

electronics today

INTERNATIONAL

MARCH 1984 95p

ETI SPECIAL REPORT: CABLE TELEVISION GOES DOWN THE DRAIN?

It might not happen,
and even if it does,
it might not be
what we want



PLUS

● **STEREO POWER METER** – true reading of audio or DC power



● **Z80 DRAM CARD** – add more memory to Z80-based systems

● **COMPLEX NUMBERS** – take circuit calculations in your stride

**BRITAIN'S LEADING
ELECTRONICS
MAGAZINE**

Low-price robots from POWERTRAN

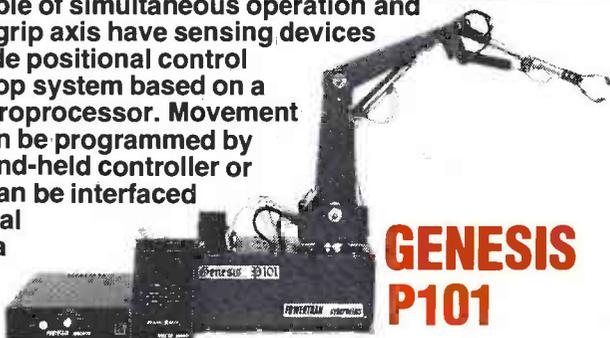
— hydraulically powered
— microprocessor controlled

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.



GENESIS S101



GENESIS P101

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 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**

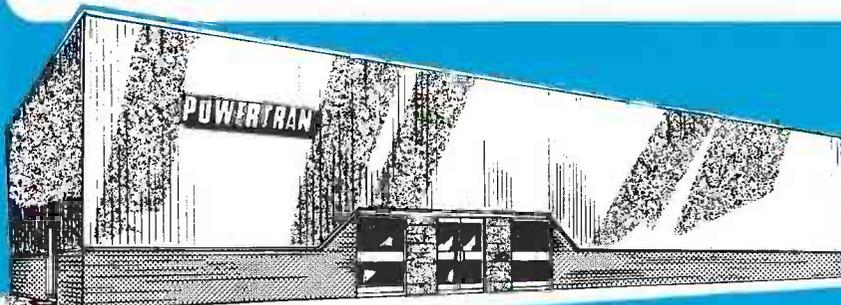
5-axis model (kit form) **£475**
5-axis complete system (kit form) **£737**

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.

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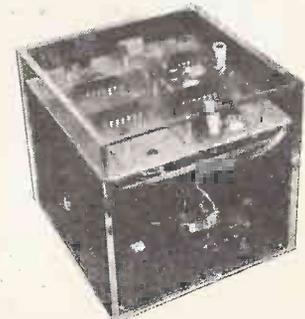
1 Golden Square, London W1R 3AB. Telephone 01-437 0626.
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Bob Bennet gets a bit exclusive with his OR binary register operations, before telling us a very (program) moving story.
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Amongst the circuit offerings this month is a rather ingenious data link circuit and a super-cheap envelope generator.
- READ/WRITE** 50
Modifications to our most recent active loudspeaker design and (almost) a competition are just two of the letters we've decided should grace our pages.
- AUDIO DESIGN** 58
John Linsley Hood sets out to prove that although circuit calculations employing complex numbers may lead to the odd bit of hairy algebra, there is nothing beyond the ken of the average ETI reader (intelligent lot that you are).

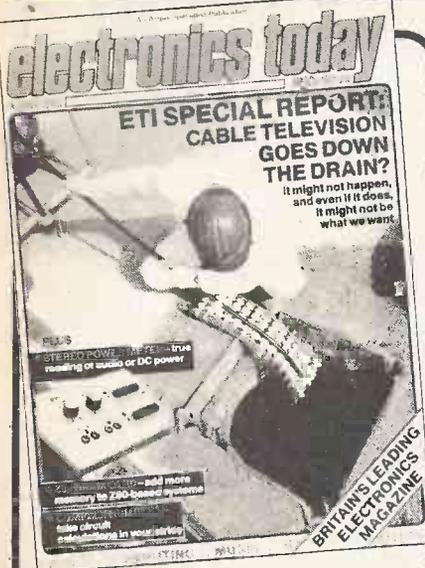
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A few additional pieces of information and a correction that some of you have spotted already, all to make it easier to use this project.
- STEREO POWER METER** 35
Find out just what it is the neighbours keep complaining about with Walker's Watt-Watcher!
- Z80 DRAM CARD** 45
The other way of adding lots of extra memory to a Z80 system, other than upgrading existing memories, is to build a whole new 64K block — Bob Campbell shows how it's done.
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Ever wished you could throw a six
- when you wanted — well now you can with this design from Ian Hickman — but don't blame us if your fellow Monopoly players send you to jail for using it!
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ELECTROLYTIC CAPACITORS: (Values in μ F) 500V: 10uF 52; 47.78; 63V: 0.47, 1.0, 1.5, 2.2, 3.3, 4.7, 8p 10 10p; 15, 22, 12p, 33 15p; 47, 68, 20p; 100 19p; 220 99p; 50V: 68 20p; 100 17p; 220 24p; 40V: 22 3p; 33 12p; 330, 470 32p; 1000 48p; 2000 90p; 25V: 1.5, 4.7, 10, 22, 47 8p; 100 11p; 150 12p; 220 15p; 330 22p; 470 25p; 680, 1000 34p; 1500 42p; 2200 50p; 3300 76p; 4700 92p; 16V: 47.68, 100 9p; 125 12p; 330 16p; 470 20p; 680 34p; 1000 27p; 1500 31p; 2200 26p; 4700 72p.

TAG-END CAPACITORS: 64V: 2200 13p; 3300 19p; 4700 24p; 50V: 2200 110p; 3300 184p; 40V: 4700 180p; 25V: 2200 90p; 3300 98p; 4000, 4700 98p; 10000 245p; 15000 345p; 16V: 2200 350p.

POLYESTER CAPACITORS: Axial Lead Type
400V: 1nF, 1n5, 2n2, 3n3, 4n7, 6n8 11p; 10n, 15n, 18n, 22n 12p; 33n, 47n, 68n 16p; 150 20p; 220n 30p; 330n 42p; 470n 52p; 680n 1uF 68p; 2u2, 8u2, 1000V: 1nF, 10n, 15n, 22n, 33n, 47n, 68n 11p; 100n, 150n, 220n 12p; 330n, 470n 15p; 680n 19p; 1000 42p; 1000p 42p.

POLYESTER RADIAL LEAD CAPACITORS: 250V
10n, 15n, 22n, 27n 6p; 33n, 47n, 68n, 100 8p; 150n, 220n 10p; 330n, 470n 15p; 680n 19p; 1000 42p; 1000p 42p.

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; 10p; 2.2, 3.3 16p; 4.7, 6.8 22p 10 18p; 15, 33p; 22 45p; 33, 47 50p; 100 95p; 10V: 15, 22, 20p; 33, 47 50p; 100 80p; 6V: 100 55p.

MYLAR FILM CAPACITORS
100V: 1nF, 2, 4, 4nF, 10p; 15nF, 22n, 33n, 40n, 47n, 56n, 100n, 200n 9p; 50V: 470nF 12p.

CERAMIC CAPACITORS 50V:
Range: 0.50pF to 10nF 4p. 15nF, 22nF 33nF, 47nF 5p. 100nF/300V 7p. 200nF/6V 8p.

POLYSTYRENE CAPACITORS:
10pF to 1nF 8p; 15nF to 12nF 10p.

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

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

RESISTORS Carbon Min-Hi-Stab 5%
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RANGE Val 1-99 100 +
0.25W 2R2 - 10M E24 3p 1p
0.5W 2R2 - 10M E12 3p 1p
1W 2R2 - 10M E24 3p 4p
2% Metal Film 1R - 1M E24 6p 4p
1% Metal Film 51R - 1M E24 8p 6p
100+ price applies to Resistors of each type not mixed

RESISTORS NETWORK S.I.L.
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8 Commoned (9 pins) 150, 180, 270, 330, 1K, 2K, 4K7, 6K8, 10K, 22K, 47K & 100K 26p.

DIODES BRIDGE RECTIFIERS
AA119 15 1A/50V 18 75107/8 96
AA129 20 1A/100V 20 75110/10 90
AA330 15 1A/100V 25 75114/15 100
BA100 15 1A/50V 25 7512/2 130
BA100 20 2A/50V 30 75150 125
BY100 24 2A/200V 40 75154 125
BY125 12 2A/200V 40 75158 100
BY127 14 2A/400V 48 75159 195
CRO33 250 2A/600V 66 75182/4 90
OA9 40 6A/100V 83 75189/9 56
OA7 12 10A/200V 215 75322 140
OA70 12 10A/200V 380 75324 380
OA75 15 10A/500V 298 75325 200
OAS1 20 25A/200V 246 75361/3 150
OAS5 15 25A/600V 396 75365 80
OAS9 8 25A/600V 56 75450 86
OAS9 8 VM18 DIL 50 75451/2 52
OAS9 8 75454 70
DA200 8 75491/2 65
OA202 8 6843 5
1N814 4 6845 5
1N816 4 6847 5
1N4001/2 5 6850 110
1N4003 6 6852 250
1N4004/5 6 33V 1.3W 6854 559
1N4006/7 6 15p each 6854 559
1N4148 4 6854 559
1N5401 15 8A800V 90 6854 559
1N5404 16 8A800V 90 6854 559
1N5406 17 12A100V 78 68000 New
1N5408 19 3A200V 54 12A400V 60
1S921 9 3A400V 50 60115 180
6A100V 60 8A100V 60 60106 60
6A400V 60 8A400V 60 10134 24
6A800V 50 12A100V 78 10134 24
12A100V 78 10134 24
12A400V 82 10134 24
12A800V 136 25A500V 120
1N816 4 25A100V 106 25A200V 130
BA102 4 16A100V 106
BRT05B 40 16A800V 100
BB106 40 25A500V 220
BB109B 40 25A800V 296
MVAM2 105 12B200 120

ZENERS
Range: 2V7 to 33V 400mW
1N4733 5 15p each
1N4734 5 33V 1.3W
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25A800V 130 68000 New
25A100V 106 68000 New
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TRANSISTORS

AC126/7 35	BC12 10	BF256A 35	MPSA56 30	VK1010 99	2SC708/9 10	2SC2078 170
AC131/2 30	BC212L 10	BF256B 45	MPSA70 30	VN10KM 70	2N3713 140	2SC2081 85
AC176 28	BC213 10	BF257/8 32	MPSU02 58	VN46AF 95	2N3717 179	2SC2314 86
AC187 37	BC213L 10	BF259 35	MPSU05 55	VN66AF 110	2N3772 195	2SC2166 105
AC188 32	BC214 10	BF336/7 40	MPSU06 55	VN89AF 120	2N3773 210	2SC2335 225
AC188 32	BC213L 10	BF394/5 30	MPSU52 65	VN89AF 120	2N3819 27	2SC2547 27
ACV19/21 75	BC237/8 14	BF394/5 30	MPSU55 50	ZTX107/8 11	2N3821 38	2SC2612 35
AD22/4 15	BC256B 30	BF411/78 23	MPSU56 30	ZTX117/8 23	2N3822/23 45	2SC2324 74
AD12 120	307B 14	BF494/5 30	MPSU56 60	ZTX12 28	2N3866 90	2SK45 80
AD149 70	BC308 18	BF494/5 30				

SWITCHES TOGGLE: 2A 250V SPST 35p 48p SUB-MIN TOGGLE SPST on/off 54p SPDT c/cover 80p SPDT Centre off 85p SPDT biased both ways 105p DPDT 6 lags 75p DPDT centre off 80p DPDT biased both ways 145p DPDT 3 positions on/on/on 185p 3-pole 2 way 205p SLIDE 250V DPDT 1A 14p DPDT 1A c/off 15p DPDT 4A 13p PUSHBUTTON 6A with 10mm Button SPDT latching 110p DPDT latching 110p SPDT moment 110p DPDT moment 160p Mini Non Locking Push to Make 15p Push to Break 25p ETI PROJECTS We stock most of the parts  TRANSFORMERS 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 6VA: 2x6V-0.5A, 2x9V-0.3A, 2x12V-0.25A, 2x15V-0.2A 270p Standard Split Bobbin type 8VA: 2x6V-0.5A, 2x9V-0.4A, 2x12V-0.3A, 2x15V-0.25A 300p 12VA: 2x4.5V-1.3A, 2x5V-1A, 2x6V-0.6A, 2x12V-0.5A, 2x15V-0.4A, 2x20V-0.3A 345p (35p p&p) 24VA: 2x6V-1.5A, 2x9V-1.2A, 2x12V-1A, 2x15V-0.8A, 2x20V-0.6A 385p (60p p&p) 30VA: 2x6V-1.5A, 2x9V-1.2A, 2x12V-1A, 2x15V-0.8A, 2x20V-0.6A, 2x25V-0.5A 420p (60p p&p) Specially wound for Multirail computer PSUs 10VA: Outputs +5V/5A, +12V, +25V, -5V, -12V at 1A 620p (60p p&p) 100VA: 2x12V-4A, 2x15V-3A, 2x20V-2.5A, 2x25V-2A, 2x30V-1.5A, 2x50V-1A 985p (75p p&p) P&P charge to be added over and above our normal postal charge	DIP SWITCHES (SPST) 4 way 65p; 6 way 60p; 8 way 85p; 10 way 125p (SPDT) 4 way 190p ROTARY SWITCHES (Adjustable Stop type) 1 pole/2 to 12 way, 2 pole/2 to 6 way, 3 pole/2 to 4 way, 4 pole/2 to 3 way 48p ROTARY: Mains DP 250V 4 Amp on/off 68p ROTARY: (Make-a-switch) Make a multiway switch. Shafting assembly has adjustable stop. Accommodates up to 6 wafers (max. 6 pole/2 way + DP switch). Mechanism only 90p WAFERS: (make before break) to fit the above switch mechanism. 1 pole/12 way, 2 pole/6 way, 3 pole/4 way, 4 pole/3 way, 6/2 way 65p Mains DP 4A Switch to fit 45p Spacers 4p. Screen 6p.	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 17 420p 4 1/2 x 17 495p Pklot 100 pins 55p Spot face cutter 150p Pin insertion tool 125p VERO WIRING PEN + spool 340p Spare spool 75p Combs 8p	VA Board 185p DIP Board 395p Vero Strip 95p PROTO DECS Veroblock 405p S-Dec 395p Euroboardboard 520p Binboard 1 575p Superstrip SS2 1350p OLAO ETCH RESIST PEN Plus spare tip 100p	IDC CONNECTORS PCB with latch 90p Plugs with Pins 99p Female Header 150p Card Plug 120p Edge Concl 120p 10 way 99p 16 way 130p 20 way 145p 25 way 175p 34 way 205p 40 way 220p 50 way 235p 60 way — EURO CONNECTORS Gold Flashed Contacts DIN41617 170p 31 way 170p DIN41612 170p 2 x 32 A + B 275p DIN41612 275p 2 x 32 A + C 320p DIN41612 3 x 32 A + B + C 320p CRISTALS 32 768kHz 100 100kHz 235 30MHz 225 200kHz 265 455kHz 370 1MHz 275 1.008MHz 275 1.28MHz 390 1.8MHz 395 1.8MHz 395 1.8432M 200 3.0MHz 225 2.4576M 200 3.278M 150 3.579M 98 3.6864M 300 4.0MHz 150 4.032MHz 280 4.19430M 200 4.433619M 100 4.608MHz 200 4.804MHz 200 5.00MHz 180 5.1855M 300 5.24288M 390 6.0MHz 175 6.5368MHz 225 7.0MHz 150 7.168MHz 250 7.328MHz 250 7.68MHz 200 8.0MHz 150 8.089333M 395 8.86723M 175 9.00MHz 200 10.0MHz 175 10.24MHz 200 10.5MHz 250 10.7MHz 150 12.0MHz 175 12.2528M 300 14.3184M 170 16.0MHz 200 18.0MHz 180 18.432M 150 19.368MHz 150 20.0MHz 200 24.0MHz 170 24.930MHz 325 26.639M 150 27.648M 170 27.145M 180 38.6667M 175 48.0MHz 170 100.0MHz 295 110.0MHz 300	RELAYS Miniature, enclosed, PCB mount. SINGLE POLE Changeover RL81 205R Coil, 12V DC, (10V5 to 19.5V), 10A at 30V DC or 250V AC 195p DOUBLE POLE Changeover, 6A 30V DC or 250V AC RL100 53R Coil, 6V DC, (5V4 to 9V9), 190p RL8-111 205R Coil, 12V DC, (10V7 to 19V5) 195p RL8-114 740R Coil, 24V DC, (22V to 37V) 200p ASTEC UHF MODULATORS Standard 6MHz 325p Wideband 8MHz 450p BUZZERS miniature, solid-state, 6V, 9V & 12V 70p PIEZO TRANSDUCERS PB2720 70p LOUDSPEAKERS Miniature, 0.3W 8 2in, 3in, 2 1/2in, 3in 80p 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. £205 ● KAGA 12" Med-res. RGB Colour. Has flicker-free characters. Ideal for BBC, Apple, VIC, etc. £210 (car £7) ● KAGA 12". As above but Hi-Resolution £259 (car £7) ● Connecting Lead for KAGA £5 Carriage E7 Securcor							
ROCKER SWITCHES ROCKER: 5A/250V SPST 28p ROCKER: 10A/250V SPDT 38p ROCKER: 10A/250V DPDT c/off 95p ROCKER: 10A/250V DPST with neon 85p	FERRIC CHLORIDE 1 lb bag Anhydrous 185p +50p p&p	ULTRASONIC TRANSDUCER 40KHz 350 pr	COPPER CLAD BOARDS Fibre Single Double S.R.B.P. glass sided sided S/Speed 6" x 6" 100p 125p 9.5 x 8.5" 6" x 12" 175p 225p 110p	EDGE CONNECTORS 1 156 2x15 way — 140p 2x18 way 180p 145p 2x22 way 180p 200p 2x22 way 175p — 2x25 way 225p 220p 2x28 way 190p — 2x30 way 245p — 2x36 way 295p — 2x40 way 315p — 2x40 way 315p — 2x75 way 550p —	OIL PLUG (Header) Solder IDC 14 pin 40p 80p 16 pin 45p 105p 24 pin 88p 178p 28 pin 290p 295p 40 pin 250p 255p RIBBON CABLE price per foot Grey Colour 10 way 15p 28p 16 way 25p 40p 20 way 30p 50p 24 way 40p 65p 28 way 55p 80p 34 way 60p 85p 40 way 70p 90p 50 way 100p 135p 64 way 120p 160p	CRISTALS 32 768kHz 100 100kHz 235 30MHz 225 200kHz 265 455kHz 370 1MHz 275 1.008MHz 275 1.28MHz 390 1.8MHz 395 1.8MHz 395 1.8432M 200 3.0MHz 225 2.4576M 200 3.278M 150 3.579M 98 3.6864M 300 4.0MHz 150 4.032MHz 280 4.19430M 200 4.433619M 100 4.608MHz 200 4.804MHz 200 5.00MHz 180 5.1855M 300 5.24288M 390 6.0MHz 175 6.5368MHz 225 7.0MHz 150 7.168MHz 250 7.328MHz 250 7.68MHz 200 8.0MHz 150 8.089333M 395 8.86723M 175 9.00MHz 200 10.0MHz 175 10.24MHz 200 10.5MHz 250 10.7MHz 150 12.0MHz 175 12.2528M 300 14.3184M 170 16.0MHz 200 18.0MHz 180 18.432M 150 19.368MHz 150 20.0MHz 200 24.0MHz 170 24.930MHz 325 26.639M 150 27.648M 170 27.145M 180 38.6667M 175 48.0MHz 170 100.0MHz 295 110.0MHz 300	THUMBWHEEL Mini front mounting Decade Switch Module 250p B.C.D. Switch Module 275p Mounting Cheeks (per pair)	DILL SOCKETS Low Wire 8 pin Prot Wrag 2x15 way — 140p 14 pin 8p 25p 2x18 way 180p 145p 14 pin 10p 35p 2x22 way 180p 200p 16 pin 10p 42p 2x23 way 175p — 18 pin 16p 52p 2x25 way 225p 220p 20 pin 20p 60p 2x28 way 190p — 22 pin 22p 65p 2x30 way 245p — 24 pin 25p 70p 2x36 way 295p — 28 pin 28p 80p 2x40 way 315p — 40 pin 30p 90p 2x40 way 315p — 2x75 way 550p —	ZIF DIL SOCKETS 24 pin 565p 28 pin 750p 40 pin 799p	'D' CONNECTORS miniature 9 15 25 37 way way way way Male Solder lugs 80p 105p 160p 250p Angle pins 150p 210p 250p 355p PCB pins 120p 130p 195p 295p Female Solder lugs 105p 160p 200p 335p Angle pins 165p 215p 290p 440p PCB pins 150p 180p 240p 420p COVERS 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 475p 36" long, Double Ended, M/M 995p 36" long, Double Ended, F/F £10 36" long, Double Ended, M/F 995p	APHENON PLUGS IDC Solder 24 way IEEE 475p 480p 36 way Centronics 525p 475p	NEW LAUNCH ZBOA 2nd PROCESSOR BOARD ZBOA 4MHz 2nd Processor Board with 64K memory, 4K Monitor EPROM, Parallel printer interface, CP/M handling, double density board will handle 3 1/2", 5 1/4" & 8" Floppy Disk Drives and many more facilities. All neatly housed in a twin slimline disc drive case. Only: £350
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 17 420p 4 1/2 x 17 495p Pklot 100 pins 55p Spot face cutter 150p Pin insertion tool 125p VERO WIRING PEN + spool 340p Spare spool 75p Combs 8p	FERRIC CHLORIDE 1 lb bag Anhydrous 185p +50p p&p	ULTRASONIC TRANSDUCER 40KHz 350 pr	COPPER CLAD BOARDS Fibre Single Double S.R.B.P. glass sided sided S/Speed 6" x 6" 100p 125p 9.5 x 8.5" 6" x 12" 175p 225p 110p	EDGE CONNECTORS 1 156 2x15 way — 140p 2x18 way 180p 145p 2x22 way 180p 200p 2x22 way 175p — 2x25 way 225p 220p 2x28 way 190p — 2x30 way 245p — 2x36 way 295p — 2x40 way 315p — 2x40 way 315p — 2x75 way 550p —	OIL PLUG (Header) Solder IDC 14 pin 40p 80p 16 pin 45p 105p 24 pin 88p 178p 28 pin 290p 295p 40 pin 250p 255p RIBBON CABLE price per foot Grey Colour 10 way 15p 28p 16 way 25p 40p 20 way 30p 50p 24 way 40p 65p 28 way 55p 80p 34 way 60p 85p 40 way 70p 90p 50 way 100p 135p 64 way 120p 160p	CRISTALS 32 768kHz 100 100kHz 235 30MHz 225 200kHz 265 455kHz 370 1MHz 275 1.008MHz 275 1.28MHz 390 1.8MHz 395 1.8MHz 395 1.8432M 200 3.0MHz 225 2.4576M 200 3.278M 150 3.579M 98 3.6864M 300 4.0MHz 150 4.032MHz 280 4.19430M 200 4.433619M 100 4.608MHz 200 4.804MHz 200 5.00MHz 180 5.1855M 300 5.24288M 390 6.0MHz 175 6.5368MHz 225 7.0MHz 150 7.168MHz 250 7.328MHz 250 7.68MHz 200 8.0MHz 150 8.089333M 395 8.86723M 175 9.00MHz 200 10.0MHz 175 10.24MHz 200 10.5MHz 250 10.7MHz 150 12.0MHz 175 12.2528M 300 14.3184M 170 16.0MHz 200 18.0MHz 180 18.432M 150 19.368MHz 150 20.0MHz 200 24.0MHz 170 24.930MHz 325 26.639M 150 27.648M 170 27.145M 180 38.6667M 175 48.0MHz 170 100.0MHz 295 110.0MHz 300	THUMBWHEEL Mini front mounting Decade Switch Module 250p B.C.D. Switch Module 275p Mounting Cheeks (per pair)	DILL SOCKETS Low Wire 8 pin Prot Wrag 2x15 way — 140p 14 pin 8p 25p 2x18 way 180p 145p 14 pin 10p 35p 2x22 way 180p 200p 16 pin 10p 42p 2x23 way 175p — 18 pin 16p 52p 2x25 way 225p 220p 20 pin 20p 60p 2x28 way 190p — 22 pin 22p 65p 2x30 way 245p — 24 pin 25p 70p 2x36 way 295p — 28 pin 28p 80p 2x40 way 315p — 40 pin 30p 90p 2x40 way 315p — 2x75 way 550p —	ZIF DIL SOCKETS 24 pin 565p 28 pin 750p 40 pin 799p	'D' CONNECTORS miniature 9 15 25 37 way way way way Male Solder lugs 80p 105p 160p 250p Angle pins 150p 210p 250p 355p PCB pins 120p 130p 195p 295p Female Solder lugs 105p 160p 200p 335p Angle pins 165p 215p 290p 440p PCB pins 150p 180p 240p 420p COVERS 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 475p 36" long, Double Ended, M/M 995p 36" long, Double Ended, F/F £10 36" long, Double Ended, M/F 995p	APHENON PLUGS IDC Solder 24 way IEEE 475p 480p 36 way Centronics 525p 475p	NEW LAUNCH ZBOA 2nd PROCESSOR BOARD ZBOA 4MHz 2nd Processor Board with 64K memory, 4K Monitor EPROM, Parallel printer interface, CP/M handling, double density board will handle 3 1/2", 5 1/4" & 8" Floppy Disk Drives and many more facilities. All neatly housed in a twin slimline disc drive case. Only: £350

CMOS 4072 20 4536 275 4073 22 4538 80 4075 25 4541 140 4077 20 4543 70 4078 20 4544 150 4081 15 4081 20 4548 40 4082 32 4085 55 4553 245 4089 24 4085 55 4553 245 4010 24 4086 60 4554 180 4011 15 4089 125 4555 35 4012 18 4093 20 4556 35 4013 20 4094 70 4557 320 4014 48 4095 95 4558 120 4015 40 4096 70 4559 395 4016 20 4097 275 4560 180 4017 32 4098 110 4562 485 4018 45 4160 95 4566 165 4019 25 4160 95 4566 165 4020 42 4161 96 4568 170 4021 40 4162 96 4569 175 4022 40 4163 96 4572 36 4023 15 4174 96 4580 460 4024 32 4175 105 4581 25 4025 16 4194 105 4582 99 4026 80 4408 790 4584 40 4027 80 4409 790 4584 40 4028 45 4410 725 4585 70 4029 47 4411 675 4597 330 4030 20 4412 775 4599 28 4031 125 4415 480 4600 90 4032 80 4419 280 40097 45 4033 125 4422 770 40098 42 4034 140 4435 850 40100 215 4035 45 4440 800 40101 130 4036 275 4450 350 40102 140 4037 115 4451 350 40103 175 4038 110 4480 360 40104 96 4039 280 4500 675 40105 108 4040 40 4501 28 40106 36 4041 40 4502 80 40107 80 4042 40 4503 40 40108 198 4043 40 4504 75 40109 100 4044 40 4505 185 40110 225 4045 105 4506 36 40114 240 4046 40 4507 60 40116 194 4047 40 4508 130 40163 50 4048 40 4510 48 40174 45 4049 30 4511 45 40175 50 4050 30 4512 45 40181 220 4051 45 4513 198 40182 80 4052 60 4514 115 40192 75 4053 50 4515 115 40193 95 4054 85 4516 55 40194 70 4055 85 4517 205 40195 75 4057 1915 4519 30 40245 196 4059 435 4520 50 40257 196 4060 45 4521 90 40373 180 4061 1185 4522 125 40374 180 4062 988 4526 60 45106 586 4063 85 4527 65 4066 27 4528 50 OCP71 120 4067 245 4529 150 OCP72 85 4068 20 4531 130 BPW25 250 4069 20 4532 50 BPW21 320 4070 20 4534 400 TL139 225 4071 22 4534 400 TL139 225	OPTO ELECTRONICS LEDs with chips TL1209 10 TL1211 GRN 14 TL1212 Yel 14 TL1220 2" Red 12 2" Green, Yellow or Amber 14 9" Bi colour Red/Green 65 Red/Green 65 Green/Yellow 78 0.2" Tri colour Red/Green/Yellow 85 Hi-Brightness Red 58 High-Bri Green or Yel 68 Flashing red 15 9" Bi colour Red/Green 65 Square LEDs, Red, Green, Yellow 30 Rectangle Stackable LEDs 90 Red, Green or Yellow 18 Triangular LEDs Red 18 Green or yellow 22 TL1211 Infra Red 48 SFH205 Detector 118 TL132 Infra Red 52 TL178 Detector 55 TL138 50 TL120 75 BARGRAPH Red 10 segments 250	ISOLATORS IL74 85 ILD74 115 ILQ74 220 TL117/4 70 ILCT6 Darlington 135 ILD100 136 7 Segment Displays 45112 45 40181 220 TL131 3" CC 105 TL1321 5" CA 120 TL1322 5" CC 120 DL702 3" CC 125 DL707 3" CA 125 FHD357 Red 120 FND500 130 6" Green CA 150 6" Green CA 215 3 + 1 Red CA 150 3 + 1 Green CA 150 LCD 3", Digits 498 LCD 4 Digits 530 LCD 6 Digits 625 Reflective Switch 170 SLTTED Optical Switch similar to RS Comp's 195
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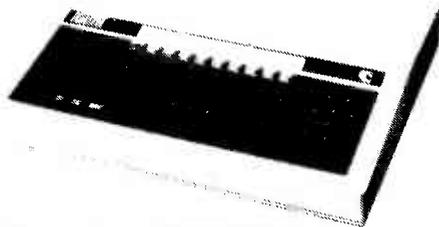
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* These drives are switchable between 40/80 tracks. 40/80 Switch Module 1 x 400k and 2 x 400k Drive £32

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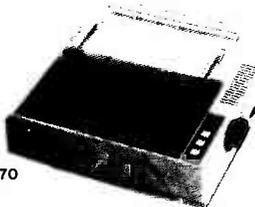
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Easy Programming on BBC £5.95
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Introducing BBC Micro £5.95
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Creating Adventure Programs £6.95
Discovering Machine Code £6.95
Structured Programming £6.50
The Friendly Computer Book BBC £4.50
Beyond Basic BBC £7.25

Many more books in stock.

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

★ ★ ATTENTION ★ ★

All prices in this double page spread are subject to change without notice.

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 eeprom selection and reliable programming in minimum programming times. £695 + £6 carriage

ACORN IEEE INTERFACE

This IEEE 488 standard interface is a general purpose system for exchanging digital data between a number of devices in a local area. The interface complies with the IEC 625-1 standard and can be connected to upto 14 other devices.

Interface board is supplied complete with software in ROM, interconnecting cables IEEE cable for connection to an external device and a comprehensive manual. £282.50 + £2.50 carr.

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.

NEW COMPREHENSIVE CATALOGUE AVAILABLE - PLEASE SEND FOR PRICE LIST

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	380p

D CONNECTORS

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

TEXT TOOL ZIF

SOCKETS	24 pin	£5.75
	28 pin	£8.00
	40 pin	£9.75
DIL SWITCHES	4 way	70p
	6 way	85p
	8 way	90p
	10 way	140p

JUMPER LEADS

24" Ribbon Cable with Headers			
1 end	14 pin	16 pin	24 pin
2 ends	145p	165p	240p
	210p	230p	345p
			540p
24" Ribbon Cable with Sockets			
1 end	20 pin	26 pin	34 pin
2 ends	160p	200p	280p
	290p	370p	480p
			525p
Ribbon Cable with D Conn			
25-way Male	500p	Female	550p

RS 232 JUMPERS

25-way D1	
24 Single end Male	£5.60
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		Dk 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
36 way socket Centronics	Parallel Solder	£5.50	IDC £5.20
24 way plug IEEE	Solder	£5	IDC £4.75
24 way socket IEEE	Solder	£5	

RIBBON CABLE

(Grey/meter)	
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	
23 way	160p	165p			
31 way	170p	170p			
DIN 41612		2 x 12 way 50 Pin	220p	275p	
2 x 12 way 40 Pin	275p	320p			
1 x 12 way 31 Pin	280p	300p			
1 x 12 way 40 Pin	375p	350p			

TEST CLIPS

14 pin	275p	40 pin	£6	16 pin	£3
5100 Conn					

EDGE CONNECTORS

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

**NEXT
MONTH**

AN ARGUS SPECIALIST PUBLICATION

electronics today

INTERNATIONAL

TAKE OFF WITH ETI!

Next month will be the time to leave your cosy workshop behind and take to the air with a project from ETI. Unfortunately (or perhaps fortunately, because we'd like to keep our readers in one piece!), we shall not be giving you instructions on how to build a hang-glider. However, we shall have a design for a (g)natty little device called a vario, which indicates changes in height. This sort of instrument is particularly useful for pilots, to tell them when they've caught a 'thermal' (a column of hot air rising up from, say, a factory or hot ground). Anyway, it makes rather an interesting change from our normal run of projects.

BASS FOR BEGINNERS

As far as home-made audio goes, it isn't really possible to construct a home-grown amplifier that's cheaper than a cheap-but-OK manufactured amplifier (as opposed to constructing a very high quality amplifier that is much cheaper than commercially made units — more of this in a month or two!). However, it is possible to save a lot of money by building your own loudspeakers, be they passive or active, cheap or expensive. And what's more, it isn't that difficult to design your own either — and that's exactly what we'll be telling you how to do next month!

MAINS-BORNE REMOTE CONTROL

Remember the original mains-borne remote control system we published some time back? Good though this design was, there were a few problems with it which we now think we have overcome. This design provides for the on-off control of up to 16 groups of devices from a standard microcomputer parallel port. The system will be open to enhancement, with a mains borne burglar alarm being one possibility for a further extension.

**ALL THIS AND MORE IN YOUR
APRIL ISSUE OF ETI — PLACE
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Articles described here are in an advanced state of preparation. However, circumstances may dictate changes to the final contents.

DIGEST



New Sinclair Micro

Sinclair claim their new QL microcomputer, launched on January 12th, is a 'Quantum Leap' forward in computing performance. Features include a full-size 65 key QWERTY keyboard, 128K RAM expandable via a 0.5 Mb RAM pack to 640K, two built-in 100K microdrives, and high resolution colour graphics. The QL has two microprocessors, a 32-bit 68008 to do all the clever stuff and an Intel 8049 to look after the keyboard, sound, and

RS-232-C option. The complete package includes four microdrive programs covering wordprocessing, planning, information handling and graphics, and costs £399 including VAT.

The QL is made by Thorn EMI who hope to be producing 20,000 units a month by the summer. The first samples of the new machine should be available towards the end of February, and will be supplied to mail order only. We haven't had a chance to play with one ourselves yet, but we hope to bring you more information when we have. Meanwhile, people out there with itchy fingers and £399 to spend should contact Sinclair Research Ltd, Stanhope Road, Camberley, Surrey GU15 3PS, tel 0276-685311.

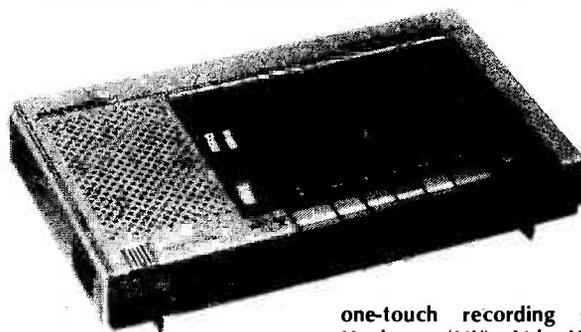
Fast Talker

Hanimex claim their new Soundpacer cassette recorder is an exciting development in speech reproduction technology which will prove invaluable to everyone who listens to speech recordings. The soundpacer allows recorded speech to be reproduced at up to twice its original speed without any apparent increase in pitch.

Hanimex give very little information on the system, which they

call Variable Speech Control, but it presumably involves frequency shifting since both the speed of the tape and the pitch of the reproduced sound are variable over a wide range. Hanimex say that this facility allows spoken information to be accepted at up to twice the normal rate without loss of understanding and indeed, with some improvement in retention.

No general specifications are given for the Soundpacer, Hanimex being content to describe it as 'full featured'. Going by the photograph alone, it appears to



include a condenser microphone, switchable sensitivity for external microphones, and a

one-touch recording system. Hanimex (UK) Ltd, Hanimex House, Faraday Road, Dorcan, Swindon, Wiltshire SN3 5HW, tel 0793 - 26211.

Second UOSAT Launch

NASA has formally confirmed that it will launch UOSAT-B, the University of Surrey's second experimental scientific and educational spacecraft, and the University's UOSAT Project Team is racing against time to get the spacecraft built and tested in time for launch on 1 March 1984. This will mean that the spacecraft has been designed, built, and prepared for launching in under five months, a task probably without precedent in space engineering.

UOSAT-B, to be known after launch as UOSAT-2, will go into space as a secondary payload with LANDSAT-5 on a Delta 3920 rocket from the Western Test Range, Vandenberg, California. The launch is at present scheduled for 1 March 1984 at 1759-1809 hrs GMT, lifting UOSAT-2 into a sun-synchronous polar orbit at a planned height of 700 km (435 miles). The spacecraft will carry scientific and engineering experi-

ments for use by professional scientists and radio amateurs, together with educational experiments primarily for schools and colleges. Working with Surrey University in building the experimental hardware are the Rutherford-Appleton Laboratory (SERC), the Universities of Sussex and Kent, and the UK, USA and Canada branches of the international Amateur Satellite Corporation (AMSAT).

Members of the UOSAT Project Team are working round the clock to assemble the spacecraft ready for environmental testing in January and transporting to the USA in February for integration with the launch rocket in time for the launch on 1 March. Any major hitch could still prevent the completion of part of the experimental hardware or even of the spacecraft itself, but so far all is going well. In addition to providing the free launch opportunity, NASA is doing all it can to assist the UOSAT Project Team to meet the launch deadline for what is scheduled to be the last Delta mission planned for a polar orbit. The Information Centre, Second Floor, Senate House, University of Surrey, Guildford, Surrey GU2 5XH.

Stereo TV Sound

The BBC has been investigating for some time the possibility of adding stereo sound to TV broadcasts. Now, following a series of over-air tests from the Wenvoe transmitter in South Wales, they believe they have found a digital system which will make this possible.

The BBC have tried a number of different systems, including proposals from Japan and Germany, and had previously conducted a series of over-air tests from the Crystal Palace transmitter. They concluded that while a second frequency modulated carrier would prove satisfactory, a digitally modulated second sound carrier would be a more attractive proposition. A series of digital tests were then carried out, the Wenvoe transmitter being chosen because nearby mountains can produce severe multipath propagation or 'ghosting' and it was important to establish that a digital sound signal could be received

satisfactorily in such conditions. The effect of multipath was found to be very small, the digital signal provided excellent stereo quality, and the signal was found to travel successfully through the five-station relay chain that is used to feed one of the more remote valleys.

The conclusion is that this digital system is perfectly viable, provides good quality, and remains compatible with existing mono receivers. The system has a bit rate of 700 kbit/s which is sufficient for two high quality sound signals, and uses a phase modulated carrier set at about -20 dB and separated by about 6.55 MHz from the vision carrier. It now remains to make quite sure that the digital system really is compatible with the wide range of monophonic receivers in use, and a further series of tests from Crystal Palace on BBC2 is planned early this year. The BBC say they are also starting discussions with Industry, the IBA, and the Home Office in order to arrive at an agreed UK standard.

The Engineering Information Department, BBC, Broadcasting House, London W1A 1AA, tel 01-927 5432.

NEW YEAR SALE

TRANSISTORS									
BC 107B 12p	BC 415C 10p	BD 243A 55p	MJ2955 80p	TIP 3055 70p	2N4033 30p	BRIDGE RECTIFIERS	4021 42p	4504 98p	100mA
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BC 115/6 17p	BC 478 23p	BD 244C 78p	MJE 340 48p	TIS 92 20p	2N4059 10p	4024 38p	4510 50p	78L15 30p	
BC 119 28p	BC 479 24p	BF 180 30p	MJE 350 70p	2N1613 30p	2N4060 10p	4025 14p	4511 52p	78L18 45p	
BC 139 32p	BC 546 10p	BF 181 30p	MJE 370 80p	2N1711 30p	2N4061 10p	4026 84p	4512 48p	78L24 45p	
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BC 141 28p	BC 547B 9p	BF 183 30p	MJE 520 60p	2N2218 24p	2N4400 15p	4028 110p	4514 110p	7805 40p	
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BC 143 27p	BC 548C 9p	BF 185 30p	MJE 2955 80p	2N2219 24p	2N4402 15p	4030 18p	4517 180p	7812 40p	
BC 160 30p	BC 549C 9p	BF 194 12p	MJE 3055 68p	2N2219A 25p	2N4403 15p	4035 56p	4518 52p	7815 40p	
BC 161 32p	BC 550C 10p	BF 195 12p	MPSA 05 20p	2N2222 18p	2N5400 18p	4040 48p	4520 55p	7818 40p	
BC 169C 8p	BC 556 10p	BF 196 12p	MPSA 06 20p	2N2222A 18p	2N5401 20p	4041 48p	4522 65p	7824 40p	
BC 171B 9p	BC 556B 10p	BF 197 12p	MPSA 12 22p	2N2222A 20p	2N5457 28p	4042 42p	4526 64p	5 A TO3	
BC 172C 9p	BC 557B 9p	BF 198 10p	MPSA 13 22p	2N2368 23p	2N5458 27p	4043 44p	4528 56p	78H05 500p	
BC 173C 9p	BC 557C 9p	BF 199 12p	MPSA 42 23p	2N2369A 15p	2N5459 25p	4044 44p	4529 72p	100 mA	
BC 177B 15p	BC 558B 9p	BF 200 40p	MPSA 43 23p	2N2484 24p	2N5460 38p	4046 55p	4530 92p	78L05 50p	
BC 178C 15p	BC 558C 9p	BF 224 15p	MPSA 55 20p	2N2646 48p	2N5550 18p	4048 30p	4531 70p	79L05 50p	
BC 179C 15p	BC 559C 9p	BF 244C 22p	MPSA 56 20p	2N2904 22p	2N5551 20p	4049 25p	4532 88p	79L12 50p	
BC 182 9p	BC 560C 10p	BF 245 25p	MPSA 63 22p	2N2904A 23p	2N6027 23p	4050 25p	4541 70p	79L15 50p	
BC 182B 9p	BC 560 10p	BF 256C 32p	MPSA 64 22p	2N2905 23p	2N6028 23p	4051 52p	4544 120p	1 A TO220	
BC 193B 9p	BC 638 20p	BF 256LC 35p	MPSA 92 24p	2N2907 23p	400 mW	4052 52p	4551 88p	7905 45p	
BC 183C 9p	BC 639 22p	BF 257 32p	TIP 29A 30p	2N2907A 25p	400 mW	4053 54p	4553 180p	7906 65p	
BC 184B 9p	BC 640 24p	BF 258 32p	TIP 29B 33p	2N3054 56p	2V 36V 6p	4056 28p	4554 148p	7908 65p	
BC 184C 9p	BCY 70 18p	BF 259 35p	TIP 29C 33p	2N3055 50p	1.3 W	4058 15p	4555 48p	7912 55p	
BC 212 9p	BCY 71 18p	BF 336 36p	TIP 30A 30p	2N3056 50p	4V 7.5V 10p	4059 15p	4556 48p	7915 55p	
BC 212B 9p	BCY 72 17p	BF 337 39p	TIP 30B 33p	2N3057 50p	THYRISTORS	4070 15p	4557 160p	7924 65p	
BC 213B 9p	BD 115 50p	BF 338 40p	TIP 30C 36p	2N3058 75p	C106D 28p	4071 15p	4558 110p	- Variable -	
BC 213C 9p	BD 131 45p	BF 457 32p	TIP 30D 36p	2N3440 58p	C116D 70p	4072 15p	4559 390p	LM 309K 120p	
BC 214B 9p	BD 132 48p	BF 458 32p	TIP 31A 33p	2N3441 120p	C126D 90p	4073 15p	4560 170p	LM 317K 250p	
BC 214C 9p	BD 133 70p	BF 459 37p	TIP 31B 35p	2N3442 120p	C126M 98p	4074 15p	4566 120p	LM 317T 98p	
BC 237 7p	BD 135 30p	BF 494 12p	TIP 31C 37p	2N3702 10p	MCR 101 30p	4075 15p	4568 270p	LM 330T 180p	
BC 238 9p	BD 136 30p	BF 595 18p	TIP 32A 33p	2N3703 10p	MCR 102 34p	4077 15p	4569 140p	LM 350T 395p	
BC 239 9p	BD 137 30p	BF 596 20p	TIP 32B 35p	2N3704 10p	T 2800D 110p	4078 15p	4572 42p	LM 723CN 35p	
BC 251 9p	BD 138 35p	BF X 29 28p	TIP 32C 37p	2N3705 10p	T 2800M 165p	4081 15p	4573 198p	78H05 500p	
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BC 302 32p	BD 203 70p	BF X 85 28p	TIP 41A 46p	2N3708 10p	2N5062 29p	4098 78p	4580 280p	TIL 38 40p	
BC 303 32p	BD 204 70p	BF X 87 27p	TIP 41C 60p	2N3709 10p	2N5064 22p	4016t 52p	4584 380p	TIL 78 50p	
BC 304 32p	BD 205 70p	BF X 88 23p	TIP 42A 46p	2N3772 170p	2N5066 29p	40162 52p	4585 74p	TIL 100 100p	
BC 307 10p	BD 206 70p	BF Y 50 23p	TIP 42C 60p	2N3773 190p	C-TRIACS	40163 52p	4599 178p	TIL 111 85p	
BC 308 10p	BD 239A 40p	BF Y 51 22p	TIP 110 45p	2N3819 20p	C 225D 60p	4501 16p	4599 178p	TIL 111 85p	
BC 309 10p	BD 239C 40p	BF Y 52 22p	TIP 115 45p	2N3823 50p	C 226D 70p	4502 55p	4599 178p	2N577 50p	
BC 327 12p	BD 240A 42p	BSY 95A 23p	TIP 120 70p	2N3866 95p	C 226M 90p	4503 34p	4599 178p	4N25 80p	
BC 328 12p	BD 240C 50p	BU 205 140p	TIP 121 70p	2N3903 10p	C 236 90p			4N28 70p	
BC 337 12p	BD 241A 42p	BU 206 190p	TIP 122 70p	2N3904 10p	C 236M 120p			4N33 128p	
BC 338 12p	BD 241C 54p	BU 208 140p	TIP 126 70p	2N3905 10p	C 245D 98p			4N35 150p	
BC 413C 10p	BD 242A 42p	MJ 2500 230p	TIP 127 70p	2N3906 10p	C 246M 140p			4N37 100p	
BC 414C 10p	BD 242C 54p	MJ 2501 248p	TIP 2955 70p	2N4030 30p	BR 100 30p			BPX 38 390p	

LINEAR IC'S	CAPACITORS	DIODES	RESISTORS	HARDWARE
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CA 3065 190p	Tantalum bead.	BAX 13 5p	1/2 Watt Carbon film 5% E12 series 1R-10M 2p each.	4xTO66 mounting kits 23p
CA 3080 72p	Value/V price	BAX 16 6p	1/4 Watt Metal film 1% E24 series 10R-1M 4p each.	64 mm Loudspeakers 8R 70p
CA 3086 56p	Value/V price	OA 47 9p	2.5 Watt wirewound OR22	300mW rating.
CA 3089 170p	Value/V price	OA 90 7p	10xTO220 bushes/washers 18p	5x 4.7 R-2M2 1p each.
CA 3090A 300p	Value/V price	OA 91 7p	10xTO220 bushes/washers 28p	5x HP7 battery holder 32p
CA 3100E 95p	Value/V price	OA 95 8p	20mm panel fuseholder 32p	20mm chassis fuseholder 7p
CA 3140E 40p	Value/V price	OA 200 7p	4mm plug 12p.	4mm sockets 20p.
CA 3160E 100p	Value/V price	IS44 6p	3.5mm jack socket 15p.	4mm insulated terminals 30p.
CA 3161E 140p	Value/V price	IS92 9p	5mm jack plug 15p.	3.5mm jack plug 15p.
CA 3240AE 165p	Value/V price	IN914 3p	Phono sockets 15p.	Switches: miniature toggle, SPST 60p, SPDT 68p, DPDT 78p each.
CA 3240E 110p	Value/V price	IN916 4p	Miniature push buttons: 1A/250V push to make 16p.	Push buttons: 23p, 28p, 33p, 39p each.
CA 3260E 100p	Value/V price	IN4148 3p	Slide switch 1A/250V DPDT (22 x 12 x 8 mm) 16p.	
CA 8100M 250p	Value/V price	IN4149 3p		
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LM 307 54p	Value/V price	IN5401 11p		
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LM 318 120p	Value/V price	IN5403 13p		
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LM 358 48p	Value/V price	IN5407 15p		
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LM 555 16p	Value/V price			
LM 556 45p	Value/V price			

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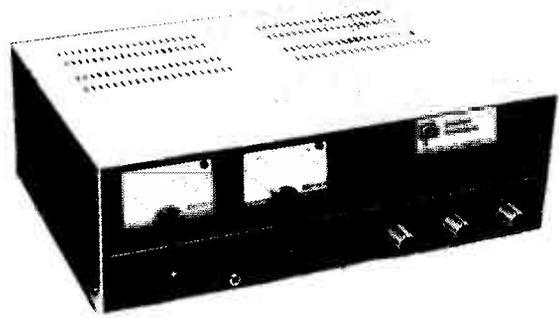
A family of four bench power supplies, the GPL series, has been introduced by Gresham Powerdyne Ltd. The series offers a choice of single, dual and triple output models featuring excellent voltage and current regulation, low ripple and noise and compact mechanical construction.

The smallest model, the GPL20, offers a variable 0-30 volts, 1 amp max output plus a fixed 5V, 1 amp max output. Ripple and noise is less than 0.5mV rms on both rails, while the variation in output voltage for a 10% mains variation is also less than 0.5mV. Output resistance is less than 5 milliohms and output impedance less than 100 ohms at 100 kHz. The GPL 20 has variable current limiting, a moving coil meter, measures 91 x 300 x 200 mm, and weighs 4 kg.

The GPL 23a unit features two independent 0-30V, 2 amp max

outputs with a choice of constant current or constant voltage modes, and a fixed 5V, 3 amp output. Load regulation for the variable rails is better than 3mV (zero to full load), with ripple and noise better than 1mV in constant voltage mode and line regulation better than 0.5mV for a $\pm 10\%$ mains change. For the fixed 5V rail, load regulation is better than 50mV (zero to full load), and ripple and noise less than 5mV rms. The unit measures 190 x 355 x 230mm, weighs 7.6kg, and has a high resolution 10-turn potentiometer which provides setting resolutions better than 5mV. The two large moving coil instruments are read in conjunction with a range change switch and are accurate to approximately 1% of full scale deflection.

Model GPL 25 has a single 0-40v, 1 amp output and features variable current limiting and two meters for simultaneous indication of voltage and current. It measures 91 x 300 x 200 mm, offers a 0.5mV max output regu-



lation for a $\pm 10\%$ mains change, ripple and noise of less than 0.5mV rms and has an output resistance of less than 5 milliohms. Weight is less than 4kg.

The largest unit in the series is the GPL 28, which offers a single 0-60V, 2 Amp output with dual tracking (0-30V, 2 A) facilities as standard. Weighing 7kg and measuring 122 x 300 x 243 mm, the GPL 28 offers the same standard of regulation found on the other units in the series.

The GPL series power supplies are made entirely in Europe and Gresham say they are holding large stocks in readiness in their warehouse at Hook, Hampshire. The GPL20 costs £99.47, the GPL23a costs £245.00, the GPL25 costs £117.89, and the GPL28 costs £222.89. All prices include VAT but not postage and packing. Gresham Powerdyne Ltd, Osborne Way, Station Road, Hook, Hampshire, tel 025627 4346.



Portable Frequency Counters

New from Aspen Electronics is the Digimax 500 series of frequency counters which feature large 8-digit displays and an accuracy of one part-per-million. The two models available have ranges of 10 Hz to 512 MHz and 50 Hz to 1 GHz, with resolutions of 1 Hz and 10 Hz respectively. The counters have 50 ohm inputs

and an input sensitivity of from 15 to 50 mV. They can be operated from a rechargeable battery pack or by means of a mains adaptor, and measure just $5\frac{1}{4} \times 5 \times 1\frac{1}{2}$ ". Aspen envisage their use in base stations for checking transmitter and receiver frequency and in boats, motor vehicles and other locations where a mains supply is not available. The Digimax 5000 series counters cost £159.00 including post and packing but exclusive of VAT. Aspen Electronics Ltd, 2-3 Kildare Close, Eastcote, Ruislip, Middlesex HA4 9UR, tel 01-868 118.

U.K.'s First Electronics Supermarket

Marco Trading have just opened a new self-service supermarket-style electronics components shop with approximately 1000 square feet of floor space. This is believed to be the

first shop of its type in the UK.

The shop is next door to the warehouse, so there are lots of items on sale that don't often find their way onto advertising lists, and of course, there should be minimal delay in obtaining fresh stock items.

The shop is at The Maltings, High Street, Wem, Shropshire, which is just outside Shrewsbury. Marco Trading say there is ample parking, useful if you intend buying some heavy transformers!

Back-to-Back Adaptor

Eurotech Electronics have introduced a male to male adaptor, which allows two female terminated ribbon cables to be connected to one another. The two sets of pins in the adaptor are connected in a 'mirror image' fashion so that two cables normally travelling in the same direction will not have their pin sense reversed by being connec-

ted back-to-back. The adaptor is available with from 10 to 60 contacts arranged on a 0.1" pitch and in a variety of latching lengths. It can also be supplied as a solder header for reversing the ribbon cable exit on a printed circuit board. Eurotech offer a wide range of other products, and details of both these and the adaptor can be obtained from the Passive Components Division, Eurotech Electronics Ltd, Dunns House, St. Pauls Road, Salisbury SP2 7BE, tel 0722 744242.

International Optical Fibre Cable

British Telecom have announced plans for an undersea optical fibre cable which will carry telephone calls and computer data between the UK and Belgium. The 122 kilo-

metre cable will be made in Britain and should be ready for use in about two years time.

There are already four cable systems linking the UK and Belgium but this will be the first international undersea link anywhere in the world to use optical fibres. The £7.25 million contract has been awarded to the submarine systems division of Standard Telephones and Cables and the investment will be shared between four countries, British Telecom holding half and the

remainder being divided between Deutsche Bundespost, the Belgian RTT and the Netherlands PTT.

The cable will contain three pairs of fibres each working at 280 mbit/s and carrying 3,840 64Kbit/s circuits, giving the complete cable the capacity to carry 11,520 simultaneous telephone calls. The system will use long-wavelength singlemode transmission and there will be three submerged repeaters in the cable, each of which will contain

three bidirectional optical regenerators. Single mode transmission of laser light along optical fibre cables requires less than one sixth of the number of repeaters which would be required by an equivalent co-axial cable.

British Telecom say the cable will be laid by their cables ship Alert in the spring of 1985, and will be buried to protect it from trawlers and other shipping. Digital communications via the cable should become available in the second half of 1985.

Rapid Electronics

MAIL ORDERS:
Unit 1, Hill Farm Industrial Estate,
Boxted, Colchester, Essex CO4 5RD.

TELEPHONE ORDERS:
Colchester (0206) 36412.



**ACCESS AND
BARCLAYCARD
WELCOME**

MIN. D CONNECTORS

9 way 15 way	25 way 37 way
Plugs solder lugs 60p 85p	125p 170p
Right angle 120p 180p	240p 350p
Sockets 150p 130p	195p 290p
Right angle 160p 210p	290p 440p
Covers 100p 90p	100p 110p



SOLDERING IRONS

Antex CS 17W Soldering iron	495
2.3 and 4.7mm bits to suit	85
CS 17Wor AS 25W element	210
Antex VS 25W	525
3.3 and 4.7mm bits to suit	85
Solder pump desoldering tool	480
Spare nozzle for above	70
10 metres 22sw solder	100

CONNECTORS

DIN Plug 5kt Jack Plug 5kt	
2 pin 9p 9p 2.5mm 10p 10p	
3 pin 12p 10p 3.5mm 9p 9p	
5 pin 13p 11p Standard 16p 20p	
10 pin 12p Stereo 24p 25p	
1mm 12p 13p 4mm 18p 17p	
UHF (CB) Connectors	
PL259 Plug 40p. Reducer 14p.	
SO239 square chassis skt 38p	
SO239S round chassis skt 40p.	
IEC 3 pin 250V/6A.	
Plug chassis mounting 38p	
Socket free hanging 60p	
Socket with 2m lead 120p	

SCRs

CT106D	30
400V 8A	70
400V 12A	95

VOICE SYNTHESISER!

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

SP0256 850p. Data: 50p.

VERO

VEROBLOC 4	3.5
Size 0.1 matrix	
2.5 x 1	22
2.5 x 3.75	75
2.5 x 5	95
3.75 x 5	85
VQ board	160
Veropins per 100	
Single sided	60
Double sided	100
Spot face cutter	130
Pin insertion tool	162
Wiring pen	330
Spare spool 75p	
Combs	6

MICRO

6116P3	320	6852	240	8228	250
6502CPU	325	6875	495	8251	250
6522VIA	295	6880	100	8253	390
6532	570	81L395	85	8255	225
5551 ACIA	850	81L586	85	8259	390
6800CPU	220	81LS97	85	MC1488	55
6802CPU	250	8080A	250	MC1489	55
2716	240	6809CPU	620	8085AC	340
2532	290	6810RAM	115	8156	350
2732	290	6821PIA	110	8212	110
2784	425	8244	360	8216	100
4116P20	85	6850	110	8224	120
				Z80ADMA	1150

SWITCHES

Submin toggle	
SPST 55p. SPDT 60p. DPDT 65p.	
Miniature toggle.	
SPDT 80p. SPDT centre off 90p	
DPDT 90p. DPDT centre off 100p.	
Standard toggle	
SPST 35p. DPDT 48p	
Miniature DPDT side 14p.	
Push to make 14p.	
Push to break 22p.	
Rotary type adjustable stop.	
PI12W, 2PW, 3PW all 55p each.	
DIL switches	
ASPST 80p 6 SPST 80p. BSPST 100p.	

SOCKETS

Low profile	Wire wrap
8 pin 5p	28p
14 pin 8p	45p
16 pin 9p	55p
18 pin 12p	60p
20 pin 16p	75p
22 pin 18p	82p
24 pin 18p	82p
28 pin 23p	95p
40 pin 25p	135p

COMPONENT KITS

An ideal opportunity for the beginner or the experienced constructor to obtain a wide range of components at greatly reduced prices. $\times 5$ % Resistor kit. Contains 10 of each value from 4.7 ohms to 1M (total of 650 resistors). 530

Ceramic Cap. kit. 5 of each value - 22p to 0.01u (135 caps). 370

Polyester Cap. kit. 5 of each value from 0.01 to 1uF (65 caps). 575

Print kit. Contains 5 of each value from 100 ohms to 1M (total 65 resistors). 425

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

25 6BA 1/4" bolts	300 6BA washers	50 6BA nuts
25 6BA 1/2" bolts	25 4BA 1/4" bolts	50 6BA washers

LINEAR

555CMOS 80	ICL7106	680	LM3911	120	NE566	140	TL064	96
556CMOS 150	ICL7611	95	LM3914	225	NE567	100	TL071	30
709 25	ICL7621	180	LM3915	225	NE570	370	TL072	45
741 14	ICL7622	180	LM3812	120	NE571	370	TL074	95
9400CJ 350	ICL8038	295	LM3824	130	RC4136	55	TL081	25
AY-3-1270 720	ICM2224	785	LM3922	100	RC4558	40	TL082	45
AY-3-8912 540	LF351	45	LM3924	350	SL490	170	TL084	90
CA3046 60	LF352	85	LM3925	210	SL76017	150	ULN2003	70
CA3080 65	LF356	90	LM3926	140	SP0256-L2	850	ULN2004	70
CA3089 190	LM10	325	LM709	25	TBA1205	70	XR2206	290
CA3390A 375	LM301A	25	LM723	35	TBA906	75	ZN414	140
CA3130E 85	LM7	50	LM725	140	TBA920	70	ZN424	135
CA3140E 36	LM138	120	LM733	350	TBA920	70	ZN424	135
CA3161E 100	LM324	30	LM737	60	TBA950	220	ZN425E	350
CA3189 290	LM334Z	100	LM747	60	TD1008	320	ZN429E	300
CA3240E 100	LM335Z	125	LM1458	205	TD1022	490	ZN427E	600
			LM2917	200	TD1024	125	ZN428E	110
			LM3900	45	TD1024	125	ZN428E	110
			LM3909	75	NE555	16	ZN459	285
			LM3909	75	NE555	16	ZN459	285
			LM3909	75	NE555	16	ZN459	285

TRANSISTORS

BC517	40	BF337	40	MPSU56	60	ZTX108	10	2N3055	50
BC547	7	BF400	23	TIP29A	60	ZTX109	12	2N3442	120
BC548	10	BF800	23	TIP29B	35	ZTX301	15	2N3702	9
AC126	30	BC149	9	BC549	10	BF881	20	TIP29C	37
AC127	30	BC157	8	BC558	10	BF829	25	TIP30A	35
AC128	30	BC158	10	BCY70	18	BF848	25	TIP30B	37
AC129	20	BC159	8	BCY71	18	BF865	25	TIP30C	37
AC176	25	BC180	45	BCY72	18	BF896	28	TIP31A	35
AC187	22	BC188C	10	BD115	55	BF887	25	TIP31C	37
AC188	22	BC189C	10	BD131	35	BF888	25	TIP32A	35
AD142	120	BC170	8	BD132	35	BFY50	23	TIP32C	37
AD149	80	BC171	10	BD133	30	BFY51	20	TIP33A	50
AD161	40	BC172	8	BD135	30	BFY52	23	TIP33C	75
AD162	40	BC178	10	BD136	30	BFY53	32	TIP34A	60
AF124	60	BC178	18	BD137	30	BFY55	32	TIP34C	85
AF126	50	BC179	18	BD138	30	BFY56	32	TIP35A	105
AF139	40	BC182	10	BD139	35	BRY39	40	TIP35C	125
AF186	70	BC182L	8	BD140	35	BSX20	20	TIP36A	125
AF239	75	BC183	10	BD204	110	BSX29	35	TIP36C	135
BC107	10	BC183L	10	BD206	110	BSY85A	25	TIP41A	45
BC107B	12	BC184	10	BD222	85	BU205	160	TIP42A	90
BC108	10	BC184L	7	BF180	35	BU206	180	TIP42B	90
BC108B	12	BC212	10	BF182	35	BU208	170	TIP121	90
BC108C	12	BC212L	10	BF184	25	MJ2955	99	TIP122	90
BC109	10	BC185	25	MJE340	90	TIP142	98	TIP142	98
BC109C	12	BC213L	10	BF194	12	MJE521	95	TIP147	110
BC114	18	BC214	10	BF195	12	MJE521	95	TIP147	110
BC115	22	BC214L	8	BF196	12	MJE3056	70	TIP2955	60
BC117	18	BC237	8	BF197	12	MPF102	40	TIP3055	55
BC119	35	BC238	14	BF198	10	MPF104	40	TIS43	40
BC137	40	BC239	10	BF200	10	MPF406	25	TIS44	45
BC139	40	BC327	14	BF200	10	MPF406	25	TIS90	30
BC140	28	BC328	14	BF248	22	MPSA12	30	TIS91	30
BC141	30	BC337	14	BF248	22	MPSA12	30	TIS91	30
BC142	25	BC338	14	BF256	45	MPSA56	30	VN46AF	75
BC143	25	BC477	30	BF257	32	MPSA05	55	VN46AF	75
BC147	8	BC478	30	BF258	25	MPSU06	55	VN88AF	95
BC148	8	BC479	30	BF259	35	MPSU85	60	ZTX107	10

CABLES

20 metre pack single core connecting cable ten different colours	75p
Speaker cable 10p/m	
Standard screened 16p/m	
Twin screened 24p/m	
2.5A 3 core mains 23p/m	
10 way rainbow ribbon 26p/ft	
20 way rainbow ribbon 47p/ft	
10 way grey ribbon 14p/ft	
20 way grey ribbon 28p/ft	

HARDWARE

PF3 battery clips	8
Red or black crocodile clips	15
Black pointer control knob	15
Pr Ultrasonic transducers	390
6V Electronic buzzer	60
12V Electronic buzzer	65
PB2720 Piezo transducer	75
64mm 64 ohm speaker	70
64mm 8 ohm speaker	70
20mm panel speaker	25
Red or black probe clip	35
4mm terminals	33
12 way "chocolate" block	30
ultra-min. 6 or 12v rel. SPDT	130
ditto, but DPDT	195

CAPACITORS

Polyester, radial leads. 250v. C280 type	0.01, 0.015, 0.022, 0.033, 0.047, 0.068, 0.1, 0.15, 0.22, 0.33, 0.47, 13p, 0.68, 10u, 1u, 23p.
Electrolytic, radial or axial leads:	
0.47/63V, 1/63V, 2.2/63V, 4.7/63V, 10/25V - 7p; 22/25V, 47/25V - 8p; 100/25V - 9p; 220/25V - 30p; 470/25V - 22p; 1000/25V - 30p; 2200/25V - 50p.	
Tag and power supply electrolytics:	
2200/40V - 110p; 4700/40V - 180p; 2200/63V - 140p; 4700/63V - 230p.	
Polyester, miniature Siemens PCB:	
1n, 2n, 3n, 4n, 6n, 8n, 10n, 15n, 7p, 22n, 33n, 47n, 68n, 8p, 100n, 9p; 150n, 11p, 220n, 13p, 330n, 20p; 470n, 26p, 680n, 29p, 10u, 5.55pF, 35p.	
Tantalum bead:	
0.1, 0.22, 0.33, 0.47, 1.0 @ 35V - 12p, 2.2, 4.7, 10 @ 25V - 20p; 15/16V - 30p; 22/16V - 27p; 33/16V - 45p; 47/6V - 27p; 47/10V - 90p; 70p; 68/6V - 40p; 100/10V - 90p.	
Cer. disc. 22p-0.01u 50v, 3p each. Multirad miniature ceramic plate: 1.5pF to 1000pF each.	
Polyester, 5% tol. 10p-1000p. 6p; 1500-4700. 8p; 6800-0.01u, 10p; Trimmers, Mullard 808 series: 2.10 pF, 2.22pF, 2.22pF, 30p; 5.5-55pF, 35p.	

REGULATORS

78L05	30	79L05	45
78L12	30	79L12	45
78L15	30	79L15	45



Low Cost Dual Trace 'Scope

Bridge Scientific Instruments, who recently took over the ailing Scopex Instruments, have introduced a general purpose oscilloscope which is available in single and dual trace versions, is British built, and costs less than £200.

The single trace SB 121 and the dual trace DB 242 are described as small and highly portable. Bridge do not give the bandwidth figure in their press release

but they do say that the 'scopes are suitable for television servicing work. Sweep speeds can be varied from 1 us/cm to 0.2 s/cm and the maximum sensitivity is 50 mV/cm. A medium persistence phosphor is used and the CRT display area is 60 x 50 mm. Features include a trace locate button which returns overscanned traces to the screen regardless of other control settings.

The DB 242 is expected to sell at a little under £200 excluding VAT, but no price is given for the SB 121. Bridge Scientific Instruments Ltd, 63-65 High Street, Skipton, North Yorkshire BD23 1EF, tel 0756-69511.

New Micro From Oric

Atmos, a new 48K microcomputer from Oric Products International, was launched at the Which Computer? show at the National Exhibition Centre in January. The new micro supercedes the Oric 1 and contains a number of new features and refinements compared with the earlier machine, most notably a professional full-pitch typewriter keyboard and a case which has been restyled in black and red.

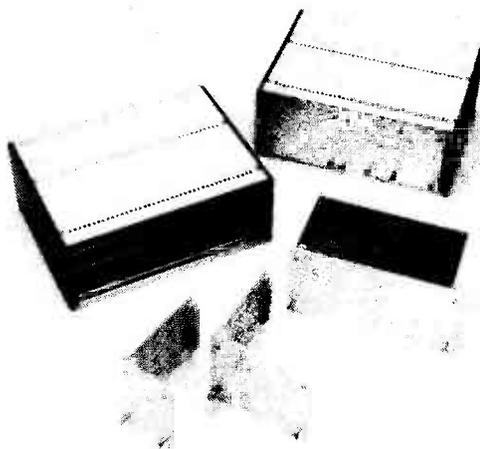
The Atmos has a new ROM operating system from which, Oric claim, all the quirks of the original Oric 1 operating system have been removed. Several new commands have been incorporated including print (a) and user controlled repeats, and there are a number of new cassette facilities designed to improve tape loading. There is also a GRAB command which allows the program to use memory normally reserved for graphics. Oric claim that there is at least 44K of memory available even when a colour printer and disc drives are attached in text mode. In spite of these changes, the operating system remains fully compatible with Oric 1 software written in

BASIC.

The new keyboard is in standard computer style and has 58 keys each with tactile feedback and 4 mm travel. Function keys include ESC, CTRL, RETURN, and additional cursor controls, and there is also a user-programmable function key which is not implemented in the ROM but may be used by programmers.

Also new is the Oric micro disc drive which, along with the existing oric four colour printer, has been styled to match the new Atmos. The system is based on the Hitachi 3" disc drives and has a double sided, double density, formatted capacity of 320K bytes. They will be available in 40 and 80 track versions with a transfer rate of 250K bits/sec.

Completing the all-new look of the Atmos is a 300 page user manual which, unusually, has been compiled and written by an independent team of writers and published by an outside company. The manual was written by a team led by Ian Adamson and is published by Pan Books. The Atmos comes complete with the manual, a new beginners guide, connecting leads and power supply and is priced at £170. Oric Products International Ltd, Coworth Park, London Road, Ascot, Berkshire SL5 7SE, tel 0990-27641.



Small Rack Enclosure

New from STC Electronic Services is a unique modular enclosure, the BICC Vero KMT, suitable for housing small electronic products and circuits. The KMT comprises two blue plastic side panels and 2mm-thick anodised aluminium front covers which are available in 42, 35, 21, 18, 12, 7 and 6 HP widths. Accommodating plug-in cards and units up to 42 HP (1HP=5.08mm or 1/5"), the front section features moulded fixing flanges for 21-

way plug connectors specified to DIN41617. The rear section is a purpose-designed aluminium extrusion for mounting the power supply, providing both electrical and thermal screening, and is designed to clip easily onto the enclosure to ensure optimum cooling. Optional accessories include front panel sets, plug-in card sets, circuit board kits, connectors and card guides (packs of 10). Prices are £8.93 for the KMT Module Set and between £0.90 and £4.98 for the accessories. For further information, contact STC Electronic Services, Edinburgh Way, Harlow, Essex, tel 0279-26777.

Radio Teleswitching

Radio Teleswitching is the name given to a new system recently agreed between the BBC and the Electricity Council. The system involves the use of BBC transmitters to provide remote control of suitably adapted tariff controlled appliances in consumers' premises, allowing the Electricity Supply Industry to smooth peak demand and hence avoid the need for excess generating capacity.

Using the BBC Radio 4 (UK

low frequency (200 kHz) transmitters at Droitwich, Burghead and Westerglen, which have nearly nationwide coverage, the system superimposes an inaudible data signal by phase-modulating the main carrier of the transmitters. The data signals come from a message assembler in Broadcasting House, London. Information from the Central Electricity Generating Board is used to key information onto the message assembler and the resultant waveform is sent to the transmitters. The data waveform is a 50 baud bi-phase signal giving an effective 18 bit/second useful

data rate that modulates the carrier by $\pm 22\%$. Because of the narrow band nature of the data-signals, the signal can be received in areas such as basements or steel framed buildings where the field strength from the transmitters is too low for normal reception.

The signals are received and decoded by Radio Teleswitching receivers installed in consumers' premises, where they are used to control appliances operated on 'off-peak' or other tariff systems such as water or storage heaters. It is understood that consumers' will have complete freedom of

choice as to whether their appliances operate on the new system or on time switches as at present. Provided storage heaters and the like receive their full 'on' period, the actual times at which they are switched on and off are not critical, and with the ability to directly control a large number of appliances throughout the country, the CEBG will be able to even out demand and thus reduce the overall generating capacity needed.

The Engineering Information Department, BBC, Broadcasting House, London W1A 1AA, tel 01-580 4468.

RESISTORS	100 100 100	Single sided	2N2905	28p	40411	3.95	BC547A	14p
CARBON FILM	2.2 350 30p	100 x 160 2.10	2N2905A	29p	40412	90p	BC547B	14p
5% HI-STAB	3.3 25 10p	100 x 220 2.50	2N2906	25p	40673	70p	BC548	12p
LOW NOISE	4.7 10 1p	203 x 11 2.40	2N2906A	30p	40822	1.80	BC548A	13p
100 to 10M	4.7 16 8p	231 x 220 5.20	2N2907	25p	40871	1.00	BC548B	13p
W/E24 2p	4.7 25 9p	100 x 160 2.20	2N2920	8.50	AC125	49p	BC549	13p
W/E24 6p	4.7 40 11p	100 x 200 2.80	2N2923	25p	AC126	32p	BC549B	14p
2W/E24 12p	4.7 63 12p	203 x 11 2.90	2N2924	15p	AC127	32p	BC549C	14p
METAL FILM	10 10 12p	AC 220 300	2N2925	25p	AC128	35p	BC549D	14p
ULTRA STABLE	10 10 14p	Developer for	2N2926	10p	AC132	68p	BC550C	25p
0.4W EXTRA	10 10 16p	Develop for	2N3053	27p	AC14K	28p	BC557	15p
LOW NOISE	10 10 18p	Use Sodium	2N3054	56p	AC14K1	28p	BC557A	16p
100 to 1M	10 10 20p	Hydroxide	2N3055	80p	AC15K	51p	BC557B	16p
2% E24	22 40 14p	500 ml 2.95	2N3056	1.20	AC152	45p	BC558	16p
1% E24	22 63 16p	WIRE	2N3250	36p	AC153	55p	BC558A	16p
LOW OHMIC	22 100 18p	2N3251	36p	AC153K	64p	BC558B	16p	
GLAZE W/P	22 150 21p	2N3439	98p	AC176	27p	BC558C	17p	
E24 11p	22 220 24p	2N3440	80p	AC176K	37p	BC559	17p	
E24 14p	47 47 17p	2N3441	1.35	AC187K	28p	BC559B	17p	
E24 16p	47 63 26p	2N3442	4.80	AC188	25p	BC559C	17p	
E24 18p	47 100 28p	2N3444	6.09	AC188K	40p	BC560C	27p	
E24 20p	100 100 28p	2N3446	5.72	AF239	55p	BC560	49p	
E24 22p	100 150 30p	2N3448	1.20	BC1240	1.00	BC1240	1.00	
E24 24p	100 220 32p	2N3468	1.00	BC107	10p	BC107	10p	
E24 27p	100 330 35p	2N3512	1.06	BC107A	12p	BC107A	12p	
E24 30p	100 470 38p	2N3553	2.85	BC107B	12p	BC107B	12p	
E24 33p	100 680 40p	2N3558	95p	BC107C	14p	BC107C	14p	
E24 36p	100 1000 42p	2N3638	1.20	BC108A	12p	BC108A	12p	
E24 39p	100 1500 44p	2N3702	10p	BC108B	12p	BC108B	12p	
E24 42p	100 2200 46p	2N3703	10p	BC108C	14p	BC108C	14p	
E24 45p	100 3300 48p	2N3704	10p	BC109	10p	BC109	10p	
E24 48p	100 4700 50p	2N3705	10p	BC109C	12p	BC109C	12p	
E24 51p	100 6800 52p	2N3706	10p	BC109C	12p	BC109C	12p	
E24 54p	100 10000 54p	2N3707	10p	BC140	29p	BC140	29p	
E24 57p	100 15000 56p	2N3708	10p	BC141	37p	BC141	37p	
E24 60p	100 22000 58p	2N3709	10p	BC142	29p	BC142	29p	
E24 63p	100 33000 60p	2N3710	10p	BC143	30p	BC143	30p	
E24 66p	100 47000 62p	2N3711	10p	BC147	10p	BC147	10p	
E24 69p	100 68000 64p	2N3712	2.00	BC147A	10p	BC147A	10p	
E24 72p	100 100000 66p	2N3713	1.38	BC147C	10p	BC147C	10p	
E24 75p	100 150000 68p	2N3714	2.88	BC148	12p	BC148	12p	
E24 78p	100 220000 70p	2N3715	3.31	BC148A	12p	BC148A	12p	
E24 81p	100 330000 72p	2N3716	3.60	BC148B	12p	BC148B	12p	
E24 84p	100 470000 74p	2N3717	1.99	BC148C	12p	BC148C	12p	
E24 87p	100 680000 76p	2N3718	2.88	BC149	13p	BC149	13p	
E24 90p	100 1000000 78p	2N3719	3.60	BC149B	12p	BC149B	12p	
E24 93p	100 1500000 80p	2N3720	3.60	BC149C	12p	BC149C	12p	
E24 96p	100 2200000 82p	2N3721	4.5p	BC149D	12p	BC149D	12p	
E24 99p	100 3300000 84p	2N3722	4.5p	BC153	23p	BC153	23p	
E24 102p	100 4700000 86p	2N3723	4.5p	BC154	27p	BC154	27p	
E24 105p	100 6800000 88p	2N3724	4.5p	BC157	11p	BC157	11p	
E24 108p	100 10000000 90p	2N3725	4.5p	BC157A	11p	BC157A	11p	
E24 111p	100 15000000 92p	2N3726	4.5p	BC158	10p	BC158	10p	
E24 114p	100 22000000 94p	2N3727	4.5p	BC158A	12p	BC158A	12p	
E24 117p	100 33000000 96p	2N3728	4.5p	BC158B	12p	BC158B	12p	
E24 120p	100 47000000 98p	2N3729	4.5p	BC158C	12p	BC158C	12p	
E24 123p	100 68000000 100p	2N3730	4.5p	BC159	13p	BC159	13p	
E24 126p	100 100000000 102p	2N3731	4.5p	BC159C	13p	BC159C	13p	
E24 129p	100 150000000 104p	2N3732	4.5p	BC159D	13p	BC159D	13p	
E24 132p	100 220000000 106p	2N3733	4.5p	BC159E	13p	BC159E	13p	
E24 135p	100 330000000 108p	2N3734	4.5p	BC159F	13p	BC159F	13p	
E24 138p	100 470000000 110p	2N3735	4.5p	BC159G	13p	BC159G	13p	
E24 141p	100 680000000 112p	2N3736	4.5p	BC159H	13p	BC159H	13p	
E24 144p	100 1000000000 114p	2N3737	4.5p	BC159I	13p	BC159I	13p	
E24 147p	100 1500000000 116p	2N3738	4.5p	BC159J	13p	BC159J	13p	
E24 150p	100 2200000000 118p	2N3739	4.5p	BC159K	13p	BC159K	13p	
E24 153p	100 3300000000 120p	2N3740	4.5p	BC159L	13p	BC159L	13p	
E24 156p	100 4700000000 122p	2N3741	4.5p	BC159M	13p	BC159M	13p	
E24 159p	100 6800000000 124p	2N3742	4.5p	BC159N	13p	BC159N	13p	
E24 162p	100 10000000000 126p	2N3743	4.5p	BC159O	13p	BC159O	13p	
E24 165p	100 15000000000 128p	2N3744	4.5p	BC159P	13p	BC159P	13p	
E24 168p	100 22000000000 130p	2N3745	4.5p	BC159Q	13p	BC159Q	13p	
E24 171p	100 33000000000 132p	2N3746	4.5p	BC159R	13p	BC159R	13p	
E24 174p	100 47000000000 134p	2N3747	4.5p	BC159S	13p	BC159S	13p	
E24 177p	100 68000000000 136p	2N3748	4.5p	BC159T	13p	BC159T	13p	
E24 180p	100 100000000000 138p	2N3749	4.5p	BC159U	13p	BC159U	13p	
E24 183p	100 150000000000 140p	2N3750	4.5p	BC159V	13p	BC159V	13p	
E24 186p	100 220000000000 142p	2N3751	4.5p	BC159W	13p	BC159W	13p	
E24 189p	100 330000000000 144p	2N3752	4.5p	BC159X	13p	BC159X	13p	
E24 192p	100 470000000000 146p	2N3753	4.5p	BC159Y	13p	BC159Y	13p	
E24 195p	100 680000000000 148p	2N3754	4.5p	BC159Z	13p	BC159Z	13p	
E24 198p	100 1000000000000 150p	2N3755	4.5p	BC159AA	13p	BC159AA	13p	
E24 201p	100 1500000000000 152p	2N3756	4.5p	BC159AB	13p	BC159AB	13p	
E24 204p	100 2200000000000 154p	2N3757	4.5p	BC159AC	13p	BC159AC	13p	
E24 207p	100 3300000000000 156p	2N3758	4.5p	BC159AD	13p	BC159AD	13p	
E24 210p	100 4700000000000 158p	2N3759	4.5p	BC159AE	13p	BC159AE	13p	
E24 213p	100 6800000000000 160p	2N3760	4.5p	BC159AF	13p	BC159AF	13p	
E24 216p	100 10000000000000 162p	2N3761	4.5p	BC159AG	13p	BC159AG	13p	
E24 219p	100 15000000000000 164p	2N3762	4.5p	BC159AH	13p	BC159AH	13p	
E24 222p	100 22000000000000 166p	2N3763	4.5p	BC159AI	13p	BC159AI	13p	
E24 225p	100 33000000000000 168p	2N3764	4.5p	BC159AJ	13p	BC159AJ	13p	
E24 228p	100 47000000000000 170p	2N3765	4.5p	BC159AK	13p	BC159AK	13p	
E24 231p	100 68000000000000 172p	2N3766	4.5p	BC159AL	13p	BC159AL	13p	
E24 234p	100 100000000000000 174p	2N3767	4.5p	BC159AM	13p	BC159AM	13p	
E24 237p	100 150000000000000 176p	2N3768	4.5p	BC159AN	13p	BC159AN	13p	
E24 240p	100 220000000000000 178p	2N3769	4.5p	BC159AO	13p	BC159AO	13p	
E24 243p	100 330000000000000 180p	2N3770	4.5p	BC159AP	13p	BC159AP	13p	
E24 246p	100 470000000000000 182p	2N3771	4.5p	BC159AQ	13p	BC159AQ	13p	
E24 249p	100 680000000000000 184p	2N3772	4.5p	BC159AR	13p	BC159AR	13p	
E24 252p	100 1000000000000000 186p	2N3773	4.5p	BC159AS	13p	BC159AS	13p	
E24 255p	100 1500000000000000 188p	2N3774	4.5p	BC159AT	13p	BC159AT	13p	
E24 258p	100 2200000000000000 190p	2N3775	4.5p	BC159AU	13p	BC159AU	13p	
E24 261p	100 3300000000000000 192p	2N3776	4.5p	BC159AV	13p	BC159AV	13p	
E24 264p	100 4700000000000000 194p	2N3777	4.5p	BC159AW	13p	BC159AW	13p	
E24 267p	100 6800000000000000 196p	2N3778	4.5p	BC159AX	13p	BC159AX	13p	
E24 270p	100 10000000000000000 198p	2N3779	4.5p	BC159AY	13p	BC159AY	13p	
E24 273p	100 15000000000000000 200p	2N3780	4.5p	BC159AZ	13p	BC159AZ	13p	
E24 276p	100 22000000000000000 202p	2N3781	4.5p	BC159BA	13p	BC159BA	13p	
E24 279p	100 33000000000000000 204p	2N3782	4.5p	BC159BB	13p	BC159BB	13p	
E24 282p	100 47000000000000000 206p	2N3783	4.5p	BC159BC	13p	BC159BC	13p	
E24 285p	100 68000000000000000 208p	2N3784	4.5p	BC159BD	13p	BC159BD	13p	
E24 288p	100 100000000000000000 210p	2N3785	4.5p	BC159BE	13p	BC159BE	13p	
E24 291p	100 150000000000000000 212p	2N37						

High-Speed, Low-Power Op-Amp

Burr-Brown has announced a high-speed low-power operational amplifier that draws only 230 μ A maximum quiescent current at ± 15 V supply voltage. Known as the OPA21, it is a monolithic device employing advanced laser trimming techniques and intended for use in low-power instrumentation amplifiers, isolation amplifiers, portable equipment and battery operated equipment.

At ± 15 V supply voltage, the OPA21's power consumption is only 6.9mW while at ± 2.5 V, power consumption is as little as 1.1mW. Other advantages include an input bias current of 50nA maximum and an offset current of 4nA. This is particularly important in low-power applications where the high resistor values used can create large voltage errors due to bias current. Other specifications include a slew rate of 0.2V/ μ Sec (typical) allowing it to be employed in high-speed applications, and a low offset voltage of 100 μ V drifting with temperature at 1 μ V/ $^{\circ}$ C maximum. In addition, the OPA21 offers 110dB typical common mode rejection ratio and an open loop gain of 120dB minimum. Burr-Brown International Limited, Cassiobury House, 11-19 Station Road, Watford, Herts WD1 1EA, tel 0923-33837.

Infra-Red Pre-Amplifier

Plessey Semiconductors have added an infra-red pre-amplifier to their family of remote control circuits. The SL486 is a high gain pre-amplifier with AGC which is designed to form an interface between infra-red transmitting diodes and the digital inputs of a remote control receiver circuit.

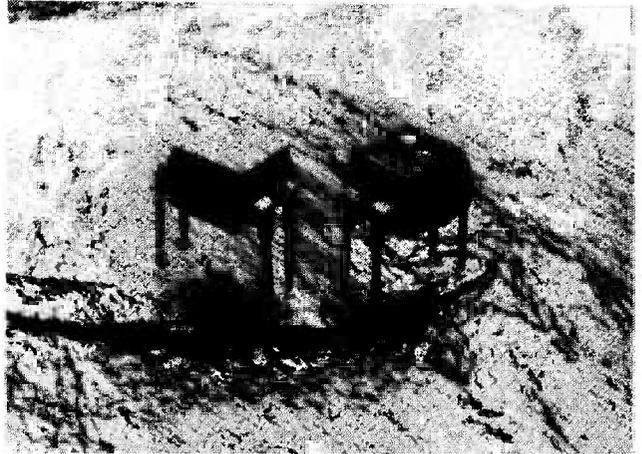
The device has a signal handling range of 120 dB which gives a range of 6-9 metres (20-30') in very bright sunlight and between 18-24 metres (60-80') in dull sunless conditions. An on chip gyrator circuit allows operation in environments with high background light levels and fast acting AGC improves operation in noisy environments. Other features include differential inputs to reduce noise and improve stability aided by an on-chip stabiliser which allows operation with a wide range of supply voltages, a pulse stretching circuit for direct interface with microprocessor decoders, and a minimal component count to achieve low system costs. The SL486 is available in a 16-pin plastic DIL and is specified over the temperature range 0 $^{\circ}$ to +70 $^{\circ}$ C. Full details are available from Plessey Semiconductors Limited, Cheney Manor, Swindon, Wiltshire SN2 2QW, tel 0793-36251.

DRAM Controllers

The SN74S408 and SN74S409 are single chip multimode dynamic RAM controller/drivers fabricated in bipolar technology, driving up to eighty-eight 64K or 256K multiplexed-address dynamic random-access memories. Designed to meet the growing demand for automatic access and automatic refreshing of DRAMs, they offer eight control modes to provide flexibility and simplicity to the system designer, who would otherwise need to use up to 15 chips.

The SN74S408 has eight address outputs and can drive 16K and 64K DRAMs; the SN74S409 has nine address outputs and drives 16K, 64K, and 256K DRAMs. Both feature address lines rated at 500 pF and are available in various speed options down to 100 nanoseconds maximum memory access time. In 48-pin dual-in-line packages, the SN74S408 and the SN74S409 are pin compatible with each other for convenient system upgrading and to allow four-fold increases in memory size.

Further details are available from Microlog Limited, 1st Floor, Elizabeth House, Duke Street, Woking, Surrey GU21 5BA, tel 04862-66771.



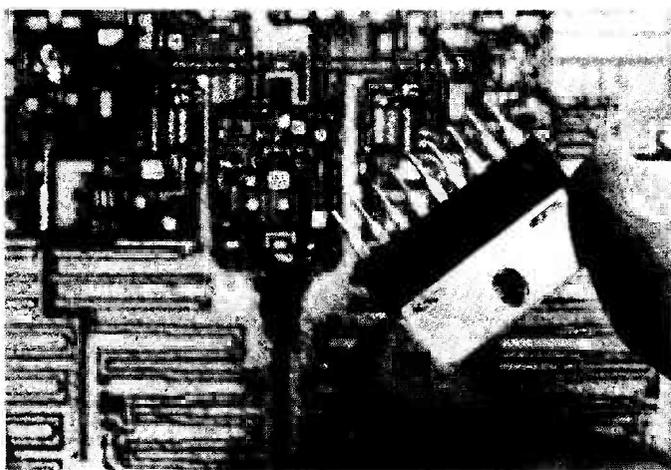
Stackable Optocouplers

A new series of end-stackable LED/Phototransistor optocouplers has been launched by Norbain Electro-Optics Limited of Reading. The new components have been specifically designed for use in circuits where space is limited.

The SFH610 and SFH611 series are contained in 4 pin dual-in-line plastic packages measuring 5.08mm by 6.4mm wide with a pin spacing of 2.54mm by 7.62mm. Except in the polarity of the LED and phototransistor pin-out, the two devices are identical in specification providing an isolation voltage of 2800V. The

couplers are banded in four groups with minimum and maximum current transfer ratios of 40% to 80%, 63% to 125%, 100% to 200% and 160% to 320% respectively.

These devices provide circuit designers with the choice of using exactly the number of optically coupled channels needed whilst keeping the space occupied to a minimum. Applications include the direct replacement of quad packaged couplers such as the ILQ74 and dual couplers such as the ICLT6 with the added advantage of needing to replace only one channel in the event of device failure. Norbain Electro-Optics Ltd, Norbain House, Boulton Road, Reading, Berkshire RG2 0LT, tel 0734-864411.



Dual Op-Amp

The Siemens TCA 2365 offers two power op-amps on a single chip. Each amplifier has an output of 2.5A, and the use of an

additional inhibit circuit enables three output states to be selected. Siemens claim that combining two amplifiers in a single package costs significantly less than two equivalent single devices and that, at the same time, assembly costs are cut.

The double op-amp comes in a

9-pin single-in-line package. Integrated protection circuits make the outputs DC short-circuit-proof with respect to negative and positive supply voltages and also prevent thermal overloading of the internal amplification circuits. The output voltage rise time is 4V/ μ s, and

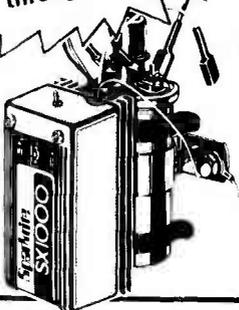
Siemens believe the new device will find application in fields such as climatology, instrumentation and control, machine controls, and monitoring and alarm systems. Siemens Limited, Siemens House, Windmill Road, Sunbury-on-Thames, Middlesex TW16 7HS, tel 09327-85691.

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

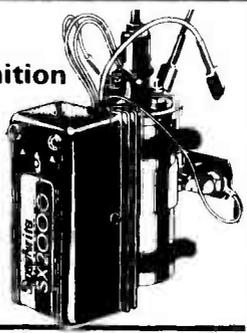
PRICES REDUCED ON SUPER SAVE D.I.Y. KITS



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

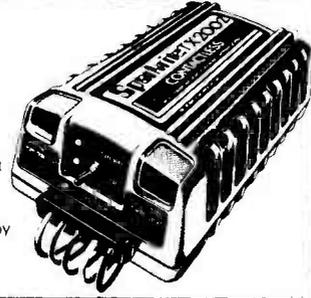
- Reactive Discharge ● Combines inductive & capacitive energy storage ● Gives highest possible spark energy ● Patented clip-to-coil fitting ● Easy assembly sequence ● Contact breaker triggered - includes bounce suppression circuit

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.



TX 2002 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

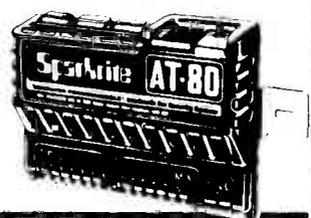
- Guards doors, boot, bonnet from unauthorised entry ● Armed/disarmed using concealed switch ● 30 second delay-to-arm: 7 second entry delay ● Can alternatively be wired to exterior key switch ● Flashes headlights & sounds horn intermittently for 60 seconds when activated ● Security loop protects accessories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



SUPER SAVE

ULTRASONIC Intruder Detector

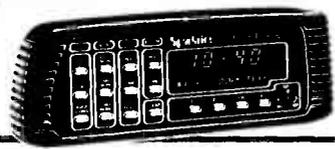
- Supplementary to AT-40 & AT-80 ● Will work in conjunction with any door switch input or voltage sensing alarm ● Detects attempted break-in and movement within passenger compartment & triggers alarm ● Includes high efficiency ultrasonic transducers ● Crystal controlled for low drift ● Ingenious sensitivity 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, ice, lights-left-on ● Independent LOG & TRIP functions ● Low consumption crystal controlled circuitry.



SPECIAL OFFER
"FREE" MAGIDICE KIT WITH ALL ORDERS OVER £40.00



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) 182 Bath Street, Walsall, WS1 3DE England Tel: (0922) 614791

KIT	OLD PRICE	NEW PRICE
SX 1000	£12.95	£11.95
SX 2000	£18.95	£18.95
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
MAGIDICE	£9.95	£6.95

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 ADDRESS _____

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PRICES INC. VAT, POSTAGE & PACKING

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BRAND LEADING BRITISH ELECTRONICS
CUT OUT THE COUPON NOW!

Hand-held Insulation Tester

Osborne Electronics have introduced a new type of 500 volt insulation tester which they believe offers radical improvements over existing test units. Designated the model 4100, it is a completely self-contained hand held unit which

offers the same order of accuracy as units currently selling for three times its price.

The complete unit, comprising the electronics, battery, display and probe, is contained in a slim-line case measuring 32 x 22 x 100 mm overall. Weighing just 75

grams, the unit nestles comfortably between thumb and forefinger and can be operated with one hand. The bright red bargraph display has a total of ten steps ranging from 1 to 100

Mohm, and is almost impossible to misread. In order to ensure total operator safety the model 4100 has been fitted with a current limiting circuit as standard. The unit's power consumption is 110mA at 9 volts, but for continuous use applications, it can be fitted with a rechargeable battery or powered by Osborne's optional mains adaptor.

Further information is available from Osborne Electronics, Binstead Road, Ryde, Isle of Wight, tel 0983-63622.



SHORTS

Following their decision to establish a new research and development centre in Bristol (reported in January News Digest), Hewlett Packard have donated equipment worth around £40,000 to the Engineering Department of Bristol Polytechnic. The equipment is intended for use in advanced silicon chip design and development, and marks the start of a number of joint ventures between the Polytechnic and Hewlett Packard.

Lucas Electrical have issued a brochure giving extensive details of methods for suppressing transients in telecommunications and data transmission systems. The brochure illustrates the use of Lucas' latest surge suppressors using silicon pn diffused junction construction, and is available from the Sales Engineering Department, Lucas Electrical Electronics & Systems Ltd, Mere Green Road, Four Oaks, Sutton Coldfield, West Midlands B75 5BN.

Esselte Dymo, manufacturers of anti-static cleaning agents, have published a booklet entitled "Caring for your Computer or Word Processor". The booklet describes the problems caused by static in data handling systems and how to overcome them, and is available free from Esselte stockists. Esselte Dymo Ltd, Spur Road, Feltham, Middlesex TW14 0SL.

The twenty-second International Electronics Exhibition, Electrex '84, will be held at the National Exhibition Centre, Birmingham from February 27th to March 2nd. More than 1200 companies will be represented and the number of visitors could well exceed last year's 43,000. Details from Electrex Ltd, Wix Hill House, West Horsley, Surrey KT24 6DZ, tel 0483 222888.

Bounding into the marketplace comes Supercat, a new electronics mail order catalogue featuring test equipment, leads, connectors, etc. New editions will appear at four monthly intervals and a greatly expanded range is promised for the summer issue. Meanwhile, the present issue is available free from Supercat Electronics Ltd, PO Box 201, St. Albans, Hertfordshire AL1 4EN, tel 0727 62171.

Wilmslow Audio have been appointed as distributors of Crimson Elektrik hi-fi products. The range includes amplifier kits and modules and two and three way active crossovers in a choice of fourteen standard frequencies. Crossover adjusted for non-standard frequencies can be supplied to order within seven days. For leaflets, reviews and a price list send a large SAE to Wilmslow Audio Ltd, 35-39 Church Street, Wilmslow, Cheshire SK9 1AS.

Superswitch have introduced a simple timer control which, unlike most programmable timers, can be set forward or backward at any time to adjust the 'on' period. Intended for use with immersion heaters and rated to suit, it is similar to many kitchen timers and has a single dial control which is set to the desired time and then counts down to zero. The 1512 immersion heater controller costs around £20 and is available from electrical and hardware shops.

Texas Instruments have published a 114 page master selection guide which gives outline data and packaging information on their semiconductor ranges. Devices listed include memories, logic arrays, digital products, linear products, opto-electronics and power and small signal devices, and copies of the guide are available free of charge from any TI distributor or by 'phoning 0234-223000.

The Computing Services Association is organising a residential conference at the Royal Bath Hotel, Bournemouth, from the 29th February to the 2nd March 1984. They aim to bring together companies from every sector of the industry to discuss issues affecting the business and to consider joint ventures. Details from the Conference organiser, Computing Services Association, Hanover House, 73-74 High Holborn, London WC1V 6LE, tel 01-405 2171.

The latest addition to the range of Swiss-made Elesta relays imported by Britec Ltd is a fully-sealed PCB mounting unit which is designed to withstand ultrasonic cleaning. The sealed versions of their SGR series relays come in a full range of coil voltage ratings from 6 to 110V and with contact ratings up to 16A. Britec Ltd, Bermondsey Industrial Estate, Rotherhithe New Road, London SE16 3LL, tel 01-237 8081.

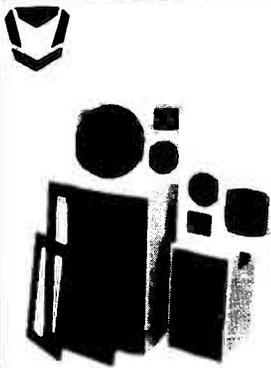
Hamlin Electronics have issued a 10 page colour catalogue featuring their range of proximity sensors. The catalogue covers standard proximity sensors and actuators using reed switches as well as special devices for use in applications such as machine control and shock sensing. Hamlin Electronics Europe Ltd, Diss, Norfolk IP22 3AY, tel 0379-4411.

INTELEC '84, the sixth International Telecommunications Energy Conference, will take place in New Orleans from the 4th to the 7th of November. The conference is concerned with the provision of power for telecommunications and the organisers welcome papers on appropriate topics for presentation at the conference. Details from M.E. Jacobs, AT & T Bell Laboratories, Room 8C-161, Whippany Road, Whippany, New Jersey 07981, tel 201-386 3362.

R.S. Electromatics offer a repair and calibration service for multimeters and other test equipment. They use the Royal Mail parcel service, will quote on repairs before carrying them out, and can be contacted on 0733 71958. R. S. Electromatics, 511 Fulbridge Road, Werrington, Peterborough PE4 6SB.

Solartron have issued a new shortform catalogue of their range of test and measurement equipment. The catalogue includes illustrations and performance details on a wide range of 'scopes, signal generators, counters, etc and is in full colour. Solartron Instrumentation Group, Victoria Road, Farnborough, Hampshire GU14 7PW, tel 0252 544433.

The latest plug for ITT Cannon products takes the form of a glossy calendar. Presumably noting Pirelli's success with pictures of unattractive women, Cannon's calendar will show "... stunningly beautiful models, wearing only a smile and a precise array of the latest Cannon connectors . . .". This 'corporate and subtle product promotion' will be limited to 2500 copies and Cannon envisage it becoming a collectors' item. But what has it all got to do with plugs and sockets, dare we ask?



MULLARD SPEAKER KITS

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

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



OMP 80 LOUDSPEAKER

The very best in quality and value.
 Ported tuned cabinet in hard-wearing black vinyl with protective corners and carry handle. Built and tested, employing 10in British driver and Piezo tweeter. Spec: 80 watts RMS; 8 ohms, 45Hz-20KHz. Size: 20in x 15in x 12in. Weight: 30 pounds.
Price £49.00 each
£90 per pair
Carriage: £5 each £7 per pair

BK ELECTRONICS

Prompt Deliveries
 VAT inclusive
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 Audio Equipment
 Test Equipment
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 Thandar
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HOBBY KITS. Proven designs including glass fibre printed circuit board and high quality components complete with instructions.

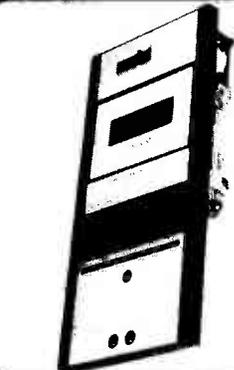
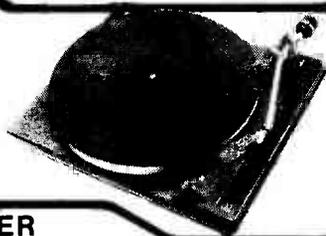
FM MICROTRANSMITTER (BUG) 90/105MHz with very sensitive microphone. Range 100/300 metres. 57 x 46 x 14mm (9 volt)
Price: £7.99p
DIGITAL THERMOMETER -9.9°C to +99.9°C LED display. Complete with sensor. 70 x 70 mm (9 volt) **Price: £27.60p**
3 WATT FM TRANSMITTER 3 WATT 85/115MHz varicap controlled, professional performance. Range up to 3 miles 35 x 84 x 12 mm (12 volt) **Price: £12.49p**
SINGLE CHANNEL RADIO CONTROLLED TRANSMITTER/RECEIVER 27MHZ Range up to 500 metres. Double coded modulation. Receiver output operates relay with 2amp/240 volt contacts. Ideal for many applications. Receiver 90 x 70 x 22 mm (9/12 volt) **Price: £16.49** Transmitter 80 x 50 x 15 mm (9/12 volt) **Price £10.29 P&P** All Kits + 75p each. SAE for complete list.



3 watt FM Transmitter

BSR P256 TURNTABLE

P256 turntable chassis ● S shaped tone arm ● Belt driven ● Aluminium platter ● Precision calibrated counter balance ● Anti-skate (bias device) ● Damped cueing lever ● 240 volt AC operation (Hz) ● Cut-out template supplied ● Completely manual arm. This deck has a completely manual arm and is designed primarily for disco and studio use where all the advantages of a manual arm are required.
Price £32.35 each. £2.50 P&P



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

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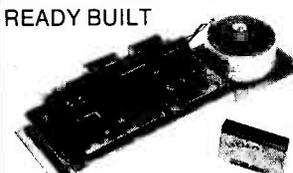
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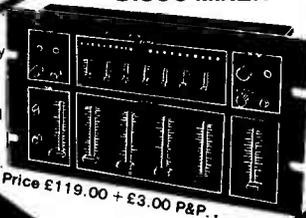
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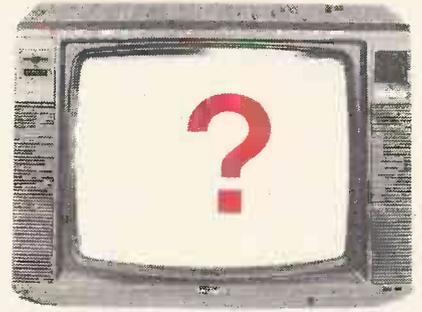
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CABLE TELEVISION DOWN THE DRAIN?



If you live in Aberdeen or Ealing, Glasgow or Belfast, or one of the other 11 initial areas for cable television, you could well be offered cable television in the next year or so. But what of the rest of us, and what might it be like if we do get it?

A month or so ago, the government announced the granting of 11 initial franchises to companies to allow them to set up cable TV services in selected areas, none of them encompassing more than 100,000 homes. There were a total of 37 applications for the franchises, and the government had initially intended to licence 12 franchises.

These initial franchises are not trial franchises: they are seen as the first of many; however, all concerned, including the Government, are feeling their way carefully, and it is expected to be a year or two at least before any further franchises are approved. Table 1 shows the first batch, with a rough outline of their plans.

There are two major paradoxes at the heart of the debate over cable television — the first is well known though rarely admitted to: there are lots of people who want it but nobody is prepared to pay for it. The second is that the cable is intended to be 'entertainment led' investment in information technology; that is, what is being bought is the facility to have extra television channels; however, what comes with it, riding piggy-back almost as an after-thought, is the wiring of UK homes ready to take the full force of the information revolution.

When commercial television first came to the UK it was described as a 'licence to print money'. There certainly haven't been any bankruptcies amongst TV companies, and there is certainly a fair amount of competition for broadcast TV franchises when they come up for renewal, so this must still be the prevailing attitude. There must be plenty of investors around who'd like to get an 'in' on television — or are there?

There are, however, very significant differences between the cable and the broadcast TV. In broadcast TV, you build (or lease space on) a handful of transmitters and aerials; in cable TV, you have to provide a network of cables to physically connect each home that you intend to serve (and you have to provide this network not knowing how many of the homes you are passing with the cable will take the service); in broadcast TV, you provide one channel; in cable TV, you have to provide several channels (a dozen or more) or you won't attract people to take the service. You also have to provide facilities to

receive all the broadcast channels as well.

These factors combine to make the amount of money required to set up a cable service to a medium-sized conurbation — such as the 100,000-home in the initial block of franchises — around £25 million.

Some cable TV companies are taking a slightly different option, in that they are finding someone else, often British Telecom, to lay the cable which will then be leased; however, the cable-providing companies will not be charitable bodies, and will want to charge a fair rent for their investment, which has led most cable companies to decide to install their own cable. In any case, someone somewhere has to shell out for the laying of the cable.

In fact, it has been predicted that the quantity of money required will severely limit the growth of cable TV. A back-of-the-envelope calculation suggests that cable TV will require an investment of around £10 billion to reach half the population. As a result, there will be a lot of cable TV companies chasing a very limited amount of money, should the government ever give the go-ahead to all-out cabling.

Who Will Buy?

To reach profitability, a cable network will need to attract a fairly high proportion of the potential customers to actually take up the service that passes their front door. Estimates of how many people actually will take up the service vary a great deal, as do estimates of the exact percentage needed to make the service financially viable. For the former, estimates span 12 to 36% by the mid 1990s; however, for the latter, one estimate is that even a 50% take-up would be marginal as far as investors in cable are concerned. (Contrast both these sets of figures with the findings of a recent survey in *Which?* magazine that indicated that only 15% of households might be prepared to pay to receive extra TV channels.)

Another factor is that at the moment we have a government that is relatively welcoming to the prospect of cable TV — what would happen if another government came along that was horrified at the prospect of £10 billion being dragged out of the economy

to pay for cable TV? I must interject, ironically, that it was the economist Keynes who said that the economy would be stimulated simply by employing people to dig holes in the road and fill them in again. This sounds remarkably like the laying of cables to me. Unfortunately, Keynes' ideas have been supplanted by the monetarist policies of Mrs Thatcher's government.)

Even though the present government is, as already mentioned, fairly 'pro' cable, there are a couple of fairly tough conditions applied to the franchised companies. Firstly, the franchise is for a fixed term; in the case of the initial franchises the term is either 12 or 20 years, depending on the type of system installed (12 for tree and branch systems, 20 for switched star — see later for explanation of terms).

The second condition is that the company must complete the wiring of the network once it has begun, no matter how poor the up-take to the system is. This may seem a rather odd requirement — what is the point of laying cable if you cannot then afford to run the service? — but it is as a consequence of the government's view that one of the objectives is the wiring of Britain for other purposes, not just TV, all using the same service. Also related to this is that the actual cable network itself has zero value — what bank, for instance, would wish to risk having to foreclose a company whose major asset was several hundred miles of copper buried in the ground?

What's On Offer?

What the cable TV companies are offering in the trial areas are all fairly similar. For a basic monthly fee of around £5 to £9 per month, you will get the basic service, consisting of a number of channels: up to 16 may be provided in some areas; although exactly what the companies will be offering is still being decided, channels proposed include local news, children's pro-

grammes, sports, music, teletext, national news, general entertainment, classified ads, general interest, business news, educational (possibly including Open University programmes), and community access.

Some of the companies plan to offer a second tier of channels for which an additional fee will be payable (usually of around £5 per month); this will 'cream off' the most popular items from the above list. However, all the companies will have 'premium' channels, which will cost an additional £6 to £8 each per month and will mainly be feature-film channels, carrying newer films than the broadcast channels can afford to buy.

The film channels are, to the customer, one of the most attractive features of the cable TV service; unfortunately, there are a number of problems with this very aspect of the service. They are:

- expense: by the time customers have paid the basic fee plus one or two premium fees, they will be shelling out around £11 to £17 per month; many prospective customers will already have videos, and at a cost of as little as £1 per night, the hiring of films looks very competitive;
- convenience: unlike a video, you will still have to watch the film when it is broadcast, not when convenient; however, it isn't necessary to visit a shop to get the film;
- supply: on average, approximately three full-length English-language feature films are completed each week; obviously, some of these will be dire or unsuitable for use on cable for other reasons, so at the somewhat restricted rate of showing one film per night (actually, two would seem a more realistic figure) demand will still outstrip supply, and prices of films to the cable companies will rise;
- resources: although the investment sums involved in cable TV are relatively high, it is unlikely that it will have the resources to be able to generate much in the

Town	Franchisee	Services
Aberdeen	Aberdeen Cable Services	Basic 11-16 channels for £8; classic first-run film channels £7 each
Coventry	Coventry Cable	Basic up to 10 channels for £6; premium movie channel £7 per month; other channels possible
Belfast	Ulster Cablevision	Basic 12 channels for £7; premium film channels (3) £8 each; also sport channel
Croydon	Croydon Cable	Basic: £5 per month; extended: £4; premium channels £2 to £8 per channel
Ealing	CableTel Communications	Basic: 8 or 9 for £10 or less; two premium movies £8 each
Glasgow	Clyde Cable Vision	Basic: £8 per month; premium film channels £6 each
Guildford	Rediffusion Consumer Electronics	Basic: £6 per month; premium movie £8; also many interactive channels planned
Liverpool	Merseyside Cablevision	Basic: £8 to £9; second tier £4 to £5; two movie channels £6 to £8 each; interactive services
Swindon	Swindon Cable Services	Basic: 8 for £5; two premium movies £7 each
Westminster	Westminster Cable	Basic: 14 channels for £6 to £7; super-basic: 5 for £2 to £3; premium: 3 for £7 each
Windsor	Windsor Television	Basic: 11 channels for £6.90; premium channels £8 each (several planned)

Table 1 The initial batch of franchises; note the details and prices are very preliminary, and that some companies may also decide to charge connection fees as well.

way of its own premium material, in the way that Channel 4 has been able to finance the making of films. For example, £1m for a 1½ hour feature film now seems to be regarded as "low-budget"; even television documentaries cost around £30,000 for every hour that the viewer sees, and this is probably well outside the reach of the cable companies.

What Will Pay Its Way

Actually, the cable TV companies will probably not be that closely involved in the purchase of material for transmission over their particular networks; they will probably 'buy in' pre-programmed material from programme providers. As it happens, London Weekend Television seriously considered entering this business, and did some research into what people would be prepared to pay for; having decided that they were not, at least at this stage interested, they made their findings public at a recent Seminar*.

LWT found that there would definitely be a market for three types of channel:

- the movie channel, provided the difficulties mentioned above do not confound it, would definitely be very popular;
- an "adult" or "club 18" channel, with sexually not-too-explicit material and slightly nasty films would also be successful (note that the Government has made it plain that it will not permit the 'excesses' that cable TV in the USA has sunk to);
- finally, what they dub "wall-to-wall, heart-to-heart" would also be popular (this would consist of continuous soap opera — imagine it — 12 hours a day of Dallas!). This last possibility is the most horrifying, but also the most interesting. For a start, there is no problem in obtaining enough material for this sort of channel. LWT found that they could easily buy in enough material to fill three 12-hours-a-day channels! Also the audience for this sort of "undemanding" TV is quite high ("Why do you think people watch snooker?").

However, people would not be prepared to pay any extra for "wall-to-wall, heart-to-heart", and to make the channel viable it would have to carry advertising. For advertising to be viable, this channel would have to reach 50% of households in the catchment area.

There is one other sort of channel that LWT discovered might make a living, and that is a pop music channel, provided that the material was given free to the cable companies.

Note that these possibilities do not include a sports channel. The government has ruled out the possibility of the cable companies being allowed to buy sole rights to national events, such as the FA cup final for instance, and has also ruled out pay-per-view. There is a debate going on as to who has who over a barrel over the future of the regulation of the channel. Cable companies think that they're the ones who hold the upper hand, because without them being able to make a healthy profit, the government will not get the cableing of Britain that it wants, so they think they will be able to force concessions in the future. On the other hand, the government obviously will hold the upper hand once the companies have installed their networks.

And, almost as a postscript to this section, another factor over the actual programme content that hardly needs pointing out is that if cable TV were to become successful, the broadcast channels, and in particular the commercial channels, would be obliged to try and

compete with the cable channels, and on their own terms; there are a number of commentators who believe that this would lead to the destruction of the diversity that goes to make British television the best in the world. Programs that are not specifically aimed at the lowest common denominator would disappear from our screens to be replaced with continuous second-rate soap opera.

Advertising

At the heart of much of the uncertainty of the future of cable TV is how well the advertising will sell. Really, it is a chicken-and-egg situation — if advertising sells well, then prices to the viewer are likely to be lower, so more people will take the cable, so more advertisers will want to use it, etc. However, advertisers are very reluctant to use cable TV due to its very low up-take: even a relatively optimistic estimate of a 35% up-take amongst households offered the cable is likely to be much too low to interest any of the 'Mainstream' advertisers.

All the same, when most of the 11 franchisees were asked about advertising, they made quite optimistic noises, largely on the basis that they felt that they could get many smaller, local advertisers to use them. As far as television advertising goes, these are uncharted waters.

It is perhaps instructive to look at the situation in the USA to see how well cable TV advertising sells over there. In 1982, approximately \$180 to 200 million was spent on cable TV advertising, compared with the figure of around \$12.7 billion on just three major broadcast companies (NBC, CBS and AB) over a similar period. So while the money spent on advertising is not to be ignored, compared to the other sums of money involved (and compared to the investment required to lay the cable), it isn't a great deal.

The Technology

Existing cable systems are in many cases pretty antiquated; for example, the Rediffusion network uses a twisted pair to distribute a HF signal (not even VHF, never mind UHF), so major changes in technology will have to take place.

There are two areas that can be examined here: firstly, there is the overall shape of the system. It could either be tree and branch (as in Fig. 1) where all the

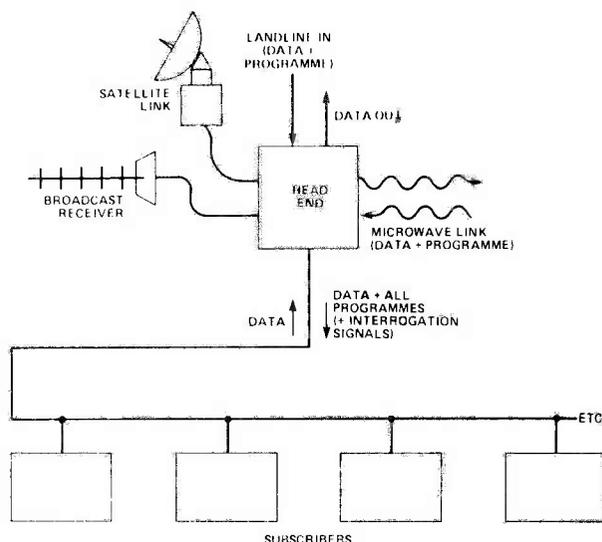


Fig. 1 The tree and branch distribution system.

subscribers have all the channels supplied to their house by a single cable. A conventional coaxial cable will have ample bandwidth for up to thirty or more channels of television; however, the channels that require an extra subscription would have to be scrambled in some way, so that they can be received only by the use of a special unscrambler which you would get upon payment of the extra fee.

The other system, shown in Fig. 2, is the switched star arrangement. Here all the available channels are supplied to a local 'switch'. Individual subscribers are then supplied with the channel they select by the 'switch'. Obviously, the method here involves an interaction between the users and the switch, and this is the reason why the government is encouraging this system. The switched star system is seen as the system of the future, as the interactive nature of the service can be extended easily to include interactive banking, shopping, and many more options as viable ideas come forward.

Thorn EMI disagree over the dismissal of the tree and branch system as the less adaptable of the two. They have their own system — teletext addressability and control for cable systems (TACCS) that they think could offer all the advantages of switched star at a much lower cost. According to them, by extending the teletext system, they can offer 30 TV channels plus 35 radio programmes, a down (to the subscriber) data capacity per channel in excess of 200Kbs on locally generated TV channels and 12Kbs on broadcast channels, with a potential up capacity of 750Kbs (presumably not from each individual subscriber but from the system as a whole!), and using various interrogation techniques and data storage at the users' receivers, they say that they would be able to supply virtually all the interactive facilities that a switched star system could support.

However, Thorn EMI seem to be fighting a losing battle and most of the initial franchisees have opted for switched star.

The Cable

The other aspect of the technology that is cause for concern is the actual carrying medium being used. All the companies will, for the foreseeable future, be using coaxial cable for the transmission of the signals to our homes. Now it is obvious that optical fibres are the medium of the future — they are cheap to produce in themselves, have much higher bandwidths with coaxial cable, and would therefore have ample room for future developments. They should also be less susceptible to the ingress of moisture — a continual problem with underground coaxial cables which causes a major maintenance burden.

However, the technology of optical fibres is very young, and although the fibres themselves are cheap, the rest of the system is pretty expensive when compared to that associated with coaxial cable: prices of approximately ten to twenty times more for a fibre system overall have been mentioned. It is predicted that optical fibres will not be price competitive until the mid-nineties at the earliest, but after that the price will continue to become more favourable in comparison to coaxial cable (and what happens if world copper prices rocket?).

The mid-nineties is rather an interesting time for cable TV: not only is it the time that some of the tree and branch system trial franchises will run out, it is also the time that cable systems should be coming on stream in a big way. So, it is most worrying that the

technology used should become obsolete just as the whole system is getting on to its feet.

Beyond Television

As yet, exactly what will go into the interactive services is still at a relatively early stage of planning, with no one able or willing to commit themselves to exactly what will be available or when. Rediffusion who have the Guildford franchise say that they will be using this to develop their expertise in interactive services. They claim that their plans are probably the most advanced, but even so they are unable to give any definite details.

The services proposed include public data lines, and private. Public services will, they hope, include home banking (the banks, facing increasing competition from the building societies, are said to be receptive to the idea), teleshopping (at least one major mail-order firm is interested), teletexting, meter reading, home security (ie monitoring of a burglar alarm while you are out and possibly a 'panic button' facility for the elderly), video games and formal learning.

The private data lines would be leased to large organisations such as hospitals or the police to enable them to pass around information such as records or electronic mail.

Conclusion

In this brief article, it hasn't been possible to delve very far into all the details of what looks like becoming a multi-million pound industry. However, it is hoped that a flavour of the situation has been conveyed, along with the controversies involved. As a personal note, I find myself agreeing with one commentator at the seminar mentioned earlier: that cable TV is the right thing to do, but now is the wrong time for it.

* The seminar mentioned was Whose Cable?, organised by the Consumers' Association. I should like to thank Dianna Collins of Rediffusion for answering my stupid questions, and Mark Phillimore of Cabletime (Systems) Ltd for providing the front cover shot of TV cable being laid in a sewer.

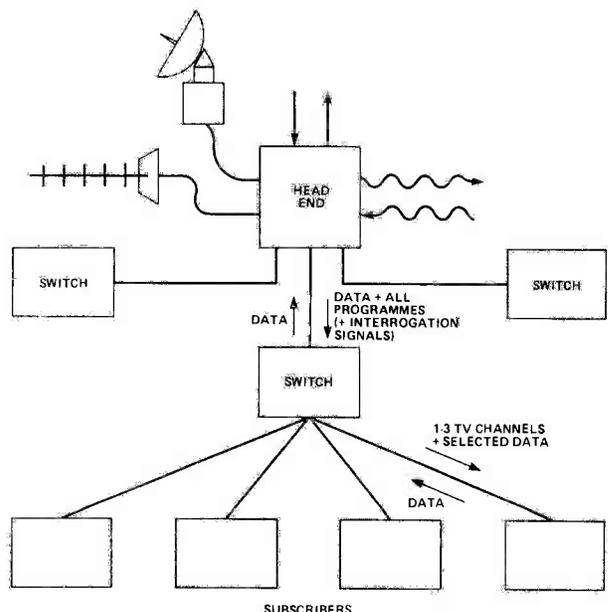


Fig. 2 The switched star distribution system. ETI

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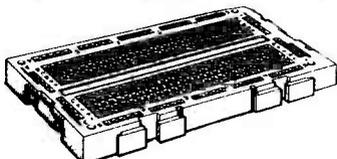
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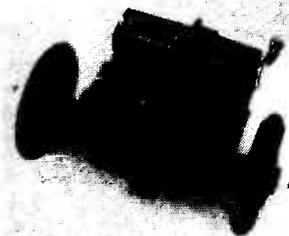
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A199 A versatile stabilized power supply with both voltage (2-30V) and current (20mA-2A) fully variable. Many uses inc bench PSU, Nicad charger, gen. purpose testing. Panel ready built, tested and calibrated. **£7.75**. Suitable transformer and pots **£6.00**. Full data supplied.

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DIGITAL ULTRASONIC DETECTOR US 5063



only **£13.95** + V.A.T.

NEW

- 3 levels of discrimination against false alarms
 - Crystal control for greater stability
 - Adjustable range up to 25ft
 - Built-in delays
 - 12V operation
- This advanced new module uses digital signal processing to handle the highest level of sensitivity whilst discriminating against potential false alarm conditions. The module has a built-in exit delay and timed alarm period, together with a selectable entrance delay, plus many more outstanding features.

ULTRASONIC MODULE US 4012

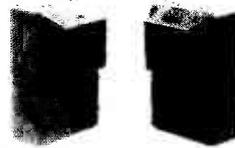


£10.95 + V.A.T.

- Adjustable range from 5-25ft.
- This popular low cost ultrasonic detector is already used in a wider range of applications from intruder detectors to automatic light switches and door opening equipment, featuring 2 LED indicators for ease of setting up.

INFRA-RED SYSTEM

IR 1470 only **£25.61** + V.A.T.



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

POWER SUPPLY & RELAY UNIT PS 4012

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

SIREN MODULE SL 157

Produces a loud penetrating sliding tone which, when coupled to a suitable horn speaker, produces S.P.L.'s of 110dbts at 2 metres. Operating from 9-15V. Price **£2.95** + V.A.T.

5½" HORN SPEAKER HS 588

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

3-POS. KEY SWITCH 3901

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

ALARM CONTROL UNIT CA 1250



Price **£19.95** + V.A.T.

The heart of any alarm system is the control unit. The CA 1250 offers every possible feature that is likely to be required when constructing a system whether a highly sophisticated installation or simply controlling a single magnetic switch on the front door.

- Built-in electronic siren drives 2 loud speakers
- Provides exit and entrance delays together with fixed alarm time
- Battery back-up with trickle charging facility
- Operates with magnetic switches, pressure pads, ultrasonic or I.R. units
- Anti-tamper and panic facility
- Stabilised output voltage
- 2 operating modes - full alarm/anti-tamper and panic facility
- Screw connections for ease of installation
- Separate relay contacts for external loads
- Test loop facility

SIREN & POWER SUPPLY MODULE PSL 1865

only **£9.95** + V.A.T.



NEW

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

HARDWARE KIT HW 1250

only **£9.50** + V.A.T.



NEW

This attractive case is designed to house the control unit CA 1250, together with the appropriate LED indicators and key switch. Supplied with the necessary mounting pillars and punched front panel, the unit is given a professional appearance by an adhesive silk screened label. Size 200 by 180 by 70mm

ULTRASONIC MODULE ENCLOSURE

only **£2.95** + V.A.T.



NEW

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

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T.V. SOUND TUNER

SERIES II

BUILT AND TESTED

In the cut-throat world of consumer electronics, one of the questions designers apparently ponder over is "Will anyone notice if we save money by chopping this out?" In the domestic TV set, one of the first casualties seems to be the sound quality. Small speakers and no tone controls are common and all this is really quite sad, as the TV companies do their best to transmit the highest quality sound. Given this background a compact and independent TV tuner that connects direct to your Hi-Fi is a must for quality reproduction. The unit is mains-operated. This TV SOUND TUNER offers full UHF coverage with 5 pre-selected tuning controls. It can also be used in conjunction with your video recorder. Dimensions: 10 1/2" x 7 1/2" x 2 1/4".



COMPLETE WITH CASE

£26.50 + £2.00 p.p.

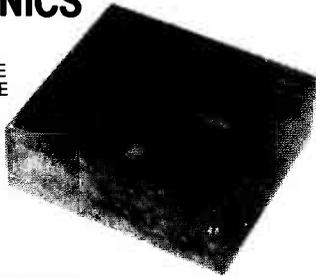
PRACTICAL ELECTRONICS STEREO CASSETTE RECORDER KIT

COMPLETE WITH CASE

ONLY £31.00 plus £2.75 p.p.

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

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



STEREO TUNER KIT

SPECIAL OFFER! £13.95 + £2.50 p.p.

This easy to build 3 band stereo AM/FM tuner kit is designed in conjunction with P.E. (July '81). For ease of construction and alignment it incorporates three Mullard modules and an I.C. IF System.

FEATURES: VHF, MW, LW Bands, interstation muting and AFC on VHF. Tuning meter. Two back printed PCB's. Ready made chassis and scale. Aerial: AM-ferrite rod, FM-75 or 300 ohms. Stabilised power supply with 'C' core mains transformer. All components supplied are to P.E. strict specification. Front scale size 10 1/2" x 2 1/4" approx. Complete with diagram and instructions.

BSR RECORD DECKS

3 speed, manual, auto, setdown; with auto return.

Fitted with viscous damped cue, tubular aluminium counter-weighted arm, fitted with stereo ceramic head. Ideally suited for home or disco use.

£17.50 + £1.75 p.p.

Auto Changer model - takes up to six records with manual override. Also supplied with stereo ceramic cartridge.

£12.95 + £1.75 p.p.

PLINTH to suit BSR Record Player Deck (with cover). Size 16 1/2" x 14 1/2" x 3 1/2". Cover size: 14 1/2" x 13 1/2" x 3 1/2". Due to fragile nature, Buyer collect only. Price: £8.95.

125W HIGH POWER AMP MODULES

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

ACCESSORIES: Stereo/mono mains power supply kit with transformer: £10.50 plus £2.00 p.p.

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

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

HI-FI SPEAKER BARGAINS

AUDAX 8" SPEAKER £5.95 + £2.20 p.p. High quality 40 watts RMS bass/mid. Ideal for either HiFi or Disco use this speaker features an aluminium voice coil and a heavy 70mm dia. magnet. Freq. Res.: 20Hz to 7KHz. Imp.: 8 ohms.

AUDAX 40W FERRO-FLUID HI-FI TWEETER Freq. res.: 5KHz - 22KHz. Imp.: 8 ohms. 60mm sq. £5.50 + 60p p.p.

GOODMANS TWEETERS 8 ohm soft dome radiator tweeter (3/4" sq) for use in systems up to 40W. £3.95 ea + £1 p.p. £6.95 pr + £1.50.

MONO MIXER AMP

Ideal for halls and clubs. £45.00 + £2 p.p.

50 Watt, six individually mixed inputs for 2 pickups (Cer. or mag), 2 moving coil microphones and 2 auxiliary for tape tuner, organs etc. Eight slider controls - 6 for level and 2 for master bass and treble, 4 extra treble controls for mic. and aux. outputs. Size: 13 1/2" x 6 1/2" x 3 1/2" approx. Power output 50 W RMS (cont.) for use with 4 to 8 ohm speakers. Attractive black vinyl case with matching fascia and knobs. Ready to use.

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74LS01 20p	AD162 42p	7404 30p	7404 30p	4001 12p
74LS02 20p	BC107 10p	2804CT 320p	CA3018 70p	4002 12p
74LS03 20p	BC108 10p	2804DART 700p	CA3046 70p	4006 90p
74LS04 20p	BC109 10p	2804PI 200p	CA3048 230p	4007 14p
74LS05 20p	BC106C 12p	2805ID 810p	CA3059 285p	4008 90p
74LS08 20p	BC177 18p	8802 225p	CA3060 280p	4009 24p
74LS10 20p	BC178 18p	8821 100p	CA3080 70p	4010 24p
74LS11 20p	BC179 18p	8822 100p	CA3088 48p	4011 11p
74LS12 20p	BC181 10p	8850 110p	CA3100 80p	4012 15p
74LS13 25p	BC183 10p	8852 250p	CA3107 110p	4013 20p
74LS14 20p	BC184 10p	8875 500p	CA3140E 90p	4014 48p
74LS15 20p	BC174 10p	8925 450p	CA3140E 90p	4015 40p
74LS16 20p	BC213 10p	8154 850p	CA3160E 100p	4016 20p
74LS20 20p	BC214 10p	8156 380p	CA3161E 180p	4017 32p
74LS21 20p	BC347 13p	8212 100p	CA3182E 450p	4018 45p
74LS22 20p	BC348 12p	8216 100p	CA3189E 300p	4019 25p
74LS24 20p	BC549C 14p	8228 270p	CA3240E 110p	4020 48p
74LS25 20p	BC558 15p	8250 850p	CA3280E 200p	4021 40p
74LS26 20p	BC557 15p	8253 900p	LF347 180p	4022 48p
74LS28 20p	BC558 15p	8255 100p	LF351 180p	4023 13p
74LS30 20p	BC559 15p	8258 400p	LF353 85p	4024 32p
74LS31 20p	BF995 23p		LF355 85p	4025 13p
74LS32 20p	BF995 23p		LF358 85p	4026 80p
74LS33 20p	BF995 23p		LF357 100p	4027 100p
74LS37 20p	BF995 23p		LM301A 25p	4028 40p
74LS40 20p	BF995 23p		LM301 120p	4029 48p
74LS42 38p	BF995 23p		LM311 70p	4030 15p
74LS43 40p	BF995 23p		LM318 180p	4031 110p
74LS46 80p	BF995 23p		LM319 215p	4037 110p
74LS47 40p	BF995 23p		LM324 30p	4040 40p
74LS48 80p	BF995 23p		LM324E 30p	4041 40p
74LS51 20p	BF995 23p		LM332 40p	4042 40p
74LS52 20p	BF995 23p		LM332E 40p	4043 40p
74LS54 20p	BF995 23p		LM339 85p	4044 100p
74LS55 20p	BF995 23p		LM339E 85p	4045 100p
74LS56 20p	BF995 23p		LM339N 85p	4046 50p
74LS57 20p	BF995 23p		LM339N 85p	4047 48p
74LS58 20p	BF995 23p		LM339N 85p	4048 50p
74LS59 20p	BF995 23p		LM339N 85p	4049 48p
74LS60 20p	BF995 23p		LM339N 85p	4050 48p
74LS61 20p	BF995 23p		LM339N 85p	4051 48p
74LS62 20p	BF995 23p		LM339N 85p	4052 48p
74LS63 20p	BF995 23p		LM339N 85p	4053 48p
74LS64 20p	BF995 23p		LM339N 85p	4054 48p
74LS65 20p	BF995 23p		LM339N 85p	4055 48p
74LS66 20p	BF995 23p		LM339N 85p	4056 48p
74LS67 20p	BF995 23p		LM339N 85p	4057 48p
74LS68 20p	BF995 23p		LM339N 85p	4058 48p
74LS69 20p	BF995 23p		LM339N 85p	4059 48p
74LS70 20p	BF995 23p		LM339N 85p	4060 48p
74LS71 20p	BF995 23p		LM339N 85p	4061 48p
74LS72 20p	BF995 23p		LM339N 85p	4062 48p
74LS73 20p	BF995 23p		LM339N 85p	4063 48p
74LS74 20p	BF995 23p		LM339N 85p	4064 48p
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74LS82 20p	BF995 23p		LM339N 85p	4072 48p
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74LS86 20p	BF995 23p		LM339N 85p	4076 48p
74LS87 20p	BF995 23p		LM339N 85p	4077 48p
74LS88 20p	BF995 23p		LM339N 85p	4078 48p
74LS89 20p	BF995 23p		LM339N 85p	4079 48p
74LS90 20p	BF995 23p		LM339N 85p	4080 48p
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74LS92 20p	BF995 23p		LM339N 85p	4082 48p
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74LS96 20p	BF995 23p		LM339N 85p	4086 48p
74LS97 20p	BF995 23p		LM339N 85p	4087 48p
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74LS99 20p	BF995 23p		LM339N 85p	4089 48p
74LS100 20p	BF995 23p		LM339N 85p	4090 48p
74LS101 20p	BF995 23p		LM339N 85p	4091 48p
74LS102 20p	BF995 23p		LM339N 85p	4092 48p
74LS103 20p	BF995 23p		LM339N 85p	4093 48p
74LS104 20p	BF995 23p		LM339N 85p	4094 48p
74LS105 20p	BF995 23p		LM339N 85p	4095 48p
74LS106 20p	BF995 23p		LM339N 85p	4096 48p
74LS107 20p	BF995 23p		LM339N 85p	4097 48p
74LS108 20p	BF995 23p		LM339N 85p	4098 48p
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74LS110 20p	BF995 23p		LM339N 85p	4100 48p
74LS111 20p	BF995 23p		LM339N 85p	4101 48p
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74LS132 20p	BF995 23p		LM339N 85p	4122 48p
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74LS134 20p	BF995 23p		LM339N 85p	4124 48p
74LS135 20p	BF995 23p		LM339N 85p	4125 48p
74LS136 20p	BF995 23p		LM339N 85p	4126 48p
74LS137 20p	BF995 23p		LM339N 85p	4127 48p
74LS138 20p	BF995 23p		LM339N 85p	4128 48p
74LS139 20p	BF995 23p		LM339N 85p	4129 48p
74LS140 20p	BF995 23p		LM339N 85p	4130 48p
74LS141 20p	BF995 23p		LM339N 85p	4131 48p
74LS142 20p	BF995 23p		LM339N 85p	4132 48p
74LS143 20p	BF995 23p		LM339N 85p	4133 48p
74LS144 20p	BF995 23p		LM339N 85p	4134 48p
74LS145 20p	BF995 23p		LM339N 85p	4135 48p
74LS146 20p	BF995 23p		LM339N 85p	4136 48p
74LS147 20p	BF995 23p		LM339N 85p	4137 48p

TYPEWRITER INTERFACE UPDATE

As expected, this has proved to be a very popular project; there were, however, one or two problems that we hope this will resolve.

There were a few errors in the typewriter interface project, one of which was major, while the majority were fairly minor and would probably have been found during construction.

The major error is that the software listings (both the EPROM listing and the data for the alternative BASIC program) were for a different generation of prototype from that for which the circuit diagram was given. There are two ways of amending this; you can **EITHER:**

- modify the circuit, by exchanging the connections to IC1 pins 9, 10, 11 with pins 13, 14, 15 in that order

OR

- change the data in your computer program or EPROM (depending on which method of driving the board you have chosen); revised data is given in Tables 1 and 2.

The minor errors are as follows:

1. The ribbon cable connector is, in fact, the wrong way round on the PCB (although this only becomes apparent if a right-angled

connector is used). Pin 1 is at the end marked with an arrow on the connector and should be connected to the coloured wire of the ribbon cable. The connections inside the typewriter are as shown in Fig. 1. As long as the correct connections are made, it does not matter that the PCB layout is incorrect — it is simply a matter of convention.

2. The interface is powered entirely from the typewriter. The

note 'Microcomputer VCC' should not have appeared on the circuit diagram. Pin 1 of SK2 is connected to VCC — there was some problem in reproducing the drawing here. The ground of both the microcomputer and the typewriter should be connected to the interface.

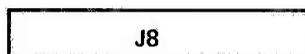
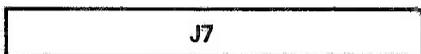
3. It was not mentioned that timing can be done by printing, for example, 50 characters continuously from the microcomputer and using the second hand of a watch.



15

16

25



UPDATE: Typewriter Interface

LOC	CONT	CH	LOC	CONT	CH	LOC	CONT	CH	LOC	CONT	CH	LOC	CONT
000	016		032	001	€	064	010	'	096	068			
001	016	!	033	071	A	065	087	ä	097	023			
002	016	"	034	103	B	066	093	b	098	029			
003	016	#	035	090	C	067	094	c	099	030			
004	016	£	036	070	D	068	086	d	100	022			
005	016	%	037	069	E	069	078	e	101	014			
006	016	&	038	101	F	070	118	f	102	054			
007	016	'	039	068	G	071	085	g	103	021			
008	016	(	040	100	H	072	117	h	104	053			
009	016	)	041	067	I	073	108	i	105	044			
010	009	*	042	082	J	074	084	j	106	020			
011	016	+	043	115	K	075	116	k	107	052			
012	016	¶	044	060	L	076	083	l	108	019			
013	033	-	045	002	M	077	092	m	109	028			
014	016	.	046	027	N	078	125	n	110	061			
015	016	/	047	059	Ö	079	075	o	111	011			
016	016	0	048	035	P	080	107	p	112	043			
017	016	1	049	007	Q	081	079	q	113	015			
018	016	2	050	039	R	082	110	r	114	046			
019	016	3	051	006	S	083	119	s	115	055			
020	016	4	052	038	T	084	077	t	116	013			
021	016	5	053	005	U	085	076	u	117	012			
022	016	6	054	037	V	086	126	v	118	062			
023	016	7	055	004	W	087	111	w	119	047			
024	016	8	056	036	X	088	127	x	120	063			
025	016	9	057	003	Y	089	109	y	121	045			
026	016	:	058	018	Z	090	095	z	122	031			
027	016	;	059	051	{	091	202		123	001			
028	016	<	060	196		092	001	|	124	187			
029	016	=	061	099	}	093	138		125	001			
030	016	>	062	194		094	001		126	001			
031	016	?	063	123	_	095	066		127	016			

Table 1

LOC	CONT	CH	LOC	CONT	CH	LOC	CONT	CH	LOC	CONT	CH	LOC	CONT
00	10		20	01	€	40	0A	'	60	44			
01	10	!	21	47	A	41	57	a	61	17			
02	10	"	22	67	B	42	5D	b	62	1D			
03	10	#	23	5A	C	43	5E	c	63	1E			
04	10	£	24	46	D	44	56	d	64	16			
05	10	%	25	45	E	45	4E	e	65	0E			
06	10	&	26	65	F	46	76	f	66	36			
07	10	'	27	44	G	47	55	g	67	15			
08	10	(	28	64	H	48	75	h	68	35			
09	10	)	29	43	I	49	6C	i	69	2C			
0A	09	*	2A	52	J	4A	54	j	6A	14			
0B	10	+	2B	73	K	4B	74	k	6B	34			
0C	10	¶	2C	3C	L	4C	53	l	6C	13			
0D	21	-	2D	02	M	4D	5C	m	6D	1C			
0E	10	.	2E	1B	N	4E	7D	n	6E	3D			
0F	10	/	2F	3B	Ö	4F	4B	o	6F	0B			
10	10	0	30	23	P	50	6B	p	70	2B			
11	10	1	31	07	Q	51	4F	q	71	0F			
12	10	2	32	27	R	52	6E	r	72	2E			
13	10	3	33	06	S	53	77	s	73	37			
14	10	4	34	26	T	54	4D	t	74	0D			
15	10	5	35	05	U	55	4C	u	75	0C			
16	10	6	36	25	V	56	7E	v	76	3E			
17	10	7	37	04	W	57	6F	w	77	2F			
18	10	8	38	24	X	58	7F	x	78	3F			
19	10	9	39	03	Y	59	6D	y	79	2D			
1A	10	:	3A	12	Z	5A	5F	z	7A	1F			
1B	10	;	3B	33	{	5B	CA		7B	01			
1C	10	<	3C	04		5C	01	|	7C	BB			
1D	10	=	3D	63	}	5D	8A		7D	01			
1E	10	>	3E	02		5E	01		7E	01			
1F	10	?	3F	7B	_	5F	42		7F	10			

Table 2

Other Points

Readers have raised a number of other points, and we can answer some of them here, as follows:

1. The interface could have been placed in the typewriter casing, but this was not done to avoid possibly invalidating any guarantee.
2. The interface should work with an EX44 model, but it must be connected in the way described for the EX42, not via the edge connector.
3. The best price we know of for the EX42 at the moment (though if anyone can tell us of a better one, we'll pass it on) is £199 + VAT from Discount Typewriters of Meadow House, Fair Oak, Lane, Oxshot, Surrey, who advertise in Exchange and Mart (but not ETI yet!). Alternatively, it is widely available from many high-street office suppliers (eg Ryman's) for around £245 including VAT. These prices are correct at the time of going to press (early January

1984) but please check them yourselves.

4. The interface should, in principle, work on any microcomputer. Obviously, though, the BASIC program will be different in each case, and we are unable to account for every computer out there! The program given was written in Micropolic BASIC and some of the statements used may be unfamiliar to some readers. These are:

Line 70: open file number 1, the file name being the string variable B\$; if the end of the file is reached, then go to line 340;

Line 80: read one line from the input file number 1;

Line 210: output to the port number 7E (hexadecimal radix) the contents of variable X;

Line 220: output to port 7F all zeros; this port is used as the strobe signal to initiate printing;

Line 230: Output to port 7F a 1 on bit 0. The strobe is connected to bit 0 of the port;

Line 240: input from port 7F; bit zero is the busy signal and is true when high.

5. The interface can probably be used with other electronic typewriters provided they have their keys arranged on an 8 x 8 matrix. However, the connections to other typewriters would be different and so would the EPROM contents or program data. Unfortunately, rather a lot of work would be involved in generating this data, so we cannot give advice in this respect; however, if someone out there has already done it with a popular model of typewriter, and wants to earn a penny or two by writing an article, we shall give it full consideration for publication.
6. There is already an RS232 interface available from Silver Reed, although we are prepared to consider publishing a design if someone offers us one.
7. We hope to organise an EPROM programming service, but details are not yet available. **ETI**

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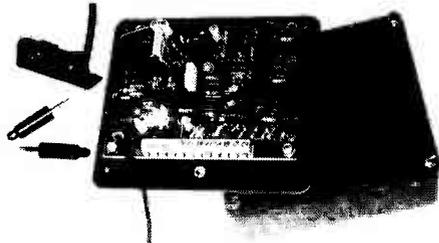
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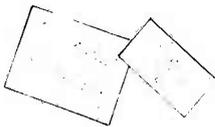
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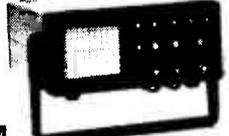


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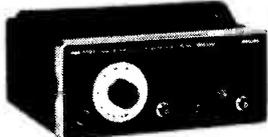
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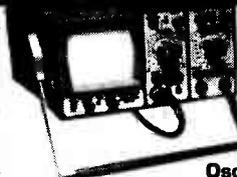
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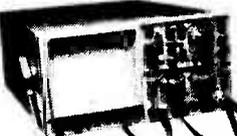
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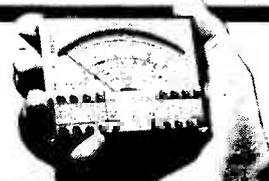
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MACHINE CODE PROGRAMMING

Bob Bennett completes his look at the operation of the three main logical instructions and goes on to consider ways of moving programs around in memory.

Last month I told you that there are usually three logical instructions that can be used and looked at the first of these, the AND instruction. We begin this month by looking at the two remaining instructions.

The second binary operation that we can use is OR, which will have the same register format as for AND. Loading Register A with COh, and register B with AA; Fig. 20 shows the result of the instruction OR,B. Note that, as with AND, only the A register is altered. Let's have a look at a practical use for the OR operation.

11000000	= Register A before the instruction
10101010	= Register B before, and after, the instruction
11101010	= Register A before the instruction

Fig. 20 The operation of the instruction OR,B.

Because machine code is so very fast it is prudent to have delay loops at certain points in the program. A delay loop just wastes time for a while in a manner similar to, but smoother than, the PAUSE instruction in BASIC. The simplest way of obtaining a loop would be to load a register with a count and then decrement the count to zero, using the zero flag to indicate that condition. However, counting down even FFh is incredibly fast, so it seems that a register pair is required to hold a larger number. Alas, although a register pair can be decremented, there is no flag indication to let us know when zero has been reached. Study carefully the delay loop in Fig. 21 which has instructions from the Z80 set. The instruction 20h — JR NZ,e means jump back (on this occasion) by e, until register A reaches zero. This loop can be finely 'tuned' by adjusting the low (in C), or high (in B), count.

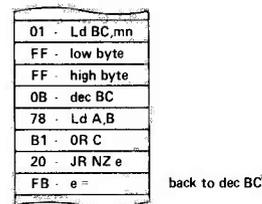


Fig. 21 A delay loop.

Even longer delays, and more precise 'tuning' can be achieved by the use of a single register to hold a count which represents the number of times we go through the loop. For example, suppose we wish to run through the loop 4 times; just before the loop in figure 21, load a register with 4d then PUSH that register. After going through the loop, POP the register, decrement it, and if not zero jump back to PUSH again. Any register pair could be used for the loop, except of course AF, provided you use the instructions pertaining to the register pair. You could use register A to hold the count outside the loop if you wanted, because even though register A is used inside the loop, the count would be preserved by the PUSH instruction.

Using Fig. 20 to sum up; the use of OR will ensure that the corresponding bit in the A register is set if that bit in either A or B is set. To remind you, set is 1, and reset is 0.

The Exclusive Set . . .

The last binary logic operation we can use is Exclusive OR, which is shown as XOR. Put into words, and using registers A and B as examples, it goes like this; the corresponding bit in register A will be set if either, but not both, bits in each register are set. Loading register B with COh, and register A with DAh,

Fig. 22 shows the result of the instruction XOR,B. XOR,A will clear register A, and reset the carry flag for you. By studying the binary pattern of the data that you are manipulating, and the binary pattern of the expected answer, a knowledge of the logical operations may help you decide what to do. If they don't help, what about the next lot?

11000000 = Register A before the instruction
 11011010 = Register B before, and after, the instruction
 00011010 = Register A after the instruction

Fig. 22 The operation of the instruction XOR,B.

Move To The Left, Then To The Right, Take Your Partners . . .

Movement of data within a register is quite feasible, and the Z80 set has a number of instructions that will do just that. These are the **rotate**, and **shift** instructions, which will allow movement of data, either to the right or to the left. Because there are so many instructions, doing similar things, I have 'lumped' all the drawings together, but explanations

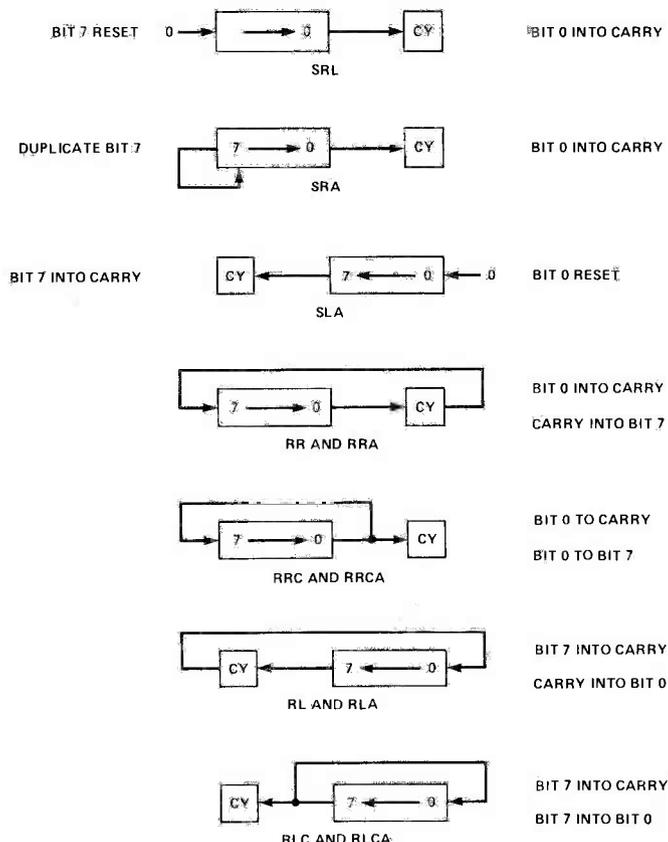


Fig. 23 The operation of the Rotate and Shift instructions.

are in order. Those instructions which involve register A, such as RLA — Rotate Left A, will only affect the carry flag, with two exceptions which I'll explain below. Rotate or Shift instructions involving registers other than A will affect all of the flags. To find out what happens after a Rotate or Shift instruction, write down the binary code before, and after, the operation, and convert both to decimal, but watch out for the carry flag if it is involved.

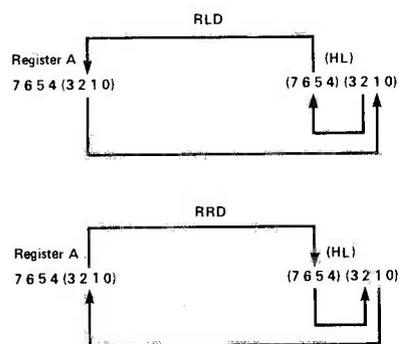


Fig. 24 The half-byte (or nibble) movement.

Figure 24 shows the two exceptions that I mentioned above from the Z80 set; these are half a byte (or nibble) manipulations. RLD or Rotate Left Decimal (don't confuse this with RL D, which is Rotate Left, D register), is the first of the nibble manipulations. In this operation bits 0 to 3 of (HL) are moved over to occupy the most significant nibble position, that is they become bits 4 to 7 of (HL). The first four bits, 0 to 3, of register A are now moved to occupy bits 0 to 3 of (HL). The previous bits, 7 to 4, of (HL) now occupy bits 0 to 3 of register A. How it is done, and in what order, doesn't matter, but the result will be as described. RRD or Rotate Right Decimal, as you can see from Fig. 24, does a slightly different 'shuffle'. RRD and RLD operations affect all flags except carry. Notice also the use of brackets, (HL); this means that it is the data in the address pointed to by HL that is manipulated.

Because of the lack of registers in the 6502 CPU, most data manipulation is done with the accumulator (register A), via the index registers and/or memory locations. However, sometimes the index registers themselves can be used, as in this example. The instruction E0h — CPX will compare the byte in index register X with a memory location, in fact the address after the byte E0. The result would effect the sign, carry, and zero flags. I shouldn't have to tell you that the example was in the immediate addressing mode.

A Bit At A Time . . .

Bit instructions fall into two categories; one will actually alter the bit, either set it or reset it, while the other will just test whether the particular bit is set or not. The result of testing will be either zero or not zero, which can be the indicator for the next instruction. If you can't think of a use for testing a bit, how about this example: suppose that you wanted to print, to the screen, a certain number of squares, alternating between, for example, black and white. Load a register with the total number of squares that you

wish to print. Point a register pair, or if using zero page, the appropriate index register, to the first colour that you wish to print. Print that, using the form (); for example, if you were using the HL pair, (HL), then decrement the counter, test bit 0, then either decrement, or increment the pointer to point at the other colour. Test the counter for zero and jump back if not yet zero. As you can see, the codes for the coloured squares only need occupy two locations. To test how it works, assume that the count was 16d, write down the binary 16, then underneath that the binary for 15, then 14, and so on until zero, then examine the pattern of bit zero, the rightmost bit. If you then write down, for example, black, opposite the 0s, together with the address of black, then do the same for white opposite the 1s, you need only do this for 3 or 4 squares before the 'pattern' of the program becomes apparent.

A Moving Story . . .

Often, when developing a machine code program, I can never be sure how many bytes the program will ultimately occupy. One method I use is to put the control program approximately where it should go and write the bulk of the program well out of the way. If I leave room either side of this bulk of program then I can extend in either direction. When I am satisfied that the program works I move the bulk down towards the control program. This usually means altering a few addresses, but that's far better than having to re-write the program because I didn't leave enough room in the first place. So how is a program moved about in memory? Study carefully the program in Fig. 25, which uses instructions from the Z80 set. The HL pair is pointing to the address from which we wish to start moving the program. The DE pair point to the address to which we are going to move the program, and the number in the BC pair represents the number of bytes we wish to move. Register A is now loaded with the byte held in the address pointed to by HL, in other words, let A equal PEEK (HL). This byte is then loaded into the address pointed to by DE, in other words POKE (DE) with the contents of register A. Both HL and DE are then incremented, and BC decremented, and this goes on until BC reaches zero.

Although that little program works quite well, take a look at the program in Fig. 25, which illustrates the

21	Ld HL,nn
	low byte
	high byte
11	Ld DE,nn
	low byte
	high byte
01	Ld BC,nn
	low byte
	high byte
7E	Ld A,(HL)
12	Ld (DE),A
23	inc HL
13	inc DE
0B	dec BC
78	Ld A,B
B1	OR,C
20	JR NZ,e
	e = F7
C9	ret

Fig. 25 Moving a block of memory.

use of an automatic instruction to load (DE), (HL), increment those two registers, decrement BC and repeat until BC reaches zero, which is exactly what happened in my program. As you would expect, because the automatic program is slightly shorter it will work a little faster. I have provided two examples for two reasons: First, if your CPU does not have any automatic instructions the first example should give you an idea how to make up a program of your own. Second, to introduce the automatic and semi-automatic instructions from the Z80 set. There are two very important things to note regarding the automatic instruction in Fig. 26. The first is that the transfer of bytes is from (HL) to (DE) only, so make sure which way round you are working. The second point is that when BC has reached zero the zero flag will not be affected, so the only flag you can use is the Parity/Overflow flag which will be reset on BC reaching zero.

21	Ld HL,nn
	low byte
	high byte
11	Ld DE,nn
	low byte
	high byte
01	Ld BC,nn
	low byte
	high byte
Ed	LDIR
B0	
C9	ret

Fig. 26 Moving a block of memory using an automatic instruction.

Another automatic instruction is ED88h — LDDR which still loads from (HL) to (DE) but this time HL and DE are both decremented along with BC, and again, only the P/O flag is affected. A very useful instruction in this group is EDB1h — CPIR which can be used to search a block of memory for a particular byte. It works like this; load HL with the starting address of the memory to be searched, load BC with the number of bytes you wish to search through, and load register A with the byte that you are looking for. If you remember, a compare instruction will only compare something with what is held in the A register. This time the comparison will be made with the byte in the address that is pointed to by HL, in other words, compare A with (HL). The program will stop either if a match has been found, in which case the zero flag will be set, or when BC has reached zero, in which case the P/O flag will be reset. Until either condition has been met HL will be incremented, and BC decremented. The other automatic instruction for comparing is EDB9h — CPDR which works in the same way but HL is decremented instead of incremented.

The four instructions that I have just described each have a non-automatic instruction format. The two byte moving instructions are ED0Ah — LDI and ED8Ah — LDD which only perform the operation once. You will have guessed by now that the I in the instruction stands for Increment, the D stands for Decrement, and the R for Repeat. The non-automatic comparison instructions are ED1Ah — CPI and ED9Ah — CPD. One very useful instruction in the Z80 set which is automatic in operation is 10h — DJNZ,e, this stands for Decrement, Jump if Non Zero, by the amount of the offset byte e. This instruction only works on the B register but as I said, it is very useful indeed.

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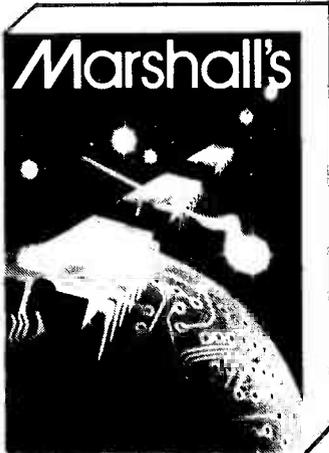
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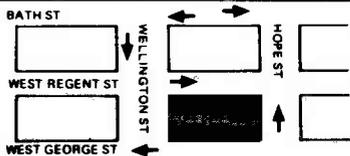
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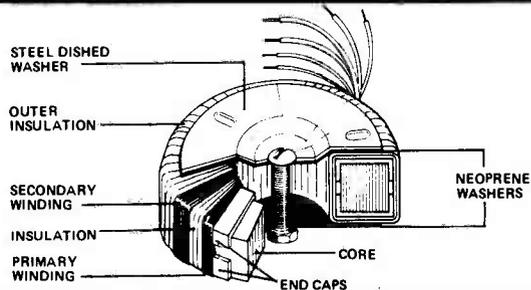
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4x011	9+9	6.66
4x012	12+12	5.00
4x013	15+15	4.00
4x014	18+18	3.33
4x015	22+22	2.72
4x016	25+25	2.40
4x017	30+30	2.00
4x018	35+35	1.71
4x028	110	1.09
4x029	220	0.54
4x030	240	0.50

160 VA
110 x 40mm 1.8Kg
Regulation 8%

5x010	9+9	8.89
5x012	12+12	6.66
5x013	15+15	5.33
5x014	18+18	4.44
5x015	22+22	3.63
5x016	25+25	3.20
5x017	30+30	2.66
5x018	35+35	2.28
5x026	40+40	2.00
5x028	110	1.45
5x029	220	0.72
5x030	240	0.66

225 VA
110 x 45mm 2.2Kg
Regulation 7%

6x012	12+12	9.38
6x013	15+15	7.50
6x014	18+18	6.25
6x015	22+22	5.11
6x016	25+25	4.50
6x017	30+30	3.75
6x018	35+35	3.21
6x026	40+40	2.81
6x025	45+45	2.50
6x033	50+50	2.25
6x028	110	2.04
6x029	220	1.02
6x030	240	0.93

300 VA
110 x 50mm 2.6Kg
Regulation 6%

7x013	15+15	10.00
7x014	18+18	8.33
7x015	22+22	6.82
7x016	25+25	6.00
7x017	30+30	5.00
7x018	35+35	4.28
7x026	40+40	3.75
7x025	45+45	3.33
7x033	50+50	3.00
7x028	110	2.72
7x029	220	1.36
7x030	240	1.25

500 VA
140 x 60mm 4Kg
Regulation 4%

8x016	25+25	10.00
8x017	30+30	8.33
8x018	35+35	7.14
8x026	40+40	6.25
8x025	45+45	5.55
8x033	50+50	5.00
8x042	55+55	4.54
8x028	110	4.54
8x029	220	2.27
8x030	240	2.08

625 VA
140 x 75mm 5Kg
Regulation.4%

9x017	30+30	10.41
9x018	35+35	8.92
9x026	40+40	7.81
9x025	45+45	6.94
9x033	50+50	6.25
9x042	55+55	5.68
9x028	110	5.68
9x029	220	2.84
9x030	240	2.60

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30	1	7.58	225	6	13.64
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For 220V primary (Europe) insert "1" in place of "X" in type number.
For 240V primary (UK) insert "2" in place of "X" in type number.
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ETI MARCH 1984

AUDIO POWER METER

This stereo unit gives true audio power readings up to 200 watts and is not dependent upon load impedance. Design by Phil Walker.

At some time or another, many people who use public address or even domestic hi-fi amplifiers wonder just how much power is actually being sent to the loudspeaker. Simple measurements with AC voltmeters or ammeters followed by mind-numbing calculations involving nominal load impedances just do not tell the whole story. The problem arises because most amplifier loads are seldom at their nominal value and are almost never a pure resistance; this means that your calculated power level can be very different from the actual figure.

This is where the ETI power meter comes into the picture. It consists of two identical circuits which sense the voltage across the load and the current flowing through it at any instant and multiplies them together to get the instantaneous power. This is then averaged by the mechanical damping of the meter to give a reading of the actual power in the load. By this means we avoid having to measure load impedance or make any assumptions about its reactive components. We still need an impedance selector switch, however, to set the voltage and current sensing ranges. If this switch were not fitted, or if it is set to an inappropriate range in use, either the voltage or the current will exceed the sensing range at a comparatively low power level and hence prevent us from using the unit's full power measurement range.

The Circuit

The circuit consists of two identical power measuring chan-

nels and a fairly standard power supply. The power supply provides +15 V and -15 V regulated supply rails offering up to 100 mA each. The regulators are necessary as the rest of the circuit uses them as a reference.

Each of the power measurement channels consists of a current measurement circuit, a voltage measurement circuit, an overload indicator, an analogue multiplier and a meter circuit. The voltage measurement circuit is very simple and consists of a switched attenuator feeding a buffer. The current measurement circuit detects the voltage developed across a low value resistor in series with the load, amplifies it and passes it on to a buffer. The voltage across the current sense resistor is also passed via a switched attenuator similar to that in the voltage circuit.

The buffers in both current and voltage circuits have switchable gains of 2, 2.8 and 4. This provides compensation for the variation of voltage and current levels with different load impedances at the same power level. Note that when the gain of one buffer is at 2 the gain of the other is at 4 and vice-versa. This maintains the meter response at the current level.

The next part of the circuit is the overload detector. This uses an op-amp with some resistors and diodes to detect when either the voltage or current detectors are giving too much output and are therefore likely to overload the analogue multiplier. This condition will light up an LED on the front panel which tells the operator to change the power range switch or the impedance selector or both.

The analogue multiplier used in this project consists of one half of a transconductance amplifier. This has the property of producing an output current which is the product of two of its input currents divided by a third one. The rather complex circuitry around this section is merely to balance out all the offsets and other unwanted effects.

Following the multiplier circuit is a high impedance buffer whose gain can be varied over a wide range. This drives a moving coil meter which averages the output to give a reading. The series resistor and diodes are present to protect the meter from damage.

Construction

This should pose no great problem provided all the normal precautions with regard to PCB assembly are taken. Start with the wire links then move on to the other components, making sure that the ICs are inserted correctly and that things like capacitors, diodes and transistors are the right way round. The PCB is actually designed in two distinct parts and could be separated into power supply and meter circuit quite easily if desired (note that the overlays for these two sections are shown separately anyway). The PCB mounted fuse can be either an open type like the one we used or a PCB mounting enclosed type for extra safety.

The main problem will probably arise when you come to wire the switches on the front panel, and great care must be taken here to get things in the right order. Two four pole, three way switches were used in the prototype and

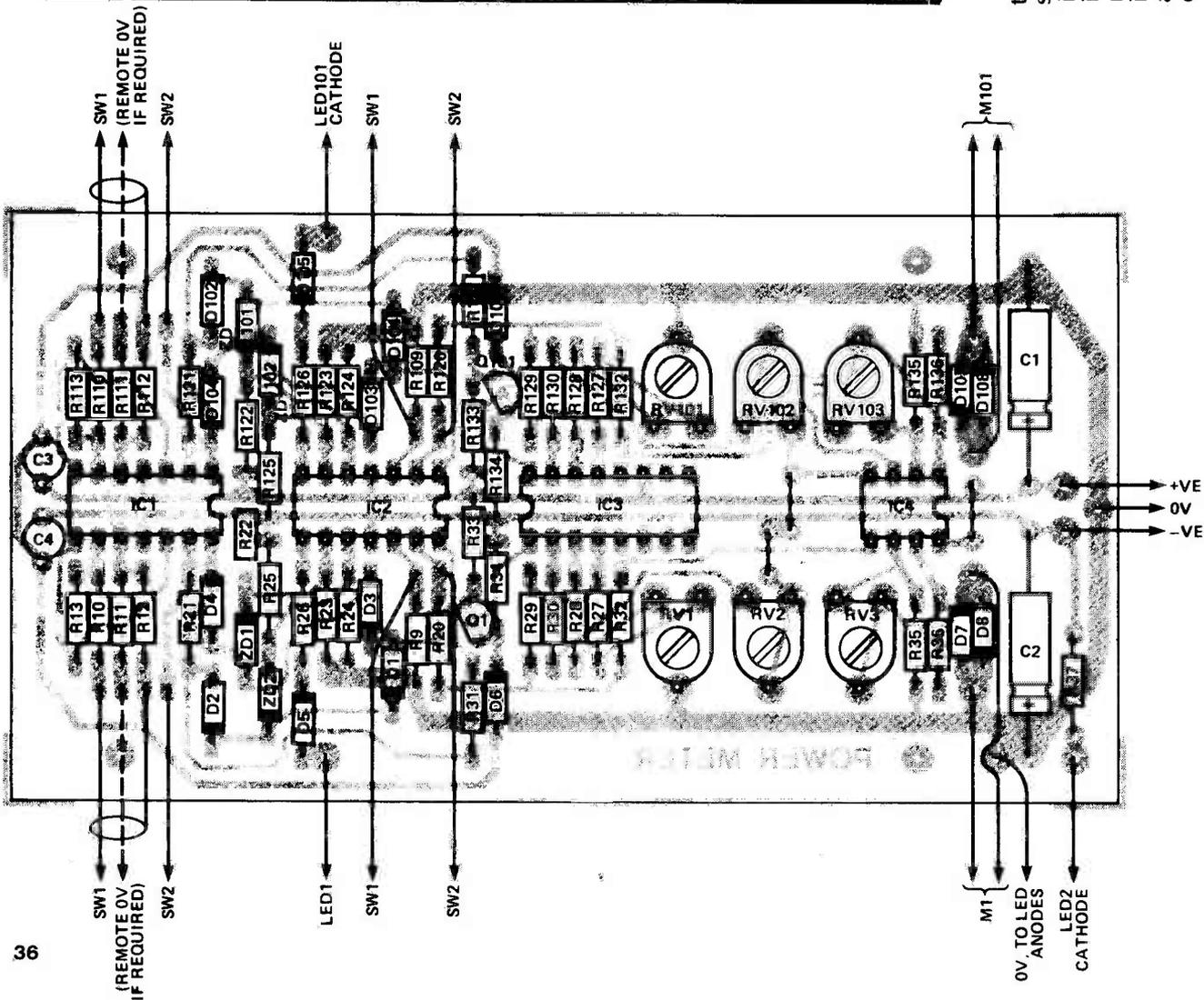


Fig. 1 Component overlay of the main PCB (larger than actual size).

PARTS LIST

RESISTORS (¼ watt 5% carbon film unless otherwise stated)	SEMICONDUCTORS
R1, 101	IC1,2 TL084
R2, 3, 102, 103	IC3 LM13600
R4, 5, 104, 105	IC4 TL082
R6, 7, 106, 107	IC5 7815
R8, 108	IC6 7915
R9, 109	Q1, 101 8C214L
R10, 11, 26, 37, 110, 111, 126	BR1 200V 1 amp potted bridge rect.
R12, 13, 112, 113	
R14, 19, 20, 21, 23, 24, 30, 114, 119, 120, 121, 123, 124, 130	D1, 2, 3, 4, 5, 6, 7, 8, 101, 102, 103, 104, 105, 106, 107, 108
R15, 18, 115, 118	LED1, 101
R16, 17, 116, 117	LED2
R22, 25, 122, 125	
R27, 28, 127, 128	IN4148
R29, 31, 32, 129, 131, 132	Red LED 0.2" with panel mount
R33, 34, 133, 134	Green LED 0.2" with panel mount
R35, 36, 135, 136	
RV1, 101	
RV2, 102	
RV3, 103	
CAPACITORS	MISCELLANEOUS
C1, 2	M1, 101 500µA moving coil meter
C3, 4	T1 0-15, 0-15 V 3 VA PCB mtg. transformer
C5, 6	FS1 1 A 20mm a/s fuse + PCB mtg holder
C7, 8	SW1, 2 4 pole 3 way rotary switch
	SW3 mains switch
	SK1, 2, 101, 102 insulated jack sockets
	PCB (see buylines); Verocase 104; 2 off 3 way PCB screw connectors; wire, nuts, bolts, knobs, etc.

the appropriate resistors for range switching and impedance matching are mounted on the back. This is a little fiddly but gives a neat result and reduces the amount of inter-wiring required. The input and output sockets are wired directly to each other with the earth line passing via the 0.1 ohm current sense resistor in each case. These are wired directly to the

range switch. The front panel LEDs all have their anodes wired to the 0 volt line, the meters are wired straight to the PCB. The mains switch for this project was mounted on the back panel next to the grommet for the power cable as it was thought better not to bring mains to the front panel if it could be avoided.

PROJECT: Audio Power Meter

Setting up

The aim here is to use the three presets in each channel to adjust for DC balance, multiplier function balance and scaling of the meter. First, after checking carefully to make sure that there are no mistakes and that nothing gets too hot, with no input adjust RV1

(101) to get a zero reading on the meter. Next, apply a signal to the input with no load on the output and adjust RV2 (102) for zero reading on the meter. Readjust RV1 if necessary after removing the input signal. Lastly, connect the signal source and a suitable load resistor, adjust RV3 to get the correct scale factor, then check that the meter gives similar readings with SW2 in all positions so long as the LEDs do not indicate an overload. If any of these steps is not possible check the circuit again looking especially at the wiring around the range and impedance switches. If the meters read in reverse you may rewire them but check first that your signal connections are correct.

In Use

The meter should be very easy to use as it is just connected in the signal path. Bear in mind that there will be a small power loss due to the current measuring resistor and that the load side earth line is not connected directly to that on the input side. Also note that the input side earth lines are commoned internally. The reading on the meter should be independent of the load impedance, but beware of overload at less than full power or caused by extremes of voltage or current when the wrong impedance range is selected. The LEDs on the front panel should warn of this condition.

BUYLINES

There's nothing here to cause any problems. The case is available from Maplin and the PCB from our PCB service, see page 65.

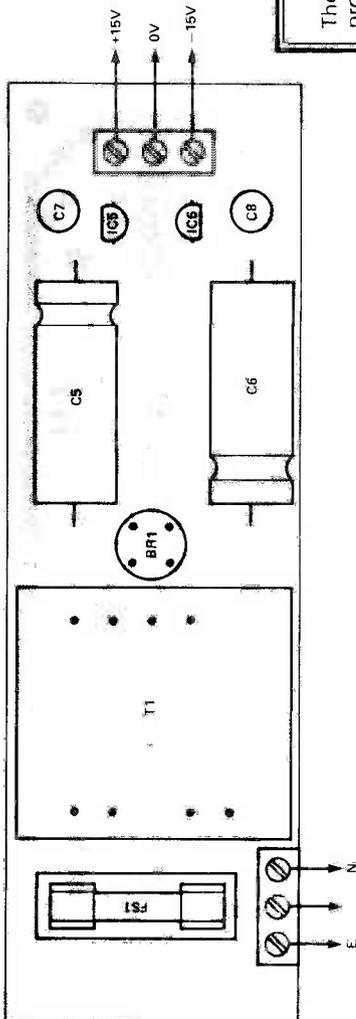


Fig. 2 Component overlay of the power supply PCB (actual size).

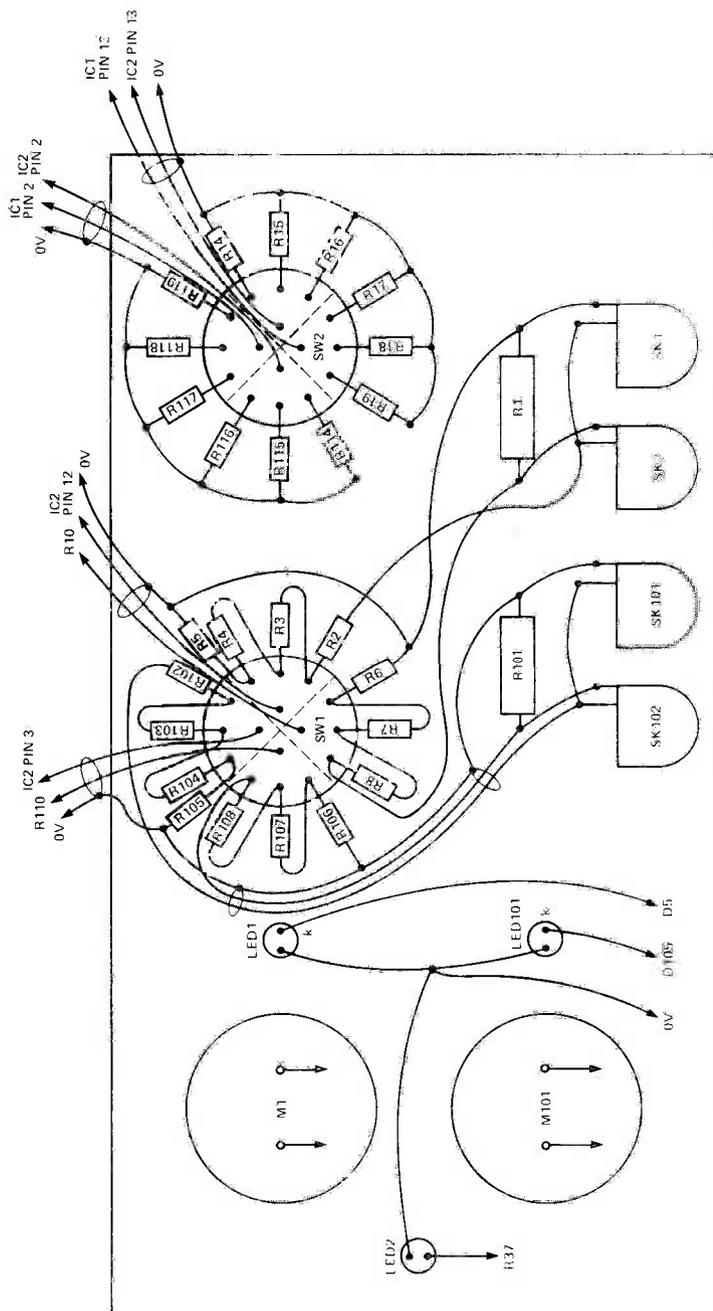


Fig. 3 Front panel wiring diagram.

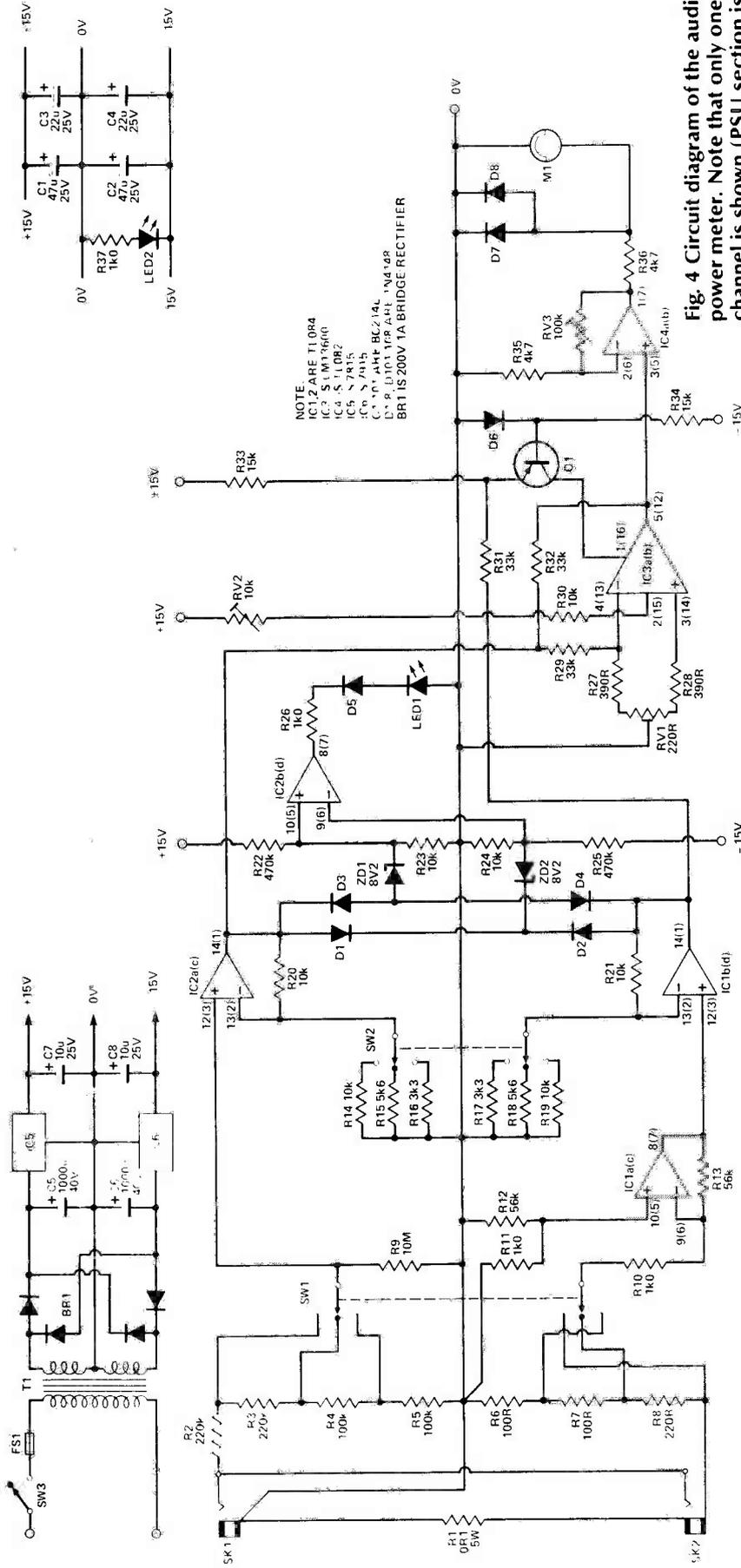


Fig. 4 Circuit diagram of the audio power meter. Note that only one meter channel is shown (PSU section is common).

HOW IT WORKS

Power is provided by a very simple dual rail supply derived from a centre tapped transformer and bridge rectifier. The output from this is smoothed by C5,6 and regulated to + and - 15V by IC5,6. C7,8 remove any residual noise and improve transient performance.

The main part of the circuit is in two identical parts so we shall only consider one of them. The signal whose power is to be measured enters SK1 and leaves SK2. En route it passes through R1 which develops a voltage across it proportional to the instantaneous current flowing. At the same time the voltage across the input is

also sampled. Two sections of SW1 tap off portions of the voltage and current signals and pass them to IC2a and IC1a respectively. The resistors R2 to 8 are chosen to give the ranges indicated on the panel. IC1a amplifies the current signal by a factor of just under 60 while R11 and 12 enable a small amount of common-mode signal on the earth lines to be eliminated if desired. From IC1a the current signal passes to IC1b which is a buffer whose gain can be set to approximately 2, 2.8, or 4. IC2a performs a similar job on the voltage signal except that when the gain of IC1b is 2 that of IC2a is 4 and vice versa. The diode network (D1 to 4 and ZD1,2) together with IC2b detect

overload conditions. If the peak signal exceeds the zener voltage then either the + input of IC2b will be pulled low or the - input pulled high. Either of these conditions will cause the output of IC2b to switch from the positive supply rail to the negative supply rail and illuminate LED1. R26 and D5 limit the current and prevent reverse voltage on the LED.

The next section is the multiplier and this is constructed around one half of an LM14600 transconductance amplifier. The part we use for this project has the property that its output current is proportional to the product of the input current and the bias

current and inversely proportional to the current through the linearising diodes on the device. R34, D6 and Q11 form a simple virtual earth summing point for producing the bias current which is a constant (via R33) plus a signal component (via R31). The other input to the device is via R29 which converts the voltage signal into a suitable current. The output from IC3a is developed as a voltage across R32 but this has one of the input voltages applied to its other end and a subtraction occurs which is essential to the correct operation of the circuit. The resulting output voltage is buffered and amplified by IC4a before driving the meter circuit.

TECH TIPS

Cheap Data Link

Jake Thomas,
Sheffield.

This circuit was designed to provide a data link between a pedalboard consisting of eight switches, and an effects box situated some distance away. This would normally require expensive 9-way cable, terminated by expensive multiway connectors. This circuit allows these to be replaced by el cheapo 5-pin DIN plugs (!) and standard 4-way audio cable.

IC1a,b,c comprises the system clock. IC2 scans the switches in sequence. This gives a series of logic highs and lows on the DATA line, depending upon the state of the switches. IC3,4,5 pass these signals to the appropriate sample and hold circuit (IC6,7 and associated components) in the decoder.

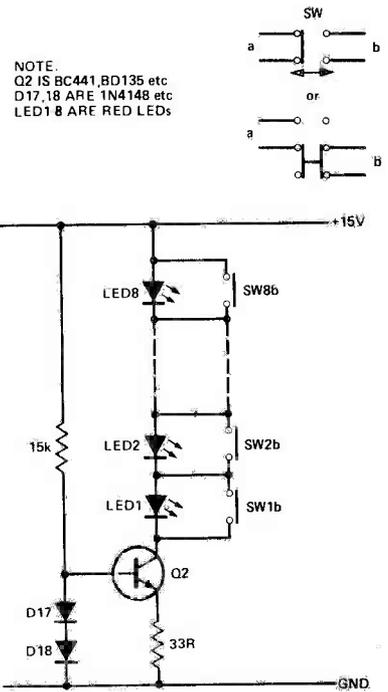
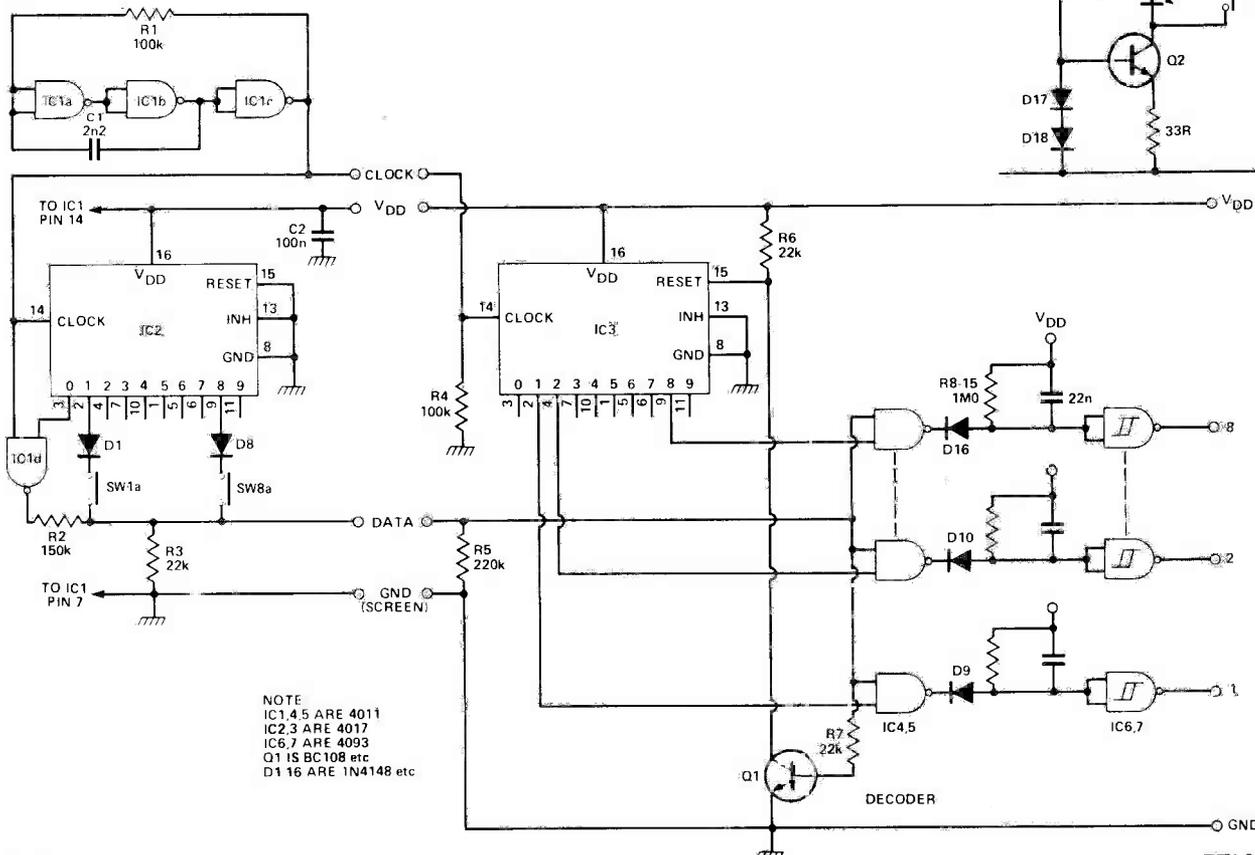
Q1 is used to reset IC3. The voltage on the DATA line is normally maintained at around 2V by R2 and R3 (which may need adjustment if a much lower supply voltage is used).

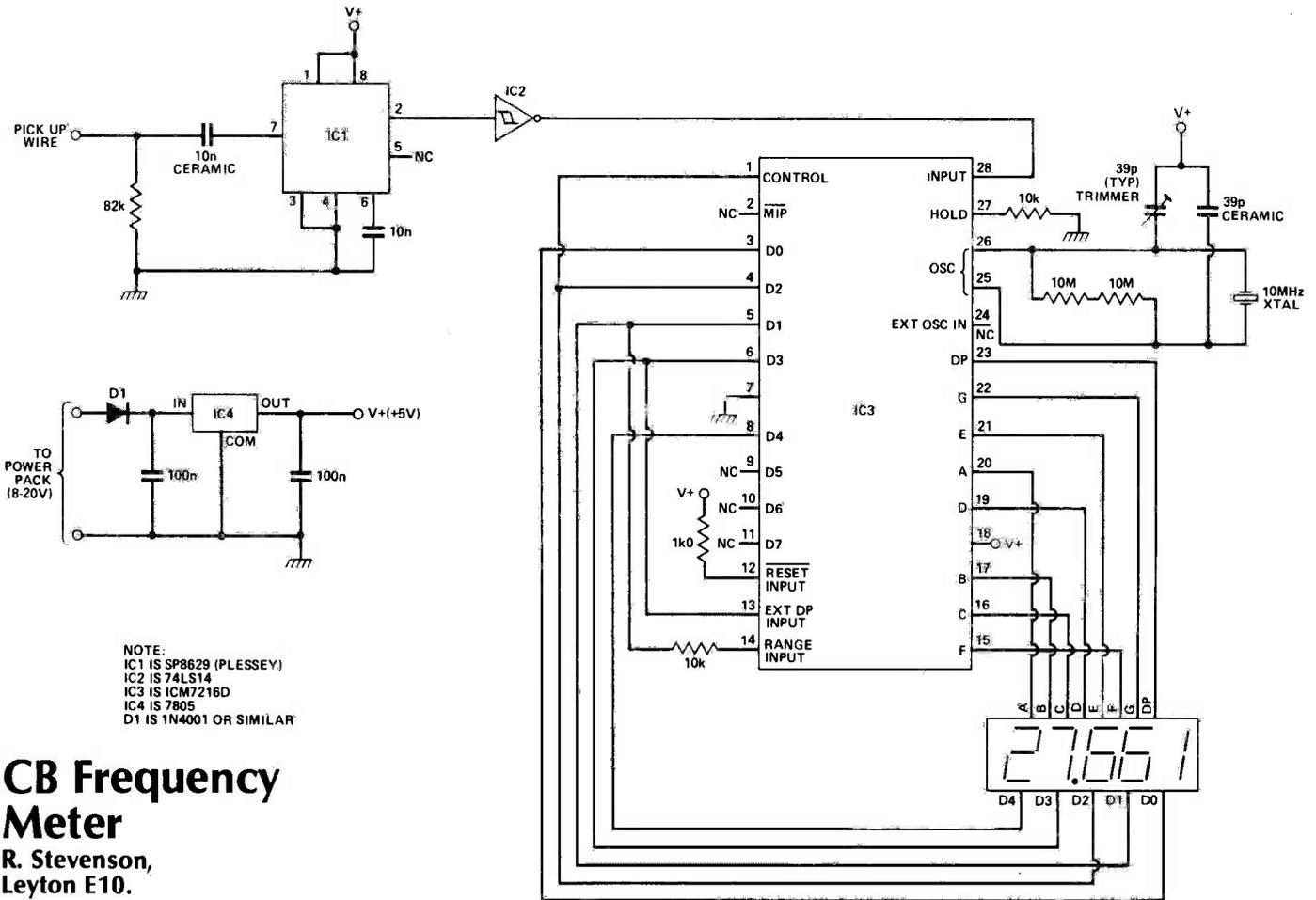
This keeps Q1 hard on. When IC2 '0' output and the clock both go to high, IC1d output goes low, taking the DATA line to 0V. This turns Q1 off, resetting IC3 to '0'. Thus the two 4017s are kept in synchronism. R4, 5 protect the decoder inputs from static when the encoder is unplugged.

With the exception of the sample & hold time constants, which are uncritical, the system is totally independent of clock frequency — unlike conventional 2-wire data links which also have more complicated circuitry. This makes the system more reliable. It can also be easily extended, either by using the spare conductor as a second data line (if you used 4-core and screen cable) or by chaining the 4017s.

You may wish to have an LED indicator for each switch. If using a 15V supply, it is rather wasteful to connect each diode to the supply by its own series resistor. At 20mA each, 8 LEDs would use 160mA when on simultaneously. Fig. 2 shows a way round this, by driving

the LEDs in series, with a constant current. This consumes around 20mA however many LEDs are on (those not required are shorted out, using the other half of the appropriate switch). The circuit should just about light 8 red LEDs simultaneously, with a 15V supply. With more LEDs or a lower supply voltage, the required voltage drop across the diodes becomes too great.





CB Frequency Meter

R. Stevenson,
Leyton E10.

This circuit is unusual in that there is no electrical connection to the CB rig — it picks up the signal to be measured from a wire adjacent to the aerial coax. It consists of just four chips, including a regulator.

IC1 receives the signal, amplifies it, and divides it by 100. IC2 converts the output of IC1 to TTL standard for IC3. IC3 is the frequency counter — it contains a high frequency oscillator, timebase counter, data counter and latches, a seven segment decoder, digit multiplexers and display drivers. IC4 provides a 5 volt supply rail which is derived from the power source that supplies the rig.

The displays are driven directly from IC3 and are the common-cathode multiplexed type. The single core unscreened pick-up wire is run alongside the aerial coax for a few yards. If the signal is found to be insufficient, lengthen the wire or move the meter closer to the aerial. Greater resolution and accuracy can be achieved with extra digits connected to the unused digit drivers, but remember that the decimal point and range connections will have to be changed. Extra digits, however, result in longer display settling times.

PS: The SP8629 prescaler chip can be obtained from Watford electronics.

Cheap Envelope Generator

Jeff Macanley,
Crawley.

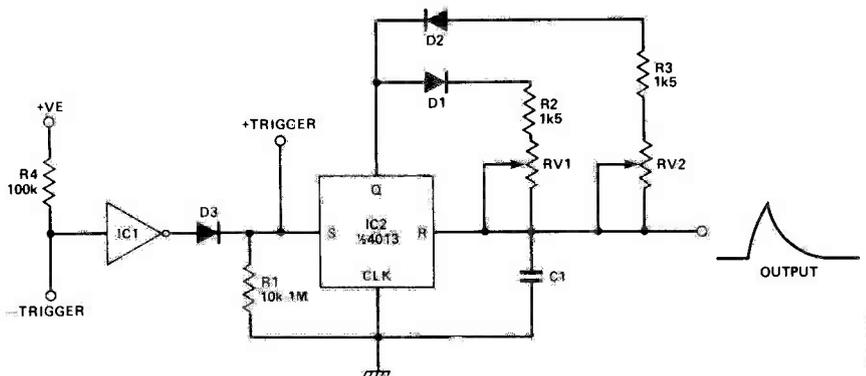
Although the ADSR envelope generator has become standard there are occasions when a simpler and cheaper alternative is desirable.

The accompanying circuit shows such a device. The basis is the humble flip flop, IC2, half a 4013B. When a positive going pulse is applied to the set input the Q output goes high allowing C1 to charge via the attack pot, RV1, and D1. Notice, though, that the reset pin is connected back across C1: in consequence, as soon as the voltage across this component exceeds

about 50% of the supply voltage, the flop flops, reverse-biasing D1.

C1 now discharges through the decay pot and D2. With the values shown both attack and decay are variable from a few milliseconds to several seconds. The two current limiting resistors should not be left out because the maximum current that can be drawn from the Q output is only about 10mA peak.

If negative triggering is required the inverter circuit shown can be employed. This has the advantage of allowing the device to be triggered from open collector devices. IC1 can be any inverting CMOS gate, NAND or NOR, with unused inputs wired to +ve (NAND) or 0V (NOR); it can even be an inverter gate! Note that supply connections to IC1 and 2 will need to be added.



Simple Cassette Motor Control

David Allen,
Bolton.

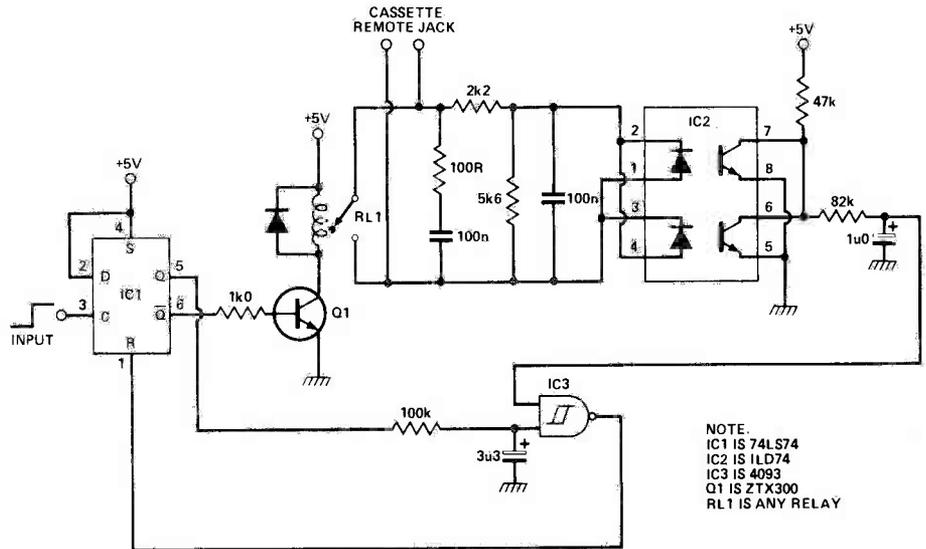
In this circuit, motor control is achieved using a single STOP pulse. The position of the stop button is sensed using a dual opto-isolator. The cassette motor is normally allowed to be on. At the end of the READ or WRITE cycle a +ve going pulse must be applied to the input to stop the motor. The motor therefore stops with the play button pressed. The opto-diodes are connected back-to-back so the polarity of the motor voltage is irrelevant.

The stable condition of the circuit is with the motor relay energised and sensing circuit inactive (opto-isolator). The cassette player is started manually by pressing the play button. At the end of reading or writing a +ve pulse is applied to the input. Flip-flop IC1 changes state, the motor relay turns off and the motor stops. The REMote input to the cassette then has the motor voltage across its contacts and the opto-

isolator circuit senses this voltage. One of the opto-transistors will turn on and after a delay of 80 msecs a low is applied to one input of IC2.

The reset input to IC1 is maintained high and so the motor relay remains off. Meanwhile, the Q output of IC1 is high, and after a delay of 300 msecs the other input of IC3

goes high. The circuit will remain in this condition until the stop button is pressed. When this happens the motor voltage disappears and the opto-transistor turns off. After 120 msecs the output of IC3 goes low and resets IC1. This closes the relay contacts and the circuit returns to the initial condition.



NOTE:
IC1 IS 74LS74
IC2 IS 1LD74
IC3 IS 4093
Q1 IS ZTX300
RL1 IS ANY RELAY

ETI

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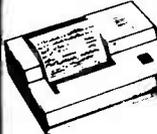
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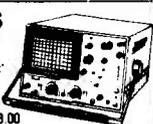


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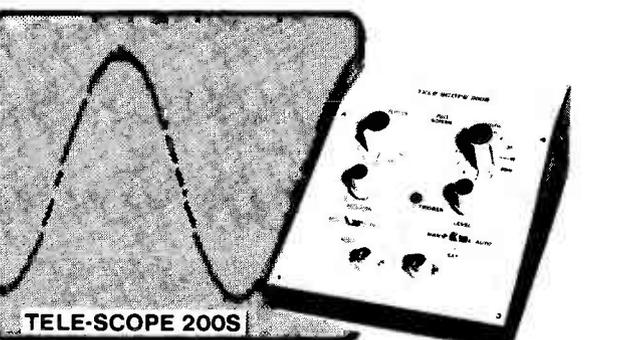
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Z80 DRAM BOARD

Here it is, the project you've all been asking for. Bob Campbell describes a 64K DRAM board for use with Z80 based systems.

Last month we examined two possible methods of increasing the available dynamic memory in Z80 based systems, either by modifying the original 6502 based 64K DRAM board (published in ETI September '83) or by extending an existing 4116 based system using 64K chips. This article describes the third option, a 64K DRAM board designed specifically for use with Z80 based systems.

Although the 74LS608 memory cycle controller used in the original 64K DRAM design proved most successful, it did require a considerable effort to develop the actual hardware from the theoretical design layout. In addition, the chip performs only one of the three functions that the more modern dynamic RAM controllers can achieve. There are two other chips within the series that can cope with the multiplexing and refresh control but because this three chip system never became very popular the price has remained relatively high.

The newer RAM controllers are single chip systems, adaptable to almost any configuration and capable of several functions in addition to the main requirements, address multiplexing, RAS CAS MUX generation, refresh row address and RAS control.

The most readily available and cost effective controller on the market at the moment is the Texas 4500 (although the Author admits that this is a somewhat subjective statement, and there are probably many people ready to disagree). In addition it is well suited for use with the type of processor which we have in mind, the Z80. Figures 1 and 3 show details of the controller, and further information can

be found in either the Cortex project article in the November 1982 issue of ETI or in TI's 'TMS 4500A Dynamic Ram Controller Users' Manual', available from wherever you usually get your data or from TI in Bradford.

Fig. 1 shows the main functional blocks within the controller. These are:-

- 1) row address latches
- 2) column address latches
- 3) address multiplexer
- 4) refresh row address counter
- 5) chip select latch
- 6) timing and control block
- 7) refresh/memory access cycle arbiter
- 8) programmable refresh rate generator

The features of this chip include:-

- asynchronous or synchronous control with the MPU clock
- internal or external refresh

initiation

- programmable refresh rate
- no crystals, delay lines, or RC networks required.
- burst, transparent, or cycle steal refresh modes
- programmable WAIT state generation for slow memories
- drives up to 256k bytes without external drivers.

I don't intend to present all the details of the design here as a great deal of information is given in the manual, and the design philosophy of the PROM decoder was adequately covered in the DRAM project article in September 1983.

There is, however, one criterion which must be met. The system requires an 8 MHz clock, or at least a clock that runs at exactly twice the frequency of the CPU clock. If the intended system runs

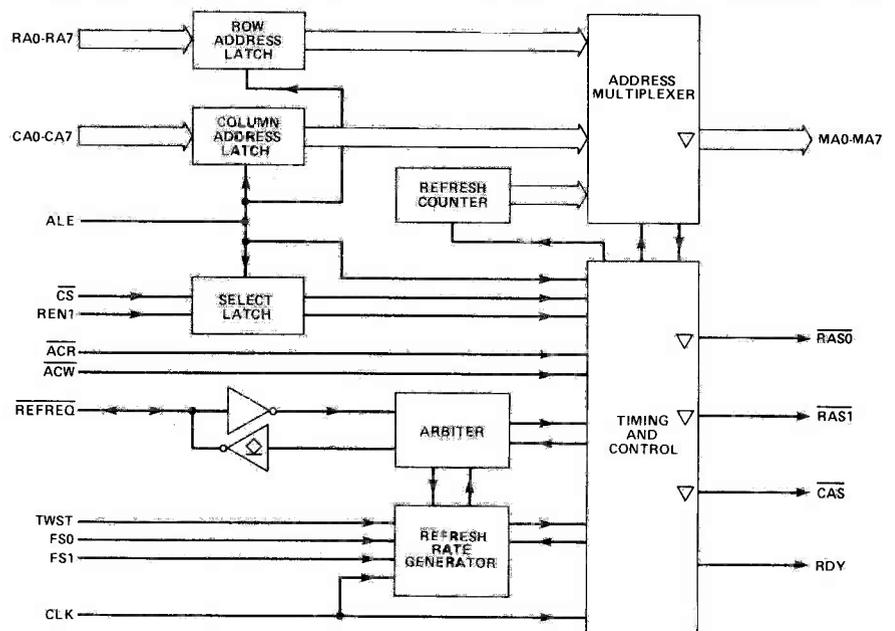


Fig. 1 Internal block diagram of the TMS 4500A dynamic RAM controller.

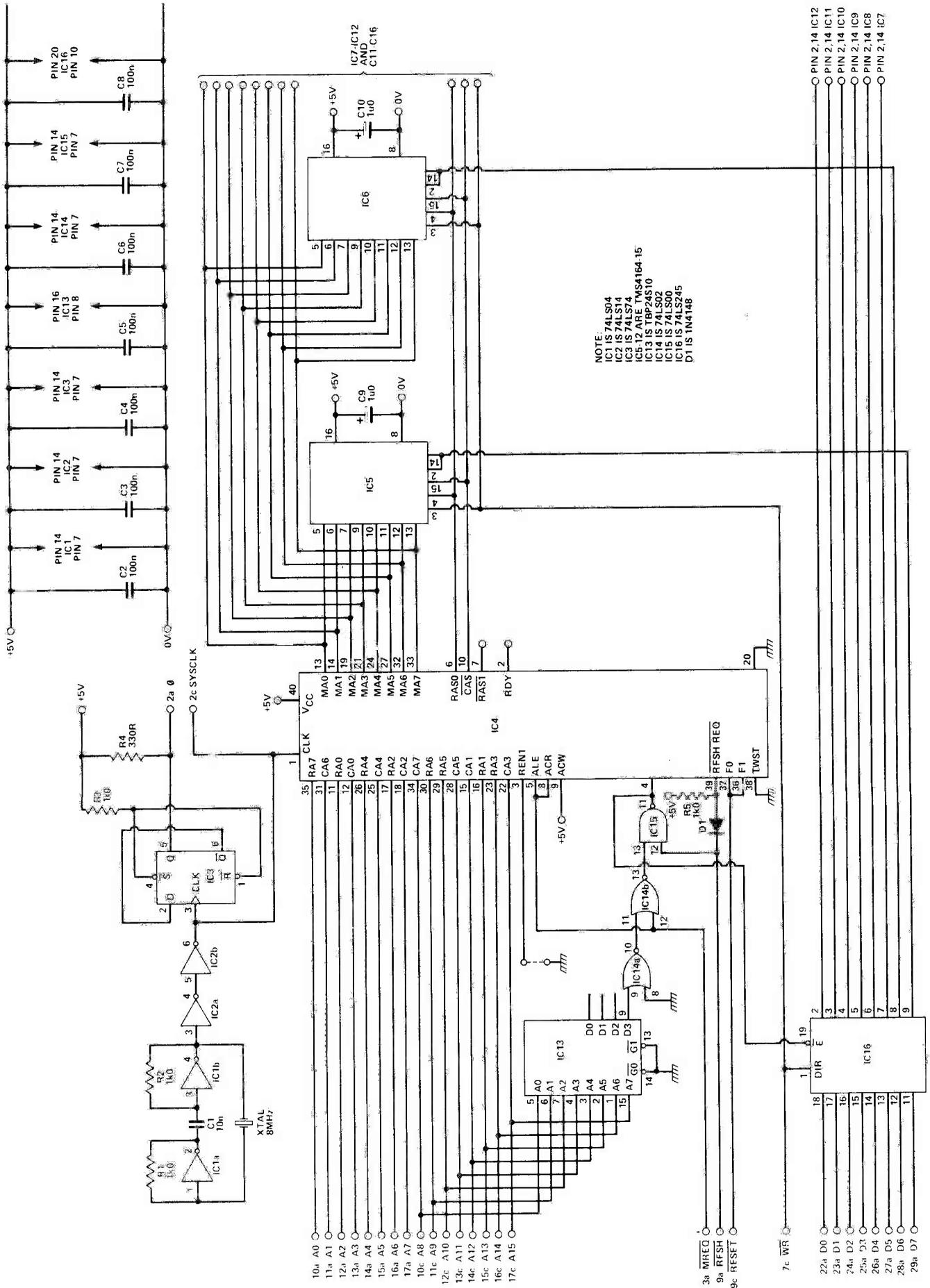


Fig. 2 Circuit diagram of the Z80 DRAM.

HOW IT WORKS

The 4 and 8 MHz clock generators are formed by ICs 1, 2, and 3 together with the associated resistors and the crystal. The raw 8 MHz signal is first cleaned up by the Schmitt gate and then divided by 2 by the D type flip flop, IC3, to give the new CPU clock of 4 MHz. The primary signal, 2ϕ , is fed directly to the TMS 4500 and the divided signal, ϕ , is fed out to the rest of the system. All sixteen address lines are connected to the 4500; these are then multiplexed out to the RAMs dur-

ing each cycle on the MA0-MA7 outputs. The upper eight address lines are used to decode the memory array, via the PROM, into 256 x 0.25K blocks. Unlike the DRAM project where the smallest decoded block was 1K, this should allow scope for even the smallest bootstrap PROMs to be accommodated. The output for the PROM decoder is gated with MREQ and RFSH to select a memory cycle for the 4500. The latter signal RFSH is included to prevent MREQ causing an

access during refresh. The 4500 itself handles all the refresh and memory cycle control, and all of the cycles are performed synchronously with the CPU clock (during T3 and T4). This excludes the need for any refresh arbitration via the RDY signal, and the need for any wait states during access. It also has the capacity to introduce additional refresh cycles during extended periods of WAIT or DMA cycles when only the system clock is present. The data bus is buffered using the

ubiquitous LS245 octal transceiver which is also controlled by the same CS signal as the 4500 and has its direction determined by the WR line. Note the difference between this synchronous approach and the asynchronous approach used in the CORTEX, where there was a 10% refresh overhead. Here the refresh is totally transparent, i.e. 0% overhead.

RA0-RA7	Input	Row Address — These address inputs are used to generate the row address for the multiplexer.
CA0-CA7	Input	Column Address — These address inputs are used to generate the column address for the multiplexer.
MA0-MA7	Output	Memory Address — These three-state outputs are designed to drive the addresses of the dynamic RAM array.
ALE	Input	Address Latch Enable — This input is used to latch the 16 address inputs, CS and REN1. This also initiates an access cycle if chip select is valid. The rising edge (low level to high level) of ALE returns RAS to the high level.
CS	Input	Chip Select — A low on this input enables an access cycle. The trailing edge of ALE latches the chip select input.
REN1	Input	RAS Enable 1 — This input is used to select one of two banks of RAM via the RAS 0 and RAS 1 outputs when chip select is present.
ACR, ACW	Input	Access Control, Read, Access Control, Write — A low on either of these inputs causes the column address to appear on MA0-MA7 and the column address strobe. The rising edge of ACR or ACW terminates the cycle by ending RAS and CAS strobes. When ACR and ACW are both low, MA0-MA7, RAS0, RAS1, and CAS go into a high-impedance (floating) state.
CLK	Input	System Clock — This input provides the master timing to generate refresh cycle timings and refresh rate. Refresh rate is determined by the TWST, FS1, FSO inputs.
REFREQ	Input/Output	Refresh Request — (This input should be driven by an open-collector output.) On input, a low-going edge initiates a refresh cycle and will cause the internal refresh timer to be reset on the next falling edge of the CLK. As an output, a low-going edge signals an internal refresh request and that the refresh timer will be reset on the next low-going edge of CLK. REFREQ will remain low until the refresh cycle is in progress and the current refresh address is present on MA0-MA7.
RAS0, RAS1	Output	Row Address Strobe — These three-state outputs are used to latch the row address into the bank of DRAMs selected by REN1. On refresh both signals are driven.
CAS	Output	Column Address Strobe — This three-state output is used to latch the column address into the DRAM array.
RDY	Output	Ready — This totem-pole output synchronizes memories that are too slow to guarantee microprocessor access time requirements. This output is also used to inhibit access cycles during refresh when in cycle-steal mode.
TWST	Input	Timing/Wait Strap — A high on this input indicates a wait state should be added to each memory cycle. In addition it is used in conjunction with FSO and FS1 to determine refresh rate and timing.
FS0, FS1	Inputs	Frequency Select 0; Frequency Select 1 — These are strap inputs to select Mode and Frequency of operation as shown in Table 1.

Table 1 Details of pin functions.

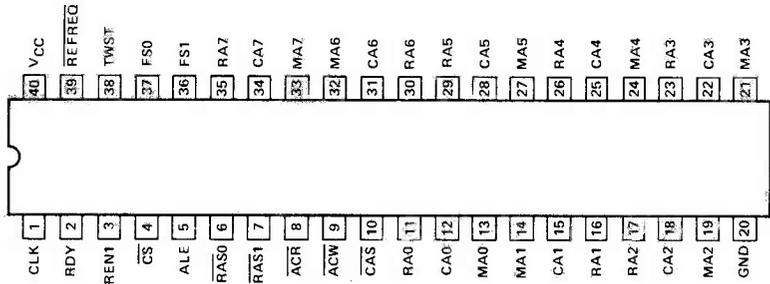


Fig. 3 Pin connections of the TMS 4500A.

PROJECT: Z80 DRAM Board

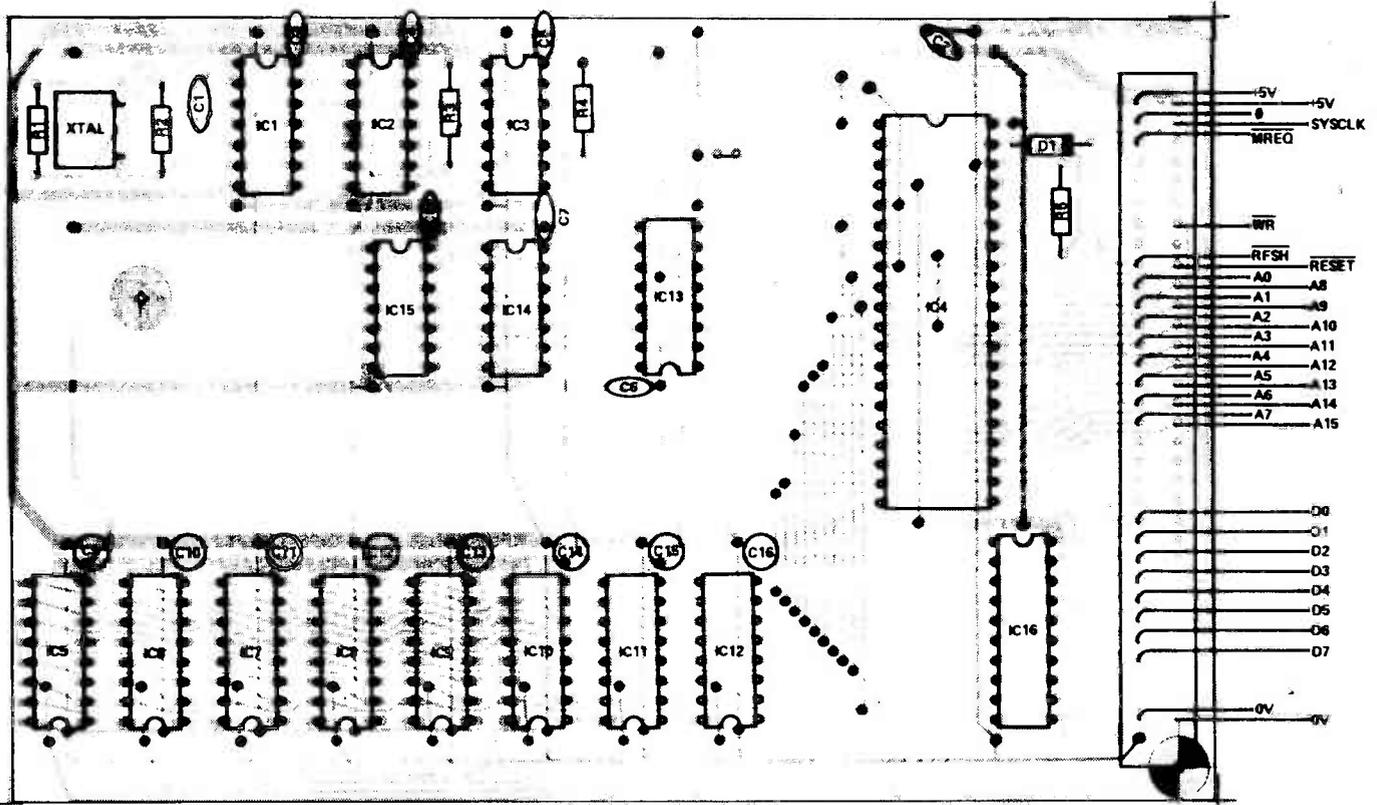


Fig. 4 Component overlay of the PCB.

at 4 MHz with only a 4 MHz clock source, a new 8 MHz clock generator will have to be provided and its output divided by two to give the 4 MHz CPU clock rate.

Construction

The Z80 DRAM is constructed on a 100 x 160 mm (3U eurocard size) double sided PCB. Printed circuit boards supplied by our PCB service will be double sided but the holes will not be plated through. This means that you will have to solder a link through each of the holes, but it does make the PCB a lot cheaper than it would otherwise be. Note also that some of the links are underneath ICs 4, 5 to 12, and 13, and crop the ends of these links off very close to the surface of the board. Note also that component leads have been used as links in some cases, and take care to solder such leads on both sides of the board. All links have been shown on the overlay diagram (Figure 4) regardless of whether they are individual wire links or component leads. Alternatively, you could produce your own single sided PCB using just the underside pattern and then use wire links on the component side, in which case you should solder the links in place first and use IC sockets which clear the board sufficiently to allow the wires out at the ends.

When the board is ready, and the links are in place, assemble the other components making sure that the diode, the electrolytic capacitors, and the ICs are the right way round, and taking care not to overheat the crystal. We recommend that you use IC sockets and insert the ICs themselves last of all. We have labelled all the connections on the board itself but obviously, what happens at the other end depends upon which micro you are using, so you will have to sort that out for yourself. Don't forget to remove or disable the original CPU clock if you are now using the DRAM board clock.

Finally, you will have to programme the PROM. The programming procedure for the TBP 24S10 is given in the book "Bipolar Microcomputer Components and Memories" which is published by Texas Instruments and should be readily available. A detailed description of the required memory contents lies outside the scope of this article, but some general guidelines were given in the original 64K DRAM project in the September 1983 ETI, and readers are referred to that article. Once programmed, the board should be ready for use because the TMS 4500A does not require any alignment.

PARTS LIST

RESISTORS (all 1/4W, 5%)

R1, 2, 3, 5	1k Ω
R4	330R

CAPACITORS

C1	10n ceramic
C2, 3, 4, 5, 6, 7, 8	100n ceramic
C9, 10, 11, 12, 13, 14, 15, 16	1 μ tantalum

SEMICONDUCTORS

IC1	74LS04
IC2	74LS14
IC3	74LS74
IC4	TMS4500A
IC5, 6, 7, 8, 9, 10, 11, 12	TMS4164-15
IC13	TPB 24S10
IC14	74LS02
IC15	74LS00
IC16	74LS245
D1	1N4148

MISCELLANEOUS

PCB; 32 x 2 way DIN 41612 A + C connector (plug and socket); 8 MHz crystal; connector, cable, etc to link with microcomputer.

BUYLINES

All of the semiconductors are widely available, with the possible exception of the TBP 24S10 which you can get from Midwich. None of the other components should present any problems and the PCB is available from our PCB Service, details on page 65.

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PFA/HV	36.04	200-300W	4, 8, 16	5dB dynamic headroom Drives 70V line direct.
*PFA500	45.22 55.33	250-600W	2, 4, 8	25A cont. output current. mounted on type 74 Heat Exchanger (see below).

*The power output of these amplifiers can be increased by approx 15% with no diminution in quality by adding PSU 102 (£7.61) to your existing power supply. (PFA250S is an improved version of PFA200).

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 - PAX2/24** 2 Way active crossover (specify frequency) **£10.10**
 - PAX3/24** 3 Way active crossover (-do-) **£19.50**
 - PSU103** Powers 2 x PAN20 + 2 Xovers **£6.91**
 - PAN1397** 20W power amp, bi-polar i/e (LOW THD) **£5.39**
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70-0-70	—	—	—	22.57	—	—

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2732 450NS D1	3 45	
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4118 150NS D1	3 25	
5516 200NS D2	9 45	
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6821 D3	1 00
6840 D4	3 75
6845 D5	6 50
6850 D2	1 10
6848 D2	7 30
6880 D7	5 25
68809 D6	12 00
68B10 D1	2 26
68B21 D3	2 20
68B40 D4	6 00
68B50 D2	2 20

Z80 Family

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280 ADART D1	5 60
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75110	0 56
75150	0 54
75154	0 77
75160	2 56
75161	2 80
75162	3 95
75172	1 95
75173	1 44
75174	1 95
75175	1 44
75182	0 50
75183	0 50
75188	0 37
75189	0 37
75451	0 22
75452	0 22
75453	0 22
75454	0 22
75458	0 88
75491	0 31
75492	0 42
A31015 D2	3 00
A31270 D2	6 47
A38910 D6	4 40
A38910 D2	6 70
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MC3242A D1	6 30
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MC3448A D1	3 75
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MC3487 D1	2 00
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ZN428 D1	4 75
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TL061	0 29
TL062	0 49
TL064	0 96
TL066	0 29
TL071	0 29
TL072	0 47
TL074	1 00
TL081	0 26
TL082	0 46
TL084	1 58
TL091	0 40
TL092	0 58
TL094	1 34
TL487	0 62
TL489	0 62
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READ/WRITE

Active Speakers

Dear Sir

As one who has been involved in the design of active speakers for many years, may I make a suggestion or two that will improve the performance of the design in your November issue?

Accepting the typographical error that reversed the values of R8 and R9, the filter stages are, as stated, standard 12dB per octave Butterworth networks, which are not really suitable for use in an active cross-over. The filters described in your article have a -3dB frequency at 2.885 kHz (the cross-over frequency), and when the outputs are summed, will give a 3dB peak in the overall frequency response. The ideal filters should be 12dB per octave (or 24dB per octave, but not 6 or 18 dB per octave for reasons that are too complex to go into here) but should each be 6dB down at the cross-over frequency, so that the summed response is flat. Suitable filters may easily be configured as shown in Fig. 1.

The modified filters do not add to the cost or complexity of the project, but by increasing the parts count by a small amount, further very worthwhile improvements may be included.

Although the KEF B200 is a good choice of bass unit, its res-

ponse is not flat enough to avoid using a limited amount of equalisation, a suggested circuit being given in Fig. 2.

The response of this stage gives unity gain at very low frequencies, then introduces a falling response that is -1dB at 300 Hz, -3dB at 650 Hz and -6dB at 3 kHz, thereby removing a hump in the B200 response that can introduce considerable colouration if left untreated. As this stage is inverting, the connections to one of the drive units should be reversed so that both units are connected in the same phase.

Additional colouration may be caused by the downward-tilting radiation pattern at the cross-over frequency. This is caused by the non-alignment of the acoustical planes of the drivers, and may be corrected by the application of a suitable delay in the high-frequency signal. As the B200 radiates at a point about 38mm behind the plane of the HD100/25, the required delay is $38 \times 10^{-3} / 343 = 110.8 \mu\text{s}$. A suitable all-pass filter, giving 28.2 μs delay per stage may be formed from four op-amps as shown in Fig. 3.

$$\text{Delay} = \frac{2RC}{1 + (2\pi fRC)^2}$$

$$= 28.2 \mu\text{s at } 2.68 \text{ kHz per stage}$$

$$= 112.8 \mu\text{s total (equiv. to } 38.7 \text{ mm)}$$

Various other 'improvements' could be incorporated, but would increase the cost out of proportion to the gain in performance; however, the suggested modifications will bring a number of benefits over the very basic published circuitry without increasing the cost by more than about £10.00.

Yours faithfully
Barry E Porter
Kings Lynn

We thank Barry Porter for his suggested enhancements to the simple active loudspeaker design, and we suggest that interested readers should 'suck them and see'.

Fuses

Dear Sirs,

I recently built your Dec '82 Spectracolumn, and was very pleased with it, until, that is, one of the bulbs blew. This in itself was of course not a major calamity. It did, however, take its controlling triac with it. Please tell me whether I can expect a triac casualty every time a bulb blows (it was a 'normal' domestic 100 W type). If not please offer an explanation and remedy to prevent further sympathetic suicides.

Yours faithfully
Paul Gallagher
Edinburgh

PS can 100 W spots be used with the Spectracolumn?

The reason for the 'sympathetic suicide' is that sometimes when a bulb blows, a piece of filament will short across the conductor supports, so momentarily reducing the bulb's resistance to a very low value and causing a high current to flow. This transient is usually much too small to damage conventional electrical switchgear, or even blow the house fuse (and most domestic bulbs have an integral fuse, or

Fig. 1

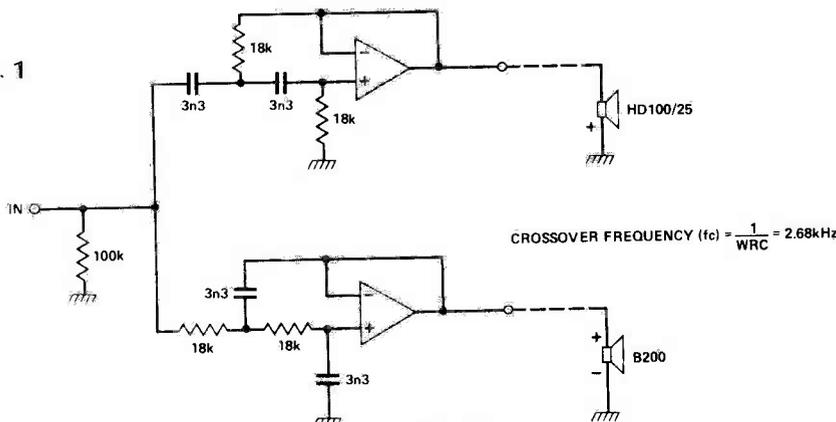


Fig. 2

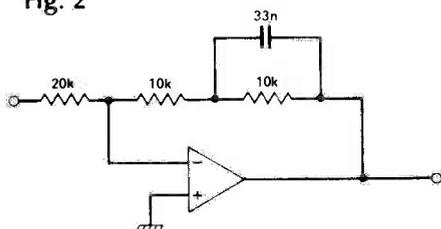
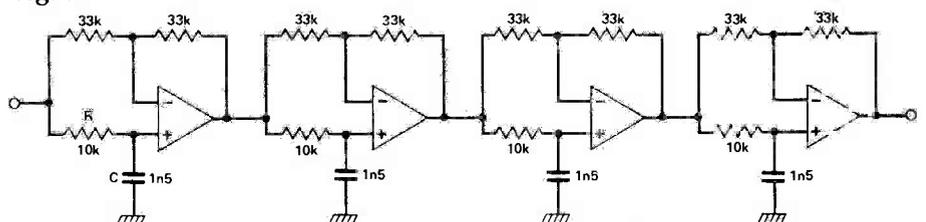
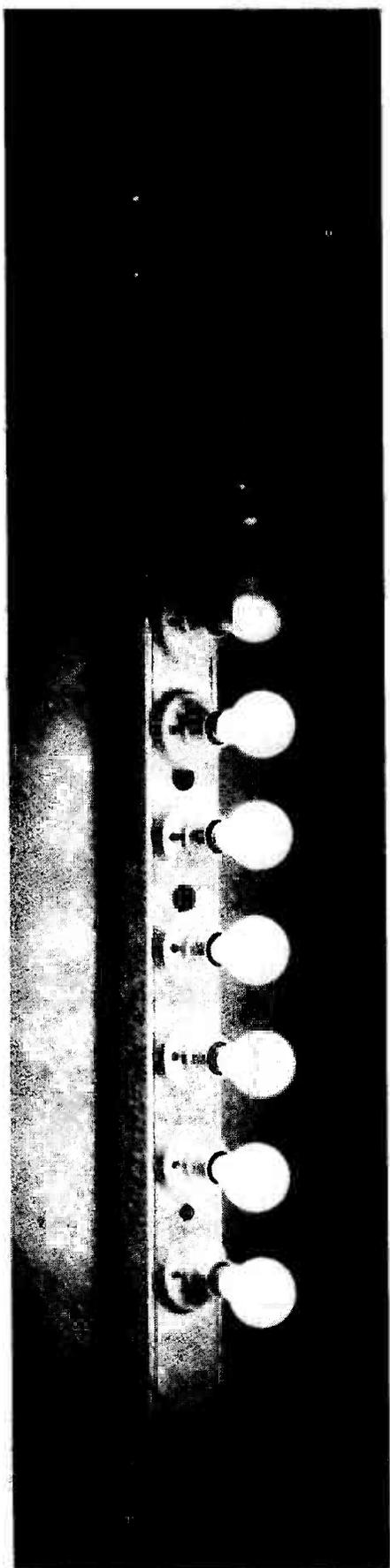


Fig. 3





The ETI Spectracolumn — expensive on triacs

rather a thinned section of conductor to prevent this) but unfortunately the transient is usually ample to take plastic-packaged triacs with it.

For this reason, many manufacturers of domestic light dimmers have started to fit special, very fast blowing fuses in their units. However, these fuses are not that easy to obtain (if you go into most suppliers and ask for them you'll probably be given a blank look or a standard 20mm fuse), and a project such as the Spectracolumn would necessitate several, along with associated fuse holders. In any case, they're quite expensive — more expensive, often, than a cheap, plastic-packaged triac. So, for gear you build yourself, you might as well reconcile yourself to having to replace the odd triac now and then.

An alternative solution is to use considerably over-rated triacs, in T03 packages. The editor has fitted one of these (of somewhat dubious origin — it just turned up somehow in the junk box) to a domestic dimmer with success. It has proved capable of surviving quite extended shorts — on one occasion, a bulb in a multi-bulb fitting blew and shorted the supply long enough to dip all the other lights in the fitting for a fraction of a second (admittedly the wiring wasn't too great in that particular flat) but the triac survived! However it would be necessary to check that there is sufficient driving current for the devices used.

In any case, frequency of shorts will probably be a function of bulb design — so change make if the bulbs take the triac with them more than, say, 50% of the time (no, we don't know which brands are best, sorry).

Finally, given our last comment above, there is no reason why you shouldn't use spot bulbs with the spectracolumn — but they may, because of their design, be more likely to short out on blowing.

Holophony

Dear Sir,

I have read with some interest what you have had to say about the so-called "holophonic" sound. I think I am in a position to throw some light on the subject, so here goes.

Last Easter I was visiting a colleague, a Dr Peter Damaske, in Goslar (Windsor's twin town in Germany) who did his doctorate at Gottingen University on just this

subject, and who is still active in the field, although he now teaches physics at the "Gymnasium" in Goslar. What follows is what he told me, as near as I can remember; your German edition could always get in touch with him direct.

When a recording is made by putting microphones into the ears of an artificial head, the exact effect can be re-created by playing the recording through stereo headphones. This isn't surprising, of course, but doesn't answer the question of how the brain locates sound. In fact, the direction is perceived by the brain measuring the time difference between the sound reaching the two ears. Although this seems incredible — the times are of the order of tens of microseconds — it is quite a well established fact, and it explains why you can tell where the keys are even with one ear partly blocked. Someone deaf in one ear, though, cannot tell which phone in an office is ringing — I know someone in Windsor who suffers from this problem.

The plot thickens when we consider how to tell the difference between sounds coming from the front and from the back. A sound at 45° left front will have exactly the same time lag as one from 45° left back, and in practice it is not that easy to tell one from another. If you move your head slightly, of course, it is easy, since the two sounds behave differently. Moving the head to the left moves the front source rightwards and the back source leftwards. However, you can't do this with a recording, yet the distinction is still there. It appears that the sound from the rear has a different quality, since its spectral composition is modified by the hair and ear lobes. We learn quite early in life to recognise these differences, and this is how the trick is worked. It is possible to think sounds coming from in front come from behind — especially footsteps — and this may be due to the surface walked on modifying the sound in a similar way to the ears. Footsteps on soft ground in front may sound like footsteps on hard ground behind, for instance.

When loudspeakers are used and not headphones, the left ear hears some of the sound intended for the right ear, and vice-versa. It is possible to compensate for this by adding some left ear signals in antiphase to the right channel to cancel this out, with the appropriate time delay, but the sound must be filtered first to imitate the

effect of the nose, face and earlobes. In an anechoic chamber this apparently works very well, and two speakers physically in front of the listener can make sounds seem to come from all round. However, the echoes in a real room mess all this up, and the effect is lost. The next thing to try is highly directional speakers to beam the sound to the ears and not the walls — Dr Damaske uses arrays of small speakers. The effect of these in a well draped room is pretty good, but the front-back effect is not easy to achieve at the same time as high quality sound. Work continues. I have heard recordings on this system, and the front-back distinction was not very good — Dr Damaske tells me it was better when his speakers were not so good!

I have not mentioned up-down cues. Humans are not good at locating the elevation of a sound, as one might expect. Mostly we know where to expect sounds to come from, but everyone knows how easy it is to be fooled by a voice from up a tree. Owls need to be good at measuring elevation if they are to find their prey, and they do so by

having the right and left ears at different angles to the horizontal. The time delay then gives the direction, and the relative volume in the two ears the elevation. It follows that an owl with earache in one ear will have problems!

Yours sincerely,
Gerald Bettridge
Physics Dept, Eton College.

Nearly A Competition

Dear Sir,

I hope you do not mind me writing to you but I have a problem you and subscribers to your magazine may be able to help me with.

I was a professional bass guitarist for ten years until three years ago when I suffered a stroke in my right side (I was 29). Although I got back some movement and feeling, my right side remains largely useless, since then I have been trying to come up with a practical idea to enable me to play again. The City University in London modified a bass guitar utilising the limited movement in my right arm to trigger off solenoids to stike whichever string

was selected by my left hand but for various reasons (mainly the expense of replacing the solenoids should they very likely go wrong, about £70 each) the idea was impractical.

So could I appeal to you and your readers to come up with a practical, reliable idea for modifying a bass guitar so it can be played using 1 1/2 hands. We could perhaps appeal using a competition formula with me donating a prize of some sort (but not too expensive!!).

Yours sincerely
Alan Todd
Birmingham

Certainly! If anyone out there has an idea, please contact the Editor before the end of February 1984. We will channel suggestions to Alan, and help to get the one or two most practical built and tried out. The solution that Alan prefers will, eventually, appear in the pages of the magazine, and we'll pay the designer(s) our standard page rate — which isn't a fortune, we'll admit, but they'll also have Alan's gratitude as well.

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ELSE	;	SAVE	GRAPH	TON	COMMANDS	@	SQR	MOD	= =
ON		LOAD	TEXT	DIM	RUN	! FUNCTIONS	SYS	RND	= =
GOTO	1 UNIT	MOTOR	PLOT	LET	SIZE	FNA-FNZ	TIC	KEY	> >
GOSUB	BAUD	ESCAPE	UNPLOT	DEF	CONT	ABS	SGN	OPERATORS	> >
POP	CALL	NOESC	COLOUR	NEW	MON	ADR	BIT	OR	<< <<
REM	DATA	RANDOM	CHAR	END	DELIMITERS	ASC	CRB	OR	<< <<
FOR	READ	ENTER	SPRITE	BIT	TO	ATN	CRF	OR	+ +
NEXT	RESTOR	LIST	SHAPE	CRB	TAB	SIN	MEM	AND	/ /
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THE OBEDIENT DIE

Here is a project for the man or woman who has everything except a conviction for fraud — a cheating die. Fun for party games, but definitely not for serious use. Design and development by Ian Hickman.

Dice have been used for centuries, both for gambling and as the element of chance in the more innocent games such as Ludo or Snakes and Ladders. Unscrupulous persons have from the earliest times employed "loaded" dice. A loaded die has a piece of lead embedded within it, slightly off-centre, so that a certain number, for example a six, occurs more often than it should. (Normally, of course, the chance of a die throwing a six is just one in six and a pair of dice throwing a double six is 1 in 36.) The degree of loading is naturally kept small, as otherwise suspicions would

soon be aroused. A loaded die is more likely (by a small margin) to throw the "loaded" number than the other numbers, regardless of who throws it. Thus the unscrupulous gamester would arrange either that the "banker" (himself) always threw the dice, or that the rules of the game were so framed that sixes favoured the bank, whoever threw them. The idea of a die that could be commanded to throw a six whenever desired would have seemed like magic!

This article describes an electronically loaded die, which can provide a lot of innocent amuse-

ment at parties, but which should obviously not be used for gaming. Its ability to throw a six whenever commanded can also liven up an otherwise tedious board game such as Ludo.

Construction And Testing

The prototype die was constructed in a hollow perspex cube bought in the fancy goods department of a well known chain store. The bottomless plastic cube came with a block of soft plastic foam inside, which was meant to retain five photographs, one behind each of the five visible faces of the cube. The printed circuit board

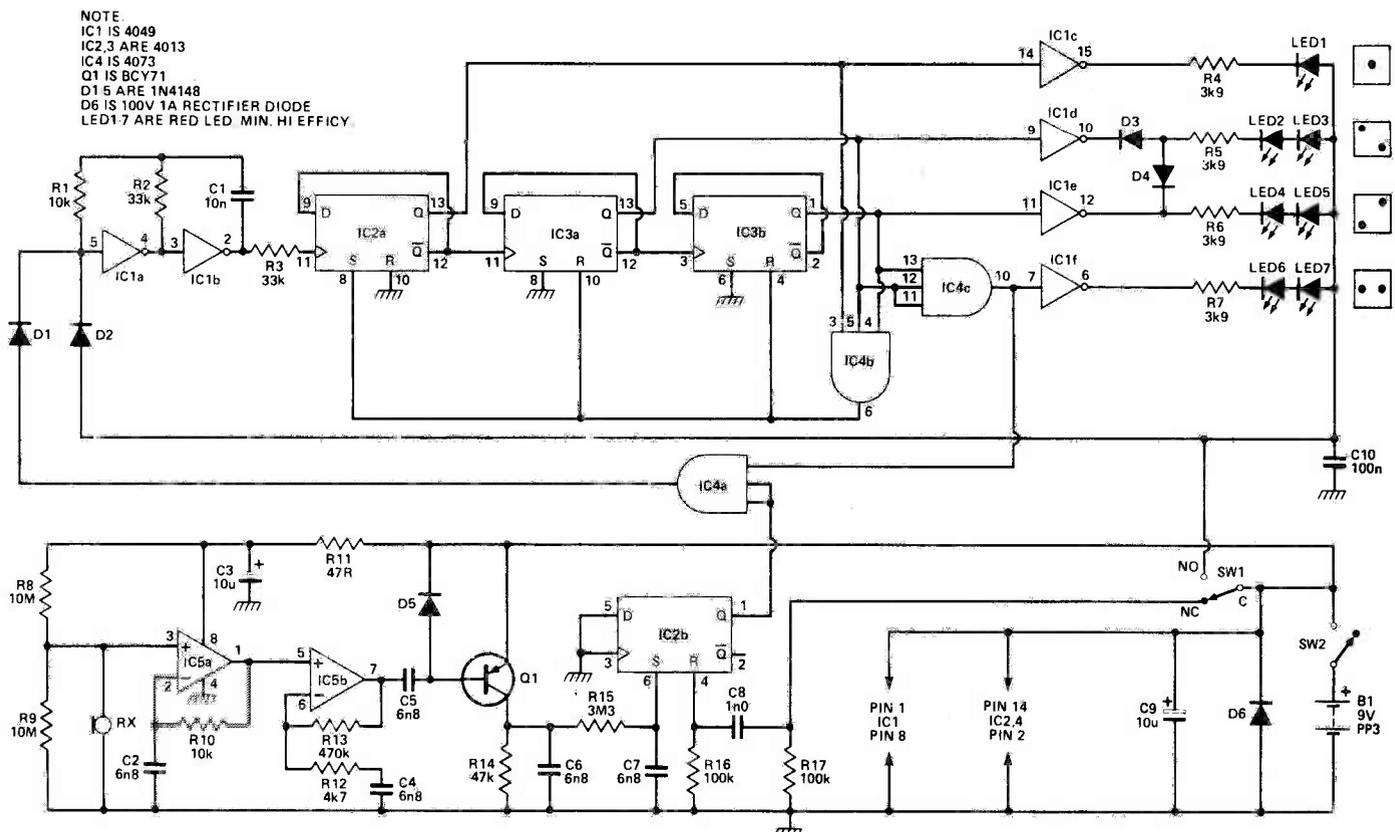


Fig. 1. Circuit diagram of the die.

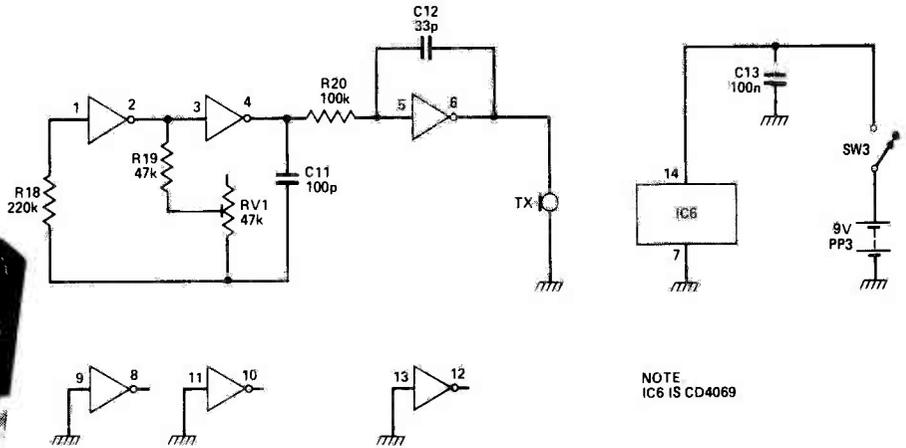
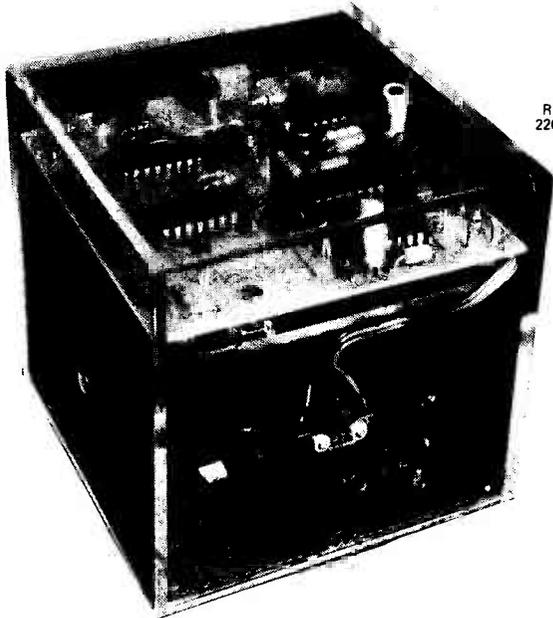


Fig. 2 Circuit diagram of the transmitter; note that it doesn't matter which particular gate is used for what — all the gates within IC6 are equivalent; no PCB has been shown for this unit, as it would be uneconomic to produce such a small board. Better to use a spare piece of circuitboard.

HOW IT WORKS

The full circuit is shown in Fig. 1, where the components forming the remote control circuit are grouped at the bottom while the basic electronic die components are at the top. ICa & b form a free-running clock oscillator, which can be inhibited by a +9V at the anode of either D1 or D2. The clock is fed to a three-stage binary ripple counter IC2a, IC3a and IC3b. This is constrained by gated feedback to count from 1 to 6 rather than from 0 to 7 as it would normally do. Whenever three 1s are simultaneously presented at the Q outputs of the three stage counter (i.e. a count of 4+2+1 or 111 in binary), the output of the AND gate IC4b goes true or high, i.e. +9V. This instantly resets IC3a and b to 0 and sets IC2a to 1, thus states 7 and zero are skipped over.

The output of the ones counter drives LED1 via the buffer IC1c. The output of the 2s counter IC3a drives the diagonally-placed LEDs, LED2 and 3, which are also lit via D4, along with LED4 and 5, by the output of the 4s counter IC3b. IC4c detects the presence of a 6 by ANDing the 4s and 2s outputs, and lights LEDs 6 and 7. The result of this simple bit of decoding is a traditional dice display with 2 and 3 displayed along a diagonal. (By lighting the four corners LEDs from the 4s counter and LED6 and 7 from the 2s counter, one can save a few components, but it hardly seems worthwhile putting up with a non-standard display for such a marginal economy.)

The LEDs will only light if micro-switch S1 is in the operated position, C (common) to NO (normally open), which occurs when the die is set down on a flat surface. The LEDs then light and as there is +9V at the anode of D2, the clock oscillator is inhibited. The LEDs therefore display whatever

number the counter had reached when the die was set down. On picking up the die, the LEDs extinguish and the counter clocks at around 1kHz until it is set down again. Thus the number 'thrown' (please don't actually throw the die!) is effectively random. This was proved by a series of nearly 400 consecutive throws, in which 1 occurred 67 times, 2 - 64 times, 3 - 61 times, 4 - 67 times, 5 - 70 times and 6 - 62 times.

Each time the die is picked up, S1 returns to the normally closed condition and a short +9V pulse is applied to the reset input of IC2b via C8. Thus both the Q output of IC2b and the output of AND gate IC4a normally remain indefinitely at 0V, but now we come to the devious bit. Connected to the input of the amplifier IC5a is an ultrasonic receiver Rx. This is sensitive to a narrow band of frequencies in the region of 40kHz, and its output is amplified by IC5a and IC5b. When a 40kHz sound wave impinges on Rx, the output of IC5b via C5 is DC restored negative-going with respect to +9V by D5 and applied to Q1. This conducts on the negative going half cycles, charging C6 to +9V, and if the supersonic 40kHz signal persists for more than 20ms or so, the voltage across C7 will rise to a level where IC2b will be set. If this occurs while the clock oscillator is running, the clock will be stopped at a count of six. The 1 at the Q output of IC2b enables IC4a, and the next 'six' output from IC4c will result in a 1 at IC4a's output, disabling the clock oscillator via D1. If a 40kHz signal is received after the die is set down, it will set IC2b, but this will have no effect as the clock has already been inhibited via D2: IC2b will be reset as normal when the die is next picked up.

With so much gain in a confined space, following a high impedance transducer, the dual op-amp circuit has been designed carefully. Supply line decoupling R11, C3 prevents supply line ripple due to clock edges getting into the amplifier, whilst hum pick-up problems (always a headache with high impedance transducers) are avoided by rolling off the LF gain of the op-amps, e.g. with R10 and C2 at IC5a. However if the same circuit were used around IC5b, instability could result due to the coincident breakpoints. This is avoided by using a different time constant and limiting the LF roll-off of IC5b with R12.

The receiver Rx will not respond to shouting, singing, whistling or other audible sounds, but impulsive sounds (such as clapping, or tapping the die) contain supersonic components up to 40kHz and beyond. To prevent these from operating the 'force a six' function, the detector circuit includes filtering. The time constant R14/C6 is just sufficient to prevent the collector voltage of Q1 falling appreciably below 9V between one half-cycle of the 40kHz signal and the next, but it falls rapidly as soon as the sound disappears. On the other hand, the filter R15/C7 requires that the 40kHz tone remain present for at least 20ms before IC2B will be set, forcing a six. Thus brief impulsive noises such as clapping are discriminated against. If you hiss loudly at the die it will throw a six, so it is not recommended for use in a boiler room where steam is escaping!

Reverse polarity protection diode D6 protects the circuit — but not the battery — in the event of the latter being connected the wrong way round. Fig. 2 shows the circuit of the 40kHz ultrasonic transmitter.

shown is a snug fit inside the cube and is mounted on a carrier-cum-battery-box fabricated out of an old tin can. This is retained by a couple of countersunk screws picking up on opposite faces of the cube. For the control transmitter any small plastic box, with room for a PP3 battery and the few components mounted on a piece of Veroboard, can be used. The

transmit transducer should be mounted behind a hole in the front panel and the on-off switch should be a push-to-make pushbutton.

It is easier to fault-find on a small amount of circuitry, especially if you do not have an oscilloscope, so it is a good idea to construct the die in parts. Start off by mounting IC1, 2 and 3 and

their associated components but NOT D1, D2 or IC4. On S1, temporarily link C to NO and tie the output of IC4b to 0V. Fit a $10\mu\text{F}$ non electrolytic capacitor (or two $22\mu\text{F}$ capacitors back-to-back — Ed) at C1 instead of the final value and connect the battery. You should see the LEDs cycle through the usual dice display of 1 to 6, followed by 7 and 0. If not, the fault should be fairly easy to locate, with so few components fitted to the board. Now switch off and fit IC4, remembering to remove the temporary short at its output. Now, the display should cycle through the states 1 to 6 only. Change C1 to 10nF , fit D2 and S1 (remove the link) and check that the basic die now operates correctly, i.e. LEDs out until S1 is pressed, then display a

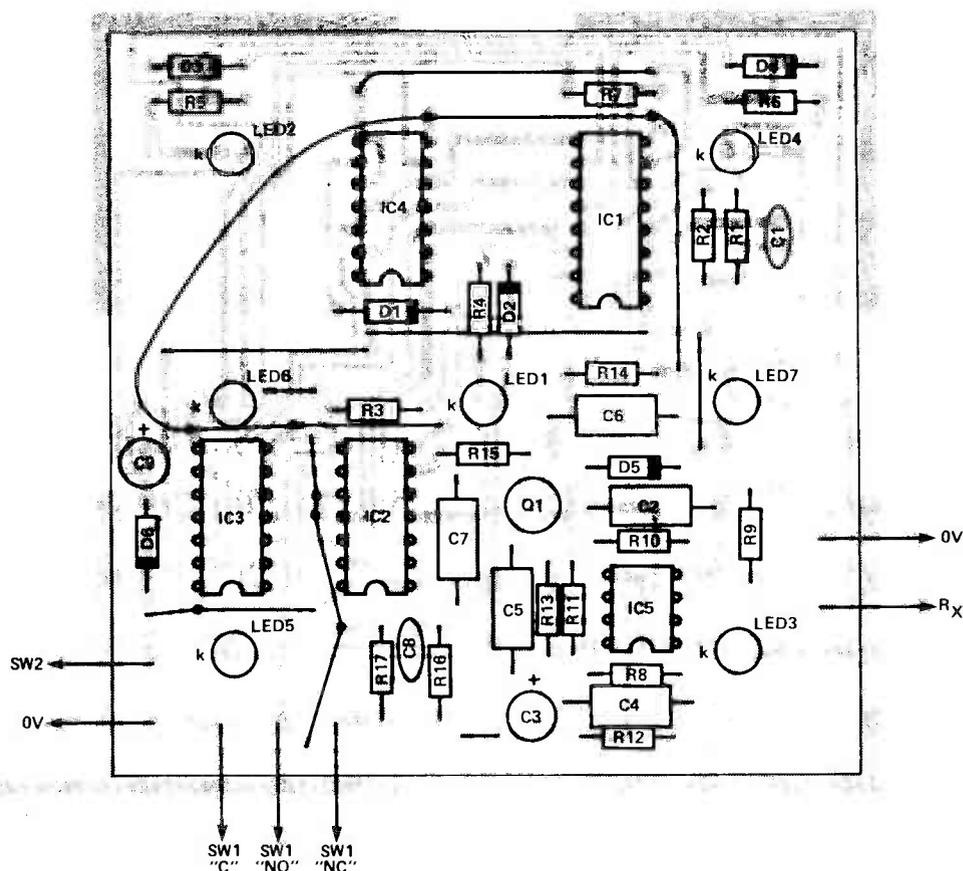
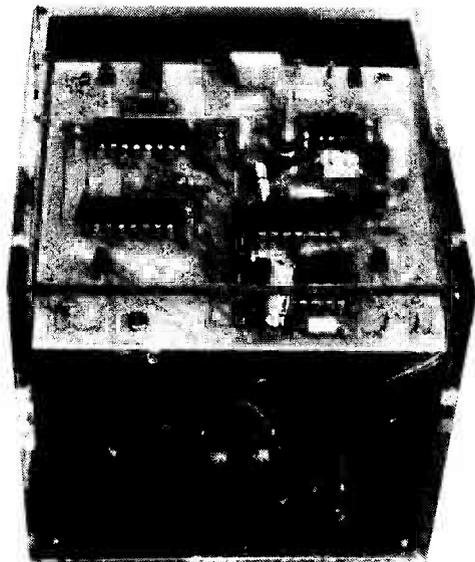


Fig. 3 Overlay diagram for the main PCB.

PARTS LIST

RESISTORS (all $\frac{1}{4}\text{W } 5\%$)

R1, 10	10k
R2, 3	33k
R4-7	3k9
R8, 9	10M
R11	47R
R12	4k7
R13	470k
R14, 19	47k
R15	3M3
R16, 17, 20	100k
R18	220k
RV1	47k min preset

CAPACITORS

C1	10n
C2, 4, 5, 6, 7	6n8
C3, 9	10μ 15V tantalum electrolytic
C8	1n0
C10, 13	100n
C11	100p
C12	33p

SEMICONDUCTORS

IC1	4049
IC2, 3	4013
IC4	4073
IC5	TL072
IC6	4069
D1-5	1N4148
D6	1N4002 or other 100V 1A rectifier diode
LED1-7	Min red LED, high-efficiency

MISCELLANEOUS

Tx, Rx	Ultrasonic transducer, 40kHz
PCB, perspex case, case for transmitter, veroboard for transmitter, on/off switch for die, microswitch for throw, (see drawing), push button switch for transmitter, batteries.	

number at random.

Now fit the remaining components of the die and make up the control transmitter of Fig. 2. Monitor the voltage at the collector of Q1 with respect to 0V, using a 20,000Ω per volt multimeter. With both die and transmitter powered up, point the transmitter at the receiver transducer at a distance of a few feet. Adjust the transmitter frequency, by means of RV1, for maximum response at the receiver. Use an insulated trimmer tool to avoid stray capacitance, otherwise the transmitter frequency may change when the screwdriver is removed. When carefully set for best response, the transmitter should cause Q1 collector to go to +9V from anywhere in the room. Check that raising and setting down the die causes a random number to be displayed unless the transmitter is on, in which case a 6 should appear. The system is now operational.

With the component values shown in Fig. 1 the circuit consumes 4 mA from the PP3 battery when picked up and only 8 mA

when set down and displaying a 6. However for a brighter display, especially if you are not using high-efficiency LEDs, R4 can be reduced to 2k2 and R5 - 7 to 1k8 each.

Using The Obedient Die

When correctly set up, the control transmitter will operate the die even when it is concealed. It may be hidden in a trouser or jacket pocket, provided the intervening distance is not more than a few feet, the material of the garment is not excessively heavy and the transmit transducer is pointing in the general direction of the die. The die is used to best effect when the operate is apparently not involved. For instance, at an office party invite the boss's secretary to have a go, when she throws more sixes than you do persuade her to take on the boss. Now melt into the bystanders and take it from there. For example, when the secretary seems to have all the luck, get an accomplice to suggest to the boss that there is a gravity switch inside the die and perhaps he ought to tilt it sideways before

putting it down. When he tries this, lo and behold (you switch sides) it works, and suddenly he is winning.

Many other scenarios are possible, with or without an accomplice, and will doubtless occur to you. For example, Ludo gets distinctly boring when one player is miles ahead of the others. But a non-playing controller of the die can turn a game into a neck and neck contest by judicious use of occasional extra sixes. Remember not to force too many sixes or suspicions will soon be aroused. After all, you can only add extra sixes, not inhibit them.

BUYLINES

Absolutely nothing here to cause any problems. The 40kHz transducers are available from Maplin and Watford among others, the perspex case is discussed in the test, and everything else is perfectly standard. The PCB is available from our PCB service, for which see page 65.

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AUDIO DESIGN

A lot of unnecessary mystique surrounds the subject of imaginary numbers, so in this coda to his series, John Linsley Hood sets out to clear a path through the muddle and to demonstrate the value of the technique in audio design work.

One of the features of audio circuitry, with the partial exception of audio power amplifiers which are largely flat frequency response devices, is that some modification of the gain/frequency characteristic is needed to correct for uneven recording or replay frequency responses, or to emphasise or exclude desirable or unwanted parts of the frequency spectrum. This is done by inserting a combination of resistors and capacitors (or inductors) in the signal path, or, possibly, in the feedback path around an amplifier. This is a very powerful technique, and with sufficient ingenuity in the circuit design, all sorts of shapes of frequency response can be achieved. However, it requires the ability to do reasonably accurate calculations of systems using capacitors or inductors in combination with resistors, and this immediately runs into the problem of the phase shifts which occur within such networks. I will explain.

If one passes an alternating current through a series combination of a resistor and a capacitor or a resistor and an inductor, the voltages developed across the two components will be 90° out of phase with each other. I have shown this graphically in Fig. 1a and 1b. Also, while the voltage developed across a capacitor will 'lag' in phase relation to the current flowing through it, (because the voltage across a capacitor depends on the charge within it and it takes time for the capacitor to charge up or discharge), the opposite is true of an inductor, in which the voltage will 'lead' in phase with reference to the current (due to the instantaneous generation of a 'back EMF' in an inductor which seeks to oppose any change in

current).

We have seen earlier in this series that the impedance of a capacitor (Z_c) is related to its capacitance and the operating frequency by the equation $Z_c = 1/2\pi fC$. Similarly, the impedance of an inductor $Z_L = 2\pi fL$, where f is the frequency and C and L are in Farads and Henries respectively. Because of the effects of phase shifts, any calculation we made, say, of the attenuation of an RC or LC network based on these formulae for impedance would probably give incorrect answers. We therefore need a better method.

The j Symbol

There is, conveniently, a mathematical trick which enables us to do calculations which take into account the phase shifts produced by inductors and capacitors, and this is the operator i or j , which is numerically $\sqrt{-1}$. Pure mathematicians call this i to denote the fact that it is an imaginary number, since all real numbers give positive values when they are squared. However, since electrical engineers have already adopted the symbol i to denote electrical current, we refer to $\sqrt{-1}$ as j instead. The use of this j operator is not as barmy as it might seem, as a way of describing a 90° phase shift, for the following reason.

In DC systems, the opposite of a positive voltage $+V$ is a negative voltage $-V$. In an AC system, the opposite of an instantaneous positive potential (and it is convenient to refer to such AC potentials as E to distinguish them from DC voltages $\pm V$) is the same potential half a cycle (180°) later when it has swung from positive to negative. A 180° phase shift in an AC signal therefore has the effect of multiplying the potential by -1 , provided always that the signal we are talking about is sinusoidal.

Now, if we have two RC (or LC) networks in series, both of which produce a 90° phase shift (and two such networks in series will have a multiplying effect on the signal, just as $1/2 \times 1/2 = 1/4$), the final effect is a 180° phase shift ($= x-1$). If we want to represent these phase shifts mathematically, we must find something which, when multiplied by itself gives the result -1 . $\sqrt{-1}$ is just such a thing. It can therefore be used in our sums as a way of denoting 90° phase shift.

The other bit of shorthand which circuit engineers normally use in these calculations is the symbol ω (Omega in Greek) to denote $2\pi f$, since these terms nearly always occur together. The true impedance of a capacitor or inductor is, therefore, not $Z_c = 1/2\pi fC$ or $Z_L = 2\pi fL$, but $Z_c = 1/j2\pi fC$ and $Z_L = j2\pi fL$. In shorthand form this becomes $Z_c = 1/j\omega C$ and $Z_L = j\omega L$.

Since the phase shift produced by L or C elements in RC or LC networks is 90° , we can represent the behaviour of this circuitry in a graphical form, as shown in Fig. 1, as a right angled triangle, where the 'j'

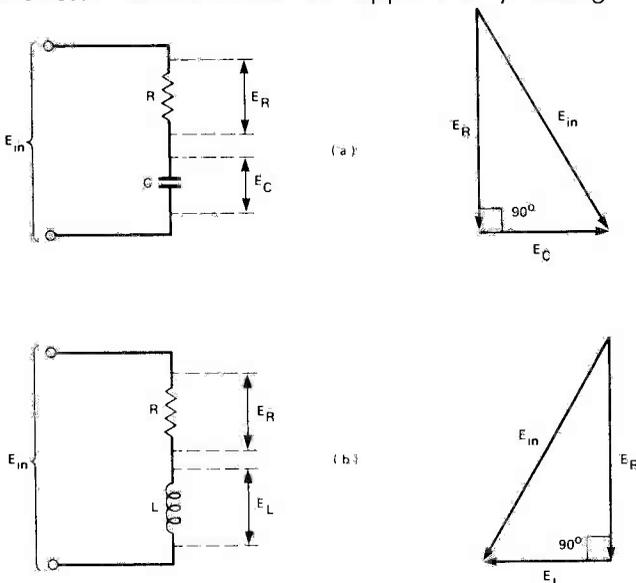


Fig. 1 Phase angle relationships in RC and RL networks.

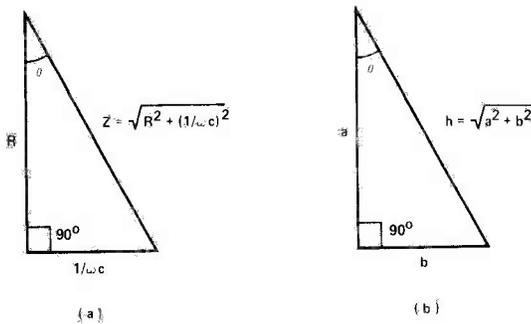


Fig. 2 Impedance diagram for an RC network.

term denotes the right angled limb, and this allows us to derive some further bits of information. Taking the case of a simple RC series network, as in Fig. 1a, the circuit impedances can be represented as in Fig. 2a, in which the vertical and horizontal limbs represent the resistive and capacitive impedances R and $1/j\omega C$ respectively. It is unnecessary to write the 'j' symbol in the capacitance impedance limb of the drawing; that is implicit in its position at right angles to the R limb. From the theorem of Pythagoras, the length of the hypotenuse, h in Fig 2b, is $\sqrt{a^2 + b^2}$, and from fairly simple trigonometry, the angle θ is such that $\tan \theta = b/a$. More conveniently, $\theta = \tan^{-1} b/a$, a calculation which a lot of pocket calculators will do very quickly.

Returning to our impedance diagram of Fig 2a, the resultant impedance of our network is therefore

$$\sqrt{R^2 + \left(\frac{1}{\omega C}\right)^2}$$

We can also determine the phase angle, θ , between the voltage developed across this network and the current flowing through it which will lag by θ , which is $\tan^{-1} 1/\omega CR$. (If C were very large indeed, or R were very large, the phase shift would be nearly zero.)

To recapitulate, we can identify the phase shifting characteristics of C s and L s by coupling the symbol j to their impedance equations, and we can derive the resultant impedance and phase angle of these 'complex' networks by sorting out the terms with and without the j symbols, and using them in simple geometric or trigonometric calculations. This process holds good no matter how many R s, C s and L s we have in our network, it just becomes more complicated if there are more phase shifting elements.

The thing, however, which we must watch, is that we keep the real and the imaginary (j containing) parts separate in the final equation at which we arrive. Now let us look at some real life examples.

Impedance Of RC Parallel Network

If the components were a and b as in Fig 3a, their impedance, when in parallel, would be

$$\frac{ab}{a + b}$$

Therefore, if they are R and $1/j\omega C$, as in Fig. 3b, their parallel impedance will be

$$Z = \frac{(1/j\omega C) \cdot R}{1/j\omega C + R}$$

If we multiply the top and bottom of this equation by $j\omega C$, we can get it into the much more manageable form

$$Z = \frac{R}{1 + j\omega CR}$$

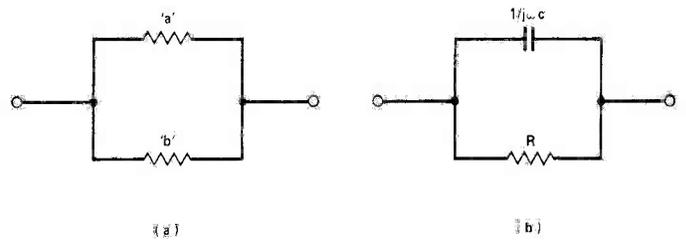


Fig. 3 Impedance of an RC parallel network.

The next mathematical dodge is to get rid of the j s in the bottom line of this equation, so that we can divide it up into two separate parts, one without j s and one with them, representing the in-phase and the 90° 'quadrature' components.

This can be done by using the relationship

$$(a + b)(b - b) = a^2 - b^2$$

If it was $(a + jb)(a - jb)$ the result would be $a^2 + b^2$, bearing in mind that $j^2 = -1$. The important thing is that j terms have disappeared. We can, therefore, multiply the top and the bottom of an equation containing a j term in the bottom line by $a - jb$ and eliminate these terms from the denominator leaving two separate fractions, which meets our original requirement for a usable equation. Treating the

$$Z = \frac{R}{1 + j\omega CR}$$

equation like this, we end up with

$$Z = \frac{R}{1 + (\omega CR)^2} - \frac{j\omega CR^2}{1 + (\omega CR)^2}$$

which allows us to calculate both the impedance and the phase angle between current flow and voltage, in our CR parallel network.

Attenuation Of An RC Network.

The circuit shown in Fig. 4b is a very versatile one in that, as it stands, it is a useful 'step' attenuator network, while if $R_2 = 0$ it is a simple HF attenuator circuit. Looking at the resistor network of Fig 4a, the attenuation of this would be

$$\frac{E_{out}}{E_{in}} = \frac{R_b + R_c}{R_a + R_b + R_c}$$

By analogy, therefore, the performance of Fig. 4b will be

$$\frac{E_{out}}{E_{in}} = \frac{1/j\omega C + R_2}{R_1 + 1/j\omega C + R_2}$$

and this can be simplified to

$$\frac{E_{out}}{E_{in}} = \frac{1 + j\omega CR_2}{1 + j\omega C(R_1 + R_2)}$$

by multiplying top and bottom of $j\omega C$. Doing the necessary mathematical manipulation extracts the in-

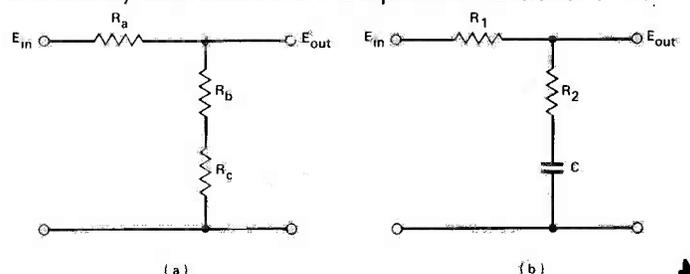
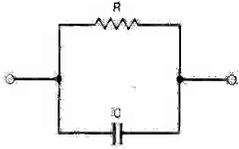


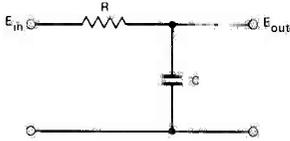
Fig. 4 Attenuation of an RRC network.



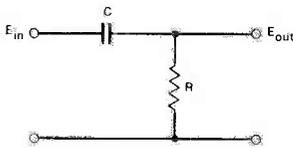
$$Z = \frac{1 + j\omega CR}{j\omega C}$$



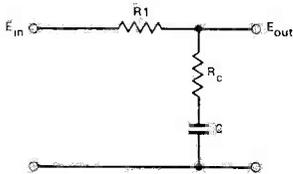
$$Z = \frac{R}{1 + j\omega CR}$$



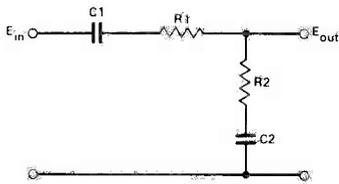
$$\frac{E_{out}}{E_{in}} = \frac{1}{1 + j\omega CR}$$



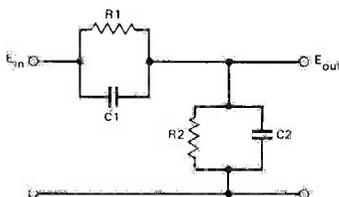
$$\frac{E_{out}}{E_{in}} = \frac{j\omega CR}{1 + j\omega CR}$$



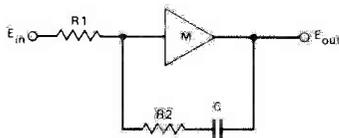
$$\frac{E_{out}}{E_{in}} = \frac{1 + j\omega CR_2}{1 + j\omega C(R_1 + R_2)}$$



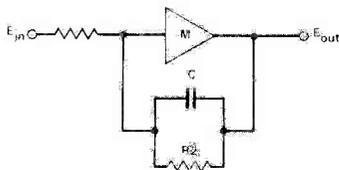
$$\frac{E_{out}}{E_{in}} = \frac{C_1 + j\omega C_1 C_2 R_2}{C_1 + C_2 + j\omega C_2 (R_1 + R_2)}$$



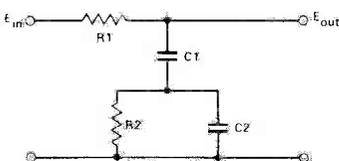
$$\frac{E_{out}}{E_{in}} = \frac{C_1 + j\omega C_1 R_1 R_2}{R_1 + R_2 + j\omega R_1 R_2 (C_1 + C_2)}$$



$$\text{Gain} = -M \frac{1 + j\omega CR_2}{1 + j\omega C (R_2 + MR_1)}$$



$$\text{Gain} = -M \frac{R_2}{R_2 + MR_1 (1 + j\omega CR_2)}$$



$$\frac{E_{out}}{E_{in}} = \frac{1 - \omega R_1 R_2 C_1 C_2 + j\omega (R_1 C_1 + R_2 C_1 + R_2 C_2)}{1 + j\omega R_2 (C_1 + C_2)}$$

Fig. 5 Characteristics of some common RC networks.

phase and quadrature components as

$$\frac{E_{out}}{E_{in}} = \frac{1 + \omega^2 C^2 R^2 (R_1 + R_2)}{1 + \omega^2 C^2 (R_1 + R_2)^2} - \frac{j\omega CR_1}{1 + \omega^2 C^2 (R_1 + R_2)^2}$$

and if we make $R_2 = 0$, the right hand side of this equation simplifies to

$$\frac{1}{1 + \omega^2 C^2 R_1^2} - \frac{j\omega CR_1}{1 + \omega^2 C^2 R_1^2}$$

In this case also we have separated out the in-phase and quadrature components, so that the transmission factor is obtained by doing a square-root of the sum of the squares of these, and the phase angle of the output is given by

$$\text{Tan}^{-1} \left(\frac{\text{quadrature}}{\text{in-phase}} \right)$$

It is always useful, when one comes to the end of an algebraic manipulation like this, to check that one hasn't done anything wildly silly by putting in some limit values. For example, in the equations above, consider the effects of $C = 0$. This causes the equation to become

$$\frac{E_{out}}{E_{in}} = 1$$

which is what we would expect, (assuming the load is infinitely high in resistance). On the other hand, if C is extremely large, the first example gives

$$\frac{E_{out}}{E_{in}} = \frac{R_2}{R_1 + R_2}$$

and the second gives

$$\frac{E_{out}}{E_{in}} = 0$$

Modern programmable pocket calculators make the task of calculating the characteristics of such RC networks relatively easy, once the labour of working out the maths has been done, and although I haven't shown any yet, the process of calculation in RL networks is very similar. One can then, for example, write a suitable programme with the component values held in the calculator memory, and let the calculator go through the process for any frequency value which one enters before pressing the run button.

To remove some of the labour in calculation I am showing in the composite Fig. 5 a selection of RC networks with their impedance and transmission equations.

Resistor-Inductor Networks

The method of calculating the performance of these is identical to that for RC networks, except that one uses $j\omega L$ instead of $1/j\omega C$ in the equations. For example, the circuits of Fig. 6a and 6b have transmissions

$$\frac{E_{out}}{E_{in}} = \frac{j\omega L}{R + j\omega L} \quad \text{and} \quad \frac{R}{R + j\omega L}$$

respectively, which can be broken down into the in-

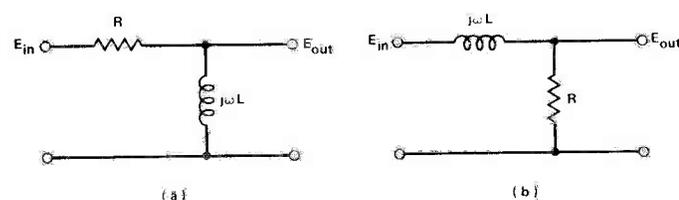


Fig. 6 RL networks.

phase and quadrature components as

$$\frac{(\omega L)^2}{R^2 + (\omega L)^2} + \frac{j\omega LR}{R^2 + (\omega L)^2}$$

and

$$\frac{R^2}{R^2 + (\omega L)^2} - \frac{j\omega LR}{R^2 + (\omega L)^2}$$

In all of the equations shown, it is possible (as I am sure you will have spotted) to change one kind of network into a simpler one by putting values of R or C or L equal to 0. As an example, if we make network (7) of Fig 5 have values of 0 for C_1 and C_2 ,

$$\frac{E_{out}}{E_{in}} = \frac{R_2}{(R_1 + R_2)}$$

which is what we would expect. Or, by just deleting C_1 ($C_1=0$) we will end up with the equation of a type 3 network, when there is a resistor across the output.

Some Practical Examples

A lot of the above may have been a bit dull reading for the non-mathematically inclined (which, I suspect, is 99% of us) and may tempt the reader to ask 'Well, that's all very nice, but what real use is it'. So I propose to show a few examples where there are some slightly surprising outcomes from the sums.

(1) The LC series circuit.

Let us take first the LC series circuit of Fig. 7. Now, it's impedance is just the sum of the two bits, $Z=1/j\omega C + j\omega L$. If we multiply through by 1 ($=j\omega C/j\omega C$), we get

$$Z = \frac{1 - \omega^2 LC}{j\omega C}$$

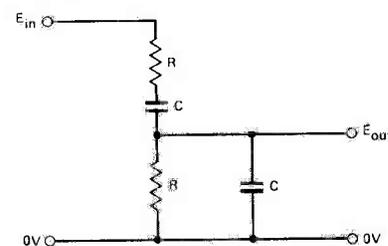
This has an interesting characteristic, that if $\omega^2 LC=1$, $Z=0$. This condition is met if $\omega^2=1/LC$ or $\omega=2\pi\sqrt{1/LC}$. So, at resonance, this series LC network looks like a short circuit. Away from resonance, there is a quadrature component due to the $j\omega C$ term in the bottom line, which causes the phase of the transmitted signal to swing from + to - as the input passes through resonance.



Fig. 7 LC series resonant circuit.

(2) The Wien network.

This interesting and useful circuit, shown in Fig. 8, and the basis for a lot of oscillator designs is basically a network of the type shown in Fig. 5 (1) in series with one of the 5(2) type, with both C s and both R s being of the same value. Since we have already worked out the impedance characteristics of 5(1) and 5(2), we can write down the output, as a proportion of the input, using the familiar $a/(a+b)$ form, where 5(2) is a,



$$\text{at } f_0 = \frac{1}{2\pi\sqrt{CR}}$$

$E_{out} = \frac{1}{3} E_{in}$
with no phase shift.

Fig. 8 The Wien network.

and 5(1) is b.

This gives the rather unwieldy looking equations

$$\frac{E_{out}}{E_{in}} = \frac{R}{1 + j\omega CR} \cdot \frac{1}{\frac{R}{1 + j\omega CR} + \frac{1}{j\omega C}}$$

$$= \frac{j\omega CR}{1 + j\omega CR} \cdot \frac{1}{1 + \frac{R}{j\omega C}}$$

$$= \frac{j\omega CR}{1 + j\omega CR} \cdot \frac{j\omega C}{1 + j\omega CR}$$

fortunately, this simplifies to:-

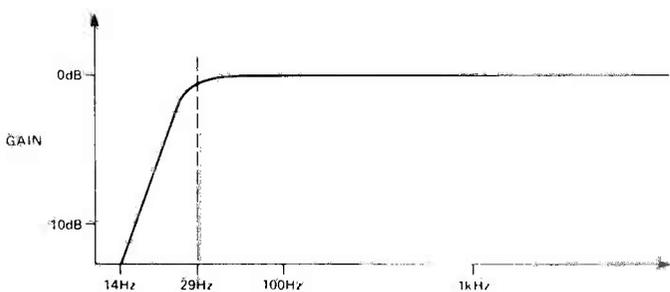
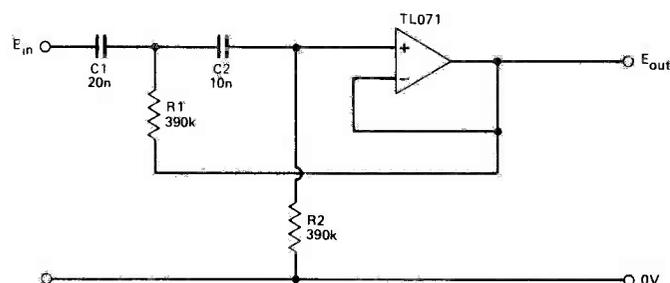
$$\frac{E_{out}}{E_{in}} = \frac{j\omega CR}{1 - (\omega CR)^2 + 3j\omega CR}$$

when $(\omega CR)^2 = 1$ 'or $\omega CR=1$, since $(\sqrt{1}=1)$ ' this becomes,

$$\frac{E_{out}}{E_{in}} = \frac{j\omega CR}{3j\omega CR} = \frac{1}{3}$$

with no 'j' terms left. Now $\omega CR (=2\pi fCR)=1$ when $f=1/(2\pi CR)$, which gives the frequency at which the Wien network output is in phase with the input, and has a magnitude of 1/3 that of E_{in} .

Fig. 9 Sallen and Key type active filters.



$$f_0 = \frac{1}{2\pi\sqrt{C1C2R1R2}}$$

for values shown
= 29Hz for (a)
= 10.2KHz for (b)

$$Q = \frac{\sqrt{xy}}{1+x} = 0.707$$

when $\frac{R1}{R2} = x$

and $\frac{C1}{C2} = y$

(3) The Sallen and Key active filter.

This is one of the archetypes of the class of circuit known as active filters, and is valuable because it can be built with a single op-amp in the form shown in Fig. 9a or 9b. These are high-pass and low-pass versions of the filter. The behaviour of this circuit is such that the gain is substantially level (and x1) at frequencies above, or below, some critical turnover frequency — depending upon whether we are using a high-pass or low-pass arrangement — but beyond this frequency the gain falls at -12dB/octave, as shown in 9c and 9d. If we substitute impedance 'blocks' for the Rs and Cs, as shown in 9e, we can work out a model for the analysis of this circuit using the 'j' techniques described above. However, to simplify your calculations we will assume that our amplifier is an ideal one with unity gain, and has an infinitely high input impedance and a negligibly low output impedance. We can derive the following relationships.

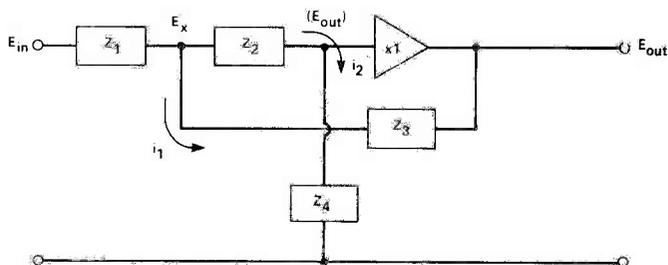
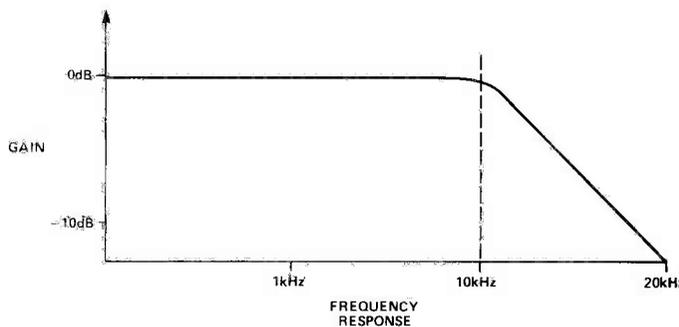
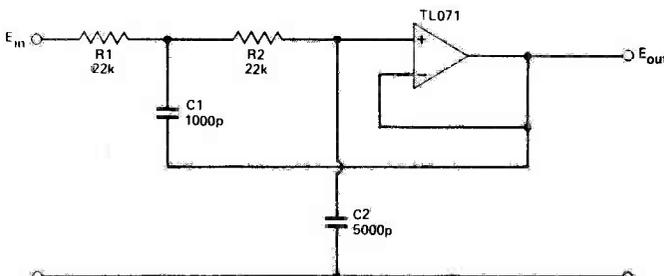
$$E_{in} = E_{out} + (i_1 + i_2)Z_1 + i_2Z_2 \dots \dots \dots (1)$$

$$\text{and } E_{out} = i_2Z_4 \text{ therefore } i_2 = E_{out}/Z_4 \dots \dots \dots (2)$$

$$\text{also } i_1 = (E_x - E_{out})/Z_3 \text{ and } (E_x + E_{out}) = i_2Z_2$$

$$\text{Therefore } i_1 = i_2Z_2/Z_3 \dots \dots \dots (3)$$

From (1) and (3)



$$E_{in} = E_{out} + i_2 Z_1 Z_2 / Z_3 + i_2 Z_1 + i_2 Z_2 \quad (4)$$

and from (4) and (2)

$$E_{in} = E_{out} (1 + Z_1 Z_2 / Z_3 Z_4 + Z_1 / Z_4 + Z_2 / Z_4) \quad (5)$$

Therefore

$$\frac{E_{in}}{E_{out}} = \frac{1}{1 + \frac{Z_1}{Z_4} + \frac{Z_2}{Z_4} + \frac{Z_1 Z_2}{Z_3 Z_4}}$$

$$= \frac{Z_3 Z_4}{Z_3 Z_4 + Z_1 Z_3 + Z_2 Z_3 + Z_1 Z_2} \quad (6)$$

We can now fit in the Rs and $1/j\omega Cs$ in place of the Zs, and get the formulae for the real circuits. In the case of the low-pass filter, (9b and 9d), where $Z_1=R_1$, $Z_2=R_2$ and $Z_3=1/j\omega C_1$ and $Z_4=1/j\omega C_2$,

$$\frac{E_{out}}{E_{in}} = \frac{1}{1 + j\omega C_2 (R_1 + R_2) - \omega^2 (C_1 C_2 R_1 R_2)} \quad (7)$$

Several things can be deduced from this: where $f=0$ ($\omega=0$) the output is $1/1$ (unity gain at VLF), where $\omega^2 (C_1 C_2 R_1 R_2) = 1$ the denominator is at its smallest, and the output is therefore at a maximum. This is the turn-over frequency where $f = 1/2\pi\sqrt{R_1 R_2 C_1 C_2}$, and at this point the output of the circuit is $1/j\omega C_2 (R_1 + R_2)$, which we can call the 'Q' of the circuit.

There is one further small trick which can be done with this calculation. Suppose we say that $x=R_1/R_2$ and $y=C_1/C_2$, then $R_1=xR_2$ and $C_1=yC_2$, and suppose that we call the frequency at which $\omega^2 (C_1 C_2 R_1 R_2) = 1$, ω_0 , then $\omega_0^2 = 1/xy(C_2 R_2)^2$ and $\omega_0 = 1/C_2 R_2 \pi xy$. Also, our middle term $j\omega C_2 (R_1 + R_2)$ becomes $j\omega C_2 R_2 (1+x)$.

Let us now express our equation for frequency as a fraction of ω_0 , the turn-over frequency, we then find that... (7) becomes,

$$\frac{E_{out}}{E_{in}} = \frac{1}{1 + j \frac{\omega (1+x)}{\omega_0 \sqrt{xy}} - \left(\frac{\omega}{\omega_0}\right)^2}$$

and the 'Q', or gain at f_0 , (when $\omega=\omega_0$) is $\frac{\sqrt{xy}}{1+x}$

This gives us a means of calculating the performance of this filter circuit over a range of frequencies, of determining what its turn-over frequency will be, and of predicting the circuit Q at that frequency (for an optimally flat response from a 2 element filter of this type, Q should be $1/\sqrt{2}$ or 0.707).

I have only gone through the sums for a low-pass filter in this instance, but the high pass version will follow if appropriate R2 and Cs are put in place of the Zs.

Conclusions

The use of the 'j' operator, to simulate mathematically the effect of the phase shift in an inductor or capacitor allows useful and instructive calculations to be made on networks which contain Ls and Cs as well as resistances. With a programmable calculator, to take the labour out of the repetitive sums, it becomes practical to calculate a frequency response — and phase shift — for any network which one has the patience to work out. This then, should allow us to explore the performance of our circuitry, while it is still at the 'drawing on paper' stage, and thus avoid surprises!

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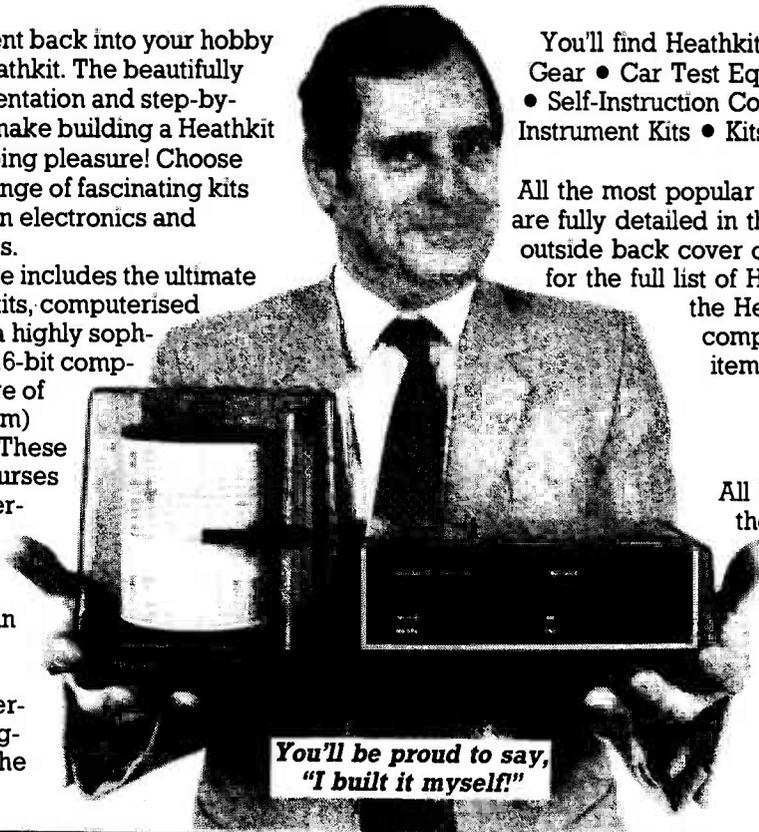
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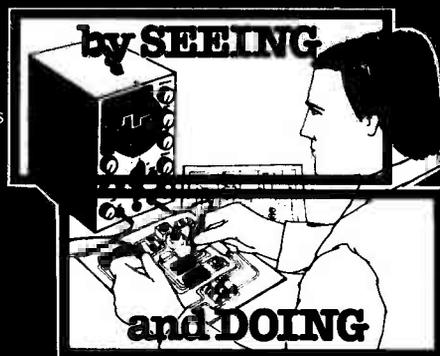
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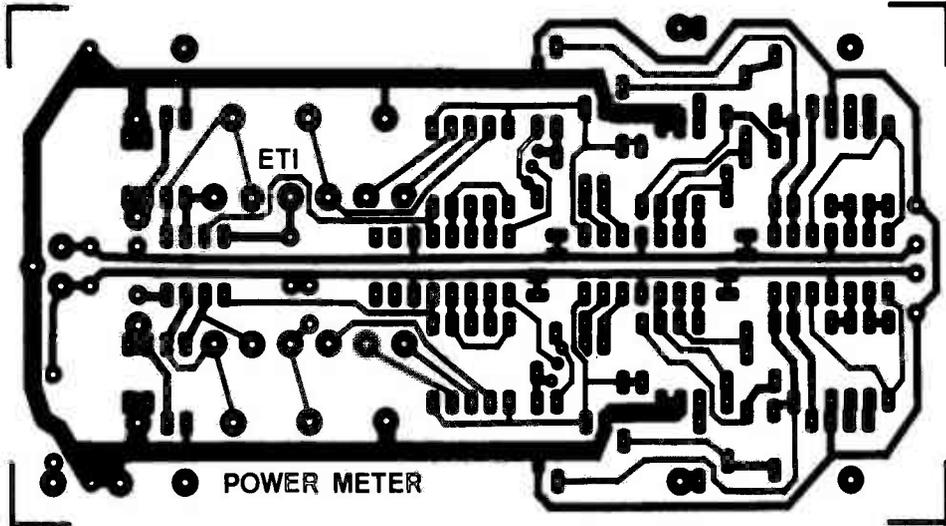
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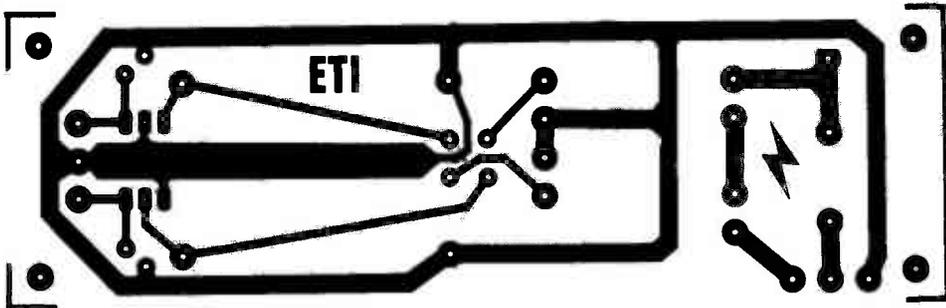


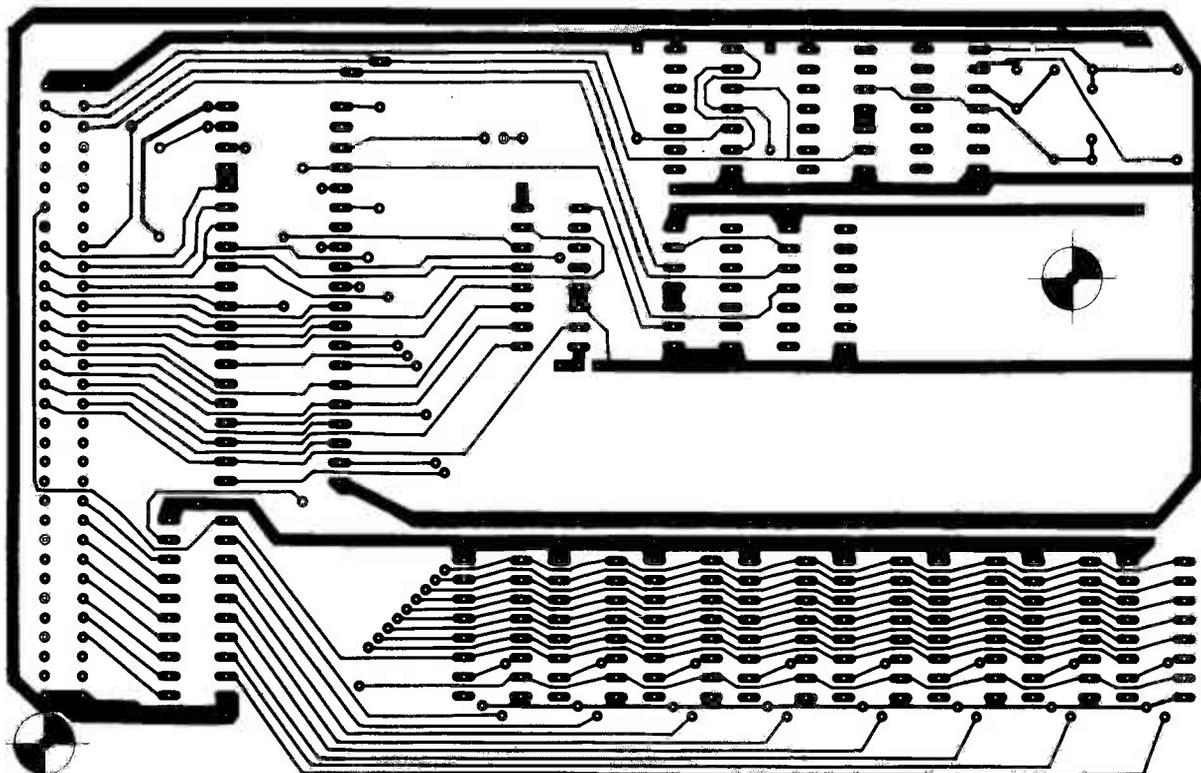
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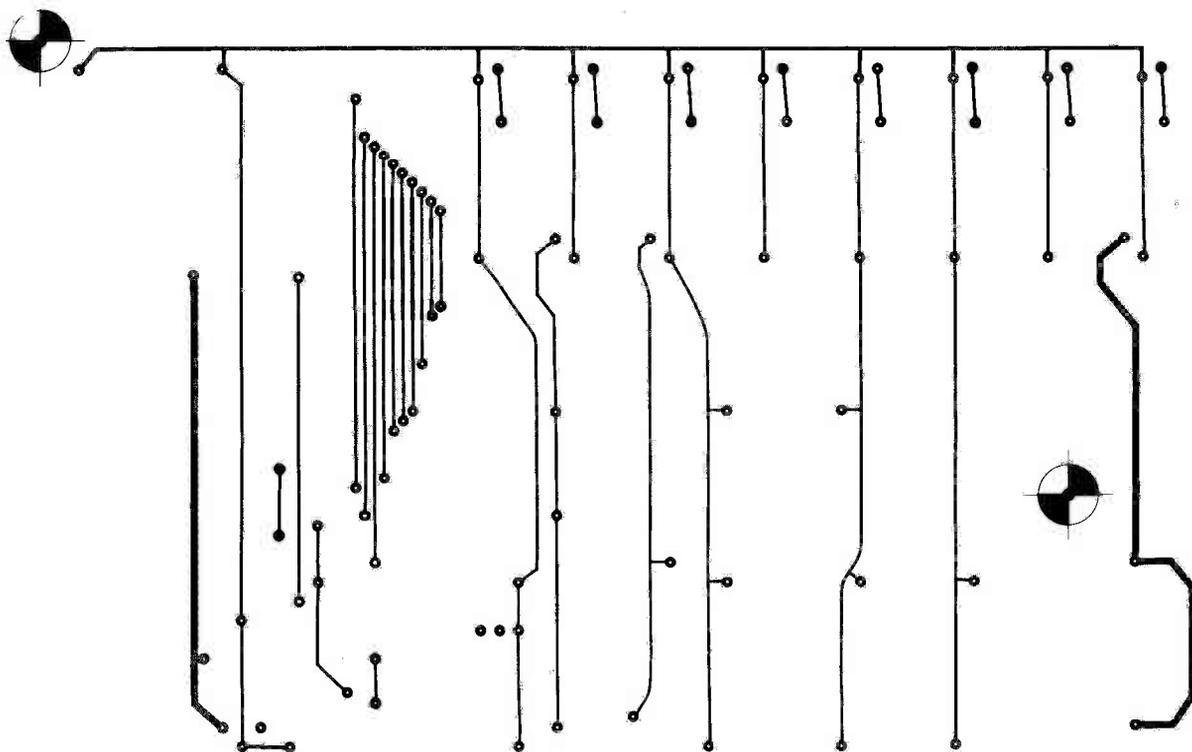


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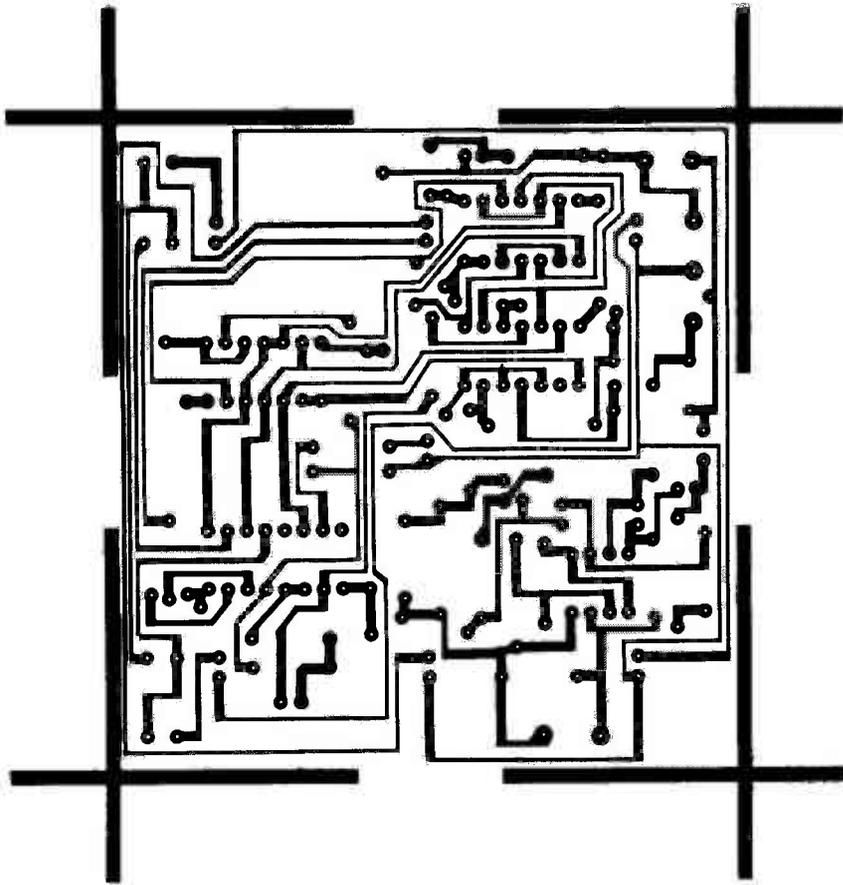




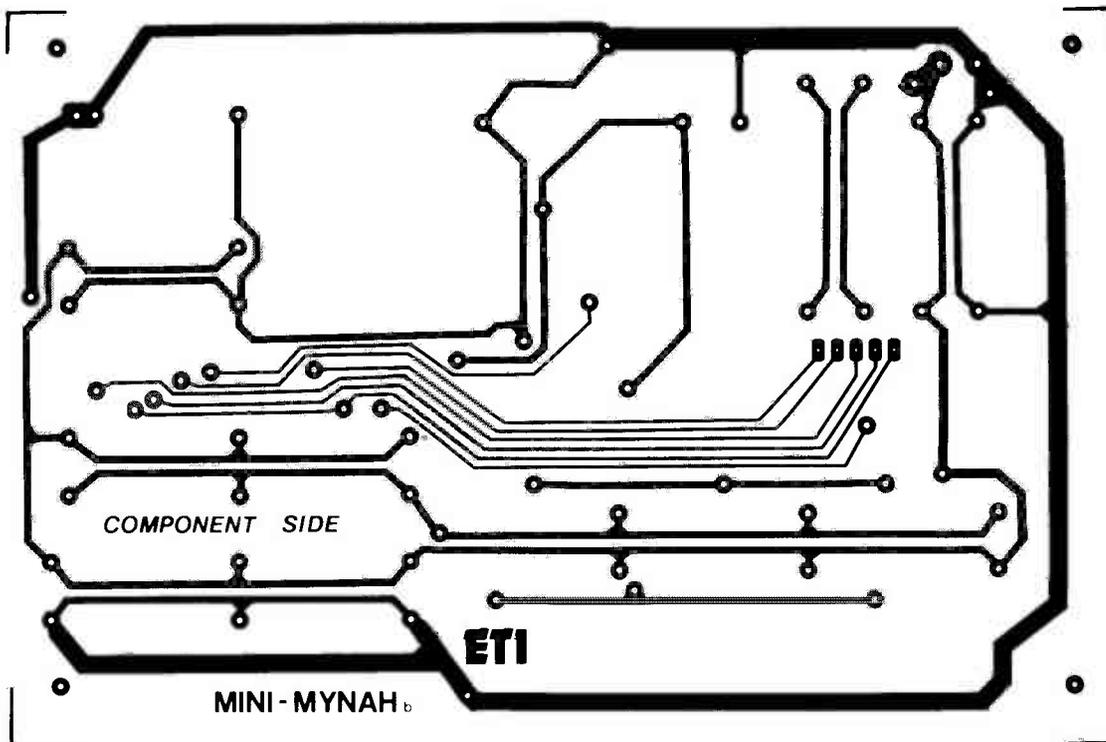
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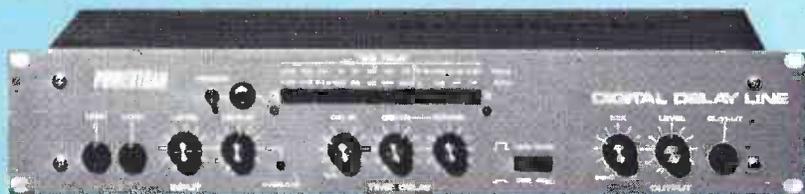
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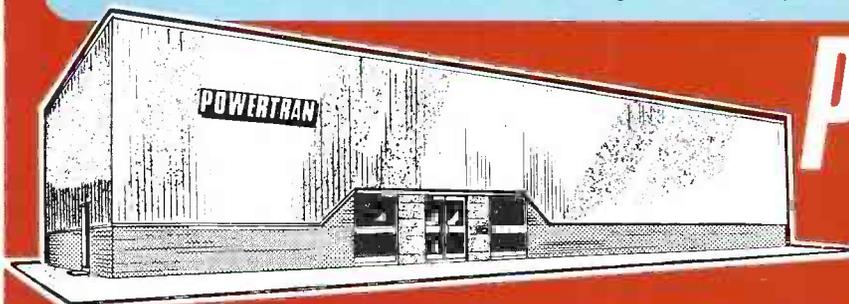


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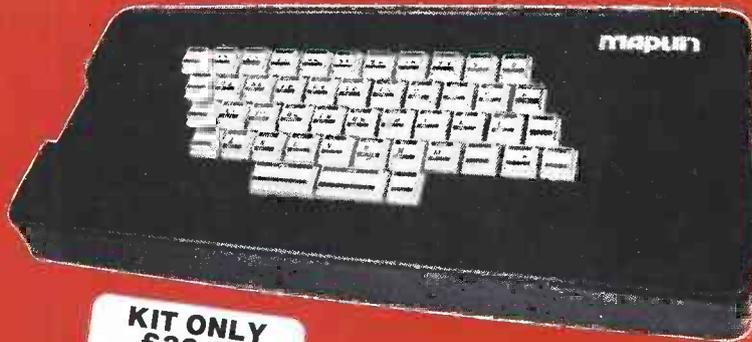
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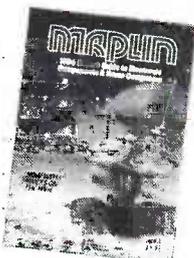
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