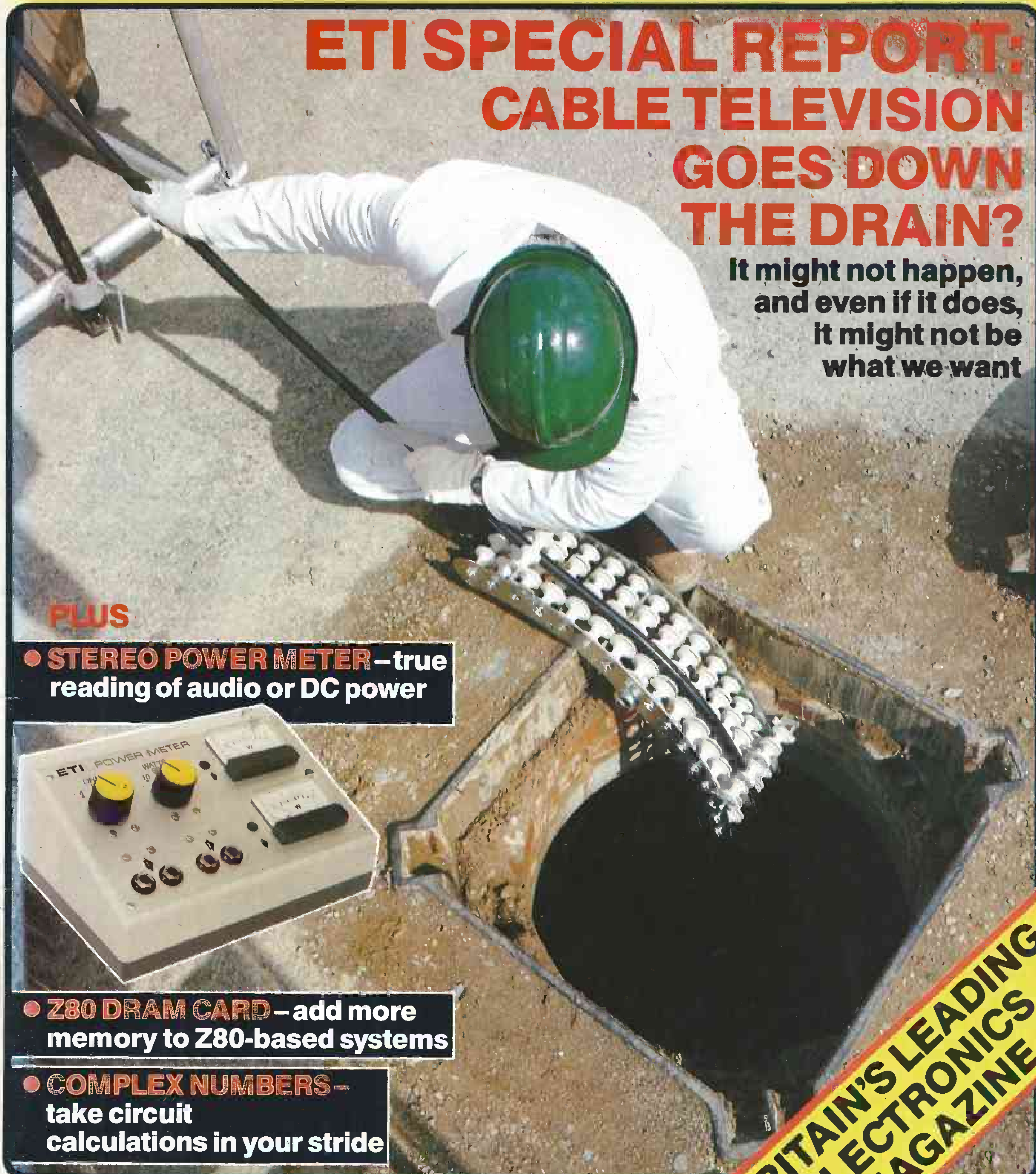
An Argus Specialist Publication

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

AUDIO....COMPUTING....MUSIC....RA ... OTICS.

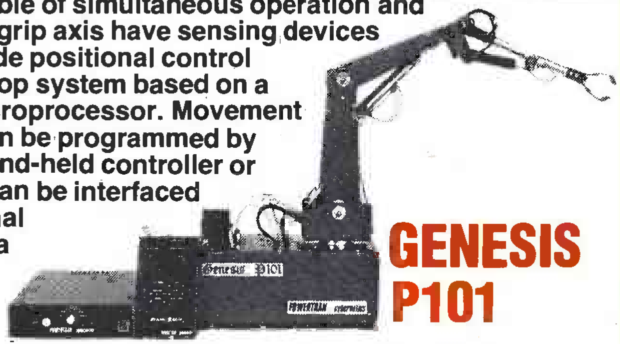
Low-price robots from POWERTRAN

– 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.

GENESIS S101

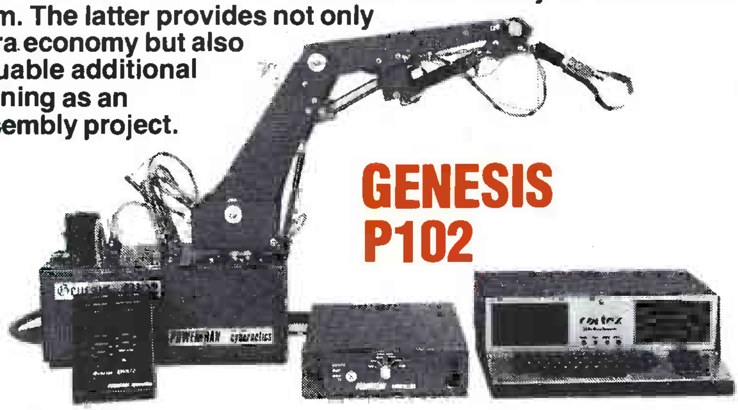
Each robot in the Genesis range has a self-contained hydraulic power source operated from single phase 240 or 120v AC or from a 12v DC supply. Up to six independent axes are capable of simultaneous operation and all except the grip axis have sensing devices fitted to provide positional control by a closed 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 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

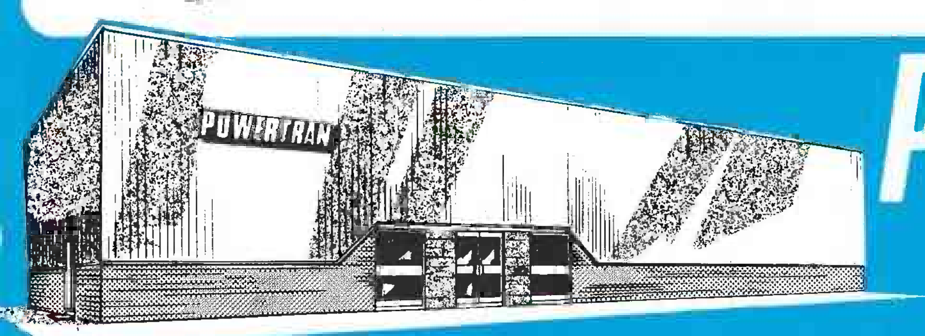
Weight 29kg, max. lifting capacity 1.5kg
4-axis model (kit form) **£425**
5-axis model (kit form) **£475**
5-axis complete system (kit form) **£737**

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.

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

ALL PRICES ARE EXCLUSIVE OF VAT — ALLOW 21 DAYS FOR DELIVERY

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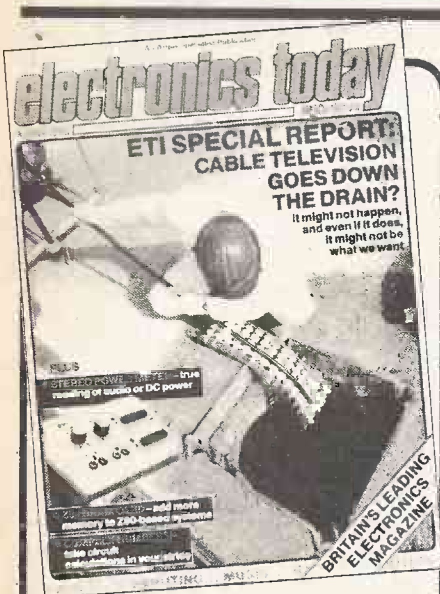

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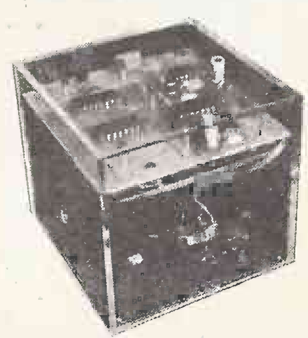
FEATURES

PROJECTS



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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 posssibility for a further extension.

**ALL THIS AND MORE IN YOUR APRIL ISSUE OF ETI — PLACE YOUR ORDER NOW OR RISK MISSING OUT!
ON SALE MARCH 2nd.**

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.

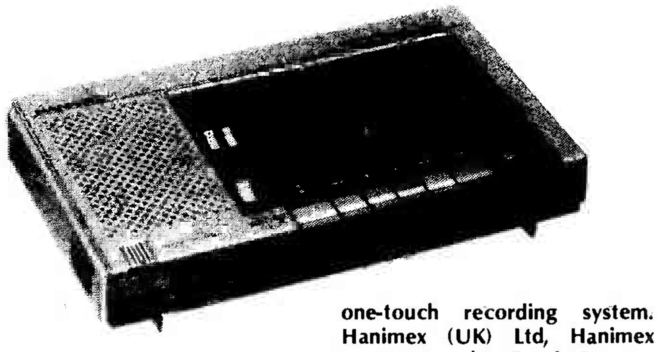
The QL is made by Thorn EMI who hope to be producing 20,000 units a month by the summer. The first samples of the new machine should be available towards the end of February, and will be supplied to mail order only. We haven't had a chance to play with one ourselves yet, but we hope to bring you more 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 descibe 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 experiments 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 Engineeering Information Department, BBC, Broadcasting House, London W1A 1AA, tel 01-927 5432.

NEW YEAR SALE

TRANSISTORS

BC 107B 12p
BC 109C 10p
BC 113/4 16p
BC 115/6 17p
BC 119 28p
BC 139 32p
BC 140 28p
BC 141 29p
BC 142 27p
BC 143 27p
BC 160 30p
BC 161 32p
BC 169C 8p
BC 171B 9p
BC 172C 9p
BC 173C 9p
BC 177B 15p
BC 178C 15p
BC 179 15p
BC 182 9p
BC 182B 9p
BC 183B 9p
BC 183C 9p
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BC 414C 10p

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BC 637 20p
BC 638 20p
BC 639 22p
BC 640 24p
BCY 70 18p
BCY 71 18p
BCY 72 17p
BD 115 50p
BD 131 45p
BD 132 48p
BD 133 70p
BD 135 30p
BD 136 30p
BD 137 30p
BD 138 35p
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BD 242C 54p

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BF 245 25p
BF 256C 32p
BF 256LC 35p
BF 257 32p
BF 258 32p
BF 259 35p
BF 336 36p
BF 337 39p
BF 338 40p
BF 457 32p
BF 458 32p
BF 459 37p
BF 494 12p
BF 595 16p
BF 596 20p
BFX 29 28p
BFX 30 28p
BFX 84 28p
BFX 85 28p
BFX 87 27p
BFX 88 23p
BFY 50 23p
BFY 51 22p
BFY 52 22p
BSY 95A 23p
BU 205 140p
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BU 208 140p
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2N5459 25p
2N5460 38p
2N5550 18p
2N5551 20p
2N6027 23p
2N6028 23p

ZENERS

400 mW
2V7-36V 6p
1.3 W
4V7-51 V 10p

THYRISTORS

C 106D 28p
C 116D 70p
C 126D 90p
C 126M 98p
MCR 101 30p
MCR 102 34p
T 2800D 110p
T 2800M 165p
2N5060 23p
2N5061 24p
2N5062 29p
2N5064 32p

TRIACS

C 206 55p
C 225D 60p
C 226D 70p
C 226M 90p
C 236 90p
C 236M 120p
C 246D 98p
C 246M 140p
BR 100 30p

BRIDGE RECTIFIERS

W 005 18p
W 01 20p
W 02 22p
W 04 24p
W 06 28p
W 08 32p
3A/50V 40p
3A/100V 42p
3A/200V 44p
3A/400V 46p
6A/50V 75p
6A/100V 80p
6A/200V 88p
6A/400V 94p
25A/100V 185p
25A/200V 198p
25A/400V 220p

LED's

3mm red 7p
5mm red 7p
3mm green 10p
5mm green 10p
3mm yellow 10p
5mm yellow 10p
clips 3p
rectangular
Red 10p
Green 14p
Yellow 14p

CMOS

4000 14p
4001 14p
4002 14p
4006 50p
4007 16p
4008 50p
4011 14p
4012 15p
4013 24p
4014 54p
4015 46p
4016 24p
4017 42p
4018 47p
4019 30p
4020 46p
4021 42p
4022 46p
4023 14p
4024 38p
4025 14p
4026 84p
4027 29p
4028 42p
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4035 56p
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4098 78p
40161 52p
40162 52p
40163 52p
4501 16p
4502 55p
4503 34p
4504 98p
4506 70p
4508 145p
4510 50p
4511 52p
4512 48p
4513 98p
4514 110p
4516 55p
4517 180p
4518 52p
4520 55p
4522 65p
4526 64p
4528 56p
4529 72p
4530 92p
4531 70p
4532 88p
4541 70p
4544 120p
4551 88p
4553 180p
4554 148p
4555 48p
4556 48p
4557 160p
4558 110p
4559 390p
4560 170p
4566 120p
4568 270p
4569 140p
4572 42p
4573 198p
4574 198p
4575 198p
4580 280p
4584 38p
4585 74p
4599 178p

VOLTAGE REGULATORS

Positive
100mA
78L05 30p
78L12 30p
78L15 30p
78L18 45p
78L24 45p
1 A TO220
7805 40p
7808 40p
7812 40p
7815 40p
7818 40p
7824 40p
5 A TO3
78H05 500p
Negative
100 mA
79L05 50p
79L12 50p
79L15 50p
1 A TO220
7905 45p
7906 65p
7908 65p
7912 55p
7915 56p
7924 65p
– Variable –
LM 309K 120p
LM 317K 250p
LM 317T 98p
LM 337T 180p
LM 350T 395p
LM 723CN 35p
78H05 500p

OPTO

TIL 32 55p
TIL 38 40p
TIL 78 50p
TIL 100 100p
TIL 111 85p
2N5777 50p
4N25 80p
4N28 70p
4N33 128p
4N35 150p
4N37 100p
BPX 38 390p
BPX 43 340p
TIL 221 20p
(high output clear red)

IC SOCKETS

8 pin 8p
14 pin 9p
16 pin 10p
18 pin 11p
20 pin 14p
22 pin 14p
24 pin 19p
28 pin 24p
40 pin 25p

LINEAR IC's

CA 3046 72p
CA 3065 190p
CA 3080 72p
CA 3086 56p
CA 3089 170p
CA 3090AQ 300p
CA 3130E 95p
CA 3140E 40p
CA 3160E 100p
CA 3161E 140p
CA 3240AE 165p
CA 3240E 110p
CA 3260E 100p
CA 810QM 250p
LF 347 160p
LF 351 45p
LF 353 80p
LF 355 85p
LF 356 88p
LF 357 110p
LM 301A 26p
LM 307 54p
LM 311 60p
LM 318 120p
LM 324 40p
LM 339 46p
LM 348 60p
LM 358 48p
LM 381 140p
LM 381 120p
LM 384 125p
LM 386 90p
LM 387 135p
LM 393 70p
LM 555 16p
LM 556 45p

LM 565 100p
LM 567 150p
LM 709 35p
LM 710 70p
LM 711 60p
LM 733 75p
LM 741 14p
LM 747 50p
LM 748 35p
LM 1458 36p
LM 3900 47p
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MC 1496 70p
MC 1748 35p
MC 3302 72p
MC 3401 68p
MC 3403 65p
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NE 532 56p
NE 544 200p
NE 550 160p
NE 555 16p
NE 556 45p
NE 558 170p
NE 565 140p
NE 560 150p
NE 567 110p
NE 570 395p
NE 571 395p
NE 644 POA
NE 645 270p
RC 4558 48p

SAA5052 £10
SL490 300p
SN76115 98p
SN76660 90p
TBA120S 70p
TBA520Q 200p
TBA550 240p
TBA570Q 200p
TBA625 100p
TBA800 70p
TBA810AS 95p
TBA810S 95p
TBA820 75p
TBA820M 78p
TBA920 195p
TBA950 210p
TCA270 120p
TCA800 250p
TCA940 180p
TDA1022 550p
TDA1024 130p
TDA2002 190p
TDA2003 220p
TDA2004 470p
TDA2005M 440p
TDA2006 240p
TDA2020 430p
TDA2030 325p
TDA2040 450p
TDA2054M 130p
TL061 40p
TL062 80p
TL064 120p
ULN2001 80p
ULN2003 80p
ULN2004 80p

CAPACITORS

Electrolytic radial/axial.

Value/ V	price
0.47 25	5p
0.47 63	6p
1 µF 63*	6p
2.2 16	5p
2.2 63*	6p
4.7 25	6p
4.7 63*	6p
10 µF 10	5p
10 µF 16	6p
10 µF 25*	6p
10 µF 63*	7p
22 µF 16	6p
22 µF 25	6p
22 µF 63*	9p
47 µF 10	7p
47 µF 25	8p
47 µF 63	12p
100 10*	6p
100 16	8p
100 25	10p
100 63	18p
220 10*	8p
220 16	10p
220 25*	14p
220 63	24p
470 10	14p
470 25*	20p
1000 10	18p
1000 25*	20p
2200 10	32p
2200 25*	45p

* axials only available these values, radial available on all of above.

Tantalum bead.

Value/ V	price
0.1 µF 35	12p
0.22 35	12p
0.33 35	12p
0.47 35	12p
0.68 35	12p
1 µF 35	12p
2.2 µF 35	16p
3.3 µF 35	18p
4.7 µF 25	20p
6.8 µF 25	20p
10 µF 16	20p
15 µF 16	28p
22 µF 16	35p
33 µF 16	60p
33 µF 10	36p
47 µF 10	60p
68 µF 10	80p
60 µF 6.3	60p
100 µF 6.3	70p
100 µF 3	38p
150 µF 6.3	90p

Ceramic Plate 63/100 V
3.3 pf to 4N7 6p

Polystyrene 5% 63 V: 10 pF to 1 nF 9p each, 1n2 to 10 nF 12p each.

Polyester C352 series 250 V
0.01, 0.015, 0.022, 0.033, 0.047 6p.
0.068, 0.1 8p
0.15, 0.22 10p
0.33, 0.47 13p
0.68 20p, 1 µ 22p.

Disc Ceramic: 10 N 4p

DIODES

AA 119 9p
BAX 13 5p
BAX 16 6p
OA 47 9p
OA 90 7p
OA 91 7p
OA 95 8p
OA 200 7p
OA 202 8p
1S44 6p
1S921 9p
1N914 3p
1N916 4p
1N4148 3p
1N4149 4p
1N4001 3p
1N4002 4p
1N4003 4p
1N4004 5p
1N4005 5p
1N4006 6p
1N4007 6p
1N5401 11p
1N5402 12p
1N5403 13p
1N5404 13p
1N5405 14p
1N5406 14p
1N5407 15p
1N5408 16p
6A/100V 25p
6A/200V 28p
6A/400V 30p

HEATSINKS

TO5 push on 6mm (80°C/W) 16p each
12mm (60°C/W) 28p each
TO3 14°C/W 40p each
TO3 10°C/W 110p each
TO126/220 18°C/W 22p
All in matt black finish

RESISTORS

¼ Watt Carbon film 5% E 24 series 4.7 R-2M2 1p each.
½ Watt Carbon film 5% E 12 series 1R-10M 2p each.
¼ Watt Metal film 1% E 24 series 10R-1M 4p each.
250p per 100, one value only.
280p per 100 mixed values.
2.5 Watt wire-wound OR22-10 ohms E12 series 25p each.
Presets: miniature horizontal & vertical 9p each 100R-500K.
Multiturn cermet trimmers 100R-500K 88p each.
Potentiometers
Single gang 2K to 1 M 43p each
Single gang with DPST switch 78p each

VEROBOARDS

2.5"x1" 25p
2.5"x3.75" 90p
2.5"x5" 110p
3.75"x3.75" 110p
3.75"x5" 115p
pak of 100 pins 55p
Spot Face cutter 150p

HARDWARE

each
4xTO3 mounting kits 23p 64 mm Loudspeakers 8R 70p
4xTO66 mounting kits 23p 64R 78p each. 300mW rating.
5 xTO126 bushes/washers 18p PP3 battery snaps 6p each.
10xTO220 bushes/washers 28p 4xHP7 battery holder 22p
5 xTO3P bushes/washers 18p 6xHP7 battery holder 32p
20mm panel fuseholder 32p 20mm chassis fuseholder 7p
4mm plugs 12p. 4mm sockets 20p. 4mm insulated terminals 30p. 3.5mm jack socket 15p. 3.5mm jack plug 15p
Phono sockets 15p Switches: miniature toggle. SPST 60p, SPDT 68p, DPDT 78p each. Miniature push buttons: 1A/250V push to make 16p. push to break 23p Midget rotary switches, pcb terminals 2P6W, 4P3W, 3P4W 39p each.
Slide switch 1A/250V DPDT (22 x 12 x 8 mm) 16p.

BRAND NEW COMPONENT PACKS

CP100 60 IC sockets: 8, 14, and 16 pin 20 of each 440p
CP101 20 BC182/BC212 transistors, 10 of each 130p
CP102 20 BC183/BC213 transistors, 10 of each 100p
CP103 20 BC184/BC214 transistors, 10 of each 130p
CP104 20 BC549C/BC559C transistors, 10 of each 130p
CP105 20 BC550C/BC560C transistors, 10 of each 160p
CP106 100 1N914 switching diodes, 75-100V/75mA 240p
CP107 100 1N916 switching diodes, 75/100V/75mA 280p
CP108 100 1N4148 switching diodes, 75-100V/75mA 160p
CP109 500 1N4148 switching diodes, 75-100V/75mA 680p
CP110 30 1N4002 1A/400V rectifiers 100p
CP111 10 MC1458 Dual op amps (741 type) 320p
CP112 100 400mW zeners, 4 of each 2V7 to 33V 450p
CP113 100 1.3W zeners, 4 of each 4V7 to 51V 850p
CP114 4 LF351 JFET op amps, Low noise 170p
CP115 4 LF353 JFET op amps, dual low noise 300p
CP117 50 mixed LED's 3mm/5mm/rect/red/green/yellow 400p
CP119 100 1N4002 1A/100V rectifiers 270p
CP120 10 C106D 400V/4A thyristors 250p
CP121 10 NE556 dual timer IC's 400p
CP124 100 mixed electrolytic capacitors 10-63V/1 1000µF £6
CP125 5 LM317T 1A/TO220 variable regulators 440p

40% off all orders over £50

25% off all orders over £20

ORDERING INFORMATION: Please add **50p** P&P to all orders under **£10.** Cheques or postal orders made payable to Comtech Electronics. Official orders welcome, trade please enquire. All items held in stock despatched same day LARGE SAE brings full list.

COMTECH ELECTRONICS

205 STURDEE ROAD
LEICESTER
LE2 9FY
Telephone: (0533) 779578

★SAME DAY DESPATCH★

★COMPETITIVE & RELIABLE★

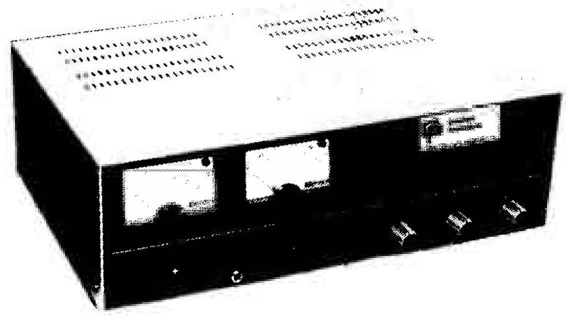
Bench Power Supplies

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 GPL20 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 ± 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, weights 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 ±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.

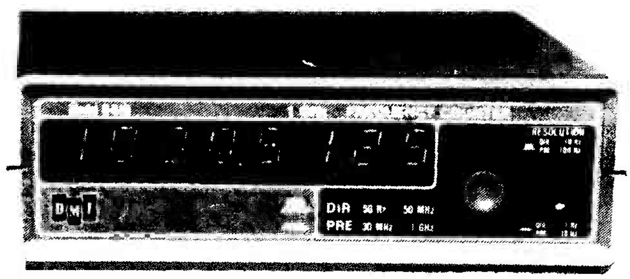
The GPL series power supplies are made entirely in Europe and Gresham say they are holding large stocks in readiness in their warehouse at Hook, Hampshire. The GPL20 costs £99.47, the GPL23a costs £245.00, the GPL25 costs £117.89, and the GPL28 costs £222.89. All prices include VAT but not postage and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

U.K.'s First Electronics Supermarket

Marco Trading have just opened a new self-service supermarket-style electronics components shop with apprroximately 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, Shrepshire, which is just outside Shrewsbury. Marco Trading say there is ample parking, useful if you intend buying some heavy transformers!



Portable Frequency Counters

New from Aspen Electronics is the Digimax500 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 5¼ x 5 x 1½". 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.

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 connected 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 kilometre 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 Bundepost, 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 cableship 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

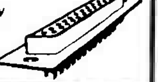
MAIL ORDERS:
Unit 1, Hill Farm Industrial Estate,
Boxted, Colchester, Essex CO4 5RD.
TELEPHONE ORDERS:
Colchester (0206) 36412.

BARCLAYCARD VISA

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 lugs	90p	130p	195p	290p
Right angle	160p	210p	290p	440p
Covers	100p	90p	100p	110p



CONNECTORS

DIN	Plug	Skt	Jack	Plug	Skt
2 pin	9p	9p	2.5mm	10p	10p
3 pin	12p	10p	3.5mm	9p	9p
5 pin	13p	11p	Standard	16p	20p
Phono	10p	12p	Stereo	24p	25p
1mm	12p	13p	4mm	18p	17p

UHF (CB) Connectors:
PL259 Plug 40p. Reducer 14p.
SO239 square chassis skt 38p.
SO239S round chassis skt 40p.
IEC 3 pin 250V/6A.
Plug chassis mounting . . 38p
Socket free hanging . . 60p
Socket with 2m lead . . 120p

SCRs

▶C106D	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.

SWITCHES

Submin toggle:
SPST 55p. SPDT 60p. DPDT 65p.
Miniature toggle:
SPDT 80p. SPDT centre off 90p.
DPDT 90p. DPDT centre off 100p.
Standard toggle:
SPST 35p. DPDT48p
Miniature DPDT slide 14p.
Push to make 14p.
Push to break 22p.
Rotary type adjustable stop.
1P12W, 2P6W, 3P4W all 55p each.
DIL switches:
4SPST 80p 6 SPST 80p. 8SPST 100p.

SOLDERING IRONS

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

VERO

VEROBLOC ◀	375
Size 0.1 matrix	
2.5 x 1	22
2.5 x 3.75	75
2.5 x 5	85
3.75 x 5	95
VQ board	160
Veropins per 100	
Single sided	50
Double sided	60
Spot face cutter	130
Pin insertion tool	162
Wiring pen	330
Spare spool 75p Combs	6

MICRO

		6116P3	320	6852	240	8228	220
		6502CPU	325	6875	495	8251	250
		6522VIA	295	6880	100	8253	390
		6532	570	81LS95	85	8255	225
		6551 ACIA	650	81LS96	85	8259	390
		6800CPU	220	81LS97	85	MC1488	55
2114L2	99	6802CPU	250	8080A	250	MC1489	55
2716	240	6809CPU	620	8085AC	340	Z80ACPU	290
2532	290	6810RAM	115	8156	350	Z80APIO	260
2732	290	6821 PIA	110	8212	110	Z80ACTC	260
2764	425	6840	360	8216	100	Z80ASIO	900
4116P20	85	6850	110	8224	120	Z80A DMA	1150

SOCKETS

	Low profile	Wire wrap
8 pin	6p	28p
14 pin	8p	45p
16 pin	9p	55p
18 pin	12p	60p
20 pin	13p	68p
22 pin	16p	75p
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. ¼W 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
Preset kit. Contains 5 of each value from 100 ohms to 1M (total 65 presets . . . 425
Nut and Bolt kit (total 300 items): 180p
25 6BA ¼" bolts | 50 6BA washers | 50 6BA nuts
25 6BA ½" bolts | 25 4BA ¼" bolts | 50 6BA washers
50 6BA nuts | 25 6BA ½" bolts

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

PP3 battery clips	8
Red or black crocodile clips	6
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 fuseholder	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 - 6p; 0.047, 0.068, 0.1 - 7p; 0.15, 0.22 - 9p; 0.33, 0.47 - 13p; 0.68 - 20p; 1u - 23p.
Electrolytic, radial or axial leads: 0.47/63V, 1/63V, 2.2/63V, 4.7/63V, 10/25V - 7p; 22/25V, 47/25V - 8p; 100/25V - 9p; 220/25V - 14p; 470/25V - 22p; 1000/25V - 30p; 2200/25V - 50p.
Tag end power supply electrolytics: 2200/40V - 110p; 4700/40V - 160p 2200/63V - 140p; 4700/63V - 230p
Polyester, miniature Siemens PCB: 1n, 2n2, 3n3, 4n7, 6n8, 10n, 15n, 7p; 22n, 33n, 47n, 68n, 8p; 100n, 9p; 150n, 11p; 220n, 13p; 330n, 20p; 470n 26p; 680n, 29p; 1u 33p; 2u2, 50p.
Tantalum bead: 0.1, 0.22, 0.33, 0.47, 1.0 @ 35V - 12p, 2.2, 4.7, 10 @ 25V - 20p; 15/16V - 30p; 22/16V - 27p; 33/16V - 45p; 47/6V - 27p; 47/16V - 70p; 68/6V - 40p; 100/10V - 90p.
Cer. disc. 22p-0.01u 50V, 3p each.
Mullard miniature ceramic plate: 1.8pF to 100pF 6p each.
Polystyrene, 5% tol: 10p-1000p, 6p; 1500-4700, 8p; 6800 0.012u, 10p.
Trimmers, Mullard 808 series: 2-10 pF, 22p; 2-22pF, 30p; 5.5-65pF, 35p

REGULATORS

78L05	30	79L05	45
78L12	30	79L12	45
78L15	30	79L15	45
7805	35	7905	40
7812	35	7912	40
7815	35	7915	40
LM309K	130	LM723	35
LM317K	270	78H05	550
LM317T	90		
LM323K	420		

EURO CONNECTORS

Gold flashed contacts:	Rt. angle plug	Wirewrap socket
64 way A+B	195	230
64 way A+C	220	270
96 way A+B+C	320	330

TRIACS

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

DIODES

		▶1N4001	3
BY127	12	1N4002	5
OA47	10	1N4006	7
OA90	8	1N4007	7
OA91	7	1N5401	12
OA200	8	1N5404	16
OA202	8	1N5406	17
1N914	4	400mW zen	6
▶1N4148	3	1.3W zeners	13

JUMPER LEADS

Length	14pin	16pin	24pin	40pin
Sgle ended DIP(header plug) jumper				
24 ins.	145	165	240	380
Dble ended DIP(header plug) jumper				
6 ins.	185	205	300	465
12 ins.	195	215	315	490
24 ins.	210	235	345	540
36ins.	230	250	375	595

25 way D Connector jumpers
18ins. long single ended male 495p.
18ins. long single ended f/male 525p.

OPTO

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

Clips to suit - 3p each.

Rectangular		TIL32	40
▶red	12	TIL78	40
green	17	▶TIL111	60
yellow	17	ORP12	85
ILD74	95	ILQ74	185
▶TIL38	40	TIL100	70
2N5777	45	Dual colour	60

Seven segment displays:
Com cathode | Com anode
DL704 0.3" 95 | DL707 0.3" 95
▶FND500 0.5" 100 | FND507 0.5" 100
10 bar DIL LED display, red 180.
LCD: 3½ digit 495p. 4 digit 520p.

BRIDGE RECTIFIERS

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

COMPUTER CONNECTORS

ZX81 2 x 23 way edge connector wire wrap suitable for ZX81 add-ons . 150
SPECTRUM 2 x 28 way edge connector wire-wrap suitable for SPECTRUM add-ons . . 200

RIBBON CABLE

Grey Ribbon cable. Price per foot

10 way	14	34 way	58
16 way	25	40 way	68
20 way	28	50 way	90
24 way	38	60 way	100

IDC CONNECTORS

	PCB Plug St.	PCB Plug Rt. ang.	Socket	Edge Conn.
10 way	90	90	85	120
16 way	130	130	110	175
20 way	145	145	125	195
26 way	175	175	150	240
34 way	205	205	170	320
40 way	220	220	190	340
50 way	235	235	200	395
60 way	330	330	230	495

LINEAR

				LM339	40	LM3911	120	NE566	140	TL064	96
				LM348	60	LM3914	225	▶NE567	100	TL071	30
				LM358	50	LM3915	225	▶NE570	370	TL072	45
555CMOS	80	ICL7106	680	LM377	170	LM13600	105	NE571	370	TL074	95
556CMOS	150	ICL7611	95	▶LM380	75	MC1496	68	▶RC4136	55	▶TL081	25
709	25	ICL7621	180	▶LM381	120	MC3340	135	▶RC4558	40	TL082	45
▶741	14	ICL7622	180	LM382	120	▶MF10CN	350	SL480	170	TL084	90
748	35	ICL8038	295	LM384	130	ML922	400	SL490	250	TL170	50
9400CJ	350	ICL8211A	200	LM386	90	ML924	195	SL76018	150	UA2240	120
AY-3-1270	720	ICM7224	785	LM387	120	ML925	210	▶SN76477	380	ULN2003	70
AY-3-8910	370	ICM7555	80	LM393	40	ML926	140	SP0256AL2	850	ULN2004	70
AY-3-8912	540	▶LF351	45	LM709	25	ML927	140	TBA120S	70	XR2206	290
CA3046	60	LF353	85	LM711	60	ML928	140	TBA800	75	ZN414	80
▶CA3080	65	LF356	90	LM725	350	ML929	140	TBA810	96	ZN423	135
CA3089	190	LM10	325	LM733	75	MM5387A	465	TBA820	70	ZN424	135
CA3090AQ	375	LM301A	25	LM741	14	NE529	225	TBA950	220	ZN425E	350
CA3130E	85	LM311	50	LM747	60	NE531	140	TDA1008	320	ZN426E	300
▶CA3140E	36	LM318	120	LM1458	40	NE544	205	▶TDA1022	490	ZN427E	600
CA3161E	100	LM324	30	LM2917	200	▶NE555	16	TDA1024	125	ZN428E	410
CA3189	290	LM334Z	100	LM3900	45	▶NE556	45	TL061	40	ZN459	285
▶CA3240E	100	LM335Z	125	▶LM3909	75	NE565	110	TL062	60	ZN1034E	200

TRANSISTORS

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

RESISTORS

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

PCB MATERIALS

Alfac transfer sheets — please state type (e.g. DIL pads etc.)	45
Dalo etch resistant pen	90
Fibre glass board 3.75 x 8"	80
Fibre glass board 8 x 12"	200
Ferric Chloride crystals	100

BOXES

Plastic with lid & screws		Aluminium	
		3 x 2 x 1"	65
		4 x 2¾ x 1½"	95
		4 x 2¾ x 2"	95
3 x 2 x 1"	55	6 x 4 x 2"	120
4½ x 3 x 1½"	88	7 x 5 x 2½"	165
7 x 4 x 2"	160	8 x 6 x 3"	205

CMOS

		4016	20	4034	140	4054	78	4081	12	40193	65	4528	45
		4017	30	4036	249	4055	80	4082	12	4502	60	4529	150
		4018	45	4039	280	4059	430	4085	48	4503	32	4532	60
4000	10	4019	25	4040	40	4060	42	4086	50	4507	35	4534	400
4001	10	4020	42	4041	40	4063	80	4089	125	4508	110	4538	60
4002	12	4021	40	4042	38	4066	22	4093	18	4510	45	4543	50
4006	50	4022	45	4043	40	4067	225	4094	68	4511	40	4549	360
4007	14	4023	16	4044	40	4068	14	4095	65	4512	40	4553	215
4008	36	4024	33	4046	40	4069	13	4097	290	4514	115	4555	35
4009	24	4025	12	4047	35	4070	13	4098	70	4515	115	4556	35
4010	24	4026	75	4048	38	4071	13	4099	70	4516	55	4559	390
4011	10	4027	20	4049	21	4072	13	40106	40	4518	40	4560	140
4012	15	4028	40	4050	21	4073	13	40109	110	4520	50	4584	35
4013	20	4029	45	4051	42	4075	13	40163	60	4521	90	4585	60
4014	45	4030	14	4052	48	4076	45	40173	100	4526	60	4724	140
4015	40	4031	125	4053	48	4077	14	40175	75	4527	50		

LS TTL

		LS20	15	LS75	26	LS123	48	LS160	38	LS197	45	LS353	60
		LS21	15	LS76	20	LS125	30	LS161	38	LS221	55	LS365	28
		LS22	15	LS78	20	LS126	30	LS162	38	LS240	60	LS366	28
LS00	14	LS26	15	LS83	35	LS132	35	LS163	38	LS241	55	LS367	28
LS01	14	LS27	15	LS85	42	LS136	28	LS164	40	LS242	58	LS368	29
LS02	14	LS30	15	LS86	24	LS138	60	LS165	50	LS243	58	LS373	58
LS03	15	LS32	15	LS90	25	LS139	30	LS166	70	LS244	100	LS374	60
LS04	15	LS37	16	LS92	25	LS145	60	LS170	80	LS245	78	LS375	43
LS05	15	LS38	16	LS93	25	LS147	95	LS173	60	LS247	50	LS377	60
LS08	15	LS40	16	LS95	40	LS148	90	LS174	36	LS251	36	LS378	57
LS09	15	LS42	30	LS96	95	LS151	40	LS175	36	LS257	32	LS390	45
LS10	15	LS47	38	LS107	40	LS153	40	LS190	40	LS258	35	LS393	40
LS11	15	LS48	38	LS109	30	LS154	95	LS191	40	LS259	60	LS399	56
LS12	15	LS51	15	LS112	27	LS155	30	LS192	40	LS266	24	LS541	78
LS13	18	LS55	15	LS113	28	LS156	36	LS193	40	LS273	55	LS670	35
LS14	33	LS73	20	LS114	28	LS157	26	LS195	36	LS279	32		
LS15	15	LS74	20	LS122	38	LS158	30	LS196	45	LS283	40		

TTL

		7413	25	7444	70	7483	38	74122	38	74161	46	74190	48
		7414	30	7446	55	7485	80	74123	40	74162	40	74191	48
		7416	26	7447	40	7486	26	74125	33	74163	40	74192	48
7400	14	7417	26	7448	42	7489	165	74126	33	74164	45	74193	40
7401	14	7420	16	7450	16	7490	22	74132	36	74165	45	74194	40
7402	14	7421	22	7451	16	7491	35	74141	55	74167	150	74195	40
7403	14	7422	22	7453	16	7492	25	74145	45	74170	125	74196	45
7404	16	7427	20	7454	16	7493	25	74147	75	74173	58	74197	40
7405	16	7428	22	7460	16	7494	35	74148	60	74174	54	74198	80
7406	28	7430	16	7472	24	7495	35	74150	55	74175	50	74199	80
7407	28	7432	22	7473	27	7496	35	74153	36	74176	40		
7408	16	7433	22	7474	23	7497	90	74154	60	74177	42		
7409	16	7437	25	7475	30	74100	80	74155	36	74179	70		
7410	16	7438	25	7476	27	74107	26	74156	36	74180	40		
7411	16	7440	16	7480	48	74109	30	74157	30	74181	105		
7412	16	7442	32	7482	65	74121	28	74160	40	74182	40		

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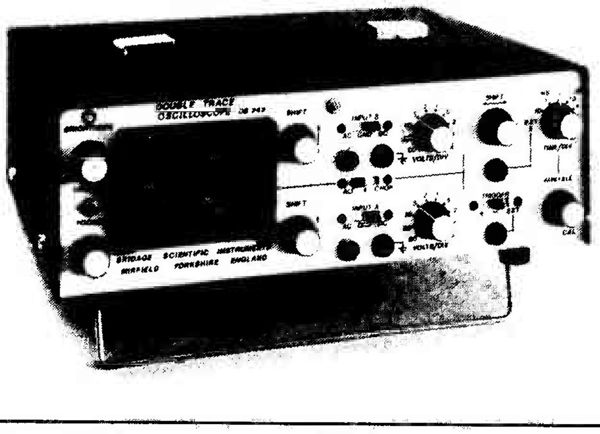


Low Cost Dual Trace 'Scope

Bridage 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. Bridage 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. Bridage Scientific Instruments Ltd, 63-65 High Street, Skipton, North Yorkshire BD23 1EF, tel 0756-69511.

New Micro From Oric

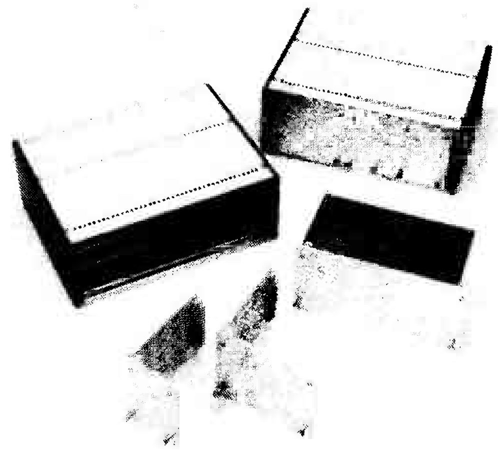
Atmos, a new 48K microcomputer from Oric Products International, was launched at the Which Computer? show at the National Exhibition Centre in January. The new micro supercedes the Oric 1 and contains a number of new features and refinements compared with the earlier machine, most notably a professional 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 @ 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 ± 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 CEGB 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.

High-Speed, Low-Power Op-Amp

Burr-Brown has announced a high-speed low-power operational amplifier that draws only 230μA maximum quiescent current at ±15V 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 ±15V supply voltage, the OPA21's power consumption is only 6.9mW while at ±2.5V, 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/μSec (typical) allowing it to be employed in high-speed applications, and a low offset voltage of 100uV drifting with temperature at 1μV/°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.

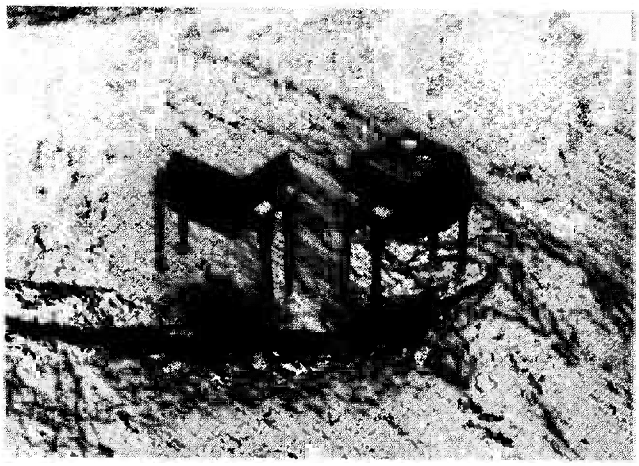
The device has a signal handling range of 120 dB which gives a range of 6-9 metres (20-30') in very bright sunlight and between 18-24 metres (60-80') in dull sunless conditions. An on chip gyrator circuit allows operation in environments with high background light levels and fast acting AGC improves 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°to +70°C. Full details are available from Plessey Semiconductors Limited, Cheney Manor, Swindon, Wiltshire SN2 2QW, tel 0793-36251.

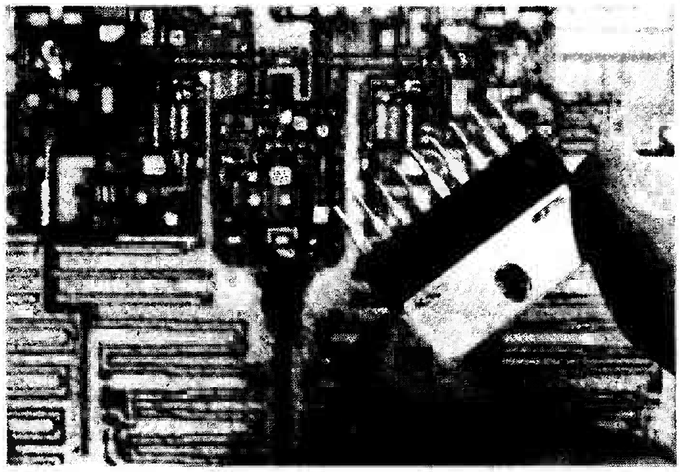
DRAM Controllers

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

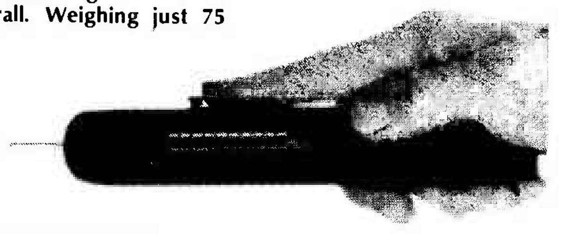
The Siemens TCA 2365 offers two power op-amps on a single chip. Each amplifier has an output of 2.5A, and the use of an additional inhibit circuit enables three output states to be selected. Siemens claim that combining two amplifiers in a single package costs significantly less than two equivalent single 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/μs, 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.

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 slimline 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.

● Eons ago (well, last November, actually) we featured an IEEE interface for the BBC micro in Digest. The Procyon Interface has sold so well that the manufacturers, Cambridge Systems Technology, have abandoned plans to market it directly and are seeking dealers in both the home computer and the educational/scientific markets. Full support, training, and generous dealer discounts are offered, and those interested should contact CST, 30 Regent Street, Cambridge CB2 1DB, tel 0223 323302.

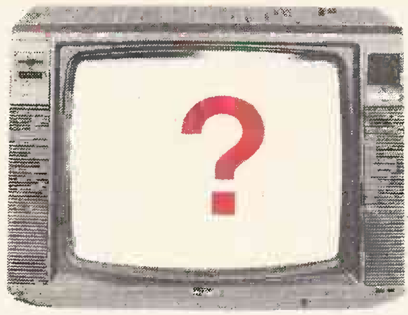
● R.S. Electromatics offer a repair and calibration service for multimeters and other test equipment. They use the Royal Mail parcel service, will quote on repairs before carrying them out, and can be contacted on 0733 71958. R. S. Electromatics, 511 Fulbridge Road, Werrington, Peterborough PE4 6SB.

● 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 unat-tyred 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?

ETI

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 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 suggest 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 moeny, 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 investers 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 then in again. This sounds remarkably like the laying of cables to me. Unfortunately, Keynes' ideas have been supplanted by the moneterist 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 programmes, 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 *he 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 Televsion 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-explcit 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 must 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 tht 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 be 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

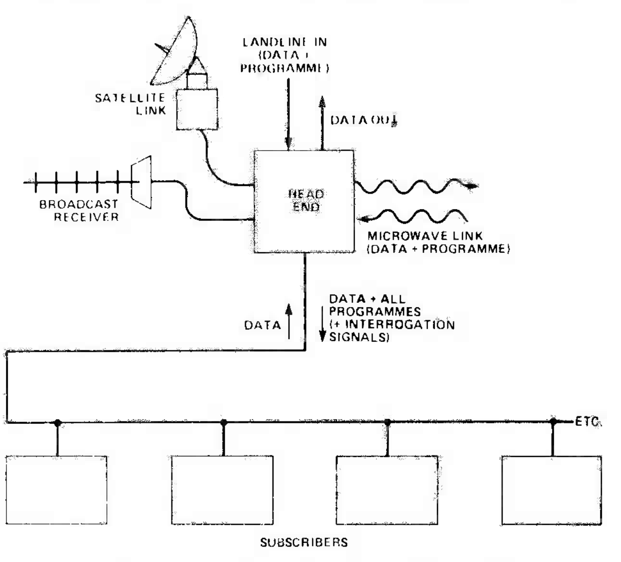


Fig. 1 The tree and branch distribution system.

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 forseeable 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 comit 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 interractive 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), telebetting, 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.*

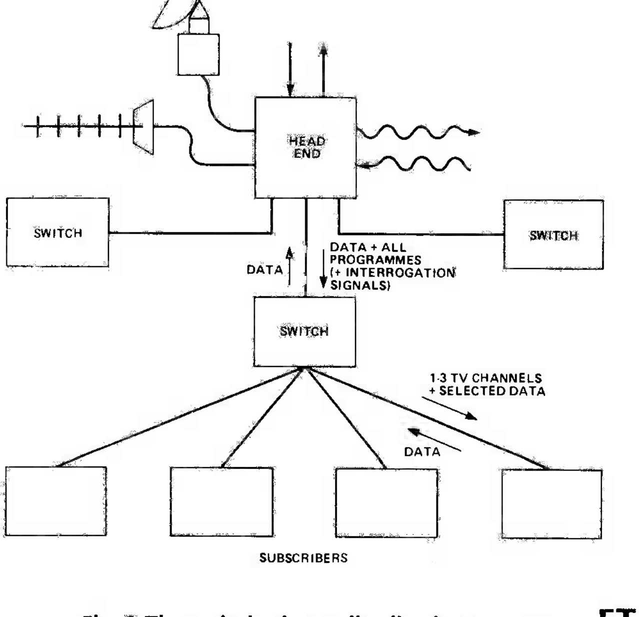


Fig. 2 The switched star distribution system. **ETI**

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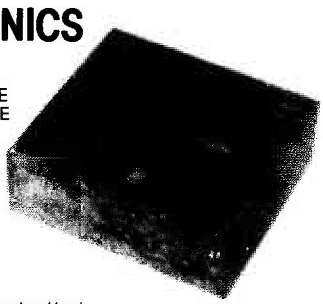

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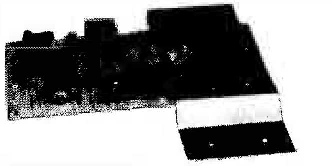

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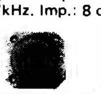

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74LS13	25p	74LS166	90p
74LS14	34p	74LS168	140p
74LS15	20p	74LS169	110p
74LS20	20p	74LS170	100p
74LS21	20p	74LS173	90p
74LS22	20p	74LS174	45p
74LS24	20p	74LS175	45p
74LS27	20p	74LS181	120p
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74LS76	27p	74LS247	70p
74LS83	46p	74LS248	70p
74LS85	60p	74LS249	70p
74LS86	25p	74LS251	45p
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74LS124	150p	74LS290	55p
74LS125	34p	74LS293	50p
74LS126	34p	74LS295	70p
74LS132	42p	74LS363	180p
74LS133	30p	74LS364	180p
74LS136	30p	74LS365	34p
74LS138	42p	74LS366	34p
74LS139	42p	74LS367	34p
74LS145	75p	74LS368	34p
74LS147	120p	74LS373	100p
74LS148	120p	74LS374	100p
74LS151	50p	74LS375	60p
74LS153	50p	74LS390	60p
		74LS393	120p

TRANSISTORS

AD161	42p
AD162	42p
BC107	10p
BC108B	12p
BC109	10p
BC109C	12p
BC177	18p
BC178	18p
BC179	20p
BC182L	10p
BC183L	10p
BC184L	10p
BC212L	10p
BC213L	10p
BC214L	10p
BC547	12p
BC548	12p
BC549C	14p
BC556	15p
BC557	15p
BC558	15p
BC559	15p
BFY50	23p
BFY51	23p
BFY52	23p
TIP29A	32p
TIP30A	38p
TIP31A	38p
TIP32A	38p
TIP33A	68p
TIP34A	74p
TIP41A	50p
TIP42A	55p
TIS43	32p
2N2646	45p
2N2904	28p
2N2905	28p
2N2906	28p
2N2907	28p
2N3053	28p
2N3055	48p
2N3702	10p
2N3703	10p
2N3704	10p
2N3705	10p
2N3706	10p
2N3707	10p
2N3708	10p
2N3709	10p
2N3819	22p
2N3903	18p
2N3904	18p
2N3905	18p
2N3906	18p
2N5457	30p
2N5458	30p
2N5459	30p

COMPUTER CHIPS

Z80A	320p
Z80ACTC	250p
Z80ADART	700p
Z80AP10	250p
Z80SIO	810p
6802	225p
6821	100p
6840	375p
6850	110p
6852	250p
6875	500p
8085	450p
8154	950p
8156	350p
8212	100p
8216	100p
8226	270p
8250	850p
8253	390p
8255	255p
8259	400p

MEMORIES

2102-3L	120p
2114-2L	100p
2516	250p
2532	375p
2708	250p
2716	250p
2732	320p
4116-20	100p
4164-15	400p
4816-AP3	280p
5101	210p
6116P-3	350p
74S188	150p
74S288	150p
74S387	225p
74S474	400p

CRYSTALS

1MHZ	290p
2MHZ	225p
4MHZ	150p
6MHZ	150p
10MHZ	175p
18MHZ	200p

LINEAR ICs

741	14p
748	36p
CA3019	80p
CA3046	70p
CA3048	220p
CA3059	285p
CA3060	280p
CA3080	72p
CA3088	48p
CA3130E	90p
CA3130T	110p
CA3140E	90p
CA3140E	50p
CA3160E	100p
CA3161E	150p
CA3162E	450p
CA3189E	300p
CA3240E	110p
CA3280G	200p
LF347	180p
LF351	48p
LF353	88p
LF355	85p
LF356	85p
LF357	110p
LM301A	25p
LM310	120p
LM311	70p
LM318	150p
LM319	215p
LM324	30p
LM324Z	90p
LM335Z	140p
LM339	50p
LM348	85p
LM380	75p
LM381N	145p
LM382	115p
LM384	180p
LM386	80p
LM387	120p
LM389	95p
LM393	100p
LM3900	60p
LM3909N	88p
LM3911	125p
LM3914	280p
LM3915	250p
LM3916	280p
LM13600	110p
MC1310P	150p
MC1445	250p
MC1456	36p
MC1495L	350p
MC1496	70p
MC3340P	120p
MC3403	65p
NE531	140p
NE544	150p
NE555	18p
NE556	45p
NE564	420p
NE565	120p
NE566	155p
NE567	140p
NE570	410p
NE571	400p
NE592	80p
NE5534P	110p
TBA810	95p
TBA820	80p
TL061CP	40p
TL062	80p
TL064	95p
TL071/81	25p
TL072/82	45p
TL074	100p
TL084	90p
TL094	200p
TL170	80p
TL430C	70p
ZN414	80p
ZN419C	190p
ZN423E	130p
ZN424E	130p

4000 CMOS

400	10p
4001	10p
4002	12p
4006	50p
4007	14p
4008	38p
4009	24p
4010	24p
4011	11p
4012	15p
4013	20p
4014	48p
4015	40p
4016	20p
4017	32p
4018	45p
4019	25p
4020	48p
4021	40p
4022	45p
4023	13p
4024	32p
4025	13p
4026	80p
4027	20p
4028	40p
4029	45p
4030	15p
4037	110p
4038	110p
4040	40p
4041	40p
4042	40p
4043	40p
4044	40p
4045	108p
4046	50p
4047	45p
4048	50p
4049	24p
4040	24p
4051	45p
4052	50p
4068	14p
4069	14p
4070	14p
4071	14p
4072	14p
4073	14p
4075	14p
4076	48p
4077	15p
4078	15p
4081	14p
4082	15p
4086	55p
4089	125p
4093	24p
4094	90p
4095	75p
4096	70p
4501	28p
4502	60p
4503	45p
4504	75p
4508	35p
4507	35p
4510	45p
4511	45p
4512	88p
4518	40p
4520	50p
4521	80p
4526	60p
4527	80p
4528	80p
4532	70r
4583	90p
4584	38p
4585	75p
40085	90p
40097	50p
40102	140p
40103	170p
40106	36p
40109	100p
40163	80p
40174	50p
40175	50p
40193	60p

OPTO ELECTRONICS

2N577	40p	TIL78	55p
OCP71	160p	TIL31A	120p
ORP12	120p	TIL32	55p
ORP60	120p	TIL81	90p
ORP61	120p	TIL100	75p

VOLTAGE REGULATORS (PLASTIC) TO220

7805	40p	7905	45p
7812	40p	7912	45p
7815	40p	7915	45p
7818	40p	7918	45p
7824	40p	7924	45p

ISOLATORS

ILD74	130p
ILQ74	240p
TIL112	70p
TIL113	70p
TIL116	70p

LED inc clip

	3 mm	5 mm
Red	9p	10p
Yellow	12p	14p
Green	12p	12p

THYRISTORS

5A 400V	40p	C106D	36p
5A 600V	48p	TIC44	24p
8A 600V	90p	TIC45	29p
12A 400V	95p	TIC47	35p
BT106	150p	2N5062	32p
BT116	180p	2N5064	38p

7 SEGMENT DISPLAYS

DL704	90	TIL312	105
DIL707	90	TIL313	105
FND357	120	TIL321	115
FND500	115	TIL322	115

TRIACS

3A/100V	46p	12A/100V	75p
3A/400V	56p	12A/400V	82p
8A/100V	60p	12A/800V	135p
8A/400V	69p	16A/100V	103p
8A/800V	115p	16A/400V	105p

DIODES

0A47	8p
0A90	9p
0A91	9p
0A200	9p
0A202	9p
1N914	4p
1N916	7p
1N4148	4p
1N4001	5p
1N4004	6p
4007	7p

BRIDGE RECTIFIERS

1A50V	19p
1A100V	20p
1A400V	25p
2A100V	30p
2A400V	45p

ZENER DIODES
2.7-33V
400mW 9p

ELECTROLYTIC CAPACITORS
(Axial & Radial) Values in uf
63V 1, 2.2, 3.3, 4.7, 6.8 10 **6p**; 15, 22 33 **8p**
40V: 330 470 **45p**; 1000 **48p**; 2200 **70p**
25V 47 100 **8p**; 220, 330 **12p**; 470 **25p**, 680 1000 **34p**; 220 **80p**, 4700 **92p**
16V 470 **14p**; 1000 **20p**
10V 1000 **15p**; 2200 **25p**
POLYESTER CAPACITORS (Radial) 250V 10n 15n 22n, 33n, 47n **6p**; 68n, 100n **8p**; 150n, 220n, 330n **10p**; 470n **15p**; 680n **20p**; 1000n **25p**
MYLAR FILM CAPACITORS (Radial) 100V 1n, 1n5, 2n2, 3n3 4n7, 6n8, 10n **6p**; 15n, 22n 33n, 47n **8p**
CERAMIC CAPACITORS 50V Radial Lead 22pf–47,000pf E12 Values **4p**

POTENTIOMETERS

Carbon track 0.25W log & linear	
5K-2M single gang	30p
5K-2M single gang D/P switch	78p
5K-2M dual gang stereo	68p
PRESET POTENTIOMETERS Horizontal & Vertical	
0.1W 100R-1 Meg	7p
0.25W 100R-1 Meg	10p
RESISTORS 5% Carbon Film E12 values	
0.25W 1R-5M1	1p
0.5W 1R-5M1	1.5p

SWITCHES

Slide 1A	
DPDT	14p
DPDT c/off	15p
Sub-min Toggle	
SPST on/off	54p
SP c/over	60p
DPDT	75p
DPDT c/off	86p
Push Button	
Push to Make	15p
Push to Break	25p

RIBBON CABLE
Grey/meter

10 way	40p
16 way	60p
20 way	65p
26 way	120p
34 way	160p
40 way	180p
50 way	200p
64 way	280p

DIL SOCKETS

Pin	Low Prof	Wire Wrap
8	8p	25p
14	10p	35p
16	10p	40p
20	22p	50p
24	24p	55p
40	30p	100p

D-CONNECTORS
No of Ways

	9	15	25	37
Male				
Solder	80p	105p	160p	250p
Angled	150p	210p	250p	365p
Female				
Solder	105p	160p	200p	335p
Angled	165p	215p	290p	440p
Hoods	90p	85p	90p	100p

EURO CONNECTORS

	Plug	Skt
DIN 41617		
21 way	160p	165p
31 way	170p	170p
DIN 41612		
2x32 way St Pin	220p	275p
2x32 way Ang Pin	275p	320p
3x32 way St Pin	260p	300p
3x32 way Ang Pin	375p	350p

DIL HEADERS

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

TRANSFORMER
Min Split Bobbin
Primary 240V
Second 6-0-6 9-0-9 12-0-12
PCB Mounting

3VA	200p
6VA	270p
Standard	
6VA	220p
12VA	295p
24VA*	330p

* Also 24-0-24

VEROBOARDS

	clad	plain
2½ x 3¾"	73p	52p
2½ x 5"	83p	—
3¾ x 3¾	83p	—
3¾ x 5"	95p	79p
3¾ x 17"	325p	211p
4¾ x 18"	425p	—
Pkt of 100 pins		50p
Spot face cutter		118p
Pin insertion tool		152p

ALUM BOXES

3 x 2 x 1"	65p
4 x 2¼ x 2"	85p
4 x 2¼ x 2½"	103p
4 x 4 x 2"	105p
4 x 4 x 2½"	120p
5 x 4 x 1½"	98p
5 x 4 x 2½"	120p
5 x 2¼ x 1½	80p
5 x 2¼ x 2½"	130p
6 x 4 x 2	120p
6 x 4 x 3	150p
7 x 5 x 3"	180p
8 x 6 x 3"	210p

PLUGS AND SOCKETS

	Plugs	Skts
¼ Mono	220p	200p
¼ Stereo	30p	25p
3.5mm Mono	12p	15p
3.5mm Metal	20p	
2.5mm Mono	12p	15p
2.5mm Metal	20p	
Phon plastic	15p	16p
Metal	20p	

Retail Shop: North Parade Electronics, Mollison Way, Edgware, Middlesex.

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.

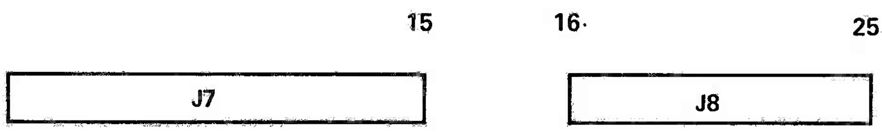
The major error is that the software listings (both the EPROM listing and the data for the alternative BASIC program) were for a different generation of prototype from that for which the circuit diagram was given. There are two ways of ammending this; you can **EITHER:**

- 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 conected 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.



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	a	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	O	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
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	O	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	C4		5C	01	|	7C	BB
1D	10	=	3D	63	}	5D	8A		7D	01
1E	10	>	3E	C2		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:

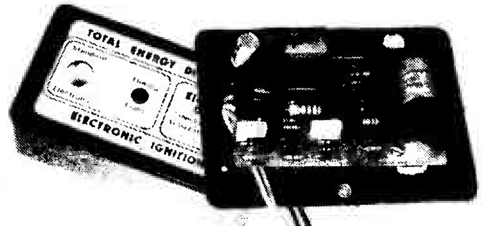
Line 70: open file number 1, the file name being the string variable B$; if the end of the file is reaced, then go to line 340;
Line 80: read one line from the input file number 1;
Line 210: output to the port number 7E (hexadecimal radix) the contents of variable X;
Line 220: output to port 7F all zeros; 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**

electronize **AUTO-ELECTRONIC PRODUCTS**

KITS OR READY BUILT

TOTAL ENERGY DISCHARGE ELECTRONIC IGNITION



IS YOUR CAR AS GOOD AS IT COULD BE?

THE BEST WINTER STARTER

★ Is it **EASY TO START** in the cold and the damp? Total Energy Discharge will give the most powerful spark and maintain full output even with a near flat battery.

★ Is it **ECONOMICAL** or does it "go off" between services as the ignition performance deteriorates? Total Energy Discharge gives much more output and maintains it from service to service.

★ Has it **PEAK PERFORMANCE** or is it flat at high and low revs. where the ignition output is marginal? Total Energy Discharge gives a more powerful spark from idle to the engines maximum (even with 8 cylinders).

★ Is the **PERFORMANCE SMOOTH**? The more powerful spark of Total Energy Discharge eliminates the "near misfires" whilst an electronic filter smoothes out the effects of contact bounce etc.

★ Do the **PLUGS and POINTS** always need changing to bring the engine back to its best? Total Energy Discharge eliminates contact arcing and erosion by removing the heavy electrical load. The timing stays "spot on" and the contact condition doesn't affect the performance either. Larger plug gaps can be used and even wet or badly fouled plugs can be fired with this system.

★ **TOTAL ENERGY DISCHARGE** is a unique system and the most powerful on the market - 1½ times the power of inductive systems - 3½ times the energy and 3 times the duration of ordinary capacitive systems. These are the facts:

Performance at only 6 volts (maximum supply 16 volts)

SPARK POWER	— 140W	SPARK ENERGY	— 36mJ
SPARK DURATION	— 500μS	STORED ENERGY	— 135mJ

LOADED OUTPUT VOLTAGE
50pF load — 38kV, 50pF + 500k — 26kV

We challenge any manufacturer to publish better performance figures. Before you buy any other make, ask for the facts, its probably only an inductive system. But if an inductive system is what you really want, we'll still give you a good deal.

★ **All ELECTRONIZE electronic ignitions feature: EASY FITTING, STANDARD/ELECTRONIC CHANGEOVER SWITCH, STATIC TIMING LIGHT and DESIGNED IN RELIABILITY (14 years experience and a 3 year guarantee).**

★ **IN KIT FORM** it provides a top performance system at less than half the price of comparable ready built units. The kit includes: pre-drilled fibreglass PCB, pre-wound and varnished ferrite transformer, high quality 2uF discharge capacitor, case, easy to follow instructions, solder and everything needed to build and fit to your car. All you need is a soldering iron and a few basic tools.

Most **NEW CARS** already have electronic ignition. Update **YOUR CAR**

ELECTRONIZE ELECTRONIC CAR ALARM

HOW SAFE IS YOUR CAR?

PROTECT YOUR CAR

More and more cars are stolen each week and even a steering lock seems little help. But a car thief will avoid a car that will cause him trouble and attract attention. If your car has a good alarm system – well there are plenty of other cars to choose from.

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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.

01 · Ld BC,mn		
FF · low byte		
FF · high byte		
0B · dec BC		
78 · Ld A,B		
B1 · OR C		
20 · JR NZ e		
FB · e =	back to dec BC	

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 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.

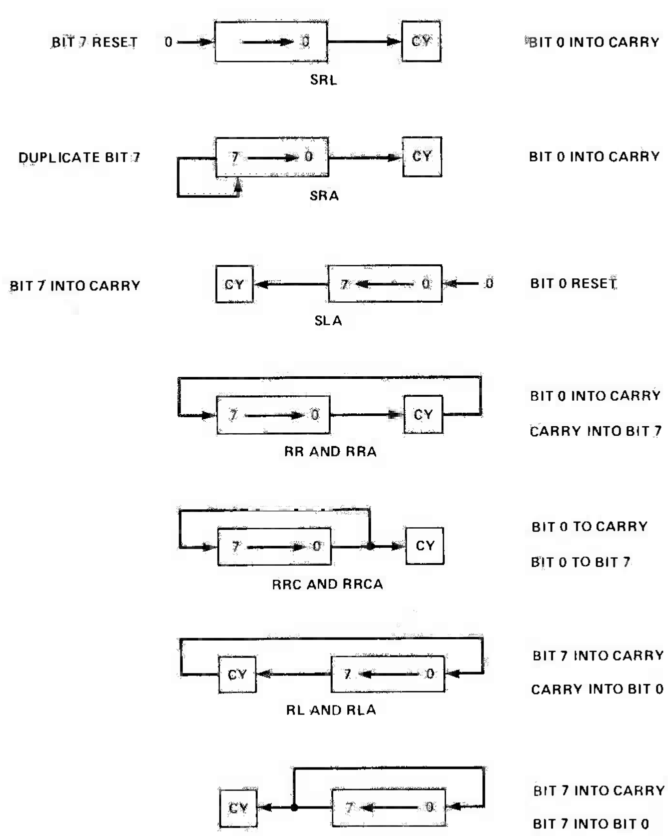


Fig. 23 The operation of the Rotate and Shift instructions.

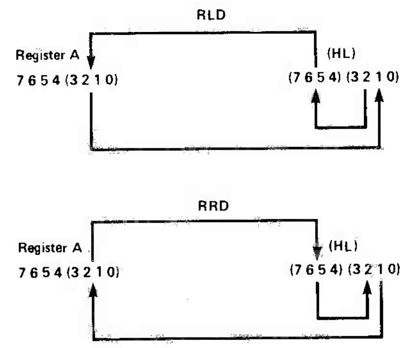


Fig. 24 The half-byte (or nibble) movement.

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 EOh — CPX will compare the byte in index register X with a memory location, in fact the address after the byte EO. 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 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	
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.

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 / B0	LDIR
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 EDA0h — LDI and EDA8h — 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 EDA1h — CPI and EDA9h — 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. **ETI**

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 indentical 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 impedence 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 comparitively low power level and hence prevent us from using the unit's full power measurement range.

The Circuit

The circuit consists of two indentical power measuring channels 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 voltage and current levels with different load impedences 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 impedence 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 impedence 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

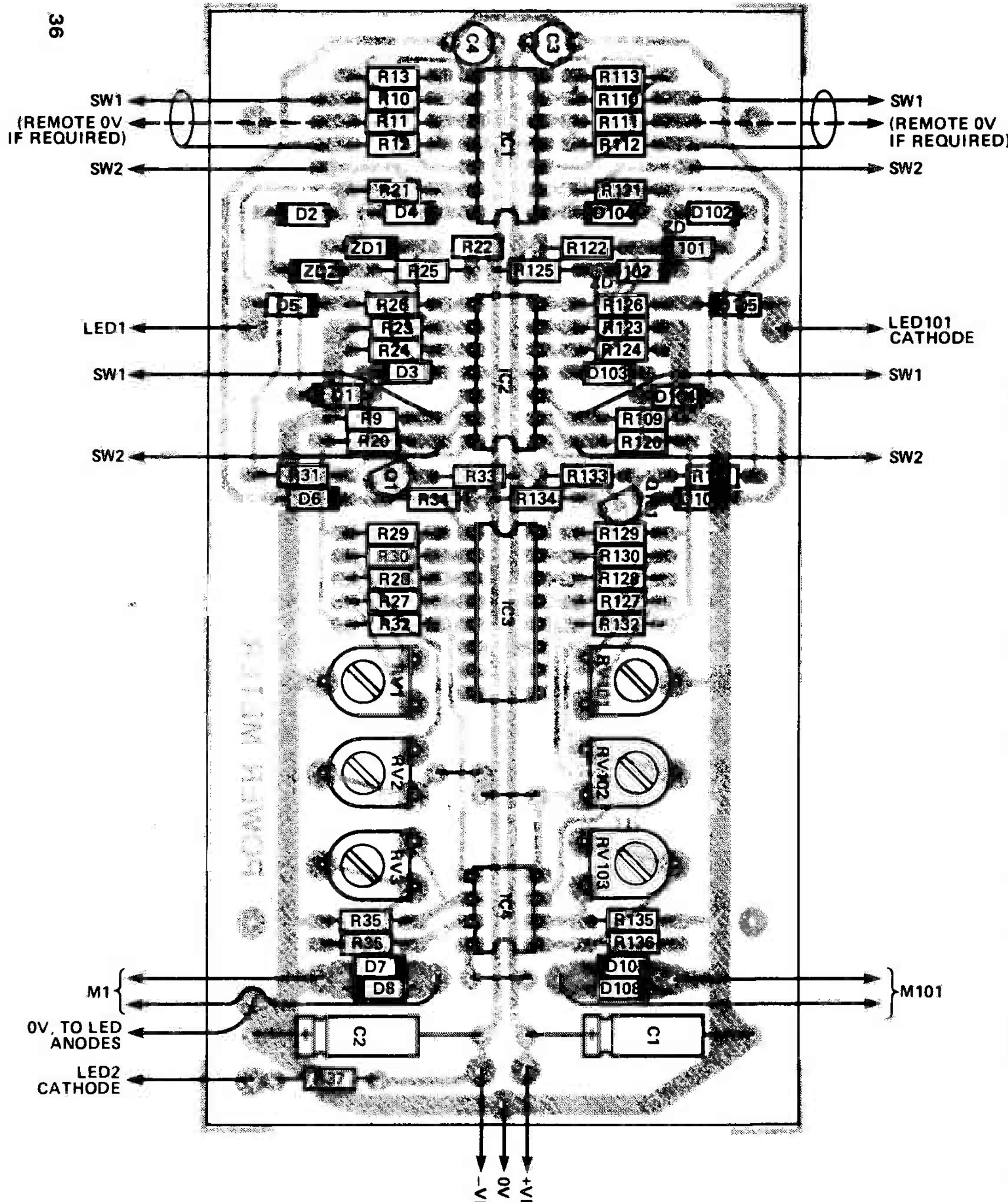


Fig. 1 Component overlay of the main PCB (larger than actual size).

PARTS LIST

RESISTORS (¼ watt 5% carbon film unless otherwise stated)

R1,101	0R1 5W W.W. (or more)
R2,3,102,103	220k
R4,5,104,105	100k
R6,7,106,107	100R
R8,108	220R
R9,109	10M
R10,11,26,37,110, 111,126	1k0
R12,13,112,113	56k
R14,19,20,21,23, 24,30,114,119, 120,121,123,124, 130	10k
R15,18,115,118	5k6
R16,17,116,117	3k3
R22,25,122,125	470k
R27,28,127,128	390R
R29,31,32,129, 131,132	33k
R33,34,133,134	15k
R35,36,135,136	4k7
RV1,101	220R min. horizontal preset
RV2,102	10k min. horizontal preset
RV3,103	100k min. horizontal preset

CAPACITORS

C1,2	47μF 25 V axial electrolytic
C3,4	22μF 25 V tantalum bead
C5,6	1000μF 40 V axial electrolytic
C7,8	10μF 25 V axial electrolytic

SEMICONDUCTORS

IC1,2	TL084
IC3	LM13600
IC4	TL082
IC5	7815
IC6	7915
Q1,101	BC214L
BR1	200V 1 amp potted bridge rect.
D1,2,3,4,5,6,7,8, 101,102,103, 104,105,106, 107,108	1N4148
LED1,101	Red LED 0.2" with panel mount
LED2	Green LED 0.2" with panel mount

MISCENLANEOUS

M1,101	500μA moving coil meter
T1	0-15,0-15 V 3 VA PCB mtg. transformer
FS1	1 A 20mm a/s fuse + PCB mtg holder
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 impedence 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.

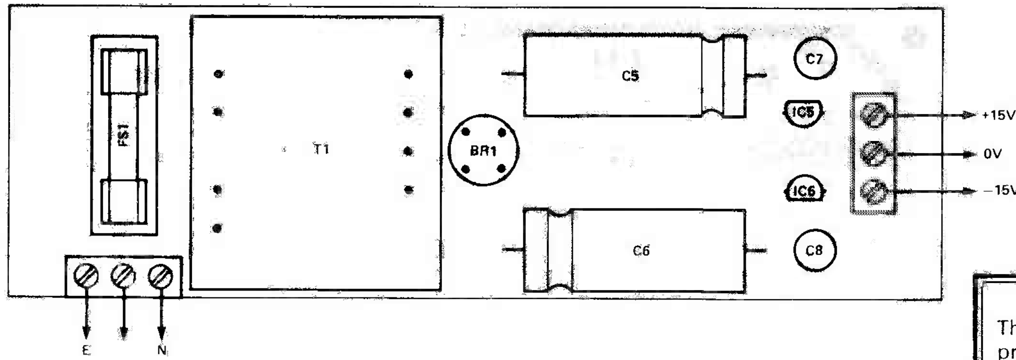


Fig. 2 Component overlay of the power supply PCB (actual size).

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.

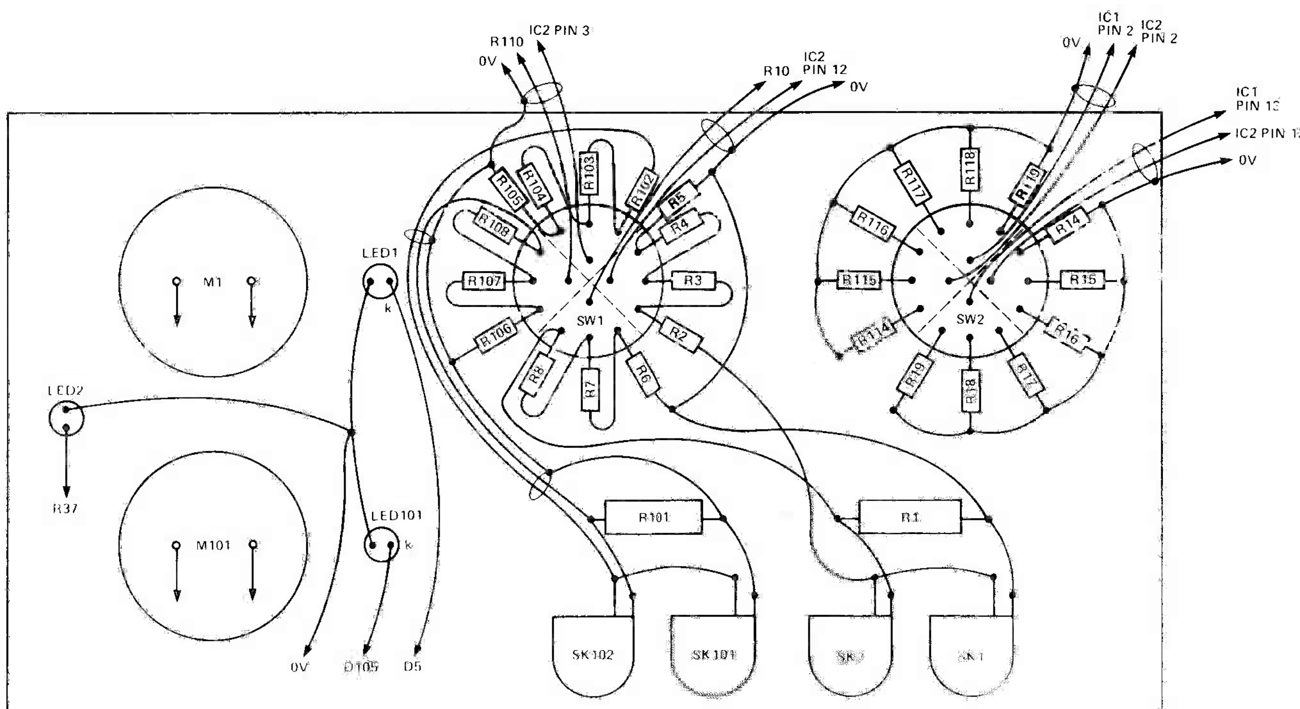


Fig. 3 Front panel wiring diagram.

Setting up

The aim here is to use the three presets in each channel to adust 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 impedence, but beware of overload at less than full power caused by extremes of voltage or current when the wrong impedence range is selected. The LEDs on the front panel should warn of this condition.

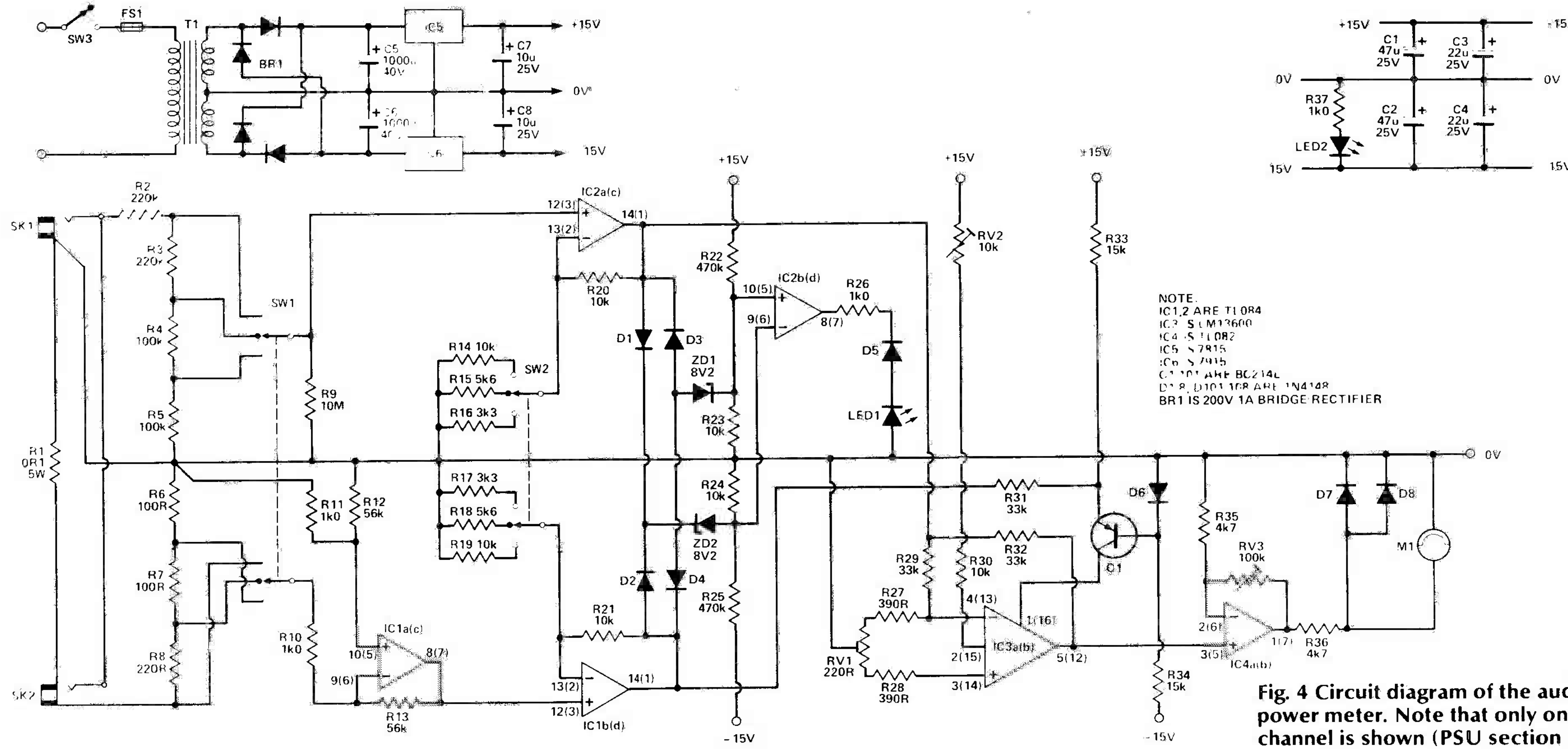


Fig. 4 Circuit diagram of the audio power meter. Note that only one meter channel is shown (PSU section is common).

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 illuminated 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.

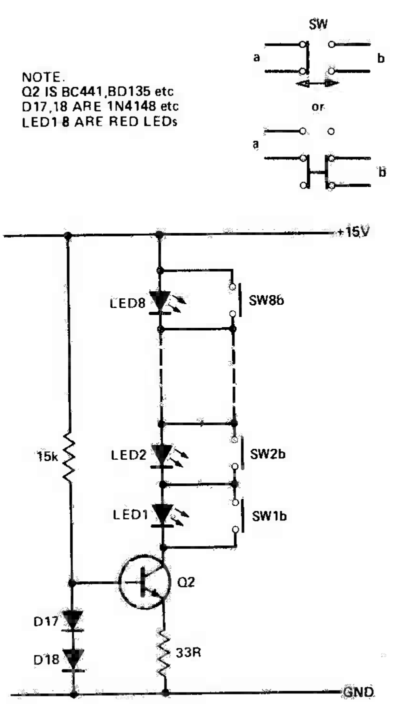
This circuit was designed to provide a data link between a pedalboard consisting of eight switches, and an effects box situated some distance away. This would normally require expensive 9-way cable, terminated by expensive multiway connectors. This circuit allows these to be replaced by el cheapo 5-pin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

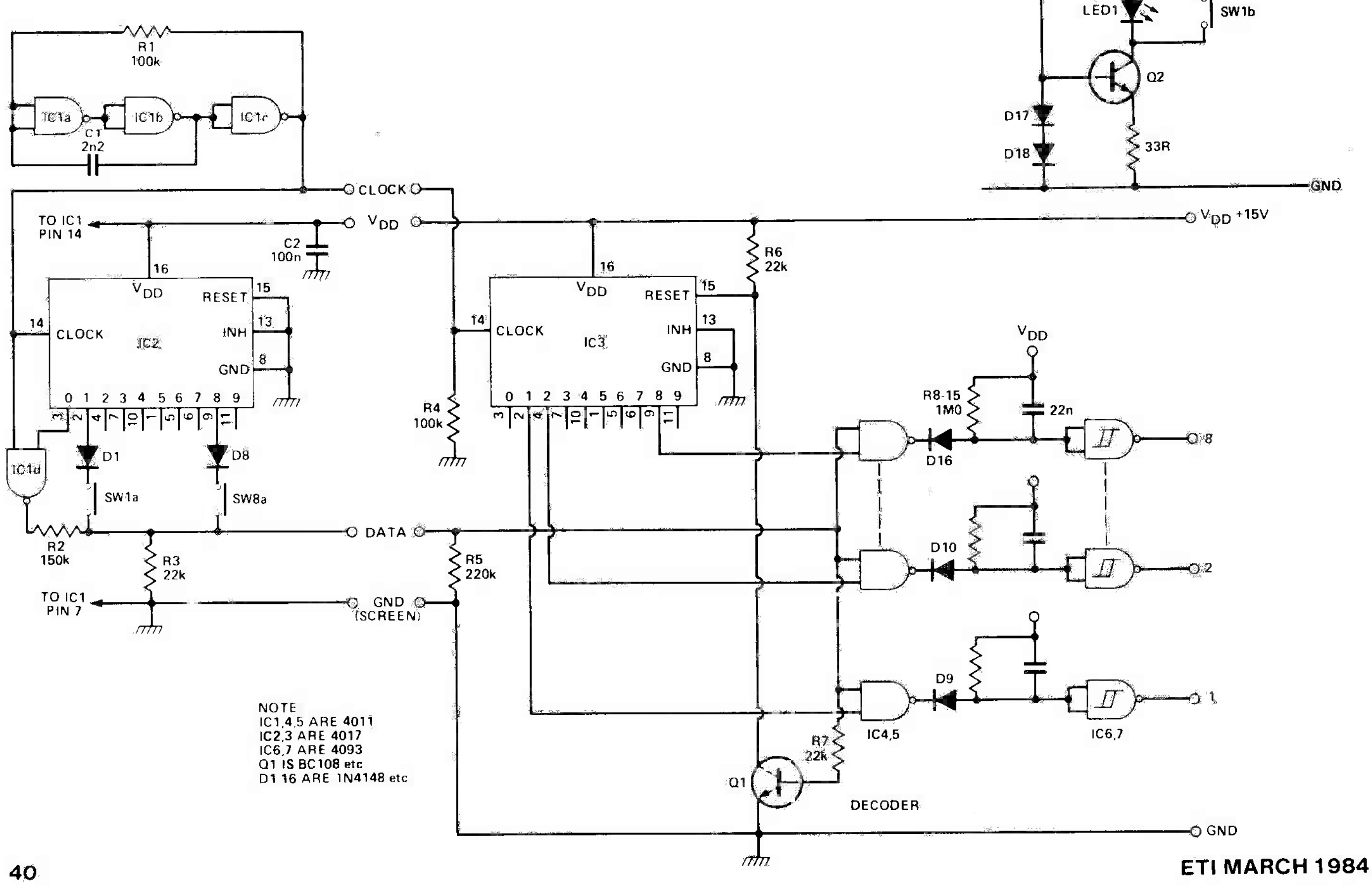
IC1a,b,c comprises the system clock. IC2 scans the switches in sequence. This gives a series of logic highs and lows on the DATA line, depending upon the state of the switches. IC3,4,5 pass these signals to the appropriate sample and hold circuit (IC6,7 and associated components) in the decoder.

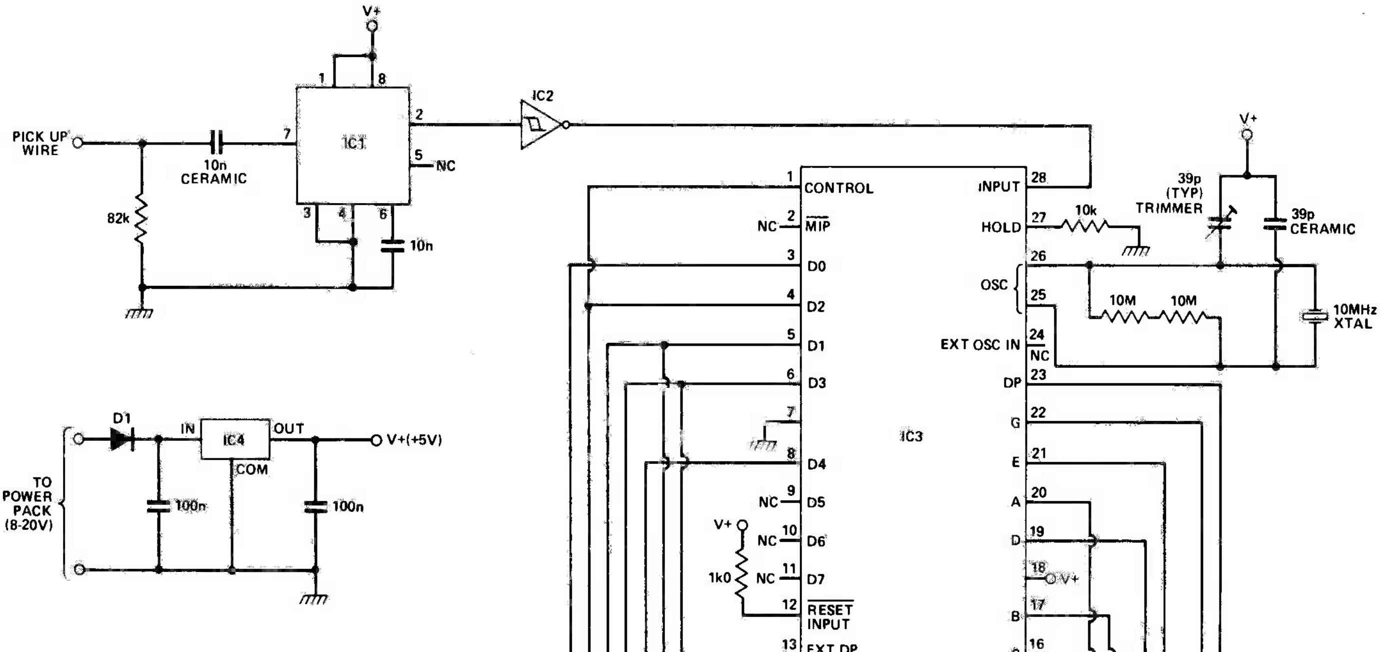
Q1 is used to reset IC3. The voltage on the DATA line is normally maintained at around 2V by R2 and R3 (which may need adjustment if a much lower supply voltage is used). This keeps Q1 hard on. When IC2 '0' output and the clock both go to high, IC1d output goes low, taking the DATA line to 0V. This turns 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.

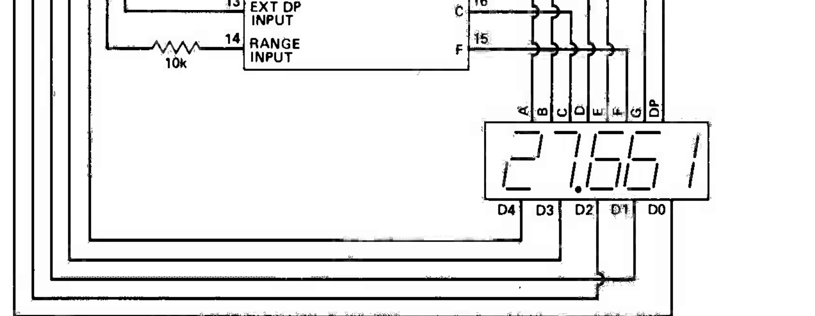
With the exception of the sample & hold time constants, which are uncritical, the system is totally independent of clock frequency — unlike conventional 2-wire data links which also have more complicated circuitry. This makes the system more reliable. It can also be easily extended, either by using the 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.









NOTE:
IC1 IS SP8629 (PLESSEY)
IC2 IS 74LS14
IC3 IS ICM7216D
IC4 IS 7805
D1 IS 1N4001 OR SIMILAR

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

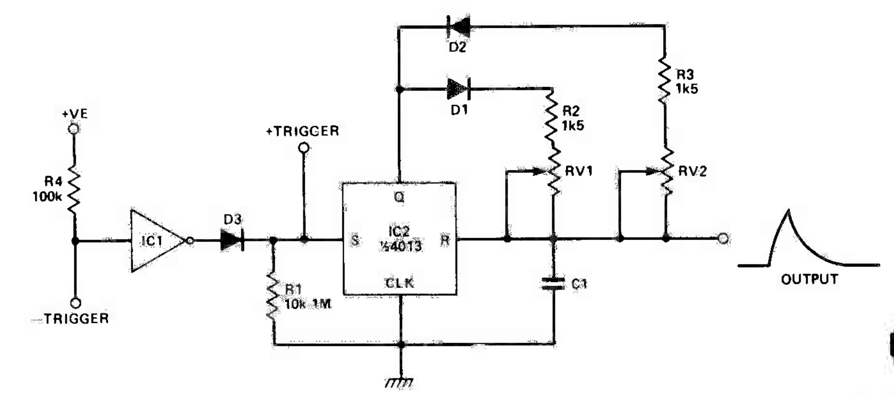
Jeff Macanley, Crawley.

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 flop resets, 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.



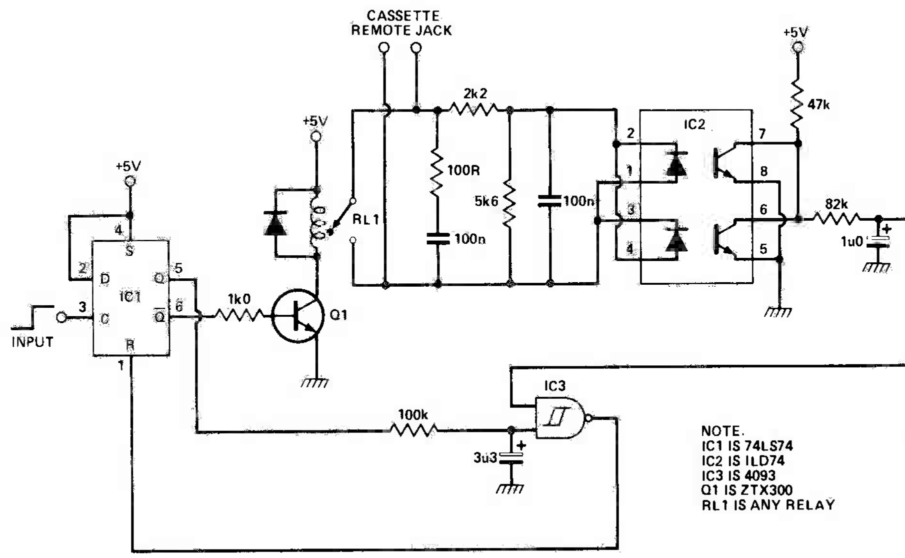
Simple Cassette Motor Control

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.



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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

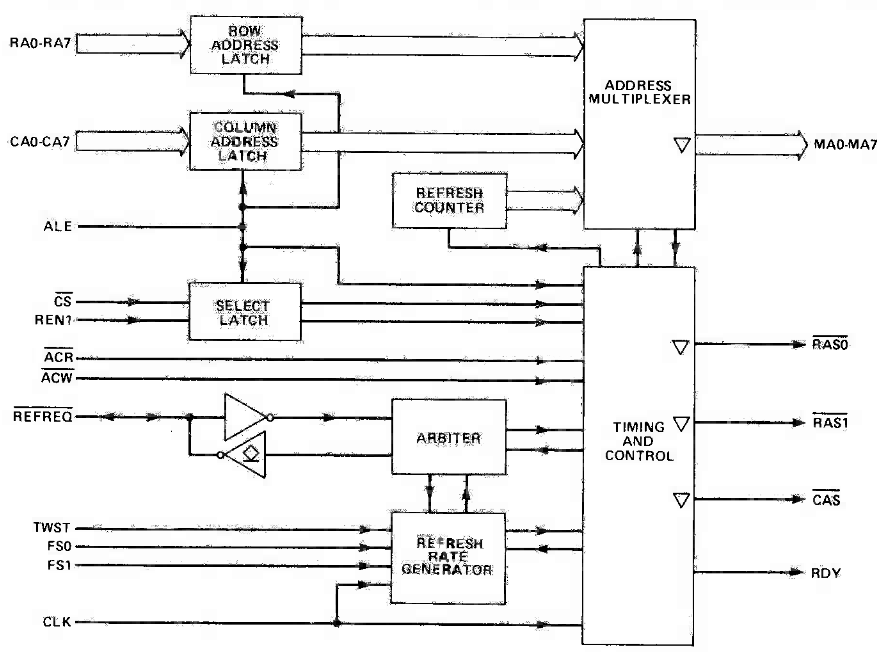


Fig. 1 Internal block diagram of the TMS 4500A dynamic RAM controller.

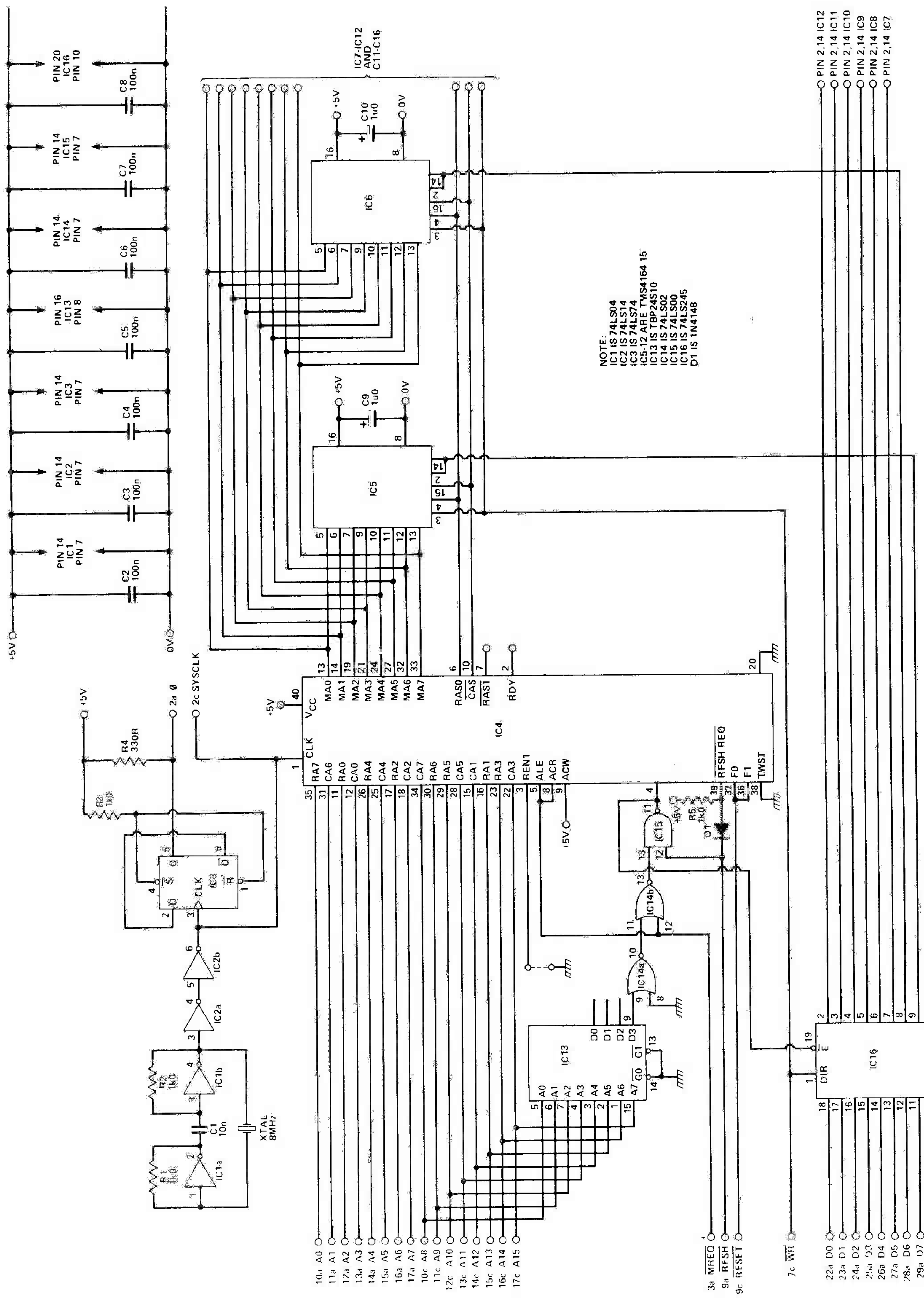


Fig. 2 Circuit diagram of the Z80 DRAM.

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 during 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 $\overline{MREQ}$ and $\overline{RFSH}$ to select a memory cycle for the 4500. The latter signal $\overline{RFSH}$ is included to prevent $\overline{MREQ}$ 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 tranceiver which is also controlled by the same $\overline{CS}$ signal as the 4500 and has its direction determined by the $\overline{WR}$ 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, $\overline{CS}$ and REN1. This also initaiates an access cycle if chip select is valid. The rising edge (low level to high level) of ALE returns $\overline{RAS}$ to the high level.
$\overline{CS}$	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 $\overline{RAS}$ 0 and $\overline{RAS}$ 1 outputs when chip select is present.
$\overline{ACR}$, $\overline{ACW}$	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 $\overline{ACR}$ or $\overline{ACW}$ terminates the cycle by ending $\overline{RAS}$ and $\overline{CAS}$ strobes. When $\overline{ACR}$ and $\overline{ACW}$ are both low, MA0-MA7, $\overline{RAS0}$, $\overline{RAS1}$, 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, FS0 inputs.
$\overline{REFREQ}$	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. $\overline{REFREQ}$ will remain low until the refresh cycle is in progress and the current refresh address is present on MA0-MA7.
$\overline{RAS0}$, $\overline{RAS1}$	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.
$\overline{CAS}$	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 FS0 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.

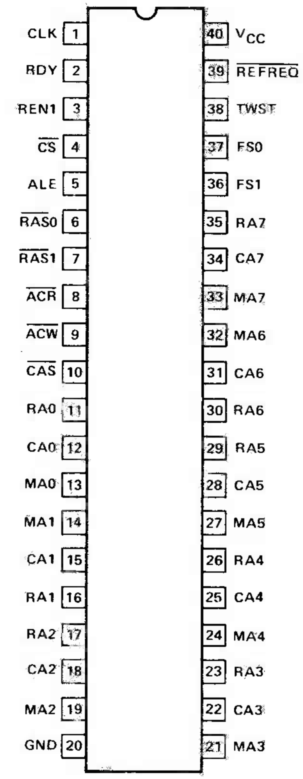


Fig. 3 Pin connections of the TMS 4500A.

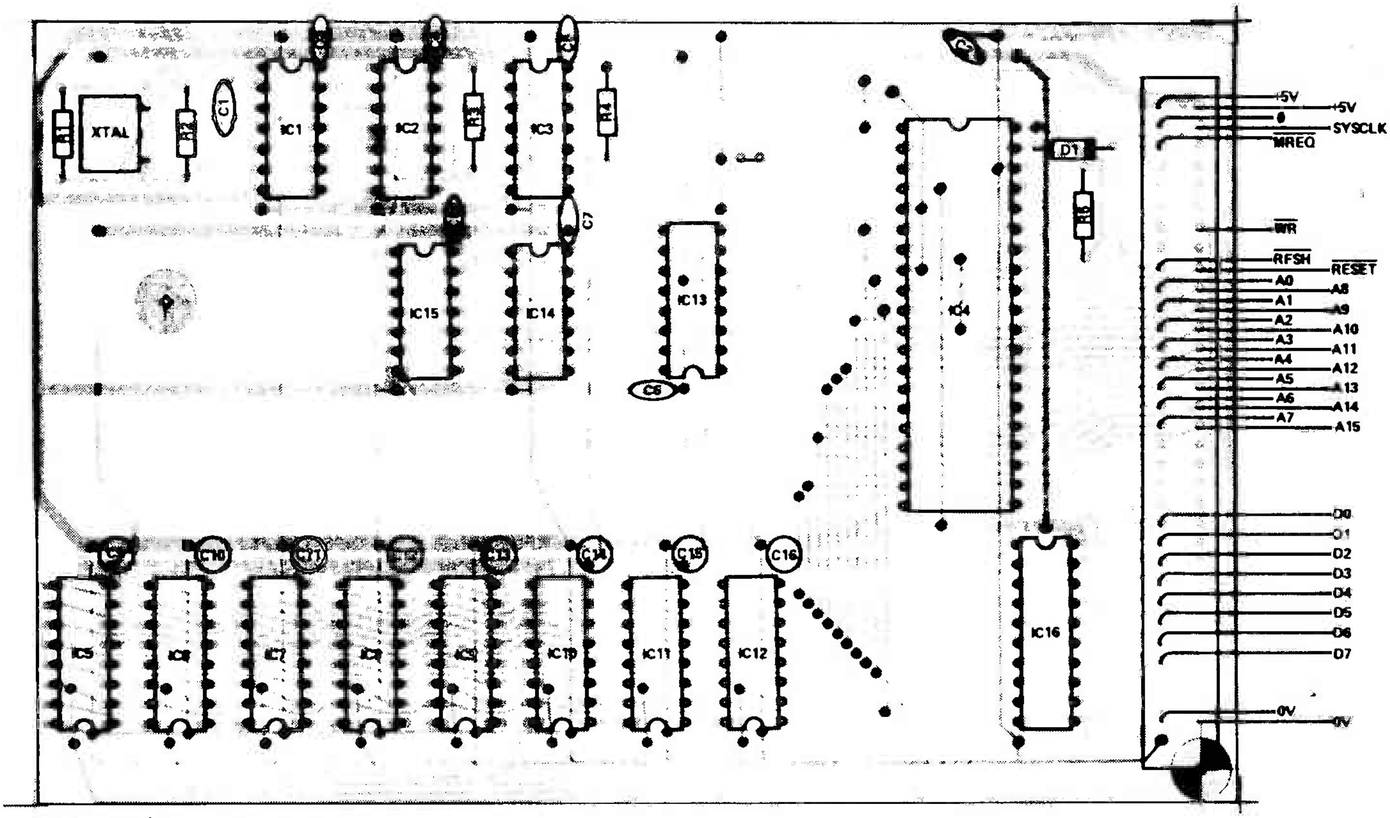


Fig. 4 Component overlay of the PCB.

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 elctrolytic 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 ¼W, 5%)

R1, 2, 3, 5	1k0
R4	330R

CAPACITORS

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

ETI

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 response 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 plaine of the HD100/25, the required delay is $38 \times 10^{-3}/343 = 110.8\ \mu s$. A suitable all-pass filter, giving 28.2 µs delay per stage may be formed from four op-amps as shown in Fig. 3.

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

= 28.2µs at 2.68 kHz per stage
= 112.8 µs total (equiv. to 38.7mm)

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

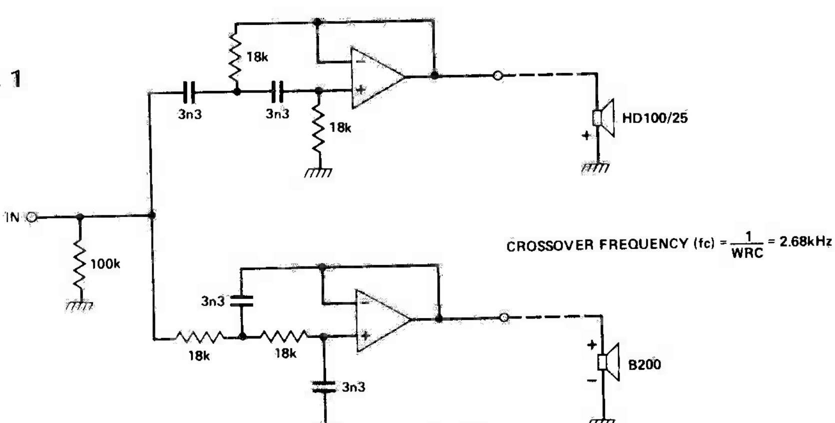


Fig. 2

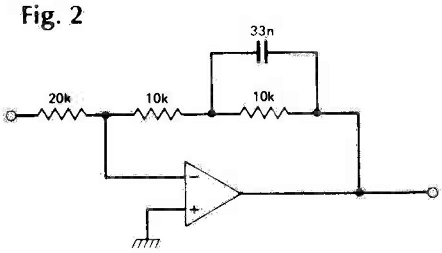
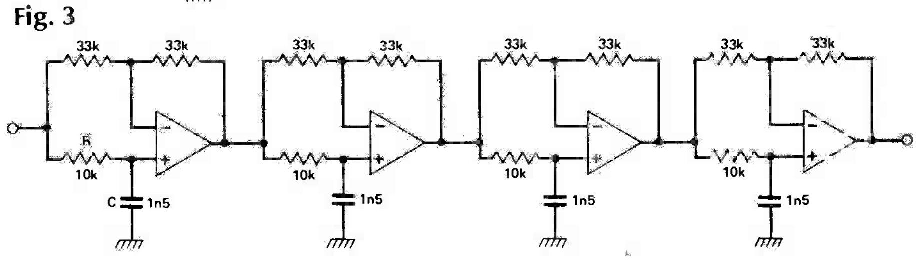
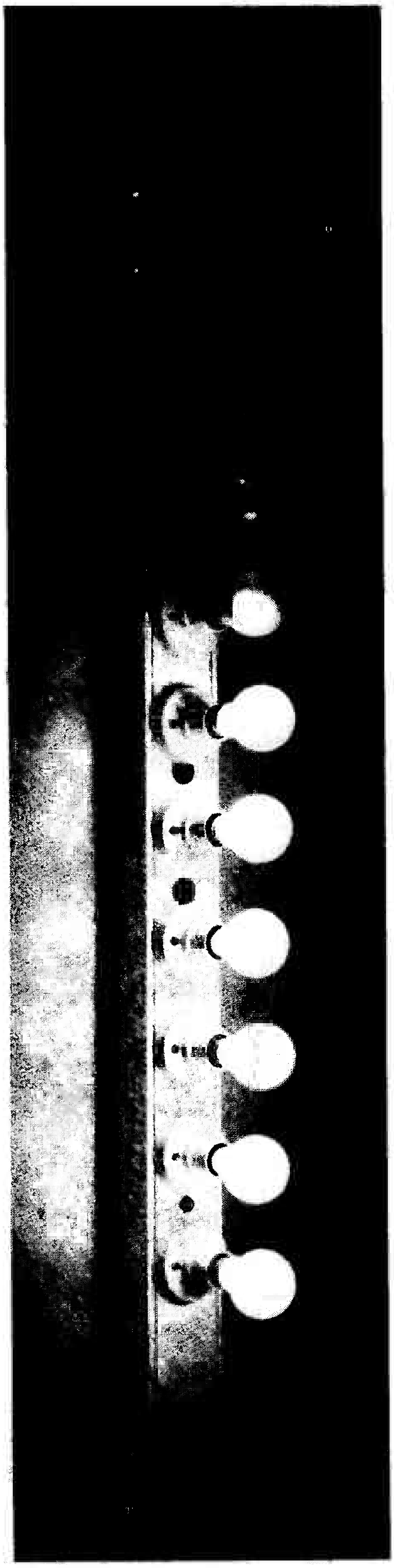


Fig. 3





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 surving 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 faction 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 Gottinghen 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 dealy, 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 1½ 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.

ETI

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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 amusement 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

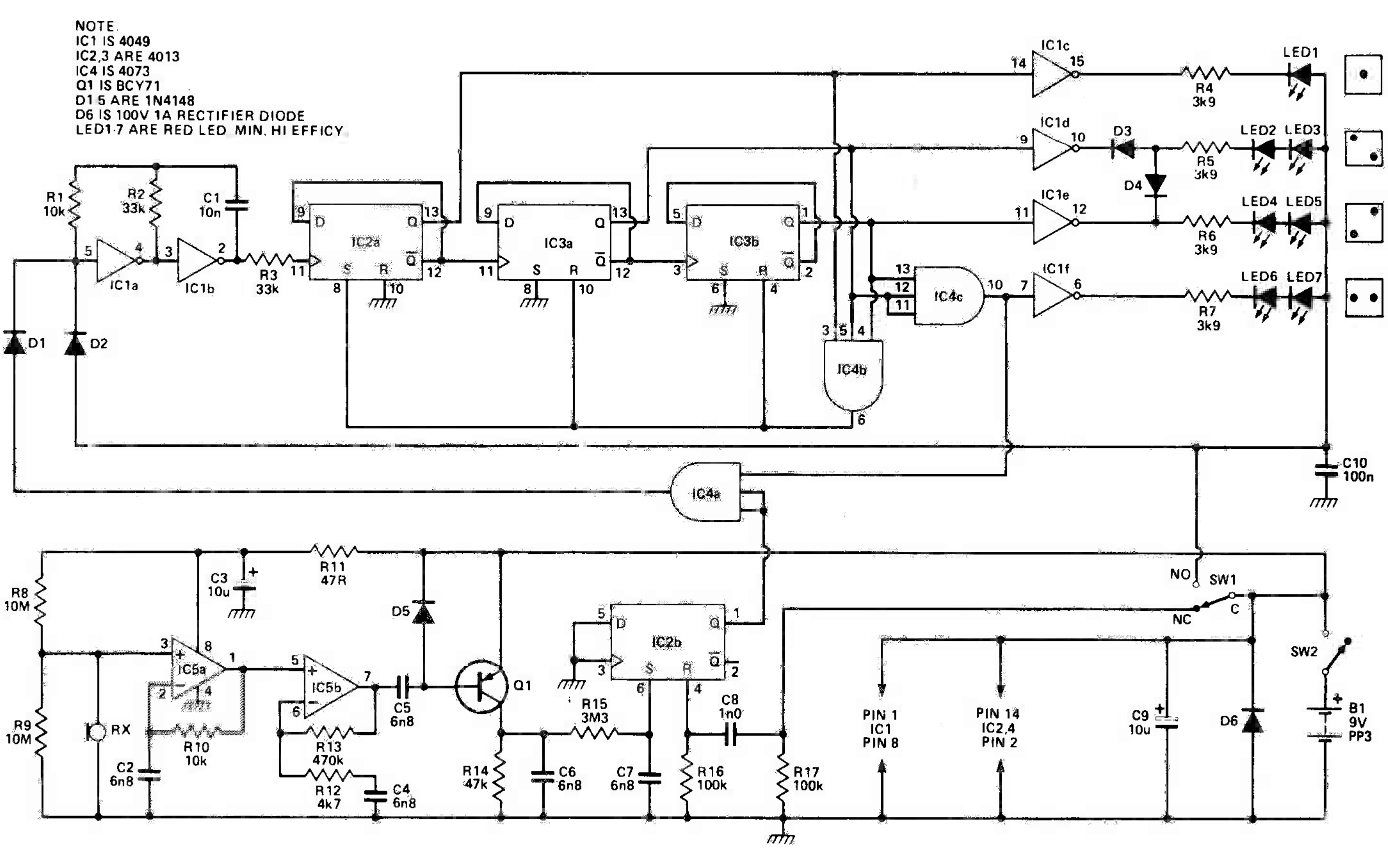
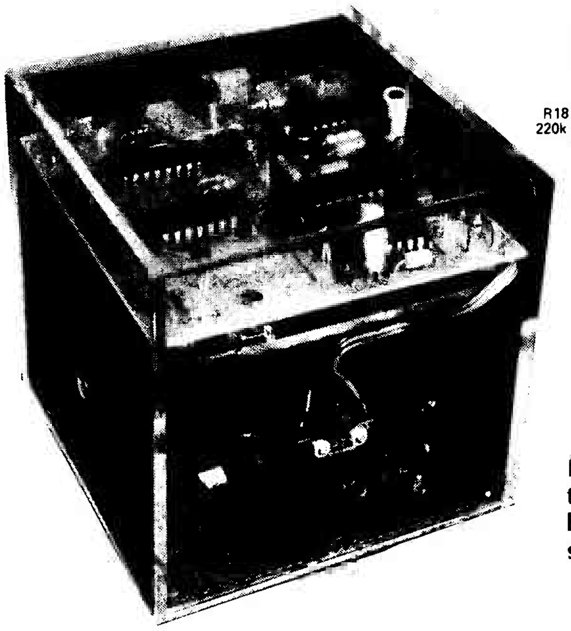


Fig. 1. Circuit diagram of the die.



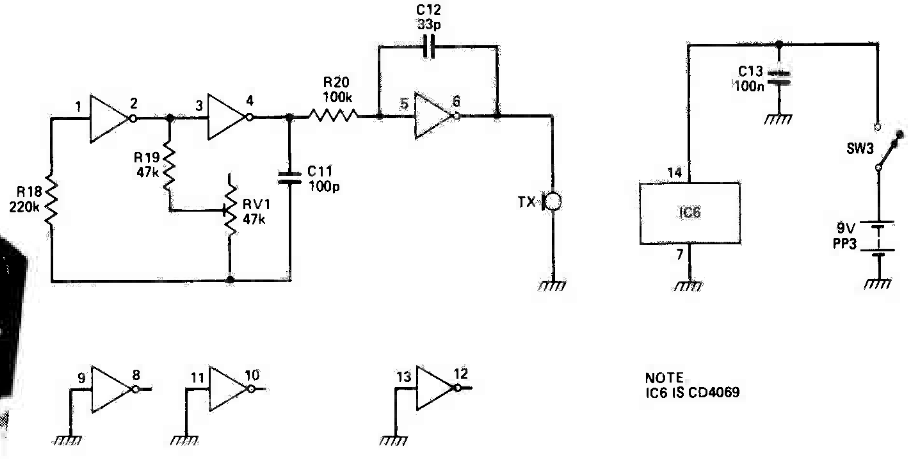


Fig. 2 Circuit diagram of the transmitter; note that it doesn't matter which particular gate is used for what — all the gates within IC6 are equivalent; no PCB has been shown for this unit, as it would be uneconomic to produce such a small board. Better to use a spare piece of circuitboard.

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 microswitch 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 occured 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 die is lifted, ie, 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.

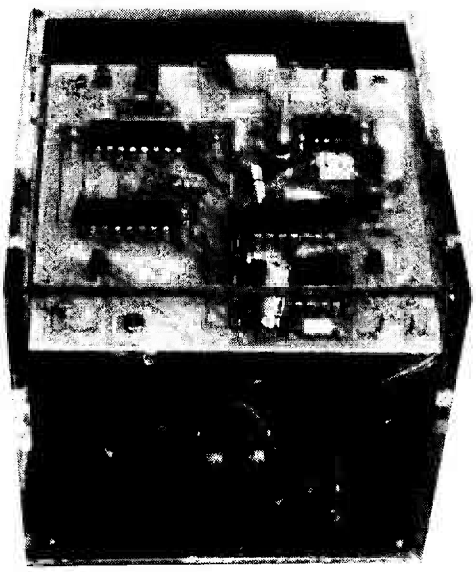
With so much gain in a confined space, following a high impedance transducer, the dual op-amp circuit has been designed carefully. Supply line decoupling R11, C3 prevents supply line ripple due to clock edges getting into the amplifier, whilst hum pick-up problems (always a headache with high impedance 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 10µF non electrolytic capacitor (or two 22µF 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



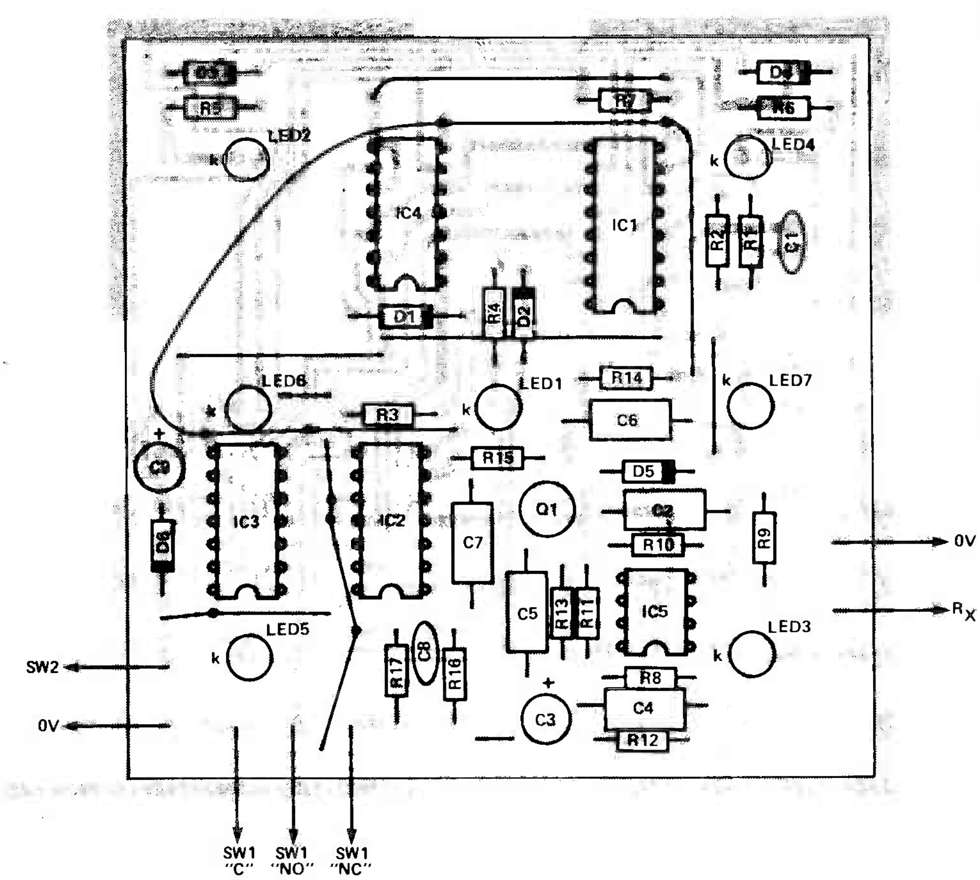


Fig. 3 Overlay diagram for the main PCB.

PARTS LIST

RESISTORS (all ¼W 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 scenarious 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.

ETI

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 in 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).

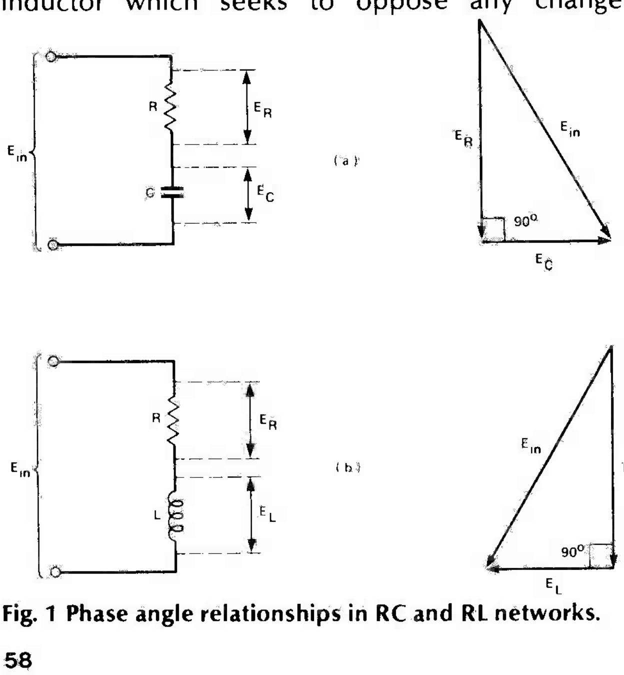


Fig. 1 Phase angle relationships in RC and RL networks.

We have seen earlier in this series that the impedance of a capacitor (Zc) 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 ±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 ½ x ½ = ¼), the final effect is a 180° phase shift (= x−1). If we want to represent these phase shifts mathematically, we mut 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'

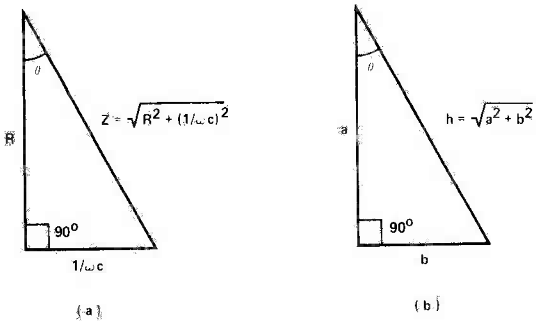


Fig. 2 Impedance diagram for an RC nework.

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 capacitative impedances R and 1/jωC 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 θ = b/a. More conveniently, $\theta = \text{Tan}^{-1}$ 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/ωCR. (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 Cs and Ls 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 Rs, Cs and Ls 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/jωC, as in Fig. 3b, their parallel impedance will be

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

If we multiply the top and bottom of this equation by jωC, we can get it into the much more manageable form

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

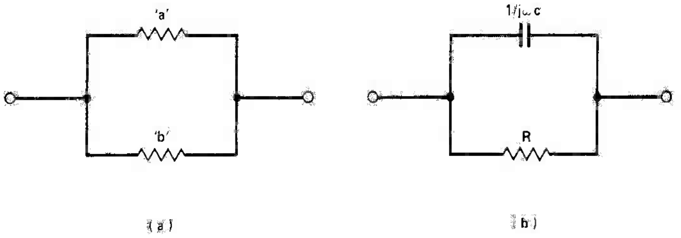


Fig. 3 Impedance of an RC parallel network.

The next mathematical dodge is to get rid of the js in the bottom line of this equation, so that we can divide it up into two separate parts, one without js 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 contining 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 R2 = 0 it is a simple HF attenuator circuit. Looking at the resistor network of Fig 4a, the attenuation of this would be

$$\frac{Eout}{Ein} = \frac{Rb + Rc}{Ra + Rb + Rc}$$

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

$$\frac{Eout}{Ein} = \frac{1/j\omega C + R2}{R1 + 1/j\omega C + R2}$$

and this can be simplified to

$$\frac{Eout}{Ein} = \frac{1 + j\omega CR2}{1 + j\omega C\ (R1 + R2)}$$

by multiplying top and bottom of jwC. Doing the necessary mathematical manipulation extracts the in-

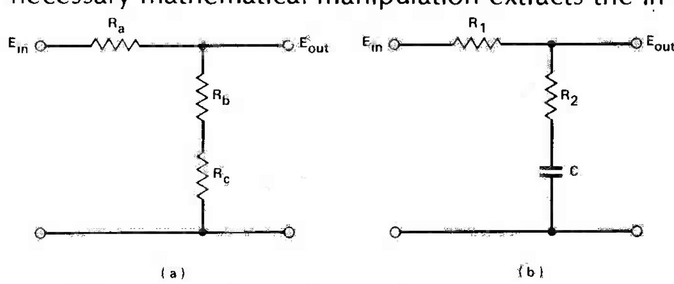
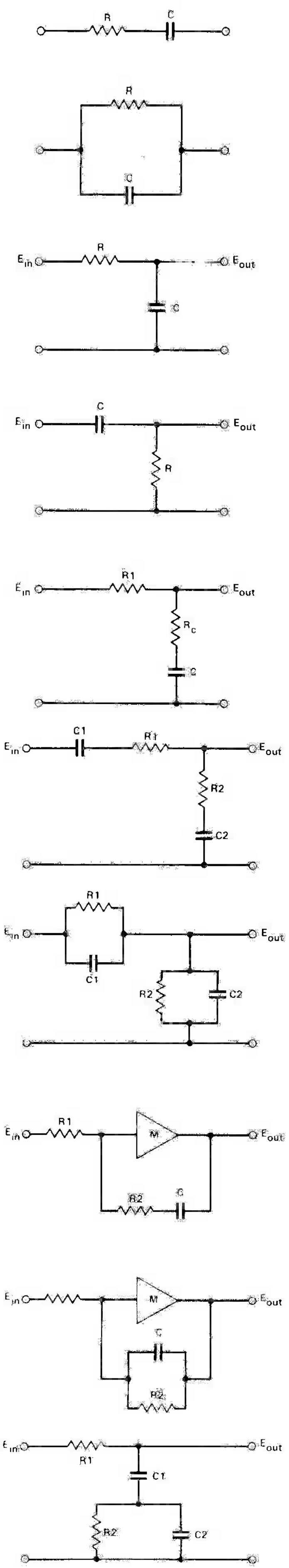


Fig. 4 Attenuation of an RRC network.



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

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

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

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

$$\frac{E_{out}}{E_{in}} = \frac{1 + j\omega CR2}{1 + j\omega C\,(R1 + R2)}$$

$$\frac{E_{out}}{E_{in}} = \frac{C1 + j\omega C1C2R2}{C1 + C2 + j\omega C2\,(R1 + R2)}$$

$$\frac{E_{out}}{E_{in}} = \frac{C1 + j\omega C1R1R2}{R1 + R2 + j\omega R1R2\,(C1 + C2)}$$

$$\text{Gain} = -M\,\frac{1 + j\omega CR2}{1 + j\omega C\,(R2 + MR1)}$$

$$\text{Gain} = -M\,\frac{R2}{R2 + MR1\,(1 + j\omega CR2)}$$

$$\frac{E_{out}}{E_{in}} = \frac{1 - \omega R1R2C1C2 + j\omega\,(R1C1 + R2C1 + R2C2}{1 + j\omega R2\,(C1 + C2)}$$

Fig. 5 Characteristics of some common RC networks.

phase and quadrature components as

$$\frac{Ein}{Eout} = \frac{1+\omega^2C^2R2\,(R1+R2)}{1+\omega^2C^2\,(R1+R2)^2} - \frac{j\omega CR1}{1+\omega^2C^2(R1+R2)^2}$$

and if we make R2 = 0, the right hand side of this equation simplifies to

$$\frac{1}{1+\omega^2C^2R1^2} - \frac{j\omega CR1}{1+\omega^2C^2R^21}$$

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

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

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

$$\frac{Eout}{Ein} = 1$$

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

$$\frac{Eout}{Ein} = \frac{R2}{R1+R2}$$

and the second gives

$$\frac{Eout}{Ein} = 0$$

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 jωL instead of 1/jωC in the equations. For example, the circuits of Fig. 6a and 6b have transmissions

$$\frac{Eout}{Ein} = \frac{j\omega L}{R+j\omega L} \text{ and } \frac{R}{R+j\omega L}$$

respectively, which can be broken down into the in-phase and quadrature components as

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

and

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

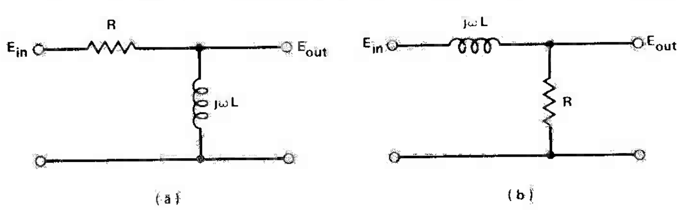


Fig. 6 RL networks.

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 C1 and C2,

$$\frac{Eout}{Ein} = \frac{R2}{(R1+R2)}$$

which is what we would expect. Or, by just deleting C1 (C1=0) we will end up with the equation of a type 3 network, when there is a resistor across the output.

Some Practical Examples

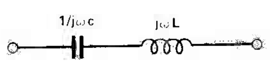
A lot of the above may have been a bit dull reading for the non-mathematically inclined (which, I suspect, is 99% of us) and may tempt the reader to ask 'Well, that's all very nice, but what real use is it'. So I propose to show a few examples where there are some slightly surprising outcomes from the 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/jωC + jωL. If we multiply through by 1 (=jωC/jωC), we get

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

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



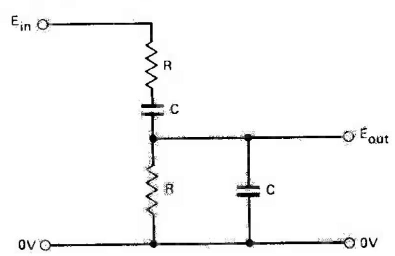
$$\text{at } f_0 = \frac{1}{2\pi\sqrt{LC}}$$

Z = 0

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 Cs and both Rs 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,



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

Eout = ⅓ Ein

with no phase shift.

Fig. 8 The Wien network.

and 5(1) is b.

This gives the rather unwieldy looking equations

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

$$= \frac{\dfrac{j\omega CR}{1 + j\omega CR}}{\dfrac{j\omega CR}{1 + j\omega CR} + 1 + j\omega CR}$$

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 ωCR $(= 2\pi fCR) = 1$ 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 Ein.

(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.

$E_{in} = E_{out} + (i_1 + i_2)Z1 + i_2 Z2$. .... (1)

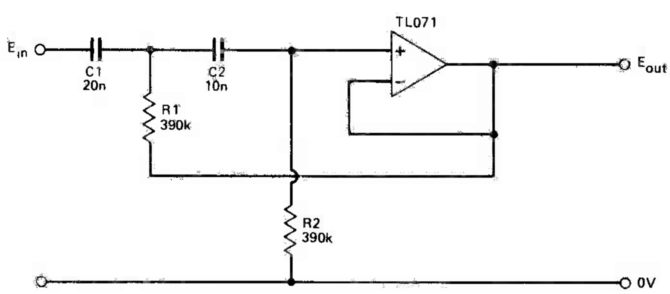
and $E_{out} = i_2 Z4$ therefore $i_2 = E_{out}/Z4$ .... (2)

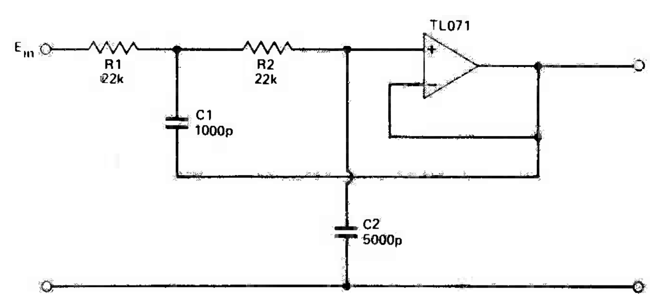
also $i1 = (Ex - E_{out})/Z3$ and $(Ex + E_{out}) = i_2 Z2$

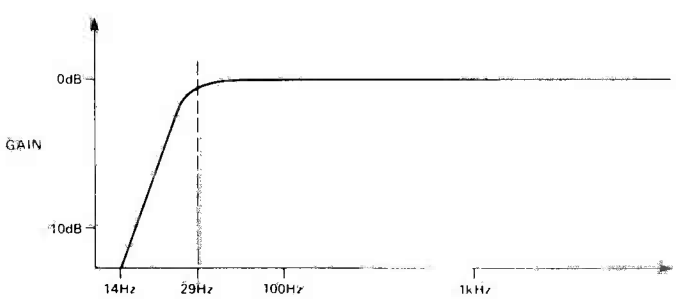
Therefore $i1 = i_2 Z2/Z3$. .... (3)

From (1) and (3)

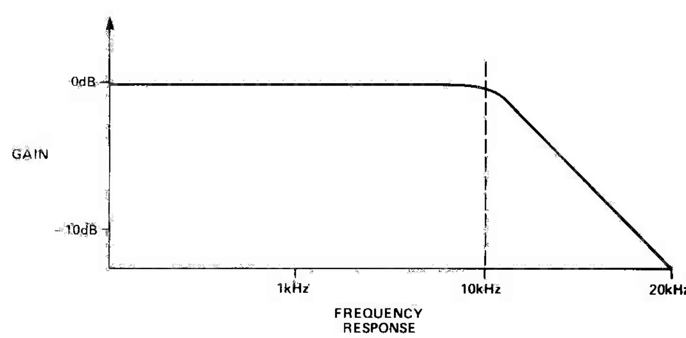
Fig. 9 Sallen and Key type active filters.







(a)



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

for values shown

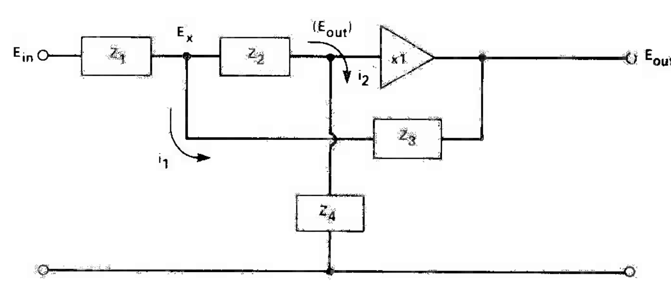
= 29Hz for(a)

= 10.2KHz for (b)

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

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

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



$$Ein = Eout + i_2 Z1 Z2/Z3 + i_2 Z1 + i_2 Z2 \quad \ldots\ldots (4)$$

and from (4) and (2)

$$Ein = Eout\,(1 + Z1Z2/Z3Z42 + Z1/Z4 + Z2/Z4) \quad \ldots\ldots (5)$$

Therefore

$$\frac{Ein}{Eout} = \frac{1}{1 + \frac{Z1}{Z4} + \frac{Z2}{Z4} + \frac{Z1Z2}{Z3Z4}}$$

$$= \frac{Z3Z4}{Z3Z4 + Z1Z3 + Z2Z3 + Z1Z2} \quad \ldots\ldots (6)$$

We can now fit in the Rs and 1/jωCs 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 Z1=R1, Z2=R2 and Z3=1/jωC1 and Z4=1/jωC2,

$$\frac{Eout}{Ein} = \frac{1}{1 + j\omega C2\,(R1 + R2) - \omega^2(C1C2R1R2)} \quad \ldots (7)$$

Several things can be deduced from this: where f=0 (ω=0) the output is 1/1 (unity gain at VLF), where $\omega^2(C1C2R1R2)=1$ the denominator is at its smallest, and the output is therefore at a maximum. This is the turn-over frequency where $f=/2\pi\sqrt{R1R2C1C2}$, and at this point the output of the circuit is 1/jωC2 (R1+R2), which we can call the 'Q' of the circuit.

There is one further small trick which can be done with this calcuation. Suppose we say that x=R1/R2 and y=C1/C2, then R1=xR2 and C1=yC2, and suppose that we call the frequency at which $\omega^2(C1C2R1R2)=1$, ω_0, then $\omega_0^2=1/xy(C2R2)^2$ and $\omega_0=1/C2R2\pi xy$. Also, our middle term jωC2(R1+R2) becomes jωC2R2(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,

$$\frac{Eout}{Ein} = \frac{1}{1 + j\,\frac{\omega\,(1+x)}{\omega 0\,\sqrt{xy}} - \left(\frac{\omega}{\omega 0}\right)^2}$$

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! **ETI**

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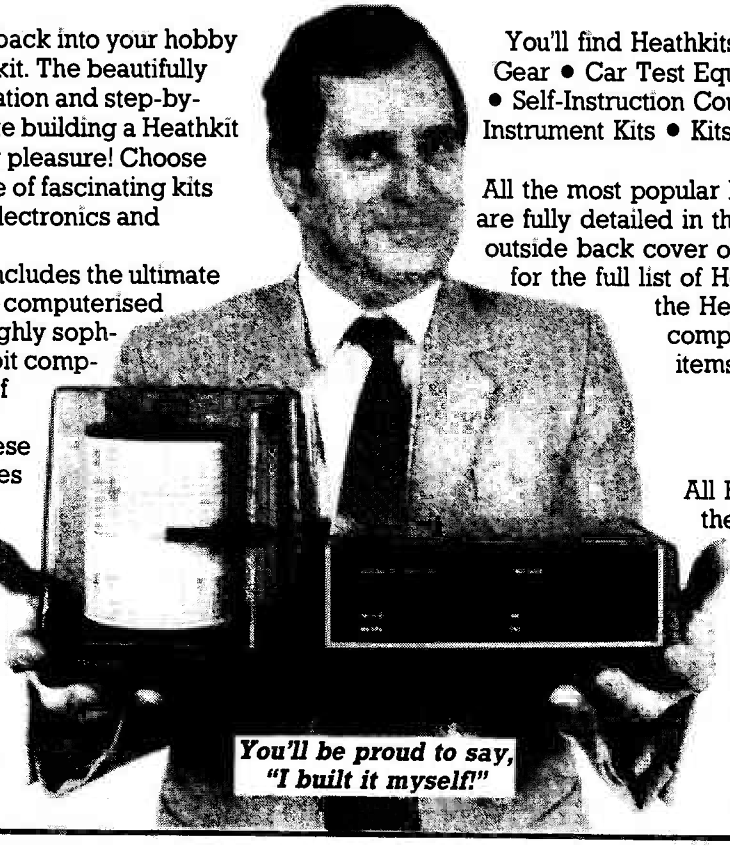

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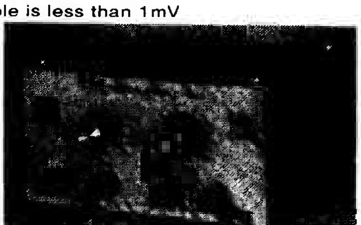

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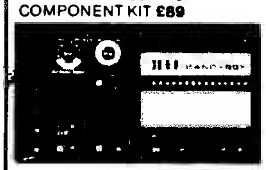

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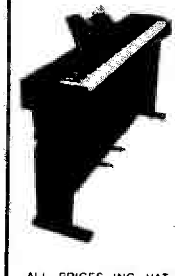

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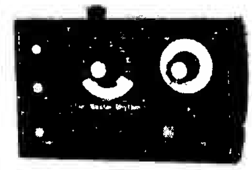

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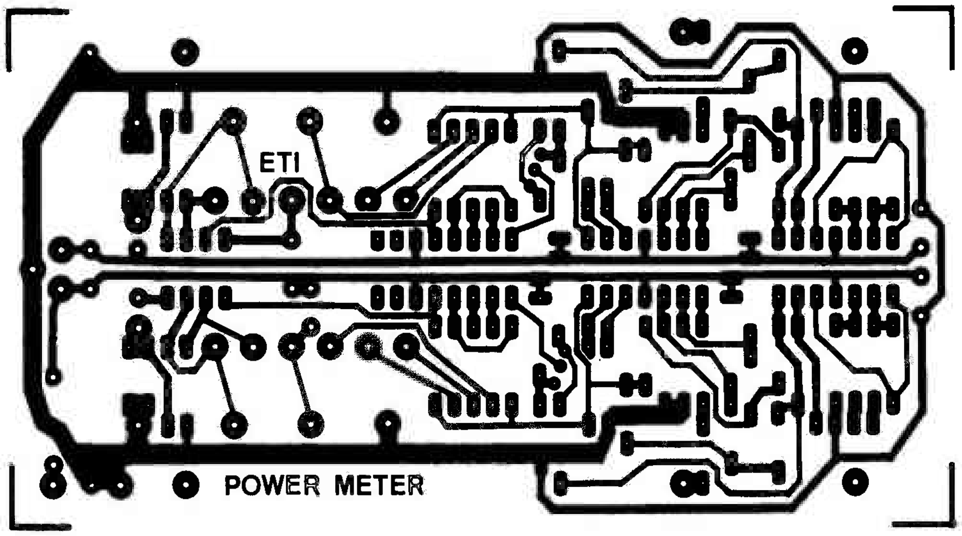

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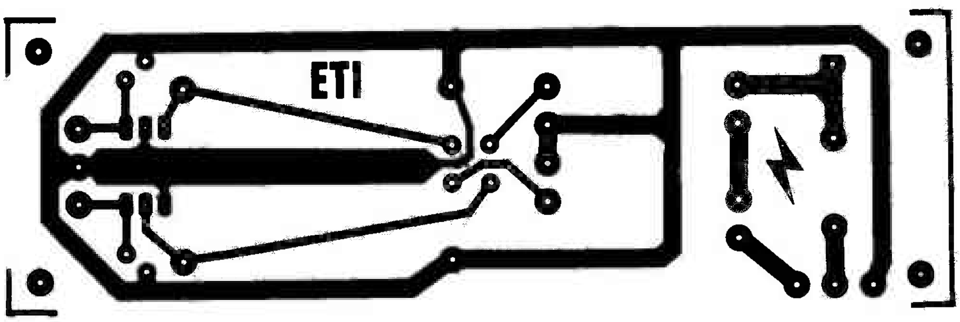
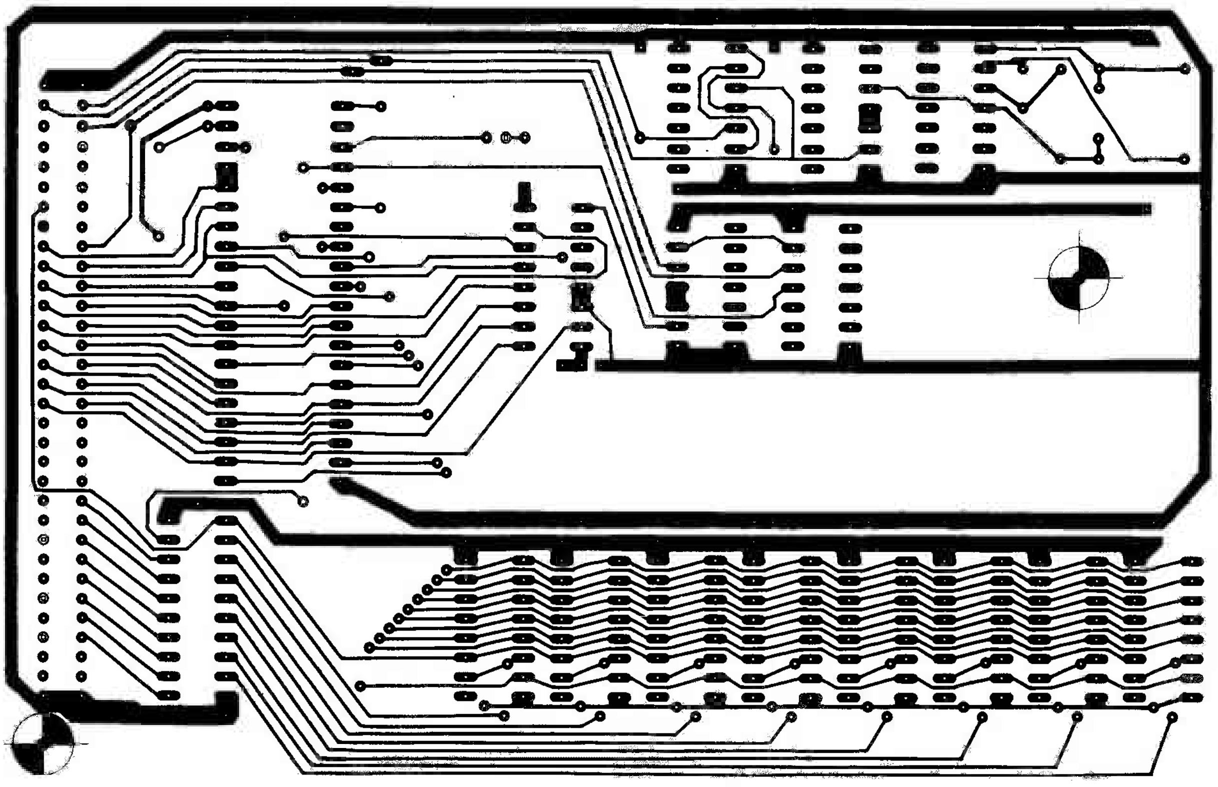
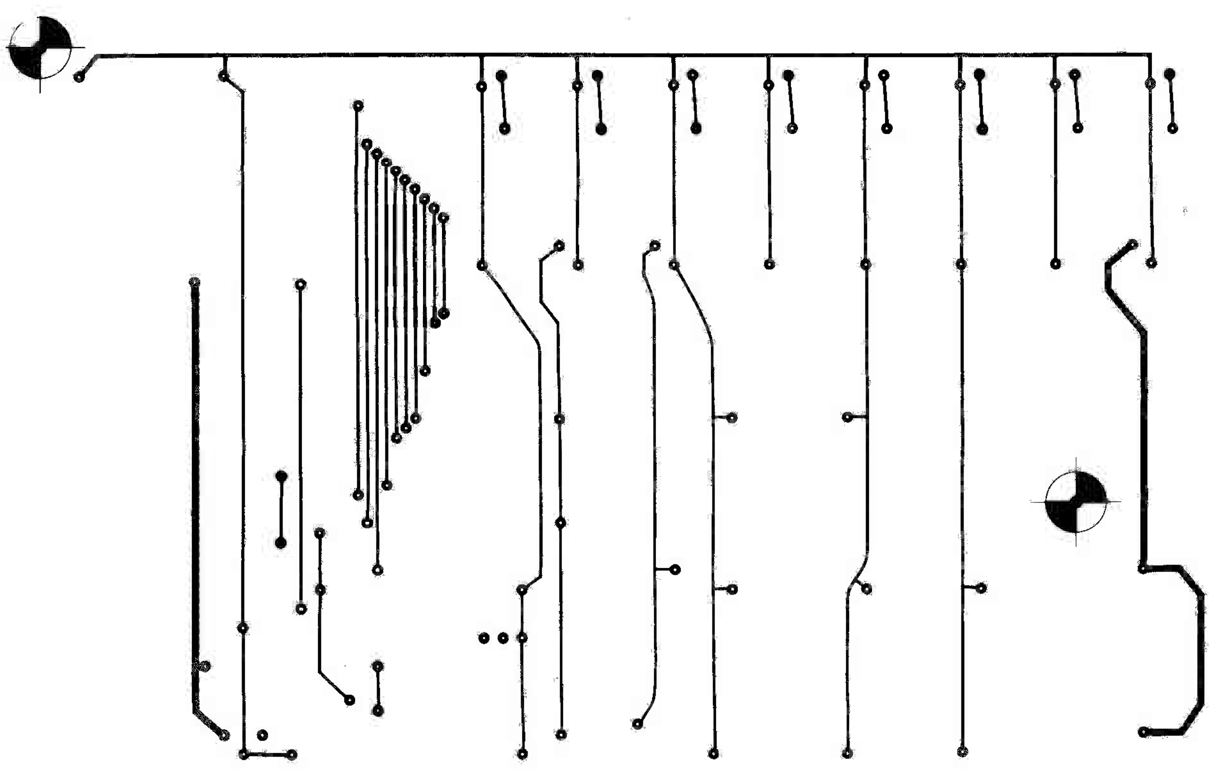
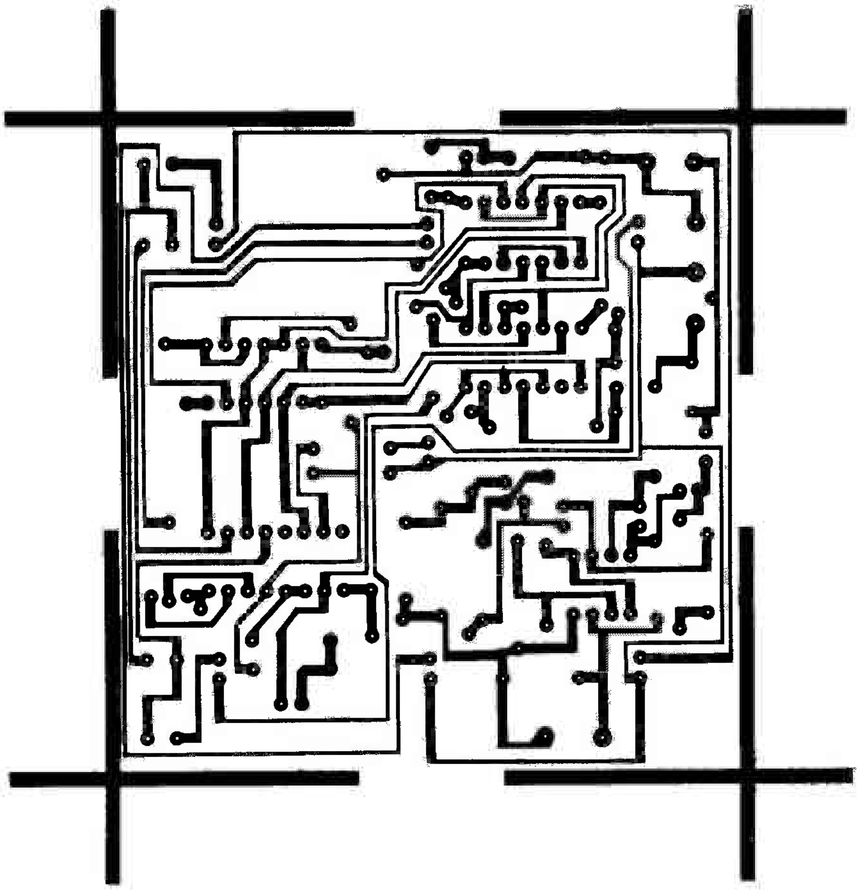




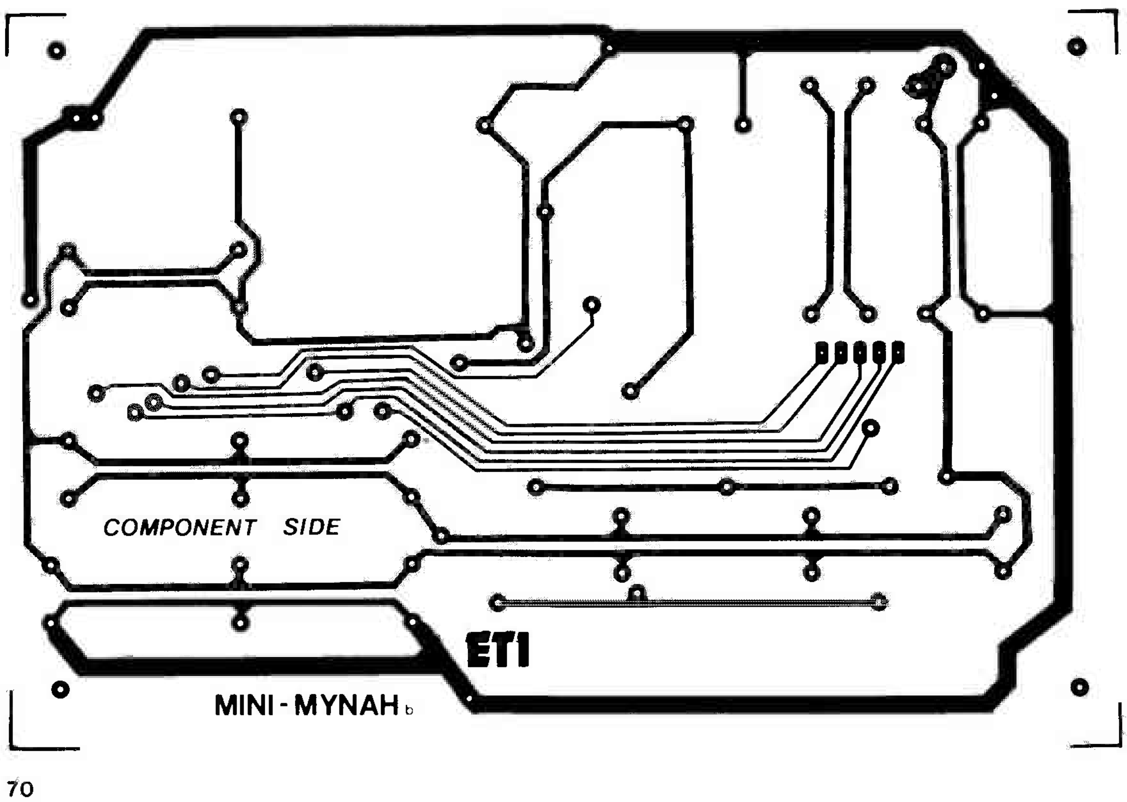
The Z80 DRAM





The Obedient die

The Mini-Mynah. This is the component side pattern which should have accompanied last month's Speech Processor project.



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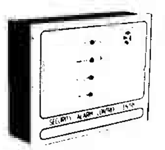

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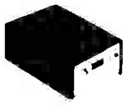

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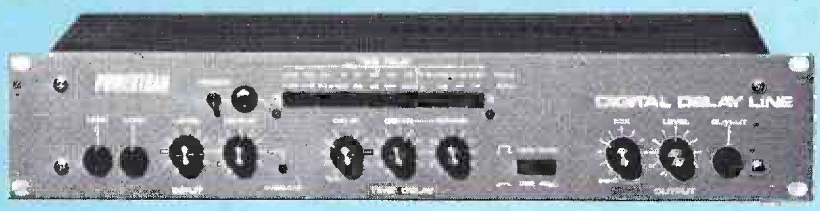


Digital delay circuitry is an absolute necessity for high quality studio work, but usually comes with a four-figure price tag.

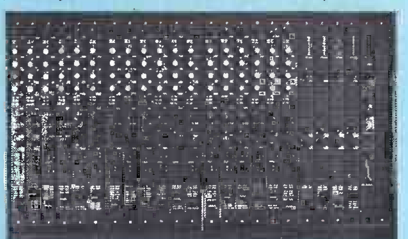
Powertran can now offer you digital quality for the price of a high analog unit. The unit gives delay times from 1.6mSecs to 1.6 secs with many powerful effects including phasing, flanging, A.D.T., chorus, echo and vibrato. The basic kit is extended in 400mSec steps up to 1.6 seconds simply by adding more parts to the PCB.

Complete kit (400mS delay) **£130**

Parts for extra 400mS delay (up to 3) **£9.50**

'DESTINY' MIXER

This versatile mixer offers a maximum of 24 inputs, 4 outputs, and an auxiliary channel. Input channels have Mic/Line, variable gain, bass/treble, and middle frequency equaliser. Output channels have PPM displays and record/studio outputs. There are send/return jacks, auxiliary, pan and fader controls, and output and group switching. There is also a headphone jack and built-in talk-back microphone.



Input channel £19.50
Output channel £18.50
Aux. channel £22.50
Blank panel £3.00
Base unit and front £27.50
Pair of end cheeks £12.50
Power supply and cabinet £19.50

TRANSCENDENT 2000

ETI single board synthesizer.

This professional quality 3-octave instrument is transposable 2 octaves up or down, giving an effective 7-octave range.

There is portemento pitch bending, VCO with shape and pitch modulation, VCF with high and low pass outputs and separate dynamic sweep control, noise generator and an ADSR envelope shaper. Other features include special circuitry with precision components to ensure tuning stability.

Complete kit **£165**

MPA 200

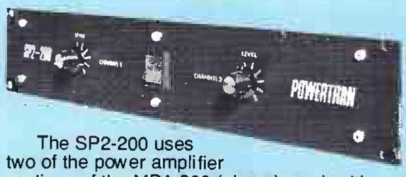
100 watt mixer/amplifier

Here's a rugged, professionally finished mixer amp designed for adaptability, stability and easy assembly. Using new super-strength power transistors and a minimum of wiring, it offers a wide range of inputs (extra components are supplied for additional inputs), 3 tone controls, each with 15dB boost and 15dB cut, and a master volume control.

Complete kit **£49.90**

SP2-200

2-channel, 100-watt amplifer

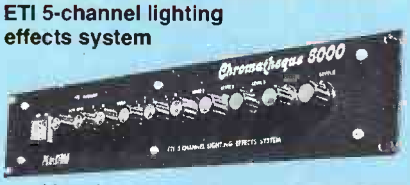


The SP2-200 uses two of the power amplifier sections of the MPA 200 (above), each with its own power supply. A custom designed toroidal transformer enables both channels to simultaneously deliver over 100W rms into 8 ohms. Each channel has its own volume control, and a sensitivity of 0.775mV (OdBm) makes this amplifier suitable for virtually all pre-amps or mixers.

Complete kit **£64.90**

CHROMATHEQUE 5000

ETI 5-channel lighting effects system



Many lighting control units are now available. Some perform switching and others modulation of light output according to musical input. The Chromatheque combines both functions. It controls 5 banks of lamps up to 500W each in either analog or digital mode. And the 5 channels give more colours and more exciting linear and random sequencing than is possible with 3 or 4-channel systems. Versatile light level controls enable the lights to be partially on to suit the mood of the occasion. Wiring is minimal and construction straightforward.

Complete kit **£49.50**

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