

electronics today

INTERNATIONAL

FEBRUARY 1984 90p

CHAT WITH YOUR COMPUTER!

Versatile allophone speech synthesis board with:

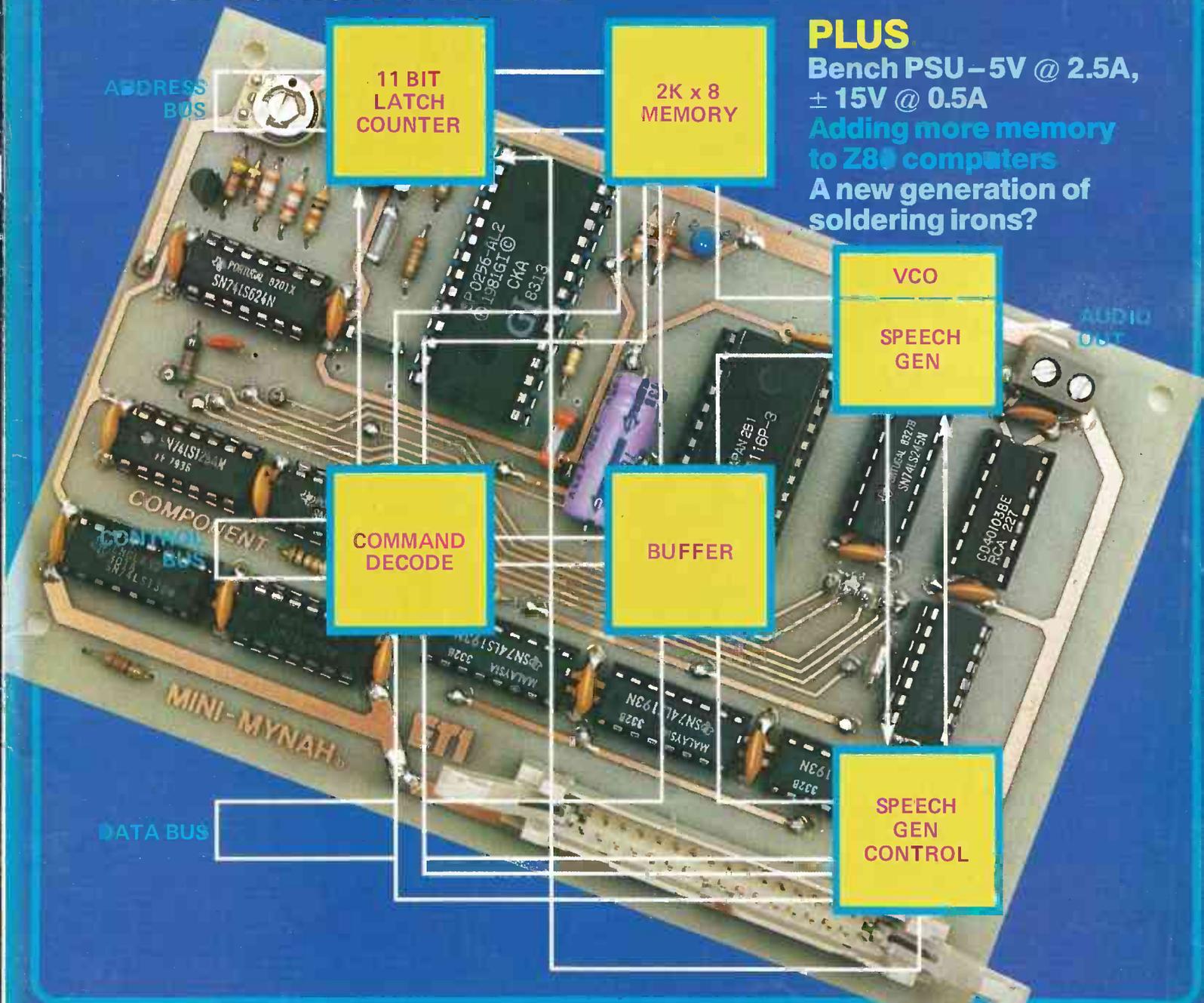
- four levels of inflection
- 2K of on-board RAM storing 100+ words
- speech reproduced as words, phrases or sentences
- simple interface requirements
- low software overhead

PLUS

Bench PSU - 5V @ 2.5A,
± 15V @ 0.5A

Adding more memory
to Z80 computers

A new generation of
soldering irons?



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

Low-price robots from POWERTRAN

— hydraulically powered
— microprocessor controlled

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

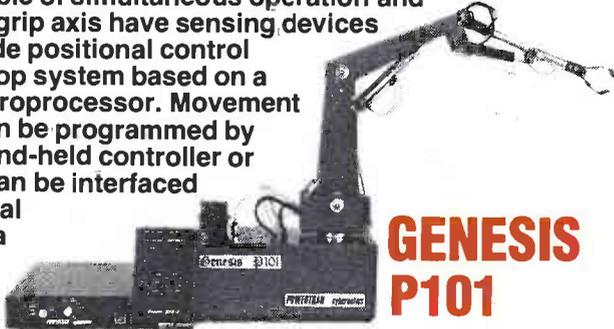
Each robot in the Genesis range has a self-contained hydraulic power source operated from single phase 240 or 120v AC or from a 12v DC supply. Up to six independent axes are capable of simultaneous operation and all except the grip axis have sensing devices fitted to provide positional control by a closed loop system based on a dedicated microprocessor. Movement sequences can be programmed by means of a hand-held controller or the systems can be interfaced with an external computer via a standard RS232C link.

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

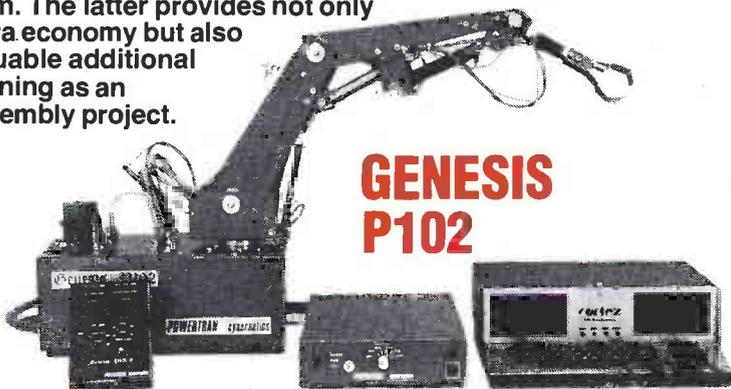
All Genesis robots are available either ready-built or in kit form. The latter provides not only extra economy but also valuable additional training as an assembly project.



GENESIS S101



GENESIS P101



GENESIS P102



HEBOT II Turtle-type robot

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

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

HEBOT II

Weight 1.8kg
complete kit with assembly instructions **£85**
Interface board kit **£10**

MICROGRASP



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

MICROGRASP

Weight 8.7kg, max. lifting capacity 100g
Robot kit with power supply **£145.00**

Universal computer interface board kit **£48.50**
23 way edge connector **£2.50**
AX81 peripheral/RAM pack splitter board **£3.00**

GENESIS S101

Weight 29kg, max. lifting capacity 1.5kg
4-axis model (kit form) **£425**

5-axis model (kit form) **£475**
5-axis complete system (kit form) **£737**

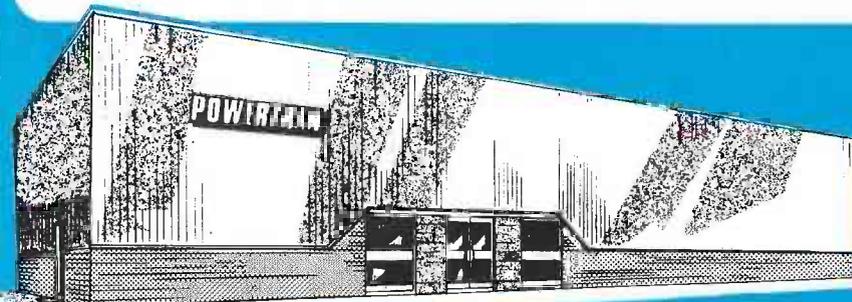
GENESIS P101

Weight 34kg, max lifting capacity 1.8kg
6-axis model (kit form) **£675**
6-axis complete system (kit form) **£945**

GENESIS P102

Weight 36kg, max lifting capacity 2kg
6-axis system (kit form) **£1175.00**

Powertran Cortex microcomputer self-assembly kit **£295.00**



POWERTRAN cybernetics Ltd.

PORTWAY INDUSTRIAL ESTATE, ANDOVER, HANTS SP10 3PE. TEL (0264) 64455



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ELECTROLYTIC CAPACITORS: (Values in uF) 500v, 10uf 52, 47 78p, 63V, 0.47, 1.0, 1.5, 2.2, 3.3, 4.7, 8p 10 10p, 15, 22 12p, 33 15p, 47 12p, 68 20p, 100 19p, 220 28p, 1000 70p, 2200 99p, 50V 68 20p, 100 17p, 220 24p, 30V 22 9p, 33 12p, 33 12p, 33 12p, 1000 48p, 2200 50p, 25V 1.5, 4.7, 10, 22, 47, 100 11p, 150 12p, 220 15p, 330 22p, 470 25p, 680, 1000 34p, 1500 42p, 2200 50p, 3300 76p, 4700 92p, 16V, 47 6p, 100 9p, 125 12p, 330 16p, 470 20p, 680 34p, 1000 27p, 1500 31p, 2200 26p, 4700 27p.

TAG-END CAPACITORS: 64V: 2200 139p, 3300 198p, 4700 245p, 50V: 2200 110p, 3300 184p, 40V: 4700 180p, 25V: 2200 90p, 3300 98p, 4000, 4700 98p, 10000 320p, 15000 345p, 18V: 22000 350p.

POLYESTER CAPACITORS: Axial Lead Type
400V: 1nF, 1.5n, 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, 10uF: 10n, 12n, 38n, 11p; 150n, 220n 11p; 330n, 470n 30p; 680n 38p; 1uF 48p; 1u5 55p; 2u2 58p; 4u7 66p.
1000V: 1nF 17p; 10nF 30p; 15n 40p; 22n 36p; 33n 42p; 47n, 100n 42p.

POLYESTER RADIAL LEAD CAPACITORS: 250V
10n, 15n, 22n 27n 6p; 33n, 47n, 68n, 100n 8p; 150n, 220n 10p; 330n, 470n 15p; 680n 19p; 1u5 40p; 2u2 48p.

TANTALUM BEAD CAPACITORS
35V: 0.1uF, 0.22, 0.33 15p 0.47, 0.68, 1.0, 1.5 16p; 2.2, 3.3 18p; 4.7, 6.8 22p, 10 25p, 15 30p; 22 36p; 33 47 50p; 100 95p; 10V: 15, 22 36p; 33 47 50p; 100 95p; 6V: 10, 10 55p.

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

CERAMIC CAPACITORS 50V:
Range: 0.5pF to 10nF 4p, 15nF, 22nF 33nF, 47nF 5p, 100nF/300V 7p, 200nF/6V 8p.

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

SILVER MICA (Values in pF)
2.3, 4.7, 6.8, 82, 10, 12, 15, 18, 22, 27, 33, 39, 47, 50, 56, 68, 75, 82, 85, 100, 120, 150, 180pF 15p each, 200, 220, 250, 270, 300, 330, 360, 390, 470, 800, 800, 820 21p each, 100, 1200, 1800, 2200 30p each, 3300, 4700pF 80p.

MINIATURE TRIMMERS Capacitors
2-8pF 2-10pF 22p; 2-25pF, 5-65pF 30p; 10-88pF 36p.

RESISTORS Carbon Film Hi-Stab 5%
RANGE Valt 1-99 100+
0.25W 2 2-10M E24 3p 1p
0.5W 2 2-4M7 E12 3p 1p
1W 2 2-10M E12 6p 4p
2% Metal Film E24 6p 4p
1% Metal Film E24 8p 6p
100+ price applies to Resistors of each type not mixed.

RESISTORS NETWORK S.I.L.
7 Commoned (8 pins) 100, 680, 1K 2K, 4K7, 10K, 47K 100K 25p
8 Commoned: (9 pins) 150, 180, 270, 330, 1K, 2K, 4K7, 6K8, 10K, 22K, 47K & 100K 25p.

DIODES BRIDGE RECTIFIERS 7S SERIES
AA119 15 1A/50V 18 75107/8 96 6167-6 795 879N 90
AA129 20 1A/50V 18 75110 90 6502ZCPU 325 8364AP 580
AA30 15 1A/100V 20 75114/5 150 6503A 450 AMZ6L531C 125
BA100 15 1A/400V 25 75121/2 130 6503 650 AMZ6L532A 125
BA1 20 2A/50V 34 75150 125 6504 600 AMZ6L533A 125
BY100 24 2A/50V 30 75154 125 6504 250 AMZ6L533A 125
BY126 12 2A/200V 40 75159 199 6505 600 AY-3-1015 300
BY127 14 2A/400V 46 75182/4 95 6505 600 AY-5-2376 800
CRO33 250 2A/600V 86 75188/9 56 6520PIA 100 AY-5-1013 300
OA9 40 6A/100V 83 75322 140 6522VIA 285 AY-5-2376 800
OA7 12 6A/400V 96 75324 160 6530 E11 COMB11 6 700
OA70 12 10A/200V 215 75361/3 150 6532RRIOT 899 DM813 275
OA79 15 10A/600V 296 75365 150 6548RTC 899 DM813 275
OA81 20 25A/200V 240 75450 86 6551ACIA 650 DPB304 250
OA85 15 25A/600V 396 75451/2 52 6552 00 DS3647 100
OA90 8 BY164 56 75454 70 8592PC 220
OA91 8 VM18 DIL 50 75491/2 65 6800 220
OA95 8 6802 250
OA200 8 6803 850
OA202 8 6805 870
IN15 4 520 6808 520
IN16 5 6809 630
IN140/1/2 5 6810 115
IN4003 6 6811 110
IN4004/5 6 6812 110
IN4006/7 7 33V 1.3W 6808B2 220
IN4148 4 15p each 6809 375
IN5401 15 12A100V 78 6843 612
IN5404 15 12A400V 78 6844 750
IN5406 17 2A800V 188 6845 750
IN5408 19 6850 110
IS4 9 3A200V 54 BT106 150
IS921 9 8A100V 56 BT116 180
6A/100V 40 8A100V 60 TIC44 28
6A/400V 50 8A800V 60 TIC45 28
6A/600V 60 8A800V 115 TIC47 38
12A100V 78 2N5062 38
12A400V 78 2N5064 38
12A800V 136 2N4444 130

VARICAPS
BA102 50 16A400V 106
BB105B 40 16A600V 220
BB108 40 25A600V 220
BB109B 45 25A800V 296
MVAM2 105 12800D 120

DIAC
8080A 50
8080B 40
8080C 40
8080D 40
8080E 40
8080F 40
8080G 40
8080H 40
8080I 40
8080J 40
8080K 40
8080L 40
8080M 40
8080N 40
8080P 40
8080Q 40
8080R 40
8080S 40
8080T 40
8080U 40
8080V 40
8080W 40
8080X 40
8080Y 40
8080Z 40

TRANSISTORS

AC126/7 35	BC12 10	BF256A 35	MPSA56 30	VK1010 99	2N3708/9 10	2SC2078 170
AC141/2 30	BC212L 10	BF256B 45	MPSA70 30	VN10K07 70	2N3713 10	2SC2091 85
AC147 25	BC213 10	BF257 35	MPSA71 30	VN16A1 58	2N3717 15	2SC2114 88
AC187 30	BC213L 10	BF258 35	MPSA72 30	VN86AF 110	2N3722 195	2SC2168 105
AC188 32	BC214 10	BF336/7 40	MPSA73 30	VN86AF 120	2N3733 210	2SC2335 225
AC188 32	BC213L 10	BF594/5 30	MPSA74 30	VN89AF 120	2N3819 27	2SC2547 30
AC191/21 75	BC237/8 14	BF939/40 23	MPSA75 30	ZX107/8 11	2N3820 38	2SC2612 225
AC22/41 75	BC256B 30	BF939/40 23	MPSA76 30	ZX109 12	2N3821 38	2SD234 74
AD142 12	BC257 14	BF939/40 23	MPSA77 30	ZX112 20	2N3822 90	2SK288 225
AD149 19	BC308 18	BF939/40 23	MPSA78 30	ZX130 13	2N3903/4 15	2SK288 225
AD161 42	BC318 80	BF939/40 23	MPSA79 30	ZX130 13	2N3905/6 15	2SK288 225
AD162 42	BC327 15	BF939/40 23	MPSA80 30	ZX130 13	2N3906 15	2SK288 225
AF115/6 80	BC337/8 15	BF939/40 23	MPSA81 30	ZX130 13	2N3907 15	2SK288 225
AF186 80	BC441/61 34	BF939/40 23	MPSA82 30	ZX130 13	2N4264 24	3N128 112
AF186 80	BC441/61 34	BF939/40 23	MPSA83 30	ZX130 13	2N4264 24	3N128 112
AF186 80	BC441/61 34	BF939/40 23	MPSA84 30	ZX130 13	2N4264 24	3N128 112
AF186 80	BC441/61 34	BF939/40 23	MPSA85 30	ZX130 13	2N4264 24	3N128 112
AF186 80	BC441/61 34	BF939/40 23	MPSA86 30	ZX130 13	2N4264 24	3N128 112
AF186 80	BC441/61 34	BF939/40 23	MPSA87 30	ZX130 13	2N4264 24	3N128 112
AF186 80	BC441/61 34	BF939/40 23	MPSA88 30	ZX130 13	2N4264 24	3N128 112
AF186 80	BC441/61 34	BF939/40 23	MPSA89 30	ZX130 13	2N4264 24	3N128 112
AF186 80	BC441/61 34	BF939/40 23	MPSA90 30	ZX130 13	2N4264 24	3N128 112
AF186 80	BC441/61 34	BF939/40 23	MPSA91 30	ZX130 13	2N4264 24	3N128 112
AF186 80	BC441/61 34	BF939/40 23	MPSA92 30	ZX130 13	2N4264 24	3N128 112
AF186 80	BC441/61 34	BF939/40 23	MPSA93 30	ZX130 13	2N4264 24	3N128 112
AF186 80	BC441/61 34	BF939/40 23	MPSA94 30	ZX130 13	2N4264 24	3N128 112
AF186 80	BC441/61 34	BF939/40 23	MPSA95 30	ZX130 13	2N4264 24	3N128 112
AF186 80	BC441/61 34	BF939/40 23	MPSA96 30	ZX130 13	2N4264 24	3N128 112
AF186 80	BC441/61 34	BF939/40 23	MPSA97 30	ZX130 13	2N4264 24	3N128 112
AF186 80	BC441/61 34	BF939/40 23	MPSA98 30	ZX130 13	2N4264 24	3N128 112
AF186 80	BC441/61 34	BF939/40 23	MPSA99 30	ZX130 13	2N4264 24	3N128 112
AF186 80	BC441/61 34	BF939/40 23	MPSA100 30	ZX130 13	2N4264 24	3N128 112

250V
1nF, 1.5n, 2n2, 3n3, 4n7, 6n8, 10n, 15n, 18n, 22n 7p
33n, 39n, 47n 8p
39n, 56n 12p
82n, 100n 11p

100V
100n, 120n 10p
150n, 180n 12p
220n, 270n 15p
330n, 390n 20p
470n, 560n 25p
680n 30p
1uF 34p 2u2 50p

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UA3023 210	M706B1 125	TBA960 300	7428 30	74184 100	S260 70	LS161 45
CA3028A 95	MS1513L 320	TBA990Q 350	7430 25	74185 100	S262 850	LS162 40
CA3035 255	MS1515L 320	TC9109 750	7432 25	74190 70	S267 225	LS163 40
CA3036 270	MS1516L 320	TC9109 750	7433 25	74191 78	S288 210	LS164 45
CA3037 275	MS1517L 320	TC9109 750	7434 25	74192 78	S288 210	LS165 50
CA3038 275	MS1518L 320	TC9109 750	7435 25	74193 60	S288 210	LS166 50
CA3039 275	MS1519L 320	TC9109 750	7436 25	74194 60	S288 210	LS167 50
CA3040 275	MS1520L 320	TC9109 750	7437 25	74195 60	S288 210	LS168 140
CA3041 275	MS1521L 320	TC9109 750	7438 25	74196 50	S288 210	LS169 140
CA3042 275	MS1522L 320	TC9109 750	7439 25	74197 50	S288 210	LS170 85
CA3043 275	MS1523L 320	TC9109 750	7440 25	74198 50	S288 210	LS171 75
CA3044 275	MS1524L 320	TC9109 750	7441 25	74199 50	S288 210	LS172 75
CA3045 275	MS1525L 320	TC9109 750	7442 25	74200 50	S288 210	LS173 75
CA3046 275	MS1526L 320	TC9109 750	7443 25	74201 50	S288 210	LS174 75
CA3047 275	MS1527L 320	TC9109 750	7444 25	74202 50	S288 210	LS175 75
CA3048 275	MS1528L 320	TC9109 750	7445 25	74203 50	S288 210	LS176 75
CA3049 275	MS1529L 320	TC9109 750	7446 25	74204 50	S288 210	LS177 75
CA3050 275	MS1530L 320	TC9109 750	7447 25	74205 50	S288 210	LS178 75
CA3051 275	MS1531L 320	TC9109 750	7448 25	74206 50	S288 210	LS179 75
CA3052 275	MS1532L 320	TC9109 750	7449 25	74207 50	S288 210	LS180 75
CA3053 275	MS1533L 320	TC9109 750	7450 25	74208 50	S288 210	LS181 75
CA3054 275	MS1534L 320	TC9109 750	7451 25	74209 50	S288 210	LS182 75
CA3055 275	MS1535L 320	TC9109 750	7452 25	74210 50	S288 210	LS183 75
CA3056 275	MS1536L 320	TC9109 750	7453 25	74211 50	S288 210	LS184 75
CA3057 275	MS1537L 320	TC9109 750	7454 25	74212 50	S288 210	LS185 75
CA3058 275	MS1538L 320	TC9109 750	7455 25	74213 50	S288 210	LS186 75
CA3059 275	MS1539L 320	TC9109 750	7456 25	74214 50	S288 210	LS187 75
CA3060 275	MS1540L 320	TC9109 750	7457 25	74215 50	S288 210	LS188 75
CA3061 275	MS1541L 320	TC9109 750	7458 25	74216 50	S288 210	LS189 75
CA3062 275	MS1542L 320	TC9109 750	7459 25	74217 50	S288 210	LS190 75
CA3063 275	MS1543L 320	TC9109 750	7460 25	74218 50	S288 210	LS191 75
CA3064 275	MS1544L 320	TC9109 750	7461 25	74219 50	S288 210	LS192 75
CA3065 275	MS1545L 320	TC9109 750	7462 25	74220 50	S288 210	LS193 75
CA3066 275	MS1546L 320	TC9109 750	7463 25	74221 50	S288 210	LS194 75
CA3067 275	MS15					

SWITCHES TOGGLE: 2A 250V SPST 35p DPDP 48p SUB-MIN TOGGLE SPST on/off 54p SPDT c/w/over 80p SPDT centre off 85p SPDT biased both ways 105p DPDT 1 way 75p DPDT centre off 85p DPDT biased both ways 145p DPDT 3 positions on/off 185p 3-pole 2 way 205p SLIDE 250V: DPDT 1A 14p DPDT 1A c/w/ 15p DPDT 7A 13p PUSHBUTTON 6A with 10mm Button SPDT latching 110p DPDT latching 180p SPDT moment 110p DPDT moment 180p Mini Non Locking Push to Make 15p Push to Break 25p ETI PROJECTS We stock most of the parts 	DIP SWITCHES (SPST) 4 way 85p; 6 way 80p; 8 way 85p; 10 way 125p (SPDT) 4 way 190p ROTARY SWITCHES (Adjustable Stop type) 1 pole/2 to 12 way 105p 4 way, 4 pole/2 to 4 way, 4 pole/2 to 4 way 48p ROTARY: Mains DP 250V 4 Amp on/off 85p ROTARY: (Make-switch) Make a multiway switch. Shafting assembly has adjustable stop. Accommodates up to 6 wafers (max. 6 pole/12 way + DP switch). Mechanism only 90p WAFERS: (make before break) to fit the above switch mechanism 1 pole/12 way, 2 pole/6 way, 3 pole/4 way, 4 pole/3 way, 6p/2Way 85p Mains DP 4A Switch to fit Spacers 4p. Screen 8p. ROCKER: 5A/250V SPST 28p ROCKER 10A/250V SPDT 38p ROCKER 10A/250V DPDT c/w/ 85p ROCKER 10A/250V DPST with neon 85p THUMBWHEEL Mini front mounting Decade Switch Module 250p B.C.D. Switch Module 278p Mounting Cheeks (per pair) 75p JUMPER LEADS (Ribbon Cable Assembly) Length 14 pin 16 pin 24 pin 40 pin Single ended DIP (Header Plug) Jumper 24 inches 145p 185p 240p 380p Double ended DIP (Header Plug) Jumper 6 inches 185p 205p 300p 485p 12 inches 195p 215p 315p 480p 24 inches 210p 235p 345p 540p 36 inches 290p 370p 480p 525p IDC Header Socket Jumper Leads 36" 20 pin 26 pin 34 pin 40 pin Single ended 180p 200p 280p 300p Double ended 290p 370p 480p 525p	VEROBOARD 0.1in 2 1/2 x 3 1/2 95p 2 1/2 x 5 110p 3 1/2 x 3 1/2 110p 3 1/2 x 5 125p 3 1/2 x 7 420p 4 1/2 x 17 45p Pkt of 100 pins 55p Pin spot cutter 150p Pin insertion tool 185p VERO WIRING PEN + spool 340p Spare spool 75p Combs 8p FERRIC CHLORIDE 1 lb bag Anhydrous 195p +50p p&p COPPER CLAD BOARDS Fibre Single Double S.P.B.P. S/Speed glass sided sided 9.5" x 8.5" 6" x 6" 100p 125p 110p 6" x 12" 175p 225p ULTRASONIC TRANSDUCER 40KHz 350p pr PROTO DECS Veroblock 405p S-Dec 395p Eurobreadboard 520p Binboard 1 575p Superstrip SS2 1350p DALO ETCH RESIST PEN Plus spare tip 100p	IDC CONNECTORS PCB Plugs Female Female with latch Header Card Pins Pins Plug Edge Strt Angle Strt Angle 10 way 90p 95p 85p 120p 16 way 130p 150p 110p 20 way 145p 165p 125p 185p 26 way 175p 200p 150p 240p 34 way 205p 235p 180p 320p 40 way 220p 250p 180p 340p 50 way 235p 270p 200p 395p 60 way — — 230p 495p EURO CONNECTORS Gold Flashed Female Socket Male Plug Contacts Strt Angle Strt Angle DIN41617 31 way 170p — — 175p DIN41612 2 x 32 A + B 275p 320p 220p 285p DIN41612 2 x 32 A + C 285p 340p 240p 300p DIN41612 3 x 32 A + B + C 380p 385p 280p 395p DIL PLUG (Header) Solder IDC 14 pin 40p 105p 16 pin 48p 105p 24 pin 66p 178p 28 pin 290p 395p 40 pin 250p 255p RIBBON CABLE price per foot Grey Color 10 way 15p 28p 16 way 25p 40p 20 way 30p 50p 24 way 40p 65p 34 way 60p 85p 40 way 70p 90p 50 way 100p 135p 64 way 120p 160p ZIF DIL SOCKETS 24 pin 855p 28 pin 785p 40 pin 785p 'D' CONNECTORS miniature 9 15 25 37 way way way way Male Solder lugs 80p 105p 180p 250p Angle pins 150p 210p 250p 355p PCB pins 120p 130p 195p 265p Female Solder lugs 105p 160p 200p 335p Angle pins 185p 215p 290p 440p PCB pins 150p 180p 240p 420p COVERS 80p 75p 75p 90p IDC 25 way 'D' Plug 385p; Socket 450p 25 way 'D' Connector (RS232) Jumper Lead Cable Assembly 18" long, Single end, Male 475p 18" long, Single end, Female 510p 36" long, Double Ended, M/M 90p 36" long, Double Ended, F/F £10 36" long, Double Ended, M/F 995p SPECIAL OFFER 2764-250 ns 399p	PANEL METERS FSD 80 x 46 x 35mm 0-100mA 0-500mA 0-1mA 0-5mA 0-10mA 0-50mA 0-100mA 0-500mA 0-5A 0.2A 0.25V 0.300V AC "S" "U" 490p each RELAYS Miniature, enclosed, PCB mount SINGLE POLE Changeover RL-91 205R Coil, 12V DC, (10V to 19.5V), 10A at 30V DC or 250V AC 195p DOUBLE POLE Changeover, 6A 30V DC or 250V AC RL-100 53R Coil, 5V DC, (5V to 9.9V) 190p RL-111 205R Coil, 12V DC (10V to 19.5V) 195p RL-114 740R Coil, 24V DC (22V to 37V) 200p AMPHENOL PLUGS IEEE 24 Way Centronics Parallel 36 Way solder 485p Centronics Parallel 36 Way IDC 480p Centronics 36 Way IDC Female 520p CRYSTALS 32.500MHz 100 100KHz 235 200KHz 285 455KHz 370 1MHz 275 1.008MHz 275 1.228MHz 250 1.6MHz 395 1.8MHz 395 1.8432M 200 2.0MHz 225 2.4576M 290 3.2768M 150 3.5794M 98 3.6864M 300 4.0MHz 150 4.032MHz 290 4.80MHz 200 4.19430M 200 4.433619M 100 5.0MHz 160 5.185MHz 300 5.24296M 390 6.0MHz 140 6.144MHz 150 6.5536MHz 225 7.0MHz 150 7.168MHz 250 7.328MHz 250 7.68MHz 150 8.0MHz 150 8.089333M 395 8.86723M 175 9.0MHz 175 10.74MHz 200 10.74MHz 150 12.0MHz 175 12.525M 200 14.31814M 170 16.0MHz 200 18.0MHz 180 18.432M 200 20.0MHz 200 24.0MHz 170 24.930MHz 325 26.69M 150 27.648M 170 27.1458M 180 38.6667M 175 48.00MHz 170 100.0MHz 295 116.0MHz 300 ASTEC UHF MODULATORS Standard 6MHz 325p Wideband 8MHz 450p BUZZERS miniature, solid-state 6V, 9V & 12V 70p PIEZO TRANSDUCERS PB270 55p LOUDSPEAKERS Miniature, 0.3W: 8 2in, 3/4in, 2 1/2in, 3in 2 1/2in 40, 64 or 80 80p MONITORS ● ZENITH — 12" Green, Hi-Resolution Popular £75 ● MICROVITEC 1431, 14" Colour RGB input. Connecting cable incl £215 ● KAGA 12". Med-res. RGB Colour. Has flicker-free character. Ideal for BBC, Apple, VIC, etc £219 (car £7) ● KAGA 12". As above but Hi-Resolution £259 (car £7) ● Connecting Lead for KAGA £5 BROTHER 8300 DAISY WHEEL PRINTER/TYPEWRITER This world famous printer connects directly to BBC Micro. Available from stock at ONLY £399 (car £7)
TRANSFORMERS 3-0-3V, 6-0-6V, 9-0-9V, 12-0-12V, 15-0-15V @ 100mA 98p pcb mounting, Miniature, Split Bobbin 3VA: 2x6V-0.25A; 2x9V-0.15A; 2x12V-0.12A; 2x15V-0.1A 200p 8VA: 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 200p 12VA: 2x4.5V-1.3A; 2x5V-1A; 2x9V-0.6A; 2x12V-0.5A; 2x15V-0.4A; 2x20V-0.3A 345p (35p p&p) 24VA: 2x9V-1.5A; 2x9V-1.2A; 2x12V-1A; 2x15V-0.8A; 2x20V-0.6A 385p (80p p&p) 80VA: 2x60V-4A; 2x90V-2.5A; 2x120V-2A; 2x150V-1.5A; 2x200V-1.2A; 2x250V-1A; 2x300V-0.8A 820p (80p p&p) Specialty wound for Multirait computer PSUs 50VA: Outputs +5V/5A, +12V, +5V, -5V, -12V at 1A 620p (80p p&p) 100VA: 2x12V-4A; 2x15V-3A; 2x20V-2.5A; 2x25V-2A; 2x30V-1.5A; 2x50V-1A 985p (75p p&p) P&P charge to be added over and above our normal postal charge	VOLTAGE REGULATORS 1A TO220 Plastic Casing +ve -ve 5V 7805 40p 7805 45p 12V 7812 40p 7812 40p 15V 7815 40p 7812 45p 18V 7818 40p 7815 45p 24V 7824 40p 7818 45p 7924 45p 100mA TO92 Plastic package: 5V 78L05 30p 78L05 50p 6V 78L06 30p — — 8V 78L08 30p — — 12V 78L12 30p — — 15V 78L15 50p 79L12 50p 79L15 60p ALUM BOXES 3 x 2 x 1 85p 4 x 2 x 2 100p 4 x 2 x 2 103p 4 x 4 x 2 105p 4 x 4 x 2 120p 5 x 4 x 1 90p 5 x 4 x 2 120p 5 x 2 x 1 90p 5 x 2 x 2 130p 6 x 4 x 2 120p 5 x 4 x 3 150p 7 x 5 x 3 180p 8 x 6 x 3 210p 10 x 4 x 3 240p 10 x 7 x 3 275p 12 x 5 x 3 280p 12 x 8 x 3 295p SOLDERCON PINS Ideal for making SIL or DIL Sockets 100 pins 75p 500 pins 350p SIL SOCKET 0.1" pitch, 20 way 80p x825W 530p Heat Stand 30p	VEROBOARD 0.1in 2 1/2 x 3 1/2 95p 2 1/2 x 5 110p 3 1/2 x 3 1/2 110p 3 1/2 x 5 125p 3 1/2 x 7 420p 4 1/2 x 17 45p Pkt of 100 pins 55p Pin spot cutter 150p Pin insertion tool 185p VERO WIRING PEN + spool 340p Spare spool 75p Combs 8p FERRIC CHLORIDE 1 lb bag Anhydrous 195p +50p p&p COPPER CLAD BOARDS Fibre Single Double S.P.B.P. S/Speed glass sided sided 9.5" x 8.5" 6" x 6" 100p 125p 110p 6" x 12" 175p 225p ULTRASONIC TRANSDUCER 40KHz 350p pr PROTO DECS Veroblock 405p S-Dec 395p Eurobreadboard 520p Binboard 1 575p Superstrip SS2 1350p DALO ETCH RESIST PEN Plus spare tip 100p	IDC CONNECTORS PCB Plugs Female Female with latch Header Card Pins Pins Plug Edge Strt Angle Strt Angle 10 way 90p 95p 85p 120p 16 way 130p 150p 110p 20 way 145p 165p 125p 185p 26 way 175p 200p 150p 240p 34 way 205p 235p 180p 320p 40 way 220p 250p 180p 340p 50 way 235p 270p 200p 395p 60 way — — 230p 495p EURO CONNECTORS Gold Flashed Female Socket Male Plug Contacts Strt Angle Strt Angle DIN41617 31 way 170p — — 175p DIN41612 2 x 32 A + B 275p 320p 220p 285p DIN41612 2 x 32 A + C 285p 340p 240p 300p DIN41612 3 x 32 A + B + C 380p 385p 280p 395p DIL PLUG (Header) Solder IDC 14 pin 40p 105p 16 pin 48p 105p 24 pin 66p 178p 28 pin 290p 395p 40 pin 250p 255p RIBBON CABLE price per foot Grey Color 10 way 15p 28p 16 way 25p 40p 20 way 30p 50p 24 way 40p 65p 34 way 60p 85p 40 way 70p 90p 50 way 100p 135p 64 way 120p 160p ZIF DIL SOCKETS 24 pin 855p 28 pin 785p 40 pin 785p 'D' CONNECTORS miniature 9 15 25 37 way way way way Male Solder lugs 80p 105p 180p 250p Angle pins 150p 210p 250p 355p PCB pins 120p 130p 195p 265p Female Solder lugs 105p 160p 200p 335p Angle pins 185p 215p 290p 440p PCB pins 150p 180p 240p 420p COVERS 80p 75p 75p 90p IDC 25 way 'D' Plug 385p; Socket 450p 25 way 'D' Connector (RS232) Jumper Lead Cable Assembly 18" long, Single end, Male 475p 18" long, Single end, Female 510p 36" long, Double Ended, M/M 90p 36" long, Double Ended, F/F £10 36" long, Double Ended, M/F 995p SPECIAL OFFER 2764-250 ns 399p	PANEL METERS FSD 80 x 46 x 35mm 0-100mA 0-500mA 0-1mA 0-5mA 0-10mA 0-50mA 0-100mA 0-500mA 0-5A 0.2A 0.25V 0.300V AC "S" "U" 490p each RELAYS Miniature, enclosed, PCB mount SINGLE POLE Changeover RL-91 205R Coil, 12V DC, (10V to 19.5V), 10A at 30V DC or 250V AC 195p DOUBLE POLE Changeover, 6A 30V DC or 250V AC RL-100 53R Coil, 5V DC, (5V to 9.9V) 190p RL-111 205R Coil, 12V DC (10V to 19.5V) 195p RL-114 740R Coil, 24V DC (22V to 37V) 200p AMPHENOL PLUGS IEEE 24 Way Centronics Parallel 36 Way solder 485p Centronics Parallel 36 Way IDC 480p Centronics 36 Way IDC Female 520p CRYSTALS 32.500MHz 100 100KHz 235 200KHz 285 455KHz 370 1MHz 275 1.008MHz 275 1.228MHz 250 1.6MHz 395 1.8MHz 395 1.8432M 200 2.0MHz 225 2.4576M 290 3.2768M 150 3.5794M 98 3.6864M 300 4.0MHz 150 4.032MHz 290 4.80MHz 200 4.19430M 200 4.433619M 100 5.0MHz 160 5.185MHz 300 5.24296M 390 6.0MHz 140 6.144MHz 150 6.5536MHz 225 7.0MHz 150 7.168MHz 250 7.328MHz 250 7.68MHz 150 8.0MHz 150 8.089333M 395 8.86723M 175 9.0MHz 175 10.74MHz 200 10.74MHz 150 12.0MHz 175 12.525M 200 14.31814M 170 16.0MHz 200 18.0MHz 180 18.432M 200 20.0MHz 200 24.0MHz 170 24.930MHz 325 26.69M 150 27.648M 170 27.1458M 180 38.6667M 175 48.00MHz 170 100.0MHz 295 116.0MHz 300 ASTEC UHF MODULATORS Standard 6MHz 325p Wideband 8MHz 450p BUZZERS miniature, solid-state 6V, 9V & 12V 70p PIEZO TRANSDUCERS PB270 55p LOUDSPEAKERS Miniature, 0.3W: 8 2in, 3/4in, 2 1/2in, 3in 2 1/2in 40, 64 or 80 80p MONITORS ● ZENITH — 12" Green, Hi-Resolution Popular £75 ● MICROVITEC 1431, 14" Colour RGB input. 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BF342	38p	MJ15028	9.2p		
BF343	38p	MJ15029	9.2p		
BF344	38p	MJ15030	9.2p		
BF345	38p	MJ15031	9.2p		
BF346	38p	MJ15032	9.2p		
BF347	38p	MJ15033	9.2p		
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BF349	38p	MJ15035	9.2p		
BF350	38p	MJ15036	9.2p		
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BF354	38p	MJ15040	9.2p		
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BF393	38p	MJ15079	9.2p		
BF394	38p	MJ15080	9.2p		
BF395	38p	MJ15081	9.2p		
BF396	38p	MJ15082	9.2p		
BF397	38p	MJ15083	9.2p		
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BF399	38p	MJ15085	9.2p		
BF400	38p	MJ15086	9.2p		
BF401	38p	MJ15087	9.2p		
BF402	38p	MJ15088	9.2p		
BF403	38p	MJ15089	9.2p		
BF404	38p	MJ15090	9.2p		
BF405	38p	MJ15091	9.2p		
BF406	38p	MJ15092	9.2p		
BF407	38p	MJ15093	9.2p		
BF408	38p	MJ15094	9.2p		
BF409	38p	MJ15095	9.2p		
BF410	38p	MJ15096	9.2p		
BF411	38p	MJ15097	9.2p		
BF412	38p	MJ15098	9.2p		
BF413	38p	MJ15099	9.2p		
BF414	38p	MJ15100	9.2p		
BF415	38p	MJ15101	9.2p		
BF416	38p	MJ15102	9.2p		
BF417	38p	MJ15103	9.2p		
BF418	38p	MJ15104	9.2p		
BF419	38p	MJ15105	9.2p		
BF420	38p	MJ15106	9.2p		
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BF422	38p	MJ15108	9.2p		
BF423	38p	MJ15109	9.2p		
BF424	38p	MJ15110	9.2p		
BF425	38p	MJ15111	9.2p		
BF426	38p	MJ15112	9.2p		
BF427	38p	MJ15113	9.2p		
BF428	38p	MJ15114	9.2p		
BF429	38p	MJ15115	9.2p		
BF430	38p	MJ15116	9.2p		
BF431	38p	MJ15117	9.2p		
BF432	38p	MJ15118	9.2p		
BF433	38p	MJ15119	9.2p		
BF434	38p	MJ15120	9.2p		
BF435	38p	MJ15121	9.2p		
BF436	38p	MJ15122	9.2p		
BF437	38p	MJ15123	9.2p		
BF438	38p	MJ15124	9.2p		
BF439	38p	MJ15125	9.2p		
BF440	38p	MJ15126	9.2p		
BF441	38p	MJ15127	9.2p		
BF442	38p	MJ15128	9.2p		
BF443	38p	MJ15129	9.2p		
BF444	38p	MJ15130	9.2p		
BF445	38p	MJ15131	9.2p		
BF446	38p	MJ15132	9.2p		
BF447	38p	MJ15133	9.2p		
BF448	38p	MJ15134	9.2p		
BF449	38p	MJ15135	9.2p		
BF450	38p	MJ15136	9.2p		
BF451	38p	MJ15137	9.2p		
BF452	38p	MJ15138	9.2p		
BF453	38p	MJ15139	9.2p		
BF454	38p	MJ15140	9.2p		
BF455	38p	MJ15141	9.2p		
BF456	38p	MJ15142	9.2p		
BF457	38p	MJ15143	9.2p		
BF458	38p	MJ15144	9.2p		
BF459	38p	MJ15145	9.2p		
BF460	38p	MJ15146	9.2p		
BF461	38p	MJ15147	9.2p		
BF462	38p	MJ15148	9.2p		
BF463	38p	MJ15149	9.2p		
BF464	38p	MJ15150	9.2p		
BF465	38p	MJ15151	9.2p		
BF466	38p	MJ15152	9.2p		
BF467	38p	MJ15153	9.2p		
BF468	38p	MJ15154	9.2p		
BF469	38p	MJ15155	9.2p		
BF470	38p	MJ15156	9.2p		
BF471	38p	MJ15157	9.2p		
BF472	38p	MJ15158	9.2p		
BF473	38p	MJ15159	9.2p		
BF474	38p	MJ15160	9.2p		
BF475	38p	MJ15161	9.2p		
BF476	38p	MJ15162	9.2p		
BF477	38p	MJ15163	9.2p		
BF478	38p	MJ15164	9.2p		
BF479	38p	MJ15165	9.2p		
BF480	38p	MJ15166	9.2p		
BF481	38p	MJ15167	9.2p		
BF482	38p	MJ15168	9.2p		
BF483	38p	MJ15169	9.2p		
BF484	38p	MJ15170	9.2p		
BF485	38p	MJ15171	9.2p		
BF486	38p	MJ15172	9.2p		
BF487	38p	MJ15173	9.2p		
BF488	38p	MJ15174	9.2p		
BF489	38p	MJ15175	9.2p		
BF490	38p	MJ15176	9.2p		
BF491	38p	MJ15177	9.2p		
BF492	38p	MJ15178	9.2p		
BF493	38p	MJ15179	9.2p		
BF494	38p	MJ15180	9.2p		
BF495	38p	MJ15181	9.2p		
BF496	38p	MJ15182	9.2p		
BF497	38p	MJ15183	9.2p		
BF498	38p	MJ15184	9.2p		
BF499	38p	MJ15185	9.2p		
BF500	38p	MJ15186	9.2p		
BF501	38p	MJ15187	9.2p		
BF502	38p	MJ15188	9.2p		
BF503	38p	MJ15189	9.2p		
BF504	38p	MJ15190	9.2p		
BF505	38p	MJ15191	9.2p		
BF506	38p	MJ15192	9.2p		
BF507	38p	MJ15193	9.2p		
BF508	38p	MJ15194	9.2p		
BF509	38p	MJ15195	9.2p		
BF510	38p	MJ15196	9.2p		
BF511	38p	MJ15197	9.2p		
BF512	38p	MJ15198	9.2p		
BF513	38p	MJ15199	9.2p		
BF514	38p	MJ15200	9.2p		
BF515	38p	MJ15201	9.2p		
BF516	38p	MJ15202	9.2p		
BF517	38p	MJ15203	9.2p		
BF518	38p	MJ15204	9.2p		
BF519	38p	MJ15205	9.2p		
BF520	38p	MJ15206	9.2p		
BF521	38p	MJ15207	9.2p		
BF522	38p	MJ15208	9.2p		
BF523	38p	MJ15209	9.2p		
BF524	38p	MJ15210	9.2p		
BF525	38p	MJ15211	9.2p		
BF526	38p	MJ15212	9.2p		
BF527	38p	MJ15213	9.2p		
BF528	38p	MJ15214	9.2p		
BF529	38p	MJ15215	9.2p		
BF530	38p	MJ15216	9.2p		
BF531	38p	MJ15217	9.2p		
BF532	38p	MJ15218	9.2p		
BF533	38p	MJ15219	9.2p		
BF534	38p	MJ15220	9.2p		
BF535	38p	MJ15221	9.2p		
BF536	38p	MJ15222	9.2p		
BF537	38p	MJ15223	9.2p		
BF538	38p	MJ15224	9.2p		
BF539	38p	MJ15225	9.2p		
BF540	38p	MJ15226	9.2p		
BF541	38p	MJ15227	9.2p		
BF542	38p	MJ15228	9.2p		
BF543	38p	MJ15229	9.2p		
BF544	38p	MJ15230	9.2p		
BF545	38p	MJ15231	9.2p		
BF546	38p	MJ15232	9.2p		
BF547	38p	MJ15233	9.2p		
BF548	38p	MJ15234	9.2p		
BF549	38p	MJ15235	9.2p		
BF550	38p	MJ15236	9.2p		
BF551	38p				

**NEXT
MONTH**

AN ARGUS SPECIALIST PUBLICATION

electronics today

INTERNATIONAL

CABLE TELEVISION — ALL IT'S SUPPOSED TO BE?

A couple of years ago, cable television was described as a 'licence to print money' — exactly the same description that was applied to commercial television. Now the picture doesn't look nearly so bright. ETI will have a special report on cable television, taking the technical and financial issues that are deciding the future of our entertainment.

STEREO POWER METER

This device will give you a true indication of power, as it measures the current going to the load and multiplies it by the voltage to obtain the power — none of these cheats where you measure just the voltage and hope the impedance is what it says on the case! And once you know the power, and you've measured the voltage, you could work out the

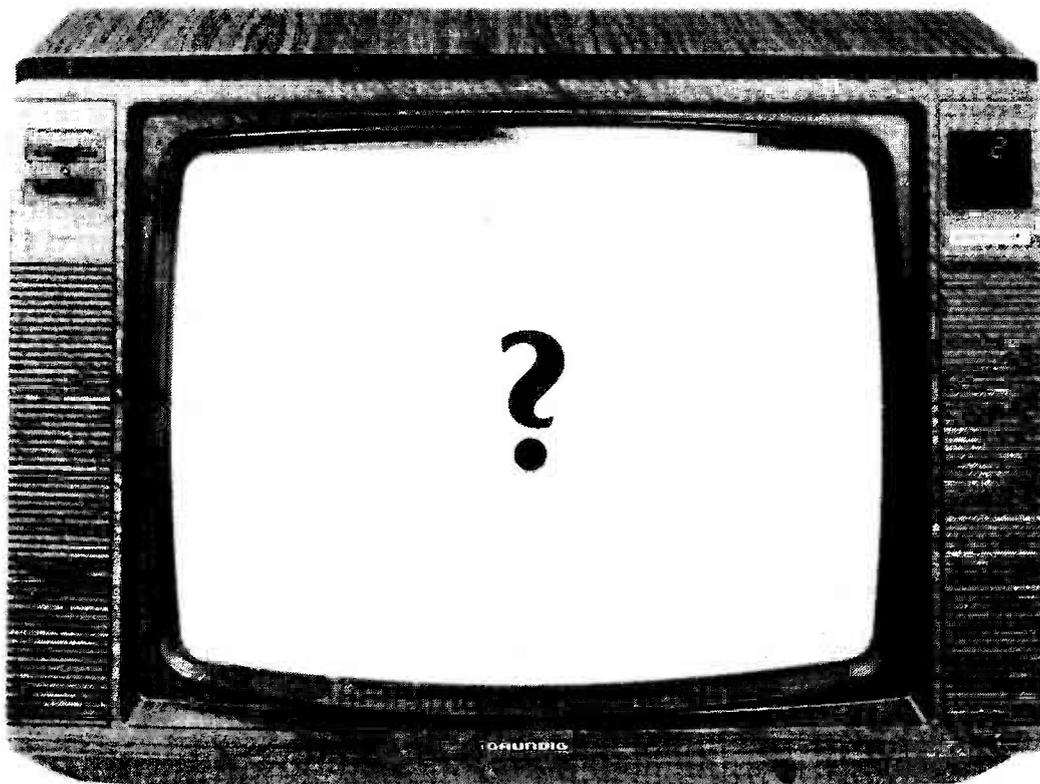
impedance. If you can also measure the current, you can then work out the phase angle as well . . .

Z80 DRAM CARD

Following on from this month's article on how to replace one set of DRAMs with a larger capacity set still within an existing system, here is a whole board full of memory, all for your Z80 system.

COMPLEX NUMBERS

Complex numbers are not as complicated as you think — in fact, once you get over your initial trepidation, you'll find that they make circuit calculations very much easier than they ever are by other means!



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

THE NEW MPF1 PLUS...



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The MPF1 PLUS incorporates the Z80 – the most widely used 8-bit microprocessor in the world, to form a Single Board Computer (SBC). Packed in a plastic bookcase together with three comprehensive manuals and power supply (to BS3651 standard), the MPF1 PLUS is a microprocessor learning tool for every application.

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Teaching you in a step-by-step method the MPF1 PLUS helps the user fully understand the Software and Hardware of a microprocessor easily and conveniently – as opposed to micro-computers that aim to teach high-level languages instead of microprocessor systems fundamentals.

Not only is the MPF1 PLUS a teaching tool but with the available accessories it can also be used as a low-cost development tool or simply for OEMs.

THE MPF1 PLUS

Just look at the specification:-

Technical Specification

CPU: Z80A – 158 instructions

Software:

- Z80/8080/8085 machine code
- Z80 Assembler, line and 2 pass.
- 8K BASIC interpreter (Extra)
- 8K FORTH (Extra)

ROM: 8K Monitor (full listing and comments)

RAM: 4K CMOS (2 x 6116)

Input/Output: 48 system I/O lines

Speaker: 2.25" coned linear

Display: 20 character 14 segment green phosphorescent

Expansion:

- Socket for 8K ROM
- Cassette interface
- Connectors 40 way, complete CPU bus

Keyboard: 49 key. Full "QWERTY" real movement good tactile feedback

Batteries: 4 x U11 for memory back-up (batteries not included)

Serial Interface: 165 baud for read/write via audio cassette

Manuals

1. User's Manual. 8 chapters.
 1. Over view and Installation.
 2. Specification (hardware and software).
 3. Description of Operation.
 4. Operating the MPF-1 Plus.
 5. 44 Useful Sub-Routines.
 6. The Text Editor.
 7. Assembler and Disassembler.
 8. System Hardware Configuration.
2. Experiment Manual. 16 experiments.
3. Monitor Program Source Listing with full commenting.
4. Also available the MPF-1 Plus Student Work Book (self-learning text).

Accessories

- **PRT-MPF-1P:** 20 character printer. Ready to plug in. Memory dump.
- **EPB-MPF-1P:** Copy/list/verify 1K/2K/4K/8K ROMs. Ready to plug in.
- **SSB-MPF-1P:** Speech Synthesizer. Inc. 20 words and clock program. 1200 words available.
- **SGB-MPF-1P:** Sound Synthesizer Board.
- **IO - MPF-1P:** Input/output board

Yes! I now realise that I need an MPF1 PLUS and that it is the lowest cost Z80 SBC available with all these features.

I enclose £165.00 (£140.00 + £21 VAT plus £4 carriage). Overseas P.O.A.

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COMTECH ELECTRONICS

TRANSISTORS				THYRISTORS				CMOS				CPU IC's				VOLTAGE REGULATORS			
BC 107B 12p	BC 546 10p	BF 195 12p	MPSA 55 20p	2N2907A 25p	C 105D 7p	4000 14p	40162 52p	6800 395p	Positive				100mA						
BC 108C 12p	BC 546B 10p	BF 196 12p	MPSA 56 20p	2N3053 23p	C 116D 7p	4001 14p	40163 52p	6802 550p	78L05 30p				78L12 30p						
BC 109C 10p	BC 547B 9p	BF 197 12p	MPSA 63 22p	2N3054 56p	C 126D 9p	4002 14p	4501 16p	6808 520p	78L15 30p				78L30 30p						
BC 113/4 17p	BC 548B 9p	BF 198 10p	MPSA 64 22p	2N3055 50p	C 126M 9p	4006 50p	4502 55p	6810 250p	78L20 30p				78L24 25p						
BC 115/6 17p	BC 548C 9p	BF 199 12p	MPSA 92 24p	2N3055H 75p	MCR 101 30p	4007 16p	4503 34p	6820 250p	78L35 30p				78L40 30p						
BC 119 28p	BC 549C 9p	BF 200 40p	MPSA 93 24p	2N3440 58p	MCR 102 34p	4008 50p	4504 98p	6821 190p	78L38 30p				78L48 45p						
BC 139 32p	BC 550C 10p	BF 224 15p	TIP 29A 30p	2N3441 120p	T 2800D 110p	4011 14p	4506 70p	6840 595p	78L50 30p				78L54 45p						
BC 140 28p	BC 556 10p	BF 244C 22p	TIP 29C 33p	2N3442 120p	T 2800M 165p	4012 15p	4508 145p	6850 180p	78L55 30p				78L62 45p						
BC 141 29p	BC 556B 10p	BF 245 25p	TIP 29C 33p		2N4443 120p	4013 24p	4510 50p	6852 360p	1 A TO220				7805 40p						
BC 142 27p	BC 557B 9p	BF 256C 32p	TIP 30A 30p	2N3702 10p	2N4444 130p	4014 54p	4511 52p	6880 140p	7808 40p				7812 40p						
BC 143 27p	BC 557C 9p	BF 256L 35p	TIP 30B 33p	2N3703 10p	2N5060 23p	4015 46p	4512 48p	6885 130p	7815 40p				7818 40p						
BC 160 30p	BC 558B 9p	BF 257 32p	TIP 30C 36p	2N3704 10p	2N5061 24p	4016 24p	4513 98p	6889 140p	7824 40p				7824 40p						
BC 161 32p	BC 558C 9p	BF 258 32p	TIP 31A 33p	2N3705 10p	2N5062 29p	4017 42p	4514 110p	6800 POA	7824 40p				7824 40p						
BC 169C 8p	BC 559C 9p	BF 259 35p	TIP 31B 35p	2N3706 10p	2N5064 32p	4018 47p	4516 55p	8T26A 120p	7824 40p				7824 40p						
BC 171B 9p	BC 560C 10p	BF 336 36p	TIP 31C 37p	2N3707 10p		4019 30p	4517 180p	8T28 140p	7824 40p				7824 40p						
BC 172C 9p	BC 637 20p	BF 337 39p	TIP 32A 33p	2N3708 10p		4020 46p	4518 52p	8T95 140p	7824 40p				7824 40p						
BC 173C 9p	BC 638 20p	BF 338 40p	TIP 32B 35p	2N3771 150p		4021 42p	4520 55p	8T97 140p	7824 40p				7824 40p						
BC 177B 15p	BC 639 22p	BF 457 32p	TIP 32C 37p	2N3772 170p		4022 46p	4522 65p	8T98 140p	7824 40p				7824 40p						
BC 178C 15p	BC 640 24p	BF 458 32p	TIP 33A 55p	2N3773 190p		4023 14p	4526 64p	8080A 400p	7824 40p				7824 40p						
BC 179 15p	BCY 70 18p	BF 459 37p	TIP 34A 60p	2N3819 20p		4024 38p	4528 56p	8085A 500p	7824 40p				7824 40p						
BC 182 9p	BCY 71 19p	BF 494 12p	TIP 41A 46p	2N3823 50p		4025 14p	4529 72p	8156C 600p	7824 40p				7824 40p						
BC 182B 9p	BCY 72 17p	BF 595 16p	TIP 41C 60p	2N3866 95p		4026 84p	4530 92p	8212C 198p	7824 40p				7824 40p						
BC 193B 9p	BD 115 50p	BF 596 20p	TIP 42A 46p	2N3903 10p		4027 29p	4531 70p	8216C 140p	7824 40p				7824 40p						
BC 183C 9p	BD 131 45p	BFX 29 28p	TIP 42C 60p	2N3904 10p		4028 42p	4532 88p	8224C 220p	7824 40p				7824 40p						
BC 184B 9p	BD 132 48p	BFX 30 28p	TIP 110 45p	2N3905 10p		4029 48p	4541 70p	8228C 450p	7824 40p				7824 40p						
BC 184C 9p	BD 133 70p	BFX 84 28p	TIP 115 45p	2N3906 10p		4030 18p	4544 120p	8251AC 495p	7824 40p				7824 40p						
BC 212 9p	BD 135 30p	BFX 85 28p	TIP 120 70p	2N4030 30p		4035 56p	4551 88p	8253AC 800p	7824 40p				7824 40p						
BC 212B 9p	BD 136 30p	BFX 87 27p	TIP 121 70p	2N4033 30p		4040 48p	4553 180p	8257C 750p	7824 40p				7824 40p						
BC 213B 9p	BD 137 30p	BFX 88 23p	TIP 122 70p	2N4037 40p		4041 48p	4554 148p	8259C 900p	7824 40p				7824 40p						
BC 213C 9p	BD 138 35p	BFY 50 23p	TIP 126 70p	2N4058 10p		4042 42p	4555 48p	8288 £16	7824 40p				7824 40p						
BC 214B 9p	BD 139 35p	BFY 51 22p	TIP 127 70p	2N4059 10p		4043 44p	4556 48p	TMS9980A£22	7824 40p				7824 40p						
BC 214C 9p	BD 140 35p	BFY 52 22p	TIP 2955 70p	2N4060 10p		4044 44p	4557 160p	TMS9981N£25	7824 40p				7824 40p						
BC 237 7p	BD 203 70p	BSY 95A 23p	TIP 3055 70p	2N4061 10p		4045 45p	4558 110p	TMS9901N£90	7824 40p				7824 40p						
BC 238 9p	BD 204 70p	RU 205 140p	TIS 44 20p	2N4062 10p		4048 30p	4559 390p	TMS9902N£50	7824 40p				7824 40p						
BC 239 9p	BD 205 70p	BU 206 190p	TIS 90 24p	2N4063 10p		4049 25p	4560 170p	Z80A 4M 380p	7824 40p				7824 40p						
BC 251 9p	BD 206 70p	BU 208 140p	TIS 92 20p	2N4400 15p		4050 25p	4566 120p	Z80A P10350p	7824 40p				7824 40p						
BC 300 36p	BD 239A 40p	MJ 2500 230p	2N1613 30p	2N4401 15p		4051 25p	4568 270p	Z80A DMA £5	7824 40p				7824 40p						
BC 301 32p	BD 239C 40p	MJ 2501 245p	2N1711 30p	2N4402 15p		4052 52p	4569 140p	Z80A P10350p	7824 40p				7824 40p						
BC 302 32p	BD 240A 42p	MJ 2955 90p	2N1893 30p	2N4403 15p		4053 28p	4572 42p	Z80A 4M 380p	7824 40p				7824 40p						
BC 303 32p	BD 240C 50p	MJ 3000 210p	2N2218 24p	2N4404 15p		4054 28p	4573 198p	Z80A P10350p	7824 40p				7824 40p						
BC 304 32p	BD 241A 42p	MJ 3001 225p	2N2218A 25p	2N4405 15p		4055 28p	4574 198p	Z80A DMA £5	7824 40p				7824 40p						
BC 307 10p	BD 241C 42p	MJE 340 48p	2N2219 24p	2N4406 15p		4056 28p	4575 198p	Z80A P10350p	7824 40p				7824 40p						
BC 308 10p	BD 242A 54p	MJE 350 70p	2N2219A 25p	2N4407 15p		4057 28p	4576 198p	Z80A DMA £5	7824 40p				7824 40p						
BC 309 10p	BD 242C 54p	MJE 370 80p	2N2221A 20p	2N4408 15p		4058 28p	4577 198p	Z80A P10350p	7824 40p				7824 40p						
BC 327 12p	BD 243A 55p	MJE 371 84p	2N2222 18p	2N4409 15p		4059 28p	4578 198p	Z80A DMA £5	7824 40p				7824 40p						
BC 328 12p	BD 243C 68p	MJE 520 60p	2N2222A 20p	2N4410 15p		4060 28p	4579 198p	Z80A P10350p	7824 40p				7824 40p						
BC 337 12p	BD 244A 64p	MJE 521 60p	2N2368 23p	2N4411 15p		4061 28p	4580 280p	Z80A DMA £5	7824 40p				7824 40p						
BC 338 12p	BD 244C 78p	MJE 2955 80p	2N2369A 15p	2N4412 15p		4062 28p	4581 280p	Z80A P10350p	7824 40p				7824 40p						
BC 413C 10p	BF 180 30p	MJE 3055 68p	2N2484 24p	2N4413 15p		4063 28p	4582 38p	Z80A DMA £5	7824 40p				7824 40p						
BC 414C 10p	BF 181 30p	MPSA 05 20p	2N2646 48p	2N4414 15p		4064 28p	4583 74p	Z80A P10350p	7824 40p				7824 40p						
BC 415C 10p	BF 182 30p	MPSA 06 20p	2N2904 22p	2N4415 15p		4065 28p	4584 38p	Z80A DMA £5	7824 40p				7824 40p						
BC 416C 10p	BF 183 30p	MPSA 12 22p	2N2904A 23p	2N4416 15p		4066 28p	4585 74p	Z80A P10350p	7824 40p				7824 40p						
BC 477 25p	BF 184 30p	MPSA 13 22p	2N2905 23p	2N4417 15p		4067 28p	4586 74p	Z80A DMA £5	7824 40p				7824 40p						
BC 478 23p	BF 185 30p	MPSA 42 23p	2N2906A 22p	2N4418 15p		4068 28p	4587 74p	Z80A P10350p	7824 40p				7824 40p						
BC 479 24p	BF 194 12p	MPSA 43 23p	2N2907 23p	2N4419 15p		4069 28p	4588 74p	Z80A DMA £5	7824 40p				7824 40p						

LINEAR IC's				CAPACITORS				DIODES				RESISTORS				HARDWARE																																	
CA 3046 72p	LM 565 100p	SAA5041 £25	Electrolytic radial/axial.	AA 119 9p	1/2 Watt Carbon film 5% E24 series 4 7 R.	4xTO3 mounting kits 23p	64mm Loudspeakers 8R70p	4xTO66 mounting kits 23p	64R 78p each	300mW rating	5 x TO126 bushes/washers 18p	PP3 battery snaps 6p each	10xTO220 bushes/washers 28p	4xHP7 battery holder 22p	5 x TO3P bushes/washers 18p	6xHP7 battery holder 32p	20mm panel fuseholder 32p	20mm panel fuseholder 32p	20mm chassis fuseholder 7p	4mm plug 12p	4mm sockets 20p	4mm insulated terminals 30p	3.5mm jack socket 15p	3.5mm jack plug 15p	Phono sockets 15p	Switches: miniature toggle, SPST 60p	SPDT 68p	DPDT 78p	each	Miniature push buttons: 1A/250V push to make 16p	push to break 23p	Midget rotary switches, pcb terminals 2P6W, 4P3W, 3P4W 35p each	Slide switch 1A/250V DPDT (22 x 12 x 8mm) 16p																
CA 3065 190p	LM 567 150p	SAA5050 £10	Tantalum bead.	BAX 13 5p	2M2 1p each	20mm per 100, one value only, 280p per 100 mixed values.	25 Watt wire-wound OR22-10 ohms E12 series 25p each.	Presets: miniature horizontal & vertical 9p each	100R-500K	CP100 60 IC sockets, 8, 14, and 16 pin 20 of each	440p	CP101 20 BC182/BC212 transistors, 10 of each	130p	CP102 20 BC183/BC213 transistors, 10 of each	130p	CP103 20 BC184/BC214 transistors, 10 of each	130p	CP104 20 BC549C/BC559C transistors, 10 of each	130p	CP105 20 BC560C/BC560D transistors, 10 of each	160p	CP106 100 1N914 switching diodes, 75-100V/75mA 240p	CP107 100 1N914 switching diodes, 75-100V/75mA 280p	CP108 100 1N4148 switching diodes, 75-100V/75mA 170p	CP109 500 1N4148 switching diodes, 75-100V/75mA 750p	CP110 30 1N4002 1A/400V rectifiers	100p	CP111 10 MC1458 Dual op amps (741 type)	320p	CP112 100 400mW zeners, 4 of each 2V7 to 33V	450p	CP113 100 1.3W zeners, 4 of each 4V7 to 51V	850p	CP114 4 LF351 JFET op amps, Low noise	170p	CP115 4 LF353 JFET op amps, dual low noise	300p	CP117 50 mixed LED's 3mm/5mm/rect/red/green/yellow	400p	CP119 100 1N4002 1A/100V rectifiers	270p	CP120 10 C106D 400V/4A thyristors	250p	CP121 10 NE556 dual timer IC's	400p	CP124 100 mixed electrolytic capacitors 10-63V/1-1000µF	£6	CP125 5 LM317T 1A/TO220 variable regulators	440p
CA 3086 56p	LM 710 70p	SL490 300p	Value/V price	OA 47 9p	1/2 Watt Carbon film 5% E24 series 4 7 R.	CP126 100 1N4148 switching diodes, 75-100V/75mA 170p	CP127 100 1N4148 switching diodes, 75-100V/75mA 170p	CP128 100 1N4148 switching diodes, 75-100V/75mA 170p	CP129 100 1N4148 switching diodes, 75-100V/75mA 170p	CP130 100 1N4148 switching diodes, 75-100V/75mA 170p	CP131 100 1N4148 switching diodes, 75-100V/75mA 170p	CP132 100 1N4148 switching diodes, 75-100V/75mA 170p	CP133 100 1N4148 switching diodes, 75-100V/75mA 170p	CP134 100 1N4148 switching diodes, 75-100V/75mA 170p	CP135 100 1N4148 switching diodes, 75-100V/75mA 170p	CP136 100 1N4148 switching diodes, 75-100V/75mA 170p	CP137 100 1N4148 switching diodes, 75-100V/75mA 170p	CP138 100 1N4148 switching diodes, 75-100V/75mA 170p	CP139 100 1N4148 switching diodes, 75-100V/75mA 170p	CP140 100 1N4148 switching diodes, 75-100V/75mA 170p	CP141 100 1N4148 switching diodes, 75-100V/75mA 170p	CP142 100 1N4148 switching diodes, 75-100V/75mA 170p	CP143 100 1N4148 switching diodes, 75-100V/75mA 170p	CP144 100 1N4148 switching diodes, 75-100V/75mA 170p	CP145 100 1N4148 switching diodes, 75-100V/75mA 170p	CP146 100 1N4148 switching diodes, 75-100V/75mA 170p	CP147 100 1N4148 switching diodes, 75-100V/75mA 170p	CP148 100 1N4148 switching diodes, 75-100V/75mA 170p	CP149 100 1N4148 switching diodes, 75-100V/75mA 170p	CP150 100 1N4148 switching diodes, 75-100V/75mA 170p	CP151 10																		

DIGEST



Portable Projection TV

For those who find Clive Sinclair's 2" marvel a mite too small, Matsushita might just have the answer. Their latest addition to the portable TV market is a fold-flat projection colour television with a 6.5" screen.

The TV has been developed

from Matsushita's large screen projection systems and uses three 5cm projection tubes for red, green and blue instead of the single CRT found in conventional TVs. When folded for carrying it measures 250 x 85 x 310 mm and it weighs just 3 kg, about half the size and weight of currently available 7" screen televisions. It is also claimed to use only about a third as much power.

Matsushita have released very

little other information on the new TV and when we telephoned their UK press office they stressed that there are no plans as yet to introduce it here at all. Disappointed would-be purchasers will have to make do with either a Sinclair and a magnifying glass or a conventional 7" TV and a body-building course.

Also new from Matsushita is a more normally-sized TV (screen size is not stated) which is described as digital and multi-functional. Again, very little information is given on the circuitry, etc, but it apparently incorporates a microprocessor and several other LSI devices and thereby reduces the component count by 30% compared with conventional sets. Features include an 11-bit digital remote infra-red control unit which is theoretically capable of controlling up to 2,048 functions, allowing it to cope with additions such as a VTR, video disc, personal computer, etc. The set is equipped to handle Viewdata and Teletext and incorporates a special facility whereby a picture from one source may be inserted into a larger main picture, allowing simultaneous viewing of, for example, a programme and an information service. As with the projection TV, Matsushita say they have no plans to introduce the new model into the UK as yet. National Panasonic UK Ltd, 300-318 Bath Road, Slough, Berks S11 6JB, tel Slough 34522.



Spaghetti Eater

If your office, workbench, or audio system is fast being swallowed up by a writhing mass of unidentified cables, Inmac's new cable tidies could be just what you need. Not only do they neatly group cables into bundles, they also allow you to indicate each cable's function, making it instantly identifiable.

The ties are available in both permanent and releasable form, and will hold up to six cables in a 35mm diameter bunch. They cost £5.00 for a packet of 35. A releasable tie is also available with a self-adhesive pad so that a bundle of cables may be secured to any suitable surface. This type secures three or more cables in a bundle of up to 19mm diameter and costs £5.50 for a pack of six. Lastly, there are identity ties, small ties which attach permanently to an individual cable and which have a 25mm wide area on which you can write. These cost £5.00 for a pack of 35. Inmac UK Ltd, Davy Road, Astmoor, Runcorn, Cheshire WA7 1QF, tel 09285 67551.

Exhibitions Galore

You've seen the best, now see the rest! No, but seriously, folks, the exhibition season doesn't end with Breadboard, and there are a lot more people out there waiting to show off their wares and expertise. There are exhibitions of general interest, exhibitions aimed just at the chosen few, big exhibitions, small exhibitions, conferences, seminars, the lot. So get out your diaries and make a note of some of the following.

First off is the Acorn Education Exhibition which will take place in the Central Hall, Westminster, London, from the 25th to the 27th January. As its title suggests, the exhibition is aimed at those involved in education, teachers, lecturers, administrators, etc, and will bring together some of the many companies offering educational software, peripherals, and services for Acorn's BBC microcomputer. Interested readers should contact Tim

Collins, Computer Marketplace Ltd, 20 Orange Street, London WC2H 7ED, tel 01-930 1612. The same people are also organising a Sinclair Education Exhibition in March, the second Acorn User Exhibition in August, and a robotics exhibition in November, and information on these can be obtained from the above address.

IFSSEC '84, the International Fire Security and Safety Exhibition and Conference, will take place at Olympia, London, from the 9th to the 13th April. Over 65,000 people are expected from all over the world to inspect the latest fire control and intruder detection products and services offered by the anticipated 700 exhibiting companies. There will also be seminars on such topics as the requirements of fire safety regulations and police policies toward intruder alarm installations. Details, conference programmes, etc, are available from IFSSEC Ltd, Cavendish House, 128-134 Cleveland Street, London W1P 5DN, tel 01-387 5050.

The British Robot Association are holding their 7th annual con-

ference in Cambridge (no single venue mentioned) from the 14th to the 16th May. Representatives from both Eastern and Western countries will be taking part and the organisers expect it to be their biggest yet. They are still considering papers for presentation at the conference and would welcome contributions from the industrial/applications viewpoint submitted within the next month or so. Details from the Conference Organiser, B.R.A.7, British Robot Association, 28-30 High Street, Kempston, Bedford MK42 7AJ, tel 0234 854477.

Micro City is described as an exhibition of computers, business systems and communications and will take place at the Bristol Exhibition Complex from the 15th to the 17th May. A major feature is the Offices Of The Future exhibition-within-an-exhibition which will occupy an entire hall. Details from Steve Hybs, Tomorrow's World Exhibitions Ltd, 9 Park Place, Clifton, Bristol BS8 1JP, tel 0272 292156.

Interconnection '84 is a new conference and exhibition which aims to cover the entire field of

interconnection under four main headings; board level interconnection, interboard connections, equipment-to-equipment, and techniques and board materials. It will be held at the Park Lane Hilton, London, on the 6th and 7th June. The organisers welcome papers for presentation at the conference, preferably concentrating on one of the above headings. For further details contact Brian Morgan, Marketing Manager, Benn Electronics Publications Ltd, 146 Midland Road, Luton LU2 0BL, tel 0582 417438.

Finally, and moving a little further afield, the second Electronic Displays exhibition and conference will be held at Frankfurt Fairgrounds from the 5th to the 7th September, and will concentrate as before on display devices, display drivers, CRT monitors and other devices used in modern information systems for text and graphic display. Again papers for presentation will be welcomed and information on this and other aspects of the event can be obtained from Network GmbH, An der Friedenseiche 10, 3050 Wunstorf 2, West Germany.

HOME LIGHTING KITS

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- LD300K Rotary Controlled Dimmer £3.95



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 x 6 x 3 cms. Supply: 5V to 15 V d.c. at 40uA. Output: 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 £11.50**

Electric lock mechanism for use with latch locks and above kit **£14.95**

"OPEN-SESAME"

The XK103 is a general purpose infra-red transmitter/receiver with one momentary (normally open) relay contact and two latched transistor outputs. 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 infra-facing the receiver to mains appliances. As with all our kits, full instructions are supplied.

ONLY £25.00

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 x 2.7 x 2cms. Requires PP3 9V battery. IDEAL FOR BEGINNERS. **£5.50**

3-NOTE DOOR CHIME

Based on the SA80600 IC the kit is supplied with all components, including loudspeaker, printed circuit board, a pre-drilled box (8.5 x 7.1 x 35mm) and full instructions. Requires only a PP3 9V battery and push-switch to complete. AN IDEAL PROJECT FOR BEGINNERS. Order as XK 102. **£5.50**

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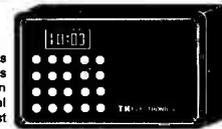
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(Kit includes all components, PCB, box, assembly and programming instructions) Order as CT6000

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

£3.90

Additional relays £1.65 each.



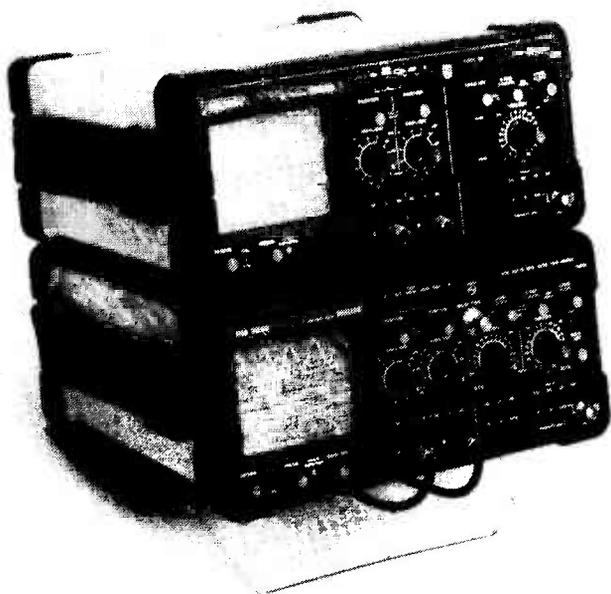
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Kit includes one relay, PCB to accommodate up to four relays, terminal blocks, etc., to fit inside CT6000 box. Provides up to four 3amp 240V AC changeover contacts.

£3.90

Additional relays £1.65 each.



Portable Oscilloscopes

Electronic Brokers is introducing into its range a pair of laboratory performance, portable oscilloscopes which are purpose-designed for tough operating conditions. They are both dual trace instruments, the PM3254 with single timebase and the PM3256 with added delayed timebase.

The trigger and timebase circuits have been developed to give over 100MHz bandwidth, with vertical amplifier bandwidth 75MHz over a wide temperature range. The ruggedised CRT generates an extremely bright, small spot which produces accurate traces even in high ambient light conditions. Operational capabili-

ties included are separate variable control of main and delayed timebases, variable hold-off, X-Y display facilities and TTL triggering as standard. The trigger-view function can also be used as a third channel. Both oscilloscopes can be operated from either AC or DC power supplies.

The oscilloscopes are constructed around a strong tubular chassis. Front and rear panels are rigid plastic mouldings, the side panels are tough ABS and thick rubber bumpers offer protection to the corners. A shoulder strap is provided for easy transportation from laboratory to alternative locations.

The PM3254 costs £1,096 and the PM3256 costs £1,196. For further information contact Electronic Brokers Limited, 61/65 Kings Cross Road, London WC1X 9LN, tel 01-278 3461.

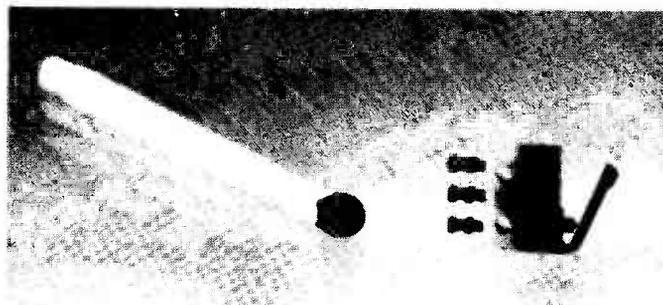
Musical Spectrum

Ricoll have introduced an add-on for the Spectrum which, they claim, allows a sound to be stored in memory and then replayed at any pitch. The "Action Replay" will accept an input from a microphone or other audio source and after storing it allows real-time replay using the Spectrum keyboard or an external keyboard and an external amplifier and speaker.

The unit comes in a box which plugs directly into the Spectrum and has sockets for audio input and output. The input signal is sampled at 32 kHz and stored in 32k of RAM in the unit. The pitch of the stored sound can then be controlled from the keyboard, Ricoll claiming four octaves upward shift and no limit to the downward shift. Using various software options, the sound can be reversed, reproduced continuously to form a sort of glitch-

free tape loop, and have effects such as echo and vibrato added. Audio bandwidth is 12 kHz, signal-to-noise ratio 66 dB, quantisation noise -72 dB, and the manufacturers claim that distortion is undetectable and that the audio quality generally compares favourably with that of a good hi-fi cassette recorder. The unit is intended to be used in conjunction with a monitor which displays such factors as input level/overload, and with some of the other software options available allows Fourier analysis and synthesis.

The complete unit with a set of demonstration software costs £99.00 including VAT and should be available from the beginning of January. A few fingers here at ETI got a bit itchy at the thought of playing with such a device, and so we have persuaded Ricoll to let us have a sample to evaluate as soon as the first production units are ready. Watch this space! Ricoll Electronics Ltd, 48 Southport Road, Ormskirk, Lancashire L39 1Qr, tel 0695 79101.



Unmatched?

It certainly won't be easy to find another microswitch which can match this one for size. Height, from the bottom of the pins to the top of the (depressed) lever is just 10mm, width is 8mm and thickness 3mm. The switching operation is single pole change-over and the contacts are rated at 300 mA, 50 V (not, we suspect, 300 mega-amps as stated in the

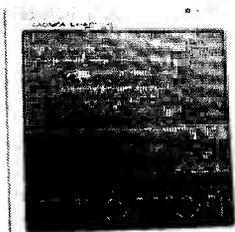
press release!) The actuating lever is designed for both simple compression and cam follower applications and the suppliers envisage it being used in scale models and for anti-tamper switching in small equipment. The switches are available in packs of ten for £4.00 including post and packing from Semiconductor Supplies International Ltd, Dawson House, 128-130 Carshalton Road, Sutton, Surrey SM1 4RS, tel 01-643 1126.

New Maplin Catalogue

The 1984 Maplin Electronic Supplies catalogue arrived at the ETI offices the other day — and kept on arriving! We don't know exactly how many copies they've sent us but if any more arrive we'll have enough to build our new offices with. The new catalogue has nearly 500 pages, 20% more than the 1983 edition, and includes a section on the Heathkit range of electronics kits. For the first time, Maplin's prices appear on the page rather than in a separate supplement. The prices will hold until at least February when an update leaflet will be issued. The new catalogue

costs £1.35 and can be purchased from branches of W.H. Smiths, from Maplin's own stores, or by post from Maplin's Rayleigh address for £1.65 including postage.

The Maplin stores mentioned above continue to increase in number. In addition to their stores in Birmingham, Manchester, London and Southend, they have recently opened a new one in Southampton. The shop is at 46-48 Bevois Valley Road, which is quite close to the City University. The existing premises had previously been used for the sale of electronic components for over forty years, and will now stock the extensive Maplin range. Maplin Electronic Supplies Ltd, P.O. Box 3, Rayleigh, Essex S56 8LR, tel 0702 554155.



Free Of Charge

Taking the idea of low battery costs through the use of Ni-Cads to its logical conclusion, Sanyo have introduced a charging

unit which doesn't need a supply of electricity. Their NC-AMI charger for AA (HP7) size cells is solar powered.

Sanyo have used what they call amorphous silicon semiconductor technology, or AMORTON for short, to produce the solar panel which has made the new charger possible. They do not say just how much output the new panel gives nor how long the unit will take to fully charge batteries. The charger, complete with four AA size Cadnics cells, should be on sale in the UK soon at a price which Sanyo say will be 'within easy reach of the average customer'.

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This unit will make your TV fully remote control (infra-red) and bring you closer to the amazing world of teletext. The kit can also be updated to incorporate full Prestel, and with a keyboard this can give you full message facilities for ordering foods or sending and receiving messages (E.G. Booking your Holidays!

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2708	3.00
2716	3.20
2732	7.50
2532	3.50
2764 (200ns)	11.00
ADC0816 (8 bit)	14.90

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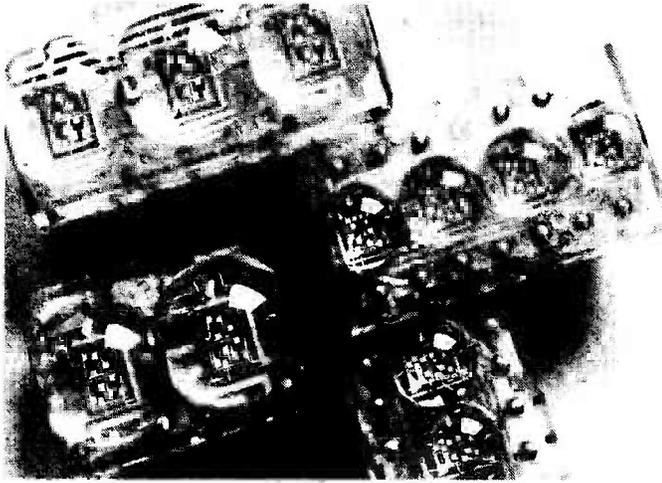
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Red-uced!

Siemens have introduced four **S**red LED digital displays which offer a considerable reduction in operating power over conventional types. Dissipation is only 80 mW per digit and Siemens claim that they are ideal for use with MOS devices and in CMOS circuitry.

The low power dissipation is achieved through the use of gallium arsenide phosphide as the semiconductor material. The luminosity is 1500 millicandela at 5mA forward current and the forward voltage reaches a maximum of 2V at 20mA. The rated temperature range is -20 to +70 C

and the wavelength of the emitted light is stated to be 650 nm.

The new displays come in two, three and four digit versions and the tiny substrate area is viewed through an integral plastic magnifying lens to give a digit height of either 2.8 or 3.8 mm. They are available in 12 or 14 pin plastic packages and all types are arranged for common cathode operation.

Siemens envisage applications for the displays in all types of battery operated equipment and particularly in multimeters, digital thermometers, etc. Siemens Ltd, Siemens House, Windmill Road, Sunbury-on-Thames, Middlesex TW16 7HS, tel 09327 85691.

Belfast Chips

Scientists at Queen's University, Belfast, have designed a chip which is capable of packing in 25 per cent more circuits and working at least 10 times faster than present types. They have done it using conventional chip manufacturing techniques and their efforts have been recognised by the UK Science and Engineering Research Council who have just given grants of £300,000 to continue their work.

Researchers in the Department of Electrical and Electronic Engineering say their design holds out the prospect of the most complex chips in the world, operating at the highest possible speed. One of the three-man team behind the new development, lecturer Dr Mervyn Armstrong, said: "Although we have developed a new principle, quite a large amount of development work is still needed before a prototype chip could be successfully produced. It is, however, a major innovation for those creating and marketing tomorrow's chips."

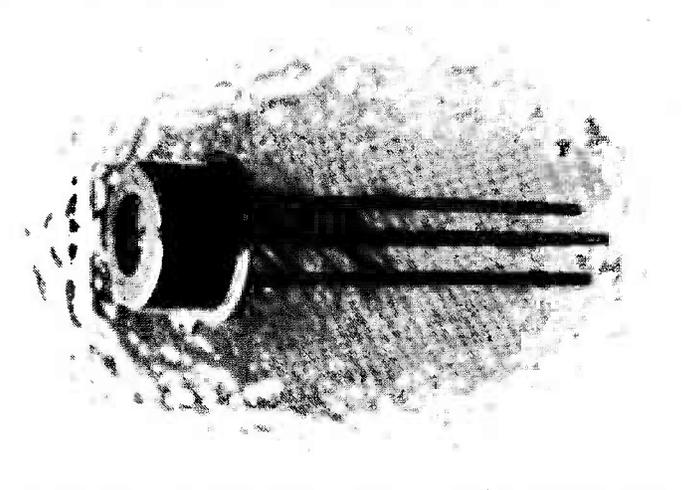
The new approach is based on the ability to align exactly certain essential layers used to make a chip. Until now the alignment of the layers could not be precisely controlled. This has meant the patterns on each essential layer have had to be made a little larger so that even if the overlying layers do not exactly register on top of the previous layer, some part of them would make contact. The penalty is that this wastes valuable space. Exact alignment, which Queen's University say they can now achieve, frees space for more circuitry.

The other problem was speed. An average microprocessor deals with two million pieces of information every second, which are processed through some 30,000 transistors. But as more transis-

100MHz Fibre Optic Emitters

Motorola have introduced two new infrared emitters for fibre optic systems which are claimed to be the industry's first planar LEDs capable of data transmission at greater than 100MHz bandwidth. The devices allow fibre optic system operation in areas previously reserved for expensive, edge-emitting LEDs and laser diodes at a significantly lower cost and a much improved operating life.

The new MFOE1201 and MFOE1202 infrared emitters are packaged in a TO-52 metal package which is hermetic, industry standard size and configuration and fits into commercially available fibre optic connectors. The internal lensing enhances coupling efficiency and provides a 250µm diameter optical spot at 0.3 N.A. (numerical aperture) on



the emitters. The spectral response peaks at 820nm, which is spectrally matched to the minimum attenuation region of most medium distance fibre optic cable. With a power output of 1.0 to 3.5mW, the devices make short to medium distance, highspeed systems economically

feasible. Applications are broad, and include industrial controls, computer systems, CATV and military.

For further information contact Motorola Ltd, European Literature Centre, 88 Tanners Drive, Blakelands, Milton Keynes MK14 5BP, tel 0908 614 614.

tors are put into the chip, the connections between them become smaller and thinner, slowing down the passage of current from one transistor to another, and consequently the response of the computer. These connections are normally made from poly silicon. To restore its efficiency when using thin connections the Belfast team have devised a technique to put a layer of aluminium on top of each part of the chip containing poly silicon.

The Belfast development holds out the promise of medium priced computers which can support many more user terminals than at present and also means that industrial processes now monitored by giant computers could soon come within the range of cheaper, microprocessor-based machines.

1.5µs, 12-Bit ADC

Burr-Brown have introduced a 12-bit analogue-to-digital converter with a maximum conversion time of only 1.5µSec. Thought to be the fastest successive approximation A/D converter on the market, the ADC803 is accurate to ±0.015% of full scale range, operates with no missing codes over a -25 C to +85 C temperature range and provides both serial and parallel outputs.

The converter incorporates a mix of proven IC and hybrid technologies and utilises state-of-the-art IC and laser trimmed thin-film components to achieve a complete A/D function including voltage reference, clock and

comparator. It is packaged in a 32-pin 43x23x5mm hermetically sealed DIP. Input scaling resistors allow internal selection of analogue input range from 0 to -10V, ±5V and ±10V. Output codes are complementary binary for unipolar inputs and bipolar offset binary for bipolar inputs. All digital inputs and outputs are TTL compatible and power supply requirements are ±15V and ±5V. Because of its differential input comparator design, the ADC803 is very easy to use. The internal DAC drives a comparator input separate from the input signal so that the user's driving circuitry does not have to handle the DAC's large, fast transients.

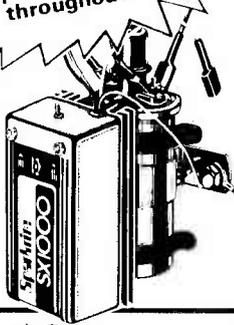
For further information contact Burr-Brown International Limited, Cassiobury House, 11-19 Station Road, Watford, Herts WD1 1EA, tel 0923 33837.

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

Sparkrite

SELF ASSEMBLY ELECTRONIC KITS

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D.I.Y. KITS



SX 1000 Electronic Ignition

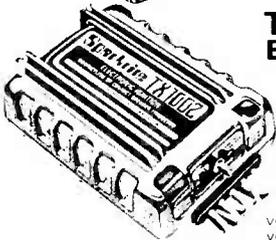
- Inductive Discharge ● Extended dwell circuit stores greater energy in coil ● Three position changeover switch ● Patented clip-to-coil fitting ● Easy to assemble, easy to fit ● Contact breaker triggered ● Includes bounce suppression circuit

SUPER SAVE

SX 2000 Electronic Ignition

- Reactive Discharge ● Combines inductive & capacitive energy storage ● Gives highest possible spark energy ● Patented clip to coil fitting ● Easy assembly sequence ● Contact breaker triggered ● Includes bounce suppression circuit

SUPER SAVE

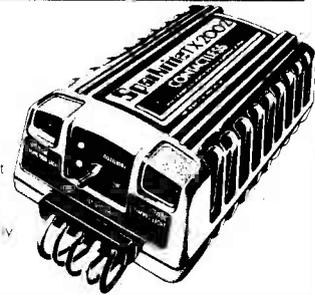


TX 1002 Electronic Ignition

- Inductive discharge ● Extended dwell circuit stores greater energy in coil ● Three position changeover switch ● Contactless or contact breaker triggered ● Clip-to-coil or remote mounting ● Rugged die-cast case ● Contactless adaptors included for majority of 4 & 6 cylinder vehicles ● Easy to build ● For details of vehicles fitted by contactless trigger, ring Technical Service Dept on (0922) 611338-9

TX2002 Electronic Ignition

- Two separate systems in one unit ● Reactive Discharge OR Inductive Discharge with three position changeover switch ● Gives highest possible spark energy ● Clip to coil or remote mounting ● Rugged die-cast case ● Contactless or contact breaker triggered ● Contactless adaptors included for majority of 4 & 6 cylinder vehicles ● For details of vehicles fitted by contactless trigger, ring Technical Service Dept on (0922) 611338-9



AT-40 Electronic Car Alarm

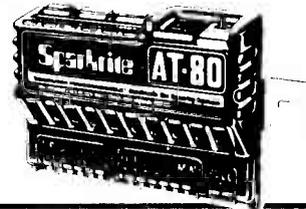
- Guards doors, boot, bonnet from unauthorised entry ● Armed/disarmed using concealed switch ● 30 second delay to arm; 7 second entry delay ● Can alternatively be wired to exterior key switch ● Flashes headlights & sounds horn intermittently for 60 seconds when activated ● Security loop protects accessories ● Low consumption C-MOS circuitry



NEW

AT-80 Electronic Car Security System

- Guards doors, boot, bonnet from unauthorised entry ● Armed/disarmed from outside vehicle by magnetic key fob passed across sensor pad adhered to inside of windscreen ● Individually programmable code ● 30 second delay to arm ● Flashes headlights and sounds horn intermittently for 60 seconds when activated ● Security loop protects accessories ● Function lights to assist setting up ● Low consumption C-MOS circuitry



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ULTRASONIC Intruder Detector

- Supplementary to AT 40 & AT-80 ● Will work in conjunction with any door switch input or voltage sensing alarm ● Detects attempted break in and movement within passenger compartment & triggers alarm ● Includes high efficiency ultrasonic transducers ● Crystal controlled for low drift ● Ingenious sensitivity control allows freedom from false alarms ● Low current consumption



NEW

VOYAGER Car Drive Computer

- 12 functions centred on Fuel, Speed, Distance and Time ● Single chip microprocessor ● Large high brightness fluorescent display with auto dimming feature ● High accuracy distance & fuel transducers included ● Displays MPG, L/100km and miles, litre at the flick of a switch ● Visual & audible warnings of excess speed, i.e. lights left on ● Independent LOG & TRIP functions ● Low consumption crystal controlled circuitry



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MAGIDICE Electronic Dice

- Triggered by waving hand over dice ● Completely random selection ● Bleeps & flashes during 4 sec tumble ● Throw displayed for 10 seconds then flashes to conserve battery ● Low consumption C-MOS circuitry

SUPER SAVE

SPARKRITE (A Division of Stadium Ltd.) 82 Bath Street, Walsall, WS1 3DE England Tel: (0922) 614791

KIT	OLD PRICE	NEW PRICE
SX 1000	£12.95	£11.95
SX 2000	£14.95	£13.95
TX 1002	£22.95	£22.95
TX 2002	£32.95	£32.95
AT-40		£9.95
AT-80	£32.95	£24.95
ULTRASONIC		£17.95
VOYAGER	£64.95	£64.95
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IEEE Controlled Logic Analyser

The Hawk 3210 logic analyser interfaces with a host of microcomputers to give powerful diagnostic, processing display and hard copy facilities, and at £2495 is claimed to cost only about half as much as other machines offering less facilities.

The 3210 offers 32 channels of 1024 bits depth, with an internal sample clock programmable to 10 MHz. Triggers are programmable in binary, hex, octal, decimal, and ASCII for all 32 channels, including don't care states. Full pre and post trigger capability is provided, using delay of up to 1024 samples.

In timing mode, each screen page displays 128 samples of the 1024 bit storage and from any two of the four pods each carrying eight data probes. Pod 1 carries a dividable external clock

input. Glitches are detected to 30MHz, with display detectable on or off. When displayed, glitches are shown as an overlay to data. In parallel state mode binary, parallel, octal, hex, decimal and ASCII displays of 32 channels wide by 16 lines are available, with on-screen command prompt for control.

The unit has fully menu-driven operation and keyboard control for setting trigger words and selecting timing, hex, binary, decimal, octal or ASCII formats. All menus carry prompt instructions at the foot of the display.

Initially, the 3210 analyser is available for use with Apple II machines, a converter card giving the computer IEEE compatibility. However, software is now in development to allow the analyser to be used with Commodore, Sirius and other popular makes of microcomputer and controller. Hawk Electronic Test Equipment, Bircholt Road, Parkwood industrial Estate, Maidstone, Kent ME15 9XT, tel 0622 686811.



Triple Output Power Supply

The Kikusui PWC 0620 is a triple output power supply which offers 0 to 6 volts at up to 3 amps, and 0 to +20 volts and 0 to -20 volts, at up to 1 amp. The 20 volt outputs operate in a dual tracking mode and the unit has two large front panel meters, one for current measurement, and the other for voltage. Any of the three outputs can be selected for display on the meter, and there

are separate voltage and current controls for the 6 and 20 volt ranges. The power supply is operable either in constant voltage or in constant current modes. Ripple is only 0.5 mV on all outputs, and line and load regulation is within 3 mV. It costs £295 plus VAT, which is a lot more than you will have to pay for the only slightly-less generously rated instrument which appears elsewhere in this issue. Telonic Instruments Ltd, 2 Castle Hill Terrace, Maidenhead, Berkshire, tel 0628 73933.

SHORTS

● The Scopex Instruments story, part 2: further to our recent report of Scopex' demise, we are now assured that the company's future is secure following the purchase of their assets from the Receiver by Bridge Scientific Instruments Ltd. Bridge say that all existing orders for Scopex products will be fulfilled as soon as possible. The new address for all enquiries is Scopex, 63-65 High Street, Skipton, North Yorkshire BD23 1EF, tel 0756 69511.

● Regisbrooke have issued a full colour brochure describing their wide range of opto-electronic devices, LED, LCD and vacuum fluorescent displays, key-switches, display driver components, and accessories. The brochure is available free of charge from Regisbrooke Ltd, Unit 5, Horshoe Park, Pangbourne, Berkshire, tel 07357 4841.

● Further doom and gloom. At a meeting of creditors which took place on the 8th November 1983, Jupiter Cantab Ltd, manufacturers of the Jupiter Ace microcomputer, was put into the hands of a liquidator. The business is now being offered for sale, and further details can be obtained from Chater & Myhill, Sussex House, Hobson Street, Cambridge CB1 1NJ, tel 0223 66692.

● The CM200 capacitance meter will measure capacitances between 1pF and 2,500uF, taking three readings per second and giving the result on its 4½ digit LCD to an accuracy of ±0.2%. It is lightweight, will run for several hundred hours from batteries or can be connected to the mains supply, and has a calibration control which allows the user to null out up to 25 pF test lead capacitance. It costs £89 plus VAT. Thurlby Electronics Ltd, New Road, St. Ives, Cambridgeshire, tel 0480 63570.

● In order to combat the shortage of skilled staff in the computing services industry COSIT, the Computing Services Industry Training Council has been given £600,000 by the government for its first year of operation. The program will run for five years and the object is to pay firms to help them with their training. For details contact COSIT, 5th Floor, Hanover House, 73-74 High Holburn, London WC1V 6LE, tel 01-242 5049.

● The DPM60 4½ digit LCD module features auto-zero, auto polarity, and logic switched 200 mV or 2V FSD with 10uV resolution. It runs from a 7.5 - 15V supply, has 10 mm high digits, and is available in kit form for £29.95 fully inclusive from Lascar Electronics Ltd, Module House, Whiteparish, Salisbury, Wiltshire SP5 2SJ, tel 079 48 567.

● Galatrek's combined fuse and 13A socket tester is about the size of a regular 13A plug and has two neons which indicate when connections are absent, reversed or correct. It costs £8.00 including VAT and post and packing from Galatrek International Ltd, Scotland Street, Llanrwst, North Wales.

● Ambit International have opened a new sales counter for their range of electronic components, books, kits, test equipment, etc. The new counter is in the Broxlea building, near the High Street in Broxbourne, Hertfordshire. There is on-site parking and features include an on-line computer terminal and other advice and information services for customers. Ambit International, 200 North Service Road, Brentwood, Essex CM14 4SG, tel 0277 231616.

● The Beckman CT233 is a clamp-type Hall effect probe which, when used in conjunction with a multimeter, oscilloscope or other voltage indicating device, allows the measurement of AC and DC currents up to 600A. The unit handles conductors up to 45mm diameter, runs from a 9V battery, has an output of 600 mV for FSD, and an accuracy of 3% or better. Beckman Instruments Ltd, Mylen House, 11 Wagon Lane, Sheldon, Birmingham B26 3DU, tel 021-742 7761.

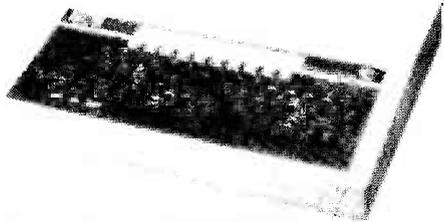
● Motorola have announced the adoption of the SOT-89 package for a broad range of micro-miniature transistors, initially including general purpose high voltage Darlington and RF transistors. The new plastic package is an alternative to the much larger 1 watt TO-92 package, and in addition to the space saving involved Motorola say the pre-formed leads of the SOT-89 will facilitate pre-assembly testing. Motorola Ltd, 88 Tanners Drive, Blakelands, Milton Keynes, tel 0908 614614.

● Gothic Crellon have published a 64 page catalogue covering their wide range of resistors, capacitors, semiconductors, valves, relays, switches and the micro and mini computer systems sold by Crellon Microsystems. Copies of the A4 size catalogue are available free from the Sales Department, Gothic Crellon Ltd, 380 Bath Road, Slough, Berkshire SL1 6JE, tel 06286 4300.

● Bulgin are giving away 1984 calendar-cum-posters which illustrate their range of switches, fuse-holders and connectors. Copies are available from Brian Diggle, Advertising Manager, A. F. Bulgin & Co. PLC, Bypass Road, Barking, Essex IG11 0AZ, tel 01-594 5588.

BBC Micro Computer System OFFICIAL DEALER

Please phone for availability



Software from ACORNSOFT/
PROGRAM POWER/GEMINI in
stock

BBC Model B £348
B + Econet £389
B + DFS £409
B + DFS + Econet £450
Carriage £7

Model A to Model B
Upgrade Kit £60
Installation £15

LANGUAGE ROMs
BCPL ROM + Disc +
Manual £87
PASCAL-T ROM £44

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View 16K Rom £52
Wordwise 8K Rom £32
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FLOPPY DISC INTERFACE £95 & £15 installation

BBC COMPATIBLE DISC DRIVES

All drives are supplied with necessary cables
Single Drive without PSU: 100k £150; 200k £215,
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Single Drive with PSU: 100k £185; 200k £260*; 400k £330
Dual Drive with PSU: 2x100k £335; 2x200k
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* These drives are switchable 40/80 drives.
40/80 Switch Module for 1x400k and 2x400k Drive £32

DISKETTES
40 track SS £15; 80 track SSDD £22
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BBC FLOPPICLENE DRIVE HEAD
Cleaning Kit with 50 disposable discs £14.50

Phone or send for our BBC leaflet

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HOBBIT Floppy Tape £135 + £2.50 carriage
HOBBIT Zero Memory Option £25 + £1 carriage
Computer Grade C12 cassette 50p each.
£4.50 for 10 + £1 carriage

MONITORS

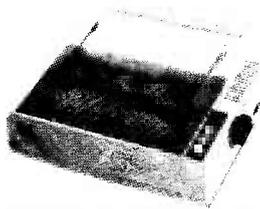
MICROVITEC 1431 14" RGB Std Res £215
MICROVITEC 1451 14" RGB Med Res £345
MICROVITEC 1441 14" RGB Hi Res £440
MICROVITEC 2031 20" RGB Std Res £287
KAGA VISION 12" RGB Std Res £230
KAGA VISION III 12" RGB Hi Res £385
KAGA 12" GREEN Hi Res £106
SANYO DM8112CX 12", Green Hi Res £99
All leads included. Carriage £7

TORCH Z-80 PACK

Your B.B.C. computer can be converted into a business machine at a cost slightly higher than an 800k disc drive. The Torch pack with twin disc drive and a Z80A processor card greatly enhances the data storing and processing capability of the computer. (NOTE: In BBC mode the disc pack functions as a normal BBC drive.). Z80A card comes with 64k of RAM and a CP/M compatible operating system. The system is supplied complete with a BBC owner's user guide, a Systems/Demo disc, a PERFECT software package and COMANEX, a business management game. The PERFECT software package comprises of a DATABASE, CALC, WORDPROCESSOR and SPELLER commercially valued at over £1,000. The complete package for only £730. Installation £20. Carr. £8.

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EPSON FX80 £350
EPSON RX80 FT £270
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SEIKOSHA GP 700A Colour £375
JUKI 6100 Daisy Wheel £365
MCO 40 Col Printer/Plotter £129
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ACCESSORIES

Parallel Printer Lead £10 + £1 carriage
Serial Printer Lead £8 + £1 carriage
Epson Serial Interface 2K £60 + £1 carriage
Epson Serial Interface £50 + £1 carriage
NEC Serial Interface £42 + £1.50 carriage
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A low cost unit opens up the total range of Real-Time applications. With its full battery backup, possibilities include an Electronic Diary, automatic document dating, precise timing & control in scientific applications, recreational use in games etc — its uses are endless and are simply limited by one's imagination. Simply plugs into the user port — no specialist installation required — No ROMs. Supplied with extensive applications software. £29.00

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A fully self-contained Eprom Programmer with its own power supply, able to program 2516, 2716/32/32A/64/128 single rail Eproms.
★ Personality selection is simplified by a single rotary switch.
★ Programming voltage selector switch is provided with a safe position.
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★ Simple menu driven software supplied on cassette (transferable to disc).
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Programmer complete with cables, software and operating instructions.
£79.50 - £2 p. & p.

PRODUCTION PROGRAM: P8000

P8000 provides reliable gang programming of up to 8 EPROMS simultaneously with device sizes up to 16k x 8 bytes. Devices supported range from 2704 to 27128 in single and three rail versions. Simple menu driven operation ensure easy eprom selection and reliable programming in minimum programming times. £695 + £6 carriage

BOOKS (no VAT; p&p £1)

Assembly Lang Prog. for BBC £8.95
Assembly Lang programming on BBC
Micro by Ferguson and Shaw £7.95
Basic Prog. for BBC £5.95
BBC An Expert Guide £6.95
Easy Programming on BBC £5.95
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Introducing BBC Micro £5.95
Programming the BBC £6.50
30 Hour Basic £5.95
35 Educational Programs £6.95
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Creating Adventure Programs £6.95
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Structured Programming £6.50
The Friendly Computer Book BBC £4.50
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EPROM ERASERS

UV1T Eraser with a built-in timer and mains indicator. Built-in safety interlock to avoid accidental exposure to the harmful UV rays. It can handle up to 5 eproms at a time with an average erasing time of about 20 mins. £59 + £2 p&p.
UV1 as above but without the timer £47 + £2 p&p.
UV140 up to 14 Eproms £61
UV141 as above but with timer £79

★ SPECIAL OFFER ★

2532	£3.50	27128-3	£18
2732	£3.50	4164-2	£4.50
2764 25	£5	6116P-3	£3.50

RH LIGHTPEN:

The Acorn-approved superior design, with a programmable 'push tip' switch, status indicator LED and an interface box. Supplied complete with manual, full software and basic demo programs. Colour graphics programs will be available separately. £39.50

SMARTMOUTH

The 'infinite vocabulary' self-contained speech synthesiser unit. Uses only 5-10 bytes per word — no ROMs required — simply plugs into the user port. (Has Aux. Audio output skt.). Supplied with Demo/Development programs and simple software instructions, £37 + £2 p. & p.

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CONNECTOR SYSTEMS

I.D. CONNECTORS

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

D CONNECTORS

No. of ways			
9 15 25 37			
MALE			
Solder	80p	105p	160p
Angled	150p	210p	250p
FEMALE			
Solder	105p	160p	200p
Angled	165p	215p	290p
Hoods	90p	85p	90p
IDC 25-way plug	385p	Socket	450p

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SOCKETS 24-pin £5.75
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DIL SWITCHES

4-way 70p 8-way 90p
6-way 85p 10-way 140p

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24" Ribbon Cable with Headers			
	14-pin	16-pin	24-pin
1 end	145p	165p	240p
2 ends	210p	230p	345p
24" Ribbon Cable with Sockets			
1 end	160p	200p	280p
2 ends	290p	370p	480p
Ribbon Cable with D Conn			
25-way Male	500p	Female	550p

RS 232 JUMPERS

(25-way D)	
24" Single end Male	£5.00
24" Single end Female	£5.25
24" Female-Female	£10.00
24" Male-Male	£9.50
24" Male-Female	£9.50

DIL HEADERS

Solder Type		IDC Type
14pin	40p	100p
16pin	50p	110p
24pin	100p	150p
40pin	200p	225p

AMPHENOL CONNECTORS

36 way plug Centronics Parallel Solder £5.25 IDC £4.95
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24 way socket IEEE Solder £5

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

EURO CONNECTORS

DIN 41617	Plug	Skt
21 way	160p	165p
31 way	170p	170p
DIN 41617		
2-12 way St. Pin	220p	275p
2-12 way Ang. Pin	275p	320p
1-12 way St. Pin	260p	300p
1-12 way Ang. Pin	375p	350p

EDGE CONNECTORS

	0.1"	0.156"
2x 18-way	—	140p
2x 22-way	190p	240p
2x 23-way	175p	—
2x 25-way	225p	220p
2x 28-way	190p	—
1x 43-way	260p	—
2x 43-way	365p	—
1x 77-way	600p	—
5100 Conn	—	600p

TEST CLIPS

14 pin 275p 40 pin £6 16 pin £3

74 SERIES

Table listing 74 series components including 7400, 7401, 7402, 7403, 7404, 7405, 7406, 7407, 7408, 7409, 7410, 7411, 7412, 7413, 7414, 7415, 7416, 7417, 7418, 7419, 7420, 7421, 7422, 7423, 7424, 7425, 7426, 7427, 7428, 7429, 7430, 7431, 7432, 7433, 7434, 7435, 7436, 7437, 7438, 7439, 7440, 7441, 7442, 7443, 7444, 7445, 7446, 7447, 7448, 7449, 7450, 7451, 7452, 7453, 7454, 7455, 7456, 7457, 7458, 7459, 7460, 7461, 7462, 7463, 7464, 7465, 7466, 7467, 7468, 7469, 7470, 7471, 7472, 7473, 7474, 7475, 7476, 7477, 7478, 7479, 7480, 7481, 7482, 7483, 7484, 7485, 7486, 7487, 7488, 7489, 7490, 7491, 7492, 7493, 7494, 7495, 7496, 7497, 7498, 7499, 7500.

74S SERIES

Table listing 74S series components including 74LS00, 74LS01, 74LS02, 74LS03, 74LS04, 74LS05, 74LS06, 74LS07, 74LS08, 74LS09, 74LS10, 74LS11, 74LS12, 74LS13, 74LS14, 74LS15, 74LS16, 74LS17, 74LS18, 74LS19, 74LS20, 74LS21, 74LS22, 74LS23, 74LS24, 74LS25, 74LS26, 74LS27, 74LS28, 74LS29, 74LS30, 74LS31, 74LS32, 74LS33, 74LS34, 74LS35, 74LS36, 74LS37, 74LS38, 74LS39, 74LS40, 74LS41, 74LS42, 74LS43, 74LS44, 74LS45, 74LS46, 74LS47, 74LS48, 74LS49, 74LS50.

74S SERIES

Table listing 74S series components including 74S00, 74S01, 74S02, 74S03, 74S04, 74S05, 74S06, 74S07, 74S08, 74S09, 74S10, 74S11, 74S12, 74S13, 74S14, 74S15, 74S16, 74S17, 74S18, 74S19, 74S20, 74S21, 74S22, 74S23, 74S24, 74S25, 74S26, 74S27, 74S28, 74S29, 74S30, 74S31, 74S32, 74S33, 74S34, 74S35, 74S36, 74S37, 74S38, 74S39, 74S40, 74S41, 74S42, 74S43, 74S44, 74S45, 74S46, 74S47, 74S48, 74S49, 74S50.

74S SERIES

Table listing 74S series components including 74S00, 74S01, 74S02, 74S03, 74S04, 74S05, 74S06, 74S07, 74S08, 74S09, 74S10, 74S11, 74S12, 74S13, 74S14, 74S15, 74S16, 74S17, 74S18, 74S19, 74S20, 74S21, 74S22, 74S23, 74S24, 74S25, 74S26, 74S27, 74S28, 74S29, 74S30, 74S31, 74S32, 74S33, 74S34, 74S35, 74S36, 74S37, 74S38, 74S39, 74S40, 74S41, 74S42, 74S43, 74S44, 74S45, 74S46, 74S47, 74S48, 74S49, 74S50.

74S SERIES

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74S SERIES

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LINEAR ICs

Table listing linear ICs including AD7581, AD7582, AD7583, AD7584, AD7585, AD7586, AD7587, AD7588, AD7589, AD7590, AD7591, AD7592, AD7593, AD7594, AD7595, AD7596, AD7597, AD7598, AD7599, AD7600.

COMPUTER COMPONENTS

Table listing computer components including CPUs (8086, 8088, 8080, 8085, 8087, 8089, 8090, 8095, 8096, 8097, 8098, 8099, 8100), MEMORYS (2817, 2818, 2819, 2820, 2821, 2822, 2823, 2824, 2825, 2826, 2827, 2828, 2829, 2830), PROMS (2708, 2716, 2732, 2764, 27128, 27128), EPROMS (2708, 2716, 2732, 2764, 27128, 27128), SUPPORT DEVICES (2651, 2652, 2653, 2654, 2655, 2656, 2657, 2658, 2659, 2660).

MODULATORS

Table listing modulators including 8197R, 8198R, 8199R, 8200R, 8201R, 8202R, 8203R, 8204R, 8205R, 8206R, 8207R, 8208R, 8209R, 8210R, 8211R, 8212R, 8213R, 8214R, 8215R, 8216R, 8217R, 8218R, 8219R, 8220R.

CRYSTALS

Table listing crystals including 32.768 kHz, 100 kHz, 200 kHz, 2.45760 MHz, 10.000 MHz, 10.700 MHz, 11.000 MHz, 11.800 MHz, 12.000 MHz, 12.800 MHz, 13.000 MHz, 14.000 MHz, 14.318 MHz, 14.745 MHz, 15.000 MHz, 16.000 MHz, 16.432 MHz, 16.969 MHz, 20.000 MHz, 24.000 MHz, 28.000 MHz, 30.000 MHz, 35.000 MHz, 40.000 MHz, 45.000 MHz, 50.000 MHz, 56.250 MHz, 60.000 MHz, 67.500 MHz, 70.000 MHz, 75.000 MHz, 80.000 MHz, 90.000 MHz, 100.000 MHz, 110.000 MHz, 120.000 MHz, 130.000 MHz, 140.000 MHz, 150.000 MHz, 160.000 MHz, 170.000 MHz, 180.000 MHz, 190.000 MHz, 200.000 MHz, 210.000 MHz, 220.000 MHz, 230.000 MHz, 240.000 MHz, 250.000 MHz, 260.000 MHz, 270.000 MHz, 280.000 MHz, 290.000 MHz, 300.000 MHz, 310.000 MHz, 320.000 MHz, 330.000 MHz, 340.000 MHz, 350.000 MHz, 360.000 MHz, 370.000 MHz, 380.000 MHz, 390.000 MHz, 400.000 MHz, 410.000 MHz, 420.000 MHz, 430.000 MHz, 440.000 MHz, 450.000 MHz, 460.000 MHz, 470.000 MHz, 480.000 MHz, 490.000 MHz, 500.000 MHz, 510.000 MHz, 520.000 MHz, 530.000 MHz, 540.000 MHz, 550.000 MHz, 560.000 MHz, 570.000 MHz, 580.000 MHz, 590.000 MHz, 600.000 MHz, 610.000 MHz, 620.000 MHz, 630.000 MHz, 640.000 MHz, 650.000 MHz, 660.000 MHz, 670.000 MHz, 680.000 MHz, 690.000 MHz, 700.000 MHz, 710.000 MHz, 720.000 MHz, 730.000 MHz, 740.000 MHz, 750.000 MHz, 760.000 MHz, 770.000 MHz, 780.000 MHz, 790.000 MHz, 800.000 MHz, 810.000 MHz, 820.000 MHz, 830.000 MHz, 840.000 MHz, 850.000 MHz, 860.000 MHz, 870.000 MHz, 880.000 MHz, 890.000 MHz, 900.000 MHz, 910.000 MHz, 920.000 MHz, 930.000 MHz, 940.000 MHz, 950.000 MHz, 960.000 MHz, 970.000 MHz, 980.000 MHz, 990.000 MHz, 1000.000 MHz.

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PROGRAMMABLE SPEECH BOARD

Help your computer to find its voice, with the ETI Mini-Mynah. Teach it words, phrases, sentences or even short stories — then have it repeat them back to you with a single command. Design, development, and awful name by Phil Walker.

The ETI Mini-Mynah is a speech generator with added extras — 100+ words of memory, inflection, and low software overheads are possibly the most important.

At the heart of the system is a General Instruments SP0256-AL2 speech processor IC. This is an NMOS LSI device, containing its own microcontroller, ROM, digital filter and pulse width modulator. The main attractions of this device are that it does not require vast amounts of data to produce understandable speech, it is easy to interface with other devices, its vocabulary is not limited, and it is available to the hobbyist.

The device uses allophone speech synthesis, which means that it provides for the generation of 64 basic speech sounds (including five silences!) from which an unlimited number of words can be assembled. This, however, has the disadvantage that you have to work out exactly which sounds you need to generate to make the words you want to say — more on this later. Other versions of the SP0256 have more, different allophones.

The on-board 2K of RAM can store up to 2048 allophones, which can be in groups of up to 255 in length. The memory is set up by one program, which can then be deleted or over-written. To call up an allophone group thereafter requires only a single instruction within the program — the computer can then get on with other tasks while the sound generator churns out the vocals! However, reproduction is not limited to the set utterances stored by the initial program — individual words, phrases, parts

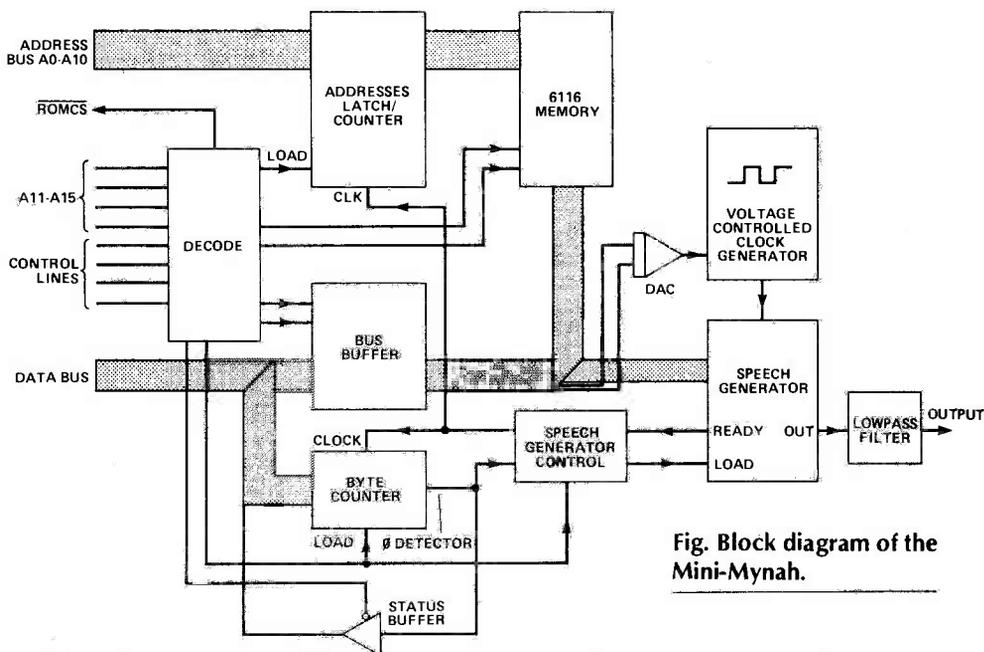


Fig. Block diagram of the Mini-Mynah.

of sentences can be picked out by single commands, and reproduced in any desired order; just because a group of allophones were entered together, they do not have to be reproduced together.

The Circuit

The circuit consists of a 2K block of memory, a speech generator chip, clock generator and output filter together with some control and interface devices.

The main requirements of the system is that data can be put into the memory (and read from it) under control of a common home computer. Having placed the required data in the memory, it is then possible to select a block of data by defining its start address and length. This data block will then be read by the

speech generator to produce words, phrases or complete sentences without further action by the controlling computer.

During the design stage, it was noted that only six bits are required to specify one of the 64 allophones provided by the SP0256. For this reason, and because it provides a TTL compatible square-wave output, it was decided to use a 74LS624 VCO to provide the clock frequency for the speech generator; the two spare data bits from the normal eight-bit word are used to provide a four-level control voltage for the VCO. This has the effect of varying the pitch of the reproduced speech as each allophone is being reproduced. The rate of change of the control voltage is slowed down by a large capacitor to give a smooth final result. Adjustment

of the 'normal' pitch and of the degree of pitch variation can be made on the board. Additionally, a VCO is rather cheaper than a crystal!

For the following discussion we will assume that the 2K memory block is normally accessed in the address range 8192 to 10239 (decimal) for normal read and write operations and in the range 10240 to 12287 (decimal) for control functions (2000_H to 27FF_H and 2800_H to 2FFF_H respectively).

By reading and writing from and to addresses in the range 8192 to 10239 the RAM can be loaded with data representing the sounds to be made. The data consists of bytes of eight data bits in which the lower six select which type of sound is to be made while the top two affect the pitch of the preceding allophone. This slight inconvenience is caused by there being no latch on the upper two data bits (this would have necessitated an extra chip had it been included).

In order to start a particular data string being rendered into speech, 2048 (decimal) is added to its starting address and a byte representing its length is written to the resulting address. When this has been done the speech generator will read out the data string in sequence and generate the required sounds. This process will continue until the full number of bytes has been dealt with without any further interference by the controlling computer.

What actually happens is that the write operation loads the address counters with the lower 11 address bits and the byte counter with the data on the data bus. After this operation the speech generator chip is enabled and generates the clock and loading signals by interaction with the byte counter and a simple gate circuit until the byte counter reaches zero. At this point the operation will stop.

If for some reason the controlling computer needs to know the current status of the unit (i.e. whether it is still talking or not) this can be done by a read operation to any address in the range 10240 to 12287 (decimal) and testing the state of data bit 7. This will be high for busy or still talking and low if the Mini-Mynah is ready to accept a new

command. Note, however, that a false result may be obtained when the last byte is being processed as the byte counter will be zero before the speech generator has finished sounding (this will not cause a problem if

the last byte was a pause).

We have not shown a power supply or audio amp for this project as there are so many simple circuits available. A power supply of 5V at about 300mA should be adequate.

PROGRAM LISTING

```

10 REM (50 or more characters to take data)
20 LET K=16514
30 FOR I=0 TO 50
40 PRINT I+K
50 INPUT A
60 IF A>255 THEN GOTO 100
70 POKE I+K,A
80 PRINT PEEK (I+K)
90 NEXT I
100 FOR J=0 TO I
110 POKE 8192+J, PEEK (16514+J)
150 POKE 10240,I
160 IF PEEK(10240)>127 THEN GOTO 160
170 GOTO 150
    
```

Fig. 2 Example program for the ZX81.

HOW IT WORKS — PROGRAM

Line 20 sets pointer to data storage start in the REM statement. Lines 30 to 90 take in up to 50 bytes of data and store it in the REM statement. The address at which each byte is to be stored is printed on the screen as is the content of that address after the operation is complete.

The process can be stopped by entering a number greater than 255.

Lines 100 to 120 transfer the data from the REM statement to the memory in the Mini-Mynah. After this, line 150 writes the number of bytes in the data string just loaded to the start address +2048. This action triggers the Mini-Mynah to speak the equivalent of the data string as a string of sounds.

Line 160 tests the status flag and only allows the program to continue when the Mini-Mynah signals that the data string has been processed. Normally line 160 would come before line 150 and other actions would be undertaken by the computer while the Mini-Mynah was speaking (hint — type line 10 in last).

Here is data for a surprise message (don't worry, it's not rude!)

```

4, 155, 135, 173, 15, 117, 132, 4, 216,
70, 131, 26, 154, 80, 67, 18, 143, 79,
67, 19, 196, 13, 19, 132, 24, 134, 67,
16, 76, 129, 139, 211, 3, 16, 216, 134,
184, 115
    
```

Note that although only 64 allophones are available from the basic chip in the Mini-Mynah we have added circuitry which affects the pitch of the reproduced speech. This is activated by the two MSBs of the data byte and is shown in the data by adding 9,64,128 or 192 to the allophone number in the range 0 to 63. Be aware also that the MSBs of one byte affect the pitch of the preceding allophone not the one to which it belongs. To illustrate the effect of not using the pitch inflection, either turn the presets on the PCB to the set-up positions or subtract 64,128 or 192 as necessary from the data bytes and run the program again.

The ZX81 program will run on the basic 1K machine and you should have no problem saving it once you have input the data so that you can store phrases and re-enter them. With 16K + machines or other systems, you will probably find it easier to store the data in arrays or data statements as appropriate.

Interfacing to the 16K or 48K Spectrum should, in theory, be quite simple (but we have not tried it yet) and a possible location in the memory map would be right at the top. Make sure that the area occupied by the Mini-Mynah is not also used by Basic or whatever high level language you use on your system.

Word	Allophone	Code (decimal)
Zero	ZZ/YR/OW	43,60,53
One	WW/AX/AX/NN1	46,15,15,11
Two	TT2/UW2	13,31
Three	TH/RR1/IY	29,14,19
Four	FF/FF/OR	40,40,58
Five	FF/FF/AY/VV	40,40,6,35
Six	SS/SS/IH/IH/PA3/KK2/SS	55,55,12,12,2,41,55
Seven	SS/SS/EH/EH/VV/IH/NN1	55,55,7,7,35,12,11
Eight	EY/PA3/TT2	20,2,13
Nine	NN1/AA/AY/NN1	11,24,6,11
Ten	TT2/EH/EH/NN1	13,7,7,11
Eleven	IH/LL/EH/EH/VV/IH/NN1	12,45,7,7,35,12,11
Twelve	TT2/WH/EH/EH/LL/VV	13,48,7,7,45,35
Thirteen	TH/ER1/PA2/PA3/TT2/IY/NN1	29,51,12,13,19,11
Twenty	TT2/WH/EH/EH/NN1/PA2/PA3/TT2/IY	13,48,7,7,11,1,2,13,19
Hundred	HH2/AX/AX/NN1/PA2/DD2/RR2/IH/IH/PA1/DD1	57,15,15,11,1,2,33,39,12,12,0,21
Thousand	TH/AA/AW/ZZ/I H/PA1/PA1/NN1/DD1	29,24,32,43,12,0,0,11,21
Million	MM/IH/IH/LL/YY1/AX/NN1	16,12,12,45,49,15,11

Table 1 Some useful words as allophones.

Construction

Construction should pose no great problem here so long as care and sensible precautions are taken. The first thing to note is that the board is double sided but without plated through the holes. So some of the holes need wire links through them soldered on **both** sides. In other places the leads of decoupling capacitors must be soldered on both sides instead, this is necessary to complete the power supply wiring so make very sure it is done. We recommend the use of IC sockets especially for the more expensive devices. Make sure all polarised components are inserted the right way round. The order of construction we

- recommend is:—
1. wire links;
 2. IC sockets;
 3. decoupling capacitors;
 4. resistors, capacitors, diode, transistor, potentiometers;
 5. power connector;
 6. 34 way connector;
 7. ICs into sockets (after checking for shorts, etc.).
- Make doubly sure the ICs are the right way round, as they don't all point the same way. We used a fairly expensive 34-way connector for this project, but it did save us having to solder an awful lot of wires, and

BUYLINES

The SP0256-AL2 is available from Rapid Electronics; the PCB is available from our very own PCB service, and everything else is absolutely standard.

- NOTE:
- IC1 IS 74LS02
 - IC2 IS 74LS138
 - IC3 IS 74LS10
 - IC4 IS 6118
 - IC5 IS 6118
 - IC6,7,8 ARE 74LS193
 - IC9 IS 74LS245
 - IC10 IS 40103
 - IC11 IS SP0256
 - IC12 IS 74LS624
 - IC13 IS 74LS122
 - C1 IS BC212L
 - D1 IS 1N4148

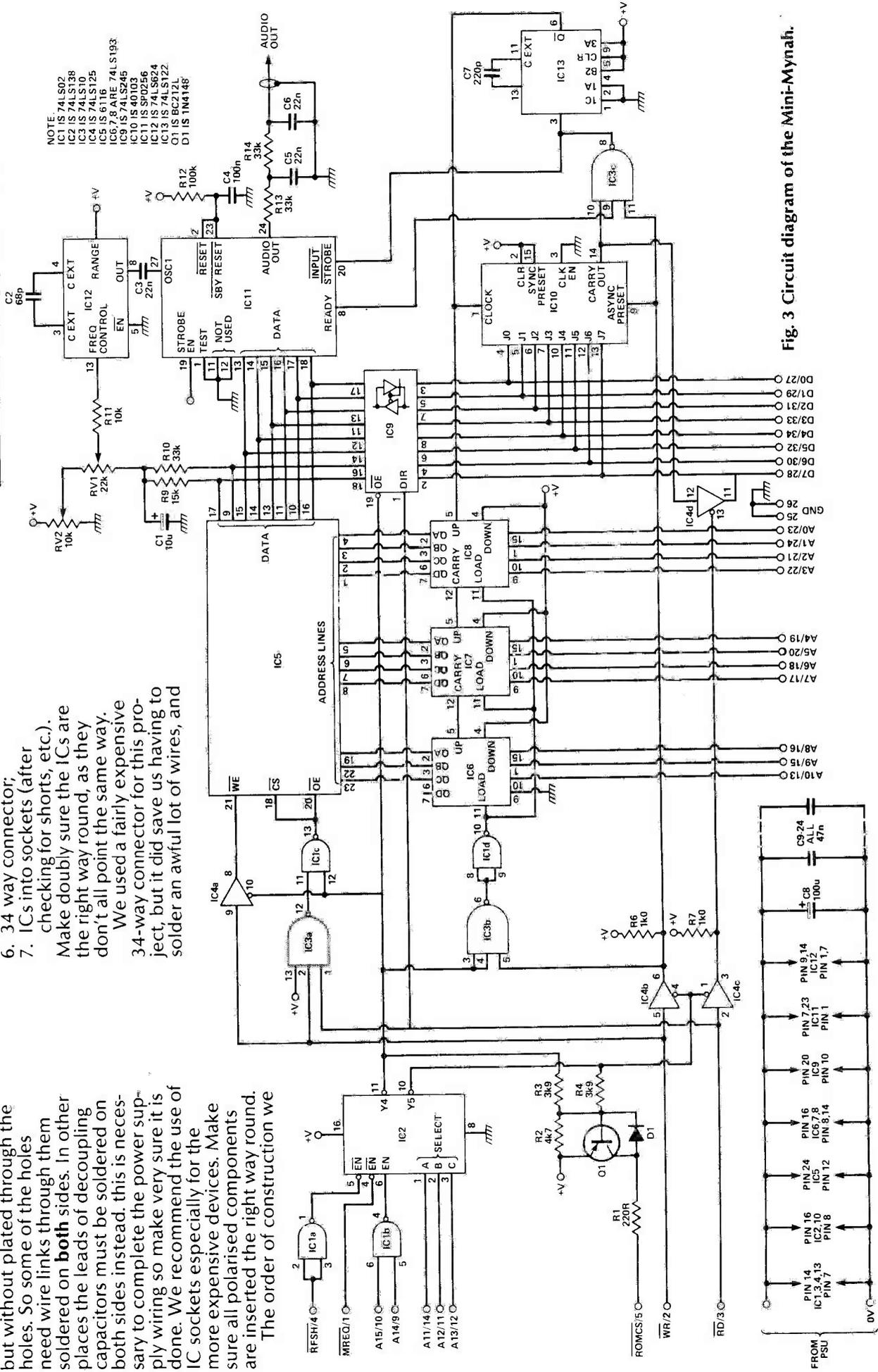


Fig. 3 Circuit diagram of the Mini-Mynah.

HOW IT WORKS

There are two main phases in the operation of this project: the first phase is the loading of the speech information into the memory (IC5); the second phase is the reading of the stored information by the speech processor to generate the required sounds. These two phases will be discussed in order.

In phase one, IC1,2 and 3 a and b are used to decode the control and more significant address lines from the computer interface. In this phase only pin 11 (Y4) of IC2 will be active (low). This enables data to be read from and written into the RAM (IC5) via the data buffer (IC9) and IC6, 7 and 8 which act as address buffers.

When IC1 pin 11 goes low, IC4a is enabled and the signal on the WR line is transferred to the WE input of IC5. Also while IC2 pin 11 is low, the CS and OE pins of IC5 are driven high by the output from IC1 pin 13 until either the WR or RD inputs to IC3a goes low, forcing IC3a pin 12 high and thus IC1c pin 12 low. This disables the RAM until a valid read or write condition is set up but it will keep the RAM in the READ mode when it is not being accessed externally.

The low on IC2 pin 11 enables the bidirectional bus buffer IC9 and also forces the output of IC1d low via IC3b. This condition causes the outputs of IC6,7 and 8 to follow the inputs from the address bus. These devices are actually four-bit binary counters which can be loaded asynchronously by taking their pin 11 low, which is the condition just described.

In phase two, once suitable data has been loaded into IC5, a WRITE operation is performed by the controlling computer such that IC2 pin 10 (75) is sent low and the WR input line is also low. Under these conditions the output of IC4b pin 6 will be low forcing the output of IC1d low via IC3b and thus loading the current contents of the lower 11 address lines into IC6,7 and 8. Also the low on IC4b output causes the contents of the data bus to be loaded into IC10 while holding the output of IC3c high.

At the end of the WRITE operation, the output of IC10 pin 14 (CARRY OUT) will normally be high indicating a non-zero count, the output of IC11 pin 8 (READY) will be high indicating that the speech generator is ready to accept data and since the output of IC4b will now be high the output of

it makes a neat and robust connection. There is nothing to stop you soldering ribbon cable direct to the board if you want to economise but make sure you tie it down securely to prevent breakages. Similarly, the power connector could be omitted if you wish.

Interfacing

Making the most effective use of this project requires a memory map space of 4K. If this can be in one block, things are much simpler; however, any method of presenting 8 data bits and 12 address bits together with READ, WRITE and SELECT (or SELECT) signals could be just as effective.

As designed, the project is very easily interfaced with Z80 systems especially the Sinclair ZX81. To assist with the connection to the ZX81, the Mini-Mynah generates a signal on the ROMCS line which pulls high via a 220R resistor when the device is being accessed. This signal temporarily turns off the ZX81 ROM to avoid a conflict between it and the devices we are adding. Whatever host computer is used, address lines A0 to A10 are used to access the 2K of on-board memory while A11 is low. When A11 is high the same address lines specify the starting address of the speech data string: A12,13,14,15, MREQ and RFSH are all treated as select lines and must be 0,1,0,0,0,1 respectively to enable any action to occur. This does not mean that all of them have to be driven individually, you may find it more convenient to use only one or two of them and connect the rest to +ve or -ve as appropriate. The RD and WR signals must be provided by your control

system. If you have only a single R/W line you must provide an inverter for the RD signal.

The data lines, D0 to D7, can be considered as standard except that when doing a READ operation with A11 high (examining the status flag) only D7 will be active (high or low), the others will be floating at undefined levels. Also in this type of operation the address lines A0 to A10 will be irrelevant as the same data is returned whichever address is accessed.

Setting Up

After building up the board and carefully checking it through for wrongly placed components, etc, set RV1 fully clockwise and RV2 fully anti-clockwise, connect an audio amplifier to the output terminal and apply power. You will probably hear a random selection of burlbles, hisses and squawks — this means that the Mini-Mynah is working; the noise should stop after a short while. If this does not happen, switch off and try again before carrying out the usual checks for component orientation, broken or shorted tracks, etc.

When it works thus far, connect it to your computer (make very sure of your connections), power up the Mini-Mynah and then power up your ZX81 or whatever you are using. Once the noise has stopped (a momentary short across C4 will clear the last noise of the sequence) you are ready to try it out. Use the demo program or something similar to put data into the RAM and away you go. Try the effect of varying RV1 and RV2 until you find the best result. The sound can vary from a rapid robot voice to a growling monster-from-the-swamp effect.

Speech Synthesis

The spoken word is a very effective way of communicating information in small quantities to and from humans. For many years and for many reasons people have been trying to imitate the sounds of speech. Early attempts used collections of (mechanical) valves, pipes, resonators and noise sources which were thought to approximate to the human vocal tract. Later on these models could be implemented electronically which greatly eased the control problems.

Another system of making machines talk was also tried in which short sections of actual speech were preserved in some recording medium and played back in the sequence required. A notable example of this type of machine was the GPO (as it was then) speaking clock, TIM. This started life with the phrases recorded on glass discs.

With the boom in popularity

enjoyed by the home computer has come the demand for speech synthesis systems which allow them to communicate with people. This can be done relatively easily by recording words and phrases in digital form (PCM — pulse code modulation) and playing them back on demand. The trouble with this is that to get good quality speech requires typically 70,000 bits of data per second. Methods have been developed which reduce this requirement (for example, LPC — linear predictive coding) by predicting what happens next partly from what has gone before, but even here the data rate is of the order of one to two thousand bits per second.

The first two methods described often have the feature that speech is available only in pre-set words or phrases; this of course makes them easy to use but on the other hand sets a limit to their applicability. Also, while memory devices are getting

cheaper all the time, they take up space and consume power.

The allophone method breaks down speech sounds into individual components, so that a word such as 'zero' would have its sound broken into three parts — one for the z sound, one for the er sound and one for the o; the individual speech components are called allophones.

There are a very large number of potential allophones, as many different sounds as the human voice can generate! However, for any one language, the number of sounds used (or, rather, the number of distinguishably different sounds used) is relatively small. In this case, it is necessary for a speech synthesiser to be told a reference number for each of the three or more allophones it has to produce per second, and this reduces the bit rate to around 100 bits per second. However, the allophones themselves are fairly complex, so

Sound Type	Symbol	Code	Duration	Example	Notes	
Silences	/PA1/	00	0	10ms		
	/PA2/	01	1	30ms		
	/PA3/	02	2	50ms		
	/PA4/	03	3	100ms		
	/PA5/	04	4	200ms		
Short vowels	/IH/	0C	12	70ms	sIt	
	/EH/	07	7	70ms	End	
	/AE/	1A	26	120ms	hAt	
	/UH/	1E	30	100ms	bOOk	
	/AO/	17	23	100ms	AUght	
	/AX/	0F	15	70ms	sUcceed	
	/AA/	18	24	100ms	hOt	
Long Vowels	/IY/	13	19	250ms	sEE	
	/EY/	14	20	280ms	trAy	
	/AY/	06	6	250ms	kItE	
	/OY/	05	5	420ms	vOIce	
	/UW1/	16	22	100ms	tO	
	/UW2/	1F	31	260ms	fOOd	
	/OW/	35	53	240ms	zOne	
	/AW/	20	32	370ms	dOWn	
R-coloured vowels	/ER1/	33	51	160ms	lettER	
	/ER2/	34	52	300ms	fERn	
	/OR/	3A	58	330ms	fORTune	
	/AR/	3B	59	290ms	alARm	
	/YR/	3C	60	350ms	hEAR	
	/XR/	2F	47	360ms	stARe	
Resonants	/WW/	2E	46	180ms	We	(See also /WH/)
	/RR1/	03	14	170ms	Read	
	/RR2/	27	39	130ms	cRane	
	/LL/	2D	45	110ms	Like	
	/EL/	3E	62	190ms	angLE,	squirrEl
	/YY1/	31	49	130ms	cUte,	compUter (Y-sound)
	/YY2/	19	25	180ms	Yes	

Table 2 The allophones that the sound generator IC used offers.

PROJECT : Sound Board

what is needed is a table where the generator can 'look up' the composition of the allophones it is being required to produce. The data that is sent to the speech processor is not, therefore, the actual allophones themselves, but the address (or a pointer to the address) of the code for the allophone, which is stored within the device itself.

The device used here does not use PCM or LPC, as these systems would still require a very large amount of stored data. The data is actually used by the on-board processor which controls noise sources and filters, as well as the basic tone generators. The quality of speech produced is not as good as PCM or LPC systems, but it is quite intelligible.

The device used is the SP0256-AL2 which provides us with a set of 64 allophones. This imposes some restriction on what we can do, but this is not too severe.

It should be understood that in a language such as English, there is no absolute correspondence between what is written and the sounds generated when the same word is spoken. Also, it is often difficult to decide where one sound finished and another starts. To some extent the same basic sound will vary a little depending on its position within a word and also on what sounds are adjacent to it.

When programming the Mini-Mynah it is necessary to decide what sounds you require rather than the letters or words as written. Experiment with alternatives where they are available to get the right sound in the right position. Table 2 shows the 64 speech sounds available from the SP0256-AL2. These are broken down into groups of similar types and are shown with their decimal and hexa-decimal addresses (these correspond to the six LSBs of the data you put into the on-board RAM).

The table also shows the duration of each sound at a nominal 3.12 MHz clock frequency and gives an example or two of the sound in a word context. Notice that alternatives are given for some sounds and that short pauses are recommended before some and after others to make them effective. Try the example words to get a feel for what constructions are needed in different circumstances.

Once you have mastered the allophone set, and can produce understandable speech, you are ready to give it some life. This is where the two MSBs of the data come in. With these you can change the pitch (and duration) of the allophone immediately preceding the one whose six LSBs you are setting. By experimenting carefully, you should be able to make much more natural sounding speech rather than the monotonous, flat sound usually associated with computer speech.

Sound Type	Symbol	Code	Duration	Example	Notes
Voiced Fricatives	/VV/	23 35	190ms	Vest	
	/DH1/	12 18	290ms	THis	
	/DH2/	36 54	240ms	baTHe	
	/ZZ/	2B 43	210ms	Zoo	
	/ZH/	26 38	190ms	pleaSure,	
Voiceless Fricatives	/FF/	28 40	150ms	Food	} These allophones may be used doubly for initial or singly for final positions.
	/TH/	10 29	180ms	THin	
	/SS/	37 55	90ms	veST	
	/SH/	25 37	160ms	SHip	
	/HH1/	1B 27	130ms	He	
	/HH2/	39 57	180ms	Hoe	
	/WH/	30 48	200ms	WHig	
Voiced stops	/BB1/	1C 28	80ms	riB	} Usually need 10-30ms silence preceding these.
	/BB2/	3F 63	50ms	Beast	
	/DD1/	15 21	70ms	enD	
	/DD2/	21 33	160ms	Down	
	/GG1/	24 36	80ms	Guest	
	/GG2/	3D 61	40ms	Got	
Voiceless Stops	/GG3/	22 34	140ms	peG	} Usually need 50-80 ms silence preceding these.
	/PP/	09 9	210ms	Pow	
	/TT1/	11 17	100ms	parTs	
	/TT2/	0D 13	140ms	To	
	/KK1/	2A 42	160ms	Can't	
Affricatives	/KK2/	29 41	190ms	speaK	
	/KK3/	08 8	120ms	Crane	
	/CH/	32 50	190ms	CHurCH	
Nasal	/JH/	0A 10	140ms	JudGe	
	/MM/	10 16	180ms	Milk	
	/NN1/	0B 11	140ms	thiN	
	/NN2/	38 56	190ms	No	
	/NG/	2C 44	220ms	aNGer	

Table 2 continued.

PROJECT : Sound Board

PARTS LIST

RESISTORS (1/4W 5% carbon film)

R1 220R
 R2 4k7
 R3,4 3k9
 R5 6,7,8 1k0
 R9 15k
 R10,13,14 33k
 R11 10k
 R12 100k
 RV1 22k lin min. horiz. preset
 RV2 10k lin min. horiz. preset

CAPACITORS

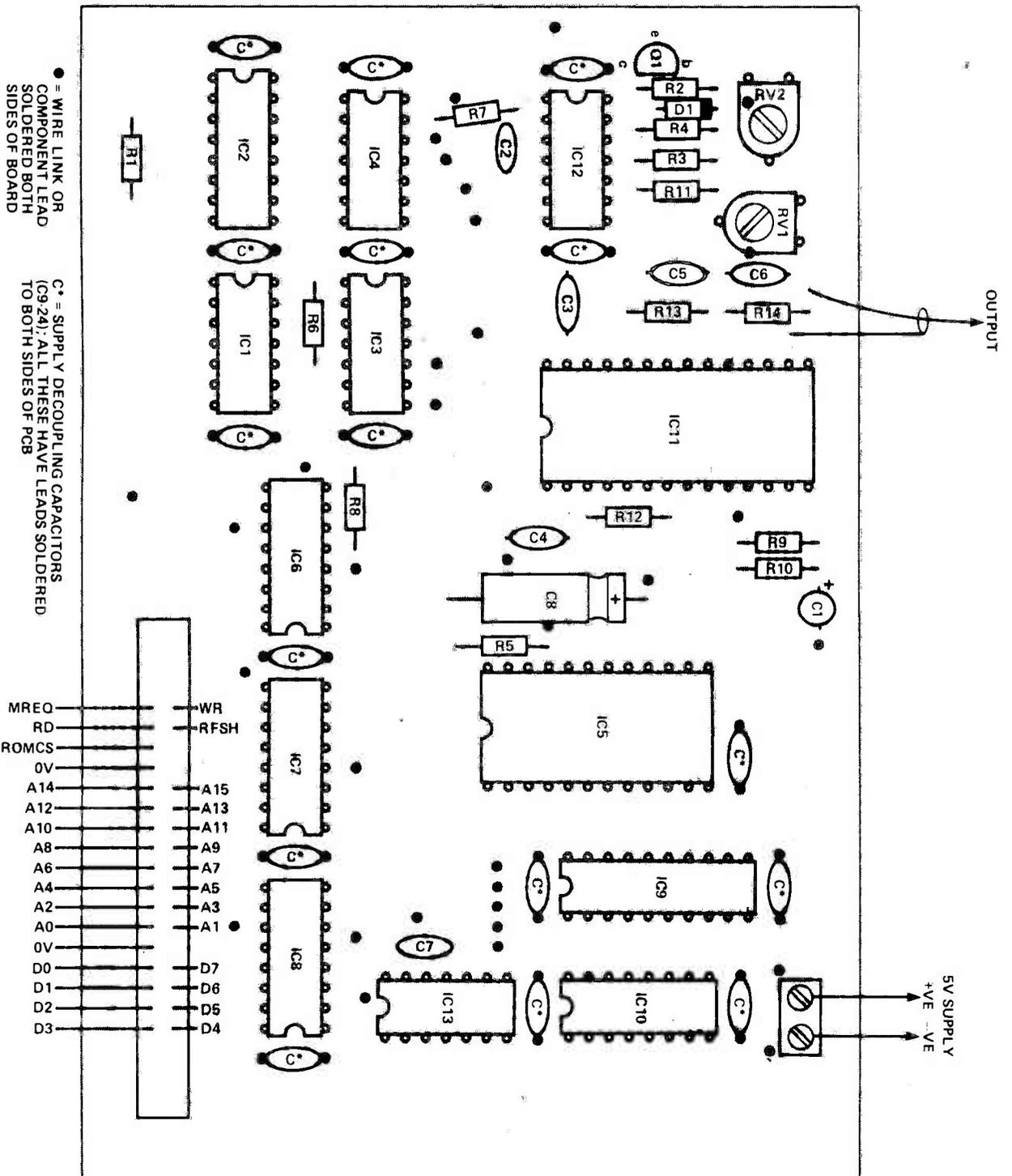
C1 10 μ F 25V tantalum bead
 C2 68pF
 C3,5,6 22nF
 C4 100nF
 C7 220pF
 C8 100 μ F 16V axial electrolytic
 C9,24 47nF ceramic

SEMICONDUCTORS

IC1 741S02
 IC2 741S138
 IC3 741S10
 IC4 741S125
 IC5 6116
 IC6,7,8 741S193
 IC9 741S245
 IC10 40103
 IC11 SP0256-A12
 IC12 741S624
 IC13 741S122
 Q1 BC212L
 D1 1N4148

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Z80 DRAM

We publish a superb project like Bob Campbell's 64K DRAM board for 6502/6800 systems and instead of gratitude, all we get are hundreds of letters asking for a Z80 version. Here it is then, you ungrateful lot, and don't forget to say "thank you"!

When I set out to design the DRAM Board (published in ETI Sept. 83) I had no intention of considering its use with the Z80 processor. However, the question "Can it be done?" provides a good introduction to the many considerations that must be given to the peculiarities of the Z80 when designing almost anything for it, not least a dynamic memory system.

Since this is to be an add-on or an extension to an existing system we must first consider the probable target system and the alternative solutions to the 'maximum memory objective'.

Probable target computers include:

- Z80 Systems with some dynamic memory, 16K eg. TRS-80, Video Genie;
- Z80 systems with little or no memory, eg. Home Brews, μ -Professor;
- ZX80, ZX81, ZX Spectrum, are not worth considering as they already have very comprehensive and cheap support.

There are three distinct solutions to satisfy the first two users. They are:-

1. Modify the DRAM Board to suit the Z80.
2. Design a new board to take in all the advantages of the Z80 using similar techniques and with the same overall objectives.
3. Replace and extend an existing 4116 based system with 64K chips (this applies to the first user only) using the original PCB, with either complete re-decoding

using a PROM or modifying the existing TTL decoding on board. This option will probably end up with the system ROM still within the memory map, ie. decoding 16K blocks and upgrading to 48K from 16K.

Modifying the DRAM Board

Consulting the circuit diagram from the original article, it can be seen that only three signals other than the address and data buses are taken from the system. These are R/W, $\Phi 1$ and $\Phi 2$. To use the board with the Z80 these signals must be mimicked in such a way that they satisfy both the requirements of the board and the processor itself.

Assuming for the moment that the discrete refresh counter, IC1, is to be retained, then the following observations can be used as a guide to the final design:

R/W — this signal is high during a read cycle and low during a write to memory cycle;

$\Phi 1$ — this signal, or more accurately, the rising edge of it initiates the refresh cycle, and also clocks the refresh row address counter;

$\Phi 2$ — this is slightly more complex as it signifies both a valid address and the start of a memory access cycle, read or write.

Obviously the R/W line is the simplest and in fact WR can be substituted directly in its place. RFSH, the Z80 signal, performs a similar function to $\Phi 1$ although

it is inverted, ie negative true, and thus must be inverted before substitution. MREQ is very similar to $\Phi 2$ although again it is inverted, ie active low. One other slight complication is that MREQ becomes active during the refresh cycle RFSH. Obviously this situation must be distinguished from a true memory access cycle.

Combining all these conditions, the two necessary logical signals can be arrived at, namely MC and RC Memory and Refresh cycle start; note that both have active rising edges. The two equations are:-

$$\overline{\text{MREQ}} \text{ and } \overline{\text{RFSH}} = \text{MC}$$

$$\overline{\text{RFSH}} = \text{RC}$$

These two equations can be resolved into a logical circuit in the usual way, ie, hard slog, copy someone else, intuitively or by guess work. However it is arrived at, it should look something like Fig. 1. The prime (') on any signal indicates that it is a substitute.

This solution will work in principle; however the timing constraints of the board as a whole,

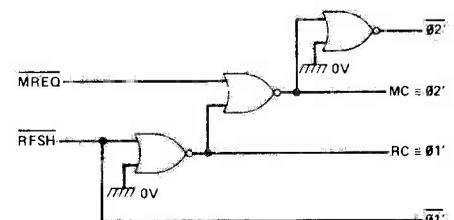


Fig. 1 Generation of $\Phi 1$ and $\Phi 2$ from RFSH and MREQ.

and particularly those of the 74LS608, are such that it will probably not work without adjusting the timing components around IC17.

A slightly better solution becomes apparent from the timing diagrams of the Z80. Consider the same situation which we have just tried to avoid, MREQ becoming active during RFSH. Taking cycle T3 in Fig. 2,

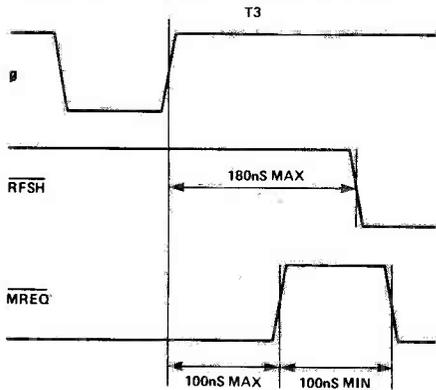


Fig. 2 Diagram showing the timing of the Z80's MREQ and RFSH functions.

only in the worst possible case can MREQ become active before RFSH. Thus MREQ could be used as a cycle start directly, and that means for both refresh and memory access cycles. In fact most systems using dynamic memory use MREQ as RAS and generate ROW/COL and CAS by delay lines from that active edge. Delay lines are to be avoided if at all possible, but unfortunately this is not always so in DRAM design. The second solution now looks like Fig. 3; this is much simpler than all the others and should work very

well, in theory at least. The need for the two signals $\Phi 1$ and $\Phi 2$ to control the address and data buffers means that the circuit is still more complex than it might be.

Further improvements can still be made to the circuit by using the Z80's on chip refresh row address counter.

During RFSH, the CPU puts out on the lower seven address lines a refresh row address which is cycled through 0-128, incrementing once every M1 cycle. Using this address the 393, IC1, can be dispensed with, and the 244 that goes with it, IC2. Since the Z80 refresh address is only seven bits wide, the TMS 4164 cannot be used as it requires an eight bit, 256 cycle refresh. The 4864 64K x 1 bit memory and its derivatives (see Table 1) use a 128 cycle 2ms refresh cycle and thus only require seven refresh address bits, and these should be used instead.

Using the Z80 refresh address counter in this way requires the primary address buffer IC 11 to be enabled on both the refresh and memory access cycles, and the address multiplexers, IC 12 and IC 14, to present the lower 8 bits A0-A7 and the upper 8, A8-A15, of any address separately. In other words, the lower 8 should be on the "a" side and the upper 8 on the "b" inputs to the multiplexers, or vice versa but not intermixed. All these modifications could be made, and the timing corrected to suit and a PROM programme devised etc,

but unless there is a pressing reason for the DRAM board to be used in this way for a Z80 application, I would advise against it. There is a great deal more to be gained by using a purpose designed Z80 RAM Board.

Such a design is presented here and the advantages are clear, but first some notes on converting the 16K 4116 system such as that of a TRS-80 or Video Genie.

16-48K Upgrade

Those computers already using the 4116 dynamic RAMs obviously have the necessary circuitry to produce the signals to drive the RAMs properly. Those signals, including the address multiplexing, are usually controlled by the decoding circuitry, by gating either CAS and/or the enable for the output/input buffers. The main difference between a 16K 4116 and a 64K 4864 memory array is the 'width' of the decoding, A7 and the supply rails. Looking at the pin configuration of the two RAM chips reveals that only three pins are different, see Fig. 4. So with the minimum of modifications it is a relatively simple matter to swap the two using the original PCB.

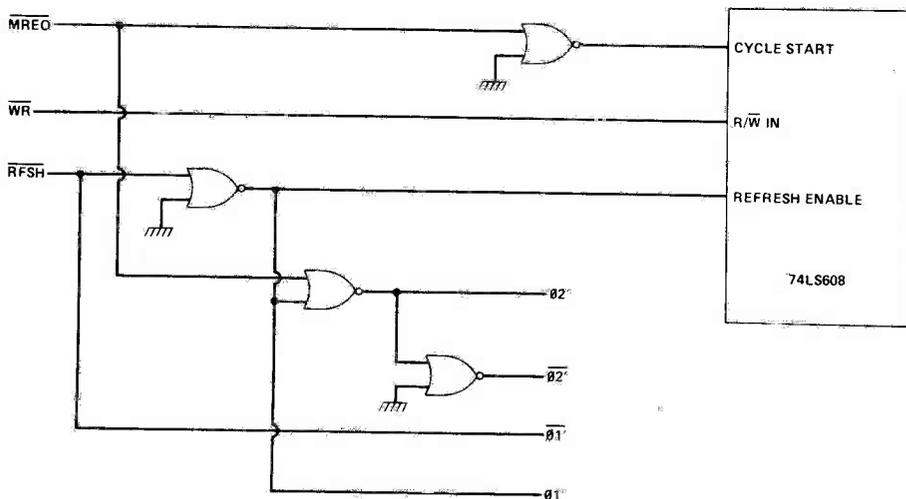


Fig. 3 Using MREQ as a direct start for both refresh and memory access cycles.

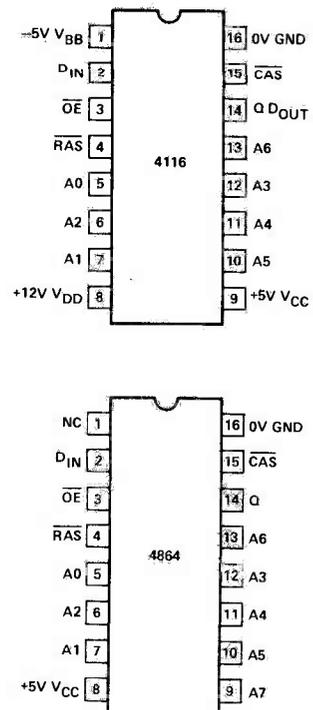


Fig. 4 Pinouts of the 4116 and 4864 DRAMs.

PROJECT: Z80 DRAM

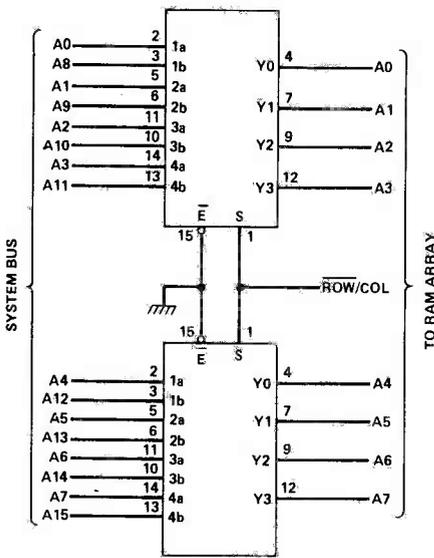


Fig. 5 Modified address multiplexer arrangement.

Modifying the power supply lines is the first and the simplest of the changes necessary:

PIN 1 $V_{bb} - 5V$: this track should be disconnected, at both ends of the RAM array, from the $-5V$ supply; furthermore all the capacitors on this line between it and either ground, $+5V$ or $+12V$ should be removed. The track now takes no further part in the circuit until we upgrade to 256Ks!

PIN 8 $V_{dd} + 12V$: this now becomes the $+5V$, ie V_{cc} , line on the 4864; thus it should be disconnected from the original $+12V$ supply and reconnected to a suitable point on the computer's $+5V$ circuit. Any capacitors between it and ground should be retained; there is usually one per IC, and if there is not, additional ones should be added; $1 \mu F$ tants or $0.1 \mu F$ MKC will do.

PIN 9 $V_{cc} + 5V$: finally, this track becomes the additional address line A7. It should be disconnected from the $+5V$ supply and all the attached capacitors removed. The now isolated track should be connected to the unused output of the address multiplexers. Normally these are a pair of 74LS157s. The remainder of the circuitry around the RAM array is identical to the original 4116 regime.

The modification to the address multiplexers, which usually consist of two 74LS157s, is dependent upon the specific system. The normal approach is to have only A0-A13

inclusive connected to the inputs of the multiplexers. Both A14 and A15 must now be added to these and should just correspond to the new output just connected to A7 pin 9 on the RAMs. Thus the final circuit should look something like Fig. 5. The main thing is that A0-A6 are all on one side of the multiplexer's inputs, ie, all a's or all b's.

Finally, the last modification is to the decoding circuitry, and this is probably the most machine dependent modification of all. Of the numerous systems in use, the most common is to gate the CAS signal to the appropriate RAM block through a tri-state buffer. It is necessary only to increase the decoding to enable the new areas of RAM.

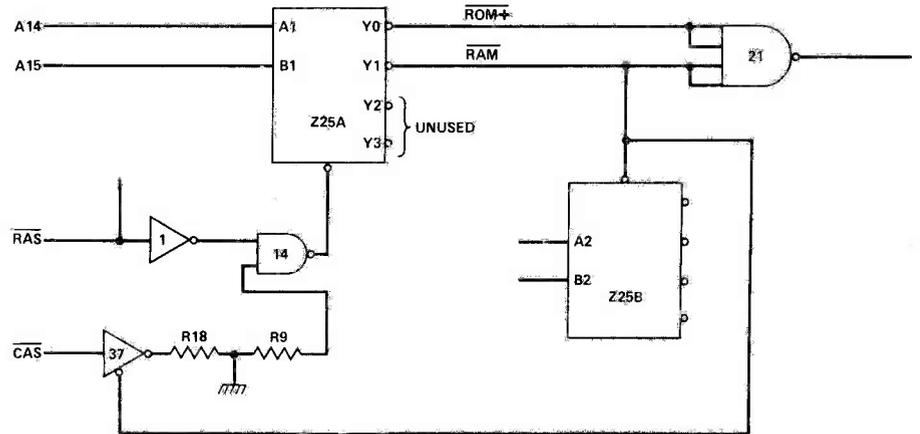


Fig. 6 Decoding circuitry of the Video Genie a) before and b) after modification.

Type No.	Manufacturer	Refresh Cycle		
TMS 4164	Texas Inst.	8 bit	256 cycle	4 ms
TMM 4164	Toshiba	7	128	2
HYB 4164	Siemens	8	256	4
2164	Intel	7	128	2
HM 4864	Hitachi	7	128	2
MCM 6664A	Motorola	7	128	2 or pin 1
MCM 6665A	Motorola	7	128	2
μPD	NEC			
MK	Mostek			
IMS 2600	Inmos	8	256	4
NCM 4164	National Semi.	8	256	4
F 4164	Fairchild	8	256	4
MB 8264	Fujitsu			
MB 8265	Fujitsu			
MSM 3764	OKI Semi.			
			pin 1	

Table 1 Comparison of 64K DRAMs.

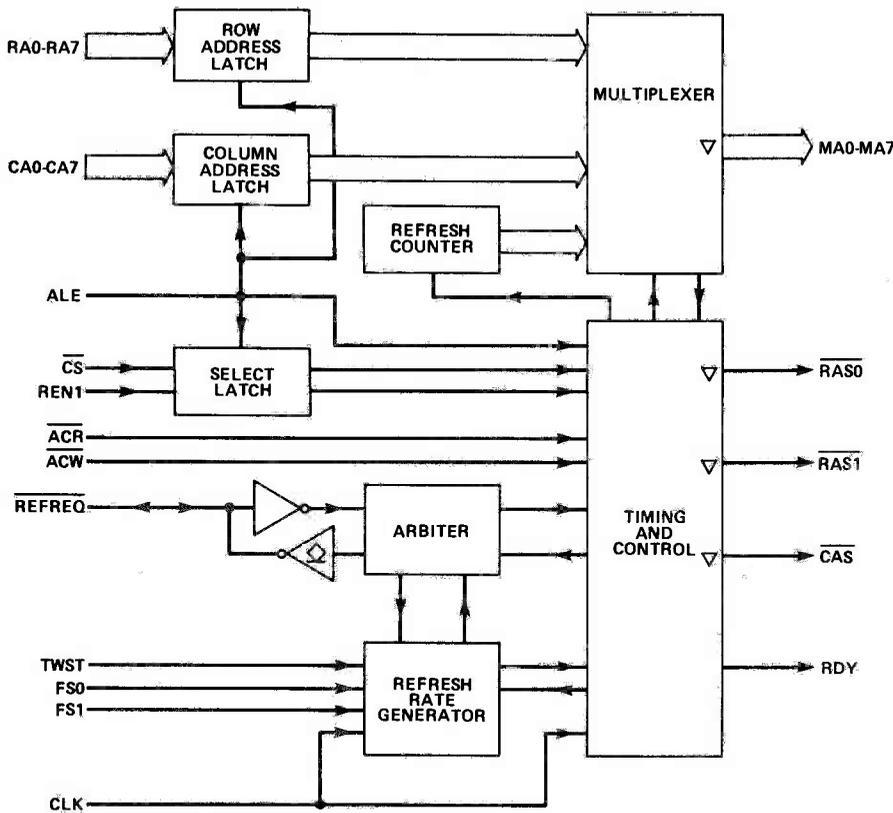
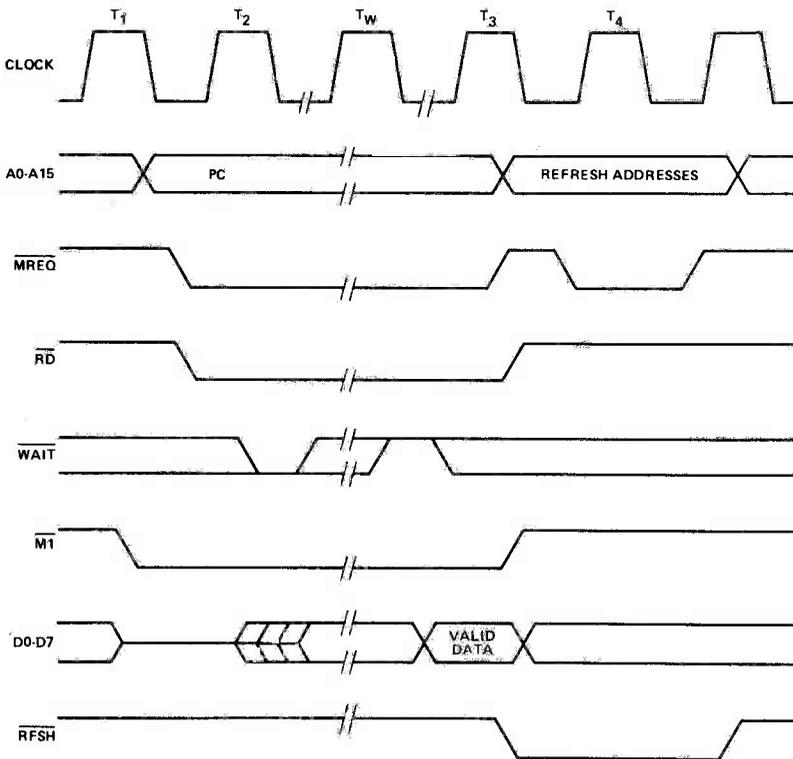


Fig. 7 Block diagram of the TMS 4500A DRAM controller.



NOTE: T_w —WAIT CYCLE ADDED WHEN NECESSARY FOR SLOW ANCILLIARY DEVICES

Fig. 8 Timing diagram of the Z80 CPU.

There are two distinct ways of doing this; one is to extend the existing decoding and the other is to use a PROM in a way similar to the original DRAM Board design. The latter approach would follow almost exactly the DRAM design, and those of you wishing to attempt that will find enough information in the original article.

The much simpler approach, if not as profitable in terms of added memory, is to modify the existing decoding. Normally the memory map is decoded into four 16K blocks at the primary decoding level, and by using the unused blocks within the memory map the usable RAM can be expanded. Using the Video Genie as an example, the original circuit is shown in Fig. 6a, and the modified one in Fig. 6b. In the latter the two unused outputs of the 74LS139 (Z25) are combined to give a total RAM area of 48K. Note that there is an unused 16 pin socket on the main PCB which can be used for the additional IC.

It can be seen then that the 4864/4116 replacement technique is relatively simple and produces a very neat and reliable 32K expansion to the average system. To go further than the 32K addition requires more effort and the advantages of retaining the RAM on the original PCB become less: the purpose-built Z80 64K RAM card then comes into its own. As with the original DRAM Board design, it can be designed to be as flexible as possible, thus allowing for all the vagaries that can and do exist in the original target system. The power on jump vector, which tricks the CPU into thinking that there is EPROM at 0000 hex at restart only where there is actually RAM, is the most common difficulty to overcome. Note that this is a must for CP/M systems.

The concluding part of this article in next month's ETI will describe the new DRAM board for use with Z80 microprocessors.

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BC308	58-00308	0.08
BC309	58-00309	0.08
BC327	58-00327	0.13
BC337	58-00337	0.13
BC413	58-00413	0.10
BC414	58-00414	0.11
BC415	58-00415	0.10
BC416	58-00416	0.11
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2N2905	58-02905	0.25
2N3905	58-03905	0.10
2SB646A	58-03646	0.30
2SB648A	58-03648	0.40
2SD666A	58-03666	0.30
2SD668A	58-03668	0.40
2SA872A	58-02872	0.19
2SA1084E	58-01084	0.25
2SA1085E	58-01085	0.25
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W005	12-10506	0.28
IN4001	12-40016	0.06
IN4002	12-40026	0.07
IN4004	12-40046	0.07
IN4148	12-41486	0.05
IN5404	12-54046	0.16
IN6263	12-62637	0.62

Varicap

Device	Stock No.	Price
BA102	12-01025	0.30
BA121	12-01215	0.30
BB105B	12-01055	0.30
BB109B	12-01095	0.27
BB204B	12-02045	0.36
BB212	12-02125	1.95
ITT210	12-02105	0.30
MVAM115	Use KV1235	
MVAM125	Use KV1225	
KV1210	12-12105	2.45
KV1211	Use KV1236	
KV1225	12-12255	2.75
KV1235	12-12355	2.75
KV1236	12-12365	2.55
KV1310	12-13105	0.40
KV1320	12-13205	0.40

INTEGRATED CIRCUITS Linear

Device	Stock No.	Price
LM10CN	61-00010	3.86
LM10	61-00011	5.06
L149	61-00149	1.86
ZNA234	61-02340	8.50
U2378	61-00237	1.28
U2478	61-00247	1.28
U2578	61-00257	1.28
U2678	61-00267	1.28
LM301AH	61-03010	0.98
LM301AN	61-03011	0.44
LM308CN	61-03081	0.85
LM311CN	61-03111	0.46
LM324	61-03240	0.48
LM339N	61-03390	0.68
LM346	61-00346	3.72
LF347	61-00347	1.82
LM348	61-03480	1.28
LF351	61-03510	0.49
LF353	61-03530	0.76
LM380N	61-00380	1.00
LM381	61-00381	1.81
LM382	61-00382	1.81
ZNA19CE	61-00419	1.98
ZNA423	61-02420	1.40
ZNA25E/B	61-04250	4.50
ZNA28E/B	61-04280	3.48
ZNA27E/B	61-04270	6.80
ZNA28E/B	61-04280	5.50
ZNA29E/B	61-04290	2.50

Device	Stock No.	Price
ZN432CJ10	61-04320	29.90
ZN433CJ10	61-04330	24.79
ZN450E	61-04500	7.61
NE542	61-05420	1.20
NE544	61-05444	1.80
NE555N	61-05550	0.21
NE556N	61-05560	0.50
SL560C	61-05600	2.24
NE564	61-05644	4.29
NE565	61-05655	1.00
NE566	61-05666	1.40
NE567	61-05667	1.30
NE570N	61-05707	3.85
UA709HC	61-07090	0.64
UA709PC	61-07091	0.52
UA710HC	61-07100	0.64
UA710PC	61-07101	0.59
UA711CN	61-07110	0.85
UA7141CH	61-07410	0.66
UA7091C	61-07411	0.22
UA741CN	61-07470	0.70
UA748CN	61-04780	0.40
UA758	61-00758	2.35
TBA820M	61-00820	0.78
TD4102B	61-01028	2.11
TD4102S	61-01029	2.11
ZNA1034	61-01034	2.10
LM1035	61-01035	4.50
LM1054M	61-01054	1.45
TD41062	61-01062	1.95
TD41072	61-01072	2.69
TD41074A	61-01074	5.04
TD41083	61-01083	1.95
TD41090	61-01090	3.05
HA1195	61-01196	2.00
HA1197	61-01197	1.00
LM11220	61-01120	1.40
LM1303	61-01303	0.95
MC1310P	61-01310	1.20
MC1330	61-01330	1.20
MC1350	61-01350	1.20
HA11370	61-11370	1.90
HA1388	61-01388	1.75
LM1458N	61-14580	0.45
MC1496P	61-01496	1.25
SL1610	61-01610	2.10
SL1611	61-01611	2.60
SL1612	61-01612	2.10
SL1613	61-01613	2.10
SL1620	61-01620	2.17
SL1621	61-01621	3.50
SL1623	61-01623	3.50
SL1625	61-01625	1.90
SL1630	61-01630	1.62
SL1640	61-01640	3.50
SL1641	61-01641	3.50
MC1648	61-01648	3.25
TD42002	61-02002	1.25
ULN2240	61-02240	3.25
ULN2242	61-02242	3.05
ULN2283	61-02283	1.00
CA3080	61-03080	0.96
CA3089	61-03089	1.84
CA3123	61-03123	1.40
CA3130E	61-31300	0.80
CA3130T	61-31301	0.90
CA31400	61-31400	0.46
CA3189E	61-03189	2.20
CA3240E	61-32400	1.27
MC3357	61-03357	2.85
MC3359	61-03357	2.85
ULN3859	61-03859	2.95
KM3701	61-03701	85.53
KM3702	61-03702	74.84
LM3900	61-39000	0.80
LM3909N	61-39090	0.88
LM3914	61-03914	2.80
LM3915N	61-03915	2.80
KB4400	61-04401	0.90
KB4412	61-04412	1.95
KB4413	61-04413	1.95
KB4417	61-04417	1.80
KB4420B	61-04420	1.09
TD44420	61-14420	2.85
TD44421	61-14421	2.85
KB4423	61-04423	2.30
KB4424	61-04424	1.65
KB4430	61-04430	2.30
KB4431	61-04431	1.95
KB4432	61-04432	1.95
KB4433	61-04433	1.72
KB4436	61-04436	1.53
KB4437	61-04437	1.75
KB4438	61-04438	2.22
KB4441	61-04441	1.35
KB4445	61-04445	1.29
KB4446	61-04446	2.75
KB4448	61-04448	1.85
NE5044	61-05044	2.28
MC5229	61-05229	8.60
NE5532	61-55320	2.20
KM5624	61-05624	4.35
SD6900	61-05900	3.75
SL6270	61-06270	2.90
SL6310	61-06310	2.00
SL6600	61-06600	3.75
SAS6610	61-06610	1.48
SL6640	61-06640	2.80
SL6690	61-06690	3.75
SL5700	61-06700	3.20
SAS6710	61-06710	1.48
ICM7555	61-75550	0.88
ICL8038CC	61-80380	4.50
MSL9362	61-09362	1.75

Device	Stock No.	Price
MSL9383	61-09363	1.75
TK10170	61-10170	1.87
TK10321	61-10321	2.75
HA11223	61-11223	2.15
HA11225	61-11225	1.45
HA12002	61-12002	1.22
HA12017	61-12017	1.95
HA12402	61-12402	0.80
HA12411	61-12411	1.20
HA12412	61-12412	1.55
LF13741	61-13741	0.33
MC14412	61-14412	6.86
MK50366	61-50366	3.35
MK50375	61-50375	3.85
MM53200	61-53200	3.90

Prescalers, Freq Display Synthes

Device	Stock No.	Price
U264	61-02640	2.27
U265	61-02650	3.16
U266	61-02660	2.43
11C900D	61-01190	12.95
MSL2312R	61-02312	3.94
MSM5523	61-05523	11.30
MSM5524	61-05524	11.30
MSM5525	61-05525	7.85
MSM5526	61-05526	7.85
MSM55271	61-55271	9.75
ICM7106CP	61-07106	9.55
LC7137	61-07137	7.50
MC7216B	61-72161	23.95
ICM7216C	61-72162	23.95
SP8629	61-08629	3.85
SP8647	61-08647	6.00
SP8793	61-08793	7.40
HD10551	61-10551	2.75
HA12009	61-12009	6.00
MC12016	61-12016	6.90
HD44015	61-44015	4.45
HD44752	61-44752	8.00
MC14515P	61-14151	6.00
MC145152P	61-14152	12.30
MC145156P	61-14156	4.80

VOLTAGE REGULATORS

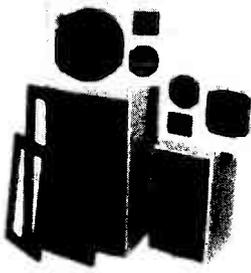
Device	Voltage	Stock No.	Price
7805	+5V	27-78052	0.40
7806	+6V	27-78062	0.40
7808	+8V	27-78082	0.40
7812	+12V	27-78122	0.40
7815	+15V	27-78152	0.40
7818	+18V	27-78182	0.40
7824	+24V	27-78242	0.40
7905	-5V	27-79052	0.49
7906	-6V	27-79062	0.49
7908	-8V	27-79082	0.49
7912	-12V	27-79122	0.49
7915	-15V	27-79152	0.49
7918	-18V	27-79182	0.49
7924	-24V	27-79242	0.49
78L05	+5V	27-78050	0.40
78L06	+6V	27-78060	0.40
78L08	+8V	27-78080	0.40
78L12	+12V		



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Purposely 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 x 218 x 445mm
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Designer approved flat pack cabinet kits including grill fabric. Can be finished with iron on veneer or self adhesive vinyl etc.
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THREE QUALITY POWER LOUD-SPEAKERS (15", 12" and 8" See Photo) ideal for both Hi-Fi and Disco applications. All units have attractive cast aluminium (ground finish) living escutcheons. Specification and Prices.

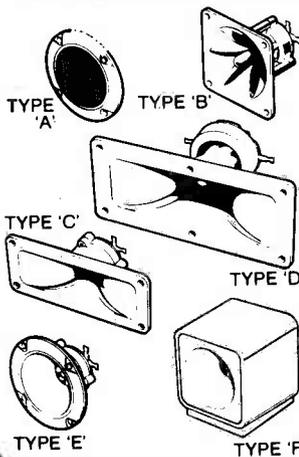
15" 100 watt R.M.S. Impedance 8 ohms. 50 oz. magnet. 2" aluminium voice coil. Res. Freq. 20 Hz. Freq. Resp. to 2.5KHz. Sens. 97dB. Price: £34.00 each + £3.00 P&P
12" 100 watt R.M.S. Impedance 8 ohms. 50 oz. magnet. 2" aluminium voice coil. Res. Freq. 25Hz. Freq. Resp. to 4 KHz. Sens. 95dB. Price: £24.50 each + £3.00 P&P
8" 50 watt R.M.S. Impedance 8 ohms. 20 oz. magnet. 1 1/2" aluminium voice coil. Res. Freq. 40Hz. Freq. Resp. to 6 KHz. Sens. 92dB. Black Cone. Price: £9.50 each. Also available with black protective grille Price: £9.99 each. P&P £1.50.

12" 85 watt R.M.S. McKENZIE C1285GP (LEAD GUITAR, KEYBOARD, DISCO) 2" aluminium voice coil, aluminium centre dome, 8 ohm imp., Res. Freq. 45Hz., Freq. Resp. to 6.5KHz., Sens. 98dB. Price: £23.00 + £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: £23 + £3 carriage.
15" 150 watt R.M.S. McKENZIE C15 (BASS GUITAR, P.A.) 3" aluminium voice coil. Die cast chassis. 8 ohm imp., Res. Freq. 40Hz., Freq. Resp. to 4KHz. Price: £47 + £4 carriage.



PIEZO ELECTRIC TWEETERS - MOTOROLA

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



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

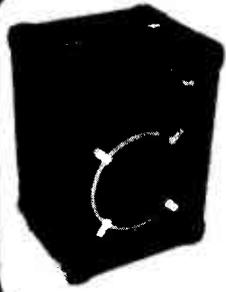
TYPE 'B' (KSN1005A) 3 1/2" super horn. For general purpose speakers, disco and P.A. systems etc. Price £4.99 each.

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

TYPE 'D' (KSN1025A) 2" x 6" wide dispersion horn. Upper frequency response retained extending down to mid range (2KHz). Suitable for high quality Hi-fi systems and quality discos. Price £7.99 each.

TYPE 'E' (KSN1038A) 3 1/2" horn tweeter with attractive silver finish rim. Suitable for Hi-fi monitor systems etc. Price £4.99 each.

TYPE 'F' (KSN1057A) Cased version of type 'E'. Free standing satellite tweeter. Perfect add on tweeter for conventional loudspeaker systems. Price £10.75 each
P&P 20p ea. (or SAE for Piezo leaflets).



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

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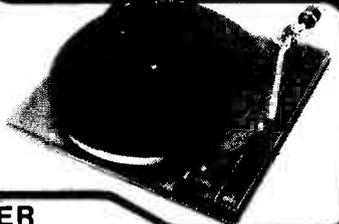


3 watt FM Transmitter

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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.

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New model.
Improved specification

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Loads:— Open and short circuit proof 4/16 ohms.
Frequency Response:— 15Hz - 30KHz -3dB.
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Both the control unit and outdoor alarm contain rechargeable batteries which provide full protection during mains failure. Power requirement 200/260 Volt AC 50/60Hz. Expandable with door sensors, panic buttons etc. Complete with instructions.

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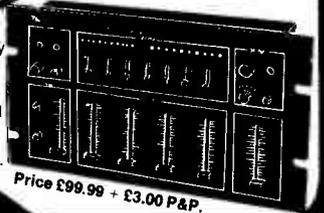
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REVIEW: EC 50 SOL

There could be a whole new generation of soldering irons just around the corner. Dave Bradshaw has been trying his skills on the EC50 iron from Litesold.

It is one of my few beliefs that one of the largest impacts that electronics will have on the world is to make hitherto 'stupid' devices 'intelligent'. By this, I mean that vacuum cleaners, as an example, may have the ability to modify the power going to the motor to prevent the usual off-load 'racing' that often occurs, and, possibly, to reduce the noise (if you have ever used an industrial cleaner, you'll understand the need for this latter point).

So it is not a little ironic (if you will excuse the impending pun) that soldering irons haven't changed all that much — most of those in use in hobby circles are pretty primitive specimens.

Actually, manufacturers have a somewhat impressive term for the sort of iron that just about everyone has — they call them **thermally balanced**; this means that the iron's temperature will settle at the point where the heat input is equalled by the convection and radiation losses from the bit and barrel and conduction losses into the handle.

When the iron is applied to a workpiece, the temperature of the tip will inevitably drop. The iron will then have to recover after removal off the job. The heat that goes to the job comes from both the heat stored in the iron before contact (the heat is stored in the thermal capacity of the materials in the bit and element) and from the heat being generated in the iron.

It is here that there is a conflict of design requirements. A fairly massive iron would be able to solder larger jobs than one with a lower capacity, because it would have a larger reservoir of stored heat to give to the job. However, it will take a lot longer to heat up a more massive iron (as well as to cool it down) and it will, after a fairly largish heat outflow, take longer to recover; also it will probably be less convenient to use because it will be 'bit-heavy'.

To get round this you can increase the power of the element. If you've ever had to solder with a more powerful iron than you would normally use, you'll probably have found, as I have, that in some ways it's a lot more convenient than using a small iron. The element is so hot that anything you apply the tip to is heated up in no time at all, and you can work a lot faster than normal. However, the crunch is that a larger power almost invariably means a longer barrel, or a much hotter tip, or both. A longer barrel means that soldering any number of joints is very tiring, because it's that much more difficult to position the bit accurately. A hotter tip means that you run the risk of destroying delicate components or of stripping off PCB foils.

All this said, it's really quite surprising that simple, thermally balanced soldering irons work as well as they do! However, if you're going to be a serious constructor,

it's almost inevitable that you will have to buy two or possibly even three irons of different sizes to make it possible to deal with all the soldering requirements you are likely to meet.

Soldering Electronic

Well, the obvious thing to do is to have some form of electronic control over the heat supplied to the soldering iron element. This is relatively simple in principle — a temperature sensor in the element is linked to some electronics that turns the element on whenever the temperature drops below a selected value. The problem is that the way that this is usually built is to have a separate control unit, with a special iron that can be used with only that particular unit. This is done because it is easiest to control a low voltage — so the control units have largish transformers in them to supply the low-voltage soldering iron element as well as the control electronics (it goes without saying that the element of a controlled soldering iron is usually rather more powerful than that of the equivalent thermally balanced unit, otherwise the controlled iron would actually be worse than the balanced unit).

This has two main disadvantages: firstly, it makes the soldering iron/control unit expensive — you'd be hard put to buy a controlled iron with control unit for under £50; secondly, it makes the iron a lot less convenient to cart around.

Even with a separate control unit, you don't always get a particularly flexible unit — with many of them, to alter the bit temperature you have to change the bit itself. This means that you have to let the iron cool off first!

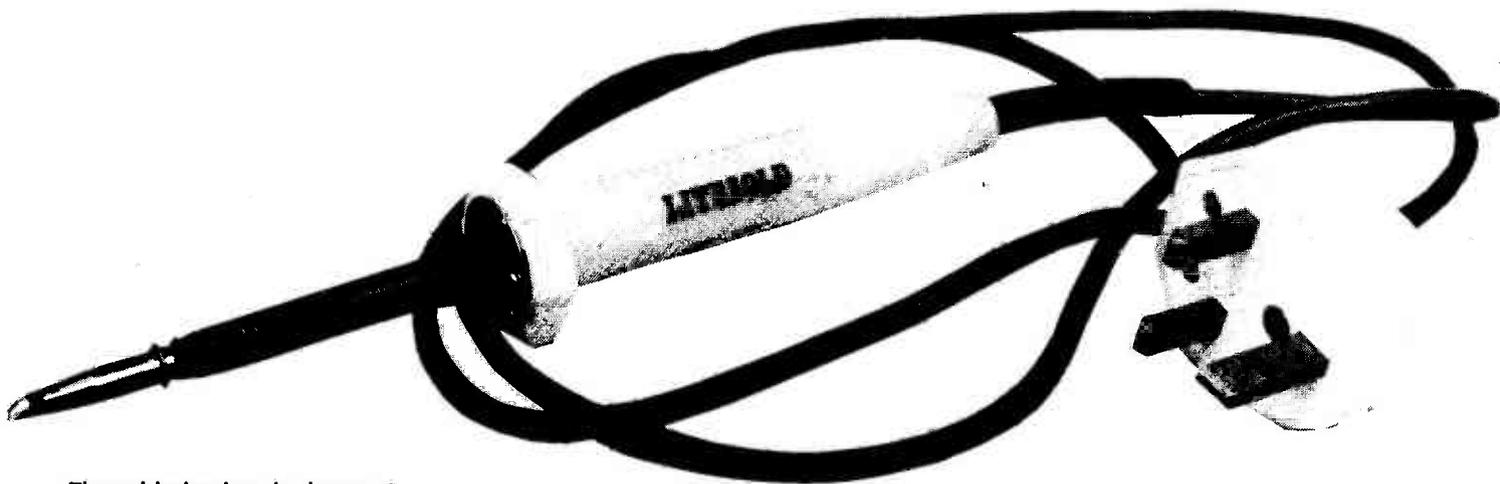
Some irons have been made that have a controlled temperature and don't need a separate unit; however, until recently, so far as we know these were not electronic — they used either the Curie point or some sort of thermal expansion effect to open and close mains contacts, with the resulting questionable applicability to delicate (particularly CMOS) electronics.

Enter The EC50!

It is on to this scene that Litesold have launched the EC50. This is an electronically controlled soldering iron but with all the electronics mounted in the handle. Don't worry, there isn't a mains transformer in there too, the element operates at mains voltage and is switched on and off by a triac at zero crossing.

To supply the electronics, Litesold have come up with a rather neat trick — and before other manufacturers copy it, I must point out that it is the subject of

DERING IRON



The soldering iron is shown at about 65% actual size here.

a patent. Like all really good ideas, it seems so obvious that you wonder why no one thought of it before.

The trick is this: to get the correct supply voltage for the electronics, some sort of mains dropper is required. A dropper resistor is used, but rather than being in the handle, where its eight watts of dissipation would make the iron uncomfortable to hold, it is wound onto the element itself, as a separate winding, so it contributes towards the heating of the element.

The temperature of the element is monitored by a thermistor mounted right up at the top end of the element, so it actually sits inside the bit. According to Litesold, this thermistor is the single-most expensive bought-in component in the iron! The temperature of the iron can be set using a control on the side of the handle.

Inside is a rather friendly neon (I'm afraid that I'm an old reactionary in that I prefer neons to LEDs as indicators!) which indicates both when the mains is applied to the iron and when the element is on. One gripe I would make about soldering irons in general is that there is no indication of when mains is being applied — how many of you (like me) have picked up a soldering iron by the wrong end, thinking that you'd switched it off some time before? Wouldn't it be a good idea if more irons had indicators in their handles?

In Use

Well, no matter how elegant the ideas that went into the iron, the crunch issue is how well it performs. This I, and a few other members of the ETI team, were only too pleased to put to the test.

First of all, I tried some PCB assembly work using the standard bit. The PCB I assembled did have 0.1" spaced DIL ICs on it; however, there was no tracking inbetween the pins. Using the standard bit, soldering was a bit tight, although possible to get a reasonable job (I'm not the world's most fussy solderer anyway!). Later, Phil Walker assembled one of our 64K DRAM boards using the iron but with a special fine-work bit, and his conclusion that this was actually easier than using his usual iron, which is a soldering station with a pointed bit.

The heat supplying capabilities of the iron were not exactly taxed by this trial, so off I went, scurrying down into my cellar to see what I could find. After beating off monstrous spiders, creepy-crawlies, etc, I eventually uncovered two items of valve gear — one was an oscilloscope that I built many moons ago, and the second was an old "Williamson" valve amplifier that had been donated to me by the father of a friend (it's amazing how junk cupboards give up their wares to you when you mention that you're interested in electronics!).

The oscilloscope had been assembled using a 25W iron, coincidentally also made by Litesold but a rather older vintage, so it was not that surprising that I could find nothing in it to tax the iron. However, the amplifier was a different matter.

It was built using a hefty piece of copper wire as a busbar earth line; besides this it used paper smoothing capacitors as there used to be a time when people thought that unpolarised capacitors 'sounded' better than electrolytic ones (I've heard that somewhere before. . .). These capacitors have massive metal terminals, and it looked as though they had been soldered to the busbar using a blowtorch (perhaps I exaggerate a little, but only a very little!). Here was a test!

However, the iron coped admirably with these joints, making it possible to dismantle them and make them up again — though this was the only time that I saw the second section of the indicator neon on for any noticeable period.

Finally, I used the iron to solder some rather awful cheap PCB board that I was foolish enough in my youth to build a whole audio amplifier with. The board is made from paxolin, and the copper has a very bad tendency to lift off when any heat is applied to it, making periodical repairs to the amplifier a nightmare.

At first, I used the iron at its temperature setting as delivered (this is the setting that it was used on for the other jobs in this report). With this setting, the foil lifted fairly quickly after application of the iron. However, turning the iron's temperature down to minimum made it possible to solder without the foil lifting — although the fluxes in the solder will

Please ignore the grubby hand and concentrate instead on the small screwdriver-setable temperature control. There are no callibrations, but this, in practice, should not cause problems.



not so warm as to ever be uncomfortable (but not like a certain iron that is very common but also sometimes very difficult to hold!), but enough to be noticeable.

Conclusion

In my opinion, this is rather an excellent tool that is a pleasure to use (in fact I hope that Litesold don't want the test iron back!). Although it is a lot cheaper than a soldering station, it is still around four times the price of a conventional soldering iron, so you would have to do quite a lot of soldering to justify the cost. That said, for use away from the bench, it is obviously much more convenient to be able to carry just one iron rather than several.

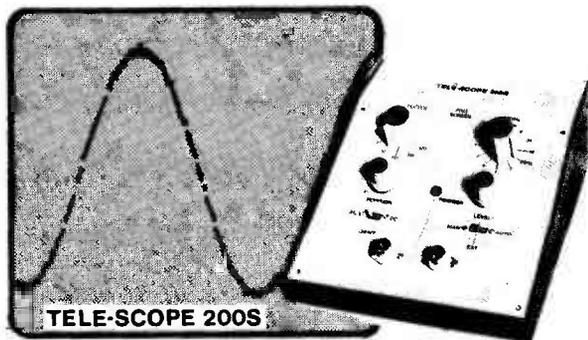
The EC50 costs £26.19 direct from Litesold, and this price includes P&P and VAT. Litesold's full name is actually Light Soldering Developments Limited, and they may be found at 97/99 Gloucester Road, Croydon, Surrey CR0 2DN, telephone 01-689 0574/5/6.

ETI

obviously have a lower scouring effect at this lower temperature, making it necessary to tin all component leads beforehand.

Ian Pitt reports that he tried using the iron for a number of unusual jobs, including soldering together the joint of a small pair of scissors and soldering metal contact straps onto RR size NiCads, all of which the iron did successfully.

The only grumble that we all had about the iron was that the handle got slightly warm in one place —



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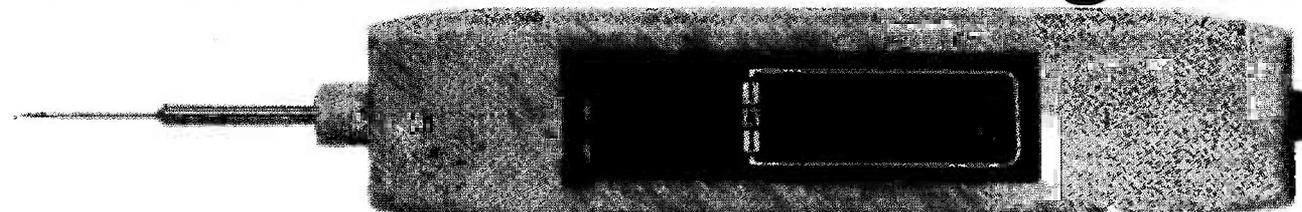
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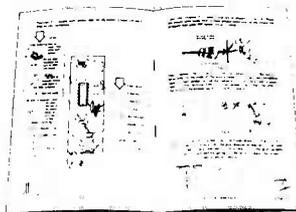
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DISPLAY ELECTRONICS



BENCH POWER SUPPLY

The floor is littered with exhausted HP2s, your home-made solar power plant has started its winter hibernation, and the gerbil hasn't spoken to you since you attached that dynamo to its exercise wheel. ETI to the rescue with a superb bench power supply unit from Grenson.

Bench power supplies rarely come high on the electronics enthusiasts' list of essential test equipment. There must be many who, having acquired a multimeter, 'scope, and possibly a signal generator, are then content to go on powering their high-tech lash-ups from a string of dry batteries. Yet for the really serious experimenter a power supply is virtually an essential, the only practical means of obtaining multiple and dual rail supplies which are reasonably stable and can be varied in voltage. Even people who only use their equipment and skills to construct projects from magazine articles (ours of course!) or to repair ailing electrical equipment are bound to wish they had one sooner or later. How many pieces of battery-operated equipment have you tried to repair in which the battery compartment becomes unusable as soon as the case halves are separated?

Fear not, gentle ETI readers, salvation is at hand. The ETI bench power supply does just about everything you could reasonably ask of such a unit, costs much less to build than equivalent commercial designs, and is even available as a full kit of parts. It has outputs of +5V, +15V and -15V all of which can be varied, and two meters measuring voltage and current which can be jointly switched to monitor any of the outputs. The +5V supply gives 2.5A and is variable over the range 3-8V. The +15V and -15V

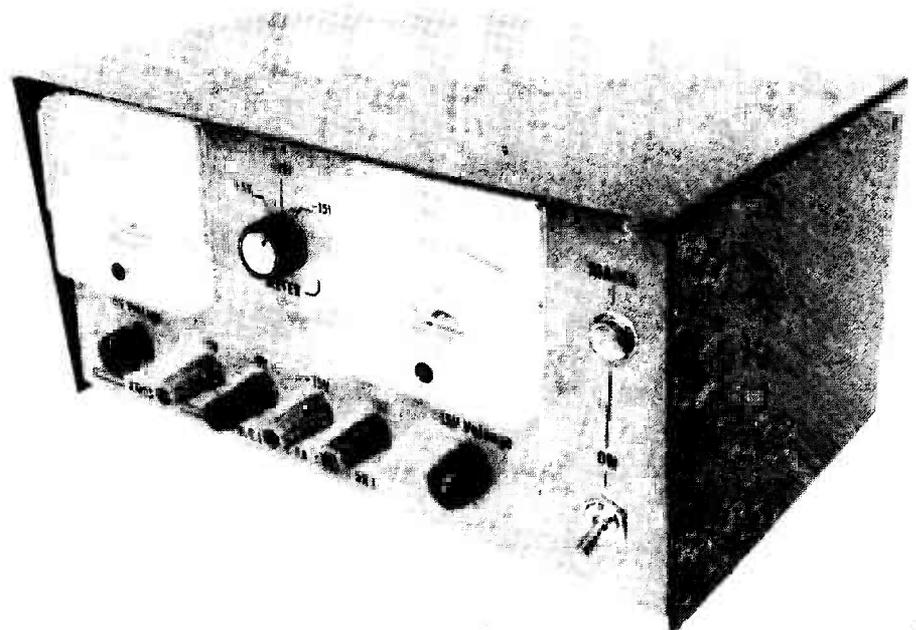
supplies give 0.5A each and are variable over the range ± 8 to ± 16 V; a single control varies both supplies, the negative output accurately tracking the positive one to ensure that the two are balanced at all times. All supplies are protected against overload and against external voltages injected into their outputs.

Construction

The PCB should be assembled first, inserting solder pins then small components such as resistors and semiconductors before the

capacitors. Ensure C5 and C11 have M4 fibre washers fitted over their legs before soldering them onto the board. This will prevent solder flowing through PCB holes. Check the polarity of all the components, particularly diodes and capacitors as these will be destroyed if fitted incorrectly. All wirewound resistors and diodes need to be mounted at least $\frac{1}{8}$ " clear of the board to prevent heating of the SRBP material. This is particularly important with D1, D2, D3 and D4.

If you are not building the power supply from the kit, you



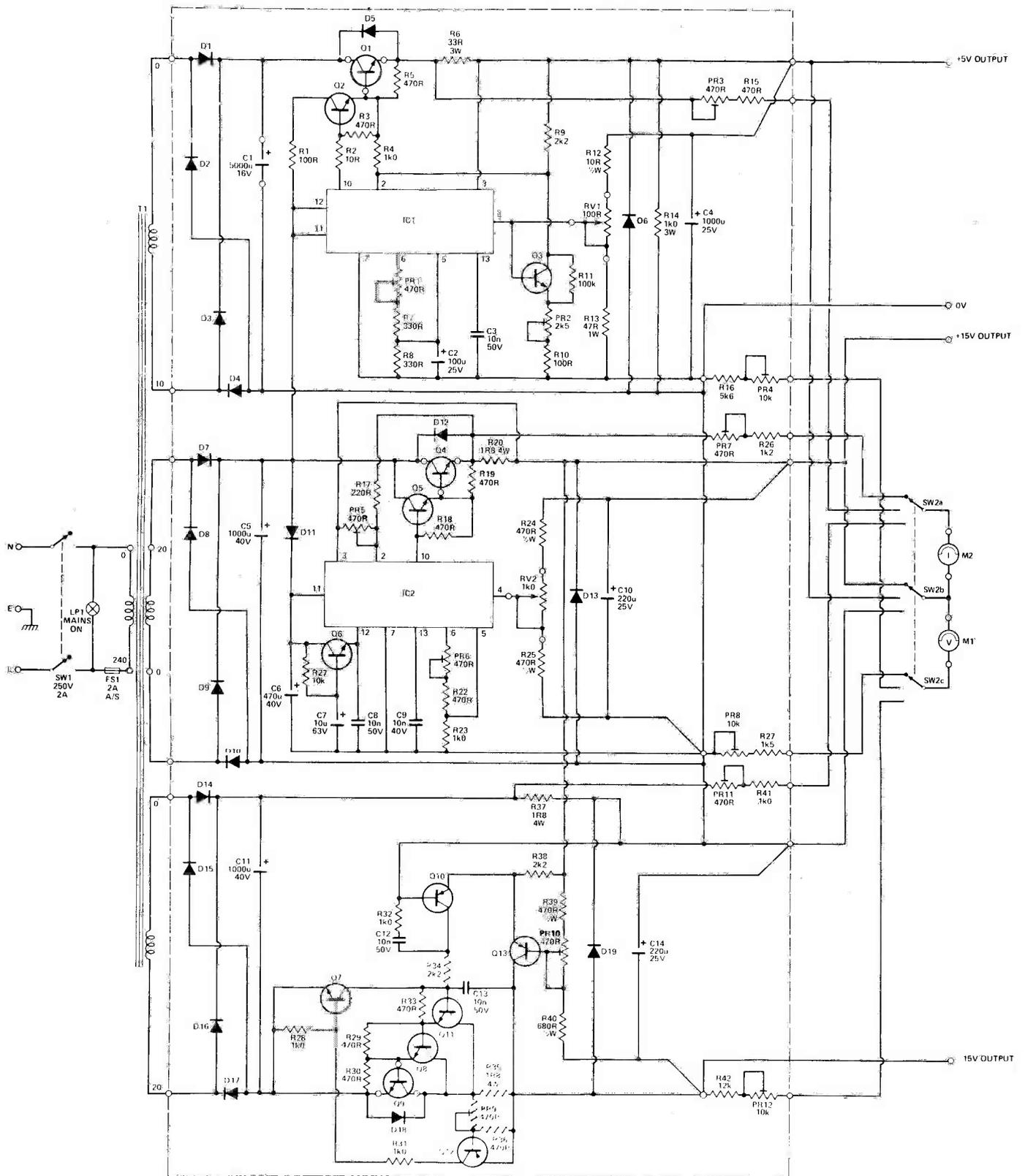


Fig. 1 Circuit diagram of the bench power supply unit.

PROJECT: Bench Power Supply

Reservoir capacitor voltages

the voltage on	C1	should be approximately	+13.5
"	C5	"	+29
"	C11	"	-29

Power transistor voltages

		collector	base	emitter
TR1	(+5V supply)	+13.5	+5.6	+5.0
TR4	(+15V supply)	+29.0	+15.6	+15.0
TR9	(-15V supply)	-15.0	-28.2	-28.7

IC voltages

		pin	4	5	6	7	10	11	12
IC1	(+5V supply)		+2.3	+2.3	+7.2	OV	+6.2	+28.3	+28.4
IC2	(+15V supply)		+3.8	+3.8	+7.2	OV	+16.2	+28.0	+26.5

Table 1 Voltage check list to aid trouble-shooting. The measurements were made with the unit running from 240V mains, the outputs set at +5, +15 and -5V, no output loads, and with respect to OV.

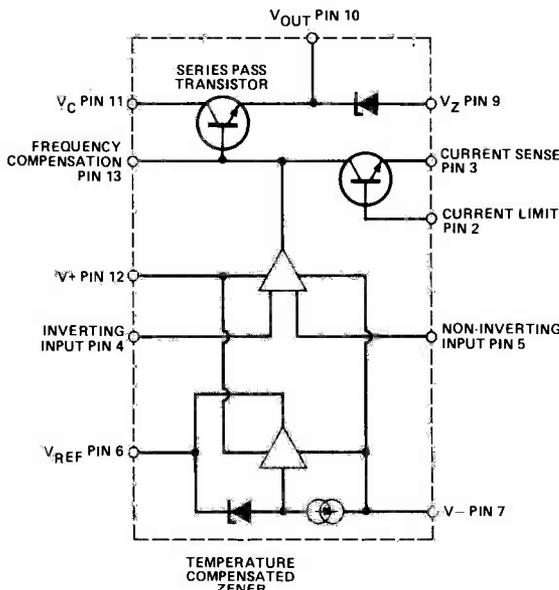


Fig. 2 (left) Equivalent internal circuit of the MC1723.

BUYLINES

A complete kit of parts for this project will be available from Grenson Electronics Ltd, High March, Long March Industrial Estate, Daventry, Northants NN11 4HQ, tel 03272 5521. The kit will cost £48.50 plus £3.35 post and packing plus VAT, making a total of £59.62. Alternatively, the unit is available built and tested for £82 plus post, packing, and VAT, making a total of £98.15. Note that the PCB for this project will NOT be available through our PCB service.

HOW IT WORKS

10V is produced from the secondary of T1 and is full wave rectified via D1, 2, 3, 4. The resulting voltage is then smoothed by C1 and fed to Q1 collector, Q1 being biased on by Q2 which is in turn controlled via pin 10 by IC1. The output from pin 10 is determined by pins 4 and 5, both being inputs to the control amplifier on the IC. Pin 6 is a fixed reference of 7V and is trimmed by PR1 and fed to pin 5, while pin 4 senses the output voltage via the divider chain R12, RV1 and R13. Therefore RV1, which is situated on the front panel, controls the output voltage over the range 3V to 8V. The capacitor C4 is used as an output filter.

The voltage produced across wirewound resistor R6 at high loads, ie greater than 2.5 amps, is used to operate the over current protection circuit. This circuit consists of R9, Q3, R11, PR2, R10 and pins 2,3, on the IC. The over current trip level is set using PR2 and is kept constant over the voltage range by the action of Q3. The over current mode on the +5V line has a foldback characteris-

tic, which results in a short circuit current of approximately 1 amp.

The +5V line is protected from +ve or -ve voltages injected back into its output by D5 and D6. Full current and voltage metering is provided and is calibrated using PR3 to set the current meter and PR4 the voltage meter.

The +15V output is produced in the same way as the +5V output using the 723 linear regulator. The only difference in circuit terms is Q6 which ensures a smoother supply to run IC2 and the absence of Q3, which is due to the difference in over current protection. Whilst the +5V has a foldback mode the +15 and -15 both go into a constant current mode. The overload limit on the +15V is adjusted with PR5.

The output voltage is adjusted in the same way using RV2, and as on the +5V line the output is fully protected against misuse and the injection of other voltages by D12 and D13.

The -15V is produced in a different way to that of the +5V and +15V. It does not use an IC but has the control circuit

constructed with discrete components. Q13 and Q10 are in a long tailed pair configuration and function as a virtual earth amplifier to control the base of Q11. Any error in the -15V output is corrected by reducing or increasing the drive on Q9 via Q8. Fine adjustments to align the -15V are made using PR10. Hence, when RV2 on the front panel is adjusted the -15V should track the +15V across its entire range of 8-16V. Overcurrent on the -15 is the same as on the +15; constant current is adjusted by PR9. The circuit Q7, R28, R31, Q12, R36, PR9 is used in place of the IC as in +5, +15 for overcurrent protection on the -15V. The -15V supply is protected against misuse and injected voltages by D18 and D19.

Full current and voltage metering is provided for the ±15V lines and is adjustable using PR12 and PR11 for -15 and PR7 and PR8 for +15V. The 3 pole, 3 way rotary switch SW2 provides switching between outputs for the meters so that they can indicate voltage and current simultaneously for each line.

PARTS LIST

Resistors (all 1/4W, 5%, unless otherwise stated)

R1 10	100R
R2	10R
R3, 5, 15, 18, 19, 22, 29, 30, 33, 36 47R	
R4, 23, 28, 31, 32, 41	1k0
R6	R33 3W wirewound
R7, 8	330R
R9, 34, 38	2k2
R11	100k
R12	10R, 1/2W
R13	47R, 1W
R14	1k0 3W wirewound
R16	5k6
R17	220R
R20,35,37	1R8 4W wirewound
R21	10k
R24,25,39	470R, 1/2W
R26	1k2
R27	1k5
R40	680R, 1/2W
R42	12k

RV1	100R
RV2	1k0
PR1, 3, 5, 6, 7, 9, 10, 11	470R horizontal skeleton preset
PR2	2k5 horizontal skeleton preset
PR4, 8, 12	10k vertical skeleton preset

Capacitors	
C1	5000u 16V electrolytic
C2	100u 25V electrolytic
C3, 8, 9, 12, 13	10n 50V ceramic
C4	1000u 25V radial electrolytic
C5, 11	1000u 40V radial electrolytic
C6	470u 40V radial electrolytic
C7	10u 63V radial electrolytic
C10,14	220u 25V radial electrolytic

Semiconductors	
IC1, 2	MC1723
Q1, 4, 9	2N3232
Q2, 5, 8, 11	2N3053
Q3, 6, 7	BC107
Q10, 13	MM4002
Q12	BCY70
D1, 2, 3, 4, 5, 6, 12, 13, 18, 19	BY255
D7, 8, 9, 10, 14, 15, 16, 17	BYX36
D11	1N4148

Miscellaneous	
M1, 2	1mA FSD meter mains toggle, 2A 250V
SW1	3 pole, 3 way rotary switch
SW2	

PCB; IC sockets; M4 fibre washers; Heatsinks; insulated terminals; mains fuseholder and fuse; knobs; mains neon; Case; mains cable and strain-relief bush; solder tags; insulating kits for the power transistors; nuts, bolts, washers, etc.

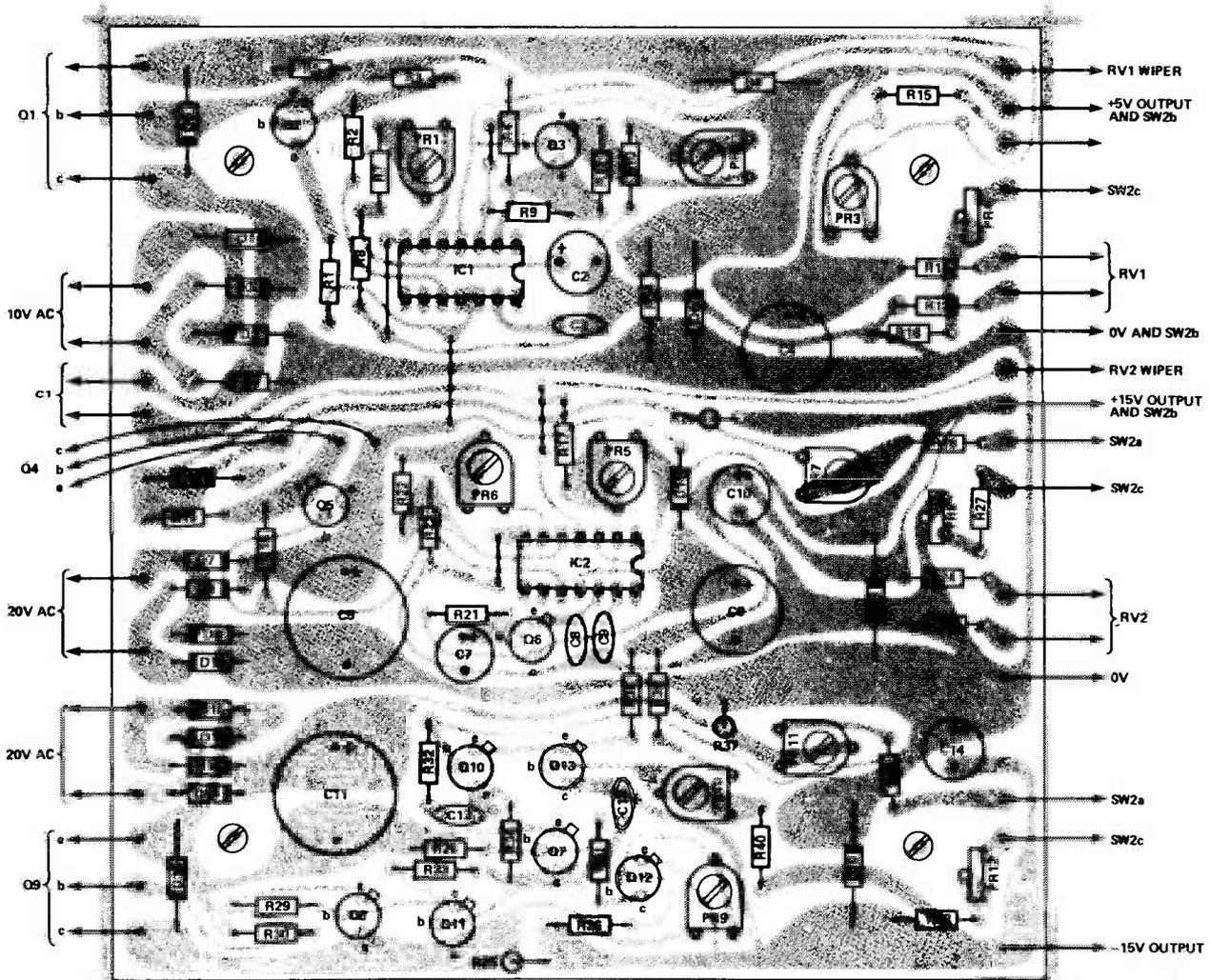


Fig. 3 Overlay diagram of the PCB.

PROJECT: Bench Power Supply

will have to find and drill your own case. The case supplied with the kit and used in our prototype measures about 265 x 130 x 180 mm, and almost any case of about the same size or a little larger should be suitable. However, you should bear in mind the weight of the transformer and choose a fairly sturdy case, preferably steel rather than aluminium. Drill out your case to suit the components, if possible following the layout used in the prototype and shown in the photographs, but don't worry if this proves difficult because the layout is not critical.

Mount all the front panel components except the two meters which are fragile and best left until last. The rotary switch, SW2, is best wired before fitting into place, but don't terminate the ends of the wires to PCB pins yet. Take care when tightening RV1 and RV2 as over-tightening will cause damage to the potentiometers.

Wire RV1, RV2 and all of the output sockets to form a loop which passes horizontally behind the front panel slightly above the components concerned. Make up the two heat-sink assemblies ensuring that each power transistor (Q1, Q4, Q9) is properly insulated using mica washers and bushes. A

smear of silicone grease under each transistor and mica washer helps heat transfer from the transistor case to the heat sink. Take the three leads from each power transistor through their respective grommets, the collector connection being via a solder tag on the transistor mounting screw.

Mount the transformer and use a large capacitor clip to mount C1 vertically near the front panel. Fit the mains fuse holder and cable clamp to the rear panel, then wire the fuse, switch, neon and the transformer primary, taking care to ensure that a good earth is established by cleaning paint off under the heatsink mounting screw and using a solder tag. Wire the transformer secondary and C1, using the solder tags. The PCB can now be fitted into place, and all wires terminated to the relevant solder pins. Start with the transformer secondary and power transistors followed by the output sockets and voltage pots and finally the rotary switch.

It is best to leave the meters off until the unit has been tested so as to avoid the risk of damage. When all has been checked and found to be working, wire the meters to the appropriate connections on the rotary switch SW2.

Setting up

When the time for switch on comes there are two options; a) use a variac and wind the input up slowly or b) just switch straight on!

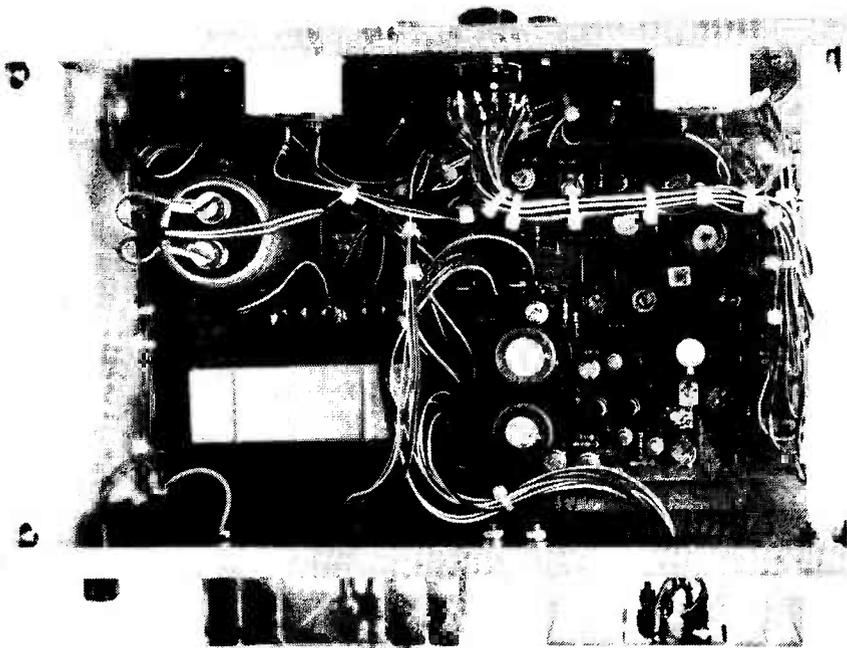
If a variac is available, initially supply the unit with a few volts only. Having ensured that the unit is not taking large amounts of mains current, check that the polarity of the DC unstabilised voltages across the terminals of C1, C5 and C11 are correct. If all is well, increase the mains supply slowly whilst measuring the outputs to ensure that they are rising a few volts behind their respective unstabilised supplies and are correctly polarized. With RV1 and RV2 set at midway, the outputs should start to stabilize at their nominal values. If the outputs are correct, increase the mains supply to 240V and proceed with the setting up.

If you intend to switch the unit straight on, double check the connections throughout the unit, paying particular attention to the mains fuse, transformer, smoothing capacitors C1, C5 and C11 and the power transistors Q1, Q4 and Q9. Make sure all the diodes and IC's are the right way round! Set pots RV1 and RV2 to mid range. If all is well, 2.5V-4V should appear at the 5V output, with 8V-11V on the $\pm 15V$ terminals.

With the unit switched on and working, rotate RV1 on the front panel and check that the +5V output varies from approximately 3V to 8V. Adjust PR1 on the PCB to set the upper and lower limits accurately.

Compare the voltages on the +15 and -15 volt outputs and adjust PR10 on the PCB until the -15V output agrees with the +15V output. Rotate RV2 on the front panel and check that both outputs swing in tandem from approximately $\pm 8V$ to $\pm 16V$, then adjust PR6 on the PCB to set the upper and lower limits accurately.

The next stage is to set the overload protection circuits on each output to the appropriate trip values, and this is most easily accomplished using variable resistors as the loads. However, don't worry if you can't get hold of any variable resistors with a high enough power rating because, with a little care, it is perfectly possible to set the levels using only a few odd fixed



PROJECT: Bench Power Supply

wirewound resistors.

Assuming the use of a 10 ohm 20 watt variable load resistor and a current meter in series between the +5V output terminal and the 0V terminal, set PR2 fully anti-clockwise and the resistor to minimum load, ie 10 ohms, and switch on. With RV1 set to give maximum output, adjust the load resistor to give 2.75 A current reading on the external meter. Slowly turn PR2 clockwise until the current just starts to fall. If the load is now increased the output voltage and current should collapse. Leaving PR2 set, return the load resistor to 10 ohms and repeat the test first with RV1 set fully in one direction and then the other, checking that the current limit remains the same from 3 to 8V output. The short circuit current should be equal to or less than one amp.

If you only have fixed value wirewound resistors to hand, choose one or more to give a value which will draw 2.75 A at between 3 and 8V. Thus a 1.2 ohm 10 watt, a 2.7 ohm 25 watt, or anything in between would be suitable. Connect this resistor or resistors in series with the meter across the +5V output and adjust the voltage until the meter reads 2.75 A. Slowly turn PR2 clockwise until the current just starts to fall, then reduce the value of the load resistance either by shorting it or, preferably, by placing another similar value of resistance in parallel with it. The output voltage and current should now both collapse. If you have sufficient wirewound resistances to hand, make up another load resistance of a different value so that you can repeat the test at a different output voltage.

The procedure for setting the +15V current limit is the same as for the +5V except for the values and the constant current characteristic of the 15V lines. The ideal load would be a 50 ohm, 50 watt variable resistor in conjunction with a 1 amp FSD meter connected between the +15V terminal and the 0V terminal. With PR5 turned fully anti-clockwise, the output current is set to 0.55 A and PR5 slowly adjusted clockwise until the voltage just starts to fall. The output current should remain the same at any overload level. Check the current limit is the

same across the +15V output range, and note that the -15V line should collapse with the +15V line even though it is not loaded.

The -15V output is set up in exactly the same way as the +15V output, except, of course, that the meter and load resistance are connected between the -15V and 0V terminals. With PR9 turned fully clockwise adjust the load resistor to give 0.55 A, then slowly turn PR9 anti-clockwise until the voltage just begins to fall. Again, the output current should remain the same at any overload level, and you should check that limiting takes place at the same point across the -15V voltage range.

As with the +5V output, the $\pm 15V$ outputs can be set up without variable loads by choosing suitably rated resistors whose value is such that they will draw 0.55 A at between 8 and 16 volts. A 15 ohm 5 watt, 27 ohm 15 watt, or anything in between could be used. The procedure is then the same as that given above except that the current is set to 0.55 A using the output voltage control, RV2, and you will have to check that the current remains the same for all overload levels by placing resistors in parallel with the load to reduce it in value.

If all is well so far, you are now ready to install the meters. M1 is the voltmeter and M2 is the current meter, and they should be connected to SW2 in accordance with the circuit diagram and taking great care to observe polarity. Set both meters mechanically to zero using their centre screws, then switch on the supply and set the +5V output to 5V exactly using an accurate external meter. Set SW2 in the +5V position and then adjust PR4 until M1 reads correctly. Connect an ammeter and variable load resistor in series across the +5V output and adjust the resistor to give exactly 2A reading on the meter (if you don't have a variable resistor with a high enough rating, choose one or more wirewound resistors to give 2A or a similar current which is clearly marked on both meter scales). Adjust PR3 until M2 agrees with the reading on the external ammeter.

Turn SW2 to the +15V position and use an accurate

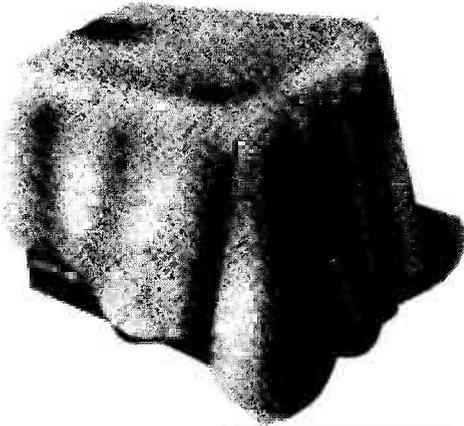
voltmeter to set the +15V output to exactly 15V using RV2. Adjust PR8 until M1 agrees with the external voltmeter. Connect an accurate ammeter in series with either a variable load resistor or a network of fixed wirewound resistors across the +15V output so that a current of 0.5 A is drawn, then adjust PR7 until M2 reads 0.5 A. Repeat the procedure for the -15V supply with SW2 set to -15V and using PR12 to adjust the voltage reading on M1 and PR11 to adjust the current reading on M2.

Trouble Shooting

The bench power supply is quite straightforward in its construction, and provided you have followed the guidelines given you should have no problems getting it to work first time. If, however, you are unfortunate enough to encounter difficulties, the following notes should help you to sort it out.

If, on switch on, the fuse blows immediately, check very carefully the mains wiring up to the primary of the transformer; it is very unlikely that a fault on the secondary of the transformer will cause the mains fuse to blow. If the fuse remains intact but the unit gives no output at all, check the wiring around C1, C5, and C11 and the orientation of the rectifying diodes. The correct voltages to be found on these three capacitors are given in Table 1. Check also the wiring of the three power transistors and make sure that the voltages on them agree with those given in Table 1. Next, check the +15V circuitry in detail since a fault here will prevent any voltage appearing at the +5 and -15V outputs even if these are working correctly. This is because the +15V line supplies the drive for the +5V line, and the -15V line is designed always to mirror exactly the voltage appearing on the +15V output. The +15V circuitry is also the first place to look if the unit works correctly on the +5V output but not on the +15 and -15V outputs. The voltages which should appear on IC1 in the +5V circuitry and IC2 in the +15V circuitry are shown in Table 1.

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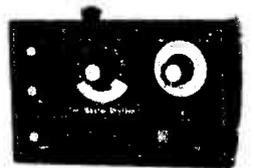
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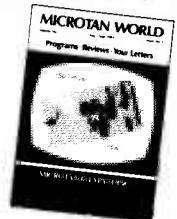
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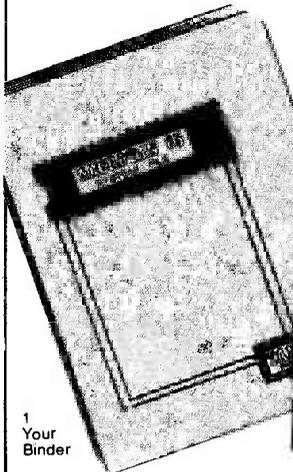
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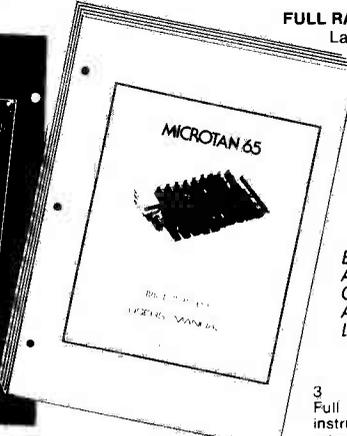
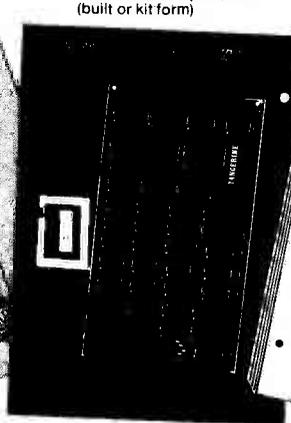
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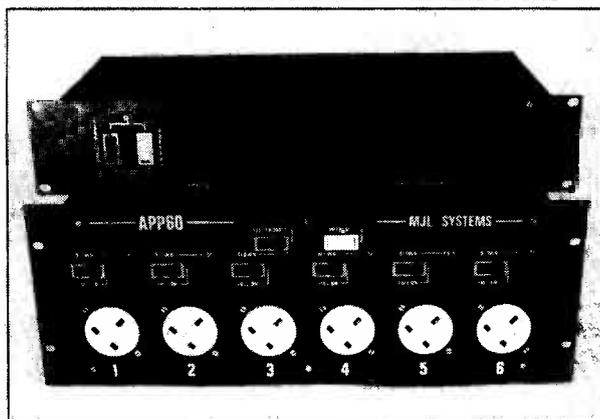
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MODULAR PREAMPLIFIER PART THREE

In this final part, we give constructional details of this expandable audio project. Designed by Barry Porter.

As with the smaller preamplifier described in December, assembly is based on the use of a mother board with the individual modules plugged into mating connectors. The pins for these are on a 0.1" pitch, so it is quite acceptable to use a length of veroboard to carry the interconnection busses between modules.

Details of the disc amplifier, muting relay control and power supply were given in part 1, and will not be repeated here. If it is required that insertion of the headphone jack plug should cause the output relay to cut off the unbalanced output, the 6V8 zener diode in the delay circuit should be connected to earth via the common contact switch on the jack socket as shown in Fig. 10. So that the headphone amplifiers are not powered when they are not in use, their supply voltages should be obtained from the switched rails of the delay relay.

BUYLINES

We have arranged for the supply of the harder-to-get parts for the various modules; in the following packs, the parts are as specified by the designer.

Disc amplifier (R2,3,6,9,10,11,12,13, 14,15,16,C3,7,8,9,11,12,13) £6.10;

Tone control (RV1-5 stereo pots, C1, 3,4,9,11,12) £6.55;

Unbalanced output stage (R4,6,11,13, balance control pot, C1,2,3,6,7,8,9,10, 13,14) £6.55;

Balanced output stage (C3,4,5,6) £3.68

Headphone amplifier (C1,2) £1.38

All these prices include VAT but not postage, which is 80p per pack on top. The packs are available from XCEL Audio Parts Ltd, 2nd Floor, 33 London Road, Bromley, Kent BR11 1JG, telephone 01-464 4967. Note that the PCBs are available from our PCB service, and that there has been additional advice on obtaining parts for the modules in earlier installments of this article, but it was too long to repeat here!

Other constructional comments in part 1 may be applied to this larger unit, which may be built into one of the standard rack-sized cabinets obtainable from a number of suppliers.

Once the preamplifier is working (again, see part 1) the output balance pre-sets must be adjusted to give equal voltages from the two outputs. The easiest way to do this is to temporarily connect two equal value, close tolerance resistors in series with the output and adjust the respective pre-set for zero volts at their junction when a 1 kHz signal is applied. (Fig. 11).

In use, the performance of this pre-amplifier is virtually identical to the more basic unit described in part 1. With the tone controls switched into circuit the noise increase is only about 1 dB with negligible additional distortion. The limited amount of control has caused no problems — in practice, if more than 10dB of lift or cut is required, it's not hi-fi you've got but a potential advertising copy for exchange and mart!

The situation that displays the advantages of the tone control most is when small bass-light loudspeakers are being used. Applying a limited amount of bass lift, with the frequency control set to about 50 Hz, will usually make it possible to increase the speakers' bass extension without encountering overload problems — something that is impossible to do when the turn-over frequency is fixed.

Although not detailed here, the individual 'building blocks' method of construction lends itself to a number of possibilities — for example, it is quite easy to modify the tape connections to allow for two recorders with cross dubbing, even providing balanced record outputs if required. A further enhancement could be to include

record level controls on the front panel, with suitable VU or LED monitors displaying the signal level being sent to the recorder. Indeed, with a little thought, that Concorde flight-deck look might not be too far away . . .

Some Changes

There have been some relatively minor changes between the circuit diagrams published last month and the PCB layouts printed here. They are:

on the tone control module: C2 was left off the circuit diagram in error; this is a compensation capacitor for IC1 (as C5 is for IC2) and is included on the overlay; C13 and C14 have been added in the leads to the wipers of RV2 and RV4; these are to prevent any offset voltages being passed around and amplified; IC4 and IC5 have been combined into a single dual op-amp rather than two single op-amps;

on the balanced output stage: IC1a and b have been interchanged;

on the headphone amplifier: the input filtering to IC1 has been changed and the values of R1 and R2 are different; however, the PCB allows the original circuit to be used if desired;

on all modules: supply line decoupling capacitors have been added; these were not shown on the circuit diagram last month (except for the headphone amplifier, where unpolarised capacitors have been added in parallel with the existing electrolytics).

Note also that the tone control stage is split over three boards for stereo operation. Unfortunately, it wouldn't quite fit onto two, so it was decided to split off the filter sections so that at some future date, constructors could alter

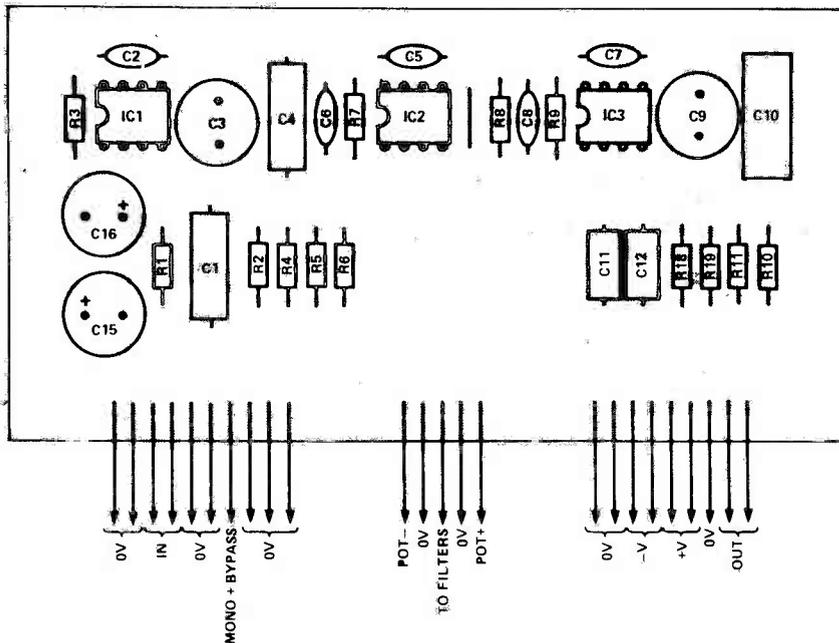
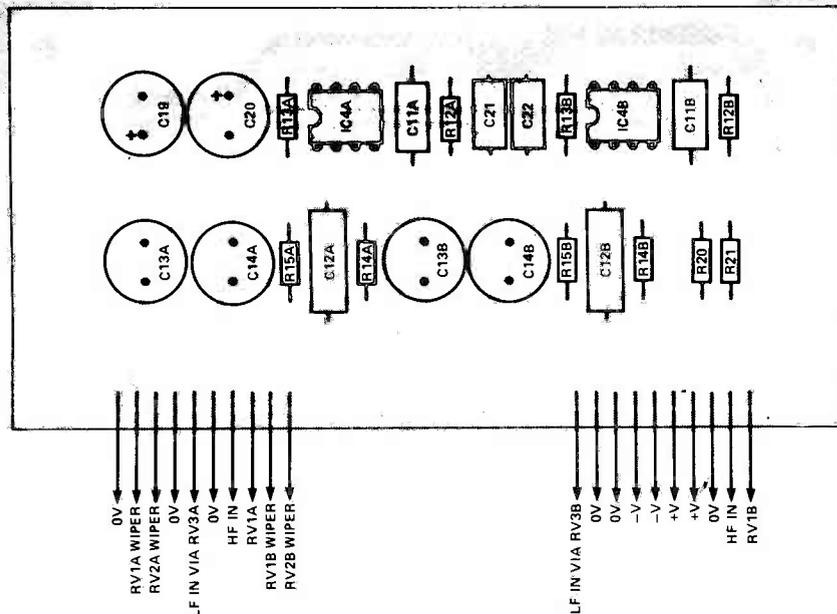


Fig. 1 PCB overlays for the tone control: the main board above is for a single channel, so two of these are required, whilst the filter board (below) is a stereo board, so only one of these is required. Note carefully which parts you need two of for stereo.



these, for example, to include a 'mid' control.

Swings And Roundabouts

It is possible to modify the component values of the **disc amplifier** and of the **unbalanced output** stage so that it is not necessary to use E96 series resistors. This will actually give a less accurate response technically (degrading the error on the RIAA characteristic to 0.3dB), but for most people this will not be that noticeable (if it is noticed at all!)

For the **disc amplifier**, the modified component values are as

follows:

- R2 4k7
- R3 6k8
- R6 12k
- R10 7k5
- R11 560R or 1k0*
- R12 39R or 82R*
- R13 6k8 or 8k2*
- R14 3k3 or 1k5*
- R15 82k
- R16 15k//330k (T3 = 3179.5μs)
- C7 10n
- C11 33n

* For R11, 12, 13, 14 the first figure given is for moving coil cartridges and the second is for moving magnet.

The value of R9 that should be used will depend on the required sensitivity of the input stage; for

PARTS LIST — TONE MODULE

RESISTORS	
R1*	100k
R2*	330k
R3*	10R
R4*	47k
R5*,10*	1k8
R6*,11*	8k2
R7*,8*,9*,16*	10k
R12*	3k6
R13*	3k9
R14*	2k2
R15*	4k7
R17*	1k2
R18-21	33R
RV1**,2**,4**	10k lin
RV3**	50k anti-log
RV5**	10k log
CAPACITORS	
C1*	330n 250V Mullard polyester
C2*,5*,7*	22p 2½% poly- styrene
C3*,9*,13*,14*	22μ16V PCB non- polarised electrolytic
C4*,10*	100n 250V Mullard polycarbonate
C6*,C8*,C11*	10p 2½% poly- styrene
C12*	150n Mullard polycarbonate
C15*,16*,19,20	220μ 25V PCB electrolytic
C17*,18*,21,22	100n polyester
SEMICONDUCTORS	
IC1*,2*,3*	NE5534
IC4*	NE5532
MISCELLANEOUS	
PCBs:	2 off tone, 1 off filter; edge connectors: 6 off 10 way, 2 off six way

* R1 to 17, C1 to 18 and IC1 to 4 are required in both channels so two of each are required for stereo.
** RV1 to 5 could be stereo potentiometers or two single potentiometers each for stereo, as required.

moving coil cartridges, the appropriate values are as follows:

R9 Value	Sensitivity
10k	0.11 mV
5k6	0.2 mV
3k3	0.33 mV
2k2	0.49 mV

For moving magnet, the following values are appropriate:

R9 Value	Sensitivity
820R	2.17 mV
560R	3.03 mV
270R	5.41 mV
150R	8.0 mV

Additionally, IC1 (LM394) can be replaced with a parallel pair of

PROJECT : Modular Preamplifier

PARTS LIST — BALANCED OUTPUT MODULE

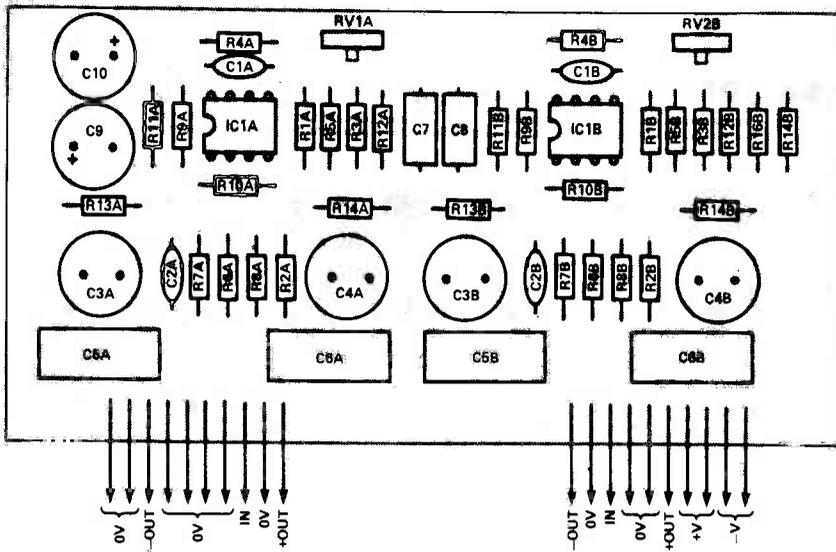


Fig. 2 Overlay of the PCB for the balanced output driver — this is a stereo board, so only one is required, but note the components that you have to obtain two of.

RESISTORS
 R1*,2*,3*,4*,5*,6*,
 7*,8* 3k3 1%
 R9*,10* 33R 1%
 R11*,12* 1k0
 R13*,14* 47k
 R15,16 33R
 RV1* 10k min vertical
 preset

CAPACITORS
 C1*,2* 22p polystyrene
 C3*,C4* 100 μ 16V PCB
 non-polarised
 electrolytic
 C5*,6* 100n Mullard
 polycarbonate
 C7,8 100n 250V Siem-
 ens polyester
 C9,10 220 μ 250V PCB
 electrolytic

SEMICONDUCTORS
 IC1* NE5532

MISCELLANEOUS
 PCB; edge connectors: 2 off 10 way

* R1-14, RV1, C1-6 and IC1 are re-
 quired in both channels, so two of each
 of these components are needed for
 stereo.

PARTS LIST — HEADPHONE AMPLIFIER

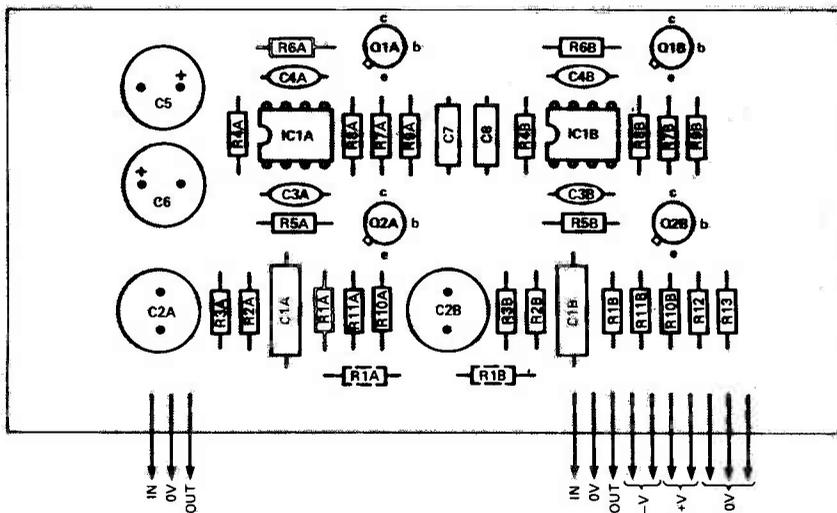


Fig. 3 Overlay diagram for the headphone amplifier; again, this is a stereo board, and again, you will have to sort out which components you need two of.

RESISTORS
 R1* 47k
 R2* 330k
 R3* 1k0
 R4* 150k
 R5* 1k5
 R6*,7* 10R
 R8* 470R
 R9*,10* 4R7
 R11* 47R
 R12,13 33R

CAPACITORS
 C1* 100n 250V
 polyester
 C2* 22 μ 16V PCB
 non-polarised
 electrolytic
 C3* 10p polystyrene
 C4* 22p polystyrene
 C5,6 100 μ 25V PCB
 electrolytic
 C7,8 100n polyester

SEMICONDUCTORS
 IC1* NE5534
 Q1* BC411 or similar
 NPN
 Q2* BC461 or similar
 PNP

* R1-11, C1-4, IC1 and Q1,2 are required
 in both channels so two of each are
 required for stereo.

2SD786 transistors, which are avail-
 able from XCEL Audio Parts Ltd,
 and they are somewhat cheaper
 than the LM394.

For the unbalanced output
 stage, the modified component

values will depend on whether it is
 to be used as a tape output buffer
 or as an output stage to feed the
 power amplifier. For use as a tape
 output buffer, the values shown in
 Table 1 apply.

Record Output Level	Gain	R6	R4	C2
499.5 mV	7.95 dB	1k5	1k0	100 μ
976.9 mV	13.77 dB	3k9	1k0	100 μ
1.2 V (0 VU)	15.65 dB	5k6	1k1	100 μ

Table 1 Revised component values for the tape output buffer.

PROJECT : Modular Preamplifier

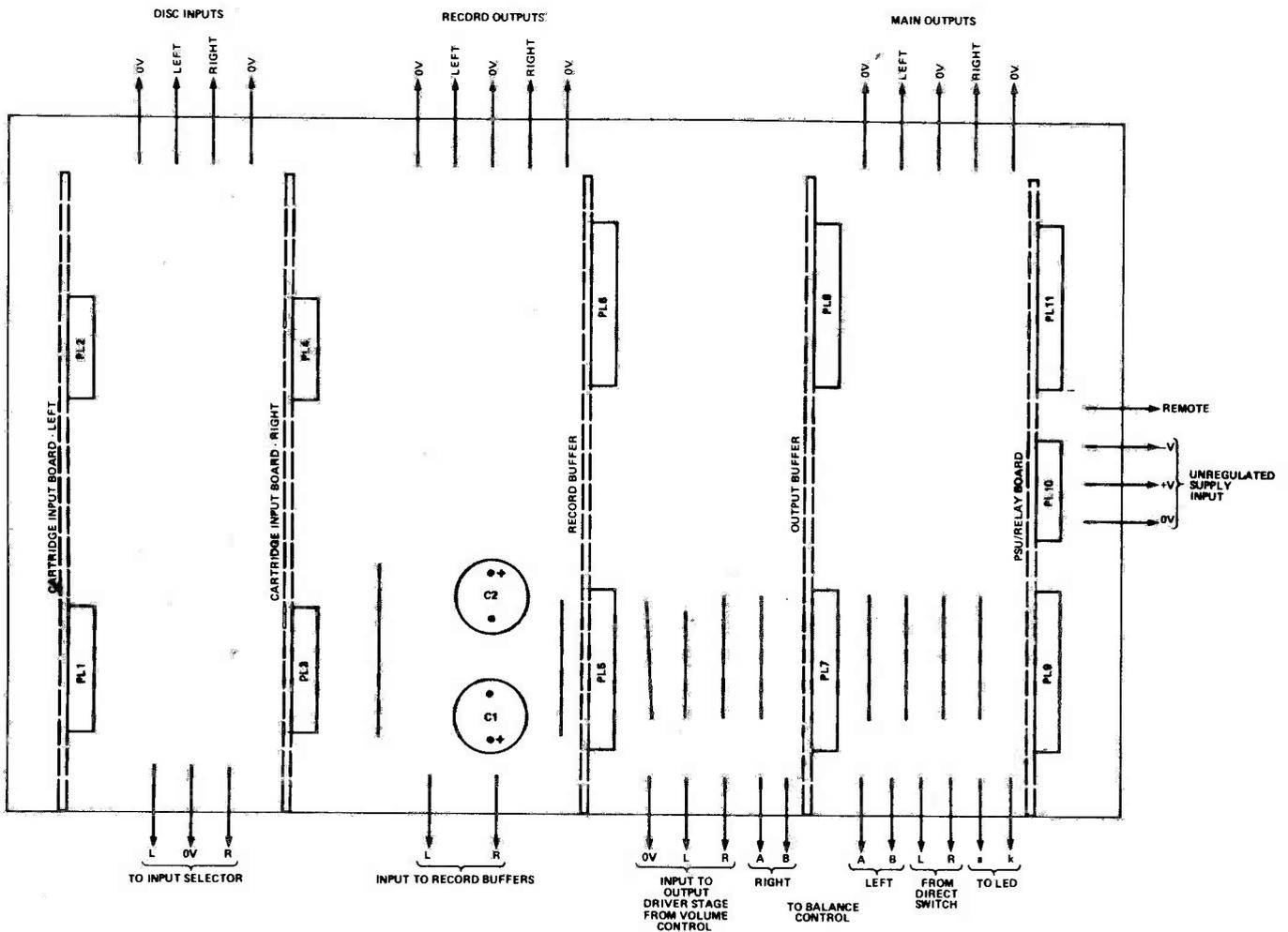


Fig. 4 Here is the overlay diagram for the mother board of the preamp as featured in the first part of the description in December '83; this board will be available through the PCB service. However, we have not reproduced a lay-out for the mother board of the extended system because the whole idea is for it to be adaptable to your needs — so everyone can make up their own, customised preamp using the same basic blocks.

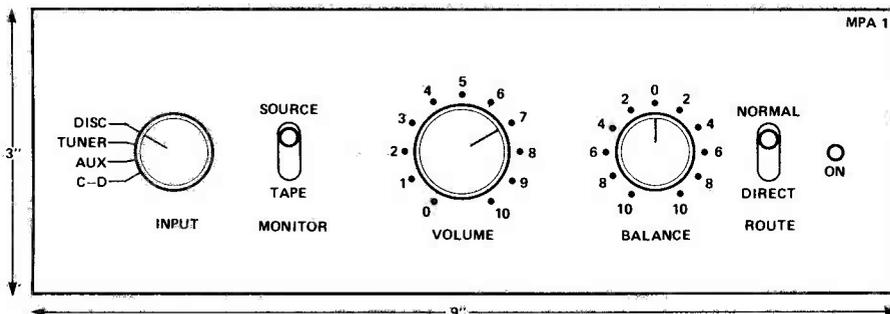


Fig. 5 A suggested front-panel lay-out for the small preamplifier.

Control Calibration	Imbalance
2	1.94dB
4	3.93dB
6	6.02dB
8	8.29dB
10	10.88dB

Table 2 Characteristics of the balance control.

For use as an output stage, R4 can be 180R and R6 can be 220R. The revised balance control characteristics are shown in Table 2.

After all that, all that remains for us to do is to wish you happy listening!

ETI

PARTS LIST — MOTHER BOARD

CAPACITORS

C1,2 220 μ 25V electrolytic

MISCELLANEOUS

PL1,3 8-way edge plug
 PL2,4,10 6-way edge plug
 PL5-9,11 10-way edge plug
ADDITIONAL PARTS REQUIRED TO MAKE FULL PREAMPLIFIER (EXC. UNREG SUPPLY)
 Input selector switch: 4-way (or to suit) 2-pole
 Tape/source switch: 2-pole 2 way
 Volume control: 10k log stereo (but see 'Construction', ETI Dec '83, page 60)
 Balance control: 1k Ω lin stereo
 Direct switch: 2-pole 2-way
 Output resistor: to suit (100R suggested)
 Indicator LED: to suit
 Connectors for disc, aux, tape, tuner (as required) and output (also PSU); knobs, case, etc as required

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 OR 4 x 300W into 2 to 4Ω (200W into 8Ω)
- OR { 1 x 600W into 2 to 8Ω
 1 x 300W into 2 to 4Ω
 1 x 150W into 4 to 8Ω
- Etc. Etc.

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AUDIO DESIGN

When it comes to the reel issues of audio recording, John Linsley Hood has got it taped.

Although the tape recorder, in its cassette form, is now so common a part of our lives that we can take it almost for granted, in reality, recording on magnetic tape is beset with so many problems, and hedged round with so many restrictions and limitations, that it is surprising that it even works at all, let alone that it gives the superb results which, when all is done well, it can!

Having said that, it is difficult to find any descriptions of this technique which explain these problems and limitations in a way which is at all easy to follow — so before I proceed to look at the types of circuitry which are needed for tape recording, I propose to try to explain, as simply and lucidly as I can, just what it is that we need to do.

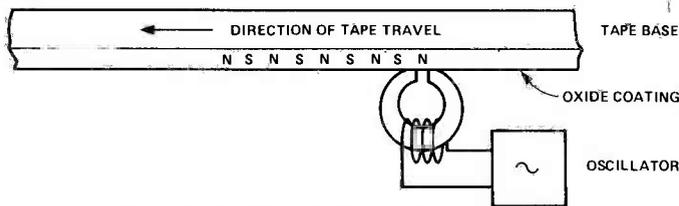


Fig. 1 The basic principle of tape recording.

The Process

If we pull a piece of unmagnetised iron oxide coated tape past a recording head, as in Fig. 1, and we apply an alternating current to the electrical winding on this head, we will leave a series of magnetised regions, as indicated by N-S-N-S-N-S . . . , produced by the magnetic field at the trailing edge of the record head gap. These will have a 'wavelength' along the tape given by $\lambda = \text{tape speed (ins/sec) / frequency (Hz)}$. If we try to replay this, with a head having a gap length X , we will have zero output when $X = \lambda$, since both ends of the gap will be sitting on parts of the tape which are identically magnetised (i.e., both N or both S). This is **Problem No. 1**: the gap length of the replay head imposes an absolute limit on the upper frequency response.

It is a characteristic of magnetic induction that the voltage induced in a coil of wire is linearly proportional to the speed with which the magnetic flux through that coil is changed. In mathematical terms this is expressed

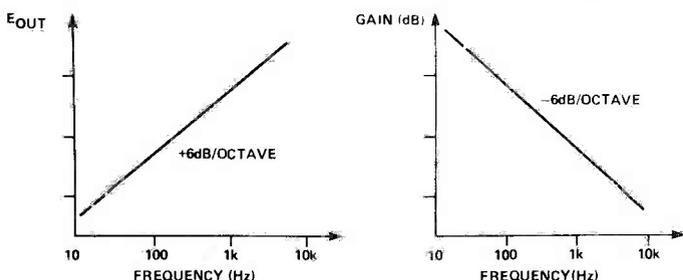


Fig. 2 (left) The theoretical AC output from a tape replay head. Fig. 3 (right) An idealised replay amplifier characteristic.

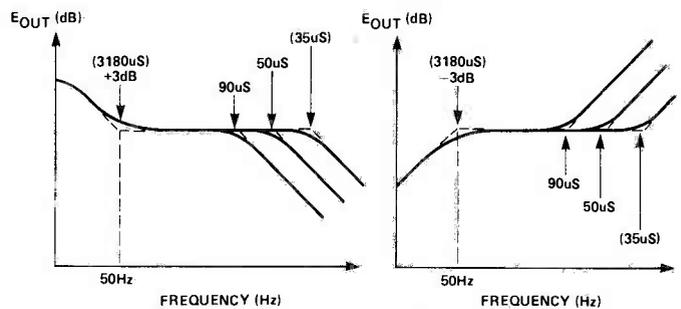


Fig. 4 (left) NAB recommended record characteristic (effective). Fig. 5 (right) NAB recommended replay response (effective).

$V = L \cdot dB/dt$ where L is the inductance, B is the flux density and t is time. (d/dt is the mathematical notation for a rate of change with time).

The result of this is that if we were to record at a constant remanent flux level on the tape, which we will assume will be given by a constant level of (RMS) current through the record head, we will end up with a replay characteristic as shown in Fig. 2, in which the output increases linearly with frequency. This will necessitate a replay characteristic such as Fig. 3 if we are to get a level final frequency response; this, in itself, would not present any great circuitry difficulty.

In the same way in which an internationally agreed standard is employed in the manufacture and replay equalisation used for 33 RPM and 45 RPM gramophone records (the RIAA standard) there is an internationally accepted standard for record and replay equalisation for tape and cassette recording (the NAB standard). This requires effective record and replay characteristics of the type shown, with the appropriate time-constants for the turn-over points on the frequency scale, in Figs. 4 and 5. When the replay equalisation curve is superimposed

15ins/sec 38cms/sec	50/3180 NAB/BSI	35 DIN/CCIR
7.5ins/sec 19cms/sec	50/3180 NAB/BSI	70 DIN/CCIR
3.75ins/sec 9.5cms/sec	90/3180 BSI	140 CCIR
	70 or 120/3180 BSI and DIN/CCIR	(Cassette only).

Table 1 Equalisation time constants of various standards; NAB (or NARTB) — National Association of Radio and Television Broadcasters (USA); BSI — British Standards Institute; DIN — Deutscher Industrie Normenausschus (W. Germany); and CCIR — Comite Consultatif International des Radiocommunications (International Standards Organisation).

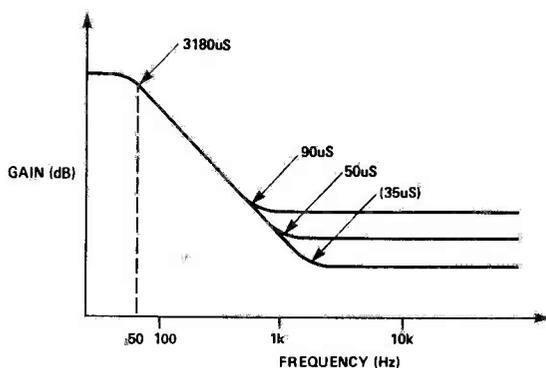


Fig. 6 A practical replay equalisation characteristic for reel-to-reel tape-recorders which conforms to NAB recommendations (cassette replay to BSI/DIN specifications would use 70/120 μ s).

on the curve of Fig. 3, we get the practical replay equalisation characteristic of Fig. 6, which is what we will hope to find if we do some measurements on the replay side of a commercial tape or cassette recorder.

To avoid the need for a replay gain characteristic which continues to rise as frequency decreases, the NAB curve provides for an LF turn-over point of 50 Hz, expressed as a 3180 μ s time constant, and an HF turn-over point that depends on tape speed as listed in Table 1. Turn over frequency, f , is given by $f=1/2\lambda\pi CR$; the value of CR is the time constant, and this is normally expressed in microseconds (μ s) so that Cs in nanofarads and Rs in kilohms can be used directly for calculations, avoiding the need to throw in factors of 10^9 , etc.

Problems

The above has assumed an ideal world; however there are a number of problems, as follows (this is not a complete list!).

1. Maximum replay frequency: As already mentioned, the size of the replay gap imposes an absolute limit on the upper frequency response.

2. Effect of replay head gap spacing: Since it is the trailing edge of the record head gap which leaves the remanent magnetic domains on the tape, to a first approximation, the width of the recording head gap is not very important. However, this is not true of the replay head (as we've already seen). Below the maximum replay frequency, the HF response is very dependent on gap width, as I have shown in Fig. 7. Unfortunately, the out-

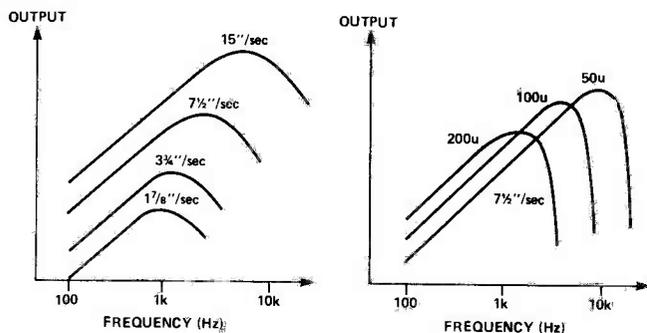


Fig. 7 (left) Output level versus frequency response for different tape speeds.

Fig. 8 (right) Output level versus frequency response for different head gaps.

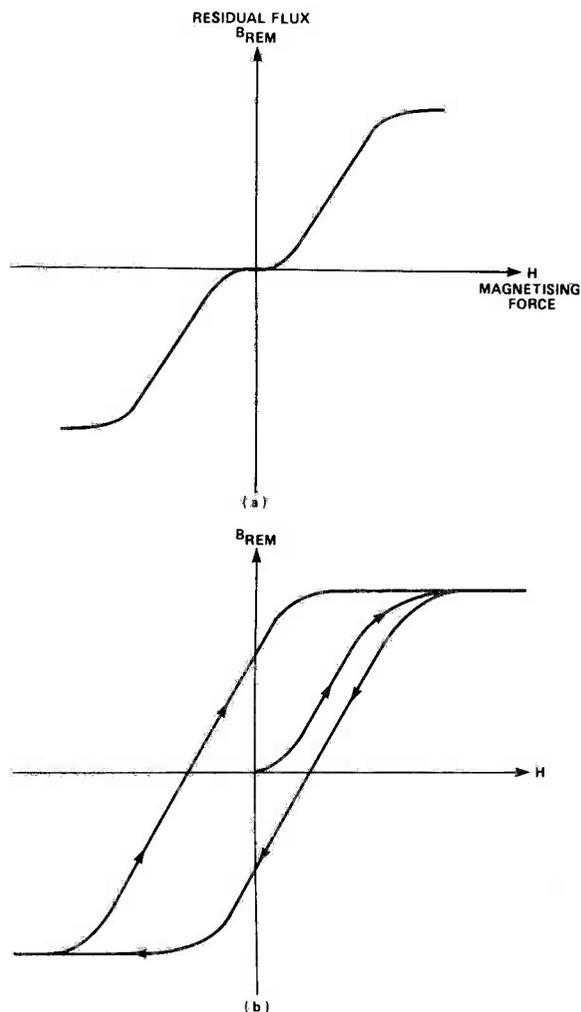


Fig. 9 Tape magnetisation characteristics: (a) for small magnetisations; (b) for large magnetisation.

put from the head also falls as the head gap-width is reduced, partly because there is less magnetic material in the gap, and partly because of the magnetic shunt effect due to the proximity of the two sides of the head gap.

3. Effect of tape speed: The differing equalisation characteristics quoted above tacitly recognise that the performance of the recorder, other things being equal, will be very strongly influenced by the speed at which the tape passes under the replay head. Not only will the output signal fall as the speed is reduced, the HF performance will also be impaired, as I have shown in Fig. 8.

4. Tape magnetic non-linearity: All of the above problems pale into insignificance in comparison with the high degree of non-linearity of the magnetic tape itself. The characteristics of this are shown in Fig. 9. If a small signal current is applied to the windings of the recording head (which is an electro-magnet with a small parallel gap held in contact with the tape, set as accurately as possible perpendicular to the direction of motion of the tape), the remaining flux on the tape (B) will be related to the applied magnetising force (H, which is proportional to the current flow through the winding on the head) in the way shown in Fig. 9a.

Clearly, this would not lend itself to hi-fi reproduction. At small signal levels the recording would be very inefficient, with hardly any remaining magnetism on the tape at all. At higher levels there would be the equivalent

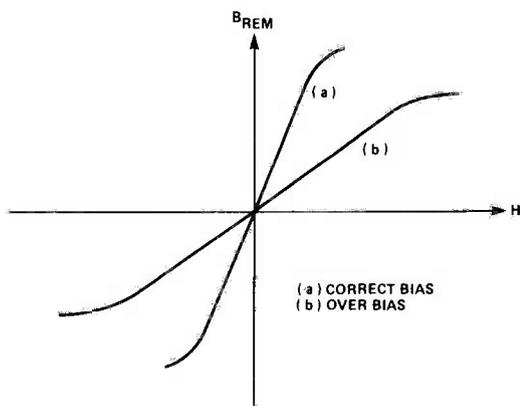


Fig. 10 The effect of HF bias on tape magnetisation linearity.

of a large amount of 'crossover' distortion, and at greater recording levels still, there would be a lot of 3rd and other high-order harmonics generated as the tape magnetisation was pushed into the regions where the curve flattened again. Also, to add to the problems, if the tape is magnetised fully, there is a 'hysteresis' loop in its magnetic characteristic, as shown in 9b.

Fortunately, after a lot of early experimentation with this medium, a trick was found which would solve this snag. This scheme was known as 'HF bias', or, in normal tape parlance simply as 'bias'. I will explain.

5. Need for bias: If a suitable high frequency AC signal is simultaneously applied to the recording head with the signal which it is desired to record, and if this HF signal, which will typically be somewhere in the range 30 kHz-250 kHz, is a good bit larger than the recording signal (typically 20 to 100 times) so that it sweeps the BH characteristics of the tape backwards and forwards across the non-linear region of the BH characteristic, one can, surprisingly, end up with a quite linear magnetisation of the tape, as shown in Fig. 10a. However, as you will by now expect, there is another snag, and this is that the final recording characteristics of the tape depend on the size of the applied bias waveform. If we apply more, we get the curve shown in Fig. 10b., which is one of reduced recording sensitivity. Also, too much bias tends to 'erase' the higher audio frequencies which we are trying to record. Moreover, the 'correct' level of bias depends a lot on the actual tape being used at the time, and, without previous experience, we cannot know what that will be!

6. Problems with bias: The dependence of recording characteristics on bias level is shown in the graph of Fig.

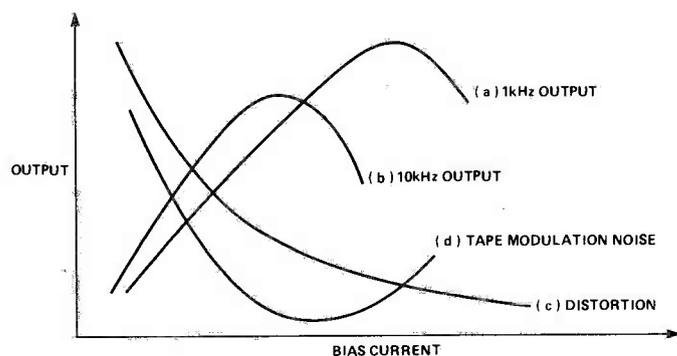


Fig. 11 How recording characteristics vary with bias current; note that only curves a) and b) are to the same scale.

11. In this curve (a) shows the relationship between recorded level and bias current at 1 kHz, and (b) the same thing for an input recording signal at 10 kHz. Clearly, the bias setting has a large effect on the flatness of frequency response of the tape recorder. Curve (c) shows the effect on the distortion of the recorded signal of the bias level. Good HF response is not readily compatible with low THD. The effect of bias level on tape 'modulation' noise is shown in Fig. 11, curve (d). Here, happily, low noise levels fit in fairly well with other needs.

The actual frequency of the bias signal is not very important, though there is some evidence that the recorded noise level on the tape, and the distortion at the upper end of the audio spectrum, may both be lessened by the choice of the higher bias oscillator frequency. The snag here is that it is the current through the head which is important, and because the windings have inductance, a higher bias frequency will require a higher applied bias voltage. Also, the head will work progressively less efficiently at higher frequencies, which contributes to this effect.

7. Design of bias oscillator: The tape cannot distinguish the source of the signal which is applied to it. It will therefore record small noise voltages present on the bias voltage waveform just as easily as it will record the noise components present on the incoming signal. So, if the bias voltage waveform is 20 times the size of the signal being recorded, its signal-to-noise ratio will need to be a lot more than 20 times better if it is not to degrade the S/N ratio of the incoming signal. You will note that I have referred to bias voltage, not to bias current. This is because the noise signal will be wide band, and will not be restricted by the inductance of the head to the same extent as the HF bias waveform. Therefore, the higher the bias frequency, the better the S/N ratio which is demanded of the bias oscillator.

The actual waveform of the bias oscillator is not so important, provided that it is symmetrical. If it is unsymmetrical, it will have the effect of the B-H curve, which will reduce the available undistorted output. Also, an unsymmetrical waveform contains an implicit DC component, which will magnetise the head, greatly reducing its effectiveness, and possibly causing partial erasure of the tape.

In the early 1970s, when I was very interested in cassette recording, I did some experiments with both square wave and sawtooth bias waveforms. Both worked, and the square appeared to be quite effective. However, for reasons of practical convenience, it is desirable that the erase oscillator should operate at the same frequency as the bias oscillator, and it is easier to get large voltages at a good S/N ratio from an LC sinewave oscillator. Square wave (RC) generators tend to have a fairly poor S/N ratio, due to jitter on the 'flip' times.

8. Effect of head inductance: Our aim, in recording, is to record all the frequencies in the audio band equally. However, the recording head has inductance, which will restrict the flow of current at higher frequencies. It is necessary, therefore, to find some way around this problem. Of the possible solutions, the simplest is to put a resistor, say 47k, in series with the output from the recording amplifier, to swamp the effect of the changing impedance of the record head with frequency. This also helps keep the bias HF voltage out of the recording amplifier. Bias voltage intrusions would probably do no harm provided that they did not push the record amplifier into a non-linear or overload condition.

Other useful solutions, which make lesser demands on the size of the signal output from the recording amplifier, are to design this amplifier so that it has a high output impedance, or to use a current NFB loop to make the amplifier look like a constant current source. All DC components must be rigorously excluded from the head windings to avoid head magnetisation. If a DC blocking capacitor is used, it should be of good quality, and switch-on current surges through this must be prevented.

9. Head alignment: The way in which the width of the replay head affects the HF response of the recorder has been shown above (Fig. 7). This presumes that the head is accurately aligned so that its gap is at right-angles to the direction of travel of the tape. If the gap is skewed, its effective length will be greater, and the HF output will be less. The same applies if the record and replay heads do not have the same alignment. This may be less important if one records ones own tapes, but on pre-recorded tapes this is vital. Happily, alignment tapes are fairly easy to buy. On these, though a double-beam oscilloscope makes matters simpler, one can do quite a good job by just adjusting head azimuth for maximum HF output, usually by working upwards through the frequency test bands provided.

10. Noise and noise reduction: Because of the granular nature of the oxide coating deposited on the tape, all tape recordings will suffer from some degree of background noise. In addition to this, any parts of the record process which tend to clump, or otherwise disturb, the uniformly random distribution of the manetic domains will make this background noise worse. Erase oscillator systems are not perfect in this respect, as can be shown by listening to the background noise on a bulk erased tape, as bought, and after it has been 'erased' by ones own recorder following the recorder of a zero signal.

The output from the tape recorder will depend on the tape speed and (although not discussed so far, this is a fairly logical extension of the arguments above) on the tape width at the head; so, the lower the tape speed and the narrower the tape head width, the worse the signal to noise ratio will be. This becomes a particular problem with cassette recorders, where the tape creeps past the head at 1.875"/sec, and the track width is only 30 thou. or so anyway. The signal output from a cassette recorder replay head will be minute, and will demand a lot of skill in the design of the replay amplifier.

The poor basic S/N ratio of the reproduced signal from a cassette replay head (though this is now improved by better heads and better tapes) has brought into prominence the various noise reduction schemes, of which the most common is the Dolby B system, used by most cassette recorder manufacturers under license from the Dolby Laboratories. In this a degree of HF pre-emphasis is applied to the record signal, in which both the amount of HF pre-emphasis and the turn-over point above which this pre-emphasis is applied, is automatically adjusted in response to the measured level of the incoming signal. The reverse compensation is applied on replay to restore a flat frequency response.

There is a snag, of course. This is that, unless some means is provided for monitoring the tape output which is only possible on relatively expensive three-head cassette machines, some assumptions must be made by the cassette recorder manufacturer, in setting up the Dolby B replay operating levels, about the actual signal level which his recorder will give on replay for a given

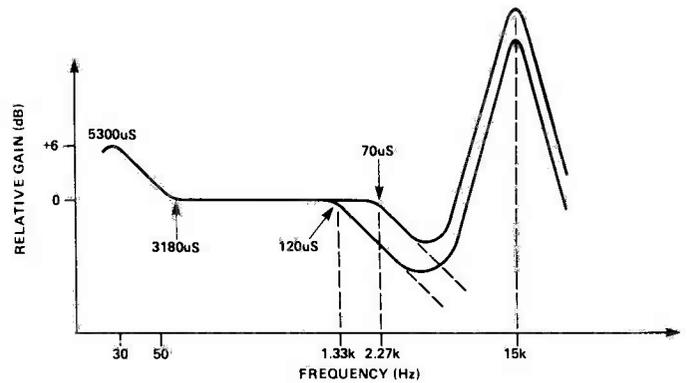


Fig. 12 Record pre-emphasis and de-emphasis for cassettes, showing additional compensation for head losses.

input recording level. This will depend on the actual tape chosen by the user, and on the appropriateness of the bias setting. Nevertheless, in spite of these objections, the Dolby B system does work surprisingly well, even on simple machines, and can give a 6-10dB improvement in overall S/N ratio.

Nowadays, predictably, Dolby B processing circuitry is available on a single IC chip, the LM 1011, which, complete with application circuitry, can be bought by the experimentally minded for a few pounds. The use of these for any commercial gain would however, require a license from the Dolby laboratories.

In many commercial machines, the relay amplifier is muted while the tape is not moving to avoid drawing the attention of the listener to the background hiss of the replay amplifier. This is a refinement I wish I had thought of in the middle 1970s when I published my own cassette recorder design. One lives and learns!

11. Head losses: We have assumed, so far, that the recording and replay heads — which are often the same unit in cassette recorders — behave in a perfect manner. They don't. Mainly because of the finite gap width, their HF performance is poor. This means that some form of HF pre-emphasis has to be applied, during recording, to assist in achieving a satisfactory HF output. This recording pre-emphasis, of 15-25dB magnitude, will be applied, as shown in Fig. 12, at the point where it is expected that the replay HF response will start to fall. This is not a good thing, since it will tend to cause HF overload, and increased distortion and intermodulation effects, but is feasible because signal amplitudes at HF are generally low.

Practical Circuit Design

We have seen from the above what some of the problems are in tape recording. Since these are exaggerated in cassette recorders, because of the narrow low-speed tape tracks, a look at the design of the electronics in a cassette recorder — excluding the Dolby processing — will show the types of circuit layout which will be needed in all these systems.

Replay Amplifier

The over-riding consideration here is of low noise in the amplifier, since the input signal will only be about 0.5 mV, and a 60dB S/N ratio will demand an effective input noise of 0.5 uV, from the amplifier and input circuitry. Figure 13 of Part 2 (ETI October 1983) we saw that this

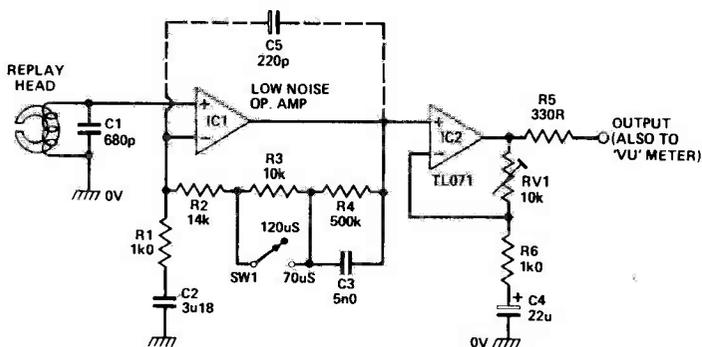


Fig. 13 A typical cassette replay amplifier giving the frequency response shown in Fig. 6.

will depend on the input circuit resistance, the bandwidth, and the input devices. Fortunately, the effective bandwidth of the replay amplifier, because of its downward slope with frequency, is only 1 to 2 kHz. Nevertheless, this necessitates an effective input resistance of only some few thousands of ohms. We must be careful, therefore, that we do not needlessly include input resistive components, to add to the 300-600 ohms of the head winding resistance. The required equivalent input noise resistance required by the desired S/N ratio does put most of the audio ICs out of consideration; however, there are a few, such as the Signetics/Mullard NE5533/5534, the Precision Monolithics/Raytheon OP27, and the Hitachi 12017, which would be satisfactory electrically. Of these, the latter has a non-standard base connection, which would make it awkward to substitute, whereas the ICs with the standard 741 type connections could be upgraded as better devices appeared.

In commercial units, for reasons of economy it is customary to use the same amplifier for both record and replay, with appropriate component changes accomplished by multiple switching, however, from the point of view of the amateur constructor, and certainly for the ease of explanation, it makes life easier to show the record and relay circuits as separate entities. I have shown a suitable circuit design, based on a low-noise op-amp, in Fig 13.

In this circuit, the output of the replay head (through suitable switching if it is combined with the record head) is taken directly to the input of IC1. The gain-frequency characteristics of this stage are determined by the RC network in its negative feedback loop. Referring back to Fig. 6, we see that the LF gain is rolled off at 50 Hz (a 3180μS time constant), at a gain of 500. From this we can infer that the total resistance in the feedback path, from

output to -ve in, must be 500K, if R1 is 1k0. Also, the time constant of R1C2 must be 3180μS. If R1 is 1k0 then C2 must be 3180 nF or 3.18μF. This shows how simple the use of 'time constants' makes the task of working out circuit component values.

Now, we require the gain to decrease linearly from 50Hz to 1.33 kHz (in the case of the 120μS equalisation) or 2.27 kHz (for 70 μS). This we can accomplish by means of C3 and R2 and R3, switched by S1. If C3 is 5n0F — this must have an impedance greater than 500k at 50 Hz, but we can't afford to go too high (Z_{f50} for 5n0 is 636k) — then the 120μS time-constant will be given for a value of R2 + R3 of 120/5 = 24k. Also, the 70μS time constant will require R2 on its own, to be 70/5 = 14k. So R2 = 14K and R3 = 10K.

IC2 is a simple output buffer stage, to give an adjustable gain of 1 to 11, depending on the setting of RV1. R5 gives some output isolation, and the value of C4 is chosen so that the LF response is adequate. Since 3.18μF gives a -3dB point at 50Hz, 22μF will give a -3dB point at 7Hz, which is low enough.

A small circuit refinement is the inclusion of C1 across the cassette head to tune the head, with its internal inductance, to some 15 to 18 kHz. The actual value will depend on the head inductance, and can be calculated from the formula $f_0 = 1/2\sqrt{LC}$. A value of 680-820pF will be in the right order. This limits the wide-band noise output from the head, and reduces the chance of noise being worsened by cross-modulation within the input IC amplifier.

C5 across the first amplifier stage performs a similar bandwidth limiting function. This may not be acceptable for the NE5533 or 5534, so regard it as an option.

Record Amplifier

This has to meet five design requirements. The output must be large enough to drive the cassette record head through the 47 k swamp series resistance. A normal IC op-amp will do this quite well, with very low distortion, when operated from ±12 or 15V supplies. It has to provide a means for adjusting the record signal level. It has to provide a modicum of bass lift, say +3dB at 50Hz and +6dB at 30Hz, to compensate for the specified roll-off in the replay curve. It has to provide the specified de-emphasis at 70μS or 120 μS as required, and finally, it has to generate a peak, of +15dB or so, at 15kHz, to offset the head losses.

A circuit which will meet these requirements, and give a high quality performance, is shown in Fig. 14. In this IC3 is a simple unity gain buffer amplifier, which has a low output impedance but yet allows a high impedance input to the record level control. R9, R10, C6 and S2 generate the 70 and 120μS de-emphasis characteristics.

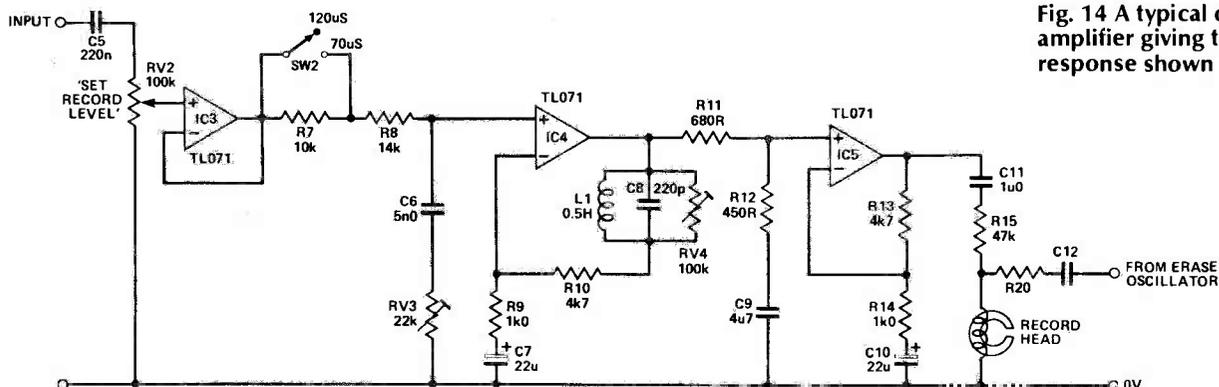


Fig. 14 A typical cassette record amplifier giving the frequency response shown in Fig. 12.

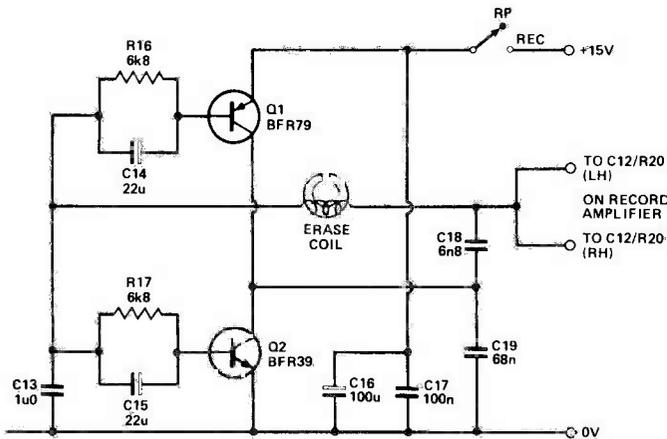


Fig. 15 A cassette recorder bias and erase oscillator.

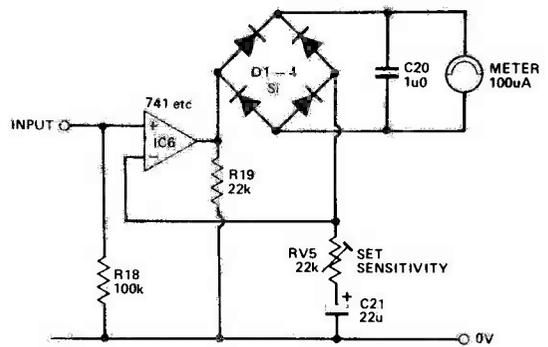


Fig. 16 A simple recording level meter circuit.

Since we have calculated suitable values for these for the replay amp., we can use these again. R11 is a trimmer resistor which we can use to assist in getting an optimally flat overall frequency response, by lessening the extent of this de-emphasis. IC4 is a gain stage with a low-frequency gain of 5.7. However, the LCR network formed by L1, C8 and RV4 is tuned to resonate at 15 kHz; this makes the gain increase at this frequency to an extent which is governed by the Q of the circuit, which can be adjusted by RV4 (for the tuned circuit, $f_0 = 1/2\pi\sqrt{LC}$).

R11, R12 and C9 generate the boost at 50 Hz (3180 μ s, the time constant of C9/R11) and the levelling off at 30 Hz (5300 μ s, the time constant of C9/(R11+R12)). IC5 is another straight gain stage, with a gain of 5.7, and this drives the record head through C11 and R19.

Overall, the gain of this amplifier is 30 at 1 kHz, which allows a 5 V RMS output from IC5 for a 170 mV input. Bias is applied to the head directly from the bias oscillator circuit.

Bias and Erase Oscillator

In reel-to-reel recorders, and in the rather more up-market cassette decks, a separate transformer would be used, both as the coil in the LC erase oscillator, and as a transformer coupling from a secondary winding to drive the erase coils and HF bias circuitry. However, in cassette recorders, provided it is not proposed to use 'metal' tape (for which very high erase voltages across the erase head are needed to achieve the required 60dB erasure of previously recorded signals) it is quite satisfactory to use the erase head itself as the coil in the oscillator circuit, and up to 25V RMS can be generated by the oscillator circuit shown in Fig. 15. A small proportion of this is then bled off through an RC network to bias the record head.

The actual RMS bias voltage across the head for optimum recording characteristics must be determined by experience for the record head and tape being used, but it will probably lie somewhere between 5.5 and 10 V RMS, as measured by a wide-bandwidth AC millivoltmeter. Understandably, from Figs. 10 and 11, there is no such thing as a 'correct' bias voltage setting. All that one can do is to try to choose a voltage at which all of the conflicting tape characteristics are partially satisfied, in your own judgment. As simple a solution as any is to design the record and replay amps so that they give a reasonably good frequency response, and then trim the 'bias' voltage so that the overall frequency response is as level as possible. Obviously, if one has good instruments and a lot of time to experiment, a better compromise value could be found.

In Conclusion

These then are the basics of tape recording, and the circuits shown above, when used with a suitable cassette mechanism, an adequate power supply (derived for example from a pair of + and - output 12 or 15 V IC stabilisers and a decent quality pair of supply line bypass capacitors) and some form of recording level indicator which could well be a simple one-IC AC millivoltmeter of the form shown Fig. 16., could be used to make a quite high performance DIY cassette recorder. However, being realistic, I do not really believe that anyone in the UK at the moment would want to build himself a cassette recorder — unless, of course, he had most of the parts already to hand — when he could buy one, ready built, and with all the trimmings, for about two thirds of the wholesale price of the components.

Nevertheless, it is useful to know what kind of circuitry is employed in tape recorders, and what the problems and limitations are, so that one might rebuild or modify existing unsatisfactory equipment, or simply so that one can know where the strengths and weaknesses of the method lie. Also, because every tape or cassette recorder represents the end product of a very large number of design compromises, which affect distortion, modulation noise, overload characteristics, flatness of response and background noise level, as well as the straightforward HF bandwidth, cassette and reel to reel tape recorders differ in sound quality, one from another, very much more than, say, audio amplifiers or tuners do. Evaluation of the effect of these many compromises is truly an appropriate field for the 'subjective' listener.

I have tried, in this series, to take a brief look at the types of circuitry which are used in audio equipment, to try to show how the designer might do his circuit calculations, and to attempt, where possible, to remove the mystery from this subject. During this, I have been aware that one of the major areas of calculation, that involving capacitors and resistors, has been skirted round rather hurriedly, and the reader has been left with just a few useful landmarks, rather than a map. This is because more detailed calculations require the use of algebra employing 'complex numbers'. However, speaking as one who is really a very poor mathematician, I honestly do not think that there is anything in this which should frighten anyone (especially if they have a pocket calculator to do the sums for them) — indeed, some of the calculations are really quite fun to do. I am therefore very pleased that the Editor has indulged my wish to try to show that this is really quite simple, in the next part of this series.

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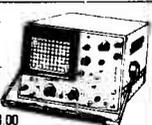


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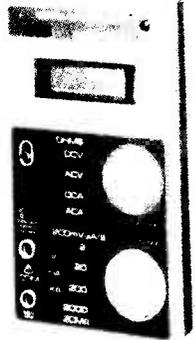
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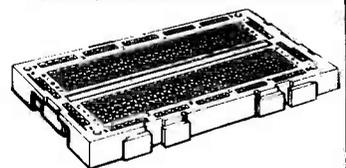
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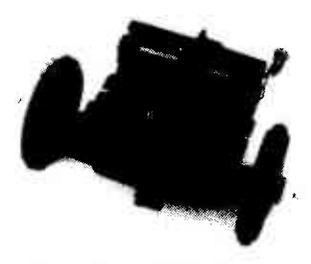
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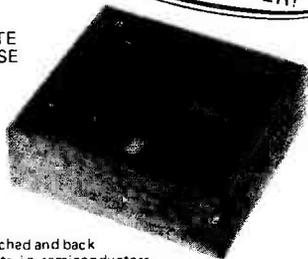
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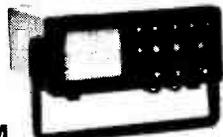
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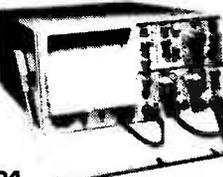
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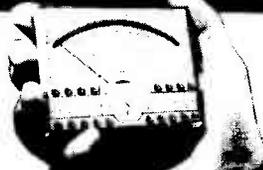
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MACHINE CODE PROGRAMMING

Every month we plunge deeper into the arcane mysteries of machine code — taking our readers with us, we hope. This month, Bob Bennett goes beyond the index registers

Last month I gave examples of instruction of the form **Ld (pq),A** etc, and showed how two bytes are pushed back onto the stack. I also left you with the question of what happens if you push HL and pop DE. The answer is that both HL and DE now hold the data that was in HL originally.

One last thing, for the moment, regarding the stack: when you have finished with your machine code program and wish to return to BASIC, for example, then you must make sure that everything that you pushed onto the stack has been popped off. This is because when you GOSUB, and call to USR (machine code) program is a GOSUB, then the return address is pushed onto the stack. When the time to return comes along then the address is popped off the stack, but if you have left some pushes un-popped, so to speak, then some very funny things can happen.

Whether you use pq to represent an address, or mn a number, doesn't matter a jot, as long as you, the programmer, know what is happening. However, what is significant is the presence or absence of brackets in the instruction, as I mentioned last month. Fig. 11 shows part of a program with a Z80 instruction to load

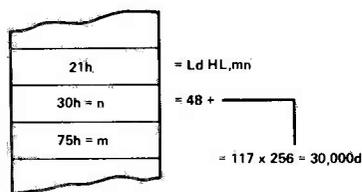


Fig. 11 Z80 instruction to load HL with 30 000 decimal.

HL with 30,000d or 7530h. Note how the low byte, the one in L, goes straight after the instruction. Some of you will be familiar with the BASIC instruction, PRINT PEEK (address) + 256 x PEEK (address + 1); now you can match up the request with Fig. 11. The difference between the two instructions 2A — **Ld HL,(Pq)** and 21 — **Ld HL,mn** should now be apparent. The first instruction loads the contents of the address pq into L, and the contents of pq + 1 into H; the second instruction loads the byte n into L and the byte m into H. If the two bytes mn represent an address, then HL is said to be pointing to that address.

Taking The Indirect Route

The Z80 instruction 77 — **Ld(HL),A** is an example of indirect addressing, which if you work it out, means load the contents of the A register into the address which is pointed to by the HL pair. This is the machine code equivalent of the BASIC instruction POKE

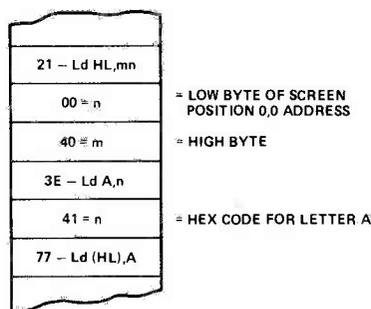


Fig. 12 One way of printing a screen position 0,0.

(address), with whatever. Earlier I explained that the display file is a series of addresses, with each address holding a byte of information relating to the screen display. I also gave the address 16384d - 400Ch as being the address of screen position 0,0 for no particular computer. Fig. 12 shows how to poke the code for the letter A onto the screen at position 0,0 using one method, and Fig. 13 shows a different method. However, an explanation is required for the method used in Fig. 13.

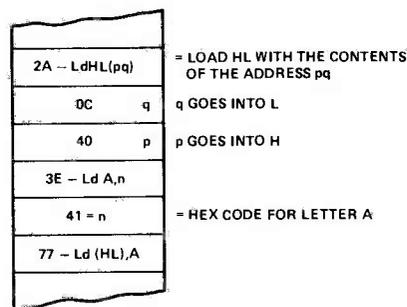


Fig. 13 Another way of printing a screen position 0,0.

Suppose that you didn't know the address of the position 0,0 on the screen, but the system variable called D File held the address. If the address of D File was 19634d - 400Ch this would mean that 400Ch would hold the low byte of the address of position 0,0 and 400Dh would hold the high byte.

One last example in this section is the Z80 instruction 7E — **Ld A,(HL)**, which is the machine code equivalent of the BASIC instruction PEEK (address). Of course, registers other than A and HL can be used, but you should by now be able to identify the other instructions. Just in case you are wondering about the term indirect addressing, the instruction 77 — **Ld (HL),A** pokes the contents of register A into the address via the HL pair. What I haven't mentioned yet is the use of such instructions in a program, so here is

a short explanation using the two instructions given above.

Suppose instead of poking the letter A onto the screen; we had poked the code for 1 (this could be the start of a score, or the first try at something or other). Later on in the program we will want to test for the limit, say 9, and if we have reached it then finish, otherwise increase (increment) the score and carry on. The instruction $7E - LD A,(HL)$, where HL points at the screen position of the number, will load A with the number on the screen. Comparing register A with the limit, 9, we can either finish if A equals 9, or increment A, poke it back onto the screen, and carry on with the program. I'll be covering the compare instructions later on, but it does involve the use of the flags. Things should be starting to fall into place now, but it does require a little thought.

Fingering The Index

Because the index registers X and Y allow great flexibility in machine code programming, this section will cover a lot of ground. As you get to know how the index registers work the easiest way to visualise them is as pointers to a table, the X registers moving horizontally, and the Y registers moving vertically. This doesn't happen literally of course, but the table concept can easily be programmed. Because I wrote about indirect addressing in the last section, I'll give a couple of examples from the 6502 set using indirect and indexed addressing together. Pre-indexed indirect addressing is the grand title of the first example, and Fig. 14 will make what's happening clearer.

The instruction $A1 - Ld A,(I,X)$ requires a second byte after the op-code (A1). This second byte is added to the contents of the X register to get the address of the first of two sequential bytes in zero page of the memory. These two bytes form the address of the byte to be loaded into the accumulator (or A register). In the example I've assumed that the X register holds 70h and that the second byte of the instruction is 0Ah. These two are then added together to get 7Ah (any carry bits will be lost) which is used as

a pointer to locations 007Ah and 007Bh in the memory. The contents of these two locations are treated as a 16-bit address (low byte in the lower address) and in our example this is 4000h. This is the address which holds the byte to be loaded into the accumulator, in this case FFh, to finish the instruction. Note that the X register still contains 70h at the end of the instruction. A most useful mnemonic would be $A - (byte 2 + (X))$ which illustrates quite clearly what is happening. Although I mentioned zero page addressing above, you could have reasoned out what was going on without it, because the X register will only hold one byte.

The second example from the 6502 set is $B1 - Ld A(I),Y$ which is a post-indexed indirect instruction, with the mnemonic $A - ((Y) + (byte2))$. Before you look at Fig. 15, and before you read my explanation, see if you can work out what it does; think of the use of brackets.

The second byte, in this case BE, is address 00BE, and 00BE and 00BF hold the two bytes of an address, in this case 4000h. The byte in the Y register, which is FFh, is now added to 4000h to make 40FFh, and in address 40FFh is the data that is loaded into the A register. What could be simpler?

Please note that only certain index registers can do particular jobs in the 6502 set. I leave it as an exercise for you to work out how the two prefixes pre- and post- are justified.

The Z80 CPU has a host of instructions involving index registers IX and IY. The instructions for the IX and IY pairs are the same as those for the HL pair with the prefix DD for IX and FD for IY instructions. As an example I'll take the Z80 opcode $77 - Ld (HL),A$ which I used in the previous section; the instruction $DD 77 - LD (IX + d),A$ is the indexed equivalent. This is quite straightforward; it means: poke the contents of A into the address formed by adding d to IX. That letter "d" means that there are three bytes in the instruction and "d", for displacement, is the third byte. This byte is treated as an 8-bit signed 2's complement number and thus has a value between $-128d$ and $+127d$. ($80h = -128d$, $00h = 0d$ and $7Fh = +127d$.) If IX held 4000h and we wanted to load

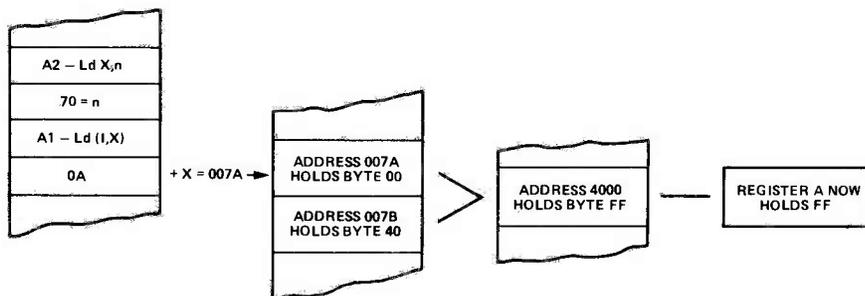
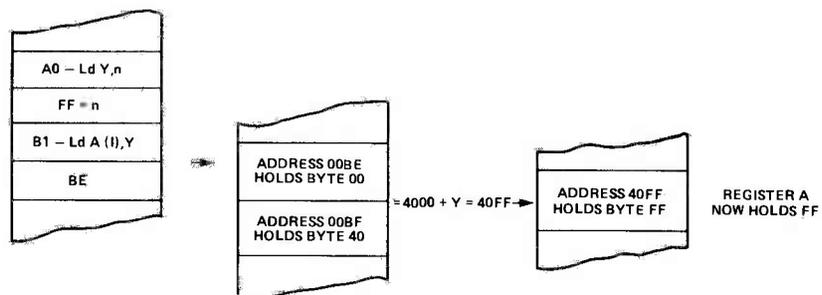


Fig. 14 Pre-indexing addressing from the 6502 set.

Fig. 15 Post-indexing indirect addressing from the 6502 set.



the A register into address 4079h, then the full instruction would be: DD 77 79.

By now you should be able to recognise just about every addressing mode that you may come across. Before I carry on, though, I would like to just clear up something I just touched upon at the beginning of this month's article, when I was discussing pushing and popping.

Apart from the fact that we can't use line numbers in machine code, we do have the equivalent to GOSUB instructions where we GOSUB to an address (location). The 6502 instruction set has only the one instruction to GOSUB and that is 20 — JSR where JSR means jump to subroutine. Now don't confuse this jump with the relative jumps and the like, that I wrote about earlier. Just as in BASIC, this jump to a subroutine expects a RETURN which with the 6502 is 60 — RTS or return to subroutine (I always think of it as return to sender!).

The Z80 set has quite a few GOSUB instructions, although they are labelled CALL, with the simplest being CDpq — Call pq. All of the flag conditions can be used for Calls in the Z80 set; for example, CCpq — CALL Zpq, which means, when the result of the last instruction is zero, GOSUB pq. Again flag conditions can be used for a return, such as DB — RET C, when carry flag is set. The straightforward return in the Z80 set is C9. A word of warning, though: keep tracks on your calls to subroutines, and make sure that the returns match up. If in doubt, re-read this month's opening section.

A Logical Conclusion

A seemingly innocuous one-byte instruction is increment, or add one to. This can apply to single registers, pairs, index registers and even inc.(HL). The 6502 has single byte instructions for incrementing its X and Y registers only. Increment is one of three add instructions which involve the use of absolute binary arithmetic. All that means is that we will be using binary, but with no fractions and no negative or positive numbers. This will become clearer as we go along anyway.

Taking a single register first, as you would expect, increment will just add 1 to the contents of that register. This is all very well until the contents of that register reach FF, which is the maximum number that one register can hold. So now what happens? Fig. 16 should be of some help, and if you don't understand binary addition then this explanation will put you right. Remember that a binary digit, or bit, can only be either 1 or 0, if we add two 1s together the answer must be 0 and carry one over to the left. Starting at bit 0, the one on the right in Fig. 16, work your way to the leftmost bit which is bit 7.

<p>Contents of register = FF = 11111111 binary 1 INC or add 1 Contents of register = 00 = 00000000</p>
--

Fig. 16 Incrementing the contents of a full register.

You should finish up with all the bits at 0, which means that the register now holds zero. So you see, incrementing a full register, or register pair, simply means that we start at zero again, and the zero flag should be set. I say *should* be set because it's always

advisable to check on the flags situation in the instructions set.

By the way, what happened to the last carry to the left, the one after we added 1 to bit 7? The answer in the case of incrementing is that it was discarded, but with the next two add operations it is important, as it affects the carry flag. The 6502 also has 2 and 3-byte instructions for incrementing (and decrementing) memory locations directly and indirectly.

In the Z80 set, you can add register to register, such as ADD A,B, or add pairs such as ADD HL,DE. Again, index registers can be involved, and even an instruction such as ADD A,(HL). Usually the only register that you can add a constant to is register A, in instructions such as ADD A,n. Fig. 17 shows the simple addition of two registers, which is quite straightforward. Again, when the two numbers added together come to more than one register can hold then the register that is being added to will pass through zero. This time, something different happens, so let's take a look at an example.

<p>Contents of register A = 50 decimal = 00110010 binary Contents of register B = 100 decimal = 01100100 binary Contents of register C = 150 decimal = 10010110 binary</p>
--

Fig. 17 Adding two full registers together.

Suppose register A held D1 or 209, and register B held B0 or 176 and the instruction was ADD A,B. Fig. 18 shows what happens, but I'll put it into words as well. Adding 209 and 176 gives an answer of 385; subtracting 256 leaves 129, which is what finishes up in register A.

Just to prove what a glutton for punishment I am, I will now go through the binary addition in Fig. 18. Bit 0, the rightmost bit, is where we start, and 0 + 1 equals 1 so a 1 goes on the bottom line. Bits 1, 2 and 3 are 0 in both registers so 0 goes on the bottom line in each case. Bit 4 in both registers is 1 so down goes 0 and a carry to the left. Two 1s make a carry from bits 5 and 6, this 1 goes into bit 7 position on the bottom line. Those two 1s above the bottom line in bit 7 position give a carry to the left, and this last carry sets the carry flag 7.

<p>Contents of register A = 209 decimal = 11010001 binary Contents of register B = 176 decimal = 10110000 Contents of register A = 129 decimal = 10000001 binary A carry to the left sets the carry flag</p>

Fig. 18 What happens when two registers added together come to more than 255 decimal.

The third add instruction is ADC, which stands for add with carry, and is really straightforward. What happens is that all the above rules apply plus the fact that the current value of the carry flag is added on to the total, and the carry flag altered according to what happens during the current instruction. In other words, if there is a carry over from bit 7 then the carry flag will be set, otherwise reset. The 6502 has no register to register arithmetic, but uses memory locations — especially zero page locations — instead, but always with ADC.

The subtraction instructions follow exactly the same pattern as the addition instructions with regard to the registers, etc. The first SUBtraction is DECrement, or decrease by 1, then SUB and finally SBC or

subtract with carry. As you might expect, if you decrement a register, or register pair, which holds zero, then the number will zoom round to FF or FFF. Rather than me give you an example of subtracting in binary, why not have a go yourself? Write down two decimal numbers, take the smaller from the greater, convert the two numbers to binary, underneath write down the answer from the decimal subtraction converted to binary. Now work out how you can arrive at the answer.

AND The Rest

Usually there are three logical instructions that you can use which are AND, OR and XOR. Taking AND as the first example, it usually comes in the form AND,r where r is another register such as AND,C. There should be an instruction such as AND,n where n is any number up to FF, and you may get AND(HL) and even AND(IX + d). Your CPU instruction set should show what AND instructions you can use. Whatever the instruction, everything is ANDed with register A, the accumulator.

Assuming that register A holds FF and register B holds 0F, Fig. 19 shows what happens when the

Register A holds FF = 11111111
 Register B holds 0F = 00001111 AND
 Register A holds 0F = 00001111

Fig. 19 The result of the instruction AND B.

instruction AND,B is met. The explanation couldn't be easier: if the bits in A and B are both 1 then that bit remains the same in register A.

Check with your CPU instruction set, but an AND instruction will usually alter all of the flags, with the carry flag always being set. If, during the writing of your program, you are not sure of the status of the carry flag, then AND A or AND FF will always reset it for you. Another use for ANDing is to mask off certain bits, and this is worth an explanation.

In the first part of this series I made a passing mention to a refresh register which is used to ensure that data isn't lost from RAM by the simple expedient of each address from time to time. What happens is that this register, R, starts off at zero and is incremented until it reaches 7F, it is then discharged and starts at zero again. So at any time register R will hold a number between 00 and 7F. The Z80 set has an instruction ED 5F — Ld A,R which, if used from time to time in a program, gives the effect of putting a random number in A. If you want to make sure that this 'random' number doesn't go above a certain number all you have to do is AND,x where x is your limit; note, however that if you chose an x that is not equal to 2ⁿ-1, this operation will not return a truly random number (why?).

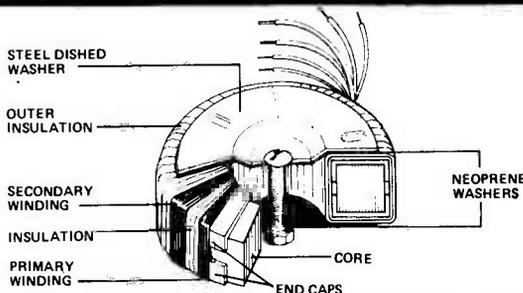
The refresh register is actually 8 bits but only the 7 lower bits are incremented automatically. The 8th bit can be set or reset by using the Ld R,A — ED 4F which transfers the contents of the A register to the refresh register. The refresh register will then be incremented from that value but the MSB will stay in its current state.

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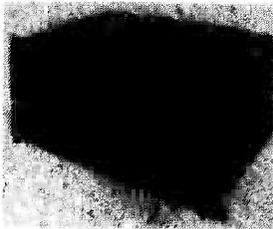
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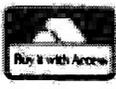


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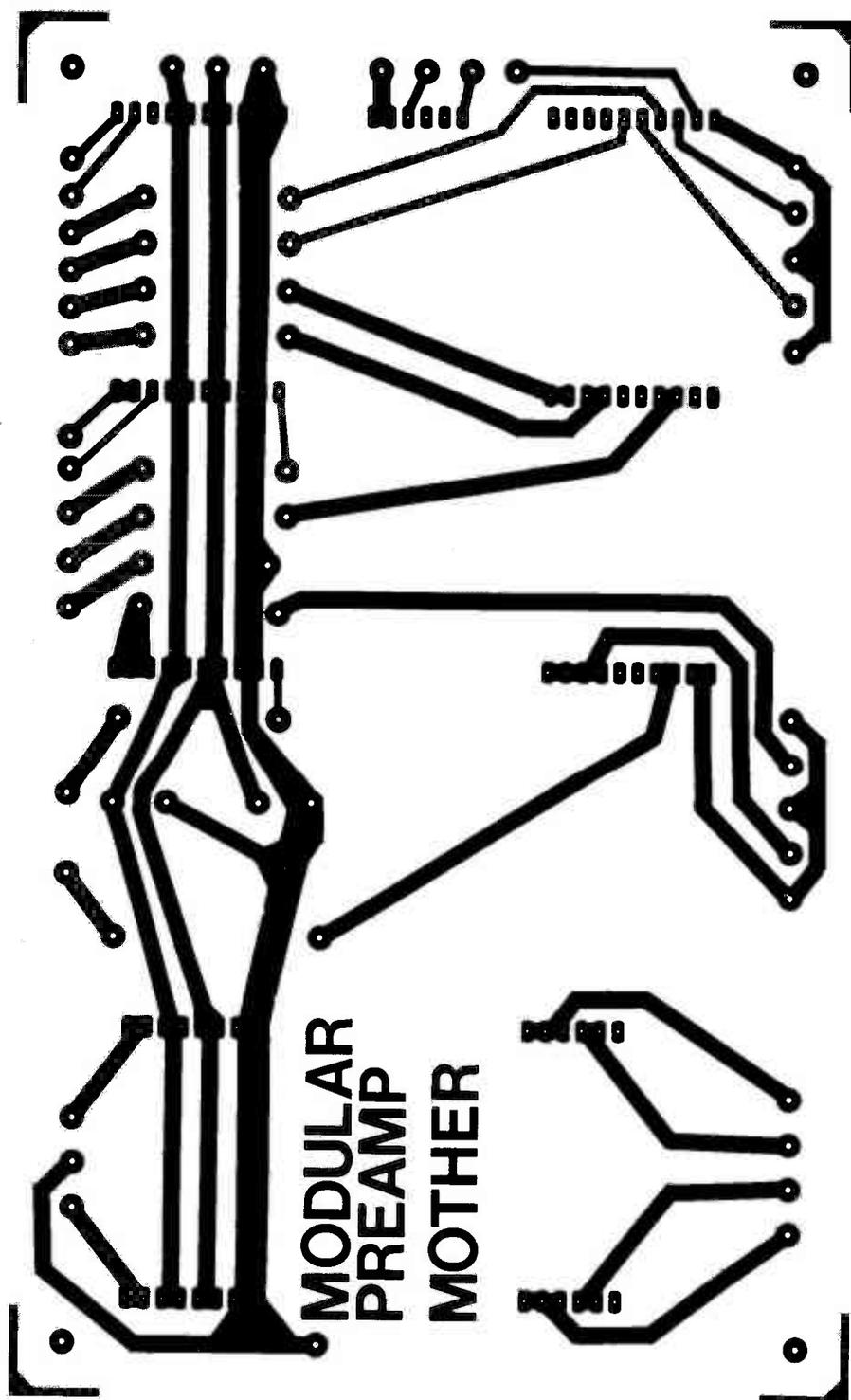
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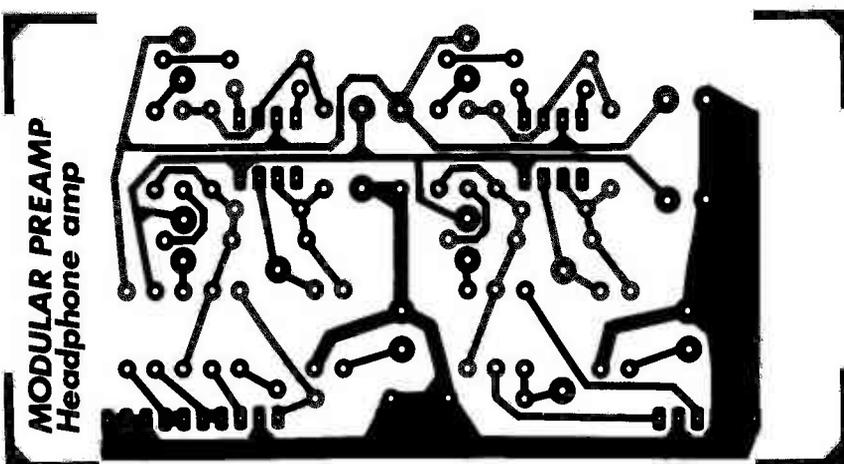
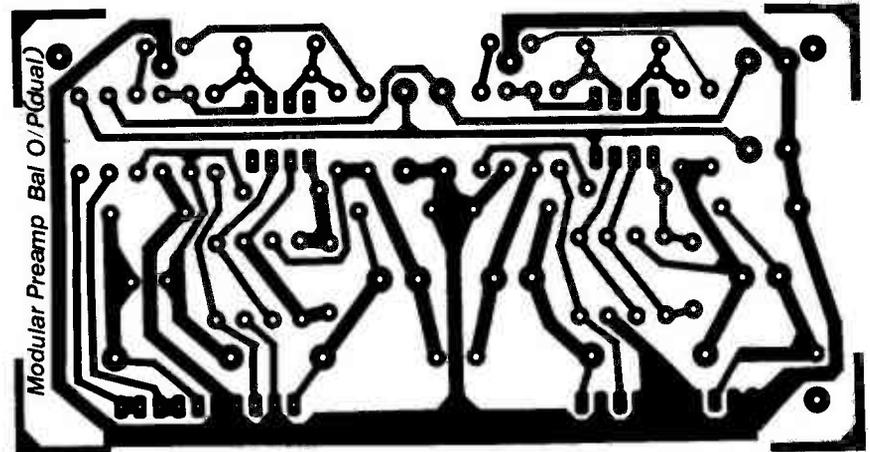
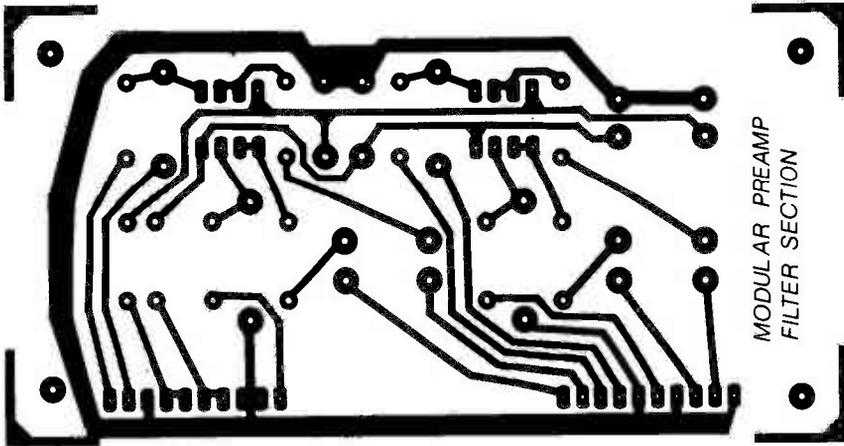
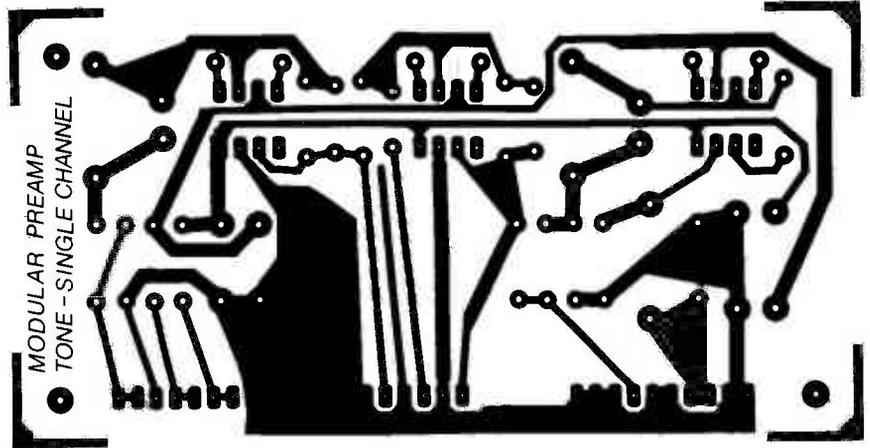
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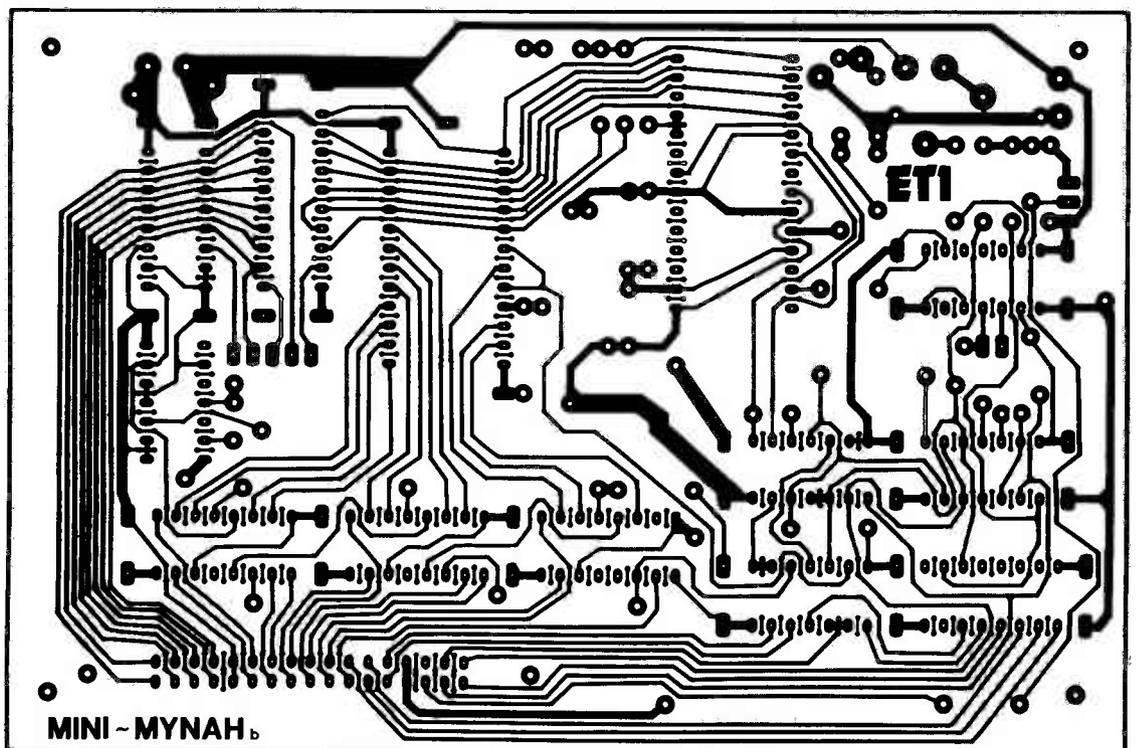


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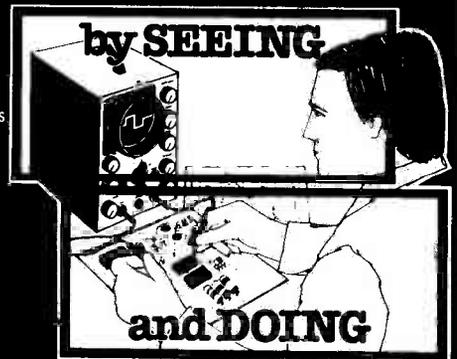
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Write For ETI

We are always looking for new contributors to the magazine, and we pay a competitive page rate. If you have built a project or you would like to write a feature on a topic that would interest ETI readers, let us have a description of your proposal, and we'll get back to you to say whether or not we're interested and give you all the boring details. (Don't forget to give us your telephone number).

We don't bother with the bureaucracy for Tech Tips — all you do is to send in your idea, stating clearly if you want an acknowledgement of receipt. If possible, please *type* your explanation of why the circuit is different, what it does and how it works, on a separate sheet from the circuit diagram; both sheets should carry your name, address and the circuit title. We'll let you know (within a month or so) if we want to use your Tech Tip.

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OOPS!

We have in the past published small corrections to projects on the letters page, and major corrections separately. From now on corrections will appear on this page, and will be repeated for several months (just to increase our embarrassment). If a correction is too large to fit on here, we will publish it just once, but will note the fact that a correction does exist, and that copies of it can be obtained from us provided you send in an SAE. But please — request copies only if you really do need them; if this service is abused, we may be forced to withdraw it.

Telescope (August 1983)

We had a shower of annotation falling off our diagrams! On Fig. 1, C19 (below IC14) was not labelled nor was Q2 (above R11), and there were two C23s — one should be IC22 and it doesn't matter which. In Fig. 5, IC12 was not labelled. Unfortunately, there was a mistake in the correction (blush!); C14 is the 22 μ tant on the -5 V line.

Graphic Equaliser (August 1983)

D2 and D3 are shown the wrong way round in the power supply circuit diagram on page 20.

Universal EPROM Programmer (August 1983)

Corrections to this project are listed in the article "Universal EPROM Programmer Revisited" which appeared in the January '84 issue.

Z80 Controller Computer (August 1983)

On the overlay, SW1 is the rectangle beside ICs 5 and 6. C6 should be shown between ICs 3 and 7, and a link through has been missed — to the right of pin 18. IC11.

Typewriter Interface (October 1983)

An update article on this project will appear in the March '84 issue.

Car Alarm (October 1983)

In the semiconductors section of the parts list, Q1, 2, 5, and 7 should be BC212L, Q3 should be BC182L, and Q4, 6 should be TIP31 or BD131. There was also another (inconsequential) silly but we bet you've already spotted that one!

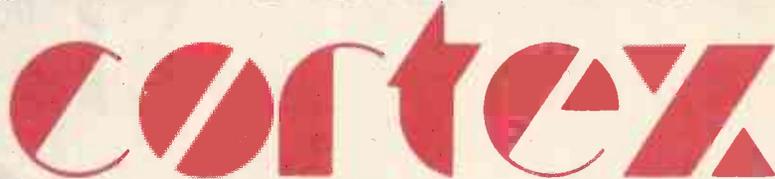
Tech Tips (October 1983)

Ramped Pulse Generator For Stepper Motors — pin 1 of IC2 should be grounded, the Ramp Up and Ramp Down inputs accept negative, not positive, going pulses, and IC7 should be a 4011 rather than a 4001.

Active Loudspeaker (November 1983)

Gremlins attacked the parts list on page 72 leaving a trail of 00's in their wake. The ceramic tiles should be 150 mm (6") square and you need six of them. The BAF wadding needs to be about as wide as the enclosure's internal height, i.e., about 21", and long enough to loosely fill the space when rolled up with a bit left over to cover the back of the bass unit. The thinner the wadding you use, the greater the length you will require.

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IF	?	WAIT	BOOT	TOF	BASE	@	LOG	COL	=
ELSE		SAVE	GRAPH	TON	TON	U	SQR	COL	=
ON		LOAD	TEXT	DIM	COMMANDS	#	SYS	MOD	>
GOTO	1 UNIT	MOTOR	PLOT	LET	LET	?	TIC	RND	>
GOSUB	BAUD	ESCAPE	UNPLOT	DEF	SIZE	:	SGN	KEY	>
POP	CALL	NOESC	COLOUR	CONT	MON	?	BIT	OPERATORS	>
REM	DATA	RANDOM	CHAR	END	DELIMITERS	%	CRB	OR	>
FOR	READ	ENTER	SPRITE	BIT	TO	!	CRF	LOR	>
NEXT	RESTOR	LIST	SHAPE	CRB	TAB	&	SIN	AND	>
ERROR	RETURN	PURGE	SPUT	CRF	STEP		COS	LAND	>
INPUT	STOP	NUMBER	SGET	MEM	THEN		EXP	NOT	>
							FRA	LNOR	>
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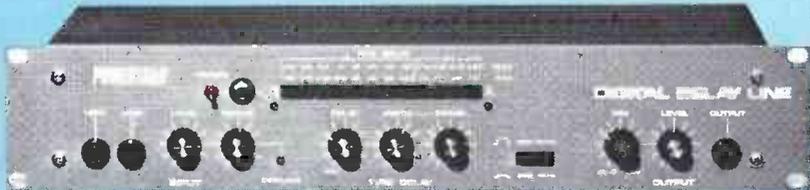
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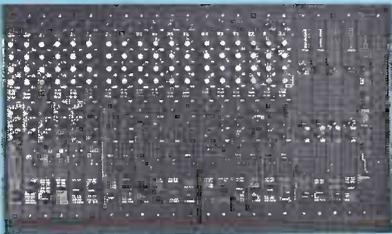
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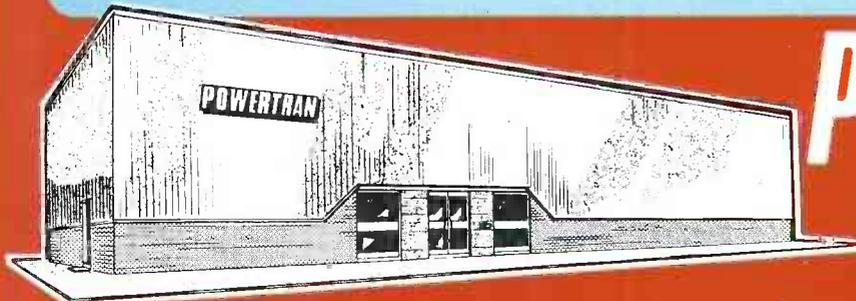


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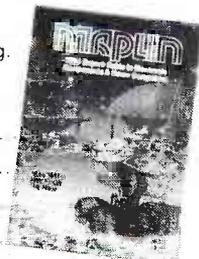
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