REFRESH YOUR MEMORY!
64 K DRAM project

- suits 6502/6800 based micros
- highly cost-effective design
- readily adaptable to different configurations

Logical scope trigger

PLUS
Audio Design—a major new series from Linsley Hood

Videotone Minimax IIIs on test

Automatic NiCad charger/regenerator
Extra voice (up to three more) phonic synthesiser with outstanding design characteristics and versatility and performance to match.

TRANSCENDENT POLYSYNTH — A four octave_polyfader controls and output and group switching. The output channels have PPM displays are two stereo inputs for magnetic cart—input. Other ‘plus’ features are auto—constructor DJ to produce a professional appearance every time. There is in a separate cabinet.

PORTWAY INDUSTRIAL ESTATE ANDOVER, HANTS SA10 3NN. ORDER BY PHONE (0264) 64455 Simply request your chosen kit and quote your Access or Barclaycard Number.

DIGITAL DELAY LINE — With its ability to give delay times from 1.6 mSecs to up to 1.6 secs. Many powerful effects including phasing, flanging, A.D.T., chorus, echo & vibrato are obtained. The basic kit is extended in 400 mS steps up to 1.6 secs. Simply by adding more parts to the PCB. Compare with units costing over £1,000.

Complete kit (400 mS delay) £130 + VAT

Parts for extra 400 mS delay £9.50 + VAT

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

Complete kit £165.00 + VAT

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

Free Soldering Practise Kit on request with your first kit — useful tips, well illustrated.

Component packs for most kits are available. See our great free catalogue, full details of all our range.

SALES COUNTER Collect your order from the factory. Open 9-12/1-4.30 Mon-Thurs. Easy parking, no waiting.

FREE SECURICOR DELIVERY on all orders over £100 (UK mainland only) Add just £2.50 on lower price orders.

Star sounds** Star quality** Star features**

数字延时线 — 具有能够提供延迟时间从1.6毫秒到1.6秒的能力。许多强大的效果包括延时、混响、ADT、合唱、回声和振荡。每增加一个部分到PCB上，可以增加这些效果。与价格超过£1,000的单位相比。

完整的套件（400毫秒延迟）£130 + VAT

额外的400毫秒延迟部分 £9.50 + VAT

TRANSCENDENT 2000 — 尽管只有一个3个八度的键盘，但2000的特点与它的大兄弟相同的设计聪明才智，细致的工程设计和质量组件。这个工具组的规格在第一流建造者 — 买它，建造它 — 演奏它！你会知道你已经做出了正确的选择。

完整的套件 £165.00 + VAT

这是一个具有多功能的模块式混音器，作为《实用电子》杂志的一篇构造性文章，可以构建最多24个输入，4个输出和一个辅助通道。每个输入通道具有麦克风和线路输入，变量增益，低音和高音控制和一个参数中频均衡器。有发送和返回端口，辅助，音场和推杆控制以及输出和群组切换。输出通道具有PPM显示和录音和工作室输出。辅助通道也具有PPM显示和有一个耳机监控端口以及内置回话麦克风。混音模块可以插入基础单元中，每个单元可以支持最多6个通道。为了消除噪音，电源供应器在一个单独的柜子里。

免费焊接实践套件在您的第一个套件上 — 有用的技巧，很好地说明。

组件包对大多数套件都是可用的。查看我们的免费目录，详细了解我们所有的产品。

销售柜台 — 在工厂收集您的订单。开放9-12/1-4.30周一周。容易停车，无需等候。

免费SECURICOR送货服务于所有订单超过£100（英国本岛仅限）仅需£2.50在较低价格订单上。

Star sounds** Star quality** Star features**
DIGEST..........................................................11
Our usual look at the news in electronics, together
with our usual iconoclasms.

AUDIO DESIGN...................................................21
Here’s a series for everyone form newcomer to
expert, written by one of the leading writers in the field - John Linsley Hood.

IC UPDATE..........................................................31
This month we’re looking at some new ICs that you
can buy right now - well, we hope you can, because
we’ve already used one of them in a project.

TECH TIPS.........................................................48
Normally any reader’s circuit using a 555 doesn’t
take long to get sent back to source ( or worse,
passed on to Hobby Electronics), but believe it or
not, someone has found a new use for a 555!

AUDIOPHILE.....................................................55
This month’s audiophile is all about little boxes - ones
with Video tone Minimax II written in one corner. Ron
Harris sees if these bargain speakers live up to their
promise.

READ/ WRITE..................................................72
Here’s where we let you get in on the act - this time
we have your views on induction loops and holophony.

FEATURES

PROJECTS

NICAD CHARGER/ REGENERATOR.............27
Ever had that sinking feeling with rechargeable
batteries - as they get older, so their capacities get
smaller? Here’s a project to fix all that.

UNIVERSAL EPROM PROGRAMMER...........37
The conclusion of this project - the software. But
coming soon will be the ETI stand-alone
programmer/emulator.

GRAPHIC EQUALISER.................................41
Constructional details of our third octave graphic
equaliser, the circuit of which we published last
month - and details of a rather nice case that you
can use for it.

THE DIGGER....................................................51
As we’ve said in rather greater length in the article,
this item has little to do with Australia - it’s title
derives from the fact that it’s a DIGital oscilloscope
trigGER.

Z80 CONTROLLER COMPUTER.................59
This month finds us looking at the circuits necessary
to interface the controller to the controlled - an I/O
board and an interrupt board.

64K DRAM BOARD.................................64
If you’ve got a 6502 or 6800 based micro, and you
find you need some more memory - look no further.
Even if you haven’t but you’d like to find out how to
use dynamic RAM, you’ll find this article very
illuminating.

INFORMATION

THIS YEAR’S BREADBOARD EXHIBITION.........35
ETI BOO KSERVICES.....................................36
READERS SERVICES.................................46
ETI PCB SERVICE.................................77
ADVERTISERS INDEX..............................82
<table>
<thead>
<tr>
<th>TRANSISTORS</th>
<th>SEMINS, TAIWAN, POLY-CAP, 4% Poly, CAP-CHIP, 4% Poly, CAP-CHIP</th>
</tr>
</thead>
<tbody>
<tr>
<td>BF399/400</td>
<td>BF399/400, 4% Poly, CAP-CHIP, 4% Poly, CAP-CHIP, 4% Poly, CAP-CHIP</td>
</tr>
</tbody>
</table>

**ACCESS & VISA ORDERS**

Access to your order online, we do the rest.

Tel: (0923) 37774, Tix. 656095, WATFORD

250 High Street, WATFORD, WD1 2AN, HEATS.
MAIL ORDER & RETAIL SHOP

ALL DEVCE BRAND NEW & FULLY GUARANTEED, SEND CHEQUES, P & P.

BANKS & CREDIT CARDS ACCEPTED. VISA & ACCESS CARDS ACCEPTED. PMP & ADD or to ALL CASH ORDERS. OVERSEAS ORDERS, POSTAGE CHARGED AT COST.

AFFILIATE ORDERS, SUBJECT TO CHANGE WITHOUT NOTICE AND AVAILABLE ON REQUEST.

VAT: Export orders no VAT. Applicable to U.K. Customer only. Unstated stated elsewhere, 5% prices are exclusive of VAT. Pixel 15% to the total cost including VAT.

We stock thousands of items to suit you.

Open Monday to Saturday: 8.00am to 1.00pm. Amenities... Car parking 1 pac - available.

ORDER ACCEPTED. P&P ADD £1 TO ALL CASH ORDERS.

OVERSEAS ORDERS, POSTAGE CHARGED AT COST AIR/SURFACE. PRICES SUBJECT TO CHANGE WITHOUT NOTICE AND AVAILABLE ON REQUEST.

Tel: (0923) 37774, Tix. 656095, WATFORD
DISC DRIVES FOR THE FORTH COMPUTER

516" Teac FD55 Slim Line Mechanism
FD55 40 track SSD 250k bytes unformatted
bare £135 Cased £155
cased + PSU £350

FD558 80 track 500k bytes unformatted
bare £180 Cased £205
cased + PSU £475

516" Mitsubishi M4853 Slim Line Mechanism
80 track SSD 1 Mbyte unformatted
bare £225 Cased £245
cased + PSU £590

516" M485 2 Mbytes
Single drive cable £8 Dual Drive Cable £12
Other parts for FORTH COMPUTER available please send SAE for details.

PLEASE SEND SAE FOR PRICE LIST
BCC SOFTWARE IN EPROM
Wordprocessor "View"

<table>
<thead>
<tr>
<th>DATA SHEETS are available on request</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1</td>
</tr>
<tr>
<td>D3</td>
</tr>
</tbody>
</table>

MEMORIES

| 2716 20ns D1  | 0.80 |
| 2716 20ns D2  | 2.95 |
| 2716 20ns D3  | 4.75 |
| 2716 40ns D1  | 1.95 |
| 2716 40ns D2  | 5.00 |
| 2716 40ns D3  | 8.50 |
| 2716 2m D1    | 12.00 |
| 2716 2m D2    | 20.00 |
| 2716 2m D3    | 32.00 |

SPECIAL OFFER
Spectrum 32K Upgrade Kit

| 32K  |
| 24.95 |

BUFFERS

| 100B  | 0.80 |
| 120B  | 0.80 |
| 121B  | 0.80 |
| 153B  | 0.80 |
| 213B  | 0.80 |
| 215B  | 0.80 |
| 225B  | 0.80 |

NO-RISER DATA CONVERTERS

| 4025  | 0.10 |
| 4585  | 0.75 |

ZIP SOFTW (TEXTOOL)

| 24 pin  | 0.50 |
| 28 pin  | 0.50 |

LINES/SCROLL

| 12LSH | 0.50 |
| 12LFM | 0.50 |
| 12LMD | 0.50 |
| 12LMP | 0.50 |

MODICOM 4000

| 4000  | 0.10 |
| 4025  | 0.10 |
| 4050  | 0.10 |

CIRCUS

<table>
<thead>
<tr>
<th>74LS SERIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>74LS SERIES</td>
</tr>
</tbody>
</table>

DATA BOOKS by

<table>
<thead>
<tr>
<th>74LS SERIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>74LS SERIES</td>
</tr>
</tbody>
</table>

Please complete this coupon for a copy of our FREE catalogue.

NAME

ADDRESS

TEL NO.

Please send this coupon to our address with a SFR 1 coin and 1 stamp.

Please check to show delivery charges.

 carriage Orders are sent by first class post.

 carriage charges are exclusive of V.A.T.

 carriage charges are subject to change without notice.

 carriage charges are subject to change without notice.

 carriage charges are subject to change without notice.

 carriage charges are subject to change without notice.

 carriage charges are subject to change without notice.

 carriage charges are subject to change without notice.

 carriage charges are subject to change without notice.

 carriage charges are subject to change without notice.

 carriage charges are subject to change without notice.

 carriage charges are subject to change without notice.

 carriage charges are subject to change without notice.

 carriage charges are subject to change without notice.

 carriage charges are subject to change without notice.

 carriage charges are subject to change without notice.
Typewriter Interface

We've come across what must be one of the more crazy situations in electronics - namely that you can't buy a daisy wheel printer for less than around £400, but you can buy a typewriter with a daisy wheel printing mechanism and a keyboard for just over £200! Needless to say, it didn't take one of our contributors long to get out his soldering iron and find out exactly how you can interface the typewriter in question to a micro - well, not a micro, but just about any micro! And the make of the typewriter, well, we're not foolish enough to tell you that until next month.

Another New Series
Following on from our attempt to de-mystify audio, we're about to embark upon an even more arcane area, the mention of which will usually bring a look of despair to even the most hardened engineer's face - machine code programming. This series will be so simple that even the Editor - a confirmed microphobe - will be able to understand it.

... And While We're Talking About Series ...
John Linsley Hood will be continuing his look at audio design with a discussion of ICs for audio applications and a look at some gremlins - noise and distortion being two of the best known of this breed.

IC Update
Almost without us thinking about it, this seems to have sprung into being an established series in the magazine; well, it seems to be one of the most useful roles we can play - that of disseminating information on new devices. To try and counterbalance all these micro-based projects (and to keep our Editor happy), we'll be looking at some up-to-date linear devices.

ZX Backup Supply
This must be one of the simplest projects we've published in a long while - and such a simple idea that it's surprising no one else has thought of it. What it does is to keep your ZX going if there should be a temporary supply interruption, or a blown fuse - or if grandfather should trip over the power connector!

ALL THIS AND MORE IN THE OCTOBER ISSUE OF ETI, ON SALE SEPTEMBER 2ND. PLACE YOUR ORDER NOW, OR RISK MISSING OUT!
Articles described here are in an advanced state of preparation. However, circumstances may dictate changes to the final contents.
MULLARD SPEAKER KITS

Popularly designed 40 watt RMS and 80 watt RMS. 8 ohm speaker systems recently developed by MULLARD’S skilled team in Belgium. Kits comprise Mullard woofer 15" or 21" with horn loaded and aluminium voice coil. Mullard 3" high power domed tweeter. B.K.E. built and tested crossover based on low Q circuit, combining low Q components, glass fibre board and recessed baffle terminal.

SUPERB SOUNDS AT LOW COST. Kits supplied in complete pre-wireable complete with instructions and recommended cables. 240V 219 x 295mm. Price £24.50 each + £2.10 P&P. 30 watt system kit £20.50 each + £2.00 P&P. Designer approved flat pack cabinet kits, including grill fabric. Can be finished with iron on, varnish or self adhesive vinyl etc. 8" system kit £10.50 each + £2.50 P&P; 5" system cabinet kit £7.00 each + £2.00 P&P.

STEREO CASSETTE TAPE DECK MODULE.

Comprising of a tap panel and tape mechanism coupled to a record player printed board assembly. Supplied as one complete unit for horizontal installation inside cabinet or outside of own choice. These units are brand new, ready built and tested.

Price £22.00 + £2 carriage.

12" 100 watt R.M.S. (HFi Fi) Die cast chassis, 2" aluminium voice coil, white cone with aluminium centre dome. 8 ohm imp. Res. Freq. 20Kz, Freq. Resp. to 2.5KHz, Sers. 70dB (As Photograph). Price: £32.00 + £3 carriage.


Black cone grille (3.50 VAT £1.5). Price £3.50.

15" 188 watt R.M.S. McKenzie C1285SP (Lead Guitar, Keyboard, Disco) 2" aluminium voice coil, aluminium centre dome, 8 ohm imp., Res. Freq. 45Kz, Freq. Resp. to 6KHz. Sers. 92dB. Price £20.50 + £3 carriage.


Matching 3-way loudspeakers and crossover

Build quality 60 watt RMS system Bohns
Build quality 60 watt RMS system.

100 WATT R.M.S. AND 300 WATT R.M.S. MODULOS

Power Amplifier Modules with integral output power supply, and heatsink. Supplied as one complete unit and tested unit. Can be fitted in minutes. An LED Vu meter is available as an optional extra.

SPECIFICATION

Max Output Power: 110 watts RMS (OMP 100) 310 watts RMS. (OMP 300)

Load: Output: AC 250 volt RMS. Frequency Response: 20Hz - 12KHz

Dimensions: Width 205mm x 80mm x 40mm

Price: £22.00 per kit + £2.50 postage and packing.

B.K. ELECTRONICS

37 Whitehouse Meadows, Eastwood, Leigh-on-Sea, Essex SS9 5TY

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

1K.WATT SLIDE DIMMER

Controls load up to 1KW
Compact size
4 1/2" x 2 1/2"
Easy snap in fixing through panel/cabinet cut out
Insulated plastic case
Full wave control using Baproc
Conforms to BS800
Suitable for both resistance and inductive loads
Innumerable applications in industry, the home, and discos/

Price: 11.70 each + 50 p P&P

BSR P256 TURNABLE

P256 turntable chassis
5 shaped tone arm
Built in preamp - aluminium arm
Precision calibrated counter balance
Anit skat bias device
Ganged cutting lever
250 volt AC operation (Hzl)
Cut-out template supplied
Completely manual arm. This deck has a complete manual arm and is designed primarily for disco and studio use where all the advantages of a manual arm are required.

Price: £28.50 + £2.50 P&P

PIEZO ELECTRIC TWEETERS - MOTOROLA

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


TYPE B (KSN102SSAI) 3") single horn. For general purpose speakers, disco and P.A. systems etc. Price £3.35 each.

TYPE C (KSN102SA1) 5" wide dispersion horn. For high quality hi-fi systems and quality disco etc. Price £6.45 each.

TYPE D (KSN205SSAI) 5" wide dispersion horn. For high quality hi-fi systems and quality disco etc. Price £6.90 each.

TYPE E (KSN205SSAI) 3/4" horn tweeter with attractive silver flush trim. Suitable for high fidelity monitor systems etc. Price £4.55 each.

TYPE E' (KSN205SSAI) 3/4" horn tweeter with attractive silver flush trim. Suitable for high fidelity monitor systems etc. Price £4.55 each.

An alternative power supply and heat sinks. All three units have aluminium centre dome and rolled foam surround. Crossover components are mounted on a Brackets. The four different types of tweeter to suit a variety of applications. Price £22.00 per kit + £2.50 postage and packing. Available separately, price on request.


BKELECTRONICS Prompt Deliveries VAT inclusive prices Audio Equipment Test Equipment by Thandas and Leader
World's Smallest Colour TV

The first-ever LCD pocket colour television in the world has been developed in Japan by the Epson Corporation and Suwa Seikosha Company Ltd, the parent company of Epson (UK) Limited. Measuring 16cm x 8cm x 2.8cm, the pocket TV utilizes new picture display devices invented by Seiko in its development of a TV watch. This flat display - which provides the key to the ultra-miniaturization represents a breakthrough in picture tube advancement and will play an important role in the progression towards a picture style colour TV, the technological goal of research organizations all over the world.

Amongst the pocket TV's advantages Epson claim no colour aberration at corners, or distortion of pictures, and good visibility in dark or light situations. There are no plans to market the TV in the UK. Epson (UK) Limited, Dorland House, 388 High Road, Wembley, Middlesex.

Is It Clicket?

A new micro-miniature switch is available through Cambion Electronic Products, and it’s called the Clicket. As you can see from the photograph, it’s pretty small, with a 0.1" leading space, and it has a push-on, push-off action. Cambion Electronic Products Division, Cambion Works, Castleton, nr Sheffield S30 2WR.

Silicon On Insulator Success

Mitsubishi Electric Corporation has succeeded in manufacturing on an experimental basis a silicon-on-insulator (SOI) structure complementary metal oxide semiconductor (CMOS) device with the world's shortest delay time of 280 picoseconds, using a laser beam recrystallization technique. This delay time is only a quarter of that of a conventional SOI device and even shorter than that of a device using a single-crystal silicon wafer. Mitsubishi Electric's success in trial manufacture of the new SOI CMOS marks a major step toward the realization of three-dimensional integration - integration greater than the conventional very large scale integration (VLSI). To make a 3-D integrated circuit, it is necessary to cover integrated circuits on every tier of the multiple layers with oxide or nitride film for complete electrical insulation, and to place a single crystal of silicon on top of this film for the next ICs.

Transistors and other devices are integrated on the surface of single crystal silicon in conventional ICs. In the case of the SOI structure IC, single-crystal silicon is formed on an insulator substrate; such as silicon oxide. When an SOI structure is employed, there is no malfunctioning from short circuits or interference, even if the distance between devices is made shorter for higher integration.

In conventional methods of making an SOI structure, polycrystalline silicon is melted by a laser beam or an electron beam for recrystallization into a single crystal. But the single crystal thus formed is small and the direction of its growth is not fixed, causing electrical leakage and shortening of circuits. Mitsubishi Electric solved these problems by developing a revolutionary recrystallization method, under which the scanning speed, the intensity and the direction of the laser beam are adjusted to control the direction and size of crystal. Mitsubishi Electric expect their SOI technology to have a wide variety of applications - as the key technology for 3-D integrated circuits of the future; for high speed and highly reliable CMOS LSI's without latch-up; and for thin film transistors for driving liquid crystal displays.

The work was performed under the management of the R & D Association for Future Electron Devices as part of the R & D project of Basic Technology for Future Industries, sponsored by the Agency of Industrial Science and Technology, MITI, Japan.

Lead Free Solder

Jimi Heat of Watford announce the introduction of a new British made all-purpose solder to replace their widely acclaimed, imported, all-metal solder launched around 12 months ago. Supa Solda is lead free, non corrosive and capable of handling all metals including aluminium. It can be shaped, polished and even chromed. Its relatively low melting point and capillary action is claimed to make it suitable for even the most delicate applications that formerly required expensive silver-based solders.

The suggested retail price of a ‘bubble pack’ of Supa Solda is £1.65 and it is available from Halfords and other selected retail outlets.
MAIL ORDERS: Unit 1, Hill Farm Industrial Estate, Boxted, Colchester, Essex CO4 5RD. TELEPHONE ORDERS: Colchester (0206) 36412.

ACCESS AND BARCLAYCARD WELCOME

NEW CATALOGUE + NEW CATALOGUE!!!!!!!!

The Rapid Guarantee

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

ORDERING INFO. All components brand-new and full specification. All prices exclude VAT. Please add to total order. Please add 50p/carriage to all orders under £15 in value. Send cheque/ P.O. or credit card number and expiry date to: Rapid Electronics, Unit 1, Hill Farm Industrial Estate, Boxted, Colchester, Essex CO4 5RD. Tel: (0206) 36412. Orders under £10 are charged at 10p extra carriage.

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

ACCESS AND BARCLAYCARD WELCOME

The Rapid Guarantee

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

ORDERING INFO. All components brand-new and full specification. All prices exclude VAT. Please add to total order. Please add 50p/carriage to all orders under £15 in value. Send cheque/ P.O. or credit card number and expiry date to: Rapid Electronics, Unit 1, Hill Farm Industrial Estate, Boxted, Colchester, Essex CO4 5RD. Tel: (0206) 36412. Orders under £10 are charged at 10p extra carriage.
Zilog have revealed details of their new Z800 family of 8/16 bit microprocessors. The new CPU's will run on all existing Z80 software at object code level and will provide up to five times greater performance operating at clock rates of 10 to 25 MHz. The Z800 also saves board space and reduces system design costs by including DMA functions, counter/timers, serial I/O and refresh logic on the chip. Using these on-chip peripherals a small system can be designed with only the Z800 CPU, external memory and a clock crystal. An on-chip memory management unit (MMU) and cache/local memory are also included to increase the power and flexibility of the Z800.

The MMU extends the Z800 CPU's logical addressing space up to 16 megabytes compared to the Z80's maximum of 64 kilobytes. This is achieved by dividing the logical address space into pages, each of which is mapped into larger physical memory. The MMU also provides all the features necessary to implement a virtual memory system transparent to the applications program. The 256 byte cache memory on the Z800 chip provides the CPU with high speed access to instructions and data that would otherwise reside in slower external memory. Since this feature coupled with programmable bus timing allows the CPU clock speed to differ from the memory clock speed, fast processors (up to 25 MHz) need not be accompanied by equally fast memory devices as was necessary with earlier designs.

The Z800 CPU instruction set includes all the Z80 instruction set plus a number of new enhancements. New instructions allow the Z800 to perform 8 and 16-bit hardware and multiply and divide, 16-bit arithmetic, 16-bit load, bank switch, (for controlled operating system access by the user) and test and set (for multi-processing support). A group of extended processing instructions are also included in the Z8000 and Z80,000 allows the Z800 CPUs to be used with any co-processor compatible with Zilog's extended processing architecture, including the Z8070 floating point processor.

Several new addressing modes have also been added to the Z80 CPU's original set: index with a 16-bit displacement, base index, and stack pointer relative. In program counter relative mode exists for the Z80 chip but in the Z800 chip it is enhanced to allow 16-bit displacement. Furthermore, the Z80's 2-byte register set has been increased by allowing byte access to both the IX and IY registers (providing four additional 8-bit registers) and the use of two stack pointers instead of one.

Honeywell has developed a process for building zinc oxide acoustical microphones and microelectronics on single silicon substrates. The "mike-on-a-chip" offers high performance, sensitivity and reliability at a fraction of the cost and size of current available ceramic acoustic microphones. The chip-sized microphone is made possible by a new Honeywell fabrication technique. The company recently developed a reproducible process for depositing high-quality zinc oxide thin films, substances similar in electronic performance to piezoelectric ceramics but compatible with standard integrated circuit processing. Honeywell used existing semiconductor processes and equipment to fabricate the zinc oxide thin-film integrated electronic conditioning circuitry on silicon.

The advantages of Honeywell's integrated acoustical microphones over ceramic devices are many. The integrated microphones provide frequencies down to 0.1 hertz, whereas ceramics lose sensitivity at about 20 hertz. The integrated sensors also offer greater reliability because they are solid state, there are no parts to glue or solder, as with ceramic devices. The Honeywell sensors are also smaller and lighter than their ceramic counterparts. In addition, the sensing element is a passive device and the electrical signal is less than 40 milliwatts, which means it can remain working in the field for months before requiring battery recharge or replacement. Zinc oxide, like piezoelectric ceramic, produces an electrical charge when strained. However, zinc oxide is also pyroelectric; it produces a voltage change in response to thermal change, and this effect must be minimised in low-frequency applications of this device. Honeywell eliminated the thermally-induced voltage fluctuations through a unique design of concentric electrodes, that cancel all pyroelectric-induced electrical signals.

The "mike-on-a-chip" is very sensitive. It can detect one microparticle of pressure (one bar equals one atmosphere or 14.69 pounds of pressure per square inch) and will exhibit signal-to-noise ratios of 5:1 at one microbar. Honeywell's "mike-on-a-chip" could have various applications, including hearing aids. Honeywell has applied for a patent on its integrated acoustical microphone technology.

Industry's Fastest RAM

The industry's fastest RAM has been introduced by Motorola. It's new bipolar 64-bit ECL RAM (MC10H145) with an address time of 3ns (typ) and 6ns (max). The MC10H145 is organised as a 16 x 4 memory array and is a member of the MECL 10KH family. These very high speeds were achieved through new circuit designs as well as advanced processing techniques. Because the device is a member of the 10K family it's a gate array product. The input to the device was changed from 10K configuration to include both constant current source gates and a voltage regulator. These additions, as well as new configurations of logic, reduce gate delays thus producing these high speeds. Since the device is in the MECL 10KH family it is processed with Motorola's new oxide isolated process called MOCASIC (Motorola Oxide Self-Aligned Implanted Circuit - but it took them quite a while to think that one up; which achieves smaller device geometry, improved bandwidth and reduced parasitic capacitances. The European Literature Centre, Motorola Semiconductors, 88 Tanners Drive, Blakelands, Milton Keynes.

New Micro With ROM

The NEC uPD7809G contains the largest on-chip ROM capacity of 8K among current commercially available products, as well as 256 bytes of RAM. In addition to the powerful instruction set with 16-bit arithmetic/logic instructions, the device contains versatile functional blocks such as 8-comparator input lines, watchdog timer, programmable wait, hold function, 16-bit event/timer counter, two 8-bit programmable timers and serial interface (UART). The new 8-bit comparator input lines can be used, for example, for direct interface with the keyboard and the watchdog timer will prevent the program from running out of control in a noisy environment.

The 7809 (seem to have seen that number before!) features a high speed instruction cycle time of 1us, which under 12MHz, allow much faster 16-bit multiply/divide operations. It is estimated at 1.5 to 5 times faster than conventional micros.

In addition to on-chip memories of 8K for ROM and 256 for RAM, external memory expansion up to 56K bytes is also provided for, with battery backup operation applicable to some on-chip RAM under stand-by mode.

NEC Electronics (UK) Limited, 116 Stevenson Street, New Stevenson, Motherwell ML3 4LT, Scotland.

New Large EPROMS

Now available in the UK from Bytech Ltd are the latest Intel range of UV-Erasable Proms. Both D2764 (8K x 8) and D27128 (16K x 8) devices are being stocked, in industry standard approved package. The 2764 is a 5V only, 65,536-bit UV Erasable Prom. Both D2764 (8K x 8) and D27128 (16K x 8) devices are being stocked, in industry standard approved package. The 2764 is a 5V only, 65,536-bit UV Erasable Prom. Both D2764 (8K x 8) and D27128 (16K x 8) devices are being stocked, in industry standard approved package.
**Crimson Elektrik**

<table>
<thead>
<tr>
<th>No</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>2560</td>
<td>CE 608 40W Mono</td>
<td>4.20</td>
</tr>
<tr>
<td>2561</td>
<td>CE1004 100W 4 Mono</td>
<td>21.30</td>
</tr>
<tr>
<td>2562</td>
<td>CE1008 100W 8 Mono</td>
<td>23.90</td>
</tr>
<tr>
<td>2563</td>
<td>CE1704 170W 4 Mono</td>
<td>30.43</td>
</tr>
<tr>
<td>2564</td>
<td>CE1708 170W 8 Mono</td>
<td>30.43</td>
</tr>
<tr>
<td>2565</td>
<td>CE3004 300W 4 Mono</td>
<td>42.60</td>
</tr>
<tr>
<td>2565a</td>
<td>FE 908 90W FET Mono</td>
<td>25.65</td>
</tr>
<tr>
<td>2565b</td>
<td>FE1704 170W FET Mono</td>
<td>33.48</td>
</tr>
<tr>
<td>2565c</td>
<td>BD1 Bridge Unit for Modules</td>
<td>7.13</td>
</tr>
<tr>
<td>2568</td>
<td>CPR 1X Pre-Amp Module</td>
<td>41.70</td>
</tr>
</tbody>
</table>

**Velleman Kits**

<table>
<thead>
<tr>
<th>No</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>K610</td>
<td>Mono UU using LEDs.</td>
<td>10.05</td>
</tr>
<tr>
<td>K1798</td>
<td>Stereo UU using LEDs</td>
<td>18.77</td>
</tr>
<tr>
<td>K1874</td>
<td>Running Light Kit</td>
<td>14.25</td>
</tr>
<tr>
<td>K2571</td>
<td>Light Computer with EPROM</td>
<td>36.23</td>
</tr>
<tr>
<td>K2566</td>
<td>Three Tone Chime</td>
<td>6.57</td>
</tr>
<tr>
<td>K2575</td>
<td>Microprocessor Doorbell 25 tunes</td>
<td>15.53</td>
</tr>
<tr>
<td>K2544</td>
<td>Complex Sound Generator</td>
<td>10.26</td>
</tr>
<tr>
<td>K2032</td>
<td>Digital Panel Meter</td>
<td>16.61</td>
</tr>
<tr>
<td>K2557</td>
<td>Digital Thermometer</td>
<td>26.57</td>
</tr>
<tr>
<td>K2545</td>
<td>50Hz Crystal Time Base</td>
<td>12.00</td>
</tr>
<tr>
<td>K615</td>
<td>High Precision Stopwatch</td>
<td>50.29</td>
</tr>
</tbody>
</table>

**PreTsel Adaptor**

A Prestel microcomputer adaptor to give full autodialing to your computer. All the usual Prestel facilities are added via this unit, plus many more, and, can be operated to any viewdata computer.

You can shop from home, bank transmit messages and receive software, which means that the uses your micro can be put to are limitless.

The unit is not restricted to just the UK, for at least 28 countries use the Prestel viewdata format, so you can also mail-order from anywhere. The Prestel unit is suitable for most micro computers even the ZX-81, so at the push of a button, the technology of tomorrow is in your home today.

**Component**

<table>
<thead>
<tr>
<th>Device</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z80A</td>
<td>3.20</td>
</tr>
<tr>
<td>Z80A PIO</td>
<td>3.20</td>
</tr>
<tr>
<td>Z80A CTC</td>
<td>3.20</td>
</tr>
<tr>
<td>6800</td>
<td>6.50</td>
</tr>
<tr>
<td>6810</td>
<td>3.00</td>
</tr>
<tr>
<td>6821</td>
<td>4.25</td>
</tr>
<tr>
<td>6502CPU</td>
<td>7.50</td>
</tr>
<tr>
<td>2114(200ns)</td>
<td>1.80</td>
</tr>
<tr>
<td>2708</td>
<td>3.00</td>
</tr>
<tr>
<td>2716</td>
<td>3.20</td>
</tr>
<tr>
<td>2732</td>
<td>7.50</td>
</tr>
<tr>
<td>2762</td>
<td>3.50</td>
</tr>
<tr>
<td>2764 (200ns)</td>
<td>11.00</td>
</tr>
<tr>
<td>ADC2081 (8-bit)</td>
<td>14.90</td>
</tr>
</tbody>
</table>

We also stock 74 series 74LSLS, CMOS, transistors, capacitors, resistors, LEDs, zener diodes, diodes, jack plugs, mains plugs, XSS plugs, cam<span>...}</span>
Electronic Memo Pad

A unique totally British designed electronic memo pad which can carry out the functions of a calendar, diary, address book, notepad and a expense account log has been launched into the UK by Domicrest Ltd. The unit measures 136mm (W) x 90mm (H) x 9mm (D) about the same size as a cigarette case, and will therefore fit in the pocket or the handbag. Called the Biztek Pad it will be percolating through the shops with a retail price of £69.95.

Vital Safety Device

New from B & R Electrical Products is the Power Breaker-S, which is a residual current circuit breaker mounted in the same body as a double 13A socket. Like the HI ELCB (Dec 1982), the device works by detecting any difference of more than 30mA between the two supply lines from the mains, and cutting off the supply before this can result in electrocution. Why every electronics hobbyist doesn't protect his or her equipment supply with one of these (or a similar) device, we'll never know let it suffice to say that we very strongly recommend doing so.

B & R Electrical Products Ltd., Temple Fields, Harlow, Essex CM20 2BC.

ZX Music Board

There are now two ready-made cased versions of the ZX81 Music Board (ETI April and May this year), one for the ZX81 which costs £24.95 inclusive, and one for the Spectrum, which costs £26.95. A demonstration cassette is available for £1.25, from Petron Electronics, 1 Courtlands Road, Newton Abbot, South Devon TQ12 2JA.

Another Video "Standard"

RCA Corporation and Hitachi Ltd have announced jointly that they plan to introduce the Capacitance Electronic Disc (CED) system in the United Kingdom this autumn in time for the Christmas selling season. RCA will make the video disc albums and Hitachi will supply the players for the UK launch.

Players are expected to be priced at under £300, and discs will be between £12.95 and £21.95, with many titles under £20.

New Portables(??)

The portables market is getting just silly, as these two pictures show. Top is the latest offering in this field from Aiwa - it's styled so that all the various 'components' (the tuner, the cassette deck, etc) look like separate units all just glued together. Actually, you can attach the speakers, but when they're attached to the unit, a special port is opened between them and the main case, which brings a passive radiator into play and boosts the bass response. Total output power is 28 Watts per channel (peak), and the thing has a built-in five-band graphic equaliser (readers wanting a proper graphic equaliser should turn to page 41, where they'll find part two of our own, 28-channel equaliser). Price is a cool £199.95. (It's the CA-70, from Ai-ee-wah UK Ltd, 163 Dukes Road, Western Avenue, London W5 OSY).

The other of these monsters has, as you can see, a B & W TV as well as the usual tape and radio facilities. But won't you bump into people if you walk along holding the TV in front of you? And how strong do your arms have to be the weight isn't stated in the press release? This beast costs £149.95 and is made by Heron Electronics, Heron House, 19 Marylebone Road, London NW1 5JL (confusingly, it's called the Ingersoll XK 500). There must be a whole generation of youth growing up with one arm longer than the other due to carrying these things around when will manufacturers think of fitting wheels to them?
New cats for old!

SEND US THE COVER FROM ANOTHER COMPONENT SUPPLIERS CURRENT CATALOGUE, PLUS A 40p STAMP, AND WE'LL SEND YOU A FREE COPY OF THE LATEST (SUMMER) AMBIT CONCISE COMPONENT CATALOGUE ALTERNATIVELY YOU CAN SIMPLY BUY A COPY FROM YOUR NEWSAGENT- OR SEND 80p TO THE ADDRESS BELOW

★ 144 PAGES : £1 DISCOUNT VOUCHERS

★ MANY PRICE REDUCTIONS : PRICE ON THE PAGE

★ AVAILABLE AT NEWSAGENTS, OR DIRECT FROM ......

ambit INTERNATIONAL

200 North Service Road
Brentwood
Essex
CM14 4SG

Telephone 0277-230909
Telex 995194 AMBIT G
Data 0277-232628 REWTEL
300 BAUD DUPLEX
New Line for TV
A slow-scan TV system currently undergoing field tests in prototype, will bring slow-scan television within reach of the average amateur pocket. Designed and built by Davenport Limited, it will be introduced in late summer with the launch of the Model SST-1000 Slow-Scan Receiver, which will be offered at the highly competitive price of less than £200.

The receiver will have facilities for accommodating a transmitter PCB that will upgrade the equipment for two-way communications. This PCB will be introduced at a later date to coincide with the launch of the full transceiver system, designated as the SST-2000 Slow-Scan Transceiver.

System specifications will be standard: that is, 128 by 128 discrete picture elements each encoded into 16 grey shades to produce one picture every 8.5 seconds. Davenport Limited, Sanderson Centre, Lees Lane, Gosport, Hampshire PO12 3JL.

Versatile LCD Display
A 175 x 50mm LCD display panel, featuring a fully programmable 240 x 64 dot matrix, has been introduced by Implectron Ltd. The panel, manufactured by Sharp of Japan, is designated the Model LM-24002G and incorporates LCD display panel, CMOS-LSI driver circuits and interconnection facilities.

The new unit is capable of displaying graphs, diagrams or animated pictures as well as letters, figures or symbols. Viewing angle is a minimum of 40°, whilst contrast ratio is typically 3.00 and response speed better than 300 milliseconds. The back of of the display contains ten CMOS control and driver chips, which ensure complete applications flexibility. Implectron Ltd, Foundry lane, Horsham, West Sussex RH13 5PX.

Fibre Optic Photodiode
Norban Electro-Optics Limited, sole distributors of RCA fibre optic components in the United Kingdom, have launched a new trans-impedance pre-amplifier photo diode module for "second-window" fibre optic applications.

The RCA C30886E utilise the new Indium Gallium Arsenide PIN photo diode which has excellent responsivity between 900nm and 1700nm and it is ideal for use at the low attenuation wavelength of 1300nm increasingly used in fibre optic systems.

High Voltage Reed Relay
A new high-voltage reed relay developed by Hamlin Electronics uses a vacuum reed switch with tungsten contacts to give an excellent isolation interface, with hold-off voltages ranging from 5kV up to 20kV.

The trans-impedance preamplifier employs a low-noise gallium arsenide FET front end and a cascade feedback circuit. An emitter follower stage has been added for improved output coupling efficiency. Additional device features include a system bandwidth of typically 250 MHz end and a signal to noise ratio of typically 22 db for a bit error rate of 10^-9. Norban Electro-Optics Ltd., Norban House, Boulton Road, Reading, Berks RG2 0LI.

Cheap DMM
Possibly the best value for money hand-held DMM in the UK is available from the House of Instruments and hit distributors. Metex type 3000 is a 3 1/2 digit LCD hand held DMM with a basic DC accuracy of 0.5%. It comes fully guaranteed for 12 months complete with test leads, battery, spare fuse, operating manual and free carrying case at £29.50 including post and packing (but exclusive of VAT).

There are 30 individual ranges of 1000V, 10 amps, 20M ohms, and diode test and zero check functions. Zeroing, over-range, polarity and low battery indication are all catered for automatically. Normal overload protection is provided as well as high voltage surge to approximately 3KV. It comes fully guaranteed for 12 months complete with test leads, battery, spare fuse, operating manual and free carrying case at £29.50 including post and packing (but exclusive of VAT).

New Cards Make Apples Grow
New from Hawk Electronic Test Equipment is a GP1B interface card which allows the Apple to become an IEEE 488 controller for test measurement and control. The board will run up to 14 separate controllable devices with a transmission path of up to 20 meters. The on-board software interfaces directly with basic and Applesoft strings, making the Apple into a powerful and easy to use IEEE 488 GP1B controller. The price of the card is £189.00 inclusive.

Also form Hawk is a 32-channel I/O card for the Apple, which enables external control and data feedback for the Apple, with four 8-bit bi-directional I/O ports, four 16-bit timers, two serial to parallel, parallel to serial, parallel to register and handshake capability. The price of £49.50 also includes documentation and example program. Hawk Electronic Test Equipment, Birchoil Road, Parkwood Industrial Estate, Maidstone, Kent ME15 9XT.
BUILD YOUR OWN

COREX

16 bit, 64 RAM colour computer

With this powerful machine (featured in Electronics Today International as a constructional project) you have access to highly advanced systems and software developed specially by MPE Ltd for the CORTEX. For business, education, R & D - or simply increasing your knowledge and understanding of computers - it beats comparably priced off-the-shelf machines hands down!

Standard features –

- High speed 24K byte extended basic interpreter
- Powerful TMS9995 16 bit microprocessor
- 48 bit floating point gives 11 digit accuracy
- High resolution (256 x 192) colour graphics
- Screen memory does not use up user memory space
- 16 colours available on the screen together in graphic mode
- Fast line drawing and point plotting basic commands
- High speed colour shape manipulation from basic
- Full textual error messages
- String and Array size limited only by memory size
- Real time clock included in basic
- Interval timing with 10mS resolution via TIC function
- Named load and save of basic or machine code programs
- Auto-run available for any program
- Powerful machine code monitor
- Assembler and Disassembler included as standard
- Auto line numbering facility
- Full renumber command
- Simple but powerful line editor
- Buffered i/o allows you to continue executing the program while still printing
- Flexible CALL statement allows linkage to machine code routines with up to 12 parameters
- Basic programs may contain spaces between key words to make programs readable without using more memory
- Over 34K bytes available for basic programs
- Extended basic includes IF-THEN-ELSE
- Supports up to 16 output devices: Screen and cassette interfaces included as standard
- Supports bit manipulation of variables from basic
- Error trapping to a basic routine included
- Basic supports Hexadecimal numbers
- Separate 16K video RAM for graphics

Self assembly kit

£295

Ready built £395

All prices + VAT
Carriage paid

Optional extras

RS232C interface kit £9.20
Floppy disc interface £65.50
Pair of 5½” disc drives and hardware kit £365.00

Ready built

CORTEX B - Basic machine + RS232C £410.00
CORTEX C - as above + disc drives £895.00

Full assembly instructions and 216 page user’s manual.

POWERTRAN cybernetics

Portway Industrial Estate, Andover SP10 3NM. Tel: 0264 64455

To POWERTRAN CYBERNETICS, Portway Industrial Estate, Andover, Hants SP10 3NM.
Please send me

I enclose cheque for ____ or charge to:

Name....................................................................................................................
Address..................................................................................................................
..............................................................................................................................
..............................................................................................................................
Tel.............................................
64K Mask ROM

- Mitsubishi Electric have been busy lately! Their semiconductor division is now mass producing its newly developed 64K mask ROM chip at the monthly rate of 100,000 units. Operating on a single 5V power source featuring low power consumption - maximum 80mA - it is capable of fast reading with a maximum access time of 250 nanoseconds. This new MSM2364P 64K ROM is totally compatible with the 64K EPROM, so EPROM chips used in experimental models may be replaced by the mask ROM chip without any modifications. It is ideally suited for use in personal computers, word processors, various peripheral equipment and video games.

- In line with the increasing memory capacities of EPROM chips, such as 128K and 256K, Mitsubishi Electric plans to develop mask ROMs compatible with them, expanding its share of the mask ROM market. Mitsubishi Electric (UK) Ltd., Centre Point, 103 New Oxford Street, London WC1A 1EB.

So far as we know, this has got absolutely nothing to do with electronics, but we thought that it might interest you anyway. It's a steam car that Acheson Colloids are sponsoring in an attempt on the land speed record for steam cars (set in 1906 at 129 mph). In case you are wondering what's happened to our caption photo, none of us here seem to have quite the same warped sense of humour as Peter Green who used to do them!

Shorts

- Mini discs are here! Advanced Memory Services Ltd., Woodside Technology Centre, Green Lane, Appleton, Warrington are now selling 3" Hitachi disc drives for the BBC micro, at £225 for the single version, and £399 for the double.

- Jingoistic jig: apparently British standards have been adopted for 98% of view data and Teletext TV sets throughout the world. But does it make us any money? It must have been done before, it seems such an obvious idea – GenRad Limited, Norreys Drive, Maidenhead, Berkshire have produced a noise dosimeter that can be worn in a shirt pocket.

- Jump on your micro! Crofton Electronics, 35 Grosvenor Road, Twickenham, Middlesex TW1 4AD have introduced a metal case for the BBC, at a price of £39.50 inclusive. Incidentally, your dear Editor and micro books that they publish.

- The production of our magazine is now hold ‘in-depth’ stocks of the MC68008, a reduced data bus version of the 68000. Axiom Electronics Limited, Turnpike Road, Cresssex Estate, High Wycombe, Bucks HP12 3NR.

- The latest edition of the IBA Technical Review has landed on our doorstep, and it contains a survey of recent developments in Teletext. ETI readers may obtain copies by sending a large SAe to IBA Information Service, Crawley Court, Winchester, Hants S021 2QA.

- A new company has been formed to exploit the microprocessor and micro computing innovations at Bath University. Called Sirius Microtech Ltd., the company is at Ashchurch Industrial Estate, Tewkesbury, Gloucestershire, and it would surprise us at ETI if this were not one of many such companies to be formed.

- Rifa have introduced a longlife electrolytic capacitor specifically for use in switched mode PSUs, with low ESR and ESL. The PEH 179 series is available through RIFA AB, Market Square, Coventry.

- AB Engineering Co. have issued a catalogue of their range of tool kits for professional engineers. AB Engineering Co. Timber Lane, Woburn, Milton Keynes MK17 9PL.
YOUR CAREER . . . YOUR FUTURE . . . YOUR OWN BUSINESS . . . YOUR HOBBY

THIS IS THE AGE — OF ELECTRONICS!

the world's fastest growth industry...

There is a world wide demand for designers/engineers and for men to service and maintain all the electronic equipment on the market today — industrial — commercial and domestic. No unemployment in this walk of life!

Also — the most exciting of all hobbies — especially if you know the basic essentials of the subject....

A few hours a week for less than a year — and the knowledge will be yours....

We have had over 40 years of experience in training men and women successfully in this subject.

Our new style course will enable anyone to have a real understanding of electronics by a modern, practical and visual method. No previous knowledge is required, no maths, and an absolute minimum of theory.

You learn by the practical way in easy steps, mastering all the essentials of your hobby or to start, or further, a career in electronics or as a self-employed servicing engineer.

All the training can be carried out in the comfort of your own home and at your own pace. A tutor is available to whom you can write personally at any time, for advice or help during your work. A Certificate is given at the end of every course.

You will do the following:

- Build a modern oscilloscope
- Recognise and handle current electronic components
- Read, draw and understand circuit diagrams
- Carry out 40 experiments on basic electronic circuits used in modern equipment using the oscilloscope
- Build and use digital electronic circuits and current solid state 'chips'
- Learn how to test and service every type of electronic device used in industry and commerce today. Servicing of radio, T.V., Hi-Fi, VCR and microprocessor/computer equipment.

Please send your brochure without any obligation to

NAME ________________________________

ADDRESS ____________________________________________

British National Radio & Electronics School
Reading, Berks. RG1 1BR

FREE!
COLOUR BROCHURE

POST NOW TO

ETI/9/841

I am Interested in:

☐ COURSE IN ELECTRONICS as described above
☐ RADIO AMATEUR LICENCE
☐ MICROPROCESSORS
☐ OTHER SUBJECTS please state below

BLOCK CAPS PLEASE

British National Radio & Electronics School
Reading, Berks. RG1 1BR

OR TELEPHONE US
0734 51515 OR (24 HR SERVICE)
TELEX 22758 ETI/9/841

CACC
The object of this series is to de-mystify audio design, and show that even a comparative beginner can design circuits that work, and work well. But don’t let the apparent simplicity of the approach fool you - there will be something here for all, including the most experienced of our readers.

In this first part, John Linsley Hood looks at transistors, both bipolar and field effect, and how to do simple yet very useful calculations on them.

There is a great deal of satisfaction to be gained in building something to one’s own design, and finding that it works as well as one had hoped, particularly if this is the sort of thing which one can do, on one’s own, without the need for a lot of technical facilities or expensive components.

This is an advantage which we share with some of the manual crafts like pottery or carpentry, but with the additional benefit that if we are not pleased with what we have done, we can take it to pieces and re-use the parts. Moreover, the scope of electronics is exceedingly wide, and this adds enormously to the interest which it will give to the experimenter.

However, there is a truism in engineering that a good design will not necessarily cost more than a poor one, in materials and labour, indeed it may sometimes cost even less, but will give much more satisfaction in use, and may have a longer trouble-free service life. Therefore, it pays in electronics, as in other forms of engineering, to know ones materials and their strengths and weaknesses. In this part, I propose to have a look at the active components (bipolar transistors and FETs) which we are likely to wish to use, and to discuss the characteristics of the passive components (resistors, capacitors and inductors) only as and when we come across them in the circuit design, and when we need to be particularly concerned with their qualities in order to obtain the best results.

Transistors Or ICs?

Most of the things which we need to do in audio circuit design can now be done just as well by the use of integrated circuits as they can be done by any assembly of transistors and separate components. Moreover, it is nearly always a lot cheaper to use an IC, if a suitable one is available, and it will also occupy a lot less space.

Unfortunately (I say this sincerely, since I am as lazy as the next person, and I like my design work to be done for me) there are still a few fields in which discrete component circuitry will perform rather better than the equivalent ICs, or in which suitable ICs are just not available. These are high voltage systems, with supply voltages in excess of some 45 volts, high power systems, very low noise circuitry (though ICs are beginning to make inroads here), and very high fidelity systems, particularly where these also involve low signal levels.

There are, indeed, some very good ICs of recent origin which are aimed specifically at the hi-fi field, and one would be foolish to ignore their existence, so I will talk about some of these later. However, discrete component (resistor/transistor) circuitry is still the mainstay of audio electronics, so I will start with this.

Bipolar Junction Transistors

These, the ‘transistors’ of common use, are now almost exclusively silicon planar devices, made from a slice of mono-crystalline, very high purity silicon, 500 to 750 microns thick, and 75 to 100 millimetres in diameter. During manufacture this slice is photographically masked in an intricate and repetitive series of patterns across its face, and controlled quantities of specific impurities are selectively diffused in a vacuum oven through the succeeding mask patterns, into the slice. This gives a construction of the type shown in cross section in Fig. 1, when the large slice is cut down into a thousand or more individual segments or ‘dies’.

When connections are attached to the impurity regions and the whole lot is encapsulated in a pea-sized piece of plastic, or, more expensively, mounted in a small hermetically-sealed metal container, this becomes the ‘transistor’ which is shown in the conventional circuit drawing of Fig. 2.

The enormous commercial success of the silicon transistor

Fig. 1 (a) Cross section of a die; (b) a complete small-signal transistor.

Fig. 2 Transistor circuit symbols - these should be all too familiar to you!
transistor, which has now almost completely superseded the earlier germanium type, stems from the fact that this method of construction makes them very cheap to produce. I don't think that I am letting too many secrets out of the bag if I say that a large scale commercial user would probably be reluctant to pay more than 1 to 2p each for these devices in any large quantity, and even at this price it is possible for the manufacturer to make a living.

Discrete junction transistors of this silicon planar type are, conveniently, available in NPN (positive supply line) and PNP (negative supply line) types, and they can be used for an enormous range of applications. However, the one which comes most readily to mind is that of a voltage amplifying stage of the type shown in Fig. 3(a) or (b). Of these, the circuit shown in 3(b) is much more predictable in its characteristics, and would therefore be preferred by the experienced circuit designer if a single transistor amplifying stage would be adequate for his purposes.

That last comment is, however, an important one, in that the performance which can be gained from the use of a group of transistors, acting in combination, is so much better than that of a single device that there is seldom any good reason for not using a more complex construction.

A typical two transistor amplifying stage, using complementary (NPN and PNP) devices is shown in Fig. 4. This employs some negative feedback (much more on this topic later on) to improve its linearity and bandwidth, and control its AC stage gain. With the circuit values shown, this has a gain of 100, a bandwidth of 10-500 kHz, an output voltage swing of 28V p-p, and a distortion of less than 0.01 %, as compared with a gain of about 40, a bandwidth of only about half this, and a distortion of some 5% for the single transistor circuit.

A typical small-signal plastic encapsulated transistor will have a maximum permitted dissipation of around 300 milliwatts, a current gain of 100 to 500, which will depend a little on collector current and a maximum operating voltage in the range 20-80 volts, with 30 volts being a typical value. In addition, to make the transistor work, there will need to be a forward bias voltage between the base and emitter of some 0.55 volts at room temperature (0.2 volts for a germanium device).

So, let us choose a 30 volt supply line for Fig 3(b), and decide to have about 15 volts across the transistor itself. A collector current of 5 mA will give a dissipation of 75 milliwatts (P_{\text{max}} = V_l I_l = I^2 R), which is comfortably within its permitted range. This sort of collector current will also give a reasonable small signal performance. If we choose an emitter potential of 3 V, the required base voltage will be 3.55 volts, and the collector voltage will be 18 V, giving a voltage drop of 12 V across R_2.

From the ohms law relationships V = IR, which can be rearranged as R = V/I or I = V/R, where V is in volts, I is in amperes, and R is in ohms, we can work out that R_3 should be 12/0.005 or 2400 ohms. For 3 volts dropped across R_4, this resistance, which carries virtually the same current, will need to be 1/4 of this, or 600 ohms. If we assume a minimum current gain for the transistor of 100, then the base current will be 50 uA. To make sure that this doesn’t influence the voltage drop in the potential divider chain R_1/R_2 too much, let us make the current through this 0.5 mA, which gives values for these resistors, calculated as above, of 53k/7k1, to provide a base voltage of 3.55 V.

Rounding these values off to the nearest ‘preferred’ values will give R_1 = 56k, R_2 = 6.8k, R_3 = 2.7k and R_4 = 680 ohms. This will not affect the desired operating potentials too much. At this sort of collector current, the input impedance of the transistor itself will be about 5k, giving an input impedance to the whole amplifier circuit of some 2k7 (R_e = 1/(1/R_1 + 1/R_2 + 1/R_3)). A calculator with a reciprocal (1/x) function make this kind of calculation very easy.

This leaves us only with the task of deciding what values to use for C_1, C_2 and C_3, which will be determined by the lowest frequency we want to amplify. The impedance of a capacitor is given by the formula Z_C = 1/(2\pi fC), where f is the frequency, in Hz, and C is the value of the capacitor, in Farads. C_1 and C_3 should both have impedances which are a bit smaller at this frequency than the input impedance (2k7) and the output load impedance (Z_o) presented to the circuit — say 10k. Z_{C_2} should be less.
than R3/M, where M is the hoped-for value of stage gain — say × 100. Doing these calculations gives C1 = 6 u, C2 = 600 u and C3 = 1.5 u, for a lowest operating frequency of 10 Hz.

The upper operating frequency will be determined mainly by the output stray capacities of the circuit with its associated wiring, but could be a few hundred pF. The −3dB point (at which the output is down to 70% of its original value) is frequency at which Zc is equal to R3 in parallel with ZL. The useful formula here is

\[ f = \frac{1}{2\pi R3CS} \]

If CS = 300p, ft will be 250 kHz.

Using the calculated resistor values shown above, we could swap transistors in the circuit of Fig. 3(b) with very little change in the DC operating conditions. How about Fig. 3(a)? In this case, the base current is determined by the collector-base voltage and the value of R1. If, as before, we make \( V_c = 15V \), and decide on a collector current of 5mA, then R2 will be 3k. If we assume a current gain of 100, then R1 = 14.45/0.0005 = 289k. However, suppose that the transistor current gain turned out to be 500, instead of 100, then the collector current would increase and the collector voltage would fall to about 5.5 V to preserve the status quo. The circuit would still work, but one wouldn’t be able to get nearly as much output voltage swing before it began to clip. So, although simpler, and a bit cheaper in components, the circuit of Fig. 3(a) would be much more influenced by transistor characteristics than that of 3(b).

Going through the same sort of calculations as above gives the component values shown for the two transistor circuits Figs. 4 and 5. A further advantage of the two transistor circuits not mentioned earlier is that the use of the internal negative feedback loop substantially increases the input impedance of the circuit, above the rather inconveniently low values given by the circuits of Fig. 3, which is typically a few kilohms.

The other frequently used transistor circuit configurations are the common collector (collector at zero AC potential) also referred to as emitter follower, and the common base, which is used mainly in RF circuits or low impedance, very low noise circuit configurations. These are shown in Figs. 6 and 7. Once again the emitter follower unity gain circuit can be improved by the use of more than one transistor, giving in a two-transistor form the very valuable compound emitter follower arrangement of Fig. 8. This has a very high input impedance, determined mainly by the input resistor network, and a very low output impedance, so that it can drive low impedance loads with very little loss of signal. Moreover, as a circuit, it has a very low distortion indeed, and, with suitable transistors and operating values, also very low circuit noise, making it usable in a whole variety of low signal level arrangements. All in all, the two transistor compound emitter follower is one of the most useful of the unity-gain circuit building blocks, which can be made, with complementary transistor types, to work from either a positive or a negative supply rail.

A word of warning is necessary at this point. All feedback circuits (and this includes those in Figs. 4, 5, 6 and 8) can oscillate if enough phase shift occurs within the input/output feedback loop. The emitter followers of Figs. 6 and 8 are very prone to this with suitable (though often unintended) combinations of lead inductance and stray circuit capacitance on input or output. To prevent this, it is useful to put a small value of resistance — a few hundred ohms will often suffice, or a bit more if the circuit conditions will tolerate this — in the input and output leads. This will not normally have any adverse effect on performance.

Combinations of transistors can be used to make oscillators and other waveform generators, but the numbers of circuits used for this are legion, and there is inadequate space to discuss these here, though they do have a part to play in audio testing.

Field Effect Transistors

These come in two basic types, junction FETs — usually referred to as just FETs — and insulated gate FETs, normally known as MOSFETs, because of their construction (metal-oxide-silicon). Both types are made by much the same general manufacturing processes as bipolar transistors. However, they tend to be quite a bit more expensive, partly because they do use rather a larger area of the slice, but mainly because they are not made as discrete transistors in such large quantities (though very large numbers are made in CMOS and NMOS ICs) and therefore don’t benefit from the same economies of scale.

Both of these devices have a much higher input impedance than bipolar devices — usually measured in millions of megohms — but do not give as high a stage gain as junction transistors when used in equivalent circuits. Junction FETs are not much bothered by static electrical charges, though some care is needed in handling MOSFETs. However, having said that, the only instance I have ever come across of them failing in handling was when a colleague of mine soldered them into an earthed circuit with a soldering iron whose case was not earthed and floated somewhere around 120 VAC!

The junction FET, whose circuit drawing is shown in Fig. 9(a), is now almost exclusively used in small signal circuitry — though Sony did produce some high power ones, a few years ago — with maximum working voltages in the range up to 50 VDC, and dissipations of a few hundred milliwatts. It is, however, a very linear device with a very high dynamic impedance. MOSFETs are very fast devices, capable of operating up to the 500MHz range, and, until comparatively recently, have been used almost exclusively as RF amplifiers. In the past few years, though, high power MOSFETs have come into service in audio output...
stages, where their fast response and good linearity has conferred useful advantages. On the debit side, they do need more careful treatment in circuit design (mainly because their very high speed makes wiring inductances and circuit capacitances important where they are not even noticed in normal power transistor output stages) if troubles are to be avoided, which is why there are still relatively few power MOSFET audio amps in general use.

The design of FET amplifier stages follows similar general principles to those indicated earlier in respect of bipolar circuit designs, but with a few significant differences, which we can consider in relation to the single. FET amplifier circuit of Fig. 10, and the rather better two stage circuit shown in Fig. 11. To begin with, the normal junction FET is what is referred to as a ‘depletion mode device’, which is to say that it normally passes current, which is reduced by the application of a bias voltage (negative in respect to an N-channel device, and positive in respect of a P-channel one) to the gate electrode. This means that an input biasing network of the kind shown in Fig. 3 is unnecessary, and the correct operating conditions can be established by a resistor in the source lead, in an identical manner to that of cathode bias in the case of a thermionic valve.

The second practical difference is that, unfortunately, the characteristics of FETs are nowhere near as precisely controlled as in the case of the normal bipolar transistor, which will always begin to turn on at a forward bias between 0.5 and 0.6 V on its base. By contrast, the specification quoted by Motorola for their 2N5457 N-channel small signal junction FET, which is quite a popular and representative type of device, merely claims a current, at zero bias, somewhere in the range 1 to 5 mA, a slope (gm) which lies between 1 and 5 mA/Volt, and a cut-off negative gate voltage between -0.5 and -6 volts. Happily these are extreme limit values quoted so that the users won’t throw too many of their FETs back at them as being ‘outside spec’. Nevertheless, although a typical 2N5457 might have a cut-off drain voltage of -2 to -3 V and a zero bias current of 2 mA.

In the case of the circuit shown in Fig. 10, the very low input leakage current means that we could make R, 10 M, which lets us use a relatively small and cheap input capacitor, while still having a good LF response. For a drain current of 1 mA, a source bias resistor of 1K will give an effective negative gate bias voltage of 1 V, and a 10K drain resistor will give (at 20V positive supply and 1mA drain current) a drain voltage drop of +10V. Unfortunately, this doesn’t give a very good stage gain. The simple formula for stage gain, where one knows the device gm, is Gain = gmRL, is still 10K, then the gain is 10 for a slope of 1mA/Volt.

To retain the FET advantage of a very high input impedance, while still having a useful stage gain, coupled with the ability to use the stage with normal load impedances, we need to use a two stage circuit such as that shown in Fig. 11. In this, by using a very high current gain (C grade) transistor for Q2, and remembering that the input impedance of a transistor amplifier stage depends at LF on its base current, which becomes less as the current gain B increases, we can operate the FET at a low drain current, and a fairly high resistor for R2. By making R2 and R4 of the same value, the voltage drop across both, due to the drain current (0.55/27k -20 uA) will be 0.55 V, and the output DC voltage, at Q2 collector will be about +11 V, with the FET having, say, -1.5 V effective gate bias. As in the circuit shown in Fig. 4, the gain is controlled by negative feedback to a value of 100; and the circuit will have a good output swing, very low distortion, and a wide bandwidth. This circuit also quite tolerate of FET characteristics, in that variations in cut-off voltage will only make smallish changes in the DC output level.

To summarise, apart from their very much higher input impedance, and their low intrinsic distortion characteristics, FETs tend to offer rather better noise levels in high impedance circuitry than bipolar devices, but for very low impedance circuits, as would be used, for example, in a moving coil head amp, even the best of the FETs are less good than suitably chosen bipolar types. At low impedances MOSFETs tend to be rather noisy. One very useful facility of the junction FET is its capability of being used as a ‘two terminal’ constant current source, as shown in Fig. 10. The ability of the source current flowing through the adjustable source resistor to bias the device to a drain current level which is almost completely independent of drain voltage, within its possible working limits, makes an almost ideal arrangement for giving a constant, though adjustable, current source which is usable right up to the maximum gate-source voltage of the FET. This could be used to provide an almost perfect ‘fail’ for the long-tailed pair circuit (Q1 and Q2 in Fig. 5).

In the next part of this series, I propose to have a look, at ICs, and some of the circuit configurations which can be used with these in the audio field, before going on to look in rather greater detail at some of the problems such as noise and distortion and other unwanted effects.
MINI KITS

MK1 CONTROLLER/THERMOMETER

Uses LM321 IC to sense temperature (32°C to 100°C) and switch to alarm or heater. 10V. £4.25

MK2 THERMOSTAT

If installed in your own setup, this is an ideal switch for motors, lights, etc. £8.25

MK3 ON/OFF DISPLAY

Displays an analog voltage on a panel or a meter as a bar or analog dot. Ideal for temperature control, etc. £2.25

MK4 MICRO DISPLAY

Displays an analog voltage on a panel or a meter as a bar or analog dot. Ideal for thermometric control, etc. £5.50

MK5 PREPARE UPLINK

£4.25

TEMPERATURE CONTROLLER

Based on the LM341, this kit will switch a mains relay (suitable for a thermostat) on or off at a pre-set time. £9.50

MK6 MINI HUB

£6.50

MK7 BROADBAND PRECISE PERIOD NAVIGATOR

Based on the LM13406 Timer IC this kit will switch a mains relay (suitable for a thermostat) on or off at a pre-set time. £9.50

MK11 PREPARE UPLINK

£4.25

MK15 5-20V MINI HUB.

£4.25

PACK 1 5x 2-10V MINI HUB.

£20.75

PACK 2 5x 2-10V MINI HUB.

£35.75

PACK 3 5x 2-10V MINI HUB.

£55.75

PACK 4 5x 2-10V MINI HUB.

£75.75

PACK 5 5x 2-10V MINI HUB.

£95.75

Order as MK11. £42.00

Additional Receivers MK111 £10.00

ELECTRONIC LOCK KIT XK 101

This Kit contains a purpose designed lock IC, twin relay boards and the necessary components and full instructions. £13.50

REMOTE CONTROL KITS

Simple Infra Red Transmitter Kit........................................ £4.20

MK1 INFRA RED RECEIVER........................................................ £4.20

MK2 INFRA RED TRANSMITTER.................................................. £4.20

MK3 INFRA RED TRANSMITTER.................................................. £4.20

MK4 INFRA RED TRANSMITTER.................................................. £4.20

MK5 INFRA RED TRANSMITTER.................................................. £4.20

MK6 INFRA RED TRANSMITTER.................................................. £4.20

MK7 INFRA RED TRANSMITTER.................................................. £4.20

MK8 INFRA RED TRANSMITTER.................................................. £4.20

MK9 INFRA RED TRANSMITTER.................................................. £4.20

MK10 INFRA RED TRANSMITTER.................................................. £4.20

MK11 INFRA RED TRANSMITTER.................................................. £4.20

MK12 INFRA RED TRANSMITTER.................................................. £4.20

MK13 INFRA RED TRANSMITTER.................................................. £4.20

MK14 INFRA RED TRANSMITTER.................................................. £4.20

MK15 INFRA RED TRANSMITTER.................................................. £4.20

MK16 INFRA RED TRANSMITTER.................................................. £4.20

MK17 INFRA RED TRANSMITTER.................................................. £4.20

MK18 INFRA RED TRANSMITTER.................................................. £4.20

MK19 INFRA RED TRANSMITTER.................................................. £4.20

MK20 INFRA RED TRANSMITTER.................................................. £4.20

MK21 INFRA RED TRANSMITTER.................................................. £4.20

MK22 INFRA RED TRANSMITTER.................................................. £4.20

MK23 INFRA RED TRANSMITTER.................................................. £4.20

MK24 INFRA RED TRANSMI...
**COOLING FANS**

Keep your hot parts cool and RELIABLE with our range of BRAND NEW professional cooling fans.

**5 AMP MAINS FILTERS**

Cure those unnerving hums and data glitches caused by mains interference. Matchbox size — Up to 5 amp 240 v. As recommended by the ZX81 newsletter. Suppression Devices 65A £2.95.

**HARD DISK DRIVES**

Fully refurbished Dac/DPC Series 30 2.5 mb hard disk drive for DEC R/30, NOVA, Texas Instruments and many other systems. P/N 030099, 920 mb for the DEC R/30 system. P/N 030103, 2000 mb for FORTRAN and DR/DOS. P/N 030105 for 2 drives £125.00.

DRE 44A/400 £10.00 To 64 £15.00 plus all configurations from £65.00. Call sales office for details.

**DISTEL ©**

The UK’s FIRST free of charge, 24 hr. public access data base. Get Information on 1000’s of stock items and order via your computer and credit card. On line now, 300 baud. CCITT tones, full duplex, fully interactive.

**DON'T MISS THOSE BARGAINS CALL NOW, IT'S FREE!**

**4 FLIPPY FLOPPY DRIVEs**

Unbelievable value the DRE “7100 8” floppy disk drives utilise the finest technology to give you 100% but compatibility with most drives available today. The main difference being our PRICE and the superb manufactur- ing. Both drives have been used and tested and 7100 double sided drive accept hard or soft sectoring IBM or ANSI standard formats giving a massive 0.6 MB (770) 1.6 MB (7200) of storage. Absolutely SHUGAR, BASH SEMI's etc. compatible. Supplied BRAND NEW with user manual and full 90 day warranty. Catalogue and insurance £9.75.

7100 single sided £25.00 + Carr. 7120 double sided £295.00 + Carr. Optional accessories: Full technical manual £20.00 ains. £15.00 with drive. Refund of difference on return of case and cable kit £8.45. 50 way IDC connector £5.50. 50 way ribbon cable £3.20 per metre.

**SUPER DEAL! NO — SUPER STEAL!**

The FABULOUS 25CP5 TEC Starwriter

Daisy wheel printer at a fraction of its original cost.

**OVER £400 SAVED**

Made to the very highest spec. DEC Starwriter. P/N 500-052, features a heavy duty cast chassis and die cast DIAL type plastic keyboard. Supplied with high quality software and programming manual. 80 col. operation. 120 col. mode. Extra processor electronics, offer full 014/015/D001 compatibility plus a direct printing backspace, 10 or 12 pitch, 136 characters per line or 1,633 characters per line, full width 100%, 80 character per line or call sales office for more details.

Units are used but in brand new condition. Offer direct or call sales office for more details. P/N 500-052 £335.00 + Carr. 500-053 £305.00 + Carr. 500-054 £290.00 + Carr. Complete with FULL data & circuit 240 v AC. 12" wide £12.30 - Tread feed option £100.00.

**8 FLIPPY FLOPPY DRIVEs**

Unbelievable value the DRE “7100 8” floppy disk drives utilise the finest technology to give you 100% but compatibility with most drives available today. The main difference being our PRICE and the superb manufactur- ing. Both drives have been used and tested and 7100 double sided drive accept hard or soft sectoring IBM or ANSI standard formats giving a massive 0.6 MB (770) 1.6 MB (7200) of storage. Absolutely SHUGAR, BASH SEMI's etc. compatible. Supplied BRAND NEW with user manual and full 90 day warranty. Catalogue and insurance £9.75.

7100 single sided £25.00 + Carr. 7120 double sided £295.00 + Carr. Optional accessories: Full technical manual £20.00 ains. £15.00 with drive. Refund of difference on return of case and cable kit £8.45. 50 way IDC connector £5.50. 50 way ribbon cable £3.20 per metre.

**D.C. POWER SUPPLY SPECIALS**

Experimentors PSUM £85.00 Ex-GPO unit all silicon electronics. Outputs give +5v @ 2 amps. +12v @ 800 ma. @ 12v 0.5 amp. 0 v @ 50 ma. Rotating Dim 160 x 120 x 350 mm. All outputs fully regulated and short circuit proof! Removed from working equipment, but untested. Complete with circuit. Transformer guaranteed. Only £74.95 + Carr.

**CUSTO M POWER COSY £5 5v @ 3 amp. Very compact unit dim 80 x 90 x 190 mm. Semi open chassis, full laser overvoltage protection. Tested Ex Equipment. £11.95 + £1.25. MINI SYSTEM PSU £15.00 Ex-GPO unit ideal for the small micro. Outputs give 5v @ 3 amps. +12v @ 1 amp and -12v @ 300 ma. Covenbroad overvoltage protection and current limit. Fully tested. Dim 70 x 185 x 320 mm. Complete with Circuit only £19.95 + Carr.

**PERIPHERAL SYSTEM SUPPLY.** Fully cased unit supplied in a Brand new or little used condition. Outputs give 5v @ 3 amps. +12v @ 1 amp and -12v @ 300 ma. Covenbroad overvoltage protection and current limit. Fully tested. Dim 70 x 185 x 320 mm. Complete with Circuit only £19.95 + Carr.

**MAIN FRAME SUPPLY.** A really neat unit designed for MINI or MAINFRAME use outputs 5v @ 3 amps, 12v @ 1 amp and 24v @ 4 amps. All outputs are covenbroad protected and the 6 volt output is fully regulated. Fan cooled. Supplied tested with transformer £59.95 + Carr.

**66% DISCOUNT**

Electronic components & equipment

Due to massive bulk purchasing programme which enables us to bring you the best possible bargains, we have thousands of items from Pin headers, Connectors, Relays, Diodes, C158, E040, 74 Series, Sub-assemblies, Switches, etc. etc. surplus to our requirements. Because we don’t have sufficient stocks of any item we have a selection of these items into the “BARGAIN PARCEL OF A LIFETIME” Thousands of components at massive prices. Guaranteed that if you say Day plus we always include something from our stocks, for unbeatable Value Sold by weight.

2.5k £4.29 + £1.25
5k £6.95 + £1.25
10k £11.75 + £1.25
20k £23.50 + £1.25
47k £47.50 + £1.25

**ALL PRICES PLUS VAT**

All prices quoted are for U.K. Mainland. paid cash with order in Pounds Sterling PLUS VAT. Minimum order value £20, Minimum Credit. Card order £10.00. Minimum BONNAR 3500 separate orders from Government departments, £25.00. All items, unless otherwise stated, are untested, unassembled. £39.95 + £3.95 post.

** vide MONITORS**

MOTORA 8 open chassis monitor. Standard configuration for use with TELPRO plus video display panel. Price quoted for the standard configuration. Dimensions approx. 9" x 9" x 9". Supplied complete with mains and input lead. £20.95 + Carr. Easiest to fit to any system that you may have. £18.95 + Carr. Also available LESS PSU with internal dim. 19", 16", 10.5", £16.95 + Carr. Carriage & insurance £3.95.

**SEMICONDUCTOR ‘GRAB BAGS’**

Mixed Semis amazing value contents include transistors, digital, linear, I.C's triacs, diodes, resistors, etc. etc. Contents guaranteed brand new with full warranty. Price quoted for the standard configuration. Dimensions approx. 9" x 9" x 9". Supplied complete with mains and input lead. £20.95 + Carr. Also available LESS PSU with internal dim. 19", 16", 10.5", £16.95 + Carr. Carriage & insurance £3.95.

**Olivetti Tesio Reduced to Clear**

Complete input/output terminal with integral lead hole paper tape punch and reader. Unit operates at 1560 baud in standard ASCII. Ideal as a cheap printer for a MICRO etc. 120 characters per second. Supplied complete with data, tested, unguaranteed £68.00 + £1.50 carr.

**THE ALADDIN’S CAVE OF COMPUTER AND ELECTRONIC EQUIPMENT - 64-64 Melford Road, Thornton Heath, Near Croydon, Surrey 01-689 7702 — 01-689 6800 Telex 27924**
NICAD CHARGER/REGENERATOR

Many a Ni-Cad charger has graced these pages in the past; the Ni-Caddy is a bit different, in that it will regenerate the battery automatically for you. Design and development by Mike Punnett.

Nickel-cadmium cells are becoming increasingly popular as replacements for conventional dry batteries in a wide range of equipment. Properly used, they can give an enormous cost saving over the life of the equipment, but if misused, tend to fail early.

Since Ni-cads have a tendency to self-discharge over a few months, they have to be charged regularly. Furthermore, to avoid the inconvenience of a flat battery, they are often "topped up" with charge even when far from discharged. This leads to an effect known as whiskering, where fine deposits of cadmium build up, which can partially short-circuit the cell, as well as reducing the active electrode size. This leads to a loss of capacity; a 500mAh cell may be reduced to 300mAh after a year of light service and frequent charges.

It has been found that "cycling" Ni-cads can return them to an almost-new condition. This process involves discharging the battery hard (at the 1 hour rate, e.g. 500mA for a 500mAh battery), until it reaches the minimum safe voltage - Ni-cads can be easily damaged by over-discharging. A full charge at the 10 hour rate follows. This rather rough treatment disintegrates the whiskers of cadmium, and the full charge redeposits the metal on the electrodes. However, cycling Ni-cads "by hand" is a risky business, since they can easily be damaged.

The ETI Ni-Caddy was designed to cycle Ni-cads correctly and easily. It uses a minimum of components, and has two "programs": cycle and charge.

Operating the unit is very straightforward: the Ni-Cad is connected to it, and the appropriate button for the required program is pressed. Many a Ni-Cad charger has graced these pages in the past; the Ni-Caddy is a bit different, in that it will regenerate the battery automatically for you. Design and development by Mike Punnett.

HOW IT WORKS

The power supply section is quite straightforward, using a very simple voltage regulator. Vcc is not critical, but the reference voltage, Vref, must be stable, even though the precise voltage is not important. With separate regulating transistor (Q1) the circuit shown is quite adequate. The two reference levels (the points at which discharge and charge respectively terminate) are derived by RV1 and RV2.

IC1 is a dual comparator which has a number of advantages over similar units, including single-rail operation, the ability to accept inputs at near-ground potential, very low offset, and open-collector outputs. In the circuit, the output of IC1a goes low to indicate that the battery has reached minimum voltage, and that of IC1b goes low when maximum voltage is reached.

IC2 is wired as two flip-flops, one for discharging (IC2a,b) and one for charging (IC2c,d). Pressing "Cycle" sets the discharge flip-flop and clears the charge flip-flop (via Q2). When the battery reaches minimum voltage, or "Charge" is pressed, the discharge flip-flop is cleared and the charge flip-flop is set. The battery reaching full charge clears the charge flip-flop but does not set the discharge flip-flop. The status LEDs are driven directly by the two flip-flops, which also drive the output stage. The latter consists of a discharge circuit - when Q4 is turned on, the battery discharges through R11 - and a constant current circuit consisting of Q3 and its ancillary components, which is turned on by an active-low signal (when IC2 pin 11 is high, Q3 is driven fully off and passes no current).
pressed. Cycle mode discharges the battery to its minimum safe voltage, and then switches to charge mode, in which the unit functions as a constant-current charger, automatically turning off when the battery reaches full charge. If the Ni-Cad is already below its minimum safe voltage when connected up, the unit will automatically enter charge mode, overriding the switches, which are re-enabled when the battery rises above minimum safe voltage.

**Construction**

Construction of the unit is quite straightforward, either on the PCB or Veroboard. Sockets are recommended for the ICs, particularly IC2 which is a CMOS device. Do not forget the three wire links on the PCB.

Table 1 gives component values for AA size (500mAh) cells (see later for details of use with other battery sizes). The circuit will work with batteries of up to eight cells. Remember that R11 will get hot, since the battery is discharged through this. For power ratings over 4W, this component should be mounted off the board, preferably outside the box, to aid heat dissipation. Some of the transistors are fitted with heat sinks; Q1 has an aluminium heatsink (see overlay), Q3 and Q4 have pusj fit TO5 heat sinks.

**Testing and Calibration**

Check the voltages across C3 and C4. Both should be in the range 1.6-5 - 17.4 V. If not, the power supply section should be investigated. The quoted values simply by reducing the resistance and increasing the wattage in proportion to the capacity; so for a 1 Ah six-cell battery, R9 would be 50R 1W and R10, 6R 15W. (The values do not have to be absolutely exact, of course.) For cells over 1 Ah capacity, it is best to upgrade Q3 and Q4; since the circuit will be on for long periods it is advisable to rate components generously, especially heat sinks. Replacing Q3/Q4 with BD132/BD131 respectively, mounted off the PCB on a suitable heat sink, will enable the battery which is known to be in full working order; at this stage the circuit should perform as described above, except that it will not turn off after charging. The charging current can be checked; it should be 0.1 of the cell capacity (e.g. about 50mA for 500mAh (AA) batteries). The test battery is then left on charge for a long period - 20 hours, if flat. This guarantees that it stabilises at full charge voltage. Since the charging is constant-current, there is no risk of damaging the battery by charging for too long. At this point, VR2 can be slowly turned down until the circuit just switches off, and the setting re-checked. The unit is now completed.

**Modifications**

The circuit was originally designed for AA size (500mAh) Ni-Cads, since these are the most widely used, but it can easily be adapted for other sizes by changing R9 and R10. These are calculated from the quoted values simply by reducing the resistance and increasing the wattage in proportion to the capacity; so for a 1 Ah six-cell battery, R9 would be 50R 1W and R10, 6R 15W. (The values do not have to be absolutely exact, of course.) For cells over 1 Ah capacity, it is best to upgrade Q3 and Q4; since the circuit will be on for long periods it is advisable to rate components generously, especially heat sinks. Replacing Q3/Q4 with BD132/BD131 respectively, mounted off the PCB on a suitable heat sink, will enable the unit to cope with cells up to about 4 Ah. As a rough guide, allow 1 Watt dissipation per Ah cell capacity when choosing heat sinks.

Remember that the heat sink on Q1 may need upgrading also. Allow a dissipation of 1.2 W per Ah cell capacity.

---

**BUYLINES**

Nothing to cause any problems here. PCB through PCB service page, case a la carte (to choice). Semiconductors all readily available - when was the last time we published such a trouble-free project?

---

![Diagram of the circuit](image-url)
FET SYSTEM AMP

Features:
- HIGH POWER: 1.2KW (single ended)
- LOW VOLUME: 1/15 Cubic foot Inc. Heat Sink
- VERSATILE. Delivers more than 1 KW into 4 to 8 ohms.
- OR 2 x 600W into 2 to 8 OHM
- OR 4 x 300W into 2 to 4 OHM (200W into 2)
- OR 1 x 300W into 2 to 4 OHM
- OR 1 x 150W into 4 to 8 OHM

Etc. etc.

Having been closely involved in a wide variety of OEM applications of their amp boards, Pantechic became aware of numerous implementation problems often left unattended by other amp board manufacturers. These problems, which are specifically of size and thermal efficiency, became particularly pronounced at high powers and considerably shortened OEM product development time.

By including the thermal details of the board design has been possible to reduce the size of the electronics, and increase the efficiency of the transistor to heat sink thermal circiut. The combined effect of this has been to dramatically increase the volumetric efficiency of the amplifier/heat sink assembly. The SYSTEM Amp offers 1.2KW of power in a space of 102mm x 102mm x 77mm, excluding PSU and Fan.

The basis of this considerable advance is the PANTECH 74 Heat Exchanger, newly designed and manufactured by us. By eliminating the laminar airflow found in conventional, extruded heat sinks, heat transfer to the environment is greatly enhanced.

The flexibility of the 1.2KW amp stems from its division into 4 potentially arrange amplifiers of 300W each (down rateable with cost savings to 150W). This can be paralleled, increasing current capability or series (bridged in pairs) doubling voltage capability. In consequence a large variety of amplifier/load strategies can be implemented.

As ever Pantechic offer a full range of customising options including DC coupling, ultra high slew etc. Contact Phil Rimmer on 01-800 6667 with your particular application requirement.

P.S. Specs, as ever, are exemplary.

OEM USERS

Pantechic present the most adaptable high powered amplifier ever.

Send technical enquiries
Phil Rimmer 01-800 6667

THE POWERFET SPECIALISTS

Type 74 Heat Exchanger. Dissipates 300W (1.2KW fan cooled) £7.50

25A 400PV Bridge Rect. £2.17

10,000f 80v electrolytic with clip £4.75

PA20 20A Pre-amplifier module. Very low noise and distortion £7.50

Type 74 in a Tantalum case. £12.00

Some Other Products & Components

Other POWERFET AMPLIFIER MODULES

Model | Price | Range | Dyn.Loads | Notes
--- | --- | --- | --- | ---
*PA100 | 20.65 | 50-150W | 4, 8, 16 | Physical size 63 x 78 x 10 (mm)
*PA200 | 27.33 | 100-300W | 4, 8, 16, 25 | Ht Watt & F ratio
PFAHV | 36.04 | 200-600W | 4, 8, 16 | 10dB in a heat sink
*PA500 | 42.00 | 250-600W | 4, 8, 16, 25 | 25A cont. output current

The power output of these amplifiers can be increased by approx 15% with no diminution in quality by adding PSU102 (£6.71) to your existing power supply.

The power output of these amplifiers can be increased by approx 15% with no diminution in quality by adding PSU102 (£6.71) to your existing power supply.

Some Other Products & Components

Type 74 Heat Exchanger. Dissipates 300W (1.2KW fan cooled) £7.50

25A 400PV Bridge Rect. £2.17

10,000f 80v electrolytic with clip £4.75

PA20 20A Pre-amplifier module. Very low noise and distortion £7.50

PA20 20A Pre-amplifier module. Very low noise and distortion £7.50

Type 74 in a Tantalum case. £12.00

Some Other Products & Components

Other POWERFET AMPLIFIER MODULES

Model | Price | Range | Dyn.Loads | Notes
--- | --- | --- | --- | ---
*PA100 | 20.65 | 50-150W | 4, 8, 16 | Physical size 63 x 78 x 10 (mm)
*PA200 | 27.33 | 100-300W | 4, 8, 16, 25 | Ht Watt & F ratio
PFAHV | 36.04 | 200-600W | 4, 8, 16 | 10dB in a heat sink
*PA500 | 42.00 | 250-600W | 4, 8, 16, 25 | 25A cont. output current

The power output of these amplifiers can be increased by approx 15% with no diminution in quality by adding PSU102 (£6.71) to your existing power supply.

The power output of these amplifiers can be increased by approx 15% with no diminution in quality by adding PSU102 (£6.71) to your existing power supply.
The toroidal transformer is now accepted as the standard in industry, overtaking the obsolete laminated type. Industry has been quick to recognise the advantages toroidals offer in size, weight, low radiated field and, thanks to ILP, price.

Our large standard range is complemented by our SPECIAL DESIGN section which can offer prototypes to your requirements with no price penalty.

Toroidals together with our large standard range are only half the weight and height of their laminated equivalents. Also available with 110V, 220V or 240V primaries coded as follows:

**IMPORTANT:** Also available at Electrovalua, Maplin, Technomatic and Barrie Electronics.

For 240V primary insert “O” in place of “X” in type number.

For 220V primary (Europe) insert “T” in place of “X” in type number.

For 240V primary (UK) insert “Z” in place of “X” in type number.

Also available at Electrovalua, Maplin, Technomatic and Barrie Electronics.

**New! New! New!**

**TABLE OF SIZES**

<table>
<thead>
<tr>
<th>TYPE</th>
<th>SERIES SECONDARY</th>
<th>No</th>
<th>Volts</th>
<th>RMS</th>
<th>Current</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 VA</td>
<td>0x010</td>
<td>6x6</td>
<td>1.25</td>
<td></td>
<td></td>
<td>£5.12</td>
</tr>
<tr>
<td>0.35kg</td>
<td>0x011</td>
<td>9x9</td>
<td>2.35</td>
<td></td>
<td></td>
<td>£6.35</td>
</tr>
<tr>
<td>30 VA</td>
<td>0x012</td>
<td>12x12</td>
<td>4.10</td>
<td></td>
<td></td>
<td>£9.40</td>
</tr>
<tr>
<td>0.5kg</td>
<td>0x013</td>
<td>15x15</td>
<td>6.10</td>
<td></td>
<td></td>
<td>£11.20</td>
</tr>
<tr>
<td>50 VA</td>
<td>0x014</td>
<td>18x18</td>
<td>9.00</td>
<td></td>
<td></td>
<td>£17.00</td>
</tr>
<tr>
<td>0.8kg</td>
<td>0x015</td>
<td>21x21</td>
<td>11.10</td>
<td></td>
<td></td>
<td>£20.00</td>
</tr>
<tr>
<td>100 VA</td>
<td>0x017</td>
<td>24x24</td>
<td>16.30</td>
<td></td>
<td></td>
<td>£32.00</td>
</tr>
</tbody>
</table>

*(encased in ABS plastic)*

**NEW! NEW! NEW!**

The benefits of ILP toroidal transformers

1. IFP toroidal transformers are only half the weight and height of their laminated equivalents, and are available with 110V, 220V or 240V primaries coded as follows:

**IMPORTANT:** Regulation — All voltages quoted are FULL LOAD. Please add regulation figure to secondary voltage to obtain full load voltage.

For 110V primary insert “O” in place of “X” in type number.

For 220V primary (Europe) insert “T” in place of “X” in type number.

For 240V primary (UK) insert “Z” in place of “X” in type number.

Also available at Electrovalua, Maplin, Technomatic and Barrie Electronics.

**LOW COST PROFESSIONAL TEST INSTRUMENTS**

**FREQUENCY METERS**

**LOGIC PROBE**

**SCOPE PROBES**

**WRITE OR PHONE FOR ILLUSTRATED TEST INSTRUMENT CATALOGUE AND PRICE LIST**

Black Star Ltd.

9A, Crown Street

St. Ives, Huntingdon

Cambs. PE17 4EB

Tel: (0480) 62-440
IC UPDATE

Here are some more new ICs this month - ones that we do know you can buy!

74LS608 Memory Cycle Controller

- Provides correct timing for memory cycles
  - read cycle
  - write cycle
  - read-modify;write. cycle
  - "RAS"-only refresh cycle
- Page or normal modes
- Stand alone controller for CPU-to-memory interface
- Also designed to be part of a three-chip set consisting of LS600 through LS603, LS604 through LS607, and LS608
- RAS output is 3-state to share bus with LS600
- Critical times are user RC-programmable to optimise system performance

The LS608 memory cycle controller is designed to interface between a microprocessor and dynamic RAM memories. It contains six RS latches, five D-type flip-flops, and more than 50 miscellaneous gates on a single chip. The LS608 combines maximum flexibility and ease of programming via RC nodes to allow optimum memory cycle performance.

After the user has selected and attached RC networks to pins 1, 12 and 15, the LS608 will deliver proper RAS, CAS, and READ/WRITE output signals to execute one memory cycle as the start input is switched from low to high. The actual cycle executed will depend upon steady state input conditions of the LS608 as indicated in the table below.

### Absolute Maximum Ratings

- Supply voltage, $V_{cc}$: 7 V
- Input voltage: 7 V
- Off state output voltage: 5.5 V
- Operating free-air temperature range: $0^\circ C$ to $70^\circ C$

* All timing modes require a resistor to $V_{cc}$ and a capacitor to ground. Programmed time is approximately 0.29 RC.
Switching Characteristics (see waveforms for more detail) $V_{cc} = 5\, V, \, T_a = 25^\circ C, \, C_L = 45\, \text{pf} \text{ to GND}$

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>FROM (INPUT)</th>
<th>TO (OUTPUT)</th>
<th>TEST CONDITIONS</th>
<th>MODE</th>
<th>TYP</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>$t_{h6}$</td>
<td>START 1</td>
<td>RAS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$t_{h6}$</td>
<td>START 1</td>
<td>RAS</td>
<td>$R_L = 667, \text{R} \text{ to } V_{cc}$</td>
<td>NORMAL READ</td>
<td>12</td>
<td>ns</td>
</tr>
<tr>
<td>$t_{h6}$</td>
<td>START 1</td>
<td>CAS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$t_{h6}$</td>
<td>START 1</td>
<td>CAS</td>
<td>$R_L = 2, \text{k} \text{0} \text{ to } V_{cc}$</td>
<td>NORMAL READ</td>
<td>425</td>
<td>ns</td>
</tr>
<tr>
<td>$t_{h6}$</td>
<td>START 1</td>
<td>R/W</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$t_{h6}$</td>
<td>START 1</td>
<td>R/W</td>
<td>$R_{4L} = 667, \text{R} \text{ to } V_{cc}$</td>
<td>NORMAL RMW</td>
<td>14</td>
<td>ns</td>
</tr>
<tr>
<td>$t_{h6}$</td>
<td>CAS HOLD1</td>
<td>CAS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$t_{h6}$</td>
<td>START 1</td>
<td>ROW/COL</td>
<td>$R_L = 667, \text{R} \text{ to GND}$</td>
<td>NORMAL READ</td>
<td>14</td>
<td>ns</td>
</tr>
<tr>
<td>$t_{h6}$</td>
<td>R/WI</td>
<td>R/W</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$t_{h6}$</td>
<td>R/WI</td>
<td>R/W</td>
<td>$R_{4L} = 667, \text{R} \text{ to } V_{cc}$</td>
<td>NORMAL RMW</td>
<td>17</td>
<td>ns</td>
</tr>
<tr>
<td>$t_{h6}$</td>
<td>R/WI</td>
<td>CAS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$t_{h6}$</td>
<td>R/WI</td>
<td>ROW/COL</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$t_{h6}$</td>
<td>RAS EN1</td>
<td>RAS</td>
<td>$R_L = 667, \text{R} \text{ to GND}$</td>
<td>NORMAL READ</td>
<td>10</td>
<td>ns</td>
</tr>
<tr>
<td>$t_{h6}$</td>
<td>RAS EN1</td>
<td>RAS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$t_{h6}$</td>
<td>RAS EN1</td>
<td>RAS</td>
<td>$R_L = 667, \text{R} \text{ to GND}$</td>
<td>NORMAL READ</td>
<td>17</td>
<td>ns</td>
</tr>
<tr>
<td>$t_{h6}$</td>
<td>RAS EN1</td>
<td>RAS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

NOTE: Measurement point for all $t_{h6}$ output pulses is 2.9 V. Measurement point for all $t_{h6}$ output pulses is 0.8 V. All other measurement points are 1.3 V.

[1] Depends on RC network at pin 12 (2k0, 180 pf; used for testing) and the RC network at pin 15 (5k0, 180 pf).
[3] Depends on RC network at pin 12 (2k, 180 pf), pin 15 (5k0 180 pf), and pin 1 (5k0, 180 pf).
[5] Depends on RC network at pin 1 (5k0, 180 pf).
Recommend Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Min</th>
<th>Nom</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply Voltage, $V_c$</td>
<td>4.75</td>
<td>5</td>
<td>5.25</td>
<td>V</td>
</tr>
<tr>
<td>High-level output current, ROW/COL</td>
<td>-0.4</td>
<td></td>
<td></td>
<td>mA</td>
</tr>
<tr>
<td>$I_{OH}$</td>
<td>2.6</td>
<td></td>
<td>-1.2</td>
<td>mA</td>
</tr>
<tr>
<td>Low-level output current, ROW/COL</td>
<td>8</td>
<td></td>
<td></td>
<td>mA</td>
</tr>
<tr>
<td>$I_{OL}$</td>
<td></td>
<td></td>
<td></td>
<td>mA</td>
</tr>
<tr>
<td>Set up time, $t_{pu}$</td>
<td>20</td>
<td></td>
<td></td>
<td>nS</td>
</tr>
<tr>
<td>Hold time, $t_{ph}$</td>
<td>0</td>
<td></td>
<td></td>
<td>nS</td>
</tr>
<tr>
<td>External timing resistor, $R_{ext}$</td>
<td>0.1</td>
<td></td>
<td></td>
<td>Ω</td>
</tr>
<tr>
<td>Operating free-air temperature, $T_a$</td>
<td>0</td>
<td>70</td>
<td></td>
<td>°C</td>
</tr>
</tbody>
</table>

Fig. 6 Typical circuit for use with 64K by 1 DRAMs; for refresh, pin 14 is taken high, pin 13 is pulsed high, and refresh address is placed on the memory devices address pins.

LF13331/2/3, LF13201/2 Quad Analogue Switches

These devices are a monolithic combination of bipolar and JFET technology producing the industry's first one chip quad JFET switch. A unique circuit technique is employed to maintain a constant resistance over the analog voltage range of ±10V. The input is designed to operate from minimum TTL levels, and switch operation also ensures a break-before-make action. These devices operate from ±15V supplies and swing ±10V analog signal. The JFET switches are designed for applications where a DC to medium frequency analog signal needs to be controlled.

General Information

"ON" resistance are essentially independent of analog voltage or analog current. The leakage currents are typically less than 1nA at 25°C and less than 100nA at 125°C in both the "OFF" and "ON" switch states and introduce negligible errors in most applications. Each switch is controlled by minimum TTL logic levels at its input and is designed to turn "OFF" faster than it will turn "ON". This prevents two analogue sources from being transiently connected together during switching.

Because these analogue switches are JFET rather than CMOS, they do not require special handling.

Logic Input

The logic input (IN), of each switch, is referenced to two forward diode drops (1.4V at 25°C) from the reference supply (YR) which makes it compatible with DTL, RTL, and TTL logic families. For normal operation, the logic "O" voltage can range from 0.8V to -4.0V with respect to $V_R$ and the logic "1" voltage can range from 2.0V to 6.0V with respect to $V_R$. Provided $V_R$ is not greater than $(V_{CC} - 2.5V)$. If the input voltage is greater than $V_{CC} - 2.5V$, the input current will increase. If the input voltage exceeds 6.0V or -4.0V with respect to $V_R$, a resistor in series with the inputs should be used to limit the input current to less than 100 µA.

Analog Voltage

Each switch has a constant "ON" resistance ($R_{on}$) for analog voltages from $(V_{ee} + 5V)$ to $(V_{CC} - 5V)$. For analog
voltages greater than \((V_{cc} - 5V)\), the switch will remain ON independent of the logic input voltage. For analog voltages less than \((V_{dd} + 5V)\), the ON resistance of the switch will increase. Although the switch will not operate normally when the analog voltage is out of the previously mentioned range, the source voltage can go to either \((V_{dd} + 36V)\) or \((V_{cc} + 6V)\), whichever is more positive, and can go as negative as \(V_{dd}\) without destruction. The drain (D) voltage can also go to either \((V_{dd} + 36V)\) or \((V_{cc} + 6V)\), whichever is more positive, and can go as negative as \((V_{cc} - 36V)\) without destruction.

**Analog Current**

With the source (S) positive with respect to the drain (D), the \(R_{on}\) is constant for low analog currents, but will increase at higher currents (>5 mA) when the FET enters the saturation region. However, if the drain is positive with respect to the source and a small analog current loss at high analog currents is tolerable, a low \(R_{on}\) can be maintained for analog currents greater than 5 mA at 25°C.

**Power Supplies**

The voltage between the positive supply \((V_{cc})\) and either the negative supply \((V_{dd})\) or the reference supply \((V_{r})\) can be as much as 36V. To accommodate variations in input logic reference voltages, \(V_{r}\) can range from \(V_{dd}\) to \((V_{cc} - 4.5V)\). Care should be taken to ensure that the power supply leads for the device never become reversed in polarity or that the device is never inadvertently installed backwards in a test socket. If one of these conditions occurs, the supplies would zener an internal diode to an unlimited current, and result in a destroyed device.

**Disable Node**

This node can be used, as shown in Fig. 8, to turn all the switches in the unit off independent of logic inputs. Normally, the node floats freely at an internal diode drop \((\approx 0.7V)\) above \(V_{r}\). When the external transistor in Fig. 8 is saturated, the node is pulled very close to \(V_{r}\) and the unit is disabled. Typically, the current from the node will be less than 1 mA.

**Absolute Maximum Ratings**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;ON&quot; Resistance</td>
<td>(V_{S} = 0, I_{O} = 1 \text{ mA})</td>
<td>(T_{A} = 25^\circ\text{C})</td>
<td>150</td>
<td>250</td>
<td>(\Omega)</td>
</tr>
<tr>
<td>&quot;ON&quot; Matching</td>
<td>(T_{A} = 25^\circ\text{C})</td>
<td>10</td>
<td>50</td>
<td>(\Omega)</td>
<td></td>
</tr>
<tr>
<td>Analog Range</td>
<td>(\pm 10 \text{ V})</td>
<td>4.0</td>
<td>pF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Logical &quot;1&quot; Input Voltage</td>
<td>(T_{A} = 25^\circ\text{C})</td>
<td>6.0</td>
<td>pF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Logical &quot;0&quot; Input Voltage</td>
<td>(T_{A} = 25^\circ\text{C})</td>
<td>8.0</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Delay Time &quot;ON&quot;</td>
<td>(V_{S} = \pm 10V)</td>
<td>(T_{A} = 25^\circ\text{C})</td>
<td>500</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>Delay Time &quot;OFF&quot;</td>
<td>(V_{S} = \pm 10V)</td>
<td>(T_{A} = 25^\circ\text{C})</td>
<td>90</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>Break-Before-Make Time</td>
<td>(V_{S} = \pm 10V)</td>
<td>(T_{A} = 25^\circ\text{C})</td>
<td>80</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>Source Capacitance</td>
<td>Switch &quot;OFF,&quot; (V_{S} = \pm 10V)</td>
<td>(T_{A} = 25^\circ\text{C})</td>
<td>4.0</td>
<td>pF</td>
<td></td>
</tr>
<tr>
<td>Drain Capacitance</td>
<td>Switch &quot;OFF,&quot; (V_{S} = \pm 10V)</td>
<td>(T_{A} = 25^\circ\text{C})</td>
<td>3.0</td>
<td>pF</td>
<td></td>
</tr>
<tr>
<td>Active Source and Drain</td>
<td>Switch &quot;ON,&quot; (V_{S} = V_{O} = 0V)</td>
<td>(T_{A} = 25^\circ\text{C})</td>
<td>5.0</td>
<td>pF</td>
<td></td>
</tr>
<tr>
<td>&quot;OFF&quot; Isolation</td>
<td>(\text{(Note 3)})</td>
<td>(T_{A} = 25^\circ\text{C})</td>
<td>50</td>
<td>dB</td>
<td></td>
</tr>
<tr>
<td>Crosstalk</td>
<td>(\text{(Note 3)})</td>
<td>(T_{A} = 25^\circ\text{C})</td>
<td>65</td>
<td>dB</td>
<td></td>
</tr>
<tr>
<td>Analog Slow Rate</td>
<td>(\text{(Note 4)})</td>
<td>(T_{A} = 25^\circ\text{C})</td>
<td>50</td>
<td>V/\mu s</td>
<td></td>
</tr>
<tr>
<td>Disable Current</td>
<td>(\text{(Note 5)})</td>
<td>(T_{A} = 25^\circ\text{C})</td>
<td>0.6</td>
<td>1.5</td>
<td>mA</td>
</tr>
<tr>
<td>Negative Supply Current</td>
<td>All Switches &quot;OFF,&quot; (V_{S} = \pm 10V)</td>
<td>(T_{A} = 25^\circ\text{C})</td>
<td>4.3</td>
<td>7.0</td>
<td>mA</td>
</tr>
<tr>
<td>Reference Supply Current</td>
<td>All Switches &quot;OFF,&quot; (V_{S} = \pm 10V)</td>
<td>(T_{A} = 25^\circ\text{C})</td>
<td>2.7</td>
<td>5.0</td>
<td>mA</td>
</tr>
<tr>
<td>Positive Supply Current</td>
<td>All Switches &quot;OFF,&quot; (V_{S} = \pm 10V)</td>
<td>(T_{A} = 25^\circ\text{C})</td>
<td>7.0</td>
<td>9.0</td>
<td>mA</td>
</tr>
</tbody>
</table>

**Notes**

1. For operating at high temperature the molded DIP products must be rated based on a +100°C maximum junction temperature and a thermal resistance of +150°C maximum junction temperature and are rated at +100°C/W.
2. Unless otherwise specified, \(V_{CC} = +15V, V_{EE} = -15V, VR = 0V,\) and limits apply; -25°C \(\leq T_{A} \leq 85°C\) for the LF13331, 2, 3 and the LF13201,2.
3. These parameters are limited by the pin capacitance of the package.
4. This is the analog signal slew rate above which the signal is distorted as a result of finite internal slew rates.
5. All switches in the device are turned "OFF" by saturating a transistor at the disable diode as shown in Fig. 8. The delay times will be approximately equal to the \(t_{on}\) or \(t_{off}\) plus the delay introduced by the external transistor.

---

Fig. 8 Use of the disable node.
Friday November 25th 10am - 6pm
Saturday November 26th 10am - 6pm
Sunday November 27th 10am - 4pm

Improved venue
We have transferred Breadboard to Cunard International Exhibition Centre, so that we can offer improved facilities to the visitor, including car parking and ease of access by rail, tube and car, all in a modern attractive setting. We have also arranged a reduced hotel/rail fare package to attract enthusiasts from all parts of the country.

Planned features include
1. Full range of lectures planned over 3 days to cover most aspects of electronics and computing.
2. Electronics/Computing Advice Centre — manned by experts.
3. Demonstration of electronic organs and synthesisers.
4. Holography presentation.
5. Practical Demonstration on “How to produce printed circuit boards”.
6. Computer Corner — extensive display of computer hardware — “Try Before You Buy”.
9. Pick of the Projects — Demonstration of the best from ELECTRONICS TODAY INTERNATIONAL, HOBBY ELECTRONICS and ELECTRONICS DIGEST over the past ten years.
11. Robotic display.

Why not bring the family to the show and enjoy a weekend in London? We have arranged a complete hotel package for our visitors to the exhibition. All inclusive rail tickets also available. Send now for details of what we, the organisers, can offer you.

Write to: Breadboard ’83
ASP Exhibitions
145 Charing Cross Road
London WC2H 0EE
How to order: indicate the books required by ticking the boxes and send this page, together with your payment, to ETI Book Service, Argus Specialists Publications Ltd, 145 Charing Cross Road, London WC2 0EE. Make cheques payable to ETI Book Service. Payment in sterling only please. Prices include postage and packing. Prices may be subject to change without notice.

**BEGINNERS GUIDES**

- Beginner’s Guide to Basic Programming: £9.95
- Beginner’s Guide to Digital Electronics: £9.95
- Beginner’s Guide to Electronics: £9.95
- Beginner’s Guide to Integrated Circuits: £9.95
- Beginner’s Guide to Computers: £9.95
- Beginner’s Guide to Microprocessors: £9.95

**COOKBOOKS**

- Master IC Cookbook: £11.95
- Design of Active Filters with experiments: £10.40
- Easy to Build Electronic Projects: £5.20
- Electronic Devices & Circuit Theory: £11.95
- How to Build Electronic Kits: £3.55
- How to Design and build electronic instrumentation: £7.95
- Introduction to Microprocessors: £7.20
- Electronic Components and Systems: £15.00
- Principles of Electronic Instrumentation: £11.40
- Computer Cookbook: £10.00
- Micro Cookbook Vol. 1: £14.00
- Basic Cookbook: £5.60
- MC6800 Cookbook: £5.60

**ELECTRONICS**

- Principles of Transistor Circuits: £9.50
- Design of Active Filters with experiments: £10.40
- Electronic Devices & Circuit Theory: £11.95
- How to Build Electronic Kits: £3.55
- How to Design and build electronic instrumentation: £7.95
- Introduction to Microprocessors: £7.20
- Electronic Components and Systems: £15.00
- Principles of Electronic Instrumentation: £11.40
- Computer Cookbook: £10.00
- Micro Cookbook Vol. 1: £14.00
- Basic Cookbook: £5.60
- MC6800 Cookbook: £5.60

**REFERENCE BOOKS**

- Electronic Engineers’ Handbook: £56.45
- Electronic Designers’ Handbook: £59.56
- Illustrated Dictionary of Microcomputer Technology: £7.25
- Design of Active Filters with experiments: £10.40
- Electronic Devices & Circuit Theory: £11.95
- How to Build Electronic Kits: £3.55
- How to Design and build electronic instrumentation: £7.95
- Introduction to Microprocessors: £7.20
- Electronic Components and Systems: £15.00
- Principles of Electronic Instrumentation: £11.40
- Computer Cookbook: £10.00
- Micro Cookbook Vol. 1: £14.00
- Basic Cookbook: £5.60
- MC6800 Cookbook: £5.60

**RESOURCES**

- Servicing Home Video Cassette Recorders: £11.80
- Complete Handbook of Video Cassette Recorders: £7.95
- Theory and Servicing of Video Cassette Recorders: £11.95
- Beginner’s Guide to Video Repair: £5.20
- Video Recording: Theory and Practice: £14.40
- Video Handbook: £21.90
- Video Techniques: £12.95

Please send me the books indicated. I enclose cheque/postal order for £. Prices include postage and packing, with a cheque payable to ETI Book Service. Please debit my account.

Signed .................................................................

Name ...........................................................................

Address ...........................................................................

...
UNIVERSAL EPROM PROGRAMMER

To use our Universal EPROM programmer, you've got to have the software to drive it. Mike Bedford fills us in on what's needed.

The logical choice of programming language for a software package which is required to perform critical timing and which contains large frequently repeated loops, is assembler. On the other hand, the obvious choice of language for a package which is intended to run on a variety of different personal computers is BASIC. The software presented here is a compromise between the two: a BASIC program which performs the I/O and which calls an assembler subroutine for the time critical or time consuming tasks.

The assembler routine starts at address 1C00, but this may need to be relocated in order to fit in with the memory map of some systems. If this routine is relocated, the variable MC on line 1 of the BASIC program will have to be changed to the decimal start address. Another portion of the BASIC program which may require tailoring to a particular machine is the start address of the EPROM programmer hardware as selected by the links on the board. This address should also be updated in the assembler subroutine on line 23 which equates IC9PIA to the appropriate address of the EPROM programmer.

Finally, the programming timing loop in the assembler routine assumes a processor clock frequency of the 750KHz as used on the Microtan. The value loaded into register Y on line 143 of the routine will have to be modified accordingly for other clock speeds (use hexadecimal 27 for 1 MHz).

As far as entering the program is concerned, the ROM in the BASIC program is rather long and it would be advisable to enter it in relatively small portions, saving it after the addition of each new section. This suggestion is made for two reasons: firstly it is difficult to concentrate for sufficiently long to enter the whole program at once without making errors; and, secondly it would be extremely frustrating if the computer were to crash for some reason after having typed in over 200 lines of code!

The assembler listing is rather long, and will only be of interest to readers wishing to modify the software. For this reason we haven't reproduced it here, but a copy may be obtained by sending a large stamped addressed envelope (or international reply coupon) to the ETI office—please mark the outer envelope "PROGRAMMER LISTING". Most users will find it easiest to enter the hex code directly.

Once the program and subroutine have been entered and recorded on cassette, it will be worthwhile investing some time carefully checking through the program. It is quite possible that a mistake may cause more than the appearance of the all too familiar SYNTAX ERROR on the screen: an error in the software could easily turn an EPROM programmer into an EPROM destroyer!

Sample Run
On page 39 is a reproduction of...
Fig. 2 The main BASIC program.
a printout obtained by running the EPROM programmer support package on a Tangerine Microtan system. Note that a base address of 2000 has been selected - this being the lowest reasonable-size area of RAM on the system, the BASIC program occupying about 6K and the machine code routine being located at 1000.

In answer to the question about EPROM type, a response of 2716 was given. A 2716 EPROM was inserted into the ZIF socket when the first '?' prompt was printed and this was tested for erasure using the (T)EST command. The program indicated that the device was not erased. At this point, the entire contents of the 2716 (0000-07FF) was transferred into computer memory using the (R)EAD command before listing the contents of a portion of this data by use of the (L)IST command. The (M)ODIFY command was then used to modify location 0007 before attempting to re-program this single byte in the EPROM using the (P)ROGRAMME command. It will be noticed that this was unsuccessful, a fact indicated by the verification message. This should come as no surprise in view of the fact that an attempt to re-program an non-erased device had been made and that programming can only set high bits low (ultra-violet erasure being required to set low bits high).

At this point the 2716 was replaced by a 2732 and the programmer was instructed of this change by use of the (N)EW command. Its entire contents (0000-0FFF) were read into memory and listed as before, by use of the (E)XIT command. Note that the (L)(ST command gives both the hexadecimal value of each byte and, where appropriate, the ASCII symbol.

PROJECT

IT LIVES AGAIN!

From the past it came growing daily, striking terror into the hearts of lesser publications, and spreading its influence across the country in its quest to infiltrate every town, every home every mind.

Not a horror story, but a success story. And if electronics theory strikes terror into you then you need the help of Electronics - It’s Easy. Originally a long-running series in Electronics Today international, Electronics - It’s Easy was printed as a set of three books. They sold out. It was reprinted as a single volume. It sold out. Now this phenomenally successful publication is available again. In its third reprint Electronics - It’s Easy is a comprehensive and simply written guide which explains the theory (and the practice) of electronics step by step. Every aspect of the subject is covered, starting with the basic principles and working through to the how and why of today’s technology.

You can obtain your copy of Electronics - It’s Easy by mail order using the coupon below. Make cheques or postal orders payable to ASP Ltd. alternatively you may pay by Access or Barclaycard.

Send to: Sales Office (Specials)
513 London Road, Thornton Heath
Surrey CR4 6AR

Please send me .......... copies of Electronics - It’s Easy.
I have enclosed £ .......... (£ 4.95 each including p&p)
NAME.................................................................
ADDRESS..................................................................
................................................................................
................................................................................
................................................................................
................................................................................
Please debit my account
My Access/Barclaycard No is .................................
Signature..............................................................
Step-by-step fully illustrated assembly and fitting instructions are included together with circuit descriptions. Highest quality components are used throughout.

**AT-80**
Electronic Car Security System
- Arms doors, boot, bonnet and has security loop to protect fog/spot lamps, radio/tape, CB equipment
- Programmable personal code entry system
- Armed and disarmed from outside vehicle using a special magnetic key fob against a windscreen sensor pad adhered to the inside of the screen.
- Fits all 12V neg earth vehicles
- Over 250 components to assemble

**SX1000**
Electronic Ignition
- Inductive Discharge
- Extended coil energy storage circuit
- Contact breaker driven
- Three position changeover switch
- Over 65 components to assemble
- Patented clip-to-coil fitting
- Fits all 12V neg earth vehicles

**TX1002**
Electronic Ignition
- Contactless or contact triggered
- Extended coil energy storage circuit
- Inductive Discharge
- Three position changeover switch
- Distributor triggerhead adaptors included
- Die cast weatherproof case
- Clip-to-coil or remote mounting facility
- Fits majority of 4 and 6 cyl 12V neg earth vehicles
- Over 145 components to assemble

**SX2000**
Electronic Ignition
- The brand leading system on the market today
- Unique Reactive Discharge
- Combined Inductive and Capacitive Discharge
- Contact breaker driven
- Three position changeover switch
- Over 130 components to assemble
- Patented clip-to-coil fitting
- Fits all 12V neg earth vehicles

**TX2002**
Electronic Ignition
- The ultimate system
- Switchable contactless
- Three position switch with Auxiliary back-up inductive circuit
- Reactive Discharge
- Combined capacitive and inductive
- Extended coil energy storage circuit
- Magnetic contactless distributor triggerhead
- Distributor triggerhead adaptors included
- Can also be triggered by existing contact breakers
- Die cast waterproof case with clip-to-coil fitting
- Fits majority of 4 and 6 cyl 12V neg earth vehicles
- Over 150 components to assemble

**VOYAGER**
Car Drive Computer
- A most sophisticated accessory
- Utilises a single chip mask programmed microprocessor incorporating a unique programme designed by EDA Sparkrite Ltd.
- Affords 12 functions centred on Fuel, Speed, Distance and Time
- Visual and Audible alarms warning of Excess Speed, Frost/Ice, Lights-left-on
- Facility to operate LOG and TRIP functions independently or synchronously
- Large 10mm high 400ft-L fluorescent display with auto intensity
- Unique speed and fuel transducers giving a programmed accuracy of + or - 1%
- Large LOG & TRIP memories 2,000 miles, 180 gallons, 12 hours, 1 Full Imperial and Metric calibrations
- Over 300 components to assemble

**MAGIDICE**
Electronic Dice
- Not an auto item but great fun for the family
- Total random selection
- Triggered by waving of hand
- Switchable over-dice
- Strobe and flashes during a 4 second tumble sequence
- Throw displayed for 10 seconds
- Auto display of last throw
- Muting and Off switch on base
- Hours of continuous use from PP7 battery
- Over 100 components to assemble

**SELF ASSEMBLY KIT**

<table>
<thead>
<tr>
<th>Product</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT-80</td>
<td>£12.95</td>
</tr>
<tr>
<td>SX1000</td>
<td>£19.95</td>
</tr>
<tr>
<td>SX2000</td>
<td>£22.95</td>
</tr>
<tr>
<td>TX1002</td>
<td>£32.95</td>
</tr>
<tr>
<td>AT 80</td>
<td>£32.95</td>
</tr>
<tr>
<td>VOYAGER</td>
<td>£64.95</td>
</tr>
<tr>
<td>MAGIDICE</td>
<td>£9.95</td>
</tr>
</tbody>
</table>

Names and addresses are fully covered by one or more World Patents.

**SPECIAL OFFER**
"FREE" MAGIDICE KIT WITH ALL ORDERS OVER £45.00
We conclude this studio-quality unit with the constructional details. Design by Dave Tilbrook, with additional work by Phil Walker.

The third octave equaliser divides the audio frequency band into 28 segments so a total of 28 slider pots are used.

Cutting the required slots in a front panel is an extremely difficult task so we strongly recommend using the special case from Newrad - see Bylines for details. We've deliberately chosen to use fairly small switches and indicator on the front panel - if you use larger ones, you can always enlarge the hole sizes.

Construction of the PCB is not difficult. The usual precautions should be taken with the orientation of all polarised components such as electrolytic capacitors, transistors, diodes and ICs. Note that the two voltage regulator ICs are mounted in the same direction.

Check the component overlay for the correct orientation. It is probably wise to leave the insertion of the quad op-amps until last since these are FET devices and are therefore more sensitive to static electricity than the other components in the unit.

Be careful when handling these devices before insertion on the board. Use an earthed soldering iron and discharge yourself by touching an earthed metal appliance before handling the ICs. The inputs are protected and should therefore be reasonably safe from damage by static electricity.

The method of construction we have chosen is to mount the slider pots directly on to the front panel (using short, countersunk M3 bolts) with the PCB behind. The potentiometer wipers are attached alternately to the top and bottom of the PCB; if you use a type of pot that has only one wiper connection (as we did), then you'll have to make sure that adjacent pots are reversed on the front panel.

Interwiring

Before we mounted the PCB into the case, we soldered leads into the correct position on the PCB for joining onto the potentiometer wipers. Note that the tops and bottoms of the slider tracks should all be joined up before the board is mounted.

We mounted the board using metal struts and plastic pillars. The struts can be attached to the aluminium extrusion by sliding the head of a 1/2" (we really mean 12mm!) M3 bolt into the aluminium extrusion, and then clamping this in the correct position using a nut (or three, in our case, to get the spacing of the strut correct). If you don't use plastic pillars, you'll have to make sure that the PCB tracks are not inadvertently earthed by the fixing screws.

We've left the drilling of the holes in the rear panel to you, as you'll almost certainly decide to use different connectors, etc, from us! Because the case is fairly compact (neat, in ETI speak) you'll need to take care over the positioning of the fuse, mains input socket and transformer, to make sure that you
This photograph shows the connections between the slider pots on the front panel and the PCB - and the mounting of the front panel using struts and spacers. Note that we couldn’t fit the prototype PCB into our equipment and had to make it in two sections - hence the join!

don’t foul the PCB. Remember that the earth on the input and output sockets must be kept separate from the case. But make sure that the case and the transformer are well earthed - we suggest making doubly sure by removing paint or varnish around the earthing point(s) (on the inside, in the case!). To cut down mains hum, we used a screened twin cable for the internal mains lead - this needs to have adequate conductor and insulation thickness, though.

Fig 1 Overlay diagram for the PCB.
We used universal adhesive to glue on the pot knobs, otherwise they all kept falling off!

**Power up**

Once construction is complete, check all power supply wiring before powering up. This is especially important if a transformer has been included inside the case. In the latter case, make certain all 240 V connections are secure and check the chassis earth. If all is correct, power the unit up. The LED should light to indicate that the unit is on.

An equaliser in/out switch has been provided to ensure that a flat response can be obtained easily and without the necessity of changing the equalisation that may have taken some time to set up. The equaliser is intended for use immediately before the power amplifier. If used in this position the level control will probably not be used. In this case turn the control fully counterclockwise. The overall gain of the equaliser with the controls set at centre will be approximately unity. If the equaliser is intended for use from a typical line level output, the gain control can be used to supply the output levels needed by the power amplifier input.

### PARTS LIST

#### RESISTORS (all 5W, 5%)
- R1, 5, 6: 15k
- R2: 47k
- R3, 9, 11, 13, 15, 17, 19, 21, 23, 25, 27, 29, 31, 33, 35, 37, 39, 41, 43, 45, 47, 49, 51, 53, 55, 57, 59, 61, 63: 1k
- R4: 100R
- R7: 100R
- RB: 100k
- R10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, 58, 60, 62: 64
- R65-80: 220k
- R81: 10R
- RV1: rotary pot, 10k log slider pots, 100k or 50k linear (see Buylines)

#### CAPACITORS
- C1, 10: 470n
- C2, 7: 47uF/25 V
- C3: 3p3 ceramic
- C4, 6: 33p ceramic
- C5: 4p7 ceramic
- C6: 600n
- C9, 18: 180n
- C11, 20: 150n
- C12: 390n
- C13, 22, 120n
- C14: 330n
- C15, 24: 100n
- C16: 270n
- C17, 28: 68n
- C19: 56n
- C21, 30: 47n
- C23, 32: 39n
- C25, 36: 27n
- C26: 82n
- C27, 38: 22n
- C29: 18n
- C31, 40: 15n
- C33: 12n
- C34: 33n
- C35, 44, 70-78: 10n
- C37, 48: 6n8
- C39: 5n6
- C41, 50: 4n7
- C42: 12n
- C43, 52: 3n9
- C45, 56: 2n7
- C46: 8n2
- C47, 58: 2n2
- C49: 1n8
- C51, 60: 1n5
- C53, 62: 1n2
- C54: 3n3
- C55: 1n0
- C57: 680p poly styrene
- C59: 560p poly styrene
- C61: 470p polystyrene
- C63: 390p poly styrene
- C64, 65: 10u polycarbonate
- C66, 67: 2200u/25 V electro
g-
- C68, 69, 80: 47/76 V tantalum

#### SEMICONDUCTORS
- IC1, IC2: NE5534A (or N)
- IC3-9: TL074
- IC10: 7812
- IC11: 7912
- D1-4: 1N4001
- LED1: red LED

#### MISCELLANEOUS
- T1: 12-12V, 6 VA transformer
- SW1: DPST mains switch
- SW2: SPDT toggle switch
- Mains neon (or LED plus 1k5 resistor; cable clamp; fuse (500 mA) and holder; insulated connector sockets to choice (jacks, phono, BNC, etc); 28 knobs for sliders; case (see Buylines); PCB; nuts, bolts, wire, etc.

### BUYLINES

The case is available by post only from Newrad Instrument Cases Ltd, Tiptoe Road, Wootton, New Milton, Hants BH25 5S1 for the special price of £21.00 all inclusive to ETI readers only (this is for either the rack mounting version we used or one with plain ends - please state which you require when ordering). The PCB is, as ever, available through our PCB service. We've already mentioned the slight problem of obtaining the capacitors and how we solved it, last month. None of the other components should present problems, though as you'll be buying a number of slider pots, it's obviously worth shopping around for a good price. The cheapest we found were those from Rapid, and that's where we bought ours from.

### OOPS!

Note that the value of R65-80 is 10R, not 1k0 as shown on the circuit diagram. We recommend that you switch the unit out of circuit (using the EQ OUT switch) before removing or connecting the supply, because it is capable of issuing a nasty squawk!
<table>
<thead>
<tr>
<th>Capacitors</th>
<th>Value</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>100nF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>220pF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>470nF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>680pF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>150pF</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Resistors**

<table>
<thead>
<tr>
<th>Value</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>1kΩ</td>
<td></td>
</tr>
<tr>
<td>2MΩ</td>
<td></td>
</tr>
</tbody>
</table>

**Miscellaneous**

- CRICKLEWOOD ELECTRONICS LTD.
- 40 CRICKLEWOOD BROADWAY, LONDON NW2 3ET.
- Tel: 01-452 0161. TELEX: 914977 CRILEL G
Enquiries
We receive a very large number of enquiries. Would prospective enquirers please note the following points:

We undertake to do our best to answer enquiries relating to difficulties with ETI projects, in particular non-working projects, difficulties in obtaining components, and errors that you think we may have made. We do not have the resources to adapt or design projects for readers (other than for publication), nor can we predict the outcome if our projects are used beyond their specifications;

Where a project has apparently been constructed correctly but does not work, we will need a description of its behavior and some sensible test readings and drawings of oscillograms if appropriate. With a bit of luck, by taking these measurements you’ll discover what’s wrong yourself. Please do not send us any hardware (except as a gift);

Other than through our letters page, Read/Write, we will not reply to enquiries relating to other types of article in ETI. We may make some exceptions where the enquiry is very straightforward or where it is important to electronics as a whole;

We will not reply to queries that are not accompanied by an SAE (or international reply coupon). We are not able to answer enquiries over the telephone. We try to answer promptly, but please request copies only if you really do need them; if this service is abused, we may be forced to withdraw it.

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

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

Trouble With Advertisers
So far as we know, all our advertisers work hard to provide a good service to our readers. However, problems can occur, and in this event you should:
1. Write to the supplier, stating your complaint and asking for a reply. Quote any reference number you may have (in the case of unsatisfactory or incomplete fulfillment of an order) and give full details of the order you sent and when you sent it.
2. Keep a copy of all correspondence.
3. Check your bank statement to see if the cheque you sent has been cashed.
4. If you don’t receive a satisfactory reply from the supplier within, say, two weeks, write again, sending your letter recorded delivery, or telephone, and ask what they are doing about your complaint.

If you exhaust the above procedure and still do not obtain a satisfactory response from the supplier, then please drop us a line. We are not able to help directly, because basically the dispute is between you and the supplier, but a letter from us can sometimes help to get the matter sorted out. But please, don’t write to us until you have taken all reasonable steps yourself to sort out the problem.

We are a member of the mail order protection scheme, and this means that, subject to certain conditions, if a supplier goes bankrupt or into liquidation between cashing your cheque and supplying the goods for which you have paid, then it may be possible for you to obtain compensation. From time to time, we publish details of suppliers who have been classified ads, and you should look there for further details.

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

ZX A to D (Jan ’83)
D2 is shown the wrong way round on the overlay; wires on the RH side of the switch SW1 should go to top contacts. Some of the early PCBs had an error: pins 2 & 4 of IC1 should go to pin 16 (top) of edge connector (published foil pattern is OK).

Stage Lighting Unit (Jan, Feb, April, May ’83)
Transformer specs are as follows: Primaries all 250 V; secondaries T1: 0-6, 0-6 V, 12 VA tot; T2: 0-12, 0-12 V, 12 VA tot; D: 0-6 V, 3 VA. Ics 34, 35, 36 are 7805 SV regulators.

ZX Sound Board Design Comp. results, Feb ’83
The first line of the program has to be entered in reverse order to get it to go in (COS, GOSUB, COPY, ASN and RND are functions). The line should read:
REM \ Y -=COS GOSUB 5 COP Y ??
ASN ?RND?

Alarm Module (March ’83)
R21 is 220k (parts list OK, circuit diagram wrong) Q5 is BC182L (left off parts list).

Max Min Thermometer (April ’83)
A revised foil pattern was published in July ETI. To get original PCB to work, replace D4 and D5 with wire links, cut tracks from pins 7 and 8 on IC6, and solder 15k resistor across cut - remove ICs while doing this! (It’s messy but it works.)

Real Time Clock (April ’83)
Frequency of XTAL1 is 32.768 kHz.

NDFL Power Amplifier (May ’83)
C12 is 33pF (parts list correct, circuit diagram wrong). Table 1: lengths of wire quoted do not allow for lead lengths - add 40 mm or so to this. This is particularly important for L3. Resistors R29 and R30 can be wire wound types, it isn’t necessary to use carbon types (their inductance will be small).

Flash Sequencer (July ’83)
Q1 should be BC184L; Q2-S should be BC182L.

Telescope (August 1983)
We had a shower of annotation falling off our diagrams! On Fig. 1, C19 (below IC14) was not labeled nor was Q2 (above R1), and there were two C23s - one should be IC22 and it doesn’t matter which. In Fig. 5, IC12 was not labeled. Unfortunately, there was a mistake in the correction (blush!): C14 is the 22µF tantalum on the –5 V line.

Universal EPROM Programmer (August 1983)
We had the same problem with falling annotation as above. On the overlay, IC7 is between SK2 and SK5; IC6 is between SK1 and C10; IC1 is between R7 and R10.

Z80 Controller Computer
Same problem yet again. On the overlay, SW1 is the rectangle beside IC5 and 6; a link through was missed to the right of pin 18 IC11.
Subscription Order Form
To: ETI Subscriptions Department, 513 London Road, Thornton Heath, Surrey, CR4 6AR, England.
Please commence my subscription to Electronics Today International. I enclose a cheque*/Postal Order*/International Money Order* for the appropriate fee*, made out to ASP Ltd.
Please debit my Access*/Barclaycard* account number*
Signature
(*) delete as appropriate
Please indicate subscription required and fee enclosed
UK & Rep of Ireland: £13.15
Overseas surface mail:
£16.95
Overseas air mail: £36.95
Until further notice, each subscription includes a free binder (normal price £4.25)
PLEASE COMPLETE YOUR NAME AND ADDRESS IN BLOCK CAPITALS
Name ......................................................
Address ........................................................................
................................................................................

PLEASE INCLUDE POSTAL CODE AS APPROPRIATE
Date of order ......................................
This Coupon is valid until: 31st October 1983

Backnumber Order Form
To: ETI Backnumbers Department, 513 London Road, Thornton Heath, Surrey CR4 6AR, England.
Please supply me with the following backnumber(s) of ETI
Month .................. Year ..............................
Month .................. Year ..............................
Month .................. Year ..............................

I enclose cheque*/Postal Order*/International Money Order* to the value of £1.50 per magazine ordered, made out to ASP Ltd (* delete as appropriate).
Total money enclosed £......................................................
PLEASE COMPLETE YOUR NAME AND ADDRESS IN BLOCK CAPITALS
Name ......................................................
Address ........................................................................
................................................................................

PLEASE INCLUDE POSTAL CODE AS APPROPRIATE
Date of order ......................................
This Coupon is valid until: 31st October 1983

Binder Order Form
To: ETI Binders, 513 London Road, Thornton Heath, Surrey CR4 6AR, England.
Please send me ........................................... binder(s) for ETI.
I enclose a cheque*/Postal Order*/International Money Order* to the value of £4.25 per binder required, made out to ASP Ltd (* please delete as appropriate).
Total money enclosed £......................................................
PLEASE COMPLETE YOUR NAME AND ADDRESS IN BLOCK CAPITALS
Name ......................................................
Address ........................................................................
................................................................................

PLEASE INCLUDE POSTAL CODE AS APPROPRIATE
Date of order ......................................
This Coupon is valid until: 31st October 1983

Photocopy Order Form
To: ETI Photocopies Department, 145 Charing Cross Road, London WC2H 0EE, England.
Please supply me with the following photocopies:
Month............. Year ............. Article ..............
.........................................................................

I enclose cheque*/Postal Order*/International Money Order* to the value of £1.50 per photocopy ordered, made out to ASP Ltd (* delete as appropriate).
Total money enclosed £......................................................
PLEASE COMPLETE YOUR NAME AND ADDRESS IN BLOCK CAPITALS
Name ......................................................
Address ........................................................................
................................................................................

PLEASE INCLUDE POSTAL CODE AS APPROPRIATE
Date of order ......................................
This Coupon is valid until: 31st October 1983
TECH TIPS

Dual Trace Unit
John Hesketh, Pontefract

There have recently been two circuits published in ETI which allow two waveforms to be displayed simultaneously on a single beam oscilloscope. Both of these circuits have drawbacks, namely poor preamp performance, inadequate control over waveform position, a tendency towards instability and poor switching circuitry. The design shown overcomes these problems and will display waveforms clearly over the frequency range DC to 200kHz.

The design may be divided into three sections, two preamplifiers (one for each channel) and a switching circuit. The switching circuit is identical to that in J.C. Harris's circuit (ETI Feb 82).

The input signal is applied to an attenuator network either via a 100nF capacitor for AC coupling or directly for DC coupling. The attenuated signal is then fed to IC1 which is wired for a gain of one and functions as an impedance matcher. This stage gives the instrument a high input impedance (approximately 9MO). A portion of the output signal from IC1 is derived via RV1, which serves as an amplitude control, and is fed to IC2 and associate components which is also wired for a gain of one. This stage provides a means of shifting the vertical position of the waveform by introducing a DC voltage onto the non-inverting input of IC2 via RV2. This stage inherently inverts the waveform and therefore a further inverting stage is employed (IC3 and associated components) to restore the original sense of the waveform. The outputs from the preamplifier's IC3/6 are fed into the signal switching arrangement consisting of IC7 and IC8. The output from the electronic switch is then fed to the oscilloscope.

In order that a wide range of signal frequencies may be displayed, two modes of switching are employed. The two modes are 'chop' and 'alternate' and the mode of switching is determined by SW5. When displaying frequencies from DC to 15kHz, it will be necessary to use the 'chop' mode but for frequencies above 15kHz the 'alternate' mode should be used.

The settings of VC1-4 are quite critical at high frequencies (200kHz), and the following procedure should be adopted in order to obtain the optimum setting of these trimmers. (The procedure is described for channel No 1 as channel No 2 is identical). Inject a 200kHz 1Vp-p square wave into channel No 1 input and set the attenuator switch (SW2) to the 1/1 position. The setting of SW1 is unimportant. Set RV1 to maximum and RV2 to mid position. Connect an oscilloscope to the output of IC2 and adjust VC1 for a perfect square wave with no overshoot or corner rounding. Remove the oscilloscope and connect to the output of IC3. Adjust VC2 for a perfect square wave. Repeat the procedure for channel No 2.

Note that the circuit requires a split supply of ±9V.
Low-Cost Mains Time Delay Switch
Alex Gray,
Emberton, Bucks
This circuit offers a cheap, reliable replacement for mechanical and pneumatic time-delay switches such as used for corridor lights. It can also be used to protect equipment which is upset by power being applied and removed too rapidly.

When the switch is closed and reopened, the load is switched on for a preset time \( R_1 C_1 \). During this period, the circuit also switches on its own power. At the end of the time-delay both the load and the circuit are disconnected. In the event of a circuit failure, the push button will still allow the load to be switched on for safety (e.g. in corridor lighting).

If the switch is a normal latching type, the load will be powered as long as the switch is closed, subject to a minimum period. This prevents rapid cycling of the power on and off and may be used to protect equipment susceptible to damage from this situation.

There are only three connections and the circuit may be wired in at the ceiling rose of a conventional 'looped through' circuit without any additional wiring.

The usual precautions with mains wiring must be observed. In particular, remember that, although the 555 is on a 12V supply, that supply is superimposed on 240V AC above earth. The switch and the 470nF capacitor must be types designed for mains operation.

Karnaugh Map Display
K. J. Beeden,
Crawley
The Karnaugh map is a common way of representing the function of a four-input logic system. It is often taught in schools and colleges, when students are given a logic system and have to draw the Karnaugh map for it. This device allows the student to go away and test his map with the actual map generated by this device and a wired-up system on a breadboard.

IC5a and b form an astable, which clocks the 4-bit binary counter IC1. The outputs of this are fed into the quad true complements buffer, IC2, providing buffered true and inverted outputs to the system under test. The counter outputs are also used to decode the display -the three LSBs are used as select lines for the eight-way analogue switches, IC3 and 4, and the MSB is used to select the chip by connecting the true value to INH IC3 and the inverted (by IC5c) value into INH IC4.

The output of the system is connected to the input of IC5d,e,f. Thus if the output output of the system is high for a given 4-bit number, then the output of IC5d, etc, will be low, and so current will flow from the +ve supply, via the selected analogue switch (resistance of which is conveniently about 160Ω) through the appropriate LED. If the output of the system is low, then the output of IC5d, etc, will be high, and so no current will flow.

This means that an illuminated LED represents a "1" from the system, and an unlit LED a "0".

Figure 2 shows the arrangements of LED's 1-16 required to obtain the desired Karnaugh map display.
CLEF ELECTRONIC MUSIC

MICROSYNTH

Two-channel touch sensitive unit plus variable angle L.F.O., phaser, internal and external triggering.

COMPONENT KIT £89

BAND-BOX PROGRAMMABLE BACKING TRIO

Generates the sounds of three instruments to back vocals.

DRUMS + BASS + KEYBOARDS

Over 3,000 chord changes (100 scores) on 132 different instruments - up to 200 scores. Master Rhythm also required.

FULL KIT £235 EXTENSION £82

88/72 NOTE PIANOS SPECIALISTS SINCE 1972

COMPONENT KITS

including keyboard

88 NOTE £245
72 NOTE £234

The above may also be purchased in four parts.

DOMESTIC KITS


88 NOTE £442
72 NOTE £396

STAGE MODEL

inc. Cabinet & S.pkr.

72 NOTE £383

MASTER RHYTHM PROGRAMMABLE DRUMS

Twenty-four rhythm programmable Drum Machine with twelve drum sets, additional sounds are extended to 2433 measures for two bar programming. Sequence and instrument tone adjustable.

COMPLETE KIT £79

MC2K - Moving coil add on kit for CK1010 £25.00

P.S.K - power supply for CK1010 (if not used with a CK power amp) £20.00.

STRING ENSEMBLE £198.50

50V. 4 Bank £50

UNISELECTORS, 50v, 4 Bank Home Bank, 25 way £3.50

RECONDITIONED TELEPHONES

Push Button Trimphones £15

£1.80 p&p. 2 for £28 + £2.50

Pull Button 748 £1.80 + £2.50

Recent Style Dial Phones £1.75 + £1.80 + £2.50

Second (in working order)

Class 1 £3.50 + £1.80. 5 for £15 + £5

Class 2 (decoded) £2.25 + £1.80, 5 for £6 + £5

Send S.A.E. for free leaflet on telephone systems.

NEW! MODULAR AUTOMATIC TELEPHONE SYSTEM

Each ready built module is a complete exchange providing up to ten extension lines.

Simply connect phones and power supply

Only two wires to each telephone

Uses ordinary dial or push-button 'phones

Complete privacy for conversations

Range of several miles

Fully expandable system

Each module allows two phones to be used at one time, two modules allows four, etc.

RECONDITIONED TELEPHONES

Push Button Trimphones £15

£1.80 p&p. 2 for £28 + £2.50

Pull Button 748 £1.80 + £2.50

Recent Style Dial Phones £1.75 + £1.80 + £2.50

Second (in working order)

Class 1 £3.50 + £1.80. 5 for £15 + £5

Class 2 (decoded) £2.25 + £1.80, 5 for £6 + £5

Send S.A.E. for free leaflet on telephone systems.

BUILD A BETTER AMPLIFIER!

How can you own a top class HiFi amplifier, of comparable standard to Naim's, Meridians, Quad's etc., for an outlay of less than £250? — Simple! Built it yourself — with a Crimson kit.

It is not necessary to spend a small fortune to obtain true HiFi performance. Crimson Kits offer all the features and sound quality of the most esoteric amplifiers available and their ease of assembly ensures that they work first time and continue to do so. Not only do Crimson Kits offer outstanding value, but they also have the flexibility to adapt to any users needs. All the P.C.B.'s are ready assembled and tested (they are not "polished") as we believe dis.

Offer closes 31st July 1983 (Return this ad with your order)

CRIMSON ELEKTRIK STOKE

MANUFACTURERS OF PROFESSIONAL, DOMESTIC & INDUSTRIAL AMPLIFICATION

PHOENIX WORKS, 500 KING STREET, LONDON, STOKE-ON-TRENT, STAFFORDSHIRE. ST2 1EZ 0782 330520
THE DIGGER

No, no, it's nothing to do with tubes of amber nectar, billabongs, tucker bags or any other antipodean artifacts. Just a device for digging around in a digital circuit using an oscilloscope - a digital trigger. Design, development, and bad puns by Phil Walker.

The ETI Digger is a very simple device which will make fault finding on digital circuits very much easier. The basic unit is in reality an eight bit comparator which provides an output signal when the input signal is the same as that set up on the unit's switches. The unit as described will handle up to eight logic inputs which will probably be sufficient for most purposes. However, it is designed so that additional units may be plugged into the first to expand the total capability in blocks of eight.

Use

The unit must be provided with a normal TTL type +5 volt power supply (probably conveniently derived from the equipment under test). The output can then be taken to the external trigger input of your oscilloscope. In case you hadn't guessed, your next move is to set the scope to external trigger; you may have to adjust the trigger controls for best results, especially if the circuit under test contains ripple counters. The reason for this is that signal propagation delays in the devices will cause glitches in the output from the Digger unit. This is not a fault, as the input conditions are in fact true, even if only for a short time. Actually this property of the Digger could be quite useful if you suspect this action in your own circuit.

The leads from the device can be connected to the test circuit in any order but remember to set the switches in the corresponding order or your results will be wrong. It is a good idea to use the input nearest the output as a clock input, as this will eliminate a good many ambiguities. Don't forget to set any unused input channels to HIGH or the unit will not trigger!

The Circuit

The circuit for this device is very simple. Most of the work is

HOW IT WORKS

Not much to say here really. The LED, switch and resistor combination on four inputs to each IC provides a low when the switch is open and a high when it is closed. Also when the switch is closed the LED will light showing that a high has been selected for that channel.

When the logic input pattern on the input pins matches that on the switches the output from each IC will change state and thus trigger a scope connected to the final output. The outputs from one IC will directly drive the cascade inputs of another and so extend the width of the comparison. The inputs from the test circuit are provided with pull up resistors so any unused input will appear as a high and this must be set on the corresponding switch. C1 and C2 are pre-sent to decouple the supply rails. R1 is a pull up for the "-" cascade input.
PARTS LIST

RESISTORS (1/4 W 5% carbon film unless stated)
R1  2K2
R2 - R9  1K (SIL resistor pack 8 x 1K)
R10 - R17  2K2 (SIL resistor pack 8 x 1K)
CAPACITORS
C1  100nF ceramic
C2  10uF 16V electrolytic
SEMICONDUCTORS
IC1, IC2  74LS85
LED1 - LED8  3mm Red LED
MISCELLANEOUS
SW1 - SW8  8 pole SPST DIL switch
10 way PCB socket 0.1" pitch; 5 way PCB socket, 0.1" pitch; 5 way right angle PCB plug 0.1" pitch; box (Vero G.P. plastic box 72 x 50 x 25 mm 202-21025K); PCB; 10, 5 way free plugs and 5-way socket for above.

Construction

Construction of the PCB is quite simple so long as the ICs are inserted the right way round. The LEDs and capacitors must likewise be put in correctly. If you are going to use resistor packs as we did, the end with the dot or similar mark is the common terminal. Verify this with a meter if in doubt. If you use discrete resistors, mount them vertically and join all the top ends to the common terminal with a piece of stripped solid-core wire.

It will be necessary to use a 16 pin wire-wrap type socket for the DIL switch so that it can be positioned through a hole in the box. The LED leads will probably be long enough without extension. We would also recommend using ordinary sockets for IC1 and IC2.

There are 5 links to insert on the board as marked on the overlay which connect the inputs to SK2. Use thin insulated wire for these. Mounting the PCB in the box is a little tricky. First make sure that the corners have been cut off at the marks shown and check that the board will fit into the box. We found it easier to fit the PCB upside down in the box (with the track side facing the lid), so that only a little of the side walls have to be cut away to allow SK1, SK2 and PL1 to fit. Also a rectangular cut-out must be made in the bottom of the box to allow SW1-SW8 through. Finally eight 3 mm holes should be drilled for the LED’s.

The PCB can now be bolted to the lid and the box put together. Connections to the outside world are made via the plugs and sockets. If you use right-angled plug parts, then a small piece of Veroboard soldered to them makes a robust connector. The socket should be a socket housing with crimp terminals. For greatest convenience the power connections can be made via the free socket and PL1 while the trigger output goes from SK1. The switch can be mounted either way round in its socket allowing you the option of the test leads coming out of the top or bottom of the device, while the switch position is still up for high, for example.

 done by the two ICs which are 74LS85 devices. These are TTL four-bit magnitude comparators, and give outputs which show whether one of the two four-bit binary numbers presented to their inputs is equal to, greater than, or less than the other. In addition to the normal inputs, there is also a set of inputs which take the outputs from another similar device. When these are connected, the final output depends on all the comparisons of all the inputs to the devices connected in this way.

The rest of the circuit is devoted to providing the requisite comparison inputs to the ICs and giving a visible indication of it. The method of doing this is to use resistors to hold the inputs normally at a low level, but with switches that can force them high via an LED which will light up to show that it has been selected. The logic inputs from the test circuit are provided with pull up resistors so as to define unused inputs.

BUYLINES

Nothing in this project should cause much difficulty: the SIL resistors are fairly widely available from suppliers such as Watford, Cricklewood, etc. The connectors are available from Maplin, and the PCB is available through our very own service.

Two or more Diggers can be cascaded.
Accurate Digital Multimeters at Exceptional Prices

**NEW ANALOGUE METER WITH CONTINUITY BUZZER AND BATTERY SCALE**

**NEW**

**HM102 BZ**

- DC Voltage: 0-25, 1, 2.5, 10, 25, 100, 250, 1000 volts
- AC Voltage: 0, 25, 100, 250, 1000 volts
- Decibels: 20 to +22dB
- DC Current: 0, 50μA, 0.5, 5, 50, 500mA
- Ohmmeter: 0-6 Megohms in 4 ranges, 30 ohms Centre Scale
- Power Supply: One 1.5V size ‘A’ battery (incl)
- Size & Weight: 135 x 91 x 39mm, 280gr.

**NEW HM 102 BZ SPECIFICATION**

- DC & AC Voltage: 0, 10, 25, 100, 250, 1000 volts, 2000 ohms/volt
- Decibels: -10 to +22dB
- DC Current: 0-100mA
- Ohmmeter: 0-1 Megohm in 2 ranges, 60 ohms Centre Scale
- Power Supply: One 1.5V size ‘A’ battery
- Size & Weight: 90 x 60 x 29mm, 92gr. incl. battery
- Price: £5.50

**OTHER FEATURES**

- Auto polarity, auto zero, battery low indicator, ABS plastic case with tilt stand, battery and test leads included, optional carrying case.

**Quantity discount for trade on application.**

Add 15% to your order for VAT. P&P is free of charge. Payment by Cheque with Order. Access & Barclaycard accepted.

ARMON ELECTRONICS LTD
Cottrell House, 53-63 Wembley Hill Road, Wembley, Middlesex HA9 88H, England
Audiophile returns with a look at a new version of an old favourite. Ron Harris (Who’s he? -Ed) has been playing with little boxes.

What do you mean "Oh no, not again?" Thought you'd got rid of me, huh? It's not as easy as that my friends. Audiophile returns to ETI with a look at some new boxes with an old and revered name - Minimax 2.

The Minimax 2s are a two-unit ported design of tiny proportions. This is a complete redesign from the originals and the speakers have a lot to live up to.

All by themselves, the original Minimaxes practically rewrote the hi-fi gospel that speakers must be big to be credible. This led to a host of manufacturers taking a serious look at the idea of high performance small enclosures, witness the plethora of imitations there are now.

Presumably the idea behind the redesign is to re-establish the Videotones as the leading small speakers and the indications are that they are selling very well. Celestions magnificent SL6s have unquestionably taken this field a good deal further forward, but at a price. The Minimax 2s are considerably cheaper and are not intended to be directly competitive.

Moving Experiences

The main problem with any small box is how to move the mass of air required to produce useful bass response when the speaker is too compact to house a large driver. Because the enclosure is smaller than the wavelength of the sound it is producing, cancellation occurs between the air mass in front of the driver and that behind the box. In short, as the unit tries to push the air away from it, instead of traveling outwards, the wave just 'wraps around' and dissipates most of its energy before reaching the listener.

This is why small speakers produce better bass close to a wall. You can't cancel a wall. The more solid the better, as the mass is what counts. As an added help, the bass driver should be of the long excursion variety in order to transfer as much energy into the air as possible. If you must use a small paddle then you have to move it further for the same effect as would be obtained with a larger surface area.

Field Work

In order that the bass driver should be able to move freely and without inducing gross distortion, the coil and magnet within which it moves must be made longer also, so that the coil never moves out of the linear region of field and is therefore evenly driven at all signal levels.

Also, although a smaller set of wooden panels should be easier to damp, and thus have their resonances kept under control, in a real box any bracing material used is more likely to affect the overall sound quality. This is simply because the volume of the bracing subtracts from the volume of the enclosure, and the less there is to start with, the less left! It is the bass which suffers, so a trade off is required. Resonating panels will colour the sound, too much bracing will reduce the base ... hmm, perhaps we could launch a computer game called 'Design A Speaker'.
In Use

Having now run briefly through the horrors of designing small speakers, how do the Minimax 2s measure up? Despite all the pitfalls do they actually produce a creditable result? In a word yes. The originals were very worthy units and the Mark 2s should carry on the tradition admirably.

I wired in the units, somewhat unfairly, in a direct comparison to my usual reference speakers, KEF105 II’s which are anything but small. The Minimax was positioned off the floor, clear of walls and for a second attempt on a shelf flat against the wall to simulate more usual conditions of usage.

The amplifier was a Denon PRA2000/POA3000 Class A set-up and the record source provided by the well trusted TD160S/SME III carrying a Shure V1 SV cartridge.

To those of you who think it ‘unfashionable’ to use an SME rude words and expletives. Unaffected by the frantic pursuit of something new for the sake of it often to the detriment of the results the SME continues to out-perform the pretenders. So there!

On an absolute scale the Minimax 2 is a worthwhile product. Taking into account its size, it is positively brilliant. Its greatest asset is the ability to project the sound image away from the enclosures, out into the room: This makes it very easy to forget the boxes and the size of them.

The Wall

Used in ‘free-space’ i.e. clear of all room boundaries, the Minimax understandably loses body in its presentation. Given a wall to help out, however, it can make a nonsense of its dimensions.

The new high frequency unit appears to improve both the smoothness and the spread of the presentation. The image is now much less dependent upon the listener’s position and is free of any noticeable frequency response irregularities. Integration between the two units is good and the mid-range has a good solid sound to it.

Someone used to big, free standing enclosures, with a good deal of power behind them, would of course notice the lack of bass extension at once. However, as a starting point in hi-fi, or as a compromise answer in a small room, the Minimax 2s have much to recommend them. At the low price of £75 per pair, they are very good value and should be listened to seriously if you are thinking of buying a pair of small speakers, for whatever purpose.

One word of caution, they are relatively inefficient and hooking up less than 20W a channel is unlikely to elicit the best results from these diminutive demons.

The Preamp And The Packing Case!

Also this month I was going to review Musical Fidelity’s “The Preamp”, an audiophile unit of modest cost and high aspirations. Due entirely to the fact that I am moving house and my entire reference system, nay life, is packed into cardboard boxes and is presently being shuffled through the lanes of Kent, I am unable to do so!

My apologies for this and as soon as normal service is resumed I will complete the findings. Meanwhile, have a topless photo.

Exit Ron Harris pursued by the office chapter of the Womens Liberation Movement, in a none-too benevolent mood.

Above: the trusted reference. An SME III doing it’s bit whilst sat on a Thorens TD160S. A great deal of mud has been slung at several excellent products lately, including the SME. Ignore it. Let your own ears decide. The SME will stand up to ANY properly conducted comparison (i.e. scientifically). If you think I’m getting upset you could be right. I’m thoroughly chosed off with unqualified, unprincipled and unsound review techniques. A mandatory qualification for producing some of this stuff seems to be that the applicant must be able to prove he has achieved brain death. End of tantrum.
When you need to update yourself with all that is available in the "Do-it-yourself" market, then you need the Hobby Herald. Packed with product information essential to the electronics enthusiast, this new electronics catalogue lists over 60 exciting products ranging from All Purpose Cutters to Verobloc, the solderless breadboard. All products are available throughout the U.K. from over 200 stockists.

Hobby Herald

Alternatively ordering products through the Herald is simplicity itself, and you can pay by either cheque, Barclaycard or Access. So make sure you get your copy of Hobby Herald by ringing (04215) 62829.

BICC-Vero Electronics Ltd., Industrial Estate, Chardners Ford, Hampshire, S05 3ZR.

---

17 exciting electronic projects to build and run on your own micro.

- Light Pen
- Picture Digitiser
- Key Pad
- Model Controller
- Weather Station
- Other Exciting & Interesting Projects

Realise the real world potential of your micro.

A newly released book written by well known author Owen Bishop and published by Bernard Babani gives fully descriptive details on how to build all 17 projects — all are fairly simple and inexpensive to construct — The most complex component (the Decoder) is supplied in kit form ready to assemble with all components and plated through PCB. — Components for the projects are readily available locally or found in your workshop drawers.

Once assembled and connected to your micro the decoder is able to run any or all of the projects simultaneously.

Simple Programmes are included to get you started but of course the more experienced programmer can have hours of fun writing complex programmes to take full advantage of these easy but exciting projects.

Please send by return (allow 28 days for delivery)

<table>
<thead>
<tr>
<th>QTY</th>
<th>REF</th>
<th>DESCRIPTION</th>
<th>PRICE</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HB/2000 &quot;EASY ADD-ONS&quot; + DECODER KIT &amp; BOOK</td>
<td>£24.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>HB/2001 &quot;EASY ADD-ONS&quot; BOOK ONLY</td>
<td>£3.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>HB/2002 DECODER KIT ONLY</td>
<td>£22.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>HB/2003 DECODER PCB ONLY</td>
<td>£8.00</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Price inclusive of VAT & carriage. Please allow 21 days for delivery. Cheques, POs or signed Access orders welcomed.

Please send full Hobbyboard Mail Order Catalogue with full range of PCB materials & hardware

Name
Address

---

A division of KELAN ENGINEERING Ltd
Hookstone Park
Harrogate, N. Yorks

Complete P.C.B. workshop

ET1 9/83
EDUCATIONAL ELECTRONIC KITS

RADIO KIT

This AM radio is supplied with building instructions plus comprehensive electronic theory, exercises and test procedure. A complete learning package, requiring only a 9V battery.

The large fibreglass printed circuit board has been designed in 3 sections as a TRF radio, a bass treble control and an amplifier push-pull output circuit. Each section can be built and tested as a separate project.

This comprehensive radio circuit shows an application of tuned circuits, I.C.‘s, field effect and bipolar transistors, common emitter and collector configurations, stabilizer circuits, feedback circuits, complementary output stages, etc.

The radio project kit should give entertainment and interest to the novice, yet provide valuable learning material for the electrical student. Particularly relevant to current T.E.C. electronic courses.

The price is only £16.70 inc. VAT + £1.50 p&p. (Allow 28 days delivery).

Educational and quantity enquiries welcome.

Send cheque or postal order to:-
HAZLEWOOD ELECTRONICS LTD.,
Sales Department,
149 Main Street,
Grenoside,
Sheffield, S30 3PN.
Tel: 0742 463585
Send an S.A.E. to receive a list of our current electronio project kits.

MUSICRAFT 383 EDGWARE RD, LONDON W 2 TEL 01-482 9329 2886

Digitise at up to 10 MHz, Store, then display on a UHF TELEVISION. Single shot Capture up to 250 KHz. Storage Facility for less than £100.

The Tele-Scope is a new concept in data capturing the latest Digitising techniques. The Tele-Scope acts - controls - displays much like a conventional scope but does much more.

A kit version is available for £89 and a Built unit for £109. A manual is included and specialist parts are available separately.

Prices exclude VAT at 15% with postage and packing at £2.95 inc. The manual is available separately for £1.50 inc. VAT which is refundable on subsequent purchase of a unit.

NAME & ADDRESS .........................................................
.......................................................................................
The only way to give MARVIN a sense of proportion is to connect him with the outside world. Peter Grigson and David Harris show us how it's done.

No computer can talk to the outside world on its own - it needs interfaces to achieve this. As we've already mentioned, MARVIN is a modular computer, and so his interfaces are built on separate boards. There are two types of interface - the I/O board and the interrupt board, both of which we will now proceed to describe.

**HOW IT WORKS**

**I/O BOARD**

The circuitry divides into three parts - the control logic (IC1 and 2), Port A (IC3 and 4) and Port B (IC5 and 6). In fact there are four ports per board the input, and to enable the relevant IC. Note that separate but sharing the same addresses.

The port selection logic is very simple; four AND gates are used to detect when one of the ports is being addressed and to enable the relevant IC. Note that the selection signals are active low. Because the system is quite simple, it was not judged necessary to include circuitry to avoid more than one port being enabled at once.

The output ports (ICs 3 and 5) are based on the 74LS373 octal 0-type transparent latches: while the EN G input is high, the outputs follow the inputs. When EN G is taken low, the latches will be set to the current data. There is also an output control which may be useful in some circumstances. When this is taken high, the outputs from the 74LS373 go into a high impedance state, irrespective of the latch contents. However, the latches themselves are unaffected by the output control, and they will retain their current data, or can be set to new data. R1 and R2 keep the output control (OC) inputs, to ICs 3 and 5 respectively, low in the case of no external control signal.

The input ports (ICs 4 and 6) use 74LS244s: these are octal buffer/line drivers with tri-state outputs (the outputs are connected directly to the data bus internally, the buffers are in two groups of four, with separate gate inputs (G1 and G2), and when these inputs are taken low, whatever information is at their data inputs will be placed on to the data bus.

The I/O board is seen by the CPU board as two I/O ports, which we've labelled A and B. Each port has eight output lines (ie, one byte in either direction) making a total of sixteen lines and eight either direction per board. As we

---

**Fig. 1 Circuit of the I/O Board.**
Project

Interrupt Board

This board is intended for use with external timing and triggering devices. Via this board, external equipment can make the CPU stop whatever it is doing and pay attention!

Eight interrupt input lines are

mentioned last month, there can be up to five I/O boards (i.e. ten ports) in use with the system as it is presently configured.

To write to a port, the CPU places the required data on the data bus and makes the WR and the relevant port selection line low. The data is actually latched into the port when one or both of these lines goes high again, and until this point the outputs will follow the input data. The data will remain set until that port is written to again.

To change just one bit, the whole byte will have to be rewritten to the port, with repeat data in the bits you don't want to change.

The output control (OC) can be used to isolate the port from its output lines. This could be useful if the system receiving the output from MARVIN is to any extent autonomous, e.g. it contains another processor. Note, however, that the output lines should never be driven beyond TTL limits (with respect to Marvin's earth), otherwise damage may occur.

When an input port is selected, the inputs to it are buffered on to the data bus. Thus, while they are being accessed, they should be held stable to avoid errors.

Note that there is no way for the I/O board to signal the CPU board that it wishes to transfer data - like a shy little wallflower at a noisy disco, it has to wait until it's asked, and the CPU does the asking by taking RD and the relevant port selection line low.

Fig. 2 Overlay of the I/O Board: note that the connections to the edge connector are in the reverse order from the other two types of board. See text before inserting pins.

Fig. 3 Circuit of the interrupt board.
provided, and these should normally be at logic high. If any line is pulled down to low, the CPU will accept the interrupt provided it has executed an enable interrupts (EI) command since the last interrupt occurred or disable interrupts (DI) command was executed. The CPU will not accept further interrupts until EI has been executed again.

The CPU will complete executing the current instruction, then go to the interrupt servicing routine in the operating system. As described in the "How It Works" section, the interrupt board latches the data on the interrupt input lines when one makes the high-to-low transition, and then the monitor instructs the CPU to read this data. This will consist of all 1s except for the bit that corresponds to the input that's causing all the fuss. According to which input lines when one makes the high-to-low transition, and then the monitor

Construction

Construction of both these boards should be absolutely straightforward. We recommend using sockets for all but the simplest of the TTL gates (ie, don't bother for IC1 and 2 on the I/O Board, or with IC3 on the Interrupt -Board). Don't forget to insert the wire links as shown, and if you're not bothering with edge connectors, you'll need to insert pins in the PCB next to the edge connector strips. In any case, you may wish to put pins in the positions marked on the I/O board, for defining the address of the ports -but see the I/O Port Identification Section first, and decide whether you'll be changing around the system much.

Making The Connections

Well, now you've got all the three types of board -how do you connect them up together? As we've already stated, you have a choice between using edge connectors (the rich hobbyists' option) or pins and ribbon cable. In either case, all three boards use exactly the same connections, but with two irregularities for the I/O board: there is one less tab (INT is omitted), and the tabs are in the opposite order from the other two boards (thus if the boards were mounted in a rack, the I/O board(s) would face in the opposite direction from the CPU and interrupt boards).

I/O Port Identification

As we've already mentioned, the CPU sees the I/O boards as two separate ports per board, and each of these two ports must have a unique address. Thus each port selection line (SELECT A and SELECT B in Fig 1) must be connected to just one port selection signal on the main board (in the top right hand corner of Fig.2 last month); furthermore, only one port must be connected to each selection signal. This can be achieved in two ways:

either you can run individual lines from the selection signals on the CPU board to the selection inputs on the ports; or

you can define the port number by connecting links or: the port PCBs, and Fig. 5 shows an example of this.
**Modular Amplifiers**

*the third generation*

Due to continuous improvements in components and design ILP now launch the largest and most advanced generation of modules ever.

**WE’RE INSTRUMENTAL IN MAKING A LOT OF POWER**

In keeping with ILP’s tradition of entirely self-contained modules featuring, integral heatsinks, no external components and only 5 connections required, the range has been optimized for efficiency, flexibility, reliability, easy usage, outstanding performance, value for money.

With over 10 years experience in audio amplifier technology ILP are recognised as world leaders.

---

**BIPOLAR MODULES**

<table>
<thead>
<tr>
<th>Module Number</th>
<th>Output Power</th>
<th>Load Impedance</th>
</tr>
</thead>
<tbody>
<tr>
<td>HY6</td>
<td>15W</td>
<td>8Ω</td>
</tr>
<tr>
<td>HY602</td>
<td>30W</td>
<td>4Ω</td>
</tr>
<tr>
<td>HY128</td>
<td>60W</td>
<td>2Ω</td>
</tr>
<tr>
<td>HY124</td>
<td>120W</td>
<td>1Ω</td>
</tr>
<tr>
<td>HY30</td>
<td>180W</td>
<td>0.8Ω</td>
</tr>
</tbody>
</table>

**Specifications**

- Frequency response: 15Hz - 100KHz
- Input sensitivity: 200mV rms
- Input impedance: 100KΩ
- Damping factor: 100Hz > 400
- Protection: Full load line, slew rate: 20mA, rise time: 1μs
- Size 85 x 40 x 80mm, weight 410gms.

---

**MOSFET MODULES**

<table>
<thead>
<tr>
<th>Module Number</th>
<th>Output Power</th>
<th>Load Impedance</th>
</tr>
</thead>
<tbody>
<tr>
<td>MOS128</td>
<td>80W</td>
<td>8Ω</td>
</tr>
<tr>
<td>MOS364</td>
<td>160W</td>
<td>4Ω</td>
</tr>
<tr>
<td>MOS368</td>
<td>120W</td>
<td>2Ω</td>
</tr>
</tbody>
</table>

**Specifications**

- Frequency response: 15Hz - 100KHz
- Input sensitivity: 500mV rms
- Input impedance: 100KΩ
- Damping factor: 100Hz > 400
- Protection: Able to cope with complex loads without the need for very special protection circuitry (fuse will suffice).
- Size 95 x 40 x 80mm, weight 256gms.

---

**Power Supply Units**

- PSU 21X 1 or 2 x HY30 £11.93
- PSU 52X 1 or 2 x HY364 £21.75

---

**Preamplifier Systems**

- Pre-amp booster amplifier to increase the output of your existing car radio or cassette player to a nominal 15 watts rms.
- Very easy to use.
- Robust construction.
- Mounts anywhere in car.
- Automatic switch on.
- Output power maximum 22w into 4Ω.
- Frequency response: 20Hz - 20KHz, T.H.D. 0.1% at 10w 1KHz
- S/N ratio: 90dB (A-weighted) 80dB, load impedance 4Ω,
- Size 85 x 40 x 60mm, weight 256gms.

---

** scooter Ampifiers**

**New to ILP**

**In Car Entertainment**

- C19 Mono Power Booster Amplifier: £9.14 (inc. VAT)
- C18 Stereo version of C15: £17.19 (inc. VAT)
WITH A LOT OF HELP FROM

PROFESSIONAL HI-FI THAT EVERY ENTHUSIAST CAN HANDLE...

Unicase

Over the years ILP has been aware of the need for a complete packaging system for its products, it has now developed a unique system which meets all the requirements for ease of assembly, adaptability, ruggedness, modern styling and above all price.

Each Unicase kit contains all the hardware required down to the last nut and bolt to build a complete unit without the need for any special tools.

Because of ILP's modular approach, "open plan" construction is used and final assembly of the unit parts forms a compact aesthetic unit. By this method construction can be achieved in under two hours with little experience of electronic wiring and mechanical assembly.

Hi Fi Separates

UC1 PRE AMP UNIT: Incorporates the HY7B to provide a "no frills", low distortion, (< 0.01%), stereo control unit, providing inputs for magnetic cartridge, tuner, and tape/monitor facilities. This unit provides the heart of the hi fi system and can be used in conjunction with any of the UP Unicase series of power amps. For ultimate hum rejection the UC1 draws its power from the power amp unit.

POWER AMPS: The UP series feature a clean line front panel incorporating on/off switch and concealed indicator. They are designed to compliment the style of the UC1 pre-amp. Performance for each unit which includes the appropriate power supply, is as specified on the facing page.

Power Slaves

Our power slaves, which have numerous uses i.e. instrument, discotheque, sound reinforcement, feature in addition to the hi fi series, front panel input jack, level control, and a carrying handle. Providing the smallest, lowest cost, slave on the market in this format.

<table>
<thead>
<tr>
<th>UNICASES</th>
<th>Price inc. VAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>HiFi Separates</td>
<td></td>
</tr>
<tr>
<td>UC1X 30 + 30W/4-8Ω Bipolar Stereo HiFi</td>
<td>£54.95</td>
</tr>
<tr>
<td>UP2X 60W/4Ω Bipolar Mono HiFi</td>
<td>£54.95</td>
</tr>
<tr>
<td>UP3X 60W/8Ω Bipolar Mono HiFi</td>
<td>£54.95</td>
</tr>
<tr>
<td>UP4X 120W/4Ω Bipolar Mono HiFi</td>
<td>£74.95</td>
</tr>
<tr>
<td>UP5X 120W/8Ω Bipolar Mono HiFi</td>
<td>£74.95</td>
</tr>
<tr>
<td>UP6X 60W/4-8Ω MOS Mono HiFi</td>
<td>£64.95</td>
</tr>
<tr>
<td>UP7X 120W/4-8Ω MOS Mono HiFi</td>
<td>£84.95</td>
</tr>
</tbody>
</table>

Power Slaves

<table>
<thead>
<tr>
<th></th>
<th>Power Slave</th>
</tr>
</thead>
<tbody>
<tr>
<td>UC1X 60W/4Ω Bipolar Power Slave</td>
<td>£99.95</td>
</tr>
<tr>
<td>US2X 120W/4Ω Bipolar Power Slave</td>
<td>£79.95</td>
</tr>
<tr>
<td>US3X 60W/8Ω MOS Power Slave</td>
<td>£89.96</td>
</tr>
<tr>
<td>US4X 120W/8Ω MOS Power Slave</td>
<td>£89.96</td>
</tr>
</tbody>
</table>

Please note X in part number denotes mains voltage. Please insert '0' in place of X for 110V, '1' in place of X for 220V (Europe), and '2' in place of X for 240V (U.K.) All units except UC1 incorporate our own toroidal transformers.

TO ORDER USING OUR FREEPOST FACILITY
Fill in the coupon as shown, or write details on a separate sheet of paper, quoting the name and date of this journal. By sending your order to our address as shown at the bottom of the page opposite, with FREEPOST clearly shown on the envelope, you need not stamp it. We pay postage for you. Cheques and money orders must be crossed and made payable to ILP Electronics Ltd. If sending cash, it must be by registered post. To pay C.O.D. please add £1 to TOTAL value of order.

PAYMENT MAY BE MADE BY ACCESS OR BARCLAYCARD IF REQUIRED

Telephone: 02271 54778, Telex: 965780.

Please send me the following ________________

Total purchase price

I enclose Cheque☐ Postal Orders☐ Int. Money Order☐

Please debit my Access/Barclaycard No. ________________

Name _______________________

Address _______________________

Signature ______________________
Mucking around in memory? Seeking space? Look no further, here's a bounty (no connection with those distracting TV ads) of bits, rapacious in real-estate, for your 6502 or 6800 system to gorge itself on. Design and development by Bob Campbell.

Most microcomputer users find out fairly quickly that there is no such thing as too much memory. But even today with memory as cheap as it is, many systems are on sale with less, often considerably less than the 64K that most eight-bit microprocessors are capable of addressing. The independent suppliers are usually very quick to provide units to fill this gap, but one system not well covered in this respect is the Tangerine Micron/Microtan 65. Until recently, there was only the TAN RAM, but now there is the CMOS alternative. However, despite advantages in power consumption and battery back-up, the CMOS unit, like the TANRAM, is large and fairly expensive. More than one board is required to provide the maximum possible memory. The approach here is to use the highest density dynamic RAM chips readily available and allow the user to access all of it except where it would clash with essential EPROM, I/O or CPU board RAM. This leads to an extremely flexible and cost-effective system.

Although specifically designed for the Microtan 65 computer together with either a disc system or TUG's Eprom Storage Card (the MOS Disc concept) the design retains enough flexibility to accommodate almost any desired configuration of computer and operating system, the only prerequisite is a 6502 or 6800 CPU.

Design

The board uses the latest 64K by 1 bit dynamic RAM chips, TMS 4164-15. These are decoded into 64 1K blocks, with all but four of the blocks used in its standard configuration. Making almost 6 1/4% of the RAM effectively redundant may at first sight seem a little extravagant, however even allowing for this the cost per K is less than £1.00. If one adds the other savings on hardware, sockets, power supply requirements board space etc., the 64k chip route stands out above all the other alternatives.

The heart of the system is the 74LS608 memory cycle-controller (MCC). This chip generates all the signals the RAM requires to perform the two types of cycles necessary for proper operation. The MCC generates these signals from the CPU's clocks 01 and 02 together with the decoded signal RE, RAM enable. It is important not to confuse this signal with the Tanbus signal RAME. The only signals used from the bus are the address and data lines together with R/W, 01 and 02 and because of this and the use of a PROM address decoder, this board is very flexible, in design and easily adapted to suit other systems.

Dynamic RAMs

The two great advantages of dynamic RAM are its extremely low power consumption and its packing density. This is achieved by the design of the actual memory element which is in fact a very small capacitor. The logic level stored being defined by the presence or absence of a charge on that capacitor. Because all capacitors have a finite leakage, the charge on the capacitors must be periodically topped up. This procedure is called refreshing and is accomplished by performing what is known as a RAS only refresh cycle. This RAS only refresh cycle consists of first setting up an eight bit address at the input latches and strobing RAS low, while maintaining CAS high. The complete chip is refreshed when all 256 row addresses have been treated similarly. Data retention is assured if all these 256 cycles are completed at least once every 4 msec.

Apart from the necessity to refresh every 4 msec there is one other penalty to pay for the 16 pin packing density and that is the multiplexed address bus. Figure 1 shows the internal architecture of the 4164.

To address every memory element within the IC, 16 address bits must be applied. These are separated into the row address and the column address, each latched onto the multiplexed address bus.
Fig. 2 Processor and memory cycle controller timing.

upon the appropriate signal RAS or CAS.
In full, the memory cycle consists of five stages. Firstly the row address pins and RAS pulled low. Then the address multiplexers are switched placing the other eight bits, the column address, onto the address pins and CAS pulsed low. This last operation enables the chip and, depending on the status of the R/W line, enables the input or output buffers, thus completing a read or write cycle.

There are two other possible types of cycle, the page mode read/write and the read modify write cycles. However since neither of these apply to the 6502 or 6800 type of processor it is not necessary to consider them further here.

It is important to note that the 6502 operates in what is known as the early write cycle where the R/W line is set up long before CAS goes low. This enables the data in (D) and data out (Q) pins to be connected together and thus have a common data bus. Obviously the sequence and timing of the two cycles, refresh and memory, is extremely important. The RAS only refresh cycle is particularly significant for two reasons: firstly, it is necessary to perform it regularly (256 times every 4 msec), and secondly, it is effectively a dead cycle, when the CPU cannot access memory. Refresh cycles can be carried out in either burst mode or hidden transparent mode. Burst refresh is a technique where all the memory elements are refreshed consecutively whilst the processor is held in a wait or halted state. This dead time is called the refresh overhead, which, more accurately, is defined as the ratio of the time taken to refresh all the memory elements and the maximum refresh interval. In well-designed systems with the 4 msec 64K rams this overhead can be as low as 2%. As the circuitry needed to maintain this type of refresh system is complex it is not commonly used outside the realms of very fast microcomputers, minis and mainframe systems.

The other technique, hidden refresh, is the more commonly used. This technique relies upon the fact that the CPU will always have a period within any instruction or machine cycle when it will not access the system bus, and one refresh cycle can be accomplished during this period. Thus after a maximum of 256 instruction cycles all the memory elements will have been serviced. This technique has the great advantage of a zero refresh overhead rate and is totally transparent to the CPU and thus the user.

In this design the two cycles, refresh and memory, are sequenced by the main CPU clocks 01 and 02. While 01 is high, the CPU sets up the R/W and address lines, the rising edge of 02 signifying a valid memory address. This edge of 02 is normally used to enable the address and data buffers. Thus while 01 is high, the CPU is normally isolated from the system bus, and the refresh cycle can be accomplished during this period. In addition by using 01 to clock the eight bit refresh row address counter all 256 row addresses can be refreshed sequentially. Figure 3 shows exactly the relationship and timing of these events.

PROM Program Design

The memory map of the RAM board is controlled directly by the TBP24S10 PROM, which acts as a complex address decoder. Before programming the PROM, the desired memory map must be established. The minimum requirement for most systems will be the system monitor, the I/O area and unless there is a serial VDU as the screen, some screen memory. Some systems use a relocatable area of memory for the screen RAM, the video controller accessing the system bus directly. If the target system is of this type then no provision should be made for the screen RAM in the PROM program. Remember the overriding factor when designing the memory map is that there must not be two components within the system which have the same address. Taking the standard configuration of the Microtan as our worked example, the minimum memory map is as shown in Fig 4.

Once you’ve determined the memory map(s) required, the upper six address lines should be written out bit fashion (bit by bit ... ?). Each bit corresponds to a PROM address bit; however because of the PCB board layout, the one-to-one
respondance is not in numerical order.

In addition, by using the two extra PROM address lines A7 and A8, there is the facility to have up to four programs and therefore four memory maps resident on the board at one time, selectable by means of the DIL switch SW1. Using the two tables 1 and 2 it is possible to calculate all the PROM addresses which are required to be 'blown'.

Remember that PROMs are not erasable, once a memory location is altered from the "all 1's" condition, it cannot be reversed. There is however an escape route if a mistake is made during programming. The program is created by blowing only the operative bits within the data word from a 1 to a 0. In this design, only one of the four bits available is used (bit 4). If an error is made during programming, then it is possible to use an alternative bit by breaking the PCB track at pin 9 IC15, installing a link to either pin 10, 11 or 12 (bits 1-3 inc.) and reprogramming the PROM using the appropriate data word. (Alternatively, this would make it possible to hold a total of 16 memory maps in the PROM).

It is beyond the scope of this article to describe the methods for actually programming the PROM, suffice to say that the amount of programming by nature of its use, is small, so it would be feasible to use the switchbox type of programmer.

Construction and Setting Up

The construction of the board is very straightforward, particularly if the PCB design presented here is followed exactly: there are, after all, only 18 ICs. The PCB is a double sided design but to keep costs down it doesn't use plated-through holes. To make the necessary interconnections, track pins or short lengths of wire must be soldered between the two in the positions marked on the overlay diagram with a black dot. These pins must be soldered in first,

<table>
<thead>
<tr>
<th>AREA</th>
<th>HEX ADD</th>
<th>SIZE</th>
</tr>
</thead>
<tbody>
<tr>
<td>A) TANBUG</td>
<td>FFFF</td>
<td>2K</td>
</tr>
<tr>
<td></td>
<td>F800</td>
<td></td>
</tr>
<tr>
<td>RAM</td>
<td>F7FF</td>
<td>14K</td>
</tr>
<tr>
<td></td>
<td>C000</td>
<td></td>
</tr>
<tr>
<td>B) I/O</td>
<td>BFFF</td>
<td>1K</td>
</tr>
<tr>
<td></td>
<td>BC00</td>
<td></td>
</tr>
<tr>
<td>RAM</td>
<td>B8FF</td>
<td>46K</td>
</tr>
<tr>
<td></td>
<td>0400</td>
<td></td>
</tr>
<tr>
<td>C) CPU BOARD</td>
<td>03FF</td>
<td>1K</td>
</tr>
<tr>
<td>RAM</td>
<td>0000</td>
<td></td>
</tr>
</tbody>
</table>

Fig. 4 Minimum memory map for the Microtan.
**PARTS LIST**

**RESISTORS**

| R1, R2, R3 | C3 | 68p ceramic plate 2% or better, or silvered mica 1% |
| R4, R6    | C4 | 220p ceramic plate 2% or better, or silver mica 1% |
| R5        | C5 | 68p ceramic plate 2% or better, or silver mica 1% |
| R7, R8    | C6 | 120p ceramic plate 2% or better, or silver mica 1% |

**CAPACITORS**

| C1 | 100p ceramic plate 2% or better, or silver mica 1% |
| C2 | 150p ceramic plate 2% or better, or silver mica 1% |
| C3 | 1u tantalum |
| C4 | 10u tantalum |
| C5 | 120p ceramic plate 2% or better, or silver mica 1% |
| C6 | 68p ceramic plate 2% or better, or silver mica 1% |
| C7, C17 | 1u tantalum |
| C8-C16, C18 | 1u tantalum |

**SEMIConDUCTORS**

| IC1 | 74LS393 |
| IC2, IC11 | 74LS244 |
| IC3, IC10 | TM4164-15p |
| IC12, IC13 | 74LS157 |
| IC14 | 74LS245 |
| IC15 | TBP24510 |
| IC16 | 74LS608 |
| IC17 | 74LS32 |
| IC18 | 74LS00 |
| IC19 | 74LS01 |
| D1, D2, D3 | 1N4148 |

**MISCELLANEOUS**

- DIN 41612 64 way double-sided connector;
- DIL 2 pole on/off switch; DIL sockets: 3 off 20 pin, 12 off 16 pin, 3 off 14 pin; PCB.

**BUYLINES**

One or two not so easy to obtain items here. The TBP24S10 PROM and 74LS608 memory cycle controller chip were tracked down to Farnell Electronic Components Ltd, Canal Road, Leeds LS12 2TU. At £2.42 and £6.44 respectively plus 55p p&p plus VAT these shouldn't break the bank. The 1% metal film resistors are available from Rapid, Cricklewood, Watford and many others. The specified memories and other TIL devices are advertised by Midwich Computer Company Ltd. And, in case you hadn't guessed, the PCB will be available through our own service.
prior to any other components, as there are some beneath the DIL sockets; I advise checking the continuity of each one thoroughly, as mistakes are difficult to rectify later. The remainder of the soldered components can be assembled in almost any order, but I've found that it pays to be systematic and to follow a list, checking off each component as it is soldered in.

All the usual checks should be carried out before the ICs are inserted into their sockets. Particular attention should be given to avoiding solder bridges in the daisy chained RAM area of the board.

It is useful to insert the chips in three stages and perform some functional checks on the system at each stage. The first of these stages is to insert the PROM and all the TTL, with the exception of the 74LS608 (IC16) and the 74LS245 data bus buffer (IC14). Now powering up the board on the bus can be performed with all the Tanex RAM and EPROM still resident without the risk of any memory conflict occurring. This procedure will allow you to check the following items with the system running.

A dual beam oscilloscope is really desirable particularly if you have deviated from the timing component values for any reason. However it should be possible if you don't have access to a oscilloscope to use a good logic probe to check that all the appropriate signals are present.

The most relevant signals to check first are 01 and 02 and their complements 01, 02, RE and DBE should be active only when a valid address within your programmed memory map is accessed. Next check that the two address buffers, IC2 and IC11, are switching correctly

<table>
<thead>
<tr>
<th>SYSTEM ADDRESS</th>
<th>A15</th>
<th>A14</th>
<th>A13</th>
<th>A12</th>
<th>A11</th>
<th>A10</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 1 Revised system memory map.
Counter IC1 is functioning correctly as an exactly 180° out of phase with each other, and that the refresh address counter IC1 is functioning correctly as an eight-bit counter. The final check at this stage is to measure the pulse delay and shaper circuits formed by the diode/resistor networks and IC17. The three signals RAS cycle start (RCS), memory cycle start (MCS) and refresh (RFSH) should all correspond to the timing diagram in Figure 3. Any deviation should be adjusted by altering the value of the capacitor and/or resistor within the relevant RC network. However if the stated tolerances of the components are adhered to there should be no problems.

Having completed all the checks and adjustments so far the next stage is to insert the 74LS608 memory cycle controller, which should produce the necessary signals RAS, CAS, MUX and R/W. These four main signals should be checked against the timing diagrams in Figures 2 and 3. The important factors are the relationships between cycle start, CS, and RAS, CAS, MUX, CAS sequence and the RAS refresh cycle. The row address hold time RAH, CAS low and the precharge time are the major controlling times and are all programmable via the three RC networks on the 74LS608. Under standard conditions with the 750KHz Microtan system clock these times have quite a large latitude. However with faster clock rates the times become proportionally more critical. All these times can be calculated from the memory data sheets. One fault which may occur at this point has the symptoms RAS permanently low, CAS, MUX and R/W permanently high. If this situation exists try shorting very briefly pin 12 to ground. If the controller then starts to function correctly then the 74LS608 is at fault. I understand from Texas that on a number of the older batches of chips there is a fault with the power-on-reset circuit, newer batches, I am assured, are all O.K.

Having checked that all the relevant signals are present at the RAM chip sockets, the RAM chips themselves can now be inserted. Power down first. These are very static sensitive so take all the usual precautions, they are also upside down in relation to the other ICs on the board.

Be warned that if they are inserted with pin 1 to the upper edge of the board they will be irreversibly damaged, and at £4.00 each a mistake could be very expensive. Finally insert the data buffer IC13. With construction and testing completed there is still one task to finish before the board is inserted back into the rack and powered up. Remove all Tanex RAM and EPROM, and all other memory map conflicts, for example the hires graphics board, failure to do this will probably destroy ALL the memory components in the system.

After powering up the board in the now "minimised" system, unless you’ve chosen to create a memory map option which retains the Tanex EPROM your system will be running in Tanbug or TUG bug. The quickest way to check the RAM from here is to boot up Basic and XBUG from disc or ESC and let it do the check. 47103 BYTES FREE should appear as the message header. Note some difficulties may be experienced because the F7F7 error jump will not exist immediately. This will show up only if an error occurs during the boot up procedure e.g. miss keying; simply RESET and start again to recover.

Assuming this initial check appears to be OK then a more comprehensive memory test routine should be performed; the one published in the November 1981 issue of Computing. Today this is most suitable. However it should be noted that these types of test do not pick out the periodic bit drop out and only extensive usage in BASIC or similar will show up this problem.

Other Systems

The board relies only upon signals derived directly from the CPU O1, 02, R/W and the address and data buses. Since all these signals will be present in any 6502 based system, conversion is relatively simple. The only component that needs to be altered in anyway is the PROM which does all the decoding. The essential considerations are those concerning the design of the memory map and, in particular, possible address conflicts. Remember no two components, be they RAM or I/0 should have the same address! A suggestion for those with a Microtan but no discs or ESC is to leave the XBUG EPROM resident (F000-F7FF) and use the tape routines instead.

As so much detail has been given in the governor section, the "How It Works" is going to be fairly brief. During O1 high the main bus buffers IC11 and IC13 are disabled, removing the RAM from the system bus. The refresh row address counter IC1 is connected directly to the RAM ICs (IC5-10) via the enabled buffer IC2. The main cycle start of 01 is buffered by two OR gates and then, via the pulse generator network D1, C1, R1, IC17, it applies a pulse to the REFRESH ENABLE pin (14) of the memory cycle controller IC16. The same rising edge is delayed by D2, C2, R2, IC17, before reaching the CYCLE START pin 13 of IC16. This delay is necessary to satisfy the refresh hold time of the memory cycle controller, and must be maintained at 20ns minimum. The MCC then responds by pulsing RAS low for a period of time determined by the RC network at pin 12, the row address hold time. The rising edge of RAS is the end of the refresh cycle.

The memory cycle starts with the rising edge of 02 (falling edge of 01) at which point the address bus buffer is enabled directly by 02 and assuming the address is within the memory map, the PROM output O13 is already high. This output combined with 02 produces, via IC18 two signals DBE and RE.

DBE enables the data buffer IC13; RE delayed via O3, C1, R3, IC17 is fed to the CYCLE START input of IC16 the memory cycle controller. This last step causes the MCC to start the actual memory access cycle. The RAS output (pin 7) goes low then, after the programmed RAH time, the R/W line is allowed to pass through and the MUX output then goes low switching over the address multiplexers IC12 and IC14 to the column address. CAS then goes low for a period of time CAS L0. All three output RAS, CAS, MUX then go high. This point should coincide with the falling edge of 02 when the data from or to the RAM is latched by either the CPU or the memory depending on the status of the R/W line.

The next refresh cycle then occurs on the rising edge of 01 and so the system carries on until the power is removed.

Those who design their own PCBs should take care to heed the memory manufacturer’s recommendations on decoupling and PCB layout around those chips. Particular attention should be given to the ground and power supplies which effectively surround each chip; the arrangement of interlocking fingers on the typical breadboard is definitely out. Similarly the decoupling of the TTL chips should be considered because it is very easy to avoid too much power supply noise, a major culprit of periodic bit drop out.

Lastly, the 74LS608 MCC gets hot, but since the lead-frame is directly coupled with the substrate through the pins, a large area of copper around pin 8 should alleviate the problem and improve reliability. With regards to systems employing faster clock rates as long as the RAH, PRECHARGE CAS low times and the refresh hold time for the MCC are satisfied (calculating them from the manufacturer’s data sheets), no significant problems should occur.
FEEL HEALTHIER WITH ZEPHION
Bring fresh clean air into your home with the Zephion Air Ioniser.

Air free from smoke, dust and other pollutants of modern day living can bring to many the relief of breathing comfortably once again.

We are confident that you will be delighted with the Zephion Air Ioniser, but if you are not entirely satisfied a full money back guarantee is available if items are returned in good condition within 28 days.

BUILD IT YOURSELF!

NAME............................................
ADDRESS...........................................

ZEPHION KITS £24.50
Kits include all parts
ZEPHION AIR TOWERS
BUILT AND TESTED... £34.50

Money immediately refunded if items returned in good condition.

Prices include VAT & postage; allow 14 days for delivery.

WEB Logic Systems Ltd
15 High Street, Harpenden, Herts.
05827-62119

PROBLEMS WITH THAT PROJECT?

We will — * BUILD
* TEST
* REPAIR
All your Electronics Kits and projects.
Prices from only £5.00
* Call us now for a quote.

Happy Memories

Part type 1 off 25-99 100 up
4116 200ns 90 .90 .85 .79
4164 200ns For BBC comp 3.85 3.55 3.80
2114 200ns Low power 1.15 1.00 .90
2114 450ns Low power 95 .85 .80
4118 250ns 3.95 3.55 3.40
6156 150ns CMOS 3.35 3.00 2.85
2708 450ns 3.25 2.95 2.80
2716 450ns 5 volt 2.25 2.10 2.02
2716 450ns three rail 5.75 5.00 4.65
2732 450ns Intel type 3.35 3.00 2.85
2532 450ns Texas type 3.35 3.00 2.85
2764 250ns 4.55 4.05 3.90

Z80A·PIO £2.99 Z80A-PIO £2.99 Z80A-CTC £2.99
6522 PIA £3.70 3691 £2.75
88LS120 £2.20 7805 reg .50 7812 reg .50

Low profile IC sockets:
Pins 8 14 16 18 20 22 24 28 40
Pence 12 13 14 16 18 22 24 27 38

Soft-sectored floppy discs per 10 in plastic library case: 5 inch SSD £17.00 5 inch SSD £19.25 5 inch SSD £21.00
8 inch SSD £19.25 8 inch SSD £23.65 8 inch SSD £25.50

74LS series TTL, large stocks at low prices with DIY discounts starting at a mix of just 25 pieces. Write or 'phone for list.

Please add 50p post & packing to orders under £15 and VAT to total. Access & Visa welcome, 24 hr service on (054 422) 618.
Government & Educational orders welcome, £16 minimum.
Trade accounts operated, phone or write for details.

Happy Memories (ETI), Gladestry, Kington, Herefordshire. HR3 3NY. Tel: (054 422) 618 or 628
Switch Troubles

Dear Sir,

I have recently had an unfortunate incident with an EPROM programmer, in which two PIRs and a 7905 regulator were destroyed. The incident happened when throwing a switch (which swapped a certain supply line between 5V and 25V). The result was that the programmer went dead, along with the 5V power supply and the two PIR's. (The 25V supply was not affected as it was simply two car batteries in series.) The cause was simple, when the switch was half way across when switching over, it joined the 25V and the 5V supplies with the aforementioned results.

To be honest I now consider myself lucky that the 5V power supply was only supplying the programmer, if it supplied the rest of the computer as well then I have no doubts whatsoever that I would be left with a PCB of fried chips of the silicon sort of course.

To get to the point, I am now very wary about what switch I use for such purposes, and I would advise that others watch out for these type of switches, which should not really be sold.

Yours faithfully,
R. P. D. Mallett,
Sandwich, Kent

P.S: If you don't believe that a firm would make such a switch then try out the enclosed one. (You can keep it!)
P.P.S: Thanks for an excellent magazine!

This reader has demonstrated all too effectively that it's important to distinguish between make-before-break and break before-make types of switches! For instance, so far as we are aware, all toggle switches are make-before-make, and a large proportion (but not all) slider switches are make-before-break. In fact, it was a slider switch that was sent to us by the above correspondent.

Induction Loops

Dear Sir,

I was very impressed by the excellence of the article on 'Inductance Loops' by Vivian Capel in the February 1979 issue of Electronics Today. It is a very clear exposition of the way to design an induction loop for hearing-aid users and to decide on the amplifier and transformers required for most systems.

As manufacturers of every sort of audio transformer for more than 40 years we have been approached on many occasions to give advice on inductor installation, particularly in churches, where frequently there is a limited budget and the volunteer from the congregation who undertakes the work is generally non-technical. In future we propose to refer him to Mr Vivian Capel's article and to co-operate by supplying the most reasonably priced transformers for the project. These can be specially designed without additional cost to fit in with the usual PA system amplifier already installed or separate amplifier if desired. The transformer audio outputs we have encountered within the last year or so are mostly between 20 and 700 watts, although last year in a large theatre up north, we supplied four 700 watt transformers which were used presumably for the stall, circles and gallery areas.

Inductor loops are not new although in connection with deaf aids they have come into prominence of recent years. In about 1934 - nearly 50 years ago - the following pioneering experiments were carried out by the undersigned who was building a new house at the time. It was decided for the purpose of listening to radio to install a continuous twin wire cable behind the wainscoting around every room in the house with sockets provided so that a loudspeaker could be plugged in anywhere and this still exists. Whilst working on inductor devices for HM Services at that time, it occurred to me that by putting my twin wires in parallel and feeding the loops in the rooms from my amplifier with two LS5 valves for output, I was creating an audio magnetic field everywhere. I then took various annealed mumetal rods about 1/4" diameter and tried them on different search coils which were connected to my very sensitive S.G. Brown A type adjustable gap earphones normally used for my ham radio reception

(my call sign then, and now was G205). Incidentally these phones had conical diaphragms like miniature moving coil speakers which were operated by a candlewick feed.

I found that by wearing the phones connected to the search coil I could sit in any room without being connected by wires and listen to the radio programs. It did occur to me that by having loops upstairs and downstairs I had a Helmholtz coil system which tended to give excellent magnetic field distribution, particularly in the middle of the room. (We use much smaller Helmholtz coils nowadays to determine the screening effect of mumet I can by taking voltages picked up by a search coil in air and then enclosed in the can).

All my experiments were published by me in an article in the Wireless World in the mid 1930's. I remember suggesting that the pick up device in cinemas and theaters could be in the form of a mumetal walking stick or umbrella stick fitted with a search coil, and for the ladies (shades of Queen Victoria) - a mumetal handle with search coil on lorgnette spectacles.

I do not claim to be the originator of induction loops but my amateur pioneering experiments were certainly carried out and published more than 45 years ago.

Yours truly,
Dr G. A. V. Sowter,
Consultant to Sowter Transformers
PO Box 36, Ipswich IP1 2EG

Holophony

Dear E.T.I.

I was interested to read about Mr Zuccarelli and his Holophony in July ETI, and thought you might be interested to hear of my own experiments with the idea. About 15 years ago, having built a stereo tape recorder, I then got to wondering why two microphones did not give a very clear recording when two ears were obviously adequate for us. The obvious difference seemed to be the ears.

I then conducted experiments at the dead of night under the bedclothes (not having an anechoic chamber!), trying to decide in the dark where the tick of a pocket watch appeared to come from. I discovered that the various lobes on the outer ear give us a means of judging direction of sound. By pressing down and 'blanking off' different bits of the ear I discovered which bit did which - those at the
top tell us about sound above the head, and the bits at the back are to do with front-back direction, and so on.

I then modeled two Plasticine ears and fitted them to omni-directional mic inserts. Fitted to a paper-mache head (filled with cloth, to damp self resonance), the results were quite spectacular - especially using headphones.

I enlisted the help of a few school friends and found that the 'head' gave quite repeatable results. We found we had to put felt 'hair' on the back to aid front-back discrimination.

There seemed to be some variation in perceived results between different people - which seemed to be due to variations in the size of ear, and different hair lengths.

When I was at university, I excitedly announced my findings to my tutor - who was at one time an accomplished recording engineer - He Said: "Oh yes, they did all that research in the '30's at Bell Telephone Labs!" So there I rather left it - but I am sure the principle has possibilities, although there will always be greater or lesser variations between the dimensions of the head and ears used to record and the head and ears which receive the recording, and therefore some subjective variation of results. As to the idea being new - it seems that truly nothing is.

Yours sincerely
Richard Buswell
Buswell Machine Electronics
Skelmersdale

We're now convinced that there is something more to the holophonic technique than we thought when we published Vivian Capel's report. This is due to Dave Bradshaw having had the opportunity of visiting Hugo Zuccarelli and hearing holophonic sound at first hand, through loudspeakers as well as headphones. We're hoping to do a full report on this at some stage in the future, time and space permitting, but in the meanwhile ETI readers might like to try explaining the results of the following experiment, that you can do for yourselves. It takes two people, one of whom we'll call the experimenter, and the other is the subject.

The subject should shut his or her eyes, and firmly jam a finger in one ear, so that all sound is excluded (so far as possible). The experimenter should take a box of matches (or a ring of keys) and shake it, moving it around the subject's head. The subject should be asked to point in the direction from which the sound is coming. Most people with normal hearing (provided their ears aren't blocked up with wax!) should be able to point approximately in the direction of the sound, even when it is on the other side of the head from the open ear. To make the conditions more stringent, you could start shaking the matches from this side, so that there is no possibility of the brain having a reference sound with which to refer the (ear lobe modified) sound to.

If any of our readers have access to an anechoic chamber we'd be most interested in hearing of the results of doing the above experiment in it. We'd also like to hear of anyone who has access to a conventional dummy head recording (Sennheiser did have such a recording, but their UK office was unable to help us).

THE

VICTORY

ORGAN

* Exciting range of authentic voices
* Preset sounds Piano, Harpsichord, Hawaiian Guitar (with glide), Banjo (with repeat), Accordion
* 16 modern rhythms with superb sounds including handclap
* Full range of 'Easi-Play' features *Custom Programmed ROM
* Walking Bass on Lower Manual and Pedals
* Real wood veneer cabinet with American walnut finish
* The only organ with update facilities for synthesizer and "add-a-chord" unit
* Starter kit from £98.80 + VAT
* Full kit £280.54 + VAT Carriage extra on kits

Send for a demonstration tape today only £1.95 inclusive. Hear the difference yourself. Full details & specification on request LEIGHTON ELECTRONIC SERVICES

17 BRIDGE STREET, LEIGHTON BUZZARD, BEDFORDSHIRE LU7 7AH  TELEPHONE (0525) 382504
**FREE CAREER BOOKLET**

Train for success in Electronics Engineering, T.V. Servicing, Electrical Engineering—or running your own business!

ICS have helped thousands of ambitious people to move up into higher paid, more secure jobs in the fields of electronics, T.V., and engineering—now it can be your turn. Whether you are a newcomer to the field or already working in these industries, ICS can provide you with the specialised training so essential to success.

**Personal Tuition and 80 Years of Success**

The expert and personal guidance by fully qualified tutors, backed by the long ICS record of success, is the key to our outstanding performance in the technical field. You study, at your pace and time that suits you best and in your own home.

You study the subjects you enjoy, receive a formal Diploma, and you’re ready for that better job, better pay.

---

**TICK THE FREE BOOKLET YOU WANT AND POST TODAY**

**ELECTRONICS ENGINEERING**

**A Diploma Course, recognised by the Institute of Engineers & Technicians as meeting all academic standards for application as an Associate.**

**T.V. & AUDIO SERVICING**

**A Diploma Course, training you in all aspects of installing, maintaining and repairing T.V. and Audio equipment, domestic and industrial.**

---

**ELECTRICAL ENGINEERING**

A further Diploma Course recognised by the Institute of Engineers & Technicians, also covering business aspects of electrical contracting.

---

**RUNNING YOUR OWN BUSINESS**

If running your own electronics, T.V. servicing or electrical business appeals, then this Diploma Course trains you in the vital business knowledge and techniques you'll need.

---

**FOR HI-FI & ELECTRONICS ENTHUSIASTS**

**CONCEPT ELECTRONICS LTD**

- **51 Tollington Road, London N7 6PB**
- **Mail order only**

We are the specialists in electronic kits and rack mounting cabinets. A catalogue with complete range of products including pre-amp modules, power amp modules, pre and power amplifier modules, complete installation kits, power supplies, tubes, amplifiers (with cases), alarm clocks, audio amplifiers, CB amplifiers, test equipment, control modules, music generator, battery four presently light and high power rack mounting cabinets etc with references include pictures now available at the cost of 35p + 25p post.

### Professional Rack mounting cabinets

<table>
<thead>
<tr>
<th>Panel Size Rear Box</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>W H (inch) W H D</td>
<td>AL STEEL</td>
</tr>
<tr>
<td>19 x 5</td>
<td>374 3.54</td>
</tr>
<tr>
<td>19 x 4</td>
<td>373 2.54</td>
</tr>
<tr>
<td>19 x 3</td>
<td>372 2.08</td>
</tr>
<tr>
<td>19 x 2</td>
<td>371 1.98</td>
</tr>
<tr>
<td>19 x 1</td>
<td>370 1.88</td>
</tr>
<tr>
<td>19 x 5</td>
<td>373 2.54</td>
</tr>
<tr>
<td>19 x 4</td>
<td>372 2.08</td>
</tr>
<tr>
<td>19 x 3</td>
<td>371 1.98</td>
</tr>
<tr>
<td>19 x 2</td>
<td>370 1.88</td>
</tr>
<tr>
<td>19 x 1</td>
<td>369 1.78</td>
</tr>
<tr>
<td>15 x 2</td>
<td>368 1.68</td>
</tr>
<tr>
<td>15 x 1</td>
<td>367 1.58</td>
</tr>
<tr>
<td>15 x 2</td>
<td>368 1.68</td>
</tr>
<tr>
<td>15 x 1</td>
<td>367 1.58</td>
</tr>
<tr>
<td>1 x 2</td>
<td>366 1.48</td>
</tr>
<tr>
<td>1 x 1</td>
<td>365 1.38</td>
</tr>
<tr>
<td>1 x 2</td>
<td>366 1.48</td>
</tr>
<tr>
<td>1 x 1</td>
<td>365 1.38</td>
</tr>
</tbody>
</table>

### Sub Box

- **TA-700 60W power amplifier**
- **Specifications:**
  - Power output: 50W rms into 8 ohms
  - Frequency response: 5Hz - 100KHz
  - THD: Less than 0.01%
  - 1kHz

### Other items

- **540 VIDEO LENS**
- **2.5x extension**
- **White plastic**
- **£15 each P&P £2 ea.

---

**CONCEPT ELECTRONICS LTD**

- **118 Wykeham Road, Reading, Berks. RG8 1PL**
- **Callers welcome 9am-6.30pm Monday to Saturday inclusive**

---

**ICS**

- **Dept L625**
- **160 Stewarts Road**
- **London SW8 4UJ**
TOTAL ENERGY DISCHARGE ELECTRONIC IGNITION

IS YOUR CAR AS GOOD AS IT COULD BE?

- **Is it EASY TO START** in the cold and the damp? Total Energy Discharge will give the most powerful spark and maintain its 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? Total Energy Discharge gives a more powerful spark from idle to the engine's maximum even with battery deterioration.
- **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. Larger plug gaps can be used, 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: 3½ times the power of inductive systems, 3 times the power of capacitive systems, 3½ times the energy and 3½ times the duration of ordinary capacitive systems. These are the facts.

Performance at only 6 volts (max. supply 16 volts)
- **SPARK POWER** — 140V, **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, it's 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; CMOS IC's, runs on selection resistors to set the combination, in fact everything down to the last nut and washer plus easy to follow instructions.

FITS ALL 12 VOLT NEGATIVE EARTH VEHICLES. **SUPPLIED COMPLETE WITH ALL NECESSARY LEADS AND CONNECTORS PLUS TWO KEY PLUGS**

Don't Wait Until It's too Late - Fit one NOW!

---

PROTECT YOUR CAR WITH AN ELECTRONIZE ELECTRONIC ALARM

- **2000 COMBINATIONS** provided by an electronic key - a miniature jack plug containing components which must match each individual alarm system. (Not limited to a few hundred keys or a four bit code).
- **60 SECOND ALARM PERIOD** flashes headlights and sounds horn, then resets ready to operate again if needed.
- **10 SECOND ENTRY DELAY** allows owner to disarm the system, by inserting the key plug into a dashboard mounted socket, before the alarm sounds. (No holes in external bodywork, fiddly code systems or hidden switches). Re-closing the door will not cancel the alarm, before or after it sounds, the key plug must be used.
- **INSTANT ALARM OPERATION** triggered by accessories or bonnet/boot opening.
- **30 SECOND DELAY** when system is armed allows owner to lock doors etc.
- **DISABLES IGNITION SYSTEM** when alarm is armed.
- **IN KIT FORM** it provides a high level of protection at a really low cost. The kit includes everything needed, the case, fibreglass PCB, CMOS IC's, random selection resistors to set the combination, in fact everything down to the last nut and washer plus easy to follow instructions.

FITS ALL 12 VOLT NEGATIVE EARTH VEHICLES. **SUPPLIED COMPLETE WITH ALL NECESSARY LEADS AND CONNECTORS PLUS TWO KEY PLUGS**

---

**TOTAL ENERGY DISCHARGE** (6 or 12 volt negative earth)
- **Assembled ready to fit** £29.70
- **D.I.Y. parts kit** £15.99

**TWIN OUTPUT** for cars and motor cycles with dual ignition
- **Twin, Assembled ready to fit** £34.45
- **Twin, D.I.Y. parts kit** £24.55

**INDUCTIVE DISCHARGE** (12 volt only)
- **Assembled ready to fit** £12.75

Prices Include VAT. P+P £1-00 (UK)

**CAR ALARM**
- **Assembled ready to fit** £37.95
- **D.I.Y. parts kit** £24.95

I enclose cheque/postal order OR debit my Access/Visa card

Name

Address

Code

Dept E · Magnus Rd · Winnece · Tamworth · B77 5BY · tel 0827 281000
Looking for components! Hardware! Cases! Try your local listed stockist.

Avon
Annley Electro
190 Bedminster Down Road
Bedminster Down, Bristol
Tel: 0272 832622
Open Mon-Sat 9am - 6.30pm
Wed 9am-2pm

Bedfordshire
Broadway Electronics
1 The Broadway, Bedford,
Tel: 0234 2136311
Open: 6 days 9-6.30, 1/2 day Thur.
Lunch 1.30 - 2.30
Specialists in components
and Acorn computers.

Dorset
D.J. Electronics
64 Ensbury Park Road,
Bournemouth
Tel: (0202) 515073
Open Mon - Sat 9am - 6pm

Hertfordshire
Goddards Components
110 · Loridon Road, St. Albans.
Tel: St. Albans 64162
Open, Mon-Sat 9.30am-5.30pm
(1/2 day Thur)

Lancashire
Eteson Electronics
EE
158 Lower Green
Poulton-le-Fylde, Blackpool
Tel: (0253) 885107

Merseyside
Myca Electronics
2 Victoria Pl, Seacombe Ferry,
Wallasey, L44 6NR,
Tel: 051838 8847
Open Mon-Sat 10am-5.30pm
Mail Order price list 50p refundable

Progressive Radio
93 Dale Street. Tel 051 236 0982-47
Whitechapel Tel 0512363489
Lunch 1.30 - 2.30
TheElectronicSpecialists
Open: Tues-Sat 9.30-5.30

W. Midlands/Warcs
WAVE Bands
Coventry St Kidderminster
Components, computers, car radios, C.B.s,
Amateur Radio
and all electronic hobby equipment
Open: Mon-Sat 9-6, Sun 10-2
Tel: 0562 2179

Northamptonshire
E M O S
A new company selling electronic components
Mail order and walk round supermarket
Vast stocks and very competitive prices
High March, Daventry NN11 4HQ
Telephone 03272 5523 Telex 311245
Off A43 opposite John O’Gaunt

For your business to be included, call Electromart on 01-437-1002

Staffordshire
Electronics Supplies
105 High Street
Woolstaston
Newcastle
Tel: 0782 636904
Open Mon-Wed 9-6, Thurs 9-12 & 5-7,
Fri & Sat 9-9, Sun 11-2

South Wales
Steve’s Electronic Supply Co. Ltd.
45 Castle Arcade, Cardiff
TEL: 0222 41905
Open: Mon-Sat 9-5.30
For components to computers

Warwickshire
Horizon Electronics
Charlotte St, Rugby. Tel: Rugby 78138
Open 5 Days 10-6 (closed Wed)
Wide range of components and R.S. stockists
1983 Mail Order Catalogue 75p

Yorkshire
Ace Mailtronix Ltd.
3A Commercial Street
Batley. Tel: (0924) 441129
Open: Mon-Fri 9am-5.30pm, (Sat 1pm)
Retail and Wholesale

Please include my business details in the next available issue of Electronics Today International:

Business Name

Address

Tel No

Opening Hours

Retail □ Wholesale □ Mail Order □ (Please tick)

Contact: (For Office Use Only)
ETI PCB SERVICE

Up till now PCBs were always the hardest component to obtain for a project. Of course you could make your own, but why bother anymore! Now you can buy your board straight from the designers - us! As of this issue all (non-copyright) PCBs will be available automatically from the ETI PCB Service. Each board is produced from the same master used to build our prototypes, so you can be sure it’s accurate, and will be finished to the high standard you would expect from ETI. In addition to the PCBs for this month’s projects, we are making available some of the more popular designs from our recent past. See the list below for details. Please note that NO OTHER BOARDS ARE AVAILABLE. If it’s not listed, we don’t have it!

**ALWAYS QUOTE THE PCB CODE WHEN ORDERING PLEASE**

<table>
<thead>
<tr>
<th>PCB Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>E/8110</td>
<td>Guitar Effects Unit</td>
</tr>
<tr>
<td>E/8111</td>
<td>Voice Over Unit</td>
</tr>
<tr>
<td>E/8112</td>
<td>Car Alarm</td>
</tr>
<tr>
<td>E/8113</td>
<td>Phone Bell Shifter</td>
</tr>
<tr>
<td>E/8114</td>
<td>Alcometer (2 boards)</td>
</tr>
<tr>
<td>E/8115</td>
<td>Bodywork Checker</td>
</tr>
<tr>
<td>E/8116</td>
<td>Component Tester</td>
</tr>
<tr>
<td>E/8117</td>
<td>LED Tacho</td>
</tr>
<tr>
<td>E/8118</td>
<td>Sound Bender</td>
</tr>
<tr>
<td>E/8119</td>
<td>Spectrascalar</td>
</tr>
<tr>
<td>E/8210</td>
<td>4 Channel Timer</td>
</tr>
<tr>
<td>E/8211</td>
<td>2 Channel Timer (2 boards)</td>
</tr>
<tr>
<td>E/8212</td>
<td>Ripple Monitor</td>
</tr>
<tr>
<td>E/8213</td>
<td>Alarm (2 boards)</td>
</tr>
<tr>
<td>E/8214</td>
<td>Moving Magnet Stages</td>
</tr>
<tr>
<td>E/8215</td>
<td>Moving Coil Stage</td>
</tr>
<tr>
<td>E/8216</td>
<td>Capacitance Meter (2 Bd)</td>
</tr>
<tr>
<td>E/8217</td>
<td>Voltage Monitor</td>
</tr>
<tr>
<td>E/8218</td>
<td>DL Mkg</td>
</tr>
<tr>
<td>E/8219</td>
<td>Analogue PWM</td>
</tr>
<tr>
<td>E/8220</td>
<td>Slot Car Controller</td>
</tr>
<tr>
<td>E/8221</td>
<td>Ion Generator (3 Bd)</td>
</tr>
<tr>
<td>E/8222</td>
<td>MOSFET Amp Module</td>
</tr>
<tr>
<td>E/8223</td>
<td>Logic Look</td>
</tr>
<tr>
<td>E/8224</td>
<td>Digital PWM</td>
</tr>
<tr>
<td>E/8225</td>
<td>Optical Scape</td>
</tr>
<tr>
<td>E/8226</td>
<td>Oscilloscope (4 Bd)</td>
</tr>
<tr>
<td>E/8227</td>
<td>2 Channel Timer</td>
</tr>
<tr>
<td>E/8228</td>
<td>TV Bargraph Main</td>
</tr>
<tr>
<td>E/8229</td>
<td>TV Bargraph Channel</td>
</tr>
<tr>
<td>E/8230</td>
<td>Hotwire</td>
</tr>
<tr>
<td>E/8231</td>
<td>Bridge适板 (3 Bd)</td>
</tr>
<tr>
<td>E/8232</td>
<td>Kitchen Scales</td>
</tr>
<tr>
<td>E/8233</td>
<td>Sound Track</td>
</tr>
<tr>
<td>E/8234</td>
<td>Auto Volume Control</td>
</tr>
<tr>
<td>E/8235</td>
<td>Dual Logic Probe</td>
</tr>
<tr>
<td>E/8236</td>
<td>ELCB</td>
</tr>
<tr>
<td>E/8237</td>
<td>Servo Interface (2 Boards)</td>
</tr>
<tr>
<td>E/8311</td>
<td>Fuel Gauge</td>
</tr>
<tr>
<td>E/8312</td>
<td>ZX ADU</td>
</tr>
<tr>
<td>E/8313</td>
<td>Programmable PSU</td>
</tr>
<tr>
<td>E/8314</td>
<td>Sound Board</td>
</tr>
<tr>
<td>E/8315</td>
<td>Alarm Module</td>
</tr>
<tr>
<td>E/8316</td>
<td>3 ZX81 User Graphs</td>
</tr>
<tr>
<td>E/8317</td>
<td>Logic Probe</td>
</tr>
<tr>
<td>E/8318</td>
<td>Real Time Clock</td>
</tr>
<tr>
<td>E/8319</td>
<td>Thermometer (2 Boards)</td>
</tr>
<tr>
<td>E/8320</td>
<td>Stage Lighting Main</td>
</tr>
<tr>
<td>E/8321</td>
<td>Stage Lighting Display</td>
</tr>
<tr>
<td>E/8322</td>
<td>Compressor/Limiter</td>
</tr>
<tr>
<td>E/8323</td>
<td>Single PSU</td>
</tr>
<tr>
<td>E/8324</td>
<td>Dual PSU</td>
</tr>
<tr>
<td>E/8325</td>
<td>MDFL Amp</td>
</tr>
<tr>
<td>E/8326</td>
<td>Balanced Input Preamp</td>
</tr>
<tr>
<td>E/8327</td>
<td>Stage Lighting Autofade</td>
</tr>
<tr>
<td>E/8328</td>
<td>Stage Lighting Triac</td>
</tr>
<tr>
<td>E/8329</td>
<td>3 PseudoROM (3 Bds)</td>
</tr>
<tr>
<td>E/8330</td>
<td>Immersible Heater</td>
</tr>
<tr>
<td>E/8331</td>
<td>Atom Keypad</td>
</tr>
<tr>
<td>E/8332</td>
<td>Switched Mode PSU</td>
</tr>
<tr>
<td>E/8333</td>
<td>Atom Keypad</td>
</tr>
<tr>
<td>E/8334</td>
<td>Flash Sequencer</td>
</tr>
<tr>
<td>E/8335</td>
<td>Trigger Unit Main Board</td>
</tr>
<tr>
<td>E/8336</td>
<td>Trigger Unit Transmitter</td>
</tr>
<tr>
<td>E/8337</td>
<td>Switched Mode PSU</td>
</tr>
<tr>
<td>E/8338</td>
<td>Graphic Equaliser</td>
</tr>
<tr>
<td>E/8339</td>
<td>Servo Fail-Safe (four off)</td>
</tr>
<tr>
<td>E/8340</td>
<td>Universal EPROM prog.</td>
</tr>
<tr>
<td>E/8341</td>
<td>NiCd Charger/Regen</td>
</tr>
<tr>
<td>E/8342</td>
<td>Digger</td>
</tr>
<tr>
<td>E/8343</td>
<td>64K DRAM</td>
</tr>
</tbody>
</table>

**IMAGE CASH WITH ORDER – OFFICIAL ORDERS ARE NOT ACCEPTED**

Prices Quoted are valid until 1st November 1983

Signed: ____________________________
NAME: ____________________________
ADDRESS: _________________________

How to order: indicate the boards required by ticking the boxes and send this page, together with your payment, to: ETI PCB Service, Argus Specialist Publications Ltd, 145 Charing Cross Road, London WC 2H OEE. Make cheques payable to ETI PCB Service. Payment in sterling only please. Prices subject to change without notice.

Total for boards £______________
Add 45p p & p ________________0.45
Total enclosed £______________
MICROTAN 65;
64K DYNAMIC RAM BOARD
©1983 RJ Campbell + Argus Specialist Publications
WARNING REMOVE ALL TANEX RAM & EPROM
PCB FOIL PATTERNS

Sorry! Due to lack of space, foil patterns for Marvin’s interface boards and the NiCaddy will have to wait until next month.
**ALARMS A1**

FREE BOOKLET on BURGLAR ALARMS with LOWEST U.K. DIY PUBLISHED PRICES. PHONE OR WRITE FOR YOUR COPY.

051-523 8440
AD ELECTRONICS
217 WARRECK MOOR, AINTREE, LIVERPOOL L9 0HU

---

**ALARMS **

FREE BOOKLET on BURGLAR ALARMS with LOWEST U.K. DIY PUBLISHED PRICES. PHONE OR WRITE FOR YOUR COPY.

051-523 8440
AD ELECTRONICS
217 WARRECK MOOR, AINTREE, LIVERPOOL L9 0HU

---

**PARAPHYSICS JOURNAL**

(Russian translation): psychotronics, kirlanography, heliophonic music, telekinetics.


**MANUALS** for test and communications equipment. Send S.A.E. for list. P. Mack, 14 Court Eight, Hemingway Road, Witham, Essex CM2 8QW.

ETI 1973 TO DATE. Offers £40. Numerous other odd mags included. Phone 01-636 9499 (9.30 - 4.30).

---

**LABORATORY CONTENTS DISPOSAL**. Wide variety of test equipment. Suitable for industries, colleges, etc. Tel: 040-378 625.

---

**3 SUPERB POWERSLAVES**.

120 Watt case & sliders/£10.85. 100 Watt modules/£7.00. 60 + 60, cased 240 volt, 0.8mm, 1.0mm, 1.2mm £0.75 each. Ferric chloride (1/2lb) £250. (Original kit cost £300). Phone 0235-3560 after 6pm.

---

**CLEARANCE SALE** of panel meters. Over 1.000 in stock from 50p each. Send 30p for list. Rainbow Electronics, 7 Greenfield Road, Colwyn Bay, LL29 8EL. Tel: 0492-209.

---

**01-437 1002**

EXT 282

Send your requirements to: Julie Bates, ASP Ltd., 145 Charing Cross Road, London WC2H 0EY.
DIGITAL WATCH
REPLACEMENT parts, batteries, displays, backlights etc. Also reports publications, charts: S.a.e. for full list Fordors Conersdrive, Holmegreen Bucks. HP15 6SGD

PRINTED CURCUTS Make your own simply, cheaply and quickly! Golden Fotolac light-sensitive lacquer now greatly Improved and very much faster. Aerosol cans with full instructions, £2.50. Developer 35p. Ferric Chloride 60p. Clear acetate sheet for master 15p. Copper clad fibreglass board approx. 1mm thick £2.00 sq. ft. Post/Packing 75p. White House Electronics, Castle Drive, Praa Sands, Penzance, Cornwall.

BURGLAR Alarm Equipment. Please visit our 2,000 sq. ft. showrooms or write or phone for your free catalogue. C.W.A.S. Ltd., 5 Hewens Road, Uxbridge UB10. Tel: 01-848 7207.

RS232 CABLES and D-type connectors at competitive prices. 25-way D connector plate/wallbox for only £5.25. Write or phone for details. VEP Limited, 5 Hewens Road, Uxbridge UB10. Tel: 01-848 7207.

COMPUTERS

Cortex Computer with RS232 working fast and powerful. £310. Phone Mr Hill, Midhurst 3632 after 7pm.

For All ETI Classifieds Tel: 01-437 1002 ext282

EXCHANGE ANYTHING related to electronics, computers, music synthesizers, etc. For immaculate Yamaha TT500 Enduro Motorcycle worth £500. Tel: 07744 35788.

TURN YOUR SURPLUS transistors, IO's etc into cash. Contact Coles Harding & Co. 103 South Brink, Wisbech, Cambs. Tel: 0945 584188. Immediate settlement.

AMAZING ELECTRONICS PLANS. Lasers, super-powered cutting rifle, pistol, light show, ultrasonic force fields, pocket defence weaponry, giant tesla, satellite TV pyrotechnics, 150 more projects... Catalogue £1 (refundable) from Plancentre, Bromyard Road Industrial Estate, Ledbury HR8.

THE TIME WRONG?

MSP CLOCK is ALWAYS CORRECT - never gains or loses time. Ideal for projects, G.P.O. shops, radio shows, minutes and seconds, auto GMT/BST and leap year. Also parallel BCD input including WEEKDAY output for alarm etc. Receives Jupiter BOC atomic time signals, built-in transmitter. 1000Km range. £7.70. 80KHz Rugby Receiver, as in MSP Clock £24.20. Sine/Square Oscillator, 10KHz-200KHz, £21.80. Each turn-to-build kit includes all parts, printed circuits, case, instruction book, return postage etc. money back assurance, GET yours now.

CAMBRIDGE KITS 45 (TW) Old School Lane, Milton, Cambridge.

Get moving with these new developments in UK Robotics - advanced electrohydraulic designs for education, industry and now available to the home constructor.

Hebot II is a turtle-type robot which takes programming out of the two dimensional world of the Z81 into the real three dimensional world. Given a DC supply of 9-15V it can perform a bewildering number of moves under computer control - forwards, backwards, left and right - with each wheel independently controlled. It has blinking eyes, beeps with a choice of two tones and has a solenoid operated pen to chart its progress. Touch sensors coupled to its shell return data about its environment, to the computer for it to calculate evasive or exploratory action. Hebot II connects directly to an I/O port or alternatively with the universal interface board to the expansion bus of a Z81 or other computer.

Robotic experience is becoming as essential a subject as computing. Micrograsp provides the lowest cost means of acquiring that experience but despite its ultra low price the robot has considerable versatility. There are 5 axes each using a servo motor and there is feedback from each of the arm movements. Control is by any computer with an expansion bus - the Z81 being particularly suitable. Servoing is achieved with hardware on the interface board to keep the system based around a dedicated microprocessor. Movement sequences can be entered, stored and replayed by use of a hand held controller. Alternatively the systems can also be interfaced to an external computer via a standard RS 232C link.

Hebot II, £295.00

Genesis P102 Processor Box, Hand Held Controller and Cortex Computer, £395.00

Example prices and specifications

<table>
<thead>
<tr>
<th>Model</th>
<th>Base: 19.5&quot; x 11&quot; x 7.5&quot;</th>
<th>Lifting capacity, 2000gm</th>
<th>Arm lengths between axes, 14.0&quot;</th>
<th>Weight, 34Kg</th>
<th>4 axis model in kit form</th>
<th>5 axis model in kit form</th>
<th>5 axis model Ready Built</th>
</tr>
</thead>
<tbody>
<tr>
<td>Genesis S101</td>
<td>£635.50</td>
<td>£695.00</td>
<td>£892.00</td>
<td>£1525.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Genesis P101</td>
<td>£650.00</td>
<td>£695.00</td>
<td>£892.00</td>
<td>£1525.00</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

With prices starting below £1,000 the Genesis range of general purpose robots provide a first rate introduction to robotics for both education and industry. Each has a self-contained hydraulic power source which enables loads of several pounds to be smoothly handled. The system operated from a single phase 240 or 120V AC supply or a 12V DC supply. The machine can be supplied with up to 6 axes each of which is fully independent but capable of simultaneous operation. Position control is achieved by means of a closed-loop feedback system based around a dedicated microprocessor. Movement sequences can be entered, stored and replayed by use of a hand held controller. Alternatively the systems can also be interfaced to an external computer via a standard RS 232C link.

Example prices and specifications

<table>
<thead>
<tr>
<th>Model</th>
<th>Base: 19.5&quot; x 11&quot; x 7.5&quot;</th>
<th>Lifting capacity, 1500gm</th>
<th>Arm length, 6.6&quot;</th>
<th>Weight, 29Kg</th>
<th>4 axis model in kit form</th>
<th>5 axis model in kit form</th>
<th>5 axis model Ready Built</th>
</tr>
</thead>
<tbody>
<tr>
<td>Genesis S101</td>
<td>£635.50</td>
<td>£695.00</td>
<td>£742.00</td>
<td>£1355.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Genesis P101</td>
<td>£650.00</td>
<td>£695.00</td>
<td>£742.00</td>
<td>£1355.00</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

All prices exclusive of VAT.
MAKING ALL THE RIGHT CONNECTIONS
with a MAPLIN MODEM KIT

Exchange programs with friends, leave or read messages from the various Billboard services, talk to computer bureaux, or place orders and check stock levels on Maplin’s Cashtel service. A Maplin Modem will bring a whole new world to your computer and vastly increase its potential.

Now you can exchange data with any other computer using a 300 baud European standard (CCITT) modem and because the Maplin Modem uses this standard, you could talk to any one of tens of thousands of existing users.

Some computers need an interface and we have kits for the ZX81, VIC20/Commodore 64, Dragon and shortly Spectrum and Atari whilst the BBC needs only a short program which is listed in Project; Book 8. A Maplin Modem will add a new dimension to your hobby.

Order As LW99H (Modem Kit) excluding case. Price £39.95.

YK625 (Modem Case). Price £9.95

Full construction details in Projects Book 5.

NEW MAPLIN STORE OPENS IN MANCHESTER

Our new Manchester store offering the full range of Maplin’s electronic components, computers and software will be opening 16th August, 1983. Part of the new store will be a self-service area where you can browse around and choose the parts you want. Counter service will be available as well. Upstairs you will find our computer demonstration area with displays of hundreds and hundreds of different software packages for Atari, BBC, Commodore 64, Dragon, Sord MS, Spectrum and VIC20. You will find us at 8, Oxford Road, opposite the BBC, between Piccadilly and the University complex. We’re just a few steps from Manchester’s Oxford Road station and about five minutes walk from the city centre. There is excellent parking in the adjacent side roads and meters in the adjacent side roads and about five minutes drive from junction 10 on the M63 at the start of the M56. Call in and see us soon!

Maplin's Fantastic Projects


In Book 6 (XA06G) Speech Synthesiser for ZX81 & VIC20 : Module to Bridge two of our MOSFET amps to make a 350W Amp : ZX81 Sound on your TV : Scratch Filter : Damp Meter : Four Simple Projects.


*Projects for Book 8 were in an advanced state at the time of writing, but contents may change prior to publication (due 13th August 1983).

LEARN ROBOTICS

Over 390 pages packed with data and pictures and all completely revised and including over 1000 new items. On sale in all branches of W.H.Smith

Price £1.25. Or send £1.50 (including P&P) to our mail order address.

Order As HK20W (Robot Kit) Price £1,599.95.

1983 CATALOGUE

Great Projects From E&MM

Our new book “Best of E&MM Projects Vol. 1” brings together 21 fascinating and novel projects from E&MM’s first year. Projects include Harmony Generator, Guitar Tuner, Hexadrum, Synthom, Auto Swell, Partyline, Car Aerial Booster, MOSFET Amp and other musical, hi-fi and car projects.

Order As XH61R. Price £1.00.

LEARN ROBOTICS

with Hero 1: the new robot who sees, hears, speaks and detects movement. This remarkable microprocessor-controlled robot is the perfect robotics training system for industry, home and schools. Hero 1 can see, hear, speak, detect moving and stationary objects and determine their distance, pick up small objects, move in any direction and can learn from your instructions.

Order As HK20W (Robot Kit) Price £1,599.95.

Mail Order P.O. Box 3, Rayleigh, Essex SS6 8LR. Tel. Southend on Sea (0702) 552911

Shops at 159–161 King Street, Hammersmith, London W6. Tel 01-749 0526

284 London Road, Westcliff-on-Sea, Essex. Tel (0702) 554000

Lynton Square, Perry Barr, Birmingham Tel 021-356 7291

8 Oxford Road, Manchester Tel 061-236 0281 (Opens 16th Aug 1983)

All shops closed Mondays.

All prices include VAT & carriage. Please add 50p handling charge if total order value is under £5.