitted to

existing alarm installations. It will work from any supply voltage between five and fifteen volts, enabling it, in most cases, to be connected directly to the existing supply and making it ideal for use with car alarm systems. With the values of R1 and C1 given the alarm will sound for about twenty minutes, but this may readily be adjusted to suit the requirements of the user.

# Construction

Everything except the relay is mounted on the PCB. The three ICs are CMOS types and are best mounted in sockets rather than soldered direct. Make sure that they are inserted the right way round, and similarly take care with Q1, C3, and D1. Note that C3 is quite close to the mounting holes at that end of the PCB, and that if a physically

# HOW IT WORKS\_

IC1 is a 4047, a CMOS multivibrator which can operate as a monostable, but which is here used as a bistable, its frequency being set by R1, C1. IC2, a 4020, is a 14-stage ripple binary counter which counts the pulses generated by IC1. When the ALM input is low, IC3b pulls pin 4 of IC1 high which prevents it oscillating, while IC3d holds pin 11 of IC2 high, thus holding its output low.

When ALM goes high, the relay is turned on via IC3b, IC3a, and Q1. IC1 and IC2 are enabled and IC1 starts supplying pulses at the rate of about 12 Hz

When ALM goes high, the relay is turned on via IC3b, IC3a, and Q1. IC1 and IC2 are enabled and IC1 starts supplying pulses at the rate of about 12 Hz (assuming the values of R1, C1 given) to IC2. After 16,384 pulses have been received, the Q14 output (pin 3) of IC2 goes high, turning off the relay and preventing further input pulses from reaching IC2.

The period can be adjusted by altering the values of C1 and R1, and is equal to

36,045 R1 C1 seconds. The output time can also be halved by using Q13 (pin 2) instead of Q14 on IC2.

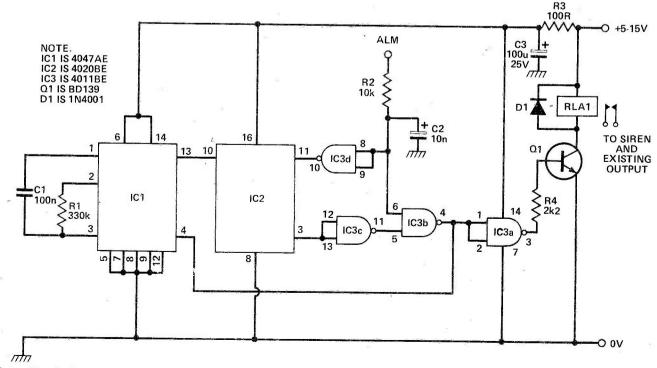


Fig. 1 Circuit diagram of the alarm extender

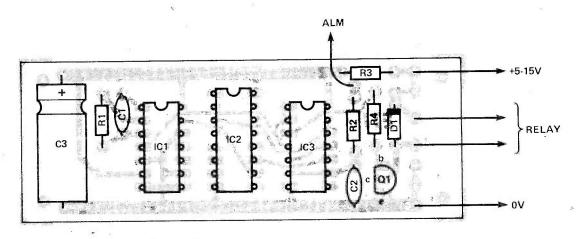


Fig. 2 Component overlay for the PCB

large capacitor is used here you may need to pass the mounting bolts or whatever through the holes before fitting it.

No case has been shown since it is assumed that the unit will be fitted inside an existing alarm, but if this proves impractical almost any small case would be suitable. Note that, if the alarm is fitted outdoors, the case and inter-unit wiring should be made as weathertight as possible. The relay can be mounted on a simple bracket, or even set in Araldite if you prefer.

Having built and installed the PCB and relay, the final step is the modification of the existing alarm wiring. If the alarm circuitry operates on a voltage higher than fifteen volts (you did check the alarm voltage before commencing construction, didn't you?) you will have to arrange a suitable dropper circuit. This should not present too many problems because the Alarm Extender is fairly tolerant of supply voltage variations. Aim for a supply voltage of rather less than fifteen (eg, twelve volts) so as to allow some room for manouevre. If the alarm voltage falls within the range

five to fifteen volts and is stabilised there are no problems and you can connect the Alarm Extender directly.

Moving on to the input and relay connections, you will have to locate within the existing alarm wiring the output lead. Depending on the type of alarm you have, this may be the + ve feed to the relay which activates the output transducer (bell, siren, etc.), or it may be the direct connection between a semiconductor switching device and the output transducer. Again, you should check this before commencing construction since we cannot guarantee that the alarm extender will work with ALL alarm systems. Having located this lead (and only after switching the alarm off!), break it and take the two ends to the two normally open contacts on the relay of the alarm extender. Identify which of these leads comes from the alarm trigger circuitry and run a further lead from it to the ALM input on the alarm extender. Note that, if the alarm runs from a

high voltage and you have had to drop the supply rail before connecting the alarm extender, you may also need to insert a further resistance in series with the ALM input (or to increase R2 in value). The unit is now ready for testing.

# PARTS LIST

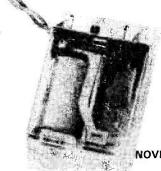
	TO A LANGE TO A LANGE	
Ī	RESISTORS (all <sup>1</sup> <sub>4</sub> V	V, 5%) 330k (see text)
ı	R2	10k (see text)
H	R3	100R
	R4	2k2
	KT	21(2
e Z	CAPACITORS	
	C1	100n (see text)
	C2	10n
2	C3	100u tubular
Ш	-	electrolytic 16 V
ı		(min) working
		(11111) 11-01-11-18
	SEMICONDUCTO	RS
	IC1	4047
ı	IC2	4020
	IC3	4011
ı	Q1	BD139
l	Ď1	1N4001
I		
4	MISCELLANEOUS	
		arley VP2 or similar);
	PCR: two 14 pin	and one 16 pin DIL
	. Cb, p	

BUYLINES.

sockets; mounting bolts, spacers, etc.

A suitable relay is available from Maplin and everything else is just too available for words. For the PCB see page 89.

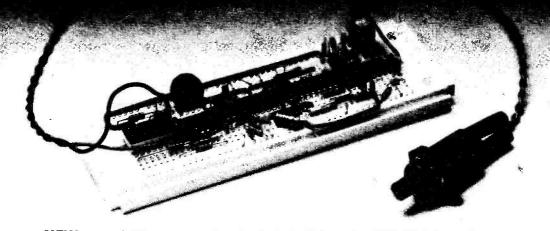
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# You win every time!

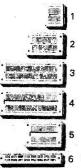
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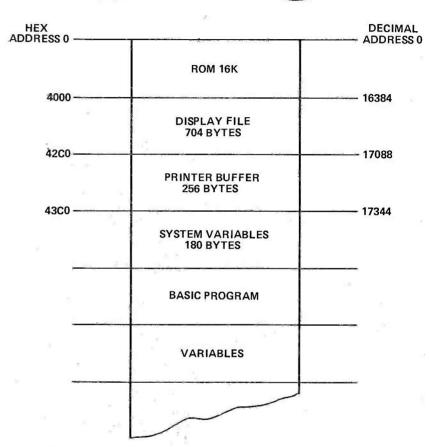
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# MACHINE CODE PROGRAMMING

In this second part of this series, Bob Bennett looks for implied and immediate addresses on the computer's memory map.



hereabouts in RAM your machine code program will go depends on the memory structure of your computer. A look at the computer's memory map will show the areas in RAM reserved by the computer for 'housekeeping' duties. These duties consist of keeping tabs on everything that happens whilst the computer is switched on. Figure 5 shows a portion of a memory map for no computer in particular; how it works is fairly simple, but does require a lengthy explanation.

The **display file** is shown as occupying 704 addresses, each of one byte: these 704 bytes store information relating to the picture on the screen. The working area of the screen in our example consists of 32 columns by 22 rows, and 32 times 22 equals 704. The reason I referred to working area is that there are usually two rows at the bottom of the screen reserved for the input data. As a rule the top left hand corner of the screen is position 0,0, and this is the first address in the display file. Suppose that you printed the letter A in position 0,0: the code for letter A would be stored in address 16384.

The **print buffer** is merely a temporary store for data going out to a printer, but this area can often be used by the programmer.

Any good computer handbook has a section devoted

to the **system variables**, which are a series of reserved addresses usually given short names. These addresses contain information, dealing with which comprises the major portion of the housekeeping I mentioned before. Each system variable consists of one, two, or very rarely, three or more bytes. If there is only one byte then the address will usually contain a number, the value of which may determine the action to be taken by the computer. The Spectrum, for example, has a single byte system variable called PIP that contains a number which determines the length of the keyboard click.

If there are two bytes, then the two consecutive addresses of the system variable themselves hold an address. This is usually the starting address of an area in RAM where a particular variable is stored. For example, when you assign letters or strings as variables, the information relating to those variables is held in an area of memory. If you had a system variable called VARS, this would consist of two bytes, and would hold the starting address of that area.

The area of RAM, from the system variables onwards, is the part that is of primary interest to machine code programmers. As your list of variables is added to, or subtracted from, then the area it occupies can fluctuate. This

is true of the area taken up by your BASIC program, as you add or delete lines. Areas in RAM can be reserved for machine code programs, and there is usually plenty of information around telling you how to do it for your particular computer.

# How ...

Once you have found out where to put your program, the next task is to get it there! There is really only one way it can get there, but there are several methods of doing it (that's a bit like saying 'there is only one road to Rome, but there are many means of transportation'). The program is POKEd into addresses, byte by byte. Starting with the first address, and the first byte, the addresses are incremented

after each POKE.

If you have never met POKE before it's how you get information into RAM. Consider this example of a direct command, POKE 32000,119 decimal: this means place the decimal number 119 into address 32000. If your computer allows you to use hex direct then the command could be POKE 32000,77 hex. The complementary command to POKE is PEEK, so, after entering the above example, the instruction PEEK 32000 would cause the number 119 decimal to be printed to the screen. Of course, you can only POKE information into RAM, but you can PEEK at either RAM or ROM.

Probably the most widely used method of entering machine code programs into home micros is via a hex loader. If your micro doesn't support hex direct then the hex code has to be entered as a string, sliced and then converted to decimal before POKEing into the addresses. Otherwise, the decimal conversion can be left out. Another method might use the READ/DATA statements if

your computer has them.

Assemblers and compilers can also be used to get your program into memory. Taking the assembler first, this is a program that could either be resident in ROM or loaded in via tape, etc. This will take your assembler language statements and convert them into machine code. Before the program can run, however, the statements are checked for validity, and an opportunity is given to edit the program. A compiler is a program, usually loaded into the computer, which converts a higher level language, such as BASIC, into machine language. If the last two methods have to be loaded in then they do use up memory, which is usually a precious commodity. So how the program gets into the computer is a combination of personal preference and what your computer will support.

# What . . .

The instruction set, mentioned last month, is where you will find all the instructions you will use in machine code programing. Ideally they will be in tabular form, giving both decimal and hexadecimal notation, and sometimes you might find the binary form given as well. Also they should include the assembler mnemonics, and the number of bytes per instruction. Those of you with Sinclair micros have everything that you need, apart from the byte count, in the handbook. Because the instruction set for the Z80 is very comprehensive | will be using that for the examples | give. Don't worry if your computer doesn't have a Z80 CPU, the same principles will apply.

# Don't Forget The Post Code!

Before very long 16-bit micros will be as common in the home as the eight-bit ones are now, but until then I will be dealing only with the eight-bit variety. Addressing modes are simply a way of getting round the fact that addresses require 16 bits, but our data word is only eight bits long. The first addressing mode I'll explain is the implied because it is the simplest, and only one byte long.

Sometimes known as the register direct, the **implied** mode is so named because the data source and destination are implied in the instruction. For example, to load the B register with the contents of the C register requires the instruction 41 hex in the Z80 set. Here the source is the C register and the destination the B register, this could be shown as C—>B. Incrementing and decrementing registers, and No OPeration and RETurn instructions use

the implied mode.

NOP, or no operation, is self explanatory, nothing happens (nothing, that is, except a fractional waste of time). This is a very useful instruction that could be used in a timing loop, or to occupy addresses that you intend to overwrite with data later on in the program. Or perhaps you haven't quite decided what to do in one patch of the program. An approximate number of NOPs will reserve the space for you until you have made up your mind. As for the RETurn, this is perhaps the most important instruction you will use. Without it, in some computers, you could be stuck in an infinite loop. In its simplest form, it can be regarded as an instruction to return to the place from whence you were sent — more will be explained later.

All simple register to register transfers use the implied mode, but as an exercise see how many of these instructions you can find in your set. The golden rule is that there

is only byte in the whole instruction.

# For Your Immediate Attention

The immediate mode is the next easiest addressing mode that you can use. As with the implied, the immediate mode does not involve any addresses, but there are now two bytes per instruction. The instruction 3E hex in the Z80 set means load register A with the number that follows; in the 6502 set the same instruction would be A9 hex. This might have the mnemonic Ld A,n, or M—>A, or even MVI A,D8; note well that the names are not CPU instructions; they are just humanised memory aids. That last mnemonic sums everthing up nicely because it means, move immediate(ly) into A a data byte of eight bits. Other instructions of this type include add n to a patricular register or subtract n from a particular register. Again as an exercise, pick out all the immediate mode instructions out

of your set.

Now that we have reached two byte instructions, I'd like to clear up a point that seems to confuse newcomers to machine code programming. The idea that the same byte can represent two different things might seem at first glance to be perplexing, but stop and think. Let me take as an example the instruction above, load A with n. This could be written in a Z80 program as 3E, 3E (or for the 6502,A9,A9). What happens is that when the computer gets to the first 3E it regards it as an instruction, an instruction to load the byte that follows (which also happens to be 3E) into register A. What the second number stands for is up to you, as the programmer, to decide. It may be just a number you want to manipulate, or it could be the code of a character you want to print to the screen. Whatever, the computer recognised the first 3E (or A9), as an instruction requiring two bytes. After carrying out that instruction the computer would carry on with the rest of the program from the instruction which came after the second bytre. Every instruction belongs to a class that requires one, two, or more bytes for proper execution. It is the programmers responsibility to ensure that the computer starts off in the right place!

# 

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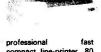
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ave you ever wished you could have extra light switches controlling the same light, yet baulked at the idea of ripping out your plastering to install those four-way mains cables that this necessitates? Figure 1a shows what would be involved in wiring up such a system in the conventional way.

Never fear, help is at hand, in the form of the ETI Multiswitch. The equivalent circuit diagram is shown in Fig. 1b. In fact this diagram doesn't show all the unit's advantages; here are a few more:

• all wiring is at earth (or +5 V relative to earth) so there's no need to use mains cable. You can use the thinnest cable you can get hold of, so it can be concealed fairly easily without the need to chase it into the wall:

• similarly, the switches do not have to be mains-rated, although you can leave your existing switches in place and use them;

you can have up to eight

switches all controlling the same light, and you can add or remove switches without having to alter any of the rest of system;

• finally, as the light can be switched on and off from lots of different positions, it's likely to be switched on and off quite a lot! Zero voltage switching can improve bulb life dramatically under these circumstances, and so the unit has been designed to allow the light to come on only when the line voltage is close to zero.

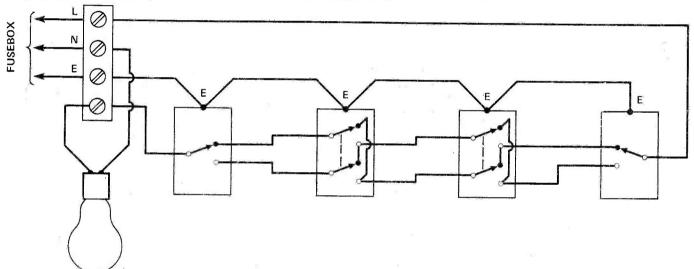


Fig. 1a Ah, in the good old days this was the circuit you'd have to use to switch a light from more than a couple of switches; it was a good circuit — it kept many a plasterer in gainful employment, not to mention the copper mills . . .

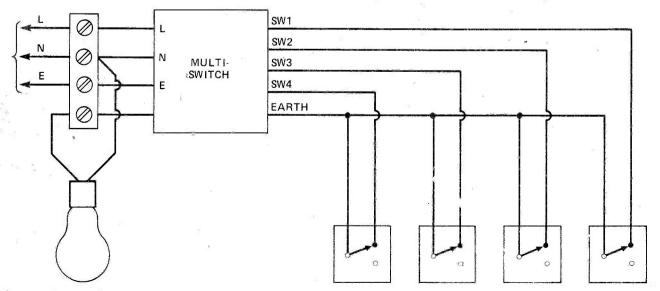


Fig 1b . . . then those young heathens from ETI came along and designed a thingummy that didn't require big thick wires to be buried in the wall — such is progress.

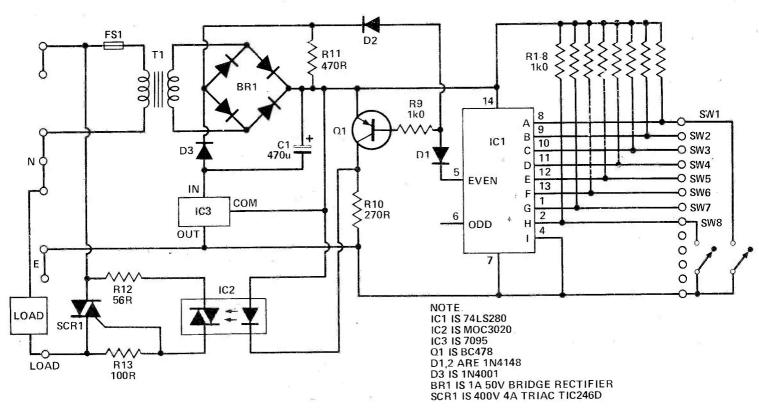


Fig. 2 Circuit diagram of the thingummy.

The idea for this unit germinated when it was noticed that the Karnaugh map required for such a unit was exactly the same as that for a parity checker, ie the output should change state when one and only one of several inputs changes state (ie, a switch goes from open to closed or vice-versa).

Unfortunately, there is no readily available CMOS parity checker (at least, not that we could find), and therefore the circuit had to be implemented using TTL. However, once it was decided that a PSU had to be designed, it was noticed that for very little extra in the way of components, the unit could also be made to perform zero voltage switching, as mentioned already.

# Construction

Not very much needs to be said about the construction of the PCB itself, though it should be pointed out that mains is present on about half of the board, and it should be accorded with suitable respect. You can finish it off by installing it in a suitable plastic or metal case note that if you use a metal case it must be earthed. Make holes at opposite ends for the mains cables and the switch wiring.

# Installation

The unit is intended to be installed well out of the way of tiny, IC1 is the parity checker. All inputs are pulled high by R1 to 8, unless any of the switches SW1 to 8 are closed. Fewer switches may be used, and unused in-puts left unconnected. We have left you the option of using either even or odd parity outputs, so that you can arrange for the lights to be either on or off with all the inputs high.

If the parity is odd, then the even output from IC1 will be low, the base of Q1 will be pulled low via D1 turning it on, and the LED in IC2 will be ex-tinguished, so that SCR1 will also be off.

The extra circuitry to detect zero voltage crossing consists of D2, D3 and R11. When no current is flowing from BR1, D3 frees the negative output of BR1 from remaining at the voltage at the negative end of C1. Thus the negative output voltage from BR1 will rise to the positive supply voltage, pulled up by R11. Q1 can only turn off when this voltage is close to the positive supply voltage (and when the even output of IC1 is high). When Q1 turns off, the load will be energised via IC2 and SCR1.

If you need to drive only a very small lamp, you could drive it directly using just IC2, and omitting SCR1. However, this risks blowing IC2 should the bulb blow (it's not uncommon for light bulbs to go momentarily S/C when blowing).

RESISTORS	(all	¹₩	5%	unless	stated)	
R1-8		7	SIL	resistor	pack,	8

	by 1k0	
R9	1k0	
R10	270R	
R11	470R, ½W	•
R12	56R	
R13	100R	

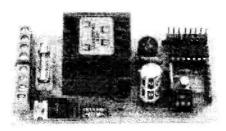
# CAPACITOR

470μ 16V PCB type

4LS280
OC3020 opto-
iac ,
905 regulator
- 5V)
C478 or similar
N4148 or similar
N4001 or similar
A 50V bridge
ectifier
00V 4A(min) triac,
IC246D or similar

# MISCELLANEOUS

Transformer (mains to 9V + 9V, 3VA total, PCB mounting, see Buylines); 20mm fuse (0A5 max) plus PCB mounting holder; PCB-mounting screw terminals, vertical (2 off); PCB; case; veropins for switch connections; switch to choice (see text).



# BUYLINES.

The transformer that the PCB is designed for is available from Rapid Electronics, and they sell it as their standard 3VA PCB mounting type. The PCB is, as ever, available through our PCB service.

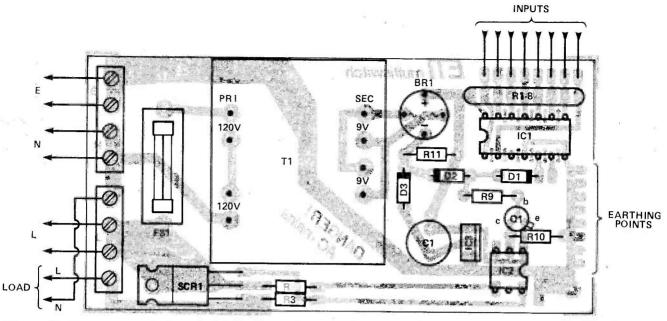


Fig. 3 Overlay diagram of the thingummy. Note that R11 gets a little warm and should be mounted standing slightly proud of the board.

inquisitive fingers, and it is **not** suitable to be treated as anything but a piece of electrical wiring hardware. The screw terminals are **not** intended to support either the weight of the unit, or of a light fitting, etc. If you do use the unit

with flex, rather than fixed cable wiring, then you must anchor the cable in some way, by using suitable cable glands for instance.

Fig. 1b shows the wiring diagram if you're using the unit in a new system; alternatively, you can

wire up an existing two-position circuit (provided it's in good condition) as just one switch, by earthing one end and connecting the other as an input to the Multiswitch.

ETI

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- VERSATILE. Delivers more than 1KW into 1/2 to 8 ohms.

OR 2 x 600W into 2 to  $8.\Omega$ 

OR 4 x 300W into 2 to 4  $\Omega$  (200W into  $8\Omega$ )

1 x 600W into 2 to  $8\Omega$ 1 x 300W into 2 to 4  $\Omega$ 

1 x 150W into 4 to  $8\Omega$ 

Etc. Etc.

Having been closely involved in a wide variety of OEM applications of their amp boards, Pantechnic became aware of numerous implementation problems often left untackled by other amp board manufacturers. These problems specifically of size and thermal efficiency became particularly aggravated at high powers and considerably lengthened OEM product development time.

By including thermal design in the totality of board design it has been possible to reduce the size of the electronics, and increase the efficiency of the transistor to heatskink thermal circuit. The combined effect of this has been to dramatically increase the volumetric efficiency of the amplifier/heatsink assembly. The SYSTEM Amp offers 1.2KW of power in a space of 180mm x 102mm x 77mm, excluding PSU and Fan.

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*PFA100	21.96	50-150W	4 ,85	Physically small (32 x 78 x 108mm)
*PFA200	29.52	100-300W	4 Ω, 8.Ω	High watts/£ ratio
PFA/HV	36.04	200-300W	4 ,8.2,16.2	5dB dynamic headroom Drives 70V line direct.
*PFA500	45.22	250-600W	2.0,40,80	25A cont. output current.
	55.33	mounted on tu	ne 74 Heat Eychai	nger (see helow)

\*The power output of these amplifiers can be increased by approx 15% with no diminution in quality by adding PSU102 (£7.61) to your existing power supply.

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Type 74 Heat Exchanger. Dissipates 300W (1.2KW blown) £7.50. 25A 400PIV Bridge Rect. £2.17

100,000uF 100v cptn. grade with clip £9.75

PAN20 Pre-amplifier module. Very low noise and distortion £8.48 PAX2/24 2 Way active crossover (specify frequency) £10.10 PAX3/24 3 Way active crossover (-do-) £19.50

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Adjustable range from 5-25ft

This popular low cost ultrasonic detector is already used in a widerange of applications from intruder detectors to automatic light switches and door opening equipment, featuring 2 LED indicators for ease of setting up, the unit represents outstanding value at

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## INFRA-RED SYSTEM IR 1470



Consisting of separate transmitter and receiver Consisting of separate transmitter and receiver both of which are housed in attractive 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, the System is available at

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# POWER SUPPLY & RELAY UNIT PS 4012

Provides stabilised 12V output at 85mA and contains a relay with 3 emp contacts. The unit is designed to operate with upto 2 utrasonicunits or 1 infra-red unit IR 1470. Price £4.25 + V.A.T.

# SIREN MODULE SL 157

Produces a loud penetrating sliding tone which, when coupled to a suitable horn speaker, produces S.P.L.'s of 110dbs at 2 metres. Operating from 9-15V, the module contains an inhibit facility for use in 'break to activate' circuits. Price £2.95 + V.A.T.

# 5%" HORN SPEAKER HS 588

This weather proof horn speaker provides extremely high sound pressure levels (110dbs at 2 metres) when used with the CA 1250, PS 1865 or SL 157. Price £4.95 + V.A.T.

# 3-POS. KEY SWITCH 3901

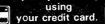
Single pole, 3-pos. key switch intended for use with the CA 1250. Price £3.43 + V.A.T.

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- loads

  Test loop facility

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Acompletesiren 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 astabilised 12 Voutput up to 100mA. A switching relay is also included so that the unit may be used in conjunction with the US 5063 or US 4012 to form a complete

Price £9.95 + V.A.T.

# 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 by 180 by 70mm

HARDWARE KIT

HW 5063

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Man This hardware kit provides the necessary this hardware kit provides the licessary enclosure for a complete self-contained alarm system which comprises the US 5063, PS 1865, loud speaker type 305 and key switch 3200. Attractively styled, the unit when completed, provides an effective warning system without installation problems.

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DBC20 3 Fili I	Jin Flug		0.60	RO32513U	D1 6.50	22 17 24 21	38 65 46 70
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2716 450NS 2716 350NS	D1 2.45 D1 4.95	8216 8224	1.00 2.10	NE555P NE556CP	0.1 <b>6</b> 0.45	D4 2.00	D8 5.00
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2732 450NS	D1 3.45	8251A 8253	4.00	TL062 TI064	0.49 0.98	A full range following pro	oducts is
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4118 150NS 5516 200NS	D1 325 D2 9.45	6502 6502A	Ď3 3.25 D <b>3</b> 5.00	TL074 TL081	1.00 0.26	★ 74LS Seri	es TTC
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4164 200NS NEC	D3 3.95			TL487 TL489	0.62 0.62	D-Type C  * Dip Jump	onnectors
4516/4816		FloppyI		TL494	1.63	★ Monochre	ome &
100NS 4532 200NS	D2 2.25 D2 2.95	Controll 8271	ers 48.00	TL496 TL507	0.60 1.33	Colour M (NEC & K	AGA)
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6800 6802	D7 2.25 D5 2.50	FD1783	D6 23,00	747 748	0.48	★ Custom C Assembli	
6809	D6 6.30	FD1795 FD1797	D6 28.00 D6 28.00	740	0.57	113HEIIIDH	cs .
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6840 6845	D4 3.75 D5 6.50						يسب
6850 68488	D2 1.10 D2 7.30	Buffers 8IL595	0.80	Carriage C	rders up to £1	99 are sent by or.	l st class
68B00	D7 5.25	8IL596	0.80	0-£100 0.50 £	100-£199 1.25:	E200+5.00 by	Securicor
68B09 68B10	D6 12.00 D1 2.26	8IA597 8IL598	0. <b>80</b> 0.80	of VAT and a	re subject to c	charges) are e hange without	notice.
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280 ACPU 280 BCPU	D2 2.99 D <b>2 9.00</b>			to status. Pay	unts are avai ment is due st	lable to <b>oth</b> ers actly nett by th	e 15th of
Z80 ACTC Z80 BCTC	D1 2.60 D1 9.00	Whav	neft.	the month.		d (Access and	
Z80 ADART Z80 ADMA	D1 5.60 D2 6.95	description.	Col Division			and NO SUR	
Z80 AP10	D1 2.75		0	Out of stock	items will foll	ow automatic	illy, at our
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Manufacturer's surplus -- brand new and operational - sold without warranty

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The power amp kit is a module for high The power amp kit is a module for high power applications - disco units, guitar amplif-iers, public address systems and even high power domestic systems. The unit is protected against short circuiting of the load and is safe in an open circuit condition. A large safety margin exists by use of generously rated com-ponents, result, a high powered rugged unit. The PC board is back printed, etched and ready to drill for ease of construction and the aluminium chassis is preformed and ready to use. Supplied with all parts, circuit diagrams and instructions.

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SPECIFICATIONS.

Max. output power (RMS): 125 W. Operating voltage (DC): 50 - 80 max. Loads: 4-16 ohm. Frequency response measured @ 100 watts: 25Hz - 20KHz. Sensitivity for 100w: 400mV @ 47K. Typical T.H.D. @ 50 watts, 4 ohms: 0.1%, Dimensions: 205x90 and 190x36mm.

**KIT £10.50** 

BUILT £14.25

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HIGH QUALITY 40 WATTS RMS BASS/MIDRANGE Ideal for either Hi-Fi or Disco use this speaker

features an aluminium voice coil a heavy 70mm diameter f5.95 magnet. Frequency res: 20Hz to 7KHz. Impedance: 8 ohms. +£2.20 P&P

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# MULTIPLE **OUTPUT PORT**

Is your computer a megalomaniac at heart? Here's a circuit that will allow it to have up to 40 slaves, by Stephen Huckstepp.

his project is intended for use with virtually any computer, the only prerequisite being access to the data and address buses and to the control signals IORQ and WR or

their equivalents.

There can be up to 40 on/off outputs from the port, all of which can be used to drive external circuitry. The port is expanded in groups of eight, with eight being the minimum (well, you could have a port with no outputs if you really wanted . . .). As the board makes provision for the maximum number of outputs, subsequent expansion up to the maximum is no problem.

However, the main draw-back is that this circuit will be fairly slow and software-intensive to operate. This is because each write operation outputs to only one bit in any group of eight outputs, but to each group simultaneously. So, for instance, while writing to bit 3 in group 2 you will be writing to bit 3 in all the other groups (though not the same information). Most of the software you will need will involve setting up

the data in the correct format to go to the port.

Provision has not been made to drive equipment that requires a handshake control. However, an alternative use for a spare output data line from the computer might be as a 'data valid' signal, rather than as a clear as suggested in the 'How It Works' section.

# Construction

There is very little to say about the construction of this project except to recommend that the usual CMOS precautions should be followed. Although all the devices used are relatively inexpensive, it is probably still a good idea to use IC sockets, as failed device could be a !!!! to remove.

When connecting up to the computer, note that the lines for D5 and D7 have been transposed on the PCB. Check your computers memory map to set up a suitable address for the port, and use the links to make the port occupy this address.

Overlay diagram of the multiple output port; note that the pin-out for SK1 is given on the circuit diagram.

# BUYLINES.

Nothing in this project should cause any difficulties. The SIL connectors are available from Maplin and others, the ICs are widely available, and the PCB is available through our very own PCB service.

# PARTS LIST.

RESISTORS R1-7

SIL resistor pack, 7 by 10k

R8-15

SIL resistor pack, 8

by 10k

R16

10k ¼W 5%

CAPACITOR

100μ 6V (min) tubular electrolytic

# **SEMICONDUCTORS**

4069 IC1 IC2 4072 IC3-7 4099

# **MISCELLANEOUS**

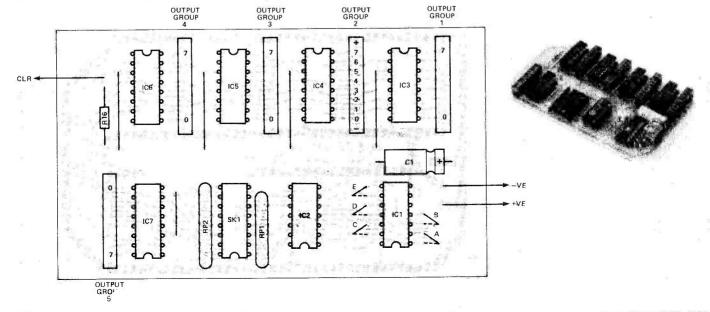
SK1

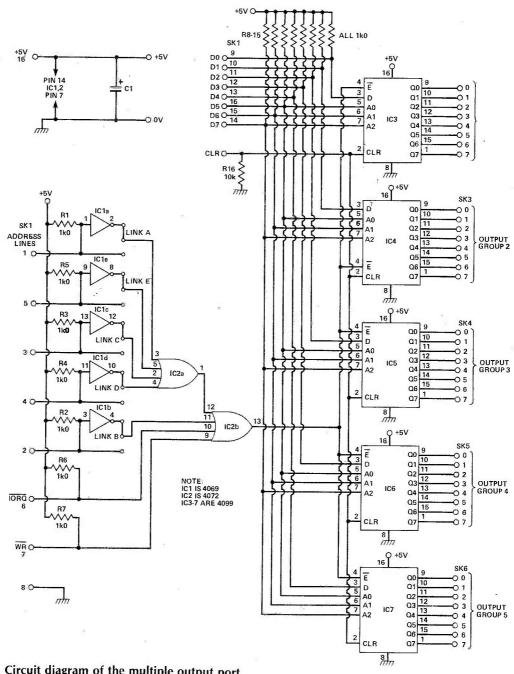
16-pin DIL socket and header plug

SK2-5

10-way SIL connectors, 0.1" pitch

PCB; case to choice; wire, etc.





Circuit diagram of the multiple output port.

# **HOW IT WORKS**

This circuit is based on the 4099 eight-bit latch, used for IC3 to 7, which is one of the cheaper low-power latches that are readily available. The circuit shown is relatively slow to operate, but is very cheap to build!

Five address lines are used to select the port; the inverters, IC1a to e can be selected in or out using the links, so as to set up an address that is convenient.

IC2 decodes both the address and the port request lines, IORQ and WR. The output from IC2b enables all the chip select lines on all the latches. Thus

when a write operation occurs, the same bit on all the latches is written to at

Of the data bits, D5 to D7 are used to address the bit to be written to. The remaining data bits are the data that is to be written, D0 being the data for the selected bit in the first latch (IC3), D1 for the second latch (IC4), etc.

Because of the mode of addressing selected, if you want to leave a particular bit in one latch unchanged, while altering the same bit in the other latches, you must re-write the same data as

before.

There is no need to install all the latch ICs if you do not need them, the system will still work with just one latch in position (though you'll only get eight outputs, of course). If you don't use the full capability, you may find it useful to connect the clear (CLR) input to one of the unused data bits.

Note that the data inputs D5 to D7 feed inputs on all five latches; this may make it necessary to buffer these lines at the computer, depending on what other peripherals are connected to the data bus.

					PARK IN IN												
RESISTORS CARBON FILM	630VPC 250VAC IDEAL AS MAINS	1d0/3V 32p MANY MDRE	2.5 × 17 2.99 3.75 × 17 3.85 4.79 × 17 4.93	D CONNECTORS Solder Type Male	R4 11×6×3" 3.85 R5 11×7 %×3%"	1%" Slow Fast 100mA 19p 15p	Chargers TYPE H:	2N2907 2N2907A 2N2920	25p 26p 8.50	2N44D0 2N44D1 2N44D2	27p	3N200 3N201	2.98	BC174A BC174B BC175	24p 24p	BC548A 13p BC548B 14p BC548C 15p	
5% HI STAB 10Ω TO 10M	SUPPRESSORS 10nF 28p 15nF, 22nF 35p	CAPACITORS IN STOCK: PLS PHONE	VQ Board 1.92 Dip Board 3.90 Track Cutter 1.48	9 way 80p 15 way 1.03 25 way 1.60	4.75 R6 13×8×4 % 7.35 R7 15×8×4"	250mA 17p 10p 315mA	Adjusted to 6 of any HP type Above £15.59 TYPE M:	2N2923 2N2924 2N2925	25p 15p 15p	2N4403 2N4409 2N4410	30p 36p 42p	3N211 3SK88 40360 40361	89p 60p	BC 177 BC 177A BC 177A BC 177B	75p 16p 25p 26p	BC548C 15p BC549 13p BC549B 14p BC549C 15p	
%WE24 2p %WE24 2%p 1WE24 6p 2WE24 12p	47nF 39p 100nF 43p 150nF 49p 220nF 55p	TRANS- FORMERS	Pin Insertor 1.79 100Pins 55p Verobloc 3.99	37 way 2.50 Female 9 way 99p 15 way 1.75	7.75	17p — 500mA 17p 10p 600mA	As above but faster charge for 4AH £25.95 TYPE P.	2N2926 2N3010 2N3011 2N3019	10p 75p 65p 50p	2N4416 2N4427 2N4440 2N4B70	79p 12.58	40362 40363 40364	2.95	BC178 BC178A BC178B BC179	16p 24p 25p 20p	8C550 15p 8C550C 25p 8C5568 15p 8C557 15p	
METAL FILM E 24 ULTRA HI	1000VDC PLASTIC	6-0-6V, 9-0-9V, 12-0-12V, 15-0-15 95p	Vero Wiring Pen+Spool 3.35 Spare Spool 75p	25 way 2.05 37 way 3.30 Angled PCB	Black Plastic V1 3×2×1" 55p V2 120×80× 35mm 90p	17p 10p 800mA 17p 10p	PP3 £5.50 TYPE A: HP7 (Up to 4 at a	2N3053 2N3054 2N3055	27p 56p. 60p	2N4B71 2N4B8B 2N4B9B	55p 99p 1.29	40372 40373 40374 40406	2.60 2.84 1.39	BC179A BC179B BC179C	25p 25p 27p	BC557A 16p BC557B 16p BC55B 14p	
STAB ULTRA LOW NOISE 0.4W 10Ω TO 1M	1nF, 2n2 26p 4n7, 6n8 29p 10nF 31p 22nF, 33nF 37p	6VA 0-6 + 0-6V 2.65 0-12 + 0-12V	Combs 6p	25w Male 2.45 25w Female 2.90 Covers 99p	V3 180×110×55 1.60	1A 17p 10p 1.5A 17p 10p 2A 17p 10p 3A 17p 10p	HEATSINKS	2N3055RC 2N3055H 2N3107 2N3109	1.20 46p 48p	2N4901 2N4902 2N4903 2N4904	1.85	40407 40408 40409 40410	1.59 1.50	BC182 BC182A BC182B BC182L	12p 13p	BC558A 15p BC558B 16p BC559 15p BC559B 16p	
2% E24 5p 1% E24 6p	47nF 41p 100nF 45p 220nF 79p	0-15 + 0-15V 2.65	DIL SPST 4 way 67p	EURO CONNECTORS Male	VEROCASES V5 220 × 174 × 100mm 10.40	4A - 10p 5A - 10p 6A - 10p	CLIP ON TO1 (AC128) 18p	2N3232 2N3250 2N3251	1.50 36p 36p	2N4905 2N4906 2N4907	2.75 2.99 3.20	40411 40412 40422	2.85 90p 2.95	BC 182LA BC 182LB BC 183	13p 14p 10p	BC559C 17p BC560 32p BC560 25p	į
LOW OHMIC GLAZE E12 0.22Ω to 8.2Ω11p	HI VOLT CERMIC	0-20 + 0-20V 2.65	6 way 82p 8 way 90p 10 way 1.40	31 way 1.75 64w. A + B Straight 2.25	V6 171 x 121 x 75mm 6.65 REMOTE	10A — 10p 15A — 10p 20A — 10p	TO5 (BFY51) 18p TO18 (BC 109) 18p TO220 (TIP29)	2N3439 2N3440 2N3441 2N3442	98p 80p 1.25	2N4908 2N4909 2N4910 2N4913	1.95	40467A 40513 40537 40594	1.75 96p	BC 183A BC 183B BC 183C BC 183L	1.2p	BC560C 26p BC650 45p BC651 46p BCY70 16p	
WIRE-WOUND E12 2 to 3W 0.22Ω	100pF 1KV 25p 100pF 2KV 30p 100pF 3KV 33p 100pF 4KV 37p	6 + 6 + 9 + 9V (total 30V 1A) 4.30	TOGGLE (MINI) SPST 49p SPDT 59p	64w A + B Angled 2.95 64w A + B Straight 2.40	CONTROL (Handheld) BOX 94x61x22.5mm White 89p	1"PLUG FUSES In Packs of 4	36p UHF MOD	2N3444 2N3445 2N3446	1.70 4.80 6.09	2N4914 2N4915 2N4918	2.69 2.95 48p	40595 40600 40601	99p 2.58 2.36	BC 183LA BC 183LB BC 183LC	13p 13p 14p	BCY71 16p BCY72 19p BCY77 34p	1
to 330Ω 28p 4 to 7W 0.47Ω- to 6KB 33p 10 to 11W 1Ω	220pF 6KV 45p 470pF 2KV 39p 470pF 6KV 48p	50VA 0-12 + 0-12V 4.35	DPDT 69p DPDT C OFF 79p 4PDT 2.75 All types of	64w.A + C Angled 2.95 Female 31 way 1.75	KNOBS	2 amp 59p 3 amp 59p 5 amp 59p 7 amp 59p	Astec BMHz Wideband 4.50	2N3447 2N3448 2N3512 2N3553	5.7.2 6.56 1.06 2.65	2N4917 2N4918 2N4919 2N4920	65p	40602 40603 40604 40608	1.09	BC 184 BC 184B BC 184C BC 184L	12p 13p	BCY7B 22p BCY79 22p BCY87 6 60 BCY88 4.90	Ī
POTS & PRESETS	1nF 2KV 39p 1nF 6KV 44p 2nZ 2KV 44p 2nZ 5KV 49p	100VA 0-12 + 0-12V 8.95	biased toggles in stock Please phone	64 w. A + B . Straight 2.25	SIFAM PROFESSIONAL COLLET KNOBS	13 amp 59p PANEL FUSEHOLDERS	BOOKS (NO VAT)	2N3563 2N3564 2N3565 2N3566	20p 25p 20p 50p	2N4921 2N4922 2N4923 2N4924	69p 99p	40631 40635 40637	2.12 1.35 2.00	BC184LB BC184LC BC186 BC187	14p 24p	BCY89 4_10 BD115 58p BD116 2.50 BD121 95p	
LOW NOISE E3 ROTARY POTS WITH '4"	3n3 2KV 47p 3n3 4KV 52p 4n7 4KV 57p	TOROIDALS Up to 500VA in	PUSH BUTTON Non-Latching Push to Make	Angled 2.95 64w. A + C Straight 2.95 64w. A + C	All fit 14 "spindles Black (suffix B) Grey (suffic G)	20mm 36p 1¼" 36p	Prices inc. post in UK. Cheaper to callers	2N3567 2N3568 2N3569	55p 50p 50p	2N4926 2N4927 2N4928	95p 95p 1.59	40643 40673 40822 40871	70p 1.80 79p	BC 204 BC 205 BC 205	29p 29p 29p	BD124 (Mullard) 2.28 BD131 44p	
SPINDLES 4K7 TO 2M LIN 32p LOG 32p	10nF 2KV 57p FEEDTHRO CAP 1nF 500V 7p	Please Phone	Push to Break 25p	Angled 3.35	15mm Short \$1508 plain 56p \$1506 plain 56p \$1518 + line 64p	QUARTZ CRYSTALS	Tower Transistor Manual (Bible) 10.50 Elektor 301	2N3570 2N3571 2N3572 2N3584	6.95 5.73 4.95 2.76	2N4964 2N4965 2N4966 2N4967	25p 25p	40872 AC125 AC126 AC127	49p 32p	BC 207 BC 20B BC 209 BC 212	29p 29p	BD132 44p BD135 35p BD136 35p BD137 37p	1
As above with OP Mains Switch 79p As above stereo	TRIMMERS MINI FILM(MULLARD) UP TO 100VDC	adequate P&P as transformers are heavy!	KEY-SWITCH Mains 4 amps	CONNECTORS PCB Male + Latch Straight 10 way 89p	S151G + line 64p 15mm Standard K150B plain 57p	Please enquire about types not listed	Circuits 6.50 Texas TTL Data 10.50 Texas Opto: 5.18	2N3585 2N3632 2N3638 2N3638A	2.99 9.88 55p 70p	2N4968 2N4969 2N5010 2N5011	25p 31p 12.75	AC128 AC132 AC151	35p 68p 51p	BC 212A BC 212B BC 212L	12p 13p 10p	BD13B 37p BD139 38p BD140 38p BD142 2.40	
DUSTPROOF	1p4 to 5pF (800MHz) 23p 2pF to 10pF	WIRE & CABLE PRICES PER METRE	DPST withdraw Key in both postions (inc. 2 keys) 3.80	16 way 1.29 20 way 1.45 26 way 1.75 34 way 1.99	K150G plain 57p K151B+line 66p K151G+line 66p	32.766K Hz 95p 100K Hz 2.35 200K Hz 2.65 1.00M Hz 2.74	Texas Mos Memory: 4.95 Texas Linear:	2N3639 2N3641 2N3642	65p 69p 50p	2N5030 2N5033 2N5036	44p 48p 1.60	AC152 AC153 AC153K AC176	55p 64p 27p	BC212LA BC212L8 BC213 BC213A		BO153 1.25 BO155 1.20 BD157 54p	1
PRESETS E3 100Ω TO 10M Mini Vert. 15p Mini Horiz. 15p	(600MHz) 27p 2pF to 22pF (400MHz) 29p 5p5 to 65pF	Salid Hook-up. Any Calour 5p	FOOTSWITCH with metal	40 way 2.25 50 way 2.45 PCB Male + Latch	15mm Winged W1508 74p W150G 74p	2.00MHz 2.24 2.097152MHz 3.49	4 95 National Interface: 2.95 National Special	2N3643 2N3644 2N3645 2N3646	30p 56p 66p 28c	2N5039 2N5086 2N5087 2N5088	1.90 36p 39p	AC176K AC187 AC187K AC188	25p 28p	8C213B BC213C BC213L BC213LB	13p 10p	BD158 55p BD160 3.80 BD181 1.75 BD182 2.50	1
Standard Vert. 18p Standard Horiz. 18p	(200MHzi 36p ELECTROLYTICS Axial by Siemens	MAINS/ SPEAKER Twin 1 Amp 14p Twin 2 1/4 Amp	SPDT 1.85 DPDT 2.75	Angled 10 way 95p 16 way 1.47 20 way 1.60	21mm Short S210B plain 69p S210G plain 69p	3.2768MHz 1.49 4.00MHz 1.49 4.194394MHz 1.99	Function 2.95 National Data Conversion 2.95 Toshiba CMOS	2N3662 2N3663 2N3702 2N3703	15p 16p. 10p	2N5089 2N5172 2N5175 2N5179	37p 15p 58p	AC1BBK ACY17 ACY20	40p 1.50 76p	BC213LC BC214 BC214B	14p 10p 12p	BD183 2.70 BD187 1.09 BD201 1.30	ł
Thumbwheel or ¼ "Spindle for Standard Types	or Matsushita (Nat. Panasonic) uFd V	3 Core 2 % Amp 18p 3 Core 6 Amp	ROTARY Main DP 4 amps with 1/4 "spindle 55n	26 way 1.99 34 way 2.40 40 way 2.55 50 way 2.75	S211B+line 75p S211G+line 75p 21mm Standard	4.433819MHz 99p 5.00MH2 1.50 6.00MHz 1.39	7.95 Hitachi Micro- pracessor 9.00	2N3704 2N2705 2N3706	10p 10p 10p	2N5180 2N5183 2N5184	43p 1.00	ACY21 ACY22 ACY2B ACY44	75p 75p	BC214C BC214L BC214LB BC214LC	10p 13p	BD202 1.39 BD204 1.44 BD220 1.00 BD221 95p	1
only 8p %" CERMET 20 TURN PRESETS	.47 63 8p .47 100 9p .47 350 30p 1 63 8p	31p 3 Core 13 Amp 56p	Lorlin Adjustable Stop Type 1p 1 to 12 way 55p	Female Header 10 way 84p 16 way 1.07	K210B plain 69p K210G plain 69p K211B+line 78p	6.9375MHz 3.50 B.00MHz 1.49 10.00MHz 1.75	Hitachi Memory 7.50 Hitachi Powerfet 8.00	2N3707 2N3708 2N3709 2N3710	10p 10p 10p 10p	2N5188 2N5189 2N5190 2N5191	1.00 1.00 68p	AD136 AD149 AD150 AD161	6.75 79p 2.80	BC 237A BC 237A BC 237B BC 237C	14p 16p 17p 18p	BD223 1.00 BD224 95p BD232 1.11 BD233 70p	
50Ω, 100Ω, 200Ω, 500Ω, 1K, 2K, 5K, 10K, 20K, 50K, 100K,	1 100 9p 1 500 40p 2.2 25 8p 2.2 63 9p	SCREENED Single 14p Stereo 27p	2p 2 to 6 way 55p 3p 3 to 4 way	20 way 1.25 26 way 1.49 34 way 1.75 40 way 1.95	21mm Winged W2108 86p	18.00MHz 1.79 20.00MHz 1.99 27.648MHz 1.69 48.00MHz 1.69	TEXAS "UNDER- STANDING"	2N3711 2N3712 2N3713	10p 2.00 1.38 2.98	2N5193 2N5194 2N5195	90p 79p 99p	AD162 AF106 AF109	39p 75p 75p	BC238A BC238B	14p 15p 16p	8D 234 72p BD 237 98p BD 238 98p	
200K, 500K each 89p	2.2 100 11p 2.2 350 30p 3.3 25 10p	Mini Single 12p Mini Stereo 15p 4 Core 4 Screens 44p	4p 4 to 3 way 55p 55p	50 way 1.99 DIN PLUGS	W210G 86p 29mm Standard K290B 88p	100.00MHz 2.95 5.5 MHz Ceramic filter 50p	Solid State 4.95 Digital 4.95 Car Electronics	2N3714 2N3715 2N3716 2N3724	3.31 3.60 75p	2N5195 2N5196 2N5209 2N5210	24p	AF114 AF117 AF118 AF124		BC 238C BC 239 BC 239A BC 239B	17p 15p 16p 17p	BD239A 57p BD239C 64p BD24DA 59p BD24OC 73p	
THERMISTORS & VDRs PLEASE PHONE	3.3 40 11p 3.3 63 12p 4.7 16 8p 4.7 25 9p	4 Core, Single Screen 54p 8 Core 61p.	Many other switches in stock Please Phone	2 pin 9p 3 pin 11p 5 pin 180° 12p 5 pin 240° 16p	K290G 88p CAPS: Blk, Red. Yel, Grn, Grey,	TOOLS. Top quality	4.95 Security Elec- tronics 4.95 Optronics 4.95	2N3725 2N3730 2N3732 2N3734	85p 4.65 2.88 1.30	2N5220 2N5221 2N5222 2N5223	15p 25p 28p 15p	AF125 AF126 AF139 AF170	72p 72p 40p 88p	BC239C BC25D BC250A BC250B	18p 22p 23p 24p	BD241C 67p BD241C 67p BD242A 65p BD242C 70p	
CAPS CERAMIC DISC/PLATE	4.7 40 11p 4.7 63 12p 4.7 100 14p 10 25 8p	12 Core 80p Heavy Duty Mike/Guitar Lead 25p	CONN-	5 pin Domino 50p 6 pin 18p	Blue. (Piease state colour)	Hand Tools Lindstrom L670. Side Cutters	Communications 4.95 Computer Science 4.95	2N3735 2N373B 2N3740 2N3741	2.46 2.00 2.38 2.76	2N5224 2N5226 2N5227	38p 25p 25p	AF172 AF178 AF200	88p 88p 66p	BC250C BC251 BC251A	25p 25p 26p	BD 243A 72p BD 143C B5p BD 244A B2p	
MICRO - MINI 100V TYPICALLY 5% E12	10 40 12p 10 63 14p 10 100 16p	AERIAL 50Ω RG58A 25p 75Ω UHF 29p	PLUGS & SOCKETS	7 pin 30p DIN CHASSIS SOCKETS	15mm plain 5p 15mm+dot 8p 15mm+line 8p 21mm plain 5p	4.3" 14.55 L890. Snipe Nose Pliers 5.2"	Microprocessors 4.95	2N3766 2N3767 2N3771	2.90 3.19 1.75	2N5245 2N5246 2N5247 2N5248	40p 45p 46p	AF2D1 AF239 AF240 AE279B	55p 1.00	BC 251B BC 251C BC 252 BC 252B	28p 22p 23p	BC244C 1.00 BD245A 1.14 BD245C 1.30 BD246A 1.20	
SIEMENS 63V MONOLYTHIC	10 350 55p 22 25 11p 22 40 14p 22 63 16p	75Ω.VHF 28p 300Ω.Flat 14p RAINBOW	DIL SOCKETS Lo- Pins prof W.Wp.	2 pin 9p 3 pin 10p 5 pin 180° 10p	21mm+dot 8p 21mm+line 8p 29mm (Red, Blk, Grey only) 8p	10.35 L870. Snips Nose Pliers 4.7" 10.35	Antex Irons	2N3772 2N3773 2N3773 Motorgla	1.83 1.99 2.67	2N5249 2N5266 2N5293 2N5294	48p 2.88 98p 1.28	AF279G AL102 AU106 AU110	4.57	BC 252C BC 253 BC 253B BC 253C	24p 22p 23p 24p	BD246C 1.50 BC249A 2.00 BD249C 2.31 BD250A 2.11	
MINI CERAMIC 10nF, 22nF 10p 33nF, 47nF 10p 68nF 14p	22 100 21p 47 25 14p 47 40 17p 47 63 26p	RIBBON Prices per foot 8 way 25p	8 8p 25p 14 9p 35p 16 10p 40p 18 16p 50p	5 pin 240° 16p 6 pin 20p 7 pin 25p	Nut Covers 15mm Colours as	L160. Long Nose Pliers 14.95 CK TOOLS	XS240 (25W) 5.25 Iron Stand 1.75	2N3773 R0 2N3773 Thomson,	2.75 2.75	2N5295 2N5296 2N5298 2N5298 2N5302	1.37	AU113 BC1D7 BC107A BC107B	3.67 10p 12p	BC 256A BC 256A BC 256B BC 257	25p 26p 27p 26p	BD250C 2.46 BD433 79p BD434 55p BD435 81p	
100nF 14p BARRIER LAYER CERAMIC DISC	47 100 28p 100 16 14p 10D 25 16p 100 40 22p	10 way 25p 16 way 39p 20 way 48p 24 way 62p	20 20p - 22 22p - 24 24p 70p	DIN LINE SOCKETS 2 pin 10p	above 8p POINTERS	C80 4 ¼ " Side Cutter 10.02 C73 4 ½ " Side Cuttter 9 28	Elements (State Iron) 2.05 C240 Bits No. 2 (Small) 85p	2N3779 2N3789 2N3790	1.70 3.27 2.73 2.47	2N5303 2N5305 2N5306	3.80 25p 37p	BC108A BC108B	10p 12p 12p	8C257A 8C258 8C258A	27p 24p 25p	BD436 B1p BD437 88p BD438 88p	
220nF, 25V 15p	100 63 25p 100 100 30p 220 10 16p	30 way 75p 32 way 82p 40 way 88p	28 28p 79p 40 30p 99g ZERO INSERTION	3 pin use 5p 180° 5 pin 15p	15mm or 21mm Colours as above 8p	C72 4 % " Pliers (Snipe) 7.52	No. 3 (Med.) 85p No. 6 (Micro) 85p XS240/X25 Bits No. 50 (Small):	2N3791 2N3792 2N3794 2N3819	2.68 25p 35p	2N5307 2N5308 2N5354 2N5355	25p	BC 10BC BC 109 BC 109B BC 109C	10p 12p	BC258B BC259 BC259B BC259C	25p 26p	BD439 90p BD440 91p BD441 91p BD442 93p	
160V 5% OR BETTER 10pF, 15pF, 22pF, 27pF,	220 16 17p 220 25 22p 22D 40 25p 220 63 30p	PCB MAT	FORCE DIL SOCKETS 24 pin 4.25 40 pin 5.25	PHONOPLUGS Matal 20p Plastic: Red,	DIALS 15mm Red + Point 26p Blk + Point 6p	DE-SÖLDERING PUMP BT 100. High Suction	No. 51 (Med.) 85p No. 52 (Lgs.) 85p	2N3820 2N3821 2N3822 2N3823	38p 1.84 90p 45p	2N5358 2N5366 2N5367 2N5401	73p 25p 28p 35p	BC113 BC114 BC115 BC116	30p 19p 22p	BC 250 BC 260B BC 260C BC 261	30p 32p 33p 33p	BD529 1.20 BD530 1.30 BD535 75p BD536 75p	3
33pF, 39pF, 47pF, 68pF, 100pF, 15DpF, 180pF, 220pF,	220 100 40p 470 16 22p 470 25 28p 470 40 33p	GRADE ONE GLASS PCB SINGLE-SIDED	UHF PL269 TYPES Low loss,	Yéllow, Green, Black 15p	Grey+Point 26p Clear 1 to 10 26p Clear Taper 26p	Anodised 4.55 Spare Teflon Nose 85p	SOLDER 125gms 18swg 2.95 22swg 3.10	2N3B24 2N3B26 2N3B27 2N3B54	1.70 78p 78p 44p	2N5415 2N5416 2N5447 2N5448	1.10 1.54 16p 19p	8C116A 8C117 8C118	37p 19p 19p	BC261A BC261B 9C261C	34p 35p 36p	BD537 80p 8D538 80p BD539 80p BD539C 1.10	
270pF, 330pF, 390pF 10p 470pF, 680pF.	470 63 43p 470 100 60p 1000 16 30p	178 × 240mm 150p 420 × 195mm 1.95	superior quality 50Ω Line plus 45p	SOCKETS Single 16p Dual 20p	DIALS 21mm Red + Point 28p Blk + Point 28p	TEST METERS	TRANS- SISTORS	2N3855 2N3855A 2N3856	30p 40p 45p	2N5449 2N5450 2N5451	21p 23p 25p	BC 119 BC 121 BC 123 BC 125	38p 82p 82p 37p	BC262A BC262A BC262B BC262C	31p 32p 33p 34p	BD 540 85p BD 540C 1.20 BO 675 72p	
1nF, 1,5nF 12p 2,2nF, 3.3nF 13p 4,7nF 14p 10nF 15p	1000 40 46p 1000 63 65p 2000 16 40p	420 × 245mm 2.95 FERRIC	Reducer 15p Raund skt. 40p Sarskt. 40p	BATTERY CONNECTORS	Grey+Point 28p Clear 1 to 10 28p Clear Taper 28p	BTC601 LCD Push Button 2 amps AC/DC 1KV DC	UK's Greatest Retall Variety. Please phone	2N3858A 2N3858A 2N3859A 2N3860	31p 37p 31p 31p	2N5458 2N5458 2N5459 2N5460	29p 29p 29p 72p	BC132 BC134 BC135 BC136	39p 36p 45p 45p	BC263B BC263C BC264	30p 31p 32p 40p	BD 676 77p BD 677 78p BD 678 83p BD 711 1:32	
SILVERED MICA 1% PLEASE PHONE	2200 25 63p 2200 40 70p 2200 63 134p 4700 16 75p	CHLORIDE PELLETS Quick dissolving	BNC 50Ω Plug 1.10 Socket 1.00 Line skt 1.15	PP3 Snaps 10p PP9 Snaps 12p Box for 4HP7 27p	STANDARD KNOBS (All for ½ " spindles)	750v AC Fully guaranteed 34.50	about types not listed due to insufficient space.	2N3877A 2N3900 2N3902	90p 35p 25p 3.33	2N5461 2N5482 2N5484 2N5485	60p 80p 40p 29p	BC137 BC138 BC140 BC141	39p 55p 29p 37p	BC264B BC266 BC266A BC266B	42p 35p 36p 37p	BD711 1:32 BD712 1:32 BDX14 1:30 BDX18 1:59 BDX32 3:47	
POLYESTER C280 TYPE (RADIAL)	4700 25 89p Radial by Matsushita	Enough to make over 1 litre 1.69 ETCH RESIST	COAX (TV) All Metal Plug 25p	Box for 6HP7 33p Box for 4HP11	Grub Screen Fitting Black Plastic	MINITESTER Pocket Size 2000 OPV	Only top quality devices sold 2N918 33p	2N3903 2N3904 2N3905 2N3906	13p 13p 13p 13p	2N5490 2N5492 2N5494 2N5496	1.37 1.56 1.37 1.59	BC142 BC143 BC147	29p 30p 10p	BC 300 BC 301 BC 302	45p 44p 43p	BDX66B 5.95 BDX67B 5.95 BDY54 1.70	
250V 10nF, 15nF, 22nF, 33nF,	uFd V 10 16 6p 22 10 6p 22 16 7p	(inc. Spare Nib) 90p	Socket 25p Line Skt 40p	TRANSISTOR SOCKETS	M1. 15+metal insert 34p M2. 33mm+ metal insert 39p	Analog Meter 5.55 MICROTEST 80	2N929 36p 2N929A 45p 2N930 20p 2N930A 30p	2N3924 2N3945 2N3962	8.30 85p 30p	2N5543 2N5551 2N5640	12.00 37p 45p	BC147A BC147B BC147C BC148	10p 10p 20p 10p	BC 303 BC 304 BC 307 BC 307A		BDY56 1.80 BDY57 5.25 BDY5B 6.15	
47nF, 68nF, 100nF 7p 150nF, 200nF, 10p	47 10 7p 47 16 8p 100 10 9p 100 16 10p	ETCH RESIST TRANSFERS 1. Thin lines 2. Thick lines	CANNON TYPE AUDIO PLUGS (3 PIN XLR) Male 1.70	TO18 (BC109) 30p TO5 (BFY50)	M3. 36mm + metal insert & skirt 39p M4. As M3	Superior 20,000 OPV 1000v AC/OC, 5 ADC,	2N1131 24p 2N1132 25p 2N1302 45p	2N3964 2N4030 2N4031 2N4032	1.42 75p 65p 69p	2N5654 2N5786 2N5813 2N5884	35p 80p 23p 5.95	BC 148A BC 148B BC 148C BC 149	12p 13p 13p 10p	8C3078 8C308 BC308A BC308B	15p 12p 13p 140	BDY62 2.34 BDY92 3.75 BF115 35p BF119 1.00	5
330nF, 470nF 13p 680nF 1µF 22p	220 10 11p 220 16 12p 470 10 17p	Thin bends     Thick bends     DIL pads	Female 1.65 Sockets (Chassis) Male 1.50	35p TO3 (2N3055) 40p	numbered 1 to 10 39p M5. As M3 but 30mm 42p	2.5A AC, 0.1B to 5M 19.00 680R 20.000 OPV 1000v DC,	2N1303 65p 2N1304 60p 2N1306 65p 2N130B 65p	2N4036 2N4037 2N4058 2N4059	63p 49p 10p 17p	2N5886 2N6027 2N6030 2N6031	5.95 30p 6.60 6.95	BC149B BC149G BC152 BC153	12p 13p 35p	BC 309A BC 309A BC 309B BC 309C	14p 15p 16p	BF121 75p BF123 70p BF127 80p BF153 39p	0
1.5µF 39p 2.2µF 39p SIEMENS	470 16 18p 1000 10 20p 1000 16 24p 2200 10 34p	6. Transistor pads 7. Dots + holes 8. 0.1" edge	JACK PLUGS Huge Discount	'KEYNECTOR' Bare Wire Mains Safety Block	M6. As M4 but 30mm 42p M7 Pointer 24p	to 10M 32.00	2N1711 35p 2N1889 50p 2N1890 50p 2N1893 49p	2N4060 2N4061 2N4062 2N4064	12p 10p 10p 1.15	2N6082 2N6083 2N6099	11.99 17.95 1.20	BC 154 BC 157 BC 157A	23p 27p 11p 12p	BC317 BC318 BC320	17p 15p 15p 25p	BF154 25p BF157 58p BF158 25p	D
POLY-C 5% 250V 7.5MM InF, In5, 2n2,	2200 16 44p 3300 10 50p 3300 16 65p 4700 10 65p	9. Mixture. Any sheet of above 35p	for quantity Please phone % "Mono 20p	EC MAINS 6 AMP 3 PIN	16mm SOLID ALUMINIUM MATCHING	DIL REED 100VA Normaliy	2N2060 7.14 2N2102 39p 2N2217 39p	2N4069 2N441BA 2N4220	1.00 1.80 75p	2N6101 2N6109 2N6111 2N6121	1.30 1.15 1.00 57p	BC1578 BC158 BC158A BC1588	13p 10p 12p 13p	BC321 BC327 BC328 BC337	25p 14p 14p 15p	BF159 58p BF160 55p BF161 58p BF163 50p	
3n3, 4n7, 6n8 7p 8n2, 10n, 12n, 15n, 18n, 22n, 27n, 33n, 39n,	CAN ELECTROLYTICS	PHDTO SENSITIVE PCB 1st Class Epoxy	% "Stereo 30p %" Metal Mono 30p 2%" mm Mono	Plug (Holes) 58p Chassis Skt. (Pins) 35p	M8. 15mm 48p M9. 24mm 56p M10. 30mm 69p	open (1 amp) 5v 3806 1.99 5v 3806+Diode & Screen 2.95	2N2218 33p 2N2218A 25p 2N2219 27p 2N2219A 28p	2N4221 2N4222 2N4223 2N4224	95p 97p 97p 98p	2N6122 2N6123 2N6124 2N6125	59p 65p 59p 65p	BC 159A BC 159B BC 159C	11p 12p 13p 18p	BC338 BC347 BC350 BC382	15p 20p 20p 30p	BF166 57p BF167 29p BF170 79p BF173 25p	p l
47n 8p 56n, 68n, 82n, 100n, 150n 10p	4700µF 40V2.50 4700µF 84V3.50 10,000µF 80V 4.50	Glass. For better results than spraying. Expose	2% mm Metal Mono 20p 3% mm Mono	Line Sk1. Pins 60p Chassis Plug (Holes) 50p	FUSES	12v 530ß 1.99 24v 2kß 1.99 PCB RELAYS	2N2220 22p 2N2221 22p 2N2221A 23p 2N2222 24p	2N4234 2N4236 2N4237	45p 46p 1.21	2N6126 2N6129 2N6130	75p 79p 93p	BC160 BC161 BC167	42p 48p 10p	BC382L BC383 BC383L	30p 30p 30p	BF174 77p BF177 25p BF178 30p	p p
SIEMENS POLY-C 5% 100V 7.5MM	TANTALIUM BEADS	to UV. Single sided 100 × 160 2 10 100 × 220 2.50	3½ MM Stereo 35p	13 AMP DOMESTIC	100mA 19p 15p 250mA	240V AC 10 amps Contacts SPDT 1×½ 6v	2N2222A 25p 2N2223 2.60 2N2223A 4.15	2N4238 2N4239 2N4240 2N4248	95p 95p 3.00 15p	2NB131 2N6132 2N6133 2N61G4	98p 83p 1.14 1.36	BC167A BC1678 BC168 BC168B	10p 13p 10p 10p	BC 384 BC 384L BC 407 BC 408	30p 30p 24p 24p	BF179 35p BF180 35p BF181 36p BF182 36p	P
100n, 120n, 150n 11p 180n, 220n, 270n 14p	0.1/35V 14p .22/35V 14p .33/35V 14p .47/35V 14p	203 x 114 2.40 233 x 220 5.20 Double Sided 100 x 160 2.20	3½ MM Metal Mono 20p JACK SOCKETS	Plug +Fuse 50p Adaptor 2 way 1.95 Trailing skt.	17p 10p 315mA 17p 10p	24v 1150B	2N2368 25p 2N2369 19p 2N2369A 20p 2N2405 88p	2N4249 2N4250 2N425B 2N4266	17p 17p 75p 45p	2N6212 2N6253 2N6254 2SC1096	3.27 1.45 1.55 95p	BC 168C BC 169 BC 169B BC 169C	10p 10p 10p	BC409 BC413 BC414 BC415	30p 25p 25p 30p	BF183 38p BF184 36p BF185 37p BF194 12p	P P
330n, 390n, 20p 470n, 560n, 26p 680n, 30p 1 <sub>p</sub> F (10mm), 35p	.68/35V 14p 1.0/35V 14p 2.2/16V 14p 2.2/35V 14p	100 × 200 2.80 203 × 114 2.90 233 × 220 5.90	Chassis 4"Mone 20p 4"Stereo 25p 2½ mm Mone	BOXES &	17p 10p 630mA 17p 10p		2N2410 1.15 2N2411 3.60 2N2483 25p 2N2484 26p	2N4275 2N4284 2N4285 2N4288	48p 32p 35p 22p	25C1306 25C1307 25C1923 25C2078	95p 1.60 40p	BC170 BC170A BC170B	10p 15p 17p 17p	BC416 BC418 BC440	30p 30p 32p	BF195 12p BF196 12p MANY	p 🖁
400V POLYESTER	3.3/35V 18p 4.7/16V 18p 4.7/35V 20p	Developer for above (do not use Sodium Hydroxide)	3½' mm Mono 15p	CASES ALUMINIUM CASES	800mA 17p 10p 1A 17p 10p	RECHARGE BATTERIES	2N2646 45p 2N2647 98p 2N2714 12p	2N4289 2N4290 2N4291	15p 45p 45p	2SJ49 2SJ50 2SJ82	3.50 3.75 4.29	BC170C BC171 BC171A BC171B	18p 12p 15p 15p	BC441 BC460 BC461 BC478	33p 32p 33p 29p 30p	MORE	
1n, 1n5, 2n2, 3n3, 4n7m 6n8, 10n 10p 15n, 22n,	6.8/25 20p 6.8/35V 21p 10/16V 18p 10/35V 27p	500 ml 2.95 VERO	1 Line 14 " Mono 20p 14 " Metal 40p 14 " Stereo 30p	Covered with Black Rexins (Scratchproof)	1.6A 17p 10p 2A 17p 10p 3.15A 17p 10p 4A 17p 10p	Guaranteed minimum 500 charges HP2(1,2AH) 2,39	2N2848 60p 2N2890 1.10 2N2891 2.28 2N2892 3.00	2N4292 2N4294 2N4297 2N4302	45p 45p 2.50 39p	25K134 35K135 25K226 2N139	3.50 3.75 4.29 3.30	BC172 BC172A BC172B BC172C	12p 15p 15p	BC479 BC516 BC517 BC546B	30p 40p 40p 15p	TRANS- ISTORS	
33n 11p 47n, 68n. 100n 14p 150n, 220n 18p	15/16V 22p 15/25V 32p 22/6 3V 26p 22/16V 29p	0.1" COPPER CLAD 2.5 x 3.7 83p 2.5 x 5 99p	%" Stereo Metal 50p 3% mm Mono 15o	R1 6 x 4 % x 1% " 2.35 R2 B x 6 x 2" 2.75	5A 17p 10p 6.3A 17p 10p 10A 17p 10p	HP2(4AH) 4.75 HP7(%AH) 99p HP11(1.2AH) 2.29	2N2904A 27p 2N2905 28p 2N2905A 29p 2N2906 25p	2N4303 2N4304	40p 41p	3N140 3N143 3N152 3N153	1.07 2.85 3.00 2.47	BC173 BC1736 BC173C	11p 16p 16p	BC547 BC547A BC547B	13p 14p 14p	IN	
330n 39p 470n 50p	33/10V 30p 47/6.3V 30p	3.75 × 3.75 99p 3.75 × 5 114	3½ mm Mono Line 20p	R39×5×2½" 3.15	L	PP3(110mAH) 4.95	2N2906A 30p		· · · · · · · · · · · · · · · · · · ·	3N153	2.56	BC174	21p	BC548	12p	STOCK	1
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# TECH TIPS

# **Cassette Logic** Driver

Mike Hobbs. **Basingstoke** 

This circuit allows microcomputers with cassette motor relays to control a logic controlled cassette deck with a remote control socket. It was originally designed for the BBC Microcomputer but will be suitable for many others. The circuit was designed to drive a TEAC C-3X cassette deck but is suitable for any machine where the control inputs are grounded to operate the control circuitry

When you LOAD a program the cassette relay closes and this is used to trigger IC2b to give the cassette deck a PLAY pulse. When the cassette relay opens it triggers IC2a to give a STOP pulse. When you need

to SAVE a program you press the RECORD SET button before pressing RETURN on the computer. IC3 holds the record mode until the STOP pulse clears it when the operation is complete. This is done to prevent inadvertently recording when intending to read into the computer.

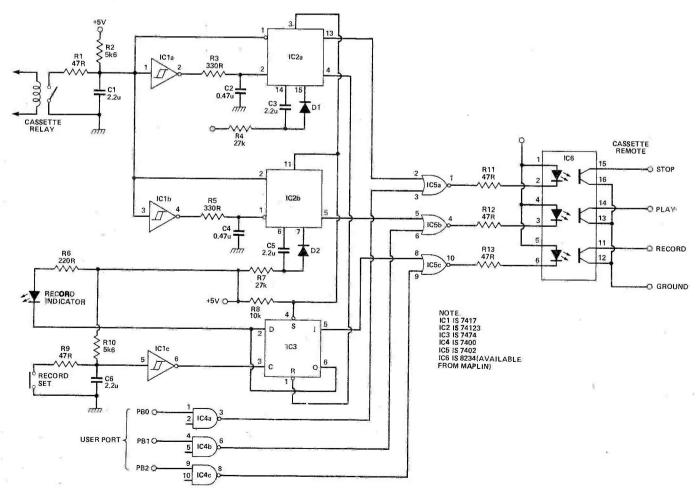
Additionally the circuitry around IC4 provides control from the computer user port so you can have direct control from the software. Obviously it is a simple matter to extend the capabilities of this interface to provide control of the rewind and fast forward functions also. In fact there is a spare gate in IC4, IC5 and IC6 which can be used for, say, the rewind function without any additional ICs being required. The computer user port has direct control over the cassette control signals and therefore the software must provide the correct pulse duration to activate the deck solenoids. The user port signal lines

must be driven low to activate the cassette deck because on the BBC Microcomputer the port is set up as an input port on power-up which means that the inputs to IC4 will float high and not try to activate all cassette solenoids at once!

Isolation is provded by the optoisolator so that there is no risk of damaging components in either the interface or the cassette deck due to different earth potentials or accidental shorting.

IC1 is a schmitt trigger inverter IC to eliminate contact bounce which is duite considerable on some microcomputer cassette relays.

The whole interface will fit onto a module  $100 \times 120$  mm which will fit neatly inside the BBC Microcomputer and with careful mounting and suitable connectors the connector can be accessed from the gap at the rear of the BBC machine. The RECORD SET button can be mounted neatly next to the row of LEDs on the front panel. The power can, of course, be taken direct from the power supply's external output and the cables routed back into the machine via the gap above the port access recess underneath.



# **Capacitor Tester**

Andy D'Rozario, Manchester.

During circuit development, situations often arise which call for a capacitor to be checked to ascertain whether or not it is functioning. The circuit shown here gives a quick audio and visual indication of the state of the capacitor by using its most basic property — that of DC blocking.

Half of the NE556 oscillates at approximately 200 kHz and is used to

provide a train of positive pulses. These pulses are passed through the device under test to the two LEDs and an audio oscillator formed by the other half of the NE556.

The resultant pulses appearing at point X will vary with the device

under test as follows:

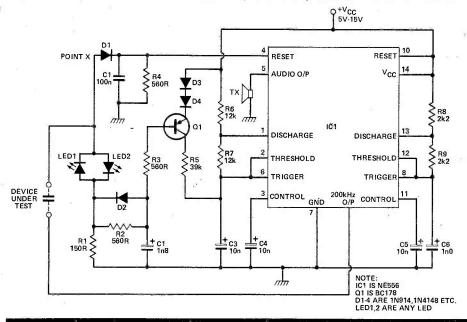
Capacitor OK — positive and negative pulse train at point X, both LEDs illuminated; Q1 conducts and an audio tone is produced.

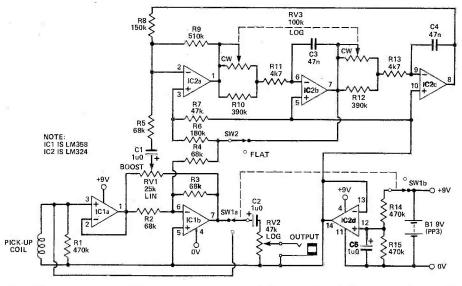
**Capacitor S/C** — only a positive pulse train at point X, only one LED illuminated, C1 charges up and a lower tone produced.

**Capcitor O/C** — no pulse train, neither LED illuminated, C2 discharges and the audio oscillator is reset.

A PB2720 piezoelectric transducer was used at the output of the audio oscillator, but a high impedance speaker or earpiece should do just as well.

The tester needs the capacitor under test to be greater than 30nF to produce an audio output reliably, however the LEDs will indicate the correct condition down to 100pF at 5 V supply voltage, and 50pF at 12 V.





# **Active Bass Tone Control**

Ian Willats, Worcester

The circuit was designed to improve the tonal variation of a bass guitar, being physically small enough to replace the passive tone controls in the guitar body. Low power consumption is achieved by the use of LM324 type op-amps (the LM358 is 'half an LM324'), allowing battery operation from a PP3. Current drain is about 1 mA.

Operation of the tone control is

as follows: the pickup signal is buffered by IC1a and fed via R2 to mixer IC1b. The boost/cut control RV1 allows a combination of signals to enter the state-variable filter formed by IC2a,b,c, whose centre frequency can be varied by means of RV3 between 40 and 700 Hz (with the given components). The output of the filter is then fed back into the mixer via R4.

In this manner, the selected frequency can be boosted or cut by up to  $\pm$  10 dB. If SW2 is opened, however, R4 is grounded via R6 and R7 so that a flat frequency response results. This allows a preset effect to

be easily applied to the guitar.

The Q of the filter is set at about 1.4 by R6 and R7. This rather broad peak was found to be musically more useful than a very 'peaky' filter response. Note that the frequency control RV3 is wired so that low frequency effects are obtained when it is turned fully clockwise, giving a subjectively linear control.

IC2d simply provides a low impedance signal ground at half the supply voltage. Switch SW1 is provided to simultaneously switch off the active circuitry and bypass it, for operation in the event of battery failure. In the passive mode only the volume control RV2 is used.

None of the component values given are critical, and some experimentation is useful to match the circuit to a particular guitar. There is no reason why the circuit should not be used in a lead guitar if C3 and C4 are changed to, say, 22nF, to suit the

higher frequency range.

Finally, a note about construction — as space is generally very limited inside a guitar body, the circuit can be built directly onto the undersides of the IC sockets and the pots, allowing for easy mounting. The smallest available components should be used. SW2 can be incorporated as a push-pull switch on pot RV1, which makes pre-setting effects very easy to accomplish.

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74LS54	20p 20p	74LS1 74LS1 74LS1 74LS1 74LS1 74LS2 74LS2 74LS2 74LS2 74LS2	41	70p	TIP33A	7	4p 2	708	375p 250p	LM319		4038 4040	110p 40p
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74LS76 74LS83	27p	74LS2	48	70p	2N2646 2N2904			184-15	400p	LM348	65p	4044	40 p
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74LS93 74LS95 74LS96 74LS107 74LS109 74LS112 74LS113	33p	74LS2 74LS2 74LS2 74LS2 74LS2 74LS2 74LS2 74LS2 74LS2	61 (	80p	2N3704	1	Op			LM390	0 50p	4068	14p
74LS112	33p 33p	74L52	73 10	25p	2N3705 2N3706	1	Op G	RYSTALS		LM390 LM391		4069 4070	14p
74LS113	30p 32p	74LS2 74LS2 74LS2 74LS2 74LS2 74LS2 74LS3 74LS3 74LS3	79 1	75p 50p	2N3707	1	Op   1	MHZ	290p	LM391	4 250p	4071	14p
741 5122	60p	74LS2	80 8	80a I	2N3708 2N3709			MHZ	225p	LM391	5 250p	4072 4073	14p
74LS124 74LS126	150p 34p 34p 42p 30p	74LS2	90	50p	2N3B19	. 2	2p 6	MHZ	150p	LM136	00 110p	4075	14p
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	- 1			1	2N577 OCP71 ORP12	40p 180p		TIL31A TIL32	120p 55p	NE565 NE566	120p 155p	4502 4503	80p 45p
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7805 7812 7815 7818 7824 TYRISTORS 5A 400V 5A 600V 9A 600V	40p 40p 40p 40p 40p 40p 40p	7905 7912 7915 7918 7924 C106D TIC44 TIC45		45p 45p 45p 45p 45p 45p 24p 29p	ISOLATO ILO74 ILQ74 TIL112 TIL113 TIL116	7 SEG	40p 70p ( 70p ( 70p ( 70p ( 90 Ti 90 Ti 90 Ti	Red Yellow Green DISPLAYS L312	3 5 mm mm 9p 10p 12p 14p 12p 12p	NE592 NE553- TBA616 TBA620 TL0610 TL062 TL064 TL071/I TL072/I TL074 TL074	400p 60p 110p 95p 80p 80p 95p 95p 95p 100p 90p	4507 4510 4511 4512 4518 4520 4521 4526 4527 4528	35 p 45 p 45 p 88 p 40 p 50 p 60 p 60 p 50 p 70 p
7805 7812 7815 7818 7824 ************************************	40p 40p 40p 40p 40p 40p 90p 95p 150p	7905 7912 7915 7918 7924 C106D TIC44 TIC45 TIC47 2N5062		45p 45p 45p 45p 45p 38p 24p 29p 35p 32p	ISOLATO ILO74 ILO74 ILC112 TIL113 TIL116 OL70 DIL7 FND:	7 SEG	40p 70p 70p 70p 70p 0 100 Ti 90 Ti 120 Ti	Red Yellow Green DISPLAYS L312 L313 L321 L322	3 5 mm mm 9p 10p 12p 14p 12p 12p	NE592 NE553- TBA616 TBA620 TL0610 TL062 TL064 TL071// TL074 TL074 TL084 TL094 /L170	400p 80p 110p 95p 80p 90p 80p 95p 100p 90p 200p 200p 50p	4507 4510 4511 4511 4518 4520 4521 4521 4528 4527 4628 4532 4583 4584 4585	35 p 45 p 48 p 40 p 50 p 60 p 50 p 70 p 90 p 35 p 75 p
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7805 7812 7815 7818 7818 7824  TYRISTORS 5A 400V 8A 500V 8A 500V 12A 400V 8T105 8T116  TRIACS 3A/100V	40p 40p 40p 40p 40p 40p 50p 95p 150p 180p	7905 7912 7915 7918 7924 C106D TIC44 TIC45 TIC45 TIC45 TIC45 2N5062 2N5064	ov :	45p 45p 45p 45p 45p 38p 24p 29p 35p 32p 38p	ISOLATO ILO74 ILO74 ILO74 ILO12 TIL113 TIL118  DL77 FND DIC7 FND DIODE 0A47 0A90 0A91	7 SEG	40p 70p 70p 70p 70p 80 Ti 20 Ti 15 Ti	Red Yellow Green DISPLAYS L312 L313 L321 L322 IRIDGE EECIFIERS A50V	3 5 mm mm 99 109 12p 14p 12p 12p 155 115 115 115 12p 20e	NESU2 NESS3- TBA618 TBA820 TL061C TL062 TL071/f TL074 TL074 TL094 TL094 TL170 TL430C ZN414	400p 60p 110p 95p 60p 95p 95p 95p 25p 100p 90p 200p 50p 70p 80p 190p 190p	4507 4510 4511 4512 4518 4520 4521 4528 4527 4528 4532 4532 4533 4584 4585 40085 40085 40085	35 g 45 p 45 p 88 p 40 p 50 p 60 p 60 p 50 p 70 p 90 p 36 p 75 p 90 p 50 p
7805 7812 7815 7818 7818 7818 7824  **YRISTORS 5A 400V 5A 600V 12A 400V BT106 BT116  **TRIACS 3A/100V 3A/400V	40p 40p 40p 40p 40p 40p 50p 95p 150p 180p	7905 7912 7915 7918 7924 C106D TIC44 TIC45 TIC47 2N5062 2N5064	ov s	45p 45p 45p 45p 45p 24p 29p 35p 32p 38p 78p 82p	ISOLATO ILO74 ILO74 ILO74 ILO74 ILO74 ILO112 TIL113 TIL116 OL77 OND DIODE	7 SEG	40p 70p 70p 70p 70p 90 Ti 90 Ti 120 Ti 15 Ti 8p 9p 1	Red Fellow Green DISPLAYS L312 L313 L321 L322 RIDGE ECIFIERS A50V A100V A100V	3 5 mm mm mm mm mm mm mm mm mm mm mm mm m	NE502 NE553- TBA610 TBA620 TL0610 TL062 TL064 TL071// TL074 TL074 TL094 /L170 TL4300 ZN419 ZN4192 ZN423E	400p 60p 110p 95p 60p 95p 95p 95p 25p 100p 90p 200p 50p 70p 80p 190p 190p	4507 4510 4511 4512 4518 4518 4520 4521 4528 4527 4528 4583 4583 4584 4585 40025 40102 40103 40103	35 B 45 D 45 D 88 P 40 D 50 P 60 P 60 P 50 P 70 P 90 P 35 P 170 P 170 P 170 P 180 P
7805 7812 7815 7818 7818 7818 7824  IVRISTORS 5A 400V 9A 600V 12A 400V BT106 BT116  TRIACS 3A/100V 3A/400V 8A/400V 8A/400V	40p 40p 40p 40p 40p 40p 48p 90p 150p 180p	7905 7912 7915 7918 7924 C106D TIC44 TIC45 TIC47 2N5062 2N5064	0V 10V 10V 10V 10V 10V 10V	45p 45p 45p 45p 45p 38p 24p 29p 35p 32p 38p 78p 82p 35p 03p	ISOLATO ILO74 ILO74 ILO74 ILO74 ILO112 TiL112 TiL113 TIL118  DL70 DIL7 FND: FND: FND: OA47 OA90 OA91 OA200 OA201 IN914	7 SEG	40p 70p 70p 70p 70p 90 Ti 90 Ti 15 Ti 8p 9p 1 9p 1 9p 1 9p 2	Red Yellow Green DISPLAYS L312 L313 L321 L321 L322 IRIDGE ECIFIERS A50V A400V	3 5 9p 10p 12p 14p 12p 12p 12p 115 115 115 115 20p 25p	NE502 NE553- TBA610 TBA620 TL0610 TL062 TL064 TL071// TL074 TL074 TL094 /L170 TL4300 ZN419 ZN4192 ZN423E	400p 60p 110p 95p 60p 95p 95p 95p 25p 100p 90p 200p 50p 70p 80p 190p 190p	4507 4510 4511 4511 4512 4518 4520 4521 4526 4527 4528 4532 4583 4584 4585 40087 40103 40106 40106 40106	35 B 45 p 45 p 88 p 40 p 50 p 60 p 50 p 60 p 50 p 70 p 90 p 35 p 90 p 140 p 170 p 180 p 180 p 19
7805 7812 7815 7818 7818 7818 7824  IVRISTORS 5A 400V 3A 500V BA 500V BT108 ET1116  ITRIACS 3A/100V 3A/400V 3A/400V 3A/100V	40p 40p 40p 40p 40p 40p 10p 150p 150p 150p	7905 7912 7915 7918 7924 C106D TIC44 TIC45 TIC47 2N5062 2N5064	0V 10V 10V 10V 10V 10V 10V	45p 45p 45p 45p 45p 38p 24p 29p 35p 35p 38p 78p 82p 35p	ISOLATO ILO74 ILO74 ILO74 ILO74 ILO112 TiL113 TiL118  DL76 DIL77 FND: FND: DIODE: 0A47 0A90 0A91 0A200 0A202	7 SEG	40p 70p 70p 70p 70p 90 11 20 115 115 115 115 115 115 115 117 9p 11 9p 12 9p 12 9p 12 9p 12 9p 12 9p 13 9p 14 9p 15 9p 16 9p 16 9p 17 9p 17 9p 18 18 9p 18 9p 18 9p 18 9p 18 9p 18 9p 18 9p 18 9p 18 9p 18 9p 18 9p 18 18 18 18 18 18 18 18 18 18 18 18 18	Red Reliow Green DISPLAYS L312 L313 L321 L322 RRIDGE ECIFIERS A50V A100V A400V A400V ENER	3 5 mm mm mm mm mm mm mm mm mm mm mm mm m	NE502 NE553- TBA610 TBA620 TL0610 TL062 TL064 TL071// TL074 TL074 TL094 /L170 TL4300 ZN419 ZN4192 ZN423E	400p 60p 110p 95p 60p 95p 95p 95p 25p 100p 90p 200p 50p 70p 80p 190p 190p	4507 4510 4511 4511 4512 4518 4520 4520 4521 4526 4526 4527 4528 4528 4584 4585 40087 40103 40103 40103 40103 40105	35 p 45 p 45 p 45 p 46 p 50 p 50 p 50 p 50 p 70 p 90 p 35 p 140 p 170 p 36 p 100 p 50 p 50 p 50 p 50 p 50 p 50 p 50 p
7805 7812 7815 7818 7818 7818 7824  IVRISTORS 5A 400V 9A 600V 12A 400V BT106 BT116  TRIACS 3A/100V 3A/400V 8A/400V 8A/400V	40p 40p 40p 40p 40p 40p 48p 90p 150p 180p	7905 7912 7915 7918 7924 C106D TIC44 TIC45 TIC47 2N5062 2N5064	0V 10V 10V 10V 10V 10V 10V	45p 45p 45p 45p 45p 38p 24p 29p 35p 32p 38p 78p 82p 35p 03p	ISOLATO ILO74 ILO74 ILO74 ILO74 ILO74 ILO74 ILO74 ILO74 ILO75 ILO7	7 SEG	40p 70p 70p 70p 70p 90 Ti 90 Ti 15 Ti 15 Ti 8p 1 1 9p 1 9p 1 9p 2 9p 2 9p 2 9p 2 9p 2 9p 2 9p 2 9p 2	Red Vellow Green JUSPLAYS L312 L313 L321 L322 RIDGE JECIFIERS A400V A400V A400V ENER TODES	3 5 mm mm mm mm mm mm mm mm mm mm mm mm m	NE502 NE553- TBA610 TBA620 TL0610 TL062 TL064 TL071// TL074 TL074 TL094 /L170 TL4300 ZN419 ZN4192 ZN423E	400p 60p 110p 95p 60p 95p 95p 95p 25p 100p 90p 200p 50p 70p 80p 190p 190p	4507 4510 4511 4511 4512 4518 4520 4521 4528 4528 4528 4528 4528 4583 4584 4583 4584 4585 40085 40085 40103 40105 40109 40163	35 p 45 p 45 p 45 p 40 p 50 p 50 p 50 p 50 p 70 p 90 p 90 p 90 p 90 p 140 p 170 p 180 p 100 p 80 p 100 p 90 p 90 p 90 p 90 p 90 p 90 p 90 p
7805 7812 7815 7818 7818 7824  **YRISTORS 5A 400V 8A 600V 8A 600V 12A 400V 8T116  **TRIACS 3A/100V 3A/400V 8A/400V 8A/400V 8A/400V 8A/800V	40p 40p 40p 40p 40p 90p 95p 150p 180p 48p 60p 60p 69p	7906 7912 7915 7918 7924 C106D TIC44 TIC45 TIC47 2N5062 2N5064 12A/100 12A/400 15A/100 16A/400	0V 80V 100V 100V 100V 100V	445p 45p 45p 45p 45p 45p 38p 24p 23p 32p 38p 78p 32p 33p 03p 05p	ISOLATO ILO74 ILO74 ILO74 ILO74 ILO74 ILO112 TIL112 TIL113 TIL116  OL70 DIC7 FND BIODE 0A47 0A90 0A200 0A200 0A200 1N914 1N916 1N918	7 SEG	######################################	Red Reliow Green DISPLAYS L312 L313 L321 L322 RRIDGE ECIFIERS A50V A100V A400V A400V ENER	3 5 mm mm mm mm mm mm mm mm mm mm mm mm m	NE502 NE553- TBA610 TBA620 TL0610 TL062 TL064 TL071// TL074 TL074 TL094 /L170 TL4300 ZN419 ZN4192 ZN423E	400p 600p 195p 195p 195p 195p 195p 195p 195p 195	4507 4510 4511 4511 4511 4518 4520 4521 4528 4528 4528 4528 4528 4528 4528 4528	35 p 45 p 45 p 45 p 45 p 45 p 45 p 46 p 50 p 50 p 60 p 70 p 90 p 50 p 140 p 170 p 36 p 100 p 50 p 50 p 60 p
7805 7812 7815 7818 7818 7824  **YRISTORS 5A 400V 8A 600V 8A 600V 12A 400V 8T116  **TRIACS 3A/100V 3A/400V 8A/400V 8A/400V 8A/400V 8A/800V	40p 40p 40p 40p 40p 90p 95p 150p 180p 48p 60p 60p 69p	7906 7912 7915 7918 7924 C106D TIC44 TIC45 TIC47 2N5062 2N5064 12A/100 12A/400 15A/100 16A/400	0V 80V 100V 100V 100V 100V	445p 45p 45p 45p 45p 45p 38p 24p 23p 32p 38p 78p 32p 33p 03p 05p	ISOLATO ILO74 ILO74 ILO74 ILO74 ILO74 ILO71 ILO7	7 SEG	90 Ti 90 Ti 15 Ti 90 Ti 90 Ti 15 Ti 9p 1 9p 1 9p 2 9p 2 9p 2 7p 2 5p 5 6p 2 77 4	Red Areliow Green DISPLAYS L313 L321 L321 L322 ECIFIERS A500 A4000 A4000 ENER IODES 7-33V OOMW	3 5 mm mm 9p 10p 12p 12p 12p 12p 12p 12p 115 115 115 115 115 12p 20p 25p 30p 45p	NESU2 NESS3- TBA61C TBA62C TL061C TL062 TL074 TL074 TL074 TL094 (L170 TL430C ZN414 ZN4192 ZN423E ZN424E	400p 600p 195p 195p 195p 1960p 1960p 1960p 1960p 1960p 1960p 1960p 1960p 1960p 1960p 1960p 1960p	4507 4510 4511 4511 4511 4518 4520 4521 4526 4527 4528 4583 4585 40007 40103 40106 40109 40163 40175 40193	35 p 45 p 45 p 45 p 46 p 50 p 60 p 60 p 50 p 70 p 90 p 36 p 170 p
7805 7812 7815 7818 7818 7824  **YRISTORS 5A 400V 8A 600V 8A 600V 12A 400V 8T116  **TRIACS 3A/100V 3A/400V 8A/400V 8A/400V 8A/400V 8A/800V	40p 40p 40p 40p 40p 90p 95p 150p 180p 48p 60p 60p 69p	7906 7912 7915 7918 7924 C106D TIC44 TIC45 TIC47 2N5062 2N5064 12A/100 12A/400 15A/100 16A/400	0V 80V 100V 100V 100V 100V	445p 45p 45p 45p 45p 45p 38p 24p 23p 32p 38p 78p 32p 33p 03p 05p	ISOLATO ILO74 ILO74 ILO74 ILO74 ILO74 ILO74 ILO75 ILO7	2 SEG	90 Ti 90 Ti 15 Ti 90 Ti 90 Ti 15 Ti 9p 1 9p 1 9p 2 9p 2 9p 2 7p 2 5p 5 6p 2 77 4	Red Areliow Green DISPLAYS L313 L321 L321 L322 ECIFIERS A500 A4000 A4000 ENER IODES 7-33V OOMW	3 5 mm mm 9p 10p 12p 12p 12p 12p 115 105 105 115 115 115 115 12p 20p 25p 30p 45p 9p	NESU2 NESS3- TBA618 TBA618 TBA62 TL0610 TL062 TL074 TL074 TL074 TL074 TL094 TL170 TL4300 ZN419 ZN423E ZN424E	400p 60p 60p 10 110p 110p 12 110p 12 120p 12 120p 12 120p 12 120p 12 120p 12 120p 130p 130p 130p 14 130p	4507 4510 4511 4512 4518 4512 4518 4520 4521 4528 4527 4528 4528 4528 4583 4584 4585 40008 40103 40106 40109 40163 40107 40107 40109 RIBB CAR Grey/mi	35 p 45 p 45 p 45 p 45 p 45 p 46 p 50 p 50 p 60 p 50 p 70 p 90 p 90 p 90 p 170 p 90 p 90 p 90 p 90 p 90 p 90 p 90 p 9
7805 7812 7815 7818 7818 7824  **YRISTORS 5A 400V 8A 600V 8A 600V 12A 400V 8T116  **TRIACS 3A/100V 3A/400V 8A/400V 8A/400V 8A/400V 8A/800V	40p 40p 40p 40p 40p 90p 95p 150p 180p 48p 60p 60p 69p	7906 7912 7915 7918 7924 C106D TIC44 TIC45 TIC47 2N5062 2N5064 12A/100 12A/400 15A/100 16A/400	0V 80V 100V 100V 100V 100V	445p 45p 45p 45p 45p 45p 38p 24p 23p 32p 38p 78p 32p 33p 03p 05p	ISOLATO ILO74 ILO7	7 SEG 44 7 7 SEG 14 7	######################################	Red Areliow Green DISPLAYS L313 L321 L321 L322 REDGE RECIFIERS A500 A4000 A4000 ENER RODES 7-330 OOMW	3 5 mm mm 9 10p 12p 14p 12p 12p 12p 12p 12p 12p 12p 12p 12p 12	NESU2 NESS3- TBA612 TBA62 TL061C TL062 TL062 TL072/ TL072/ TL072/ TL072 TL072 TL072 TL072 TL170 TL430 ZN419 ZN419 ZN424E SWIT SIIIde DPDT DPDT	400p 600p 10 110p 110p 10 110p 10 10p	4507 4510 4511 4512 4518 4512 4518 4520 4521 4528 4527 4528 4528 4528 4583 4584 4585 40008 40103 40106 40109 40163 40107 40107 40109 RIBB CAR Grey/mi	35 p 45 p 45 p 45 p 45 p 45 p 45 p 45 p
7805 7812 7813 7818 7818 7818 7818 7824 7818 7828 8 400V 24 800V 25 800V 26 800V 26 800V 27 800V 28 800V 28 400V 40p 40p 40p 40p 40p 40p 90p 150p 180p 180p 60p 60p 60p 61p 115p 11C CAPAC 33, 47, 68, 91, 100 115p	7905 7912 7915 7918 7924 C106D TIC44 TIC45 TIC47 2N5062 2N5064 12A/40C 12A/40C 12A/40C 16A/10C 16A/10C 16A/40C	5, 22, 33 8 5, 22, 2200 70, 25, 270 25, 92p	445p 45p 45p 45p 45p 38p 24p 32p 32p 32p 32p 32p 05p 05p	ISOLATO ILO74 ILO74 ILO74 ILO74 IL113 TIL113 TIL116 DL77 DL77 FNDD BIODE 0A47 0A90 0A200 0A200 1N916 1N4148 1N4001 1N4004 4007 POTENTIC Carbon trac 5%:2M sing 5%:2M	7 SEG 1 1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	440p 770p 770p 770p 770p 770p 770p 770p	Red Fellow Green DISPLAYS L312 L313 L321 L322 RRIDGE RECIFIERS A50V A100V A400V A100V A100V A00V A00V A00V A00V A00V	3 5 mm mm 9p 10p 12p 12p 12p 12p 115 115 115 115 12p 20p 30p 45p 9p	NE592 NE553- TBA812 TLO912 TLO92 TLO92 TLO94 TLO72/	400p 400p 400p 400p 400p 400p 400p 400p	4507 4510 4511 4512 4518 4512 4518 4520 4521 4528 4527 4528 4528 4528 4583 4584 4585 40008 40103 40106 40109 40163 40107 40107 40109 RIBB CAR Grey/mi	35 p 45 p 45 p 45 p 45 p 46 p 50 p 50 p 60 p 50 p 70 p 90 p 90 p 170 p 90 p 170 p 170 p 18	
7805 7812 7813 7818 7818 7818 7818 7824 7818 7828 8 400V 24 800V 25 800V 26 800V 26 800V 27 800V 28 800V 28 400V 40p 40p 40p 40p 40p 40p 90p 150p 180p 180p 60p 60p 60p 61p 115p 11C CAPAC 33, 47, 68, 91, 100 115p	7905 7912 7915 7918 7924 C106D TIC44 TIC45 TIC47 2N5062 2N5064 12A/40C 12A/40C 12A/40C 16A/10C 16A/10C 16A/40C	5, 22, 33 8 5, 22, 2200 70, 25, 270 25, 92p	445p 45p 45p 45p 45p 38p 24p 32p 32p 32p 32p 32p 05p 05p	ISO ATC ILO74 ILO74 ILO74 ILO74 ILO74 ILL113 ILL118 OLT7 FND  BIODE 0A47 0A90 0A91 0A200 0A91 1N916 IN4108 IN4108 IN4108 IN4001 IN4000	7 SECONDETERS	40p 770p 770p 770p 770p 800 Th 900 Th 900 Th 90p 11 1	Red Fellow Green DISPLAYS L312 L313 L321 L322 RRIDGE RECIFIERS A50V A100V A400V A100V A100V A00V A00V A00V A00V A00V	3 5 mm mm 9 10p 12p 14p 12p 12p 12p 12p 12p 12p 12p 12p 12p 12	NESU2 NESSA: TIBASTE T	400p 60p 1P 110p 1P 10p 1P 40p	4507 4510 4511 4512 4518 4512 4518 4528 4528 4528 4528 4528 4528 4583 4583 40003 40103 40103 40103 40107 40103 40109 601	35p 45p 45p 45p 45p 60p 60p 60p 60p 60p 70p 90p 90p 90p 170p 130p 140p 150p 150p 150p 150p 150p 150p 150p 15	
7805 7812 7813 7818 7818 7818 7818 7824 7818 7828 8 400V 24 800V 25 800V 26 800V 26 800V 27 800V 28 800V 28 400V 40p 40p 40p 40p 40p 40p 90p 150p 180p 180p 60p 60p 60p 61p 115p 11C CAPAC 33, 47, 68, 91, 100 115p	7905 7912 7915 7918 7924 C106D TIC44 TIC45 TIC47 2N5062 2N5064 12A/40C 12A/40C 12A/40C 16A/10C 16A/10C 16A/40C	5, 22, 33 8 5, 22, 2200 70, 25, 270 25, 92p	445p 45p 45p 45p 45p 38p 24p 32p 32p 32p 32p 32p 05p 05p	ISO ATC ILO74 ILO74 ILO74 ILO74 ILO74 ILL113 ILL118 OLT7 FND  BIODE 0A47 0A90 0A91 0A200 0A91 1N916 IN4108 IN4108 IN4108 IN4001 IN4000	7 SECONDETERS	40p 770p 770p 770p 770p 800 Th 900 Th 900 Th 90p 11 1	Red Fellow Green DISPLAYS L312 L313 L321 L322 RRIDGE RECIFIERS A50V A100V A400V A100V A100V A00V A00V A00V A00V A00V	3 5 mm mm mm 9p 10p 12p 14p 105 105 115 115 12p 20p 25p 30p 45p 25p 30p 45p 25p 30p 45p 25p 30p 45p 25p 30p 45p 25p 30p 45p 25p 30p 45p 25p 30p 45p 25p 30p 45p 25p 30p 45p 25p 30p 45p 25p 30p 45p 25p 30p 45p 25p 30p 45p 25p 30p 45p 25p 30p 45p 25p 30p 45p 25p 30p 45p 25p 30p 45p 30p 45p 25p 30p 45p 30	NESU2 TBASIC TIBASIC TIBASIC TLOSIC T	400p 400p 400p 100p 100p 100p 100p 100p	4507 4510 4511 4512 4518 4512 4518 4528 4528 4528 4528 4528 4528 4583 4583 40003 40103 40103 40103 40107 40103 40109 601	35 p 45 p 45 p 45 p 45 p 45 p 45 p 45 p	
7805 7812 7815 7816 7814  **YHISTORS SA 400V SA 800V S	40p 40p 40p 40p 40p 40p 90p 150p 180p 180p 60p 60p 60p 61p 115p 11C CAPAC 33, 47, 68, 91, 100 115p	7905 7912 7915 7918 7924 C106D TIC44 TIC45 TIC47 2N5062 2N5064 12A/40C 12A/40C 12A/40C 16A/10C 16A/10C 16A/40C	5, 22, 33 8 5, 22, 2200 70, 25, 270 25, 92p	445p 45p 45p 45p 45p 38p 24p 32p 32p 32p 32p 32p 05p 05p	ISOLATO ILO74 ILO7	7 SEC 44 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4	40p 770p 770p 770p 780p 90 T1 15 T1 15 T1 16 T2 170p 90	Red Fellow Green MSPLAYS L312 L312 L312 L321 L322 L322 ECIFIERS A500 A4000 A4000 A4000 ENER 10DES 17-330 OOMW	3 5 mm mm 9p 10p 2p 14p 12p 12p 12p 115 115 115 115 115 115 115 115 115 11	NESSA: TBASIC TBASIC TLOSIC TL	400p 60p 10 110p 110p 120p 10 20p 10	4507 4510 4511 4510 4511 4512 4518 4520 4521 4526 4527 4528 4528 4528 4583 4584 4585 40085 40103	35 p 45 p 45 p 45 p 45 p 46 p 80 p 60 p 60 p 60 p 60 p 75 p 75 p 90 p 140 p 170 p 36 p 100 p 80 p 140 p 150 p 160 p
7805 7812 7813 7818 7818 7818 7818 7824 7818 7828 8 400V 24 800V 25 800V 26 800V 26 800V 27 800V 28 800V 28 400V 40p 40p 40p 40p 40p 40p 90p 150p 180p 180p 60p 60p 60p 61p 115p 11C CAPAC 33, 47, 68, 91 100, 92 100, 92 100, 92 100, 93 100,	7905 7912 7915 7918 7924 C106D TIC44 TIC45 TIC47 2N5062 2N5064 12A/40C 12A/40C 12A/40C 16A/10C 16A/10C 16A/40C	5, 22, 33 8 5, 22, 2200 70, 25, 270 25, 92p	445p 445p 445p 445p 445p 445p 445p 445p	ILO74 ILO74 ILO74 ILO74 ILO74 ILO74 ILO74 ILO74 ILO75 ILO16 ILO5 ILO5 ILO5 ILO5 ILO5 ILO5 ILO5 ILO5	7 SEC 44 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4	40p 770p 770p 770p 780p 90 T1 15 T1 15 T1 16 T2 170p 90	Red Fellow Green MSPLAYS L312 L312 L312 L321 L322 L322 ECIFIERS A500 A4000 A4000 A4000 ENER 10DES 17-330 OOMW	30 5 mm mm pm pm pm pm pm pm pm pm pm pm pm	NESUS TRANSIT TO THE TO THE TO THE TO THE TO THE TO THE TO THE TO THE TO THE THE THE THE THE THE THE THE THE THE	400p 400p 60p 60p 60p 60p 60p 60p 60p 60p 60p	4507 4510 4511 4512 4518 4512 4518 4528 4528 4528 4528 4528 4528 4583 4583 40003 40103 40103 40103 40107 40103 40109 601	35 p 45 p 45 p 45 p 45 p 45 p 45 p 45 p	
7805 7812 7815 7818 7818 7824  **YRISTORS 5A 400V 8A 600V 8A 600V 12A 400V 8T116  **TRIACS 3A/100V 3A/400V 8A/400V 8A/400V 8A/400V 8A/800V	40p 40p 40p 40p 40p 40p 40p 40p 90p 150p 95s 150p 95s 150p 86p 66p 66p 66p 66p 66p 66p 66p 66p 66	7905 7912 7915 7918 7924 C106D TIC44 TIC45 TIC47 2N5062 2N5064 12A/400 112A/400 112A	W 11 W 11 W 11 W 11 W 11 W 11 W 11 W 1	445p 445p 445p 445p 445p 445p 445p 445p	ISOLATO ILC74 ILC7	7 SEC 44 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4	40p 770p 770p 770p 780p 90 T1 15 T1 15 T1 16 T2 170p 90	Red Fellow Green MSPLAYS L312 L312 L312 L321 L322 L322 ECIFIERS A500 A4000 A4000 A4000 ENER 10DES 17-330 OOMW	3 5 mm mm mm 9p 10p 12p 14p 105 105 115 115 12p 20p 25p 30p 45p 25p 30p 45p 25p 30p 45p 25p 30p 45p 25p 30p 45p 25p 30p 45p 25p 30p 45p 25p 30p 45p 25p 30p 45p 25p 30p 45p 25p 30p 45p 25p 30p 45p 25p 30p 45p 25p 30p 45p 25p 30p 45p 25p 30p 45p 25p 30p 45p 25p 30p 45p 25p 30p 45p 30p 45p 25p 30p 45p 30	NESUS TRANSIT TO THE TO THE TO THE TO THE TO THE TO THE TO THE TO THE TO THE THE THE THE THE THE THE THE THE THE	400p 400p 400p 400p 400p 400p 400p 400p	4507 4510 4511 4512 4518 4512 4518 4528 4528 4528 4528 4528 4528 4583 4583 40003 40103 40103 40103 40107 40103 40109 601	35 p 45 p 45 p 45 p 45 p 45 p 45 p 45 p
7805 7818 7818 7818 7818 7818 7818 7818 781	40p 40p 40p 40p 40p 40p 40p 90p 95p 150p 95p 150p 115p 115p 115p 115p 115p 115p 11	7905 7912 7915 7918 7918 7924 C106D T1C44 T1C45 2N5064 12A/10C 12A/30C 16A/10C 16A/30C 16A/30C 100 100 100 100 100 100 100 100 100 1	W 11 W 11 W 11 W 11 W 11 W 11 W 11 W 1	445p 45p 45p 45p 45p 45p 45p 76p 82p 33p 33p 33p 33p 33p 32p 33p 32p 33p 30p 32p 30p 30p 60p 60p 60p 60v 60v 60v 60v 60v 60v 60v 60v 60v 60v	DIODE 100 M	7 SEC 44 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4	440p 170p 170p 170p 170p 170p 170p 170p 17	Green State of State	100 3 3 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5	NESS3- TBASIZ- TBASIZ- TLOS-12	400p 400p 60p 60p 60p 60p 60p 60p 60p 60p 60p	4507 4510 4511 4512 4518 4512 4518 4528 4528 4528 4528 4528 4528 4583 4583 40003 40103 40103 40103 40107 40103 40109 601	35 p 45 p 45 p 45 p 45 p 45 p 45 p 45 p
7805 7812 7813 7814 7814 7814 7814 7814 7814 54 400V 84 600V 81 600V 8	40p 40p 40p 40p 40p 40p 40p 40p 40p 40p	7905 7912 7915 7912 7915 7918 7914 7918 7924 7918 7924 71049	W 11 W 11 W 11 W 11 W 11 W 11 W 11 W 1	445p 45p 45p 45p 45p 45p 38p 24p 33p 33p 33p 32p 33p 32p 33p 005p 00V 800 00V 800 00V 800 00V 800 800 800	ISOLATO ILC74 ILC7	7 SEC 44 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4	40p   10p	Red defelow areas and a second	100 3 3 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5	NESS3- TBASIZ- TBASIZ- TLOS-12	400p 60p 1P 110p 110p 1P 110p 1P 60p	4507 4510 4511 4511 4512 4512 4512 4512 4512 4512	35 p 45 p 45 p 45 p 45 p 45 p 45 p 45 p
7805 7812 7818 7812 7818 7818 7818 7824 7924 7924 7924 7924 7924 7924 7924 79	40p 40p 40p 40p 40p 40p 40p 40p 40p 60p 180p 180p 180p 115p 60p 60p 60p 60p 60p 60p 60p 60p 60p 60	7906 7912 7913 7914 7918 7914 7918 7918 7924   C106D TIC44 TIC44 TIC45 7924   12A100 12A400 12A400 12A400 12A400 11A40 1	0V 10V 10V 10V 11V 11V 11V 11V 11V 11V 1	445p 45p 45p 45p 45p 38p 24p 33p 33p 33p 33p 32p 33p 005p 00V 800 00V 100 00V	ISOLATO   ILO74   IL	7 SEC 1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	40p   10p	Red defelow areas and a second	100 3 3 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5	NESS3- TBASIZ- TBASIZ- TLOS-12	400p 60p 1P 110p 110p 1P 110p 1P 60p	4507 4510 4511 4511 4512 4512 4512 4512 4512 4512	35 p 45 p 45 p 45 p 45 p 45 p 45 p 45 p
7505 7501 7512 7515 7516 7516 7516 7516 7516 7516 7516	40p 40p 40p 40p 40p 40p 40p 90p 95p 90p 95p 90p 150p 150p 150p 150p 150p 150p 150p 15	7906 7912 7918 7918 7918 7918 7918 7918 7918 7918	0V 10V 10V 10V 11V 11V 11V 11V 11V 11V 1	445p 45p 45p 45p 45p 38p 24p 33p 33p 33p 33p 32p 33p 005p 00V 800 00V 100 00V	ISOLATO   ILO74   IL	7 SEC 1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	40p 70p 70p 70p 70p 90 71 90 11 90 11 90 15 17 90 17 90 17 90 18 90 17 90 18 90 18 90 19 90 19 90 19 90 19 90 10 10 10 10 10 10 10 10 10 10 10 10 10	Red defelow areas and a second and a second and a second and a second and a second and a second and a second and a second and a second and a second	30 5 5 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7	NE593- TBA812 TBA812 TL0812 TL0812 TL0812 TL0812 TL0814 TL071 TL07	400p 60p 1P 110p 110p 1P 110p 1P 60p	4507 4510 4511 4511 4512 4512 4512 4512 4512 4512	35 p 45 p 45 p 45 p 45 p 45 p 45 p 45 p
7805 7812 7818 7812 7818 7818 7818 7824 7818 7824 7821 7824 7821 7824 7824 7824 7824 7824 7824 7824 7824	40p 40p 40p 40p 40p 40p 40p 90p 90p 91s 90p 91s 90p 91s 90p 91s 90p 91s 90p 91s 90p 91s 90p 91s 90p 91s 90p 91s 90p 91s 90p 91s 90p 91s 90p 91s 90p 91s 90p 91s 91s 91s 91s 91s 91s 91s 91s 91s 91s	7905 7912 7915 7912 7916 7924 C105D 11C44 11C45	0V 10V 10V 10V 11V 11V 11V 11V 11V 11V 1	445p 45p 45p 45p 45p 38p 24p 33p 33p 33p 33p 32p 33p 005p 00V 800 00V 100 00V	ISOLATO   ILO74   IL	7 SEC 1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	40p 70p 70p 70p 70p 90 71 90 11 90 11 90 15 17 90 17 90 17 90 18 90 17 90 18 90 18 90 19 90 19 90 19 90 19 90 10 10 10 10 10 10 10 10 10 10 10 10 10	Red defelow areas and a second and a second and a second and a second and a second and a second and a second and a second and a second and a second	30 5 5 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7	NE593- TBA812 TBA812 TL0812 TL0812 TL0812 TL0812 TL0814 TL071 TL07	400p 60p 1P 110p 110p 1P 110p 1P 60p	4507 4510 4511 4511 4512 4512 4512 4512 4512 4512	35 p 45 p 45 p 45 p 45 p 45 p 45 p 45 p
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7805 7812 7818 7818 7818 7818 7818 7818 54 1007 84 800V 84 800V 81 800 81 800V	40p 40p 40p 40p 40p 40p 40p 40p 40p 40p	7905 7912 7915 7912 7916 7924 C106D TIC44 TIC45 TIC45 TIC45 TIC45 112A/300 16A/300 16A	0V 10V 10V 10V 11V 11V 11V 11V 11V 11V 1	445p 45p 45p 45p 45p 45p 45p 45p 45p 45p	SOLATOR	7 SEG	40p 70p 70p 70p 70p 90 71 90 11 90 11 90 15 17 90 17 90 17 90 18 90 17 90 18 90 18 90 19 90 19 90 19 90 19 90 10 10 10 10 10 10 10 10 10 10 10 10 10	Seed defelow areas and a seed and	3 5 3 9 3 9 1 9 1 9 1 9 1 9 1 9 1 9 1 9 1 9	NE593-18-A812-	400p 60p 1P 110p 110p 1P 110p 1P 60p	4507 4510 4511 4511 4512 4512 4512 4512 4512 4512	35 p 45 p 45 p 45 p 45 p 45 p 45 p 45 p
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7805 7812 7818 7818 7818 7818 7818 7818 7818	40p 40p 40p 40p 40p 40p 40p 40p 40p 40p	7905 7912 7915 7912 7915 7924 C106D T1044 2N5054 12A400 1104	0V 10 V 10 V 10 V 10 V 10 V 10 V 10 V 1	445p 45p 45p 45p 38p 224p 23p 38p 38p 38p 38p 38p 38p 38p 38p 38p 3	DEATH   100	1 2 SIECE	MEN   1   1   1   1   1   1   1   1   1	Seed defelow areas and a seed and	3 5 3 9 3 9 1 9 1 9 1 9 1 9 1 9 1 9 1 9 1 9	NESS3-1BA612 NESS3	400p 400p 60p 60p 60p 60p 60p 60p 60p 60p 60p	4907 4911 4911 4911 4911 4911 4911 4911 491	35 p 45 p 45 p 45 p 45 p 45 p 45 p 45 p
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# DAC/ADC FILTER/AMPLIFIER

ETI supplies the missing link for all your analogue to computer interface circuits. Design by C. D. Oddy.

nvone who has ever seriously experimented with analogue interfaces to home computers must be all too aware of the problems involved — if you're not too careful you wind up with opamps everywhere in a variety of hastily concocted amplifier, buffer, and filter circuits. And some of them won't even be hastily concocted; some of them will have taken up a considerable amount of your precious time in the designing. What you need is a handy little unit that will perform any or all of the functions of amplifer, buffer, and filter at the mere twiddle of a control or two. What you need is the ETI filter-amplifier.

The filter-amplifier consists of two active blocks together with

input and output buffers and switchable AC or DC coupling. The two active blocks are an amplifier with a variable gain of 0 to 100 and a plus or minus five volt variable offset followed by a low pass filter whose cutoff frequency may be varied over the range 16 Hz to 30 kHz and which may be switched out of circuit when not required. It can be used as an amplifier to match low level signals to the input of an ADC, as a buffer to correct mismatching of signal sources, as a filter to smooth the stepped output of a DAC, and for a multitude of other similar purposes.

# Construction

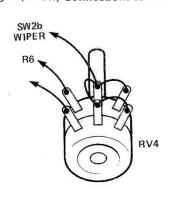
Assembly is simplified by the use of a single quad op-amp for the

	SW2a SW2b	
	RV4 SW3 RV2	
	† † † † † † † † †	
		*
(*		
RV3	R8 - RV1	+ 15V
RV2 (WIPER)	R3 + C2	
	TY Goodood T	> 0V
INPUT	——————————————————————————————————————	
	)   FRA  -)	-15.V
	RV2 SW3	
	SW1 (WIPER) OUTPUT	

PARTS LIST = RESISTORS (all 1W, 5%) R1 R2 1M0 1k0 R3 33k R5, 6 560R R8 10k R9, 11 120k R10 150k RV1 20k horizontal skeleton preset RV2 50k linear with centre click-stop RV3 100k linear RV4 100k dual gang log CAPACITORS 100n polyester 10u 35V tantalum C1, 4, 5, 7 C2, 3 C6, 8 10n polyester **SEMICONDUCTOR** MISCELLANEOUS SPST SW<sub>2</sub> DPDT PCB; case, input and output sockets, knobs, etc as desired.

Fig. 1 (left) Component overlay for the PCB

Fig. 2 (below) Connections to RV4



# **PROJECT: Filter-amplifier**

C1 100n

IC1a

560R

CUTOFF RV4

560R

10g

LOW PASS

100n

SW2b

**{** 

120k

중

쯔

5 ជ

33 24 32 33

100n

10n

Fig. 3 Circuit diagram of the filter-amplifier.

100k

100k

IC1c

FILTER ON/OFF

R10 150k

 $\frac{5}{2}$ 

2

SW3

IC1d

OUTPUT

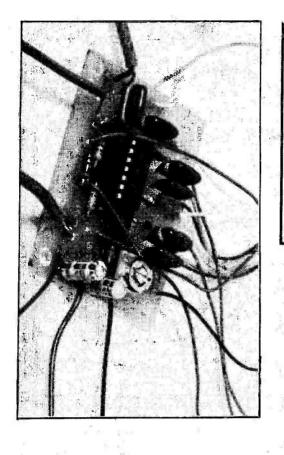
DC T

COUPLING

INPUT BUFFER

10°C

+15V



service (where else?) for which see page click-stop potentiometer and that is available from Ambit. PCB from our PCB The only unusual item here is the centre

BUYLINES:

OFFSET

-RV2

CLICK

20×

100n

by IC1b, the gain being set by R2 and RV3. RV1 and RV2 set the offset voltage, as a butter. The signal is then amplified or SW1 to IC1a, the first stage of the TL074 quad BIFET op-amp, which acts The input signal is passed via either C1 **HOW IT WORKS** 

a low pass filter of the second order Bessel type which is well suited to the smoothing of stepped signals, such position. those obtained from DAC outputs. The IC1c and its associated circuitry form

RV1 being preset such that the offset is zero when RV2 is in its centre click-stop

justed using RV4 and the range switch SW2, the latter selecting either 16 Hz to 3 kHz (position 1) or 160 Hz to 30 kHz (position 2). The gain of the stage is set by R7 and R8. filter's cut-off frequency may be

amplifier plus filter outputs via R9 and R10, the slight difference in their values being necessary in order to allow for the gain (approx. 2.3 db) of the filter. The signal then passes through IC1d, the gain (approx. 2.3 db) of the filter. signal then passes through IC1d, inal buffer stage, to the output. SW3 selects either the amplifier or

potentiometer and SW2, as shown connection between this wiring must be in agreement if the and switches, especially SW2 which check on the PCB itself is that this filter is to work correctly. Note also has two separate elements whose the wiring of the potentiometers right way around. Take care with capacitors (C2, C3) are inserted the four stages, and the only point to the wiring around RV4 and the IC and the two electrolytic

We have not shown either a

could be powered from whatever

would probably be sufficient and supply, whereas for others, one

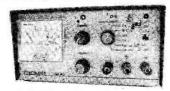
you're experimenting with you're using to supply the ICs equipped with a common power amplifiers built into a single unit and is obviously a lot to be gained from having several of these filter-

the really serious experimenter there complete, self-contained unit. For as a building block than as a project because it is intended more case or a power supply for this

OUTPUT

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- 0-110 v 0-300 mA 0-30 v 0-1 A
- In Kit £37.90 Built & Tested £49.90

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- \* 0 1.5 amp output continuous
- \* Integral 6 range meter giving, 0 3 v 0 100 mA 0-3 v
- 0-3v 0-100 mA 0-10v 0-500 mA 0-30 v 0-1.5 A

- \* In Kit £46.90

Built & Tested £59.90

# PSU 303 (DVS)

- \* 0 30 volt output
- \* 0 -3 amp output continuous
- \* Integral 6 range meter giving,
- 0-3 v 0-100 mA 0-10 v 0-500 mA 0-30 v 0-3 A

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Z903 Panel 240 x 165 with 6802uP, 6821 PIA, 6850 ACIA, 4040, 4512 x 2, LS00, LS367 x 2, 555 x 2 all in sockets, plus R's, C's, plugs, sockets etc, also 12V sub-min relay. £4.95

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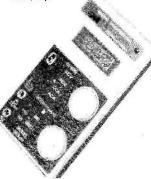
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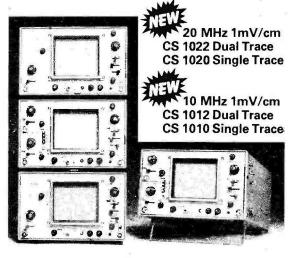
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# IC UPDATE

The world of op-amps never stands still, as a glance at the specifications of these devices will testify. No sooner have we got used to the third (or fourth, depending on which manufacturer's literature you've been reading) than the next one comes along.

# OP-27, OP-37 Very Low Noise Op-**Amps**

# **Features**

■ Very low noise; spectral noise density: 3nV/\/Hz 1/f noise corner frequency 2.7Hz

Very low Vos drift:  $0.2\mu V/month$ 0.2μV/°C

High gain:  $1.8 \times 10^6 \text{V/V}$ 

High output drive capability:  $\pm 12$ V into 600Ω load High slew rate:  $2.8V/\mu S(17V/\mu S, OP37)$ 

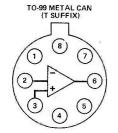
Wide gain bandwidth product: 8MHz(63MHz, OP37)

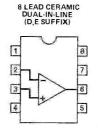
Good common mode rejection radio: 126dB

Low input offset voltage: 10µV

Minimum low frequency noise:  $0.08\mu V_{p-p}0.1Hz$  to

Low input bias and offset currents: 10nA





PIN	FUNCTION
1	VOS TRIM
2	INVERTING INPUT
3	NON-INVERTING INPUT
4	V
6	OUTPUT
.7	V+
8	VOS TRIM



OPEN LOOP

TOTAL NOISE

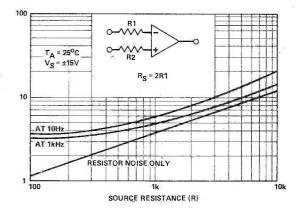
(nV/√Hz)

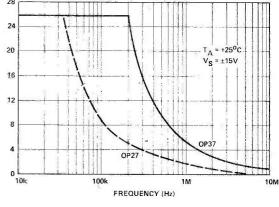
# Absolute Maximum Ratings

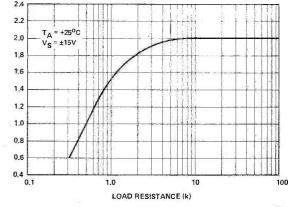
	0
Supply Voltage	+ 22V
Supply VoltageInput Voltage <sup>1</sup>	±22V
Differential Input Voltage	+0.7V
Internal Power Dissipation	500mW
Output Short Circuit Duration.	Indefinite
Störage	4
Temperature Range	65°C to +150°C
<b>Operating Temperature Range</b>	
OP-37A/B/C	55°C to +125°C
OP-37E/F/G	25°C to +85°C

Description

The OP27 and OP37 are designed for use where low noise (both spectral density and burst), wide bandwidth, and high slew rate are required along with low input offset voltage, low input offset temperature coefficient, and low input bias currents in gains greater than or equal to ten. Digital nulling techniques performed at wafer sort make it







#### **Electrical Characteristics**

 $(V_s = \pm 15V \text{ and } T_A = 25^{\circ}C \text{ unless otherwise stated})$ 

(vs = ±13v and 14	= 25 C unless (	, ,	OP-27A/E OP-37A/E			OP-27B/F OP-37B/F			OP-27C/G OP 37C/G		
Parameters Input Offset Voltage <sup>5</sup>	Test Conditions	Min	<b>Typ</b> 10	<b>Max</b> 25	Min	<b>Typ</b> 20	<b>Max</b> 60	Min	<b>Typ</b> 30	<b>Max</b> 100	Units $^*$ $_{\mu}$ V
Input Offset Current			7.0	35		9.0	50		12	75	nA
				±40		±12	± 55		± 15	+80	nA
Input Bias Current	0.111= to 1011=		_	0.18		0.08	±33		0.09	0.25	μVp-p
Input Noise Voltage <sup>2</sup>	0.1Hz to 10Hz					3.5	5.5		3.8	8.0	μ <b>ν</b> p-p
Input Noise	fo = 10Hz		3.5	5.5			5.5 4,5		3.3	5.6	-17
Voltage Density <sup>2</sup>	fo = 30Hz		3.1	4.5		3.1					<u>nV</u> √Hz
3 8	fo = 1000Hz		3.0	3.8		3.0	3.8,		3.2	4.5	¥ 112
Input Noise	fo = 10Hz		1.7	4.0		1.7	4.0		1.7		m A
Current Density <sup>2</sup>	fo = 30HZ		1.0	2.3		1.0	2.3		1.0	~ 3	pA
	fo = 1000Hz		0.4	0.6		0.4	0.6		0.4	0.6	√ Hz
Input Resistance (Diff. Mode) <sup>4</sup>		1.5	6.0		1,2	5.0		0.8	4.0	ıń	MΩ
Input Resistance			3.0			2.5			2.0		$G\Omega$
(Com. Mode)	45		3.0			L 400			2.0		CII
Input Voltage Range <sup>3</sup>		±11	± 12.3	94.5	±11	$\pm 12.3$		± 11	$\pm 12.3$		V
Slew Rate <sup>4</sup> (OP27)	$R_L \geqslant 2k\Omega$	1.7	2.8		1.7	2.8		1.7	2.8		$V/\mu S$
Slew Rate4 (OP37)	$R_L \geqslant 2k\mu$	11	17		11	17		11	17		V/µS
Gain Bandwidth			\$0								
Prod.4 (OP27)		5.0	8.0		5.0	8.0		5.0	8.0		MHz
Gain Bandwidth	fo = 10kHz	45	63		45	63		45	63		MHz
Prod.4 (OP37)	fo = 1MHz		40			40			40		MITZ
Open Loop Output Resistance	Vo = 0, lo = 0	18	70			70			70		Ω.
Power Consumption			90	140	96	90	140		100	1.70	mW
Offset Adjustment Range	$R_P = 10k\Omega$		± 4.0		-	$\pm 4.0$			±4.0		m√

Notes: 1. For supply voltages less than ±22V, the absolute maximum input voltage is equal to the supply voltage.

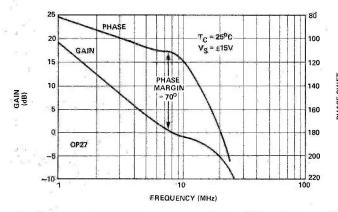
2. This parameter is tested on a sample basis only, and guaranteed to an LTPD of 10.

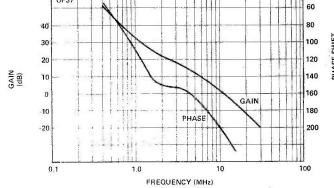
3. Caution the common mode input range is a function of supply voltage, see typical performance curves. Also, the input protection diodes do not allow the device to be removed or inserted into the circuit without first removing power.

Parameter is guaranteed by design.

5. Input offset voltage measurements are performed by automated test equipment approximately 0.5 seconds after application of power.

OP37





feasible to guarantee temperature stable input offset voltages as low as 25 µV. Input bias current cancellation techniques are used to obtain 10 nA input bias currents.

These op-amps are especially useful for instrumentation and professional quality audio systems. Applying the slew rate — power bandwidth equation (fp =  $SR/2\pi V_p$ ) the OP27 will have an undistorted output up to its power bandwidth frequency of 34 kHz, and an undistorted output of  $8V_{p-p}$  at 100 kHz. The same equation applied to the OP37 gives a power bandwidth frequency of 208 kHz, with an undistorted output of 8  $V_{p-p}$  at 338 kHz. This performance is adequate for the most demanding high fidelity

applications.

In addition to providing superior performance for the professional audio market the design of these op-amps uniquely addresses the needs of the instrumentation designer. Power supply rejection and common mode rejection are both typically 120dB. Input offset voltage can be externally trimmed without affecting input offset voltage drift with temperature or time.

The OP27 has a phase margin of 70° at unity gain, which guards against peaking (and ringing) in low gain feedback circuits. Stable operation can be obtained with capacitive loads up to 2000pF. By decoupling the load

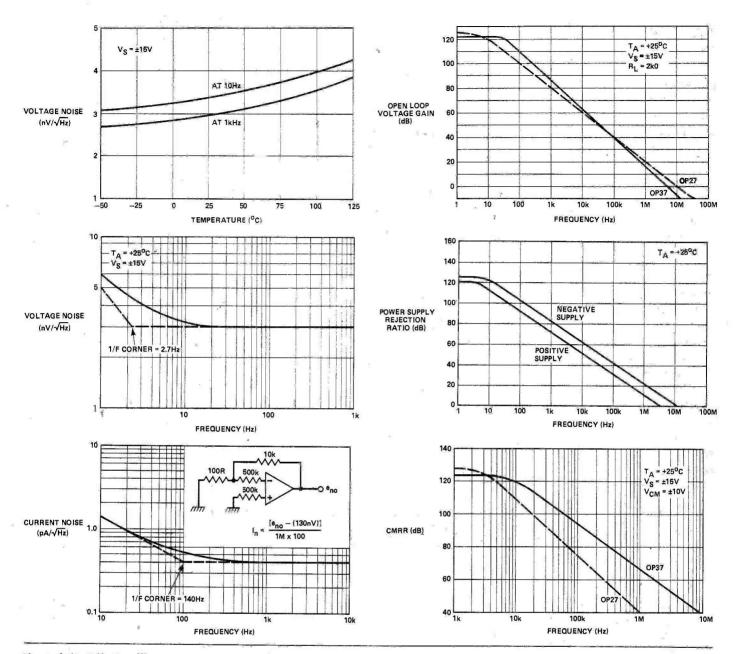


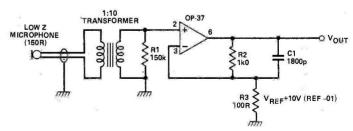
Fig. 1 (left) Offset nulling
Fig. 2 (right) Large signal transient response of OP37

capacitance with a series resistor of 50R or more load capacitances larger than 2000pF can be accommodated. Input offset voltage can be externally trimmed without affecting input offset voltage drift with temperature or time.

**Low Impedance Microphone Preamp** 

In this preamp the transformer converts the low microphone impedance up to a value that is close to the optimum source impedance required by the OP37 for best noise performance. The optimum source impedance can be calculated as the ratio of  $e_n i_n$  which for the OP37 is ap-

Fig. 3 Low-Z microphone preamp.



proximately 7000R. Fortunately the noise performance does not degrade appreciably until the source impedance is four or five times this optimum value. The source impedance at the output of this transformer of 15k still provides near optimum noise performance. C1 rolls off the high frequency response at 90 kHz giving a noise power bandwidth of 140 kHz.

Instrumentation

The OP27 and OP37 are particularly adaptable to instrumentation applications. When wired into a single opamp difference amplifier configuration, they exhibit

outstanding common mode rejection ratio. The spot voltage noise is so low that it is dominated almost entirely by the resistor Johnson noise.

The three op amp instrumentation amplifier of Figure 8 avoids the low input impedance characteristics of difference amplifiers at the expense of two more operational amplifiers and a slight degradation in noise performance. The noise increases because two amplifiers are contributing to the input voltage spectral noise instead of one. Thus the noise contribution, exclusive of resistor Johnson noise, increases by slightly more than the  $\sqrt{2}$ . The spectral noise voltage increases from approximately 3 nV/√Hz to approximately 4.9 nV/\/Hz, with the third amplifier contributing about 10% of the noise.

The gain of the input amplifier is set at 25 and the second stage at 40 for an overall gain of 1000. R7 is trimmed to optimize the common mode rejection (CMRR) with frequency. With balanced source resistors a CMRR of 100dB is achieved. With a 1k source impedance imbalance CMRR is degraded to 80dB at 5 kHz due to the finite (3G $\Omega$ ) input impedance.

**RIAA Phono Preamplifier** 

The new moving coil magnetic phono cartridges have sensitivities that are an order of magnitude lower than the sensitivity of a typical moving magnet cartridge (0.1 mV per cm/S versus 1.0 mV per cm/S). This places a greater burden on the preamplifier to achieve more gain and less noise. The OP27 is ideally suited for this task. The object in designing an RIAA phono preamp is to achieve the RIAA gain-frequency response curve while contributing as little noise as possible to avoid masking the very small signal generated by the cartridge. The circuit shown is adjusted to match a 40dB RIAA curve. Note that by convention the RIAA gain is specified at 1 kHz. With the "break points" of the curve specified at 50, 500 and 2.1 kHz respectively the entire curve is fixed by the specified gain at 1 kHz.

The circuit is designed to operate with a 3/4000 step up transformer to present the optimum source impedance to the amplifier for best noise figure. The optimum source impedance is obtained as the ratio of the spectral noise voltage  $e_n$  to the spectral noise current  $i_n$  (when  $e_n$  has dimensions of  $nV/\sqrt{Hz}$  and  $i_n$  has dimensions of  $pA/\sqrt{Hz}$ and the ratio has dimensions of  $k\Omega$ ). The circuit is designed to be tested and adjusted independent of the transformer; for this purpose introduce a very low level signal around 1mV at test point TP-1. The first stage is a wideband stage which provides a small amount of gain (1 + R4/R5) approximately equal to 10dB. Low value feedback resistors must be used to prevent additional noise due to the spectral current noise or excessive Johnson noise. The gain of the first stage reduces the noise contribution of the second stage. The RIAA transfer curve poles and zeros are due entirely to the feedback network of the second stage.

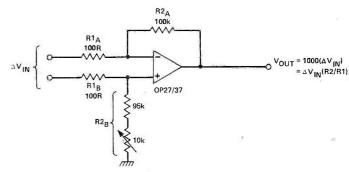
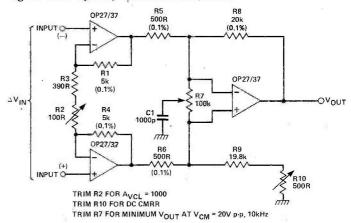


Fig. 4 Single op-amp difference circuit. Fig. 5 Three op-amp difference amplifier,

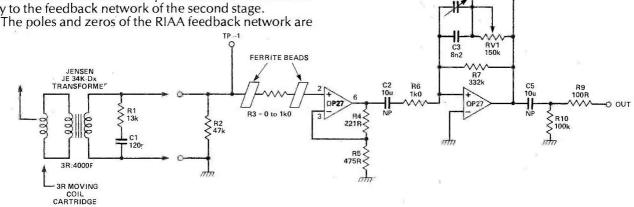


sufficiently separated in frequency that they may be estimated with the following equations:

$$f_1(50Hz) \approx \frac{1}{2\pi R7C3}$$
  $f_2(500Hz) \approx \frac{1}{2\pi R8C3}$   $f_6(2100Hz) \approx \frac{1}{2\pi R8C2}$ 

These equations are only approximations. Final tuning is performed with the adjustable capacitors and potentiometers; by successfully injecting 100 Hz, 1000Hz and 21 kHz at TP1 and adjusting CV1, RV1 and CV2 for -6dB, -20dB, and -40dB (relative to LF response).

CV1 680p



TO TEST, DISCONNECT TRANSFORMER AND INJECT SIGNAL AT TP-

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REGULATORS (5/12) 100mA +ve 1 amp +ve 723 var ZENERS (3.3 to 30V) 500mW	28p 33p 28p	COMPACITORS RADIAL (63V) 1.0 MFD 22 MFD 4.7 MFD 10 MFD 22 MFD	7p 7p 8p 10p 120	AXIAL 1.0 MFD 2.2 MFD 4.7 10 22 47	7p 7p 8p 10p 12p	LINEAR IC's 747 748 ICM 7655 ICM 7556 LF 351 LF 353	50r 33e 70p 130p 40p 70p 24p 86p 86p 85p
1.3 watt  DIODES IN 4001 3p 4002 4p 4004/6 6p IN 5401 12p	0PTO TIL112 83p 4N33 117p MOC3020 185p	47 MED 100 MED 220 MED TRANSISTORS BC107B	13p 19p 44p	100 220 470 1000 BC337 BD139	21p 50p 55p 70p 8p 32p	LM 301A LM 324 LM 380 LM 3909 NE 567v TDA 2020 TDA 2002	24p 27p 80p 86p 85p 285p 185p
5405 13p 5406 14p SRIDGES 1 amp 50v 2 amp 100v 2 amp 200v	LED's 2" Red 7p 2" Green 8p 2" Yellow 8p	BC142	9p 10p 25p 22p 35p 15p 15p	BC140 BF178 BF179 BF257 BF258 BF259 BFX85	33p 25p 30p 30p 30p 33p 27t	SOLDERING IRONS Antex C 15w CON 15w X25 25w All bits D' (Min) connectors 15 way plug	445p 465p 470p 60p
2 mmp 400v 6 amp 100v 6 amp 200v 6 amp 400v 10 amp 50v 10 amp 100v 10 amp 200v		BC182 BC212 BC237 BD300 BC301 BC302	7p 7p 8p 52p 25p 39p	BFX86 BFX87 BFX88 BFY50 BFY51 TIP318	28p 26p 25p 20p 22p 35p	Socket Cover 25 way plug Socket Cover	128p 99p 122p 190p 99p
THYRISTORS (plastic) 4 amp 400v 35p 8 amp 400v 60p	TRIACS (plastic) 4 amp 400v 50p 8 amp 400v 60p 25 amp 400v 168p	BC304 BD135	30p 40p 33p 35p	TIP328 VN10KM VN66AF VN88AF	38p 50p 85p 95p	Min. SP ST Min. SP ST S. Min. SP ST S. Min. DP DT	57p 70p 46p 62p
	25 amp 400v 168p		35p	vnaaar Ies Ser	956 nd S.Á.E	./List	#20 #20

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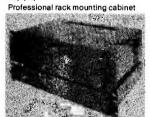
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19 x 3.5	17 x 3 x 10	24.09 20.09
19 x 3	17 x 2.5 x 10	24.09 —
19 x 2.5	17 x 2 x 10	22.94 18.94
19 x 6	17 x 5.5 x 12	28.69 24.69
19 x 5	17 x 4.5 x 12	27.54 23.54
19 x 4	17 x 3.5 x 12	25.24 21.24
19 x 3.5	17 x 3 x 12	24.09 20.09
17 x 3.5	15.5 x 3 x 9	21.79 17.79
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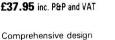
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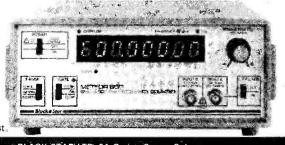
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ETI November 1983

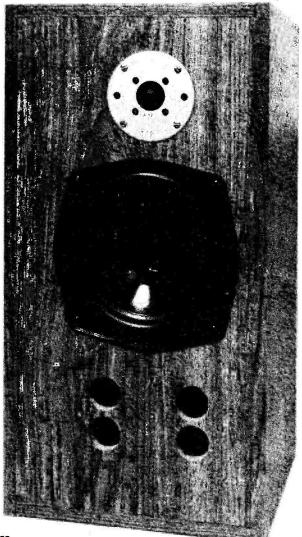
# ACTIVE LOUDSPEAKER

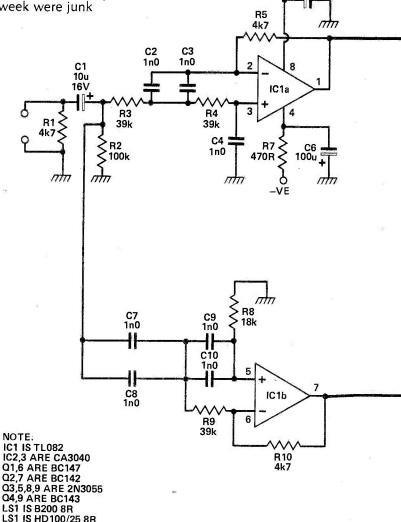
In the halycon days of the hi-fi boom, DIY loudspeakers were published at a rate of several a month. However, it's now been over a year since we last published a design in ETI. Jeff Macaulay takes a fresh look!

here is confusion reigning in the hi-fi world at the moment, and reading some hi-fi magazines you might well be convinced that the only apporach is to spend all your money on just the record deck and make do with whatever amp and speakers you can afford on the little change you have left from your life's savings.

The alternative is to make do with the latest chrome-plated wonder with built-in obsolescence (though, thankfully, hi-fi rack systems seem to have gone out of fashion). To read the advertising blurb that accompanies these units, one could be forgiven for thinking that products launched as recently as the previous week were junk

Fig. 1 (below and page facing) Circuit diagram of the active loudspeaker.





\*Q3,5,8,10 ARE MOUNTED ON A HEATSINK

compared to the current 'flavour of the month'.

This situation has been compounded by the introduction of compact disc — is it worth spending money on analogue systems when digital is just around the corner? One can already hear the cries of anguish from certain highlanddwelling turntable manufacturers.

While we'll admit that it is a truism that if you degrade the sound at the start of its journey through your hi-fi, there is absolutely nothing you can do to improve it, there is still a case for having a good speaker system to do the final conversion of electrical energy into sound energy.

Unfortunately no currently available drive unit can be made to cover the whole audio spectrum properly. For good bass response a heavy large diameter cone is required. The acual amount of bass that can be radiated by the speaker is directly proporitonal to both the

#### **HOW IT WORKS**

For the purposes of analysis, the circuit can be split up into four sections: the low-pass filter around IC1a, the high-pass filter around IC1b and the two power amplifiers around IC2 and IC3

The two filters are based on the wellknown Sallen and Key configurations, and both have component values such as to give a Butterworth type response with a Q of 0.7. All that this means is that the values are chosen so as to give a minimum of response ripples in the pass-band whilst giving a maximum rolloff outside the pass-band that a twopole filter can deliver.

It is usual to include some compensation for the uneveness of the responses of the drive units at this stage. However, as we've already explained, both the drive units selected have very good flat responses, and this was judged to make compensation superfluous

Both the power amplifiers are the same (with the minor difference of the connection C13 and C14), and are based on the 'brains and brawn' principle. In this, the op-amps IC2 and IC3 provide the open-loop gain for the system, while the transistors simply provide a current sourcing capability well beyond that of the op-amps.

Taking a close look at the bass amplifier circuit, IC2 is a CMOS type opamp which offers very low noise and a very good slew rate. The output from this is fed to the quasi-complementary output stage built around Q1 to 5.

To avoid serious distortion at the crossover between the lower and upper sets of driver transistors, a bias voltage is provided between the 'bases' of the compound output transistors (Q2/3 and Q4/5) by Q1 which is, with PR1, wired as a V<sub>be</sub>

multiplier.

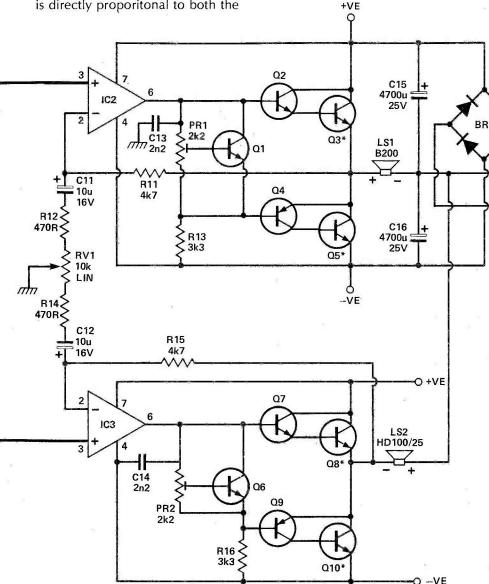
Because of the high input signal, very low gain is needed from the power stage, so the feedback level can be very high. R12 and RV1 in one arm and R11 in the other set the level of feedback, so RV1 can be used to adjust the level of the bass output - in fact, it's wired as a balance control, so it simultaineously adjusts the treble output.

Finally, note that the treble and bass units are connected in the opposite phases. This is to keep the reponse level at crossover; without this the two units would be in antiphase at the crossover point (this is due to the inevitable phase alteration caused by the filters).

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cone area and the maximum cone excursion. For good treble, though, the converse is true. A small light cone, or dome, with low mass is required to give good transient response.

As a consequence, almost all practical speaker systems that merit the title "hi-fi" contain two or more drive units connected to the power amplifier through a crossover. To work properly (or even at all) the crossover has to be designed for the specific drive units it is to be used with, to take account of the very complex (in both senses of the word) load that an audio drive unit presents on its terminals. Standard filter equations just don't work when you're dealing with a circuit component that defies any sort of simple representation.

require only a few watts without the ntended for the audio drive units. As a result, a 100W amplifier may system whose drive units would be needed to drive a speaker components, absorb power Another problem is that crossovers, being passive crossover in the way.

filters are built using standard components and will produce nearamplifier has the potential to solve Using active (or passive if vou all these problems. For a start, the impedance variations of the drive perfect text-book responses; the units will have no effect at all. prefer) filters before the power

bass unit is driven into clipping, the conventional cross-over system, the ill effects are not transmitted to the by clipping are directly coupled to A hidden benefit is that if the nigh-frequency harmonics caused the tweeter and this can have destructive consequences high frequency unit. in a

the speakers wil be much better Amongst the many other any resonances.

there was room for an active design towards the bottom end of the made active speakers are very very much cheaper than

range. Having selected the drive units,

domes have the advantage over

range 1.5 kHz to 20 kHz. Soft hard domes of not having a

within + 3dB of flat within the

resonance within their working

the next task is to decide the cross-

design, it was decided to restrict the KEF B200 and the Audax HD100/25 drive unit count to two, and to use two fairly well known units - the

frequency that you can use this unit

to. The HD100 has a fundamental

resonance at 800 Hz, so the cross-

between these limits. After quite a

over point has to be somewhere

The first of these units must be drive unit of all time! It features an exceptionally flat response up to ust about the best known bass

and in the end, second-order filters both the drive units are operating, order filters with steep cut-offs are problems with transient response range of frequencies over which attractive, as they will limit the In practice, such filters give about 3 kHz and gives an excellent sound pressure. The B200 also has neutral sound. Driven directly, 12 quite a nice low bass resonance. The HD100/25 is a soft dome unit, which delivers a response W RMS will produce 96 dB of

were chosen.

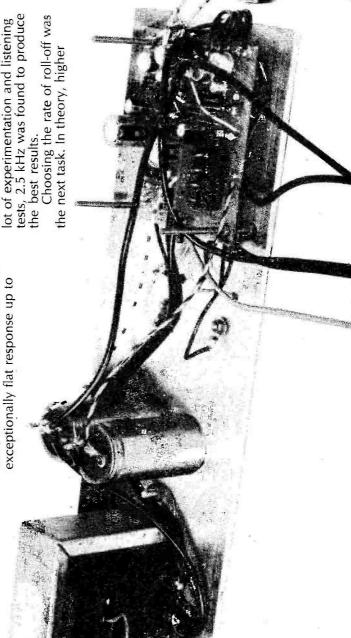
distortion from the power amps was compatible with existing equipment regimes, even with a comparatively found to be well below 0.1% at all driver amplifirs was set at close to constructors would have a power amplifier already), the gain of the Here comes the clever bit: to unity. The consequence of this is output levels short of overload. make the loudspeakers directly distortion and negligible noise that they operate in very low simple circuit. The measured (we assumed that potential

additional advantage that the active speaker can be hooked directly up to the back of your existing power This approach has the

# Boxing It Up

The last part of the design to be most common are the infinite baffle enclosure. Despite over 50 years of response of any speaker system is rather limited. At present the two considered is the enclosure. The choice of enclosure type is still research and development the critically dependent upon the and the reflex.

The former has the advantage of simplicity since it is merely a closed box. The reflext is also a box but with a tuning port incorporated. The



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medance of the amplifier, and this eads to a much lower Q figure for damped, because they see the low benefits from this approach is that

expensive - doubly so because vou in September 1982, which, although Unfortunately, all commercially will have to change the amplifier to use them. We've already published one active design, ourselves, back expensive and large. We felt that commercial units, was still rather

To make a simple but effective market, so here it is!

The choice of these parameters

cross-over frequency, and the roll-

off rates.

over characteristics, namely the

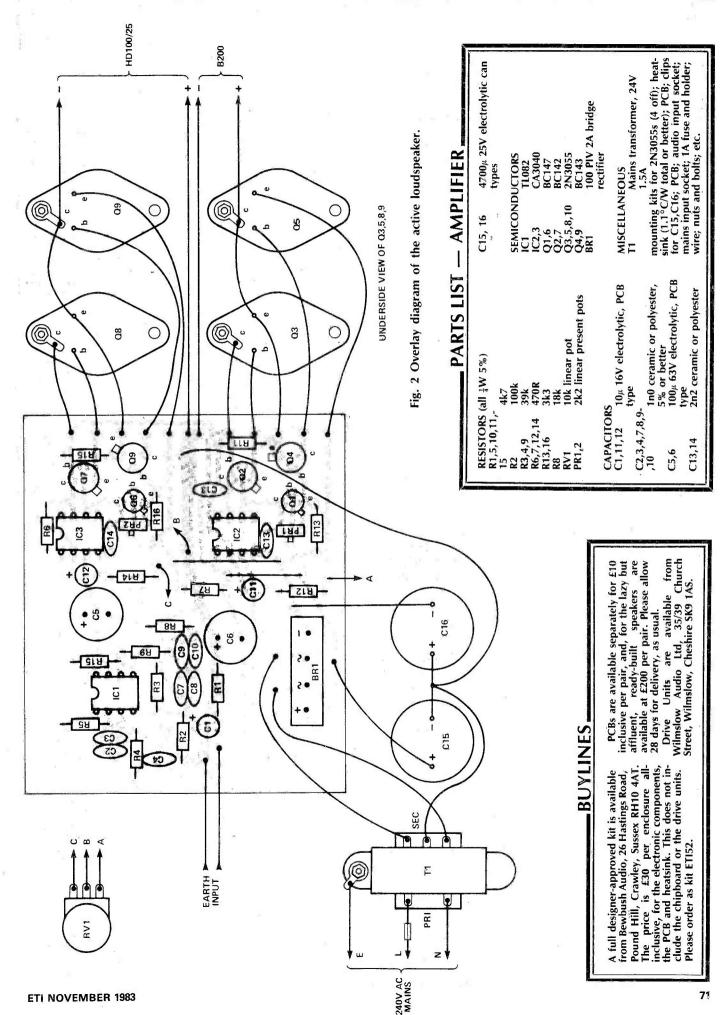
might at first think. The B200 has a

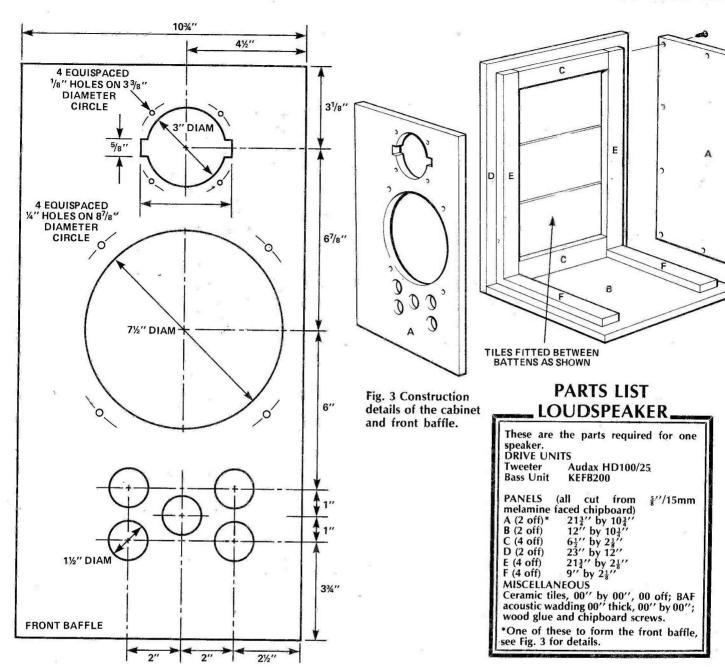
is rather more limited than you

mechanical roll-off at 3 kHz, and

this sets the absolute maximum

#### **PROJECT:** Active Speaker





tuning extends the LF response by making the enclosure into a mechanical tuned circuit. However, to operate effectively the enclosure and drive unit have to be matched and adequately damped. This can be difficult for the constructor.

For this design, a resistive port enclosure has been used. This form of loading is similar to the reflex but in this instance the port is fabricated from a series of small holes in the front baffle. This form of loading has one major advantage over both reflex and infinite baffle types. The Q of the speaker resonance is greatly reduced. This renders the enclosure essentially aperiodic at low frequencies. At the same time, deep bass output is augmented by the port whilst the transient response is better than both reflex or sealed box.

#### Construction

The construction of this project can be neatly divided into two parts, electronic and mechanical. The electronics can be tackled first. As you can see from Fig. 2 most of the components are mounted on the PCB. Very little comment is required about this except to ensure that all the semiconductors and electrolytics are correctly orientated.

The board is mounted on the heatsink along with the power transistors. Before mounting the board, though, be sure to solder the veropins in! To avoid the underside of the board shorting out on the heatsink spacers are used. Alternatively the board can be supported by means of nuts on the retaining bolts.

The power transistors and transformer should now be

mounted onto the heatsink. The latter is mounted with self tapping screws into  $\frac{1}{8}$ " pilot holes drilled as shown. The output stage power transistors are mounted on their insulating kits and a check for short circuits between the cases and the heatsink should be made. Last to be mounted are the smoothing capacitors C15 and C16.

Now the interwiring should be attended to. The leads to the drive units, to the collector and emitters of the power transistors, and those between the PCB and the smoothing capacitors should all be in fairly heavy duty wire.

To set the quiescent current, the following procedure should be followed. First, adjust the two presents PR1 and PR2 so that their sliders are shorted to the outputs of IC2 and IC3 respectively. Check that

this is the case using a multimeter.

Remove the two wire links (or, if you're very clever, don't fit them in the first place!) and connect up two 100R resistors instead. When you switch on, you should find a 2 V voltage drop across both of these. If you don't find this, there must be a fault somewhere - this will be particularly noticeable if either of the resistors should decide to burn out! Also check that the amplifier outputs are at zero volts.

Next adjust PR1 until the voltage across the 100R resistor near to C11 has risen by a futher 1.0 volts. Adjust PR2 for a further 1.0 volts increase across this resistor.

Switch off, replace the wire links; the amplifier module is now ready for use. Repeat this procedure for the other channel's module.

#### Cabinet Making

The mechanical work consists of making the cabinet. Fig. 3 shows the plans for this item. It is absolutely vital to ensure that the chipboad is cut accurately to size, or a little over as you can trim it down to the exact size with a Surform or similar.

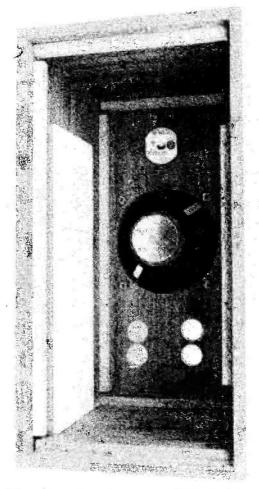
It's usual to use either high density or mixed density chipboard for loudspeaker construction. We've taken the slightly unusual step of using melamine-veneered type because the high density chipboard tends to have resonances with higher Qs. The mixed density chip could be used instead, but it's not easy to obtain. Before assembly begins, carefully check the sizes of all the panels. Also check the squareness.

Assembly is achieved as follows: first fix the battens in place using chipboard screws and a suitable glue. Assemble the enclosure except for the front panel, using screws

and glue again.

Next fit the amplifier module as shown in the rear of the case; drill holes to accommodate RV1's spindle and the wiring to the mains transformer and for the input connections. You can use either a piece of wire (dodgy) or suitable connectors for these, but do be sure not to leave any air gaps.

Damping of the cabinet walls by adding mass to them in the form of ceramic tiles - will help to prevent radiation from the rear of the drive unit reaching the outside world through the walls. The tiles will reflect the sound back into the wadding (which you'll be putting into the cabinet at a later stage) where it can be absorbed.



One position where it isn't appropriate to use tiles is on the rear panel behind the bass unit: sound would be reflected back to the cone, which would then reradiate it, resulting in a smeared sound. However, adequate mass loading is achieved by the heatsink, which, because of its shape, doesn't generate the same problems with reflection.

The ceramic tiles should be glued in as shown; they will fit neatly between the battens with a clearance of about 1/4". Many adhesives are suitable for this job, but we've found that Araldite Rapid, applied as a blob on each corner,

gives reliable results.

All that now remains is the front baffle (see Fig. 3 for cutting details). Note that the front baffles are made in mirror image pairs, and that the drive units are slightly offset from the centre line to avoid possible

diffraction problems.

The B200 is mounted using the template provided with the speaker unit. Note that the 7.5 mm recess is not cut here. Initial experiments with the recess cut showed no discernible audio advantage so the unnecessary complication has been avoided. Note, though, that the

foam gasket supplied has been used. Also supplied with the B200 are the mounting screws and T nuts.

The tweeter is fitted with four self-tapping screws;  $\frac{3}{4}$  No. 6 size is suitable. Note the recesses needed for the tweeter's terminals: these should be cut out with a rasp or similar. Connect the wires to the tweeter before fitting as it can be difficult to manouvre the soldering iron in the confines of the recess.

The last part of the assembly consists of fitting the BAF wadding. This is done in two stages. First cut a section out of the sheet about 12" square. This is stretched across the rear of the B200 and fixed into place with a few panel pins.

The remainder is now rolled up and placed in the cabinet. Finally screw the front baffle into place with chipboard screws. Now the

speaker is ready for use!

We haven't included a mains switch in the speaker; if your amp has one, wire the speakers to a suitable switched outlet socket on the existing amplifer. Connect the input to the loudspeaker to the output of the power amplifier, using screened cable if you wish (though this is probably not necessary), and switch on.

# USING FIBRE OPTICS

Does copper wire leave you stranded? Is your data missing the bus? L. N. Owen focusses our (tunnel?) vision on a radical alternative.

t is common knowledge that British Telecom and similar organisations now use optical fibres as a transmission medium instead of conventional wiring. This comparatively new technology has been refined to provide a highly efficient system for long-distance telecommunications, but as yet has not been used widely by the experimenter and hobbyist. This is almost certainly because of the high cost and the scale of typical applications (do you really want to build a 10 km transmission line?), but like most new technologies it has produced a number of spin-offs, and some of these do fall within the scope of the humble experimenter.

The main cause of the high cost of transmission systems is the need to use coherent light, that is, light of a specific phase and wavelength. To achieve this, and because of the need for a concentration of high energy to overcome long distance transmission losses, lasers are used. Obviously, if we can do without the laser, things become much cheaper. If we use a much lower energy source, and one which produces incoherent (random) light, we lose the ability to transmit over distances greater than 50m and to use certain phase dependent techniques, but we open up a very broad field of applications indeed.

In all the sample circuits given here, the incoherent light source is a narrow-beam, high-intensity, red LED. These can be bought ready mounted into fibre optic hardware, or, for the painstakingly adventurous, bought loosely and then mounted and polished for the specific application. The former method is strongly recommended for the inexperienced.

When using fibres, signals are transmitted using light. Light is electromagnetic radiation, and thus since it has no electrical charge, it cannot be affected by electric fields. In other words, by using fibre optics, the system is free from electrical noise such as mains or radio interference.

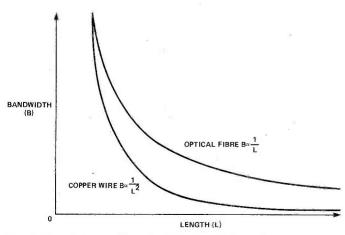


Fig. 1 Comparison of bandwidth over distance for copper wire and optical fibre.

Similarly, magnetic fields have no effect on the signal, and two fibres cannot interfere with each other since the light travels longditudinally, any stray photons being absorbed by the fibre jacket material. Thus crosstalk is non-existant, reducing the need for heavy screening and filtering equipment. Furthermore, as light is the carrier, any safety hazards that may arise with warm wires or electrical sparks are eliminated, a considerable advantage in, for example, the petro-chemical industry, where fibre-optic sensors are rapidly replacing all other systems. In addition, most optical fibres are chemically inert, small in size, light in weight, and are sufficiently flexible to be run just about anywhere. And yet, in spite of all these advantages, the single most important factor in the choice of fibre-optics as a transmission system is the range of frequencies it will handle (see Fig. 1).

For optical fibres

Bandwidth  $\sim 1/\text{length}$  whereas for electrical cables
Bandwidth  $\sim 1/(\text{length})^2$ 

#### **Fibre Physics**

Before using fibre a few principles must be understood, the most fundamental being that of the critical angle, or total internal reflection (TIR). Referring to Fig. 2, when light passes from one medium to another of a different density, some light will be reflected and the remainder will be refracted. The angle of emergence of the refracted ray,  $\theta$ , is found from Snell's Law:

 $n_1 \sin\theta = n_2 \sin\theta$ 

where  $n_1$ ,  $n_2$  are the respective refractive indices and  $\theta$  is the angle of incidence.

If  $\theta$  is increased, there will be a specific point where the angle of emergence,  $\theta$ , is 90°. At this angle there is no partial reflection, and this is known as the critical angle,  $\theta$ . The critical angle can be determined from:

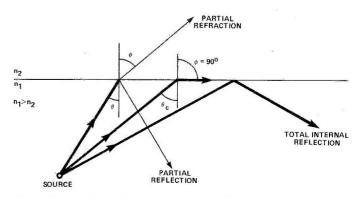


Fig. 2 Illustration of Total Internal Reflection.

$$n_1 \sin \theta_c = n_2 \sin \theta$$
  
 $\theta = 90^{\circ}$  at the critical angle  
 $\sin 90^{\circ} = 1$   
 $\theta_c = \sin^{-1} (n_2/n_1)$ 

If the angle of incidence is further increased, then all the light rays are internally reflected, and this is known as total internal reflection (TIR). Light is transmitted through a fibre by TIR; all other spurious partially reflected, or sub-critical rays dissipate very rapidly.

From this it can be seen that there is a discrete range of angles of valid input. This range is illustrated in Fig. 3 for an air/fibre interface, and is called the acceptance angle,  $\theta_a$ . Applying Snell's Law again we have:

$$\begin{array}{c} n_{0}sin\theta_{a} = n_{1}sin\ (90\ -\ \theta_{c})\\ = n_{1}cos\theta_{c}\\ = n_{1}\sqrt{1-sin^{2}\theta_{c}}\\ but \qquad sin\theta_{c} = n_{1}/n_{2}\\ sin\theta_{a} = n_{1}\sqrt{1-n_{2}/n_{1}})^{2}\\ = n_{1}-n_{2}\\ = 0.45\ typically \end{array}$$
 For the most typical case 
$$\begin{array}{c} n_{0} = 1\ (air)\\ sin\ \theta_{a} = n_{1}\sqrt{1-(n_{2}/n_{1})^{2}}\\ = \sqrt{n_{1}^{2}-n_{2}^{2}}\\ = 0.45\ typically \end{array}$$

Sin  $\theta_a$  is known as the numerical aperture, and it is a basic parameter for fibre selection.

Fibre is a three-dimensional media, and as such it supports several modes of propagation, the fundamental two being meridonal and skew. Skew rays follow light paths which never intersect the fibre axis; a special case of the skew mode of travel is that of a ray which travels parallel to the fibre axis, never being reflected throughout the fibre length. Fundamental fibre theory is concerned only with meridonal rays. These, as implied, travel through the fibre axis after each rebound from the fibre/cladding interface.

The final piece of mathematics waiting to be tackled is in calculationg transmission losses. There losses come from three major sources:

- i) curvature loss
- ii) core/cladding interface
- iii) fibre material

The curvature loss is a long-distance phenomena and can be ignored for our purposes. Core/cladding interface losses are due to slight non-uniforimities causing a localised change in c (the speed of light in the fibre body) and subsequent transmission loss. The attenuations in the fibre material are due to two processes. Firstly, impurities in the fibre can cause light to be scattered in a similar manner to the core/cladding interface. Secondly, impurities within the fibre can absorb certain wavelengths. There are two ways around this latter problem: buy an expensive, highly purified cable, or choose a suitable emitter whose peak

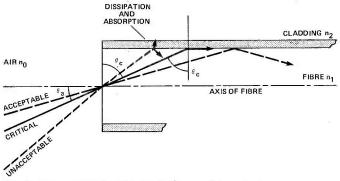


Fig. 3 Acceptable Angle needed to achieve TIR.

wavelength coincides with the maximum transmission spectra of the fibre.

Additional transmission losses come from couplings. The coupling loss is generally given in the respective data sheet (usually in dB/connection). For fibres it is given as dB/km. Thus, for a 1m length of polymer cable with a LED emitter and two bulkhead connectors, the representative calculations are:

Overall

but the overall attenuation = 10 log(emitter flux/detector flux) = 10 log( $\Phi_1/\Phi_2$ )

We usually know the maximum transmissable power,  $\Phi_t = 20 \ \mu W$  say

$$\log \Phi_r = \log 20 - 1$$

$$\Phi_r = 2\mu W$$

 $\log \Phi_r = \log \Phi_t - 1 dB$ 

It is also usual to know the optical sensitivity of the detector,

$$\$ = 0.44 \text{ A/W}, \text{ say}.$$

Hence

current = 
$$0.44$$
 or  
=  $0.88 \mu A$  maximum

This example shows the importance of keeping connections to a minimum, especially when using high attenuation fibres, which the cheaper variety tend to be.

#### **Techniques**

Optical fibres can be used in one of three ways: illumination, data transmission and sensing.

Taking the simplest case first, fibres can be used very effectively as illuminators, the principle being that of providing a light source channelling it where you will. Any form of optical fibre can be used for this purpose, in fact several types of heavy-gauge fishing line have sufficed for short distances. many cables can use the same source and thus provide a very effective and efficient means of illumination. Typical examples are instrument panels, microscopes, meters, switches, logos, etc.

Transmission of data is, as mentioned earlier, not generally practicable for the hobbyist, but there are exceptions, and a few possibilities are discussed in the section on circuits. Both analogue and digital data may be transmitted, although digital data will have to be handled serially.

Sensing covers an enormous range of fibre-optic applications. Optical sensors must be able to convert an input (pressure, temperature, flow, etc.) into variations of either light intensity, phase spectrum, or polarisation, but within the limitations we have set ourselves only amplitude modulation can be used. This not as great a restriction as it might seem because the majority of sensors use amplitude modulation anyway.

Amplitude can be modulated by absorption, emission, and by changes in refractive index. By juggling with these three parameters, fibre optics can be used for measuring strain, pressure, vibration, liquid and solid levels, gas presence, shaft position, temperature, and much more depending upon the type of end transducer used.

One of the simplest applications of fibres as sensory devices is in position detection (Fig. 4a). A similar system using reflected light could be equally well employed (Fig. 4b). The same system can be extended easily to counting

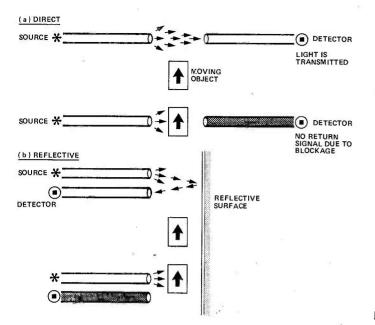


Fig. 4 Position detection using optical fibres.

applications, using pulse counting circuitry, and some forms of quality control. In the reflective mode there is a threshold of surface finish order for the light to be reflected at sufficient intensity, and in the direct mode there are intensity thresholds depending upon the colour density or opacity of thw moving object (eg, testing paper quality).

Taking the principle a stage further why not apply it to a shaft encoder — too late, several systems are already in use, operating both in the reflective and direct modes (Fig. 5). Encoders are also being mechanically coupled to measure pressure. With the same ingenuity, attach fins to

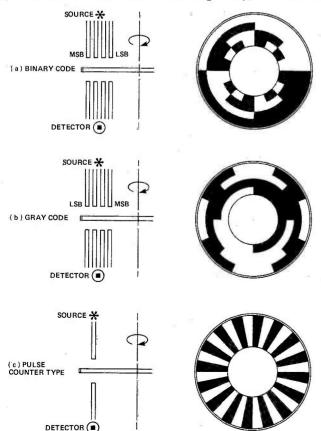


Fig. 5 Shaft encoders and flow meters.

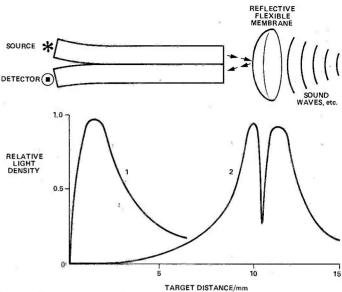


Fig. 6 Measurement of pressure.

another encoded disc (Fig. 5c) and you have a successful form of flow measurement. This particular type operates by counting the number of pulses per unit time and thus calculates the flow rate.

If the reflection method is reconsidered and the polished surface is replaced by a reflective flexible membrane then a form of pressure transducer is realised. Physical arrangement and typical response are shown in Fig. 6. Response 1 is for a single fibre pair whereas trace 2

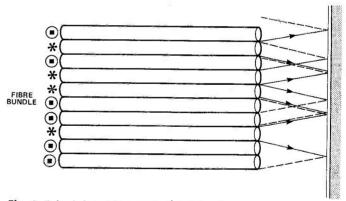


Fig. 7 Principle of the optical level.

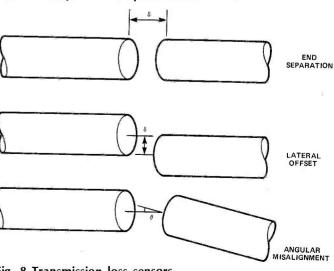


Fig. 8 Transmission loss sensors.

#### **FEATURE:** Fibre Optics

is for a semicircular fibre bundle. This vividly shows that transmission and reception need not be limited to a single fibre, in fact, most cases employ bundles of fibre in various configurations. One of the most popular is a random bunch of emitter and receiver fibres in a larger circular or semicircular cable. The reasoning behind this is that light leaves the fibre generating a cone of light rays. Reflecting this cone will disperse the rays even more, thus covering a greater reception area (Fig. 7). This technique is known as an optical lever.

À very sensitive optical sensor can be produced using the principle illustrated in Fig. 8. Two fibres can be made to lose transmission energy in three different ways, according to the distance between the ends, the lateral displacement, and the angular displacement. Using this technique, researchers have managed to measure displacement of as little as 0.005 angstorms. A graph showing typical characteristics for the three methods is given in Fig. 9.

All of the sensors described above work by interfering with the transmission of light between two terminated fibres. This is by no means the only way in which amplitude modulation can be used in sensor applications,

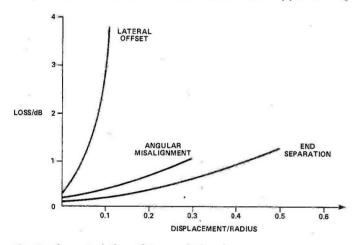


Fig. 9 Characteristics of transmission loss sensors.

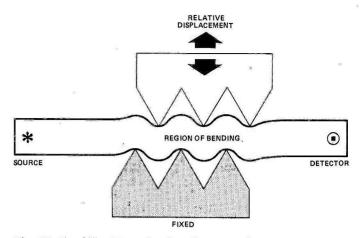


Fig. 10 Fixed/floating microbending transducer.

and a possible alternative is shown in Fig. 10. As mentioned earlier, where the angle of incidence exceeds the critical angle, light is transmitted through the cladding, thus reducing the overall intensity at the detection end. If the critical angle is artificially exceeded by some external excitation, then not only have we another form of displacement sensor, we also have one which modulates an unbroken beam of light. Such microbending transducers can be adapted to measure many different variables, but they are obviously ideally suited to the measurement of pressure. They have been used in microphones, since acoustic signals produce pressure changes, in flow meters (measuring turbulence) and in various other vibrational measuring devices.

#### Circuits!

The purpose of this section is simply to present a few tested emitter/detector circuits as a guide to further experimentaiton. Design usually revoles around input sensitivity and speed of serial transmission; however, various other factors such as analogue linearity, fitting, etc., do creep in.

The first circuit, Fig. 11, is one of the most useful since

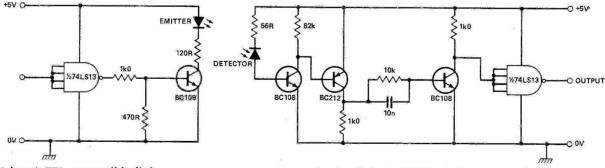
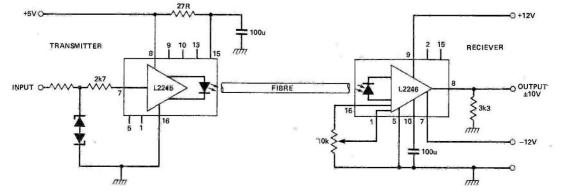


Fig. 11 (above) TTL compatible link.

Fig. 12 (below) RS232 replacement link.



#### **FEATURE:** Fibre Optics

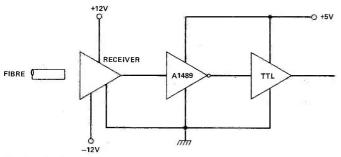


Fig. 13 TTL receiver

it provides a medium-distance TTL-compatible link. Using standard polymer cable this circuit can transmit up to 200K bit/s over a distance of 10m.

Figure 12 is a standard transmission line, the RS232. Belling-Lee produce a pair of transmitter/receiver modules designed to directly replace RS232 links. The use of fibres then eliminates all the noise problems, twisted pairs and emitting loops. The modules are made for PCB mounting with screw-on connectors. Primarily they are intended for glass fibres but any type can be used. They provide viable computer/VDU links up to 200m.

The circuit of Fig. 12 can be modified to become a TTL or CMOS transmission system simply by shorting the 2k7 input resistor of the transmitter and modifying the receiver as shown in Fig. 13. The A1489 linear receiver acts as a current buffer and thus provides the RS232 to TTL interface.

Figure 14 is an audio frequency fibre optic transmitter. It is simply an inverting amplifier with a gain of about -60 which drives the emitter via an NPN transistor. The preset, RV1, should be set to give 0V at the collector of Q1.

If power consumption is a problem with transmitters then a series-driven emitter circuit is required (Fig. 15a). This configuration is TTL compatible, gives easy digital control, and high brightness. The driving current in the LED is given by

$$I_f = (V_{cc} - V_f - V_{ol})/R1$$
  
where  $V_{cc} =$  supply voltage  
 $V_f = ON$  voltage of LED  
 $V_{ol} =$  low voltage of the open-collector

V<sub>ot</sub> = low voltage of the open-collector output

If the current step is so high that supply line modulation is occurng, a shunt driven emitter can be used (Fig. 15b). The power consumption is greater than a series circuit but the current step is reduced. The drive current is given by

$$I_f = (V_{cc} - V_f)/R1$$

Receiver design depends on which parameter you want to measure, and whether it is digital or analogue. However, the final signal processing is up to you.

Figure 16 is an audio frequency receiver compatable with the transmitter of Fig. 14. In its base form it is a simple one transistor amplifier driven by a photodiode. Obviously there are many variations on this simple theme: DC/AC amplifiers, A/D convertors, logarithmic or linear, etc.

Finally, for the keen and wealthy, there are several optical communication receiver hybrid circuits available. These provide most of the reception functions on chip, the user being able to control the sensitivity and operating speed. One such chip is the LH0082. This requires only a photodiode and a stable power supply for its basic preparation (Fig. 17a). Add a few minor components and the device can function over a range of 3 nW input sensitivity (@ 100 Kbit/s) to 300 nW input sensitivity (@ 15 Mbit/s). Additionally it can operate in an analogue mode (Fig. 17b).

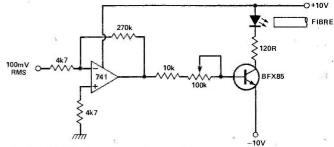


Fig. 14 Audio frequency transmitter.

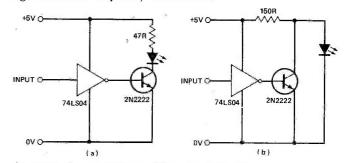


Fig. 15 Series and shunt driven transmitters.

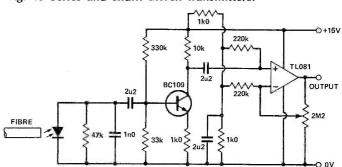
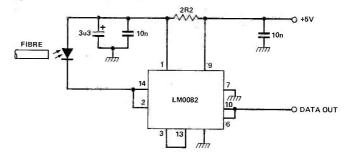
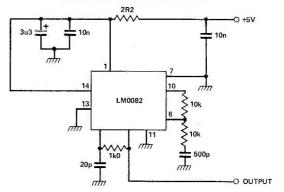


Fig. 16 Audio frequency receiver.

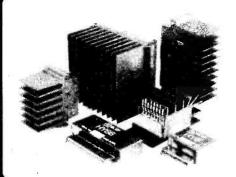


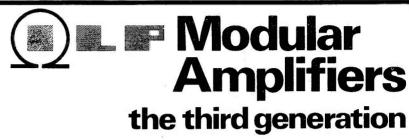
(a) BASIC CONFIGURATION, 30nW, 650 kbit/S



(b) ANALOGUE CONFIGURATION, 50mV/uW Fig. 17 Optical communcation receiver.

Hopefully these circuits will provide a useful springboard for many projects, as well as making a relatively new technology accessable to the masses!





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HY30	15	4-8	0.015%	<0.006%	± 18	76 x 68 x 40	240	£8.40
HY60	30	4-8	0.015%	< 0.006%	± 25	76 x 68 x 40	240	£9.55
HY6060	3 <b>0</b> + 30	4-8	0,015%	< 0.006%	± 25	120 x 78 x 40	420	£18.69
HY124	60	4	0.01%	< 0.006%	± 26	120 x 78 x 40	410	£20.75
HY128	60	8	0.01%	< 0.006%	± 35	120 x 78 x 40	410	£20.75
HY244	120	4	0.01%	< 0.006%	± 35	120 x 78 x 50	520	£25.47
HY248	120	8	0.01%	< 0.006%	± 50	120 x 78 x 50-	520	£25.47
HY364	180	4	0.01%	< 0.006%	± 45	120 x 78 x 100	1030	£38.41
HY368	180	8	0.01%	< 0.006%	± 60	120 x 78 x 100	1030	£38.41

Protection: Full load line. Slew Rate: 15v/µs. Risetime: 5µs. S/N ratio: 100db. Frequency response (-3dB) 15Hz - 50KHz. Input sensitivity: 500mV rms. Input Impedance: 100K  $\Omega$  . Damping factor: 100Hz >400.

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HY73	Guitar pre amp		20mA	£15,36	
HY78	Stereo pre amp	As HY66 less tone controls	20mA	£14.20	

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MOS 128	60	4-8	< 0.005%	<0.006%	± 45	120 x 78 x 40	420	£30.41
MOS 248	120	4-8	< 0.005%	< 0.006%	± 55	120 x 78 x 80	850	£39.86
MOS 364	180	4	< 0.005%	< 0.006%	± 55	1:20 x 78 x 100	1025	£45,54

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PSU-43X	1 x MOS128	£16.70	
PSU 51X	2 x HY128, 1 x HY244	£17.07	
	1		

Model Number	For Use With	Price inc. VAT
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PSU 71X	2 x HY244	£21.75

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# FAST LIGHT PEN

If you want to use your computer for some real work instead of all these silly games, a light pen can be a useful tool. Design by Martin Postranecky.

his circuit will enable you to build a light pen for use with most home computers, but at a fraction of the price of any commercial unit with comparable performance. Apart from cost, the circuit's main advantages are the very high response speed and the compatability with a large range of TV or monitor brightness and contrast settings.

#### **Going Soft**

In order to construct a light-pen system, both software and hardware are needed. This article covers the hardware in some detail, but, apart from giving some hints, leaves the construction of the software largely up to the reader. However, we do hope to be able to give software details in a future issue (no promises, though, so there's no excuse for laziness on your part).

Generally, computers have a dedicated area of RAM that contains the information for the TV display. Words of data are read sequentially, each word being enough information to determine the brightness and colour of an area of screen known as a pixel. The size of the pixel — the number of lines it extends across and how far it extends along them depends on the computer, but the pixel will be refreshed at a standard rate, every 40 mS in the UK system of two fields of  $312\frac{1}{2}$  lines in 20 mS.

When the electron beam "hits" the pixel at which the light pen is pointing the sudden change in phosphor brightness will trigger the light pen circuit. The resultant TTL output pulse can then be used to generate an interrupt which will identify the display file pointer position for that pixel. Your software should then either vary the content of that particular display element

generate an offset vector to move the element to follow (TRACK) the light

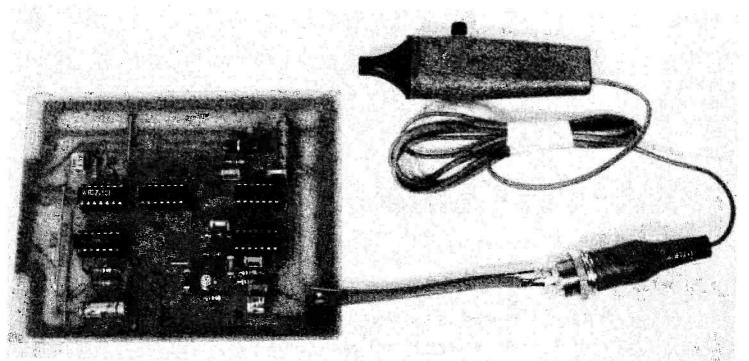
#### Light Hardware

Obviously the response of the light pen must be very fast to enable you to capture the required element. With the photodiode used in this design, the TTL pulse is generated in under 300 nS; if an even faster response is required try a silicon PIN photodiode, eg BPX-65.

The circuit is very easy to build using the PCB layout provided. The

only difficult part is the negative supply line, -7.0 V at about 30mA (the Video Amplifier will probably catch fire above  $\pm 8\text{V}$  and the comparator will not work with less than -6V!). But as most computers provide -7V, -12V or  $-15\dot{V}$  line, the simple

BZY88 (6V8) Zener regulator should be satisfactory provided the correct



The ETI version of the light pen — unlike the author, we used the body of a highlight pen so that we could fit in the optional

value for the series esistor, R11, is used, as given by Table 1.

The MIXED SYNC line is normally available at the TTL level in any computer somewhere on the video mixer board — most likely as an output of a ZNA134J or an equivalent IC. If all else fails try the cheap and simple circuit shown in Fig. 3 using the

VIDEO OUTPUT line

computer.

#### **Body Building**

To form the lightpen body, I used the barrel of a cheap ball-point pen with the photodiode push-fitted in the "sharp" end behind the 1mm 'hole'. But any ball-point / fountain / felt-tip pen /cigar tube / etc would be just as effective — use your imagination! Two points to remember — it is much easier to use a pen barrel

where the tip separates or unscrews from the body so that you don't have to work in a 4" long tube. And make sure that the photosensitive element "sees" only a single TV line width. This depends on the size and resolution of the CRT but the aperture in front of the photodiode should not exceed 1 mm diameter. If you like weight-lifting you could even use one of those large 12-colour ball-point pens and build the whole circuit into the body of the pen (though you'll have to re-design the PCB!)

Two suggesions you might like to use are:

• you could mount the main PCB inside your computer case, and connect the pen to the circuit board us-

#### HOW IT WORKS.

of your

Light falling on the reverse-biased photodiode PD1 increases the leakage current through the diode and R1. The resultant voltage change is AC coupled to the emitter follower Q1 and appears across its emitter load R4. Signal amplification is further provided by the variable-gain Video Amplifier IC1. The SET GAIN potentiometer PR1 is connected between the high gain select pins 4 and 11 and allows the voltage gain to be set between about 50 and 200.

Any small change in the amplifier output (about 10 mV) is detected by the analog voltage comparator, IC2 and appears as a negative-going TTL pulse at the output pin 11. This pulse is inverted by IC3a and clocks out the two complementary output lines LPOUT (Q1, pin 5) and LPOUT (Q1, pin 6) of the dual flip-flop, IC4 with its DATA 1 (pin 2) tied high via R8.

The low-going edge of LPOUT also triggers the monostable IC5. After the preset time period — variable by the SET PULSE LENGTH potentiometer PR2 — the high-going edge of the IC5 output Q

(pin 1) clocks-out the low-going output Q2 (pin 8) of the flip-flop IC4 (DATA 2, pin 12, is again tied high via R7). After passing through gate IC3b and inverter IC3c, this pulse sets the CLEAR 1 (pin 1) of IC4 low and thus clears the flip-flop IC4 outputs, LPOUT and LPOUT. The CLEAR 1 will remain low (and so prevent any further triggering of IC4) until the CLEAR 2 (pin 13) is brought low by the next Line Sync pulse of the MIXED SYNC line. This system ensures that only one pulse in any TV scan line is passed to the computer and prevents any spurious trigerring caused by the CRT flyback or sync pulses.

The STROBE (pin 13) of IC2 is normally held high by R2. If the optional switch SW1 is used in the LIGHT PEN body the STROBE will normally be low, inhibiting the IC2 output. The operation of the push-to-break switch SW1 allows the STROBE line to swing high enabling the IC2 output. Capacitor C4 removes the worst of the switch bounce from the STROBE line.

#### BUYLINES.

ing a three-pin DIN plug and socket;

No problems with the components here — NE529A and NE592A are offered by a number of suppliers advertising in this magazine, and the photodiode PD1 (RS Components Stock No. 305-462 used in the prototype) can be any fast response/visible light silicon diode in TO18 can. The PCB is available through our PCB service.

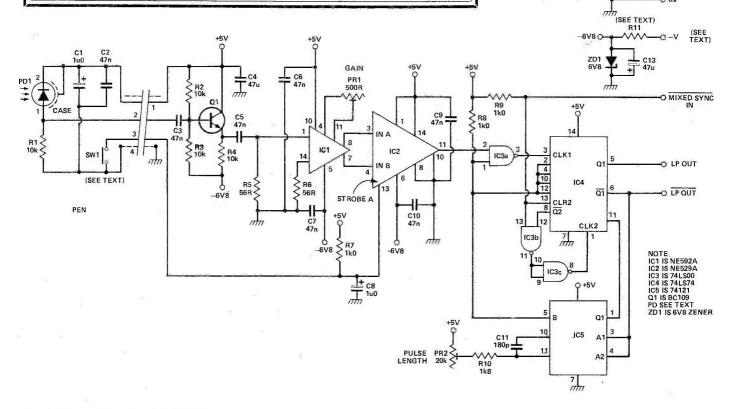


Fig. 1 Circuit diagram of the light pen.

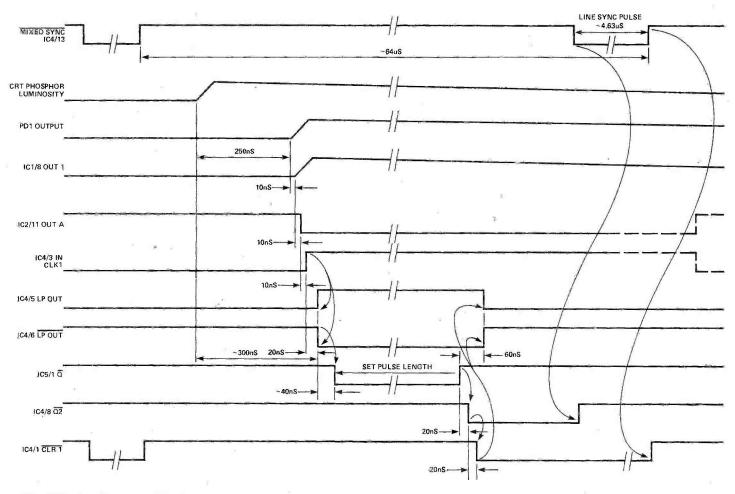


Fig. 2 Timing diagram of the light pen.

• if the size of the light pen body permits, you might find it useful to mount a small push-to-make switch on it (SW1) connected between the ground (shield) and the third wire. You can use SW1 as a push-to-write switch.

#### Setting Up

Construction of the main PCB should pose no problems. Please make sure that all the ICs are the right way round — they don't all fit the same way! Don't forget to insert all

five links as shown on the PCB overlay and re-check the polarity of the zener ZD1 and the electrolytic capacitors. (If you think all this is superfluous, you don't know your Murphy's law).

Use and oscilloscope or a logic probe to look at the output of IC4 pin 5. Point the light pen at the TV screen with the brightness and contrast setting fully down (ie, dark) and adjust the GAIN present potentiometer PR1 so that the line stays low.

Then set both brightness and contrast back to the usual level and

point the light pen at some white display element. Slowly increase PR1 until a single pulse appears on the TTL output line. Because the light pen could cover two or more scan lines depending on the CRT size, you may get two or three pulses repeated at  $64 \mu S$  interval. You should be able to reduce the gain with PR1 and/or TV brightness control sufficiently to obtain just a single pulse.

Finally set the required pulse duration by the PULSE LENGTH potentiometer, PR2 (adjustable between about 200 nS and 2µS).

All that remains now is to sit down and write your software to actually use the light pen. What about a (computer) game of battleships...?

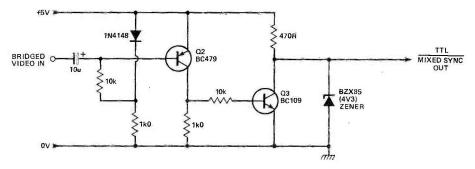


Fig. 3 Circuit to recover the MIXED SYNC pulse from the composite video. ETI NOVEMBER 1983

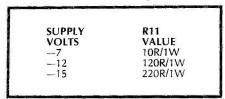


Table 1 Values of R11 for various negative host computer supply voltages.

# PROJECT : Light Pen

RESISTORS (a R1, 2, 3 R4, 7, 8, 9 R5, 6 R110 R111 PR1 PR2	
RESISTORS (all ¼W 5% unless stated) R1, 2, 3 10k R4, 7, 8, 9 1k0 R5, 6 R10 R11 PR1 PR1 See Table 1 PR2 20k lin preset PR2	GND { -V { -V { SYNC SYNC SYNC SYNC SYNC SYNC SYNC SYNC
ed) CAPACITORS C1, 8 C2-7, 9, 10 C11 C12, 13	
1u0 10V tant 47n polyester 180p ceramic 47u 10V tubular electrolytic	
SEMICONDUCTORS IC1 NESS IC2 NESS IC3 741S IC4 741S IC5 PATE PATE PATE PATE PATE PATE PATE PATE	
NE592A PD1 NE529A PD1 NE529A 741574 74121 BC109	
High light TO10 text BZX8 Zene	
High-speed visible light photodiode in PC TO18 can — see two text — BZX85 (6V8) 1W mazener diode	
MISCELLANEOUS  PCB; three-core plus shield cable (or two core without SW1); light pen body — see text; SW1; miniature push-to-make switch (optional); three-pin DIN plug and socket (optional).	
shield cable (or 1); light pen body niature push-to- i); three-pin DIN (onal).	TO LIGHT

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# READ/WRITE

#### **Component Supplies**

Dear ETI,

Your IC Update feature is most interesting, not least for your introductory remark about neither IC being actually available to the hobbyist.

It encapsulates something I've long been feeling — that the home constructor/hobbyist/amateur etc is often regarded as a convenient

disposal route for the obsolete, substandard and just plain trashy.

Maybe I'm in a minority, my electronics interests being focused on audio with aspirations to the building of equipment with the sonic qualities of Mark Levinson, Threshold, etc. It's a continual pain to deal with supliers who can't even deliver what they advertise (and what they advertise often lags far behind industrially-available components).

I'd have thought that there was scope for someone, somewhere to get on a platform as a purveyor of genuine quality up-to-date goods as an alternative to the present system of 'bargain packs' and 'just as good only cheaper' (it's never as good and always costs you more to put right in the long run). Not that I condemn the cheapos entirely, many of us started there — but to what extent are we stuck there for the want of an alternative and for the want of a bit of imaginative energy?

Yours Dick Bowman London E17

We're very glad that at least one reader concurs with our remarks. We have, ourselves, access to 'professional' sources for components, and frequently we are unable to specify components that we'd like to because they are not available on the hobby market. So what do we do — do we leave out the devices in question, as we've done so far, or do we use them and hope that we can persuade someone, somewhere to sell them to readers?

To a great extent, what actually makes its way on to the hobby market depends on manufacturers' pricing policies — if the 100 (or even 1000) off prices are punitive,

none of the advertisers in our magazine will stock bits because no one will buy them. And can you blame them?

We've spent quite a lot of effort trying to get manufacturers to recognise that the hobbyist market is important. It is very frustrating indeed to speak to an engineer who started out as a hobbyist (admittedly, probably before going on to do a formal qualification in electronics) who still doesn't recognise that we're important. It's also surprising how little it is recognised that ETI and (to be generous to the opposition for once!) other hobbyist magazines are widely read by professional engineers.

#### ZX81 Tape Mod

Dear Sir,

On page 61 of the February issue you publish an article by Mr lan Ridout concerning modifications to facilitiate recording programs from the ZX81 on to cassette. Talk about a sledgehammer to crack a nut!

A year or so ago I did modify my son's ZX81 — and then quite a few of his friends' got done - to increase the write signal to cassette. Inspection of the Sinclair circuitry had revealed, as Mr Ridout states, that only about 1 millivolt RMS of signal emerged from the '81' at the cassette port, after the double 47 uS filter. Changing Sinclair components R29/C12 to 330K and 150pF worked with some 20 different machines, from metered hi-fi decks to autolevelled portables. This, of course, tripled the signal to the cassette. 220K/220 PF combinations were also acceptable, giving a fivefold increase approx.

To use an FET as a buffer is a substantial overkill — needless when even a loading of, say, 10k/4n7 would be acceptable to the machine and give over 100 mV of signal, RMS. It is far more likely to create difficulties with the circuit published in your magazine owing to the very high signal level, than the easy and modest change of 1 resistor and 1 capacitor.

Yours sincerely, P. A. Duvall Theydon Bois We don't accept that using one transistor is comparable to using a sledgehammer! Certainly, if we'd managed to fit in a couple of ICs, perhaps a dedicated micro to handle the tape signals . . . then that criticism really would be in order. As to difficulties with high signal levels, we've had none reported as yet — and, in any case, it's always far easier to get rid of excessive levels than it is to boost inadequate ones.

#### **Fuel Economy**

Dear Sir,

Your comments on the Hyconomiser suggested that readers might be interested in the possible advantages of electronic mpg devices. Mine is a Mobelex Maximiser, giving an instantaneous readout in mpg, and a record of fuel used, to tenths of a gallon. My car is a 1972 Datsun Bluebird (1600cc) which, until a replacement carburettor was fitted a few years ago gave exceptionally economical consumption. I had always suspected that I had been lucky, and when the consumption on a run increased from the early 40s to the late 30s I fitted the meter to check up on the situation.

I had hoped that the meter might indicate places on the performance curve where the carburettor was delivering an economical mixture, and this proved to be the case. Observing the meter readings at steady speeds showed that just above 50mph gave a noticeably low reading. This was a rather lower cruising speed than the one I had found by trial and error to be economical with the previous carburettor, but checks on mileage and fuel put in (which agreed very closely indeed with the meter readings) showed that I could now get an overall consumption very close to 50 mpg, though traffic hold-ups and so on seemed perpetually to conspire to limit me to forty-nine point something and deny the triumphant fifty-plus. Nevertheless, I found the improvement of over ten miles per gallon very satisfying on those unavoidable long runs.

Of course, it is not all joy, and meter watching needs a certain frame of mind, where driving satisfaction comes from saving, rather than the wind in the hair. The meter shows what we all know but prefer not to believe. Hard acceleration can show as little as six

or seven mpg, while one

enthusiastic overtaking up hill can more than counteract ten miles of careful driving on the level. Most of the economical methods I already knew, but didn't practise regularly until the meter kept reminding me of my wastefulness. One new — to me — tip is not to let the speed increase as the car breasts a hill. Easing off to keep the speed constant can show startling improvements, which of course follows logically if one considers that if acceleration up hill is far worse.

One doesn't need to watch the meter all the time - in fact, once one has explored the performance envelope with it, if you drive by your findings you don't need to use it at all, yet I personally wouldn't be without one in future. On the other hand the ideal meter would differ in some respects from the one I have fitted. When one is using small quantities of petrol the fuel flow transducer appears to give a signal every second or two, and the combination of this data with the more frequent speed signals gives a display that flickers over some 5-10 mpg. It would be easy to be dismissive about the meaningfulness of the display, but in fact the trend of the figures is quite easily followed indeed, after some degree of use one can begin to read subtleties into the way the display is operating. Nevertheless, some kind of integrating device that would operate over a second or two would make the device easier to interpret, particularly by the impatient or nontechnical. Again, reading the tenths against the mileage enables a quick check on mpg attained over the last five miles or fifty miles, or since the beginning of the journey, but it would be pleasant to do this automatically rather than by mental arithmetic.

Incidentally, the best mpg I have ever attained over a distance was coming eastward on the M4 from the service area on the summit level. A strong tail wind enabled me to display (and check on the mileage/consumption figures) over 80 mpg for some thirty miles. Needless to say, awful rush-hour jams at the London exit reduced my overall figure to about fifty . . .

Unfortunately I lack both the time and the expertise to design my own ideal meter, but I feel that I would now be able to offer quite a lot of useful advice to anybody thinking of obtaining or designing one.

I am sure that a device like the Hyconomiser could improve the consumption of any car that, like mine on its new carburettor, was operating slightly rich. However I don't understand the emphasis on the so-called optimum mixture, where the oxygen and hydrocarbons are present in the exact quantities needed for the theoretical reaction. In real life, some of the petrol and some of the oxygen just can't get together, and both petrol and oxygen are wasted. For some forty or fifty years two mixtures have been aimed at: 1. A rich mixture for maximum power with excess fuel, where all the oxygen is burned, but some

petrol is wasted. 2. A weak mixture for cruising, with excess air, where all the fuel is burned, but some oxygen passes off unburned (don't forget that four fifths of the gas in the cylinder is nitrogen, that passes out hot but unchanged, so a little excess oxygen is unimportant). Modern carburettors try to operate in thesetwo regimes, and avoid the 'optimum' mixture like the plague. The problem, leaving aside gross failures to atomize, is that no improvement in mixing arrangements can improve the

mixing beyond a certain point determined by the mathematics of probability. This effect was first noticed, to

my knowledge, in connection with the Lumiere 'Autochrome' colour photographic plates circa 1910. The system depended on an intimate mixture of red, green and blue fine transparent powders to produce a mosaic screen with many million elements to the square inch. However aggregations of many grains all of the same colour produced objectionable spots on the plates, and it became apparent that more thorough mixing did nothing to alleviate the problem. In the 1920s E. J. Wall showed that the number and size of these clumps of grains was very close to that predicted by probability theory. Even larger clumps of grains should have been present, but plates with these were presumably rejected by visual inspection.

Anyone who hopes to create an ideal mixture without 'lumps' merely by mixing or agitation is, I am afraid, attempting to evade one of the laws of nature. Yours sincerely Michael C. Jones Harrow

We have considered doing a project for a fuel consumption monitoring system, as the electronics involved would be relatively simple and easy to design. However, the problems come in trying to design the fuel volume and the distance travelled transducers.

#### **Tropical Programming**

Dear Editor,

I'm having infinite trouble with my Atari Cassette Programmer and wrote to HE wondering if their EPROM project earlier this year (the magazine takes some time to reach me out here!) would be of use. They say not, but suggested contacting you.

I need some way of storing programs and loading them; my 410 program recorder seems to store them but won't load. There are two of us in Fiji with Ataris and both of us have exactly the same problem. My friend got a disc drive, but that's packed up too, so we are driven to lying on the beach, drinking from a coconut and dreaming of programming.

Any suggestions welcome.

Rob Patterson

Lelan Memorial School

This must be the cruellest letter we've received in a long time — how is it possible for anyone to worry about programming when there's important business like lying on the beach to get on with? There's nowt so queer as folk (well known north of England saying No. 42)

So far as we are aware, the 410 programmer is a reliable piece of equipment and should work. However, it's probably the excess heat that's giving the trouble, by causing the timing components in either the recorder or the interface to change value just enough for the two not to be compatible. Have you tried using the computer and recorder in an air conditioned room? Alternatively, we suggest contacting Atari themselves.

ETI welcomes all it's readers (publishable) opinions on the contents of the magazine, and issues related to electronics. Send your letters to The Editor, ETI, 145 Charing Cross Road, London WC2H 0EE.

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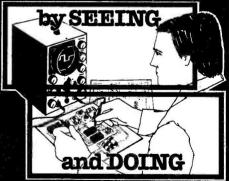
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# LOGIC CLIP

Ever been frustrated trying to test a digital circuit with only one single-point logic probe? Never fear, ETI comes to the rescue with this 16-point, 4-state CMOS/TTL logic probe.

his logic clip is a very useful addition to a digital test-set, speeding up the tedious testing of MSI devices, such as flip-flops and counters. Such clocked logic requires both stimulus and effect to be observed, and this is difficult to do with a conventional logic probe. The usual solutions of a multi-trace oscilloscope and a logic analyser will be just a bit beyond the means of the average ETI reader. The ETI logic clip provides equivalent facilities at a much more approachable cost.

When built, the logic clip simply clips on top of the IC to be tested (using an IC test clip), showing the logic state (high, low, undefined or pulsing) of all 16 pins of the IC. The probe caters for both TTL and CMOS ICs — the high and low logic levels are selected by a

single switch.

#### **Goodbye Tedious Testing**

The logic clip is the ideal partner for the ETI Dicrobe logic pulser (September 1982), which can provide suitable stimuli for the IC under test. For example, let us suppose that we wish to test for the proper operation of a binary counter. If we use a normal probe, each counter output must be checked before the next clock pulse can be applied, to make sure that the clock pulse is producing the desired response - a binary count. Contrast this with using the logic clip, which simply fits on top of the counter chip, leaving your hands free. You sit back, push the pulser button and watch the count progress.

#### **Dazzling Dual Colour**

The circuit basically consists of two identical logic probes, which compare the input with selectable logic levels for low and high, and drive the display LEDs accordingly. The small size of the clip is achieved by scanning eight pins on either side of the test IC, and feeding the selected test voltage to these two logic probes. Of course, there would be little point in doing this if all the data was displayed on one LED — the result would be a meaningless blur, so the display is made up of two rows of eight multiplexed dual colour LEDs, one row for each logic probe.

These dual colour LEDs are connected between the outputs of the high and low comparators, and give the following indications:

High: green Low: red Undefined: off Oscillating: yellow

With experience, the mark/space ratio of an oscillating mode can be estimated from the degree of red or green in the yellow indication. To make the device easier to read, the LEDs are laid out in the pattern of the IC pins (see Fig. 2a), each LED

corresponding to the test pin below it.

The scanning is done by 4051 CMOS one-of-eight analogue selectors for both input and display. These have an on resistance of about 160R, and so will limit the current through the LEDs. The scan address lines are provided by the binary counter IC2, fed by oscillator IC1, which runs at a frequency high enough to maintain persistence of the display (ie, no flicker). The rather odd order in which the pins are scanned is due simply to the constraints of the PCB design.

#### Construction

The probe consists of two circuit boards attached to an IC test clip, each board displaying the state of the eight pins on it's side of the IC. Start the construction by soldering the wire links above R6 on board 2, then insert the resistors

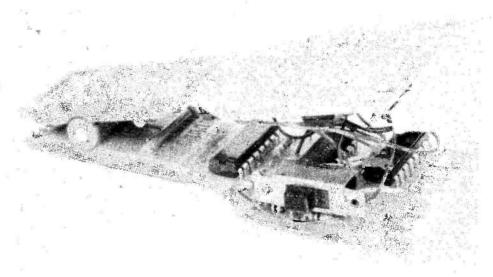
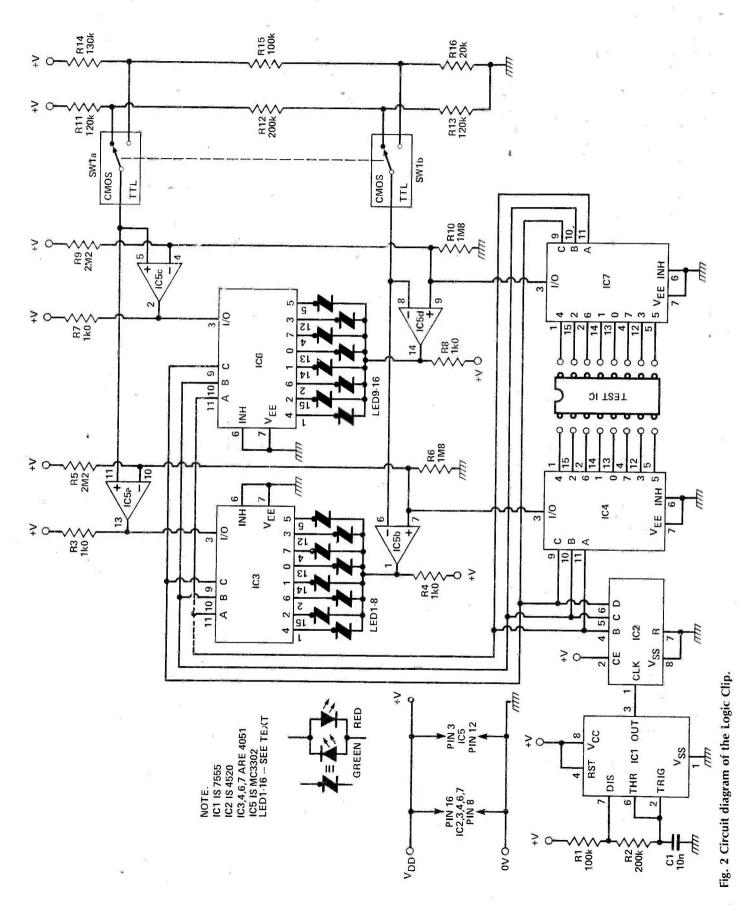


Fig. 1 Construction of the logic clip is on two boards which are then glued onto an IC clip.



**ETI NOVEMBER 1983** 

# HOW IT WORKS

The logic clip relies on the multiplexing/demultiplexing action of the 4051 analogue selectors. The scan address is provided by the dual binary counter, IC2. Only one of the counters is used, and the count outputs B, C and D are taken to the 4051s for ease of PCB design. The counter is fed by the 7555 oscillator, IC1. The components used set the oscillation frequency at around 500 Hz, so each of the test IC pins is scanned approximately 30 times a second:

As each of the pins is scanned in turn, the voltage at that pin is fed to the high and low comparators of ICS (two comparators for each side of the chip). The upper and lower threshold voltages are provided by R11-R16, and are selected by SW1. The outputs of the comparators vary with input as shown in Table 1.

and do nothing when high. Thus, the LEDs have to be driven by resistors R3, the output is high, the current can flow through the LED. The outputs of the low comparators, IC5b and IC5d, are connected to the commoned green The comparators have uncommited colanodes, and the high comparators, IC5a IC5c, are connected to the demultiplexers, IC3 and IC6. These are fed by the same address lines as the multiplexers, and have a similar PCB ayout, so each LED corresponds to the are passive high, i.e. they just sit there 4, 7 and 8. When an output is low, the preventing the LED from lighting. When test pin directly below it. The net resul all this is a four-state display of wha is happening on the sixteen pins of the open collector sinks current to ground commoned under the clip. nected

# BUYLINES.

Problems here are the LEDs and the test clip. Make sure that the LEDs are 2-lead devices, NOI the 3-lead common cathode type sometimes called 'dual colour'. Suitable LEDs are available from Warford Electronics.

Watford Electronics.

Our test clip was obtained from Basic Electronics, but Maplin, GSC and RS stock equally suitable clips forder codes FY74R, 08-0016 and 423-627 respectively)

		ther	36
	TTL 6 0 8 11 0 0 9 CMOS	SW1 CONNECTIONS +VE	
LED 16 15 14 13 12 11 10 9	2 3 4 4 4 4 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5	10 10 10 10 10 10 10 10 10 10 10 10 10 1	TEST CLIP BOARD 2
(ED) 2 3 4 5 6 7 8	1   1   2   3   1   2   3   1   2   3   1   2   3   1   2   3   3   1   3   3   3   3   3   3   3	FVE — R5 — R6 — R6 — R6 — R6 — R6 — R6 — R6	TEST CLIP BOARD 1

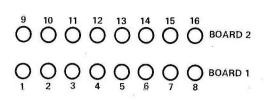
# PARTS LIST

Fig. 3 Overlay diagram of the logic clip. Note that all the numbered points and the points with letters A and B should be joined up (ie, join 1 to 1, 2 to 2, A to A, etc. The point marked 'X' is where the foil may be cut if you want to power the clip from an external source (see Expanda-clip section of text). Note also that resistors R4, R7 and R8 are mounted on the foil side of the PCB, and should be very carefully soldered onto the pads

provided to avoid lifting the track.

IED 1-16 0.2' two-lead red/green dual colour colour MISCELLANEOUS PCBs, DPDT switch (as small as possible), IC test clip, 2.5mm jack plug and socket, two core lead, red and black croc. clips.	10n (B37448) JCTORS 7555 4520 4051 MC3302	CAPACITOR 10n (B37448) C1 SEMICONDUCTORS IC1 7555 IC2 45. 7 4051 IC3, 4, 6, 7 4051
in (B37448) 555 20 530 C3302	JCTOR	CAPACITOR C1 SEMICONDUCTOR IC1 IC2 IC3, 4, 6, 7
	CTOR	JCTOR

#### **PROJECT: Logic Clip**



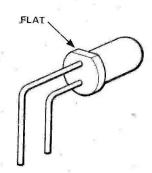


Fig. 4(a) The layout of the indicator LEDs. (b) Mounting details of the two-colour LEDs.

and C1. Next, fit the LEDs: these are dual colour devices, with a flat on the package that indicates the red anode/green cathode lead. Form the LED leads as shown in figure 4b.

Connect SW1 to points 6 to 11, following the layout shown in the overlay diagram. Now solder the ICs in place, noting their orientation and taking care not to make any solder bridges across the many fine tracks. Next, carefully solder the resistors R3, 4, 7 and 8 on the foil side of board 2, keeping the resistors as close to the board as possible. Finally, solder the power jack socket in place, taking both power rails to each board from the socket.

Once the boards have been assembled, it would be advisable to test them before attempting final construction. Temporarily wire the boards together using lengths of insulated wire to join points 1-5. Plug in the power jack and apply suitable test voltages to each of the sixteen inputs (e.g. try V+, 0V and V+/2). Check that the LEDs light correctly for both CMOS and TTL threshold levels. If they do not, check that the LEDs are connected the right way round, and that all the components are inserted correctly.

#### Tricky . . .

Now for the tricky bit of mounting the boards onto the test clip. Details will depend on the type of clip used, but the method we used for our hinged clip will apply to most types.

First, shape the test contacts so they fit through the holes in the PCB. Bend these pins to make the edge of the board flush with the plastic of the clip. Then solder the boards to the clip with the components facing inwards. This joint may be strengthened by filling between the board and the clip with epoxy resin, such as Araldite. Finally, make the inter board

connections 1 to 5 with lengths of fine, flexible insulated wire. These wires will be flexed as the clip is used, so it would be wise to reduce the strain on them. This can be done by making a loop in the wire like that shown in figure 5, and ensuring that the wire is at right angles to the board.

#### ... But You Can Do It

The probe is a rather odd shape, so we recommend building a case around the boards, using 60 thou plastic sheet ('Plasticard'), available from most good model shops. This should be cut to size and glued together with polystyrene cement

If you have never worked with plasticard before, we had better explain how easy it is to use. To cut it, you just score a line with a sharp knife, such as a scalpel (fairly heavily for 60 thou), and snap along the score line. As the clip hinges, there are two halves to the case, which simply shroud the boards, covering the soldering. The logic select switch is glued into a hole in one of the sides, and the power jack socket into the other.

If you feel unable to build the case, then find a suitably sized box to hold both boards, wire the boards firmly together, and connect

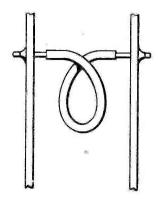


Fig. 5 How we suggest looping the connecting wires between the two boards.

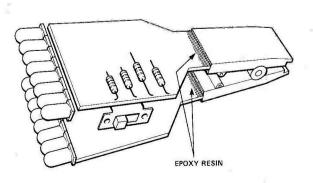
the test clip to the probe unit via a length of ribbon cable.

#### **Expanda-clip**

There are other possible uses of the clip, for instance, a number of similar units could be built on one board (with a different PCB layout), for use on 40-pin devices. Alternatively, the logic clip could be used to monitor bus lines, etc.

Also, it is worth noting that there is facility on the board for the clip to be powered by a supply other than that of the circuit under test, allowing low voltage devices to be tested, whilst keeping the LEDs brightly lit. This can be done by breaking the foil at the point marked 'X' (the connection between the +ve supply and the resistor divider chain) and connecting a voltage sense line to the spare PCB pad just below point X. This line is then connected to the +ve supply rail of the unit under test, with the clip powered by another source. This may be necessary even for TTL circuits, due to the variation in 'on' resistance of the 4051 selectors.

Having struggled through a rather involved construction, you should be left with a very useful and time saving tool. Happy probing!



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1982 appeared in December 1982). Send your request to ETI Photocopies, Argus Specialist Publications Ltd, 145 Charing Cross Road, London WC2H 0EE (cheques should be made out to ASP Ltd).

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#### Write For ETI

We are always looking for new contributors to the magazine, and we pay a competitive page rate. If you have built a project or you would like to write a feature on a topic that would interest ETI readers, let us have a description of your proposal, and we'll get back to you to say whether or not we're interested and give you all the boring details. (Don't forget to give us your telehone number).

We don't bother with the bureaucracy for Tech Tips - all you do is to send in your idea, stating clearly if you want an acknowledge-ment of receipt. If possible, please type your explanation of why the circuit is different, what it does and how it works, on a separate sheet from the circuit diagram; both sheets should carry your name, address and the circuit title. We'll let you know (within a month or so) if we want to use your Tech Tip.

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#### OOPS!

We have in the past published small corrections to projects on the letters page, and major corrections separately. From now on corrections will appear on this page, and will be repeated for several months (just to increase our embarrassment). If a correction is too large to fit on here, we will publish it just once, but will note the fact that a correction does exist, and that copies of it can be obtained from us provided you send in an SAE. But please — request copies only if you really do need them; if this service is abused, we may be forced to

Programmable Power Supply (January 1983) Lascar Electronics have now moved to Module House, White Parish, Salisbury, Wiltshire SP5 2SI.

Flash Sequencer (July '83) Q1 should be BC184L; Q2-5 should be

Telescope (August 1983)

We had a shower of annotation falling off our diagrams! On Fig. 1, C19 (below IC14) was not labelled nor was Q2 (above R11), and there were two C23s - one should be IC22 and it doesn't matter which. In Fig. 5, IC12 was not labelled. Unfortunately, there was a labelled. Unfortunately, there was a mistake in the correction (blush!): C14 is the  $22\mu$  tant on the -5 V line.

Graphic Equaliser (August 1983)

D2 and D3 are shown the wrong way round in the power supply circuit diagram on page

Universal EPROM Programmer (August

Quite a few sillies here! On the circuit diagram (page 46), C6 is 100u and C9 is 100n, not the other way round as given. Some bars were omitted from note three of Table 1 on page 48: it should have read Table 1 on page 48: it should have read "CE/PGM (27 series) is equivalent to PD/PGM (not PD/PGM) (25 series)." The penultimate sentence of the first paragraph on page 50 should read "... adjust RV1 for a potential of +25 V at 1/C10 output." On the overlay, IC7 is between SK2 and SK1, IC6 is between SK2 and SK1, Total R10. SK1 and C10, IC11 is between R7 and R10, R3 is between R2 and Q2, and Q7 is between Q6 and Q8. A link is missing between IC7 and SK1, and the unidentified pins at the right hand end of SK3 are the +5V line. Finally, C10 appears twice in the parts list but only the first entry is correct, and the second DIL socket should, of course, be 8, not 80, way.

**Z80 Controller Computer (August 1983)**On the overlay, SW1 is the rectangle beside ICs 5 and 6, C6 should be shown between ICs 3 and 7, and a link through has been missed — to the right of pin 18, IC11.

Typewriter Interface (October 1983)

There are two errors in Table 1 on page 24: location 3C should contain E7 and location 3F should contain 5F.

Car Alarm (October 1983)

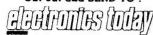
In the semiconductors section of the parts list, Q1, 2, 5, and 7 should be BC212L, Q3 should be BC182L, and Q4, 6 should be TIP31 or BD131. There was also another (inconsequential) silly but we bet you've already spotted that one! Tech Tips (October 1983)

Ramped Pulse Generator For Stepper Motors
– pin 1 of IC2 should be grounded, the Ramp Up and Ramp Down inputs accept negative, not positive, going pulses, and IC7 should be a 4011 rather than a 4001.

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