electronics today

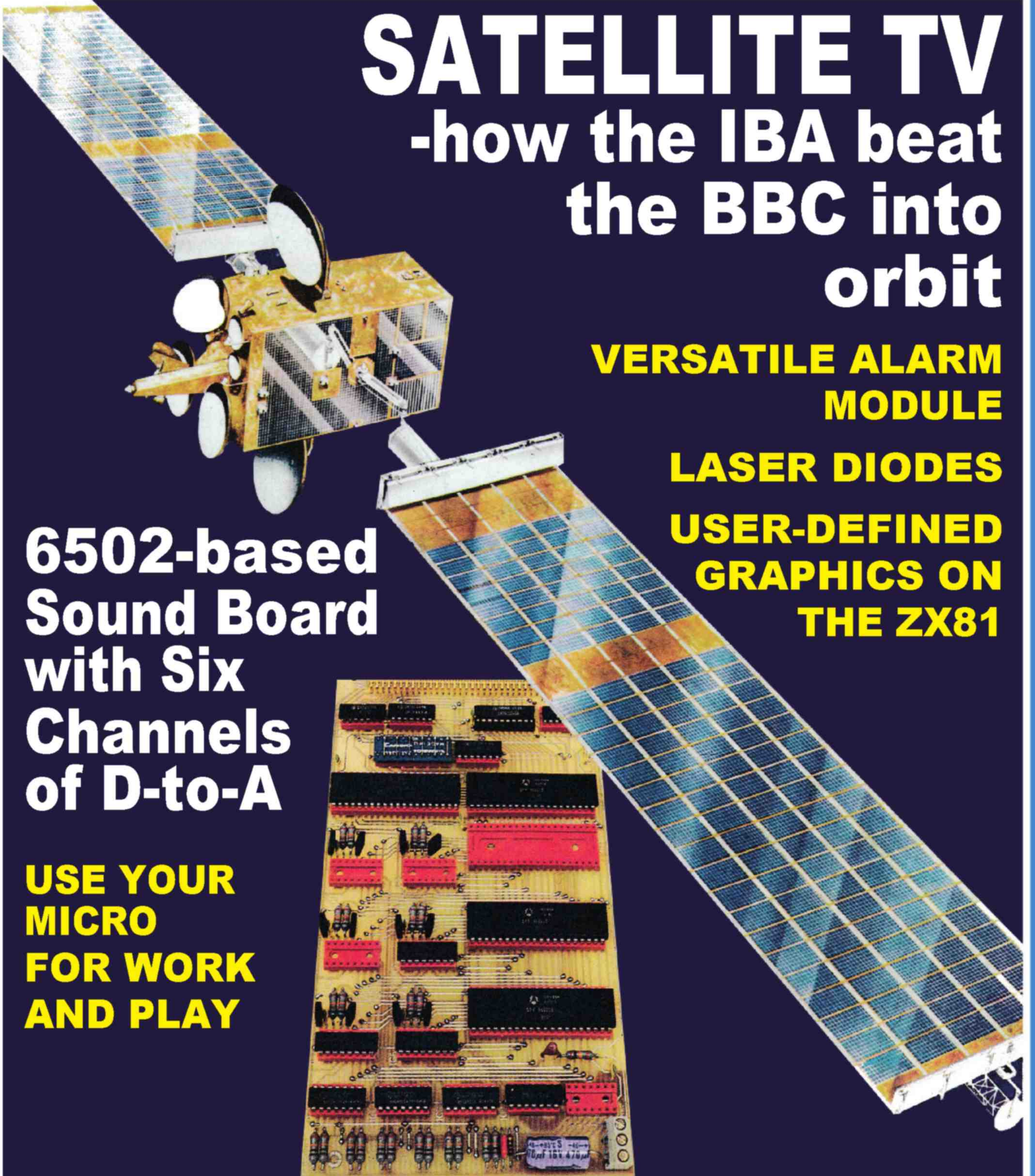
INTERNATIONAL MARCH 1983 85p

SATELLITE TV
-how the IBA beat the BBC into orbit

VERSATILE ALARM MODULE

LASER DIODES

USER-DEFINED GRAPHICS ON THE ZX81



6502-based Sound Board with Six Channels of D-to-A

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DJ90 Stereo Mixer — this is a really versatile new mixer that enables the constructor DJ to produce a professional performance every time. There are two stereo inputs for magnetic cartridges, a stereo auxiliary input and mike input. Other 'plus' features are auto-panning for fast or slow slider controls, multi-mixing, ducking, interrupt, input modulation, in short everything . . . the whole works — AND — under £100 complete! Complete kit **£97.50** + VAT

TRANSCENDENT 2000 — Although only a 3 octave keyboard the '2000' features the same design ingenuity, careful engineering and quality components of its larger brethren. The kit is well within the scope of the first time builder — buy it, build it — play it! You will know you have made the right choice.
Complete kit **£165.00** + VAT

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This versatile modular mixer, featured as a constructional article in Practical Electronics 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 parametric middle frequency equalizer. There are send and return jacks, auxiliary, pan and fader 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.

KIT PRICES

Input channel	**£19.90**	Base unit and wooden front	**£27.50**
Output channel	**£18.50**	Pair of mahogany end cheeks	**£12.50**
Auxiliary channel	**£22.50**	Power Supply and cabinet	**£19.50**
Blank Panel	**£3.00**		

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Parts for extra 400 mS delay
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TRANSCENDENT POLYSYNTH — A four octave polyphonic synthesiser with outstanding design characteristics and versatility and performance to match.
Complete kit **£275.00** plus VAT (single voice)
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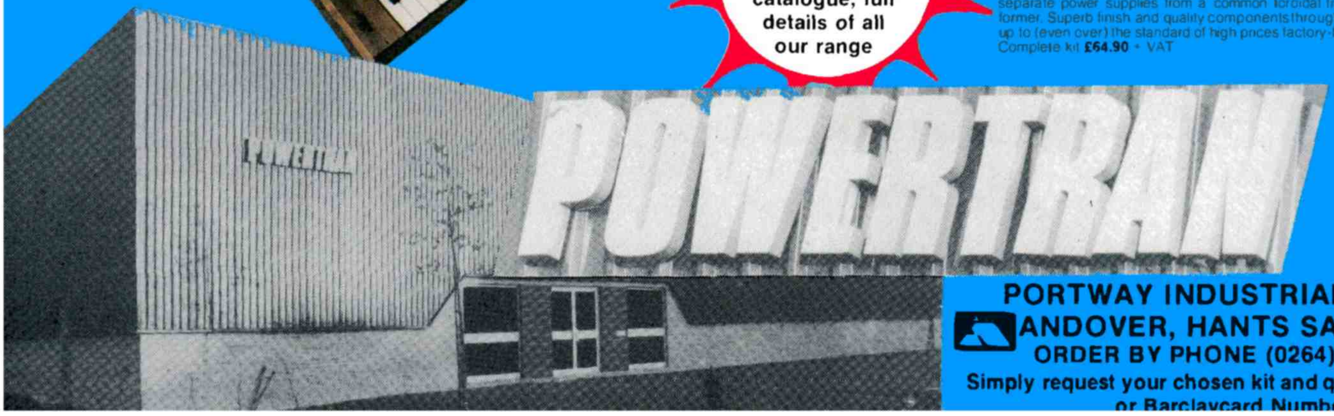

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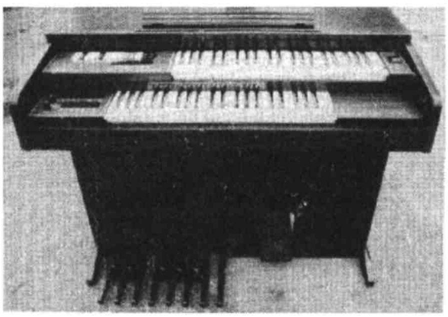
FEATURES

PROJECTS



Due to lack of space in this issue and other circumstances beyond our control the Stage Lighting Dimmer and Cortex BASIC articles have been postponed until next month.

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TAG-END CAPACITORS: 64V: 2200 139p; 3300 198p; 4700 245p; **50V:** 2200 110p; 3300 154p; **40V:** 4700 160p; **25V:** 2200 80p; 3300 98p; 4000, 4700 98p; 10,000 320p; 15,000 345p; **16V:** 22,000 350p

POLYESTER CAPACITORS: Axial Lead Type
400V: 1nF, 1n5, 2n2, 3n3, 4n7, 6n8 11p; 10n, 15n, 18n, 22n 12p; 33n, 47n, 68n 16p; 150n 20p; 220n 30p; 330n 42p; 470n 52p; 680n 1uF 68p; 2u2 82p.
160V: 10nF, 12n, 39n, 100n 11p; 150n, 220n 17p; 330n, 470n 30p; 680n 38p; 1uF 42p; 1u5 45p; 2u2 48p; 4u7 58p.
1000V: 1nF 17p; 10nF 30p; 15n 40p; 22n 36p; 33n 42p; 47n, 100n 42p.

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

POLYESTER RADIAL LEAD CAPACITORS: 250V
10n, 15n, 22n, 27n 6p; 33n, 47n, 68n, 100n 7p; 150n, 220n 10p; 330n, 470n 13p; 680n 19p; 1u 23p; 1u5 40p; 2u2 46p.

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TANTALUM BEAD CAPACITORS
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5KΩ-2MΩ Single Gang D/P Switch 78p
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100V: 1nF, 2, 4, 4nF, 10 6p; 15nF, 22n, 30n, 40n, 47n 7p; 56n, 100n, 200n 9p; **50V:** 470nF 12p.

SLIDER POTENTIOMETERS
0-25W log and linear values 60mm
5KΩ-500KΩ single gang 70p
10KΩ-500KΩ dual gang 110p
Self Stick Graduated Bezel 40p

CERAMIC CAPACITORS 50V:
Range: 0-5pF to 10nF 4p. 15nF; 22nF; 33nF; 47nF 5p. 100nF/30V 7p. 200nF/6V 8p.

PRESET POTENTIOMETERS
0.1W 50Ω 5MΩ Miniature Vertical & Horizontal 7p
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200, 220, 250, 270, 300, 330, 360, 390, 470, 500, 600, 820 21p each
1000, 1200, 1800, 2200 30p each
3300, 4700pF 60p each

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½W	2Ω2-4M7	E12	2p	1p
1W	2Ω2-4M7	E12	5p	4p
2% Metal Film		E24	6p	4p
1% Metal Film		E24	8p	6p

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BRIDGE RECTIFIERS
1A/50V 18; 1A/100V 20; 1A/400V 25; 1A/600V 34; 2A/50V 30; 2A/200V 40; 2A/400V 46; 2A/600V 65; 6A/100V 83; 6A/400V 95; 6A/600V 125; 10A/200V 215; 10A/600V 298; 25A/200V 240; 25A/600V 395; BY164 56; VM18 DIL 50

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

NOISE Diode
Z5J 195p

VARICAPS
BA102 50; BB105B 40; BB106 40; BB109B 45; MVAM2 165

TRIACS
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74C
74C244 195; 74C245 195; 74C373 240; 74C374 246; 74C922 420; 74C923 500

74L
74L00 68; 74L04 85; 74L30 50; 74L47 380; 74L75 145; 74L85 340; 74L121 105; 74L123 325

74S
74S00 30; S02 30; S03 30; S04 30; S05 60; S08 60; S20 40; S32 70

S74 75; S86 65; S112 80; S114 80; S132 110; S133 60; S138 100; S139 115; S157 225; S158 210; S188 140; S189 140; S194 195; S195 195; S201 250; S225 240; S241 250; S244 290; S251 170; S257 170; S262 850; S287 225; S288 210; S289 200; S301 350; S412 380; S470 325; S471 620; S472 1150; S475 800; S571 620

74LS
LS00 11; LS01 11; LS02 11; LS03 12; LS04 12; LS05 13; LS08 12; LS09 12; LS10 13; LS11 13; LS12 13; LS13 20; LS14 26; LS15 13; LS20 13; LS21 12; LS26 14; LS27 13; LS28 14; LS30 13; LS32 13; LS33 15; LS37 15; LS38 15; LS40 13; LS42 28; LS47 35; LS48 45; LS49 50; LS51 14; LS54 14; LS55 14; LS63 120; LS73 18; LS74 18; LS75 25; LS76 18; LS78 18; LS83 38; LS85 42; LS86 16; LS90 24; LS91 60; LS92 30; LS93 23; LS95 40; LS96 95; LS107 40; LS109 23; LS112 22

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AC126/7 35; AC141/2 30; AC176 28; AC187 32; AC188 32; ACY19/21 75; ACY22/41 75; AD142 120; AD149 79; AD161 42; AD162 42; AF115/6 80; AF118 80; AF124/26 70; AF139 40; AF178 75; AF186 70; AF239 65; ASZ21 125; BC107 10; BC107B 12; BC108 10; BC108B 12; BC109 10; BC109B 12; BC109C 12; BC114/5 22; BC117/8 20; BC137/9 40; BC140 30; BC142/3 30; BC147 9; BC147B 10; BC148 9; BC148B 10; BC149 9; BC149C 10; BC153/4 27; BC157/8 10; BC159 11; BC160 45; BC167A 10; BC168C 10; BC169C 10; BC170 15; BC171/2 11; BC173 11; BC177/8 15; BC179 20; BC181 20; BC182/3 10; BC184 10; BC182L 10; BC183L 10; BC184L 10; BC188 6/7 25; BC212 10; BC212L 10; BC213 10

BC213L 10; BC214 10; BC214L 10; BC237/8 14; BC256B 30; BC307B 14; BC308 16; BC318 80; BC327/8 15; BC337/8 15; BC441/61 34; BC477 40; BC516/7 40; BC547/8 12; BC549C 14; BC556/7 15; BC558/9 15; BCY30 65; BCY34 85; BCY35 60; BCY39/40 85; BCY41/42 14; BCY45 60; BCY58/59 35; BCY70/71 16; BCY72 20; BCY78 24; BD112 125; BD114 190; BD121 95; BD124 115; BD131/32 48; BD133 70; BD135 40; BD136/37 40; BD138/39 40; BD140 40; BD144/45 198; BD158 55; BD205/6 110; BD222 85; BD245 60; BD378 70; BD434 55; BD517 85; BD645 80; BD695A 125; BD696A 125; BDY56 180; BDY60 160; BF115 35; BF154/8 25; BF167 20; BF173 27; BF177 25; BF178 30; BF179 35; BF184/5 39; BF194/5 12

BF196/7 12; BF198/9 18; BF200 30; BF224A 25; BF224B 29; BF245 30; BF256A 35; BF256B 45; BF257/8 32; BF259 35; BF274 42; BF336/7 40; BF394 27; BF451 35; BF594/5 30; BFR39/40 23; BFR41/79 23; BF494/5 23; BFR41/79 23; BFR80/81 25; BFR98 105; BFX29 28; BFX81 45; BFX84 28; BFX85/6 28; BFY18 50; BFY50/51 23; BFY52 23; BFY53 32; BFY55/6 32; BFY64 35; BFY81 120; BFY90 80; BRY39 40; BSX20 20; BSX26/29 34; BSX78 45; BSY26 30; BSY95A 25; BU105 170; BU205 190; BU206 200; BU208 200; BUY69C 225; E421 250; MD8001 250; MJ491 175; MJ2955 70; MJE170 150; MJE180 150; MJE340 54; MJE370 100; MJE371 100; MJE520 95; MJE521 95; MJE2955 98; MJE3055 70; MPF102 40; MPF103 30

MPF104 30; MPF105 30; MPF106 40; MPSA05 25; MPSA08 25; MPSA12 32; MPSA55 30; MPSA56 30; MPSA70 30; MPSU02 58; MPSU05 55; MPSU06 55; MPSU52 65; MPSU55 50; MPSU56 60; MPU131 52; OC26 170; OC28/35 220; OC36/41 75; OC71/72 40; OC81/82 50; OC83/84 40; OC170/71 50; OC200 50; OC42 50; OC70 40; OC75/76 50; TIP29A 32; TIP29C 38; TIP30A 35; TIP30C 37; TIP31A 38; TIP31B 39; TIP31C 39; TIP32A 38; TIP32C 42; TIP33A 65; TIP33C 78; TIP34A 74; TIP34C 88; TIP35A 110; TIP35C 128; TIP36A 130; TIP36C 140; TIP41A 50; TIP41B 55; TIP42A 55; TIP42B 58; TIP120 70; TIP121/2 73; TIP141/2 105; TIP147 120; TIP2955 60; TIP3055 60; TIS43 32; TIS44/5 45; TIS46 45; TIS48 50; TIS59/74 50

TIS88A 50; TIS90/91 30; UC734 65; VK101 80; VN10KM 55; VN46AF 78; VN66AF 80; VN88AF 94; VN89AF 96; ZTX107/8 11; ZTX109 12; ZTX212 28; ZTX300 13; ZTX301 16; ZTX302 18; ZTX303 25; ZTX304 17; ZTX314 25; ZTX326 30; ZTX341 30; ZTX451 23; ZTX500 14; ZTX501/2 16; ZTX503 18; ZTX504 25; ZTX531 25; ZTX550 25; 2N697 23; 2N698 40; 2N699 48; 2N706A 19; 2N708 19; 2N918 35; 2N1131/2 24; 2N1302 40; 2N1671B 180; 2N2160 295; 2N2217 45; 2N2218A 25; 2N2219A 25; 2N2220A 25; 2N2221A 25; 2N2222A 25; 2N2303 45; 2N2368 28; 2N2369A 18; 2N2476 80; 2N2483/4 27; 2N2646 48; 2N2904/5 28; 2N2906/7 24; 2N2907A 25; 2N2926G 10; 2N3011 28; 2N3053 25; 2N3054 58; 2N3055 48; 2N3252 48; 2N3302 38; 2N3441/2 140

2N3614/5 199; 2N3663 15; 2N3702/3 10; 2N3704/5 10; 2N3706/7 10; 2N3708/9 10; 2N3710/11 10; 2N3713 140; 2N3771 178; 2N3772 195; 2N3773 210; 2N3819 22; 2N3820 38; 2N3822/3 45; 2N3824 65; 2N3866 90; 2N3903/4 18; 2N3906/8 18; 2N3906 17; 2N4037 40; 2N4058 10; 2N4061/2 10; 2N4064 116; 2N4234/6 60; 2N4264 24; 2N4286 15; 2N4289 18; 2N4314 78; 2N4400 18; 2N4427 80; 2N4871 60; 2N4898 135; 2N4901 175; 2N4921 65; 2N4922 70; 2N5135/6 20; 2N6138 18; 2N5172 18; 2N5179 45; 2N5180 45; 2N5190/1 75; 2N5194 80; 2N5305/8 30; 2N5457/8 30; 2N5459 30; 2N5485 36; 2N5777 45; 2N5879 180; 2N6027 32; 2SA671 250; 2SA715 60; 2SC495 70; 2SC496 70; 2SC1061 250; 2SC1096 65; 2SC1162 30; 2SC1173 125; 2SC1306 100; 2SC1307 150; 2SC1449 65

2SC1678 140; 2SC1679 190; 2SC1923 60; 2SC1945 225; 2SC1953 90; 2SC1957 80; 2SC1969 140; 2SC2028 85; 2SC2029 210; 2SC2078 170; 2SC2091 85; 2SC2314 85; 2SC2166 185; 2SC2335 225; 2SC2547 30; 2SC2612 225; 2SD234 74; 2SK45 90; 2SK288 225; 2SJ83 225; 2SJ85 225; 3N128 112; 3N140 112; 40315 90; 40316 95; 40324 100; 40326/7 70; 40347 90; 40348 120; 40360 60; 40361/2 70; 40407/8 75; 40411 285; 40412 90; 40467A 130; 40468 85; 40594 105; 40603 110; 40673 75; 40871/2 90

RF CHOKES Miniature PCB type
1uH, 2u2, 4u7, 10u, 22u, 33u, 47u, 100u, 220u, 330u, 470u 30p
1mH, 1m5, 2m2, 4m7, 10mH 35p
22m, 33m, 43m 60p
100m 75p

SWITCHES

TOGGLE: 2A, 250V.

SPST	33p
DPDT	44p

SUB-MIN TOGGLE

SPST on/off	54p
SPDT c/over	60p
SPDT centre off	85p
SPDT biased both ways	105p
DPDT 6 tags	75p
DPDT centre off	88p
DPDT biased both ways	145p
DPDT 3 positions on/on/on	185p
3-pole 2 way	205p

SLIDE 250V:

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

PUSHBUTTON 6A with 10mm Button

SPDT latching	99p
DPDT latching	145p
SPDT moment	99p
DPDT moment	145p

Mini Non Locking

Push to Make	15p
Push to Break	25p

DIL SWITCHES
(SPST) 4 way **70p**; 6 way **85p**; 8 way **90p**; 10 way **145p**. (SPDT) 4 way **190p**.

ROTARY SWITCHES: (Adjustable Stop type)
1 pole/2 to 12 way; 2p/2 to 6 way; 3 pole/2 to 4 way; 4p/2 to 3 way **45p**

ROTARY: Mains DP 250V 4 Amp on/off **56p**

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

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

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

THUMBWHEEL Mini front mounting

Decade Switch Module	220p
B.C.D. Switch Module	275p
Mounting Cheeks (per pair)	75p

VEROBOARD 0.1in

	clad	plain
2½ × 3¼"	80p	–
2½ × 5"	91p	–
3¾ × 3¾"	91p	–
3¾ × 5"	106p	87p
3¾ × 17"	380p	232p
4¾ × 17"	470p	–
Pkt. of 100 pins	50p	
Spot face cutter	135p	
Pin insertion tool	178p	

VQ Board	180
DIP Board	350
Vero Strip	374

PROTO DECs

Veroblock	405p
S-Dec	350p
Eurobreadboard	520p
Bimboard 1	575p
Superstrip SS2	1380p

VERO WIRING

PEN + spoool	340p
Spare spool	75p
Combs	6p

DALO ETCH RESIST PEN
Plus spare tip **90p**

FERRIC CHLORIDE
1 lb bag Anhydrous 195p + 50p P&P

ULTRASONIC TRANSDUCER
40KHz 325 pr

COPPER CLAD BOARDS

Fibre glass	Single-sided	Double-sided	S.R.B.P. 9.5" × 8.5"
6" × 6"	90p	110p	95p
6" × 12"	150p	195p	

DIL SOCKETS

	Low Prof	Wire Wrap
8pin	8p	25p
14pin	10p	35p
16pin	10p	42p
18pin	16p	52p
20pin	20p	60p
22pin	22p	65p
24pin	25p	70p
28pin	28p	80p
40pin	30p	98p

EDGE CONNECTORS

	.1	.156
2 × 15 way	–	140p
2 × 18 way	180p	145p
2 × 22 way	198p	200p
2 × 23 way	175p	–
2 × 25 way	225p	220p
2 × 28 way	190p	–
2 × 30 way	245p	–
2 × 36 way	295p	–
2 × 40 way	315p	–
2 × 43 way	395p	–
2 × 75 way	550p	–

ETI PROJECTS
We stock most of the parts

JUMPER LEADS (Ribbon Cable Assembly)

Length	14 pin	16 pin	24 pin	40 pin
Single ended DIP (Header Plug) Jumper				
24 inches	145p	165p	240p	380p
Double ended DIP (Header Plug) Jumper				
6 inches	185p	205p	300p	465p
12 inches	198p	215p	315p	490p
24 inches	210p	235p	345p	540p
36 inches	230p	250p	375p	585p

IDC Female Header Socket Jumper Leads 24"

	20 pin	26 pin	34 pin	40 pin
Single ended	160p	200p	280p	300p
Double ended	290p	370p	480p	525p

ANTEX SOLDERING IRON

C-15W	455p	CX17W	475p
CCN-15W	495p	CX25W	510p
Spare tips, assorted sizes			65p
Spare Elements			210p
Iron Stand with sponge			165p

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

IDC CONNECTORS

	PCB Plugs with latch Pins Strt	pins Angle	Female Header Plug	Female Card Edge Connect
10 way	90p	99p	85p	120p
16 way	130p	150p	110p	–
20 way	145p	166p	125p	195p
26 way	175p	200p	150p	240p
34 way	205p	236p	180p	320p
40 way	220p	250p	190p	340p
50 way	235p	270p	200p	395p
60 way	–	–	230p	495p

EURO CONNECTORS

	Female Socket Strt. Pins	Female Socket Angle Pins	Male Plug Strt. Pins	Male Plug Angle Pins
DIN41617 31way	170p	–	–	175p
DIN41612 2×32 A+B	275p	320p	220p	285p
DIN41612 2×32 A+C	285p	340p	240p	300p
DIN41612 3×32 A+B+C	380p	395p	280p	395p

DIL PLUG (Header)

	Solder	IDC
14pin	40p	90p
16pin	48p	105p
24pin	88p	178p
40pin	250p	255p

RIBBON CABLE price per foot

	Grey	Color
10 way	12p	22p
16 way	18p	32p
20 way	25p	40p
24 way	35p	50p
34 way	48p	60p
40 way	55p	75p
50 way	65p	90p
64 way	85p	110p

ZIF DIL SOCKETS

24 pin	575p
28 pin	820
40 pin	975p

'D' CONNECTORS miniature

	9 way	15 way	25 way	37 way
Male				
Solder lugs	80p	105p	160p	250
Angle pins	150p	210p	250p	365p
PCB pins	120p	130p	195p	295p
Female				
Solder lugs	105p	160p	200p	335p
Angle pins	165p	215p	290p	440p
PCB pins	150p	180p	240p	420p
Covers	90p	85p	90p	100p

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

PANEL METERS
FSD 60 × 46 × 35mm
0-50µA
0-100µA
0-500µA
0-1mA
0-5mA
0-10mA
0-50mA
0-100mA
0-500mA
0-1A
0-2A
0-25V
0-50V AC
0-300V AC
"S"
"VU"
425p each

CRYSTALS

32.768KHz	100
100KHz	235
200KHz	268
455KH	370
1MHz	275
1.008M	275
1.28MHz	392
1.6MHz	395
1.8NHz	395
1.8432M	200
2.0MHz	225
2.4576M	200
3.278M	150
3.5794M	98
3.6864M	300
4.0MHz	150
4.032MHz	290
4.80MHz	200
4.194304M	200
4.433619M	100
5.0MHz	160
5.185MHz	300
5.24288M	390
6.0MHz	140
6.144MHz	150
6.5536MHz	225
7.0MHz	150
7.168MHz	250
7.68MHz	200
8.0MHz	150
8.08333M	395
8.86723M	175
9.00MHz	150
10.0MHz	175
10.24MHz	200
10.7	150
12.0NHz	175
12.528M	300
14.31814M	170
16.0MHz	200
18.0MHz	180
18.432M	150
20.0MHz	200
19.968MHz	150
24.0MHz	170
24.930MHz	325
26.69M	150
27.648M	170
27.145M	190
38.66667M	175
48.0MHz	170
100.0MHz	295
116.0MHz	250

Miniature, enclosed, PCB mount.
SINGLE POLE Changeover
RL-91 205Ω Coil; 12V DC, 10V5 to 19.5V). 10A at 30V DC or 250V AC **195p**
DOUBLE POLE Changeover. 6A 30V DC or 250V AC
RL6-100 53Ω Coil, 6V DC (5V4 to 9V9 **190p**
RL6-111 205Ω Coil, 12V DC (10V7 to 19V5) **195p**
RL6-114 740Ω Coil, 24V DC (22V to 37V) **200p**

AMPHENOL PLUGS

IEEE 24 Way	550
Centronics Parallel 36 Way solder	530
Centronic Parallel 36 way IDC	495

BUZZERS, miniature, solid-state 6V: 9V & 12V **70p**

PIEZOI TRANSDUCERS
PB2720 **55p**

LOUDSPEAKERS
Miniature, 0.3W: 8Ω
2in, 3¼in, 2¼in, 3in **80p**
2¼in 40Ω, 64Ω or 80Ω **80p**

ASTEC UHF MODULATORS

Standard 6MHz	280p
Wideband 8MHz	480p

'WEMON' New Version WATFORD'S Ultimate Monitor IC
A 4K Monitor chip specially designed 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.
Only £10

TRANSFORMERS:

3-0-3V; 6-0-6V; 9-0-9V; 12-0-12V; 15-0-15V @ 100mA **96p**
pcb mounting. Miniature, Split Bobbin
3VA: 2x6V-0.25A; 2x9V-0.15A; 2x12V-0.12A; 2x15V-0.1A **200p**
6VA: 2x6V-0.5A; 2x9V-0.3A; 2x12V-0.25A; 2x15V-0.2A **270p**
Standard Split Bobbin type:
6VA: 2x6V-0.5A; 2x9V-0.4A; 2x12V-0.3A; 2x15V-0.25A **220p**
12VA: 2x4.5V-1.3A; 2x6V-1A; 2x9V-0.6A; 2x12V-0.5A; 2x15V-0.4A; 2x20V-0.3A **295p** (35p p&p)
24VA: 2x6V-1.5A; 2x9V-1.2A; 2x12V-1A; 2x15V-0.8A; 2x20V-0.6A **330p** (60p p&p)
50VA: 2x6V-4A; 2x9V-2.5A; 2x12V-2A; 2x15V-1.5A; 2x20V-1.2A; 2x25V-1A; 2x30V-0.8A **465p** (60p p&p)
Specially wound for Multirail Computer PSUs
50VA: Outputs +5V/5A; +12V, +25V, −5V, −12V at 1A **575p** (60p p&p)
100VA: 2x12V-4A; 2x15V-3A; 2x20V-2.5A; 2x25V-2A; 2x30V-1.5A; 2x50V-1A **920p** (75p p&p charge to be added over and above our normal postal charge).

VOLTAGE REGULATORS

1A	TO220 +ve		Plastic −ve	Casing
5V	7805	40p	7905	45p
12V	7812	40p	7908	60p
15V	7815	40p	7912	45p
18V	7818	40p	7915	45p
24V	7824	40p	7918	45p
			7924	45p

100mA TO92 Plastic package

5V	78L05	30p	79L05	60p
6V	78L06	30p	–	
8V	78L08	30p	–	
12V	78L12	30p	79L12	60p
15V	78L15	30p	79L15	60p

LM300H	170p	TAA550	50p
LM304H	170p	TDA1412	150p
LM305H	140p	78H05 +5V/5A	550p
LM309K	135p	78H12 +12V/5A	
LM317K	320p		580p
LM317KP	98p	78HG +5V to +25V	
LM323K	450p	5A	598p
LM337	175p	79HG +2.25V to 24V	
LM723 Var	38p	5A	685p

SOLDERCON PINS
Ideal for making SIL or DIL Sockets

100 pins	75p
500 pins	350p

ALUM BOXES

3 × 2 × 1"	65p
4 × 2½ × 2"	85p
4 × 2½ × 2½"	103p
4 × 4 × 2"	105p
4 × 4 × 2½"	120p
5 × 4 × 1½"	99p
5 × 4 × 2½"	120p
5 × 2½ × 1½"	90p
5 × 2½ × 2½"	130p
6 × 4 × 2"	120p
6 × 4 × 3"	150p
7 × 5 × 3"	180p
8 × 6 × 3"	210p
10 × 4 × 3"	240p
10 × 7 × 3"	275p
12 × 5 × 3"	280p
12 × 8 × 3"	295p

25 way 'D' CONNECTOR Jumper Lead Cable Assembly

18" long, Single end, Male	495p
18" long, Single end, Female	525p
36" long, Double Ended, M/M	1025p
36" long, Double Ended, F/F	1050p
36" long, Double Ended, M/F	995p

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CMOS

4000	10	4075	13	4541	140
4001	10	4076	50	4543	70
4002	12	4077	13	4544	150
4006	60	4078	15	4548	40
4007	14	4081	13	4549	375
4008	32	4082	13	4553	245
4009	24	4085	50	4554	190
4010	24	4086	80	4555	35
4011	10	4089	125	4556	35
4012	18	4093	20	4557	320
4013	20	4094	70	4558	120
4014	48	4095	95	4559	395
4015	40	4096	90	4560	180
4016	20	4097	290	4561	104
4017	32	4098	75	4562	495
4018	45	4099	110	4566	185
4019	25	4160	95	4568	250
4020	42	4161	99	4569	175
4021	40	4162	99	4572	30
4022	40	4163	99	4580	480
4023	13	4174	99	4581	250
4024	32	4175	105	4582	80
4025	13	4194	105	4583	80
4026	80	4408	790	4584	40
4027	20	4409	790	4585	80
4028	39	4410	725	4597	330
4029	45	4411	875	4599	290
4030	15	4412	775	40085	80
4031	125	4415	480	40097	45
4032	80	4419	280	40098	42
4033	125	4422	770	40100	215
4034	140	4435	850	40101	130
4035	45	4440	999	40102	140
4036	275	4450	350	40103	175
4037	115	4451	350	40104	85
4038	110	4490	350	40105	105
4039	260	4500	875	40106	35
4040	40	4501	28	40107	80
4041	40	4502	80	40108	198
4042	40	4503	60	40109	80
4043	40	4504	75	40110	198
4044	40	4505	185	40114	240
4045	105	4506	35	40161	194
4046	48	4507	35	40163	80
4047	40	4508	130	40174	45
4048	40	4510	46	40175	86
4049	25	4511	45	40181	220
4050	25	4512	60	40182	90
4051	45	4513	199	40192	75
4052	60	4514	115	40193	70
4053	50	4515	115	40194	70
4054	86	4516	65	40195	75
4055	86	4517	275	40244	195
4056	86	4518	40	40245	195
4057	1916	4519	35	40257	195
4059	436	4520	80	40373	180
4060	45	4521	90	40374	180
4061	1195	4522	125	45106	595
4062	995	4526	70		
4063	86	4527	65	**OPTO**	
4066	24	4528	70	LS400C	255
4067	245	4529	150	OCP71	120
4068	14	4530	90	ORP12	85
4069	16	4531	130	ORP61	85
4070	13	4532	70	2N5777	45
4071	13	4534	400	BPX25	195
4072	13	4536	275	BPW21	295
4073	15	4538	80	BPX65	270
		4539	90		

OPTO ELECTRONICS
LEDs with Clips

TIL209 Red	10
TIL211 Grn	14
TIL212 Yel.	14
TIL220 .2" Red	12
.2" Green, Yellow or Amber	14
0.2" Bi colour Red/Green	65
Green/Yellow	70
0.2" Tri colour Red/Green/Yellow	85
Hi-Brightness Red	69
Flashing red 0.2" red	65
Square LEDs, Red, Green, Yellow	30
Rectangle Stackable LEDs Red, Green or Yell	18
Triangular LEDs Red	18
Green or yellow	22
LD271 Infra Red	46
SFH205 Detector	118
TIL32 Infra Red	58
TIL78 Detector	60
TIL38	45
TIL100	80
BARGRAPH. Red 10 segments	225
ISOLATORS	
IL74	65
ILD74	99
ILQ74	185
TIL111/2/4	90
TIL117	125
4N33 Photo Darlington	135
7 Segment Displays	
TIL307	675
TIL312 .3" CA	105
TIL313 .3" CC	105
TIL321 .5" CA	115
TIL322 .5" CC	115
DL704 .3" CC	99
DL707 .3" CA	99
FND357 Red	120
FND500	115
.3" Green CA	150
.6" Green CA	215
.3" ±1 Red CA	150
.3" ±1 Green CA	150
DVM176	1895
LCD 3½ Digits	495
LCD 4 Digits	530
LCD 6 Digits	625

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- **SEIKOSHA GP250X.** 10", 50 CPS, Normal and Double width and height Char. RS232 and Centronix Intrf. standard **£240** (£7 car)
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				LM339	45	LM3911	120	NE566	140	TL064	96
				LM348	60	LM3914	175	▶NE567	100	TL071	30
				LM358	50	LM3915	195	▶NE570	370	TL072	50
555CMOS	80	ICL7106	790	LM377	170	LM13600	105	NE571	370	TL074	95
556CMOS	150	ICL7611	95	▶LM380	65	MC1496	68	▶RC4136	55	▶TL081	25
709	25	ICL7621	180	▶LM381	120	MC3340	135	▶RC4558	60	TL082	45
▶741	14	ICL7622	180	LM382	120	▶MF10CN	350	SL480	170	TL084	95
748	35	ICL8038	295	LM384	130	ML922	400	SL490	250	TL170	50
9400CJ	350	ICL8211A	200	LM386	65	ML924	195	SL76018	150	UA2240	120
AY-3-1270	720	ICM7224	785	LM387	120	ML925	210	▶SN76477	380	ULN2003	85
AY-3-8910	370	ICM7555	80	LM393	100	ML926	140	SP8629	250	ULN2004	90
AY-3-8912	540	▶LF351	45	LM709	25	ML927	140	TBA120S	70	XR2206	290
CA3046	60	LF353	85	LM711	60	ML928	140	TBA800	75	ZN414	100
▶CA3080	65	LF356	90	LM725	350	ML929	140	TBA810	96	ZN423	135
CA3089	190	LM10	360	LM733	75	MM5387A	465	TBA820	70	ZN424	135
CA3090AQ	375	LM301A	25	LM741	14	NE529	225	TBA950	220	ZN425E	350
CA3130E	85	LM311	70	LM747	60	NE531	150	TDA1008	320	ZN426E	330
▶CA3140E	36	LM318	120	LM1458	40	NE544	205	▶TDA1022	490	ZN427E	650
CA3161E	100	LM324	40	LM2917	200	▶NE555	16	TDA1024	125	ZN428E	480
CA3189	290	LM334Z	100	LM3900	45	▶NE556	45	TL061	40	ZN459	285
▶CA3240E	110	LM335Z	125	▶LM3909	70	NE565	110	TL062	60	ZN1034E	200

MICRO

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2716	205	Z80A P10	260	81LS97	85
2532	340	Z80A CTC	260	1488	55
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4116 P20	70	Z80A DMA	1150	Epson Printers and D	
6116-P3 150nS	365	Z80A DART	500	Connectors now avail-	
4164	440	81LS95	85	able at low low prices.	

CRYSTALS

100KHz	235	4.43M	100
1MHz	275	6.0M	140
1.8432M	200	7.0M	150
2.0M	225	8.0M	140
2.4576M	200	10.0M	170
3.579M	95	12M	170
4.0M	140	16M	200

CMOS

		4016	20	4034	140	4054	78	4081	12	40193	65	4528	45
		4017	30	4036	249	4055	80	4082	12	4502	60	4529	150
		4018	45	4039	280	4059	430	4085	48	4503	32	4532	60
4000	10	4019	25	4040	40	4060	42	4086	50	4507	35	4534	400
4001	10	4020	42	4041	40	4063	80	4089	125	4508	110	4538	60
4002	12	4021	40	4042	38	4066	22	4093	18	4510	45	4543	50
4006	50	4022	45	4043	40	4067	225	4094	68	4511	40	4549	360
4007	14	4023	16	4044	40	4068	14	4095	65	4512	40	4553	215
4008	36	4024	33	4046	40	4069	13	4097	290	4514	115	4555	35
4009	24	4025	12	4047	35	4070	13	4098	70	4515	115	4556	35
4010	24	4026	75	4048	38	4071	13	4099	70	4516	55	4559	390
4011	10	4027	20	4049	21	4072	13	40106	40	4518	40	4560	140
4012	15	4028	40	4050	21	4073	13	40109	110	4520	50	4584	35
4013	20	4029	45	4051	42	4075	13	40163	60	4521	130	4585	60
4014	45	4030	14	4052	48	4076	45	40173	100	4526	60	4724	140
4015	40	4031	125	4053	48	4077	14	40175	75	4527	50		

TRANSISTORS

				BC517	40	BF337	40	MPSU56	60	ZTX108	8	2N3055	50
				BC547	7	BFR40	23	TIP29A	30	ZTX109	12	2N3442	120
				BC548	10	BFR80	23	TIP29B	55	ZTX300	14	▶2N3702	6
AC125	35	BC149	9	BC549	10	▶BFR81	20	TIP29C	37	ZTX301	16	2N3703	9
AC126	25	BC157	8	BC558	10	BFX29	25	TIP30A	35	ZTX302	15	▶2N3704	6
AC127	25	BC158	10	BCY70	18	BFX84	25	TIP30B	50	ZTX304	17	2N3705	9
▶AC128	20	BC159	8	BCY71	18	BFX85	25	TIP30C	37	ZTX341	30	2N3706	9
AC176	25	BC160	45	BCY72	18	BFX86	25	TIP31A	35	ZTX500	15	2N3707	10
AC187	22	BC168C	10	BD115	55	BFX87	25	TIP31C	37	ZTX501	15	2N3708	10
AC188	22	BC169C	10	BD131	35	BFX88	25	TIP32A	35	ZTX502	15	2N3709	10
AD142	120	BC170	8	BD132	35	BFY50	23	TIP32C	37	ZTX503	18	2N3772	170
AD149	80	BC171	10	BD133	50	BFY51	20	TIP33A	60	ZTX504	25	▶2N3773	195
AD161	40	BC172	8	BD135	40	BFY52	23	TIP33C	75	2N697	20	▶2N3819	18
AD162	40	BC177	18	BD136	30	BFY53	32	TIP34A	60	2N698	40	2N3820	40
AF124	60	BC178	18	BD137	30	BFY55	32	TIP34C	85	2N706A	20	2N3823	65
AF126	50	BC179	18	BD138	30	BFY56	32	TIP35A	105	2N708	20	2N3866	90
AF139	40	BC182	10	▶BD139	35	BRY39	40	TIP35C	125	2N918	35	2N3903	10
AF186	70	▶BC182L	8	▶BD140	35	BSX20	20	TIP36A	125	2N1132	22	2N3904	10
AF239	75	BC183	10	BD204	110	BSX29	25	TIP36C	135	2N1613	30	2N3905	6
BC107	10	BC183L	10	BD206	110	BSY95A	25	TIP41A	45	2N2218A	45	2N3906	10
BC107B	12	BC184	10	BD222	85	BU205	160	TIP42A	45	2N2219A	25	2N4037	45
▶BC108	9	BC184L	7	BF180	35	BU206	180	TIP120	90	2N2221A	25	2N4058	10
BC108B	12	BC212	10	BF182	35	BU208	170	TIP121	90	2N2222A	20	2N4060	10
BC108C	12	BC212L	10	BF184	25	MJ2955	99	TIP122	90	2N2368	25	2N4061	10
▶BC109	9	BC213	10	BF185	25	MJE340	50	TIP141	98	2N2369	16	2N4062	10
BC109C	12	BC213L	10	BF194	12	MJE520	65	TIP142	98	2N2484	25	2N5457	36
BC114	18	BC214	10	BF195	12	MJE521	95	TIP147	110	2N2646	45	2N5458	36
BC115	22	▶BC214L	8	BF196	12	MJE3055	70	TIP2955	60	2N2904	20	2N5459	30
BC117	18	BC237	8	BF197	12	MPF102	40	TIP3055	55	2N2904A	20	2N5485	36
BC119	35	BC238	14	BF198	10	MPF104	40	TIS43	40	2N2905	22	2N5777	45
BC137	40	BC308	12	BF199	18	MPSA05	22	TIS44	45	2N2905A	22	2N6027	30
BC139	40	BC327	14	BF200	30	MPSA06	25	TIS90	30	2N2906	25	40360	40
BC140	28	BC328	14	▶BF244B	22	MPSA12	30	TIS91	30	2N2906A	25	40361	50
BC141	30	BC337	14	BF245	30	MPSA55	30	VN10KM	45	2N2907	25	40362	50
BC142	25	BC338	14	BF256B	45	MPSA56	30	VN46AF	75	2N2907A	25	40408	70
BC143	25	BC477	30	BF257	32	MPSU05	55	VN66AF	85	2N2926	9		
BC147	8	BC478	30	BF258	25	MPSU06	55	VN88AF	95	▶2N3053	23		
BC148	8	BC479	30	BF259	35	MPSU55	60	ZTX107	8	2N3054	55		

LS TTL

		LS20	12	LS75	20	LS123	34	LS160	35	LS197	45	LS353	60
		LS21	12	LS76	17	LS125	24	LS161	35	LS221	50	LS365	28
		LS22	12	LS78	17	LS126	25	LS162	35	LS240	60	LS366	28
LS00	11	LS26	14	LS83	35	LS132	35	LS163	35	LS241	55	LS367	28
LS01	11	LS27	12	LS85	48	LS136	26	LS164	40	LS242	55	LS368	29
LS02	11	LS30	12	LS86	16	LS138	30	LS165	55	LS243	55	LS373	58
LS03	12	LS32	13	LS90	24	LS139	30	LS166	60	LS244	55	LS374	60
LS04	12	LS37	14	LS92	25	LS145	70	LS170	75	LS245	70	LS375	43
LS05	12	LS38	15	LS93	24	LS147	150	LS173	60	LS247	48	LS377	60
LS08	12	LS40	13	LS95	38	LS148	75	LS174	45	LS251	28	LS378	57
LS09	12	LS42	28	LS96	95	LS151	38	LS175	45	LS257	32	LS390	45
LS10	12	LS47	35	LS107	40	LS153	38	LS190	35	LS258	32	LS393	40
LS11	12	LS48	45	LS109	21	LS154	75	LS191	35	LS259	55	LS399	156
LS12	12	LS51	14	LS112	21	LS155	33	LS192	35	LS266	20	LS541	78
LS13	19	LS55	14	LS113	21	LS156	36	LS193	36	LS273	58	LS670	135
LS14	30	LS73	18	LS114	22	LS157	26	LS195	32	LS279	30		
LS15	12	LS74	17	LS122	35	LS158	29	LS196	45	LS283	38		

TTL

		7413	17	7444	85	7483	30	74122	38	74161	46	74190	40
		7414	23	7446	58	7485	60	74123	38	74162	46	74191	40
		7416	19	7447	36	7486	19	74125	33	74163	46	74192	40
7400	11	7417	19	7448	43	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	86	74154	47	74177	42		
7409	13	7437	23	7475	26	74100	78	74155	36	74179	75		
7410	13	7438	24	7476	25	74107	22	74156	36	74180	38		
7411	15	7440	14	7480	45	74109	24	74157	28	74181	100		
7412	17	7442	30	7482	65	74121	24	74160	55	74182	55		

SWITCHES

Submin toggle:
SPST 55p. SPDT 60p. DPDT 65p.
Miniature 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 12p.
Push to break 22p.
Rotary type adjustable stop.
1P12W, 2P6W, 3P4W all 55p each.
DIL switches:
4SPST 80p 6 SPST 80p. 8SPST 100p.

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606V, 909V, 12012V all @ 100mA 100p each.
PCB mounting. Miniature:
3VA 0-6, 0-6 @ 0.25A; 0-9, 0-9 @ 0.15A; 0-12, 0-12 @ 0.12A 200p each.
6VA 0-6, 0-6 @ 0.5A; 0 9, 0-9 @ 0.3A; 0-12, 0.12 @ 0.25A 270p each.
High quality. Split bobbin construction
6VA 0-6, 0 6 @ 0.5A; 0-9, 0-9 @ 0.4A; 0-12, 0-12V @ 0.3A 220p each.
12VA 0-6, 0-6 @ 1A; 0-9, 0-9 @ 0.8A, 0-12, 0-12 @ 0.5A; 0-15, 0-15 @ 0.4A 295p (plus 40p carriage).
25VA 0-6, 0-6 @ 1.5A; 0-9, 0-9 @ 1.2A; 0-12, 0-12 @ 1A; 0 15, 0-15 @ 0.8A 330p each (plus 60p carriage)
50VA 0-12, 0-12 @ 2A, 0-15, 0-15 @ 1.5A. 440p each (plus 75p carriage)

VERO

VEROBLOC◀	350
Size 0.1 matrix:	
2.5 x 1	22
2.5 x 3.75	75
2.5 x 5	85
3.75 x 5	95
VQ board	160
Veropins per 100:	
Single sided	50
Double sided	60
Spot face cutter	105
Pin insertion tool	162
Wiring pen and spool	310
Spare spool 75p Combs	6

HARDWARE

PP3 battery clips	6
Red or black crocodile clips	6
Black pointer control knob	15
Pr Ultrasonic transducers	350
▶6V Electronic buzzer	60
▶12V Electronic buzzer	65
▶PB2720 Piezo transducer	75
▶64mm 64 ohm speaker	70
▶64mm 8 ohm speaker	70
20mm panel fuseholder	25

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	Standard	16p	20p
Phono	10p	12p	Stereo	24p	25p
1mm	12p	13p	4mm	18p	17p

UHF (CB) Connectors:
PL259 Plug 40p. Reducer 14p.
SO239 square chassis skt 38p.
SO239S round chassis skt 40p.
IEC 3 pin 250V/6A.

Plug chassis mounting	38p
Socket free hanging	60p
Socket with 2m lead	120p

BOXES

Plastic with lid + screws		Aluminium	
		3x2x1"	70
		4x3x1½"	85
3x2x1"	55	4x3x2"	100
4½x3x1½"	88	6x4x2"	120
7x4x2	160	6x4x3"	150

SCRs

▶C106D	30
400V 8A	70
400V 12A	95

BRIDGE RECTIFIERS

		2A 200V	40
		2A 400V	45
		6A 100V	80
		6A 400V	95
1A 50V	20	VM18 DIL 0.9A	
1A 400V	35	200V	50

MULTIMETERS

HT-120 4,000 opv
A smart looking 11 range pocket sized multimeter with an impressive spec. Complete with battery, etc. 650p each.
HT-320 20,000 opv.
Highly sensitive 19 range multimeter including transistor tester. Overload protection. DC volts – 1000, AC volts – 1000; DC current 0.25A. 4 resistance ranges. Complete with batteries, leads, etc. 1395p

DIODES

BY127	12	▶1N4001	3
OA47	10	1N4002	5
OA90	8	1N4006	7
OA91	7	1N4007	7
OA200	8	1N5401	12
OA202	8	1N5404	16
1N914	4	1N5406	17
▶1N4148	2	400mW zen	6

CABLES

20 metre pack single core connecting cable ten different colours. 65p

Speaker cable	10p/m
Standard screened	16p/m
Twin screened	24p/m
2.5A 3 core mains	23p/m
10 way rainbow ribbon	65p/m
20 way rainbow ribbon	120p/m

NEW CATALOGUE * NEW CATALOGUE!!!!!!!!
Our latest catalogue has just been released containing over 2000 stock lines all at extremely competitive prices backed by Rapid's return of post service. Stocks include Denco coils, tools, Verocases, data sheets etc. etc. Send 45p for your copy now (sent free of charge with all orders over £10).

CAPACITORS

Polyester, radial leads. 250v. C280 type: 0.01, 0.015, 0.022, 0.033 - 6p; 0.047, 0.068, 0.1 - 7p; 0.15, 0.22 - 9p; 0.33, 0.47 - 13p; 0.68 - 20p; 1u - 23p.
Electrolytic, radial or axial leads: 0.47/63V, 1/63V, 2.2/63V, 4.7/63V, 10/25V - 7p; 22/25V, 47/25V - 8p; 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; 2200/63V - 140p; 4700/63V - 230p
Polyester, miniature Siemens 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, 50p.
Tantalum 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 ceramic 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

POTENTIOMETERS

Rotary. Carbon track Log or Lin 1K - 2M2. Single 32p. Stereo 85p. Single switched 80p. Slide 60mm travel single Log or Lin 5K - 500K 63p each.
Preset submin. hor. 100 ohms -1M 7p each.
Cermet precision multiturn, 0.75W ¾" 100 ohms to 100K - 88p each.

REGULATORS

78L05	30	79L05	65
78L12	30	79L12	65
78L15	30	79L15	65
7805	35	7905	40
7812	35	7912	40
7815	35	7915	40
LM309K	130	LM723	35
LM317K	270	LM338K	475
LM317T	120	78H05 5A	
LM323K	350	▶5V	550

TOOLS

Small trimming tool	22
Small pocket screwdriver	16
Large pocket screwdriver	13
6 piece precision screwdriver set in plastic case	170
Low cost side cutters	160
High quality side cutters	650
Low cost pliers	160
High quality pliers	650
Wire strippers	120
Expo reliant drill	695
Expo Titan drill	1025
Drill stand	1200
Reduced shank drill bits for above 0.8mm, 1mm, 1.4mm	60

OPTO

▶3mm red	7	▶5mm red	7
▶3mm green	10	▶5mm green	10
▶3mm yellow	10	▶5mm yellow	10

Clips to suit - 3p each.

Rectangular		TIL32	40
▶red	12	TIL78	40
green	17	▶TIL111	60
yellow	17	ORP12	85
▶TIL38	40	TIL100	90
2N5777	45	Dual colour	60

Seven segment displays:

Com cathode		Com anode	
DL704 0.3"	95	DL707 0.3"	95
▶FND500 0.5"	100	FND507 0.5"	100
TIL313 0.3"	115	TIL312 0.3"	115
TIL322 0.5"	115	TIL321 0.5"	115

LCD: 3½ digit 580p. 4 digit 620p.

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 desoldering tool	480
Spare nozzle for above	70
10 metres 22swg solder	100

RESISTORS

¼W 5% Carbon film E12 series 4.7 ohm - 1M. 1p each.
½W 5% Carbon film E12 series 4.7 ohm to 4M7 2p each.
¼W 1% metal film E24 series 10 ohm - 1M 6p each.

PCB MATERIALS

Alfac transfer sheets – please state type (e.g. DIL pads etc.)	45
Dalo etch resist pen	100
Fibre glass board 3.75"x8"	80
Ferric chloride 250ml bottle.	100

TRIACS

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

SOCKETS

	Low profile	Wire-wrap
8 pin	6p	25p
14 pin	8p	35p
16 pin	9p	42p
18 pin	12p	52p
20 pin	13p	60p
22 pin	16p	70p
24 pin	18p	70p
28 pin	23p	80p
40 pin	25p	93p

Soldercon pins 60P/100

COMPONENT KITS

An ideal opportunity for the beginner or the experienced constructor to obtain a wide range of components at greatly reduced prices.

¼W 5% Resistor kit. Contains 10 of each value from 4.7 ohms to 1M (total of 650 resistors)	480
Ceramic Cap. kit. 5 of each value - 22p to 0.01u (135 caps)	370
Polyester Cap. kit. 5 of each value from 0.01 to 1uF (65 caps)	575
Preset kit. Contains 5 of each value from 100 ohms to 1M (total 65 presets	425

Nut and Bolt kit (total 300 items): 180p

25 6BA ¼" bolts	50 6BA washers	50 6BA nuts
25 6BA ½" bolts	25 4BA ¼" bolts	50 6BA washers
50 6BA nuts	25 6BA ½" bolts	

The Rapid Guarantee

★ Same day despatch ★ Competitive prices
★ Top quality components ★ In-depth stocks

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

NEXT MONTH

electronics today INTERNATIONAL

SWITCHED MODE PSU

Specially for those interested in extending their knowledge of electronics (which must be about 100% of you), we are returning to the Designer's Notebook feature with not one but two articles. As you may gather from the .heading, one of these is not a million miles away from the subject of switched mode power supplies, one of the design fields often regarded as a no-go area for the hobbyist -that is, until that hobbyist reads ETI. The other Designer's· Notebook will be on voltage multipliers, so start queuing at the newsagents now.

REAL-TIME CLOCK CALENDAR

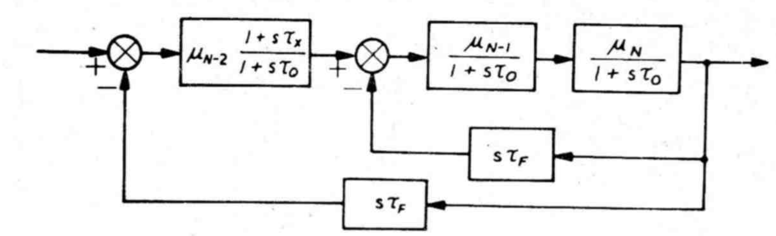
A project for all those readers with 6502-based micros that can't tell the. time, or remember what day it is.If you liked the 6502 Sound/DAC card this month, you'll love this project: only in the April edition of ETI.

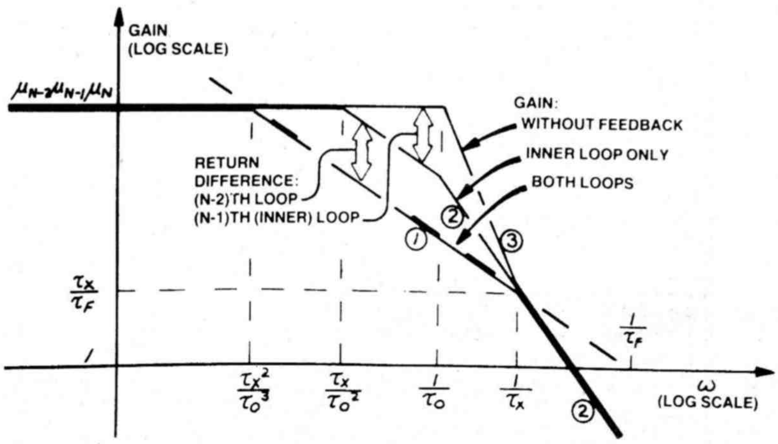
ZX81 MUSIC BOARD

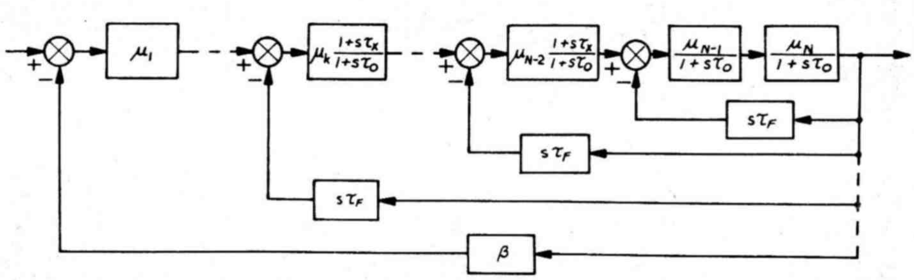
This is a quite sophisticated though cost-effective music board for the ZX81. The board is capable of playing music without continuous CPU maintenance, and three notes may be played at once, each with independently variable volume.If you want more out of your micro, get next month's ETI.

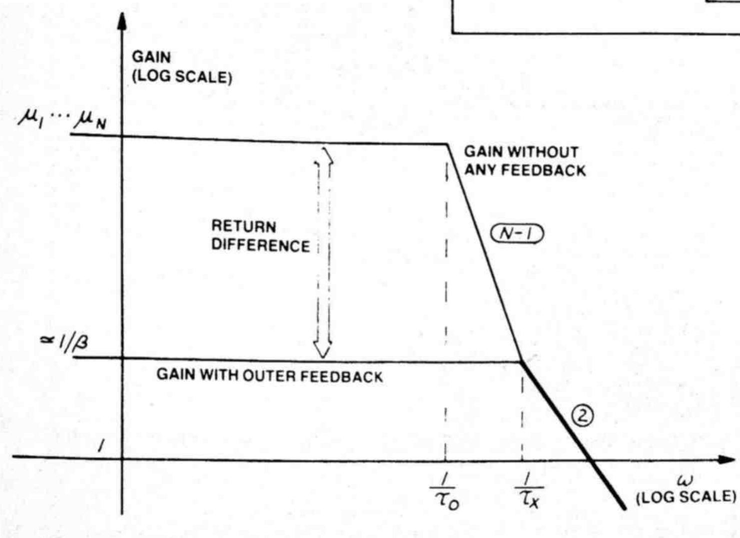
NDFL

NDF what? We're afraid you'll have to wait until the next ETI is published to find out what those letters stand for, but it will culminate in an entirely new audio amplifier design. Sounds interesting.Meanwhile, here are a few clues ...









LOOK OUT FOR THE APRIL ISSUE ON SALE MARCH 4th

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

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SUPERIOR QUALITY CARBON FILM RESISTORS, HI STAB LOW NOISE

¼W 10Ω-1MΩ 5% E24	2p
½W 10Ω-10MΩ 5% E24	3p
1W 10Ω-10MΩ 5% E12	6p
2W 10Ω-10MΩ 5% E12	16p

METAL OXIDE/FILM RESISTORS

Very high thermal & electrical stability. Extremely low noise

0.4W 10Ω-1MΩ 2% E24	5p
0.4W 10Ω-1MΩ 1% E24	8p

LOW OHMIC VALUE RESISTORS (½W OR ¼W)

0.22Ω-8.2Ω E12	11p

WIREWOUND RESISTORS 5%

2-3W 0.22Ω-330Ω E12	28p
4-7W 0.47Ω-6K8 E12	32p
10-11W 1.0Ω-33K E12	37p

LOW NOISE ROTARY POTS E3 Series

4.7K-2M Lin	32p
4.7K-2M Log	32p
As above with DP switch	80p
As above but stereo (no switch)	80p

Mini Vert	14p
Mini Horiz	14p
Standard Vert	17p
Standard Horiz	17p
Thumbwheel or ¼" Spindle for Standard Presets only	8p

MICRO-MINI 100V CERAMIC PLATE CAPS 5% or better

E12 Series 1pF-10nF 7p

DISCOUNTS ON QUANTITY PLEASE PHONE

Cermet 20 Turn Precision Presets

50Ω, 100Ω, 200Ω, 500Ω, 1K, 2K, 5K, 10K, 20K, 50K, 100K, 250K, 500K — 95p each

SIEMENS 63V MINI MONOLYTHIC CERAMIC

10nF	10p
22nF	10p
33nF	10p
47nF	10p
68nF	10p
100nF	14p

160V Polystyrene Caps 5% or better

10pF, 15pF, 22pF, 27pF, 33pF, 39pF, 47pF, 68pF, 100pF, 150pF, 180pF, 220pF, 270pF, 330pF, 390pF, 470pF, 680pF, 820pF, 1nF, 1.5nF, 2.2nF, 3.3nF, 4.7nF, 10nF — 12p each

SIEMENS POLY-C 5% 7.5mm 250V CAPACITORS E12

1nF-68nF	10p
82nF-150nF	15p

5% 7.5mm 100V CAPACITORS E12

100nF-180nF	12p
220nF, 270nF	15p
330nF, 390nF	20p
470nF, 560nF	27p
680nF	32p
1µF (10mm)	36p

Complete range of other voltages & spacings in stock. Please phone

C280 or Equiv Polyester Caps Radial Long Leads

10nF, 15nF, 22nF, 33nF, 47nF, 68nF, 100nF	9p
150nF, 220nF	11p
330nF, 470nF	16p
680nF, 1µF	24p
1.5µF, 2.2µF	44p

SILVER MICA CAPS 1% 350V

Cement coated. Extremely stable

2.2pF, 3.3pF, 18pF	20p
20pF-100pF	20p
120pF-220pF	25p
250pF-470pF	30p
680pF-1nF	33p

Veroboard 0.1" Copper clad

2.5 × 3.75	80p
2.5 × 5	90p
3.75 × 3.75	90p
3.75 × 5	103p
2.5 × 17	280p
3.75 × 17	366p
4.79 × 17	466p
VQ Board	180p
Dip Board	375p
Track Cutter	136p
100 Pins	52p
Verobloc	399p

Vero Wiring

Pen + Spool	360p
Spare Spool	72p
Combs	6p

1000vdc Caps (300VAC) Axial

1nF, 2.2nF	23p
4.7nF, 6.8nF	26p
10nF	28p
22nF, 33nF	37p
47nF	45p
100nF	48p
220nF	74p
470nF	1.10

1500VDC Caps (300VAC) Axial

1nF, 2.2nF	30p
3.3nF, 4.7nF	32p

2000VDC Axial

100nF 20% 76p

Ceramic Hi Volt Disc Capacitors

100p/1KV	20p
100p/2KV	24p
100p/3KV	26p
100p/4KV	28p
220p/6KV	30p
470p/2KV	27p
470p/6KV	32p
1n/2KV	28p
1n/6KV	32p
2n2/2KV	30p
2n2/4KV	32p
2n2/5KV	33p
3n3/2KV	31p
3n3/4KV	32p
4n7/4KV	33p

400V Polyester Capacitors

1nF, 1.5nF, 2.2nF	18p
3.3nF, 4.7nF, 6.8nF	19p
10nF, 15nF, 22nF	20p
33nF, 47nF, 68nF	22p
100nF, 150nF	25p
220nF	38p
330nF	58p
470nF	68p

Wire & Cable

Prices per metre. Solid Hook up Wire. Any colour 5p

Grade One Glass PCB Single Sided

178 × 240mm	95p
420 × 195mm	130p
420 × 245mm	196p

Ferric Chloride Pellets makes one litre with water, per bag 1.60

ETCH RESIST TRANSFERS

1 Thin lines
2 Thick lines
3 Thin bends
4 Thick bends
5 DIL pads
6 Transistor pads
7 Dots + holes
8 0.1" edge cons
9 Mixture

Any sheet of above 30p. Set of 13 sheets £3.00

PHOTO SENSITIVE PCB 1st Class Epoxy Glass. For better results than spraying. Expose to UV

Single sided

100 × 160	1.55
100 × 220	1.90
203 × 114	1.86
233 × 220	3.99

Double sided

100 × 160	1.66
100 × 220	2.15
203 × 114	2.21
233 × 220	4.56

Developer for above (do not use Sodium Hydroxide) 500ml 2.50

DALO ETCH RESIST PEN + spare nib 90p

ANTEX SOLDERING IRONS

C240 (15W)	4.58
X25 (25W)	4.99
Iron stand	1.65
C240 Element	1.99
X25 Element	2.06
Bits C240	
No2 (Small)	65p
No3 (Med)	65p
No6 (Micro)	65p
Bits X25	
No50 (Small)	65p
No51 (Med)	65p
No52 (Lge)	65p
SOLDER 125gms	
18 swg	2.95
22 swg	3.10

Quality Electrolytics

By Matsushita or Siemens (other good makes may be sent only in the rare event of supply difficulty)

TRANSISTORS

Probably the largest retail variety in UK. If you don't see what you want please phone or write as this is not a full list

2N404	1.50
2N914	20p
2N916	39p
2N917	65p
2N918	33p
2N929	36p
2N929A	45p
2N930	20p
2N930A	30p
2N1131	24p
2N1132	25p

-CRICKLEWOOD -STOCKING PARTS OTHER STORES CANNOT REACH!

Items not fully covered on this list include: OPTO 7 seg LEDs, LCDs bezelled LEDs, Lamps, Lampholders, FUSES: 20mm 1¼ inch, slow or quick blow. Fuseholders. CONNECTORS: DIL. DIN. Phono, 1mm, 2mm, 4mm. Bulgin USA. I.E.C. KNOBS: Plastic, Aluminium, Anodised, Collet, Pointer. SWITCHES: Toggle, Biased, Rocker, Rotary, Slide, Dil, Push. METERS: LCD, Analogue. Test and Panel. TOOLS: Pliers, Cutters, Strippers, Trimmers, Cable Cutters. And much, much more. All in stock items (that's 95%) posted same day. OFFICIAL ORDERS FROM SCHOOLS. GOVT DEPTS ETC WELCOME. OVERSEAS ORDERS WELCOME (CWO + ADEQUATE POSTAGE). QUANTITY DISCOUNTS BY NEGOTIATION.

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TIS62 44p
TIS64 67p
TIS87 60p
TIS88A 62p
TIS90 28p
TIS91 30p
TIS92 30p
TIS93 54p
VN10KM 60p
VN46AF 84p
VN66AF 85p
ZTX107 10p
ZTX108 10p
ZTX109 10p
ZTX300 13p
ZTX301 15p
ZTX302 15p
ZTX303 23p
ZTX304 15p
ZTX310 35p
ZTX311 32p
ZTX312 35p
ZTX313 36p
ZTX314 24p
ZTX320 35p
ZTX330 35p
ZTX341 28p
ZTX500 14p
ZTX501 14p
ZTX502 14p
ZTX503 17p
ZTX504 24p
ZTX510 34p
ZTX530 24p
ZTX531 25p
ZTX650 45p

DIACS
BR100 40p
ST2 25p

THYRISTORS
Sensitive Gate
Small Signal
2N4444 1.80
BT101-500R 1.40
BT106 2.19
2N5063 37p
2N5064 40p
BR101 75p
BRY39 60p
BRY56-100 60p
BRY55-300 67p
BRY56 50p
TIC44 35p
TIC47 50p

4, 6 & 12Amps Texas TO220
Suffix: A = 100V
B = 200V
C = 300V
D = 400V
M = 600V
TIC106A 46p
TIC106B 47p
TIC106C 48p
4A TIC106D 59p
TIC106M 68p
TIC116A 66p
TIC116B 66p
8A TIC116C 71p
TIC116D 73p
TIC116M 80p
TIC126A 72p
12A TIC126B 72p
TIC126C 73p
TIC126D 77p
TIC126M 95p

SIEMENS THYRISTORS
1.2 amp plastic
Bs B0106 (100V) 60p
Bs B0113 (200V) 70p
Bs B0146 (700V) 1.12
4.7 amp plastic
Bs B0206 (100V) 80p
Bs B0213 (200V) 1.10
Bs B0246 (700V) 2.00

TV Thyristors
2N4444 1.80
BT101-500R 1.40
BT106 1.50
BT116 Use TIC116M
BT119 1.70
BT120 1.50
BT121 1.50
BT139-600 2.50

TRIACS
Texas 400V
TO220 Case
TIC206D(4A) 58p
TIC225D(8A) 74p
TIC228D(8A) 88p
TIC236D(12A) 1.16
TIC248D(16A) 1.22
TIC253D(20A) 1.90
TIC263D(25A) 2.11

Other Triacs
2N5756 (TO5) 1.44
2N6155 (TO127) 3.39
40432 (Quadrac) 2.23
40486 (TO5) 1.66
40512 2.70
40576 (TO66) 3.33
40842 1.92

DIODES
1N34A 30p
1N821 70p
1N823 92p
1N914 08p
1N916 10p
1N1190 1.47
1N1192 1.76
1N1194 1.65
1N1194A 1.80
1N1196A 2.41
1N1198A 2.16
1N1201A 97p
1N1204A 1.00
1N1206 1.20
1N3063 36p
1N3065 48p
1N3492 1.88
1N3493 2.20
1N3493R 2.20
1N3602 36p
1N3604 45p
1N3766 3.00
1N3768 4.50
1N3768R 4.50
1N4001 4p
1N4002 4½p
1N4003 5p
1N4004 5½p
1N4005 6p
1N4006 6½p
1N4007 7p
1N4009 20p
1N4148 4p
1N4150 18p
1N4448 22p
1N4517 22p
1N5172 30p
1N5176 94p
1N5400 12p
1N5401 13p
1N5402 14p
1N5403 15p
1N5404 16p
1N5405 17p
1N5406 18p
1N5407 19p
1N5408 20p
1N5024 52p
1N5625 60p
1N5626 62p
1N5627 68p
1S44 10p
1S131 40p
1S134 56p
1S421 1.00
1S421R 1.00
1S940 10p
1S941 11p
1S961 22p
AA118 28p
AA129 57p
AA144 25p
AAY30 44p
AAY33 46p
AAZ17 27p
BA100 22p
BA102 25p
BA115 25p
BA133 40p
BA138 30p
BA142 20p
BA144 15p
BA155 15p
BA156 18p
BA182 40p
BA201 18p
BA202 26p
BA316 25p
BA317 25p
BA318 30p
BAV10 18p
BAV19 15p
BAV20 15p
BAV49 15p
BAX13 10p
BAX16 11p
BAY38 20p
BAY44 15p
BAY93 10p
BB103B 70p
BB103G 70p
BB104B 80p
BB104G 80p
BB105 52p
BB105A 57
BB105B 58p
BB109G 65p
BY126 20p
BY127 22p
BY134 52p
BY182 1.26
BY188A 65p
BY206 36p
BY207 36p
BY223 1.56
BY297 48p
BY299 55p
BYW11-800 1.40
BYW11-1000 2.00
BYW12-100 1.30
BYW12-200 1.40
BYW12-400 2.00
BYX10 36p
BYX50-200R 2.00
BYX55-350 62p
BYX71-350 1.10
BYX71-600 1.52
ITT33 15p
ITT44 10p
ITT921 10p
ITT923 15p
ITT2002 27p
MZ2361 1.80
OA10 70p
OA47 20p
OA90 10p
OA91 10p
OA95 20p
OA200 25p
OA202 20p
RAS508AF 75p
SPD9000 75p
SPD9002 95p

BRIDGE RECTIFIERS
(PIV shown in brackets)
1½amp type
W01 (100) 20p
W02 (200) 26p
W04 (400) 28p
W08 (800) 40p
2 amp type
Square with hole
S01 (100) 37p
S02 (200) 40p
S04 (400) 45p
S08 (800) 55p
6 amp type
Square with hole
PW01 (100) 50p
PW02 (200) 78p
PW04 (400) 85p
PW06 (600) 90p
25 amp type
Metal clad with hole
K01 (100) 2.20
K02 (200) 2.30
K04 (400) 2.80
K06 (600) 3.40
Proprietory Bridges
B40C1500 1.20
B80C3700 1.80
BY164 55p
BY179 92p

ZENER DIODES
400-500mW
E24 Series
2.4-47V 8p
1.3 Watt
E24 Series
3.3-82V 15p
2.5 Watt
E24 Series
7.5-75V 1.10
5W wire ended following voltages only 3V3, 3V6, 4V3, 4V7, 5V6, 7V5, 8V2, 8V7, 9V1, 10V, 12V, 20V, 33V, 51V, 62V, 68V 1.26
10W Pos. Stud
Following voltages only 7V5, 13, 18, 20, 24, 27, 30, 33, 68, 82, 91, 100, 110 1.26
20W Pos. Stud (BZY93 series) E24 values 7V5-75V 2.00

OPTO ELECTRONICS
2N5777 78p
2N5778 88p
2N5779 1.09
4N25 1.10
BP100 1.00
BP104 1.00
BPX25 2.47
BPX29 2.47
BPX48 6.76
BPX60 4.75
BPX61 3.48
BPX63 2.93
BPX79 4.60
BPX86 4.15
COX13 40p
COX23 53p
COX33 48p
LD30A 15p
LD36A 12p
LD37A 12p
LD52A 12p
LD56A 15p
LD57A 15p
LD52C 30p
LD56C 30p
LD57C 30p
LD80A 18p
LD86A 22p
LD87A 22p
LD242 75p
LD271 40p
LD461 25p
LD466 1.45
LD468 1.65
LD471 27p
LD476 1.20
LD478 1.45
LD479 1.65
LD481 27p
LD486 1.70
LD488 1.70
LD489 1.89
LD599 81p
ORP12 1.20
RPY60 2.65
RPY63 2.65
TIL32 71p
TIL63 1.95
TIL64 1.95
TIL65 2.25
TIL66 2.30
TIL67 2.35
TIL78 60p
TIL81 1.60
TIL99 1.35
TIL116 1.10
TIL138 2.40
TIL139 2.40
TIL209 15p
TIL211 19p
TIL212 19p
TIL224 32p
TIL228 42p
TIL312 1.65
TIL313 1.65
TIL401 3.50
TIL403 3.80
TIL406 4.10

NEW OPTO DEVICES
inc. Superbright see next column

D CONNECTORS 25 WAY
Solder type
Male 1.60
Fmale 2.05
Angled PCB
Male 2.46
Fmale 2.90
Covers 99p

GLASS FUSES
100mA-5 Amp
State value in amps and we will supply nearest to above
20mm slow 17p
20mm quick 10p
1.25" slow 17p
1.25" quick 10p

ICE MULTI-METERS
Microtest 80 £16.00
Supertest 680R £32.00

NEW OPTO DEVICES
New LEDs
Now in stock
R = red
G = green
Y = yellow
Large diffused 1+ 50+
R5D 9p 7p
G5D 15p 12p
Y5D 15p 12p
Small diffused
R2D 8p 6p
G2D 12p 10p
Y2D 12p 10p
Micro 0.1"
R1D 25p 22p
G1D 27p 25p
Y1D 27p 25p
Large clear
R5C 12p 10p
G5C 17p 13p
Y5C 17p 13p
Super bright Large (100 times brighter)
R5U 38p 29p
G5U 42p 34p
Y5U 42p 34p
Tri-colour flat
RGY8 83p 78p

LINEAR ICs
AY1-5050 95p
AY3-8910 5.39
AY3-8912 5.59
AY510103A 3.00
AY5-2376 5.88
CA3000 4.80
CA3001 4.95
CA3002 4.60
CA3005 3.15
CA3007 4.92
CA3010 1.30
CA3012 1.75
CA3013 4.12
CA3014 2.35
CA3015 2.62
CA3018 75p
CA3018A 2.00
CA3020 2.00
CA3020A 3.90
CA3021 3.20
CA3022 3.12
CA3026 1.52
CA3028A 1.21
CA3028B 2.53
CA3029 1.44
CA3030A 2.97
CA3033 5.44
CA3034 5.18
CA3036 2.75
CA3039 1.50
CA3041 3.47
CA3042 3.47
CA3043 3.92
CA3046 69p
CA3047 4.60
CA3048 2.99
CA3049 3.21
CA3050 4.11
CA3051 3.80
CA3052 2.92
CA3053 1.00
CA3054 1.66
CA3059 2.80
CA3060 4.09
CA3062 13.84
CA3065E 2.95
CA3068 4.23
CA3070 3.20
CA3071 3.30
CA3075 2.25
CA3076 3.42
CA3078T 2.25
CA3080 1.89
CA3080A 3.96
CA3080E 70p
CA3081 1.90
CA3085 1.36
CA3086 55p
CA3088E 2.36
CA3089E 1.95
CA3090AQ 3.70
CA3130E 87p
CA3130T 1.80
CA3140E 39p
CA3140T 85p
HA1366W 2.40
HA1388 2.54
ICL7106 7.40
ICL7107 9.50
ICL7611 1.16
ICL8038 2.99
ICM7555 80p
LC7120 3.20
LC7130 3.20
LC7137 400p
LF351 47p
LF353 92p
LF355 83p
LF356 92p
LF357 1.08
LF13201 2.99
LF13331 3.30
LF347 1.50
LF13741H 68p
LF13741N 59p
LM10CH 4.25
LM11CH 4.60
LM114 6.75
LM137K 11.52
LM301AH 1.00
LM301AN 25p
LM305AH 2.90
LM305H 88p
LM307H 1.05
LM307N 55p
LM308AH 3.15
LM308AN 2.14
LM308H 95p
LM308N 88p
LM309K 2.80
LM310H 1.95
LM310N 1.89
LM311H 1.04
LM311N 70p
LM317K 2.80
LM317MP 1.04
LM317T 1.50
LM318H 2.40
LM318N 1.49
LM319H 2.48
LM319N 2.10
LM320 - See 79XX Series Volt. Regulators
LM324N 29p
LM337K 4.75
LM337MP 1.65
LM337T 1.99
LM339AN 1.60
LM339N 47p
LM340 - See 78XX Series Volt Regulators
LM345K 8.60
LM348N 62p
LM349N 1.16
LM350K 4.80
LM359N 1.44
LM360N 3.88
LM376N 65p
LM377N 1.89
LM378N 3.40
LM379S 4.79
LM380N14 75p
LM380N8 1.50
LM381AN 2.26
LM381N 1.40
LM382N 1.12
LM383T 3.40
LM384N 1.40
LM386N1 88p
LM386N4 1.20
LM388N 2.43
LM391N60 1.70
LM391N80 1.93
LM392N 76p
LM393N 96p
LM394H 3.80
LM395K 13.52
LM709N8 64p
LM709CH 1.00
LM710CH 89p
LM710CN 52p
LM711CH 1.38
LM711CN 70p
LM723CH 1.21
LM723CN 40p
LM725CH 3.40
LM725CN 3.19
LM733 69p
LM741CH 96p
LM741CN 15p
LM741CN14 80p
LM747CN 69p
LM748CH 1.00
LM748CN 35p
LM1303N 1.20
LM1304N 2.50
LM1305N 3.10
LM1307N 2.75
LM1310N 1.45
LM1330N 2.25
LM1458 44p
LM1496 1.08
LM1800 3.24
LM1801 2.99
LM1812 8.00
LM1818 2.99
LM1820 2.15
LM1828 4.79
LM1830 2.44
LM1845 4.12
LM1848 2.89
LM1850 2.75
LM1871 4.39
LM1872 4.39
LM1886 7.44
LM1889 3.77
LM2907N 2.75
LM2907N8 2.60
LM2917N 1.89
LM2917N 1.88
LMC524 6.77
LM3301 1.00
LM3302 74p
LM3401 65p
LM3403 75p
LM3405 1.46
LM3900 48p
LM3905 1.25
LM3909 79p
LM3911 1.20
LM3914 1.79
LM3915 1.99
LM3916 2.19
LM4250CH 2.63
LM4250N 2.39
LM13600 1.09
MB3712 1.99
MB3756 3.80
MB8719 7.95
M53200 8.54
MC1303 = LM1303N
MC1304 = LM1304N
MC1305 = LM1305N
MC1307 = LM1307N
MC1310 = LM1310N
MC1330 = LM1330N
MC1352 1.75
MC1456 1.80
MC1458 = LM1458
MC1466L 6.77
MC1495L 3.75
MC1496 = LM1496
MC3340 1.46
NE531N 1.36
NE543N 2.50
NE540 4.95
NE544N 1.80
NE555 16p
NE556 45p
NE558 1.89
NE560 3.25
NE565 1.18
NE566 1.49
NE567 1.37
NE570 3.75
NE571 3.75
NE5534A 1.25
OM335 7.20
PLL02A 4.95
PLL03A 12.75
RC4136 59p
RC4194 3.95
RC4195 2.95
S566B 2.59
SAD1024A poa
SAS560 2.59
SAS570 2.50
SAS580 2.59
SAS590 2.59
SFF96364 7.99
SL470 3.47
SL490 3.47
SL610C 4.00
SL611C 4.00
SL612C 4.00
SL620C 6.00
SL621C 6.00
SL623C 10.00
SL630C 6.00
SL640C 6.00
SL641C 6.00
SN76001N 2.80
SN76008 3.90
SN76018 3.90
SN76003N 2.95
SN76013N 2.95
SN7023N = SN76033N
SN76033N 2.95
SN76110 2.25
SN76115 2.65
SN76116 2.75
SN76226 3.45
SN76228 2.90
SN76477 4.49
SN76530 1.80
SN76550 80p
SN76666 2.90
SO41P 1.60
SO42P 1.60
TA7210 1.49
TA7204 1.95
TA7205 89p
TA7222 1.45
TA7223 3.74
TA7310 1.49
TAA263 3.99
TAA300 3.95
TAA320 2.05
TAA350 3.60
TAA521 1.50
TAA522 2.47
TAA550 73p
TAA560 2.35
TAA570 2.35
TAA621AX1 2.75
TAA661A 1.50
TAA661B 1.70
TAA700 2.80
TAA930 2.50
TAA930B 2.63
TAA970 2.45
TAA991D 2.45
TAD100 2.00
TBA120AS 75p
TBA331 1.50
TBA341 2.05
TBA395 1.65
TBA396 1.50
TBA450 1.96
TBA460 1.53
TBA500 2.97
TBA500Q 3.11
TBA510 2.95
TBA510Q 3.05
TBA520 2.57
TBA520Q 2.75
TBA530 2.55
TBA530Q 2.76
TBA540 2.72
TBA540Q 2.74
TBA550 3.25
TBA550Q 3.27
TBA560C 2.87
TBA570 2.37
TBA570Q 2.48
TBA581 3.11
TBA641 3.00
TBA651 1.90
TBA673 4.15
TBA700 2.38
TBA700Q 2.47
TBA720AQ 2.60
TBA750 2.25
TBA750Q 2.46
TBA790A 2.11
TBA800 78p
TBA810 95p
TBA820 75p
TBA820M 75p
TBA920 1.96
TBA9200 1.97
TBA950 2.25
TBA990 2.65
TBA990Q 2.74
TCA105 3.00
TCA160C 2.67
TCA220 3.44
TCA270 2.44
TCA440 2.20
TCA450 2.66
TCA640 4.16
TCA650 4.16
TCA660B 4.16
TCA730 4.80
TCA740 4.80
TCA750 4.86
TCA760 2.75
TCA800 3.50
TCA800Q 3.80
TCA830S 1.90
TCA910 2.19
TCA940 1.68
TDA1002 3.39
TDA1003 3.94
TDA1004 2.87
TDA1005 3.94
TDA1010A 2.26
TDA1022 4.96
TDA1024 1.19
TDA1034 3.28
TDA2020 2.99
TDA2030 2.85
TDA2522 4.20
TDA2530 3.30
TDA2540 4.10
TDA2541 4.10
TDA2560 4.10
TDA2571 4.40
TDA2581 3.75
TDA2590 5.20
TDA2591 4.73
TDA2600 6.15
TDA2610 3.90
TDA2611A 2.50
TDA2640 3.64
TDA3000 2.76
TL061 40p
TL062 60p
TL064 99p
TL071 35p
TL072 50p
TL074 1.30
TL081 50p
TL082 75p
TL083 86p
TL084 89p
TL170 49p
TL430 3.99
TL494 3.99
UAA170 1.69
UAA180 1.69
ULN2003 85p
UPC575C2 2.96
UPC1156 2.75
XR2206 2.92
ZN414 79p
ZN419 2.25
ZN1034 1.98
ZN1040 6.68
ZTK22 89p
ZTK33 89p

TTL
7400 10½p
7401 11p
7402 11p
7403 12p
7404 12p
7405 15p
7406 16p
7407 16p
7408 14p
7409 14p
7410 15p
7411 16p
7412 14p
7413 16p
7414 17p
7416 17p
7417 17p
7420 15p
7421 20p
7422 20p
7423 20p
7425 18p
7426 18p
7427 18p
7428 18p
7430 14p
7432 17p
7433 21p
7437 19p
7438 19p
7440 15p
7441 65p
7442 27p
7443 65p
7444 65p
7445 46p
7446 50p
7447 35p
7448 40p
7450 15p
7451 15p
7453 15p
7454 14p
7460 15p
7470 30p
7472 25p
7473 23p
7474 18p
7475 22p
7476 24p
7480 40p
7481 1.19
7482 63p
7483 38p
7484 63p
7485 60p
7486 18p
7489 1.70
7490 20p
7491 35p
7492 25p
7493 34p
7494 24p
7495 34p
7496 34p
7497 86p
74100 80p
74104 50p
74105 55p
74107 20p
74107 20p
74109 25p
74110 29p
74116 50p
74118 53p
74119 57p
74120 59p
74121 25p
74122 30p
74123 34p
74125 30p
74126 29p
74128 35p
74132 29p
74136 27p
74141 55p
74142 1.75
74143 1.95
74144 1.95
74145 38p
74147 80p
74148 80p
74150 49p
74151 35p
74153 35p
74154 49p
74155 40p
74156 40p
74157 30p
74159 75p
74160 40p
74161 40p
74162 40p
74163 40p
74164 40p
74165 40p
74166 40p
74170 1.17
74172 2.50
74173 48p
74174 54p
74175 49p
74176 39p
74177 45p
74178 68p
74180 40p
74181 1.15
74182 55p
74184 90p
74185 90p
74186 4.68
74188 2.58
74190 45p
74191 45p
74192 45p
74193 45p
74194 40p
74195 40p
74196 40p
74197 48p
74198 77p
74199 77p
74221 58p

74LS TTL
74LS00 11p
74LS01 11p
74LS02 11p
74LS03 10p
74LS04 12p
74LS05 12p
74LS08 12p
74LS10 12p
74LS11 12p
74LS12 12p
74LS13 19p
74LS14 22p
74LS15 12p
74LS20 12p
74LS21 12p
74LS22 12p
74LS27 12p
74LS28 14p
74LS30 12p
74LS32 13p
74LS33 14p
74LS37 14p
74LS38 14p
74LS40 12p
74LS42 28p
74LS47 35p
74LS51 14p
74LS54 14p
74LS55 14p
74LS73 18p
74LS74 18p
74LS75 18p
74LS76 18p
74LS78 18p
74LS80 1.20
74LS83 33p
74LS85 39p
74LS86 16p
74LS90 22p
74LS92 25p
74LS93 24p
74LS93 24p
74LS95 36p
74LS96 50p
74LS107 20p
74LS109 23p
74LS112 20p
74LS113 22p
74LS114 22p
74LS122 25p
74LS123 34p
74LS124 89p
74LS125 24p
74LS126 25p
74LS132 33p
74LS136 24p
74LS138 24p
74LS139 27p
74LS145 70p
74LS147 99p
74LS148 69p
74LS151 30p
74LS153 39p
74LS154 79p
74LS155 29p
74LS156 36p
74LS157 27p
74LS158 30p
74LS160 30p
74LS161 35p
74LS162 35p
74LS163 35p
74LS164 40p
74LS166 50p
74LS168 84p
74LS169 85p
74LS170 70p
74LS173 55p
74LS174 39p
74LS175 39p
74LS181 88p
74LS183 1.20
74LS190 36p
74LS191 36p
74LS192 38p
74LS193 37p
74LS194 32p
74LS195 32p
74LS196 45p
74LS197 48p
74LS221 50p
74LS240 55p
74LS241 56p
74LS242 55p
74LS243 56p
74LS244 55p
74LS245 70p
74LS247 50p
74LS248 55p
74LS249 56p
74LS251 30p
74LS253 32p
74LS257 29p
74LS258 33p
74LS259 55p
74LS261 99p
74LS266 18p
74LS273 53p
74LS275 1.26
74LS279 30p
74LS280 85p
74LS283 40p
74LS289 4.70
74LS290 45p
74LS293 40p
74LS295 75p
74LS298 79p
74LS299 1.55
74LS323 1.56
74LS324 1.45
74LS325 2.96
74LS326 2.30
74LS327 2.30
74LS347 95p
74LS348 88p
74LS352 99p
74LS353 58p
74LS362 7.25
74LS365 27p
74LS366 27p
74LS367 27p
74LS368 27p
74LS373 59p
74LS378 80p
74LS386 1.14
74LS390 46p
74LS393 42p
74LS395 87p
74LS396 1.90
74LS398 2.70
74LS399 1.50
74LS445 1.30
74LS490 1.96
74LS540 88p
74LS541 88p
74LS640 99p
74LS641 99p
74LS643 88p
74LS644 99p
74LS668 1.19
74LS669 99p
74LS670 99p
74LS673 5.50
74LS674 9.98

74S TTL
74S00 30p
74S02 32p
74S04 32p
74S08 75p
74S20 60p
74S30 60p
74S32 70p
74S40 1.45
74S64 1.02
74S65 1.02
74S74 75p
74S85 2.99
74S86 1.75
74S112 90p
74S113 90p
74S124 2.96
74S132 1.09
74LS133 60p
74S138 1.25
74S139 1.48
74S140 2.58
74S153 7.96
74S157 2.76
74S163 3.00
74S174 2.50
74S175 3.29
74S188 3.50
74S188 3.50
74S194 3.58
74S200 4.50
74S201 4.00
74S225 5.25
74S261 3.00
74S262 8.50
74S287 2.99
74S288 1.98
74S289 1.57
74S301 3.20
74S470 3.25
74S471 6.25
74S473 12.50
74S474 3.98
74S475 6.25
74S571 9.00
74S573 9.00

74H TTL
74H00 1.46
74H01 1.46
74H04 1.56
74H05 1.56
74H10 1.46
74H11 1.46
74H20 1.46
74H21 1.45
74H30 1.48
74H40 1.56
74H51 1.75
74H53 1.85
74H54 1.45
74H55 1.40
74H60 1.70
74H62 1.76

74L TTL
74L02 1.00
74L10 1.70
74L47 3.27
74L74 1.20
74L85 4.20
74L86 1.50
74L93 2.30
74L98 2.98

74C CMOS/TTL
74C00 27p
74C04 29p
74C10 28p
74C14 89p
74C20 28p
74C30 36p
74C42 96p
74C48 1.40
74C73 54p
74C76 57p
74C83 1.74
74C85 1.34
74C86 1.10
74C89 5.96
74C90 1.06
74C93 1.44
74C95 1.00
74C107 80p
74C151 2.56
74C154 4.96
74C157 2.20
74C160 1.64
74C161 1.18
74C182 1.16
74C163 85p
74C164 1.15
74C165 2.08
74C173 98p
74C174 85p
74C175 75p
74C192 88p
74C193 88p
74C194 88p
74C195 70p
74C200 10.00
74C221 1.20
74C901 1.91
74C902 71p
74C903 2.30
74C904 1.84
74C905 10.88
74C907 1.91
74C908 1.87
74C911 9.59
74C912 6.00
74C914 2.88
74C915 1.99
74C918 2.50
74C920D 8.50
74C922 4.50
74C923 5.00
74C925 6.00
74C926 6.58
74C928 6.00
74C929 5.20
74C930J 7.90
74C932 3.12

40 CMOS
4000 10p
4001 10p
4002 11p
4006 40p
4007 15p
4008 32p
4009 24p
4010 24p
4011 10p
4012 15p
4013 20p
4014 46p
4015 39p
4016 20p
4017 32p
4018 44p
4019 25p
4020 44p
4021 39p
4022 39p
4023 12p
4024 32p
4025 12p
4026 77p
4027 20p
4028 37p
4029 43p
4030 14p
4031 1.19
4032 80p
4033 1.20
4034 1.29
4035 59p
4036 2.48
4037 1.30
4038 39p
4040 40p
4041 40p
4042 39p
4043 46p
4044 41p
4045 99p
4046 44p
4047 39p
4048 39p
4049 22p
4050 23p
4051 44p
4052 49p
4053 49p
4054 83p
4055 83p
4056 89p
4059 4.36
4060 42p
4063 79p
4066 22p
4067 2.22
4068 14p
4069 13p
4070 13p
4071 13p
4072 13p
4073 13p
4075 13p
4076 44p
4077 13p
4078 13p
4081 12p
4082 12p
4085 49p
4086 53p
4089 1.20
4093 20p
4094 89p
4095 75p
4096 70p
4097 2.68
4098 74p
4099 90p
For higher numbers in 40 Series, substitute 74C for 40 prefix. eg 40107 = 74C107

45 CMOS
4502 50p
4503 29p
4507 33p
4508 1.19
4510 46p
4511 48p
4512 39p
4514 1.10
4515 1.10
4516 50p
4518 39p
4519 29p
4520 48p
4521 90p
4526 59p
4527 58p
4528 46p
4532 89p
4534 4.28
4536 2.59
4538 65p
4539 99p
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6522 3.19
6532 6.96
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6845 10.00
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8155 3.50
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78L12A 30p
78L15A 30p
78L24A 30p
100mA To5
78L05CH 80p
78L12CH 80p
78L15CH 80p
78L24CH 80p
500mA T0202
7805M 47p
7812M 47p
7815M 47p
7824M 47p
1 Amp T0220
7805T 39p
7812T 39p
7815T 39p
7824T 39p
1.5 Amp T03
7805K 1.38
7812K 1.38
7815K 1.38
7824K 1.38
- Negative -
100mA T092
79L05 58p
79L12 58p
79L15 58p
500mA T0202
7905M 59p
7912M 59p
7915M 59p
7924M 59p
1 Amp T0220
7905T 44p
7912T 44p
7915T 44p
7924T 44p
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7905K 1.98
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3½ DIGIT LCD MULTIMETER
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Incredible £34.50
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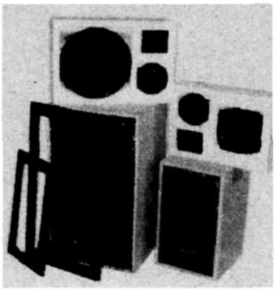
MULLARD SPEAKER KITS



Purposefully designed 40 watt R.M.S. and 30 watt R.M.S. 8 ohm speaker systems recently developed by MULLARD'S specialist team in Belgium. Kits comprise Mullard woofer (8" or 5") with foam surround and aluminium voice coil. Mullard 3" high power domed tweeter. B.K.E. built and tested crossover based on Mullard circuit, combining low loss components, glass fibre board and recessed loudspeaker terminals. SUPERB SOUNDS AT LOW COST. Kits supplied in polystyrene packs complete with instructions.
8" 40W system — recommended cabinet size 240 × 216 × 445mm
Price £14.90 each + £2.00 P & P.
5" 30W system — recommended cabinet size 160 × 175 × 295mm
Price £13.90 each + £1.50 P & P.

Designer approved flat pack cabinet kits, including grill fabric. Can be finished with iron on. veneer or self adhesive vinyl etc.
8" system cabinet kit £8.00 each + £2.50 P & P.
5" system cabinet kit £7.00 each + £2.00 P & P.

OMP80 LOUDSPEAKER

The very best in quality and value. Ported tuned cabinet in hard wearing black vynide with protective corners and carrying handle. Built and tested, employing 10 in British driver and Piezo tweeter. Spec: 80 watts RMS; 8 ohms; 45Hz- 20KHz; Size: 20in x 15in x 12in; Weight: 30lbs.
Price: £49.00 each. £90.00 per pair
Carriage: £5.00 each. £7.00 per pair

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1K.WATT SLIDE DIMMER

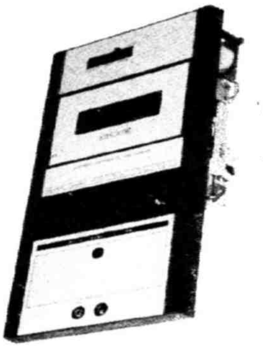
- Controls loads up to 1KW
- Compact size $4\frac{3}{4}'' \times \frac{13}{16}'' \times 2\frac{1}{2}''$
- Easy snap in fixing through panel/cabinet cut out
- Insulated plastic case
- Full wave control using 8amp triac
- Conforms to BS800
- Suitable for both resistance and inductive loads

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

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

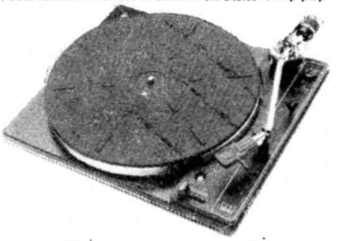
KEYBOARDS

manufactured from a tough poly carbonate film mounted on 1mm glass fibre printed circuit board assembly incorporating silver plated contacts.
16 way numeric keyboard Standard keyboard providing 0-9 and A-F functions.
Size: 100mm × 100mm × 2mm. Price: £5.99 + 35p p&p
Alpha Numeric Keyboard Full size 55 key non encoded keyboard with the commonly required functions in a Qwerty array. Matrix output via a 16 pin DIL socket.
Size: 350mm × 100mm × 2mm. Price: **£13.99 + 50p p&p**



STEREO CASSETTE TAPE DECK MODULE.
Comprising of a top panel and tape mechanism coupled to a record/play back printed board assembly. Supplied as one complete unit for horizontal installation into cabinet or console of own choice. These units are brand new, ready built and tested.
Features: Three digit tape counter. 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 Impedance:** 68K. **Output level:** 400mV to both left and right hand channels. **Output Impedance:** 10K. **Signal to noise ratio:** 45dB. **Wow and flutter:** 0.1%. **Power Supply requirements:** 18V DC at 300mA. **Connections:** The left and right hand stereo inputs and outputs are via individual screened leads, all terminated with phono plugs (phono sockets provided). **Dimensions:** Top panel $5\frac{1}{2}$in × $11\frac{1}{2}$in. Clearance required under top panel $2\frac{1}{4}$in. Supplied complete with circuit diagram and connecting diagram. Attractive black and silver finish.
Price £26.70 + £2.50 postage and packing.
Supplementary parts for 18V D.C. power supply (transformer, bridge rectifier and smoothing capacitor) **£3.50.**

BSR P256 TURNTABLE

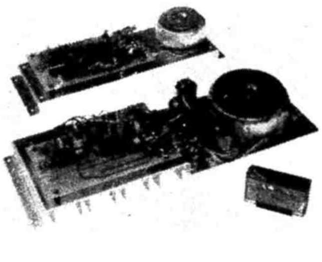


P256 turntable chassis ● S shaped tone arm ● Belt driven ● Aluminium platter ● Precision calibrated counter balance ● Anti-skate (bias device) ● Damped cueing lever ● 240 volt AC operation (Hz) ● Cut-out template supplied ● Completely manual arm. This deck has a completely manual arm and is designed primarily for disco and studio use where all the advantages of a manual arm are required.
Price: **£28.50** + £2.50 P&P

LOUDSPEAKERS

15" 100 watt R.M.S. (HI-FI, P.A., DISCO, BASS GUITAR) Die cast chassis, 2" aluminim voice coil, white cone with aluminium centre dome. 8 ohm imp., Res. Freq. 20Hz., Freq. Resp. to 2.5KHz., Sens. 97dB (As photograph). **Price: £32.00** + £3 carriage.
12" 100 watt R.M.S. (HI-FI) Die cast chassis. 2" aluminium voice coil. Black cone. 8 ohm imp., Res. Freq. 20Hz., Freq. Resp. to 4.5KHz. Sens. 95dB. (As photograph). **Price: £23.50** + £3 carriage.
8" 50 watt R.M.S. (HI-FI, P.A.) 1½" aluminium voice coil. White cone. 8 ohm imp. Res. Freq. 40Hz., Freq. Resp. to 6KHz. Sens. 92dB. Also available with black cone fitted with black metal protective grille. (As photograph). **Price:** White Cone **£8.90**, Black cone/grille **£9.50** P&P £1.25.
12" 85 watt R.M.S. McKENZIE C1285GP (LEAD GUITAR, KEYBOARD, DISCO) 2" aluminium voice coil, aluminium centre dome, 8 ohm imp., Res. Freq. 45Hz., Freq. Resp. to 6.5KHz., Sens. 98dB. **Price: £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 carriage.

OMP POWER AMPLIFIER MODULES

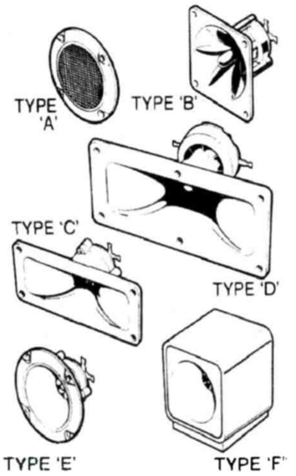


100 WATT R.M.S. AND 300 WATT R.M.S. MODULES
Power Amplifier Modules with integral toroidal transformer power supply, and heat sink. Supplied as one complete built and tested unit. Can be fitted in minutes. An LED Vu meter is available as an optional extra.

SPECIFICATION:
Max Output Power: 110 watts R.M.S. (OMP 100) 310 watts R.M.S. (OMP 300)
Loads: Open and short circuit proof. 4-16 ohms.
Frequency Response: 20Hz — 25KHz ±3dB.
Sensitivity for Max. Output: 500mV at 10K (OMP 100) 1V at 10K (OMP 300)
T.H.D.: Less than 0.1%
Supply: 240V 50Hz
Sizes: OMP 100 360 × 115 × 72mm; OMP 300 460 × 153 × 66mm
Prices: OMP 100 £31.50 each + £2.00 P&P; OMP 300 £89.00 each + £3.00 P&P; Vu Meter £6.50 each + 50p P&P

PIEZO ELECTRIC TWEETERS – MOTOROLA

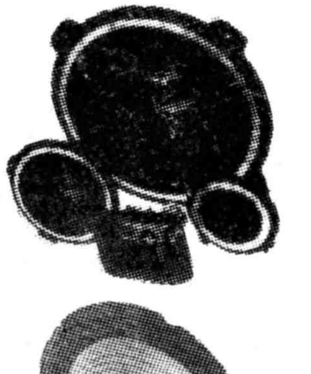
Join the Piezo revolution. The low dynamic mass (no voice coil) of a Piezo tweeter produces an improved transient response with a lower distortion level than ordinary dynamic tweeters. As a crossover **is not** required these units can be added to existing speaker systems of up to 100 watts (more if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



TYPE 'A' (KSN2036A) 3" round with protective wire mesh, ideal for bookshelf and medium sized Hi-fi speakers. **Price £3.45 each.**
TYPE 'B' (KSN1005A) 3½" super horn. For general purpose speakers, disco and P.A. systems etc. **Price £4.35 each.**
TYPE 'C' (KSN6016A) 2" × 5" wide dispersion horn. For quality Hi-fi systems and quality discos etc. **Price £5.45 each.**
TYPE 'D' (KSN1025A) 2" × 6" wide dispersion horn. Upper frequency response retained extending down to mid range (2KHz). Suitable for high quality Hi-fi systems and quality discos. **Price £6.90 each.**
TYPE 'E' (KSN1038A) 3¾" horn tweeter with attractive silver finish trim. Suitable for Hi fi monitor systems etc. **Price £4.35 each.**
TYPE 'F' (KSN1057A) Cased version of type 'E'. Free standing satellite tweeter. Perfect add on tweeter for conventional loudspeaker systems. **Price £10.75 each.**
P&P 20p ea. (or SAE for Piezo leaflets).

Matching 3-way loudspeakers and crossover

Build a quality 60watt RMS system 8ohms

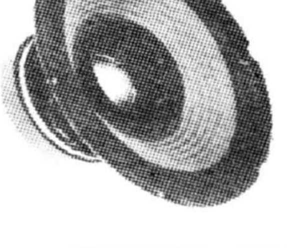


Build a quality 60 watt R.M.S. system.

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

Recommended Cab-size 26" × 13" × 13"

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



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

B.K. ELECTRONICS

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★ SAE for current lists. ★ Official orders welcome. ★ All prices include VAT. ★ Mail order only. ★ All items packed (where applicable) in special energy absorbing PU foam. Callers welcome by prior appointment, please phone 0702-527572.

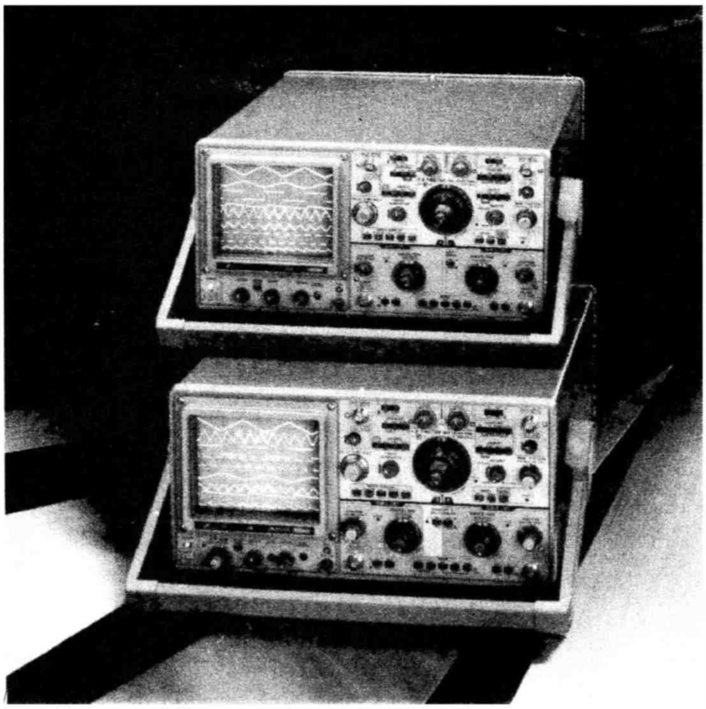
DIGEST

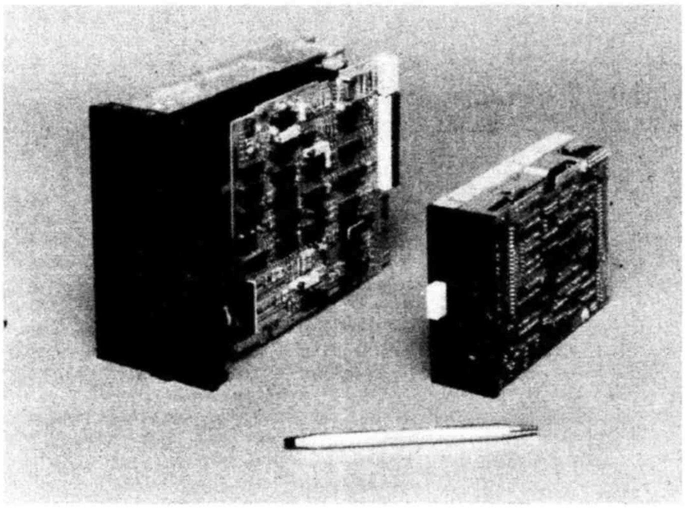
Low-Price High Performance Oscilloscopes

STC Instrument Services have introduced the new Iwatsu SS5710 and SS5711 4-trace oscilloscopes which combine very high performance with prices significantly lower than instruments of comparable performance. Both models offer high accuracy combined with easy to use controls and feature delayed time base (50ns min. for the SS5710 and 20ns min. for the SS5711), four input channels, full 10 x 8cm CRT screen, and an operating temperature of −10°C +50°C.

The SS5710 has a rise time of 5.8ns (approx.), a deflection factor of 5mV/div — 10V/div. ±2% (1-2-5 sequence in 11 steps), and a frequency response of DC-60MHz, −3dB (x 1 GAIN). The instruments come complete with two probes, an instruction manual and a storage bag for accessories.

Prices are a mere £635 for the SS5710 and £950 for the SS5711. For further information contact STC Instrument Services, Edinburgh Way, Harlow Essex. Tel. Harlow (0279) 29522.





31/2 inch Micro floppy

Adding to the proliferation of different sized micro floppy disks, Shugart Associates have launched a 3.5 inch floppy disc drive. Claimed specifications for the new unit, the SA300, include 500 kilobytes of unformatted capacity, track-to-track access time of six milliseconds, 135 tracks per inch (80 tracks per side), 300 rpm rotating speed, and transfer rate of 125 or 250 kilobits per second, in single or double density respectively. Price is expected to be around $200 for high volume orders. Evaluation units will be available in the se-cond quarter of 1983, but when the production model will hit the streets is not yet known.

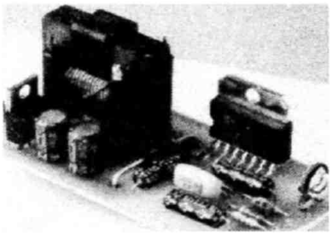
The multiplicity of standards (see 'Will Industry Standardize on the 3" Floppy', Digest Dec '82) can only be harmful to end users. It's a great pity that the manufac-turers couldn't have got together at the start and sorted out their own standards first before laun-ching products. Of course, it does mean that some users will end up having to buy two rather than just one set of micro floppy drives, which all goes to make money for someone.

160 Watt Monolithic Switchmode Supply

Replacing costly hybrids the L296 Power Switching Regulator delivers 4A at a voltage programmable from 5.1V to 40V and incorporates features such as soft start, programmable current limiting, remote inhibit and a reset output for microprocessors. The L296 is mounted in a MULTIWATT-15 plastic power package and very few external components are required.

For microprocessor systems, the reset output provides a delayed reset signal when the supply reaches a preset threshold. Both the delay time and threshold can be programm-ed by external components and either the input voltage or the output can be monitored.

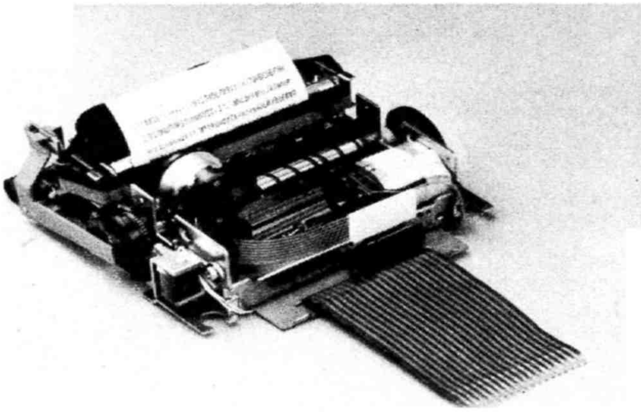
Crowbar over voltage protec-tion can be realized simply by ad-ding an external SCR. The L296 incorporates the voltage sense and SCR drive circuitry for this function.
Internally, the L296 is pro-tected against reverse polarity input voltages and thermal overload. Output short circuit protection is provided by the programmable current limiter. Multi-ple L296s can be synchronised easily and remote on/off control is simplified by the TTL-level in-hibit input. The soft start rise time is programmed by an external capacitor. SGS-ATES (UK) Ltd.,1 Walton Street, Aylesbury, Bucks. Tel. (296) 5977.



Cheap Print

Datac Limited, of Tudor Road, Altrincham, Cheshire have recently introduced a new range of printer mechanisms from Citizen. The 555 and 575 models are 24 and 40 column impact printers that feature red/black print, 2 and 1.2 lines per second printing speeds and 5 lines per second paper feed. Operation is from 12V DC. Both cost £49 for the mechanism only (1-off price).

Interface boards should be available towards the middle of the year for around £80, and these will have facilities for serial and parallel interfaces.



HOME LIGHTING KITS

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

TDR300K	Remote Control Dimmer	£14.30
MK6	Transmitter for above	£4.20
TD300K	Touchdimmer	£7.00
TDE/K	Extension kit for 2-way switching for TD300K	£2.00
LD300K	Rotary Controlled Dimmer	£3.50

HOME CONTROL CENTRE

This New Remote Control Kit enables you to control up to 16 different appliances anywhere in the house from the comfort of your armchair. The transmitter injects coded pulses into the mains wiring which are received by receiver modules connected to the same mains supply and used to switch on the appliance addressed. Receivers are addressed by means of a 16-way keyboard, followed by an on or off command. Since pushing buttons can become rather boring, the transmitter also includes a computer interface so you can programme your favourite micro to switch lights, heating, electric blanket, make your coffee in the morning, etc., without rewiring your house. JUST THINK OF THE POSSIBILITIES. The KIT includes all PCBs and components for one transmitter and two receivers, plus a drilled box for the transmitter.
Order as XK112. **£42.00**

Additional Recievers XK111 £10.00

MINI KITS

MK1 TEMPERATURE CONTROLLER/THERMOSTAT
Uses LM3911 IC to sense temperature (80°C max.) and triac to switch heater. 1KW **£4.00**

MK2 Solid State Relay
Ideal for switching motors, lights, heaters, etc. from logic. Opto-isolated with zero voltage switching. Supplied without triac **£2.60**

MK3 BAR/DOT DISPLAY
Displays an analogue voltage on a linear 10 element LED display as a bar or single dot. Ideal for thermometers, level indicators, etc. May be stacked to obtain 20 to 100 element displays. Requires 5-20V supply. **£4.50**

MK4 PROPORTIONAL TEMPERATURE CONTROLLER
Based on the SL441 zero voltage switch, this kit may be wired to form a "burst fire" power controller, enabling the temperature of an enclosure to be maintained to within 0.5°C. Max. load 3KW **£5.95**

MK5 MAINS TIMER
Based on the ZN1034E Timer IC this kit will switch a mains load on (or off) for a preset time from 20 mins. to 35 hrs. Longer or shorter periods may be realised by minor component changes. Max. load 1KW. **£4.50**

♫ 3-NOTE DOOR CHIME ♫

Based on the SAB0600 IC the kit is supplied with all components, including loudspeaker, printed circuit board, a pre-drilled box (95 × 71 × 35mm) and full instructions. Requires only a PP3 9V battery and push-switch to complete. AN IDEAL PROJECT FOR BEGINNERS. Order as XK102 **£5.00**

XK113 MW RADIO KIT

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

COMPONENT ACKS

PACK 1 650 Resistors 47 ohm to 10 Mohm – 10 per value £4.00
PACK 2 40 × 16V Electrolytic Capacitors 10μF to 1000μF – 5 per value £3.25
PACK 3 60 Polyester Capacitors 0.01 to 1μF/250V – 5 per value £5.55
PACK 4 45 Sub-miniature Presets 100 ohm to 1 Mohm – 5 per value £2.90
PACK 5 30 Low Profile IC Sockets 8, 14 and 16 – pin – 10 of each £2.40
PACK 6 25 Red LEDs (5mm dia.) £1.25

DVM/ULTRA SENSITIVE THERMOMETER KIT

This new design is based on the ICL7126 (a lower power version of the ICL7106 chip) and a 3½ digit liquid crystal display. This kit will form the basis of a digital multimeter (only a few additional resistors and switches are required—details supplied), or a sensitive digital thermometer (-50°C to +150°C) reading to 0.1°C. The basic kit has a sensitivity of 200mV for a full scale reading, automatic polarity indication and an ultra low power requirement—giving a 2 year typical battery life from a standard 9V PP3 when used 8 hours a day, 7 days a week.

Price £15.50

DISCO LIGHTING KITS

DL 1000K
This value-for-money kit features a bi-directional sequence, speed of sequence and frequency of direction change, being variable by means of potentiometers and incorporates a master dimming control. **£14.60**

DLZ1000K
A lower cost version of the above, featuring undirectional channel sequence with speed variable by means of a pre-set pot. Outputs switched only at mains zero crossing points to reduce radio interference to a minimum. **Only £8.00**

Optional opto input DLA1
Allowing audio ("beat") – light response. **60p**

DL3000K
This 3 channel sound to light kit features zero voltage switching, automatic level control and built in mic. No connections to speaker or amp required. No knobs to adjust – simply connect to mains supply and lamps. (1Kw/channel) **Only £11.95**

Have you got our **FREE** ORANGE CATALOGUE yet?
NO?! Send S.A.E. 6" × 9" TODAY!!
It's packed with details of all our KITS plus large range of SEMICONDUCTORS including CMOS, LS TTL, linear, microprocessors and memories, full range of LEDs, capacitors, resistors, hardware, relays, switches etc. We also stock VERO and Antex products as well as books from Texas Instruments, Babani and Elektor.
ALL AT VERY COMPETITIVE PRICES.

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"OPEN-SESAME"

The XK103 is a general purpose infra-red transmitter/receiver with one momentary (normally open) relay contact and two latched transistor output. Designed primarily for controlling motorised garage doors and two auxiliary outputs for drive/garage lights at a range of up to 40 ft. The unit also has numerous applications in the home for switching lights, TV, closing curtains, etc. Ideal for aged or disabled persons.
The Kit comprises a mains powered receiver, a four button transmitter, complete with pre-drilled box, requiring a 9V battery and one opto-isolated solid state switch kit for interfacing the receiver to mains appliances. As with all our kits, full instructions are supplied.

ONLY £23.75

ELECTRONIC LOCK KIT XK101

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

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

LCD 3½ DIGIT MULTIMETER

16 ranges including DC voltage (200 mv-1000v) and AC voltage, DC current (200 mA-10A) and resistance (0-2 M) + NPN & PNP transistor gain and diode check. Input impedance 10M. Size 155 × 88 × 31mm. Requires PP3 9V battery. Test leads included **£29.00**

REMOTE CONTROL KITS

MK6 SIMPLE INFRA RED TRANSMITTER
Pulsed infra red source complete with hand-held plastic box. Requires a 9V battery. **£4.20**

MK7 INFRA RED RECEIVER
Single channel. range approx. 20ft. Mains powered with a triac output to switch loads up to 500W at 240V ac. £9.00 (RC500K – Special Price for MK6 and MK7 together **£12.50**

MK8 CODED INFRA RED TRANSMITTER
Based on the SL490, the kit includes all components to make a coded transmitter and only requires a 9V (PP3) battery and keyboard. 8 × 2 × 1.3cms **£5.90**

MK10 16-WAY KEYBOARD
For use with MK8 and MK18 to generate 16 different codes for decoding by the ML928 or ML926 receiver (MK12) kit. **£5.40**

MK11 10-Channel + 3 Analogue o/p IR Receiver
Based on ML922 decoder IC. Functions include on/standby output, toggle, control of volume, tone and lamp brightness. Includes its own mains supply. **£12.00**

MK12 16-CHANNEL IR RECEIVER
For use with MK8 kit with 16 on/off outputs, which with further interface circuitry, such as relays or triacs, will switch up to 16 items of equipment on or off remotely. Latched or momentary outputs – please specify when ordering. Includes its own mains supply. **£11.95**

MK13 11-WAY KEYBOARD For use with MK8, MK18 and MK11 kits. **£4.35**

MK16 Mains Powered IR Transmitter
Mains powered for continuous operation – single channel, for applications such as burglar alarms, automatic door openers, etc. Range approx. 6 ft. **£2.50**

MK17 12V d.c. IR RECEIVER
For use with MK6 or MK16. Relay output with DP 3 Amp change-over contacts, may be used as latched, momentary or "break beam" receiver. Operates from 8-13V d.c. **£9.50**

MK18 HIGH POWER IR TRANSMITTER
Similar to MK8 but with range of approx. 60ft. **£8.20**

Ancillary Kits : MK2 Solid State Relay
Opto-isolated with zero voltage switching. No. triac supplied. **£2.60**

MK15 DUAL LATCHED SOLID STATE RELAY
Comprises 2 x solid state relays and latch for use with momentary version of the MK12. 2 output triacs required (not supplied). **£4.50**

THE MULTI-PURPOSE TIMER HAS ARRIVED

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

FEATURES INCLUDE:-
* 0.5" LED 12 hour display.
* Day of week, am/pm and output status indicators.
* 4 zero voltage switched mains outputs.
* 50/60Hz mains operation.
* Battery backup saves stored programmes and continues time keeping during power failures. (Battery not supplied).
* Display blanking during power failure to conserve battery power.
* 18 programme time sets.
* Powerful "Everyday" function enabling output to switch every day but use only one time set.
* Useful "sleep" function–turns on output for one hour.
* Direct switch control enabling output to be turned on immediately or after a specified time interval.
* 20 function keypad for programme entry.
* Programme verification at the touch of a button.

NOW ONLY £39 WITH SO MANY EXTRA FEATURES. OPTIONAL BLACK PLASTIC CASE. READY DRILLED £2.50

(Kit includes all components, PCB, assembly and programming instructions). ORDER AS CT5000

24 HOUR CLOCK/APPLIANCE TIMER KIT

Switches any appliance up to 1kW on and off at present times once per day. Kit contains: AY-5-1230 IC, 0.5" LED display, mains supply, display drivers, switches, LEDs, triacs, PCBs and full instructions.

CT1000K Basic Kit	£14.90
CT1000K with white box (56/131 x 71mm)	£17.40
(Ready Built)	£22.50

For a detailed booklet on remote control — send us 30p and S.A.E. (6" × 9") today.

ALL PRICES EXCLUDE VAT

Add 55p postage & packing +15% VAT to total.
Overseas Customers;
Add £2.50 (Europe), £6.00 (elsewhere) for p&p.
Send S.A.E. for further STOCK DETAILS.
Goods by return subject to availability.

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01-579 2842 TECHNICAL AFTER 3PM

No, It Isn't A Mock-up

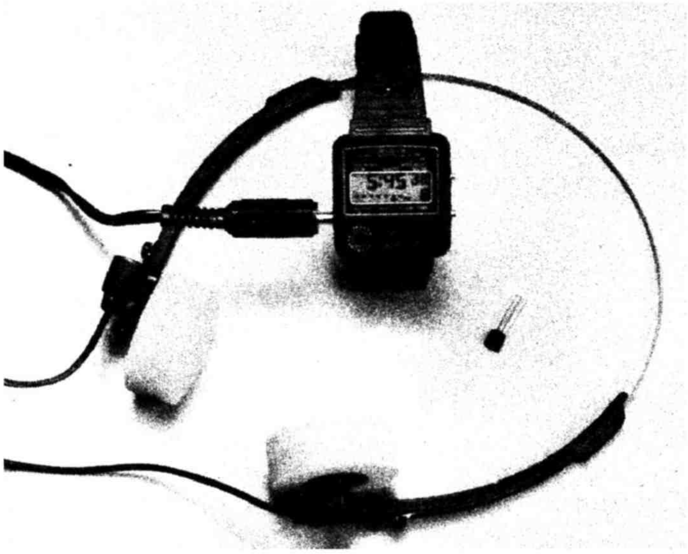
Ferranti is now offering its widely-used tuned radio frequency (TRF) circuit in a TO-92 style plastic package, designated ZN414Z: introducing the plastic packaged version has led to price reductions of up to 25 %, enabling the device is to be used in a wide range of new products. One of the first of these new applications is in an electronics wrist watch/radio.

The circuit provides a complete RF amplifier, detector and AGC circuit, requiring only six external components to give a high quality AM medium wave tuner, operating from a single cell supply with low power consumption.

Simple but effective AGC action is available using one external resistor. No setting-up or alignment is required and the ZN414Z will give excellent audio output directly into an earphone or a suitable output stage. Ferranti Electronics Limited, Fields New Road, Chadderton, Oldham, Lancashire, OL9 BNP. Telephone 061-624 0515 and Telex 666803.

Detect Damp Desks!

A new desktop indicator from Vaisala allows simultaneous digital display of relative humidity and temperature to 0.1 digit accuracy. The HM 32 humidity and temperature indicator may be us-ed with a range of Vaisala probes, or connected direct to a recorder for a continuous permanent out-put reading. Relative humidity is displayed in % RH, and temperature in either degrees Celcius (°C) or Fahrenehit (°F), selected with an internal jumper. The indicator can be operated from a standard power supply, or by a rechargeable NiCad battery if required. Although designed for desktop use, the HM 32 has its own carrying handle for portability. Operation is simply a matter of switching on, with the measured values being shown almost immediately on the large 3½ digit liquid crystal displays. Full details of the HM 32 may be obtained from Vaisala (UK) Ltd, 11 Billing Road, Northampton NN1 5AW (telephone 0604 22415).



Shorts

● The more observant amongst you might have noticed a new component supplier, EMOS, advertising in our hallowed pages. Whilst new to the hobby market, they are by no means strangers to electronics, as the parent company, the Grenson Group, has been manufacturing stabilising power supplies for more than 20 years. Grenson's director, Stuart Taylor, has said '. . . the work that hobbyists are doing these days is often anything but amateur . . .', which is somthing we've been proving for years.

● A portable, self-contained floppy disk drive tester has been introduced onto the UK market by Kontext, PO Box 11, East Hornsey, Surrey (Tel 04865 3406). The Redwood Supertest is intended for field service engineers, and provides the means of quickly positioning the heads of floppy disc drives over all the standard tracks of an alignment diskette. The UK price should be around £339 inclusive.

● The new Toolrange Catalogue incorporates a section on power supplies and transformers. Clever these Toolrange people, they time the release of their press releases so that we can't keep them back and say what they have in the catalogue all in one go. Toolrange Limited, Upton Road, Reading RG3 4JA, Berks.

● BICC-Vero have produced a new shortform catalogue specially for hobbyists. Products covered include circuit boards, breadboards, boxes, tools and accessories. Retail Department, BICC-Vero Electronics, Parr, St. Helens, Merseyside.

● Looking for a project but can't find the exact one you want? New from EPI Sales, Central Library, Northumberlands Square, North Shields, Tyne & Wear NE30 1QU, at a price of £2.50 inclusive, is the Electronics Projects Index No 3. The Index covers projects produced by most mags with cover dates from January 1979 to December 1980. The next edition, covering 1981 and 1982 is almost ready, they tell us, though why anyone would want to know about projects in other magazines, we do not know . . .

● Another new publication, slightly more expensive, is the new IC Master. Weighing in at 3,500 pages (no, we haven't actually checked what the weight is) is a listing of over 50,000 ICs, including a section on gate arrays, addresses of IC manufacturers and distributors, reps and agents, and an applications note directory. The directory will be available in March from Paterson/Steadman & Partners, 34/36 High Street, Saffron Walden, Essex CB10 1EP, at £65 a time, they're not cheap, but if you order before March 1st, there's a special reduction to £55.25. Both prices include post, packing and updates.

● Flag waving time: Thandar Electronics have managed to sell £100,000 worth of electronics to a ' "major" Japanese instrument manufacturer'. They're rather coy about who it actually is that has bought their gear.

● Tangerine Users' Group (TUG) has moved to a new HQ. They are now at 1 Marlborough Drive, Worle, Avon BS22 0DQ, tel 0934 21315.

● A case for study? Semiconductor Supplies International Ltd, Dawson House, 128/130 Carshalton Road, Sutton, Surrey SM1 4RS are now supplying a range of cases designed for desk-top and other uses, at prices starting from £5.06 exclusive.

● Radio Rentals report that the first would-be TV thief has been caught using their Burglar Alarm TV sets. The intruder was not only deafened by the alarm itself, but was set upon by the owner's two dogs as well. The owner felt so sorry for the would-be thief that he decided not to press charges!

● Ambit International have been at it again — taking on new products, that is. Amongst them are the ALPS range of high-quality laser-trimmed potentiometers, the Ritel range of knobs and accessories, and some low-cost piezo-acoustic resonators. See Ambit's ad for their address and ordering details.

● Got a gear? A geared motor, that is, from McLennan servo supplies, Doman Road, Camberley, Surrey. Motors are available with a new British-built gearhead and AC synchronous, DC servo or stepped motors. Also available is a low-cost reversible AC synchronous motor.

● An addition to the 'Way' range of personal stereos from Panasonic is the RQ-J20X; Panasonic say that it's the first personal stereo to incorporate dbx noise reduction. At an RRP of £110.95, it's not cheap, but if the dbx works anything like as well as it is capable of, and if dbx tapes become widely available, it may well be worth it.

● Ross Electronics have recently released four new mo dels of headphones, and also a pair of in-ner ear fitting mini-phones, that bring their total range to over 20 models. Ross Electronics, 49/53 Pancras Road, London NW1 2QB.

● Boss Industrial Mouldings Ltd, James Carter Road, Mildenhall, Suffolk IP28 7DE are now selling a range of snap-in lenses for 5mm LEDs. The one-piece lenses are available round or square in a variety of colours. The lens is locked in position when the LED is inserted — ingenious, eh?

POWERFET AMPLIFIERS

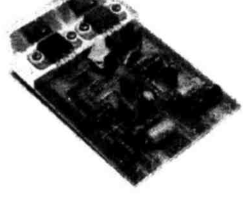
NEW DESIGNS

With the introduction of four new boards PANTECHNIC have pushed forward the performance and reliability of their powerfet amplifiers. Four key improvements have been incorporated in these second generation modules —

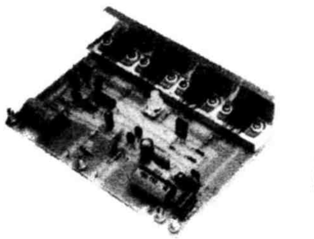
1.) The use of H-PAK powerfets, resulting in improved thermal efficiency and consequently enhanced power output capabilities.
2.) Low C_{OB} drivers now in power transistor packages, maintaining the superb HF performance and improving driver reliability.
3.) Separate driver and input supply rails allowing a 10% increase in available output power by increasing output stage efficiency.
4.) Bridge mode input pin allowing instant bridging between any two amplifiers without the need for extra circuitry.

PFA100 Specification

Bandwidth	10Hz-100KHz ± 1dB
Output Power into 8Ω	100W (Vs = ± 55V)
THD (20Hz-20KHz)	<0.008%
THD (1KHz at 100W)	0.004% typ.
SNR	120dB
Slew rate	>30 V/uS
Gain	x 23
Rin	30K
Vs max	± 70V



Price
£17.35 (Built & Tested)
£15.17 (Kit)



PFA200 Specification

Bandwidth	10Hz-100KHz ± 1dB
Output power into 8Ω	180W (Vs ± 60V)
THD (20Hz-20KHz)	<0.005%
THD (1KHz at 150W)	0.002% typ
SNR	120dB
Slew rate	>30 V/uS
Gain	x 23
Rin	30K
Vs max	± 70V

PFA200 180W into 8Ω
300W into 4Ω (V_S = ± 67V)

Price
£23.87 (Built & Tested)
£21.70 (Kit)

And for those with a taste for power . . .

- **PFA500** Delivers 475W into 4 ohms and 600W into 2 ohms. These highly current capable units can deliver 25 amps continuous into a load, whilst maintaining the exemplary performance figures of the smaller units . . . . **£42.00** (built & tested)
- **PFA/HV** A very special module aimed at digital audio and wide dynamic range programme material. Delivers 300W into 4 ohms and 8 ohms on a continuous basis, it will peak for musically significant periods of time at up to 5dBs above this. The PFA/HV is the widest dynamic range power amplifier currently available . . . . **£34.30** (built & tested)
- **THE HEAT EXCHANGER.** Other people sell heatsinks. Pantechnic design, manufacture and sell heatexchangers. Re-examination of the heat transfer process has resulted in a radically new design possessing greatly improved efficiency. The unit 7" × 4" × 2" handles PFAs up to 300W or 1.2KW when blown **£7.50**

POWER SUPPLY COMPONENTS

Toroidal Mains Transformers

Voltage	160VA	225 VA	300 VA	500 VA	625 VA
40-0-40	9.71	11.36	12.32		
45-0-45		11.36	12.32	16.05	
50-0-50				16.05	18.80

Special low flux windings. Carriage included

25A 400PIV Bridge rectifier	£2.17	For the PFA/HV 500VA 70-0-70	£16.06
10,000uF 80V Electrolytics	£4.13		
30,000uF 75V Electrolytics	£10.00	10,000uF 100V Electrolytics	£5.70

Phone or write for advice on selecting the right components for your particular application.

All prices excl. VAT. Carriage 75p. Trade supplied

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Phil Rimmer 01 800 6667

NEW! T.V. SOUND TUNER BUILTANDTESTED

In the cut-throat world of consumer electronics, one of the questions designers apparently ponder over is "Will anyone notice if we save money by chopping this out?" In the domestic TV set, one of the first casualties seems to be the sound quality. Small speakers and no tone controls are common and all this is really quite sad, as the TV companies do their best to transmit the highest quality sound. Given this background a compact and independent TV tuner that connects direct to your Hi-Fi is a must for quality reproduction.

£22.95 + £2.00 p&p.

This TV SOUND TUNER offers full UHF coverage with 5 pre-selected tuning controls. It can also be used in conjunction with your video recorder. Dimensions: 11¾"x 8½"x 3¼"

E.T.I. kit version of above without chassis, case and hardware. £12.95 plus £1.50 p&p.

PRACTICAL ELECTRONICS STEREO CASSETTE RECORDER KIT

SPECIAL OFFER!

COMPLETE WITH CASE

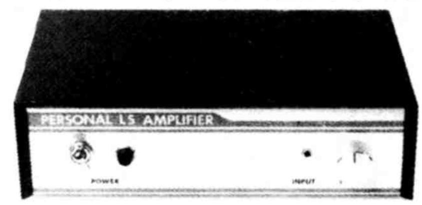
ONLY £31.00 plus £2.75 p&p.

• NOISE REDUCTION SYSTEM. • AUTO STOP. • TAPE COUNTER. • SWITCHABLE E.Q. • INDEPENDENT LEVEL CONTROLS. • TWIN V.U. METER. • WOW & FLUTTER 0.1%. • RECORD/PLAYBACK I.C. WITH ELECTRONIC SWITCHING. • FULLY VARIABLE RECORDING BIAS FOR ACCURATE MATCHING OF ALL TYPES.

Kit includes tape transport mechanism, ready punched and back printed quality circuit board and all electronic parts. i.e. semiconductors, resistors, capacitors, hardware, top cover, printed scale and mains transformer. You only supply solder & hook-up wire. Featured in April P.E. reprint 50p. Free with kit.

PERSONAL LS AMPLIFIER KIT

Amplifier for your personal stereo cassette player — as featured in January issue of Everyday Electronics. Turn your personal stereo into a mains powered home unit.



Parts:
Stereo power amp PCB with all components, **£3.50 + 75p p&p.** Power supply unit **£1.95 + £1.50** p&p. Pair of eliptical speakers, **£1.50** the pair + £1 p&p. Input & output sockets and plugs, **£1.50.** Recommended case (for the power supply and amp only), **£2.95 + 80pp&p.** P&P inclusive price of £1.75 for any two or more.

125W HIGH POWER AMP MODULES

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

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

ACCESSORIES: Suitable mains power supply kit with transformer: £8.50 + £2.00 p&p. Suitable LS coupling electrolytic. £1 + 25p p&p.

KIT	BUILT
£10.50	**£14.25**
+£1.15 p&p	+£1.15 p&p.

BSR RECORD DECK

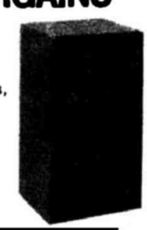
Manual single play record deck with auto return and cueing lever. Fitted with stereo ceramic cartridge 2 speeds with 45rpm spindle adaptor ideally suited for home or disco.

£12.95 + £1.75 p&p. 13"x 11" app.

SPECIAL OFFER! Replacement Stereo cassette tape heads — £1.80 each. Mono: £1.50 each. Erase: £0.70 each. Add 50p p&p to order.

SPEAKER BARGAINS

2 WAY 10 WATT SPEAKER KIT



8" bass/mid range and 3¼" tweeter. Complete with screws, wire, crossover components and cabinet. All wood precut — no cutting required. Finish - chipboard covered wood simulate. size 14½"x 8¾"x 4". PAIR for ONLY

£12.50 plus £1.75 p&p.

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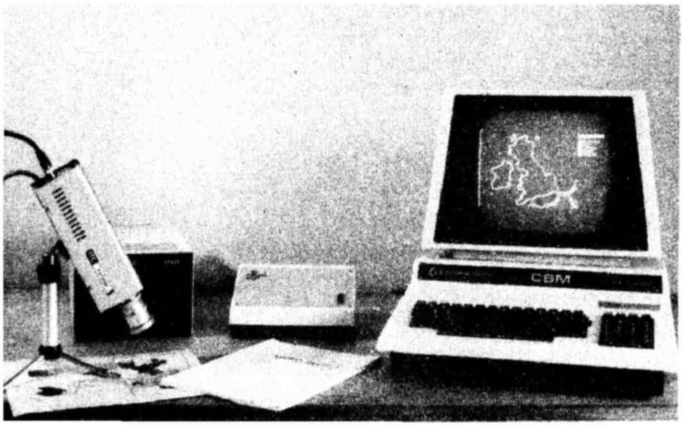
Note: Goods despatched to U.K. postal addresses only. All items subject to availability. Prices correct at 30/10/82 and subject to change without notice. Please allow 7 working days from receipt of order for despatch. RTVC Limited reserve the right to update their products without notice. All enquiries send S.A.E. Telephone or mail orders by ACCESS welcome.

ALL CALLERS TO: 323 EDGWARE ROAD, LONDON W2. Telephone: 01-723 8432.
(5 minutes walk from Edgware Road Tube Station)
Now open 6 days a week 9 – 6. Prices include VAT.

RTVC



Give Your Micro An Eye

Digithurst Ltd are now selling two vision systems suitable for use with microcomputers. MicroSight 1 (pictured) is a CCTV based system which uses a Micro Eye camera interface to send images back to the computer as 8 bit digitised video. The system is aimed at the educational and R&D market and will be of particular interest to people who are looking for a low cost introduction to the expanding field of microcomputer vision and Artificial Intelligence.

MicroSight 2 is a solid state camera based system which uses a 128 x 128 CID sensor to capture an image and a high speed interface to pass images back to the microcomputer either as 8 bit digital video or as threshold video.

Both systems use versions of MicroSight software which consists of a command processor and disk I/O routines, a camera control routine and three display routines: one to allow interactive adjustment of camera settings, one to display facsimile and one to display binary images. A machine code routine is used to process images and produce run length encoded data which as well as being a compact form of image data also allows applications programs access to a structured database. A boundary/edge detection program is supplied to give the user an insight into the use of run length encoded data.

The MicroSight 1 system including camera, interface and software costs £499 + VAT. And for the micro with a very rich owner, the MicroSight 2 system, including camera, high speed interface and software costs a mere £1990 + VAT.

British Company In Orbit

Signature of the L-Sat contract between British Aerospace Dynamics Group and the European Space Agency on December 30 1982 brought the value of BAe contracts for building new satellites to more than £250 millions in 1982. Worth £160 millions alone, the L-Sat contract is the highlight of a very successful year for the company's Space and Communications Division which has also signed contracts as prime contractor for two other new satellite programmes: Skynet 4, the defence communications satellite for the United Kingdom Ministry of Defence worth £58 million, and Giotto (see below), worth £34 million. Other space contracts signed last year amount to more than £30 million.

L-Sat 1, a large communications satellite scheduled for launch in 1986, is the most ambitious communications satellite programme yet undertaken by the European Space Agency, making important advances in satellite platform capability and communications techniques. (L-Sat will be used for direct TV broadcast services). L-Sat and its derivatives will rank as one of the world's most powerful satellite communications systems with a range of services that can include TV broadcasts to the home, high density international telecommunications, voice, data and video links, for small earth terminals on business premises, high quality voice and data links to ships, aircraft and road vehicles and a very high capacity inter-city telecommunications service.

An agreement has been signed by British Aerospace (UK), Fokker (Netherlands), Aeritalia and Selenia (Italy), and Spar Aerospace (Canada) to co-operate in the worldwide marketing of L-Sat derivatives. (These signatories are the major contractors on the L-Sat program, with British Aerospace as the prime contractor.) A demand is foreseen for more than 100 large satellites before the end of this century. L-Sat has the distinct advantage over many smaller satellites filling similar needs in that it reduces the multiplicity of spacecraft, orbital crowding and the need for extensive ground control facilities.

A £34m contract was signed just before Christmas between the European Space Agency and British Aerospace Space and Communications Division for the Giotto spacecraft, Europe's first deep space probe. British Aerospace are prime contractor, leading a consortium of. European companies and will deliver the spacecraft for launch in July 1985 to begin an eight month journey to intercept Halley's Comet' in March 1986.

The Russians and Japanese are also launching satellites to observe Halley but Giotto is the most elaborately instrumented and will pass closest to the comet. Its instruments will provide data on the chemical composition of the coma region surrounding the nucleus and of the tail of the comet. A camera will take colour, photographs of the comet's nucleus and measurements will also be made of its magnetic field.

This is an exciting and technically challenging project and the total time for observation as it passes the comet will only be a few hours since the closing speed will be about 70km per second. A special shield is being built to protect the satellite from impact of dust articles that will be about 70km per second. A special shield is being built to protect the satellite from impact of dust particles that will vaporise metal at these speeds. The trajectory will be adjusted during flight using data from the NASA/ESA space telescope in which British Aerospace is also in-volved. There will be no second chance and great emphasis will be placed on the reliability of the spacecraft systems. The satellite has been named Giotto after the Renaissance painter whose 1303 fresco 'The Adoration of the Magi', in Padua, depicts a comet to represent the Star of Bethlehem. This is believed to have been based on personal observation of the Halley comet during one of its periodic 76 year appearances.

Major European companies supporting British Aerospace in the project include Dornier System in Germany, Thom, CSF in France, LM Ericcson in Sweden and Contraves in Switzerland.

SATELLITE TV THE SEQUEL

The government recently chose a system proposed by the IBA for the way that TV signals will be transmitted from satellites, in preference to one proposed by the BBC. Was it the right decision? Vivian Capel explains the difference between the two systems.

Very shortly a milestone in TV broadcasting will come to an end. The world's first 'high definition' TV transmissions on 405 lines which started before the war from Alexandra Palace, will soon cease having lasted, except for the break during the war, for more than forty years.

While it was still going strong, the present 625-line standard was introduced, and later, the PAL colour system. These are serving very well and for most domestic applications give results which are largely free from glaring inadequacies. The quality of the picture is probably nearly as good as you can get with the present generation of TV displays.

The main drawback which sometimes intrudes is that over areas of fine detail, such as a herringbone-pattern coat, a false colour is often displayed: this is called **cross luminance.**

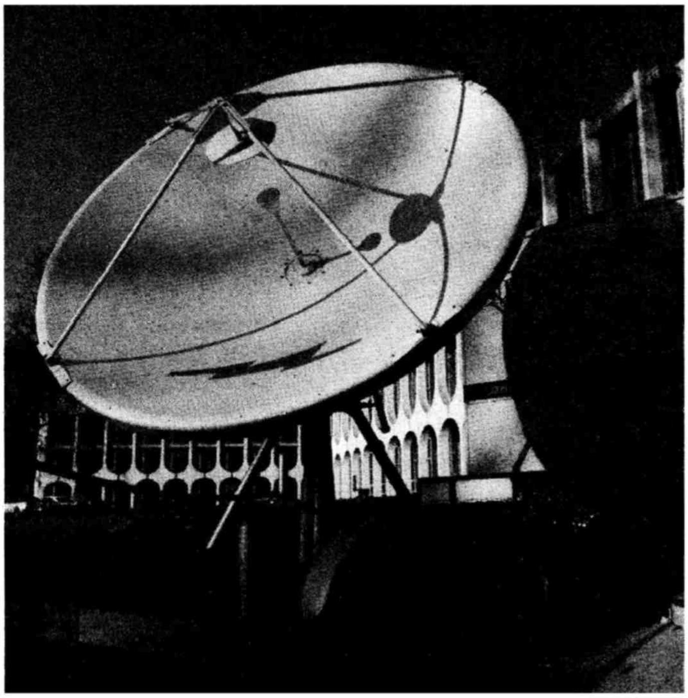
The composite video signal consists of two main components: the black-and-white detail, termed the luminance signal, and the colour information (actually *two* colour difference signals multiplexed), known as the chrominance signal. The picture is organised thus for two reasons. One is that the transmission can be received by black-and-white sets which simply ignore the chrominance signal. The other is that economies can be made in transmitted bandwidth.

The latter reason needs a little explanation. The amount of information that can be transmitted in a given time is limited by the bandwidth of the channel. To give good resolution over 625 lines a video signal of 5.5 MHz is required. When amplitude modulated on a carrier this produces frequencies of +5.5 MHz and −5.5 MHz or a total bandwidth of 11 MHz. However, one sideband is redundant and is reduced to 1.25 MHz, giving a bandwidth of 6.75 MHz. Sound is FM modulated and space must be left to separate adjacent channels.

The total channel width is 8 MHz, so it can be seen that there is little room for any colour information. However, the human eye is much less sensitive to colour detail than light-and-shade. Hence, the colour signal can be of a much lower resolution than the luminance without any subjective degradation of the picture.

A Red Herringbone

This is useful as it enables the colour to be accommodated without extending the bandwidth, by processing it separately as a lower-frequency signal. It is modulated on a sub-carrier of 4.43 MHz. Why 4.43 MHz? Well, as



MAC has been tested and demonstrated over this experimental transportable 'up-link' dish aerial:

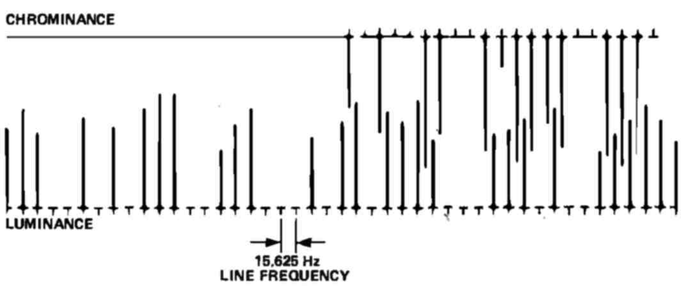


Fig 1 Spectrum of luminance signal showing how details occur at multiples of the line frequency. The chrominance signal is also at multiples of the line frequency, but being centred on 4.43 MHz, it interleaves with the luminance multiples. If there is movement of luminance detail around 4 MHz, the signals interact producing spurious colour.

most succeeding lines in the picture are largely repetitive, most of the video information is at multiples or harmonics of the line frequency, which at 625 lines and 25 frames per second is 15,625 Hz. In between these multiples there is nothing except on moving parts of the picture.

Now 4.43 MHz falls halfway between two multiples, and any modulation of information such as the colour signal which is also based on the line frequency, will likewise fall between other multiples. So, although the subcarrier and its sidebands occupy the same frequency spectrum as the luminance signal, they do not mutually interfere because the harmonics of each interleave with the other.

This is true of stationary pictures, but when there is motion between successive frames the information no longer is at line-frequency multiples, and so luminance and chrominance signals interact. Hence the herringbone coat looks fine as long as its wearer remains still, but the slightest movement sweeps the luminance signal detail across the 4.43 MHz harmonics so producing a spurious colour.

Coarser detail does not have the same effect because its video frequencies fall below the limited colour region which is just over 1 MHz either side of 4.43 MHz. So detail up to 3.5 MHz is innocuous. To minimise the effect, some set manufacturers limit the video response, rolling it off between 3.5 and 4 MHz. This reduces picture resolution, so one bad effect must be set against the other, and as usual, a compromise seems the best solution.

Extended PAL

So here we have an evident area for improvement, though little can be done with present channel bandwidths. When satallite TV comes on the scene matters will be quite different. The transmissions at UHF which carry the present TV service range from 470 to 854 MHz. However, the satellite transmission will be from 11.7 to 12.5 GHz (1 GHz = 1,000 MHz). This will permit wider bandwidths for each of the 40 channels which have been allocated to the European broadcasting countries.

The actual bandwidth is 27 MHz, although the channel separation is 19 MHz. Interference is unlikely in spite of the overlap because adjacent channels are assigned to different countries with different satellite positions and opposite polarisation (see ETI December 1982 for a fuller explanation).

With a bandwidth of 27 MHz much can be done to improve television standards (the technical ones that is). The BBC proposed a system called Extended PAL (E-PAL), which has as its object maintaining or even increasing luminance resolution without any interaction between luminance and chrominance signals.

So how is it done? Low video frequencies are modulated on the carrier as with the existing system, but they are cut off at the transmitter above 3.5 MHz. The

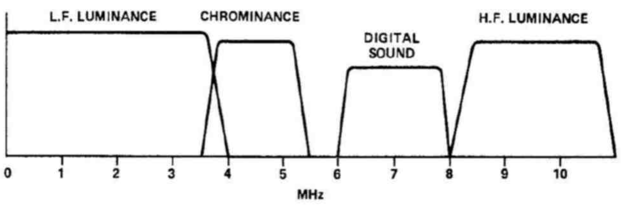


Fig. 2 Frequency spectrum of Extended PAL. All luminance detail above 3.5 MHz is frequency shifted upward well beyond the range of the chrominance signal. In addition there is a 2 MHz gap which accommodates the digital audio channels.

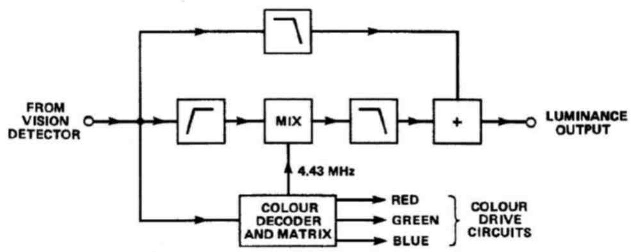


Fig. 3 Block diagram of decoder for Extended PAL. The shifted HF video signals are filtered through a high-pass filter to a mixer which is also supplied with 4.43 MHz from the colour decoder. Resulting stepped-down HF signals are filtered, then added to the LF video signals which are passed through a low-pass filter direct from the vision detector.

video frequencies above 3.5 MHz are not lost, but are shifted upwards in frequency by 4.43 MHz. So, detail at 4 MHz in the original picture appears at 8.43 MHz and so on. Thus the highest video frequency of 5.5 MHz comes out at 9.93 MHz. Actually, the range extends to over 10 MHz, so detail finer than 5.5 MHz is transmitted.

This leaves a gap between 3.5 MHz and 8 MHz. The chrominance sub-carrier remains at 4.43 MHz and so falls within the gap. There is no interleaving except at the extreme lower chrominance sideband so there is no mutual interference.

In the receiver all video frequencies above the chrominance and sound channels are changed back down to their original value and added to the low-frequency video signal, thus reconstituting the full range of the original. The reconstituted signal is applied to the display to give a high resolution picture that is free from spurious colour effects.

A feature of this arrangement is the 4.43 MHz frequency shift. In every PAL receiver there is a 4.43 MHz oscillator which is controlled by a synchronising signal known as the colour-burst which is transmitted after every line pulse. The purpose of this is to decode the colour information, and it provides a phase reference whereby the alternate lines are reversed in phase to compensate for colour discrepancies due to phase shifts in the transmission and receiving links.

Part of the output of this oscillator can therefore be us-ed for the same purpose as the local oscillator in a superhet receiver, to produce a change of frequency. The new frequency is the difference between that of the input and the oscillator, so the down-conversion is accomplished with the minimum of extra components and circuitry.

A big advantage with E-PAL is that it is largely compati-ble with existing receivers. These could just ignore the band of up-converted high video frequencies and give a response up to the roll off of 3.5 MHz. This is only a little below what is commonly received at present, and no worse than many sets that are mis-tuned. However, these sets will require some sort of sound adapter — see later.

Another potential advantage is that many countries that at present use the PAL system, which is most of Western Europe, may find the compatibility feature attractive and adopt it themselves for their satellite broadcasts.

Enter the Challenger

What might have proved a simple and logical step to go ahead with E-PAL was confused by the entry of IBA's contender MAC. The letters stand for Multiplexed Analogue Component which is not a particularly apt description, but one no doubt chosen to make a good-sounding acronym.

It is quite different from PAL or SECAM or in fact any other known system and therefore is incompatible, and cannot be received with any existing receiver. It has one thing in common with SECAM in that information is transmitted sequentially.

With both PAL and SECAM the colour information is resolved into two (red and blue) colour difference signals. The third primary colour, green, is obtained by a process of adding and subtracting these with the luminance signal which being white, contains all three. In the case of PAL, as we have seen, the two signals are phase and amplitude modulated on to a sub-carrier which is interleaved with the video signal. With SECAM, the red and blue difference signals are transmitted sequentially on alternate lines. Each is fed to a delay line which stores it for one line and then mixes it with the incoming one. So each displayed line is a mixture of the present and previous one which reduces the vertical colour resolution by half although it avoids the luminance/colour interference of standard PAL.

With MAC, the composite colour signal and the luminance signal are transmitted *sequentially,* but not on alternate lines. Exactly how the signals are multiplexed depends on the sound system chosen — see Fig. 4 for details. However, both signals have to be time-compressed, so that the luminance is transmitted over 40μS and the chrominance over 20μS (compared to the 53μS normally required for a line scan, and the 64μS interval between starts of successive lines).

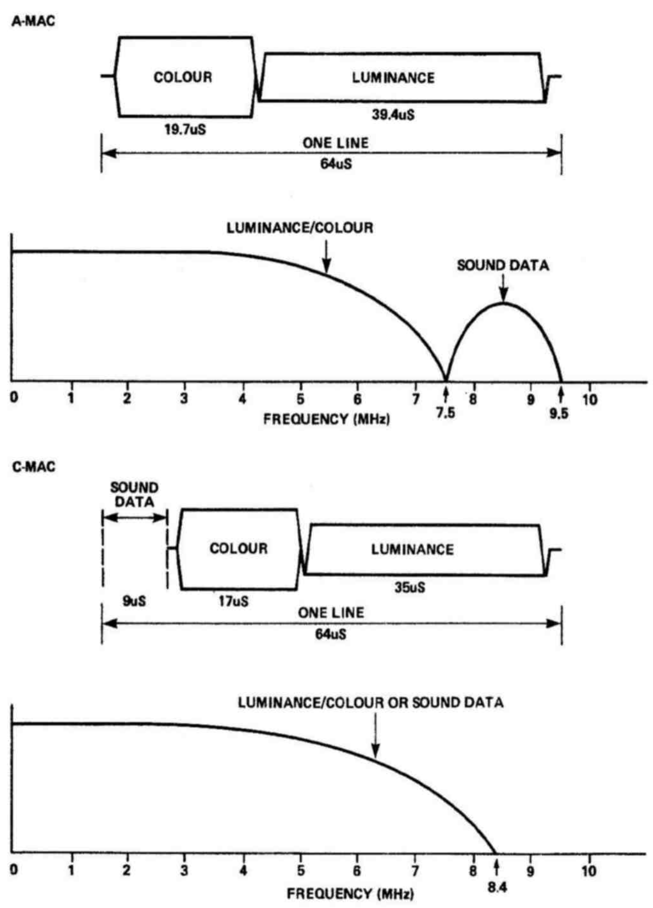


Fig. 4 Structure of the MAC signal for A-type and C-type sound. Note that the luminance and chrominance signals are time-compressed less for A-MAC than for C-MAC, thus obtaining the same eventual bandwidth for a lower transmitted bandwidth.

Both signals are generated simultaneously in the camera, but the chrominance signal is delayed until the end of the luminance signal for that line, then doubled in frequency and transmitted in compressed form. The luminance signal undergoes a rather smaller speeding up. As we have already seen, the chrominance signal in any colour system is of lower resolution, hence contains no high video frequencies, so the transmission of the chrominance signal at double frequency is still well within the video bandwidth of the system.

At the receiver, the reverse process takes place. The luminance signal is delayed so that it starts at the same time as the chrominance, and both are time expanded to occupy the 53μS line scan period, and both are applied to the display circuits together. Thus the same object is achieved as with Extended PAL, luminance and chrominance are prevented from mutual interaction but in a totally different manner.

The video bandwidth at present proposed for MAC is 5.6 MHz for luminance and 1.3 MHz for chrominance. For a complete line to be transmitted in 40μS, the luminance bandwidth must be 7.5 MHz; there is, however, room to spare if the same bandwidth is used for the chrominance signal.

Incompatible - That's What You Are

The principal drawback of MAC is its incompatibility with any other television system. Whereas existing PAL receivers could be used with front-end frequency converters to receive satellite transmissions in Extended PAL, this would not be so if the transmissions were in the MAC format. New sets would have to be purchased, which is why I think the TV manufacturers favour MAC! This doesn't mean though that everyone's TV set would be obsolete overnight when satellite transmissions commence. Terrestial UHF PAL broadcasts would continue for the foreseeable future, just as 405 line transmissions have. But inevitably there would be pressure to move towards a single system eventually.

Another factor that perhaps has not been considered, is that video recordings and games are usually played through the family TV. A change of set to another system would mean all those tapes as well as the recorder would become unplayable unless the existing set was retained. In modern homes the space required for two full-sized TV receivers may pose something of a problem. An answer to this would be dual-standard sets such as were produced when 625-line transmissions began. However, the dissimilarity between the two systems, in my opinion, makes dual-standard sets impractical.

No doubt the protagonists of MAC hope that it would be accepted as a standard by other countries, but as this would mean running two separate systems, PAL or SECAM and MAC, then dropping their existing one eventually, the chances appear slim. They are not improved either by political considerations. So, if MAC were adopted here, most likely it would leave the UK out on a limb with a non-standard system used nowhere else in the world.

Therefore, I find it surprising that the advisory panel appointed by the Government to recommend the standard to be used for direct satellite TV broadcasting has come down in favour of MAC rather than Extended PAL. The chairman, Sir Anthony Part said that 'it was better technically, easier to manufacture, and has greater development potential'. The PAL system, he said was 'based on technology that was becoming outdated'. Sir Anthony, it might be noted, is a chairman of an insurance company.

Sound

It is generally agreed that the sound accompanying the satellite broadcasts should be digital, but there has yet to be any final decision as to its format. The European Broadcasting Union has looked at two systems, EBU System A and EBU System C (there was originally a System B, but this was withdrawn at a very early stage).

System A uses a single digitally-modulated sub-carrier with six channels of sound multiplexed together. Each channel would, under the BBC's E-PAL proposals, have had a 15 kHz bandwidth, sampled at 32 kHz, initially coded into 14-bit words but compressed to 10-bits; the resulting 2.048 Mbits per second would have been modulated onto a sub-carrier using phase-shift keying.

System C takes a different approach and switches the whole channel into digital mode during the 9.5 μS intervals between picture lines. Using the same techniques for data compression and modulation as in the BBC's proposals, the IBA proposed putting eight sound channels into the signal. The IBA also had a proposal for using System A sound, though it did express a marked preference for System C.

There is no reason why the multiplexed information should always have to have equally sized components. The BBC have developed a system whereby a **structure map** is transmitted periodically; this tells the receiver how to treat the informaiton it is receiving, ie which bits go to which output.

Another system, called **packet multiplexing** splits the information up into packets, each one of which has its own digital label to tell the receiver how it is to be treated. However, this system carries a higher overhead and one of the sound channels would have to be sacrificed to accommodate it.

Further Enhancement

Whatever system is finally chosen, further enhancement of the picture is possible by various means. One way is by the use of a frame store. These have already been used to reduce picture noise.

The technique is based on the fact that each picture frame is almost identical to its predecessor. Examination of a short length of cine film will confirm this. Each frame can therefore be mixed with several previous ones during which time the picture will not have changed much. Noise, though, is different for each frame and the mixing averages it out.

Mixing two frames by using a single frame-store produces 3 dB noise reduction, but to achieve 10 dB a mix of 10 frames would by required necessitating 9 stores. As frame-stores are bulky and expensive, an alternative is to use a feedback loop across a single store. Feedback can be adjusted to control the mix, the greater the feedback, the more frames recycled and the greater the noise reduction. An optimum value has been found to give 8.5 dB.

While averaging has no detrimental effect on stationary portions of the picture, it produces blurring on moving parts as would be expected. To minimise this, feedback is regulated by a motion detector which compares successive frames. If there is appreciable difference, motion is assumed and feedback reduced.

Thus blurring is avoided to any great extent, but the noise reduction is also decreased. This is not a major drawback, as noise is less noticed in pictures with plenty of action than stationary ones in which reduction is greatest. The system is used by the BBC to clean up noisy programme sources, but a frame-store could also be used in a receiver to increase resolution. This is becoming more practical now frame-stores are getting smaller and cheaper.

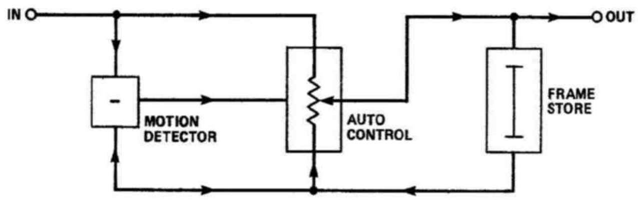


Fig. 5 Basic principle of frame-store noise reducer. Output is fed either direct from the input or from the frame-store output depending on the auto control setting. This is governed by the motion detector which compares incoming and previous frames for differences.

Here again the idea relies on the fact that successive frames are similar with large stationary areas. Instead of unnecessarily repeating such areas in transmission, they can be sent and stored, updating occurring when there is any deviation from the stored picture. The transmission time thus saved can then be filled with finer detail to add to the stored frame. The BBC claim that a resolution equivalent to 900 lines can be obtained in this way.

Resolution varies over the picture just as noise does with the frame store noise reduction system. Stationary objects appear with the greatest detail, while moving objects have less. As we tend to examine visually stationary objects, while having little time to do so with moving ones, the subjective effect is not greatly impaired by the difference. It can though produce some rather strange effects when a stationary object starts moving slowly away, whereupon much of the detail disappears.

Lines and Frames

Neither Extended PAL or MAC propose to change the number of lines and frames. For all domestic and many other purposes, 625 lines is perfectly adequate when displayed on normal-sized direct-view screens. Colour also serves to render the line structure less noticeable than monochrome. Although having a better vertical resolution, the 819-line system in France is being phased out, so the higher number of lines is evidently considered of less benefit than other factors. The 625-line system has also established itself as a worldwide standard except in the American continent and some Eastern countries.

When projected on to a large screen though, 625 lines do give a liney appearance, which is a consideration if the large flat wall screens that have been said to be on the way for a long time, ever turn up. In such a case the lines may have to be increased.

In Japan and America where the 525-line standard is used it is natural that there should be more urgent thoughts of uprating their line standard. Most of us will not have seen a 525-line picture, but the effect can be judged being halfway between our 625 lines and the old 405 lines. Not a pretty sight on large-screen direct-view sets to say nothing of projection screens!

It comes as no surprise then, that the Japanese Broadcasting Corporation NHK, has devised a new high-definition TV standard for use with satellites. It uses 1,125 lines and has an aspect ratio of 5:3, which is closer to some of the wide-screen cinema films that so often appear on television, and also to natural human vision. Bandwidth required is 20 MHz which although high by present standards could be accommodated within the channel width of 27 MHz allocated for the European satellites.

The Japanese hope that their high-definition system will become a world-standard. Most of the Japanese manufacturers have lined up firmly behind it with JVC, Sony, Matsushita, Toshiba, Panasonic, Hitachi and

Ikegemi either developing equipment or actually having it in production.

America too is more than just interested. CBS are conducting trials and propose to launch it in 1987. It is to be expected that many other countries in the American continent of the 525-line standard will leap-frog over 625 lines to the NHK system. Likely too, is it that some presently on 625 will join them.

A demonstration was held at the EBU's annual meeting in Killarney using the facilities of Radio Telefis. Material used was a CBS videotape of an American football match which was projected on to a 100-inch screen. It is reported that not only could the stitches be seen on the football, but during a scan of the stadium the seat numbers could be clearly read! As such details could hardly be visible to a spectator actually present at the event it cannot be ignored that the story came from the land of the Blarney Stone!

So what propsect does the NHK system hold out? Only a multiplicity of standards with the possibility of MAC being used here and straight or enhanced versions of PAL and SECAM being adopted elsewhere. It looks as though the hope that the coming of satellite TV might have brought a common international standard is rapidly fading, if ever there was any grounds for its existence.

Line and Frame Doubling

In order to reduce the conspicuousness of the line structure with large projection screens, it is possible to double the line number artificially by scanning the same line twice. This can be done with a minimum of modification to existing systems. As the same amount of information is transmitted it does not increase the vertical definition, but it does give a better subjective effect.

Some readers may remember the spot-wobble that was introduced with some 405-line receivers. It gave a small vertical oscillation to the scanning spot and thereby filled in the gaps between lines. It wasn't wholly successful as the spot was lengthened as well as widened to form an ellipse. This reduced the horizontal definition, and the whole effect was that of being slightly out of focus. Most viewers switched it off. Line doubling has the same objective but would not impair horizontal resolution.

Another factor which may be considered for improvement is the flicker rate. Flicker is noticeable when the rate is low. This can be demonstrated with a cine projector having variable speeds. As the speed is reduced, so the flicker become more pronounced.

Although the frame rate is 25 per second, the flicker rate is 50. This is because each frame is split into two fields which are interlaced; that is the lines of one fall in between those of the other. Thus lines 1, 3, 5, 7, and so on are scanned to be followed by lines 2, 4, 6, 8, to the bottom of the picture.

Under normal conditions the flicker rate of 50 is not noticeable, but on larger screens, large bright areas can produce flicker, especially if seen out of the corner of the eye. The American frame rate of 30 giving a flicker rate of 60 is better, though only marginally so.

To increase the number of frames would entail an increase of bandwidth, but as with the line, the flicker rate could be doubled by scanning each field twice in the receiver. A similar method of reducing flicker is employed in cine projectors where the light is interrupted not only when each frame is pulled down but also once or twice when the frame is stationary in the gate.

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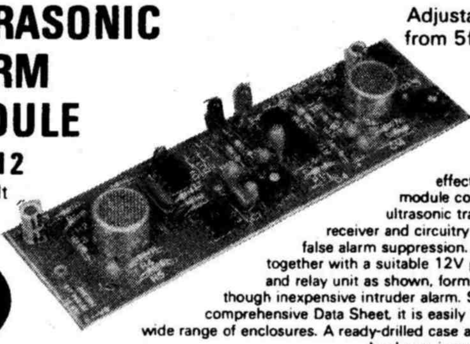

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ZX81 USER-DEFINED GRAPHICS

For our second example in the DIY guide to making your ZX81 a whole lot better, we present a project that gives 16K RAM pack owners the facility for user-defined graphics. Design by G.N. Hill, MA Hons.

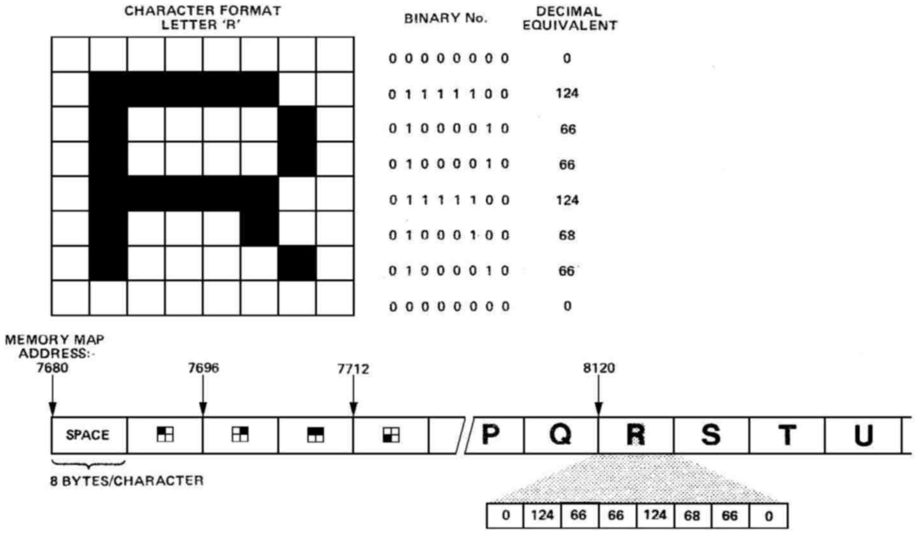


Fig 1 Memory map of the character generator and the method character generation, illustrated by the letter 'R'.

The restrictions imposed by the Sinclair defined character set can considerably reduce impact of many programs and the attractions of having user-definable graphics are apparent. While several manufacturers supply modules to expand the character set, the cost of £20 plus must be a rather daunting prospect to the impecunious '81 owner.

It is possible, however, to obtain user-definable graphics on the 16K ZX81 for a total expenditure of less than £1 and some clever work with a soldering iron! It must be said, however, that this is not a project for the fainthearted, involving as it does a certain amount of modification and soldering within the computer; it also renders the computer unusable without the RAM pack.

Principle of Operation

In normal operation the pattern of each character is defined by eight successive bytes in the ROM. Each byte represents the display for one of the eight lines of the character, and each binary bit one dot of that line: Fig. 1 clarifies the way that this works. As there are 64 characters, a total of 512 (64 × 8) bytes are required, and these are located at the top of the ROM from addresses 7680 to 8191 (1E00 to 1FFF in hexadecimal). An examination of these addresses reveals that the character generator is being addressed exclusively when lines A9 to A12 are high.

The additional circuit operates by detecting when these four lines are simultaneously high with the ROM chip select line, and instead of allowing the ROM to be switched on, the internal 1 K RAM is activated (this is not normally used when the 16K RAM pack is attached). This can then be filled with characters of the programmer's choice. The circuit diagram is given in Fig. 2.

Construction

The circuit is constructed on a PCB as shown in Fig. 3. Use fairly thin (insulated) wire, preferably with colour coding, for the leads between the PCB and computer. The length of the leads will need to be adjusted carefully during connection to the computer PCB in order to keep the modification as neat as possible.

Installation And Computer Modifications

To open the computer remove all leads and accessories and then peel off the rubber pads on the underside of the computer, taking care to ensure that the adhesive film is removed with the pads. Now remove the five Phillips screws visible on the underside of the computer; note that these are of different lengths and *must not* be mixed on re-assembly. The base of the computer can now be lifted away to reveal the computer printed circuit board held in place by a further two Phillips screws, which must also be removed. The board is still attached to the case through the ribbon connector and should be carefully folded over the keyboard when you want to turn it over, since the ribbon connector is not easy to disconnect or reconnect.

The positioning of the switch does need to be thought out fairly carefully in order to ensure that it does not foul anything. Providing the switch is not too big, it should fit through the top of the case. Just in front of the RAM pack, towards the centre of the computer offers the most room, but do make sure before drilling the hole that it will all go back together (including the RAM pack connection) without fouling. If you find the prospect of drilling holes in your beloved computer a little daunting, the leads can be brought out through one of the existing holes (eg round the aerial socket) to a floating switch.

The addressing of the RAM and ROM chips is performed in a slightly different way by the computer and it is therefore necessary to disconnect the 10 address lines to the RAM chip(s), reconnecting nine of them to the (A0' to A8') ROM chip address lines and the tenth to either an earth or a logic high. This cannot be done easily from the underside of the board, as the address tracks servicing the 1K RAM also service the 16K RAM pack. The most straightforward (if somewhat inelegant) solution is to remove the RAMs from their sockets, to bend the relevant legs through 90° and then to replace the RAMs in their sockets, but with 10 of the pins sticking out at right angles. It is now necessary to solder the address leads to these legs and into the computer PCB — Figs. 4a, b, c and d give details.

Spot Your RAM

Before doing this, it will be necessary to decide whether your particular ZX81 is of the 2114 RAM or 4118 RAM type. The former consists of two separate chips as shown in Fig. 4a; the latter has only one and the position of this is shown as a dotted outline. Identify each of the address pin numbers from Fig. 4d and run a lead from this to the relevant computer PCB hole as shown in Fig. 4c. In the case of the 2114 type it is also necessary to run leads between the two ICs. If you find difficulty in soldering directly to the IC pins, it may help to have a very thin strip of Veroboard pushed over the pins and solder to this. The leads to the switch can now be soldered into place.

Figure 5 shows the nine connections to be made to the other side of the computer board; the letters for each connection correspond with those of Fig. 3. Resistor 'R28' is removed from the computer PCB and the ROM chip select input and output connections are made through the resulting holes as shown. Figure 5 also identifies the RAMCS' track, which must be (carefully!) cut through. The PCB fits under the keyboard by the side of the heat sink.

Testing And Reassembly

It is worth quickly testing the computer at this stage. First, however, check, check and check again that all the joints and connections are correct and that there are no solder bridges between tracks.

Place the RAM pack in position and connect the TV lead and power supply lead. With the switch in 'normal' mode the computer should operate quite normally. In 'user' mode a regular pattern should cover the screen (each space now calling up the same random character). The program given below can be entered in 'normal' mode and run in 'user' mode to ensure that the modification is functioning correctly:

```
10 SLOW
20 FOR N=1 TO 64
30 PRINT CHR$ N;
40 NEXT N
50 FOR N=7680 TO 8191
60 POKE N, 255
70 NEXT N
```

When run in 'user' mode the screen should suddenly black out apart from the top two lines, which should then progressively fill one character position at a time from left to right, each individual character filling from top to bottom.

Reassembly of the computer is simply a reversal of the disassembly procedure. Ensure that no leads are trapped between the pillars and the board and that the correct screws are used; short ones at the front, long at the back.

Operation Of User Graphics

It is unlikely that you will want to redefine all 64 of the available characters and the most likely requirement will be to have four or five special characters amongst the existing ones. As it is not possible to display both the Sinclair graphics

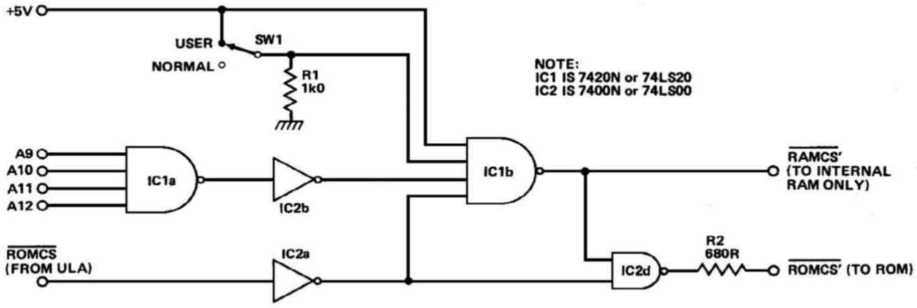


Fig. 2 Circuit diagram of the user-graphic modification.

HOW IT WORKS

The inputs of the quad NAND gate IC1a are connected to the four address lines A9 to A12. The output of this gate is inverted (using the NAND gate IC2b with its two inputs connected together) and used as one of the four inputs for IC1b. A second input is produced by inverting the ROMCS (ROM chip select) signal from the ULA using IC2a. The third input is provided by the switch, which in 'user' mode supplies a high and in 'normal' mode a low. The fourth input is held permanently high.

Thus, when the switch is in 'user' mode and the ROM and the character generator are being addressed, all the inputs to IC1b will be high and the output will be low: in any other circumstances the output will be high. This, therefore, satisfies the condition required by the RAMCS' line to the internal 'user' RAM.

The output of IC2d provides the new ROM chip select line (ROMCS') by performing a logical NAND between the new RAMCS' output and the inverse of the ROMCS input from the ULA. Thus, when the user RAM is being selected, the output will always be high, and when the RAM is not being selected the output will copy the ROMCS input.

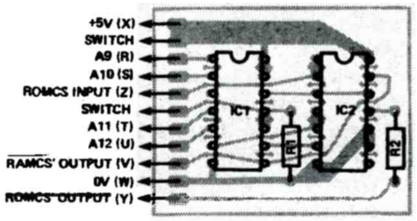


Fig. 3 Component overlay for the off board components. The letters correspond to Fig. 5.

PARTS LIST

Resistors (all ¼W, 5%)
R1 **1k0**
R2 **680R**

Semiconductors
IC1 **74LS20**
IC2 **74LS00**

Miscellaneous
SW1 **SPST miniature toggle or slide switch**
PCB (see Buylines).

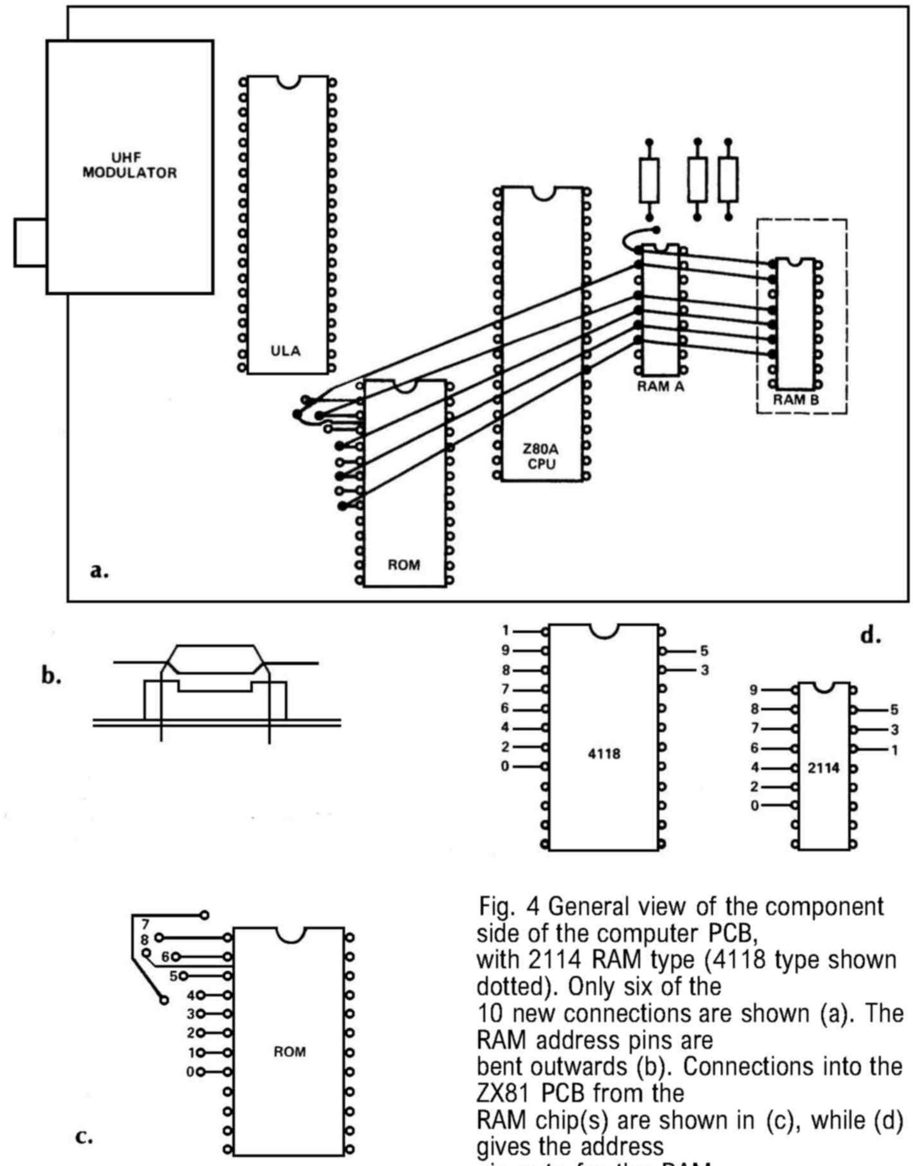


Fig. 4 General view of the component side of the computer PCB, with 2114 RAM type (4118 type shown dotted). Only six of the 10 new connections are shown (a). The RAM address pins are bent outwards (b). Connections into the ZX81 PCB from the RAM chip(s) are shown in (c), while (d) gives the address pin outs for the RAM.

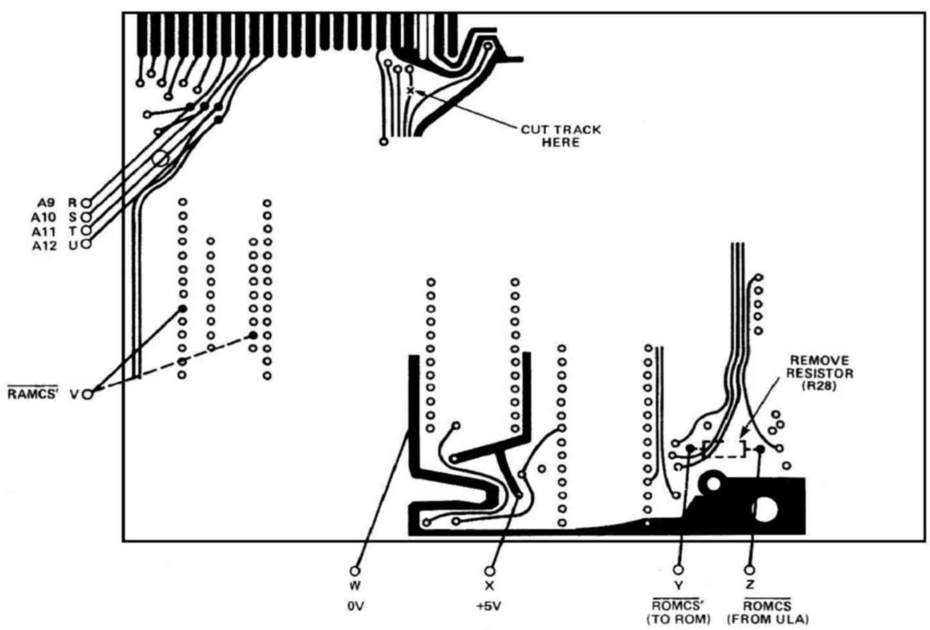


Fig. 5 Connections to the underside of the ·ZX81 PCB.' RAMCS' connections are shown for both the 2114 type (dotted) and. the 4118 type (solid) RAM ICs.

and the user graphics at the same time, the simplest solution is to copy the Sinclair graphic set into the user RAM, and then to select some little-used primary characters (eg ≤, >, £, ?) and redefine them.

The exact way that this is done can vary, but my usual approach is to copy the Sinclair graphics into the user RAM at switch on. Listing 1 gives a short program (using machine code) to achieve this. When entering the REM statement (line 1) it must be entered exactly as listed. The outlines of the graphic characters have been added to clarify which symbols to use, and don't miss the three spaces in line l which require keying in. The keyword in line 1 is entered by first . typing THEN (shifted 3), followed by GOSUB and deleting THEN using the Edit functions, but leaving the GOSUB intact. As a quick check that the line has been entered correctly, PEEK 16526 should return 118. The program borrows some of the unused computer RAM to temporarily store the 512 bytes read from the ROM and should not, therefore, be used as part of a larger program, otherwise this may be overwritten and corrupted. If this is a problem, the program can be written entirely in BASIC and listing 2 gives such a program.

Having thus copied the Sinclair graphics into the user RAM, each program can then amend the characters as required and preferably restore the original ones at termination.

```
   1 REM ▪  ▀5 2) 2 GOSUB ▌TAN
   2 POKE 16522,80
   3 LET U=USR 16514
   4 PRINT "SWITCH TO ""USER"" A
ND PRESS ""CONT"""
   5 STOP
   6 POKE 16522,30
   7 POKE 16519,80
   8 LET U=USR 16514
   9 POKE 16519,30
```

Listing-1 Program to copy Sinclair character set into user RAM, using a machine code routine.

```
  10 FAST
  20 DIM C(512)
  30 FOR A=7680 TO 8191
  40 LET C(A-7679)=PEEK A
  50 NEXT A
  60 PRINT "SWITCH TO ""USER"" A
ND PRESS ""CONT"""
  70 STOP
  80 FOR A=7680 TO 8191
  90 POKE A,C(A-7679)
 100 NEXT A
```

Listing 2 BASIC program to copy Sinclair character set into user RAM.

BUYLINES

Absolutely nothing out of the ordinary in this project, and any of the mail order component suppliers advertising in this issue will be able to supply all the parts. The PCB Service order form is on page 83.

```
   1 REM 0000000000000000000000
00000000000000000000000000000000
00000000000000000000000000000000
00000000000000000000000000000000
00000000000000000000000000000000
0000000000000000
   5 LET AD=16580
  10 DIM A(8,8)
  20 FOR Y=1 TO 8
  30 PRINT "XXXXXXXX";Y
  40 NEXT Y
  50 PRINT "ABCDEFGH"
  60 PRINT AT 15,0;"INPUT PIXEL
COORD EG. A1 . HIT  NEWLINE TO F
INISH"
  70 INPUT A$
  80 IF A$="" THEN GOTO 160
  90 IF CODE A$(1)<CODE A$(2) TH
EN GOTO 70
 100 LET Y=CODE A$(2)-28
 110 LET X=CODE A$(1)-37
 120 IF X>8 OR X<1 OR Y>8 OR Y<1
 THEN GOTO 70
 130 LET A(X,Y)=ABS (A(X,Y)-1)
 140 PRINT AT Y-1,X-1;CHR$ (61+A
(X,Y)*67)
 150 GOTO 70
 160 CLS
 165 PRINT AT 15,0;"WHICH CHARAC
TER IS TO CHANGE?"
 170 INPUT A$
 180 LET CA=7680+8*CODE A$
 190 LET HB=INT (CA/256)
 200 LET LB=CA-256*HB
 210 POKE AD,LB
 220 POKE AD+1,HB
 230 LET AD=AD+2
 240 FOR Y=1 TO 8
 250 LET D=0
 260 FOR X=1 TO 8
 270 LET D=D+A(X,Y)*2**(8-X)
 280 NEXT X
 290 POKE AD,D
 300 LET AD=AD+1
 310 NEXT Y
 320 IF AD<16671 THEN GOTO 350
 330 PRINT AT 15,0;"YOU HAVE DEF
INED THE MAXIMUM OF 10 CHARACTER
S. IF YOU WISH TO DEFINE MORE CH
ARACTERS PLEASE SEE TEXT OF ARTI
CLE, OTHERWISE TYPE PRINT USR 16
360"
 340 STOP
 350 PRINT AT 15,0;"****
*****TYPE Y OR N"
 360 INPUT A$
 370 IF A$(1)="Y" THEN PRINT USR
 16560
 380 CLS
 390 GOTO 10
```

ADDRESS					
16514	62	10	33	196	64
16519	17	186	64	229	213
16524	229	1	10	0	237
16529	176	42	186	64	209
16534	229	19	19	1	8
16539	0	237	176	209	225
16544	35	35	1	8	0
16549	237	175	225	1	10
16549	237	175	225	1	10
16554	0	9	61	200	24
16559	215	33	41	65	195
16564	3	4			

Listing 3 Program for defining new characters and storing the information in the REM statement for later use (left): the values above are to be POKEd into the REM statement of line 1 using listing 4.

Listing 4 Program for POKEing machine code values into the REM statement of listing 3.

```
 500 PRINT "WHAT IS THE START AD
DRESS?       (NORMALLY 16514)"
 510 INPUT A
 515 CLS
 520 PRINT AT 0,0;"INPUT NEXT NO
. TO BE POKED. TYPE 999 TO TERMI
NATE"
 530 INPUT D
 540 IF D=999 THEN STOP
 550 IF D<0 OR D>255 THEN GOTO 5
30
 560 POKE A,D
 570 SCROLL
 580 PRINT AT 18,0;A,D
 590 LET A=A+1
 600 GOTO 520
```

Listing 3 gives a program enabling up to 10 new characters to be defined with the aid of a visual display and the information stored in the REM statement of line 1. Only the primary characters (with their inverse) can be redefined and these are the first 64 characters of the list on page 181 of the Sinclair manual. When all the characters have been defined and "FINISHED?" is answered with "Y", the program deletes itself, excepting the REM statement. This can then be used as the first line of the main program and a call for USR 16514 will exchange the Sinclair characters with the new characters required; a further call of USR 16514 will exchange them back.

When entering the REM statement of listing 3, it is important to use noughts and to have exactly the right number (166). This can be checked by PEEKING 16680, which should return 118.

This program (ie listing 3) requires the machine code values given alongside it to be POKED into the REM statement. Listing 4 gives a suitable program for doing this and this should be entered and run immediately after entering the REM statement. All of this program (except the REM statement) may then be deleted and the rest of listing 3 entered.

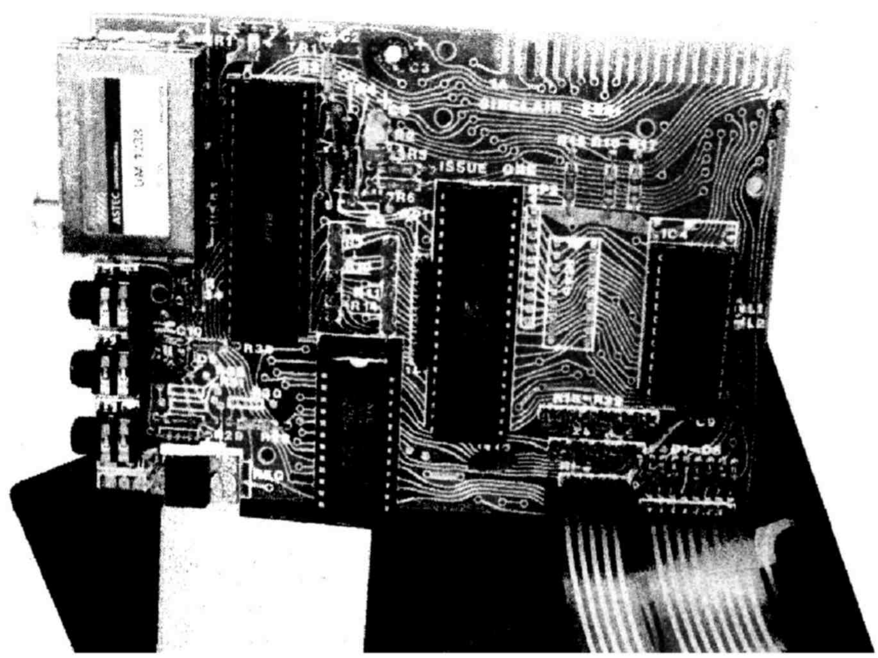
If more than 10 characters need to be defined, it will be necessary to add 10 further noughts to the REM statement for each extra character required; the final address (currently 16671) in line 320 will have to be increased by 10 for each extra character, as will the value held by the two bytes in addresses 16561 and 16562 (currently 16681). This latter value is held in the usual Z80 manner, ie. low byte first and high byte second. Having added on the required number of tens to 16681, divide by 256 to give the high byte (being the whole number part of the result) and multiply the remainder by 256 to give the low byte. For example, 16691/256 = 65.19922. Now 0.19922 × 256 = 51, so we have to POKE 16561, 51 and POKE 16562, 65.

Because the graphics are completely unaffected by RUN, NEW, LOAD, and so on, it is also possible to enhance many of your existing games and programs by redefining specific characters used in the game before loading the program. Thus chess games using I, K, Q etc can have proper chess symbols, missiles can magically turn from As into Cruise look-alikes, and so on.

Further Hardware Modifications

While this project was conceived as a very low-cost entry into user-definable graphics, several modifications could be made to bring a greater degree of sophistication to their operation. The manual switching could be replaced by software switching, for example: if you have an input/output port, this can be done by using one of the output port lines as the switch input for IC1b.

Only half of the 1K memory is used and the A10 address line from the RAM chip could be switched between high and low instead of being fixed to a high, thus allowing two pages of user graphics to be available. Again, this could be a software switch controlled by an input/output port.



The PCB before modification; this is a 4118 type (compare with fig. 4a).

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4020	23 04020	0.55
4021	23 04021	0.55
4022	23 04022	0.55
4023	23 04023	0.15
4024	23 04024	0.33
4025	23 04025	0.15
4027	23 04027	0.26
4028	23 04028	0.50
4029	23 04029	0.55
4035	23 04035	0.87
4040	23 04040	0.88
4042	23 04042	0.50
4043	23 04043	0.60
4044	23 04044	0.68
4046	23 04046	0.60
4049UB	22 04049	0.24
4050	23 04050	0.24
4051	23 04051	0.55
4052	23 04052	0.55
4053	23 04053	0.55
4060	23 04060	0.75
4066	23 04066	0.30
4068	23 04068	0.16
4069UB	22 04069	0.14
4070	23 04070	0.16
4071	23 04071	0.16
4072	23 04072	0.16
4073	23 04073	0.16
4075	23 04075	0.16
4076	23 04076	0.55
4077	23 04077	0.18
4078	23 04078	0.18
4081	23 04081	0.18
4082	23 04082	0.18
4093	23 04093	0.30
4099	23 04099	0.80
4175	23 04175	0.80
4502	23 04502	0.60
4503	23 04503	0.50
4506	23 04506	0.70
4507	23 04507	0.37
4508	23 04508	1.50
4510	23 04510	0.65
4511	23 04511	0.45
4512	23 04512	0.55
4514	23 04514	1.25
4515	23 04515	1.25
4516	23 04516	0.60
4518	23 04518	0.35
4520	23 04520	0.60
4521	23 04521	1.30
4522	23 04522	0.89
4526	23 04526	0.60
4527	23 04527	0.80
4528	23 04528	0.65
4529	23 04529	0.70
4531	23 04531	0.65
4532	23 04532	0.80
4534	23 04534	4.00
4536	23 04536	2.50
4538	23 04538	0.85
4539	23 04539	0.80
4543	23 04543	0.80
4549	23 04549	3.50
4553	23 04553	2.70
4554	23 04554	1.20
4555	23 04555	0.35
4556	23 04556	0.40
4557	23 04557	2.30
4558	23 04558	0.80
4559	23 04559	3.50
4560	23 04560	2.50
4561	23 04561	1.00
4562	23 04562	2.50
4566	23 04566	1.20
4568	23 04568	1.45
4569	23 04569	1.70
45672UB	23 04572	0.32
4580	23 04580	3.25
4581	23 04581	1.40
4582	23 04582	0.70
4583	23 04583	0.80
4584	23 04584	0.27
4585	23 04585	0.45
4702	23 04702	4.50
4703	23 04703	4.48
4704	23 04704	4.24
4705	23 04705	4.24
4706	23 04706	4.50
4720	23 04720	4.00
4723	23 04723	0.95
4724	23 04724	0.95
4725	23 04725	2.24
40014	23 40014	0.54
40085	23 40085	0.99
40098	23 40098	0.54
40106	23 40106	0.69
40160	23 40160	1.05
40161	23 40161	1.05
40162	23 40162	1.05
40163	23 40163	1.05
40174	23 40174	1.05
40175	23 40175	1.05
40192	23 40192	1.08
40193	23 40193	1.08
40195	23 40195	1.08

74LSXX

Type	Stock No.	Price
74LS00	31 07400	0.11
74LS01	31 07401	0.11
74LS02	31 07402	0.11
74LS03	31 07403	0.11
74LS04	31 07404	0.14
74LS05	31 07405	0.14
74LS08	31 07408	0.14
74LS09	31 07409	0.14
74LS10	31 07410	0.14
74LS11	31 07411	0.14
74LS12	31 07412	0.14
74LS13	31 07413	0.32
74LS14	31 07414	0.32
74LS15	31 07415	0.14
74LS20	31 07420	0.14
74LS21	31 07421	0.14
74LS22	31 07422	0.14
74LS26	31 07426	0.14
74LS27	31 07427	0.30
74LS28	31 07428	0.18
74LS30	31 07430	0.14
74LS32	31 07432	0.14
74LS33	31 07433	0.14
74LS37	31 07437	0.18
74LS38	31 07438	0.14
74LS40	31 07440	0.18
74LS42	31 07427	0.30
74LS47	31 07447	0.75
74LS48	31 07448	0.40
74LS49	31 07449	0.80
74LS51	31 07451	0.14
74LS54	31 07454	0.14
74LS55	31 07455	0.14
74LS74	31 07474	0.21
74LS75	31 07475	0.21
74LS76	31 07476	0.25
74LS78	31 07478	0.19
74LS83	31 07483	0.33
74LS85	31 07485	0.44
74LS86	31 07486	0.15
74LS90	31 07490	0.24
74LS91	31 07491	0.36
74LS92	31 07492	0.32
74LS93	31 07493	0.24
74LS95	31 07495	0.36
74LS107	31 74107	0.31
74LS109	31 74109	0.25
74LS112	31 74112	0.21
74LS113	31 74113	0.21

Type	Stock No.	Price
74LS114	31 74114	0.21
74LS122	31 74122	0.27
74LS123	31 74123	0.36
74LS125	31 74125	0.27
74LS126	31 74126	0.27
74LS132	31 74132	0.27
74LS133	31 74133	0.24
74LS136	31 74136	0.20
74LS138	31 74138	0.30
74LS139	31 74139	0.30
74LS151	31 74151	0.30
74LS153	31 74153	0.34
74LS155	31 74155	0.30
74LS156	31 74156	0.33
74LS157	31 74157	0.27
74LS158	31 74158	0.27
74LS160	31 74160	0.34
74LS161	31 74161	0.36
74LS162	31 74162	0.36
74LS163	31 74163	0.36
74LS164	31 74164	0.40
74LS165	31 74165	0.60
74LS166	31 74166	0.58
74LS168	31 74168	0.89
74LS170	31 74170	0.63
74LS173	31 74173	0.47
74LS174	31 74174	0.37
74LS175	31 74175	0.40
74LS181	31 74181	0.87
74LS183	31 74183	1.05
74LS190	31 74190	0.39
74LS191	31 74191	0.39
74LS192	31 74192	0.39
74LS193	31 74193	0.39
74LS194	31 74194	0.39
74LS195	31 74195	0.39
74LS196	31 74196	0.39
74LS197	31 74197	0.47
74LS221	31 74221	0.50
74LS240	31 74240	0.60
74LS241	31 74241	0.60
74LS242	31 74242	0.55
74LS243	31 74243	0.55
74LS244	31 74244	0.60
74LS245	31 74245	1.00
74LS251	31 74251	0.36
74LS253	31 74253	0.36
74LS257	31 74257	0.36
74LS258	31 74258	0.36
74LS259	31 74259	0.51
74LS260	31 74260	0.26
74LS266	31 74266	0.20
74LS273	31 74273	0.70
74LS279	31 74279	0.35
74LS283	31 74283	0.40
74LS290	31 74290	0.40
74LS293	31 74293	0.46
74LS298	31 74298	0.54
74LS365	31 74365	0.34
74LS366	31 74366	0.40
74LS367	31 74367	0.30
74LS368	31 74368	0.30
74LS373	31 74373	0.72
74LS374	31 74374	0.72
74LS375	31 74375	0.31
74LS377	31 74377	0.60
74LS378	31 74378	0.44
74LS379	31 74379	0.44
74LS385	31 74385	1.30
74LS386	31 74386	0.77
74LS390	31 74390	0.51
74LS393	31 74393	0.48
74LS398	31 74398	0.80
74LS399	31 74399	0.65
74LS490	31 74490	0.80
74LS670	31 74670	1.15

74CXX

Type	Stock No.	Price
74C00	29 07400	0.35
74C02	29 07402	0.35
74C04	4069	
74C08	29 07408	0.35
74C10	29 07410	0.35
74C14	4584	
74C20	29 07420	0.35
74C30	29 07430	0.35
74C32	29 07432	0.35
74C42	29 07442	1.05
74C48	29 07448	1.50
74C73	29 07473	0.75
74C74	29 07474	0.75
74C76	29 07476	0.60
74C83	29 07483	1.30
74C85	29 07485	1.30
74C86	29 07485	1.30
74C89	29 07489	3.60
74C90	29 07490	1.05
74C93	29 07493	1.05
74C95	29 07495	1.25
74C107	29 74107	0.60
74C151	29 74151	2.10
74C154	29 74154	3.05
74C157	29 74157	2.10
74C160	40160	
74C1610	40161	
74C1620	40162	
74C1630	40163	
74C164	29 74164	1.05
74C165	29 74165	1.10
74C173	4076	
74C1740	40174	
74C1750	40175	
74C1920	40192	
74C1930	40193	
74C1950	40195	
74C200	29 74200	6.50
74C221	29 74221	1.55
74C901	29 74901	0.55
74C902	29 74902	0.55
74C903	29 74903	0.55
74C904	29 74904	0.55
74C905	29 74905	6.50
74C906	29 74906	0.55
74C907	29 74907	0.55
74C908	29 74908	1.10
74C909	29 74909	2.10
74C910	29 74910	5.00
74C914	29 74914	1.10
74C918	29 74918	1.30
74C925	29 74925	6.00
74C926	29 74926	6.00
74C927	29 74927	6.00

74HCXX

Type	Stock No.	Price
74HC00	30 07400	0.56
74HC02	30 07402	0.56
74HC04	30 07404	0.66
74HC10	30 07410	0.56
74HC20	30 07420	0.56
74HC86	30 07486	0.74
74HC132	30 74132	1.26
74HC266	30 74266	0.81
74HC4002	30 04002	0.56
74HC4075	30 04075	0.56
74HC242	30 74242	2.00
74HC243	30 74243	2.00
74HC74	30 07474	0.74
74HC109	30 74109	0.68
74HC175	30 74175	1.08
74HC373	30 74373	2.40
74HC374	30 74374	2.40
74HC533	30 74533	2.40
74HC534	30 74534	2.40
74HC165	30 74165	1.96
74HC173	30 74173	1.20
74HC160	30 74160	1.33
74HC161	30 74161	1.33
74HC162	30 74162	1.33
74HC163	30 74163	1.33
74HC4538	30 74538	2.10
74HC85	30 74280	2.95
74HC280	30 74280	2.95
74HC42	30 07442	1.00
74HC138	30 74138	1.08
74HC139	30 74139	1.08
74HC4514	30 04514	3.40
74HC4543	30 04543	2.75
74HC157	30 74157	0.92
74HC158	30 74158	0.96
74HC257	30 74257	0.90

SMALL SIGNAL AUDIO

Device	Stock No	1-24	25-99	100+
BC182	58 00182	0.10	0.08	0.07
BC212	58 00212	0.10	0.08	0.07
BC237	58 00237	0.08	0.06	0.05
BC238	58 00238	0.08	0.06	0.05
BC239	58 00239	0.08	0.06	0.05
BC307	58 00307	0.08	0.06	0.05
BC308	58 00308	0.08	0.06	0.05
BC309	58 00309	0.08	0.06	0.05
BC327	58 00327	0.13	0.11	0.09
BC337	58 00337	0.13	0.11	0.09
BC413	58 00413	0.10	0.06	0.07
BC414	58 00414	0.11	0.09	0.08
BC415	58 00415	0.10	0.08	0.07
BC416	58 00416	0.11	0.09	0.08
BC546	58 00546	0.12	0.10	0.08
BC550	58 00550	0.12	0.10	0.08
BC556	58 00556	0.12	0.10	0.08
BC560	58 00560	0.12	0.10	0.08
BC639	58 00639	0.22	0.17	0.16
BC640	58 00640	0.22	0.17	0.16
MPSA13	58 04013	0.30	0.25	0.20
MPSA63	58 04063	0.30	0.25	0.20
ZTX108	58 01108	0.10	0.08	0.07
ZTX212	58 01212	0.10	0.08	0.07
ZTX653	58 01653	0.20	0.18	0.16
ZTX753	58 01753	0.20	0.18	0.16
2N2904	58 02904	0.25	0.22	0.20
2N2905	58 02905	0.25	0.22	0.20
2N3905	58 03905	0.10	0.08	0.07
2SB646A	58 03646	0.30	0.27	0.23
2SB648A	58 03648	0.40	0.35	0.30
2SD666A	58 03666	0.30	0.27	0.23
2SD668A	58 03668	0.40	0.35	0.30
2SA872A	58 02872	0.19	0.16	0.17
2SA1084E	58 01084	0.25	0A	0A
2SA1085E	58 01085	0.25	0.24	0.23
2SC1775A	58 01775	0.19	0.18	0.17
2SC2546E	58 02546	0.24	0A	0A
2SC2547E	58 02547	0.24	0.23	0.22

AUDIO POWER

Device	Stock No	1-24	25-99	100+
BD139	58 15139	0.29	0.23	0.19
BD140	58 15140	0.31	0.24	0.20
BD165	58 15165	0.46	0.42	0.38
BD166	58 15166	0.48	0.44	0.40
BD179	58 15179	0.39	0.29	0.24
BD180	58 15180	0.41	0.31	0.36
TIP31A	58 15031	0.35	0.32	0.29
TIP32A	58 15032	0.35	0.32	0A
MJ2955	58 12955	0.66	0.61	0.58
2N3055	58 13090	0.58	0.52	0.47
2SB720	58 15720	0.60	0.54	0.59
2SD760	58 17600	0.60	0.54	0.59
2SJ49	60 01049	3.10	3.00	2.75
2SJ50	60 01050	4.25	3.75	3.35
2SJ83	60 01083	3.55	3.40	2.88
2SK134	60 00134	3.10	3.00	2.75
2SK135	60 00135	4.25	3.75	3.35
2SK227	60 00227	3.55	3.40	2.88
2SD753	58 03753	2.34	1.98	1.65

SMALL SIGNAL RF

Device	Stock No	1-24	25-99	100+
BFY50	58 06500	0.22	0.18	0.16
BF241	58 06741	0.18	0.14	0.12
BF273	58 06273	0.18	0A	0A
BF274	58 06274	0.20	0A	0A
BF362	58 06362	0.49	0.40	0.32
BF440	58 06440	0.21	0.18	0.16
BF441	58 06441	0.21	0.18	0.16
BF479	58 06479	0.66	0.55	0.44
BF6795	58 06679	0.55	0.47	0.33
BFR91	58 07091	1.33	1.10	0.95
BFT95	58 10095	0.99	0.88	0.77
BFW92	58 08092	0.60	0.51	0.42
BFY90	58 09090	0.90	0.65	0.70
NE21936	58 21936	5.00	4.30	3.90
ZTX323	58 06232	0.60	0.55	0.45
2N2369A	58 02369	0.38	0.34	0.30

RF POWER

Device	Stock No	1-24	25-99	100+
BFW16A	58 08016	0.65	0.60	0A
MRF237	58 14237	3.20	2.80	2.45
MRF238	58 14238	16.50	14.00	12.00
MRF245	58 14245	40.00	35.00	0A
MRF449A	58 14449	16.50	14.00	12.00
MRF472	58 14472	1.25	0.99	0.75
MRF475	58 14475	4.60	4.15	3.60
MRF629	58 14629	4.99	3.75	3.25
PT8811	58 18811	9.50	8.75	8.05
TP2320	58 12320	10.24	9.26	7.82
VN66AF	60 02066	0.95	0.87	0.81
ZTX3866	58 03866	0.45	0.40	0.33
2N3866	58 13866	1.20	0.98	0.89

SMALL SIGNAL FET

Device	Stock No	1-24	25-99	100+
BF256	59 00256	0.38	0A	0A
BF960	60 06960	0.99	0.85	0.75
BF961	60 06961	0.70	0.62	0.54
BF963	60 06963	0.99	0.85	0.75
J310	59 02310	0.69	0.60	0.54
J176	59 02176	0.65	0.52	0.46
2SK55	59 01055	0.32	0.29	0.26
2SK168	59 01168	0.37	0.33	0.28
3SK45	60 04045	0.49	0.34	0.26
3SK51	60 04051	0.54	0.44	0.34
3SK60	60 04060	0.58	0.46	0.35
3SK88	60 04088	0.99	0.85	0.79
40673 see 3SK51				
40822 see 3SK51				
40823	60 03823	0.65	0.49	0.41
3SK112	60 04112	4.60	4.20	3.80

DIODES

Device	Stock No	1-24	25-99	100+
AA112	12 01126	0.25	0.20	
BA244	12 02447	0.17	0.12	0.10
BA379	12 03797	0.35	0.32	0.30
ND4981 7E	12 49817	0.51	0.44	0.38
OA91	12 00916	0.07	0.06	0.05
OA47	12 00476	0.10	0.09	0.08
PW02	12 62006	0.75	0.65	0.59
S04	12 24006	0.45	0.40	0.36
W005	12 10506	0.28	0.25	0.23
1N4001	12 40016	0.06	0.05	0A
1N4002	12 40026	0.07	0.06	0A
1N4004	12 40046	0.07	0.06	0A
1N4148	12 41486	0.05	0.04	0.03
1N5404	12 54046	0.16	0.13	0A
1N6263	12 62637	0.62	0.50	0.41

VARICAPS

Device	Stock No	1-24	25-99	100+
BA102	12 01025	0.30	0.27	0.24
BA121	12 01215	0.30	0.23	0.21
BB105B	12 01055	0.30	0.23	0.21
BB109B	12 01095	0.27	0.24	0.18
BB204B	12 02045	0.36	0.30	0.24
BB212	12 02125	1.95	1.68	1.22
ITT210	12 02105	0.30	0.23	0.20
MVAM115 see KV1236				
MVAM125 see KV1225				
KV1210	12 12105	2.45	0A	0A
KV1211 see KV1236				
KV1225	12 12255	2.75	2.25	1.80
KV1235	12 12355	2.75	2.25	1.80
KV1236	12 12365	2.55	2.04	1.30
KV1310	12 13105	0.40	0.30	0.26
KV1310	12 13205	0.40	0.30	0.26

ZENER DIODES

BZY88C 400mW 5%

Device	Stock No	1-24	25-99	100+
2V7	12 00278	0.10	0.08	0.07
3V3	12 00338	0.10	0.08	0.07
3V9	12 00398	0.10	0.08	0.07
4V7	12 00478	0.10	0.08	0.07
5V1	12 00518	0.10	0.08	0.07
5V6	12 00568	0.10	0.08	0.07
6V8	12 00688	0.10	0.08	0.07
8V2	12 00828	0.10	0.08	0.07
9V1	12 00918	0.10	0.08	0.07
10	12 01008	0.10	0.08	0.07
11	12 01108	0.10	0.08	0.07
12	12 01208	0.10	0.08	0.07
15	12 01508	0.10	0.08	0.07
18	12 01808	0.10	0.08	0.07
22	12 02208	0.10	0.08	0.07
27	12 02708	0.10	0.08	0.07
33	12 03308	0.10	0.08	0.07

SCRS TRIACS

Type	Stock No.	1-24	25-99	100+
BRY55 100	52 55100	0.50	0.40	0.48
C106D1	52 00106	0.70	0.65	0.58
C122D1	52 00122	1.45	1.35	1.20
2N6403	52 06403	2.22	2.00	1.80
2N6073A	58 06073	0.98	0.85	0.80

BALANCED MIXERS

Type	Stock No.	1-24	25-99	100+
SBL1	12 00003	4.88	4.22	0A
SBL1-8	12 00013	5.00	4.50	0A
SBL1-X	12 00023	6.33	5.70	0A
SRA1	12 00033	10.80	10.28	0A
SRA1-1	12 00043	12.77	12.14	0A
SRA1H	12 00053	16.34	15.52	0A
SRA3	12 00063	15.35	13.65	0A

LEDs

3mm round types

Type	Stock No.	1-24	25-99	100+
CQX25 Red clear	15 20250	0.15	0.13	0.12
V178P Red	15 01780	0.15	0.13	0.12
CQX26 Green clear	15 20260	0.16	0.15	0.14
V179P Green	15 01790	0.16	0.15	0.14
CQX27 Yel/clear	15 20270	0.18	0.17	0.16
V180P Yellow	15 01800	0.18	0.17	0.16
CQX41A Or/red	15 20410	0.19	0.18	0.17

Standard 5mm DIA LEDs

Type	Stock No.	1-24	25-99	100+
CQY40L Red	15 10400	0.12	0.10	0.09
CQY72L Green	15 10720	0.15	0.14	0.13
CQY74L Yellow	15 10740	0.15	0.14	0.13
CQX38A Or/red	15 20380	0.20	0.18	0.17
CQX39B Or/red/clr	15 20390	0.29	0.25	0.23

Rectangular 2.5 x 5mm LEDs

Type	Stock No.	1-24	25-99	100+
CQX10 Red	15 20100	0.17	0.16	0.15
CQX11 Green	15 20110	0.20	0.18	0.17
CQX12 Yellow	15 20150	0.20	0.18	0.17
CQX40 Orange red	15 20400	0.24	0.21	0.19

Infra-Red LEDs

Type	Stock No.	1-24	25-99	100+
CQY99 Emitter	15 10990	0.56	0A	0A
BPW41 Detector	15 30410	1.51	0A	0A

I-R Optocoupler

Type	Stock No.	1-24	25-99	100+
BNY37	15 40370	1.44	1.28	0.89

FLAT DIFFUSED

Type	Stock No.	1-24	25-99	100+
V320	15 03200	0.17	0.16	0.15
V321	15 03210	0.26	0.22	0.20
V322	15 03220	0.20	0.18	0.17
V323	15 03230	0.20	0.18	0.17
V330	15 03300	0.17	0.16	0.15
V331	15 03310	0.26	0.22	0.20
V332	15 03320	0.20	0.18	0.17
V333	15 03330	0.20	0.18	0.17
V340	15 03400	0.17	0.16	0.15
V341	15 03410	0.26	0.22	0.20
V342	15 03420	0.20	0.18	0.17
V343	15 03430	0.20	0.18	0.17
V510	15 05100	0.17	0.16	0.15
V511	15 05110	0.26	0.22	0.20
V512	15 05120	0.20	0.18	0.17
V513	15 05130	0.20	0.18	0.17
V520	15 05200	0.17	0.16	0.15
V521	15 05210	0.26	0.22	0.20
V522	15 05220	0.20	0.18	0.17
V523	15 05230	0.20	0.18	0.17
V530	15 05300	0.17	0.16	0.15
V531	15 05310	0.26	0.22	0.20
V532	15 05320	0.20	0.18	0.17
V533	15 05330	0.20	0.18	0.17
V540	15 05200	0.17	0.16	0.15
V541	15 05410	0.26	0.22	0.20
V542	15 05420	0.20	0.18	0.17
V543	15 05430	0.20	0.18	0.17
V550	15 05500	0.17	0.16	0.15
V551	15 05510	0.26	0.22	0.20
V552	15 05520	0.20	0.18	0.17
V553	15 05530	0.20	0.18	0.17

TRI COLOUR

Type	Stock No.	1-24	25-99	100+
V518	15 05180	0.60	0.57	0.53

LEDs WITH CHROME MOUNTING BEZEL

Prominent Type (3mm LED)

Type	Stock No.	1-24	25-99	100+
Red	15 60850	0.52	0.46	0.41
Green	15 60860	0.53	0.47	0.42
Yellow	15 60870	0.54	0.48	0.43
Or/red	15 60880	0.58	0.52	0.46

Recessed Type (3mm LED)

Type	Stock No.	1-24	25-99	100+
Red	15 61850	0.52	0.46	0.41
Green	15 61660	0.53	0.47	0.42
Yellow	15 61870	0.54	0.48	0.43
Or/red	15 61880	0.58	0.52	0.46

Prominent Type (5mm LED)

Type	Stock No.	1-24	25-99	100+
Red	15 62850	0.62	0.56	0.51
Green	15 62860	0.65	0.59	0.54
Yellow	15 62870	0.66	0.60	0.56
Or/red	15 62880	0.68	0.62	0.58

Recessed Type (5mm LED)

Type	Stock No.	1-24	25-99	100+
Red	15 63850	0.62	0.56	0.51
Green	15 63860	0.65	0.59	0.54
Yellow	15 63870	0.68	0.60	0.56
Or Red	15 83880	0.66	0.62	0.58

LINEAR ICs

Type	Stock No.	1-24	25-99	100+
LM10CN	61 00010	3.88	3.50	3.12
MF10	61 00011	5.05	4.40	3.75
L149	61 00149	1.86	1.55	0.85
ZNA234	61 02340	8.50	7.60	0A
U237B	61 00237	1.28	0.98	0.83
U247B	61 00247	1.28	0.98	0.83
U257B	61 00257	1.28	0.98	0.83
U267B	61 00267	1.28	0.98	0.83
LM301AH	61 03010	0.67	0.64	0.61
LM301AN	61 03011	0.27	0.25	0.24
LM308H	51 03080	0.70	0.55	0.45
LM308CN	61 03081	0.65	0.62	0.59
LM324	61 03240	0.45	0.43	0.41
LM339N	61 03390	0.66	0.63	0.60
LF347	61 00347	1.60	1.48	0A
LM348	61 03480	0.90	0.80	0.75
LF351	61 03510	0.49	0.47	0.45
LF353	61 03530	0.76	0.70	0.65
LM380N	61 00380	1.00	0.75	0.45
LM381	61 00381	1.81	1.22	0A
LM382	61 00382	1.61	1.22	0A
ZN419CE	61 00419	1.98	1.72	1.55
ZNA423	61 04230	1.60	0.95	0.90
ZN425E/8	61 04250	3.50	3.00	0A
ZN426E/8	61 04260	3.00	2.60	0A
ZN427E/8	61 04270	6.28	5.44	0A
ZN428E/8	61 04280	4.78	4.14	0A
ZN429E/8	61 04290	2.10	1.80	0A
ZN432CJ10	61 04320	28.09	24.39	0A
ZN433CJ10	61 04330	22.59	19.69	0A
ZN440J	61 04400	0.80	0.75	0.60
ZN450E	61 04500	7.81	6.08	0A
NE542	61 05420	1.20	0.85	0.75
NE544	61 00544	1.80	1.40	1.12
NE555N	61 05550	0.20	0.19	0.18
NE556N	61 05560	0.50	0.48	0.45
SL560C	61 05600	1.98	1.79	0A
NE562	61 00562	4.05	0A	0A
NE564	61 00564	4.29	3.43	2.99
NE565	61 00565	1.00	0.78	0.68
NE566	61 00566	1.30	0.95	0.70
NE567	61 00567	1.30	1.05	0.90
NE570N	61 00570	3.85	2.25	0A
SL624	61 00624	3.28	2.84	2.55
uA709HC	61 07090	0.64	0.61	0.58
uA709PC	61 07091	0.36	0.34	0.32
uA710HC	61 07100	0.64	0.61	0.58
uA710PC	61 07101	0.59	0.56	0.50
uA711CN	61 07110	0.85	0.80	0.75
uA733CN	61 07330	0.89	0.85	0.81
uA741CH	61 07410	0.66	0.62	0.55
uA741CN	61 07411	0.20	0.19	0.18
uA747CN	61 07470	0.70	0.67	0.63
uA748CN	61 04780	0.30	0.28	0.27
uA758	61 00758	2.35	0A	0A
TBA820M	61 00820	0.78	0.65	0.45
TDA1028	61 01028	2.11	1.62	1.52
TDA1029	61 01029	2.11	1.62	1.52
ZNA1034	61 01034	2.10	1.95	1.75
LM1035	61 01034	2.10	1.95	1.75
TDA1054M	61 01054	1.45	1.12	0.86
TDA1062	61 01062	1.95	1.65	1.45
TDA1072	61 01072	2.69	0A	0A
TDA1074A	61 01074	5.04	4.22	3.35
TDA1083	61 01083	1.95	1.60	1.35
TDA1090	61 01090	3.05	2.30	1.95
HA1137	61 12411	1.20	1.00	0.95
HA1196	61 01196	2.00	1.70	1.25
HA1197	61 01197	1.00	0.92	0.84
TDA1220	61 01220	1.40	1.22	0.90
LM1303	61 01303	0.99	0A	0A
LM1307	61 01307	1.55	0A	0A
MC1310P	61 01310	1.90	0A	0A
MC1330	61 01330	1.20	0.99	0A
MC1350	61 01350	1.20	0.99	0A
HA1370	61 11370	1.90	1.65	1.45
HA1388	61 01388	2.75	1.95	1.65
LM1458N	61 14580	0.45	0.43	0.41
MC1496P	61 01496	1.25	0.90	0A
SL1610	61 01610	1.92	1.60	1.60
SL1611	61 01611	1.90	1.50	1.35
SL1612	61 01612	1.60	1.50	1.35
SL1613	61 01613	2.06	1.65	1.67
SL1620	61 01620	2.50	2.20	1.95
SL1621	61 01621	2.50	2.20	1.95
SL1623	61 01623	2.64	2.25	2.20
SL1625	61 01625	2.50	2.20	1.95
SL1626	(SL6270)			
SL1630	61 01630	1.62	1.52	1.40
SL1640	61 01640	2.25	1.95	1.85
SL1641	61 01641	2.25	1.95	1.85
MC1648	61 01648	3.25	2.95	2.75
TDA2002	61 02002	1.25	1.04	0.85
ULN2240	61 02240	3.25	2.52	2.12
ULN2242	61 01090	3.05	2.30	1.95
ULN2283	61 02283	1.00	0.85	0.65
CA3080	61 03080	0.70	0.55	0.45
CA3089	61 03089	1.64	1.38	1.15
CA3123	61 03123	1.40	1.30	0.99
CA3130E	61 31300	0.90	0.74	0.72
CA3130T	61 31301	0.90	0.86	0.81
CA3140E	61 31400	0.46	0.42	0.35
CA3189E	61 03189	2.20	1.80	1.50
CA3240E	61 32400	1.27	1.20	1.14
MC3357	61 03357	2.65	1.95	1.35
MC3359 (see ULN3859)				
ULN3859	61 03859	2.95	2.05	1.45
KM3701	61 03701	85.53	72.20	0A
KM3702	61 03702	74.84	61.00	0A
LM3900	61 39000	0.60	0.57	0.54
LM3909N	61 39090	0.68	0.65	0.62
LM3914N	61 03914	2.80	2.40	1.90
LM3915N	61 03915	2.80	2.40	1.90
KB4400	61 04400	0.80	0.75	0.60
KB4412	61 04412	1.95	1.55	1.42
KB4413	61 04413	1.95	1.55	1.24
KB4417	61 04417	1.80	1.55	1.24
KB4420B	61 04420	1.09	0.90	0.85
TDA4420	61 14420	2.95	1.75	1.60
TDA4421	61 14421	1.95	1.75	1.60
KB4423	61 04423	2.30	1.95	1.45
KB4424	61 04424	1.65	1.12	0.82
KB4430	61 04430	2.30	1.95	1.54
KB4431	61 04431	1.95	1.55	1.24
KB4432	61 04432	1.95	1.55	1.24
KB4433	61 04433	1.52	1.45	0.95
KB4436	61 04436	2.53	2.05	1.55
KB4437	61 04437	1.75	1.55	1.30
KB4438	61 04438	2.22	1.92	1.60
KB4441	61 04441	1.35	1.25	1.10
KB4445	51 04445	1.29	1.08	0.85
KB4446	61 04446	2.75	2.34	1.85
KB4448	61 04448	1.65	1.22	0.95
NE5044	61 04497	2.26	1.85	1.34
MC5229	61 05229	5.60	8.64	0A
NE5532	61 55320	1.65	1.75	1.66
KM5624	61 05624	4.35	0A	0A
SD6000	61 06000	3.75	0A	0A
SL6270	61 06270	2.03	1.74	1.65
SL6310	61 06310	2.45	2.05	1.95
SL6440	61 06440	3.38	2.95	2.75
SL6600	61 06600	3.75	3.22	2.90
SAS6610	61 06610	1.48	1.08	0.91
SL6640	61 06640	2.75	2.50	2.40
SL6690	61 06690	3.75	3.45	3.30
SL6700	61 06700	2.75	2.30	2.20
SAS6710	61 06710	1.48	1.08	0.91
LS7225	61 07225	3.85	3.20	2.86
ICM7555	61 75550	0.80	0.75	0.70
CL8038CC	61 08038	4.50	3.97	3.35
MSL9362	61 09362	1.75	1.45	0.95
MSL9363	61 09363	1.75	1.45	0.95
K10170	61 10170	1.87	1.55	1.02
TK10321	61 10321	2.75	2.30	1.94
HA11223	61 11223	2.15	2.05	1.55
HA11225	61 11225	1.45	1.30	1.25
HA12002	61 12002	1.22	0.99	0.75
HA12017	61 12017	0.80	0.69	0.54
HA12402	61 12402	1.95	1.80	1.35
HA12411	61 12411	1.20	1.00	0.95
HA12412	61 12412	1.55	1.40	1.25
LF13741	61 13741	0.33	0.31	0.28
MK50386	61 50366	3.35	2.75	2.25
MK50375	61 50375	3.85	3.10	2.56
MM53200	61 53200	3.90	3.51	3.12

PRESCALER

Type	Stock No.	1-24	25-99	100+
U264	61 02640	2.27	2.14	0A
U265	61 02650	3.16	2.98	0A
U266	61 02660	2.43	2.29	0A
11C90DC	61 01190	12.95	11.00	0A
MSL2312R	61 02312	3.94	2.71	2.40
MSL2318	61 02318	3.84	2.61	2.35
MSM5523	61 05523	11.30	8.00	6.35
MSM5524	61 05524	11.30	8.00	6.35
MSM5525	61 05525	7.85	6.45	4.95
MSM5526	61 05526	7.85	6.45	4.95
MSM55271	61 55271	0.75	7.85	5.25
ICM7106CP	61 07106	9.55	0A	0A
ICM7107CP	61 07107	9.55	0A	0A
LC7137	61 07137	7.50	5.75	4.80
ICM7216B	61 72161	19.50	0A	0A
ICM7216C	61 72162	19.95	0A	0A
ICM7217A	61 07217	9.50	0A	0A
SP8629	61 08629	3.85	2.95	0A
SP8647	61 08647	6.00	5.10	0A
SP8793	61 08793	7.70	6.65	5.95
95H90	61 09590	7.80	6.00	4.97
HD10551	61 10551	2.45	1.95	1.20
HA12009	61 12009	6.00	4.55	3.25
HD44015	61 44015	4.45	3.25	2.75
HD44752	61 44752	8.00	5.75	3.75
MC145151P	61 45151	6.00	5.40	4.86
MC145152P	61 45151	6.60	5.95	5.14
MC145156P	61 45156	4.60	4.14	3.72

MIN ELECTROLYTICS

RADIAL PCB MOUNTING

Type		Stock No.	1-24	25-99	100+
0.47	50V	05 47408	0.07	0.06	0.05
1u	50V	05 10508	0.07	0.06	0.05
2u2	50V	05 22508	0.07	0.06	0.05
3u3	50V	05 33508	0.07	0.06	0.05
4u7	50V	05 47508	0.07	0.06	0.05
10u	16V	05 10606	0.07	0.06	0.05
10u	50V	05 10608	0.07	0.06	0.05
22u	10V	05 22605	0.07	0.06	0.05
22u	25V	05 22607	0.07	0.06	0.05
22u	63V	05 72608	0.09	0.38	0.07
33u	6.3V	05 33605	0.07	0.09	0.05
33u	25V	05 33607	0.08	0.07	0.06
47u	10V	05 47605	0.07	0.06	0.05
47u	16V	05 47606	0.08	0.07	0.06
47u	25V	05 47607	0.08	0.07	0.06
47u	63V	05 47608	0.10	0.09	0.08
100u	10V	05 10705	0.08	0.07	0.06
100u	16V	05 10706	0.09	0.08	0.07
100u	25V	05 10707	0.09	0.08	0.07
100u	63V	05 10708	0.18	0.15	0.12
220u	10V	05 22706	0.10	0.09	0.08
220u	25V	05 22707	0.14	0.12	0.11
220u	50V	05 22708	0.18	0.15	0.12
330u	16V	05 33706	0.14	0.12	0.11
330u	25V	05 33707	0.18	0.15	0.12
470u	6.3V	05 47705	0.10	0.09	0.08
470u	16V	05 47706	0.14	0.12	0.11
470u	25V	05 47707	0.18	0.15	0.12
470u	63V	05 47708	0.29	0.23	0.18
1000u	16V	05 10806	0.23	0.17	0.13
1000u	25V	05 10807	0.28	0.23	0.18
1000u	63V	05 10808	0.66	0.55	0.41
2200u	16V	05 22806	0.28	0.23	0.18
2200u	35V	05 22807	0.68	0.55	0.41
4700u	16V	05 47806	0.68	0.55	0.41
1u	50V	05 10511	0.08	0.07	0.06
2u2	50V	05 22511	0.08	0.07	0.06
3u3	50V	05 33511	0.08	0.07	0.06
4u7	35V	05 47511	0.08	0.07	0.06
10u	16V	05 10609	0.08	0.07	0.06
10u	35V	05 10611	0.09	0.08	0.07
22u	16V	05 22609	0.08	0.08	0.07
22u	35V	05 22611	0.09	0.08	0.07
33u	16V	05 33609	0.09	0.08	0.07
47u	25V	05 47610	0.10	0.09	0.08
100u	16V	05 10710	0.10	0.09	0.08
100u	35V	05 10711	0.11	0.10	0.09
220u	16V	05 22709	0.10	0.10	0.08
220u	35V	05 22711	0.11	0.10	0.08
330u	16V	05 33709	0.16	0.14	0.12
470u	16V	05 47709	0.25	0.22	0.19
470u	25V	05 47710	0.29	0.27	0.25
1000u	25V	05 10810	0.29	0.27	0.25
1000u	35V	05 10811	0.35	0.33	0.30
1000u	63V	05 10812	0.45	0.40	0.36
2200u	16V	05 22809	0.45	0.40	0.36
2200u	25V	05 22810	0.45	0.40	0.36
2200u	63V	05 22812	0.49	0.45	0.44
4700u	16V	05 47809	0.49	0.45	0.44
4700u	35V	05 47811	0.92	0.82	0.75

ULTRA MINIATURE

Type	Stock No.	1-24	25-99	100+
1u	05 10514	0.09	0.08	0.07
2u2	05 22514	0.09	0.08	0.07
4u7	05 47514	0.09	0.08	0.07
10u	05 10613	0.09	0.08	0.07
10u	05 10614	0.10	0.09	0.08
22u	05 22612	0.09	0.08	0.07
22u	05 22613	0.10	0.09	0.08
22u	05 22614	0.11	0.10	0.09
47u	05 47612	0.11	0.10	0.09
47u	05 47613	0.11	0.10	0.09
100u	05 10712	0.11	0.10	0.09
100u	05 10713	0.14	0.12	0.10
220u	05 22712	0.14	0.12	0.10

ULTRA LOW LEAKAGE

Type	Stock No.	1-24	25-99	100+
0.1uF	05 10210	0.08	0.07	0.06
0.22uF	05 10404	0.12	0.10	0.08
0.47uF	05 47404	0.12	0.10	0.08
1uF	05 10504	0.12	0.10	0.08
2u2	05 22504	0.12	0.10	0.08
4u7	05 47504	0.14	0.12	0.10
10uF	05 10604	0.12	0.10	0.08
22uF	05 22604	0.14	0.12	0.10
33uF	05 33604	0.14	0.12	0.10
47uF	05 47603	0.14	0.12	0.10
47uF	05 47604	0.16	0.14	0.12
100uF	05 10703	0.18	0.15	0.13

HIGH RIPPLE CAPACITOR

Type	Stock No.	1-24	25-99	100+
10000uF	05 10915	5.50	4.95	4.45

COMPUTER GRADE

Type	Stock No.	1-24	25-99	100+
15000/10	04 15915	3.88	3.49	0A
47000/10	04 47915	7.22	6.50	0A
150000/10	04 41015	15.56	14.01	0A
15000/25	04 15916	5.72	5.15	0A
68000/25	04 68916	15.56	14.01	0A

TANTALUM BEAD ELECTROLYTICS

Type	Stock No.	1-24	25-99	100+
0.22	05 22402	0.15	0.13	0.11
0.33	05 33402	0.15	0.13	0.11
0.47	05 47402	0.16	0.14	0.12
0.68	05 68401	0.16	0.14	0.12
1u	05 10501	0.18	0.15	0.13
2u2	05 22502	0.20	0.18	0.15
2u	05 47501	0.22	0.19	0.15
4u	05 47502	0.26	0.23	0.20
10	05 10601	0.28	0.25	0.21
10	05 10602	0.36	0.32	0.28
22	05 22601	0.40	0.35	0.31
22	05 22602	0.42	0.36	0.32
22	05 22603	0.43	0.40	0.36
47	05 47601	0.45	0.40	0.36
47	05 47602	0.92	0.84	0.75
10	05 10701	0.94	0.85	0.76

BI-POLAR

Type	Stock No.	1-24	25-99	100+
1u	04 10513	0.20	0.18	0.16
1u5	04 15513	0.21	0.19	0.17
2u2	04 22513	0.22	0.20	0.18
3u3	04 33513	0.23	0.21	0.19
4u7	04 47513	0.24	0.22	0.20
6u8	04 68513	0.26	0.23	0.21
10u	04 10613	0.28	0.25	0.22
22u	04 22613	0.34	0.31	0.28
33u	04 33613	0.45	0.41	0.37

MONOLITHIC

Type	Stock No.	1-24	25-99	100+
1n	04 10204	0.14	0.12	0.09
4n7	04 47204	0.16	0.11	0.10
10n	04 10304	0.17	0.12	0.10
47n	04 47304	0.18	0.13	0.11
100n	04 10404	0.18	0.13	0.11

CERAMIC PLATE

Type	Stock No.	1-24	25-99	100+
2.2pF	04 22901	0.05	0.04	0.03
2.7pF	04 27901	0.05	0.04	0.03
3.3pF	04 33901	0.05	0.04	0.03
3.9pF	04 39901	0.05	0.04	0.03
4.7pF	04 47901	0.05	0.04	0.03
5.6pF	04 56801	0.05	0.04	0.03
6.8pF	04 68901	0.05	0.04	0.03
8.2pF	04 82901	0.05	0.04	0.03
10pF	04 10001	0.05	0.04	0.03
12pF	04 12001	0.05	0.04	0.03
15pF	04 15001	0.05	0.04	0.03
18pF	04 18001	0.05	0.04	0.03
22pF	04 22001	0.05	0.04	0.03
27pF	04 27001	0.05	0.04	0.03
33pF	04 33001	0.05	0.04	0.03
39pF	04 39001	0.05	0.04	0.03
47pF	04 47001	0.05	0.04	0.03
56pF	04 56001	0.05	0.04	0.03
68pF	04 68001	0.05	0.04	0.03
82pF	04 82001	0.06	0.05	0.04
100pF	04 10101	0.06	0.05	0.04
120pF	04 12101	0.06	0.05	0.04
150pF	04 15101	0.06	0.05	0.04
180pF	04 18101	0.06	0.05	0.04
220pF	04 22101	0.06	0.05	0.04
270pF	04 27101	0.06	0.05	0.04
330pF	04 33101	0.06	0.05	0.04
390pF	04 39102	0.06	0.05	0.04
470pF	04 47102	0.06	0.05	0.04
560pF	04 56102	0.06	0.05	0.04
680pF	04 68102	0.06	0.05	0.04
820pF	04 82102	0.06	0.05	0.04
1000pF	04 10202	0.06	0.05	0.04
1200pF	04 12202	0.06	0.05	0.04
1500pF	04 15202	0.06	0.05	0.04
1800pF	04 18202	0.06	0.05	0.04
2200pF	04 20202	0.06	0.05	0.04
2700pF	04 27202	0.06	0.05	0.04
3300pF	04 33202	0.06	0.05	0.04
4700pF	04 47202	0.06	0.05	0.04

DISC CERAMIC

Type	Stock No.	1-24	25-99	100+
10n	04 10303	0.05	0.04	0.03
22n	04 22303	0.06	0.05	0.04
47n	04 47303	0.06	0.05	0.04
100n	04 10403	0.09	0.08	0.07

FEEDTHROUGHS

Type	Stock No.	1-24	25-99	100+
1000pF	04 10210	0.08	0.07	0.055

SCREW IN FTs

Type	Stock No.	1-24	25-99	100+
1000pF	04 10215	1.50	1.35	1.21

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Type	Stock No.	1-24	25-99	100+
1n	04 10206	0.05	0.04	0.03
2n2	04 22206	0.05	0.04	0.03
3n3	04 33206	0.05	0.04	0.03
4n7	04 47206	0.05	0.04	0.03
6n8	04 68206	0.05	0.04	0.03
10n	04 10306	0.05	0.04	0.03
22n	04 22306	0.06	0.05	0.04
33n	04 33306	0.06	0.05	0.04
47n	04 47306	0.06	0.05	0.04
68n	04 68306	0.06	0.05	0.04
100n	04 10406	0.08	0.06	0.05
220n	04 22406	0.10	0.08	0.07
330n	04 33406	0.11	0.09	0.08
470n	04 47406	0.14	0.12	0.10

POLYESTER (C280 TYPE)

Type	Stock No.	1-24	25-99	100+
10n	04 10305	0.06	0.05	0.04
15n	04 15305	0.06	0.05	0.04
22n	04 22305	0.06	0.05	0.04
33n	04 33305	0.06	0.05	0.04
47n	04 47305	0.08	0.07	0.06
68n	04 68305	0.08	0.07	0.06
100n	04 10405	0.08	0.07	0.06
150n	04 15405	0.10	0.09	0.07
220n	04 22405	0.10	0.08	0.07
330n	04 33405	0.17	0.16	0.14
470n	04 47405	0.17	0.16	0.14
680n	04 68405	0.17	0.16	0.14
1uF	04 10505	0.24	0.22	0.18

POLYESTER (SIEMENS)

Type	Stock No.	1-24	25-99	100+
10n	04 10307	0.10	0.08	0.07
22n	04 22307	0.10	0.08	0.07
33n	04 33307	0.11	0.09	0.08
47n	04 47307	0.11	0.09	0.08
68n	04 68307	0.12	0.10	0.08
100n	04 10407	0.13	0.11	0.10
150n	04 15407	0.16	0.14	0.11
220n	04 22407	0.17	0.15	0.12
330n	04 33407	0.22	0.19	0.16
470n	04 47407	0.26	0.22	0.19
680n	04 68407	0.36	0.32	0.28
1uF	04 10507	0.42	0.38	0.29
2u2	04 22507	0.85	0.55	0.44

LEADLESS CERAMICS

Type	Stock No.	1-24	25-99	100+
18pF	04 18011	0.06	0.05	0.04
22pF	04 22011	0.06	0.05	0.04
180pF	04 18111	0.06	0.05	0.04

POLYSTYRENE

Type	Stock No.	1-24	25-99	100+
10pF	04 10009	0.08	0.07	0.06
15pF	04 15009	0.08	0.07	0.06
18pF	04 18009	0.08	0.07	0.06
22pF	04 22009	0.08	0.07	0.06
27pF	04 27009	0.08	0.07	0.06
47pF	04 47009	0.08	0.07	0.06
56pF	04 56009	0.08	0.07	0.06
68pF	04 68009	0.08	0.07	0.06
100pF	04 10109	0.08	0.07	0.06
180pF	04 18109	0.09	0.08	0.07
220pF	04 22109	0.09	0.08	0.07
270pF	04 27109	0.09	0.08	0.07
330pF	04 33109	0.09	0.08	0.07
390pF	04 39109	0.09	0.08	0.07
470pF	04 47109	0.10	0.09	0.08
680pF	04 68109	0.10	0.09	0.08
820pF	04 82109	0.10	0.09	0.08
1nF	04 10209	0.11	0.10	0.09
1n2	04 12209	0.11	0.10	0.09
1n5	04 15209	0.11	0.10	0.09
1n8	04 18209	0.11	0.10	0.09
2n2	04 22209	0.12	0.11	0.10
2n7	04 27209	0.12	0.11	0.10
3n3	04 33209	0.12	0.11	0.10
3n9	04 39209	0.12	0.11	0.10
4n7	04 47209	0.13	0.12	0.11
5n6	04 56209	0.13	0.12	0.11
6n8	04 68209	0.13	0.12	0.11
10nF	04 10309	0.13	0.12	0.11

SILVER MICA

Type	Stock No.	1-24	25-99	100+
2.2pF	04 22908	0.20	0.18	0.15
4.7pF	04 47908	0.20	0.18	0.15
10pF	04 10008	0.20	0.18	0.15
22pF	04 22008	0.20	0.18	0.15
33pF	04 33008	0.20	0.18	0.15
47pF	04 47008	0.20	0.18	0.15
56pF	04 56008	0.20	0.18	0.15
68pF	04 68008	0.20	0.18	0.15
100pF	04 10108	0.20	0.18	0.15
120pF	04 12108	0.20	0.18	0.15
150pF	04 15108	0.20	0.18	0.15
220pF	04 22108	0.23	0.18	0.16
330pF	04 33108	0.32	0.29	0.26

MICA UNELCO

Type	Stock No.	1-24	25-99	100+
10pF	04 10014	1.10	0.98	0.88
22pF	04 22014	1.10	0.98	0.88
47pF	04 47014	1.10	0.98	0.88
100pF	04 10114	1.10	0.98	0.88
220pF	04 22114	1.10	0.98	0.88
470pF	04 47114	1.10	0.98	0.88
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Type	Stock No.	1-24	25-99	100+
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2x335pF/3x20pF	06 33102	1.85	1.45	1.25

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500pF	06 50006	3.12	2.80	0A

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Type	Stock No.	1-24	25-99	100+
25pF	06 02506	3.55	2.00	0A
50pF	06 05006	3.55	2.00	0A
100pF	06 10006	4.01	3.57	0A

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Type	Stock No.	1-24	25-99	100+
3x426pF	06 42603	5.60	4.96	4.36
1x100k	06 42803	5.60	4.96	4.36

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2.8 12.5pF	06 12003	0.15	0.14	0.13
3.5 20pF	06 20003	0.15	0.14	0.13
5 30pF	06 30003	0.15	0.14	0.13
9 50pF	06 50003	0.15	0.14	0.13

10mm DIAMETER CERAMIC TYPES

Type	Stock No.	1-24	25-99	100+
5 30pF	06 30005	0.23	0.22	0.21
8 50pF	06 50005	0.23	0.22	0.21
16 100pF	06 10005	0.23	0.22	0.21

MINIATURE CERAMIC TRIMMERS

CTZ31 - 3.7mm

Type	Stock No.	1-24	25-99	100+
3 10pF	06 10007	0.14	0.12	0.11
4.5 20	06 20007	0.14	0.12	0.11
6.5 30	06 30007	0.14	0.12	0.11

CTZ31

Type	Stock No.	1-24	25-99	100+
2.5 6	06 06008	0.14	0.12	0.11
3 10	06 10008	0.14	0.12	0.11
4.5 20	06 20008	0.14	0.12	0.11
5.5 30	06 30008	0.14	0.12	0.11
7.5 50	06 50008	0.14	0.12	0.11
9 70	06 70008	0.14	0.12	0.11

FOIL TRIMMERS

Type	Stock No.	1-24	25-99	100+
1.5 10pF	06 10001	0.18	0.15	0.14
2 22pF	06 22001	0.20	0.16	0.14
3 36pF	06 36001	0.27	0.23	0.19
5 60pF	06 60001	0.26	0.22	0.18
3 90pF	06 80001	0.29	0.24	0.22

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Type	Stock No.	1-24	25-99	100+
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LASER DIODES

The subatomic goings-on at a p-n semiconductor junction can, in some materials, generate pulses of laser light. Peter Gatehouse explains how, and it'll disappoint anyone hoping to make a death-ray with a handful of 1N4148s.

Since the first lasers were born on the laboratory bench in 1960, when ruby and helium-neon devices were first set up, a vast spectrum (pun intended) of lasers has gradually been uncovered (or stumbled upon). There are now thousands of known laser lines; some materials can emit many different lines according to the energy levels between which laser action can occur. However, very few of these are convenient for use outside the laboratory as many require temperatures far below 0°C or use very exotic and troublesome materials.

The ruby laser is not obsolete, and some manufacturers are clearing their stock of these at reduced prices of several thousand pounds. It is an example of the solid-state laser, which, as its name suggests, has a solid laser material. A modern type is the neodyium laser which is a powerful and robust device and probably the most common solid-state laser, usually giving an infra-red output at 1060 nm at up to a few hundred watts power.

It's A Gas

There is no doubt that gas lasers are the most widely used. This is perhaps surprising as a gas is hardly as convenient to deal with as a solid, but gases have several endearing qualities: (usually) completely even distribution throughout a container; the ability to flow so the laser medium can be circulated to assist cooling; and they are far easier to prepare as a laser medium than solids, because for the latter highly pure and perfect crystals often need to be 'grown' and then cut and polished, which is expensive. Gas lasers fall into one of three groups, depending on what gives rise to the energy levels necessary to laser action. Energy levels of neutral atoms are used in one type, those of ions (atoms that have lost or gained one or more electrons) in another and the third employs the modes of vibration of molecules.

The output from a gas laser is of high quality and sometimes the efficiency (power output in the laser beam divided by the power fed in) is as high as 20% but usually only a fraction of a per cent is obtained (which is typical of lasers in general). Helium-neon gas lasers are in the first group: in the mixture of gases, helium is excited first, then transfers its energy to the neon which releases it in laser emission. Helium-neon lasers are sold by some electronics companies and you will find them in many school physics labs. They yield a high-quality continuous red beam which is difficult to use without producing the interference effects you can spend hours trying to discern with other sources of coherent light. At a cost of around £100-£200 (with a power supply) this is the only type of laser within reach of the (wealthy) amateur.

The Ion Age

The second group, ion lasers, will be found in any university physics lab, as they offer many different output

A typical infra-red emitting laser diode. The light is emitted through the clear window in the end.

frequencies. These are selected by placing a prism in the laser cavity which sends different frequencies in different directions and putting the end mirror of the cavity in the path of the desired frequency. Ion lasers also yield far more power than the first group (which can provide only milliwatts), giving many watts continuous output. Typical ion lasers are the argon and krypton lasers which between them can lase at various lines from 437 to 799 nm.

The third group, molecular vibration mode lasers, includes the carbon dioxide (CO_2) laser which is an extremely powerful and efficient device that yields infra-red lines near the 10600 nm 'atmospheric window' (ie the atmosphere does not absorb it, unlike most infra-red wavelengths). In continuous operation it can yield several kilowatts. Military scientists have shown much interest in this device and the Americans have recently built one into a large jet aircraft. The CO_2 laser may one day fairly soon bear the dubious honour of being the first weapon fired in space; on earth, it has less potential as a weapon, because, although the beam is not absorbed, it is spread and rendered ineffectual by the atmosphere.

Other devices include the dye laser which makes use of molecular energy levels. Electrons in many complex organic chemicals can orbit not just a single atom but an entire molecule or part of a molecule, and can absorb — or emit — light by shifting between different orbits of different energies; the bright colours of dyes occur as only certain wavelengths correspond to the energy differences by Planck's relation. The lasing material, the dye, is in solution in water or an alcohol and usually has to be excited by another laser. Because of the useful property of being tunable to any wavelength in broad bands of the spectrum, dye lasers are becoming very popular in laboratories. Some chemical reactions release so much energy that laser action is possible with no external power supply; the reaction of hydrogen and fluorine is an example, though special conditions are required to achieve population inversion (more atoms in the excited state than the stable one and thus great potential for emission of photons).

Diode Lasers

These devices, which are basically p-n junctions (semiconductor diodes), have been around since 1962, when lasing took place in a GaAs p-n junction whose ends had been polished to form a cavity and which had an enormous current passed through it. The laser diode uses very heavily doped extrinsic semiconductors (Fig. 1). The energy diagram shows the **valence** band and **conduction** band separated by an energy gap called the **band gap**. The gap is too large to allow electrons to gain kinetic energy (ie move) as there are no unfilled energy levels energetically near enough to those containing the electrons; yet it is small enough for an electron which receives enough energy to ocupy an energy level in the conduction band where it is free to move. Here we have an energy gap which an electron can cross if it receives a large enough kick in the form of thermal vibrations in the crystal lattice — or by a photon with an energy sufficient to supply the band-gap energy to the electron.

In the p-region of the diode, an impurity which has energy levels (without any electrons in them) just above the valence band has been diffused into the semiconductor. Electrons in the valence band are easily excited by even weak thermal vibration and acquire more energy ie move up into the level marked 'a' for acceptor. This leaves **holes** in the *valence* band, so forming a p-type semiconductor in which the holes move under the influence of an electric field (conduction). Similarly, in the n-region an impurity whose occupied energy levels are marginally below the *conduction* band can **donate** electrons into the conduction band where they are free to acquire kinetic energy as before.

Thus, in the n-region of this heavily-doped crystal of a semiconductor there are many electrons in the conduction band, and in the p-region many holes. Now apply a voltage as marked; holes 'enter' the lattice at A (actually, electrons leave the lattice at A which amounts to precisely the same thing), and electrons enter at K, as holes and

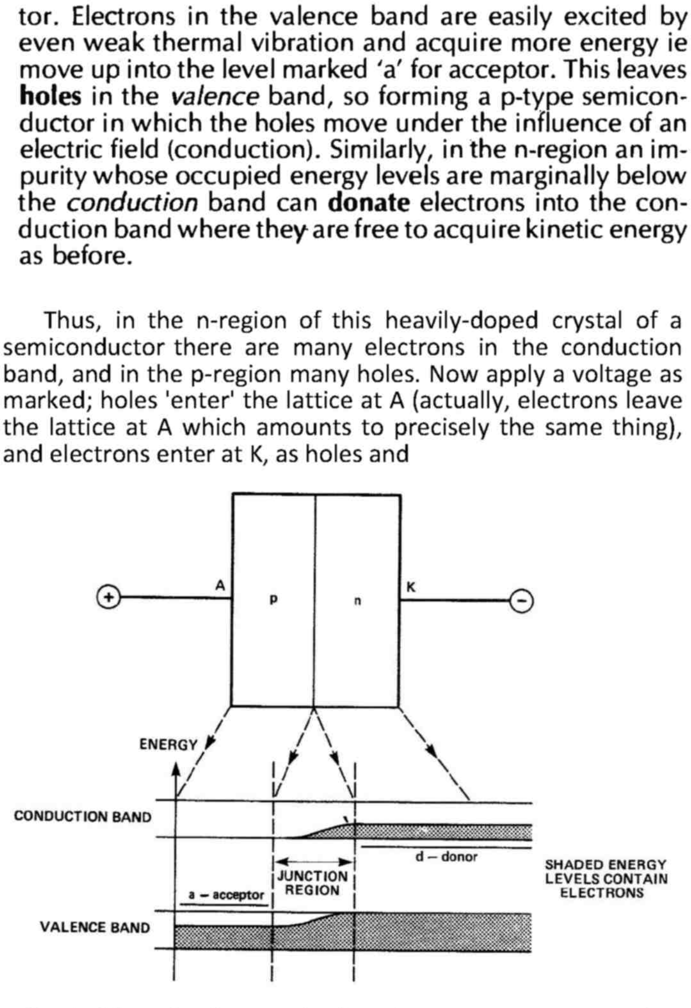

Fig. 1 Schematic of energy levels and occupancy across a p•n' junction.

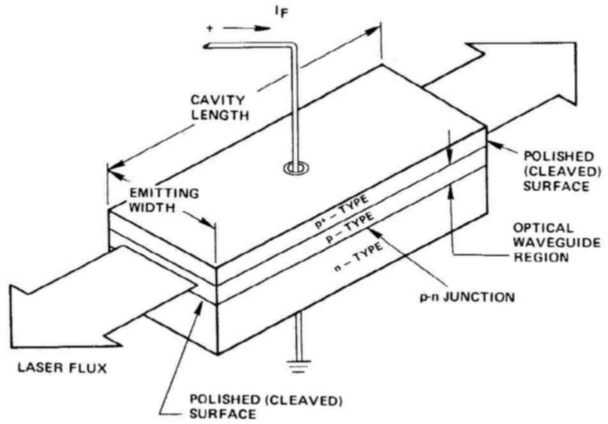

Fig. 2 Typical injection laser diode structure.

electrons move into the junction region. These electrons and holes are injected into the same physical space in the lattice, the junction between the p-region and the n-region (giving rise to the name injection laser) with the electrons all having virtually the same amount of energy *more* than the holes. The excitation of electrons by photons (mentioned before) is reversed as free electrons 'fall' into the holes in mutual annihilation; the electron is no longer active in the conduction band and there is one less hole acive in the valence bends — they are replaced as described above. In moving from the conduction band to the valence band, each electron releases the bandgap energy as a photon. Light is emitted from the junction region: all of it has exactly the same wavelength.

This diode is nothing more than an LED! To obtain laser action, **population inversion** must be achieved. That is, there must be more electrons in the conduction band ready to drop down to the valence band than there are in the valence band able to be promoted to the conduction band. In an LED, conduction band electrons decay spontaneously to the valence band. The photon emitted can do two things that are of interest to us: it can *stimulate* the emission of another photon of exactly the same frequency and, what's more, in phase with the first, provided it encounters another electron in the valence band at the right moment; or it can be absorbed, and in doing so promote another electron to the conduction band. The first of these processes iswhat gives rise to laser action; the second is what prevents it from occurring, and the way that this is avoided is by creating a population inversion, so that the first is more likely than the second.

In a laser, **stimulated emission** gives rise to the coherent light output; to turn the LED into a laser diode you need an enormous rate of injection of electrons so that there are plenty of them available for stimulated emission; this takes a very large current. When the current through a laser diode is increased, stimulated emission takes over and laser action takes place as a few photons give rise to an entire output of the same frequency and phase. The cavity is needed to reflect at least some photons back into the junction region so that the avalance is CONTINUOUS. Unless the diode gets too hot, this emission can continue for as long as you apply a current.

The acronym laser stands for **L**ight **A**mplification by the **S**timulated **E**mission of **R**adiation: the avalanche is precipitated by perhaps a single photon and the frequency and phase of that photon are (ideally) reproduced in the output of many millions of photons. This process is more familiar under the name amplification!

The Real Laser Diode

These do exist; please don't try to turn any LEDs info laser diodes (as I once did). RCA manufacture a range of infra-red laser diodes which are available in this country (the photograph shows one of this range). I have yet to find any ,manufacturer of visible-light laser diodes, though these have been set up in laboratories. Most laser diodes have to be operated in pulses of less than 1% duty factor; the 'large' current mentioned before to obtain laser action, called the threshold current, is responsible for this as it causes immense heating. A typical device needs a current of 36 A to lase, emitting at a rate of 20 W during a pulse. That is a respectable power for a laser, but this only occurs during the pulses. The duty cycle reduces the effective output, for this device, to a few milliwatts. So, at present, laser diodes are somewhat disappointing - an invisible output which may be useful for remote-control applications (as sensors could hardly miss such enormous flashes), or for fiber-optics.

The p-n junction is only a few millimeters square and the junction is a few thousandths of an inch thick. At present, the output is not collimated, ie it isn't a beam of low divergence, and spreads out rapidly (divergence angles approach 20 degrees). The efficiency of laser diodes is good (for lasers) at around 10% and is improved by adding layers which channel the photons into the junction area, as they tend to move out into regions where population inversion has not occurred; these are called heterostructure diodes. Continuous operation at high power has been obtained at low temperatures (meaning in liquid nitrogen), and at low power {again in the infra-red) at room temperature in double heterostructure diodes at around 5 mW - no better than the helium-neon laser. As demand is still low, these. still cost about .£100. Pulse-operated devices cost about . £20 - but you need many hundreds of volts of power sup- ply to drive that sort of current through! The low power and high divergence of the beam make the output harmless except at close range when the eye can be damaged as with all lasers.

The Future

Industry is slowly picking up on the laser diode, and this should speed the availability and flow of new devices. The laser diode is a favourite for fibre optics; the pressure is on to develop reliable continuous operation cheaply as it is really very easy to modulate laser diode output. Visible devices will occur soon with any luck, and in the distant future we may see the exotic devices such as frequency doubling crystals, electro-optic switches, beam deflection systems which are solid-state etc, all of which would doubtless find many applications outside the laboratories and military research centres - just as the laser itself did.

Data on laser diodes and many other electro-optic devices can be obtained from Norbain Electro Optics Ltd, Emitter and Sensors Division, Norbain House, Arkwright Road, Reading, Berks RG2 OLT. Anyone interested in lasers might find 'Lasers and their applications' by M. J. Beesley (published by Taylor & Francis Ltd) interesting. We would like to thank RCA Ltd for their kind permission to reproduce Fig. 2.

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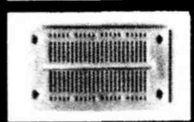

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*Connector for bus & cable (BBC66)	3.50
*Single disc drive (100K) (BBC31)	225.00*
*Dual disc drives (BBC32)	375.00*
Teletext Receiver (200K) (BBC71)	144.34**
Prestel receiver (BBC72)	80.00**
*Games Paddles (per pair) (BBC45)	11.30

*Prices on these items are likely to change please contact sales office before ordering.
As some items are on extended delivery from Acorn please check availability before ordering items marked**.

ACORNSOFT FOR THE BBC MICROCOMPUTER

Graphs & charts on the BBC Micro (AC122)	7.50
Graphs & Charts Cassette (AC123)	7.50
Algebraic manipulation pk (AC124)	8.85
Forth on BBC Micro (AC125)	7.50
Forth pack (AC126)	14.65
Lisp on BBC Micro (AC127)	7.50
Lisp pack (AC128)	14.85
Games-Philosophers quest (AC129)	8.85
Games-Defender (AC130)	8.65
Games-Monster (AC131)	8.65
Games-Snapper (AC132)	8.65

NEW EPROM PROGRAMMER FOR BBC MICROCOMPUTER

★ Programs 2516, 2716, 2532, 2732 Industry Standard EPROMS
★ No external power supply required
★ Plugs straight into expansion socket
★ Easy to use ★ Includes all Software required

EPROM Programmer (Kit)	49.95
EPROM PROGRAMMER (Assembled)	57.95

ACORN & BBC MICRO COMPONENTS

2114 Low Power 200ns	0.80
4516/4816 100ns	2.25
6522	2.99
74LS244	0.59
74LS245	0.69
81LS97	0.90
DP8304	4.50
DS3691N	4.50
DS88LS120N	4.50
20 way Right Angle IDC Header	2.48
26 way Right Angle IDC Header	3.24
34 way Right Angle IDC Header	3.80
15 way Right Angle D. SKT	3.50

NEW GAMES PADDLES FOR BBC MICRO, DRAGON 32, ZX81*, AND SPECTRUM* EX-STOCK

*Requires controller (see below)

BBC Micro	11.30/Pair
ZX81, Spectrum*, Dragon 32	6.95/Each

Games Paddle Controller for ZX81 and Spectrum
★ Very High Speed Operation Possible
★ Plugs into ZX81/Spectrum Expansion Bus
★ Connector provided for Ram Pack, Printer

Paddle Controller Kit	14.95
Ass	19.99

Please specify ZX81 or Spectrum when ordering.

NEW CATALOGUE NOW AVAILABLE
Please send **0.25** + SAE

SPECIAL OFFERS

Z80ACPU	3.45
6522	2.99
UPD7002	4.35
DP8304	4.50
4164(TI)	3.99
2732 450ns	2.99
2532 450ns	2.99

MEMORIES

2114 Low Power 200ns	0.80
2708 450ns	2.79
2716 450ns (+5V)	2.10
2716 350ns (+5V)	3.59
2716 450ns 3 Rail	5.95
2732 350ns	4.40
2732 450ns	2.99
2532 450ns	2.99
2564 450ns	9.99
2764 450ns	9.99
4116 150ns	0.85
4116 200ns	0.75
4118 150ns	3.38
4164 200ns T.I.	3.99
4164 200ns NEC	3.99
4516/4816 100ns	2.99
~~5516 250ns~~	~~0.39~~
6116 P3 150ns	3.85
6116 LP3 150ns	5.75

★ SPECIAL LOW PRICES FOR QUANTITIES ★

Device	Price
Z80 FAMILY	
Z80CPU	2.95
Z80ACPU	3.45
Z80CTC	2.64
Z80ACTC	2.95
Z80ADART	5.70
Z80ADMA	11.95
Z80PIO	2.75
Z80APIO	2.95
Z80ASIO-0	11.99
Z80ASIO-1	11.99
Z80ASIO-2	11.99
MK3886	11.00
MK3886-4	14.47
Z80BCPU	7.15
Z80BCTC	7.15
Z80BPIO	7.15
Z80BSIO-0	23.87
Z80BSIO-1	23.82
Z80BSIO-2	23.82
6800 FAMILY	
6800	2.99
6802	3.49
6803C	12.10
6809	8.45
6810	1.12
6821	1.20
6840	3.95
6845	8.75
6850	1.40
6880	1.07
6887	0.80
68488	9.11
6875	5.82
6843	13.99
68B00	8.30
68B09	19.11
68B21	2.29
68B10	2.00
68B40	4.70
68B50	2.86
6500 FAMILY	
6502	3.45
6520	2.99
6522	2.99
6532	5.95
8080 FAMILY	
8085A	4.40
8212	1.55
8216	0.60
8251A	3.19
8255A	2.95
BUFFERS	
81LS95	0.90
81LS97	0.90
81LS98	0.90
8T26A	1.20
8T28A	1.20
8T95	1.35
8T97A	1.35
8T98	1.45
DATA CONVERTERS	
ZN425	3.45
ZN426	3.00
ZN427	5.99
ZN428	4.75
ZN429	2.10
ZN432	13.00
ZN433	25.90
ZN435	4.40
UPD7002	4.35
ZN447	72.9
ZN448	5.48
ZN449	2.55
ZN440	56.83
FLOPPY DISC CONTROLLERS	
8271	37.50
FD1771	14.75
FD1791	21.75
FD1793	22.75
FD1795	27.75
FD1797	27.75
WD1691	10.87
WD2143	5.77
MISC SUPPORT CHIPS	
AY3-1015	2.99
AY3-1270	7.95
AY3-8910	5.99

Device	Price
AY5-1013	2.99
AY5-3600	7.95
DP8304	4.50
MC1488	0.55
MC1489	0.55
MC3446	2.95
MC3448A	4.25
MC3480	7.95
MC3487	2.95
MC14411	6.94
MC14412	7.99
R03-2513L	6.89
R03-2513U	6.99
6402	4.45
4702	7.45
7660	2.59
LF398N	5.59
NEW VOLTAGE REFERENCES	
ZN404 2.45V	0.49
ZN423 1.26V	1.00
ZN4588 2.45V	1.08
ZN Ref 025 2.49V	1.60
ZNRef 040 4.10V	1.60
ZNRef 062 6.17V	1.80
ZN Ref 100 1.96V	2.59
DVM CHIPS	
ZN450E	7.81
ZN450 KIT	17.35
LINEARS	
LM301AN	0.25
LM308N	0.69
LM311N	0.69
LM319N	2.14
LM324N	0.30
LM348N	0.59
LM555N	0.18
LM556CN	0.45
LM741 (8 PIN)	0.14
LM474CN	0.64
LM748 (8 PIN)	0.34
LM725CN	3.20
REGULATORS	
7805	0.39
7812	0.39
7815	0.39
78L05	0.29
78L12	0.29
78L15	0.29
7905	0.55
7912	0.55
7915	0.55
LM309K	0.99
LM317K	3.20
LM323K	4.95
LM338K	5.75
UHF MODULATORS	
6MHZ(UM1111)	3.70
8MHZ(UM1233)	4.40
CRYSTALS	
1MHZ	2.80
1.008MHZ	2.90
1.8432MHZ	2.20
2.4576MHZ	2.45
3.6864MHZ	2.95
4MHZ	1.45
6MHZ	1.45
8MHZ	1.70
9.6804MHZ	1.95
CMOS 4000 'B' SERIES	
4001	0.10
4002	0.12
4006	0.65
4007	0.15
4008	0.60
4009	0.34
4010	0.39
4011	0.11
4012	0.15
4013	0.24
4014	0.74
4015	0.49
4016	0.19
4017	0.37
4018	0.87
4019	8.41
4020	0.49
4021	0.69
4022	0.85

Device	Price
4023	0.15
4024	0.31
4025	0.18
4026	1.29
4027	0.23
4028	0.49
4031	1.89
4033	1.84
4034	1.90
4035	0.94
4040	0.49
4041	0.77
4042	0.44
4043	0.69
4044	0.64
4045	1.89
4046	0.64
4047	0.49
4048	0.54
4049	0.24
4050	0.24
4051	0.44
4052	0.59
4053	0.77
4054	0.84
4055	0.64
4060	0.59
4063	0.98
4066	0.29
4068	0.21
4069	0.15
4070	0.14
4071	0.14
4072	0.19
4073	0.14
4075	0.14
4076	0.45
4077	0.25
4078	8.25
4081	0.15
4082	0.20
4085	0.64
4086	0.51
4093	0.25
4502	0.89
4507	0.38
4508	1.29
4510	0.45
4511	0.44
4512	0.49
4514	1.14
4515	1.14
4516	0.54
4518	0.39
4519	0.29
4520	0.49
4521	1.89
4522	1.24
4526	0.89
4527	0.84
4528	0.89
4532	0.89
4541	0.89
4543	0.79
4553	2.44
4555	0.50
4556	0.50
4585	0.79
Nd. Other devices available	
74LS SERIES	
00	0.10
01	0.11
02	0.11
03	0.11
04	0.11
05	0.11
08	0.11
09	0.11
10	0.11
11	0.13
12	0.11
13	0.15
14	0.29
15	0.12
20	0.12
21	0.12
22	0.13
26	0.12
27	0.12
28	0.12
30	0.12

NEW FLOPPY DISC DRIVES

SCHUGART SA 200 Single Uncased 40-Track single sided 122.00

Device	Price
32	0.12
33	0.14
37	0.12
38	0.12
40	0.12
42	0.27
47	0.34
48	0.45
49	0.80
51	0.14
54	0.14
55	0.15
73	0.18
74	9.16
75	8.19
76	8.17
78	0.24
83	0.34
85	0.47
86	0.15
90	0.28
91	0.80
92	0.31
93	0.25
95	0.40
109	0.27
112	0.20
113	0.20
114	0.22
122	0.35
123	0.35
125	0.24
126	0.25
132	0.39
136	0.23
138	0.27
139	0.29
145	0.70
148	0.89
151	0.39
153	0.28
155	0.34
156	0.34
157	0.25
158	0.29
160	0.35
162	0.35
163	0.34
164	0.39
165	0.54
166	0.83
173	0.84
174	0.40
175	0.44
181	0.90
190	0.36
191	0.44
192	0.44
193	0.44
194	0.34
195	0.34
196	0.45
197	0.45
221	0.54
240	0.55
241	0.85
242	0.84
243	0.64
244	0.59
245	0.89
247	0.40
248	0.40
249	0.89
251	0.29
253	0.30
257	0.34
258	0.35
259	0.57
261	1.85
266	0.19
273	0.59
279	0.59
283	0.39
290	0.57
293	0.40
365	0.29
366	0.29
367	0.29
368	0.39
373	0.59
374	0.64
377	0.89
378	0.45
379	0.65
386	0.34
390	0.49
393	0.41
629	1.21

Device			Price
DIL sockets low profile			
Pins	Tin	Gold	W/W
8	7	22	25
14	9	29	35
16	9	31	35
18	13	33	52
20	14	35	60
22	17	40	70
24	19	42	70
28	25	54	80
40	29	61	99

DIL JUMPERS

Single ended 24"	
14 PIN	1.40
16 PIN	1.60
24 PIN	2.35
40 PIN	3.25
Double Ended 6"	
14 PIN	1.90
16 PIN	2.05
24 PIN	3.10
40 PIN	4.85
Double Ended 12"	
14 PIN	2.00
16 PIN	2.15
24 PIN	3.25
40 PIN	5.10
Double Ended 18"	
14 PIN	2.65
16 PIN	2.25
24 PIN	3.40
40 PIN	5.25

ZERO INSERTION FORCE SOCKETS

24 PIN	5.95
28 PIN	7.40
40 PIN	8.80

25 WAY 'D' CONNECTORS

MALE-MALE (36" CABLE)	10.15
MALE-FEMALE (36" CABLE)	18.13
MALE S ENDED (18" CABLE)	5.83
FEMALE S Ended (18" CABLE)	6.25

NEW IDC CONNECTORS

SHROUDED HEADERS (WITH EJECTORS) (Right Angle PCB MTG)

10 PIN	0.86
14 PIN	1.22
16 PIN	1.34
20 PIN	1.48
26 PIN	1.78
34 PIN	2.06
40 PIN	2.32
50 PIN	2.70
60 PIN	3.20

IDC Sockets inc 36" Ribbon Cable

10 PIN	1.40
14 PIN	1.82
16 PIN	2.10
20 PIN	
26 PIN	3.24
34 PIN	3.80
40 PIN	4.80
50 PIN	5.48
60 PIN	6.38

NEW VIDEO MONITORS NEC GREEN SCREEN

9" / 12" — Tel. Sales Office for price and deal

NEW CP INDUSTRIAL EPROM Programmers & Erasers

~~EP4000~~	~~545.00~~
P4000	545.00
UV141	78.50

NEW DATASHEETS & DATABOOKS

MEMORIES DATA	
2114	0.50
2708	1.10
2716	1.10
2716 3 rail	1.00
2732	1.40
6116	0.80
2532	0.99
4116	1.10
4118	0.90
4164 (TI)	1.80
4164 NEC	1.80
4816	0.90
5516	1.10
Z80 FAMILY DATA	
Z80 CPU	0.80
Z80CTC	0.90
Z80ADART	0.80
Z80ADMA	1.10
Z80PIO	0.90
Z80ASIO	2.00
MK3886	6.75
6500 FAMILY DATA	
6502	1.80
6520	0.65
6522	2.60
6532	1.10
8000 FAMILY DATA	
8085A	2.00
8251	2.40
8255	1.00
DATA CONVERTERS DATA	
ZN425	0.75
ZN427	0.75
ZN428	0.75
ZN432	0.75
ZN433	0.75
ZN447/8/9	0.75
UPD 7002	0.75
MISC. SUPPORT CHIPS DATA	
AY-3-1015	1.28
AY-3-1270	0.50
AY-3-8910	1.00
AY-5-1013	1.30
AY-5-3600	3.25
AY-5-2376	3.25
DP8304	0.65
6800 FAMILY DATA	
6800	4.50
6802	2.09
6803C	1.00
6809	3.50
6810	0.85
6821	1.50
6840	2.00
6845	2.60
6850	1.10
68488	1.50
UHF MODULATORS DATA	
UM1111	0.40
UM1233	8.40
FLOPPY DISC CONTROLLERS DATA	
FD1771	2.60
FD179X	3.00
WD2143	1.00
WD1691	1.10
WD Kits	5.10
MISC. SUPPORT CHIPS DATA	
MC1488	0.90
MC1489	0.90
MC3446	0.69
MC3448A	0.90
MC3480	2.20
MC3487	0.65
MC14411	0.65
RO-3-2513X	0.00
DVM CHIPS DATA	0.75
TI DATA BOOKS	
Linear Control Circ.	4.00
Voltage Regulators	4.50
MOS/Memory	3.95
Interface Circuits	7.00
TTL 5th Edition	8.50
Bipolar Microcomp	4.80
TI POCKET GUIDES	
TTL 1st Edition	3.50
Linear & Interface	2.50

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Front load £550.00 – Top load £295.00
PSU type ME3029 for 2 drives £125.00
DRE 44A/4000A/B 10 mb 5+5 all configurations from £995.00. Call sales office for details.

5 AMP MAINS FILTERS

Cure those unnerving hang ups and data glitches caused by mains interference. Matchbox size – Up to 5 amp 240 v load. As recommended by the ZX81 newsletter. Suppression Devices SD5A £5.95.

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COMPUTER 'CAB'

All in one quality computer cabinet with integral switched mode PSU, Mains filtering, and twin fan cooling. Originally made for the famous **DEC PDP8** computer system costing thousands of pounds. Made to run 24 hours per day the PSU is fully screened and will deliver a massive +5v DC at 17 amps, +15v DC at 1 amp and −15v DC at 5 amps. The complete unit is fully enclosed with removable top lid, filtering, trip switch, 'Power' and 'Run' LEDs mounted on Ali front panel, rear cable entries, etc. etc. Units are in good but used condition – supplied for 240v operation complete with full circuit and tech. man. **Give your system that professional finish** for only £49.95 + Carr. Dim. 19" wide 16" deep 10.5" high. Useable area 16"w 10.5"h 11.5"d.
Also available **LESS PSU** with internal dim. 19"w, 16"d, 10.5"h, £19.95". Carriage & insurance £9.50.

COOLING FANS

Keep your hot parts COOL and RELIABLE with our range of **BRAND NEW** professional cooling fans.
ETRI 99XUOI Dim. 92 x 92 x 25 mm. Miniature 240 v equipment fan complete with finger guard. **£9.95.**
GOULD JB-3AR Dim. 3" x 3" x 2.5" compact very quiet running 240 v operation. **NEW £6.95**
BUHLER 69.11.22. 8-16 v DC micro miniature reversible fan. Uses a brushless servo motor for extremely high air flow, almost silent running and guaranteed 10,000 hr life. Measures only 62 x 62 x 22 mm. Current cost £32.00. **OUR PRICE ONLY £12.95 complete with data.**
MUFFIN-CENTAUR standard 4" x 4" x 1.25" fan supplied tested EX EQUIPMENT 240 v at £6.25 or 110 v at £4.95 or BRAND NEW 240 v at £10.50. 1000's of other fans Ex Stock. Call for Details. Post & Packing on all fans £1.60

8" FLOPPY DISK DRIVES

Unbelievable value the DRE 7100 8" floppy disk drives utilise the finest technology to give you 100% bus compatibility with most drives available today. The only difference being our **PRICE** and the superb manufacturing quality!! The 7100 single sided and 7200 double sided drive accept hard or soft sectoring IBM or ANSI standard formats giving a massive 0.8 MB (7100) 1.6 MB (7200) of storage. Absolutely SHUGART, BASF, SIEMANS etc. compatible. Supplied BRAND NEW with user manual and full 90 day warranty. Carriage and insurance £9.75.
7100 Single sided £225.00 + Carr. **7200 Double sided £295.00** + Carr.
Optional accessories: Full technical manual £20.00 alone. £10.50 with drive. Refund of difference on drive purchase. DC and AC power connector and cable kit £8.45. 50 way IDC connector £5.50. 50 way ribbon cable £3.20 per metre.

VIDEO MONITORS

MOTOROLA 9" open chassis monitor. Standard 240 v AC with composite 75 ohm video input, bandwidth in excess of 18 mhz. Monitors are ex equipment and although unguaranteed they are all tested prior to despatch, and have no visible burns on the screens. Dim approx. 9" x 9" x 9". Supplied complete with mains and input lead. Ideal ZX81 etc. or giving the tele back to the family!! Black and white phosphor. **£35.00** + £9.00 Carr.
12" CASED. Made by the British KGM Co. Designed for continuous use as a data display station, unit is totally housed in an attractive brushed aluminium case with ON-OFF, BRIGHTNESS and CONTRAST controls mounted to one side. Much attention was given to construction and reliability of this unit with features such as, internal transformer isolated regulated DC supply, all components mounted on two fibre glass PCB boards – which hinge out for ease of service, many internal controls for linearity etc. The monitor accepts standard 75 ohm composite video signal via SO239 socket on rear panel. Bandwidth of the unit is estimated around 20 Mhz and will display most high def graphics and 132 x 24 lines. Units are secondhand and may have screen burns. However where burns exist they are only apparent when monitor is switched off. Although unguaranteed all monitors are tested prior to despatch. Dimensions approx. 14" high x 14" wide by 11" deep. Supplied complete with circuit. 240 volt AC operation. ***ONLY £45.00 PLUS £9.50 CARR.***
14" COLOUR superb chassis monitor made by a subsidiary of the HITACHI Co. Inputs are TTL RGB with separate sync. and will plug direct into the BBC micro etc. Exceptional bandwidth with good 80 col. definition. Brand new and guaranteed. Complete with full data & circuit. 240 v AC working. Dim. 14" x 13" x 13". ***ONLY £199.00 PLUS £9.50 CARR.***

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The FABULOUS 25CPS TEC Starwriter Daisy wheel printer at a fraction of its original cost.

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Made to the very highest spec. the **TEC Starwriter FP1500-25** features a heavy duty die cast chassis and DIABLO type print mechanism giving superb registration and print quality. Micro-processor electronics offer full DIABLE/QUME compatibility plus Bi directional printing, 10 or 12 pitch, 136 or 163 chars per line, full width 381 mm friction or single sheet paper, – order now or call sales office for more information and print sample. Please specify RS232 or CENTRONICS interface. Supplied complete with **FREE** dust cover and daisy wheel. Optional extras: RS232 data cable **£10.00** – Tech. manual **£7.50.** Carriage & Ins. (UK) **£12.50.** – Tractor feed option **£120.00**

TELETYPE ASR33 I/O TERMINALS

FROM £195 + CAR. + VAT
Fully fledged industry standard ASR33 data terminal. Many features including ASCII keyboard and printer for data I/O auto data detect circuitry. RS232 serial interface. 110 baud, 8 bit paper tape punch and reader for off line data preparation and ridiculously cheap and reliable data storage. Supplied in good condition and in working order
Options: Floor stand ***£12.50*** + VAT
KSR33 with 20ma loop interface ***£125.00*** +
Sound proof enclosure ***£25.00*** + VAT

SOFTY 2

The amazing SOFTY 2. The complete "toolkit" for the open heart software surgeon. Copies, Displays, Emulates ROM, RAM and EPROMS of the 2516, 2532 variety. Many other features include keyboard, UHF modulator. Cassette interface etc. Functions exceed capabilities of units costing 7 times the price! Only ***£169.00*** pp £1.95 *Data sheet on request*

RECHARGEABLE BATTERIES

CYCLON type D001 sealed lead acid maintenance free 2v 2.5 ah. will deliver over 300 amps on short circuit!! Brand new at only ***£2.95***
SAFT VR2C size 'C' 1.2v 2 ah. nickel cadmium ***£1.50*** each 10 for ***£11.50***

D.C. POWER SUPPLY SPECIALS

Experimentors PSU Ex-GPO unit all silicon electronics. Outputs give +5v @ 2 amps. +12v @ 800 ma. -12v @ 800 ma. +24v @ 350 ma. 5v @ 50 ma. floating. Dim 160 x 120 x 350 mm. All outputs fully regulated and short circuit proof. Removed from working equipment, but untested. Complete with circuit. Transformer guaranteed. Only ***£14.50*** +£2.50 pp.
CUSTOM POWER CO55 5v @ 3 amp. Very compact unit dim. approx 60 x 90 x 190 mm. Semi open chassis, full crowbar overvoltage protection. Tested Ex Equipment. ***£11.95*** + pp £1.25
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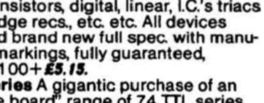

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ORGAN PART2

In this month's trip through the Victory organ circuitry, we look at the lower keyboard and the filtering and envelope arrangements for the preset voices. Design by Richard Watts.

Before we start to talk about this month's circuitry, there are a few things to mention about last month's diagrams. For a start, some of the lettering dropped off Fig. 1 somewhere between the drawing board and the printers, so: the unmarked diodes by IC2a and IC2b are D4 and D5, while those by IC5c and IC5d are D11 and D12. The terminal marked PEDAL TRIGGER should also be labelled C5 and that marked MANUAL TRIGGER should also be labelled C7. C here denotes the switchbank controlling the automatic functions of the organ. The junction just below D7 should have a dot, ie it *is* a junction and not a crossing point.

In Fig. 2, pins 5 and 6 of IC9a should be linked together. In Fig. 3, the op-amp marked IC10 is actually IC10a, the other half appearing this month. Also, the label 'TO RHYTHM CIRCUIT' on IC12a pin 5 should be 'TO R127/128' (on Fig. 2 this month).

Finally, the number of letters and phone calls we've had in the last couple of weeks prove how popular this project is — what a shame we forgot to include a 'Buylines' last month! That's been rectified this time round. So, get out last month's ETI — you'll need to refer to some of the circuits — and off we go with some more of How It Works.

The Lower Keyboard

The lower keyboard or manual uses an M108 IC (IC14), which operates in exactly the same way as the M208 but has one fundamental difference. Both ICs have the facility to operate as either a single 61-note keyboard or as a split keyboard, with the lower section able to perform the single finger chord function, amongst others. It is the size of this lower section that differs between the ICs. The M208 has a 17 key lower section and the M108 a 24 key lower section. The use of these ICs in their specific locations in the Victory organ is necessary to fulfil the total specification of the instrument.

Lower keyboard scanning is as for the upper keyboard except that the data input lines B1 to B5 are used. The circuitry comprising IC13, IC6e and Q5 which sits between the M108 B line inputs and the B line connections from the keyboard is used to enable the keyboard data information to be transferred to alternative B inputs on the M108, and is necessary under certain switch settings to maintain constant pitch outputs from the lower keyboard.

In normal operation the audio outputs are taken from pin 17 through R98 to amplifier IC16a, from where they are taken to the passive filter network R129, R130, C51 and C52. This filter produces the lower keyboard melodia voice. The audio is also taken via R137 to the VCA IC19 which is used for the rhythm guitar voice. Control current for this IC is supplied from Q4 and C54 via R142. Q5 base receives negative-going pulses via C55 from the rhythm memory IC pin 8 (see next month). The decay rate of C54 and thus the length of decay on the rhythm guitar voice can be reduced on application of a low signal to the cathode of D37. This effectively discharges C54 through R145 and D37. This low signal is also provided by the rhythm memory IC. Without this low on D37 cathode, the discharge path for C54 is through R142 and the 3080E itself. The rhythm guitar voice is therefore not available without the rhythm unit on.

Switching of the lower keyboard voices is as for the upper voices and mixing is accomplished in IC16b. The output from the mixer is fed via R134, which is shorted out if Lower Manual Accent is selected, to R127 and the main mixer/amplifier.

Single finger chord is available on the lower keyboard and, when selected, outputs a complete four-note chord plus bass note when only one key is depressed. The four notes of the chord are output from pins 3-6 of IC14. The SFC selection takes point C1 high which turns on all the switch sections of IC15, thus connecting these outputs through to the voicing circuits. Point C1 also connects through D33 to pin 12 of IC7d which enables $\overline{F7}$ via D16 to B6. This performs the keyboard split mentioned earlier and enables the lower section for its special functions.

The positive voltage at point C1 is also connected to pin 5 of IC2d, thus connecting $\overline{F6}$ via D31 to B6. This gives the SFC instruction to IC14 and causes the chord contents to be output to pins 3-6. The root note of the chord is available at pin 6, the third note at pin 5, the fifth at pin 4 and an octave to the root note at pin 3 (unless the 'seventh' feature is selected, in which case pin 3 outputs the 7th note).

Lower Manual Memory

Lower manual memory is also available by removing 0 V from point C3. This enables IC2c which connects F4 and F5 to B6 via D21 and D22 respectively. $\overline{F4}$ latches the outputs of the upper section of the lower keyboard while $\overline{F5}$ latches the outputs of the lower section of the lower keyboard. The bass note is latched at pin 7. If SFC and lower manual memory are both selected, bass audio is automatically selected to come from the lower keyboard since point C2 is disconnected from +12 V by the SFC switch. The bass trigger input point C6 must be connected to point C7 by selecting bass from the lower keyboard on the changeover switch. Since lower keyboard memory is being used and therefore keys are being played and then released, utilisation of the $\overline{KPA}$ signal from IC14 cannot be used to trigger the bass, otherwise it would be heard only when the key is held, and leaving the chord output less a bass note when the key is released. To overcome this, another output signal from the M108 is used.

This signal is called NPA and goes low whenever a memorised note is present in the accompaniment section ie the lower section of the keyboard when it is split. This low voltage is inverted by IC5c which is enabled by the state of point C10. The positive output from IC5c is passed via D11 to the bass trigger circuitry. This ensures that a memorised chord always has bass accompaniment.

If the SFC is de-selected while a chord is being memorised, the change at point C1 from +12 V to 0 V is coupled through C40 and D25 to pin 13 of IC2c. This momentarily disconnects $\overline{F4}$ and $\overline{F5}$ from B6, disabling the output latches and stopping the chord and bass outputs. If a note is now played on the lower keyboard it will be latched at the output pin 17. Up to four notes played simultaneously can be latched. The $\overline{TDS}$ output from the M108 is connected via

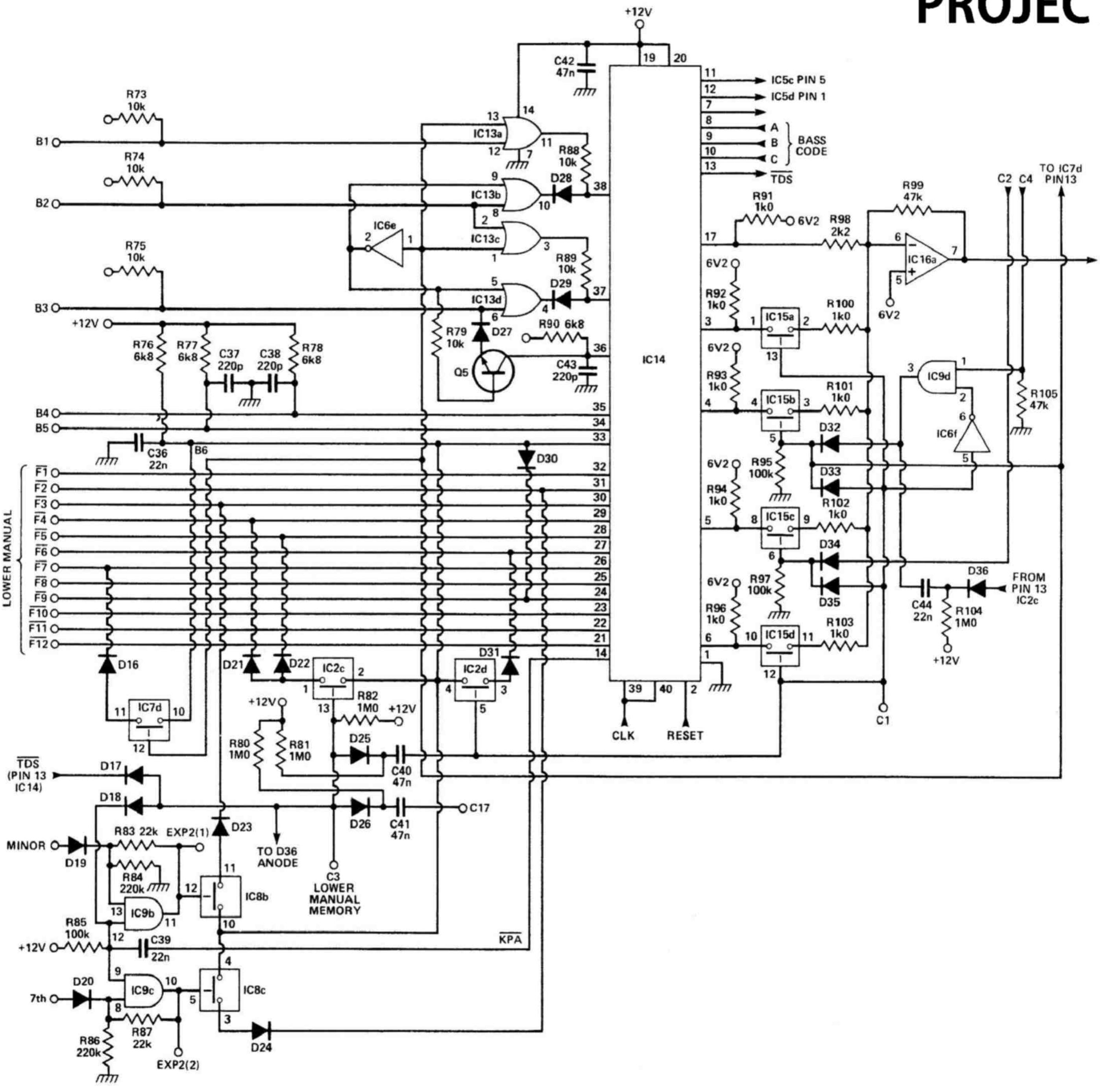

Fig. 1 Circuit diagram of the lower keyboard circuitry. The output from ICI6a pin 7 passes to the circuit on the next page.

D17 to pin 13 of IC2c (the latch enable) to ensure that any previously latched note or notes are cancelled when the next is played.

A bass note corresponding to the leftmost or only note played will be output on pin 7. The enable for the split keyboard mode (connecting $\overline{F7}$ to B6) to pin 12 of IC7d is supplied, when the SFC is off, by virtue of the fact that point C4 is high (bass from lower keyboard) and point C1 is low (SFC is off). This gives the AND gate IC9d highs on both pins 1 and 2, giving a high at pin 3. This is connected via D32 to pin 12 of IC7d.

Back now to the situation with both SFC and lower keyboard memory on. The chord can be modified to a minor (flattened third) or a seventh by use of the pedals which are disabled from their normal function by the SFC switch. Playing any black pedal (ie sharps and flats) causes +12 V to be connected through the second pole of the pedal switch via D19 to pin 13 of IC9b. Since the other input (pin 12) of this gate is held high by R85, the output pin 11 will go high, thus connecting $\overline{F3}$ via D23 and IC8b to B6. This tells IC14 to change the chord being output to a minor. Since the output of the AND gate is connected back to its input by R83, the minor function remains latched on until another key is pressed to change the chord, or the same key is pressed again. This causes the M108 to output a KPA pulse which is coupled through C39 to the AND gate input pin 12. This momentary low disables the AND gate and causes the newly played chord to be played as normal. Operation of the 7th modification to the chord is achieved by playing any brown pedal (naturals). The switching arrangement is the same as for minor except that $\overline{F2}$ gets connected to B6.

Preset Voices

These voices (the piano, harpsichord, Hawaiian guitar, banjo and accordion) all use IC18, another 3080E operational transconductance amplifier

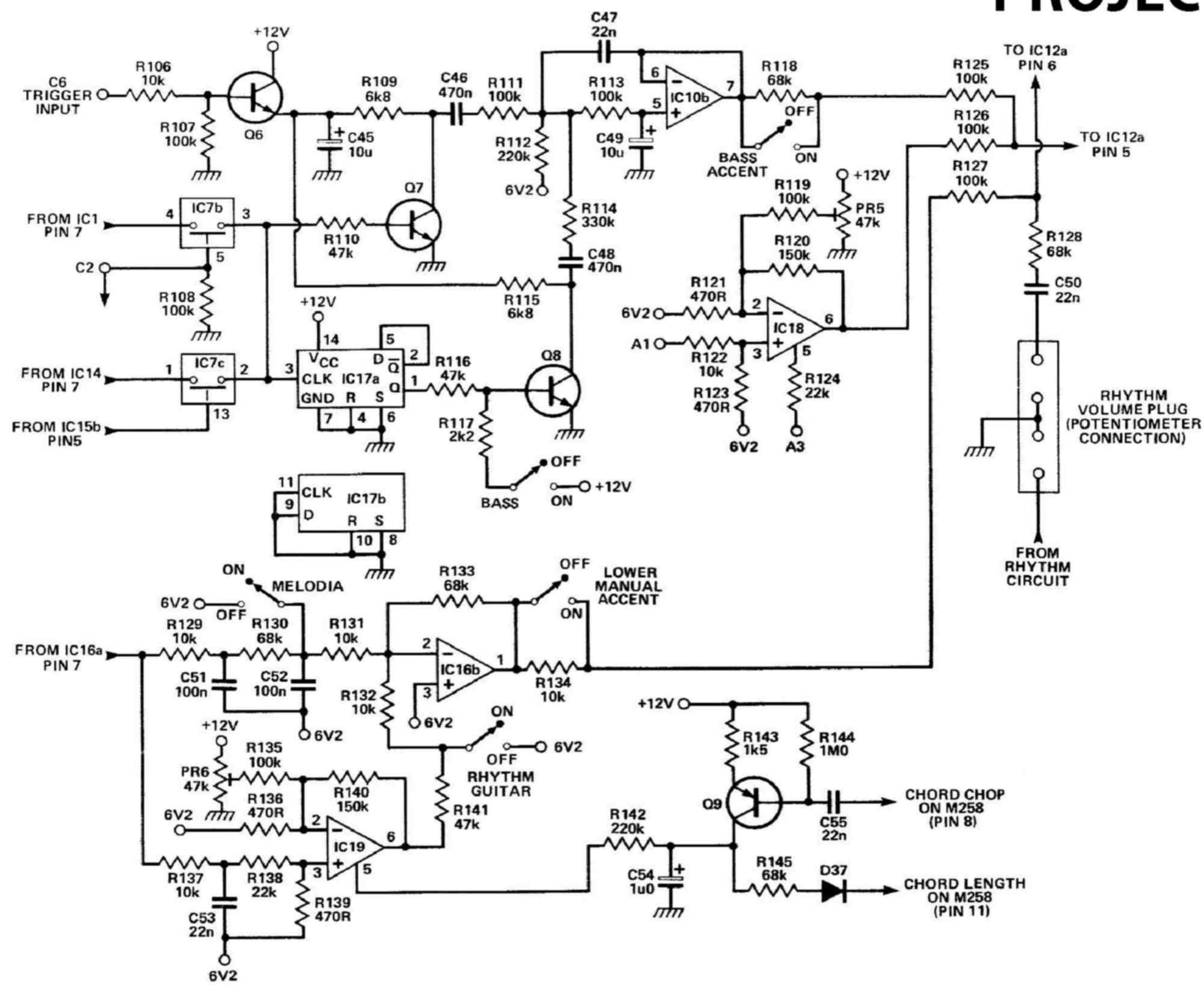

Fig. 2 The preset voicing circuitry. The rhythm volume plug allows the connection of a 25k logarithmic off-board potentiometer.

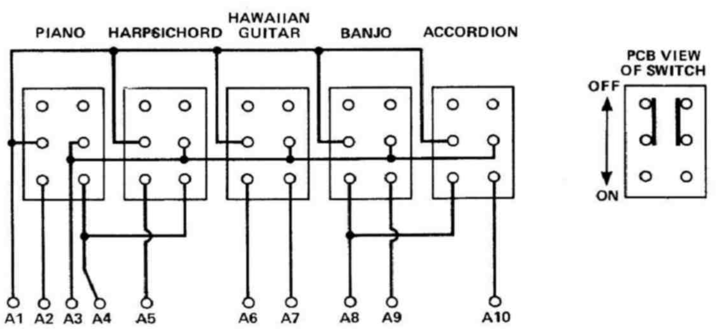

Fig. 3 The wiring for the preset voice switch bank.

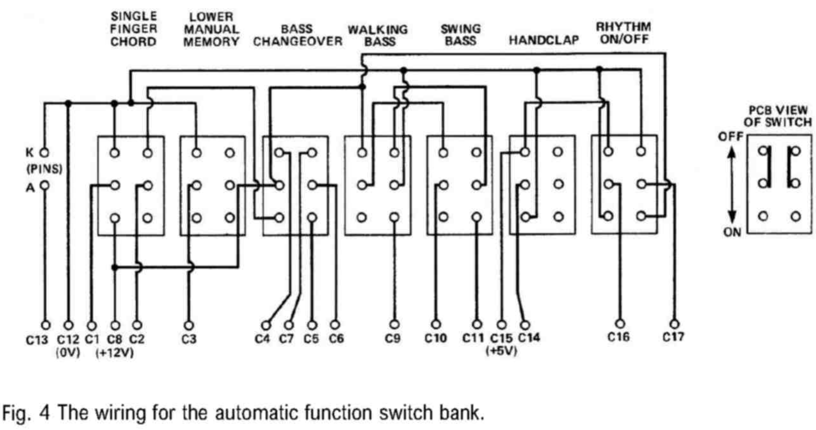

Fig. 4 The wiring for the automatic function switch bank.

configured as a VCA. The audio input is applied to the point A1 and the control envelope to the point A3. These points connect, through an edge connector, to the preset voice switch bank. As can be seen from Fig. 3, the selection of piano, harpsichord and Hawaiian guitar each connects an independent audio input to A1. The banjo and accordion select the same voice but considerably different envelopes.

The piano voice which connects to point A2 is actually a tap off the trombone voice via RS1. The amplitude envelope on A4 is also utilised by the harpsichord preset and operates as follows. When a key is depressed, the M208 (IC1), outputs a signal called (trigger decay solo) which, in common with KPS is active low, but unlike RPS does not remain low .for the duration that the key is held. It is a pulse output of approximately 9 ms which is developed internally by the M208 and is output whenever a key is depressed, even if a previously depressed key is still held down. TDS is inverted by Q10 and applied to follower Q11 whose emitter connects to C56. It is the charge and discharge rate of C56 which determines the piano and harpsichord amplitude envelope.

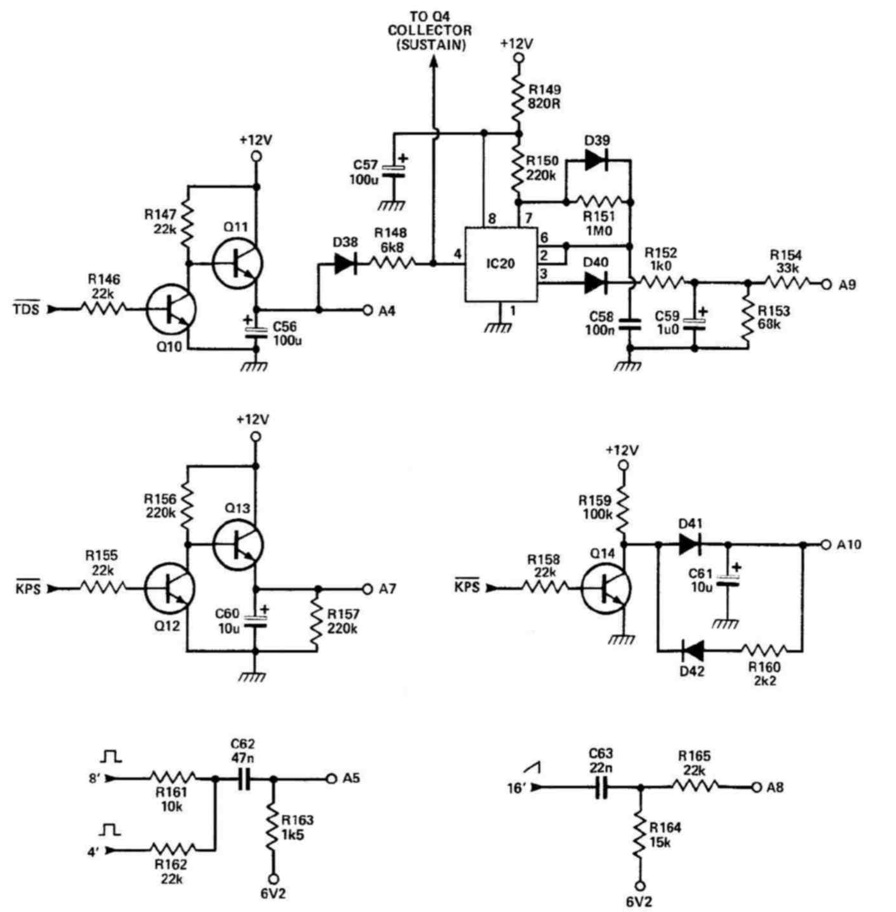

Fig. 5 (Top) The circuitry to produce the piano/harpsichord envelope and the banjo repeat. (Middle left) The circuit for the Hawaiian guitar envelope. (Middle right) The accordion envelope circuit. (Bottom left) Filter for the harpsichord voice. (Bottom right) Filter for the banjo and accordion voice.

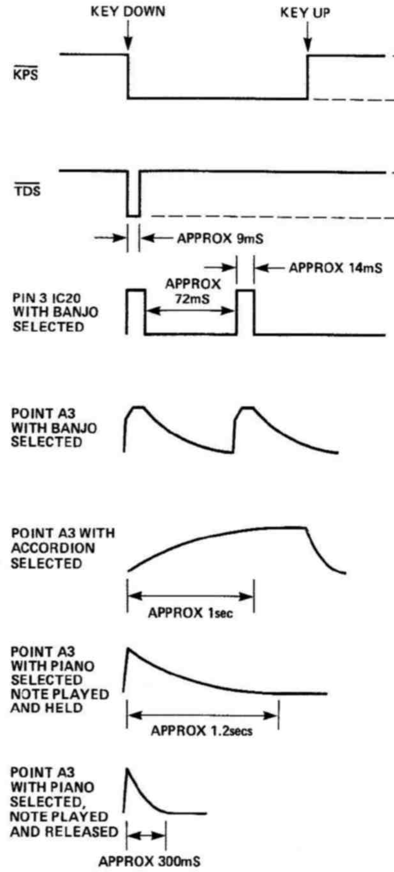

Fig. 6 Waveforms associated with the preset voicing circuitry, as described in the text below.

Two decay rates are possible: one if a key is played and held and a second, shorter, delay if a key is played and released quickly, as is the case when playing a real piano or harpsichord. First, if a key is played and held, C56 is charged very quickly through Q11, resulting in a fast (percussive) attack. After about 9 mS the TDS signal returns to its normal state and no more current is supplied to C56, which starts to discharge. Since the key is still held down, the KPS signal is still present and so the collector of Q4 is high. This reverse biases D38 so the only discharge path for C56 is through R124 and IC18. This results in a long decay.

If a key is played and then released, the same attack is apparent but since KPS is no longer present, Q4 returns to its saturated state, thus providing a discharge path for C56 through D38, R148 and Q4. This gives a short decay.

The harpsichord voice is developed by mixing 8' and 4' square wave signals via R161 and R162, then filtering this mixture with C62 and R163. This audio signal is then connected to the harpsichord switch through point A5.

The Hawaiian guitar voice at point A6 is another 'tap off', this time via R50 from the clarinet voice. The amplitude envelope on point A7 is similar in operation to the piano/harpsichord envelope except that there is only one decay rate and KPS is used as the trigger. KPS is supplied to an inverter, Q12, and via Q13 to C60, resulting in the same fast attack: however, since R57 is connected across C60 this will be its discharge path, giving a long decay but only when all the keys are released.

The banjo and accordion voice is developed from the 16' staircase (IC3b pin 1) through the filter network C63, R164 and R165, and is available at point A8. The banjo is a repeating voice, ie when a key is depressed and held, the audio is alternately passed and blocked by the VCA (IC18) at about 11 Hz. This technique is widely used on organs to give the effect of plucking or strumming the instrument. The repeat oscillator comprises a 555 (IC20) and its associated components. It is configured here as a gated astable multivibrator which will give square wave pulses at pin 3 whenever pin 4 is taken high. D39 is included to give a very short pulse (about a 1:5 mark/space ratio). Since pin 4 is connected to Q4 collector, output pulses are produced whenever a KPS signal is present. The components between IC20 pin 3 and point A9 act as attack and decay shapers for the output square waves and produce an exponential control voltage.

In Accordion

The accordion amplitude envelope requires a slow attack and, when the key or keys are released, a fast decay. This envelope is available from point A10 and is developed by KPS causing Q4 to shut off. This allows C61 to charge through R159 and D41, resulting in the slow attack. Once charged, C61 is able to remain charged so long as the key is held down (ie KPS is present) and therefore the voice remains audible. Once all the keys are released and KPS is removed, Q14 returns to its saturated state and provides a rapid discharge path for C61 via R 160 and D42. The output from the preset VCA (IC18) is fed via R 126 to the output mixer/amplifier IC12a.

BUYLINES

The response to this project has been amazing! Unfortunately, the prices for all the various options haven't been finalised as we go to press, so interested parties should contact the designers: that's Leighton Electronic Services, 17 Bridge Street, Leighton Buzzard, Bedfordshire LU7 7 AH (telephone 0525 382504).

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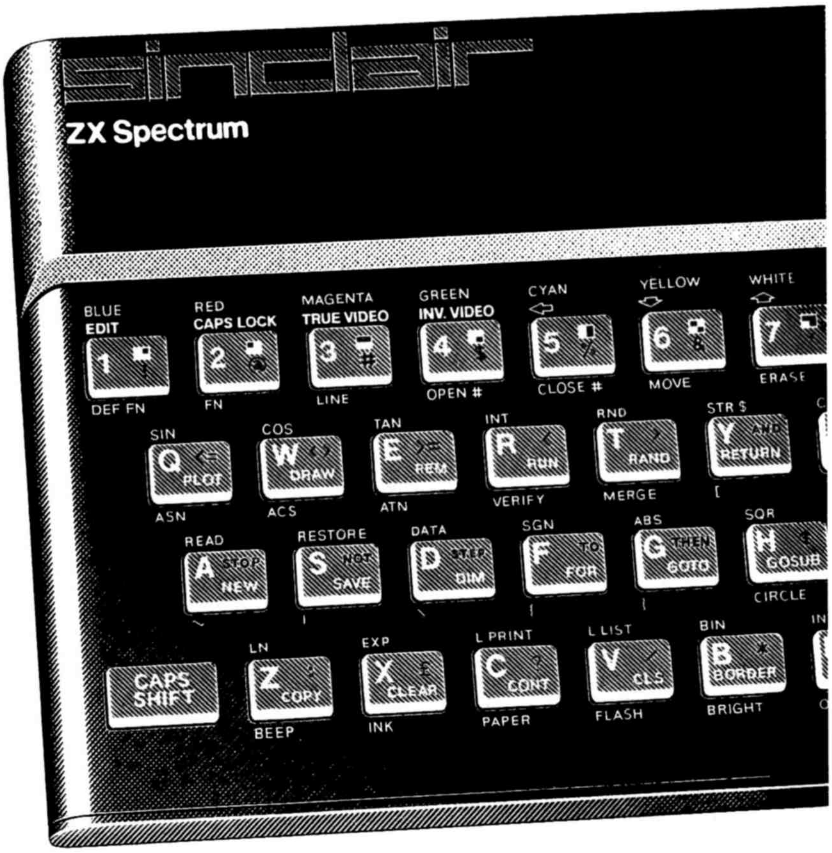

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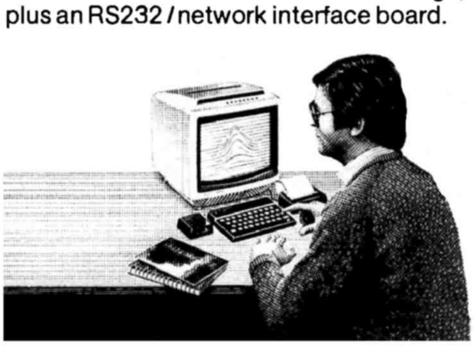

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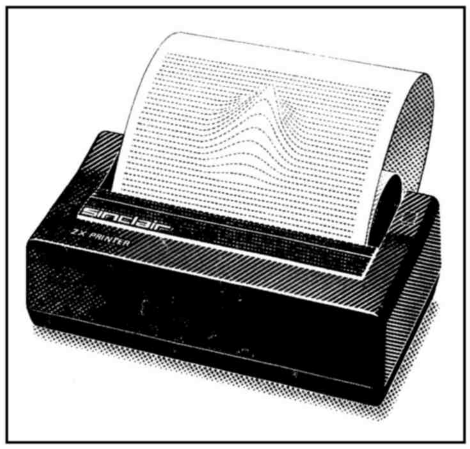

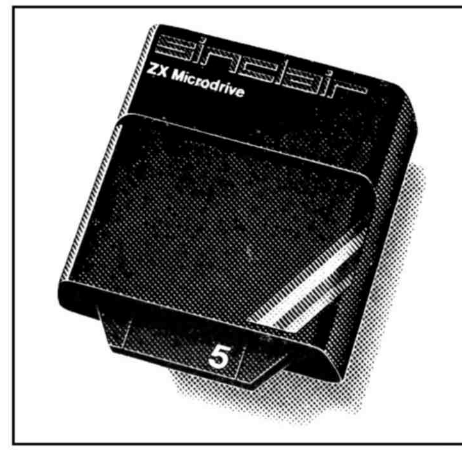

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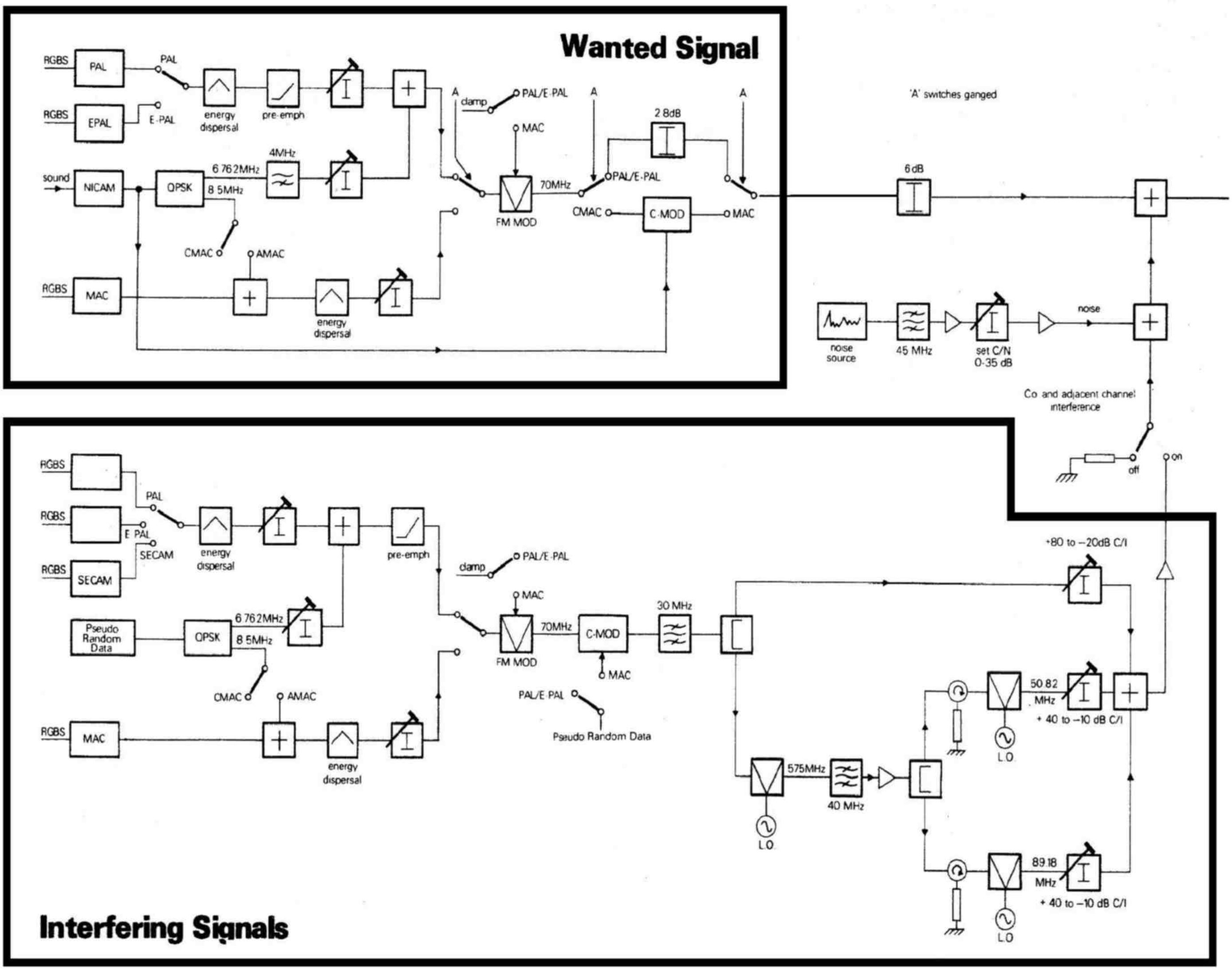
BROADCAST STANDARDS

What factors made the government choose .. the IBA's Multiplexed Analogue Component system in preference to what seemed the logical choice, Extended PAL? Dave Bradshaw investigates.

The two system proposals submitted by the BBC and IBA were examined by an 'Advisory Panel', chaired by Sir Anthony Part, and hence the report of the panel is known as the Part Report. As already described by Vivian Capel in his article (page 16), MAC uses System C sound, in which the sound is compressed into the intervals between picture lines: this gives a capacity of up to eight sound channels. When the IBA originally submitted its proposal, it wasn't known if System C would be a practical proposition by the time that DBS was due to come into service, and so their original proposal was for System A, using an 8.5 MHz sub-carrier. During the course of the Advisory Panel's deliberations, the British Radio and Electronic Equipment Manufacturers' Association (BREMA, a very welcome acronym) stated that they thought that System C would be practicable, and the IBA changed its proposal to System C. Hence the panel actually considered two MAC systems — known as A-MAC and C-MAC, though only C-MAC was put through the technical trials.



Technical Assessment

The competing systems were put on trial and the location was chosen, by drawing lots, to be the BBC research department at Kingswood in Surrey. Transmission and reception of two signals was simulated, as were the different noise levels, and co-channel interference from the same and different systems. However, the possible effect of an out-of-alignment receiver was not evaluated.

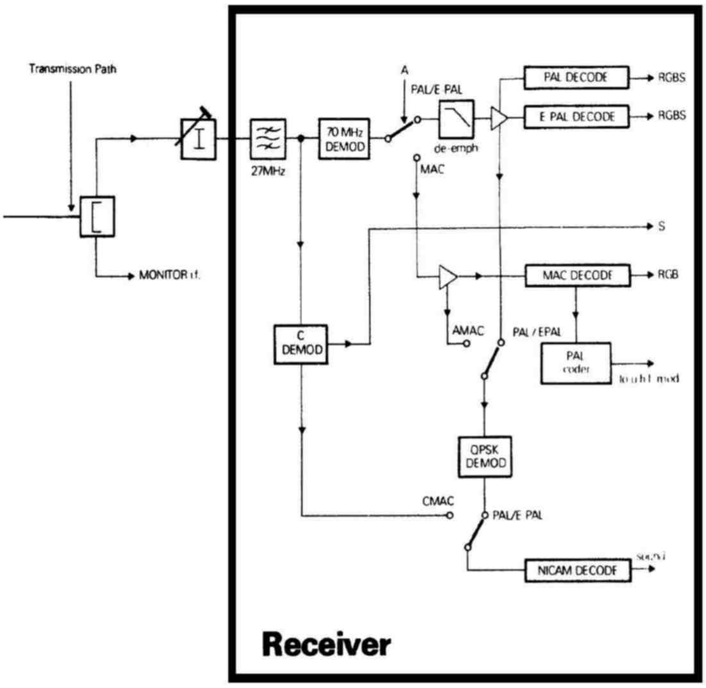
The panel reported that both systems showed a 'noticeable improvement in definition compared with PAL', with MAC having the edge over E-PAL, though E-PAL still offered a considerable improvement over PAL.

Both systems began to show the effects of noise impairment on vision at around the same noise level, 14 dB, but were quite viewable at 11 dB. At lower carrier-to-noise ratios, E-PAL gave a less acceptable picture than MAC, the latter having approximately a 2 dB advantage over the former. Sound quality remained very good down to 7 dB carrier-to-noise ratio.

MAC had a lower tolerance to co-channel interference than E-PAL. However, the interfering signal levels needed to produce **any** observable effect on either system were quite unrealistic. So, round one to MAC.

War of the Words

As you may imagine, neither the BBC nor the IBA were silent about the merits of their systems. Both made written and aural submissions to the Advisory Panel. Amongst the arguments advanced for E-PAL were:



QPSK - Phase Shift Keyer
NICAM - Near Instantaneous Companding
C/N - Carrier to Noise Ratio
C/I - Carrier to Interference Ratio

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Fig. 1 Set-up for comparative demonstrations:

- the PAL system has been in use since 1967 and there are 14 million receivers operating on this standard. E-PAL transmissions are compatible with conventional PAL decoders (though a converter would be needed for the digital audio). There would be a very marginal loss of quality compared to that obtained from PAL transmissions — so marginal that most users would not notice any difference.
- the resolution of pictures at home is limited by the receiver and display. High definition TV (HDTV) is about 10 years away, so there is little point in radically altering transmission standards before its introduction.
- the extra circuity needed for an E-PAL receiver compared to a PAL receiver is very small, simple and well understood.

Enter the IBA

The IBA's two-pennyworth included the following points:

- MAC is more likely to be adopted as a common European standard than E-PAL because of its technical superiority (most of the rest of Europe is currently engaged in debating DBS systems, and the European Broadcast Union, EBU, will be considering the possibility of a single common standard later this year)
- because in the MAC system the components (luminance, Y, and colour differences U and V) are kept separate, MAC is a closer complement to the emerging studio practice of keeping and storing the components separately rather than encoded into a composite single video signal.
- MAC is designed from scratch to match the FM satellite channel (rather than to be compatible with existing practice) which leads to a better subjective noise performance.
- MAC has greater potential for enhancement or providing the basis for HDTV systems.
- finally (and here's the rub), MAC is well suited to the scrambling systems that would be necessary for pay-TV.

A European Standard?

The situation in Europe is that countries are divided between the PAL and SECAM systems, and for political reasons, SECAM countries are not very likely to adopt PAL, or vice-versa. Ironically, the only possible way of getting uniformity is to make everyone change.

The European manufacturers' association, EACEM, has shown an interest in the MAC system. However, the EBU has expressed a strong preference for System-A sound, though this preference was expressed at a time when it appeared that System-C sound could not be implemented in time. France and Germany have already decided to proceed at an early stage to DBS using their existing SECAM and PAL systems for vision, though it is not clear whether either has ruled out the possibility of changing to an enhanced system at some stage in the future (fortunately the coding of the signals is done on the ground, the satellite being a 'transparent' device in this respect).

Incidentally, a note to all you cynics out there. Harmonisation of broadcast standards is not simply another case of rather pointless Euro-bureaucracy, because there is expected to be a considerable international audience for TV programmes. In fact, the BBC thinks that its pay TV service could gain a lot of revenue from the continent.

What has Cable TV to do with it?

Quite a lot actually, because cable companies stand to make a penny or two out of satellite TV themselves. This is

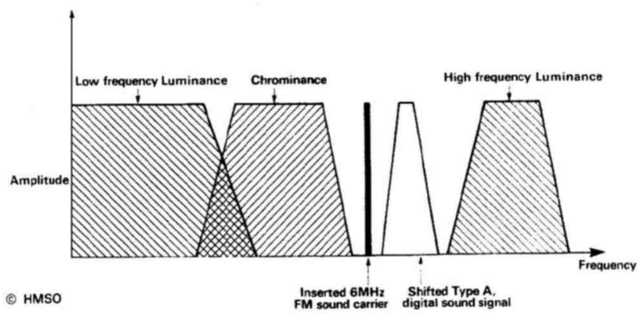

Fig. 2 Modified E-PAL signal spectrum - an E-PAL signal with Type A sound.

because the cost of putting up your own antenna will be much more than the cost of getting a cable company to deliver the signal to you via their network (provided you're one of the lucky 60% or so of the population to whom cable TV will be offered . . .) So, because cable companies will be carrying the DBS services, they too had their comments to deliver to the Advisory Panel.

As it happens, the cable companies wanted yet another system, a modified E-PAL with *both* digital sound *and* conventional analogue sound, so that existing sets would be fully compatible with E-PAL without the digital sound module. However, the panel felt that this would be impractical, and, in its conclusions, said that it thought that MAC would be more suitable for cable transmission because of the absence of sub-carriers.

Judgment Day

In its recommendation, a recommendation that was very rapidly accepted by the government, the Advisory Panel endorsed MAC, rejecting three of the BBC's central points. Firstly, they considered that the results obtained using an E-PAL signal with a standard PAL receiver were unacceptable; secondly, that it would be worth developing a new system before the introduction of HDTV; and thirdly, that the extra circuitry for MAC would be little trouble to manufacture.

On the last point, there was felt to be some difficulty in fabricating one of the filters for the E-PAL receiver, whereas, once integrated, the time multiplexing circuits for the MAC receiver would be relatively simple to fabricate. The panel accepted all the IBA's claims for the MAC system. The BBC is philosophic about the decision going against it, and view the subject now as a dead issue.

Program And Payment

Very much a live issue is the way the BBC will use the two DBS channels it has been allocated. One is presently planned to be an open service, possibly called 'Window on the World' and utilising the best of programmes from abroad and the BBC's extensive archives. There will be a supplementary licence fee for DBS services, presently planned to be comparatively small (around £10); after all, it won't be necessary to use special detector vans to spot DBS antennas.

The other channel is planned to be a pay service, using some sort of signal scrambling; you will have to pay to get the unscrambling device (or, more likely, you will have to pay to get the data that your receiver will need to do the unscrambling). There are all sorts of different proposals for how the scrambling and unscrambling might be done, and the scrambling method will be varied from time to time, with a mode-shifting digital key being transmitted periodically.

How viewers are going to be asked to pay for the service also has to be decided. The two possibilities are a simple monthly subscription (this has the attraction of simplicity) and a pay-as-you-go system. The latter would greatly ease negotiations for material such as feature films, because the BBC would be able to negotiate an apportioning of the income generated rather than a fixed fee; and it is very much a feature of plans for the pay channel that it should have new films. However, the government has ruled out pay-as-you-go for cable TV, so DBS may also have that option closed to it.

Despite the prediction that cable TV will reach, at most, only 60% of the population, and despite the cable companies' plans to carry the DBS channels, the BBC is very seriously worried by the prospect of direct competition between DBS and cable pay services. The BBC has undertaken that its DBS services will be self supporting, and that it should not place an additional burden on the standard licence income. For a while there was serious consideration of withdrawing from DBS altogether, but it has now been decided to go ahead — this may have been helped by some recent, rather pessimistic forecasts for cable TV.

As yet the IBA has not been granted a DBS channel, though three remain unallocated and it is thought certain that the IBA will get at least one.

Hardware Issues

Initially, the average domestic installation will consist of three parts: the antenna and out-of-doors unit that will be mounted directly beneath the antenna and will do the down-conversion of signal frequency; the indoor unit that will convert the MAC encoded video signals and the digital sound signals into a form the TV can cope with; and the TV set itself. It is possible to make indoor units that would produce a PAL output, but this would mean that a lot of effort had been wasted!

Better would be an indoor unit that produced either an RGB or YUV output, and a TV set with inputs to match. Providing such component video inputs would add little to the cost of the TV, and the indoor unit would actually be cheaper to make. Eventually, dual standard TV sets would become available, incorporating both MAC and standard PAL circuits. Unfortunately there is not the bandwidth available to transmit MAC signals from terrestrial transmitters, so we are stuck with PAL for the foreseeable future.

One Final Thought

There is just one last horrible possibility: what if the EBU does, against all the odds, decide on a European standard, but one that isn't MAC? The BBC or the government might be seriously tempted to change again, and we could have a re-run of all the arguments.

Direct Broadcasting by Satellite: Report of the Advisory Panel on Technical Transmission Standards, Chairman Sir Anthony Part, is available from HMSO for £5.60. The BBC have withdrawn their leaflet detailing their plans because it dealt very largely with E-PAL; they do not intend to issue a replacement in the foreseeable future.

I would like to thank the BBC, IBA and British Aerospace for their help in the preparation of this article; also Her Majesty's Stationery Office for permission to reprint the diagrams.

Finally, I think that Plymouth Poly deserve a mention; they too proposed a DBS system, though it obtained only a couple of rather dismissive mentions in the report. Full marks for trying, anyway, Plymouth.

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

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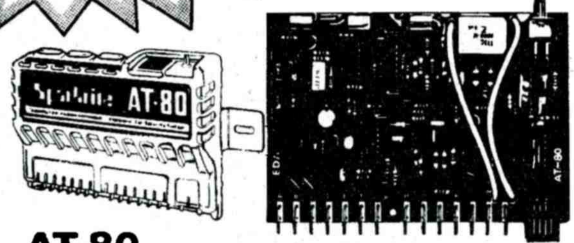

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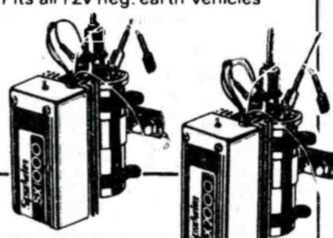

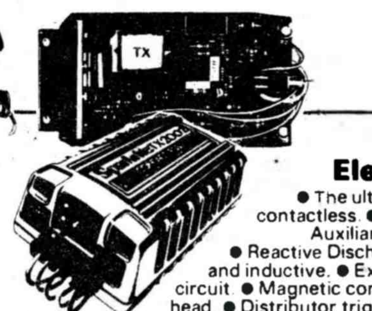

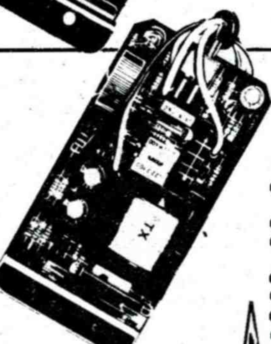

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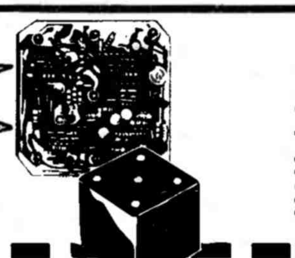

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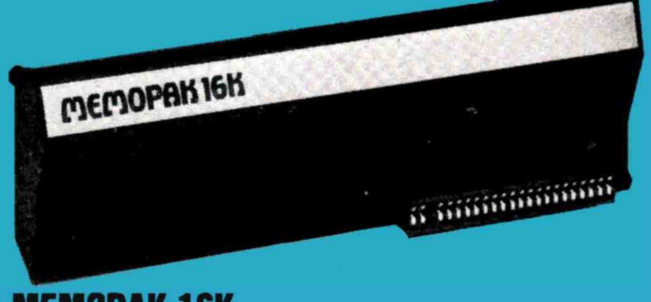
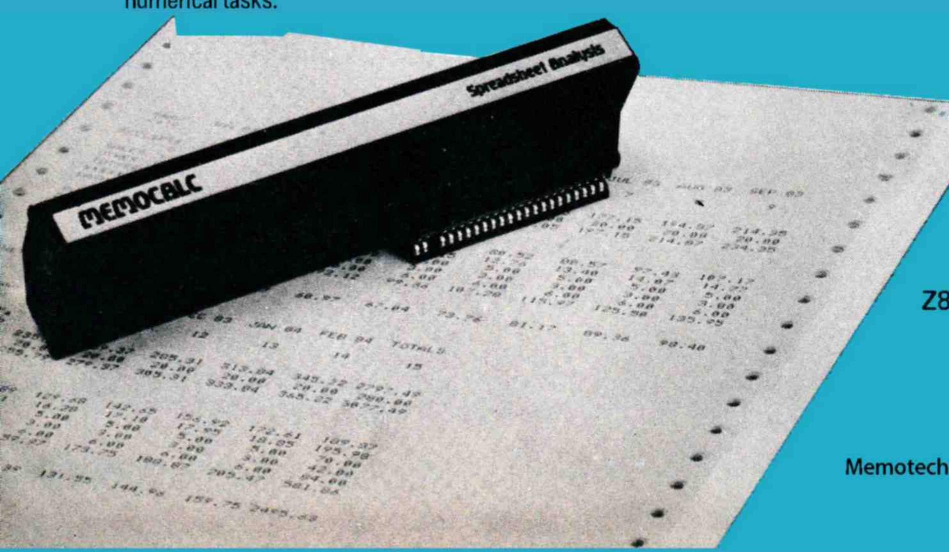


MEMOPAK 16K For those just setting out on the road to real computing, this pack transforms the ZX81 from a toy to a powerful computer. Data storage, extended programming and complex displays become feasible.
For even greater capacity, memory packs can be added together (16 + 16 + 16K or 16 + 32K). The MEMOPAK 32K and the MEMOPAK 64K offer large memories at economical prices.

MEMOTECH

The Memotech approach to micro-computing is to take the well-proven and popular ZX81 as the heart of a modular system. This small computer houses the powerful ZBOA processing unit and acts as the central processor module through which the MEMOPAKS operate.
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 inter-compatibility 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 1/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 BO-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 cyclically to give animated displays.

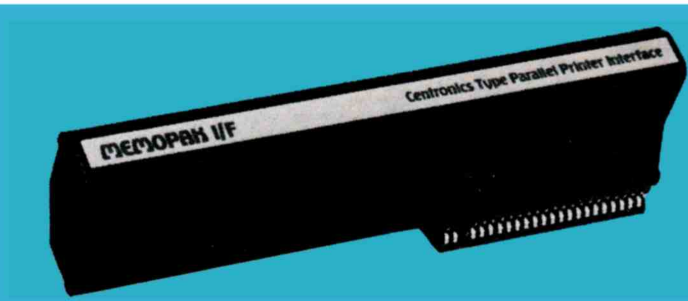
MEMOCALC The screen display behaves as a 'window' on a large sheet of paper on which a table of numbers is laid out. The maximum size of the table is determined by the memory capacity, and with a MEMOPAK 64K a table of up to 7000 numbers with up to 250 rows or 99 columns can be specified. Each location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



16K	£26.00	+	£3.90	VAT	£29.90
32K	£43.43	+	£6.52	VAT	£49.95
64K	£68.70	+	£10.30	VAT	£79.00
HRG	£34.70	+	£5.20	VAT	£39.90
CI/F	£34.70	+	£5.20	VAT	£39.90
MEMOCALC	£26.00	+	£3.90	VAT	£29.90
Z80 ASSEMBLER	£26.00	+	£3.90	VAT	£29.90
KEYBOARD WITH BUFFER	£43.43	+	£6.52	VAT	£49.95

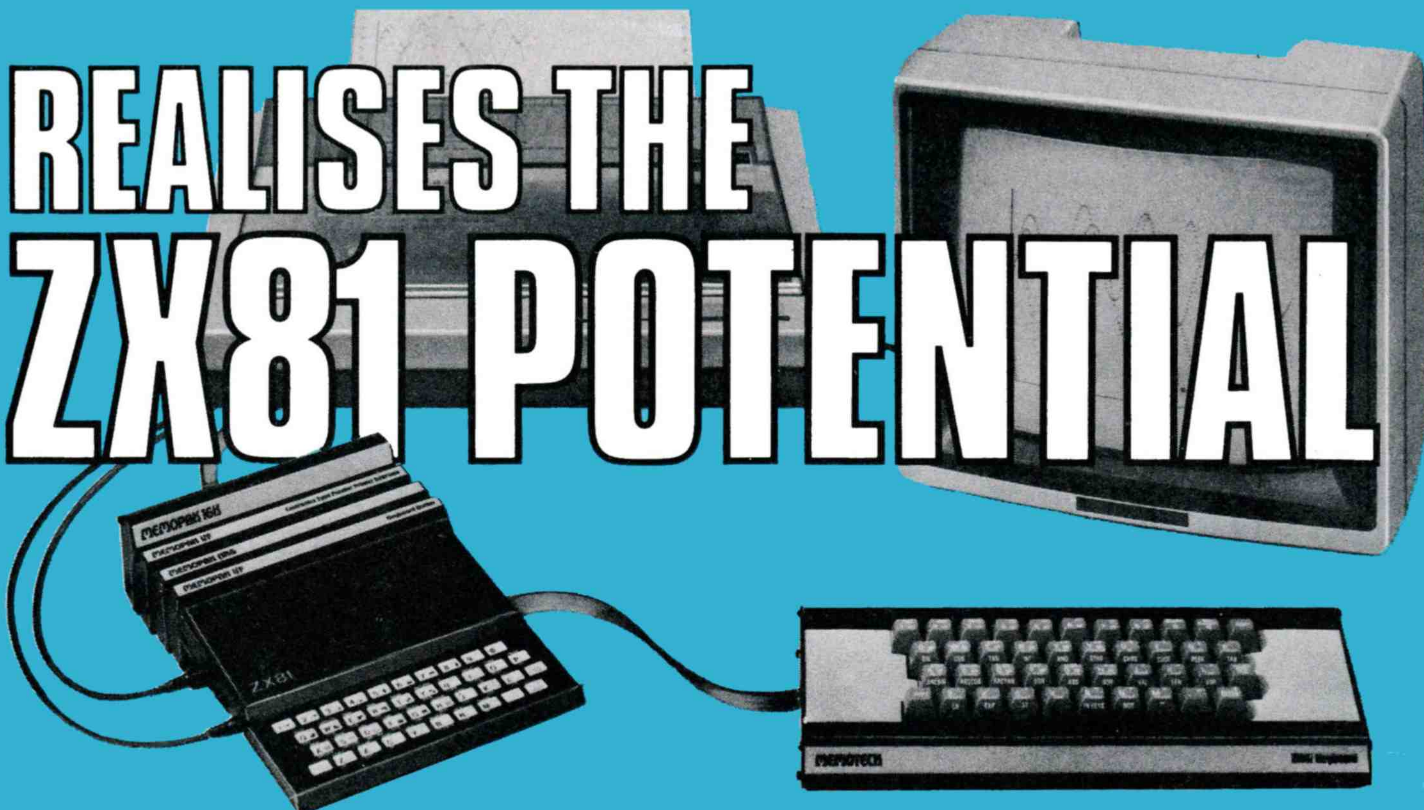
Memotech products are available at larger branches of **WHSMITH**

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.

REALISES THE ZX81 POTENTIAL



MEMOPAK Z80 Assembler 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.
B) 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 few 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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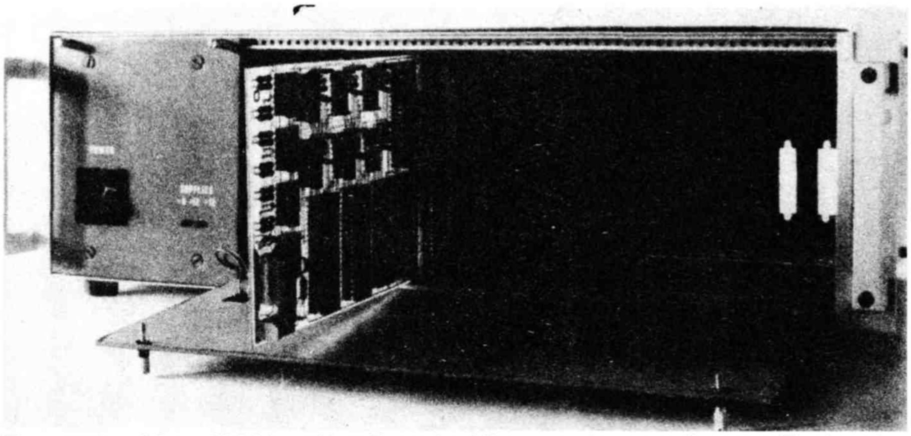
6502-BASED AUDIO BOARD

Here's a powerful and versatile peripheral for people requiring a digital-to-analogue or sound-generating capability for their computer. Although the PCB is designed for Tangerine users, the circuit may be readily interfaced to any 6502-based system. Design and development by M. D. Bedford.

When control applications on a microcomputer are proposed, it soon becomes evident that DACs and ADCs are required to interface to the real world. For more light-hearted uses and for games, the addition of sound effects can do much to enhance a program. Although multiplexed ADCs are available, giving eight or 16 channels and requiring only one eight-bit port plus control lines to support them (see the ZX ADC in the January '83 issue), DACs require eight bits per channel and would quickly use up the available I/O ports on most systems. For this reason, the circuit which is presented here was designed so that it wouldn't use system I/O ports. The board presented here is specifically intended for the Tangerine Microtan system and as such will plug directly into any expansion slot on the system motherboard: DIL switches or links are provided on the board in order to configure it to start at any 16-byte boundary within the 1K I/O area.

For users with other 6502-based systems it should not prove difficult to interface the circuit. The only non-standard signal is the one designated IO which is used in the Microtan system to indicate that an address within the I/O area (ie within the address range BC00 to BFFF) is being accessed. On any other system, address lines A10-A15 should be decoded to generate such a signal and Fig. 3 shows a simple circuit which may be used:



The completed Sound/OAC board in a Tangerine Microtan rack-mounted system. The board may be used with other 6502-based systems.

The Circuit

The DAC0800 is a low-cost high-speed multiplying DAC with an accuracy of ± 1 LSB which, when used in conjunction with an op-amp, is capable of giving a low impedance voltage output. Six of these devices have been used with 747 dual op-amps to give outputs in the range 0-10 V.

The General Instruments AY-3-8910 programmable sound generator IC forms the basis of the sound effect feature of this board, the LM380 being provided in order that a loudspeaker may be driven with no external circuitry. 6520 PIOs are used as a simple and inexpensive means of interfacing the DAC0800 and AY-3-8910, but 6821s may also be used. Buffering of some signals limits the load presented to the bus signals.

The circuitry comprising IC16, IC17 and the bank of DIL switches allows the positioning of the board in any 16-byte block within the I/O area. The start address is calculated as the binary number given by the six switches multiplied by 16, where the switches on the circuit diagram are shown in the '1' position and SW1 is the least significant. For example, if switches SW1-6 are in positions 0,0,0,0,0,1 then the first address on the board will be 16 bytes from the start of the I/O area

Construction

The layout of a printed circuit board is presented here and, due to the fairly high packing density it is suggested that, for those intending to incorporate the circuit into a Microtan system, this layout be adhered to. It should be noted that the board is of the double-sided, pinned-through type with the result that every hole not intended for the mounting of components should be fitted with a pin and soldered both on the top and the bottom of the board. Scrutiny of the overlay will reveal that this must be carried out prior to the fitting of any DIL sockets. If, however, it is not intended to fit the circuit board into a card frame along with other Tangerine boards, then a larger board may be used and some form of breadboarding technique employed for construction. If this option is taken care should be

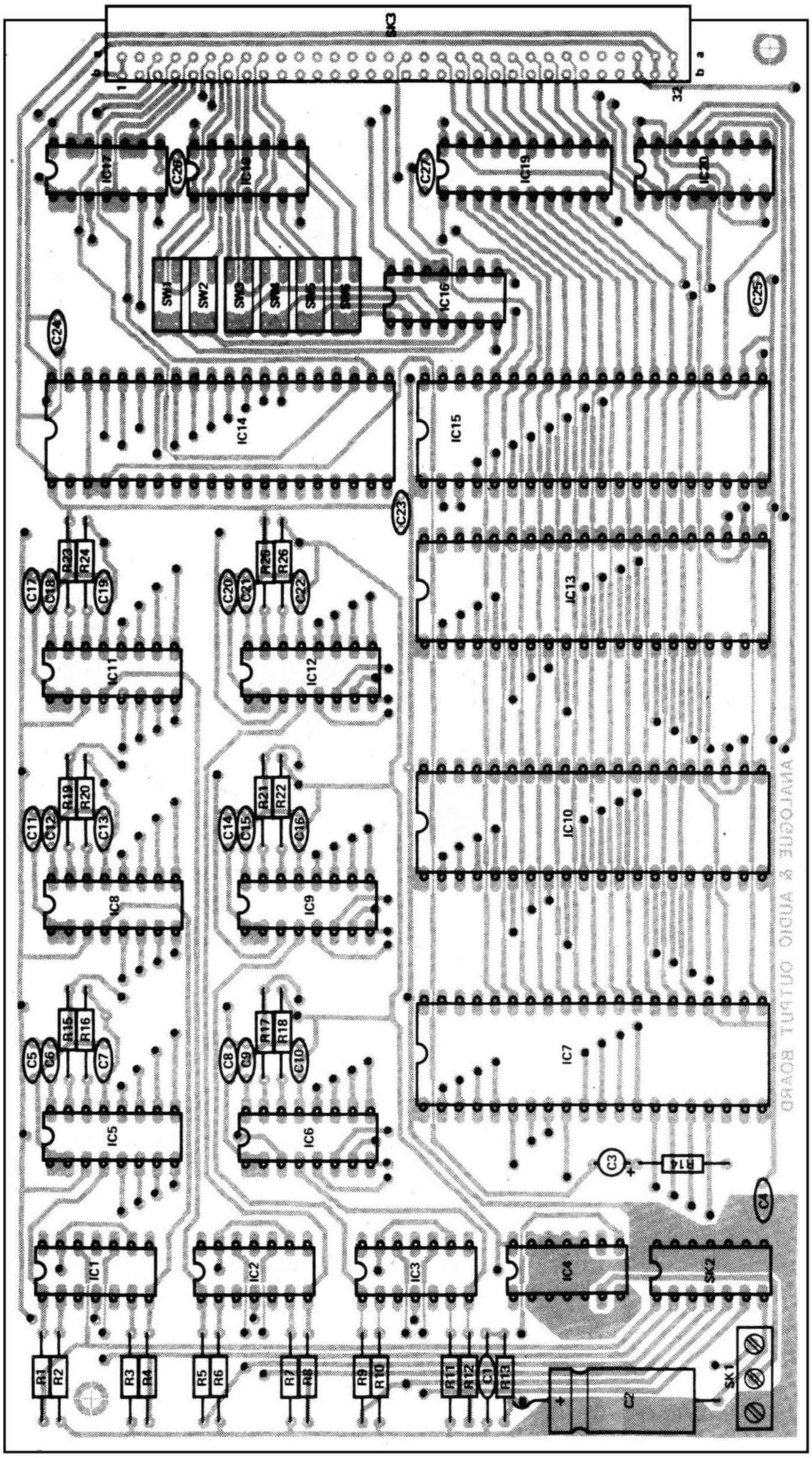


Fig. 1 Component overlay. The tinted tracks are the underside of the double-sided board: through-board pins soldered on both sides are required wherever a dot appears.

PARTS LIST

Resistors (all ¼W, 5% except where stated)	
R1-12	10k 2%
R13	2R7
R14	20k
R15-26	12k 2%
Potentiometer	
RV1	22k logarithmic
Capacitors	
C1, 5, 7, 8, 10, 11, 13, 14, 16, 17, 18, 20, 21	100n ceramic
C2	470u 16 V axial electrolytic
C3	2u2 10 V tantalum
C4, 6, 9, 12, 18, 19, 22-27	10n ceramic
Semiconductors	
IC1-3	LM747
IC4	LM380
IC5, 6, 8, 9, 11, 12	DAC0800 or DAC0801
IC7, 10, 13, 15	6520, 6820 or 6821
IC14	AY-3-8910
IC16	74LS30
IC17	74LS08
IC18	74LS04
IC19	74LS245
IC20	74LS138
Miscellaneous	
SK1	3-way, 5mm pitch, PCB terminal block
SK2	14-pin DIL socket
SK3	2 × 32 way A + B DIN Euro connector (male, angled pins)
SW1-6	hex DIL changeover switch (see text)
PCB (see Buylines); DIL sockets to suit	

BUYLINES

No problems with the semiconductors for this project - it's all standard stuff and people like Technomatic, Watford and Cricklewood should have no trouble supplying you. The only difficulty may lie in finding a supplier for the DAC0800 which seems to be a bit elusive: Maplin supply the 0801 which is an acceptable substitute. The Euro socket required for Tangerine rack owners is available from Watford, while the PCB can be obtained from our PCB Service as usual. The order form is on page 83.

exercised in the positioning of certain capacitors. C4 and C23-27 should, as far as possible, be well distributed around the board. C7, 10, 13, 16, 19 and 22 decouple the —12 V rail, and these components should be positioned so that one capacitor from each of the two sets is close to each of the DAC0800s.

One final point applies irrespective of the method of construction: since DIL switches are relatively expensive and in such an application will most probably be set up once and rarely changed, it is suggested that, as an alternative, DIL headers with appropriate soldered links are used and plugged into DIL sockets.

Programming

While it is beyond the scope of this article to give a detailed functional description of the 6520 and AY-3-8910 ICs, it is expected that the BASIC routines presented here will enable the board to be used without difficulty. In order to make full use of the sound generator, however, it is suggested that an AY-3-8910 data sheet is consulted (the company you buy the chip from should be able to help). In the routines given, the

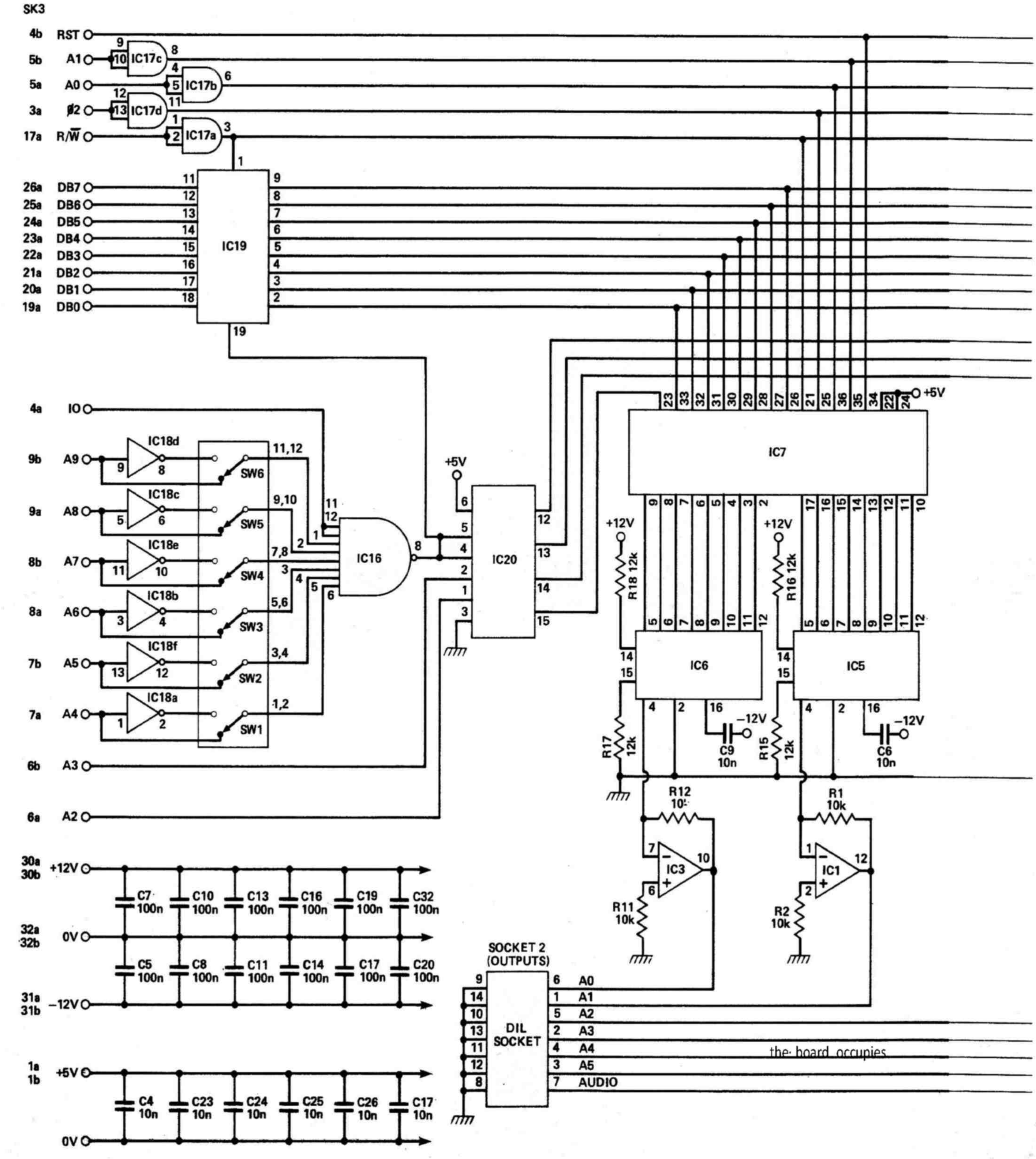


Fig. 2 Circuit diagram of the sound/DAC card.

HOW IT WORKS

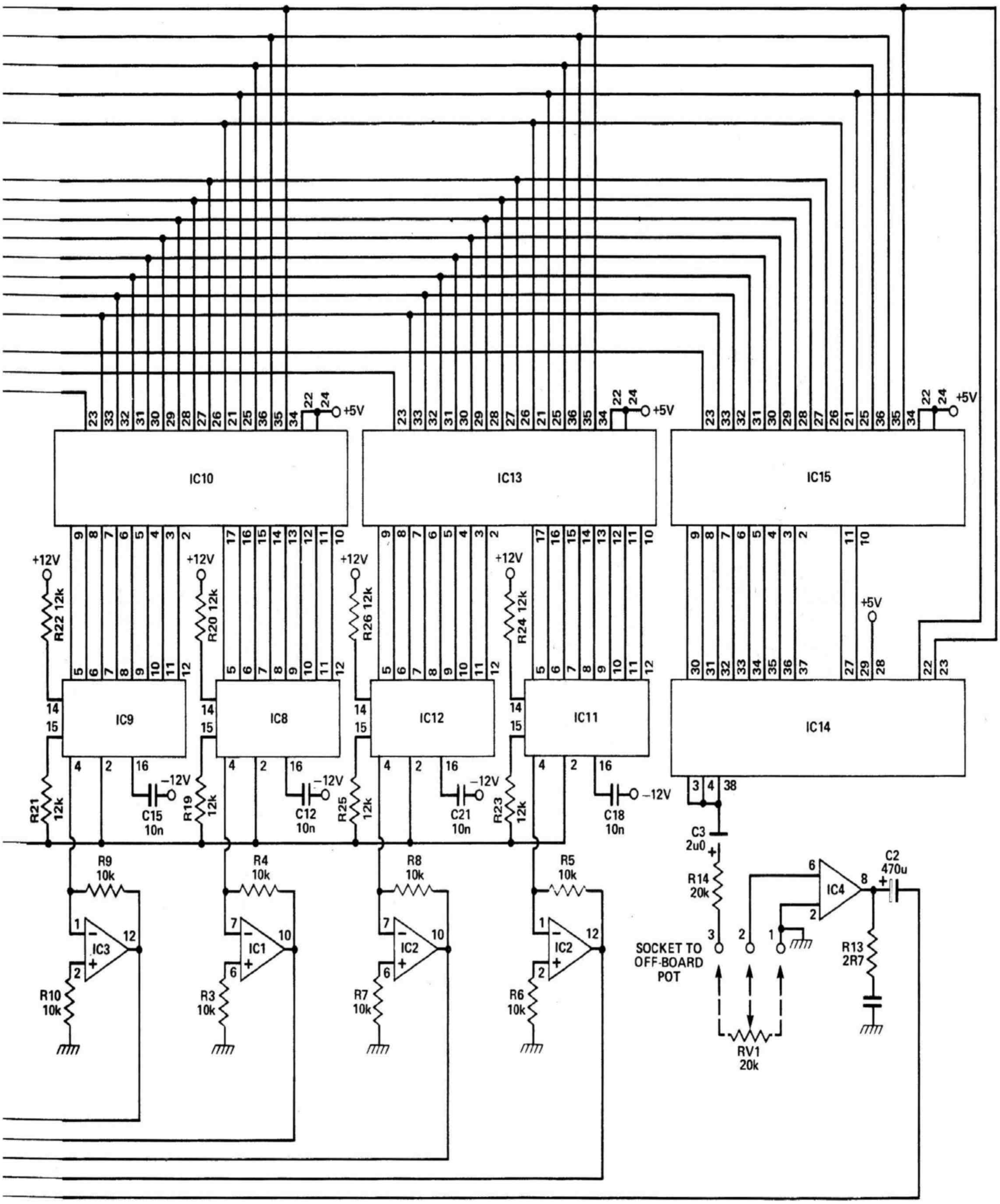
The circuitry consists of six DACs, ICs 5-12, and one sound generator chip, IC14, which has three separate sound channels and a noise generator. The circuitry for each of the DAC ICs Is identical and we will only discuss IC6. The eight bits of data are held on pins 5-12, while the complementary current outputs are on pins 2 and 4. The DAC is configured for positive impedance output operation with 100 on pin 2 connected to ground and the other output fed into the buffer op-amp IC3a.

The data Input to IC6 is latched by port A of the peripheral interface adapter IC7 (port B of IC7 latches the data for ICS). Similarly ICs 10 and 13 latch the data for ICs 8,9 and 11, 12 respectively.

The fourth PIA, IC15, utilizes both ports to control the sound generator chip, IC14. The three audio outputs of this chip are fed via C3, R14 and the volume control RV1 into IC audio power amp IC4.

C1 and R13 form the Zobel network and C2 the DC blocking capacitor for the amp output. The audio signal and analogue voltages are fed off board via SK2, a DIN socket with a header-plug.

Address decoding for the board is performed by ICs 16, 18 and 20. SW1-6 select which 16-byte block of memory the board occupies. For people using systems other than the Microtan, which generates the 10 signal required, the additional decoding circuit for lines A10-15 shown in Fig. 3 will be required. The data bus is buffered by IC19, with the R/W signal on pin 1 selecting the direc-tion and the output of IC16 enabling the tri-state buffers via pin 19. Bus signals which are required by several chips in the circuit are buffered by IC17.



IC10
IC13
IC15
IC9
IC8
IC12
IC11
IC14
+5V
+12V
−12V
R22 12k
R20 12k
R26 12k
R24 12k
R21 12k
R19 12k
R25 12k
R23 12k
C15 10n
C12 10n
C21 10n
C18 10n
R9 10k
R4 10k
R8 10k
R5 10k
IC3
IC1
IC2
R10 10k
R3 10k
R7 10k
R6 10k
C3 2u0
R14 20k
IC4
C2 470u
R13 2R7
SOCKET TO OFF-BOARD POT
RV1 20k

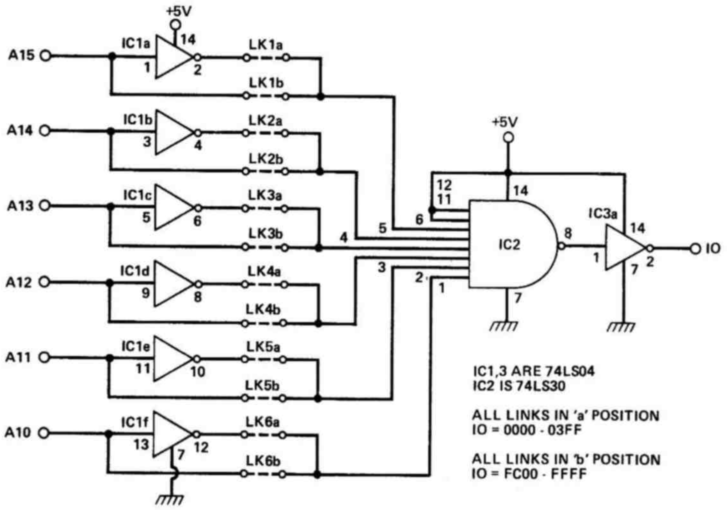


Fig. 3 Non-Microtan users who wish to build this project will require this circuit to produce the 10 signal.

	IC1	IC2	IC3	IC4	IC5	IC6	IC7	IC8	IC9	IC10	IC11	IC12	IC13	IC14	IC15	IC16	IC17	IC18	IC19	IC20
0V				3,4,5 7,10 11,12			1			1			1	1	1	7	7	7	10	8
+5V							20			20			20	40	20	14	14	14	20	16
+12V	9,13	9,13	9,13	14	13	13		13	13		13	13								
–12V	4	4	4		3	3		3	3		3	3								

Table 1 This is a list of power supply connections to the various ICs for people doing their own board layout.

variable BA should be set to the base address of the board.

DAC Handling Routine. In this routine, which should be executed once at the start of the program, N should be set to the number of DAC channels to be initialised. After execution of the routine, the statement:

POKE X, BA+2*(N—1)

will write the value X to the Nth DAC channel.

```
10 REM ....DAC INITIALISATION
20 FOR AD = BA TO BA + 2*
(N-1) STEP2
30 POKE AD+1,0: REM....ALLOW
ACCESS TO DDR
40 POKE AD,255: REM....SET DDR
TO OUTPUTS
POKE AD+1,4: REM....ALLOW
ACCESS TO OUTPUT REGISTER
60 NEXT AD
```

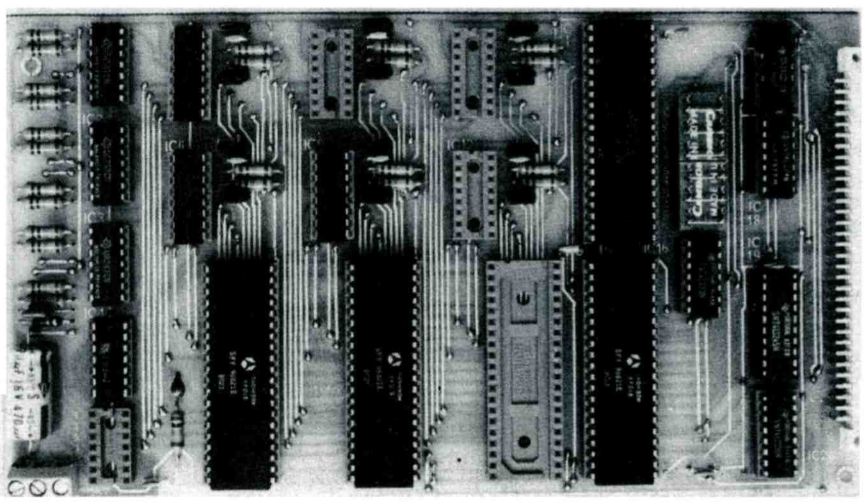
Sound Effect Routines. The initialisation routine should be executed once at the start of the program: after this subroutines 1000 and 2000 may be called for writes and reads respectively to the AY-3-8910 registers. In these two routines, REG should be set to the register number before entry: for a write, DAT should be set to the value of the data to be written and when reading, DAT will contain the data read after return from the subroutine.

```
10 REM....AY-3-8910
INITIALISATION
20 POKE BA+15,0: REM....6520
PORT B TO WRITE
30 POKE BA+14,255
40 POKE BA+15,4

1000 REM....AY-3-8910 WRITE
ROUTINE
1010 GOSUB 3000: REM....LATCH
ADDRESS
1020 POKE BA+12,DAT:
REM....WRITE DATA
1030 POKE BA+14,2
1040 POKE BA+14,0
1050 RETURN
```

```
2000 REM....AY-3-8910 READ
ROUTINE
2010 GOSUB 3000: REM....LATCH
ADDRESS
2020 POKE BA+13,0: REM....6520
PORT A TO READ
2030 POKE BA+12,0
2040 POKE BA+13,4
2050 POKE BA+14,1: REM....READ
DATA
2060 DAT=PEEK(BA+12)
2070 POKE BA+14,0
2080 RETURN

3000 REM .. LATCH ADDRESS
ROUTINE
3010 POKE BA+13,0: REM....6520
PORT A TO WRITE
3020 POKE BA+12,255
3030 POKE BA+13,4
3040 POKE BA+12,REG:
REM....LATCH ADDRESS
3050 POKE BA+14,3
3060 POKE BA+14,0
3070 RETURN
```

Where it is only intended to write to the AY-3-8910 registers, a saving in execution time and program size may be made by incorporating lines 3010-3030 of the latch address routine into the initialisation routine and using the following routine for writing. In this case subroutines 2000 and 3000 are not required.

```
1000 REM.:..AY-3-8910 WRITE
ROUTINE FOR WRITE-ONLY
APPLICATIONS
1010 POKE BA+12,REG:
REM....LATCH ADDRESS
1020 POKE BA+14,3
1030 POKE BA+14,0
1040 POKE BA+12,DAT:
REM....WRITE DATA
1050 POKE BA+14,2
1060 POKE BA+14,0
1070 RETURN
```



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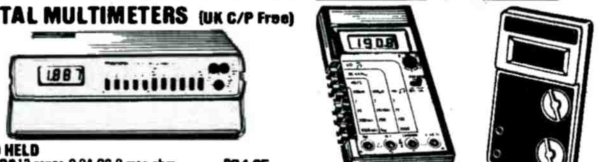

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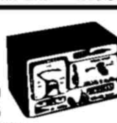

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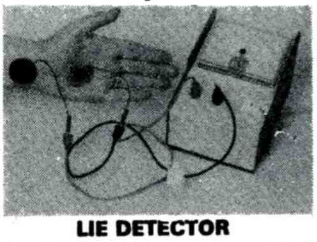

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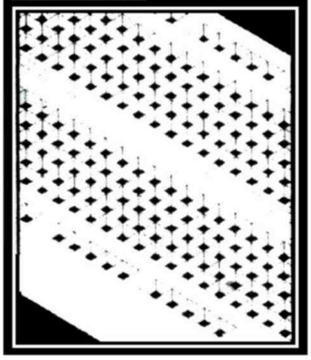

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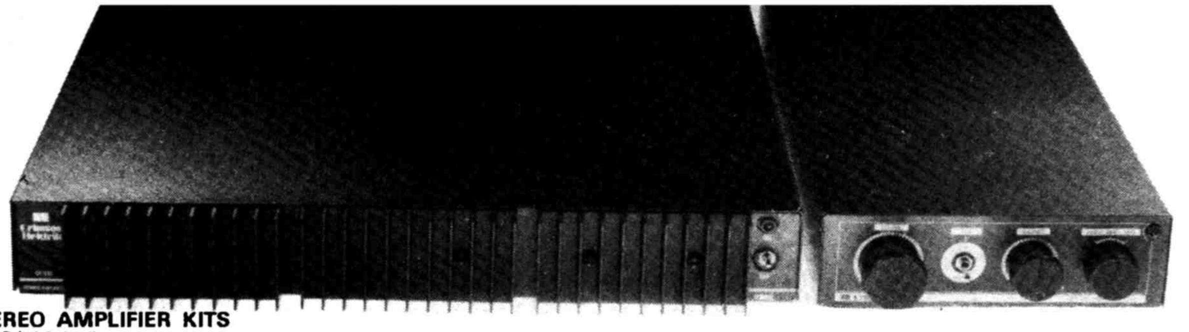

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ET/382

AUDIOPHILE

After dispensing, on tablets of newsprint, some wise words about various readers' problems, Ron Harris turns his attention to the new cartridge from Coral.

I'm going to start this month with a selection of letters, chosen to illustrate a general point or two that crops up in a number of readers' enquiries. There are several overall principles concerning setting up a hi-fi system, such as compatibility, component-matching, power requirements etc etc that have been repeated endlessly by all the hi-fi press — and *will* ever more be repeated — that are so fundamental to the task they should be inscribed across the walls of hi-fi emporia throughout the land.

I do not wish to go through ritual incantations herein, so please to accept a summary.

This can be as concise as: everything must be matched to everything else (especially cartridge to speakers) and the system is only as good as its weakest link.

With that in mind let us take up the discourse . . .

Getting Decked Out

I have recently acquired a Sony PSX600 automatic record deck and wish to replace the cartridge (supplied) with something better. I am not sure what cartridge will match the deck and want your advice to choose a new one. How good is the Sony one anyway? My amplifier is a Sony STRV55 and I use Mission 700 loudspeakers.
J. BANKS, STRETFORD, MANCHESTER.

Answer The easy one first. If you'd read your December '82 copy of ETI properly (lose 10 points for inattention) you would have seen our review of the Goldring G910IGC which is designed to work in a range of the bet-ter automatic decks, such as yours. Taking into account the bright loudspeakers you favour, this would be a good choice. Have a listen to it yourself if you can manage it and see what you think. Others to try: Shure M97HE and Dynavector DV20.

Unbalanced And Bias

My hi-fi system is made up of a Thorens TD1 50 and Mayware arm and a Shure V15 III cartridge, a home-made Texan amplifier and a pair of Mordaunt-Short Signifier speakers that I got as a birthday present. I am happy with it except that it seems to have no bass since I changed the speakers and it doesn't have the same power. The sound is a bit 'tinny' now and I get more surface noise. I had the speakers checked by the shop and there was nothing wrong with them. Do they match the amplifier or should I change them again? If so *what* should I buy to match it?
P. RAWLINGS, TUNBRIDGE WELLS, KENT.

Answer What car do you drive? A Lincoln-Continental with a Mini engine perhaps? There is nothing amiss with the speakers by the sound of it, but that amp is just *ever* so slightly out of place. It is not powerful enough to drive the Signifiers. t is not good enough to be in the system at all. In fact it wants dropping out — from a great height preferably.

You are not getting increased surface noise: it is just that the Signifiers are showing you what has *always* been there! (I shudder to think what sort of speakers you used before . . .) While I am at it, that record player could do with sorting out, too. The Shure is a very bright cartridge, unless loaded properly — and the Texan won't do *that* either. This is almost certainly aggravating the 'tinny' sound, as you so graphically describe it. The Mayware arm we have had problems with under test for similar reasons, but if it works in your system . . .

I would suggest you get yourself a decent amp of around 50-100W per channel, and the HE stylus upgrade for your V15 III. If the system still sounds bad to you then, you have two choices: (i) Sell the lot and buy a transistor radio. It'll still sound 'tinny' but at least you'll know why. (ii) Change your ears.

First Time Nerves

Being of unsound mind and a little body I am about to buy my first ever hi-fi. After a lot of research activities and reading up I have decided on the following. My room is about 12′ × 8′ and I will be using it for all types of music. I am being foolishly brave I know, but could I have your comments and suggestions for improvement please.

Also which tape should I use with a Sony TCK-55 deck? I know you reviewed it years and years ago and I thought you might remember.
Ms D. COSTERN, OXFORD.
System: — Oracle/SME III/Dynavector Karat Diamond, Carver C1/M-400 Cube, Celestion SL6 speakers.

Answer First system???? A £600 record deck and £500 cartridge and it's your *first* system . . . ?

The Cube and the SL6's are an inspired choice. That set-up will provide magnificent transients and a sound out of all proportion to the size of the units.

The record deck, however, is not so inspired. For a start, the arm and cartridge don't match. You will need to either go down to the Karat Ruby, or change the arm upwards to either the Ittok or 'The Arm' to get the best out of the cartridge.

Frankly, though, I wonder if you've auditioned something like a TD160S/SME III/V15 V against the Oracle combination. Beyond reproach as your intended deck may be (and it *is* the best turntable in the universe) it is probably *too* expensive for your needs. Quite a way to start, nonetheless.

PS (It wasn't years and years either, and Maxell or Sony are your best bet.)

All Things Being Equal I'm Helping

I have an unusually shaped living room and it's got a wooden floor. No matter what sort of system we try in it, there is NO WAY to get a flat response. I think I need a graphic equaliser and wondered if you could help out with a circuit or something . . . (Preferably one-third octave.) I think your past projects are old-fashioned now and wondered if you are going to do a modern one.
B. EVANS, BIRKENHEAD, MERSEYSIDE.

Answer How to win friends and influence people. You want me to give you a circuit for a one-third octave equaliser after you dared to call our past attempts old-fashioned? Smooth talkers like you should be in politics.

You'd go down well in the SDP.

Since you've been so charming about it, how could I refuse? Below you will find the circuit for an ultra-high quality equaliser. ETI may well produce it in a project later, but for now it is simply a tried and tested design. Board layouts and all that are *not* forthcoming, so please don't write in for them.

Coral MC-82

This month's review is the new Coral moving-coil cartridge, the MC-82. A deal has obviously been done and it sports a (Goldring) van den Hul stylus! The unit is sold as an up-market version of the excellent MC-81, which by now has probably reached 'Classic' status.

The MC-82 will cost around £130
design, requiring step-up of some sort. As an ever-increasing number of better
decent head-amp these days, this is a problem
fast disappearing.

There are, in addition, a goodly number of specialist head-amps to be had, and choosing is as much a matter of taste as anything else.

The MC-82 is an interesting product, offering more than just a new point to an old success story. As always it is immaculately presented, in a thick clear perspex box.

The pickup itself is a pretty golden colour and the body is identical to the MC-81 and MC-88E. Saves on the production, I suppose. The stylus is not user-changeable and must be returned to Coral for exchange.

Test Run

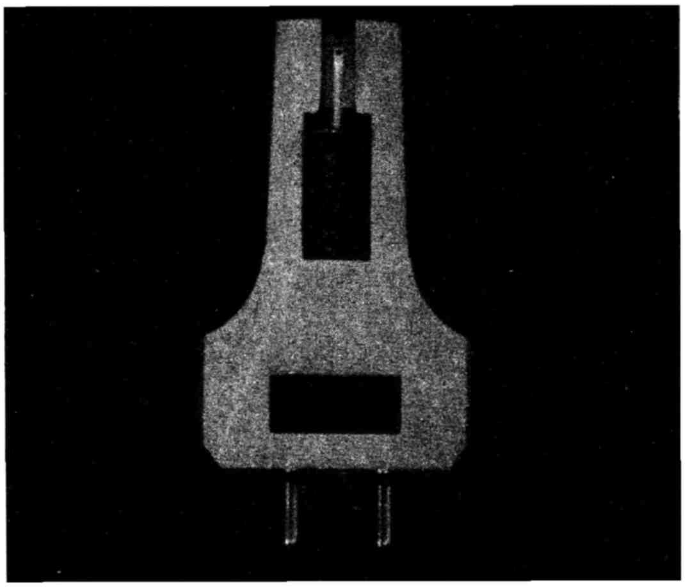
As can be seen from the results below, the MC-82 turned in the to-be-expected faultless technical performance. Optimum tracking was achieved at 2g1, above which no improvement could be obtained. With a weight of round 5 g and a compliance at over 20 cu ($\times 10^{-6}$ cm/dyne), the unit will match a wide range of arms and decks. (Tests were conducted using an SME III.)

The frequency response was flat 20-20 kHz ± 1 dB, a remarkable result. Excellent control of tip resonances shows in the smooth treble extension. Nothing to complain about and much to praise.

The van den Hul stylus is one recently covered in this feature, in connection with Goldring's own G910IGC.

TEST RESULTS: CORAL MC-B2

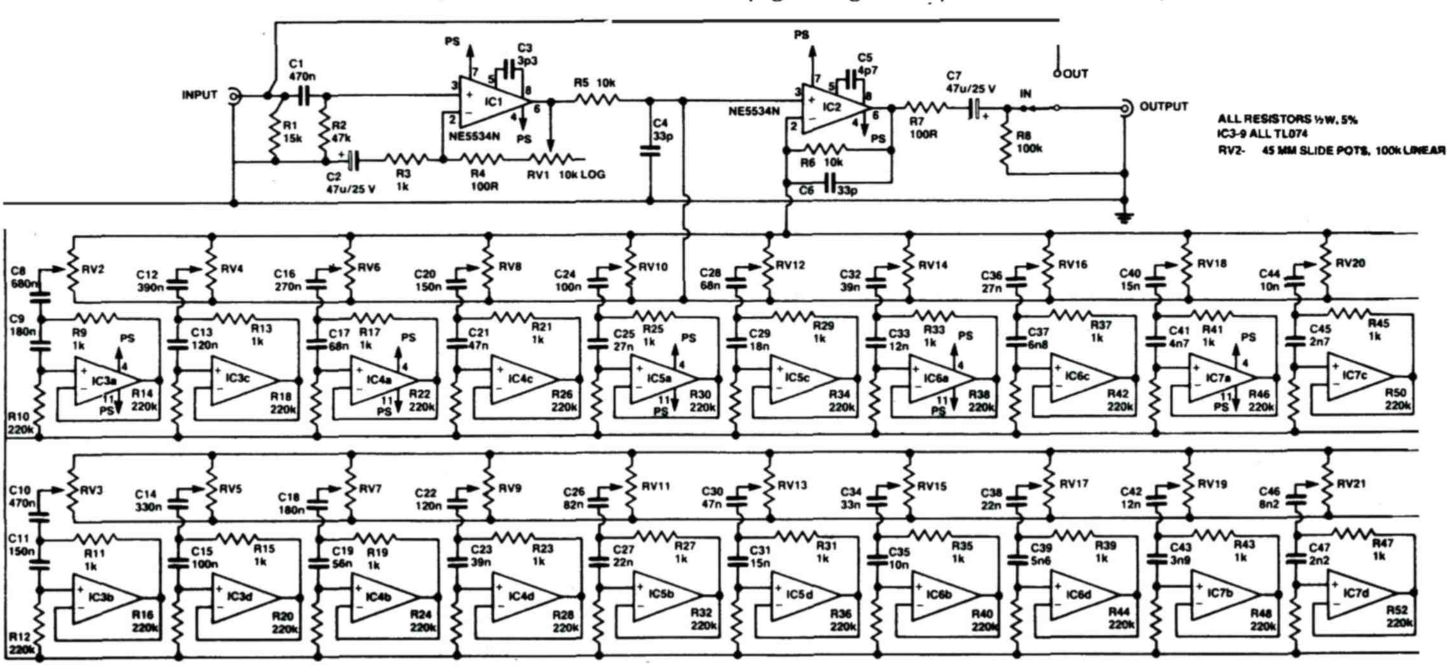
Frequency Response	: 20-20 kHz $\pm$ 1 dB
Channel Separation	: 27 dB at 1 kHz
Impedance	: 5 ohms (recommended loading of 30R)
Optimum Tracking Weight	: 2g1
Channel Balance	: within 1.2 dB
Compliance	: approximately 22 cu
Output Voltage	0.25 mV into 30R
Weight	: 5 g
Price	: around £130



You are referred to ETI December 1982 for a detailed description. Basically it imparts better groove contact and thus better tracking. In addition it seems to reduce susceptibility to surface noise — a contention borne out in the MC-82, incidentally — and on the Goldrings has a very open and detailed presentation.

Sound Product?

Having set up the MC-82 and settled back to listen, amp glowing merrily (well it *is* Class A), I found it a rewar-



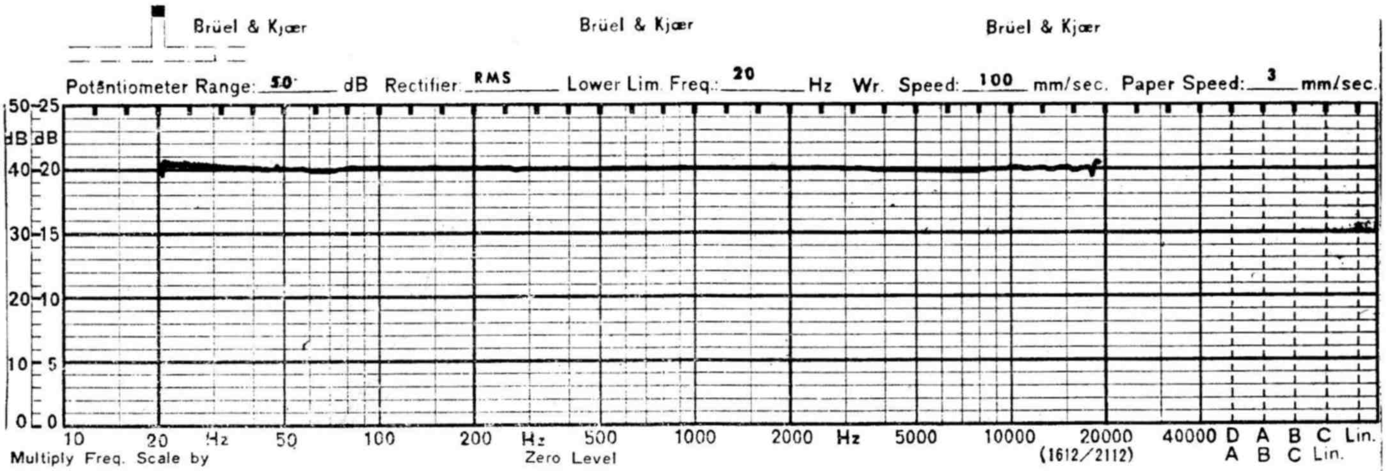


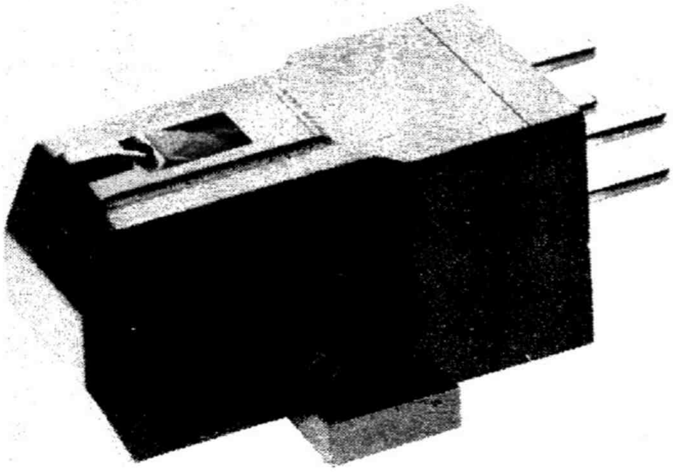
Fig. 1 Frequency response of the Coral MC-82 moving coil cartridge.

ding experience. This Coral is very good. It is totally unlike the MC-81, totally unlike the Goldrings and I can think of no other cartridge at all to which it is similar, except perhaps the Ortofon MC-30 and that is high praise indeed.

The Coral has the open mid-range of all the best moving-coil units, with a good detailed bass, which is perhaps a trifle loose at the very bottom end of the spectrum. The treble is clean and sharp without ever being hard or incisive. A cymbal sound demonstrates this very well.

The van den Hui once again seems to reduce its carrier's susceptibility to surface noise and backgrounds, ac-cordingly, are quieter than with other cartridges. Voices are portrayed very well and the sound stage as a whole is well balanced and without undue emphasis in any part of the spectrum.

At the price of £130 the MC-82 is not cheap. It is value for money, however, when you consider the competition around. Coral have produced a cartridge here which performs exceptionally well and at a level which forces me to compare if to far more expensive units. I can only recommend that if you are looking for a cartridge in this price range - or higher - you give the MC-82 a try.



It must be the season for van den Huls, because here we go again! Goldring have just released their first ever moving coil cartridge, called the Electro II and retailing at around £125.

The main design aim has been to improve upon the ability of present cartridges to reproduce detail by eliminating non-linear energy losses in the cartridge itself. To this end, no adhesive is employed in the construction and a rigid die-cast assembly is used. Very high precision mouldings are required.

Audiophile is on the phone, trying to get hold of one and see how it all manages to stay in one piece.

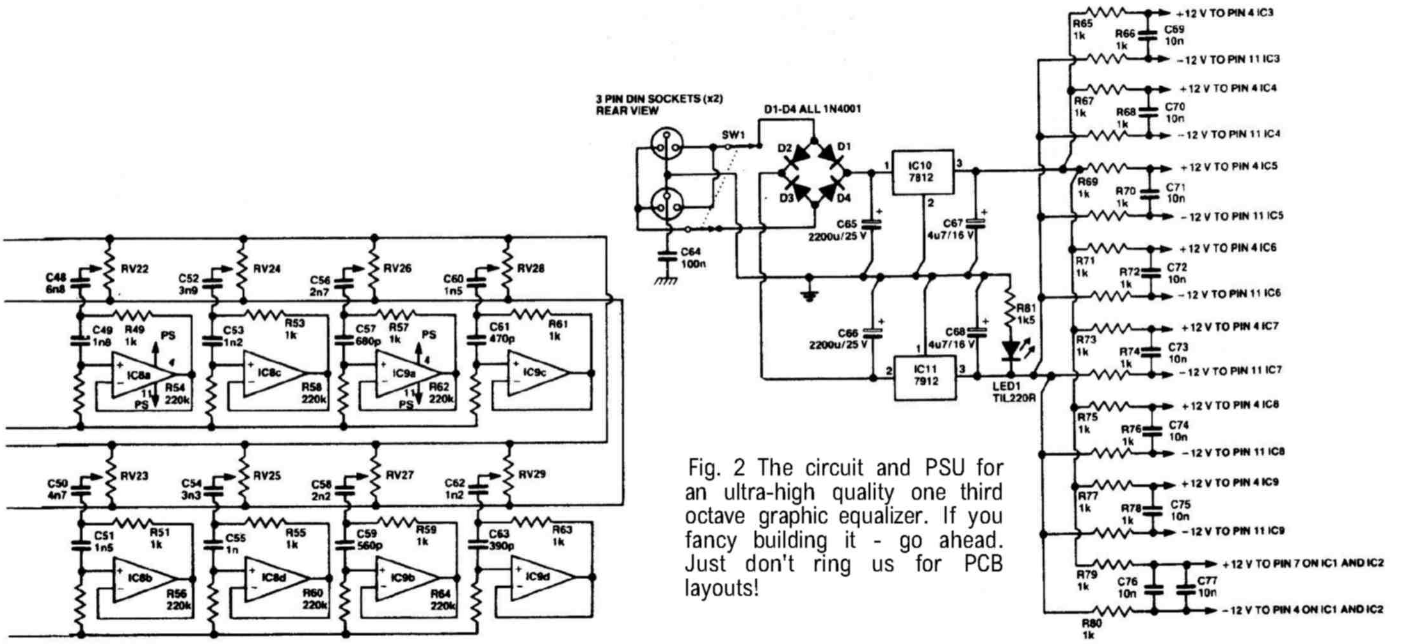


Fig. 2 The circuit and PSU for an ultra-high quality one third octave graphic equalizer. If you fancy building it - go ahead. Just don't ring us for PCB layouts!

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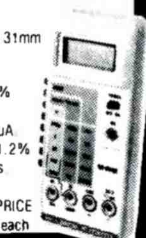

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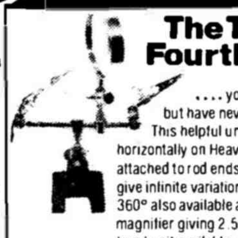

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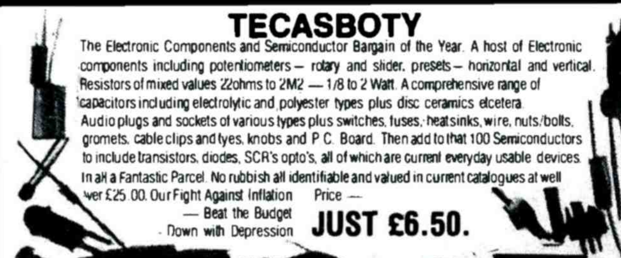

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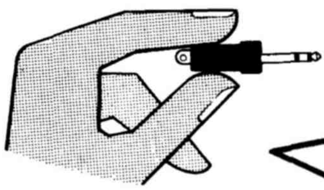

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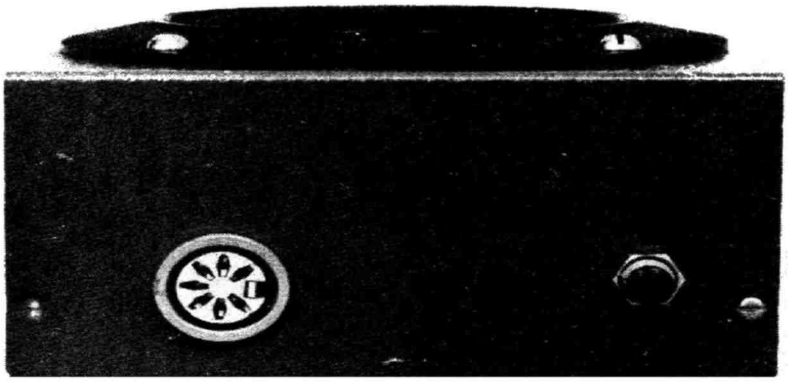
ALARM MODULE

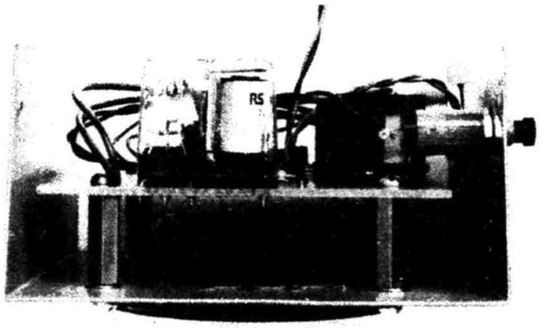
This module is very small, very cheap, very simple and extremely loud indeed. Use it to make an existing burglar alarm tamper-proof or as the basis of a new system. Design by Phil Walker.

This project is designed to monitor the state of open and closed loop alarm circuits, together with the main power supply. If disconnected from the main system or from its external power source, it will trigger the internal noise source to draw attention. A rechargeable battery inside should keep it going for some hours once triggered; the unit cannot be reset until the fault condition has been removed.

A delay has been built into the trigger circuit so that the initial alarm tone is at reduced volume: useful if you wish to dash into a protected area and switch off the alarm circuit before all hell breaks loose, or if you've triggered it by accident. This could be shortened from the present 10 seconds or so if more immediate response is required. The sound output from the device is quite painful at close quarters even though the battery drain is reasonably small: testing the project in our workshop nearly led to insurrection and multiple lynchings by the staff from our other magazines! If used in a car the normal current drain from the car battery will be less than 5 mA. The time delay in this case may need to be altered for best effect (C1 adjusts this).



The Alarm module is completely self-contained. Here you can see the tweeter, the reset button and DIN socket for connecting the alarm sensor switches and optional external alarm.



With the case apart you can see how the tweeter fixing screws hold the PCB stand-off pillars in place.

The Alarming Truth

The circuit for this project can be considered as four basic blocks. The first is dedicated to detecting all the alarm conditions, which are power failure, closed loop disconnection, and open loop contact. All these conditions will start the delay timer in the second block, and all except the power failure detector will make the alarm sound immediately.

The second block contains a time delay circuit, a thyristor latch and a power switch. When an alarm condition is detected in the first block, the time delay circuit will start. This may allow a small amount of current to flow through the output power switch, thus making a low volume sound as a warning. If the alarm condition is not a power failure, a larger current will be drawn to make a more definite sound.

If the alarm condition persists until the delay circuit times out, the SCR switch can be turned on, switching the sound output to maximum, activating the relay driver and maintaining this condition until the reset button is pressed and released. However, the reset button is not effective unless the alarm condition has been removed from the input circuitry. The reset button also acts as a test button in that it causes the alarm to sound while it is pressed (but only when everything else is in a normal condition).

The third block is the alarm sound generator and output transducer. The basis of this is a self-oscillating transformer-coupled multivibrator. This is tuned by the capacitance of the piezo-electric tweeter to a frequency of a few kilohertz. Note that a normal loudspeaker is not usable here.

This circuit configuration takes the 8V available from the battery and converts it to an approximate sine wave of around 18V peak to

BUYLINES

There are a number of unusual components for this project. The piezo-electric tweeter is the Motorola type A and can be obtained from BK Electronics Ltd, 37 Whitehouse Meadows, Eastwood, Leigh-on-Sea, Essex SS9 5TY. The pot core can be ordered as type 29-835-41 from Neosid (Small Orders), PO Box 86, Welwyn Garden City, Herts AL7 1AS. The relay is RS type 349-658, or else the Electrovalue type 42 should fit. Electrovalue are at 28E St Judes Road, Englefield Green, Egham, Surrey TW20 0HB. Watford Electronics, 33/34, Cardiff Road, Watford, Herts stock the 2N5062, and the PCB can be obtained from our PCB Service on page 83.

peak across the tweeter. As these devices are much more efficient than moving coil loudspeakers, the sound output is pretty high. In addition the current drain from the battery is only about 30 mA while the alarm is sounding. While not sounding, the battery is charged via the LM334Z constant current device (this feature should be omitted if a normal PP3 battery is used).

The final block of the project is the relay driver. This consists of a VMOS FET acting as a switch to turn on the current through a small relay. A diode is placed across the coil to absorb the back EMF when the current is switched off. The contacts of the relay can be used to activate an external alarm if required.

A useful tip: when assembling and testing this project connect the external +12 V supply first, then ensure that the 'closed loop' contact is connected to 0 V and the 'open loop' is unconnected before connecting the internal battery. Alternatively, a wool pullover or thick cushion may be used to protect the ears!

Construction

The prototype unit fitted into a small general purpose box. The piezo-electric tweeter was screwed to the outside and the circuit board mounted with pillars to the same screws. For better protection, the mounting screws can be made loose at the case and PCB so that there can be no possibility of undoing them from the outside of the case. A trace of epoxy glue on the threads should hold them in the right place. Then again, there's always pop rivets.

The construction of the PCB poses no unusual problems provided that the component polarities are followed carefully (although some lead bending may be necessary). The transformer, T1, is a standard RM10 ferrite transformer core. Starting at one of the inner pins of the single section former, wind on 100 turns of 32 swg wire and terminate it to one of the outer pins. Now wind on from the remaining outer pin, another 100 turns in the same direction and terminate this to the inner pin adjacent to the start of the first winding. If desired, a layer of tape can be placed over each layer of wire to keep the windings neat.

When assembling the transformer, place the ferrite cores around the bobbin and *without pressing the centre of the cores at all* ease the clips provided into the recesses on the ferrite parts.

For connection to the outside world we used a seven-pin DIN plug and socket. This was sufficient to carry all the necessary connections, including the relay output. However, you may prefer to solder wires from the sensor directly onto the PCB. For added protection the 'closed loop' connection could be used to ensure that the case could not be opened without setting off the alarm.

HOW IT WORKS

The sound output from the unit is produced by TX1 (a piezo-electric tweeter) which is driven by the oscillator Q7, 8, R18, 19 and T1. The frequency of operation of the circuit is determined by the inductance of T1 and the capacitance inherent in TX1.

If SCR1, Q2 or Q3 (via PB1) are on then the current through R17 will make Q6 conduct, thus applying the battery voltage to T1 and the relay driver circuit around Q9. This causes the alarm to sound and also activates any external device connected to the relay contacts RLA1.

The presence of an external power supply is sensed by Q4. This transistor is kept non-conducting while the input voltage is above about 10 V and the voltage across R11 is greater than about 8 V. If the supply voltage drops below 10 V or Q2 conducts, then the voltage across R11 will drop and allow Q4 to conduct. This causes C1 to charge up via R14 until Q5 conducts enough to turn SCR1 on via ZD2. This then sound the alarm.

Q2 can be turned on in two ways. Either the 'closed loop' input can be disconnected from ground, allowing current to flow down R2,3 and D2 into its base, or the 'open loop' input can be grounded, thus turning on Q1 and supplying Q2 base via R6. Both these conditions are abnormal and will trigger the sound circuit after a short delay.

The reset switch PB1 is connected to the anode of R1 on one side and to Q3 collector on the other. In order for the unit to be reset by this switch, Q3 must be on. This is only the case when Q2 is off and the input supply voltage is connected. When Q3 is on and PB1 is operated, the anode of SCR1 is pulled low, thus removing its holding current. When PB1 is released, SCR1 will not conduct until it is triggered again. Note that the alarm will sound when PB1 is pressed to test or reset the unit.

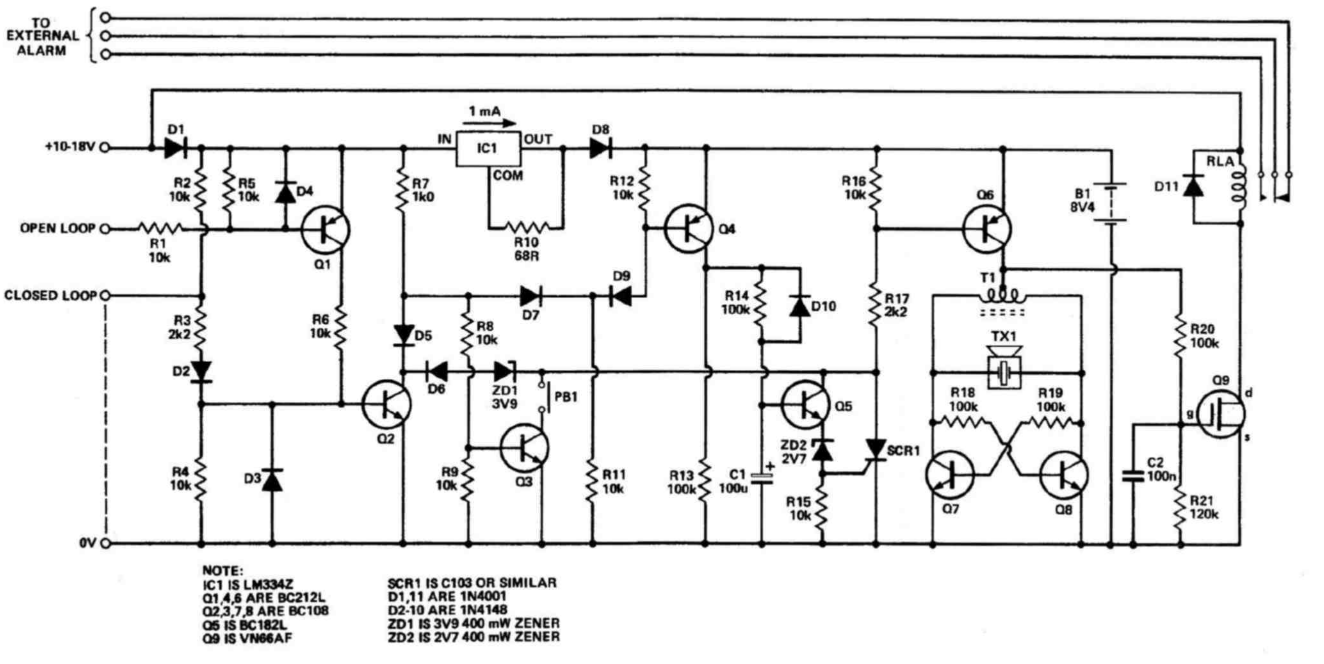


Fig. 1 Complete circuit diagram of the Ell Alarm Module.

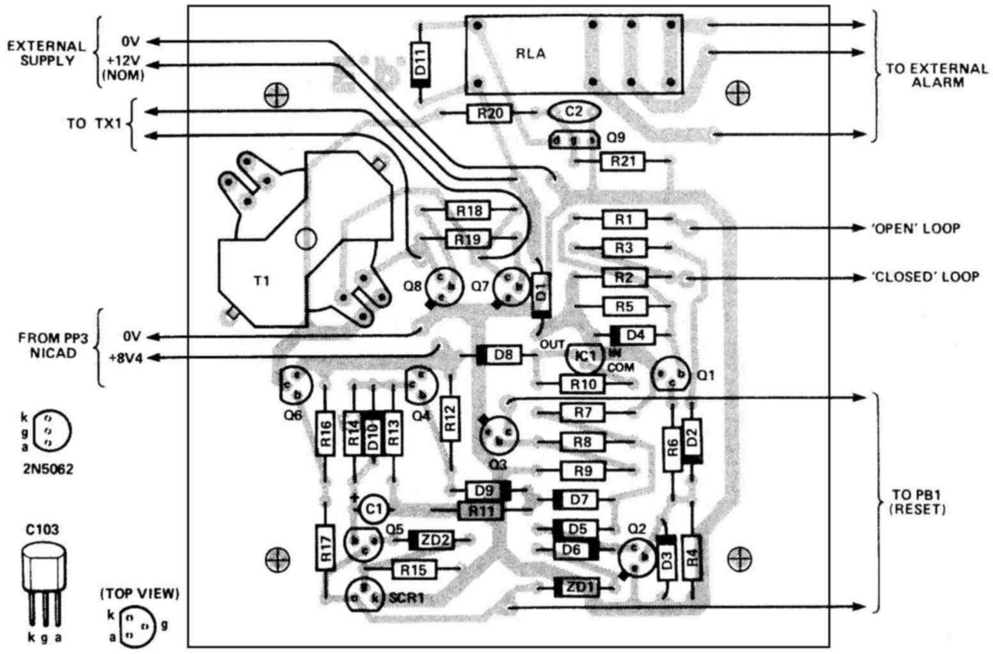


Fig 2. Component overlay for the Alarm Module.

PARTS LIST

Resistors (all ¼W, 5%)

R1, 2, 4-6, 8, 9, 11, 12, 15, 16	**10k**
R3, 17	**2k2**
R7	**1k0**
R10	**68R**
R13, 14, 18-20	**100k**
R21	**220k**

Capacitors

C1	**100u 10 V tantalum**
C2	**100n ceramic**

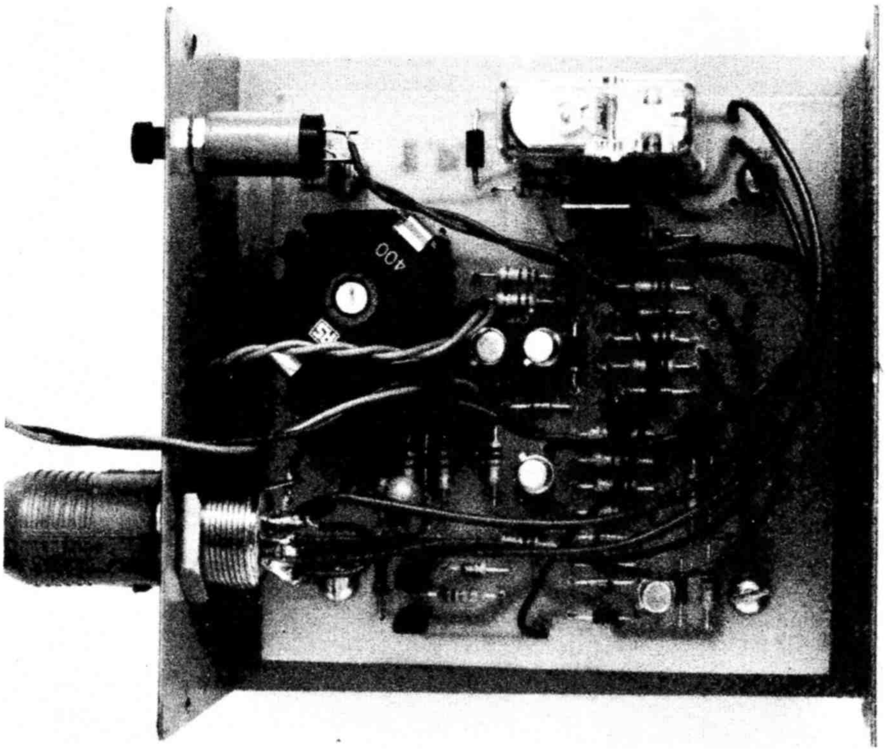
Semiconductors

IC1	LM334Z
Q1, 4, 6	BC212L
Q2, 3, 7, 8	BC108
Q4	BC182L
	VN66AF
SCR1	C103 or 2N5062
D1, 11	1N4001
D2-10	1N4148
ZD1	3V9 400 mW zener
ZD2	2V7 400 mW zener

Miscellaneous

PB1	**single pole push-button**
RLA	**two-pole relay, 12 V 200 R coil, PCB-mounting**
T1	**RM10 pot core (A_L = 400), with 100 + 100 turns of 32 swg copper wire on a single section bobbin (8 pin)**
TX1	**Motorola piezo-electric tweeter type A**

PCB (see Buylines): PP3-sized rechargeable Nicad battery; metal case approximately 100 x 100 x 50mm; battery clips, nuts, bolts, pillars, etc; optional seven-pin DIN plug and socket.



This vertical view shows the internal layout of the project with the wiring connections. With a case of the specified size, there is just enough room for a PP3 battery.

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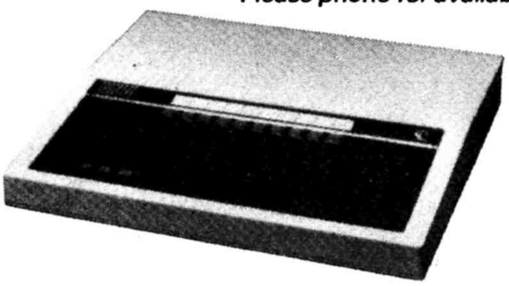

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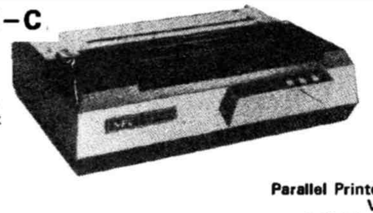

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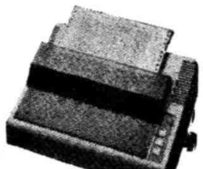

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No of ways	Header Plug	Receptacle	Edge Conn
10	90p	90p	200p
20	145p	125p	240p
26	175p	150p	300p
34	200p	160p	380p
40	220p	190p	550p
50	235p	200p	600p

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1 end	145p	165p	240p	380p
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2 ends	280p	385p	490p	540p

24in Ribbon Cable with D. Conn
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36 way Solder Type Plug (centronix type)	550p
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24 way Solder Socket	500p
24 way IDC Plug	485p

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Angled	180p	230p	265p	425p
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24 pin	100p	180p
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1612 2 x 32 way	280p	320p
Angled 2x32 way	325p	375p
1612 3x32 way	275p	380p
Angled 3x32 way	-	400p
x32 way zidc a + c	-	525p

(for 2x32 way specify a + b or a + c)

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	0.1in	0.156in
2x16 way	—	140p
2x22 way	200p	170p
2x23 way	210p	—
2x25 way	225p	220p
1x43 way	280p	—
2x43 way	395p	—
2x50 way		
1x77 way	700p	—
S100 Conn	—	600p

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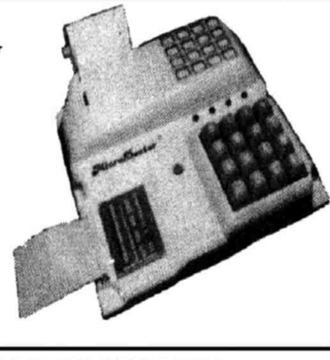

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LM1872	400p
LM1886	400p
LM1889	300p
LM2917	300p
LM3302	300p
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18V		7818	50p	7918	50p
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75161	300p
75162	600p
75172	300p
75182	90p
75188	90p
75189	60p
75365	150p
75450	60p
75451	90p
75452	60p
75453	75p
75454	70p
75480	180p
75491	65p
75492	65p
8T26	120p
8T28	180p
8T95	120p
8T96	120p
8T97	100p
8T98	100p

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81LS96	140p
81LS97	140p
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9602	300p
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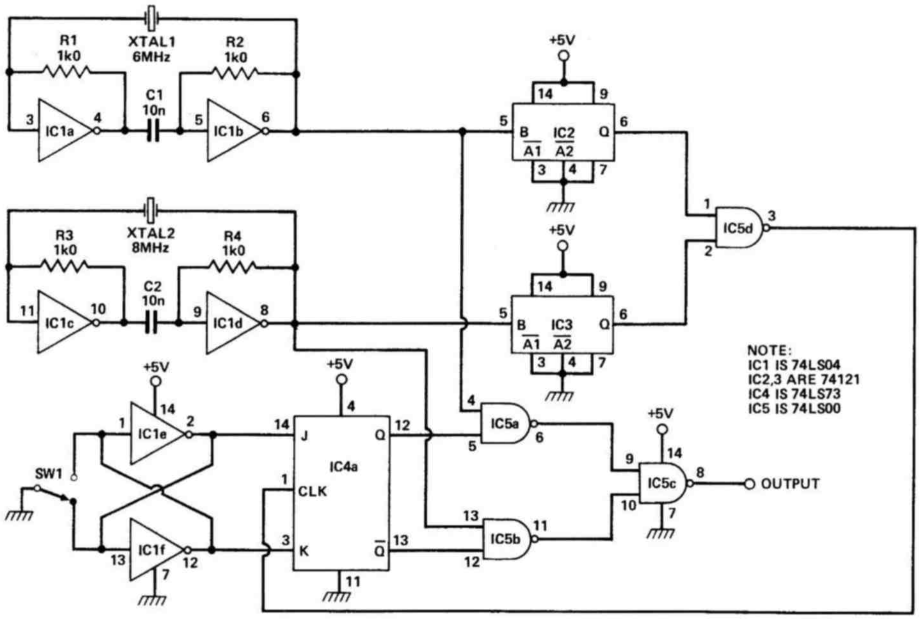


Microtan Clock Switching For Software Tests

K. E. Knibbs, Huntingdon

I designed this circuit because I needed a system of switching the clocks on Microtan system from the normal speed of 750 kHz to 1 MHz in order to test software in real time which had been written for a stand-alone 6502 controller. The circuit functions as follows: the two oscillators fire the monostables IC2 and IC3 for their minimum period of approximately 20 nanoseconds. Only when these fire at the same time does an output appear at pin 3 of IC5d. This pulse is used to clock the D-type flip-flop IC4, the input of which is the debounced switch. The output enables IC5a or IC5b which allows either a 6 MHz or an 8 MHz clock signal to enter IC5c. This ensures that no clock pulse is either too short or too long and is glitch-free. The circuit has been in use for over three months and no system crashes have been caused by it.

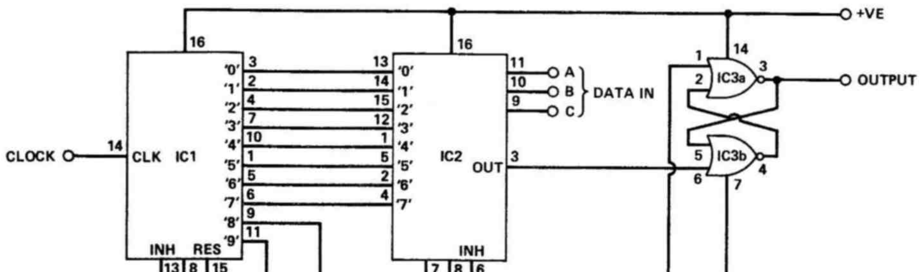
Low Resolution Pulse Generator

G. Foote, Woodford Green

This circuit produces pulses whose width is controlled by a three bit word and which can be used to control motors and similar devices where high resolution isn't needed.

IC1 is a decade counter with outputs '0' to '9' going high in turn. Here it counts from '0' to '8' and is reset by the '9' output which is connected back to the reset pin. Outputs '0' to '7' are connected to IC2, an eight-line-to-one-line multiplexer. The output which is connected to pin 3 by the internal switches of the IC depends on the value of the three-bit word on pins 9, 10, 11.

IC3 is configured as a bistable and is set by the '8' output of IC1. It is reset by one of the other outputs of IC1; the one selected by IC2. The length of the output pulse at pin 3 of IC3a depends on which output of IC1 is used to reset the bistable, the output being selected by the three-bit word input to IC2. Note that the 4051 could be replaced by a 4512 data selector.



NOTE:
IC1 IS 4017B
IC2 IS 4051B
IC3 IS 4001B

CONNECT PINS 8,9,12,13 OF IC3 TO GROUND

Digital Frequency Meter

William Leung, Harlow

The design shown is an alternative to those projects for DFMs that utilise one of those new fangled all-in-one DFM chips. As you can see from the circuit diagram, the only additional circuitry required is an input preamplifier and a suitable regulated 12V power supply.

IC5 is a real-time five-decade counter incorporating a multiplexed BCD output. With the aid of IC8 (a BCD-to-seven-segment decoder) and transistors Q1 to Q5, the counter and display section of the DFM is formed.

The BLANK pin on IC8 is used to extinguish the displays while IC5 is counting, otherwise pin 4 of IC8 should be connected to the positive rail. The frequency reference oscillator is somewhat unique in that a 500 kHz ceramic resonator is used.

In practice it offers reasonable accuracy: however, the circuit can be easily modified to use a 1 MHz quartz crystal. In this case, the connections between IC2 and IC7 of the frequency divider section will require the inputs of IC7 to be connected to pins 3, 5, 12, 14 and 15 of IC2. Pin 14 of IC3 should also be connected to IC2 pin 2, and a suitable multiplexing frequency of around 1 kHz should be fed to pin 10 of IC5.

Depending on the position of SW1b, either 1 Hz, 10 Hz or 100 Hz will appear at IC9 pin 11 (see Fig. 2, point P), where IC9a is a D-type flip-flop configured to divide by two.

Should IC9a be continuously enabled, the output of IC9a will, in fact, be a square wave of half the applied frequency with a mark/space ratio of 1:1. This means that for a 1 Hz applied frequency, 0.5 Hz will appear at IC9a pin 13 and the time for which the cycle will be high is, in fact, one second. This is then fed to the gate IC6a. However, only one such gating

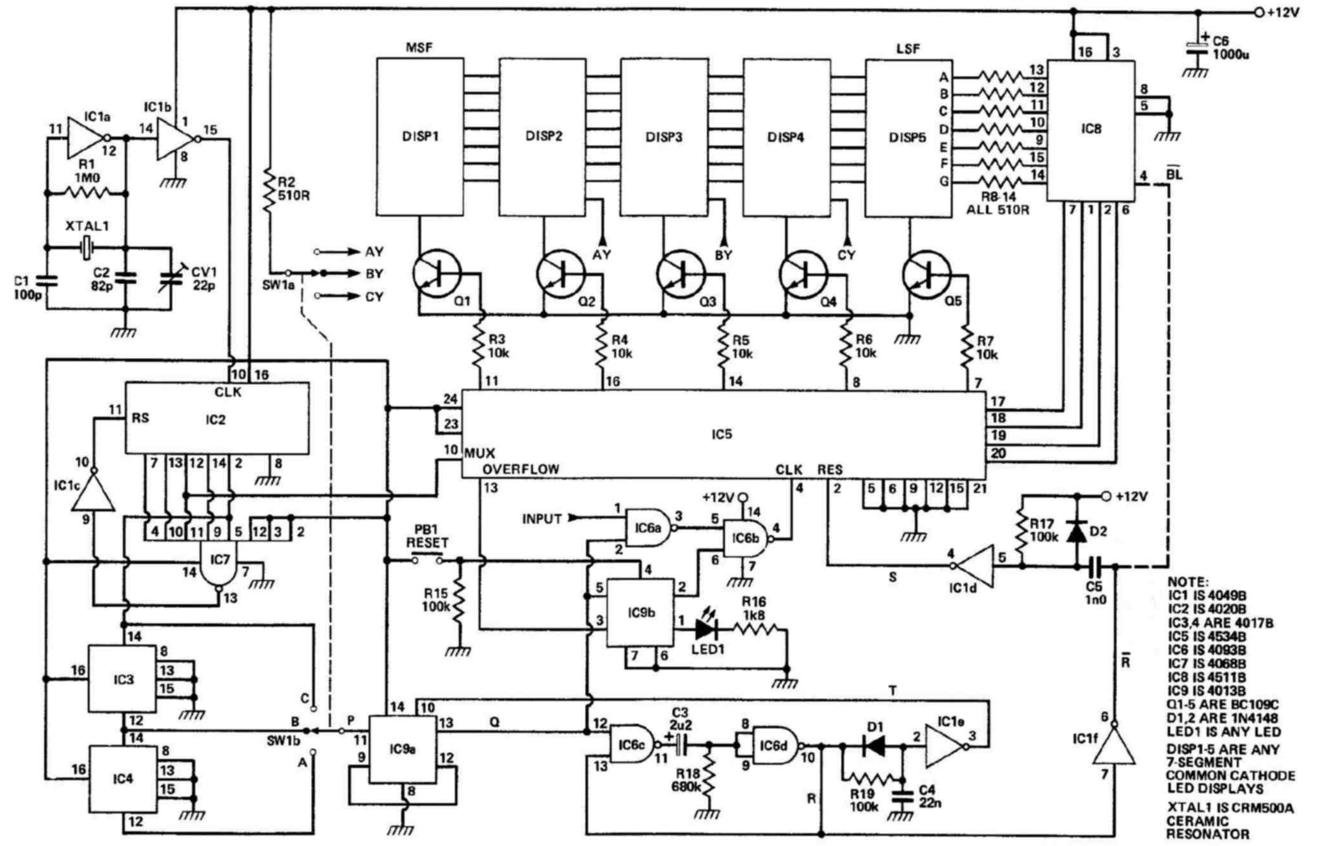


Fig. 1

pulse is produced, after a certain time period set by C3 and R18. The monostable formed round IC6c,d is used to give the reading period of the display, when triggered, by enabling IC8 and disabling IC9a. At the end of the monostable period, a short pulse is produced at S which resets the counter. IC1e is there to ensure that IC9a is not enabled before the reset pulse to the counter is produced (see T), otherwise all hell will break out!

Finally, the D-type flip-flop that remains is used as the basis of the overflow indicator; on the transition of the counter from 99999 to 00000, a pulse is produced at IC8 pin 15 which latches IC9b pin 1 high, thus lighting up the LED. Pressing PB1 resets the whole system.

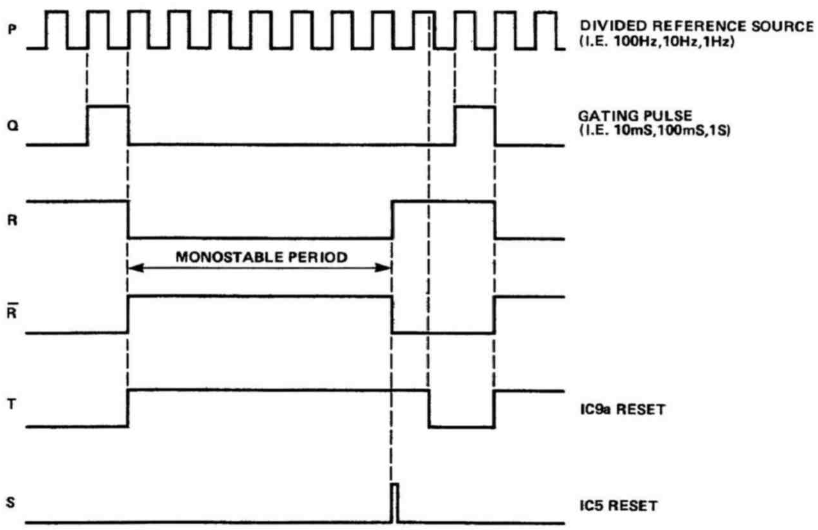


Fig. 2

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Drawings should be as clear as possible and the text should be typed. Text and drawings must be on separate sheets. Circuits must not be subject to copyright. Items for considerations should be sent to ETI TECH-TIPS, Electronics Today International, 145 Charing Cross Road, London WC2H 0EE

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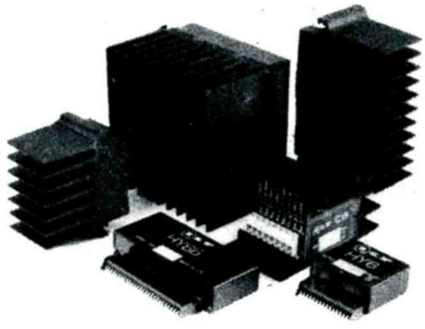

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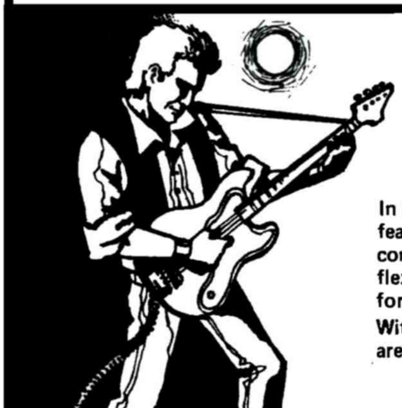

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HY60	30	4-8	0.015%	<0.006%	± 25	76 x 68 x 40	240	£9.55
HY6060	30 + 30	4-8	0.015%	<0.006%	± 25	120 x 78 x 40	420	£18.69
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HY128	60	8	0.01%	<0.006%	± 35	120 x 78 x 40	410	£20.75
HY244	120	4	0.01%	<0.006%	± 35	120 x 78 x 50	520	£25.47
HY248	120	8	0.01%	<0.006%	± 50	120 x 78 x 50	520	£25.47
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Protection: Full load line. Slew Rate: 15v/μs. Risetime: 5μs. S/N ratio: 100db.
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Input Impedance: 100K Ω. Damping factor: 100Hz >400.

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MOS 128	60	4-8	<0.005%	<0.006%	± 45	120 x 78 x 40	420	£30.41
MOS 248	120	4-8	<0.005%	<0.006%	± 55	120 x 78 x 80	850	£39.86
MOS 364	180	4	<0.005%	<0.006%	± 55	120 x 78 x 100	1025	£45.54

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

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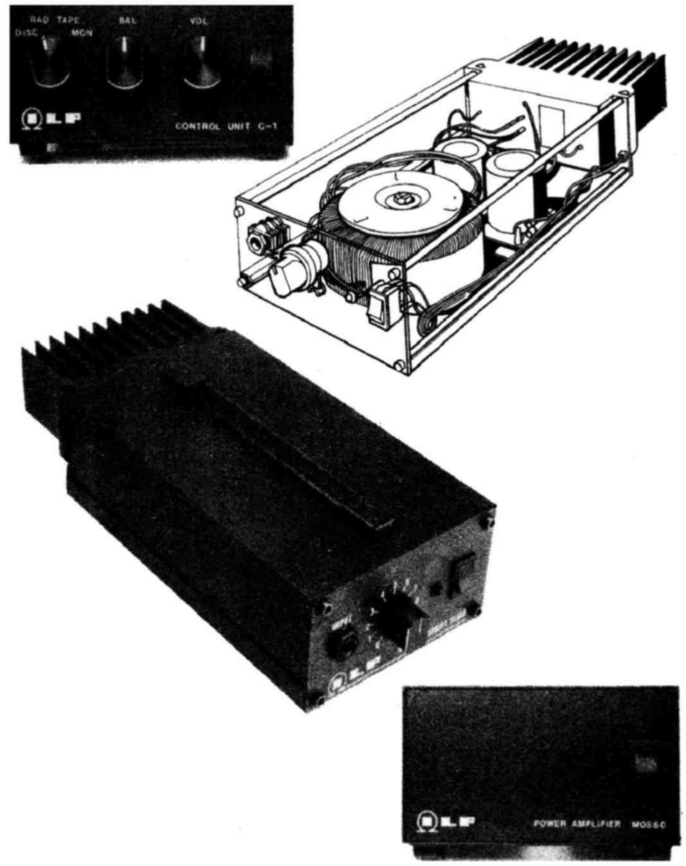

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LOGIC PROBE

Are you probing logically? S. G. Applebaum describes a circuit that will help if you are.

The logic probe circuit described here has been found to be invaluable in debugging and fault-finding on logic systems using discrete CMOS ICS. Utilising three integrated circuits, the probe will allow the checks listed in Table 1 to be carried out.

The probe is supplied from the logic system under test — power is picked up by a flying lead from the board and terminated with croc clips or miniature connectors. The probe will work from a DC supply of 5 V to 15 V and consumes less than 10 mA. Input impedance is approximately 100k and threshold levels are set at logic 0 $< 1/3V_{cc}$ and logic 1 $> 2/3\ V_{cc}$.

The circuit diagram is shown in Fig. 1 with a suitable component layout in Fig. 2 . Utilising the layout shown the probe may be housed in a length of $\frac{7}{8}$" diameter polythene tubing as stocked by DIY shops for plumbing applications. If this diameter tubing is used, then the two 47nF capacitors determining the timing of the MC,14538 monostables should be mounted on the track side of the PCB.

Alternative types of IC may be used for IC1 and IC2 e.g. TL062, CA3240E for IC1, and CD4098, MC14528 for IC2. Total component cost should be less than £5.00, plus PCB.

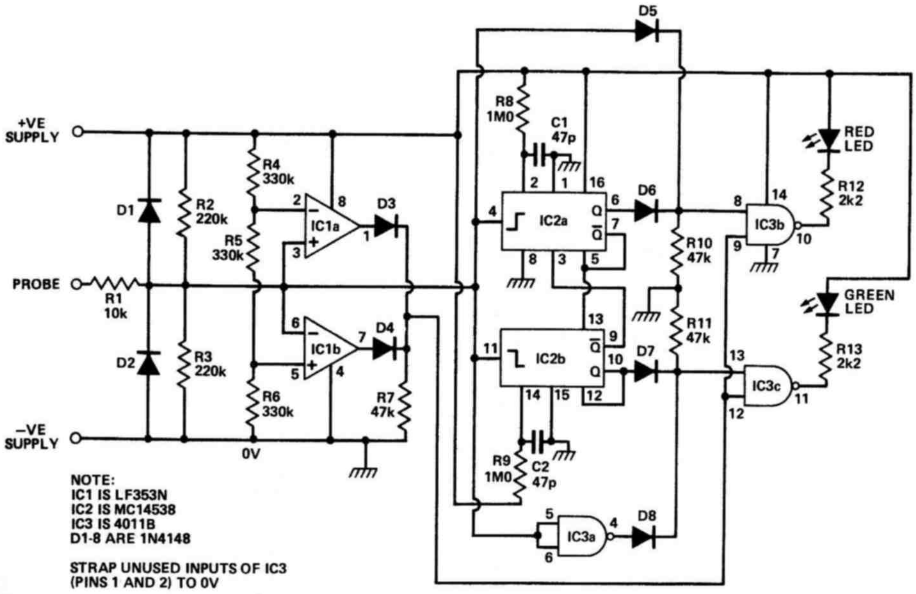


Fig. 1 Circuit diagram for the Logic Probe.

HOW IT WORKS

R1, D1 and D2 form the input protection; IC1a detects high logic levels, and IC1b detects lows. If neither of these are present, neither of the LEDs can light.

D8 and IC3a/D8 detect steady high and low states respectively, while monostable IC2a and IC2b detect positive and negative going pulses respectively. The cross-connections from the data outputs to the reset inputs prevent both monostable firing concurrently, so that, for example, a positive-going pulse will trigger IC2a. but IC2b will be held off until the monostable period has timed out, and so will not be trigge red by the trailing edge of the pulse.

NAND gates IC3b,c only allow the LEDs to light when there is a valid logic state as detected by IC1a,b.

TABLE 1

FAULT	INDICATION
1. Open circuit check	Both LEDs off Green LED on
2. Circuit at logic 0	Red LED on
3. Circuit at logic 1.	Red and Green LEDs on
4. Square wave input	Red LED on, Green LED flashing
5. Negative-going pulse	Green LED on, Red LED flashing
6. Positive-going pulse	Pulse stretching causing red or green LED to flash for approximately 100mS.
7. Presence of glitches or pulses down to 100nS duration	

PARTS LIST

Resistors (all 1/4 watt 5% carbon)

R1	10k
R2, 3	220k
R4-6	330k
R7, 10, 11	47k
R8, 9	1M0
R12, 13	2k2

Capacitors

C1, 2	47n polycarbonate

Semiconductors

IC1	LF353N
IC2	MC14538, 4098 etc.
IC3	4011B
D1-D8	1N4148
LED 1	Red high intensity 0.2in.
LED2	Green high intensity 0.2in.

Miscellaneous

PCB, connectors, case

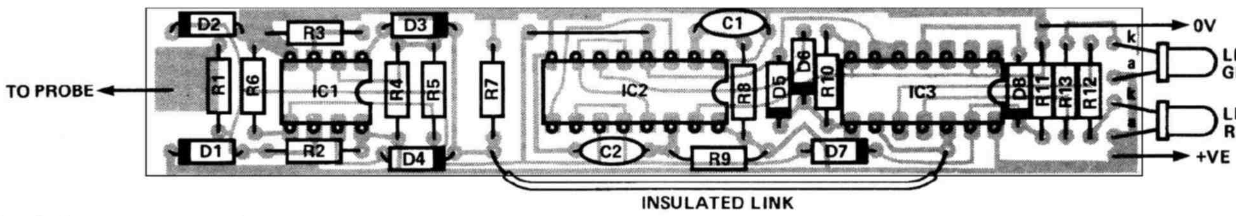
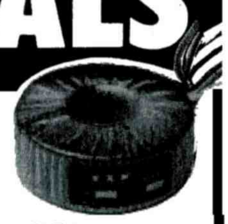


Fig. 2 Component overlay.

TOROIDALS



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TYPE	SERIES No	SECONDARY Volts	RMS Current	PRICE
30 VA 70 × 30mm 0.45Kg Regulation 18%	1x010	6+6	2.50	**£5.12** +p/p £1.04 +VAT £0.92 TOTAL £7.08
	1x011	9+9	1.66	
	1x012	12+12	1.25	
	1x013	15+15	1.00	
	1x014	18+18	0.83	
	1x015	22+22	0.68	
	1x016	25+25	0.60	
	1x017	30+30	0.50	
50 VA 80 × 35mm 0.9Kg Regulation 13%	2x010	6+6	4.16	**£5.70** +p/p £1.30 +VAT £1.05 TOTAL £8.05
	2x011	9+9	2.77	
	2x012	12+12	2.08	
	2x013	15+15	1.66	
	2x014	18+18	1.38	
	2x015	22+22	1.13	
	2x016	25+25	1.00	
	2x017	30+30	0.83	
	2x028	110	0.45	
	2x029	220	0.22	
	2x030	240	0.20	
80 VA 90 × 30mm 1Kg Regulation 12%	3x010	6+6	6.64	**£6.08** +p/p £1.67 +VAT £1.16 TOTAL £8.91
	3x011	9+9	4.44	
	3x012	12+12	3.33	
	3x013	15+15	2.66	
	3x014	18+18	2.22	
	3x015	22+22	1.81	
	3x016	25+25	1.60	
	3x017	30+30	1.33	
	3x028	110	0.72	
	3x029	220	0.36	
	3x030	240	0.33	
120 VA 90 × 40mm 1.2Kg Regulation 11%	4x010	6+6	10.00	**£6.90** +p/p £1.67 +VAT £1.29 TOTAL £9.86
	4x011	9+9	6.66	
	4x012	12+12	5.00	
	4x013	15+15	4.00	
	4x014	18+18	3.33	
	4x015	22+22	2.72	
	4x016	25+25	2.40	
	4x017	30+30	2.00	
	4x018	35+35	1.71	
	4x028	110	1.09	
	4x029	220	0.54	
	4x030	240	0.50	
160 VA 10 × 40mm 1.8Kg Regulation 8%	5x011	9+9	8.89	**£7.91** +p/p £1.67 +VAT £1.44 TOTAL £11.02
	5x012	12+12	6.66	
	5x013	15+15	5.33	
	5x014	18+18	4.44	
	5x015	22+22	3.63	
	5x016	25+25	3.20	
	5x017	30+30	2.66	
	5x018	35+35	2.28	
	5x026	40+40	2.00	
	5x028	110	1.45	
	5x029	220	0.72	
	5x030	240	0.66	

TYPE	SERIES No.	SECONDARY Volts	RMS Current	PRICE
225 VA 110 × 45mm 2.2Kg Regulation 7%	6x012	12+12	9.38	**£9.20** +p/p £2.00 +VAT £1.68 TOTAL £12.88
	6x013	15+15	7.50	
	6x014	18+18	6.25	
	6x015	22+22	5.11	
	6x016	25+25	4.50	
	6x017	30+30	3.75	
	6x018	35+35	3.21	
	6x026	40+40	2.81	
	6x025	45+45	2.50	
	6x033	50+50	2.25	
	6x028	110	2.04	
	6x029	220	1.02	
	6x030	240	0.93	
300 VA 110 × 50mm 2.6Kg Regulation 6%	7x013	15+15	10.00	**£10.17** +p/p £2.00 +VAT £1.83 TOTAL £14.00
	7x014	18+18	8.33	
	7x015	22+22	6.82	
	7x016	25+25	6.00	
	7x017	30+30	5.00	
	7x018	35+35	4.28	
	7x026	40+40	3.75	
	7x025	45+45	3.33	
	7x033	50+50	3.00	
	7x028	110	2.72	
	7x029	220	1.36	
	7x030	240	1.25	
500 VA 140 × 60mm 4Kg Regulation 4%	8x016	25+25	10.00	**£13.53** +p/p £2.35 +VAT £2.38 TOTAL £18.26
	8x017	30+30	8.33	
	8x018	35+35	7.14	
	8x026	40+40	6.25	
	8x025	45+45	5.55	
	8x033	50+50	5.00	
	8x042	55+55	4.54	
	8x028	110	4.54	
	8x029	220	2.27	
	8x030	240	2.08	
625 VA 140 × 75mm 5Kg Regulation 4%	9x017	30+30	10.41	**£16.13** +p/p £2.50 +VAT £2.79 TOTAL £21.42
	9x018	35+35	8.92	
	9x026	40+40	7.81	
	9x025	45+45	6.94	
	9x033	50+50	6.25	
	9x042	55+55	5.68	
	9x028	110	5.68	
	9x029	220	2.84	
	9x030	240	2.60	

IMPORTANT: Regulation – All voltages quoted are FULL LOAD. Please add regulation figure to secondary voltage to obtain off load voltage.

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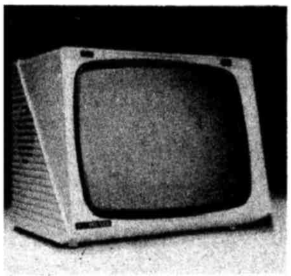

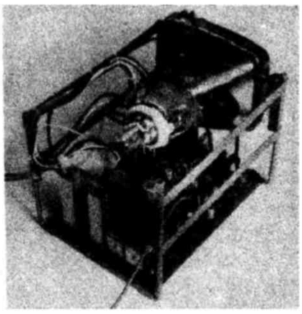

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4816 100ns For BBC comp	**2.01**	**2.25**	**1.95**
4164 200ns	**3.99**	**3.56**	**3.42**
2114 200ns Low power	**1.15**	**1.00**	**0.90**
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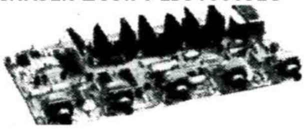

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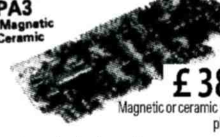

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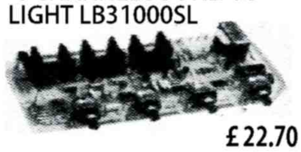

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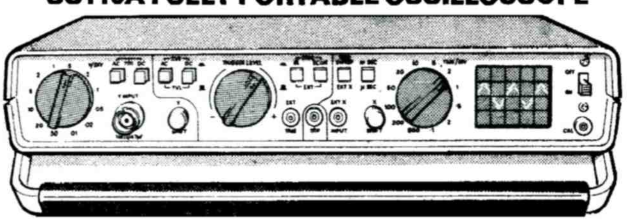

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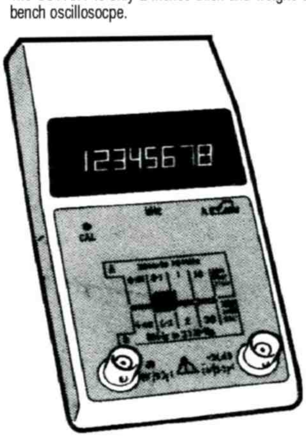

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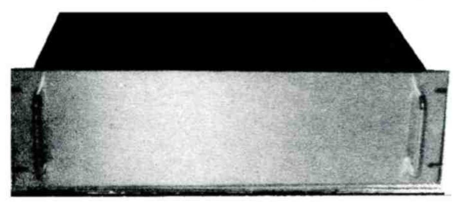

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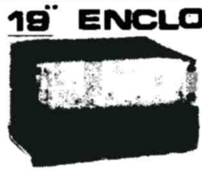

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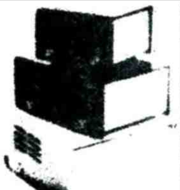

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READ/WRITE

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

Dear Sir

I would like to ask Tim Orr why he states that 'most complex filter designs require a large number of precision resistors and capacitors'.

What does he mean by 'most filters'? What is a 'complex filter' — is it in the form a + jb? What is a 'large number' in this context? Do switched capacitor filter systems use fewer components?

The accuracy of monolithic capacitors of 1% tolerance is not low but is typically within the range ±1% . . . So what?

Switched capacitor techniques do not 'get over' many problems, but simply defer them, at the expense of increased complexity, meaning more system components (eg, clock generators), and 'sweep the real problems under the carpet.'

The fact is that there is absolutely no way a normal, switched capacitor filter can be, component by component, any better, or less expensive, than its analogue counterpart, nor can it perform any better for a given set of fixed requirements (in the sense of classical filter design or modern network theory), nor can it handle high power, as wire-inductor types do. The only advantage I can see for switched-capacitor filters is their ability to scale according to the clock frequency. Whereas this is an advantage for certain, specific applications, Tim Orr gives the impression that it is universally true. It is not so.

I must point out that I have no connection with commercial interests regarding linear filter suppliers, just an interest in your magazine and in the whole truth!

What, for example, are the phase characteristics and filter characteristics of switched-capacitor filters? What are their time-delay equations? I find nothing, apart from scaling, to recommend switched capacitor filters instead of analogue designs, for most applications. By comparison, one can easily determine the phase/time/response characteristic of any analogue filter, construct it from published data (in design tables) and accurately predict how it will behave. It needs no clocks, etc, and transmits power.

Why use an untried technique when there is a perfectly good proven design methodology available, which meets all the requirements?

Would it be possible, for example, to construct the following filter (in which I do have an interest) using switched capacitor techniques:

Q=2.0, 0.1 dB, Cauer, 8th order, band-pass, —40 dB stop, gain=1.0.

If it is possible, does it use fewer components than, or is it cheaper than, or any better than my LC version, and can we find its phase delay?

Putting it another way, most filters in use today are simple RC 3 dB per octave types — what could be simpler than one resistor and one capacitor?

Yours faithfully
Terence B Layzell
Enfield

We take Mr Layzell's point, in that switched-capacitor filters will not replace all discrete filters. However, they can be very useful on occasion, and the two occasions that come to mind are the Spectrum Analyst and Spectracolumn published recently. In equipment manufacture, the costs of any particular item of equipment is largely determined by the package count, and, within certain fairly obvious limits, the price of the packages has little influence. So, in many cases, it may pay manufacturers to go to much more complex (Sorry! complicated) filter design using fewer packages with many legs - ie using a switched-capacitor design with a very complicated circuit rather than a conventional filter with a relatively simple circuit.

Dear Sir

Having read several of the latest issues of ETI, I find it most distressing that a lot of the circuits I have made have come from the Tech Tips section, not because your designs do not interest me, but because the circuits I find in this section have invariably been in ETI or one of the other leading mags before (OTHER leading mags? - *Ed.); but the readers have found a cheaper way of doing the same thing, in fact sometimes 50% or more cheaper. For example the circuit I am working on at present was featured in ETI Tech Tips in January 1981: a simple combination lock. With this circuit and a solenoid I made a combination bolt for my outside shed door, and many of my friends have tried (at my request) and failed to crack it. A combination lock was featured in the magazine some months before but not with a 4017 IC. Needless to say, it cost me less than a quarter of what it would have done if I had made it from the magazine as it was first featured. All I can say is 'thank you' to M. D. Chapman, as he saved me a lot of money. The whole unit complete in a box but less the solenoid cost me £5 as opposed to £22.75 for the other one.*

So, all you designers at ETI, get your brains working on some cheaper circuits for us, or, failing that, make the Editor publish some more of the readers' designs so that we can save enough money to buy next month's issue of ETI. There must be more than seven or eight designs sent in each month. How much longer must we waste time and money putting in a stack of components and ICs when, with slightly different components, we can halve the time and cost it takes to make these projects?

Yours sincerely
D Saunders
Sittingbourne

The original Combination Lock design you refer to was published in ETI in March 1981; since then we have published a rather cheaper design as a project in June and July 1982; and we've also published yet another as a Tech Tip in November 1982, so you can't say we don't give you a wide choice! The two designs we published as projects do incorporate rather more features than the two Tech Tips, so, on balance, all the circuits have something to offer.

As to cost, we try to keep ETI at the fore-front in technology, and this sometimes means that the circuits we publish are rather more expensive to build than we'd like, because, for obvious reasons the components used will not be found in readers' spares boxes. We also like to publish designs that do something more cheaply and/or more elegantly than existing designs when we get hold of them.

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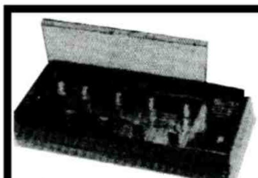

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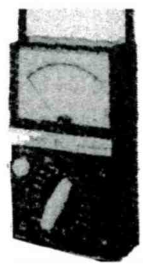

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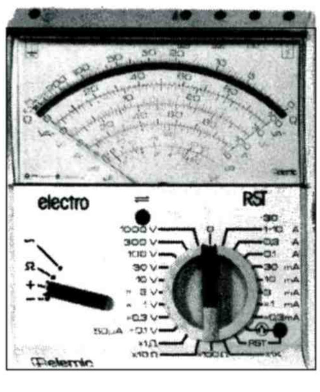

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CONFIGURATIONS

The editor expressly forbids his neighbours from reading this month's Configurations, because it's all about audio power output stages. Ian Sinclair shows the way to deafness for the quiet life.

A lot of people who feel quite happy with the design of voltage amplifier stages are never quite so confident with power output stages. The reasons are not difficult to find, because few textbooks go into much detail about transistor power output stages, and one or two offer rather misleading advice.

The essential problem of power output is to get power delivered into a load, and a theorem which is often quoted in this respect is the maximum power theorem — Fig. 1. This states that if the power source has fixed values of internal resistance and supply voltage, then the maximum transfer of power will occur when the load has the same value of resistance. The maximum power in the load will then be 50% of the total power, with the other 50% being dissipated across the internal resistance. The use of this theorem governed the design of valve output stages for decades.

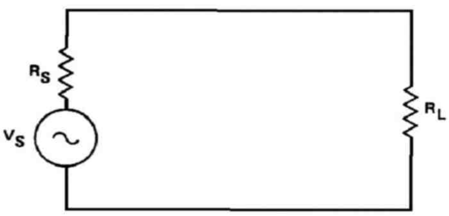

Fig. 1 Maximum power theorem. This states that the maximum possible power, is transferred to the load when RL = Rs. This does not imply that the load gets the maximum share of power.

Things have changed, however, and we can easily obtain transistors with very low internal resistance values and use them in circuits whose internal resistance can be as lttle as a fraction of an ohm. The maximum power theorem isn't useful here, because we don't actually want maximum power, only as much as we can handle, and preferably most of it across the loudspeaker terminals. In any case, we don't want to have to use loudspeakers with im-pedances of only a fraction of an ohm. When we use a loudspeaker whose impedance is several times that of the amplifier, we can be sure that most of the power dissipated is across the loudspeaker rather than across the output transistors, and that's just what we want, whether it's the maximum possible power or not.

The very low output resistance of transistor power amplifiers also explains why it is that the power output of a transistor amplifier increases when you use a loudspeaker of lower impedance — your average pre-war textbook can't explain that one! If we were to attempt to use a load that matched the resistance of the amplifier output stage, it's pretty certain we would burn out the transistors.

Some Like It Hot

Speaking of which brings us to the second point about power output stages. With low internal resistance, there is no problem about delivering power, but the performance of a power amplifier in this respect is limited by the rate at which the transistors in the output stage can dissipate the heat which is inevitably caused when current flows through them. As long as the rate of heat generation' (which is volts x amps) equals the rate of heat dissipation, the temperature will remain steady, but raising the dissipa-tion also means raising the temperature, and this is the limiting factor for transistors, because if the collector junction, which is where the heat is generated, gets too hot, it will melt, and that's the end of the transistor. Many output transistors which could dissipate 150 W if the heat could be removed efficiently will dissipate only a miserable 20 W under realistic working conditions.

The design of a transistor power amplifier, therefore, starts with a consideration of heat-sinks. The traditional method is to use a quantity called thermal resistance, which is defined as the temperature rise per degree (centigrade) of dissipated power. When a heat-sink has a thermal resistance of 4° C/W, then it will be 4° C hotter than the air around it when it is dissipating 1 W, 40°C hotter than the air when it is dissipating 10 W, and so on - the temperature rise equals thermal resistance times power dissipated. For a transistor bolted on to a heat-sink, there are several thermal resistances in series (Fig. 2) the thermal resistance of the collector junction to the mounting surface of the transistor, the thermal resistance of the mounting surface to the heat-sink (which will be increased if you use a mica washer for insulation), and the thermal resistance of the heat-sink itself to the air. Like electrical resistances, these can be added (that's why we use them!), and when the result is multiplied by the intended power dissipation, the result will tell you how much hotter than the air your transistor junction will be. Remember that the air actually around the area of the heat-sink may not be all that cool,- a conservative figure to use is 40°C - and then add on the rise in temperature that you have calculated. If the result is well short of the maximum

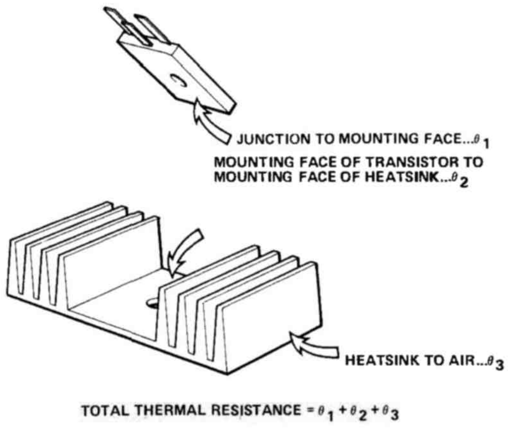

Fig. 2 Thermal resistances. For a single· transistor ·on a heat-sink, the thermal resistances are in series, and can be added. For other configurations, these quantities can be treated exactly like electrical resistances.

allowable figure for the transistor, well and good; if not, then you need to improve your heatsinking, or use a different transistor, or both.

Making A Transformation

With that out of the way, we can now look at some configurations. Most of us automatically think of the PNP-NPN direct coupled pair when we think of output stages, but there are still a lot of single-ended transformer-coupled stages around, similar to the design of Fig. 3. A Class A stage like this is designed by finding the maximum dissipa-

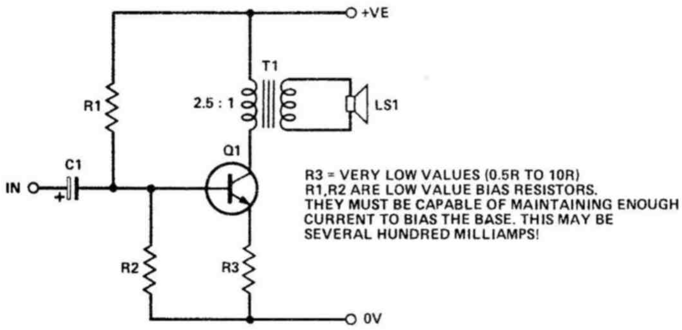

Fig. 3 A single-ended Class A stage, using transformer coupling.

tion you can get away with, and then fixing the supply voltage and calculating the signal current. If we take it that the average DC level at the collector of the transistor is equal to the supply voltage (Fig. 4), then at peak power output, the signal voltage (instantaneous voltage, that is)

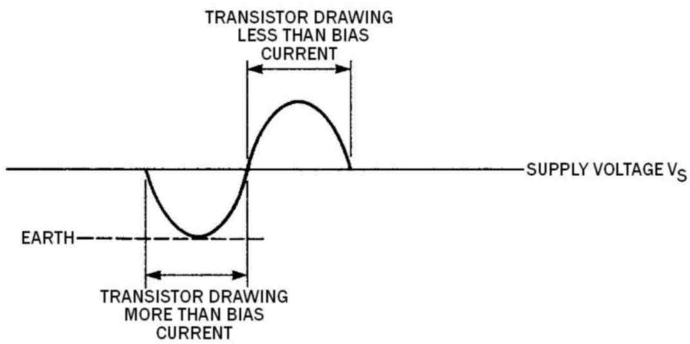

Fig. 4 The (ideal) output waveform at the collector of the circuit of Fig 3. The inductance of the transformer is responsible for the portion of the wave which is above supply voltage.

will drop to zero and rise to twice supply voltage. This makes the peak voltage of the output signal equal to the supply voltage, and the RMS power is equal to

$$\frac{\text{peak volts x peak current}}{8}$$

so that peak current, I_p, equals

$$\frac{8 \text{ x power}}{\text{supply power}}$$

— you will have to check for yourself that the transistor can cope with this peak current. The next step is to calculate the transformer ratio. The peak voltage V_p across the loudspeaker will be

$$\sqrt{\frac{\text{power}}{8}}$$

and the transformer ratio will have to be

$$\frac{\text{supply voltage}}{V_p}$$

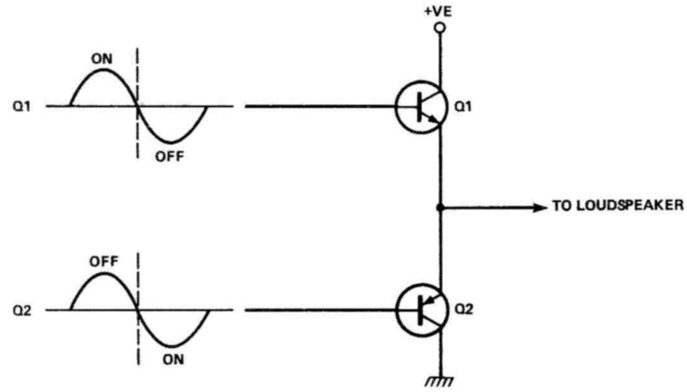

Fig. 5 The basis of the single-end push-pull Class B stage, most succinctly known as the totem-pole output.

— this is usually a step-down ratio. The transformer should have enough primary inductance to ensure that it will handle low frequencies reasonably well, but you don't want to design the transformer in detail unless you are a card-carrying masochist.

The single-ended stage is not exactly brilliant from the point of view of distortion, and the voltage gain is usually very low, so that negative feedback from the speaker terminals to the input of the power stage is rather ineffective. The negative feedback can be taken to an earlier stage, but the drawback here is that the phase shifts may be excessive, particularly since a transformer is present, and these can make your negative feedback become positive at one end of the frequency range, causing distinctly nasty sounds to come from the speaker. The main merit of a single-ended transformer-coupled stage of this type is that it can deliver a fair amount of power from a low supply voltage, something that is not easy for the traditional direct-coupled design.

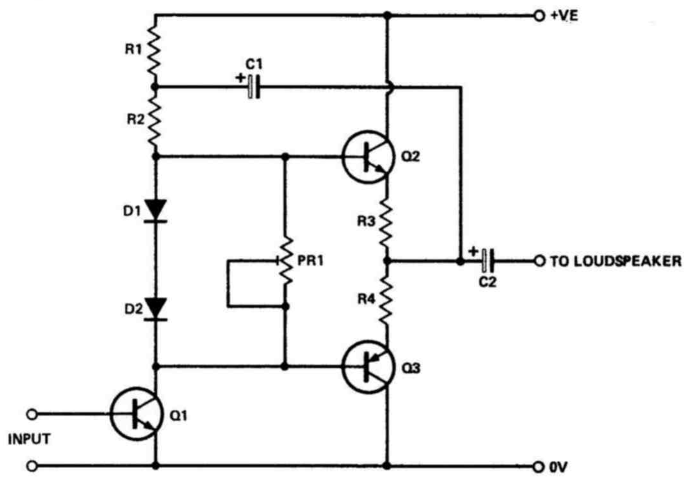

Fig. 6 Using two diodes in series to stabilize the bias of the output pair.

The Traditional Transistors

With that brief introduction —meet the traditional direct-coupled output stage as used in practically all of the hi-fi, medium-fi and no-fi amplifiers in the world. The design consists of a pair of complementary emitter-followers in a Class B single-ended push-pull circuit (Fig. 5), with both transistors on one heat-sink, capacitor coupl-ing to the loudspeaker, and lots of negative feedback. It's a design on which an incredible number of variations can be achieved, however, and also one whose performance can be greatly enhanced by Careful choice of components, and well-planned construction. The driver stage for the output pair may use diodes to adjust the DC voltage difference that is needed between the bases of the output pair (Fig. 6) or an almost-saturated transistors (Fig. 7) or with a common-emitter pair used in place of emitter-followers, and driven by an op-amp (Fig. 8).

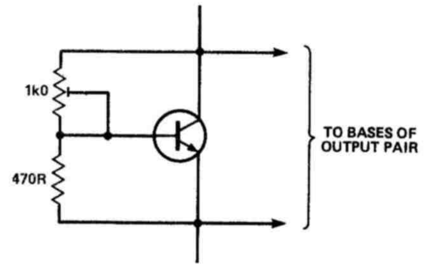

Fig. 7 An alternative method of stabilisation using a transistor.

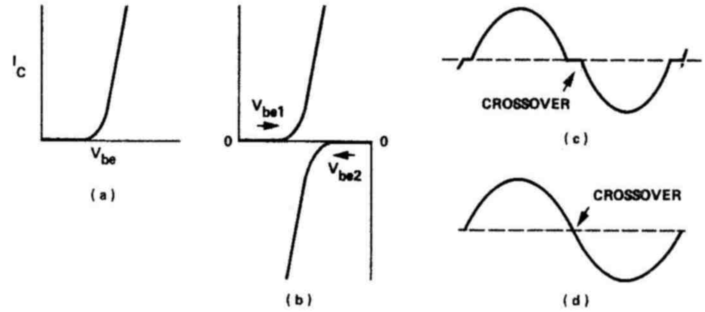

Fig. 9 Crossover distortion. (a) an ideal mutual characteristic for a power transistor. (b) How the characteristics of two identical transistors would combine if each were just cut-off with no signal present. (c) The distortion of wave-shape caused at crossover with insufficient bias. (d) Crossover distortion can be reduced by increasing bias on each transistor, but unless the transistors have unusually straight characteristics, a lot of bias will be needed.

Like all Class B stages, linearity, especially near the crossover point (Fig. 9) where one transistor starts to conduct as the other one stops, is always a problem. The gain in this region is very low, so that negative feedback is not the cure-all that many designers seem to expect it to be. Since the basic output stage is a couple of emitter-followers, it has a voltage gain that is less than unity, and the driver stage usually has a low gain also, so that the feedback loop has to be taken over a number of stages (Fig. 10).

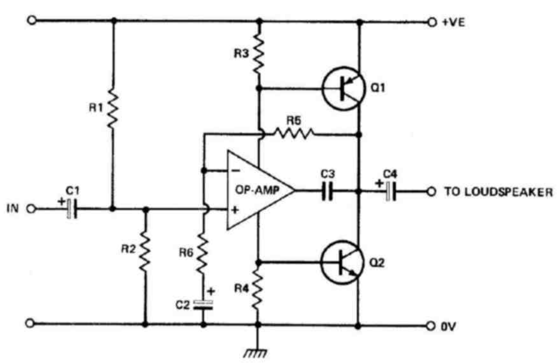

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Fig. 8 A circuit which uses an op-amp to drive an output pair. The transistors are NOT in the normal totem-pole configuration, because each is being used as a common emitter amplifier rather than as an emitter-follower. If Darlington power output transistors are used, this can be a very economical high-power stage.

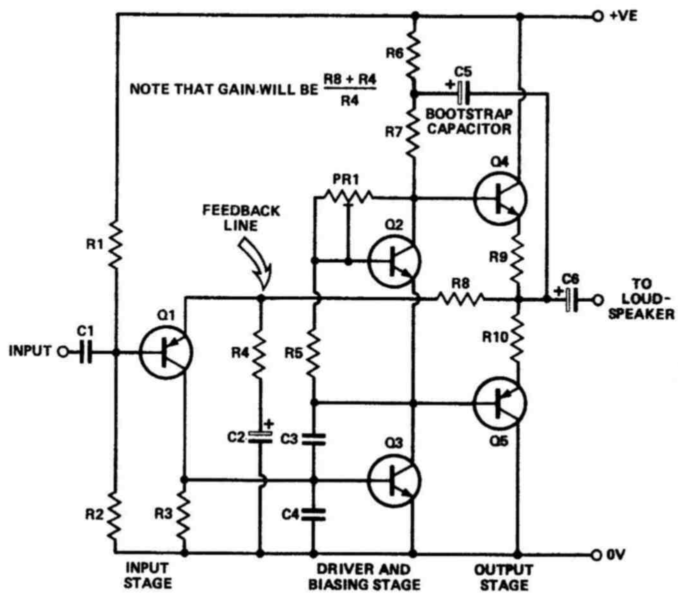
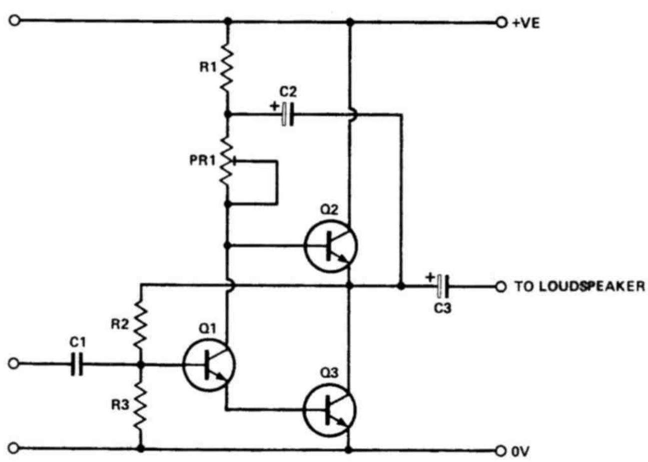


Fig. 10 Using feedback over several stages in a Class B output circuit.

The problem of crossover distortion has driven several designers to use Class A stages of very similar configuration. When both of the transistors of the output pair are driven with a signal, the efficiency can be as high as 30% (as compared with 78% for Class B), and the availability of high-power transistors with low thermal resistances has encouraged the use of Class A — a typical circuit is shown in Fig. 11. The distortion figure, measured before applying feedback, is still fairly high (10% or more at full power), but feedback greatly improves this. More important, the distortion level tends to be least at low power outputs, unlike the Class B circuit in which the distortion is greatest at low level — when it is also most noticeable — due to the crossover problem.



PR1 SETS OUTPUT CURRENT
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Fig. 11 A Class A output stage - note that both output transistors are of the same type. For low distortion, they should be carefully matched.

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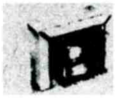

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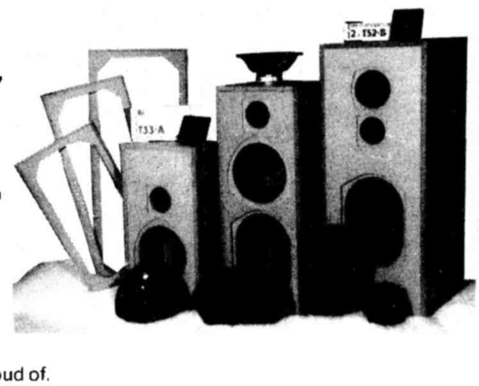

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They look lovely, home computers, don't they — until you bolt on all the things round the back that the designer couldn't (or wouldn't) include.

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David Parkins

P.S. Although this advert may sound a bit corny (we have to get your attention somehow) Interak 1 really is a serious, sensible system with thousands of cards sold, and in daily use. Cards, Manuals, all available separately inc. circuit diagrams.

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Up till now PCBs were always the hardest component to obtain for a project. Of course you could make your own, but why bother anymore!
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In addition to the PCBs for this month's projects, we are making available some of the more popular designs from our recent past. See the list below for details. Please notes that NO OTHER BOARDS ARE AVAILABLE. If it's not listed, we don't have it!

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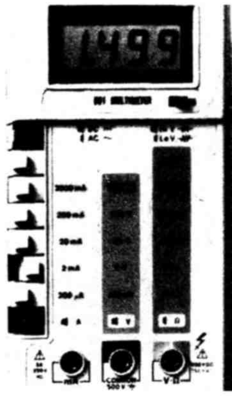

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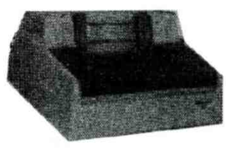

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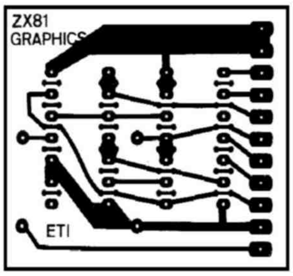

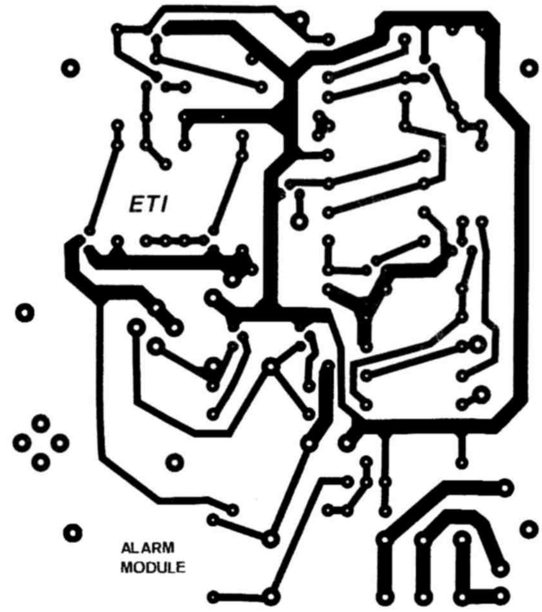

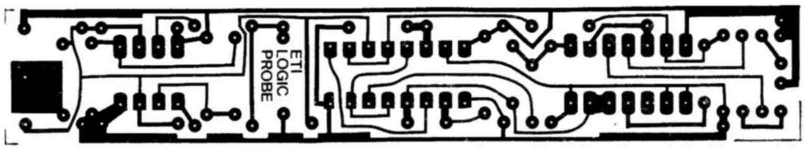

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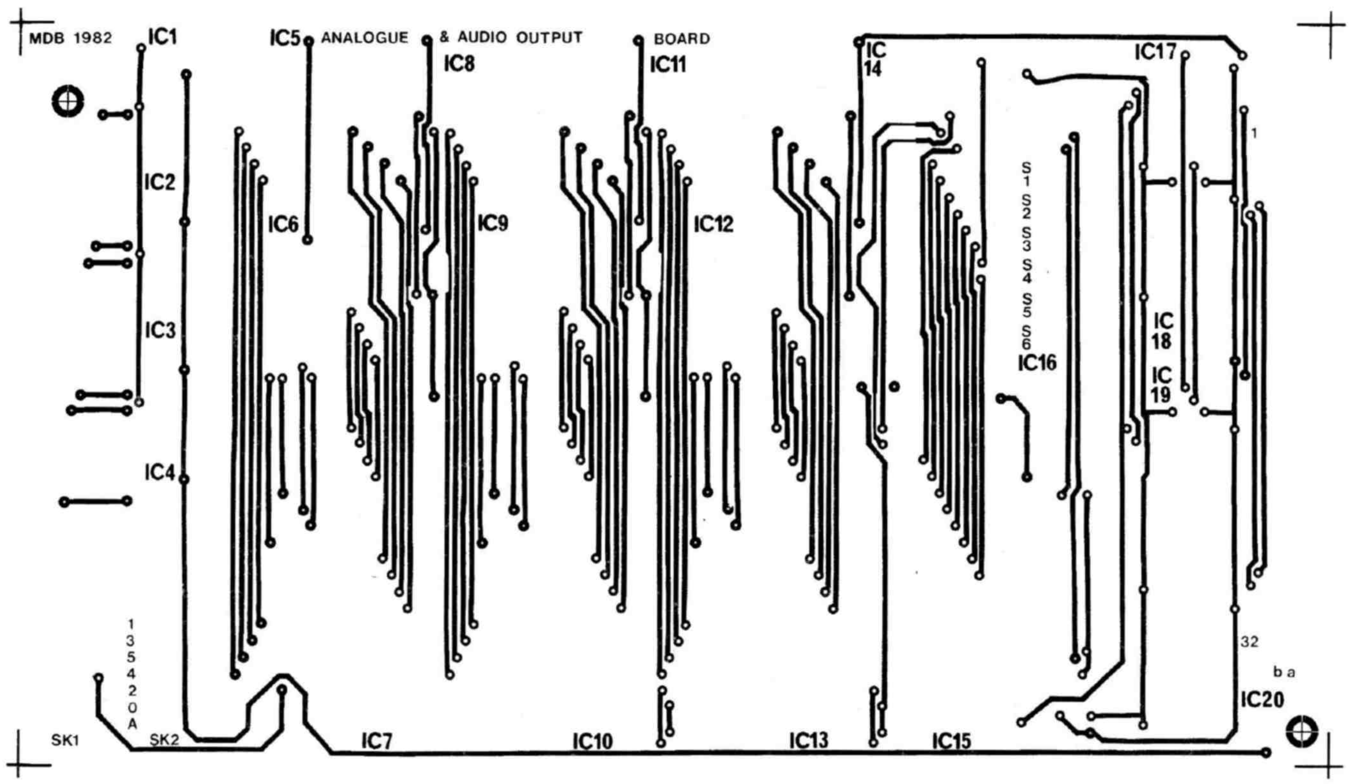

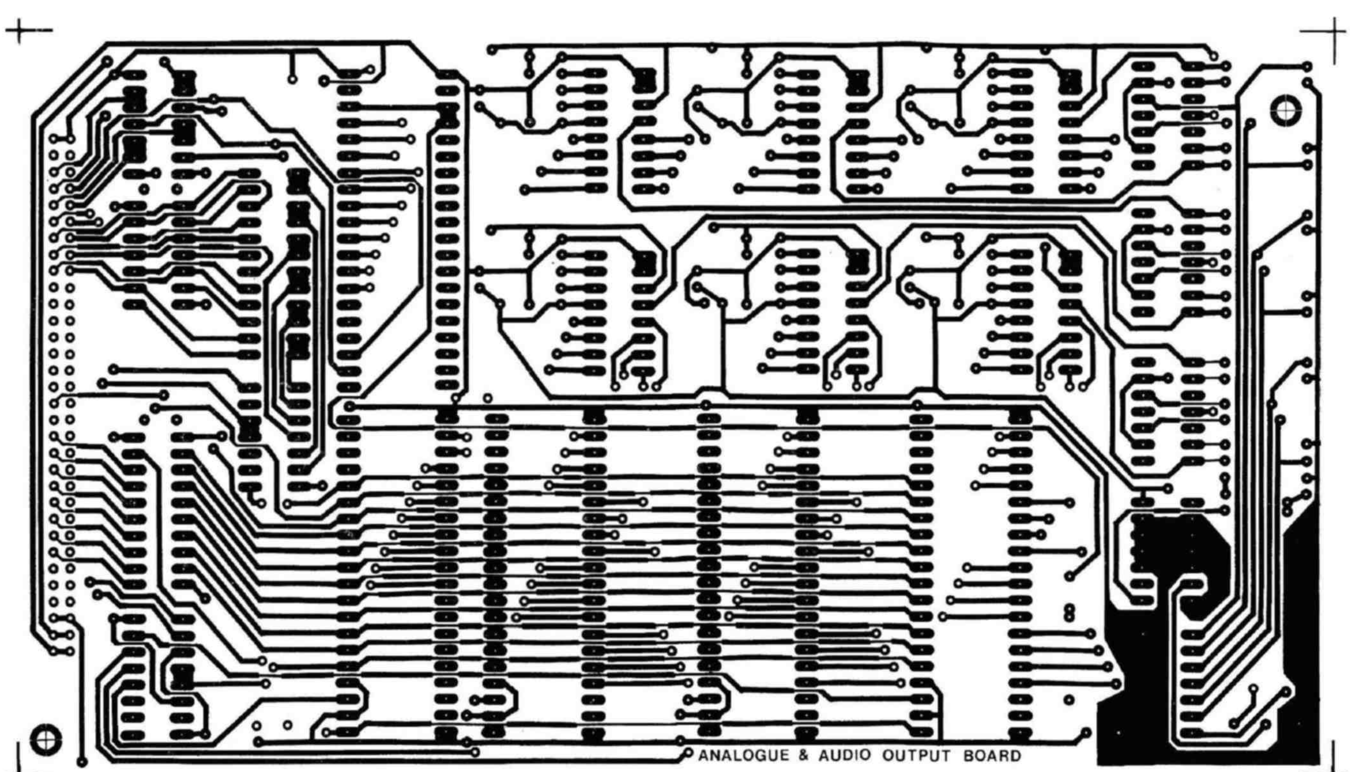

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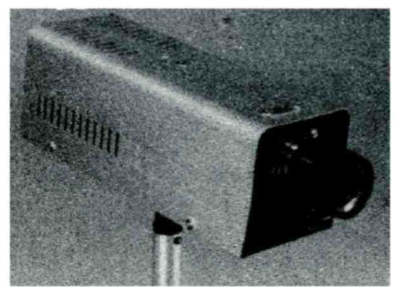

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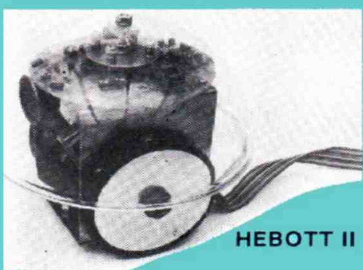

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(Electronics Today International December issue on CORTEX)

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Arm lift: 6.6"
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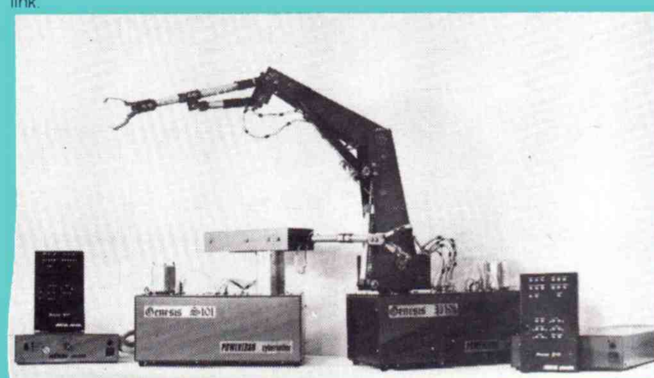

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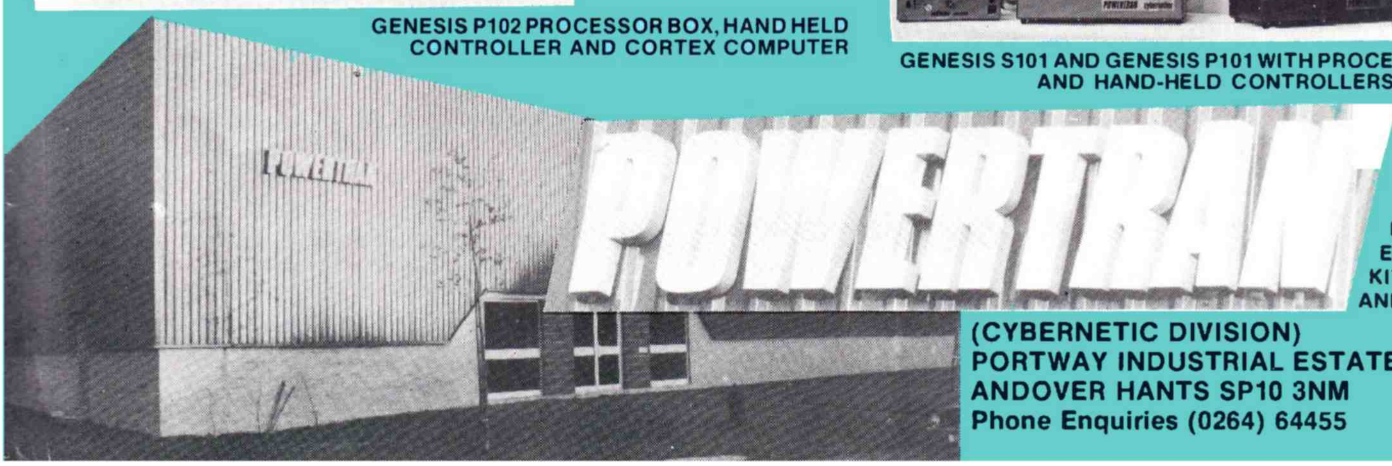

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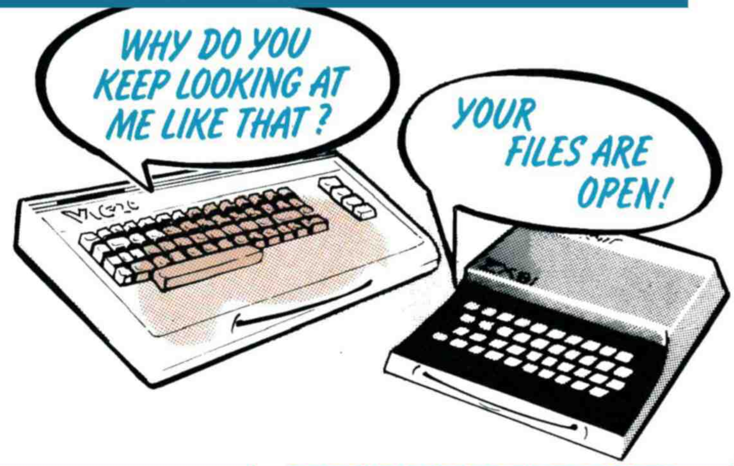
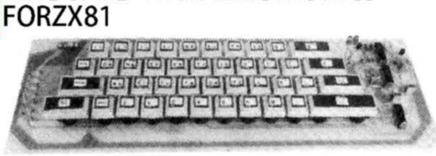


KEYBOARD WITH ELECTRONICS FOR ZX81



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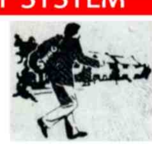

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**Projects for Book 6 were in an advanced state at the time of writing, but contents may change prior to publication (due 11th February 1983).*

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