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This versatile modular mixer, featured as a constructional article in Practical Electronic can be built up to a maximum of:24 inputs. 4 outputs and an auxiliary channel. Each input channel has Mic and Line inputs variable gain, bass and treble controls and a para metric middle frequency equalizer. There are send and return jacks, auxiliary, pan and feder controls and output and group switching. The output channels have PPM displays and record and studio outputs. The auxiliary channel also has a PPM display and there is a headphone monitor jack and a built-in talk-back microphone. The mixer modules plug into base units each of which takes up to 6 channels. To eliminate hum, the power supply is in a separate cabinet

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**EDITORIAL AND ADVERTISEMENT OFFICE** 

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#### **PROJECTS**

PORTABLE INDUCTION LOOP...52 Vivian Capel's article on Induction Loops in February raised quite a lot of interest, so here's a practical design. SWITCHED MODE PSU.......83
Constructional details of the switched mode PSU commenced last month.

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#### **TRANSISTORS** VK101 VN10KM VN46AF VN66AF VN68AF VN89AF ZTX109 ZTX109 ZTX212 ZTX300 ZTX300 ZTX302 ZTX303 ZTX303 2N3708/9 2N3713 2N3771 2N3772 2N3773 2SC2078 2SC2091 2SC2314 2SC2162 2SC2335 2SC2547 2SC2612 2SD234 2SK45 2SK288 2SJ85 3N128 3N128 3N128 3N128 3N128 40316 40324 40326 40347 40347 40407/8 40407/8 40468 40594 40594 40693 4060 8F256A BF256B BF257/8 BF259/8 BF336/7 BF594/5 BFR39/40 BFR41/79 BFR41/79 BFR41/79 BFR80/81 BFR80/81 BFR84 BFX85/6 AC126:7 MPS A56 MPS A70 MPS U02 MPS U05 MPS U05 MPS U55 MPS U56 OC26 OC28 OC35 OC36/41 OC71/72 10 33/34 CARDIFF ROAD, WATFORD, HERTS, ENGLAND AC141/2 AC176 AC187 AC188 BC213L BC214 BC214L BC237/8 BC256B 78 80 94 99 11 12 28 13 MAIL ORDER, CALLERS WELCOME Tel. Watford (0923) 40588. Telex; 8956095 VN89AF 98 2NJ3619 ZTX107/8 11 2NJ3620 ZTX109 12 2NJ3620 ZTX109 12 2NJ3620 ZTX300 12 2NJ3905/8 ZTX300 16 2NJ3905/8 ZTX300 16 2NJ3905/8 ZTX304 17 2NJ4264 ZTX304 17 2NJ4264 ZTX306 17 20 2NJ4264 ZTX306 17 20 2NJ4264 ZTX501 16 2NJ4266 ZTX451 20 2NJ4314 ZTX500 16 2NJ4266 ZTX451 20 2NJ4314 ZTX500 16 2NJ4266 ZTX501 28 2NJ4266 ZTX503 16 2NJ4314 ZTX500 17 2NJ4266 ZTX501 18 2NJ426 ZTX501 28 2NJ5136 ZTX550 28 2NJ5136 ZNJ513 28 2NJ5136 ACY19/21 ACY22/41 AD142 AD149 BC307B BC308 ALL DEVICES FULLY GUARANTEED. SEND CHEQUE, P.O.S, CASH, BANK DRAFT WITH ORDERS, ACCESS/MASTER CHARGE ACCEPTED. GOVERNMENT & EDUCATIONAL ESTABLISHMENTS OFFICIAL ORDERS WELCOME. P&P ADD 60p TO ALL CASH ORDERS. OVERSEAS ORDERS POSTAGE AT COST. AD161 AD162 AF115/6 AF118 170 220 50 76 40 50 40 50 AF124/26 AF139 AF178 AF178 AF1786 AF239 BC107 BC107 BC108 BC108 BC109 BC109B BC109C BC114/5 BC117/8 BC137/9 BC147B OC81/92 OC83/92 OC83/93 OC170/10 OC42 OC70 OC70 OC75/76 T1929A T1929C T1921A T1 Export orders no VAT. 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TAG-END CAPACITORS: MV: 2200 138p; 3300 198p; 4/UU 246p; 80V: 2200 110p; 3300 194p; 40V: 4700 180p; 26V: 2200 80p; 3300 88p; 4000, 4700 88p; 10,000 320p; 15,000 346p; 16V: 22,000 350p 200 225 250 250 70 160 160 64 100 100 95 96 90 70 40 BC148B BC149C BC153/4 BC157/8 BC159 BC167A BC168C BC168C BC169C BC171/2 BC173 BC177/8 BC177/8 BC173 BC184 RF CHOKES Miniature PCB type Type Miniature poly Capacitors 250V 250 v 1nF, 1n5, 2n2, 3n3, 4n7, 6n8, 10n, 15n 7p 18n, 22n, 27n, 33n, 39n, 47n 8p 39n, 56n 12p 82n, 100n 11p POLYESTER RADIAL LEAD CAPACITORS: 250V 10n, 15n, 22n, 27n 8p; 33n, 47n, 68n, 100n 7p, 150n, 220n 10p; 330n, 470n 13p; 680n 19p; 1u 23p; 1u5 40p; 2u2 44p. , 22u, 47u, 220u, 470u 30p 1m5, 4m7, 35p, 33m, 80p 35 36 12 18 60 25 20 30 TANTALUM BEAD CAPAC(TORS 35V: 0 1uF, 0.22, 0.33 15p; 0.47, 0.68, 1.5 16p; 2.33 18p; 4.7, 6.8 22p; 10 28p; 18V: 2.2, 3.3 18p; 4.7, 6.8 22p; 10 18p; 15, 38p; 22 30p; 33, 47 40p; 100 78p; 105, 22 28p; 33, 47 35p; 100 58p; 8V POTENTIOMETERS: Rolary, Carbon, Track 0.25W Log & Lin values. 5000. IKΩ & 2KΩ I Linear only single Gang Sang Log & Lin SKΩ-ZMM Single Gang D/P Switch 5KΩ-ZMM Single Gang D/P Switch 5KΩ-ZMM Single Gang D/P Switch SKΩ-ZMM Double Gang 82n, 100n 11p 100V 100n, 120n 10p 150n, 180n 12p 220n, 270n 15p 330n, 390n 20p 470n, 560n 20p 680n 30p 1uF 34p 2u2 50p MPF103 MPF104 MPF105 MPF106 MPSA05 MPSA08 MPSA12 MPSA55 BF184/5 BF194/5 BF198/9 BF200 90 1mH, 90 2m2, 90 10mH 140 22m, 95 43m 210 100m 30 30 40 25 25 22 BC183L 10 BC184L 10 BC188 6/7 25 BC212 10 BF224A BF224B BF245 MYLAR FILM CAPACITORS 100V: 1nF, 2, 4, 4nF, 10 8p; 15nF, 22n, 30n, 40n, 47n 7p; 56n, 100n, 200n 8p; 50V: 470nF 12b. SLIDER POTENTIOMETERS 0-25W log and linear values 60mm 5KΩ-500KΩ single gang CERAMIC CAPACITORS 50V: Range: 0.5pF to 10nF 4p. 15nF; 22nF 33nF, 47nF 5p. 100nF/30V 7p 200nF/6V 8b. ICL7204 ICL7611 ICL7660 ICL8038CC ICL8211A ICM7205A LS162 LS163 LS164 LS165 LS166 LS168 550 MC1495 MC14961 MC1596 MC15 \$301 \$412 \$470 \$471 \$472 \$475 \$671 350 380 325 620 1150 600 ACCESS 350 70 225 290 90 120 120 65 76 150 00 350 75 635 275 TDA1022 TDA1024 TDA1034 499 115 Orders Just phone your orders through. 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10M | E19 | 3p | 1p | 25W | 202 - 4M7 | E12 | 3p | 1p | 2W | 202 | 10M | E12 | 6p | 4p | 2% | Metal Film | E24 | 8p | 6p | 1% | Metal Film | E24 | 8p | 6p | 100 + price applies to Resistors of each 8288 £10 8 P8304BN 250 8 P8304BN 250 8 P826A 99 8 T277 160 8 T287A 120 8 T31 360 8 T35 90 8 T378 90 8 T388 ULN2003 75 75 100 275 320 275 196 307 575 875 360 80 130 346 300 410 210 210 220 686 860 LF356 LF357 LS27 LS28 LS30 LS32 LS33 LS37 LS38 LS40 LS42 LS47 LS48 LS49 LS51 LS54 LS55 LS55 ULN2283 UPC572 UPC1025H UPC1025H UPC11366 XR2207 XR2207 XR2207 XR2216 ZN419E ZN426 ZN426 ZN419E ZN425E ZN425E ZN427E ZN427E ZN428E ZN42 LF398 LM301 LA LM307 LM301 LA LM308 T LM318 LM318 LM318 LM319 LM318 LM339 LM358 LM379 LM381 LM389 LM381 LM389 LM381 LM389 LM381 LM389 LM381 LM389 LM381 LM391 LM39 LINEAR ICs RESISTORS NETWORK S.I.L. 7 Commonad: (8 pins) 100Ω, 680Ω, 1K 2k2, 4K7, 10K, 47K 100K 28bp 8 Commoned: (9 pins) 150Ω, 180Ω, 270Ω, 330Ω, 1K, 2k2, 4K7, 6K8 10K 22K, 47K δ 100K 26p 555CMOS 702 709C 8 pin 710 LS257 LS258 LS259 LS260 710 741 8 pin 747 C 14 pin 748 C 8 pin 753 8 pin 750 60 45 225 425 325 486 286 286 380 150 74105 74107 74109 741109 741110 741118 741121 741121 741223 741223 741225 741225 741226 741226 74128 74136 74144 74145 74144 74145 74145 74155 74155 74156 74156 74156 74157 74159 74163 7 BRIDGE RECTIFIERS LS261 LS266 LS273 LS275 LS279 LS280 LS283 LS293 LS295 LS298 LS298 LS298 LS320 LS323 LS324 LS325 LS326 LS326 LS326 LS326 LS326 LS326 LS326 LS327 810 9400CJ SAB3210 SAB3271 SAB4209 SG3402 SL490 SL6270CD SN78013 SN78023ND SN78023ND SN78131 SN76227N SN76477 3N76488 SP8629 1A/50V 1A/100V 1A/400V 1A/600V 2A/50V 2A/200V 2A/400V 2A/600V 6A/100V AY-1-1320 225 AY-1-5050 1100 AY-1-5050 1100 AY-1-5050 1100 AY-1-5070 2700 AY-3-1350 350 AY-3-8910 420 Booklet for AY-3-8910 420 Booklet for AY-3-8910 420 AY-3-8910 420 Booklet for AY-3-8910 420 AY-3-1350 350 CA3012 175 CA3018 8, CA3028A 276 CA3045 276 CA3046 70 CA3046 70 CA3046 70 CA3046 270 CA3046 75 SERIES 6522VIA 6530 74C BA100 6530 £11 6532RRIOT **570** LS70 LS73 LS74 LS75 LS76 LS76 LS83 LS85 LS86 LS87 LS87 96 90 150 130 75107/8 75110 75114/5 75121/2 74C244 196 74C245 196 74C373 240 74C374 246 653ZRRIOT 6545RTC 6551ACIA 659ZPC 6800 6802 6803 6804 350 240 125 95 420 480 299 87126 75150 75154 125 125 125 125 99 56 140 360 150 150 150 86 52 70 65 74C922 420 74C923 500 75154 75159 75182/3 75188/9 75322 75324 75361/3 75365 75450 75450 75454 75491/2 6A/400V 6A/600V 10A/200V 10A/600V 25A/200V 25A/600V BY164 VM18 DIL 125 215 298 240 395 56 50 745 6805 6808 74500 \$02 \$03 \$04 \$05 \$08 \$20 \$32 TA7204 TA7205 TA7205 TA7205 TA7205 TA7310 TA7310 TAA621AX1 TAA661A TAA700 TAA900 TAD100 TBA120S TBA540Q TBA550Q TBA550Q TBA550Q TBA550Q TBA550Q TBA550Q TBA550Q TBA550 6810 115 6821 68954 6840 6843 6845 6847 100 780 375 £12 860 860 110 296 190 276 396 159 Range 2V7 to 39V 400mW 0A202 \$74 \$86 \$112 \$114 \$132 6847 6850 6854 68821 6875 68000 74C922 8080A 8085A 8085A 8085A 8118-10 8123 8155 8156 91LS95 81LS95 SCR 8p each Range 3V3 to 33V 1.3W 15p each LS113 LS114 THYRISTORS 70 275 330 599 220 500 £70 400 250 350 £18 225 350 80 80 80 80 625 225 110 1425 100 5A/40V 5A 400V 5A 600V 8A 300V 8A 600V 12A 100V 12A 400V 12A 800V BT106 BT116 C106D TIC44 TIC45 TIC47 2N5062 2N5062 2N4444 LS122 LS123 MC6845 625 MC68846 625 MC3886-2W E7 MM52800 896 MM5303 636 MM5307 1275 MM53174 770 MM74C922 420 RO 3-25131 650 RO 3-25131 650 SFP96364 800 SP0256AL2 £11 TMS2716-3V 25 TMS2716-3V 25 TMS2416-2 475 LS124 LS125 LS132 LS133 LS136 LS138 LS139 LS145 LS147 LS148 LS151 LS151 LS155 LS155 LS155 LS156 LS157 LS158 LS156 LS157 LS158 LS384 LS385 LS396 LS390 LS394 LS398 LS398 LS399 LS445 LS455 LS450 LS541 LS660 LS645 LS666 LS666 LS666 LS73 LS667 LS666 LS73 LS667 LS667 LS667 LS667 LS73 LS73 LS74 N5404 N5408 TRIACS 230 320 476 220 3A 200V 3A 400V 8A 100V 8A 400V 15921 7420 7421 7422 7423 7425 7426 7427 7428 7430 7432 7433 7437 7438 56 60 69 115 8A 400V 8A 800V 12A 100V 12A 400V 12A 800V 16A 100V 16A 800V 25V 500V 25A 800V 12800D 250 79 81LS95 81LS96 81LS97 81LS98 8202 8205 8212 8214 8216 TC9109 MC1303 MC1304P MC1310P MC1445 MC145106 MC1466 TCA220 TCA2700 TCA280A TCA940 350 350 220 176 VARICAPS TMS410-2 475 TMS4416-2 475 TMS4500 £14 TMS4532-3 350 TMS5100 600 130 74175 74176 S262 S287 HA1336W HA1388 TCA965 TDA1004 TDA1008

145 290 310

MC1469 MC1494

300 694

DIAC ST2

SWITCHES TOGGLE 2A 250V (SPST) 4 way 65p; SPST 33p 8 way 85p; 10 wa	6 way 100p;	SOARD 0 lin clad plain 3 <sup>1</sup> /a: 850	VQ Board 195p DIP Board 395p Vero Strip 95p	IDC CONNECTORS PCB Plugs Female Female	PANEL METERS	RELAYS Miniature, enclosed, PCB mount,
DPDT 44p (SPDT) 4 way 190p SUB-MINN TOGGLE SPST on/off 54p SPDT c/over 60p SPDT centre of 85p SPDT brissed both ways 100p DPDT 6 tags 75p DPDT 6 tags 75p	212 / 334 /	5 100p - 3 <sup>3</sup> / <sub>4</sub> 100p - 5 116p 17 390p 98p	PROTO DECs Veroblock 405p S-Dec 350p Eurobreedboard 575p Guperstrip SS2 1360p	Web   Section   Header   Card   Free   Pree   Pre	FBO 60 x 46 x 35mm 0-50 pA 0-100 pA 0-500 pA 0-5mA 0-5mA 0-5mA 0-50 pA	SINGLE POLE Changeover RL-91 2050 Coil: 12V DC, 10V5 to 19:5VI. 10A at 30V DC or 250V AC 185p DOUBLE POLE Changeover. 6A 30V DC or 250V AC RL8-100 530 Coil, 5V DC (5V4 to 9V9 RL6-111 2050 Coil, 12V DC (10V7 to
DPDT biased both ways 146p DPDT 3 positions Make a multiway si sembly has adjusts modates up to 6 were	vitch, Shafting as- ble stop, Accom- s	WIRING spood 340p spool 75p	DALO ETCH RESIST PEN Plus spars tip 100p	EURO CONNECTORS	0-100mA 0-500mA 0-1A 0-2A	19V5) 186p RL6-114 740Ω Coil, 24V DC 122V to 37V) 200p
on/on/on 185p 3-pole 2 way 26p 8LIDE 260V: DPDT 1A 14p DPDT 1AC 0ff 15p DPDT 1/2A 13g wsy: 4 pole/3 wsy: 6	DP switch).  90p  efore break) to fit ichenism. 1 b b 186 way; 3 pole/4 /2 way ###	C CMLORIDE ag Anhydrous 50p P&P	ULTRABONIC TRANSDUCER 40KHz 32B pr	Female Socket Male Plug Strt. Angle Strt. Angle Pins Pins Pins Pins Jaway 170p 175p DiM41812	0-25V 0-50V AC 0-300V AC "VU" (28p eech	AMPHENOL PLUGS IEEE 24 Way Centronics Parallel 36 Way solder 530 Centronics Parallel 36 Way IDC 485 Centronics 36 Way IDC Female 520p
PUBHBUTTON 6A with 10mm Button SPDT latching 98p DPDT latching 1456 SPDT moment 99p SPDT moment 99p	ofit 45p COI Fibre PST 28p 91sss 5 4 5 5 5 5 5 5 5 6 4 5 6 6 6 6 6 6 6 6	sided 6 100p	OARDS  Double S.R.B.P. sided 95 ^ 8.5 125p 110p 225p	2 x 32 A x 8 276p 320p 220p 286p DIN41612 2 x 32 A x C 286p 340p 240p 300p DIN41612 3 x 32 A x 8 + C 300p 386p 280p 386p	32.768KHz 100 100KHz 236 200KHz 366 455KH 370 1MHz 276 1.008M 276	BUZZERS, miniature, solid-state 6V: 9V & 12V PIEZO TRANSDUCERS PB2720
DPDT moment 145p Mini Non Locking Push to Meke 15p 8, C.D. Switch Modu	front mounting	SOCKETS  Low Wire  Prof Wrap  n ap 25p  n 10p 35p	EDGE CONNECTORS .1 .158 2×16 way - 140p 2×18 way 180p 146p	DIL PLUG (Header) Soldas IDC 14pin 40p 105p 16pin 40p 105p 24pin 80p 178p 178p 10 wey 15p 28p	1.28MHz 382 1.6MHz 365 1.8NHz 365 1.8432M 200 2.0MHz 226	Miniature, 0.3W: 8Ω 2in, 3 jin, 2 jin, 3in 80p 2 jin 40Ω, 64Ω or 80Ω 80p
JUMPER LEADS (Ribbon ETI Length 14 pin 16	Cable Assembly) 18pi nin 24 nin 40 nin 23mi	n 10p 42p n 10p 62p n 20p 60p	2 x 22 wey 188p 200p 2 x 23 wey 175p — 2 x 25 wey 225p 220p 2 x 28 wey 190p — 2 x 30 wey 245p —	40pin 280p 286p 20 way 30p 80p 22 way 40p 66p 22 way 40p 66p 66p 34 way 80p 66p	2.4676M 200 3.278M 180 3.5794M 98 3.6864M 300 4.0MHz 180	ASTEC UHF MODULATORS Stendard 6MHz 325p Wideband 8MHz 480p
We stock most of Double ended DIP (Heade the parts 185p 2 12 inches 185p 2	Plug) Jumper 24pi Plug) Jumper 28pi Plug) Jumper 40pi 75p 300p 485p 15p 315p 480p	in 26p 70p in 28p 60p in 30p 88p	2 x 36 wey 295p — 2 x 40 wey 315p — 2 x 43 wey 395p — 2 x 75 wey 550p —	80CKETS 40 wey 70p 80p 24 pin 576p 28 pin 520p 40 pin 576p 54 wsy 120p 190p	4.032MHz 280 4.80MHz 200 4.194304M 200 4.433619M 100 5.0MHz 160	"WEMON" New Version WATFORD'S Ultimate Monitor IC A 4K Monitor chip specially designed
36 inches 230p 2 IDC Female Header Socket J 20 pin 26 Single ended 180p 2	50p 375p 565p C-15W G18W G18W Spare to 50p 280p 300p Spare el	EX SOLDERING 495p CS17V 520p XS25W ps, assorted sizes ements	7 495p 525p 85p 225p 20 way	'D' CONNECTORS	5.185MHz 300 5.24288M 300 6.0MHz 140 6.144MHz 180 6.5536MHz 225	to produce the best from your: Superboard Series I & II, Enhanced Superboard & UK101. As reviewed by Dr A. A. Berk in Practical Electronics, June 1981.
TRANSFORMERS:	VOLTAGE RE		SOLDERCON PINS	Solder lugs 80p 105p 160p 250p Angle pins 150p 210p 250p 355p PCB pins 120p 130p 195p 295p Female	7.0MHz 180 7.168MHz 280 7.7928MHZ 250 7.68MHz 200	Only £10 BBC MICRO
3-0-3V; 8-0-8V; 9-0-9V; 12-0-12V; 15-0-15 © 100mA 98 pcb mounting. Minieture, Split Bobbin 3VA: 2x6V-0.25A; 2x9V-0.15A; 2x12V-0.12A 2x15V-0.1A 200	5V 7805 40p 12V 7812 40p 15V 7815 40p	Plastic Casing — ve 7905 46p 7908 80p 7912 46p	Ideal for making SIL or DIL Sockets 100 plns 75p 500 pins 380p	Solder lugs 105p 160p 200p 335p Angle pins 165p 215p 290p 440p PCB pins 150p 180p 240p 420p Covers 900 85p 90p 100p	8.0MHz 180 8.08333M 365 8.86723M 176 9.00MHz 180 10.0MHz 176	AND UPGRADE KITS (Our BBC Micro Upgrade Kits will save you £sss) BBC Micro
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2H3V-0.25A 220 12VA: 2x4.5V-1.3A; 2x5V-1A; 2x9V-0.6A 2x12V-0.5A; 2x15V-0.4A; 2x20V-0.3A	6V 76L06 30p 8V 78L06 30p 12V 78L12 30p	79L05 <b>60</b> p  79L12 <b>60</b> p	4 × 2 × 2 1 103p 4 × 4 × 2 105p 4 × 4 × 2 120p 5 × 4 × 1 80p 5 × 4 × 2 120p	Jumpe Leed Cable Assembly 18" long, Single end, Male 18" long, Single end, Female 36" long, Double Ended, M/M 36" long, Double Ended, F/F 1050p	14.31814M 170 18.0MHz 200 18.0MHz 100 18.432M 100 20.0MHz 200	save you £sss
24VA: 2x6V-1.5A; 2x9V-1.2A; 2x12V-1A 2x15V-0.8A; 2x20V-0.6A 30b; 160p.p6p 60VA: 2x6V-4A; 2x9V-2.5A; 2x12V-2A; 2x16V 1.5A; 2x20V-1.2A; 2x26V-1A; 2x30V-0.8A	ICL7660 248p T RC4194 375p T RC4195 1800 7	79L15 <b>80</b> p AA550 <b>80</b> p DA1412 180q 8H05 + 5V/5A <b>580</b> q	5 × 2 × 1 * 90p 5 × 2 × 2 * 130p 6 × 4 × 7 * 120p	36" long, Doubel Ended, M/F 966p	20.0 MHz 200 19.968 MHz 190 24.0 MHz 170 24.930 MHz 325 26.69 M 180	Disc Interface Kit £65 Analogue I/O Kit £6.45 Serial I/O Kit £6.70
Specially wound for Multirail Computer PSUI   50VA: Outputs +5V/5A; +12V, +25V -5V   -12V at 1A   575p (60p p&p	LM309K 135p 7 LM317K 320p	8H12 + 12V/5A 880; 8HG +5V to +25\	7×5×3" 180p 8×6×3" 210p 10×4×3" 240p	● <b>SPECIAL OFFER</b> ● 2764- 1+ 50+	27.648M 170 27.145M 180 38.66667M 175	Expansion Bus Kit £6,10 Complete Upgrade Kit from Model A to Mod. B £43
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	BC159 8		18	BFX85	25	TIP30C	37			2N3706	9
	BC160 45		18	BFX86	28	TIP31A	35			2N3707	10
	BC168C 10		55	BF XB7	25	TIP31C	37	ZTX501		2N3708	10
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AD149 80 8	BC171 10		50	BFY51	20	TIP33A	50			▶2N3773	
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	BC177 18		30	8FY53	32	TIP34A	60			2N3820	40
AF124 60 I	BC17B 18		30	BFY55	32	TIP34C	85		20	2N3823	65
	BC179 18		30	BFY56	32		105		20	2N3866	90
	BC182 10		35	BRY39	40		125		35	2N3903	10
AF186 70 I	▶BC182L 8		35	B5X20	20		125			2N3904	10
	BC183 10		10	BSX29	35		135			2N3905	6
	BC183L 10		10	BSY95A	25	TIP41A	45	2N2218A		2N3906	10
BC107B 12	BC184 10		85	BU205	160	TIP42A	45	2N2219A		2N4037	45
▶BC108 10	BC184L 7		35	BU206	180	TIP120	90	2N2221A		2N4058	10
	BC212 10		35	BU208	170	TIP121	90	2N2222A		2N4060	10
	BC212L 10		25	MJ2955	99	TIP122	90		25	2N4061	10
	BC213 10		25	MJE340	50	TIP141	98	2N2369	16	2N4062	10
	BC213L 10		12	MJE520	65	TIP142	98	2N2484	25	2N5457	36
	BC214 10		12	MJE521	95		110		45	2N5458	36
	▶BC214L B		12	MJE3056	70	TIP2955	60	2N 2904	20	2N5459	30
	BC237 8		12	MPF102	40	TIP3055	55	2N2904A	20	2N5485	36
	BC238 14		10	MPF104	40	TIS43	40	2N2905	22	2N5777	45
	BC308 12		18	MPSA05	22	T1S44	45		22	2N6027	30 40
	BC327 14		30	MPSA06	25	TIS90	30	2N2906	25	40360	
	BC328 14		22	MPSA12	30	TIS91	30		25	40361	50
	BC337 14		30	MPSA55	30	VN10KM	45	2N2907	25	40362	50
	BC338 14		45	MPSA56	30	VN46AF	75		25	40408	70
	BC477 30		32	MPSU05	55	VN66AF	85	2N2926	9		
	8C478 30	BF258	25	MPSU06	55	VN88AF	95	▶2N3053	23		
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OA200 8 OA202 8 1N914 4 ►1N4148 3

OPTO

Red or black procedile clips	8
Black pointer control knob	
Pr Ultrasonic transducers	
▶6V Electronic buzzer	
▶12V Electronic buzzer	
▶P82720 Piezo transducer	
▶64mm 64 ohm speaker	
▶64mm 8 ohm speaker	
20mm panel fuseholder	

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½" 100 ohms to 100K - 88p each.

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

#### JUMPER LEADS

			_	
Length	14pin	16pin	24pin	40pin
Sgle end				
24 ins.	145	155	240	380
Dble end	ted DIP	(heade	r plug)	umper
6 ins.	185	205	300	465
12 ins.	195	215	315	490
24 ins.	210	235	345	540
36ins.	230	250	375	595
25 way	D Conn	ector ]	umpers	1
18ins. lo	ng sing	le ende	d male	495p.
10 ne Yo	no singl	a anda	d f /m al	a 5250

#### CAPACITORS

ı	type: 0.01, 0.015, 0.022, 0.033 -
ı	6p; 0.047, 0.068, 0.1 - 7p; 0.15,
ı	0.22 - 9p; 0.33, 0.47 - 13p; 0.68 -
ı	20p; 1u - 23p.
ı	Electrolytic, radial or sxial leads:
١	0.47/63V, 1/63V, 2.2/63V, 4.7/63V,
ı	10/25V - 7p; 22/25V, 47/25V - 8p;
1	100/25V - 9n - 220/25V - 14n -

100/25V - 9p; 220/25V - 14p; 470/25V - 22p; 1000/25V - 30p; 2200/25V - 50p. Tag end power supply electrolytics: 2200/40V - 110p; 4700/40V - 160p 2200/40V - 140p; 4700/63V - 230p 2200/03V - 1400/47V-230P Polyester, miniature Slemens PCB: 1n, 2n2, 3n3, 4n7, 6n8, 10n, 15n, 7p; 22n, 33n, 47n, 68n, 8p; 100n, 9p; 150n, 11p; 220n, 13p; 330n, 20p; 470n 26p; 680n, 29p; 1u 33p; 2u2,

307. Tentalum bead: 0.1, 0.22, 0.33, 0.47, 1.0 @ 35V - 12p. 2.2, 4.7, 10 @ 25V - 20p; 15/16V - 30p; 22/16V - 27p; 33/16V - 45p; 47/6V - 27p; 47/16V - 70p; 68/6V - 40p; 100/10V - 90p. Cer. disc. 22p-0.01u 50V, 3p each Mullard miniature ceremic plate: 1.8pF to 100pF 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

BRIDGE RECTIFI	ERS	2A 200V 2A 400V 6A 100V	40 45
1A 50V	20	6A 400V 9	
		00011	-

#### EPSON PRINTERS

Latest generation printers from Epson, Logic seeking, bi-direction bit image printing, 9 x 9 Matrix, Auto underline, Centonix 8 Bit Parallel Interface as standard.

RX80 100 CPS 80 column Tractor feed

FX80 160 CPS 80 column Tractor Feed



Carriage £7 per printer

MIN. D CON	NECT	ORS		46
	9 way	15 way	25 way	37 way
Plugs solder lugs	60p	85p	125p	170p
Right angle	120p	180p	240p	350p
Sockets lugs	90p	130p	195p	290p
Right angle	160p	210p	290p	440p
Covers	100p	90p	100p	110p

#### CONNECTORS

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	Standar	d16p	20p
Phono	10p	12p	Stereo	24p	25p
1mm	12p	13p	4mm	18p	17p
UHF (	CB) (	Conn	ectors:		
PL259	Plug	40p.	Reduci	er 14p	ο.
SO239	squi	are ch	lassis skt	38p.	
SO239	S roi	and c	hassis sk	t 40p	).
IEC 3	pin 2	50 V	6A.		
Plug cl	hassis	mou	nting .		38p
Socke	t free	hang	ing		60p
Socke	t with	2m	lead .		120p

Submin toggle: SPST 55p, SPDT 60p, DPDT 65p, Ministure toggle: SPDT 80p, SPDT centre off 90p, DPDT 90p, DPDT centre off 100p Standard toggle: SPST 35p, DPDT48p Miniature DPDT slide 12p. 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

#### SCRs

▶ C106D	30
400 V 8A	70
400V 12A	95

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Now your computer can talk. The GI SP0256 speech processor is able through stored program to synthesize speech. Allophone (extended phoneme) system gives unlimited vocabulary. Easily interfaced with any digital system; ten TTL compatible signals are used to select the allophones. SP0256 , 770p, Deta: 50p.

#### SOLDERING IRONS

Antex CS 17W Soldering iron	460
2.3 and 4.7mm bits to suit .	65
CS 17W Iron: 450, element:	210
Antex XS 25W	480
3.3 and 4.7mm bits to suit .	65
Solder pump desaldering tool.	480
Spare nozzie for above	70
10 metres 22swg solder	100

VEROBLOC	4					350
Size 0.1 matr	ix:					
2.5 x 1 .						22
2.5 × 3.75						75
2.5 × 5 .						85
3.75 x 5						95
VQ board	,					160
Veropins per	10	0:				
Single sided						50
Double sided						60
Spot face cut	ter					105
Pin insertion	too	1				162
Wiring pen ar	nd s	DOC	ı			310
Spare spool 7	5p		Co	mb	16	. 6

MICRO	6116P3 320 6502 CPU 325 6522 VIA 295 6532 570	6852 240 6875 495 6880 100 81LS95 85	8228 220 8251 250 8253 390 8255 225
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#### COMPONENT KITS

An ideal opportunity	for the beginner or the	experienced const	ruct	Or
to obtain a wide ran-	on of components at gree	stly reduced prices.	144	V 5%
Resistor kit. Contain	s 10 of each value from	4.7 ohms to 1M (to	otal	
of 650 resistors)				530
Ceramic Cap, kit. 5	of each value - 22p to 0.0	31u (135 caps) .		370
	of each value from 0.01			575
Preset kit, Contains	5 of each yelue from 100	ohms to 1M (total	1	
65 presets				425
Nut and Boit kit (to	ral 300 (terns): 180p			
25 6BA %" bolts	50 6BA washers	50 6BA nuts		
25 68A %" bolts	25 4BA %" bolts	50 6BA wesher		

%W 5% Carbon film	E12 series 4.7
ohm - 1M,	. 1p each,
%W 5% Carbon film	E12 series 4.7
ohm to 4M7	. 2p each.
1/4W 1% metal film E	24 series 10
ohm - 1M	. 6p each,

#### RESISTORS

PFND500 FND507 0.5" 100 0.5" 100 TIL313 0.3"115 TIL3120.3"115 TIL3220.5"115 TIL3210.5"115 LCO: 3½ digit 580p. 4 digit 620p.

 ▶3mm red
 7
 ▶5mm red
 7

 ▶3mm green 10
 ▶5mm green 10
 ▶5mm green 10

 ▶3mm yellow10
 ▶5mm yellow10

 Clips to şuit - 3p aech.
 Rectangular

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 2
 TLL78
 40

 green
 17
 ▶TIL111
 80

 yellow
 17
 ORT12
 85

 ▶T1L33
 40
 TIL100
 90

 2N5777
 45
 Dual coloror
 60

 Seven segment displays:
 Com anode
 DL704 0.3"
 95

 DL707 0.3"
 95
 PFND507
 ND507

 0.5"
 100
 0.5"
 100

14W 5% Carl	bon film E12 series 4.7
ohm - 1M.	1p each,
1/4W 5% Carl	bon film E12 series 4.7
ohm to 4M?	
1/4W 1% met	al film E24 series 10
ohm - 1M	6p each,

on film E12 series 4.7 	Alfac transfer she type [e.g. DIL pa Delo etch resistan Fibre glass board Fibre glass board Ferric Chloride or
Op each,	Partic Childride C

4050 4051

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4082	12	4502	60	4529	150
4085	48	4503	32	4532	60
4086	50	4507	35	4534	400
4089	125	4508	110	4538	60
4093	18	4510	45	4543	50
4094	68	4511	40	4549	360
4095	65	4512	40	4553	215
4097	290	4514	115	4555	35
4098	70	4515	115	4556	35
4099	70	4516	55	4559	390
40106	40	4518	40	4560	140
40109	110	4520	50	4584	35
40163	60	4521	130	4585	60
40173	100	4526	60	4724	140

LS160 35 LS197 45 15353 60

LST	112	LS21	12	LS76	17	LS125	24	L\$161	35	LS221	50	L\$365	28
-		LS22	12	LS78	17	LS126	25	LS162	35	LS240	60	LS366	28
LS00	11	L\$26	14	LS83	35	LS132	35	LS163	35	LS241	55	L\$367	28
LS01	11	LS27	12	LS85	48	LS136	26	LS164	40	LS242	55	L\$368	29
LS02	11	LS30	12	LS86	16	LS138	30	L\$165	55	LS243	55	LS3 73	58
LS03	12	LS32	13	LS90	24	LS139	30	L\$166	60	LS244	55	L\$374	60
LS04	12	LS37	14	LS92	25	LS145	70	LS170	75	LS245	70	LS3 75	43
LS05	12	L\$38	15	LS93	24	LS147	150	LS173	60	LS247	48	LS377	60
LS08	12	LS40	13	LS95	38	LS148	75	LS174	45	LS251	28	L\$378	57
LS09	12	LS42	28	LS96	95	LS151	38	LS175	45	LS257	32	L\$390	45
LS10	12	LS47	35	LS107	40	LS153	38	LS190	35	L\$258	32	LS393	40
LS11	12	LS48	45	LS109	21	LS154	75	LS191	35	LS259	55	L\$399	156
LS12	12	LS51	14	LS112	21	LS155	33	LS192	35	LS 266	20	LS541	78
LS13	19	L\$55	14	LS113	21	LS156	36	LS193	36	LS273	58	LS670	135
LS14	30	LS73	18	LS114	22	LS157	26	LS195	32	LS279	30		
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	_	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	14	7490	19	74132	30	74165	46	74194	40
7402	11	7421	19	7451	14	7491	34	74141	54	74167	150	74195	40
7403	12	7422	19	7453	14	7492	24	74145	48	74170	115	74196	40
7404	12	7427	18	7454	14	7493	24	74147	75	74173	58	74197	40
7405	14	7428	25	7460	14	7494	33	74148	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	96	74154	47	74177	42		
7409	13	7437	23	7475	26	74100	78	74155	36	741 79	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		

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# NTERNATIONAL

#### THE "MARVIN" MICROCONTROLLER

The microprocessor is so strongly identified with the microcomputer that most people forget that it started life as an industrial control device. We haven't forgotten, though: next month we present a multi-purpose Z80-based control computer that you can use for a wide variety of domestic, laboratory or industrial control functions. The system is modular, consisting of an MPU board and two types of interface board, and a variety of control boards will be available.

I think you should know I'm feeling very depressed.

#### **GRAPHIC EQUALISER**

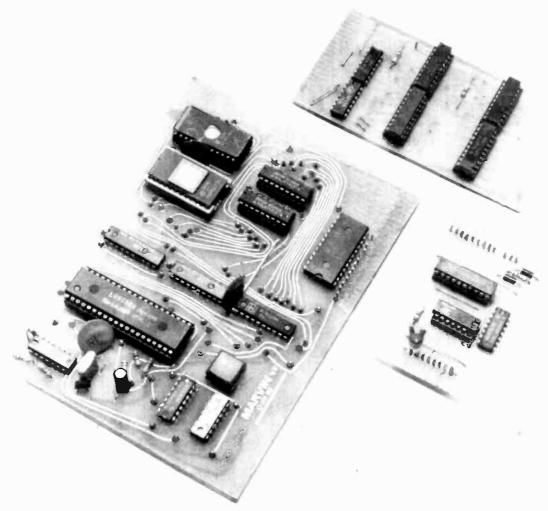
The circuit diagram in the March '83 Audiophile has led to so much interest that we've decided to publish it as a full project. The unit is a very high quality device offering one-third octave

intervals, as required for professional applications, and an impressive noise and distortion performance. For reasons that will be obvious when you see the size of the thing, this is a mono unit; two are required for stereo.

#### **EPROM PROGRAMMER**

Hands up all those readers who'd prefer the convenience of programs stored in EPROM, but are put off by the sheer inconvenience caused by erasure and programming difficulties. Next month's ETI will feature a project that is cheap to build and capable of blowing every single-supply EPROM in the 27- and 25-series up to and including 256K bit devices. The appropriate driving software for 6502-based computers will also be provided.

#### LOOK OUT FOR THE AUGUST ISSUE ON SALE JULY 1st



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

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#### Some are easy some are hard

Na K2543 K2555 K2566 K2572 K2574 K2577	Transistor Ignition Digital Freq Counter for Receivers 3 Channel Coloured Light Organ Universal Stereo Pre-Amplifier Universal 4 Digit U/D counter with memory Electric Motor Speed Control	11.16 45.40 19.19 6.56 44.72
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This unit will make your TV fully remote control (infra-red) and bring you closer to the amazing world of teletext. The kit can also be updated to incorporate full Prestel, and with a keyboard this can give you full message facilities for ordering foods or sending and receiving messages (E.G.) Booking your Holidays!

With a microcomputer as an alternative keyboard the world is even greater adding bulk updating to viewdata computers an receiving telesoftware for implementation to any

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Even without the Prestel option, Telesoftware from the Teletext pages freel

The full features of Teletext, Including subtitles are all included in the basic kit. An attractive styllsh case is available to complement the finished kit.

Basic Teletext Kit (no box) £130 + VAT P/P £2.50 with box £144.95 + VAT P/P £3.00 box by itself £14.95 + VAT P/P 75p

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

# DIGEST

#### Hyconomiser

M ould all those readers who've rung us, sent telexes, telegrams, telemessages, letters, carrier pidgeons and so on, please note that you can get information on dealers in your area from the manufacturers, who are: Atwell Construction Ltd, Station Road, Wrington, Avon (telephone Bristol 719441). (Yes, we know, we should have said so in the first place . . .)

#### Static RAM Lookalike

ntegrated RAMs offering all the advantages of a static RAM but with the higher circuit density and lower cost of dynamic RAMS are shortly to be available from

Jermyn.
The Intel 2186 is a 64K IRAM organised as an 8K x 8 device but having the major advantage that it requires no external refreshing circuitry. All the DRAM refresh control circuitry is integrated on the chip allowing the user to treat the IRAM as a purely static device yet with all the advantages and performance of Intel's volume HMOS dynamic high RAM production technology.

Incorporating many systems oriented features such as low power dissipation, automatic initialisation, extended cycle operation and two-line bus control to eliminate bus contention, the 2186 is particularly suited to microprocessor systems applications where higher integration yet lower cost is required.

For further information contact Jermyn Distribution, Vestry Estate, Sevenoaks, Kent.

#### Government **Unveils Cable**

Work on advanced cable systems in up to 12 areas could start this year under proposals published recently by the Government in the White Paper, "The Development of Cable Systems and Services".

The White Paper, presented to Parliament jointly by the Home Secretary and the Secretary of State for Industry, is a comprehensive statement of Government policy across the range of cable issues. In the broadcasting field, it sets out the Government' reponse to the Hunt Report, published last October.

In outline, the broad strategy

 Cable investment should be privately financed and marketled.

· Regulation should be as light as possible to allow the development of a wide range of services and facilities.

The regulatory framework should be flexible so that it can adapt as technology changes.

 Key safeguards are needed to ensure that existing broadcasting and telecommunications services are not impoverished and to take account of the fact that cable services will be directly available in the home.

Legislation will be introduced to establish a new Cable Authority to award franchises, supervise programme services and promote cable development. If this then goes ahead as the White Paper envisages, the Government will be prepared to authorise up to 12 pilot cable systems each covering



W e're sad to report that Peter Green will be leaving the ETI fold, taking his hideous puns with him. He won't be going far, though, just across the corridor in fact, to the Computing Toady, whoops, I mean Today, office, where he'll be assuming the editor's chair (and funny little peaked cap too). The things some people will do for a bigger

Unfortunately, until we find a successor to Peter, our ability to answer technical enquiries will be severely restricted, so we'd appreciate it if you could try and sort out the problem yourself before writing. If you do write, it would help enormously if you could follow the guidelines given our Reader Services page, page



The ex-deputy editor unwinds after a hard day battling against broken typewriters, Space Invaders and colour-blind artists.

a maximum of about 100,000 homes. The systems will have to offer a positive contribution to advanced technology, prehensive programme services, and interactive capability. In the interim, the pilot projects will be set up under existing legislation. The Department of Industry will assess technological and telecommunications proposals, while programme services will require Home Office approval.

Existing relay operators will be

allowed to offer new programme services over their systems for a transitional period, pending the installation of advanced technology. (Most relay services are limited to 4 or 6 channels.) Where necessary, the normal "must carry" rule — under which they have to relay current broadcast services will be relaxed if customers are provided with alternative means of receiving BBC and IBA channels at no extra cost.



ompetition for our attention can be pretty hot, you know, PR companies sometimes resort to dirty tricks, like, having noticed that ETI has an all male staff, sending us pictures of scantily clad women adorning their products. They really should know better, because here, at ETI, it's the naked truth about electronics we are after.

What has provoked this little

diatribe is the near simultaneous announcement of two companies that they were the first to introduce legal cordless telephones.

We think that the fact that Fidelity (left) look so relaxed probably means it was them, and that's also the reason why British Telecom didn't send us a photo. for fear of giving the game away with their false smiles . . .

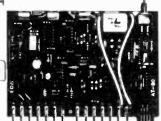
No, we're not going to give you any addresses — both phones will be very widely available.



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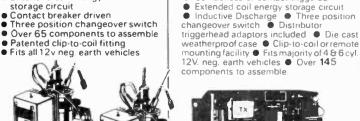
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Contactless or contact triggered



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- Inductive Discharge Extended coil energy storage circuit
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- The brandleading system on the market today
- Unique Reactive Discharge Combined Inductive and
- Capacitive Discharge Contact breaker driven
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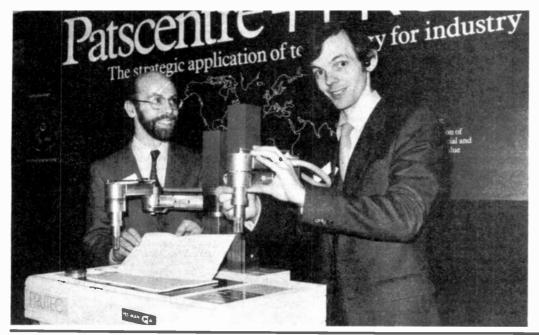
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#### **NEWS:NEWS:NEWS:NEWS:NEWS:NEWS**



#### **Shorts**

• Non-volatility in Sinclair memory has its advantages, or so Cambridge Microelectronics Ltd, because they've just released the CRAMIC-81 upon an unsuspecting world. For £79.95 (plus VAT, but including p&p), you can have 16K of long-life (10 years) of memory retention on your ZX81 . . . they must have seen our PseudoROM project. If you want complete permanance, Cambridge Microelectronics are also offering an EPROM programfor the '81, called PROMER-81. Cambridge Microelectronics Ltd may be found at One Mi ton Road, Cambridge C84 1YU.

Looking for a way to get rich? The National Computing Centre, Oxford Road, Manchester M1 7ED, have launched a management training package entitled 'Profits from Microchips'. Mind you, you've got to be fairly well off to start oft with, as the package will cost you a cool £800. • Ferranti have extended their range of microphone amplifier ICs by introducing three new products, the ZN475E, ZN476E and ZN477E, designed for piezo-electric, moving coil and simple transducers. Ferranti Electronics Ltd, Fields New Road, Chadderton, Oldham, Lancashire OL9 8NP.

• They've been busy at ILP, as they've recertly aunched a new range of regulated power supply modules, as well as a new range of modular power units. Do they ever sleep? ILP Electronics Ltd, Graham Bell House, Roper Close, Canterbury, Kent CT2 7EP.

• NEC Electronics (UK) Ltd, of 116 Stevenson Street, New Stevenson. Motherwell ML1 4LT, have launched a new 1 F (yes, one farad) super-cap, specifically for on-board memory power backup. Rated at 5 V DC, the unit occupies less than 1 cubic inch in volume. • Why buy when you can hire? Aughton Automation Ltd have written a brochure on their range of computers, peripherals and robots that you can hire. Aughton Hire, Woodward Road, Kirkby Industrial Estate, Kirkby, Liverpool L33 7UZ.

OK Industries UK Ltd, Dutton Lane, Eastleigh, Hants SO5 4AA have launched a new desoldering station, the SA-4, for production, prototype or laboratory use.

 Also from OK, a desolder pump that has a bronze alloy tip in order to avoid CMOS static problems.

● Litesold also have a new product, the MG self-feeding soldering gun, which allows the option of using solder from a benchmounted reel or from a reel mounted on the gun itself. Light Soldering Develoments Ltd, Spencer Place, 97/99 Gloucester Road, Croydon, CRO 2DN.

• Enclosure Technology of Unit G, Southampton Airport, Southampton SO2 2HG have launched two new product ranges: the Chassis Europe, a range of chassis kits in 11 height ranges and four depths and the Harmonite instrument cases, in five heights, three widths and three depths, and also with a range of accessories.

• First of this month's rash of catalogues: this one's from HB Electronics, of Lever Street, Bolton, BL3 6BJ, and features Ungar soldering and de-soldering equipment.

Not exactly a catalogue, but 'a new 8pp colour brochure' is available from BICC-Vero Packaging, Industrial Estate, Chandlers Ford, Eastleigh, Hants SO3 3ZR, and it describes Speedwire, as reviewed in your very own ETI in June 1982.

• There seem to be a lot of small companies based in Cambridge and specialising in ZX peripherals. Here's another one, called (original name, this) Cambridge Computing. They're ever

so excited about their new, 'totally unique' joystick for both the '81 and the Spectrum, that they say will work with all software. They won't be launching the thing till lune, though (they're at 1 Benson Street, Cambridge).

• We mentioned Southampton Universities' computer holidays a couple of months ago in Digest. They now tell us that they are able to offer places to disabled people, due to their having a purpose built hall for disabled students. For more information write to M.A.P.S., 37 University Road, Southampton SO2 1TL (tel 0703 558621).

558621).

● Why do suppliers seem to shy away from calling a catalogue a catalogue? Latest offenders (again) are Elkan Electronics, Freepost, 11 Bury Road, Prestwich, Manchester M25 8JZ, who call their catalogue of soft and hardware for the Dragon computer the 'Dragon Supermarket'. Well, really.

 Cetron c Components Ltd have issued a brochure on their wirewound resistors and potentiometers. Free to trade people, your copy may be had from Cetronic Components Ltd, Hoddesdon Road, Stanstead Abbots, Ware, SG12 8EJ.

The Computer Trade Association inform us that if you managed to join them before June 1st, then the membership would have cost you £20, whereas after it'll set you back £50. The association aims to represent all sections of the industry, including retailers, distributors, software houses, manufacturers and consultants, and may be found at 108 Margaret Street, Coalville, Leicestershire LE6 2LX.

• Pronto Electronic Systems, 466-478 Cranbrook Road, Gants Hill, Ilford, Essex have released two new ultra-low noise opamps, the OP-27 and the OP-37 Depending on their availability, we're hoping to bring you a data sheet on these in the near future.

#### Yes, Ma'am?

A new robot, designed to work alongside rather than replacing a human being, has been launched by Patscentre International and Prutec. Yes-Man (he's the one in the middle, without a silly grin) is the latest development from the association between Patscentre, the science and technology division of PA International, the management consultancy group, and Prutec, the high technology funding subsidiary of the Prudential Assurance Company.

The importance of Yes-Man

The importance of Yes-Man lies in its ability to work with an operator in 'mixed assembly' tasks. Yes-Man carries out the more routine portions of the task leaving the human being free to exercise his skills in the cognitive and manipulative elements to which he is best suited. This specialisation is claimed to both improve productivity and contribute to a more rewarding working environment.

• Feeling boxed in? You may be a case for assistance from Boss Industrial Mouldings Ltd, who have extended their range of ABS potting boxes. Boss Industrial Mouldings Ltd, James Carter Road, Mildenhall, Suffolk IP28 7DF.

• At last! Someone who calls their catalogue a catalogue, and not a short-form supermarket file system. Rafi Electronics, 98 Croydon Road, London SE20 7AB present a range of professional DIN standard keyboards with considerable scope for customisation.

• The Irish Amateur Computer Club has written to inform us of their existence, and to say that our readers will get a warm welcome from them. In particular, they say that they are keen to recruit people with a good knowledge of hardware. The club may be reached via Nigel Carry (general secretary), 166 McKee Avenue, Finglas East, Dublin 11.

● Last but by no means least on our list (actually, it was at the top of the pile until it fell on the floor) comes Towers' International Digital IC Selector. From 11311 to ZN74119F, it lists a very large number of ICs (no, we didn't count) with brief details of use, an indication of the pin-out, and any substitutes that are available. Published by W. Foulsham & Co, it should be available through any good technical bookshops. (Note that it doesn't cover microprocessor ICs, these have a volume of their own in the series).

• We would tell you that the British Amateur Electronics Club, c/o Dickens, 26 Forrest Road, Penarth, South Glamorgan, have just published their latest newsletter... we would tell you, but they addressed the accompanying letter to "The Editor, Electronics and Music Maker..."



#### 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 Beiglum. Kits comprise Mullard wooler (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 foudspeaker terminals. SUPERB SOUNDS AT LOW COST. Kits supplied to potential parts of the control of the components of the control of the components of the components of the control of the components of the control of the components of the control of the SUPERB SOUNDS AT LOW COST. Kits supplied in polystyrene packs complete with Instructions. 8" 40W system — recommended cabinet size 240 x 216 x 445mm Price £14.30 each + £2.00 P & P. 5" 30W system — recommended cabinet size 160 x 175 x 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

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The very best in quality and value.

Ported tuned cabinet in hard-wearing 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; Slze: 20in x 15ln x 12in; Welght: 30 pounds

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3 watt FM



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DECK MODULE

Comprising of a top panel and tape mechanism coupled to a record/play back printed board assembly. Supplied as a record/play back printed board assembly. Supplied as one complete unit for horizontal installation into cabinet or console of own choice. These units are brand new, ready built and tested digit tape counter. Autostop. Six piano type keys, record, rewind, fast forward, play, stop and eject. Automatic record level control. Main inputs plus secondary inputs for stereo microphones. Input Sensitivity: 100mV to 2V. Input Impedence: 68K. Output level: 400mV to both left and right hand channels. Output impedance: 10K. Signal to noise ratio: 456k. Wow and flutter: 0.1%. Power Supply requirements: 18V DC at 300mA. Connections: The felf and right hand stereo inputs and outputs are via individual screened leads, all terminated with phono plugs (phono sockets provided). Dimensions: Top planel 21m. Supplied complete with forcut diagram. Attractive black and silver finish. Price £28.70 + €2.50 postage and packing.

Supplementary parts for 18V D.C. power supply (transformer, bridge rectifier and smoothing capacitor) \$3.50.

#### LOUDSPEAKERS

LOUDSPEAKERS
THREE OUALITY POWER LOUDSPEAKERS (15". 12" and 8" See "Photo)
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8" 50 watt R.M.S. Impedance 8 ohms. 20
oz. magnet. 1%" aluminium volce coil. Res.
Freq. 40Hz. Freq. Resp. to 6 KHz. Sens.
92dB Black Cone. Price: £9.50 each. Also
available with black protective grille Price:
£9.99 each. P&P£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. aluminium voice coil, aluminium centre dome, 8 ohm imp., Res. Freq. 45Hz., Freq. Resp. to 6.5KHz., Sens. 98dB. Price: £22.00 + £3 carriage.

12" 85 watt R.M.S. McKENZIE C1285TC (P.A., DISCO) 2" aluminium voice coil. Twin cone. 8 ohm imp., Res. Freq. 45Hz., Freq. Resp. to 14KHz. Price £22 + £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

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This deck has a completely manual arm and is
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SPECIFICATION
Output Power:— 110 watts R.M.S.
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T.H.D.;— 0.01%. S.N.R. (Unweighted):— ·118dB ±3.5dB. Sensitivity for Max. Output:— 500mV ⊚ 10 Price:— £31.99 + £2.00 P&P. Vu Meter Price:— £7.00 + 50p P&P.

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TYPE 'A' (KSN2036A) 3" round with protective wire mesh, ideal for bookshelf and mer 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 horn. For quality Hi fi systems discos etc. Price £5.99 each.

TYPE 'D' IKSN1025A) 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 f10.75 each P&P 20p ea. (or SAE for Plezo leaflets).

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



Extended

Bleep Britain's first wide-area radiopager with a message display was launched by British Telecom Radiopaging in April.

A ten-digit liquid crystal display on the new pager can be used to identify the caller (by giving a phone number), or to convey a message. The last two messages are stored in its memory

and can be displayed at the touch of a button.

Like a tone pager, the new version gives a distinctive bleep to alert users. It also has a tiny lamp which flashes in response to a call. This enables users to keep in touch even when the bleep is muted to avoid disturbing others.

Display Page is the name of British Telecom Radiopaging's new service. For the first time it makes it practical for customers to advertise their paging numbers so that anyone may call them.

#### **Guildford Gets** The Wire

iscussions have been taking place between Rediffusion and Guildford Borough Council on a proposal by the company to install and operate an advanced multi channel cable television

system in the city.

The proposed network would be a modern switched star cable system providing initially up to 30 television channels together with up to 20 FM channels. The system would be interactive, offering the community opportunities several new information technology services. These include teleshopping, telebanking, security and education in the home.

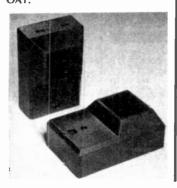
If central government approval is given, Rediffusion's plans could make Guildford the first city in Britain to possess a system which, while providing a wide range of national and other tv programmes, would enable a new concept in community television to be developed. As such it would become a model for other similar systems both in the UK and abroad.

Guildford is considered by Rediffusion to be ideally suited to this new enterprise with a demographically well balanced community (we think that means rich). It encompasses a wide range of activities and interests with opportunities for cultural and educational services provided by the university, cathedral and other the local organisations.

Modular Security

Riscomp Limited announce an addition to their range of security mocules and accessories with an infra-red system known as the IR 1470. The unit, which operates from a conventional supply, consists of a separate transmitter and and provides a infra-red receiver. modulated beam of infra-red light over distances of up to 50ft. In the event of the beam being interrupted, a relay in the receiver unit is energised, which if connected to an appropriate warning device can be used to sound an alarm. Both transmitter and receiver are housed in compact moulded enclosures and easily mounted on most surfaces.

The system which is British made and 'ully guaranteed, is supplied with comprehensive data and costs £25.60 + VAT. For further information further contact Riscomp Limited, 21 Duke Street, Princes Risborough, Bucks H217



#### **EMI Joins CD**

s you may have seen in the newspapers, EMI have decided to join in on the compact disc bandwagon. They had been a significant absentee from the furore of the CD launches, but it looks as though the fact that all the players have sold out wherever they've been put on sale has persuaded EMI to adopt the medium.

They say that they will be building a catalogue strength of over 200 titles during the first twelve months. Though this is a tiny proportion of just the new releases from EMI and its subsidiaries, it would still represent a 100% increase on the CD launch catalogue.

#### Watch With The BBC

Digithurst's latest analysis product has been designed to run with the BBC microcomputer. It enables the Model B BBC computer to be linked to a standard home video recorder and pre-packaged images to be transferred into the

interface, known as

MicroEye, enables pictures to be digitised with a 256 x 256 resolution, although with the BBC Model B only 128 x 128 pixels are used. Digithurst decided to go for a high resolution as it feels users will want to upgrade the system when they add a second processor to their BBC kit. The interface is supplied as a total package providing the cable connections to both the video recorder and the BBC user port. A complete suite of software is supplied

allowing the user to analyse captured images, and to dump them onto the disk or a printer.

As well as running with the BBC machine the above package can also be connected to a range of other microcomputers such as Research Machine 380Z, Apple, Commodore, Hewlett Packard, IBM, Sirius, etc.

The package price is £295 VAT. Digithurst Ltd, Leaden Hill, Royston, Herts, SG8 Orwell, 50H.

#### No Mail Order Orics

ric Products' own mail order Oric Products own man order operation for the Oric 1 and all peripherals has stopped accepting orders, and Oric is putting its promotional strength behind retailers with a £50,000 advertis-ing campaign for the April-June period and full colour point of sale kits available to all stockists. Oric 1 is now available from W. H. Smith, Dis Dixons, Greens, Micro Peripherals, Spectrum, puters for A11 and Comand other specialist outlets.



#### Play the AMBIT numbers game .....

The long awaited implementation of on-line order processing is with us at last, and whilst this means that orders for in-stock items can now be processed more efficiently, it also means that orders should be submitted using stock codes for best results. Our current catalogue (75p) includes all order codes (watch out for the new expanded Spring edition), but here's an abstract from some of the more popular lines to use as a quick reference.

Remember that you can also access our catalogue via REWSHOP on REWTEL, which now includes on-line current price and delivery information. You need a 300 baud MODEM and RS232 terminal, (various suitable configurations based on popular micros have been published in recent past issues of Radio and Electronics World).

Prices shown here exclude VAT, and the P&P charge is currently 60p per order (unless otherwise indicated). Remember that our telesales service operates with human beings (not 'dumb' machines) from 8am to 7pm (and frequently later) Monday to Friday, and 9am to 8pm on Saturdays. REWSHOP operates 24 hours a day, 365 days a year with full price and delivery information.

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4025 23 04025 0.15 4027 23 04027 0.26	40195 23 40195 1.08	74LS258 31-74258 0.36 74LS259 31-74259 8.51	74HC109 30-74105	0.68	MC1350 HA1370	61 01350 61-11370	1.20	MSM5524 MSM5525		11,30 7.85	ZTX323 2N2369A	58 06232 58 02369	8.38	BALAN	ICED MIXE	ERS
4028 23 04028 0.50 4029 23 04029 0.55	74LSXX 74LS00 31-07400 0.11	74LS260 31-74260 0.26 74LS266 31-74266 0.20	74HC175 30 74175 74HC373 30 74373	2,40	HA 1388 LM 1458N	61-01388 61-14580	2.75	MSM5526 MSM55271	61 05526	7.85	R	POWER		SBL1	12 00003	4.58
4035 23 04035 D.67	74LS01 31 07401 0.11 74LS02 31 07402 0.11	741 S273 31-74273 0.70 741 S279 31-74279 0.35	74HC374 30 74374 74HC533 30 74533		MC1496P St 1610	61 01496 61 01610	1.25	ICM7106CP	61-55271 61 07106	9.55	BFW16A MRF237	58 08016 58 14237	0.65	SBL1-X	12 00013 12 00023	5.00 6.33
4040 23 04040 0.68 4042 23 04042 0.50	74LS03 31 07403 0.11	74LS283 31-74283 0.40	74HC534 30 74534 74HC165 30 74165		St 1611	61 01611	1.92	ICM7107CP LC7137	61-07107 61-07137	7.50	MRF238	58 14238	3,20 18.50	SRA1-1	12 00033 12 00043	10.60
4043 23 04043 0.80 4044 23 04044 0.88	74LS04 31 07404 0.14 74LS05 31 07405 0.14	74LS290 31-74290 0.40 74LS293 31-74293 0.40	74HC173 30-74173 74HC160 30-74160		SL1612 SL1613	61 01612 61 01613	1.92 2.08	ICM72168 ICM7216C		19.50 19.95	MRF245 MRF449A	58 14245 58 14449	18.50	SAA1H SAA3	12 00053 12 00063	18.34 15.35
4046 23 04046 0.80 4049UB 22 04049 0.24	741S08 31-07408 0.14 74LS09 31-07409 0.14	74LS298 31-74298 0.54 74LS365 31-74365 0.34	74HC161 30 7416 74HC162 30 7416	1,33	St 1620 St 1621	61-01620 61-01621	2.50	ICM7217A SP8629	61 07217 61 08629	9.50 3.05	MRF472 MRF475	58-14472 58 14475	1.25 4.80			_
4050 23 04050 0.24 4051 23 04051 0.55	74LS10 31 07410 0.14 74LS11 31 07411 0.14	74LS366 31-74366 0.40 74LS367 31 74367 0.30	74HC163 30 74163	1.33	St 1623 St 1625	61 01623 61 01825	2,50 2,50	SP8647 SP8793	61 08647 61 08793	8.00 7.70	MRF629 PT8611	58-14629 58-18811	4.99 9.50	300	LEDS round types	
4052 23 04052 0.55 4053 23 04053 0.55	74LS12 31 07412 0.14 74LS13 31 07413 0.32	74LS368 31 74368 0.30 74LS373 31 74373 0.72	74HC4538 3/774538 74HC85 30 74280	2.95	St 1626 St 1630	(\$16270) 61-01630	1.62	95H90 HD10551	61 09590 61:10551	7.80	TP2320 VN66AF	58 12320 60 02066	0.95	CQX25 Redi	Cir 15 20250	0.15
4060 23 04060 0.75	74LS14 31 07414 0,32 74LS15 31 07415 0.14	74LS374 31 74374 0.72 74LS375 31-74375 0.31	74HC280 30 74280 74HC42 30 07442	1.00	St 1640 St 1641	61 01640 61 01641	2.25	HA12009	61 12009	6.00	21X3866 2N3866	58 03866 58 13866	8.45 1.20		h 15 20260	0.15
4068 23 04068 0,18	74LS20 31.07420 0.14 74LS21 31.07421 0.14	74LS377 31 74377 0.60 74LS378 31 74378 0.44	74HC138 30 74138 74HC139 30 74138		MC1648 TDA2002	61-01648 61-02002	3.25	HD44015 HD44752	61 44015 61-44752	8,00		SIGNAL			n 15-01790 to 15-20270	0.18
4069UB 22 04069 0.14 4070 23 04070 0.18	74LS22 31 07422 0.14	7415379 31 74379 0.44	74HC4514 30 0451- 74HC4543 30 04543		ULN2240	61 02240	3.25	MC145151P MC145152P		8.00 6.60	BF256	59 00256	0.36	V180P-Yello	n 15 01800 Rd 15 20410	0,10
4071 23 04071 0.16 4072 23 04072 0.16	74LS26 31 07426 0.14 74LS27 31 07427 0.30	74LS385 31 74385 1.30 74LS386 31 74386 0,27	74HC157 30 7415 74HC158 30 74158		ULN2242 ULN2283	61 01090 61 02283	1.00	MC145156P		4,60	8F960 8F961	60 06960 60 06961	0.99 0.70		d 5mm DIA L	
4073 23 04073 0.16 4075 23 04075 0.16	741S28 31-07428 0.18 741S30 31-07430 0.14	74LS390 31-74390 0.51 74LS393 31 74393 0.48	74HC257 30 7425		CA3080 CA3089	61 03080 61 <b>03</b> 089	1.84		SIGNAL A	_	BF963 J310	60 06963 59 02310	0.99		d 15 10400 pen 15 10720	0.12
4076 23 04076 0.55 4077 23 04077 0.18	74LS32 31 07432 0.14 74LS33 31 07433 0.14	74LS398 <i>31 74398</i> 0.80 74LS399 <i>31 74399</i> 0.65	LINEAR IC	s	CA3123 CA3130E	61 <b>03123</b> 61- <b>31</b> 300	0.80	8C182 8C212	58 00182 58 00212	0.10	J176 25K55	59 02176 59 01055	0.65	COY74L Yel	inw15 10740 ird 15 20380	8.15 0.20
4078 23 04078 0.18 4081 23 04081 0.18	74LS37 31-07437 0,18 74LS38 31-07438 0.14	74LS490 31 74490 0.60 74LS670 31 74670 1.15	LM10CN 61 000H		CA31307 CA31408	61 31301 61 31400	0.90	8C237 8C238	58 00237 58 00238	0.08	2\$K168 3\$K45	59 01168 60 04045	0.37	CQX398 OA	rich 15 20390	0.28
4082 23 04082 0,16	741S40 31-07440 0.18 741S42 31 07427 0.30		MF10 61 0001 L149 61 00141	5.05	CA3189E CA3240E	61 03189 61-32400	2.20	8C239 8C307	58 00239 58 00307	0.08	35K51 35K60	60 04051	0.54		15 20100	0.17
4093 23 04093 0 30 4099 23 04099 0 80	74LS47 31-07447 0.75 74LS48 31-07448 0.40	74CXX	ZNA234 61 02340 U237B 61 0023	8.50	MC3357 MC3359 tas	61-03357	2.85	BC308 BC309	58 00308 58 00309	0.08	3SK88	60 04060 60 04088	0.58	COX11 Gree	ow 15-20110 ow 15-20150	0.20
4175 23 04175 0.80 4502 23 04502 0.80	744549 31 07449 0.80	74002 29 07402 0.35	U247B 61 0024	7 1.28	ULN 3859	61 03859	2.95	BC327 BC337	58 00327 58 00337	0.13	40673 see 40822 see	3SK51			Red 15 20400	0.24
4503 23 04503 0.50 4506 23 04506 0.70	74LS51 31.07451 0.14 74LS54 31.07454 0.14	74C04 4069C 74C08 29-87408 0.35	U257B 61 0025. U267B 61 0026.	7 1.28	KM3701 KM3702	61 03701 61 03702	85.53 74.84	BC413 BC414	58 00413	0.10	40823 3SK 112	60 03823 60 04112	0.85 4.80		ra-Red LEDs	
4507 23 04507 0.37 4508 23 04508 1.50	74LS55 31.07455 0.14 74LS74 31.07474 0.21	74C10 29 07410 0.35 74C14 45B4C	LM301AH 61 0301 LM301AN 61 0301		LM3900 LM3909N	61 39000 61 39090	0.60	BC415	58 00414 58 00415	0.11		DIODES			15 10990	0.56
4510 23 04510 0.55 4511 23 04511 0.45	74LS75 31-07475 0.21 74LS76 31-07476 0.25	74C20 29 07420 0.35 74C30 19 07430 0.35	LM 308H 61 0308 LM 308CN 61 0308		LM3914N LM3915N	61 <b>0391</b> 4 <b>61 03</b> 915	2.80	BC416 BC546	58 00416 58 00546	0 11	AA112 BA244	12 01126	0.25			_
4512 23 04512 0.55	74LS78 31 07478 0.19 74LS83 31 07483 0.33	74C32 29 07432 0.35 74C42 29 07442 1.05	LM324 61-0324 LM339N 61-0339		KB4400 KB4412	61 04400 61 04412	0.B0 1.95	8C550 8C556	58 00550 58 00556	0.12	BA379	12 02447 12 03797	0.17	BNY37	Optocouple 15 40370	1.44
4515 23 04515 1.25	741585 31 07485 0.44	74C4F 29 07448 1.50	LF347 61 0034 LM348 67 0348	7 1.60	KB4413 KB4417	61 04413	1.85	BC560 BC639	58 00560 58 00639	0.12	ND4981-76 0491	12 49817 12 00916	0.51	BH137	15 40370	1.44
4516 23 04516 0,80 4518 23 04518 0.35	74LS86 37-07486 0.15 74LS90 37-07490 0.24	74074 29 07474 0.75	LF351 61 0351	0.49	KB4420B	61 04420 61 14420	1.09	BC640 MPSA13	58 00640 58 04013	0.22	0A47 PW02	12 00476 12 62006	0.10	FLA	T DIFFUSE	D
4520 23 04520 0 60 4521 23 04521 1.30	74LS91 31-07491 0.36 74LS92 31-07492 0.32	74C76 29 07476 0.60 74C83 29 07483 1.30	LF353 61 0353 LM380N 61 0038	0 1.00	TDA4421	61 14421	2.65	MPSA63 ZTX108	58 04063 58 01108	0.30	S04 W005	12 24006 12-10506	0.45	V320 V321	15 03200 15 03210	0.17
4522 23 04522 0.89 4526 23 04526 0.80	74LS93 31 07493 0.24 74LS95 31-07495 0.38	74085 29-07485 1.30 74086 29-07485 1.30	LM381 61 0038 LM382 61 0038		KB4424	61 04423 61 04424	2.30 1.65	ZTX212	58 01212	0.10	1N4001 1N4002	12-40016	0.08	V 322 V 323	15 03220 15 03230	0.20
4527 23 04527 0.80 4528 23 04528 0.85	74LS107 31-74107 0.31 74LS109 31-74109 0.25	74089 29 07489 1.60 74090 29 07490 1.05	ZN419CE 61 0041 ZNA423 61 0423		KB4430 KB4431	61 04430 61 <b>04</b> 431	1.95	ZTX653 ZTX753	58 01653 58 01753	0.20	1N4004 1N4148	12 40046 12 41486	0.07	V330 V331	15 03300 15 03310	8.17 0.28
4529 23 04529 0.70 4531 23 04531 0.65	74LS112 31-74112 0.21 74LS113 31-74113 0.21	74C93 29 07493 1.05 74C95 29 07495 1.25	ZN425EIB 61 0425 ZN426EIB 61 0426	0 3.50	K84432 K84433	61 04432 61 04433	1.95	2N2904 2N2905	58 02904 58 02905	0.25	1N5404	12 54046	0.18	V332 V333	15 03320 15 03330	0.20
4532 23 04532 0 80 4534 23 04534 4 00	74LS114 31-74114 0.21 74LS122 31-74122 0.27	74C107 29 74107 0.60 74C151 29 74151 2.10	ZN427E/8 61 0427 ZN428E/8 61 0428	0 6.28	KB4436 KB4437	61 04436 61 04437	2.53 1.75	2N3905 2SB646A	58 03905 58 03646	0.10 0.30	1N6263	ARICAPS	0.62	V340 V341	15 03400 15 03410	0.17
4536 23 04536 2.50	74LS123 31-74123 0.38	740154 29 74154 3.05	ZN429EIB 61 0429	0 2.10	K84438 K84441	61 04438 61 04441	2.72	2SB648A 2SD666A	58 03648 58 03666	0.40	BA 102	12 01025	0,30	V342	15 03420	0.20
4538 23 04538 0 85 4539 23 04539 0 80	74LS125 37-74125 0.27 74LS126 31-74126 0.27	74C157 29 74157 2.10 74C160 40160	ZN432CJ10 61 0432 ZN433CJ10 61 0433	0 22.58	KB4445	61 04445	1.29	2SD668A 2SA872A	58 03668 58 02872	0.40	BA121 BB1058	12 01215	0.30	V343 V510	15 03430 15 05100	0.20
4543 23 04543 0.80 4549 23 04549 3.50	74LS132 31-74132 0.27 74LS133 31.74133 0.24	74C1610 40161CM 74C1620 40162CM	2N450E 61 0450 NE542 61 0542	0 1.20	KB4446 KB4448	61 04446 61 04448	2.75 1.65	2SA1084E 2SA1085E	58 01084 58 01085	0.25	881098 882048	12 01095 12 02045	0.27	V511 V512	15 05110 15 05120	0.26
4553 23 04553 2.70 4554 23 04554 1.20	74LS136 31-74136 0.20 74LS138 31-74138 0.30	74C1630 40163CM 74C164 29 74164 1.05	NE544 61 0054 NE555N 61 0555		NE 5044 MC 5229	61 05044 61 05229	9.60	2SC1775A	58-01775	0.19	88212 (TT210	12 02125	1.95	¥513 ¥520	15 05130 15 05200	0.17
4555 23 04555 0.35 4556 23 04556 0.40	74LS139 31-74139 0.30 74LS151 31-74151 0.30	74C165 29 74165 1.10 74C173 4076C	NE556N 61 0556 SL560C 61 0560		NE 5532 KM 5624	61-55320 61-05624	1.85 4.35	2SC2546E 2SC2547E	58 02546 58 02547	0.24	MVAM115	see KV1236	0.30	¥521 ¥522	15 05210 15 05220	0.26
4557 23 04557 2.30 4558 23 04558 0.80	74LS153 31-74153 0.34 74LS155 31-74155 0.30	74C1740 40174CM 74C1750 40175CM	NE562 61 0056 NE584 61 0056		SD6000 SL627D	61 06000 61 06270	3.75	AUD	IO POWER		KV1210	12-12105	2.45	V523 V530	15 05230 15 05300	0.20
4559 23 04559 1.50 4560 23 04560 2.50	74LS156 31-74156 0.33 74LS157 31-74157 0.27	74C192O 40192CM 74C193O 40193CM	NE565 61 0056 NE566 61 0056	5 1.00	SL6310 SL6440	61 06310 61 06440	2.45 3.38	BD139 BD140	58-15139 58-15140	0.29	KV1211 sa KV1225	12-12255	2.75	V531 V532	15 05310 15 05320	0.26
4561 23 04561 1.00	74LS158 31 74158 0.27	74C1950 40195CM	NE567 61 0056 NE570N 61 0057	7 1.30	S16600 SAS6610	61 06600 61 06610	3.75	B0165 B0166	58 15165 58 15166	0.48	KV1235 KV1236	12-12355 12-12365	2.75 2.55	V533	15 05330	0.20
4562 23.04562 2.58 4566 23.04566 1.20	74LS160 31-74160 0.34 74LS161 31-74161 0.38	74C200 29-74200 8,50 74C221 29 74221 1.55	SL624 61 0062	4 3.28	S16640	61 06640	2.75	BD179 BD180	58 15179	0.38	KV1310 KV1310	12-13105 12-13205	0.40	V540 V541	15 05200 15 05410	0.26
4568 23 04568 1.45 4569 23 04569 1.70	74LS162 31 74162 0.38 74LS163 31 74163 0.38	74C901 29 74901 0.55 74C902 29 74902 0.55	uA709HC 61 0709 uA709PC 61 0709	7 0.36	SL6690 SL6700	61 06690 61 06700	3.75 2.75	TIP31A	58 15180 58-15031	0.35		ER DIODE	_	V542 V543	15 05420 15 05430	0.20
45672UB 23 04572 0.32 4580 23 04580 3.25	74LS164 31 74164 0.40 74LS165 31 74165 0.80	740903 29-74903 0.55 740904 29-74904 0.55	uA710HC 61 8710 uA710PC 61 8710	0.59	SAS6710 LS7225	61 06710 61 07225	1.48 3.85	TIP32A MJ2955	58-15032 58-12955	0.35	BZYBBC 4	DOmW 5%.		V550 V551	15 05500 15 05510	0.28
4581 23 04581 1.40 4582 23 04582 0.70	74LS166 31 74166 0.58 74LS168 31-74168 0.89	740905 29 74905 6.50 740906 29 74906 0.55	uA7110N 61 0711 uA7330N 61 0733		CL8038CC		4.50	2N3055 2SB720	58-13099 58-15720	0.58	2V7 3V3	12 00278 12 00338	0.10	V552 V553	15 05520 15 05530	
4583 23 04583 0.80 4584 23 04584 0.27	74LS170 31-74170 0.83 74LS173 31 74173 0.47	74C907 29 74907 0.55 74C908 29 74908 1.10	UA741CH 81 0741	0 0.95	MS19362 MS19363	61 09362 61 09.	1,75 1.75	2S0760 2SJ49	58 17600 60 01049	3,10	3V9 4V7	12 00398 12 00478	6,18		RI COLOUF	_
4585 23 04585 0.45 4702 23 04707 4.50	7415174 31-74174 0.37	740909 29 74909 2.10 740910 29 74910 5.00	uA747CN 61 0747 uA748CN 61 0478	0.70	K10170 TK10321	61-10170	1.87	2SJ50 2SJ83	60 01050 60 01083	4.25 3.55	5V1 5V6	12 00518 12 00568	0.10	V518	15 05 180	
4792 2304702 4.30	1,505113 3176173 0.40	1 . 40010 2374010 3.00	30.700	3.50						_		_	_			_

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

#### **Bistromathics?**

A new restaurant management system peing introduced by Automatic Revenue Controls claims to be easier for table staff to use and give more accurate control over inventories than comparable systems. But will it stop you getting soup spilt on your lap?

Dart is the name of the system which has been on field trial in the UK for six months and has undergone several improvements to software as a result.

Waiter terminals, where staff enter their orders instead of rushing them to the kitchen or bar physically, are not the conventional off-putting numeric keypads. Instead, what waiters and waitresses see is a mimic of the menu itself, with page turnover just like the folder the guest uses at the table. Every menu item is identified by name and one-button selections are possible for most, if not all, of them. Up to 350 different individual items can be ordered at each terminal in this way. Those items may be varied between terminals—no point in having a key for Rump Steak rare in the par, for example.

Details from Automatic Revenue Control Ltd, Home Park Estate, Station Road, Kings Langley, Hertfordshire WD4 8LZ.

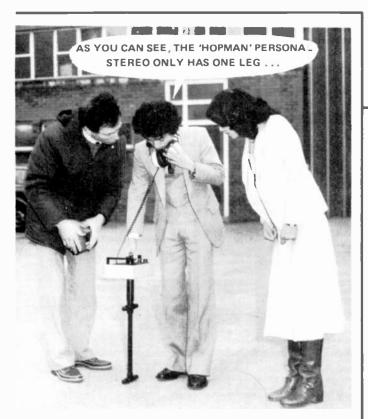




### **Get Taped**With Aiwa

A iwa, renowned for their high specification cassette decks,

have introduced three new top line decks. According to Aiwa, these decks will capture on tape the crystal clear sound of the Compact Disc. We do hope that this doesn't mean they're en-



couraging our readers to break the copyright law. All three machines — the AD-F990, AD-F770 and the AD-F660 — feature Dolby HX Professional Circuitry and Micro-grain Dual Capstan Tape Transport. Delby HX Pro is a specially developed anti-saturation circuit that prevents high frequency loss, and therefore greatly improves the dynamic range at the top end of the frequency response curve

the frequency response curve
It is claimed that a metal tapelike performance can be achieved
with Dolby HX Pro, even when
recording with normal tapes, so
the sound quality on play-back is
excellent, even through a car
stereo. Dolby HX Pro is not a
noise reduction system — Dolby
B & C noise reduction systems are
also incorporated into the decks
for improving the dynamic range
over a wider frequency range.

Aiwa developed the Micrograin Dual Capstan Tape Transport to increase the contact between tape and capstan. The Micro-grain surface which is incorporated in the AD-F990 is composed of millions of uniform hemispheric domes, each only  $2\mu$  (micron) in diameter to ensure correct tape tension and reduced modulation noise, plus reduced wow and flutter — 0.025% (WRMS).

At a cool £349 or so, the AD-F990 is Aiwa's top-of-the-range Digital Era (for so they are called) cassette deck, which as well as featuring Dolby HX Pro and Dolby B & C has high performance 3 head technology and introduces a newly developed amorphous alloy combination head. Also new for the AD-F990 is the auto noise reduction detector, which selects the correct noise reduction system automatically for tapes previously recorded on it.

Offering most of the features of the above, is the AD-F770 that weighs in at £279.95. Slightly lower down the market (but only very slightly) is the AD-F660, at £229.95. All these should be available through Aiwa dealers.

Digivision

TT Television & Video have announced the results of a 10 year 20 million pound investment project which, they say, has led to a revolutionary new system of television receiver bechnology known as Digivision. According to ITT, this represents not one but a series of quantum jumps in the design, giving the consumer enhanced performance, reliability and greatly increased flexibility.

Digivision is not simply an extension of the digital techniques already incorporated in the tuning and remote control sections of some receivers, but a completely new European development which will transform television receiver design world-wide.

In the first production designs up to 300 components of a comparable analogue-technology receiver will be replaced by seven VLSI chips, bringing increased reliability, greater stability of per-

formance and extended yet simplified control features, together with quicker and more certain diagnosis and servicing. Later designs will include improved picture displays, with zoom and picture-in-picture facilities, noise and ghost suppression and direct digital inputs from data networks and other signal sources.

A recent study of the market for TV, by Mackintosh International, has predicted that digital technology will be taken up by a large proportion of TV manufacturers, resulting in up to 40% of the market of colour receivers sold in the developed nations being taken by TVs with digital chassis. These results are in the company's report, 'Television Receivers: The Next Ten Years', which also analyses trends in other areas, such as display technology, cable TV and DBS. Unfortunately, this report is not publically available (well, they wouldn't give us a copy).

ETI

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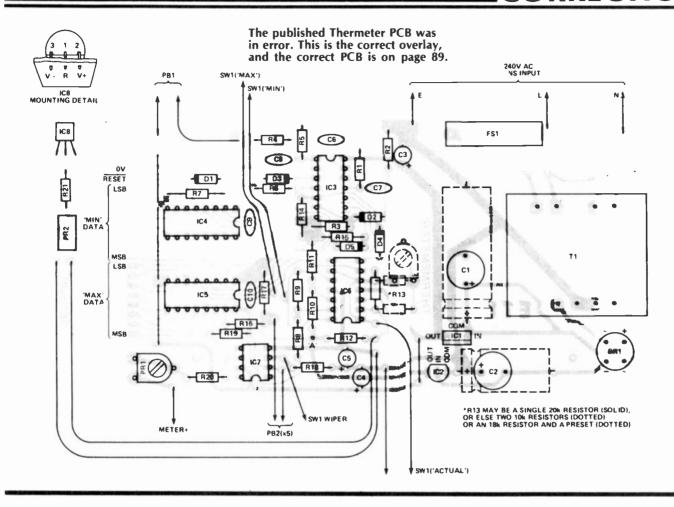
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# TV STORAGE SCOPE

he ETI Telescope is so simple, it's surprising no-one thought of it before. Well, they did, but the new range of high-speed A-to-Ds from Ferranti have made it possible to get the 'scope to work at over i MHz, while keeping the price within acceptable limits.

The project splits into two main sections: the logic board, featured here, and the memory board, to be featured next month. Unfortunately, you need both circuit diagrams in front of you to understand how the creature works, so we'll have to save the overall explanation until then.

#### BUYLINES.

Hawk Elect onics Test Equipment supply a full kit of parts for this project. All PCBs, the case (drilled and screenprinted), the ZN441 and all the other components are included, together with a comprehensive manual. The kit price is £89. The 'TeleScope' is also available built and tested for £109.

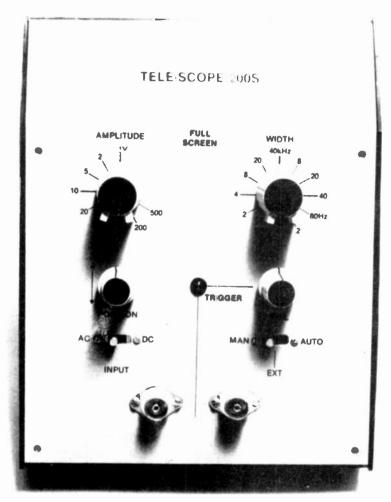
The manual may be purchased separately for E1.50, refunded on the subsequent purchase of a kit or finished circuit

Prices exclude 15% VAT, and postage and packing is £2.95 extra. The case, A-to-D converter, and the PCBs may all be purchased separately.

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#### HOW IT WORKS

The input attenuator is a series chain of resisters to ground, whose collective resistance is 1M2. The front panel amplitude switch (SW2) provides the voltage range select by tapping from this chain. The cpacitors connected to the chain (C2-7) compensate for the inductive effects of the resistors at high frequencies.

The input may be AC or DC-coupled by switching C1 in and out of circuit with SW1.

The :rigger select switch SW3 provides either an input signal trigger, an auto trigger (a 2 kHz signal derived from the sample rate switch), or an external trigger.

Q1 is a source-coupled FET which buffers the input signal between the input series chain variable attenuator and the flash A-to-D converter (which will be described in the next article). Q2 acts as a current source, enabling a DC offset to be added to the input signal. This offset is adjusted by RV1 and is used to shift the vertical position of the displayed trace. Q3 and RV2 set the trigger level, and LED1 is lit when the trigger is running.

the trigger is running.
IC2a is a D-type flip-flop, which enables the input address clock (IC3a) on

the leading edge of the input data via the trigger level. It is held in the reset state by a signal on pin 1 (from interboard link 5) when the input addressing is completed.

IC4a-c and the crystal XTAL1 form a 10 MHz oscillator and ICs 6 to 10 provide a series dividing network at divide-by-5 and divide-by-2 stages, thus producing division in steps of 10, 5, and 2 etc down to 100 Hz. The sampling rate is selected from this chain by the rotary switch on the front panel. IC13a is a divide-by-2 and is used as the output address clock at 5 MHz. It is also used to re-time the data out to the modulator via IC11a.

IC2b is a D-type flip-flop which is enabled by a line synchronisation pulse thus enabling IC3b. IC3b then allows IC14 to count eight pulses, each of one microsecond duration, before the output clock cycle is started (by IC7b). This produces an eight microsecond delay at the beginning of each line, so all data is displayed and none of the output is outside the video display area. When the output address cycle is completed (50 microseconds later), this counter resets and waits for the

reset line sync pulse.

In the same manner, IC18, 12b and 19 count line synchronisation pulses at the beginning of each field scan to enable the video output only during the middle 256 lines of interlaced scanning.

By dividing the 1 MHz signal by 16 using 1C15 and 1C16a, we produce a signal of 15.625 kHz, and 1C17a, a monostable, then produces the line syrchronisation pulses (4.7 microseconds wide), which are mixed into the UHF modulator by 1C12c and 12d. IC17b produces the field synchronisation pulses from the 50 Hz clock provided by 1C16b: these are approximately 50 microseconds wide. IC11b provides the control lines to switch over the memories and addressing. This changeover occurs when the input address counter has completed its cycle and the frame scan is completed.

The summing circuits used to mix the video data and the line and field synchronisation pulses are the open-collector gates IC12c and 12d at the UFF modulator input, with the resistor network providing the DC offset and modulation depth required to drive the video circuitry.

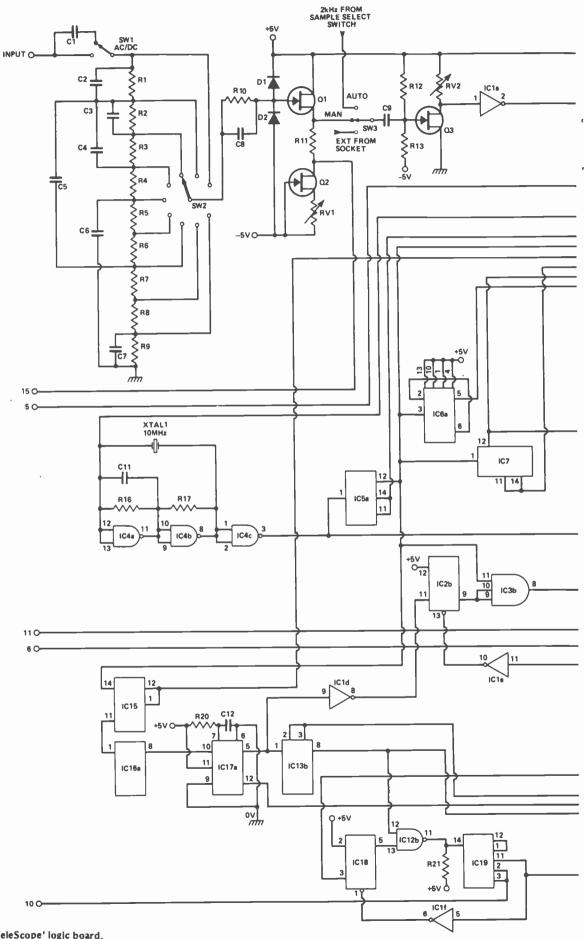
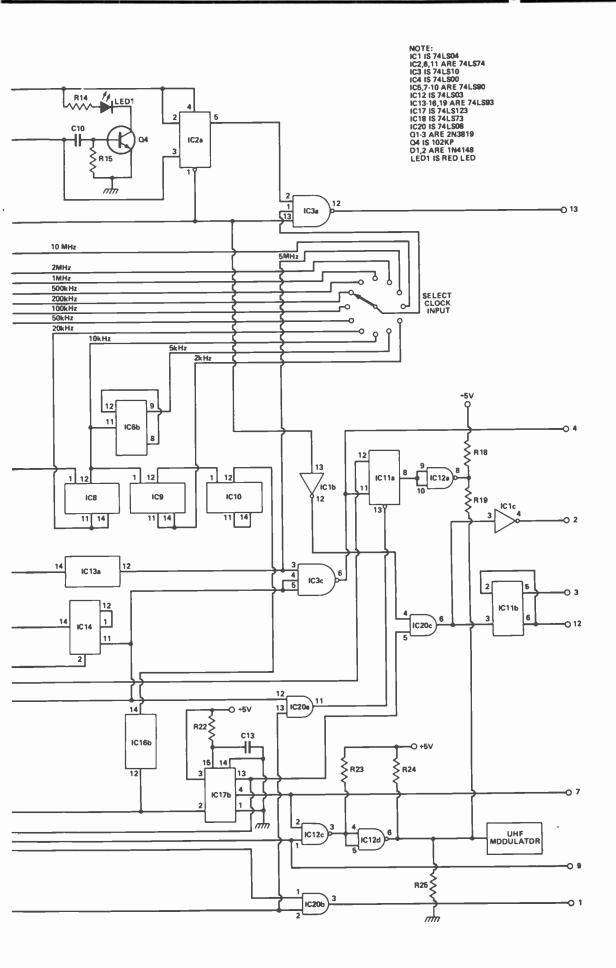


Fig. 1 Circuit diagram of the ETI 'TeleScope' logic board.



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# Do you think that designing and understanding electronic circuits is beyond you?

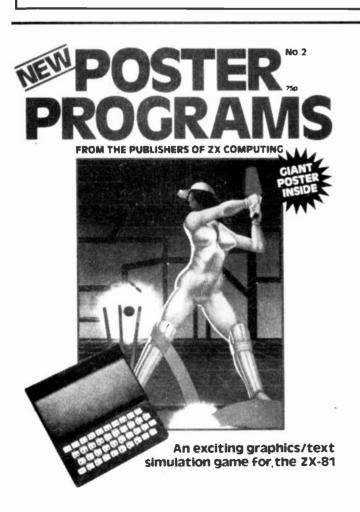
The summer edition of Electronics Digest, *Gateway To Circuit Design*, provides a step-by-step introduction for the newcomer to the art of circuit design. Firstly, you'll be introduced to the commoner electronic components — but not in a passive way. Electronics is a practical subject, so *Gateway To Circuit Design* will enable you to build simple circuits for yourself, and take measurements on them (along the way learning how to use a multimeter). Once these introductions are over, *Gateway To Circuit Design* shows you what goes into the design of a wide range of electronic equipment — for audio, computing and electronic music, for instance.

Gateway To Electronics is an occasional popular series in Electronics Digest, published by Argus Specialist Publications. Previous issues in the series have concentrated on projects; now we'd like you to design your own!

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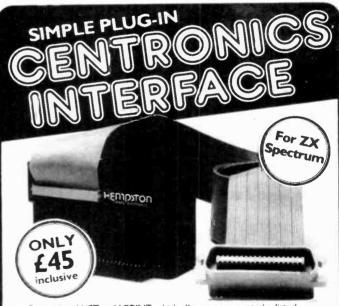
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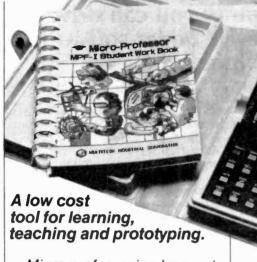
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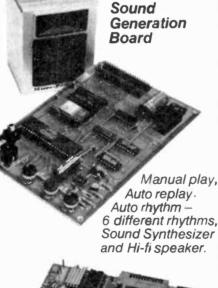
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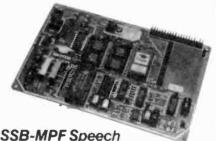


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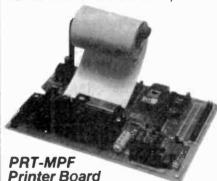
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of passing half of the total load

current through each terminal OR

personal computer need not necessarily be used for playing games, learning programming or producing computer club newsletters. With this project, you can put it to some practical use. Just what that is I'll have to leave to your imagination

and ingenuity!

Two independent groups of eight outputs are provided. Each of the 16 output driver circuits is configured to run from a 12 V supply, although higher supply voltages may be used. Each can be configured to sink up to 3 A. Simple address selection for the board is provided by an on-board DIP switch. It's a pretty straightforward project and you can vary things to suit your application(s).

#### **Component Options**

The component values shown in the circuit diagram are for output currents of up to 2 A. If other load currents are desired, then a few components need changing in order to reduce power dissipation in the output transistors.

For currents of less than 1 A, the TIP31Bs (Q17-32) may be replaced by BD139s — which have the distinct advantage of costing considerably less than TIP31Bs. However, note that BD139s have a different pinout such that the metal face on BD139s is on the opposite side of the package to the TIP31Bs.

The base current drive to the output devices is determined by R17 and R32 and may be optimised for different loads. The table here (Table 1) summarises component values for various output currents.

If the total output current is expected to exceed 20 A for more than a few minutes, then it is advisable to make the following changes:

solder the power ground directly to the PCB ground plane. (b) Solder several lengths of tinned copper wire to the heavy power ground track on the PCB. Intermittent use over 20 A

(a) Use a terminal strip capable

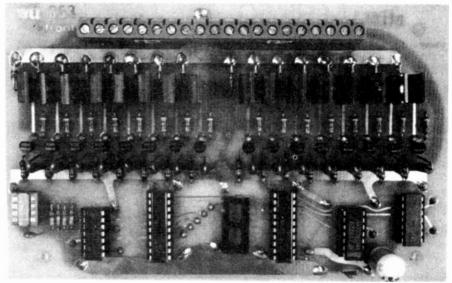
Intermittent use over 20 A should not require these changes. The power dissipation calculations for transistors Q17 to Q32 were based on data for RCA-manufactured TIP31Bs. The prototype transistors developed a collector-emitter voltage of 0V65 at 2 A, which does not necessitate heatsinking the transistors. If high current loads are to be used, measure V<sub>cc</sub> × I<sub>c</sub>.

measure  $V_{\rm ct} \times I_{\rm c}$ .
The TIP31B can dissipate 2 W at 25°C ambient without heatsinking. Continuous use at high currents may require a small flag heatsink on each TIP31B.

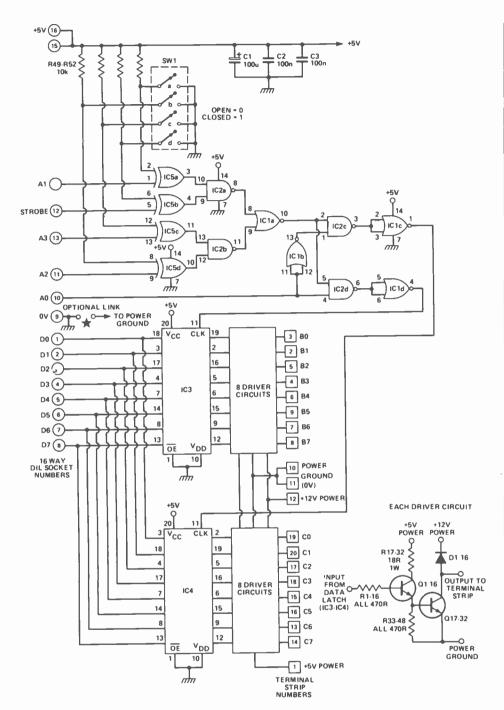
The entire electronics for this project is mounted on a double-

sided PCB. During the early design phase, it was found that a single-sided PCB would require an unacceptably huge number of links. To keep the cost down, throughhole plating was not specified for this board and connections between top and bottom side tracks are made with links of 22 swg tinned copper wire, of which there are a total of 61. IC sockets were installed on the prototype, but these are not essential.

Commence construction by giving the PCB a good inspection, looking for broken tracks and undrilled holes. Make sure the tracks are clean and bright so that soldering is easily carried out. Insert all the links first. These are identified on the component overlay diagram by a •. Note that a large star is next to a '62nd' link more or less in the centre of the board. This is the optional 0 V link — see the text under the heading 'Power supplies'.



The project is built on a board measuring 103 x 165 mm.



#### HOW IT WORKS.

First of all, note that the component values shown on the circuit diagram are for the 2 A output version. Other output current versions are possible, as explained in the text, but basic circuit operation is the same.

The host processor connects to the driver board via the 16-pin DIL socket. IC5 compares the logic levels present on the DIL socket pins 14 (A1), 11 (A2), 13 (A3) and 12 (STROBE) to the settings of SW1a-d respectively. When a match is found, pin 10 of IC1 goes high. The STROBE input should receive a pulse edge timed to coincide with a valid data bus (pins 1 to 8 of the DIL socket) and a valid address (pins 11, 13, 14). Note that either a positive-going or a negative-going edge of the strobe pulse may be used, according to whether the setting of SW1d is closed or open, respectively.

The A0 input on pin 10 of the DIL socket determines which of the two onboard latches are being addressed. When pin 10 is low, IC4 is selected ('Boutputs active'), if high, then IC3 ('Coutputs active').

Each driver circuit buffers one of the 16 latch outputs and provides an open collector current sink of up to 3 A (see the text on 'Component options').

To simplify the description of the driver circuits, consider the one comprising R1, Q1, R17, R33, Q17 and D1. Diode D1 is a flywheel diode and protects transistor Q17 from excess back emf voltage when turning off inductive loads, such as a solenoid. When the latch output is low, Q1 is held off via R1 and Q17 is held off by R33. Resistor R33 speeds up the turn-off time of Q17 by providing a path to remove stored charge in the base-emitter junction.

When the latch output is high, about 5 mA of current flows into the base of Q1, thus turning it on. R17 sets the base current of Q17 and is chosen according to the output current requirement. Transistor Q17 must be saturated in order to reduce power dissipation and up to 300 mA of base current may be required for 3 A loads (see component options in main text).

Fig. 1 Circuit diagram for the ETI Computer Output Driver. Our artist drew the line (!) at reproducing 16 identical driver circuits, so we've shown just the one.

Next, solder diodes D1 to D17 in place. Note that the cathodes of these diodes are soldered on the component side of the board. Solder resistors R1 through R16. then R33 through R48 in place next. Mount and solder the BFR39 transistors, Q1 to Q16, in place next. All the 1 W resistors, R17 through R32, stand up on end and these may be soldered in place after the transistors. Follow with the remaining four resistors and the three capacitors. Now you can mount and solder in the output devices, Q17 to Q32. Watch orientation.

Now mount SW1, but take care you put it round the right way. The ON position of the switches should be adjacent to the edge of the board. If you're using IC sockets, put these on next. If not, solder the ICs in place. A 16-pin DIL IC socket is used for the input connections and this can be mounted now. Last of all, mount and solder in the output terminal strip or strips. We used one 12-way and one 8-way strip as we could not obtain a single 20-way strip.

Having completed the construction, go over the board very carefully, looking for missed

links and components, bad joints or mis-oriented semiconductors. Fix any faults and, if you're satisfied all is well, the best way to test the board is to hook it up and try it out!

#### **Power Supplies**

The logic power supply of +5 V should be supplied from the host computer  $V_{cc}$  rail through the DIL socket pins 15 and 16. The computer's ground (0 V) should be cannected to pin 9.

The +5 V power to the drive circuits should not come from the host computer unless it has the



#### PARTS LIST\_

Resistors (all 1W, 5% except where stated) R1-16,33-48 470R R17-32 18R, 1W R49-52 10k Capacitors 100uF 16 V PCB electrolytic 100n ceramic C2.3 **Semiconductors** 74LS02 74LS00 IC3,4 74LS374 IC5 741 \$86 Q1-16 RFP39 TIP31B, BD139 (see text) Q17-32 1N4002, 1N4004 etc D1-16 Miscellaneous 4-way SPST DIP switch PCB (see Buylines); 16-pin DIL socket; 2 off 16-pin DIP headers; one off 12-way and one off 8-way PCB-mounting ter-

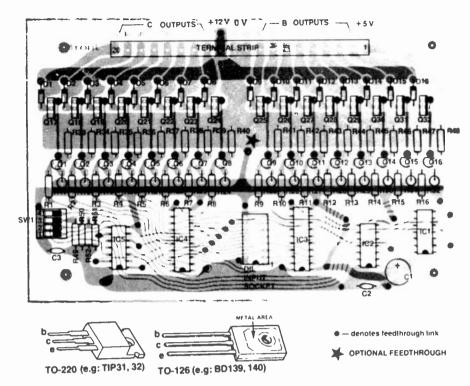


Fig. 2 Component overlay for the driver board, and lead details for some suitable output transistors.

#### BUYLINES.

minal strips; 16-way ribbon cable; 22

swg tinned copper wire.

No severe supply problems are anticipated with anything we've used for this project. The hardest thing to find will probably be the PCB-mounting terminal strips, but Maplin, at least, stock a suitable type, and you may be able to find other suppliers too. The PCB will, as usual, be available from the PCB Service as advertised on page 91.

capability to supply at least an extra 3 A. In any case, heavy wire should be used (at least 24 x 0.2 mm hookup wire) for the power connections to the terminal strip to minimise voltage drop.

The optional 0 V link (marked with a star) should only be used for light loads. Normally, the connection between 0 V logic and power should be at the power

supply.

The output drivers' power supply is shown as +12 V, but other voltages may be used, up to about 70 V. The PIV rating of diodes D1 to D16 should not be exceeded, however (best use 400 V diodes here, at least).

#### Hooking It Up

This project has been designed to allow up to eight boards to be connected to a computer through a single ribbon cable. In order to do this a special strobe signal must be supplied by the computer whenever any of the driver boards are being selected. This will probably require a small hardware circuit, unless your computer is favoured by the famous Murphy! If there is sufficient interest we may publish a general purpose interface board, but until then you will have to work out for yourself how to connect a particular computer from the following guidelines.

Assuming that the computer has an I/O scheme with eight I/O address lines — AD0 to AD7 — then the driver board inputs A0 to A3 are connected to the lowest four I/O address lines of the computer, ie AD0 to AD3. Each driver board is then set up at a different address via the DIL switches, SW1a-d. This means that the driver boards will occupy 16 consecutive I/O ports. Now for the hard part!

The STROBE input (A4) must have a positive or negative going edge (see the How it Works box) that occurs when an I/O WRITE to the driver boards is taking place. In order to fully decode the I/O port address space, the other I/O address lines (AD4 to AD7) must be gated with the I/O control signals to produce the STROBE signal. In order to get the STROBE transition timing correct, a signal such as WRP (write pulse) should also be gated in the STROBE logic. This allows the data bus to settle before the latches are locked.

The ribbon cable requires a buffered driver for each wire carrying logic signals, especially if multiple driver boards or long cable runs are envisaged.

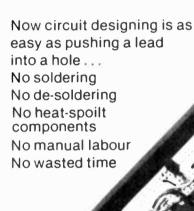
A simpler interconnection may be implemented if a couple of I/O ports are available. In this case, the D0-D7 inputs can connect to one output port and the A0-A4 inputs to another output port. The timing of the STROBE pulse is then a matter of software driving routines.

TABLE 1

		-IABLE	l	THE PART NAMED IN
OUTPUT CURRENT (amps)	Q17-32	R17-32	R1-16	+ 5 V SUPPLY CURRENT (maximum)
3 2 1	TIP31B TIP31B TIP31B	15R, 1W 18R, 1W 22R, ½W	330R 470R 470R	3A4 2A8 2A3
<1	BD139	33R, ‡W	470R	1A6

**ETI JULY 1983** 

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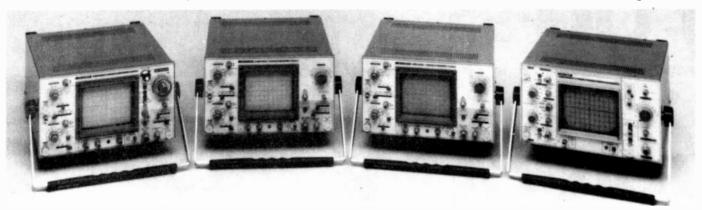
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# BUYER'S GUIDE TO TEST EQUIPMENT

This month, all you ever wanted to know about oscilloscopes



#### but were afraid to ask the man in the shop.

ext to a multimeter, an oscilloscope is the most basic measuring instrument of electronics, yet comparatively few hobbyists possess one. It's true that they're not cheap, we didn't find a single one for less than £100, but they're not that expensive either. In this survey, we've found a very wide choice of instruments is available for around £350 or less (excluding VAT).

All the oscilloscopes in the table have the following basic facilities: a Y-amplifier, with switched calibrated ranges, switchable AC or DC coupling, and a shift control; a timebase generator, with switched ranges, position control, and some means of synchronising sweep commencement at a particular point on the input Y-waveform; an on-off switch, and brightness and focus controls. (None of these features is listed in the table).

All the sensitivities are given in volts per division (note that unless a 'scope has a 130 mm screen, 1 division will be smaller than a centimetre), but not all the sweep speeds are in seconds per division: the two cheapest 'scopes (the Leader LBO-310A and the Trio CS1303D) give sweep frequencies. These two 'scopes, and the Leader LBO-512B, have relatively few calibrated Y and sweep ranges, so you would have to

rely a lot on the variable controls to view, but would not be able to measure intermediate waveforms.

All the other 'scopes have their sweep and voltage ranges in 1, 2, 5 sequences, eg 1 mV/div, 2 mV/div, 5 mV/div, 10 mV/div, etc.

**Expansion Options** 

Scopes with X and Y expansion options (features E and F) will have maximum sweep rates and sensitivities higher than those quoted in the calibrated range columns; expansions are typically ×5 or ×10. However, note that Y-expansion amplifiers usually have a lower bandwidth than the main Y amplifier, sometimes less than 1 MHz, and often decrease the accuracy as well. Variable gain controls, on the other

hand, nearly all decrease sensitivity and variable sweep controls nearly all increase sweep times (from calibrated positions).

As all the scopes have DC coupling, the bandwidth quoted is just the upper limit; in AC coupled modes, the lower - 3 dB point is typically 2 Hz.

**Trigger Happy** 

After finding the on/off switch, the next most difficult task on any oscilloscope is persuading the thing to trigger when and where you want it to. The 'scopes we've looked at have a wide variety of trigger facilities, mostly in an attempt to be user-friendly.

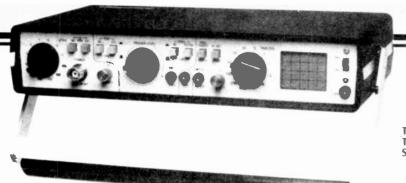
Firstly, in nearly all cases you can select triggering from the Y-channel or from an external trigger input. Most dual trace 'scopes allow you to select which Y-channel the triggering comes from as well. Usually the threshold signal level at which you can get any scope to trigger is equivalent to around 0.3 to 1 division on the screen. The vast majority of trigger circuits are AC coupled; DC coupled types are easier to get to trigger on slowly rising waveforms.

A level control and a slope polari-

ty control will allow you to move the trigger point along a waveform. Some 'scopes have a single control that sets

The Trio CO-1303D: not quite our cheapest 'scope





The Thandar SC110A

both the level and slope polarity (eg, Scopex 4S6, Trio CS1575). A few 'scopes have trigger delay facilities, so that you can delay triggering for a pre-selected time: this is particularly useful for observing pulses with a low but regular repetition rate, because you can set the 'scope to trigger on one pulse, yet wait until just before the next pulse before commencing the sweep. One 'scope in the survey, the Hitachi V302F, achieves this in another manner, by delaying the signal slightly; however, this will only be of use on very high frequency pulses. In any case, trigger delay is extremely useful for general digital work, so that you can pick out sections of words to examine.

Many 'scopes have TV video signal filters (also called LF filters by some manufacturers) that will enable the scope to synchronise to line or frame pulse signals embedded in the video signal. The Scopex 14D10V (similar to the 14D15 in the table) takes this a stage further, by having a delay system that allows any line between number 17 and 312 to be selected and examined.

Some scopes give you the choice between bright line (or autotriggering) where the 'scope free runs in the absence of a signal, and normal triggering, where the trace is only present when there is sufficient signal to trigger the 'scope. Also available on some 'scopes is a line triggering option, where the sweep free runs all the time, with or without a signal. battery-operated Thandar SC110A has a further, economy option, that shuts down unused sections of the scope in the absence of a signal, so reducing the average power consumption (in this mode) to 350 mW.

None of the new dual beam 'scopes in this survey are true two beam types; that is they all have just one beam that is switched between the two traces, either by chopping the beam or by switching it at the end of each sweep. Which mode is appropriate depends on the sweep rate, and some 'scopes will switch between the two modes automatically, depending on the setting of the sweep control (feature P); the others have manual selection of display mode (feature M).

#### **Other Features**

Some 'scopes have a component testing facility (feature T); in this mode, the scope itself applies a low frequency (usually 50 Hz or 1 kHz) signal to a component connected to it, and displays the resultant V/I graph on the screen automatically. Some waveforms for the component tester on the Crctech 3131 are shown in Fig. 1.

Oscilloscopes with an internal graticule will enable you to make parallax free measurements, because the graticule is actually on the same side of the screen glass as the phosphor.

Direct connection to the 'scope plates can be a handy facility on occasions, as this will allow much higher frequencies to be examined than the Y or X amplifiers can cope with. Z-modulation can also be a handy facility, particularly when the 'scope is used for less orthodox measurements.

#### Hanging On?

Most 'scopes are normally supplied with a short or medium persistence phosphor tube as standard. To our knowledge, the following manufacturers offer a choice of persistences: Farnell, Gould, Hameg, Scopex. It may be worth approaching other manufacturers if you want a particular 'scope but with a longer persistence tube.

Oscilloscope probes are usually designed to feed an input impedance of 1M0 in parallel with 30 pF, with some adjustment usually available to compensate for slightly different impedances. Using an oscilloscope with a significantly different impedance will lead to ringing at high frequency, and possibly other problems. If the input capacitance is on the low side, you can always increase it, but if it's high, then you will have to use a probe that is designed specially for the input impedance.

#### All Singing . . .

Trio don't seem to have been content with offering just normal 'scope features on their C\$1575, because it has the facility to do phase comparisons at the same time as observing the two Y channels. In fact, as you may guess from its relatively

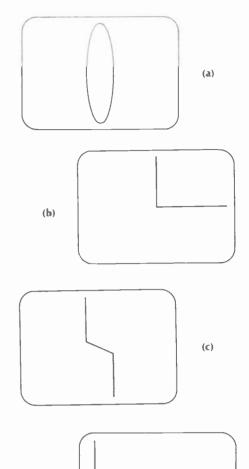


Fig. 1 Above: some typical traces for the 3131; (a) when looking at a capacitor; (b) a diode; (c) diodes back to back; (d) a J-FET source to drain. Below: the beast itself in action on a transistor.

(h)



	OSCILLOSCOPES .	Pin	e f ex VAT Models	Single or Di	al trace Califiated techniques of the	Raintees Well	4 Accuracy	idin 73 de	Market Mallof Speeds, selding Speeds, selding Speeds of Range Speeds, selding Speeds of Range Speeds
1	Crotech.3030	154		Single	5m to 20(12)	3	15	1//35	0.5u to 200m(18)
2	Crotech 3131	250	3034	Dual	5m to 20(12)	3	15	1//35	0.5u to 200m (18)
3	Farnell DTC12	345	DT12	Dual	5m to 20(12)	3	12	1//30	0.5u to 500m (19)
4	Gould OS300	325	_	Dual	2m to 10(12)	3	20	1//28	0.5u to 200m(18)
5	Hameg HM103	158	_	Single	5m to 20(12)	3	10	1//28	0.5u to 200m(18)
6	Hameg HM203-4	264	_	Dual	5m to 20(12)	3	20	1//28	0.5u to 200m(18)
7	Hitachi V152F	260	V302	Dual	5m to 5(10)	5	15	1//30	0.2u to 200m(19)
8	Hitachi V203F	355	V2102	Dual	5m to 5(10)	3	20	1//30	0.2u to 200m(19)
9	Kikusui COS5020	265	******	Dual	5m to 5(10)	NS	20	1//30	0.2u to 500m (20)
10	Leader LBO-310A	119	LBO-510B	Single	20m to 2(3)	NS	4	1//40	10Hz to 100kHz(4)
11	Leader LBO-512B	223	LBO-510B	Single	10m to 10(4)	3	10	1//30	1u to 1m(4)
12	Leader LBO-514A	313	LBO-513A	Dual	5m to 10(11)	3	15	1//30	0.5u to 200m(18)
13	Leader LBO-522	338	-	Dual	5m to 5(10)	3	20	1//30	0.2u to 200m(19)
14	Philips PM3207	385		Dual	5m to 10(11)	5	15	1//35	0.5u to 200m(9x2)
15	Safgan DT420	183	DT410,415	Dual	5m to 20(12)	5	20	1//22	0.5u to 200m(18)
16	Scopex 4S6	148		Single	10m to 50(12)	5	6	1//35	1u to 100m(16)
17	Scopex 14D15	230	14D10,SG315	Dual	5m to 20(12)	3	15	1//33	1u to 100m(16)
18	Thandar SC110A	149		Single	10m to 50(12)	3	10	1//47	0.1u to 500m(21)
19	Trio CO1303D	120	CO1303G	Single	10m to 1(3)	NS	5	1//35	10Hz to 100kHz(4)
20	Trio CS1560A	324		Dual	10m to 20(11)	NS	15	1//22	0.5u to 500m(19)
21	Trio CS1562A	258	CS1559A	Dual	10m to 20(11)	NS	10	1//22	1u to 500m(18)
22	Trio CS1575	298	_	Dual	10m to 3(6)	NS	5	1//27	0.5u to 2m(12)
SECOND HAND OSCILLOSCOPES									
23	Advance OS1000B	330		Dual	5m to 20(12)	3	20	1//28	0.5u to 1(20)
24	Solartron CD1400	125		Dual	100m to 50(9)	5	15	1//35	0.5u to 200m(18)
25	Tektronix 545B	100		Dual	50m to NS	NS	33	NS	0.1u to 5(24)
26	Telequipment D63	300	_	Dual	1m to 20(12)	3	15	1//29	0.2u to 1(21)

Note: prices in italics are for equipment that has not been reconditioned.

	96			mm
	Accurating	aure <sup>5</sup>	3e 512	isions
	Sweed of Facili	alfeatt	an's har of di	
435	(AM)(BN)ES	General keatures	Steelistade of di	
5	(AM)(BN)ES	CGRTUW	Rect/95/8×10	1
5	(AM)(BN)CELST	CDGIMRSTWYZ	Circ/130/8×10	2
3	BCEMNST	ACDEIMRSTVWYZ	Rect/130/8×10	3
3	BCEMNST	CDEGIPRSVWYZ	Rect/130/8×10	4
5	(AM)(BN)EST	CGKRTVWX	Rect/95/6×7	5
3	(AM)(BN)EFLST	CDEGIKLMORSTVWY	Rect/130/8×10	6
5	BCELMNST	CDEFGJOPRSVWYZ	Circ/140/8×10	7
3	BCELMNST	CDEFGJKLOPRSVWYZ	Rect/140/8×10	8
NS	ABCDEMNOT	CDEFGIJKLMOPRSUWY	Rect/152/8×10	9
NS	AM	VWXZ	Circ/75/8×10	10
5	BEMS	CVWXY	Circ/130/8×10	11
5	(AM)(BN)CEFST	CEFGMORVWYZ	Circ/130/8×10	12
3	(AM)(BN)CEFLST	CDEFGIKLMORSVWYZ	Rect/130/8×10	13
5	BCEMST	CDEIOPSY	Rect/130/8×10	14
5	BCEMNST	CEGOPYZ	Circ/102/8×10	15
5	(BS)EMN	GX	Circ/100/6×8	16
3	BEMNST	CDEGHIPRSYZ	Rect/130/8×10	17
3	BELMNST	BCY	Rect/41/4×5	18
NS	EN	GQVWZ	Circ/75/8×8	19
NS	(AM)(BN)CET	ACDEGOPRSVWY	Circ/130/8×10	20
NS	(AM)(BNS)CET	CEGOPVWY	Circ/130/8×10	21
NS	(BS)CEJM	CGOPUVWY	Circ/130/8×10	22
	-			
. 5	(AM)(BN)CDEFLST	ACDEFGIJLOPSVWYZ	Rect/130/8×10	23
5	ABCEFPS	ACEFLYW	Circ/130/8×10	24
3	(AM)(BN)DEFGOT	ACEFKLYW	Circ/130/8×10	25
3	(AM)(BN)DELOS	ACEFGHVWXZ	Rect/115/8×10	26

### **Key to Trigger Facilities**

- Automatic or preset level control
- Manual level control
- Trigger source channel selectable
- DC coupling of trigger available
- External trigger available
- HF trigger facility
- G
- Delay facility Sweep hold-off facility Н
- Separate trigger level controls for two Y channels
- Line triggering available
- M Automatic (or bright line) triggering available
- Normal triggering available
- One shot triggering available
- TV sync pulse separator available

Where facilities are bracketed together, they are only available together.

### **General Features**

- Astigmatism control
- Operates from batteries
- Calibrator output provided
- Difference of two Y channels can be displayed
- Expansion facility on sweep
- Expansion facility on Y channel(s)
- G Facility to ground Y input
- Trace locate function
- Inverting facility on one or both Y channels
- Y output socket provided
- Internal graticule
- Illuminated graticule
- M Manual selection on chopping or alternating
- Y channel turn-off facility
- Auto selection of chopping or alternating
- Direct connection to deflection plates
- Trace rotation adjustable
- Sum of two traces can be displayed
- Component testing facility
- Variable sweep length control
- Variable Y gain control
- W Variable sweep rate control
- Access to X amplifier (ie for X-Y mode)
- One Y channel can be used as X amplifier
- Z modulation available



<sup>\* =</sup> maximum value

modest bandwidth, this 'scope is specially designed for audio test work.

### **New Or Second Hand?**

There is quite a healthy market in second hand oscilloscopes, and you can get a slightly outdated but still very useful 'scope for a fraction of the price that a new 'scope with similar specs would cost you. Newish 'scopes do turn up on the second hand market from time to time, but they don't tend to spend very long on the shelves before being snapped up. So, if you're buying a 'scope it's well worth taking a look at the second hand market.

The 'pro' of buying a second hand oscilloscope is, then, price; however, there are a few 'cons' that you should consider:

Size: due to integration and rectangular tubes, new 'scopes are typically smaller, lighter and more economical on power (ie, don't get as hot) than older models (particularly 'scopes with valves).

Guarantees: with any new 'scope, you will get a guarantee, though the length of the guarantee will vary from manufacturer to manufacturer, and sometimes from supplier to supplier. In addition, the manufacturer has a legal obligation to provide goods of a merchantable quality. With a second hand 'scope, you may get a warranty for up to a year if the instrument has been fully reconditioned, or no warranty at all if you're buying the 'scope 'as seen'. We'd advise that unless you know what you're doing, you should steer well clear of the latter option.

• Parts: older scopes will probably be more unreliable and more easily damaged by a knock than new 'scopes, so you could find yourself having to scour the country while searching for a vital yet elusive bit.

• Information: though good dealers will do their best to give you reliable information, you're unlikely to get a glossy brochure to take away and peruse at your leisure. So, to an extent, unless you are already well acquainted with instruments of that type, you will possibly be purchasing an unknown quantity.

To give you an idea of what you can get second hand, we've included in the table a few 'scopes that do turn up on this market fairly often. However, dealers can't predict what their stocks will be, and that's why we can't give you a full break-down of what's available; the only way is to go to (or telephone) a dealer for up-to-date information.

The Gould Advance OS1000B is



The Trio CS-1559A (left) and the CS-1662A (right): spot the difference.

a conventional 'scope with fixed features; the other second hand 'scopes are all modular, ie you can buy different Y and, in the case of the Solartron and Telequipment, different X modules, so the actual specs you get depend on what modules the 'scope you buy has. And a word of warning: we'd like beginners to beware the Tektronix, as you need at least a pilot's licence to fly that thing (go and look at one and you'll see what we mean).

### Similar Models (all prices ex VAT)

Crotech 3033 (287) rechargeable battery-powered version of the 3030, but without component tester

Crotech 3035 (174) similar to 3030, but with lower bandwidth (10 MHz), larger screen (130 mm) and calibrator output

Crotech 3034 (370) similar spec to 3131, but rechargeable battery powered and smaller screen (95 mm) Farnell DT12-55 (235) as DTC12, but without component tester, sum and difference Y modes, and a slightly lower accuracy (5% on Y deflection) Farnell DT12-14J (255) as DTC12 but without component tester

Hitachi V302F (350) similar to V152F, but with 30 MHz bandwidth and signal delay line

**Hitachi V202F** (220) as V203F but without delay sweep facility

**Leader LBO-510B** (164) vertical amplifier has same specs as LBO-310; rest as LBO-512 (tube not identical but similar)

**Leader LBO-513A** (263) single trace version of LBO-512

**Safgan DT-410** (164), **Safgan DT-415** (172) 10 MHz and 15 MHz versions of the DT-420

**Scopex 14D10V** (260) similar to 14D15, but lower bandwidth (10 MHz), 2 mV/div max. sensitivity, TV delay system (see text) and no Z modulation

Scopex SG315 (270) as 14D15, but with integral function generator
Trio 1303G (161) as 1303D but with 1.8-54 MHz two-tone generator

**Trio CS1559** (235) single trace version of the CS1562A

### **Addresses**

Crotech Instruments Ltd, 5 Nimrod Way, Elgar Road, Reading, Berkshire RG2 0EB

Farnell Instruments Ltd, Sandbeck Way, Wetherby, West Yorkshire LS22 4DH

Gould Instruments Ltd, Roebuck Road, Hainault, Essex IG6 3EU

Hameg Oscilloscopes Ltd, 74-78 Collingdon Street, Luton, Bedfordshire LU11 1RX

Hitachi: Reltech Instruments, Coach Mews, St Ives, Huntingdon, Cambridgeshire

**Kikusui:** Martin Associates (see secondhand 'scopes)

Leader: Thandar (see below)

**Philips Instrument Dept,** Pye Unicam Ltd, York Street, Cambridge CB1 2PX

Safgan Electronics Ltd, Omega Road, Woking, Surrey GU21 2PX

Scopex Instruments Ltd, Pixmore House, Pixmore Avenue, Letchworth, Herts SG6 1HZ

**Thandar Electronics Ltd,** London Road, St Ives, Huntingdon, Cambridgeshire PE17 4HJ

**Trio:** House of Instruments Ltd, Clifton Chambers, 62 High Street, Saffron Walden, Essex CB10 1EE

### Suppliers of secondhand oscilloscopes

Carston Electronics Ltd, Shirley House, 27 Camden Road, London NW1 9NR (Tel 01-267 5311)

Martin Associates, Parthia, Beckhampton, Nr Marlborough, Wiltshire SN8 1JQ (Tel 06723-219)

P F Ralfe (Electronics), 10 Chapel Street, London NW1 (Tel 01-723 8753)

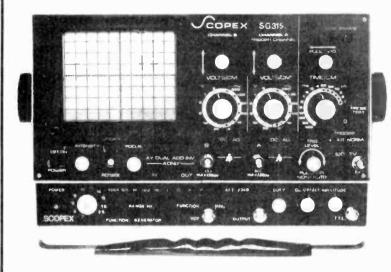
Stewarts of Reading, 110 Wykenham Road, Reading, Berkshire RG6 1PT (Tel 0734-6804)

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X-Y display.

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The Function Generator 0.2 Hz-250 KHz Sine

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Function Generator also available in an instrument case, FG1.

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Function Generator for mounting on Scopex Dual Trace Scopes: FG4, FG14/25—£69+VAT
Function Generator: FG1—

# ULP-I MEMORY LOGIC PROBE.

#### Specification:

Logic thresholds (switch selectable) DTL/TTL/CMOS. – Logic "1" thresholds (HI-LED): TTL/DTL 2.25V ± 0.15V. CMOS 70% Vcc + 10%

- Logic "0" thresholds (LO-LED). TTL/DTL 0.8V  $\pm$  0.10V; CMOS 30% Vcc  $\pm$  10%

Pulse detect mode: High speed pulse train or single events (+ or - transitions) activate 1/3 sec. pulse stretcher.

Memory mode: Latches pulse LED for catching low repevents and one shot events.

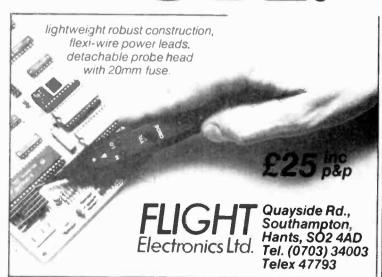
Input impedance: 100k Ohms.

Minimum detectable pulse width: 50 nanosec. Maximum input signal frequency. More than 10 MHZ Probe Power: 5V Vcc. 30mA, 15V Vcc 40mA

Probe power protection: 30V max., with power leads reverse protection.

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YN 360TR 19 range 20K/V plus Hie tester £15.95

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Fast line drawing and point plotting basic commands High speed colour shape manipulation from basic Full textural error messages

String and Array size limited only by memory size Real time clock included in basic

Interval timing with 10mS resolution via TIC function Named load and save of basic or machine code programs Auto-run available for any program

Powerful machine code monitor

### **ULTRA POWERFUL 24K BASIC**

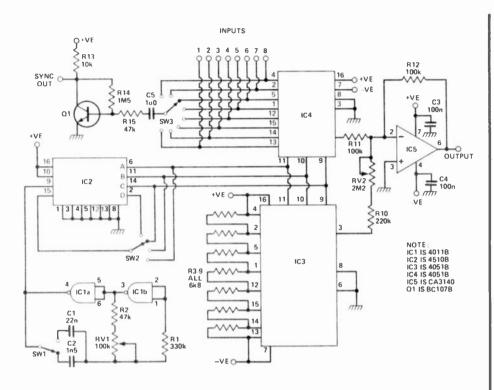
COMMANDS	LOG	KEY	?	RANDOM ENTER	SGET
RUN SIZE	SQR SYS	STATEMENTS	UNIT	LIST	TOF
CONT	TIC	IF	BAUD	PURGE	TON
MON	SQN	ELSE	CALL	NUMBER	DIM
	BIT	ON	DATA	RENUM	DEF
FUNCTIONS	CRB	GOTO	READ	BOOT	NEW
ABS	CRF	GOSUB	RESTOR	GRAPH	END
ADR	MEM	POP	RETURN	TEXT	BIT
ASC	MWD	REM	STOP	PLOT	CRB
ATN	LEN	FOR	TIME	UNPLOT	CRF
SIN	MCH	NEXT	WAIT	COLOUR	MEM
COS	POS	ERROR	SAVE	CHAR	MWD
EXP	COL	INPUT	LOAD	SPRITE	BASE
FRA	MOD	PRINT	ESCAPE	SHAPE	
INT	RND		NOESC	SPOT	
Event analytics	to Dowerts	an Internationa	L Hollom Di	own Farm.	

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Auto line numbering facility Full renumber command Simple but powerful line editor Buffered i/o allows you to continue executing the program while still printing Flexible CALL statement allows linkage to machine code routines with upto 12 parameters Basic programs may contain spaces between keywords to make programs readable without using more memory 64K RAM using latest technology 64K DRAMS Over 34K bytes available for basic programs even when extended basic includes IF-THEN-ELSE Supports up to 16 output devices Screen and cassette included as standard Supports bit manipulation of variables from basic Error trapping to a basic routine included Basic supports Hexadecimal numbers

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## TECH TIP SPECIAL

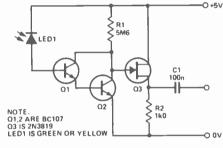


### **Cheap Photodiodes**

### **Donald Hopkins, Tarves**

This circuit was evolved using an LED in place of a photodiode. Diode D1 can be any run-of-the-mill green or yellow LED. Red LEDs do not work, presumably because of their spectral response.

When the light source to D1 is interrupted, its reverse leakage current decreases sufficiently to cause the Darlington pair Q1, Q2 to switch off. This in turn causes the FET to conduct giving a pulse at the output.



### **Eight Traces On A Single Trace Scope**

Tore Solheim, Norway

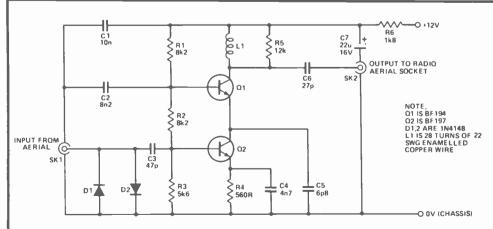
This simple and inexpensive circuit can display up to eight traces on a single beam oscilloscope. Even though the capacity of such a simple circuit is limited, it will be fine as part of a home workshop. The frequency response is DC to 100 kHz with the circuit shown, and the scope sensitivity should be 0V5 per division, preferably DC-coupled.

IC1 is the clock oscillator: SW1 selects chopped or alternate mode. RV1 allows the frequency to be adjusted over the range 10-30 kHz or 200-700 Hz depending on the setting of SW1. The counter IC2 controls the two analogue multiplexers IC3, 4. One, two, four or eight traces may be selected using SW2, which couples one of the counter outputs back to the reset pin to reset the IC after the desired count length. The analogue inputs of IC3 are connected to a voltage divider, R3-9, and the output is connected, via R10 and RV2, to the negative input of the op-amp, IC5. This allows the offset voltage of the op-amp to be adjusted over a wide range. The trace changes position by changing the offset voltage, which has no effect on the gain of the opamp. RV2 allows the voltage offset between the upper and lower traces to be adjusted from  $\pm 0V3$  to  $\pm 3$  V, ie RV2 is the position control. Separate controls aren't needed here. The eight channel inputs are connected to the analogue inputs of IC4.

The circuitry around Q1 and SW3 is to allow external triggering of the scope. This circuit isn't strictly necessary, but will often give a better display. The whole circuit is designed

for a  $\pm 6$  V power supply, and the inclusion of IC3, 4 means that  $\pm 7$ V5 should never be exceeded.

Why is IC5 wired in the inverting mode, when the non-inverting mode would give better results? The offset adjustment of a non-inverting low-gain amplifier using the method shown here would affect the gain. Also, the inputs should not be left open-circuit as this will cause not-ches on the traces. The inputs should therefore be connected to an inverting amplifier, preferably with an attenuator due to the low sensitivity.



### Adding Preset Channels To A Tuner

### A. Cassarrubios, London

The following circuit is a modification I made to my Audiophile FM Tuner (ETI January 81). My main design concept was to increase the number of preset channels to 10 but not increase the number of pushbuttons on the front panel, and if possible reduce the number to one. Some form of indication of which channel is selected must also be

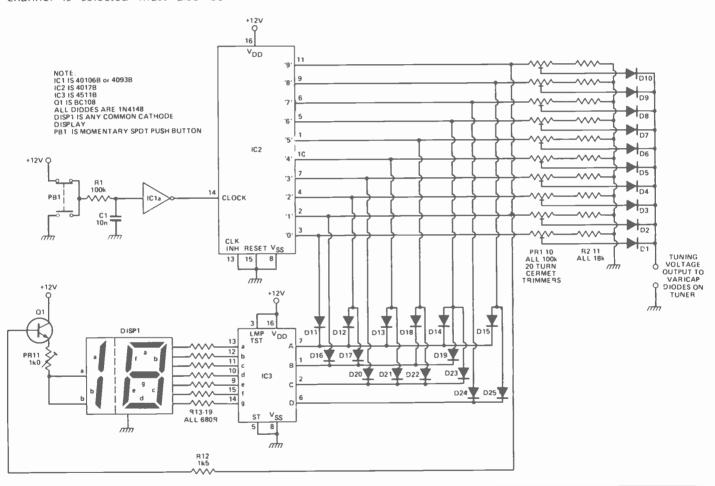
provided.

The operation of the circuit is simple to understand and is as follows. IC1 along with R1 and C1 provide switch debouncing to produce clean pulses for IC2's clock input. IC2 is a decade counter with 10 decoded outputs. The outputs from IC2 are taken to PR1-PR10 which along with R2-R11 provide a potential divider from which to tap off the required tuning voltage. The tuning voltage ranges from about 1V5 to about 10 V with the values shown, which is adequate for most tuners. Diodes D1-D10 stop any interaction between channels. The tuning

voltage output is taken from the cathode end of these diodes and is fed to the varicaps on the tuner.

Diodes D11-D25 are a decoding matrix for IC3, which is a seven-segment decoder driver. When pin 11 of IC2 is high, there are no logic signals on any of the binary inputs of IC3, so a zero is displayed. The logic signal from pin 11's output drives Q1, which in turn illuminates the figure '1' in the display. PR11 is set so that the intensity of the figure '1' matches that of the seven-segment display.

The circuit is relatively easy to construct and component layout is not critical.



### Car Radio Aerial Preamplifier

Neil Dobson, Newcastle-Upon-Tyne

This circuit is a very high gain, high frequency amplifier using two NPN transistors in cascode. The input is taken via SK1 and C3 to the base of Q2. The amplified signal (between 200 kHz and 200 MHz) is passed to the base of Q1, which is connected in the common base mode, giving a very good gain at high frequencies.

R1-3 set the bias voltages for the two transistors, while R4 and C4 provide negative feedback and help increase the bandwidth of the stage.

Capacitor C1 and C7, along with R6, are the supply decoupling components and also help to filter out any noise generated by the engine. Note that L1 is a radio frequency choke, which can be made by winding 28 turns of 22 swg copper wire on resistor R5; this will give a lower gain on long and medium wave, but as the desired frequency increases (ie VHF) the reactance of L1 will increase,

allowing more of the amplified signal to pass through capacitor C6.

The two diodes connected across the input socket are to protect the transistors against static discharges and overloading. If it is found that the gain is too high, then by changing C4 to, say, 500pF, the gain can be reduced to a lower level.

The amplifier has been in use for over five months now and has proven to be very stable and surprisingly quiet as regards adding any noise to signals in low signal-strength areas—especially on VHF.

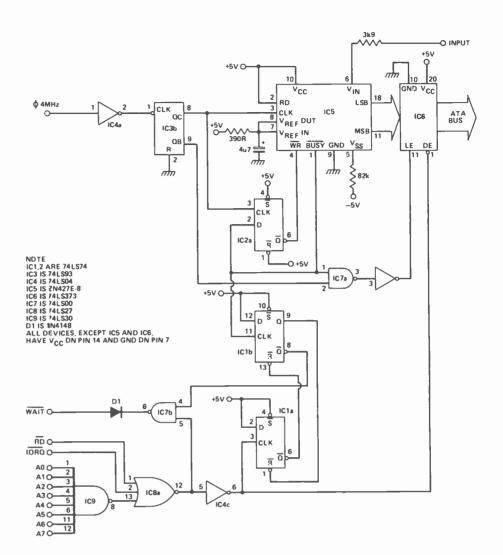
### High Speed Eight-Bit A-to-D Converter

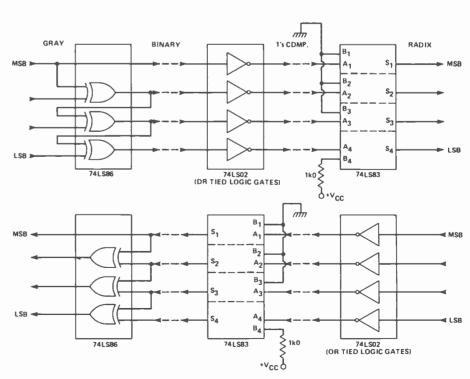
### Michael Jones, Dorset

An analogue-to-digital converter is a useful device for any computer system. The circuit shown operates at up to 100,000 conversions per second - making it ideal for use with the full range of audio frequencies. As shown, the circuit has just one channel; more may be added by using more converter ICs (for maximum speed) or using an analogue multiplexer, such as the CD4051, which has eight channel inputs selectable under software with a three bit output port. If it is to be used at full speed, machine code programming is essential.

The given circuit will work on any Z80A system running at 4 MHZ without automatic I/O cycle wait state insertion. It will work with slower clock frequencies with corresponding increases in conversion time. Decoding occurs on port OFFH only; this may be changed by placing inverters on the appropriate input to IC9. There is no need for a status port since the circuit is constantly converting and latching the result in IC6. It returns the result of the most recent conversion when read, unless it has already been read, in which case it inserts wait states until the current conversion is complete. In this way continuous reading will guarantee one result per 10 microseconds. It is not possible, because of time constraints, to use polling software. In addition, this arrangement permits a DMA device to carry out the transfer in the background. By adjusting the clock reduction circuit around IC3 it should be possible to cater for frequencies of 2 MHZ or less, but still having 100,000 conversions per second.

Circuit operation is fairly simple. ICs 8 and 9 decode the input port, so enabling the tri-state latch (IC6), the WAIT gate (IC7b) and the wait latch (IC1). The latter ensures that WAIT is only issued when there is no new data. IC2a restarts the conversion as soon as possible after the end of the previous conversion. IC7a and IC4b latch the data into IC6 after it has settled. The actual converter (IC5) accepts an input in the range 0-2V55 in 10 mV steps, continually outputting its best estimate on pins 18 through 11 using successive approximation (binary search). Care should be taken that the input doesn't exceed 3V5 or become negative.



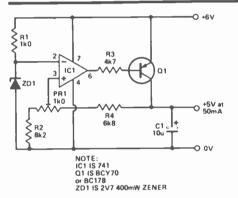


### **Expander Gate**

W. K. Todd, Colchester

This circuit is a simple expander gate and can be used to reduce the surface noise of records and tapes. It is based around an NE571 compander chip, used as an expander below the threshold set by the red LED. The LM381 amplifies the input signal by 40 dB; this is rectified in the 571 by a current mirror circuit and is smoothed by C4. When the voltage reaches the forward voltage of LED1 it draws current and hence limits the current to the gain cell. This causes linear operation above the threshold.

For stereo operation the LEDs should be matched for forward voltage. The circuit as shown is designed for 15 V; if other supplies are to be used R2 will have to be changed. Better DC biasing around the op-amp in the 571 will improve the DC offset.



### Battery Back-up Supply For RAM

R. Metcalf, Sheffield

Using a rechargeable 6 V lead acid battery and the voltage control circuit shown here, data can be held in a memory for a considerable length of time (governed only by the storage capacity of the battery). Nicads have a comparatively small Amp-hour rating for their package size and recharge rate.

An IC regulator would find the 1 V voltage margin between input and output too small for reliable operation. In this circuit the 741 op-

INPUT O

OUTPUT

OUTPU

amp sees a fixed 2V7 on its inverting input and subtracts the difference between this and the non-inverting input from its output. The ratio, once set by the preset, remains constant.

tery. The circuit uses a 'voltage doubler' and an astable multivibrator. Germanium transistors and diodes are used, as these have a smaller forward voltage drop across p-n junctions than comparable silicon devices. (This is to increase the output voltage and enable the circuit to operate at lower input voltages.)

To operate the circuit to make the LEDs appear on continuously C1 and C2 should be chosen to be 47nF, and C3 and C4 to be 10uF. To make the LEDs flash alternately, C1 and C2 should be around 100uF and C3 and C4 should be about 1000uF. To operate only one LED omit the circuitry within the dotted box.

Although TIL 209s are indicated in the circuit diagram, other LEDs may be used.

### Gray, Binary And Radix Code Manipulation

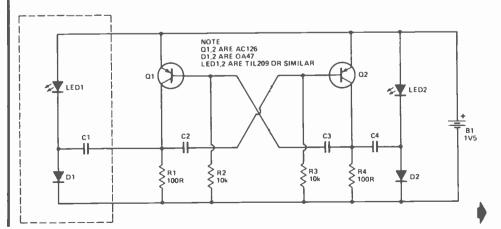
L. N. Owen B.Sc, Beaulieu

When working with encoders it is desirable to use a coding system which changes only one bit at a time Gray code is designed for this purpose. However, for manipulation Gray code is not very convenient and has to be converted to another form; this usually being binary, one's complement or radix. The modules shown provide simple means of converting from one code to another by using standard TTL hardware. Using these circuits, code manipulation to and from any of the above conventions is possible. In many cases the speed of operation has considerable that advantages over microprocessor software-based code conversions.

### Running LEDs From A 1V5 Battery

Andrew Marshall, Nottingham

Most LEDs require operating potentials of between 1V6 and 2 V, but the circuit shown here enables light emitting diodes to operate from a 1V5 bat-



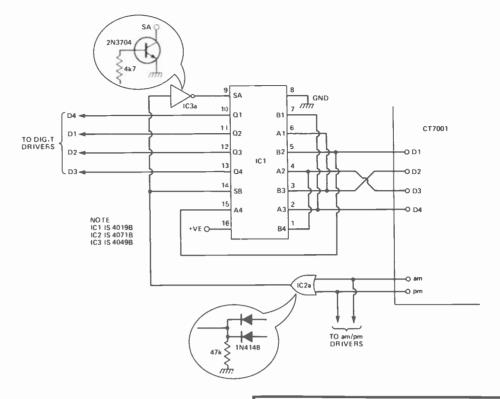
### Date Display In European Format Using American Digital Clock Chips

R.C. Callister, Cambridge

Many hobbyists will have built digital clock/calendars based on American LSI circuits. These invariably display the date in American format (month-day) rather than the day-month preferred in European countries. The following simple circuit allows inversion of the month and day displays on a typical chip (the CT7001) without affecting the time display, even though the latter is multiplexed on the same digit lines.

The trick is to use the am/pm indicator output signals to tell whether the time or date is currently being displayed. When the time is being output either the am or pm signal is active (high); when the date is output both are inactive (low). Thus the am/pm outputs may be ORed together and used to switch a four pole data selector. A single CMOS 4019B chip provides all the required logic except for the OR gate and one inverter. If spare inverter and OR gates are not available on the clock board, they may be replaced by a transistor and diodes as indicated.

When the output of the OR gate

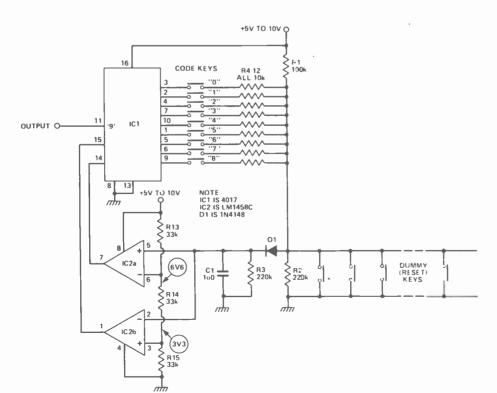


is high (time displayed) the data selector outputs follow the A inputs; when the OR gate output is low they follow the B inputs. The A and B inputs are interconnected so that the digit pairs D1/2 and D3/4 are interchanged when the data selector switches.

### **ZX Graphics Board Modification No. 1**

Simon Gamble, Coventry

This is a modified circuit diagram for the ETI ZX Graphics Board. With the



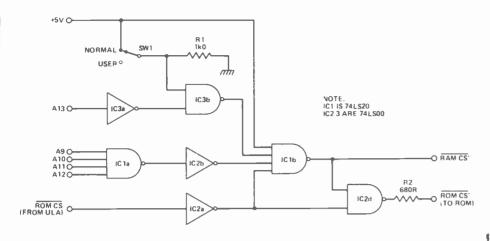
### Foolproof Combination Lock

Ben S. Meyer, South Africa

This lock really is foolproof, as all the keys except the correct one will cause a reset. The problem with other types of lock is that only the dummy keys will cause a reset. All voltages given are for a 10 V supply.

A power-on reset is provided by C1. When reset, pin 3 of IC1 is at 10 V. When code key '0' is pressed, the voltage across C1 rises to above 8 V. This triggers IC2a whose output clocks IC1. This causes pin 3 to return to 0 V, and pin 2 goes high. Pressing the other keys repeats this action until pin 11 goes high.

Pressing a dummy key will cause the voltage across R2 to fall to zero, while pressing a code key out of order will cause a drop to 1 V. C1





addition of the two NAND gates as shown, the character RAM appears in the memory map at both 7680-8191 and 15872-16383. However, when the switch is set to 'normal', the RAM only appears at 15872-16383. This means that the graphics set can be PEEKed from ROM and POKEd straight into the character RAM without having to be loaded into the user RAM first and does not require switching midway through the setting up program.

If R1 is removed from the ETI board and placed together with IC3 on a separate piece of Veroboard, then connect the output of IC3b to the connection originally used by the switch on the ETI board. No further

discharges via R3 and as soon as the voltage at pin 2 falls below the 3V3 reference, IC1 is reset by a high at pin 15.

All the output pins except the one currently switched high by the count are held at ground by IC1. This causes a problem, as it would be impossible to advance the counter since the respective switch would be grounded before it could be released and so reset the count to zero. C1 holds the charge on it during clocking, long enough for the key to be released. The diode prevents any discharge through R2. R3 discharges C1 and provides a bias path for the diode. The value of the capacitor can be altered to suit your needs, but R3 is a part of the voltage divider R1, 2, 3 and its value cannot be changed.

R4-12 are current limiters which prevent damage to IC1 if more than one key is pressed. To reset the system after the output has been enabled, just press any key.

changes need to be made to this PCB and it can then be sold at a later date in pristine condition! Note that the switch functions are now reversed.

Incidentally, when PEEKing from the ROM, if the value PEEKed is subtracted from 255 and the remainder is POKEd to the character RAM, then on switching to 'user' the whole screen will be inverted except for the border.

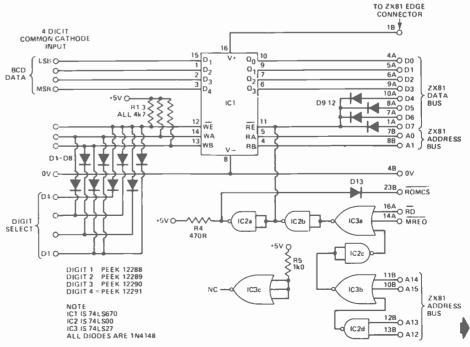
### Four-digit Multiplexed BCD to ZX81 Adaptor

W.K. Todd, Colchester

This device interfaces a four-digit common-cathode multiplexed BCD output device, such as the 7217 counter IC, with a ZX81. The circuit is based around IC1, a 74LS670 4  $\times$  4 register file. The digit select inputs address the Write Address pins, WA and WB, via diodes D1-4. The Write Enable pin,  $\overline{WE}$ , is pulled low by diodes P5-8 when any digit is selected.

The ZX81 address decoding is performed by IC3a, b and IC2d in the same manner as the A-to-D interface in ETI, January '83. When an address between 12288 and 16383 is PEEKed, the output of IC2b goes low and enables the outputs of IC1 via the RE pin: the data is output onto the data bus on lines D0-3. Data lines D4-7 are pulled low via the diodes D9-12, allowing the computer to read the data bus directly. The Read Address of the register file is driven directly by the address lines A0 and A1. IC2a disables the internal ROM via D13 when the device is being PEEKed.

Common anode devices could be used with this circuit if the digit select lines were driven by transistor inverters.



### Digital Audio Switch

### J. W. Harris, Macclesfield

The circuit uses a CMOS 555 which oscillates at a frequency determined by the equation:

$$F = \frac{1.46}{C1(R1 + R2)}$$

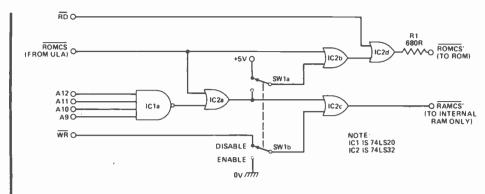
The output from IC1 is decoded by IC2, a decade counter divider, which is activated by PB1. When PB1 is pressed, IC2 produces a positive voltage at one of its four outputs, each of which controls two of the eight switches in ICs 3 and 4, and an LED circuit.

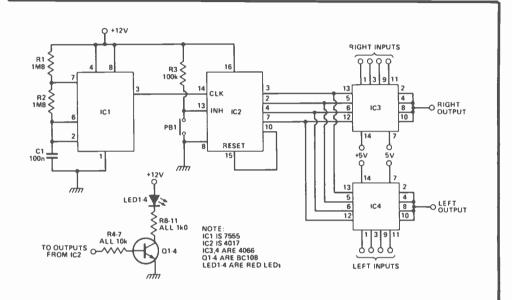
When a switch control goes high, the corresponding audio input is selected, and an LED lights to indicate which input has been selected.

Output 5 on IC2 is connected to RESET, so when pin 10 of IC2 goes high the decoder resets and the next pulse from IC1 selects input A.

The chosen values for R1, R2, and C1 produce a frequency of 4 Hz, so IC2 selects each audio input and then resets in 1 second. If PB1 is kept pressed, the input will change every quarter of a second.

ICs 1 and 2 are powered from +12 V, and ICs 3 and 4 are powered from +5 V and -5 V.





### **Logic State Analyser**

### L. V. Barker, Swansea

When testing a logic circuit, it is sometimes necessary to know the simultaneous state of several nodes. A logic probe or oscilloscope will not easily tell this and the best solution is usually a logic analyser. These are, unfortunately, rather expensive; a

solution presented here is a logic state analyser. This is an eight bit latch controlled by an input from the circuit under test and easily expandable to more input lines.

The heart of the circuit is the 74LS373, IC3: an eight bit latch. It is controlled by pin 11; when this pin is high (logic 1) the output data is equal to the input data, but when it is taken low, the device latches the data then on the input pins, thereby remember-

ing it. In this application the input pins are connected to the circuit under test and the outputs drive light emitting diodes LED3-10.

IC1 is a D-type flip flop used to control IC3. In its reset state, achieved by pressing PB1, Q1 is at logic 1 as is IC3 pin 11. The LEDs now follow the input data. When a rising edge appears on IC1 pin 3, Q1 goes to logic 0 causing the data on the input pins to be latched. It stays in this condition until PB1 is pressed. LED1 and LED2 give readouts on the state of IC1.

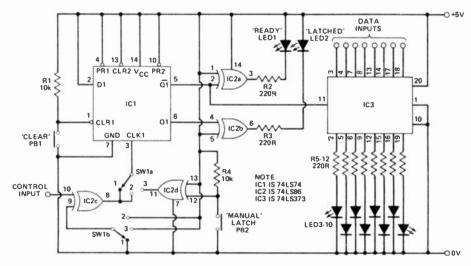
IC2 is a quad exclusive-OR gate; IC2c is used as either a buffer or as an inverter depending on the position of SW1. Three triggering modes exist; these are:

1) SW1 in position 1: latch on rising edge on control input

2) SW1 in position 2: latch on falling edge on control input

3) SW1 in position 3: latch when PB2 is pressed

To increase the number of channels, more 74LS373 devices can be connected, with the pin 11 of each connected to pin 6 of IC1. The prototype used five devices giving 40 channels of input.



### **ZX Graphics Board** Modification No. 2

M. Austen B.Sc. Hatfield

must congratulate G.N. Hill on an extremely simple and clever circuit for obtaining user-defined graphics from a ZX81. However, I was a little disappointed that the idea had not been thought out a little more carefully to provide an improved circuit. The problem with the published circuit is that of having to first read the character data from the ROM and store it in memory, and then enable the character RAM before writing the stored character data into this RAM. A slightly different circuit will allow data to be written to the RAM without it being 'selected', and without causing a bus contention with the ROM. The revised circuit has a lower component count (by one), but does require two further connections to the ZX81 circuit board.

When the address lines A9, A10, A11 and A12 all go high, the output of IC1a will go low. If ROMCS from the ULA is low also, the output of IC2a will be low too. With the switch in the position shown, the output of IC2c (and hence RAMCS') will go low only if a write operation is being performed by the CPU. The output of IC2d, and hence ROMCS', will only go low if a read operation is being carried out. With the switch in the alternative position, RAMCS' will go low whenever the output of IC2a goes low, and ROMCS' will not go low when IC2a goes low.

This means that when the switch is in the disable position as shown, the character ROM can only be read from, and the character RAM can only be written to. With the switch in the enable position, the character ROM is effectively disabled and the character RAM can be read from and written to.

Therefore. to transfer character data from ROM to RAM, simply read from the appropriate location and then write the data to the same location. When the RAM is then enabled, it will contain the required character data. The BASIC program given will illustrate this.

10 FOR I = 7680 TO 8191 20 POKE I, (PEEK (I))

### **Keyboard Auto-**Repeat Circuit

G Franklin, Mid-Glamorgan

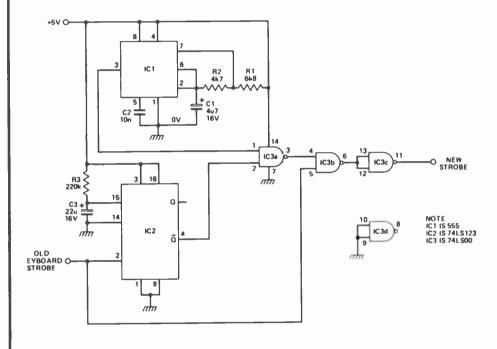
This circuit is intended for use with keyboards that do not have a 'repeat' facility. It is not only simple to install, but gives the user the repeat facility on every key on the keyboard.

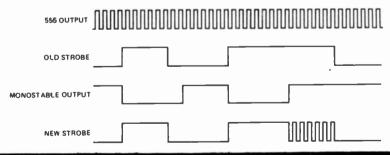
Basically, the strobe line from the keyboard activates the monostable (IC2); this disables the output of the 555 and prevents its pulses reading the new strobe line. After approximately 3 seconds, the output of IC2 changes state and the signal from the

555 is passed on to the new strobe line. If the key is released before the monostable finishes its timing period, only one character will be sent. For a key press of longer than 3 seconds, approximately 10 characters per second will be entered (the frequency being set by the 555, used in its astable mode). The circuit is shown for use with a positive-going strobe signal: for a negative strobe, simply move the last NAND gate (used as an inverter) to the input strobe line.

Connecting the circuit into your computer requires the removal of the current strobe line from your keyboard and re-routing it through

the circuit.





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ETI



**MEMOPAK 16K** For those just setting out on the road to real computing, this pack transforms the ZX81 from a toy to a powerful computer. Data storage, extended programming and complex displays become feasible.

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# MEMOTECH

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Memotech has a reputation for professional quality, producing units which are designed to fit perfectly, to look well-balanced, and to work efficiently and reliably.

The modular approach gives ZX81 owners the freedom to design the system they really need. Furthermore, the intercompatibility of the modules ensures that later additions will click straight in, to give you a system that grows with your ambitions and abilities.

As one example, a system with 16K of memory and MEMOCALC is all that is required to perform sophisticated numerical calculations giving the same results as a computer at 10 times the price. The problem may be as complicated as a cash flow or production schedule, or as simple as household accounts or pocket money budgeting. If the bank manager wants to see the cash flow, then a single print instruction to the Centronics I/F, will give a printout which is more than acceptable to any bank.

The example system which is shown, on the other hand, would satisfy the needs of someone who wanted to enter data via a light-touch keyboard, construct and label graphs, and then copy the screen to an 80-column printer. Only 16K of memory is used here but with additional memory, more than one video page can be stored. Up to 7 successive pages can be displayed cyclicly to give animated displays.

**MEMOCALC** The screen display behaves as a 'window' on a large sheet of paper on which a table of numbers is laid out. The maximum size of the table is determined by the memory capacity, and with a MEMOPAK 64K a table of up to 7000 numbers with up to 250 rows or 99 columns can be specified. Each location in the table can be either a number which is keyed in or a formula which generates a number. Every time the command to 'calculate' is given, all the formulae in the table are re-evaluated. Spreadsheet analysis started as an aid to cash-flow analysis, but this powerful tool has now been generalised and MEMOCALC with its special ability to perform iterative calculations is invaluable in the performance of numerical tasks.

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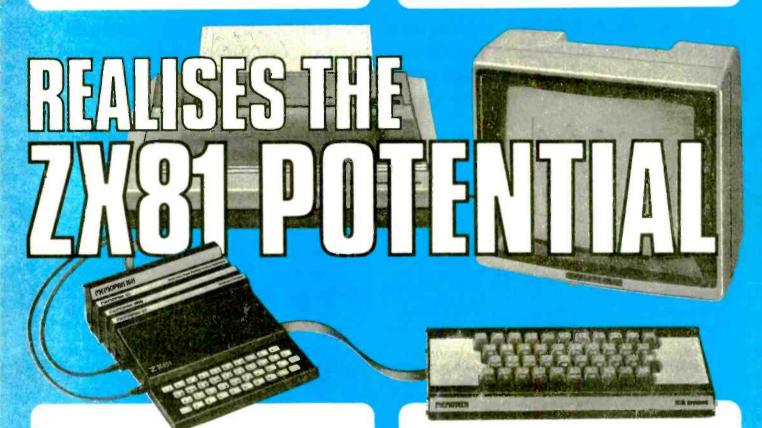
Memotech products are available at larger branches of WHSMITH



**MEMOPAK HRG** This pack breaks down the constraints imposed by operating at the ZX81 character level and allows high definition displays to be generated. All 248 × 192 individual pixels can be controlled using simple commands, and the built in software enables the user to work interactively at the dot, line, character, block and page levels. Scrolling, flashing and animation are all here.



MEMOPAK Centronics I/F The BASIC commands LPRINT, LLIST and COPY are used to print on any CENTRONICS type printer. All ASCII characters are generated and translation takes place automatically within the pack. Reverse capitals give lower case. Additional facilities allow high resolution printing. The full capabilities of your printer are now under the control of the ZX81.



**MEMOPAK Z80 Assemble!** This click-in EPROM based pack accepts standard Z80 assembly language mnemonics to allow you to write faster and more compact programs. It has its own ADD, EDIT, LIST, ASSM and QUIT functions, the editor allowing insertion, deletion, automatic line renumbering and error checking. Source code and object code listings can be displayed and printed in decimal or hex format.

**MEMOTECH Keyboard** The light-touch positive stop keys of this elegant typewriter-pitch keyboard allow you to work faster, more accurately and more confidently. To speed you along we have added an extra SHIFT key to the array at top right. The keyboard is attached by a cable to the Keyboard Buffer which fits in amongst your other Memopaks or straight onto the back of your ZX81.

To ensure that your expectations are realised, care is taken at every stage to design features into the system to anticipate your frustrations and to forestall them. For example:

A) Memories are cumulative e.g. 16K and 32K can be added to the MEMOPAK 16K or even to the Sinclair 16K RAM pack.

Bi The HRG firmware allows,commonly used constructions (such as scrolling, shading and labelling graphs), which might otherwise be beyond the user's programming capabilities, to be evoked by a lew simple commands.

C) The Centronics I/F converts ZX81 character codes into ASCII and extends the print line to the width of the printer, still using the LLIST, LPRINT and COPY commands.

Looking forward, Memotech will continue to back the ZX81 through 1983 with fast storage devices, pressure sensitive electronic drawing boards and more software packs including a wordprocessor and an RS232 interface.

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# PORTABLE INDUCTION LOOP

A few months ago we highlighted the problems of the hard-ofhearing when attending public performances. Now Vivian Capel shows how a do-it-yourself system can be easily implemented for small halls.

resistance of suitable cable, number

of turns in the loop, available

he problems of the hard-ofhearing when trying to listen to a public address system in hall, and how these can be eliminated by the installation of an induction loop was fully covered in the article contained in the February 83 issue of ETI. For the benefit of readers who might have missed it we will give a brief recap.

When listening through a hearing-aid hall acoustics are emphasised, as also are nearby audience sounds. This makes the PA sound almost unintelligible. For the past few years, most NHS hearingaids have an internal induction coil which can be switched in in place of the microphone: this enables the user to pick up electromagnetic fields directly from some telephones and so avoid the distortion of double conversion from electrical signal to sound and from sound back to electrical signal. The switch on the hearing-aid is labelled T (telephone) and M (microphone).

If an induction loop is wired around the hall and fed from the PA system, any such hearing aids switched to T will pick up the programme free from acoustics and all extraneous noises. The design of a loop depends on the area to be enclosed, total length of loop wire,

output impedance of amplifier and output power available. Optimum vertical displacement from the hearing aid is 3-4 feet, which for a seated audience puts it at skirting board or floor level. This gives a fairly even field intensity over the whole loop area. Wiring over obstructions such as doorways has little effect, nor do intervening objects such as chairs, even if these are metal framed.

In short, the induction loop is

In short, the induction loop is an ideal method of enabling the hard-of-hearing to hear perfectly via their own hearing-aids and with few problems in design or installation.

Having enjoyed the facility in halls where loops are installed, disappointment has been expressed by some hearing aid users when attending meetings or functions in premises not so equipped. Where the halls are hired for one-off occasions, installing a loop is hardly practical, especially in a large auditorium unless of course it was

to remain permanently thereafter. Even then, the installation would take time, and the design some advance measurement and calculations.

### Loop the Loop

A solution which has been devised and proved highly successful is that of a portable loop of fixed length, which is run to enclose a selected block of seating. Although the whole hall is not covered, the block is large enough to be more than adequate to serve those needing it along with their friends and families, thus avoiding segregation.

The loop is housed in a Portabloc cable drum (or similar) and consists of 30 yards of three-core 16/0.2 mains cable. One end is connected to a socket on the side of the drum, while the free end is terminated in a matching plug. When the plug is inserted in the socket, the three cores are connected in series to form a three-turn loop.

### PARTS LIST\_

One Portabloc empty cable drum (see Buylines).

One MT 10 10 watt 100 V line transformer, Eagle or similar (see Buylines).

One pair of three (or more) contact plug and socket (socket to be chassismounting).

One red LED with mounting clip.
One silicon diode (any type).
One 68R \(\frac{1}{2}\text{W}\) resistor.

One pair of screwed terminal blocks. 30 yards of three-core 16/02 mains cable (see Buylines).

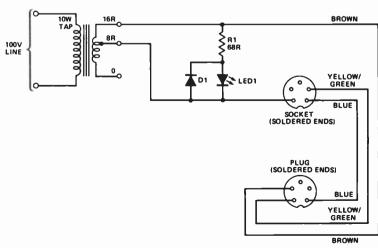


Fig. 1 Circuit diagram for the portable induction loop.

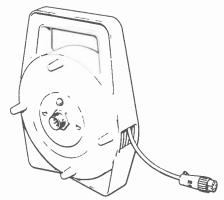


Fig. 2 Assembling the self-contained loop. The socket and the LED are mounted on the central plate on this side, the terminal block for the 100 V line connection on the other.

The 30 yards of cable is about the maximum that the drum will hold, and when paid out will give a loop of some 28 yards circumference. A couple of yards must be allowed going to and from the drum. The cable is just run around the desired area, laying it on the floor. If required it can be secured to a wooden floor at certain points with masking tape to keep it in place, especially the ends

leading to the drum which should be placed at a convenient nearby position. It is not usually necessary to tape it excessively.

A feature of this arrangement is the flexibility of the shape of the area served. On average, seating rows are a yard apart, and along the row there are two seats to the yard. So if the loop is formed into a square with 7-yard sides, it will serve seven rows of 14 seats each, a total of 98 seats. Another configuration could be a 10 x 4 yard rectangle which would enclose four rows of 20 seats. Of course, any combination up to the maximum loop length can be accommodated. There need be little cable left over, as each extra row takes only a further 2 yards approximately, irrespective of its length. So the number of rows can be selected to take almost the full length of cable.

### Got A Match?

Loop resistance is 3.2 ohms total. This might appear to present a matching problem for the amplifier: however, there is a simple solution. As the loop will be fed from a PA amplifier, it is assumed that the output will be 100 V line; so the matching is done by a 100 V transformer. The 10 watt MT 10 unit supplied by Eagle will just fit inside the hub of the Portabloc drum.

### BUYLINES\_

There are some specialist items in this project, but nothing that could cause great difficulties. The cable drum is supplied by RS Components, order code 488-668, but as RS do not supply to the public you will have to buy this through a local component supplier or radio shop. Eagle, too, will not supply small orders direct to the public, but if you ring them at 01-902 8832 they will give you the address of your nearest local distributor. The mains cable can be expensive if bought by the yard at a local shop; in addition to the profit there is also a mark-up for the cutting wastage. It will be cheaper to buy a 50 metre drum and keep the extra for something else.

There are two taps on the secondary, 16 ohms and 8 ohms, but it is often overlooked that taking the output from between the 16 and 8 ohm taps does not, as might be expected, result in an impedance of a further 8 ohms but a much lower value.

When the tappings are accurate, the impedance between the 16 and 8 ohm connections is a surprising 1.37 ohms. In practice, the tappings are often higher than the nominal value. With the transformer used for the prototype they measured 8.7 and 22.5 ohms. The formula for calculating intertapping impedance is:

 $Z = (\sqrt{Z_1} - \sqrt{Z_2})^2$ 

where Z is the unknown impedance,  $Z_1$  is the impedance of the higher tap and  $Z_2$  the impedance of the lower one.

Remarkably, the value for the transformer used worked out to 3.2 ohms, an exact match for the loop resistance. However, any impedance from this value down to the 1.37 ohms would drive the loop satisfactorily. This method of obtaining low impedance outputs by intertapping connection is a useful one which could be applied for driving other unconventional loads. Using the 4 and 8-ohm taps gives lower impedances still, of the order of 0.68 ohms.

The primary of the transformer is set to the 10 watt tap, and the loop takes 8 watts from the line. With a lower impedance output between the tappings, power consumption would be less. Most PA amplifiers would have enough reserve power to drive this, so it can be connected to any convenient amplifier in the system.

Connections are brought out from the transformer in the drum

hub to a terminal block on the outside, this being the opposite side to the socket for the loop itself. The Portabloc drums have aluminium discs on each side which can easily be drilled to take sockets or component mountings.

The final feature is the provision of an LED to indicate that the loop is working. This is connected across the loop via a 68-ohm resistor and with a shunt reverse-connected diode to protect it from inverse voltages. It can be mounted on the aluminium disc bearing the loop socket, and the drum placed when in use so that the LED can easily be seen. It will flicker on and off in sympathy with the sound and so indicate whether power is reaching the loop. If it is brighter than usual, the loop may be open-circuit somewhere.

The plug and socket used was a metal clad five-pin pair obtained quite reasonably from the local electronics emporium. This gives a couple of spare contacts in case of future trouble, but only three contacts are required and any suitable plug combination will serve. Robustness is the main consideration, and some means of securing the plug in the socket by a screwed ring or latch is desirable.

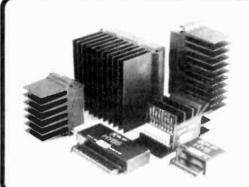
### **Installation**

This is simple and can be done in very little time. First select the area to be served: count the number of seats in the row, subtract from 28, and halve the remainder. The result will be the number of rows that can be covered, unless the seats or rows are wider than normal. Start paying out the cable at the point where the drum will rest, and circumnavigate the block until you return to the stating point. If there is more than a couple of yards left, the loop can be extended to another row: if it doesn't quite make it, the loop will have to be brought forward a row. Secure to the floor where necessary with masking tape.

Plug in the cable plug to the socket, then run a twin pair from the connecting block back to the PA amplifier and connect to the 100 V output. Put some music and check that the LED is flickering and

that's it.

Remind the ushers to direct users to the right place and tell them to switch their hearing aids over to the T position. A notice to this effect can also be displayed in the foyer or somewhere where potential users will see it.





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167,81	15	4-8	0.015%	<0.000%	2:18	/b = 68 = 40	240	18,40
HYGO	30	8.8	0,015%	<0.006%	1.75	76 = 68 × 40	240	€9,55
HYGOGO.	30 ( 30	4-8	0.015%	< 0.006%	1.25	120 x 78 x 40	420	€ 18.69
HY174	60	4	(1,01%	< 0.006%	1.26	120 + 78 - 40	410	£20.75
DFY 1291	(60)	В	0,01%	< 0.006%	1.35	120 + 78 × 40	410	€20,75
F1Y 244	120	4	0.01%	< 0.006%	: 35	120 x 78 x 50	520	F25.47
HM, VH	120	8	0.01%	<0.006%	1.50	120 × 78 × 50	520	£25.47
FFV.3641	180	4	0.01%	<0.006%	1.45			138.41
DEVISED	180	8	0,01%	<0.006%	1.60			£38,41

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

#### PRE AMP SYSTEMS

Module Number	Module	Functions	Current Required	Price inc
TEVE	Misou pre amp	Mic Mag. Cartridge/Timer/Tupe/ Aux + Vol/Bass/Treble	10mA	£7,60
TO bb	Scherce pre seutr	Mic/Mag, Cartridge/Turier/Tape/ Aux > Vot/Bass/Treble/Ballance	20mA	€14,32
HY 7,1	Fullar pre-limp	Two Guitar (Bass Lead) and Mic + separate Volume Bass Treble + Mix	20mA	£15.36
115 78	Stereo pre amp.	As FIY66 less tone controls	20mA	F14.20

Most presump modules can be driven by the PSU driving the main power amp. A separate PSU 30 is available purely for pre-amp modules if required for £5,47 (inc., VAT), Pre-amp and mixing modules in 18 different variations. Please send for details.

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PSU 42X	1 x HY128	£15.90
PSU 43X	1 x MOS128	€16.70
PSU 51X	2 × HV128, 1 × HV244	£17.07

Number	For Use With	Price inc.
PSU 52X	2 x HV124	£17,07
PSU 53X	2 x MOS128	£17,86
PSU 54 X	1 x HY248	£17,86
PSU 55X	1 × MOS248	£19.52
PSU 71X	2 x HY244	£21.75

#### MOSFET MODULES

Module Number	Output Power Watts rms	Load Impedance	DISTO T.H.D. Typ at 1KHz	RTION I.M.D. 60Hz/ 7KHz 4:1	Supply Voltage Typ	Size	WT	Price inc. VAT
MOS 12B MOS 24B MOS 364	60 120 180	4-8 4-8	<0.005%	<0.0064 <0.0064 <0.0064	± 45 ± 55 ± 55	120 x 78 x 40 120 x 78 x 80 120 x 78 x 100	d50	£30.41 £39.86 £45.51

Protection Able to cope with complex loads without the need for very special protection circuitry (bases will suffice). Siew rate: 20v/ps. Rise time: 3ps. SiN ratio 100db Frequency reponte 1–38B 1 5Hz - 1000Hz, Input sensitivity 500mV rms. Input impedance: 100K  $\Omega$ . Damping factor: 100Hz  $\geq$  400.

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£17.19 (inc. VAT)

Size 95 x 40 x 80. Weight 410 gms.

Model Number	For Use With	Price inc.
PSU 72X	2 x HV 248	122.54
PSU 73X	1 s HY364	£22.54
PSU 74X	1 c HY368	£24,20
PSU 75x	2 x MOS248, 1 x MOS368	€24.20

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54

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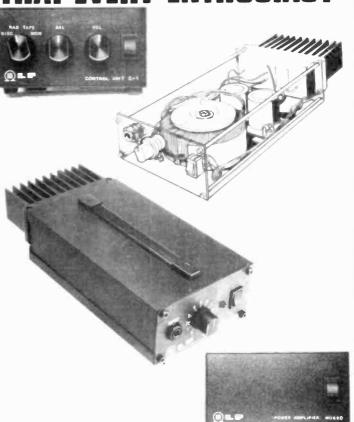
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UP3X	60W/8Ω	Bipolar	Mono	HiF)	£54.95
UP4X	120W/4	Bipolar	Mono	HiFi	€74.95
UP5X	120W/8 A	Bipolar	Mono	HiFi	€74.95
UP6X	60W/4−8 <b>Ω</b>	MOS	Mono	HiEi	£64.95
UP7X	120W/4−8 <b>Ω</b>	MOS	Mono	HiFi	€84.95
Power St	aves				
US1X	60W/4 <b>Ω</b>	Bipolar	Power	Slave	£59.95
US2X	120W/4 <b>Ω</b>	Bipolar	Power	Stave	£79.95
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## **CONFIGURATIONS**

It's been a year since Configurations started, and now Ian Sinclair brings the series to a close, shutting the AND, OR, and NOT gates behind him.

or anyone who has worked with linear circuits for a long time, the first contact with digital circuits always comes as a shock because the action of digital circuits is unfamiliar, and the way in which the circuits respond to signals is equally unfamiliar. In this final part of Configurations, therefore, we shall concentrate on the most basic of digital circuit, the gate, and how the two most common of 'families' of digital circuits, TTL and CMOS, carry out gate action. For once, also, we're going to assume rather less in the way of background knowledge than we've taken for granted in previous parts, because all the problems in adapting to digital circuitry are at the start — once you have had some experience, this sort of message is not needed!

Let's be clear from the start what we mean by digital circuits and gates. A digital circuit is, strictly speaking, one which works with signals that consist of several separate voltage levels, so that a voltage which is to be counted as a signal must be at or near one of these levels. The digital circuits that we make most use of are binary digital circuits, meaning that the signals into them and from them consist of only two voltage levels which we refer to as a matter of convenience as 0 and 1. What the actual voltages happen to be is unimportant — the important feature is that there should be just these two levels. Most logic circuits operate with what we call positive logic, in which 0 means zero volts and 1 means a positive voltage; a few older circuits can still be found which use negative logic, in which 1 is a negative voltage.

The advantages of using just two voltage levels are considerable. We don't have to worry about bias, for example, in the design of circuits, provided that we arrange for each active device in a circuit to be turned on at one voltage level and off at the other. This encourages the use of ICs, because bias is difficult to arrange reliably inside ICs. We don't need much in the way of voltage amplification, because with only two voltage levels to consider, the output signals can be of about the same voltage levels as the input signals. The only voltage amplification we need to consider is as much as is needed to restore the 1 level to normal when it has been reduced by, say, the 0V6 drop across a conducting diode (Fig. 1). The third major factor is that tolerances in component values have much less effect

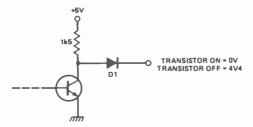


Fig. 1. Voltage levels. The presence of a diode, or a transistor junction, in the path of an output can change the output level by 0V6 or so. The tolerance of voltage must be enough to make allowances for this.

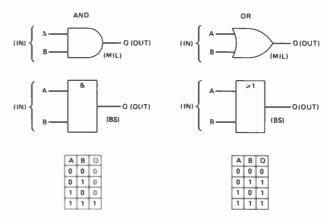


Fig. 2. The two main gate types, with International (MIL) symbols, and the BS symbols that are used for TEC and C & G courses. The truth tables describe the gate actions.

on signals than they have in linear circuits. A logic 1 voltage which is nominally 5 V can drop as low as 3V6 and still be useable as a logic 1 voltage. The logic 0 voltage can rise as high as 0V8 and still be useable as a logic 0 voltage.

Since the normal concern of linear circuits, amplification with low distortion, is simply not necessary for digital circuits, the actions that digital circuits perform are necessarily quite different. One of the fundamental actions of a digital circuit is gating, and it is gating that we shall look at in the rest of this article.

### **Digital Gates**

A digital gate is a circuit which has inputs that are digital signals and an output (or more than one output) which is also a digital signal. Since the output is a digital signal, it must have a voltage level at any instant which is at logic 0 or at logic 1, and what the level actually is depends entirely on the combination of inputs that happens to be present at that instant. It is for this reason that the gate circuit is often referred to as a combinational circuit. The two most important types of gate circuits are referred to as AND and OR gates respectively, and we can describe their actions by a table that shows what the output will be for every possible combination of inputs. Such a table is called a 'truth table', and the truth tables for AND and OR gates with two inputs are illustrated in Fig. 2. These tables show that for the two-input AND gate, the output will be at logic level 1 only when both inputs are at level 1: for the OR gate, the output will be at level 1 when either or both inputs are at level 1.

Truth tables become less useful when a gate has a large number of inputs, because the number of lines needed for a truth table is 2°, where n is the number of inputs to the gate. The same rules apply, however, irrespective of the number of inputs, so that the action of the AND and the OR gates can be described in ways that are more compact.

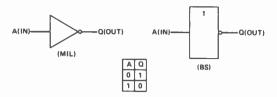


Fig. 3. The inverter or NOT gate.

than truth tables, using what is called Boolean Algebra. We haven't space to deal with this here.

Another circuit which is usually classed among the gates is the inverter, sometimes called a NOT gate. Its truth table (Fig. 3) is simple — the logic voltage output is the inverse of its logic voltage input. Circuits which combine the action of the NOT gate with the action of AND are called NAND gates; circuits which combine NOT action with OR action are called NOR gates, and the truth tables for these types are shown in Fig. 4. One further gate which is less important as a basic circuit, but which is needed in arithmetic circuits, is the exclusive-OR gate, or EXOR-gate, whose action is illustrated in Fig. 5. The name comes from the fact that the action is like that of the OR gate but excluding the case where both inputs are 1.

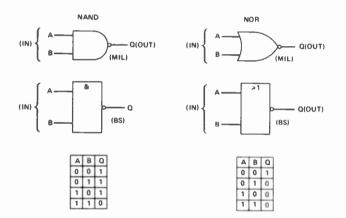


Fig. 4. NAND and NOR gates, formed by combining AND/OR gates with inverters.

Logic circuits which make use of gates are connected so that the output of one gate can pass signals to the input of the next gate in the circuit — we say that one output can **drive** one or more inputs. This usually means that the output has to be able to supply (source) or absorb (sink) current, and the number of inputs that can be driven by one output is called the **fanout** of that gate. The size of the

Fig. 5. The exclusive-OR (EXOR) gate and its truth table.

fanout depends on the design of the input and the output stages of the gates. A fanout of 10 is generally considered to be satisfactory, meaning that 10 gate inputs can reliably be driven from one gate output.

### TTL Gates

The old-style 'standard' TTL gate uses bipolar transistors, but using a common-base circuit rather than the more familiar common-emitter. The inputs (Fig. 6) are to the emitters of transistors whose bases are connected through a current-limiting resistor to the supply positive voltage of 5 V. A common feature of the IC construction is the creation of several emitters on to one base, so that several inputs are fed in by the same transistor. An input stage like this will draw no current when the input voltage is logic 1, because such an input biases the transistor off. An input which is at logic 0, however, has the effect of earthing the input terminal, and current will flow through the base-emitter junction of the transistor to earth. Unlike our linear circuits, this input current comes out from the input! Standard TTL is constructed so that this current is about 1.6 mA, so the resistance between the input terminal and earth must be low enough to ensure that when this amount of current flows, the input voltage at the terminal must not rise above the maximum voltage level permitted for logic 0, usually around 0V8.

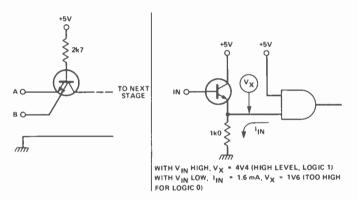


Fig. 6 (Left) TTL input. The base of the transistor is connected to + 5 V through a resistor, and the inputs are to emitters — more than one emitter (and as many as 13) can be formed on to one base.

Fig. 7 (Right) Driving a TTL stage from an NPN emitterfollower. The logic 0 voltage is likely to be too high because of the current from the input of the gate.

The requirement to have current flowing out from the input at logic 0 means that not all driving circuits are useable. In particular, the NPN emitter-follower, which is so often the automatic choice for many purposes, is unsuitable because (Fig. 7) when the input is at logic 0, the current from the gate will flow through the emitter resistor. A PNP emitter-follower, arranged as shown in Fig. 8, can allow a satisfactory logic 0 voltage, but only if the voltage at the base of the emitter follower can be taken low enough — preferably to a negative voltage, because of the inevitable 0V6 difference between base and emitter voltage levels. The most satisfactory simple driving stage is the straightforward common-emitter amplifier circuit as shown in Fig. 9.

No driving problems should exist if the input of a gate is driven by the output of another gate of the same family. Figure 10 shows the conventional circuit arrangement for a standard TTL gate output, which uses two transistors and a diode in series. A logic 1 output corresponds to having

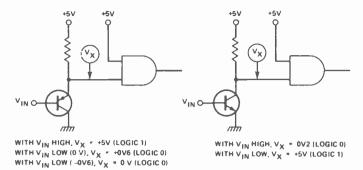


Fig. 8. (Left) Using a PNP emitter follower as a driving stage — a better approach.

Fig. 9. (Right) Driving a gate from a common-emitter stage — the most satisfactory single-transistor drive stage.

the top transistor of the pair conducting and the bottom transistor shut off, and because the base voltage of this top transistor cannot be more than the supply voltage of +5 V, the emitter voltage must be no more than 4V4-4V5, which makes the output voltage (because of the diode) only around 3V8-4V0. Don't be surprised, then, if you find that the logic 1 output from a gate is lower than the supply voltage. The logic 0 voltage from this circuit will be the voltage across the bottom transistor when it is fully conducting, which can be as low as 0V2, depending on the load.

The layout of the output stage is such that only one of the output pair of transistors will be conducting at any time during normal operation. If two gate outputs are connected together, however, it would be possible to have one output at logic 1 (top transistor conducting) and the other at logic 0 (bottom transistor conducting), so that at a low resistance path for current was created (Fig. 11). This would have the effect of burning out one transistor in each gate, so that for the few applications in which gate outputs have to be connected together, special gate ICs described as opén-collector types are used. These have no 'top' transistor in the output stages, and are designed to work with an externally connected resistor load (Fig. 12).

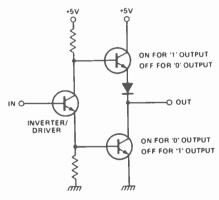


Fig. 10. The usual TTL output stage. One of the pair of output transistors will conduct to connect the output to either 0 or 1 levels.

Standard TTL, though still circulating in very large numbers, has been replaced in production by the low-power Schottky TTL chips, distinguished by the letters LS in the type numbers. These LS chips make use of a component, the Schottky diode, which is not particularly well known, so that some description is called for. The Schottky diode uses a combination of metal (usually aluminium) and semiconductor in its junction to obtain a very low for-

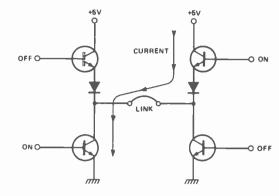


Fig. 11. Why gate outputs should not be connected together.

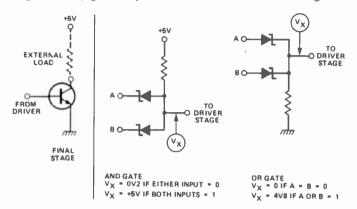


Fig. 12. (Left) The output stage of an 'open-collector' stage. These stages need an external load resistor.

Fig. 13. (Right) Using Schottky diodes as logic elements.

ward voltage, between 0V1 and 0V2 as compared to the 0V6 for a silicon diode. This makes these diodes ideal for use in logic circuits, as illustrated in Fig. 13, and also makes it possible to construct transistor stages which do not saturate. Saturation occurs in a conventional transistor stage when the base current of a transistor, which has a collector load, is so high that the collector voltage bottoms. The effects of saturation are to achieve a very low collector voltage, around 0V2, but also to flood the base junction with charge carriers (electrons or holes depending on whether the transistor is PNP or NPN). When the base voltage is suddenly removed from such a saturated transistor, this charge takes some time to clear, so that the transistor remains conducting — it will not switch rapidly from the conducting state to the non-conducting state. The time is usually less than a microsecond, but it limits the speed at which a gate circuit can operate reliably.

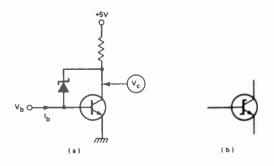


Fig. 14. (a) Using a Schottky diode to prevent transistor saturation. (b) The symbol for a transistor into which a Schottky diode has been incorporated.

A Schottky diode placed between the collector and the base of a transistor (Fig. 14) will prevent such saturation. When the collector voltage reaches a level which is about 0V2 lower than the base voltage, the Schottky diode wil conduct, connecting the base and the collector circuits and so bypassing the base. By avoiding saturation in this way, the transistor can be made to switch very much more rapidly at the minor expense of having a collector voltage which does not reach quite so low as that of a standard TTL stage. Figure 15 shows the internal circuitry of a typical LS type of gate circuit in which the presence of Schottky diodes is indicated by the modification to the shape of the base symbol in the transistors.

#### **CMOS**

Finally among the commonly-used logic gate circuits we have the CMOS types. These depend on the use of MOSFETs rather than bipolar transistors, and the inputs are invariably to the gates of the MOSFETs as compared to the emitters of the transistors in TTL stages. For this reason, no measurable current flows either into or out from the input of a CMOS gate when we use low-frequency signals, and the fanout under these conditions can be very high. The size of fanout is limited by the ability of the outputs of CMOS gates to supply currents of more than a milliamp or so, because the capacitance of each CMOS input is fairly high, and rapid switching demands that each capacitance be charged and discharged rapidly, calling for current which the output of a CMOS gate may not be able to supply. The operating currents and the dissipation of a CMOS gate will therefore increase as the operating frequency is increased, and it is this factor which limits the fanout and the speed of these gates. A typical CMOS gate circuit is shown in Fig. 16.

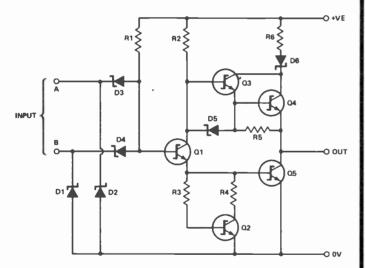


Fig. 15. Circuit for a NAND gate using Schottky diodes.

CMOS gates have a convincing list of advantages for many purposes. The supply voltage can be in the range + 3 V to + 15 V rather than the fixed + 5 V of the TTL circuits. The currents that are required by CMOS gates are very much smaller, so that CMOS is almost an automatic choice when battery operation is required.

For most practical purposes, your choice of logic circuits will be between LS TTL types and CMOS types, with the CMOS types chosen from the 4000 family (RCA), or from the less-well known 74C series (National Semiconductor) in which the type numbers correspond to those of the 74 series of TTL chips. For all purposes which require

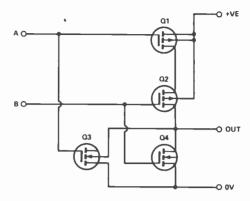


Fig. 16. Circuit of a typical CMOS gate — this one is an AND gate.

low consumption, lower operating speeds and small power outputs, CMOS is the more likely choice, but LS TTL chips are essential for many computing operations in which a high clock-rate is used — you may even find that you need the still-faster (and more power-consuming) 74H types.

We have now reached the end of Configurations, having covered a large number of devices and circuits. I hope that you have found the descriptions and the hints useful, and that some of them will have opened up new frontiers in circuit design for you, because that was the aim of the series. All I can do now is to wish that your circuits will always do what you want them to!

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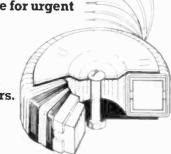
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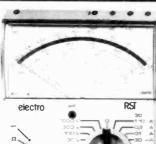
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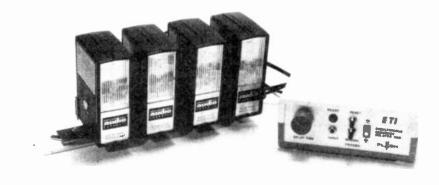
his unit has been designed to be used either on its own or with the multi-function trigger unit described on page 70.

It can be used with up to four separate flashguns connected directly to it and will enable you to get some very interesting action shots.

The delay between each flash can be set by means of the single control over a range of about 1 millisecond to 1 second. This should cover most needs of this sort of shot, but could be altered easily by changing component values.

### Use

This is, of course, up to the individual user but with the basic unit described here it would probably be reasonable to set up camera and flash guns on tripods or similar firm supports. Then connect the trigger unit to the camera flash socket (use a suitable adaptor if necessary) and the flashguns to the unit. Set up the focus and aperture



The ETI Flash Sequencer can control up to four flashguns.

to suit the subject and flashguns used and set the shutter speed so that it is longer than the TOTAL delay on the unit. This usually means that you will have to work on a dark night or indoors if you use long delay times.

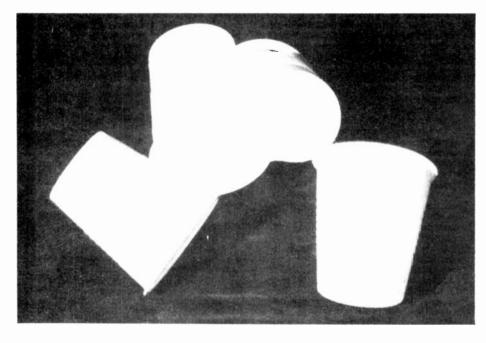
You will probably have to find the proper aperture setting by trial and error at first, but if you use a black or very dark background and your subject moves between flashes, the normal or slightly smaller aperture is a good starting point.

With the multi-function trigger unit all sorts of interesting possibilities open up for photographing wildlife or transient events, especially if a solenoid-operated shutter release can be arranged.

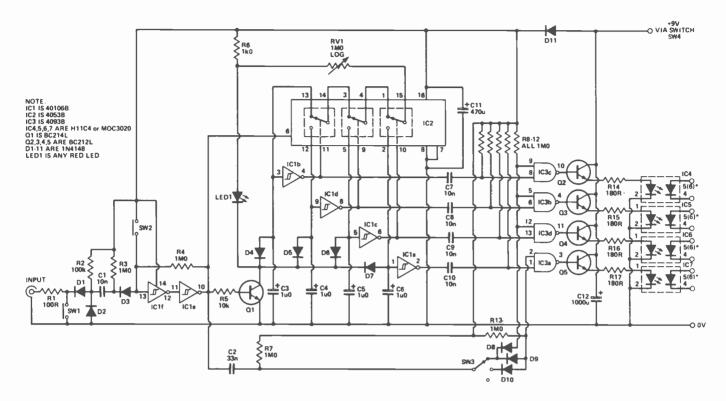
### The Circuit

The main parts of the circuit are the input latch configured around IC1e and f, the sequence generator consisting of IC2, IC1a, b, c and d, and the output pulse generators IC3. 4, 5, 6, 7 and Q2, 3, 4 and 5. The input latch can be reset to the READY condition by SW2 and will force the timing network to discharge all its capacitors by means of Q1 and D4 to 7. This state is indicated by the LED.

A negative-going pulse at the input or a press on SW1 will make the latch change state and allow the sequence to start. After the first delay period the LED in IC4 will be turned on for about 10 mS, causing its associated SCR (or triac) to turn on and trigger the flashgun to which it is connected. This action occurs when C3 has been charged by the current through RV1 and R6 to the upper threshold voltage of IC1b. The output from IC1b is coupled via a differentiating network (C7 and



Not four, but one. This bouncing plastic cup was captured at various points in its flight using the sequencer.



R8) to IC3c — also a Schmitt trigger. This negative-going pulse causes the output from IC3c to go high for about 10 mS, thus turning Q2 on and hence IC4.

IC1b having changed state, the current from RV1 is now diverted to C4 and will charge this up at the same rate until its voltage reaches the upper threshold of IC1d. A similar set of actions now occurs in IC3b and IC5, resulting in another flashgun being triggered and the timing current being diverted yet again to C5.

The sequence ends when C6 charges and the final flashgun triggers. The circuit is now ready to be reset for another operation.

By means of SW3, a negative pulse generated by C2 and R7 can be routed to the sections of IC3 such that one or all the outputs can be triggered with no delay. This could be used to advantage if the unit is triggered direct from a camera socket and no other lighting is used for special effects or just to get as much light as possible. Beware when using this facility with long delay times set on RV1, as one or more flashguns may recharge and trigger again as the delay operates.

The circuit should not take more than about 10 mA when READY and much less than that when timed out.

The negative-going input pulse to trigger the unit can be derived from a switch or logic source.

Fig. 1 Circuit diagram. The output connections (marked with an asterisk) depend on the opto device used — see text.

### HOW IT WORKS

IC1e and f are connected together to form a simple latch: R4 is included to avoid shorting the output of IC1e. When SW2 is pressed the output from this latch is set high, this will cause C2 to discharge via R7 and turn Q1 on. Q1 will discharge C3, 4, 5, 6 via D4, 5, 6 and 7 while lighting LED1 via R6. At the same time IC2 will be disabled by the high level on pin 6 from the input latch. This prevents LED1 from being bypassed by the switches in IC2.

In this condition the outputs from IC1a, b, c and d will be high and C7, 8, 9 and 10 can discharge via their associated resistors. This will set the inputs to IC3a, b, c and d to high levels and thus the outputs to a low. Q2, 3, 4 and 5 will be off and the outputs of IC4, 5, 6 and 7 will not conduct.

Assume for the moment that SW3 is in the open position (delayed sequence). If SW1 is now closed or a negative-going pulse appears at the input, this will be passed on via C1 and D3 to the latch formed by IC1e and f causing its output to go low. Q1 will now turn off, extinguishing LED1 and releasing C3, 4, 5 and 6. IC2 will now be enabled and current can now flow in C3 via R6, RV1 and the three switch sections of IC2. This capacitor will charge up until its voltage reaches the upper threshold of IC1b (this is a Schmitt trigger device), whereupon IC1b output will go low. This causes the current to be diverted to C4, where a similar process occurs. At the same time the high-to-low transition is passed through C7 to IC3c whose output will go high from 10 mS or so. This will turn Q2 on and thus IC4 will turn on.

Some time later C4 will charge up to the Schmitt threshold and IC1d will go

low, diverting the current into C5 while also causing IC5 to conduct. The cycle of events will continue with IC1c/IC6 and IC1a/IC7. The result of all this is that flashguns connected to the outputs of IC4, 5, 6 and 7 will be fired in sequence with a delay between each one determined by R6 and the setting of RV1 (and the residual resistance of IC2). IC2 is in fact a triple CMOS changeover switch with a typical on state resistance of 200 ohms.

C7, 8, 9 and 10 have been included to ensure that the opto-coupler LED inputs are not driven continuously, as this would take a lot of current. These capacitors and R8, 9, 10 and 11 define the 'on' time to be about 10 mS. C12 will hold enough charge to provide this even from an aging battery. C11 and D11 isolate the rest of the circuitry from the LED drivers to maintain proper operation.

C2 and R7 (via SW3, D8, 9, 10) provide the alternative operating modes. The initial trigger pulse can be fed via these components to the sections of IC3 such that IC7 will turn on immediately or all the outputs will come on together. Care must be used here as the outputs may pulse again after the set delay time and thus trigger the flashgun(s) again if they recharge in time.

You may notice that the inputs to IC1a, b, c and d will only have their capacitors connected, and no DC path exists to bias them, once the switches have been operated. This will not cause any problems over the 5 seconds maximum of the timing period, as the leakage of the tantalum bead capacitor is quite low and they will have to discharge a long way before the Schmitt

trigger gates change state.

### PARTS LIST.

Resistors (all 1W, 5%) 100R R1 100k R2 R3,4,7-13 1M0 R5 10k

Potentiometer

1M0 logarithmic

Capacitors

10nF miniature disc

ceramic

C2 33nF miniature polyester C3-6 C7-10 1u0 35 V tantalum bead 10nF miniature polyester C11 470uF 10 V aluminium PCB electrolytic

1000uF 10 V aluminium axial electrolytic C12

Semiconductors

IC1 40106B IC2 4053B

IC3 4093B IC4-7

H11C4 (opto-SCR) or MOC3020 (opto-triac).

See text.

**BC214L** Õ2-5 D1-11 BC212L 1N4148

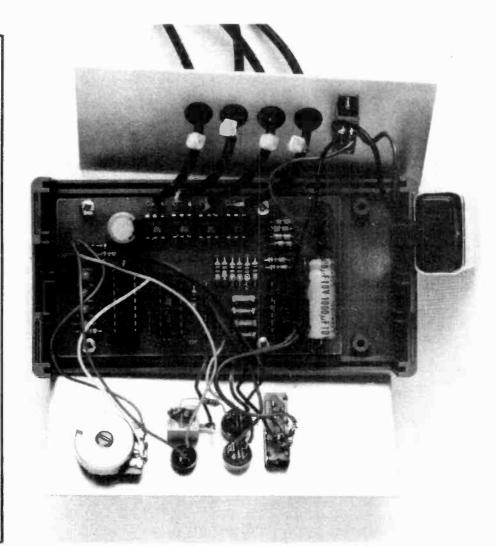
LED1 any red LED

Miscellaneous SW1,2 miniature push-to-make

push-button switch three-way slide switch SW3 miniature on/off slide SW4

switch

PCB (see Buylines); box — Verocase 125 × 65 × 50 mm (order ref. 202-21049A); 3.5 mm jack socket and plug; PP3 battery and clip; four small grommets; four off 1 metre flash extension cables; wire, cable ties etc.



Inside the sequencer.

# FLASH GUNS S CONNECTION FOR SCR<sub>2</sub> T CONNECTION FOR TRIAC<sub>2</sub> TO BV1 012

Fig. 2 Component overlay of the ETI Flash Sequencer.

#### Construction

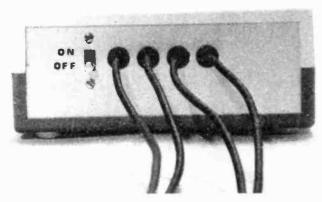
Construction of this project should pose no great problems. Take care when positioning the front panel components that they do not foul the parts on the assembled PCB. Note that R1, D8, 9 and 10 are mounted on the panel. It is essential that all the diodes, ICs, and any other polarised components are mounted the correct way round.

We recommend that IC holders are used for the CMOS devices and that care is taken to avoid static discharge damage to these devices.

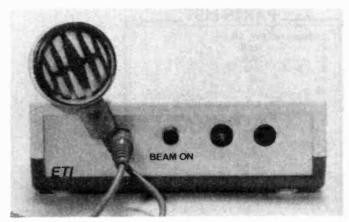
### BUYLINES.

MOC3020 is available from Technomatic and is much easier to obtain than the H11C4. Everything else is standard and readily available, although if you can't find the specified case in the catalogue of your favourite supplier, it can be bought direct from BICC-Vero Electronics, Retail Dept., School Close, Industrial Estate, Chandlers Ford, Eastleigh, Hants SOS 3ZR. The PCB can be bought from our PCB Service as advertised on page 91.

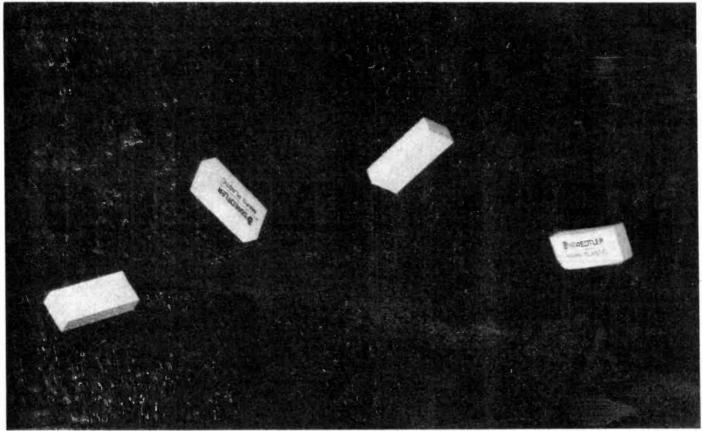
### .PROJECT : Flash Sequencer



The rear of the sequencer carries the on-off switch. We bought four flash extension cables in order to get the right connectors.



The picture on page 63, and the one below of an eraser bouncing from right to left, were shot using the sequencer and the trigger unit above. See page 70.



### **Output Connections**

There are two different connection points for the output from the opto-couplers. This is to accommodate either opto-SCR or opto-triac devices. If opto-SCR devices are used, the flashgun trigger leads must be connected across pins 4 and 5 with pin 4 negative and pin 5 positive. You will have to check the polarity of the connections to the base of the flashguns you use, and this will vary from make to make (ours had a positive inner). If you connect up for one particular make, the trigger unit may not work on another.

If you use opto-triacs, the

flashgun trigger leads should be connected across pins 4 and 6; polarity is unimportant, which will save all the above messing about, so we recommend this option.

### **Other Points**

As we found that sockets for flashgun connectors are unobtainable (unless already connected to something such as a camera) we bought four flash extension cables and cut the unwanted ends off. These were then taken into the box via small grommets and wired directly to the proper terminals. A small cable tie on each lead just inside the box served to take the strain off the

connections. It may be a good idea to buy three one-metre extension cables and one much longer one, so that you can use the extra length from this for the camera-to-unit link (it will have the correct connector).

For greater protection the unit could be built inside a diecast box. This may also be necessary if static discharge causes premature triggering of a flashgun.

Calibration of the delay control would need special apparatus and would depend on the quality of RV1. But the type of device specified should give a reasonable subjective control over the required range.

**ETI JULY 1983** 

### **COMTECH ELECTRONICS**

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C328 12	129 BF 459	32p 2N2218A 36p 2N2219A	28p LF351 25p LF353	BOD TLOB1	40p A202	BD 4042	420 Jarne SAE for fa		neo seme day, semo
	12p BF X29 12p BF X30	28p 2N2221A 28p 2N2222	20p LF355 18p LF356	85p SE 50 86p C1060	200 BAX16	*P 4048	360 COMPONENT		FREE!
IC413C 10	10c BF x84	28p 2N2222A	20p LF 357	110p C116D 25p C120D	70p 1544 90p 15921	P 4049	20p CP2 10 BC182 ( 20p CP3 10 BC549)	8 10 BC 212 Transistors 130p 8 10 BC 559 Transistors 130p	WITH
C415C 10	108 BF 186	28p 2N2368 28p 2N23694	15p LM307	540 2N4444	130p 11914	3p 4051	44p CP7 100 1N914	Eswitching diodes 100V 240p	ALL
	10p 8f 187 23p 8f 188	27p 2N2484 23p 2N2904	24p LM311N 20p LM318N	80p 2N5061 120p 2N5062	29p 1N4148	3p 4069	14p CP9 30 1N4002	1A/100V reclifiers 100p	ORDERS
	33P BF Y50	23g 2N2904A	22p LM324	40p 2N5064 480 THYRISTORS	32p 1N4001	3p 4070 3p 4071		148 switching diodes 150p electrolytic capacitors 380p	OVER
IC546 10	10# BF V52	22p 2N2905 22p 2N2905A	25p LM348	80p (C2061)	55p 114002	40 4072 40 4073	14p CP174LF351.	JFET Op Amps (low noise) 170p JFET Op Amps (wide band) 300p	63
	BF V53	78p 2N2906 33p 2N2906A	20p LM358 22p LM376	44p C225D 68p C226D	700 1N4004/5	50 4075	1.4p CP21.20 Red re	clangular Leds 1750	10
IC549C 1	9-9 BU205	140p 2N2907 150p 2N2907A	23p LM380 25p LM382	68p C236D 120p BR100	90p 1N4006/7 30p 1N5401	5p 4077	14p CP28 10 C 106E	D 4A/400V Trigristors 250p Red Leds with clips 195p	BC182's
C556 10	10p BU206	140p 2N3053	23p LM384	125p ZENERS	1N5402 1N5402/4	120 4081		Red Leds with clips 170p	BC 102 5
	90 MJ2955 90 MJE340	98p 2N3054 88p 2N3055	56p LM386 50p LM387	130p 2v7 36V	6p 1N5405/6 1N5407 B	140			
C9568 C559C C560C	10P MJE 370	70p 2N3441 84p 2N3442	120p LM388 120p LM389	170p 1 3W 150p 3V9 51V	120 6A/100V	15p 28p			
C 770 11	MJE520	50p 2N9702	10p LM393	70p 1150s	6A/200V	30p			
CY72 1	180 MJE521 179 MJE2955	85p 2N3703 80p 2N3704	10p LM703 10p LM741	32p Clids 14p 3mm red	3p 6A/600V	15p			
	5Co	2N3706	10p LM711	80p		REAL PROPERTY.		STATE CALL PROPERTY.	A STATE OF THE PARTY.
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20 way	145	125	195p
26 way	175	150	240
34 way	200	160	320
40 way	220	190	340
50 way	235	200	390

#### **D-CONNECTORS**

No of Ways 9 15 25 37

Male
Solder 80p 105p 160p 250p
Angled 150p 210p 250p 365p
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Solder 105p 160p 200p 335p
Angled 165p 215p 290p 440p
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21 way 160p 165p
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CONNECTORS

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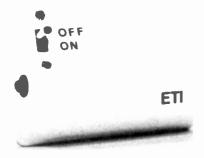
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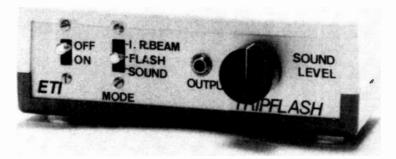
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# TRIGGER UNIT





If you're building the ETI Flash Sequencer described elsewhere in this issue, a unit to fire it on various stimuli is a must. This design triggers on sound, light or an infra-red beam. Design by Phil Walker.

his project has been designed to drive the ETI Flash Sequencer and provide facilities to trigger one or more flashguns and get the effect of a multiple exposure at one go. It can be used to trigger on the breaking of an invisible infra-red light beam up to 1 metre in length, on the sound of a pin dropping or even when another flashgun goes off. These functions add a new dimension to creative photography, especially on action shots.

#### Use

The visible light trigger will normally be used as a slave trigger, allowing up to four extra flashguns to be set off by one which may be fitted to the camera. This will allow 'filling in' or special effects to be created by using relatively cheap flashguns.

The sound trigger option allows all sorts of things to be captured on film, such as objects being thwacked by hammers, drops of water being thrown in all directions and many other poisy events

and many other noisy events.

Lastly the infra-red beam will allow many other events to be recorded in which the object of the picture is not broken, mangled, or disturbed except by the flash. The content of your pictures can now explore new fields.

If you wish to use this unit to trigger the camera shutter, there are two possibilities open. The first is

that you have an electrical release on your camera, in which case the maker's handbook should be consulted to see whether it can be used.

The second is that a small extra circuit will be necessary, consisting of a power switch and solenoid. Some mechanical linkage could connect the solenoid to a cable or air release and thus release the shutter. The flashgun or flash sequencer would then connect to the camera in the normal way. These methods will avoid the shutter being open for long periods, which might cause unwanted images if all the extraneous light has not been kept out.

### Construction

Construction of this unit is relatively straightforward but care must be taken that the components on the front panel do not foul the PCB or battery when assembled. The most critical part in this respect is the three-way mode-select switch. If you use the case specified it will be found necessary to cut off the screw pillars on the lid portion of the box so that the battery and switches fit in. It is recommended that thin screened wire is used for the PCB-to-panel connections (except LED and power) as there are two high-gain amplifers on board which will probably pick up any stray signals.

Keep the transistor leads short (not more than 5 mm above board) and take full anti-static precautions when fitting IC1 into its socket. Make sure all the diodes, transistors and electrolytics etc are fitted the right way round.

The infra-red photodiode should have its leads kinked before soldering in place so that it can be positioned properly in front of the hole in the back panel. It will be about 8 to 10 mm above the board. The visible light photodiode is mounted in a small grommet and connected to the PCB with flying leads.

It may be advisable to use a panel-mounting LED as the infra-red beam indicator, or paint the rear of an ordinary one black to prevent light from it reaching the photodiode. From this point of view it may be a good idea to paint the whole interior of the case black or line it with black light-proof tape.

#### **Transmitter**

This is very easy to assemble so long as the components are put in the right way round. The leads of the IR transmitter LED should be left long enough so that the LED can be bent round and fitted through the case. Make sure that there is enough room for this when fitting the switch. There should be enough space to fit the PCB into the box vertically but a little filing may be needed.

### **HOW IT WORKS**

#### RECEIVER

The circuit can be considered in three sections. First the modulated infra-red receiver circuit starts with the detector diode D1. This converts the incoming light pulses to small current changes through R1. The resulting voltage is greatly amplified by Q1 and Q2 before being converted to a suitable logic signal in Q3. The output from Q3 is shaped by IC1f before triggering the 700 uS monostable formed by IC1a and b. When the infra-red beam is being received the output from this monostable consists of a train of pulses 700 uS low and 300 uS high (approximately). This train of pulses is applied via R13, 14 and D4 to C6. The time constant for C6 charging is about 1 mS while for discharging it is about 10 uS. This means that the voltage on C6 is always low while the IR beam is

being received. Thus the output from IC1c is normally high and LED1 will be lit to indicate this condition. If the beam is broken for more than 1 mS a pulse will be missed, the monostable will not discharge C6 and will allow it to charge to the threshold of IC1c. This is a Schmitt trigger device and its output will change state sharply to a low level. This will be transferred via C7 and may be selected by SW1 as the required trigger signal.

Secondly, any sound in the area may be picked up by the crystal microphone and amplified by Q5 and Q6. A portion of this is tapped off by RV1 (acting as a sensitivity control) to drive Q7 which converts it to a suitable logic signal. This may now be selected by SW1 as the desired trigger.

Thirdly, D6 may selected as the

signal source. This will respond to bright lights such as other flashguns to give a 'slave' capability. Any of these signals can be selected by SW1 and used to drive the monostable formed by IC1d and e. This provides a low-going output pulse each time the required trigger conditions are met — that is, on a broken IR beam, a loud noise or a bright light.

THE INFRA-RED TRANSMITTER

This produces a 1 uS pulse through the IR transmitter diode every 1 mS. The pulse width is determined by R2 and C2 while the repetition rate is set by R1 and C2. IC1 is a 555 timer IC whose output drives the LED via R3 to limit the current a little. D1 and C1 isolate the timing network from the effect of the high current pulses on the battery supply. C3 also helps to reduce these effects.

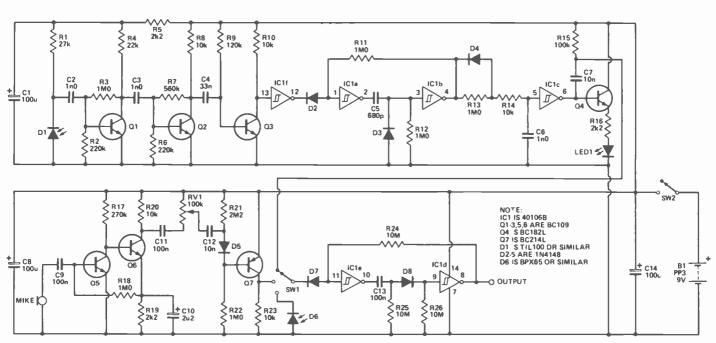


Fig. 1 Circuit diagram for the main board.

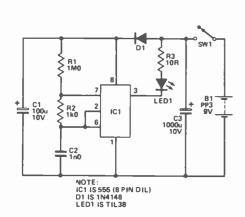
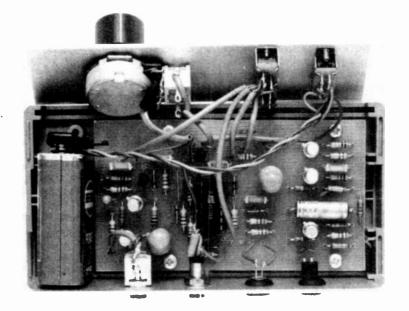
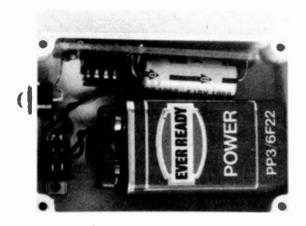


Fig. 2 Circuit diagram for the separate transmitter.

Right: Inside the main unit. Take care when wiring to the switches.





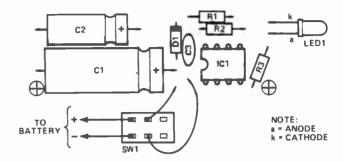


Fig. 3 Component overlay for the transmitter. Left: A tight squeeze but it will all fit in!

PARTS LIST — RECEIVER.

### PARTS LIST

	TAKIS LIST
Resistors	(all ‡W, 5%)
R1	1M0
R2	1k0
R3	10R
Capacitor	s
C1	100uF 10 V axial
1	aluminium electrolytic
C2	1n0 miniature disc
.	ceramic
C3	1000uF 10 V axial
	aluminium electrolytic
Semicond	luctors
IC1	555
D1	1N4148
LED1	T1L38 1R transmitter diode
Miscellan	eous
SW1	miniature on/off slide switch
nco ba	
PCB; DOX	— Verocase 71.5 × 49 × 25.4 r ref. 202-21025K); PP3 battery
and clip;	M2 × 5 mm screws, wire etc.

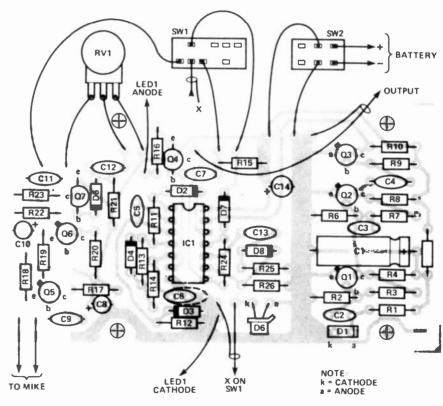
### Setting up

The infra-red beam link may need a little adjustment for best operation. While doing this it will be necessary to shade the receiver from room lights and other sources. First, switch on the transmitter and place its LED close to the unmarked side of the photodiode (this should be the side nearest the rear panel and visible through the hole in it). Make sure that the 'beam-on' LED lights up. Keeping the transmitter LED pointing toward the receiver, move it away until the indicator LED goes out. Adjust the receiver LED so that it comes on again. Repeat this until a range of about 1 metre is achieved.

The visible light photodiode should not need much attention unless it is too sensitive. If this is the case, it can be de-sensitised with a small piece of masking tape or similar material over the front surface.

Fig. 4 Component overlay for the trigger unit main board.

#### C7,12 10nF ceramic Resistors (all 1W, 5%) C8,14 100uF 10 V tantalum R1 27k 100nF ceramic 2u2 35 V tantalum R2,6 220k C9,11,13 C10 R3, 11-13, 18, 22 **1M0** Semiconductors R4 22k 40106B IC1 R5,16,19 2k2 Q1-3,5,6 Q4 BC109 R7 560k R8,10, 14, 10k **BC182L** Q7 D1 BC214L 20, 23 TIL100 IR receiver 120k R9 photodiode 100k R15 D2-5,7,8 IN4148 270k **R17** BPX65 or similar visible **D6 R21** 2M2 light photodiode R24-26 10M Miscellaneous Potentiometer three-way slide switch . 100k logarithmic SW1 RV<sub>1</sub> SW2 on/off slide switch PCB; box Capacitors - Verocase 125 x 39 mm (order ref. 202-21048D); two off 100uF 10 V axial 3.5 mm miniature jack sockets and plugs; miniature crystal microphone; PP3 9 V battery; M2 × 5 mm screws, aluminium electrolytic C2,3,61n0 ceramic C4 33nF ceramic 680pF ceramic **C5**



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74LS85 48p 74LS253 35p 74LS86 18p 74LS257 30p	74123 40p 74160 80p 74161 48p 74162 48p 74163 48p 74164 48p 74166 48p 74166 48p 74190 50p 74191 50p	2PL2646 dbp 2N2904 2Bp 2N2905 2Bp 2N2905 2Bp 2N2907 2Bp 2N2907 2Bp 2N30053 2Bp 2N3005 dbp 2N3702 10p 2N3703 10p	4049 24p 4040 24p 4051 46p	LM384 100 LM386 50
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74LS139 Z7p 74LS378 60p 74LS145 70p 74LS390 46p 74LS147 120p 74LS393 46p	Green 1	1p 12p 4p 14p	4501 28p 4502 60p	NE571 400p NE592 80p
	Yellow 1	4p 14p	4503 45p 4504 75p	NE5534P 113p NE5534AP 120p
VOLTAGE REGULATORS	OPTO ELECTRO 2N677 45p	ORP60 120p	4506 35p 4507 35p 4510 45p	TBA810 95p TBA820 90p ZN423 135p
7805 40p 7905 46p 7812 40p 7912 46p	OCP71 180p ORP12 120p	ORP61 120p TIL78 55p	4511 <b>46</b> p 4512 <b>88</b> p	ZN423 135p ZN425E 350p
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2N5064 35p	. 75. 7 7			0A47 8p 0A90 9p 0A91 9p
ELECTROLYTIC CAPACITORS (Axial & Radial) Values in uf.		TRANS Min So	FORMER HI Bobbin	0A200 9p 0A202 9p
63V: 1, 2.2, 3.3, 4.7, 6.8, 10 6p; 1 40V: 330, 470 6lip: 1,000 68p; 2.2	00 70p	Prima: Secondary	ry: 240V 6 0 6. 9-0 9.	1N914 4p 1N916 7p
25V: 47, 100 8p; 220, 330 12p; 47 2,200 50p; 3,300 79p, 4,700 82p.	0.25p; 680, 1,000 34	p; 12-0-12 PCB A	2, 24 0-24 Aounting	1N4148 4p 1N4001 5p
16V: 470 14p; 1000 20p. 10V: 1000 15p; 2200 25p.		3VA 6VA	290p 270p	1N4004 6p 1N4007 7p
POLYESTER CAPACITORS (Rac 10n, 15n, 22n, 33n, 47n 8p; 68n, 1	Fal Lead) 250 V. 100n 8p; 150n. 220n	6VA	228p	Diac
10n, 15n, 22n, 33n, 47n 8p; 68n, 1 330n 10p; 470n 150p; 680n 20p; 1 MYLAR FILM CAPACITORS (R	ladial Lead) 100V		295p 138p	ST2 ZSp
1n, 1n5, 2n2, 3r3, 4n7, 6n8, 10n CERAMIC CAPACITORS 50V	lip; 15n, 22n, 33n, 4 (Radiel Lead).	7n Bp.	DIL SOCKET	
22pf-47,000pf E12 Values 4p ea	ich.		8 pin 8	r Prafile to 20 pm 22p
Carbon track, 0.25W log & linear 5K-2M single gang	30p Slide 1	A	14 pm 10 16 pm 10	p 24 pm 25p
5K-2M single gang D/P switch 5K-2M dual gang stereo	78p DPOT o		VEROBO	DARDS 0.1in
PRESET POTENTIOMETERS Horizontal & Vertical	Sub m	in Toggle n/off 54p	2 : 31.	clad plain 73p 52p
0.1W 100R-1 Meg 0.25W 100R-1 Meg	7p SP c/o 10p DPDT	ver 60p 75p	2 · 5 31 · 31 31 × 5	83p 83p 95p 79p
RESISTORS 5% Carbon Film	DPDT o		32 = 17 42 = 18	325p 211p 425p
E12 values: 0,25W 1R-5MI 0,5W 1R-5MI	1p Push to	Make 15p	Pki of 10 Spot face	O pins 50p cutter 118p
Retail Shop: No	1.op		Pin insent	ion tool 162ts
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# **AUDIOPHILE**

Stop press. Just in time for this issue, Vivian Capel supplied a report on the topical and apparently revolutionary Hugo Zuccarelli and Holophonic Head. Don't go away, it isn't a music hall act . . .

I hat caused hard-bitten cynical audio experts to gasp in amazement? What produces multidirectional sound from two channels; and still does so when one channel is switched off? What has put conventional stereo, and even quad, into the same class as the wind-up trumpet gramophone? What modern discovery has been clouded with more myths and confusion than The Ring? Who or what is Ringo?

The answer to all these questions lies in the new brainchild of 26-year old inventor Hugo Zuccarelli, the Argentine-born Italian now resident in London. The system is termed holophony after a claimed, though rather

tenuous, comparison with holography.

It seems that Mr. Zuccarelli has been musing over the principles of holophony for a long time, since he was nine no less, but it wasn't until October 1981 that he filed a European Patent Application which describes his invention and gives patent protection in nine European

Since then, particularly in January and February of this year, there have been press demonstrations and a TV programme in the 'Real World' series. The results of these have been impressive indeed, with audio experts and reviewers being converted from scepticism to astonished acceptance. Neurophysiologist Dr. Martin Rosenberg of London University has joined the redoubtable Angus Mackenzie (who is not given to extravagant praise) in acclaim with phrases such as "quite striking and novel," and "absolutely remarkable."

## **Sounds Interesting**

So what was the cause of all the excitement? The demonstrations were conducted with recordings played through a pair of conventional stereo headphones, although a pair of stereo speakers suitably placed will give the same result. This immediately strikes a favourable note, as it means that potential users do not have to buy or change expensive hi-fi, or find room for extra speakers as with the defunct quad systems. Existing speakers can do the trick, with perhaps a move from the usual stereo front location to a side position. Another proviso we shall see later

Some of the recorded material was played by digital recorder, but there were also recordings from an ordinary stereo cassette machine. There was no evidence of a special decoder (as needed with the quad systems): in fact there was little different from an ordinary stereo system -

except the recordings.

These consisted of everyday sounds rather than music, and so were more readily comparable to normal experience; people moving about and talking, matches being struck, birdsong and jet aircraft. The remarkable thing was that in every case the exact location of the sounds could be pin-pointed. Not only in front, as is the case with normal good stereo, but at the sides and the back, and even overhead and below at floor level. There was a complete sphere of locatable sound sources. This demonstrated the superiority over quad systems, which imperfectly create the illusion of 'surround sound' and fail

to give a height dimension.

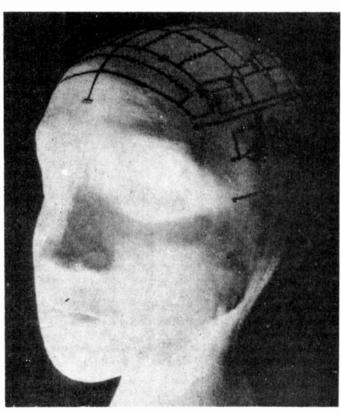
The degree of realism was so great as to produce descriptions such as 'terrifying' from the subjects especially when the experience took place in a darkened room, and the eyes could not contradict the evidence of the ears. One auditioner spoke of withdrawing his feet instinctively as he heard someone walking directly in front of him, the sound of footsteps coming unmistakably from the floor, while another claimed to have felt the "heat" from a match that was struck in front of his face. Those listening in a normally lit room but with eyes closed as instructed, frequently had to open them to reassure themselves that it was only a recording.

## Myths And Legends

There is then no doubt, that the system does work, and it works guite remarkably. The guestion (and it is a big

one) is HOW does it work?

Although protected by patent, Zuccarelli is more than normally protective in guarding the secret. Perhaps he has good reason to be, as imitators in the past have not found it impossible to get around patents. So, in addition to be-



ing vague in describing the principle of working, he has disseminated half-truths which have been interpreted in various ways by journalists, mostly with completely erroneous 'explanations'. Also statements have been made which are quite misleading.

The result, as readers who may have seen press reports in other magazines will have gathered, is confusion and conflicting theories. Some of these appear to be contrary to the known facts of physics and biology, and unfortunately have done little to raise the system's credence in the minds of doubters. It is a pity that what is undoubtedly a genuine breakthrough should be so surrounded by clouds of suspicion and scepticism.

Let us take a look at what has been already published. Firstly, the name holophony is meant to imply a similar mode of operation to that of holography. With this, a beam from a coherent light source such as a laser is split into two parts. One is the reference beam which is directed at a photographic plate or film. The other illuminates the object to be photographed from which reflections are also received at the plate. These are delayed by reason of the extra distance they have travelled, the delay thus being proportional to the depth of the object.

The object beam is now has a slightly different phase than the reference, and re-combining them at the photographic plate produces interference patterns. Where there are no reflections from the object such as from holes in its surface or beyond its boundaries, there are no patterns on the plate, only the reference beam.

Thus the plate carries two-dimensional information corresponding to the flat or frontal appearance, but in addition it has information reagarding the depth as conveyed by phase differences and the resulting patterns. So the original image in depth can be reconstituted with the use of a laser.

## Your Theory Is Crazy . . .

In an attempt to reconcile this principle with the claimed workings of holophony, writers have tried to idenfity the two components, the signal and reference, and have met with trouble, especially in the case of the latter. They report Zuccarelli as asserting that the ear is not a receiver but a transmitter. It actually radiates a sound which interacts with the incoming pressure waves and compares them to produce a resultant signal which somehow has spatial information.

A variant of this is that the reference is like 'pink' noise (the audio technician's term for noise in which each octave of random frequencies contains equal power, in contrast with 'white' noise where the power increases according to a square law for each rise in octave), and that we call this noise 'silence'. Incoming signals are alleged to mix with this and thereby become spatially identifiable.

There are two obstacles to this theory. One is that there seems to be nothing published in the medical and biological books as to the ear radiating sound — strange that such a phenomena has passed unnoticed before!

The second is that, even if true, in what way could the mixture of an internally generated signal and the external ones identify the location of the latter? Remember that with the hologram, the reference and object beams originate from the same source, and it is the displacement from the phase of the original that conveys the spatial information in the reflected one.

Mr Zuccarelli is also reported as saying that he communicates directly with the brain: "We actually record brain codes". As we shall see, spatial coding which the brain unravels as spatial information certainly does take place, but such a statement is rather misleading. It suggests

that sound and the ears are not involved at all, in which case one might expect to have electrodes implanted in the head in order to accept the recorded signals!

This mysterious non-auditory concept of the recorded signals is further heightened by Zuccarelli's reported emphatic denial that microphones are used at all in the recording process. In fact this is simply not true; two cardioid microphones with a minimum diaphragm diameter of 7 mm are employed as transducers in the recording device.

Allusions to 'encoding', the 'generator', and the coments that 'if an electronics expert were to examine the latter it is unlikely he would understand it', all serve to enhance the aura of way-out complexity, and discourage too-close investigation. We are further told that Hugo would never sell the secret, and that 'someone might find it in 10 or 20 years'.

All highly intriguing stuff, but having blown away the chaff, let us see what remains.

## **Limitations Of Traditional Hearing Theory**

The traditional explanation of how we distinguish the origin of sounds is that the pressure waves reach one ear slightly later than the other, thus giving rise to a phase difference. Furthermore, the amplitude is marginally greater at the nearer ear. The head casts an acoustic shadow, thus giving rise to these effects. The extent of the phase and amplitude differences depend on the sound location, allowing us to sense direction.

Zuccarelli correctly points out that this theory is inadequate to explain all the facts of spatial identification in hearing. For example, persons who are completely deaf in one ear can still identify sound-source locations, although to a limited extent. According to the theory they should have no spatial information at all.

You can check this for yourself by closing your eyes and plugging one ear, then getting someone to rattle a box of matches or some keys at various points around your head. You will find that the locations can be closely identified both laterally and vertically, especially around the hemisphere of the exposed ear.

Another fact is that two microphones placed on either side of a dummy head in the position of the ears will indeed give a spatial location to sounds coming from the front, this being the way binaural recordings are made. However, the effects are ambiguous: sounds from the rear have the same effect and there is no way they can be distinguished. Furthermore, there is no means of telling whether sources are high or low-height information is absent

Now why should this be? We have only two auditory receptors on our heads, just like the microphones. We have no hearing organs on the top or at front or back, only at the sides. Yet these can identify sound sources in any direction, and for good measure, whether they are near or distant! How? Why?

#### Holophony

By asking questions such as these, Hugo Zuccarelli arrived at an explanation which seems to fit all the known facts. The spatial encoding takes place as the sound enters the ear. While the head plays a part in this, the major factor is the auricle or the external part of the ear. A pressure wave enters the ear canal directly and is conducted down to the eardrum, but a larger portion is collected by the auricle (due to its larger area) and is reflected around the whorl, to follow the direct wave slightly later. The delay is small, but it does produce a phase difference, especially at higher frequencies.

If the auricle was symmetrical, then such reflections would be similar irrespective of the direction of the wave

fronts. What is required is a reflector that is asymmetric in all directions. The human auricle fits this need perfectly, there being no two directions in which the reflective path is the same. Hence the delay and phase difference depends largely on the direction of the sound source. It is in this sense that the ear generates its own spatial code, by comparing these reflections with the direct sound originating from the same source.

Thus the similarity with holography can be more clearly appreciated and the term holophony justified.

Reflection of a sound pressure wave only occurs to any degree when the reflecting surface is a quarter-wavelength in size or larger. The spatial location facility would therefore be expected to be frequency-dependent. Frequencies above 3.4 kHz are well handled by the shortest auricle dimension, and down to 1.4 kHz by the longest. Below this, the head itself comes into play at frequencies down to 450 Hz, although with rather less precision.

It must be remembered, though, that there are few if any natural sounds that are pure fundamentals; nearly all consist of fundamental plus a varying number of harmonics. Thus a sound in the low frequency range could be

spatially located by reason of its harmonics.

This is in accord with common experience; low frequency sounds with few harmonics are notoriously difficult to place. Have you ever tried to locate the source of a mains hum from several separate pieces of equipment? Or the direction of a distant explosion? Such low frequencies travel through the auditory system without modification and so without any spatial coding.

The theory also fits the phenomena of the retention of restricted locational ability with one ear only. One of the things that can be affected by hearing in mono is the facility for judging the distance of a sound. Each ear fixes the direction, and if the directions are notably different it must be because the sound source is near. Conversely a virtually similar direction means the source is distant.

All this information is fed to the brain which supplies an instantaneous fix on the location of any sound. Thus it serves as the decoder of the data encoded by the external ear and its orifice.

## Recording

So now we come to the big question; how can audio signals be recorded and encoded to simulate our natural direction-finding mechanism? It doesn t take long to arrive at the conclusion that the best way is to copy nature. If an artificial head is constructed that contains an auditory system closely resembling that of the human head, but has microphones in the position of the ear drums, then the sounds picked up by them will have spatial coding just as those reaching the natural ear drums. The same phase displacements and diffractions are all present.

This is the basis of Zuccarelli's system; an artificial head called Ringo. Of course artificial heads have been used before for making realistic binaural recordings, but these have not duplicated the auditory system with any accuracy, and their main object is to simulate the acoustic

shadow of the human head between the ears.

Ringo is quite different. The head is made of a plastic material such as polystyrene and rubber, and has two ears which faithfully copy the auricle of the human ear. These lead into cavities which again duplicate the ear orifice, and from there pass into the auditory canal. This is some 24 mm long, the first 8 mm of which is the same plastic material as the auricle, but the remaining 16 mm is lined with a more rigid plaster coating. This is to simulate the fibro-cartilaginous and bony portions of the human canal respectively. It is of elliptical cross-section which is twisted



Fig. 1. The received sound from a nearby source makes different angles at each ear. From a distant sound the angles are vitually the same. The brain interprets the directional differences between the ears in terms of distance.

through about a quarter turn, and has an abrupt dilation some half-way along. Thus the internal contour of the

human channel is closely duplicated.

At the end of each canal is a cardioid microphone oriented in the same plane as the ear drum. Cardioid microphones are not pressure-operated but are exposed at the rear of the diaphragm, giving them the pressure-gradient or velocity mode of operation. The ear drum is also not enclosed at the rear but opens through a tube known as the Eustachian tube into the pharynx at the top of the throat. By means of this, air pressure is equalised on both sides of the ear drum.

In a similar manner, a tube runs from the back of each microphone diaphragm to a large cavity which corresponds to the human oral cavity. In this way, the acoustic properties of the Eustachian tubes and oral cavity (which influence the result although they may not be in the direct sound path) are duplicated. Microphone cables

pass out through the oral orifice.

It was found in the development of the head that the identification of front and rear sounds was influenced by the presence of hair. In fact, it seems that men who are bald are less able to distinguish between certain front and rear originating sounds than those with normal hair (one wonders if a hat might improve the ability in such cases). Anyway, Ringo is also equipped with a wig, and so has all the features for accurate spatial sound identification demanded by the theory.

## Reproduction

Recorded sounds are amplified in the usual way and fed to a pair headphones or loudspeakers. They are heard by listeners, but because they include the natural spatial coding, the brain interprets them as coming from some location relative to the listener corresponding to that of the original sound relative to the recording head.

So far so good, but in entering the listener's ear do not the reproduced sounds ungergo a spatial coding again and so present the brain with a doulbe coded signal? The short answer must be yes, and if the reproduced sounds were actually coming from various directions the brain would

be much confused.

However, the *real* direction of the reproduced sounds is fixed; in the case of headphones, it is on an axis with the ear. The sounds are therefore unidirectional and no different spatial coding takes place in the ear. The recorded coding provided by the dummy head herefore takes over, and the brain responds. We can therefore regard the side position as a mean point or reference from which the apparent direction deviates according to the recorded coding.

However, as may be expected, the human auditory system consists of various air chambers producing resonances, and some frequencies are favoured at the expense of others. According to the International Standard Loudness Contours, peaks in human hearing occur at 400 Hz, 4 kHz, and 12 kHz, these being the average over a

large number of subjects tested.

The dummy head also has resonances, although these are somewhat lower at 2.5 kHz and 7.5 kHz. Like the

human hearing system, the peaks are due to the fundamental and third harmonic.

If uncorrected, these peaks would appear in addition to those present in natural hearing and would result in a distorted frequency response. They play no part in the spatial coding, so can be ironed out without any detriment to the working of the system.

Correction can be done by means of acoustic boxes in the head near the microphone diaphragms, but more conveniently it is done by connecting an equaliser circuit

somewhere in the recording chain.

It was also found in developing the system, that sounds coming from the front and rear differed in their frequency response from those facing the ear at the side. Front radiated sounds emphasize the high frequencies, while those from the rear accentuate the low. Furthermore, there is a displacement between the fundamental and harmonics caused by the auricle reflection, and these also differ according to the direction of propagation. All this adds to the spatial coding.

Earlier the point was made that holophonic recordings need no decoder other than the brain, and so can be played on any domestic playing equipment, disc or tape. This is true but there is one proviso: hi-fi speakers having two or more units fed by a crossover network may not be suitable. The reason is that these often introduce phase anomalies. Since it is the subtle phase differences that constitute the spatial codification, any other introduced by the speakers (or amplifiers, for that matter) would disrupt the code.

The best type of loudspeaker for holophonic material is a single wide-range driver. Alternatively a multi-driver speaker may be used providing it has been designed to give zero phase shift between the drivers. Some have been produced with this characteristic.

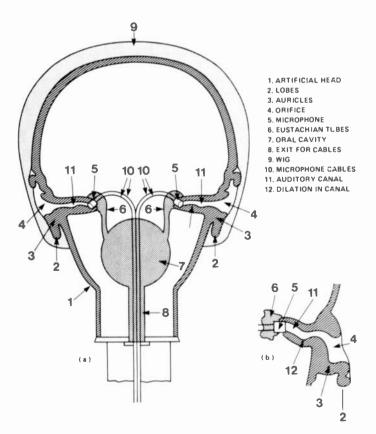


Fig. 2. The anatomy of Ringo.

## **Future Prospects**

As prospective users do not have to equip themselves with special players or decoders, and the results are so startlingly better than conventional stereo or quad, the future of holophony would appear to be bright. As one-channel reproduction gives results almost as good as twinchannel, even cheap mono player users could benefit.

The technique could be used in broadcasting and television to considerably enhance some of the existing dreary fare. All that is required is to convince the upper echelons of the BBC and ITA of the fact. Unfortunately, the confusion and mysticism surrounding the subject

won't have improved its chances there.

On the recording front things are more hopeful, with discs being made and more on the way. So far (as might be expected) the recordings are of pop, but serious music lovers may well imagine the effect with a large-scale choral work. In 'ive broadcasts, the coughs and programme rustling come from various points behind and would be less intrusive (as at an actual performance) than they usually are when broadcast. Imagine what could be done with broadcast drama with the constraints of the small television screen replaced by a wide stage stretching all round. The possibilities for creative use are almost without limit.

Hugo Zuccarell and his associate Mike King have formed a company, Holophonic Zuccarelli Laos Ltd, for the exploitation of holophony. Ringo is understood to be

an active partner!

## **Postscript**

Since preparing the above article, I have had the opportunity of a conversation with Hugo Zuccarelli. He blames the confusion surrounding holophony entirely on the journalists who have reported it and describes their efforts in rather strong terms that I would prefer not to repeat. Now it is true that non-technical reporters writing for the popular press often get the wrong end of the stick when reporting on technical matters, and many use their imagination to fill in the bits they don't know. However, the extent of the misinformation in this case points to a paucity of information at the source. I found this to be true myself; in response to my request for details and specific questions about the system, I received merely a montage of photocopied press-cuttings. These just underlined the confusion of the reporters who wrote them. Accordingly I had dig elsewhere and pursue other channels for the information.

Now this may be due to inexperience in PR and disseminating accurate information to the press — a fault not unknown in more established enterprises — or it could be attributable to the aforementioned caution over giving

too much away to potential competitors.

In cur conversation he maintained that holophony does not consist of recorded sound, and referred to the analogy of the hologram which is not a record of a picture as such but interference patterns. True, but a hologram is a recording of *light*, although in a different pattern from a normal photograph. Similarly holophony is a recording of sound which can be defined as vibrations in air that produce sensations of hearing, even though these contain spatial-encoded phase delay.

If this were not so, holophonic recordings could not be reproduced directly through headphones and

loudspeakers.

It seems that Mr Zuccarelli restricts his definition of sound to the original propagations from the sound source, and this could well be responsible for the confusion and some of the more fanciful descriptions.

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# READ/WRITE

Letters for this page should be addressed to Read/Write at our Charing Cross Road address.

Dear Sir

I was most disappointed to see your article on FEVAs or Valves, in the April edition of ETI. I see enough stupidity in the world without reading it in electronics magazines.

I can do without that sort of rubbish. You have just lost one regular customer.

Yours sincerely, K. J. Sparkes, BSc, AIEE, ARCS, Hemel Hempstead.

Dear ETI

Any prizes for spotting the April fool? Mind, the FEVAs nearly had me fooled — I read half the article like a lamb — then it clicked!

Nice try — ETI! Margaret Hibbert, Pontypridd.

Dear Sir

Please find enclosed a photo of a FEVA in my possession. It was found that Bakelite did not like high temperatures, and the pins were a little weak. An Edison screw was much more robust, and, as you can see, it is the No. 6 Valve.

This one is brand new; the heater is low voltage for safety and runs very bright. Ideal for reading ETI by.
Name and address supplied.

You can please some of the people some of the time . . . . . .

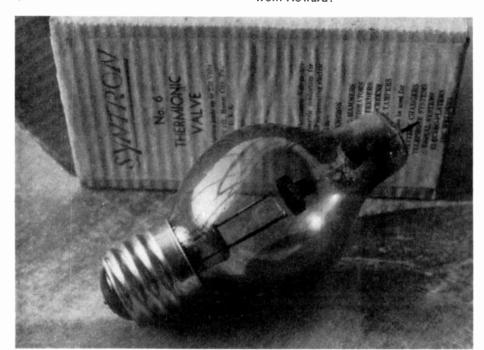
Dear ETI

Your RAM has had a power failure. Gareth Lee (Read/Write October 1982) wrote asking you about expander/compressor noise reduction circuits and you FORGOT even to MENTION your own — November 1977 — "COMPANDER" based on the NE571.

"COMPANDER" based on the NE571. I built one and it did have some unsatisfactory features: the record/play switch and compression ratio switch introduced noise and made tape monitoring impossible, but a Mark II version using one NE570 per channel and based on the "100 Circuits" design works well and produces a major noise reduction. Mark III — using 4066s to control expansion/compression ratio — is now on the breadboard.

Howard B Broughton Putney, London

We look forward to receiving a Tech Tip from Howard!



Dear Sir

I read with interest your article in the April 1983 ETI, using our MM58174AN (the Real Time Clock — Ed.) Unfortunately, the design breaks many of the design rules for using the part.

1. The diode derived supply will be typically 4.3 volts normally, well out of spec. This will cause read errors. It may also cause latch up if any pin is driven above 4.3 volts. This is usually destructive.

2. The write protect switch SW1 is a good idea, but will not prevent IC6 and IC5c producing glitches on power up/down, causing erroneous data to be written into the MM58174AN. This is a common but serious design fault, and typically stops the clock or corrupts data during power down.

3. Most 6502 based systems demand memory and peripherals with an access time of less than 1 microsecond. The MM58174AN does not meet this requirement, having an access time of 1.2 microseconds at 5 volts and 25 deg C. At 4.5 volts and 70 deg C, this increases to 1.9 microseconds. Clearly wait states must be introduced. Typically some registers will be read correctly and others will not if this important parameter is ignored. 4. I commend your designer for fitting C5, many people fail to realise its importance. Ideally it should be 12 or 15 pF, but 10 pF will probably be OK. 5. You correctly state the importance of reading all required registers of the MM58174AN in 100 mS, which is tricky in BASIC, but make no mention of servicing the Interrupt, which is somewhat involved.

6. The PCB track to pin 15 (clock in) should be moved further away from the track to pin 12 (AD0), or noise may be coupled in causing the clock to run fast.

Quirky behaviour may be tolerable in some home constructed equipment, but I honestly believe that your readers will demand utter reliability from a real time clock if it is to have any practical value.

My fear is that many of your readers will waste their time building a real time clock card that doesn't work very well. They will probably blame the component and waste the manufacturer's time, craving advice and assistance. They will probably also

waste much of your time, by phoning and writing to ETI.

Sorry to sound super critical, but I have spent three years helping and persuading people to use the MM58174AN properly, and I think you have undone it all!

Yours sincerely D.E.Brown, Applications Manager, National Semiconductor (UK) Ltd.

#### The author replies:

Taking National Semiconductor's points in order:

1. If a supply voltage of 4V3 is "well out of spec", then the data sheets contain wrong information. I have both an N.S. and an R.S. data sheet for the device, both of which quote a minimum supply voltage of 4V0.

2. Whereas in theory I accept that powering up/down could cause glitches on CS and NWDS hence corrupting data, I haven't found in practice that this happens. If the device is prone to this sort of problem, it is unfortunate that it is not mentioned in the data sheet which in actual fact suggests the contrary. The N.S. data sheet describes a typical microprocessor application in which the

circuit diagram includes a battery back up and is therefore intended for uses in which it will be powered up and down without resetting the MM58714AN. This circuit contains no write protection facility at all, CS and NWDS being connected directly to the bus. 3. I was concerned whilst designing the RTC board that the access time on the MM58714AN was rather long for the 6502 processor. However, since an alternative method of interfacing would have greatly increased the complexity of the board, I was tempted to experiment with the configuration actually used. The circuit proved to be successful in practice and my choice of this configuration was confirmed when I encountered a similar circuit in another magazine (Shame! - Ed). I have more recently spoken to the author of this article who informed me that the circuit was closely based on applications information supplied by R.S. Components and that the circuit has also been manufactured on a commercial basis with no problems. 4. No comments.

5. I would imagine that no more than 5% of readers building this board would wish to use it in the interrupt mode. It was therefore my intention to make

mention of the fact that the board could also be used to generate interrupts without using a lot of space to describe something that would be of interest to a small minority. Obviously any reader intending to use interrupts may obtain all the relevant information from the data sheet.

6. I have noticed that the RTC does in fact run slightly fast. I had originally explained this as being due to the tolerance of the crystal, as the inaccuracy is no greater than that which I experience with my digital wrist watch which presumably uses a similar chip and crystal. I would imagine that the comment made by N.S. is a more likely explanation. It is a pity that if the circuit board geometry is so critical to the correct operation of this device that no mention of this requirement is made in the data sheet.

To summarise, I think that the following two points sum up my thoughts:

A. The board does in fact work. B. All but one of the points above could not have been discovered by reading the data sheet. Perhaps there is a need here for a more accurate and more detailed data sheet.

Mike Bedford

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# POWER SUPPLY PART 2

efore powering up the complete supply it is better to check each of the control circuit functions separately. The first check should be the auxiliary power supply for the control IC. Connect an isolated 12 V power supply to V<sub>A</sub> and check that the

current is not greater than 200 mA. Verify that the collector waveforms of Q3, Q4 and the waveform at the gate of each HexFET is as shown in the photographs at the end of last month's article.

The next task is to set up the dead time. With a dual trace scope connected to pins 11 and 14 of IC1, adjust the preset PR3 so that the dead time measures 1.5 microseconds.

To set up the current limit circuit, disconnect R15 and apply a voltage of 550 mV in its place. With the scope connected to pin 11 of IC1, adjust

## .TABLE 1\_

Output Inductor L1: Siemens pot cores  $30 \times 19$  AL400, with 20 turns of 1.4 mm diameter enamelled copper wire in three layers (7 turns per layer). L =  $160 \text{ uH} \pm 5\%$ .

Power Transformer T1: Siemens pot cores 30 x 19 AL10500; Primary P1, 24 turns of 0.355 mm diameter enamelled copper wire in one layer;

Secondaries S1, S2, 6 + 6 turns of 0.95 mm diameter enamelled copper wire wound bifilar in one layer; Primary P2, 24 turns of 0.355 mm diameter enamelled copper wire in one layer;

insulation suitable for 220 V should be wound between each primary and secondary layer; primaries and secondaries should be wound in the order listed.

Drive Transformers T2,3: Siemens pot cores 14 x 8 AL3300-5500; Primary is 60 turns of 0.2 mm enamelled copper wire;

Secondary is 60 turns of 0.2 mm enamelled copper wire. Insulation suitable for 220 V should be wound between the primary and secondary layers.

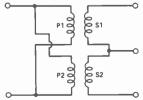


Fig. 1 How to connect the windings of T1.

preset PR1 until the waveform disappears. The current limit is now set for about 5.5 amps.

To adjust the stabilisation circuitry, connect an auxiliary adjustable power supply across the output terminals (making sure you follow the polar ty), and slowly increase the voltage from zero to 12 V. With the scope still connected to pin 11 of IC1, check that the frequency of operation changes from 40 kHz to 75 kHz as the voltage passes through 5 V. This confirms that the short circuit protection is working. When the voltage reaches 12 V, adjust the preset PR2 until the waveform present at pin 11 disappears.

Now the power supply is ready to be powered up. Connect the main line to the AC input through a variac, and connect a load to the output. Slowly increase the input voltage and verify that the supply begins to operate. With a nominal 220 V AC input adjust again, if necessary, PR1 and PR2. If everything is working correctly, remove the variac and plug the supply directly into the AC mains for normal operation.

#### Kindly Note . . .

The text for the switched mode power supply was originally written in Italian, and some errors have occurred in the translation. Please note the following corrections to the June article:

Page 36, column 2. The sentence should read "A 400 V HexFET allows a 15% margin in voltage and gives a lower loss during the conduction time than would a device with a higher voltage rating, because of its lower 'on' resistance".

Page 37, column 1. The statement before the first equation should be "— must be chosen higher than the critical value so that current circulation will *not* be stopped".

Page 37, column 2. The first paragraph should read "— the zener diodes ZD5 and ZD6 are connected in parallel with the transistors on the primaries of the transformers".

Page 37, column 3. The first paragraph should read "The width of this dead time is controlled by the value of the timing capacitor CT . . . "

Page 38, column 2. The figure referred to under DC Output Stabilisation should be Fig. 6, not Fig. 5.

In the specification, the sixth line is "100 Hz ripple", not "100 kHz ripple".

Additionally, not that the control circuit is 'grounded' to the positive rail

of the output, providing a -12 V supply rather than a +12 V supply. Also, the first photo was printed upside down.

## **PARTS LIST**

P	AKIS LISI
Resisters (all	1/4W, 5% except where
stated)	
R1,2	390k
R3,4,15	27 R 270 R
R5,6 R7,8	1k0
R9-12	430R
R13	2k2 3W
R14	0R1 3W
R16	2k2
R17	1M0 10k
R18 R19	12k
R20	1k5
R21	5k6 510k
R22,25 R23,24	510k
R23,24	5k1
R26 R27,28	51k 2k49 ½% metal oxide
K27,20	2R49 7276 Hietai Oxide
Potentiomet	ers
PR1	200R multiturn cermet
PR2	2k0 multiturn cermet
PR3	5k0 multiturn cermet
Capacitors	
C1,2	10nF 630 V polyester
C3,4	220uF 250 V aluminium
	electrolytic (switching) 2u2 63 V polycarbonate 560pF 630 V ceramic
C5	2u2 63 V polycarbonate
C6,7 C8,14,16	1u0 polycarbonate
C9	470pF 630 V ceramic
C10	4n7 1000 V ceramic
C11	4u7 50 V polycarbonate
C12,19	1000uF 25 V aluminum
C13	electrolytic (switching) 4n7 ceramic
C15	33uF 10 V tantalum
či7	100nF polycarbonate
C18	2n21 1/2% polycarbonate
Caminander	tore
Semiconduc   IC1	SG3524
Q1,2	IRF720
Q3,4	BSX32
Q5	2N3502
Q6	2N1613
D1-4 D5,6	1N5408 1N3981
D7.9	RAV20
ll ZD1 4	15 V, 1W zener
ZD5,6 ZD7	15 V, 1W zener 33 V, 1W zener 10 V, 400 mW zener
	10 V, 400 mW zener
ZD8	2V7, 400 mW zener
Miscellaneou	ıs
TH1	15R NTC thermistor
	e); T1-3 (see Table); PCB
(see Buyline	s); heatsinks for Q1,2 and

## BUYLINES.

rectifier diodes.

A complete kit of components for this project can be obtained from Electrovalue, 28E St. Judes Road, Englefield Green, Egham, Surrey TW20 0HB. The price is £51 plus VAT and does not include the double-sided, plated-through hole board which is available from our PCB Service for £14 plus postage and packing (see the ad on page 91).

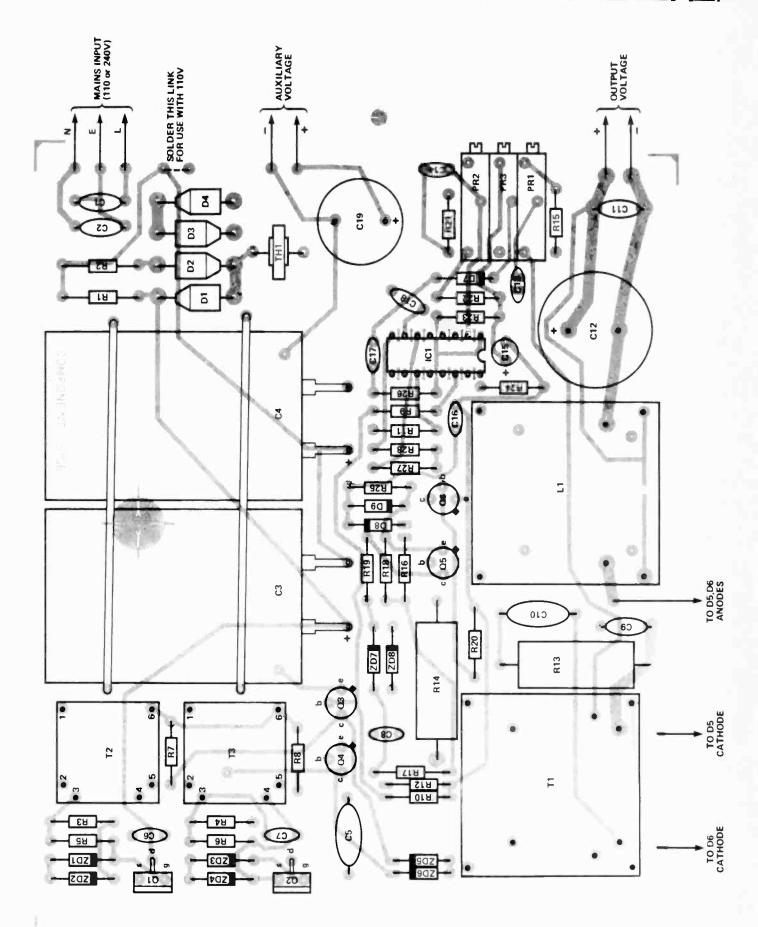


Fig. 2 Component overlay for the switched mode power supply. D5 and D6 are mounted off-board on a heatsink.

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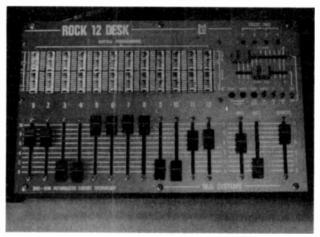
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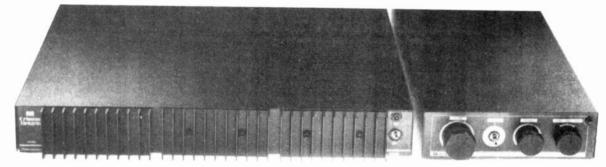
## OOPS!

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.

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IN 5401 5405 5406 BRIDGES	12p 13p 14p	BC1068 9p 8C1098 10p 8C 140 25p BC 142 22p 8C160 35p	TIP 328 38p BCY71 15p BFY51 22p BC182 7p BC212 7p	LEO's .2" Red .2" Green .2" Yellow	7p
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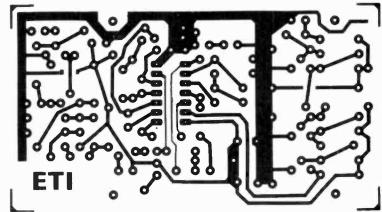
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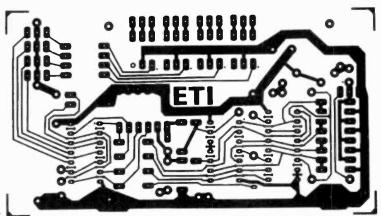
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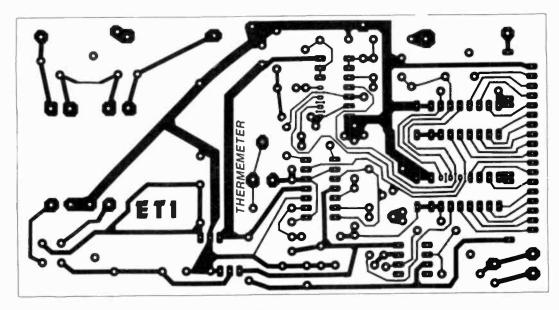
PCB for the Trigger Unit IR transmitter.



The Trigger Unit PCB.



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The correct version of the Thermemeter (see page 29).

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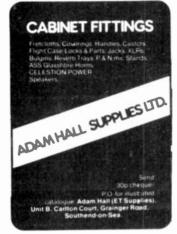
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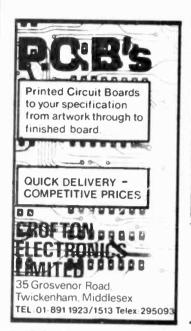
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