

PRACTICAL

AUGUST 1989 • £1.25

ELECTRONICS

SCIENCE & TECHNOLOGY

STEPPER MOTOR DRIVER

**STEP INTO ROBOTICS AND
MOTIVATE YOUR
MICRO WORLD**

HF RADIO

**LEARN THE
HOWS AND WHYS
WITH OUR
WAVE GUIDE**

HANDCLAPPER

**CHIP INTO OUR
AUTOMATIC CLAP TRAP**



WIN

**THE NEW SHARP
IQ ORGANISER**



**ENCRYPTION
HOW ATMS AND PINS
SECURE YOUR PLASTIC**

MICRONTA

MULTIMETERS FROM TANDY®



BENCHTOP DIGITAL LCD MULTIMETER £79⁹⁵

- Measures AC/DC Volts, Current And Resistance
- Manual Or Autoranging Facility

22-195

43-RANGE ANALOGUE MULTIMETER £29⁹⁵

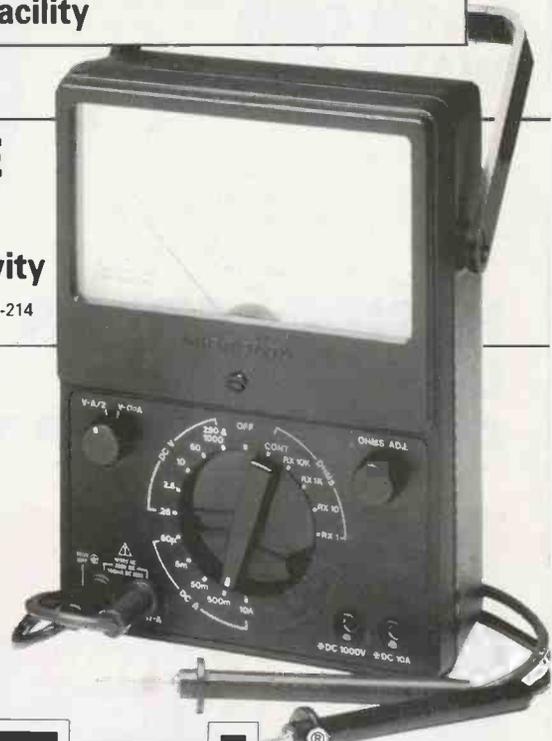
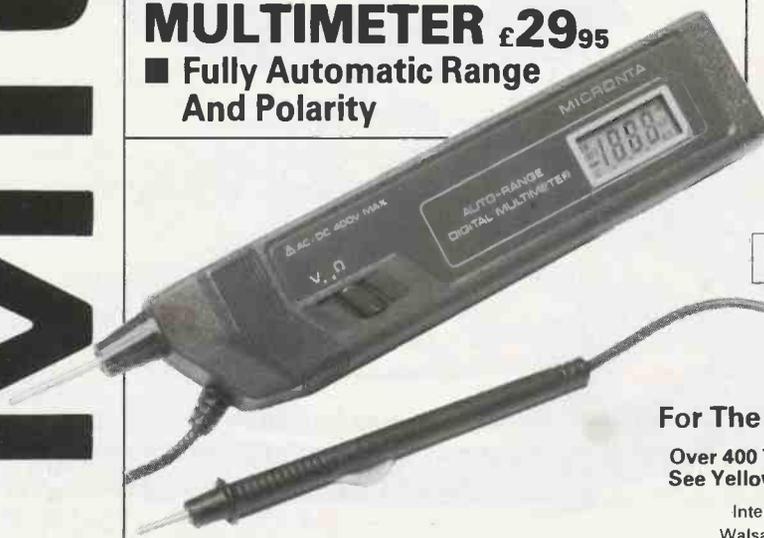
- 50,000 Ohms Per Volt DC Sensitivity
- Range Doubler Facility

22-214

PROBE-STYLE MULTIMETER £29⁹⁵

22-165

- Fully Automatic Range And Polarity



Tandy®

For The Best In High Quality Electronics

Over 400 Tandy Stores And Dealerships Nationwide. See Yellow Pages For Address Of Store Nearest You.

InterTAN U.K. Ltd., Tandy Centre, Leamore Lane, Walsall, West Midlands. WS2 7PS Tel: 0922 710000

PRACTICAL ELECTRONICS

VOL 25 NO 8

AUGUST 1989

CONTENTS

COMPETITIONS

- WIN THE NEW SHARP IQ ORGANISER!**61
Sharpen up your organisational intelligence with a Sharp IQ personal electronic organiser. Worth £170. Three to win - just pit your wits against the Editor's authoritative punning!
- TELEPOINT TELEPHONES - THE WINNERS**53
Did you ring the bell in our May 89 competition? With decorum Ed's quorum drew five for the Forum - we've lined up the answers, so don't ignore 'em!

CONSTRUCTIONAL PROJECTS

- STEPPING MOTOR DRIVER by Mark Stuart**12
Step into the world of robotics by adding motive power to your home micro using the new M5804 chip in a multimode motor module.
- HAND CLAPPER by Harvey Kent**26
With comparative ease you can automatically applaud us for putting rhythm in your chip board with this handy effects box.
- EASI-BUILD CIRCUIT by John Becker**49
Fancy exterminating the Doctor? Build a Vodalek voice box as this month's project and speak-easi like a robot.

SPECIAL FEATURES

- HF RADIO - PART ONE by Mike Sanders**19
Wave upon wave, layer upon layer, electromagnetic radiation randomly fills the universe - yet from chaos we seek order and communication, and achieve them! How? We examine the principles.
- BOATING REVOLUTION - CONCLUSION by John Becker** .35
Monitoring your craft's precise position is greatly simplified by the new generations of satellite-linked microterminals.
- ENCRYPTION - PART TWO by Mike Sanders**39
How the modes and standards of data encryption enhance electronic security for personal and corporate communications and finance.

REGULAR FEATURES

- EDITORIAL** by John Becker - Home automation update 9
- LEADING EDGE** by Barry Fox - Mac scrambling8
- SPACEWATCH** by Dr Patrick Moore - The New Technology Telescope 46
- INDUSTRY NOTEBOOK** by Tom Ivall - CIM and Society57
- READERS' LETTERS** - and a few answers30

PRODUCT FEATURES

- MARKETPLACE** - what's new, where and when4
- ARMCHAIR BOOKSHOP** - a haven for practical bookworms58
- PCB SERVICE** - professional PCBs for PE Projects60
- BAZAAR** - Readers' FREE advertising service52
- ADVERTISERS' INDEX** - locating favourite stockists62
- PE TAKES TECHNOLOGY FURTHER - BE PART OF IT!**



PAGE 61 ▲

PAGE 35 ▼



NEXT MONTH

Improve your workshop and enhance your experimenting with our triple function test gear project - combined lcd frequency counter with separate audio and digital logic signal generators. And add hi-tech security to your home with our sophisticated microprocessor controlled alarm system monitor. Owen Bishop will continue his discussion of practical theory in the Digital Electronics series, and ... well, you'll have to wait and see what other interesting features we've lined-up. They'll be worth waiting for, that's for sure! Start the count down now - it's not long till our next edition is hot off the press ...

★ DON'T MISS THE
SEPTEMBER 1989 ISSUE

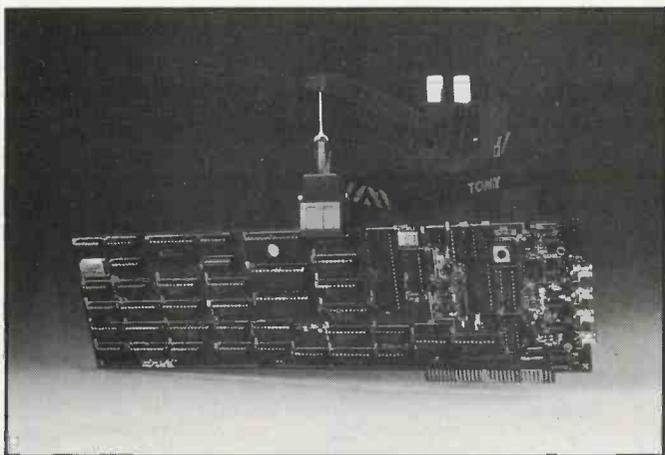
★ ON SALE FROM FRIDAY
AUGUST 4TH

★ AND STILL AT ONLY
£1.25

★ YOU CAN'T BEAT OUR
VALUE

★ OR OUR HI-TECH GOOD
LOOKS!

FRAME GRABBING



The imagewise/pc real-time Video digitiser/display board can digitise any NTSC, PAL or SECAM video source. It has a wide potential in industrial, security and desk top publishing applications.

The system can grab a single video frame and digitise it to a resolution of 256x255 with 256 grey levels. The board provides composite video output and digitised pictures can also be shown on an ega or vga monitor. A digitised picture, grabbed or software generated, can be applied as a caption or mask on a live video signal.

The board comes with a generous complement of free software, giving advanced image enhancement, overlay and split screen capabilities. Digitised images are compatible with paint and desktop publishing programs. Sophisticated ZIP software enables these images to be modified, enhanced, filed, displayed and printed.

For more information contact:
J.B. Designs & Technology Ltd, 15 Market Place, Cirencester, Glos, GL7 2PB. Tel: 0285 68122.



FUSED FOR SAFETY

As part of their current safety campaign, TMK Instruments have announced the availability of fused test prods. Designed and manufactured in the UK the new prods are compatible with most test and measuring equipment. Safe and reliable, they comply with the requirements of the Health and Safety Executive and the Electricity Council's Engineering Recommendation Standards.

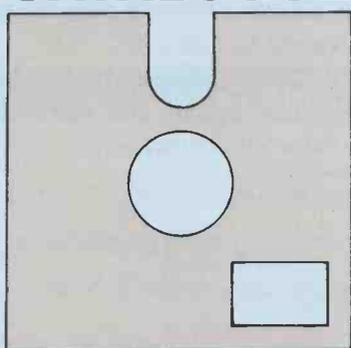
Manufactured using a tough, high impact nylon casing both the red and

black prods have moulded finger grips and guards for additional safety. Internal contacts, assemblies and tips use solid brass, phosphor bronze and silver plating. The 4mm banana plugs have safety shrouds with a smooth spring loaded action which helps when changing over to the moulded crocodile-clips. Easy multi-turn access to the fuse assembly allows simple replacement of the recommended 500mA fuse. Supplied as a pair in a plastic wallet, these fused probes offer the user a safer working environment.

The price of the fused test prods, in a wallet, is £24.95 excluding vat. (Croc-clips are available at an extra cost.)

For further information please contact Mike Dixon of TMK at Building 3, GEC Estate, East Lane, Wembley, Middx, HA9 7PJ. Tel: 01-908 3355.

CATALOGUE



DATABASE

We have recently received the following literature:

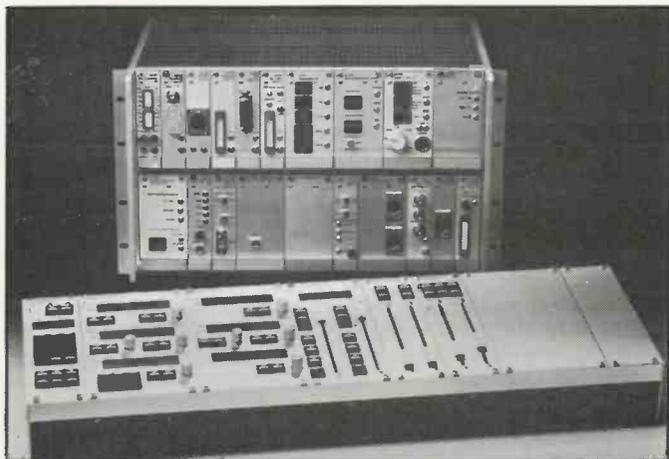
We've been inundated with catalogues from many of our advertisers - we start them here in alphabetical order, and shall continue next month.

Barrie Electronics specialise in transformers and allied products, with a range exceeding that shown in their usual advert.

They will also **wind transformers to your specification** if they don't already have one to suit you straight off the shelf. In addition, they have a good range of components available, including semiconductors, resistors, pots, capacitors and connectors. And don't overlook the **range of transmitting and receiving valves stocked**, nor the very wide selection of workshop tools. Boat owners will be especially interested to know of Barrie's Powerverter dc-ac marine inverters. **Barrie Electronics Ltd**, Unit 211, Stratford Workshops, Burford Road, London E15 2SP. 01-555 0228.

J and N Bull's catalogue has always been an **Aladdin's cave of fascinating products**. The range is too great to even cover briefly, but I'll highlight a few interesting items - acoustic chamber, battery operated laser, electronic spaceship, gardener's friend (time and temp module), 12V siren, ioniser for cars, golf trolley charger, and so it goes on Ask for your own copy of the **amazing offerings and bargains from J and N Bull Electrical**, 250 Portland Road, Hove, Sussex, BN3 5QT. 0273 734648.

On a personal note, I am sorry to learn that **Jessie Bull has decided to retire**. I've known for some time that he has been considering it, but he has announced in the newsletter he sent me that **he is actively looking for someone to take over the business**. For anyone with the right interest, and the willingness to make a capital investment, taking over the business should be a most rewarding opportunity. Jessie Bull has been in the surplus electronics business for around 43 years and during that time has made many friends in the trade. I hope that he readily finds one of those friends to take over from him. If anyone is interested, **give him a personal call** in the afternoons, preferably after 4pm, on **0273 734648**.



EQUAL HARMONY

The introduction of a Dynamics Processor module and remote panel to the Harmonia Mundi BW102 system, further extends its creative capabilities. This new addition offers the comprehensive digital audio processing functions of level (mixing) control, parametric equalisation, compression, limiting, expansion, noise gate and reverb functions.

With the new module, a wide range of attack/release times are possible. The release time can be set manually or automatically, with the automatic function permitting the choice of two different releases times, for fast peaks and mean level.

A unique feature of the BW102/34 dynamics processor is its pre-delay function. The pre-delay, again set manually or automatically, enables the processor to look into future time, anticipating level

changes, thus avoiding overshoots and distortion.

Automatic level compensation is also provided to make life easier during mastering and post production.

F.W.O. Bauch, who, you probably know, handle Revox products as well, have already delivered five tailor-made BW102 systems over the past few months to CBS Studios London, Fine Splice Limited, Battery Studios, Townhouse Studios and Audio FX Camden. All of the systems include processing with equalisation and all systems have been installed in mastering suites, while the unit held by Audio FX is available for hire purposes.

CONTACT: F.W.O. Bauch Limited, 49 Theobald Street, Boreham Wood, Hertfordshire, WD6 4RZ. Tel: 01-953 0091

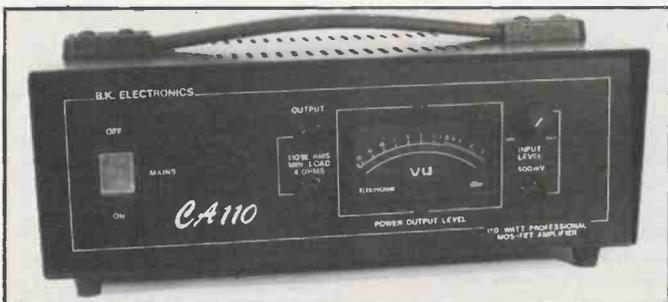
DEMANDING CASE

B.K. Electronics have at last succumbed to a real demand to case their OMP mono mos-fet chassis amplifiers, and have started by casing their MF100 and MF200 modules.

The new cased amplifiers will be known as the CA110 and CA210 slave amplifiers. All the advanced features of the mos-fet chassis amplifiers, including the toroidal transformer power supply, have been

retained. These features have been combined with a led vu meter and an input level control, and are housed in a purposely designed black anodised aluminium case.

Both amplifiers have an input sensitivity of 500mV for full power output. The CA110 provides 115 watts into 4 ohms and 105 watts into 8 ohms, whilst its larger brother boasts 215 watts into 4 ohms and 150 watts into 8 ohms (All power



EVENTS DIARY

If you are organising any event to do with electronics, big or small, drop us a line - we shall be glad to include it here.

Please note: Some events listed here may be trade or restricted category only. Also, we cannot guarantee information accuracy, so check details with the organisers before setting out.

Jul. 10-13 EWEC '89. European wind energy conference and exhibition. Scottish Conference and Exhibition Centre, Glasgow. No reference tel, known.

Jul. 24-26. Vacuum Microelectronics - 2nd International Conference. Bath. Contact Dr R.A. Lee, GEC Hirst Research Centre, Wembley, Middx, HA9 7PP. 01-908 9000.

Aug. 25-Sep 3. International Audio and Video Fair. Berlin. 01-408 0111.

Sep. 4-6. Eurobus 89 - UK Conference. Novotel Hotel, London. 01-940 4625.

Sep. 12-14. Optical Systems. Ramada Inn, London.

Sep. 12-15. EPOS 89. The World's largest exhibition of retail information systems. Alexandra Palace, London. RMDP. 0273 722687.

Sep. 26-28. British Laboratory Week 89. Incorporating Computer Aided Sciences. Olympia, London.

Oct. 16-20. Systems, Computers and Communications. 11th International Trade Fair and Congress. Munich Trade Fair Centre. 01-948 5166.

Oct. 24-26. Sensors and Systems - International Transducer Exhibition and Conference. Wembley Conference Centre. 0822 614671.

Nov. 7-11. Productronica. 8th International Trade Fair for Electronics Production. Munich Trade Fair Centre. 01-948 5166.

being watts rms). The power bandwidth (-3dB) is 1Hz-50kHz. Both models are realistically priced at £79.00 + £4.00 P&P for the CA110 at £99.00 + £5.00 P&P for the CA210, inc. vat.

The amplifiers are available direct from B.K. Electronics, Unit 5, Comet Way, Southend On Sea, Essex, SS2 6TR. Tel: 0702 527572.

simultaneously monitor up to 16 pins. Functioning as a logic monitor and ic test clip it is a convenient circuit troubleshooting tool. Its logic threshold is 1.5V +/-0.34V and voltage range is 3.5-1.5V Bandwidth is 1MHz and current load 11mA.

For further information contact: OK Industries UK Ltd, Barton Farm Industrial Estate, Chickenhall Lane, Eastleigh, Hants, SO5 5RR. Tel: 0703 619841.

SAFE CLIPPING

The new LC-160 logic clip from OK, said to be the first electrostatic discharge safe logic monitoring instrument, will





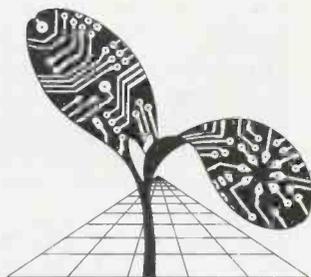
DEBORAH'S TRIBUTE

Deborah Gardner, aged 17, of Whickham Comprehensive School in Gateshead, is pictured with her YEDA trophy and her school's new Texas Instruments desktop publishing installation. She won them both for producing the most commercially viable project in the 1988 Young Electronic Designer Awards. Her project was an electronic time teaching aid for primary school children.

With less than a month to go the deadline for 1989 entries, Whickham's headmaster Bill Smith invited Texas Instruments' corporate communications manager, Richard Mann, to inaugurate the prize installation and address sixth-formers on the importance of electronics in everyday life and the exciting career prospects offered by the world of electronics. Most importantly however, the special assembly was called to enable the school to formally acknowledge Deborah's achievement in winning this major national prize.

Organised by the YEDA Trust, a registered charity, under the chairmanship of Professor John Eggleston and sponsored jointly by Cirkit Holdings PLC and Texas Instruments Ltd, the Young Electronic Designer Award scheme was recently acknowledged by the CBI's Director General, John Banham, for its impressive contribution in encouraging young people to combine technical skills creatively with an appreciation of the commercial demands of the marketplace.

For further information contact:
The YEDA Trust, 24 London Road,
Horsham, West Sussex, RH12 1AY.
Tel: (0403) 211048.



AVO MONITORING RAC

All of the RAC's nationwide team of roadside patrolmen are to be equipped with the latest AVO M2005 analogue/digital multimeters as part of the organisation's plans to combat the rising number of electrical breakdowns.

As many as 1150 patrolmen will be issued with the instrument as part of a two-year programme associated with recruit and refresher training.

The move comes as the level of



electrical faults approaches 70 per cent of all breakdowns on British roads – a trend reflecting the increasing sophistication of modern vehicle electrical/electronics systems.

One of the key requirements was that the instrument should be rugged and weatherproof. The meter includes built-in casing buffers to resist breakage and incorporates probe holders to allow genuine single-handed use – vital in roadside applications.

The combination of a high resolution, dynamic pointer and digital displays provided the RAC with an unexpected bonus. The clear digital read-out in 10.5mm high numerals has enabled them to use the meter to interrogate the computer-based Electronic Control Units (ECU's) found on many modern cars. **CONTACT:** Kate Grenshaw, Megger Instruments Limited, Archcliffe Road, Dover, Kent, CR17 9EN. Tel: 0304 202620.

OPTICAL POLE VAULT

The equivalent of 25,000 simultaneous telephone conversations have been carried over a single optical fibre link in British Telecom's network, in a record-breaking demonstration of a technique which offers even bigger increases in capacity in the future.

The demonstration was carried out on a fibre in the optical submarine cable between the Cumbrian coast and the Isle of Man. The system, which came into service last summer, operated without regenerators over its entire 94km length.

British Telecom is the first to use optical wavelength division multiplexing over its operational network, by sending light at different "colours" or frequencies simultaneously along the same hair-thin optical fibre.

The microchip lasers, which produce the separate light outputs at slightly different wavelengths, were developed by British Telecom scientists at the company's research laboratories at Martlesham Heath, near Ipswich.

Dr Tom Rowbotham, Director Network Technology at the laboratories, explained: "The research team combined the outputs of these lasers to feed one of the fibres in the cable. The wavelength spacing of the four separate outputs was significantly closer – by an order of magnitude – than that achieved in earlier trials of wavelength division multiplexing.

"This is the first time that WDM has been used in the field using fully packaged and commercially available components. The demonstration was part of British Telecom International's assessment of the impact of new technologies on future submarine systems.

"It will enable such systems to be readily upgraded in the future at minimum cost to provide direct increases in capacity. And this benefit will apply with equal force to longer systems incorporating optical amplifiers, which are able to handle multiple transmissions without difficulty."

For those of you who have a craving for hi-tech facts and figures: The Isle of Man cable contains six pairs of fibre, each singlemode operating in the 1,550nm band, at which the end-to-end transmission loss is -27dB. Currently five pairs are in commercial service, each operating at a direct detection line rate of 140 Mbit/s, which gives a capacity of 1,920 telephony

channels per fibre pair.

In the experimental transmission, the laboratory staff used four distributed feedback lasers operating at 1,525, 1,536, 1,546 and 1,557nm respectively. One laser was moulded at 140 Mbit/s, the other three at 565 Mbit/s, all four outputs being multiplexed onto a single fibre using a combination of passive and wavelength-sensitive fibre couplers.

After transmission through the fibre the four signals were separated at the receive end using a commercially available, singlemode, fibre-tailed grating demultiplexer, each laser wavelength being temperature tuned to the centre of the grating pass band.

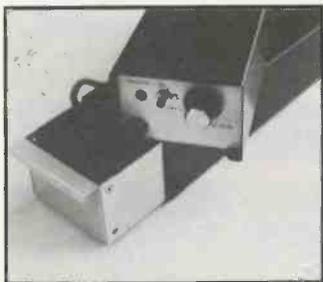
The operation of three channels at 565 Mbit/s and one at 140 Mbit/s increased the capacity of the system by 13 times, to 24,960 telephone channels. This was equivalent to operating the complete fibre system at 1.8 Gbit/s.

And just as a side-line story, BT offered engineering training to Scottish telephone operators when the Dumfries operator service switched to Ayr as part of a Modernisation programme. The picture shows five of the "Hallo-Girls" who followed up the call. They're now top of the pole in our headlines!



SAFETY AT WORK

With health and safety at work receiving greater attention than ever before, TMK Instruments have introduced a new portable appliance tester. Designed and manufactured in the UK, Model TEM 4600 can be used by non-technical personnel after brief training. Ideal for suppliers, hirers and users to check the electrical safety of appliances, tool, equipment and extension wiring for compliance with the Health & Safety at Work Act. Two fault simulators are supplied for carrying out regular self checks, one for earthed appliances, the other for double insulated class II devices. **CONTACT:** TMK Instruments, Building 3, GEC Ind. Estate, East Lane, Wembley, Middx, HA9 7PJ.



EPROM WIPEOUT

Two versions of J.P. Designs' new eprom eraser are available, with or without switch selectable timer. The basic construction is the same for both versions: an anodised aluminium unit, featuring a sliding drawer section with high density anti-static foam into which the eproms are placed for erasing. It is possible to erase upto 40 eproms at one time and when the drawer is closed it becomes almost light tight.

Erasing is performed by a lower power 6 watt lamp, which keeps the unit cool whilst emitting the correct light level to the eproms. Erasing takes between 20 and 30 mins. The unit is compact at 320 x 87 x 60mm and the tube is totally enclosed. All units are supplied with 1 metre mains cable and lamp fitting instructions. The timer version also features an led indicator and times of 10, 20 or 30 mins can be selected. For your safety the casing is earthed and carries a warning label.

These erasers are available at the low cost of £54.95 for the basic version and £64.95 for the timer version.

For further information contact: J.P. Designs, The Old School, Prickwillow, Ely, Cambridgeshire, CB7 4UN. Tel: 035 325/455.

PHAX-SWITCH

The latest product from The Switch Electronics stable is the BIT PHAXswitch which enables a phone and a fax to operate, problem-free, on a single telephone line. Thought to be ideal for small businesses or use at home, the unit is convenient, fully automatic and cost effective.

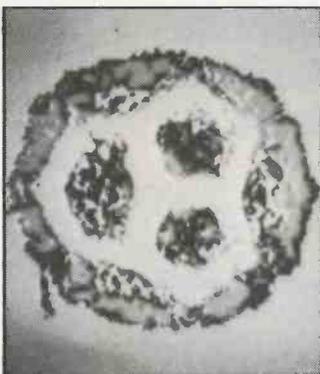
Convenient, because it can be installed in seconds by the user (no waiting for the telephone company to install a new line) and because it can be easily moved from one location to another. Taking work home at the weekend? Simply take your fax and PHAXswitch with you.

Automatic, because it is able to

identify whether an incoming call is from a fax machine wishing to transmit or a person wishing to speak – and directs the call accordingly. Calls from non-automatic fax machines are also accommodated – in most ingenious and simple manner. After two rings the caller is greeted with a friendly, digitised voice which says: "This is a BIT PHAXswitch answering your call. If you wish to send a fax, please say 'fax' after the tone. Otherwise, please wait until the phone is answered." A time delay of three seconds, for the caller to say 'fax', is utilised to determine which way the call should be directed.

The PHAXswitch can also be used in manual modes; for example, when a call from a friend is expected and the user does not wish him to be greeted with the recording message. Comments Steven Wickens of Switch Electronics: "This new device provides an invaluable automatic switch-over for fax machines and dramatically increases the scope of a single telephone line. It's no wonder that the BIT PHAXswitch walked away with the 1988 Best New Product award in its category at the prestigious Telecom Asia exhibition in Hong Kong."

For details of the further benefits of the PHAXswitch contact Switch Electronics, 241 Desborough Road, High Wycombe, Bucks, HP11 2QW. Tel: 0494 463532.



VISIOMATION

New company has been formed specifically to provide image processing modules and systems for education and others who wish to learn about machine vision.

Their first product is a complete image processing system based on the BBC microcomputer. Despite its low price of £365 it is complete (less the BBC, of course) with all the facilities of far more expensive system. Included are a camera, interface, comprehensive software and a very comprehensive instruction manual.

The system is based on one that has been developed over the last few years by Leicester Polytechnic, specifically for teaching image processing and machine vision to non-specialist students.

CHIP COUNT

This month we highlight the new TL030 and TL050 series of enhanced jfet-input opamps introduced by Texas Instruments. They are of immediate relevance to many PE readers since the chips are improved and direct replacements for the familiar TL060, TL070 and TL080 series.

TL030 AND TL050 OPAMPS

With the introduction of the first bifet family in the late 1970's, jfet-input opamps have become firmly established as low cost, high speed amplifiers.

In applications where dc precision, in addition to ac performance is required, a trade off generally exists between the two. Texas Instruments, with its advanced design and processing, believes it has solved the problems of dc precision in bifets with the release of the TL030 and TL050 series. The new bifets combine, and even improve on, the excellent slew rates of the first generation bifet devices with a step function improvement in dc precision.

Bifets employ junction field effect transistors in the differential input stage of what is in effect a bipolar opamp. The result is higher slew rates and lower input bias currents than bipolar opamps. System designs using jfet-input opamps generally rely on these two key parameters: high slew rates for good ac performance and low bias currents for high impedance interfacing.

Many applications require both good ac performance and steady state precision. Bipolar opamps can offer excellent dc precision in terms of input offset voltage (V_{io}) and gain, but at the expense of ac performance. Furthermore, jfet-input opamps with good dc precision have been especially difficult to produce as a result of shifts in V_{io} caused by package induced stress. Existing bifet technology opamps, when assembled in plastic such as the familiar dual-in-line package, typically exhibit a 300 microvolt shift in V_{io} , often moving V_{io} out of specification.

For this reason TI has, over the last few years, evaluated the possibility of a low offset bifet while retaining the characteristic ac performance. The result is the new TL030 and TL050 series. The new bifets are also more stable with time - in precision applications drift with time can cause significant problems and result in continual recalibration. The new designs have reduced the 300 μ V average shift down to 60 μ V.

Unity gain bandwidths remain unchanged, with between a 25% to 85% increase in slew rate for the TL050 series when compared with the TL070 series. The TL050 series are improved versions of the TL070 and TL080 series, and the TL030 series are improved versions of the low power TL060 series. They are all plug-in replacements.

For further information contact: Texas Instruments Ltd, Manton Lane, Bedford, MK41 7PA. Tel 0234 270111.

It is ideally suited for those people who wish to obtain a practical insight into machine vision for automated inspection, machine control, surveillance, etc, without a big investment in cash or time. The comprehensive instruction manual will lead even those with a superficial experience of microcomputers through the subject quickly and easily. No knowledge of programming is necessary. Despite its simplicity, it is capable of

achieving real results with practical machine vision problems.

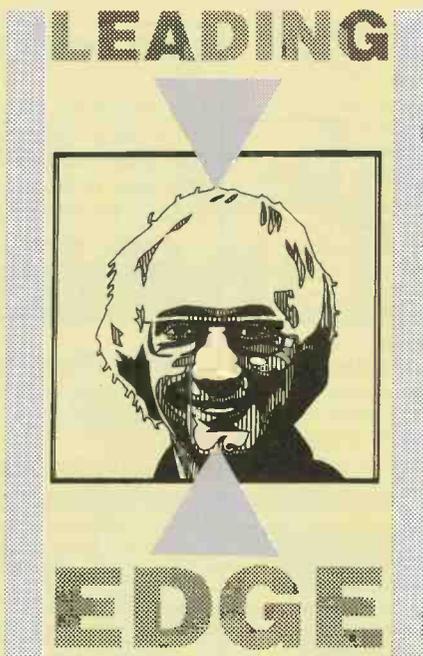
By the time this information goes to press. Visiomation expect to introduce a range of STE modules, starting with a 256 x 256 Framestore, and a video input and output module.

CONTACT: Visiomation Ltd, Unit 12, Lyons Farm Industrial Estate, Lyons Road, Slinfold, Horsham, W. Sussex, RH13 7QP. Tel: 0403 790988.

It does now look as if the firms trying to sell the idea of satellite to the British public may fail, with catastrophic cash losses all round. Much of the damage is self-inflicted. Instead of joining forces to try and educate the public on a very muddled field of new technology, rival factors have fought in public and created even more confusion.

This is the current state of play. When (if?) launched this autumn, BSB's satellite will hang at a completely different place in the sky from the Astra satellite which already carries Sky and W H Smith (31 degrees West for BSB, 19 degrees East for Astra). One aerial cannot pick up both signals, unless it is an expensive and difficult-to-install beast which moves under remote-controlled motor power. In most cases it will be easier and cheaper to have two aerials, or use one aerial and forget about the other service.

BSB will use a completely different transmission system from Sky, D-MAC instead of PAL. BSB will also use a different scram-



in the Act which make it a criminal offence for even two flats to share a dish without becoming a licensed cable station.

DUTCH COURAGE

When Philips signed with BSB, in February, to become the fourth supplier of set-top D-MAC receivers, the Dutch company was put in a very difficult position. The position got even worse when, less than a month later, Philips signed to supply descrambling equipment for Sky too.

The decisions were pragmatic and commercially sound. Unfortunately they were covered in face-saving fudge which only adds to the general confusion.

The original MAC system (C-MAC) and the British variant to be used by BSB (D-MAC) will not work on the Continent, because the eight channel digital sound signal has too broad a bandwidth to be distributed by their extensive cable systems.

MAC SCRAMBLING

bling more accurate, encryption system from Sky, Eurocypher instead of Videocrypt (previously called Palcrypt). Eurocypher was developed by General Instruments, in the USA, from the Videocrypt system which is the defacto standard in North America.

EUROCRYPT

W H Smith still threatens to switch from PAL to D-MAC and adopt yet another scrambling system, called Eurocrypt.

This had prevented the owners of the Astra satellite from launching a generic advertising campaign for all programmes available from the same source.

BSB will only supply its descrambling equipment to four selected suppliers of BSB receivers - Ferguson, Philips, Tatung and Salora. So Sky receivers made by other firms cannot be modified to receive BSB. This is why the Evening Standard cancelled its competition with supposedly "future-proof" Grundig receivers as prizes.

So, the total kit needed to receive all programmes promised for the end of this year becomes an absurd two aerials and four set-top boxes costing up to £1000 to buy and install, and gobbling subscriptions at the rate of around £30 a month. Because there is no agreed electrical interface standard between dishes and receivers, it is impractical to mix and match.

Compare that with the price of a BBC tv licence (£66) and the simplicity of a conventional tv aerial and video recorder.

A full eight months after BSB scored extensive publicity by unveiling its squarial flat dish aerial (without actually explaining that it was only unveiling a wood and plastic

BY BARRY FOX
Winner of the
UK Technology Press Award

Satellite TV - will it end up in the crypt, or just turn out to be a cypher?

dummy) the company had still not demonstrated a working prototype to the trade and press or placed manufacturing contracts.

BSB still pledges a full receiver kit for £250. In Japan, where there is already a DBS service, flat plate aerials cost more than that on their own.

FIXING LIMITS

Whatever the shape of the aerial, diy dish fixing is to be recommended only to electronics hobbyist. Even then it is downright dangerous to learn by trial and error how to connect, align and then secure an aerial on a high ladder or sloping roof.

Although the government has ditched its scheme for a £10 dish licence, because it cost more than £10 to process each piece of paper, the Department of the Environment's planning regulations set a limit of one dish (of less than 90cm) per building. The Home Office's Cable and Broadcasting Act, 1984 flies in the face of this. The Cable Authority is duty-bound to enforce clauses

This is why Philips has so far backed D2-MAC, which was half the number of sound channels and half the bandwidth.

Two years ago Philips and Thomson (with software company Logica) formed the Euromac consortium to develop a scrambling and encryption system for MAC. In 1988 it crystallised into Eurocrypt. The decoder is controlled by a smart card (credit card with built-in computer). This is the system W H Smith plans to use with D-MAC.

Fearing delays in availability of the vital chips, BSB signed with ITT Intermetall to produce D-MAC chips and with General Instruments in America to provide Eurocypher encryption modules.

But Philips cannot bear to admit the hard truth - that it has had to turn against both D2-MAC and Eurocrypt, and use D-MAC and Eurocypher instead. With unbounded optimism Philips satellite boss Peter Groenenboom has told the UK Government what it should do; adopt a common MAC standard and a common scrambling system by January 1st 1991.

This is technical nonsense, as well as astonishing cheek.

The Eurocrypt and Eurocypher systems are quite different. Whereas Eurocrypt needs a smart card reader in the receiver, Eurocypher sends all the necessary decoding and subscription validation signals over the air. And there is no compatibility between dedicated D and D2-MAC systems.

Now Philips has signed with Sky to produce the PAL Videocrypt decoders which will be needed to receive scrambled movies.

Quite simply everyone in the satellite game is betting on all competing systems - which could simply ensure that none of them win.

PE

PRACTICAL ELECTRONICS



EDITORIAL

On the April and May issues I reported on the Home Automation conference held in London during December 1988. Since then, the organisers, RMDP Ltd and the National Economic Development Office, have continued their research into consumer reaction to the concept of home automation. Their 130-page updating report released at the end of May makes interesting reading.

To summarise briefly, the most important issues raised by consumers relate to reliability, control, Big Brother, familiarity, isolation and loss. The first of these, reliability, is a principle concern among those questioned, and is a factor to which manufacturers must pay considerable attention. Although it is apparent that consumers expect change and do not resist it, their reservations about home automation are based upon their experience of unreliability in computers and other complex machines at work.

The research shows that consumers expect to be given much better control over domestic equipment, and that automated systems must be designed to be flexible. It is particularly important that any appliances forming part of a complex system must be able to operate on their own even if there is fault elsewhere in the system. (I wholeheartedly endorse that since at the time of writing there is a peculiar electrical system problem in my own home which I have not yet resolved!) The report summarises that "it is extremely important to consumers that

they continue to be in charge of what goes on in their homes".

The Big Brother concept is of concern to me, and is obviously of concern to many others, particularly those who are better informed about computer-based systems. The fear is that home automation will permit invasion of privacy. Consequently, the report concludes that collation of and dealing in information derived from home-based transactions may need strict regulation to forestall consumer resentment and fear. I for one am unclear as to how the Data Protection Act currently applies to telebanking, teleshopping etc.

Fear of the unknown is a common human condition, and is a factor to be addressed regarding

home automation products and services. If these can be presented in such a way that they can be perceived as an extension of something with which consumers are already familiar, they are more likely to be accepted. The same is true if they provide a solution to an already recognised problem. The report rightly concludes that perception that an item falls into one of these categories can have a major effect on its evaluation. In this context, familiarity is likely to breed contentment, not contempt.

Another issue highlighted is that home automation arouses concern among many consumers about a deterioration in the quality of their lives. The reason given is that passivity, isolation, de-skilling and atrophy of mental and imaginative functions are all to some degree feared. This, to me, is indeed an unexpected finding. One of the primary motives for introducing automation to the home is surely to enhance one's life style. That has usually been the case presented for many domestic devices, and it seems reasonable to extend that case to include the newer concepts emerging under the general title of home automation.

Although I cannot overlook the profit motive driving manufacturers concerned with this infant technology, I am convinced that there will be true benefit to society in general arising from widespread implementation of home automation.

THE EDITOR

Editor:

John Becker

Sub-Editor:

Helen Armstrong

Technical Illustrator:

Derek Gooding

Advertisement Sales:

Sarah Holtham

Business Manager:

Mary-Ann Hubers

Circulation:

David Hewett

Publisher:

Angelo Zgorelec

Editorial and Advertising Address:

Practical Electronics,
Intra House, 193 Uxbridge Road,
London W12 9RA
Tel: 01-743 8888
Telecom Gold: 87: SQQ567
Fax: 01-743 3062

Advertisements

All correspondence relating to advertise-



ments, including classified ads, should be addressed to: **The advertisement department, Practical Electronics, at the above address and telephone number.**

Readers' Enquiries

All editorial correspondence should be addressed to the editor and any letters requiring a reply should be accompanied by a stamped addressed envelope, or equivalent payment.

We regret that lengthy technical enquiries cannot be answered over the phone.

Subscription Address:

Practical Electronics, Subscription Dept.,
P.O. Box 500, Leicester LE99 0AA.

Annual Subscription Rates:

U.K. £15.00 Overseas £18.00

Cover Illustration

Mark Taylor

© Intra Press 1989. Copyright in all drawings, photographs and articles published in PRACTICAL ELECTRONICS is fully protected, and reproduction or imitations in whole or in part are expressly forbidden. All reasonable precautions are taken by PRACTICAL ELECTRONICS to ensure that the advice and data given to readers is reliable. We cannot, however, guarantee it, and we cannot accept legal responsibility for it. Prices quoted are those current as we go to press. All material is accepted for publication on the express understanding that the contributor has the authority to permit us to do so. **ISSN 0032-6372**

Published on 1st Friday of each month by Intrapress, 193 Uxbridge Road, London W12 9RA. Typesetting, artwork and film by Gilfillan Ltd. Mitcham, Surrey and printed in England by McCorquodale Magazines Ltd. Andover, Hants. Distributed by Seymour Press 01-679 1899. PRACTICAL ELECTRONICS is sold subject to the following conditions, namely that it shall not, without the written consent of the Publishers first having been given, be lent, resold, hired out or otherwise disposed of by way of Trade at more than the recommended selling price shown on the cover, and that it shall not be lent, resold, hired out or otherwise disposed of in a mutilated condition or in any unauthorised cover by way of Trade or affixed to or as part of any publication or advertising, literary or pictorial matter whatsoever.

BBC Computer & Econet Referral Centre

AMB15 BBC MASTER £346 (a)		AMB12 BBC MASTER Econet £315 (a)	
AMC06 Turbo (65C - 02) Expansion Module £99 (b)			
ADC08 512 Processor	£195 (b)	ADJ24 Advanced Ref Manual	£19.50 (c)
ADF14 Rom Cartridge	£13 (b)	ADF10 Econet Module	£41 (c)
ADJ22 Ref Manual Part 1	£14 (c)	ADJ23 Ref Manual Part II	£14 (c)
		BBC Master Dust Cover	£4.75 (d)

BBC MASTER COMPACT
A free packet of ten 3.5" DS discs with each Compact
SYSTEM 1 128K Single 640K Drive and bundled software £385 (a)
SYSTEM 2 System 1 with a 12" Hi Res RGB Monitor £469 (a)
SYSTEM 3 System 1 with a 14" Med Res RGB Monitor £599 (a)
Second Drive Kit £99 (c) Extension Cable for ext 5.25" drive £12.50 (d)
View 3.0 User Guide £10 (d) Viewsheet User Guide £10 (d)
BBC Dust Cover £4.50 (d) 1770 DFS Upgrade for Model B £43.50 (d)
ADFS ROM (for B with 1770 DFS & B Plus) £26 (d) 1.2 OS ROM £15 (d)
ACORN Z80 2nd Processors £329 (a) ACORN 6502 2nd Processor £173 (b)
MULTIFORM Z80 2nd Processor £289 (b) ACORN IEEE Interface £269 (a)
TORCH Z80 2nd Processor ZEP 100 £229 (a)
TZDP 200 ZEP 100 with Technomatic PD800P dual drive with built-in monitor stand. £439 (a)

META Version III - The only package available in the micro market that will assemble 27 different processors at the price offered. Supplied on two 16K roms and two discs and fully compatible with all BBC models. Please phone for comprehensive leaflet £145 (b).

We stock the full range of ACORN hardware and firmware and a very wide range of other peripherals for the BBC. For detailed specifications and pricing please send for our leaflet.

PRINTERS & PLOTTERS

EPSON LX86	£189 (a)	STAR NL10 (Parallel Interface)	£209 (a)
Optional Tractor Feed LX80/86	£20 (c)	STAR NL10 (Serial Interface)	£279 (a)
Sheet Feeder LX80/86	£49 (c)	STAR Power Type	£229 (a)
FX800	£319 (a)	BROTHER HR20	£329 (a)
FX1000	£449 (a)	COLOUR PRINTERS	
EX800	£409 (a)	Dotprint Plus NLQ Rom for Epson versions for FX, RX, MX and GLP (BBC only)	£28 (d)
LQ800 (80 col)	£439 (a)	PLOTTERS	
LQ1000	£589 (a)	Hitachi 672	£459 (a)
		Graphics Workstation (A3 Plotter)	£599 (a)
		Plotmate A4SM	£450 (a)
TAXAN			
KP815 (160 cps)	£249 (a)		
KP915 (180 cps)	£369 (a)		
JUKI			
6100 (Daisy Wheel)	£259 (a)		
NATIONAL PANASONIC			
KX P1080 (80 col)	£149 (a)		

PRINTER ACCESSORIES

We hold a wide range of printer attachments (sheet feeders, tractor feeds etc) in stock. Serial, parallel, IEEE and other interfaces also available. Ribbons available for all above plotters. Pens with a variety of tips and colours also available. Please phone for details and prices.

Plain Fanfold Paper with extra fine perforation (Clean Edge):
2000 sheets 9.5" x 11" £13(b) 2000 sheets 14.5" x 11" £18.50(b)
Labels per 1000s: Single Row 3" x 1 7/16" £5.25(d) Triple Row 2-7/16" x 1 7/16" £5.00(d)

MODEMS

All modems carry a full BT approval

MIRACLE TECHNOLOGY WS Range

WS4000 V21/23 (Hayes Compatible, Intelligent, Auto Dial/Auto Answer)	£149 (b)
WS3000 V21/23 Professional As WS4000 and with BELL standards and battery back up for memory	£245 (b)
WS3000 V22 Professional As WS3000 V21/23 but with 1200 baud full duplex	£450 (a)
WS3000 V22 bis Professional As V22 and 2400 baud full duplex	£595 (a)
WS3022 V22 Professional As WS3000 but with only 1200/1200	£350 (a)
WS3024 V22 Professional As WS3000 but with only 2400/2400	£450 (b)
WS2000 V21/V23 Manual Modem	£95 (b)
DATA Cable for WS series/PC or XT	£10 (d)
DATATALK Comms Package * If purchased with any of the above modems *	£70 (c)
PACE Nightingale Modem V21/V23 Manual (Offer limited to current stocks)	£75 (b)

SOFTY II

This low cost intelligent eprom programmer can program 2716, 2516, 2532, 2732, and with an adaptor, 2564 and 2764. Displays 512 byte page on TV - has a serial and parallel I/O routines. Can be used as an emulator, cassette interface. Softy II £195.00 (b) Adaptor for 2764/2564 £25.00

PLEASE TELEPHONE FOR CURRENT PRICES

RT256 3 PORT SWITCHOVER SERIAL INTERFACE 3 input/1 output or 1 input/3 output manual channel selection. Input/output baud rates, independently selectable 7 bit/8 bit, odd/even/none parity. Hardware or software handshake. 256K buffer, mains powered.	£375 (b)
--	----------

PB BUFFER Internal buffer for most Epson printers. Easy to install. Inst. supplied.	£99 (c)
---	---------

I.D. CONNECTORS

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

D CONNECTORS

No of Ways				
	9	15	25	37
MALE:				
Ang Pins	120	180	230	350
Solder	60	85	125	170
IDC	175	275	325	-
FEMALE:				
St Pin	100	140	210	380
Ang Pins	160	210	275	440
Solder	90	130	195	290
IDC	195	325	375	-
St Hood	90	95	100	120
Screw	130	150	175	-
Lock*				

TEXT TOOL ZIF	
SOCKETS	24-pin £7.50
28-pin	£9.10
	40-pin £12.10

DISC DRIVES

5.25" Single Drives 40/50 switchable:	
TS400 400K/640K	£114 (b)
PS400 400K/640K with integral mains power supply	£129 (b)
5.25" Dual Drives 40/80 switchable:	
TD800 800K/1280K	£199 (a)
PD800 800K/1280K with integral mains power supply	£229 (a)
PD800P 800K/1280K with integral mains power supply and monitor stand	£249 (a)
3.5" 80T DS Drives:	
TS351 Single 400K/640K	£99 (b)
PS351 Single 400K/640K with integral mains power supply	£119 (b)
TD352 Dual 800K/1280K	£170 (b)
PD352 Dual 800K/1280K with integral mains power supply	£187 (b)
PD853 Combo Dual 5.25"/3.5" drive with p.s.u	£229 (a)

3M FLOPPY DISCS

Industry Standard floppy discs with a lifetime guarantee. Discs in packs of 10

5 1/4" Discs		3 1/2" Discs	
40 T SS DD	£10.00 (d)	40 T DS DD	£12.00 (d)
80 T SS DD	£14.50 (d)	80 T DS DD	£15.50 (d)
		80 T SS DD	£20.00 (d)
		80 T DS DD	£25.00 (d)

FLOPPICLENE DRIVEHEAD CLEANING KIT

FLOPPICLENE Disc Head Cleaning Kit with 28 disposable cleaning discs ensures continued optimum performance of the drives. 5 1/4" £12.50 (d) 3 1/2" £14.00 (d)

DRIVE ACCESSORIES

Single Disc Cable £6 (d)	Dual Disc Cable £8.50 (d)
10 Disc Library Case £1.80 (d)	30 x 5 1/2" Disc Storage Box £6 (c)
50 x 5 1/2" Disc Lockable Box £9.00 (c)	100 x 5 1/2" Disc Lockable Box £13 (c)

MONITORS

RGB 14"		MONOCHROME	
1431 Std Res	£179 (a)	TAXAN 12" HI-RES	
1451 Med Res	£225 (a)	KX1201G green screen	£90 (a)
1441 Hi Res	£365 (a)	KX1203A amber screen	£95 (a)
MICROVITEC 14" RGB/PAL/Audio		PHILIPS 12" HI-RES	
1431AP Std Res	£199 (a)	BM7502 green screen	£75 (a)
1451AP Std Res	£259 (a)	BM7522 amber screen	£79 (a)
All above monitors available in plastic or metal case.		8501 RGB Std Res	£139 (a)
TAXAN SUPERVISION II		ACCESSORIES	
12" - Hi Res with amber/green options.		Microvitec Swivel Base	£20 (c)
IBM compatible	£279 (a)	Taxan Mono Swivel Base with clock	£22 (c)
Taxan Supervision III	£319 (a)	Philips Swivel Base	£14 (c)
MITSUBISHI		BBC RGB Cable	£5 (d)
XC1404 14" Med Res RGB, IBM & BBC compatible	£219 (a)	Microvitec	£3.50 (d)
		Taxan £5 (d)	Monochrome £3.50 (d)
		Touchtec - 501	£239 (b)

OVERASERS

UV1T Eraser with built-in timer and mains indicator. Built-in safety interlock to avoid accidental exposure to the harmful UV rays. It can handle up to 5 erasures at a time with an average erasing time of about 20 mins. £59 + £2 p&p. UV1 as above but without the timer. £47 + £2 p&p. For Industrial Users, we offer UV140 & UV141 erasers with handling capacity of 14 erasures. UV141 has a built-in timer. Both offer full built-in safety features. UV140 £69, UV141 £85, p&p £2.50.

EXT SERIAL/PARALLEL CONVERTERS

Mains powered converters	
Serial to Parallel	£48 (c)
Parallel to Serial	£48 (c)
Bidirectional Converter	£105 (b)

Serial Test Cable

Serial cable switchable at both ends allowing pin options to be re-routed or linked at either end - making it possible to produce almost any cable configuration on site. Available as M/M or M/F £24.75 (d)

Serial Mini Patch Box

Allows an easy method to reconfigure pin functions without rewiring the cable assay. Jumpers can be used and reused. £22 (d)

Serial Mini Test

Monitors RS232C and CITT V24 Transmissions, indicating status with dual colour LEDs on 7 most significant lines. Connects in Line. £22.50 (d)

CONNECTOR SYSTEMS

I.D. CONNECTORS

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

D CONNECTORS

No of Ways				
	9	15	25	37
MALE:				
Ang Pins	120	180	230	350
Solder	60	85	125	170
IDC	175	275	325	-
FEMALE:				
St Pin	100	140	210	380
Ang Pins	160	210	275	440
Solder	90	130	195	290
IDC	195	325	375	-
St Hood	90	95	100	120
Screw	130	150	175	-
Lock*				

TEXT TOOL ZIF	
SOCKETS	24-pin £7.50
28-pin	£9.10
	40-pin £12.10

EDGE CONNECTORS

2 x 6-way (commodore)	0 1 0 156	300p
2 x 10-way	150p	-
2 x 12-way (VIC 20)	-	350p
2 x 18-way	-	140p
2 x 23-way (Z80)	175p	220p
2 x 25-way	225p	220p
2 x 28-way (Spectrum)	200p	-
2 x 36-way	250p	-
1 x 43-way	280p	-
2 x 22-way	190p	-
2 x 43-way	395p	-
1 x 77-way	400p	500p
2 x 50-way (S100conn)	600p	-

EURO CONNECTORS

DIN 41612	Plug	Skt
2 x 32 way St Pin	230p	275p
2 x 32 way Ang Pin	275p	320p
3 x 32 way St Pin	260p	300p
3 x 32 way Ang Pin	375p	400p
IDC Skt A + B	400p	-
IDC Skt A + C	400p	-

For 2 x 32 way please specify spacing (A + B, A + C).

MISC CONNS	
21 pin Scart Connector	200p
8 pin Video Connector	200p

AMPHENOL CONNECTORS

36 way plug Centronics (solder 500p) (IDC) 475p
36 way skt Centronics (solder) 550p (IDC) 500p
24 way plug IEEE (solder)
475p (IDC) 475p
24 way skt IEEE (solder)
500p (IDC) 500p
PCB Mtg Skt Ang Pin
24 way 700p 36 way 750p

GENDER CHANGERS

25 way D type	
Male to Male	£10
Male to Female	£10
Female to Female	£10

RS 232 JUMPERS

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

DIL SWITCHES

4-way	90p	6-way	105p
8-way	120p	10-way	150p

RIBBON CABLE

(grey/metre)			
10-way	40p	34-way	160p
16-way	60p	40-way	180p
20-way	85p	50-way	200p
26-way	120p	64-way	280p

DIL HEADERS

14 pin	Solder	IDC
16 pin	40p	100p
18 pin	50p	110p
20 pin	60p	-
20 pin	75p	-
24 pin	100p	150p
28 pin	160p	200p
40 pin	200p	225p

ATTENTION

All prices in this double page advertisement are subject to change without notice. ALL PRICES EXCLUDE VAT Please add carriage 50p unless indicated as follows: (a) £8 (b) £2.50 (c) £1.50 (d) £1.00

74 SERIES			
7400	0.30	74283	1.05
7401	0.30	74284	2.20
7402	0.30	74289	0.90
7403	0.30	74290	0.90
7404	0.30	74291	1.80
7405	0.30	74351	0.80
7406	0.40	74352	0.80
7407	0.40	74353	1.40
7408	0.30	74354	1.00
7409	0.30	74355	1.10
7410	0.30	74356	1.20
7411	0.30	74357	1.40
7412	0.30	74358	1.40
7413	0.30	74359	1.40
7414	0.30	74360	1.40
7415	0.30	74361	1.40
7416	0.30	74362	1.40
7417	0.30	74363	1.40
7418	0.30	74364	1.40
7419	0.30	74365	1.40
7420	0.30	74366	1.40
7421	0.30	74367	1.40
7422	0.30	74368	1.40
7423	0.30	74369	1.40
7424	0.30	74370	1.40
7425	0.30	74371	1.40
7426	0.30	74372	1.40
7427	0.30	74373	1.40
7428	0.30	74374	1.40
7429	0.30	74375	1.40
7430	0.30	74376	1.40
7431	0.30	74377	1.40
7432	0.30	74378	1.40
7433	0.30	74379	1.40
7434	0.30	74380	1.40
7435	0.30	74381	1.40
7436	0.30	74382	1.40
7437	0.30	74383	1.40
7438	0.30	74384	1.40
7439	0.30	74385	1.40
7440	0.30	74386	1.40
7441	0.30	74387	1.40
7442	0.30	74388	1.40
7443	0.30	74389	1.40
7444	0.30	74390	1.40
7445	0.30	74391	1.40
7446	0.30	74392	1.40
7447	0.30	74393	1.40
7448	0.30	74394	1.40
7449	0.30	74395	1.40
7450	0.30	74396	1.40
7451	0.30	74397	1.40
7452	0.30	74398	1.40
7453	0.30	74399	1.40
7454	0.30	74400	1.40
7455	0.30	74401	1.40
7456	0.30	74402	1.40
7457	0.30	74403	1.40
7458	0.30	74404	1.40
7459	0.30	74405	1.40
7460	0.30	74406	1.40
7461	0.30	74407	1.40
7462	0.30	74408	1.40
7463	0.30	74409	1.40
7464	0.30	74410	1.40
7465	0.30	74411	1.40
7466	0.30	74412	1.40
7467	0.30	74413	1.40
7468	0.30	74414	1.40
7469	0.30	74415	1.40
7470	0.30	74416	1.40
7471	0.30	74417	1.40
7472	0.30	74418	1.40
7473	0.30	74419	1.40
7474	0.30	74420	1.40
7475	0.30	74421	1.40
7476	0.30	74422	1.40
7477	0.30	74423	1.40
7478	0.30	74424	1.40
7479	0.30	74425	1.40
7480	0.30	74426	1.40
7481	0.30	74427	1.40
7482	0.30	74428	1.40
7483	0.30	74429	1.40
7484	0.30	74430	1.40
7485	0.30	74431	1.40
7486	0.30	74432	1.40
7487	0.30	74433	1.40
7488	0.30	74434	1.40
7489	0.30	74435	1.40
7490	0.30	74436	1.40
7491	0.30	74437	1.40
7492	0.30	74438	1.40
7493	0.30	74439	1.40
7494	0.30	74440	1.40
7495	0.30	74441	1.40
7496	0.30	74442	1.40
7497	0.30	74443	1.40
7498	0.30	74444	1.40
7499	0.30	74445	1.40
7500	0.30	74446	1.40

Special offer to PE readers only - 10% off on all TTLs and CMOS

74LS SERIES

4000 SERIES

74S SERIES

LINEAR ICs

4076	0.85	ADC0808	11.90	LM710	0.48	TBA231	1.20
4077	0.25	AM17510C	12.00	LM711	1.00	TBA800	0.80
4078	0.25	AN103	2.00	LM723	0.60	TBA810	0.90
4079	0.25	AY-3150	5.00	LM725CN	3.00	TBA820	0.80
4080	1.20	AY-38910	4.90	LM733	0.55	TBA820M	0.75
4081	0.85	CAD100	1.00	LM747	0.22	TBA850	2.25
4082	0.90	CAD105A	1.00	LM774	0.70	TCA950	12.00
4083	0.95	CAD130	3.50	LM1011	4.80	TC109	5.00
4084	0.90	CAD130A	3.50	LM1014	1.50	TCAD270	3.50
4085	2.70	CAD130B	3.50	LM1801	3.00	TD1010	2.25
4086	1.20	CAD130C	3.50	LM1830	2.50	TD1024	1.10
4087	0.85	CAD130D	3.50	LM1871	0.75	TD1110S	3.00
4088	0.35	CAD130E	0.70	LM1872	3.00	TD1170N	3.00
4089	0.35	CAD130F	0.70	LM1886	5.00	TD2002	3.25
4090	0.35	CAD130G	0.70	LM1889	4.50	TD2003	1.90
4091	0.35	CAD130H	0.70	LM2917	3.00	TD2004	2.40
4092	0.35	CAD130I	0.70	LM3302	0.90	TD2006	2.50
4093	0.35	CAD130J	0.70	LM3303	0.90	TD2008	2.50
4094	0.35	CAD130K	0.70	LM3304	0.90	TD2010	2.50
4095	0.35	CAD130L	0.70	LM3305	1.40	TD2012	2.50
4096	1.20	CAD130M	0.70	LM3310	1.30	TD2015	2.50
4097	0.35	CAD130N	0.70	LM3311	1.30	TD2018	2.50
4098	0.35	CAD130O	0.70	LM3312	1.30	TD2020	2.50
4099	0.35	CAD130P	0.70	LM3313	1.30	TD2022	2.50
4100	0.35	CAD130Q	0.70	LM3314	1.30	TD2024	2.50
4101	0.35	CAD130R	0.70	LM3315	1.30	TD2026	2.50
4102	0.35	CAD130S	0.70	LM3316	1.30	TD2028	2.50
4103	0.35	CAD130T	0.70	LM3317	1.30	TD2030	2.50
4104	0.35	CAD130U	0.70	LM3318	1.30	TD2032	2.50
4105	0.35	CAD130V	0.70	LM3319	1.30	TD2034	2.50
4106	0.35	CAD130W	0.70	LM3320	1.30	TD2036	2.50
4107	0.35	CAD130X	0.70	LM3321	1.30	TD2038	2.50
4108	0.35	CAD130Y	0.70	LM3322	1.30	TD2040	2.50
4109	0.35	CAD130Z	0.70	LM3323	1.30	TD2042	2.50
4110	0.35	CAD130AA	0.70	LM3324	1.30	TD2044	2.50
4111	0.35	CAD130AB	0.70	LM3325	1.30	TD2046	2.50
4112	0.35	CAD130AC	0.70	LM3326	1.30	TD2048	2.50
4113	0.35	CAD130AD	0.70	LM3327	1.30	TD2050	2.50
4114	0.35	CAD130AE	0.70	LM3328	1.30	TD2052	2.50
4115	0.35	CAD130AF	0.70	LM3329	1.30	TD2054	2.50
4116	0.35	CAD130AG	0.70	LM3330	1.30	TD2056	2.50
4117	0.35	CAD130AH	0.70	LM3331	1.30	TD2058	2.50
4118	0.35	CAD130AI	0.70	LM3332	1.30	TD2060	2.50
4119	0.35	CAD130AJ	0.70	LM3333	1.30	TD2062	2.50
4120	0.35	CAD130AK	0.70	LM3334	1.30	TD2064	2.50
4121	0.35	CAD130AL	0.70	LM3335	1.30	TD2066	2.50
4122	0.35	CAD130AM	0.70	LM3336	1.30	TD2068	2.50
4123	0.35	CAD130AN	0.70	LM3337	1.30	TD2070	2.50
4124	0.35	CAD130AO	0.70	LM3338	1.30	TD2072	2.50
4125	0.35	CAD130AP	0.70	LM3339	1.30	TD2074	2.50
4126	0.35	CAD130AQ	0.70	LM3340	1.30	TD2076	2.50
4127	0.35	CAD130AR	0.70	LM3341	1.30	TD2078	2.50
4128	0.35	CAD130AS	0.70	LM3342	1.30	TD2080	2.50
4129	0.35	CAD130AT	0.70	LM3343	1.30	TD2082	2.50
4130	0.35	CAD130AU	0.70	LM3344	1.30	TD2084	2.50
4131	0.35	CAD130AV	0.70	LM3345	1.30	TD2086	2.50
4132	0.35	CAD130AW	0.70	LM3346	1.30	TD2088	2.50
4133	0.35	CAD130AX	0.70	LM3347	1.30	TD2090	2.50
4134	0.35	CAD130AY	0.70	LM3348	1.30	TD2092	2.50
4135	0.35	CAD130AZ	0.70	LM3349	1.30	TD2094	2.50
4136	0.35	CAD130BA	0.70	LM3350	1.30	TD2096	2.50
4137	0.35	CAD130BB	0.70	LM3351	1.30	TD2098	2.50
4138	0.35	CAD130BC	0.70	LM3352	1.30	TD2100	2.50
4139	0.35	CAD130BD	0.70	LM3353	1.30	TD2102	2.50
4140	0.35	CAD130BE	0.70	LM3354	1.30	TD2104	2.50
4141	0.35	CAD130BF	0.70	LM3355	1.30	TD2106	2.50
4142	0.35	CAD130BG	0.70	LM3356	1.30	TD2108	2.50
4143	0.35	CAD130BH	0.70	LM3357	1.30	TD2110	2.50
4144	0.35	CAD130BI	0.70	LM3358	1.30	TD2112	2.50
4145	0.35	CAD130BJ	0.70	LM3359	1.30	TD2114	2.50
4146	0.35	CAD130BK	0.70	LM3360	1.30	TD2116	2.50
4147	0.35	CAD130BL	0.70	LM3361	1.30	TD2118	2.50
4148	0.35	CAD130BM	0.70	LM3362	1.30	TD2120	2.50
4149	0.35	CAD130BN	0.70	LM3363	1.30	TD2122	2.50
4150	0.35	CAD130BO	0.70	LM3364	1.30	TD2124	2.50
4151	0.35	CAD130BP	0.70	LM3365	1.30	TD2126	2.50
4152	0.35	CAD130BQ	0.70	LM3366	1.30	TD2128	2.50
4153	0.35	CAD130BR	0.70	LM3367	1.30	TD2130	2.50
4154	0.35	CAD130BS	0.70	LM3368	1.30	TD2132	2.50
4155	0.35	CAD130BT	0.70	LM3369	1.30	TD2134	2.50
4156	0.35	CAD130BU	0.70	LM3370	1.30	TD2136	2.50
4157	0.35	CAD130BV	0.70	LM3371	1.30	TD2138	2.50
4158	0.35	CAD130BW	0.70	LM3372	1.30	TD2140	2.50
4159	0.35	CAD130BX	0.70	LM3373	1.30	TD2142	2.50
4160	0.35	CAD130BY	0.70	LM3374	1.30	TD2144	2.50
4161	0.35	CAD130BZ	0.70	LM3375	1.30	TD2146	2.50
4162	0.35	CAD130CA	0.70	LM3376	1.30	TD2148	2.50
4163	0.35	CAD130CB	0.70	LM3377	1.30	TD2150	2.50
4164	0.35	CAD130CC	0.70	LM3378	1.30	TD2152	2.50
4165	0.35	CAD130CD	0.70	LM3379	1.30	TD2154	2.50
4166	0.35	CAD130CE	0.70	LM3380	1.30	TD2156	2.50
4167	0.35	CAD130CF	0.70	LM3381	1.30	TD2158	2.50
4168	0.35	CAD130CG	0.70	LM3382	1.30	TD2160	2.50
4169	0.35	CAD130CH	0.70	LM3383	1.30	TD2162	2.50
4170	0.35	CAD130CI	0.70	LM3384	1.30	TD2164	2.50
4171	0.35	CAD130CJ	0.70	LM3385	1.30	TD2166	2.50
4172	0.35	CAD130CK	0.70	LM3386	1.30	TD2168	2.50
4173	0.35	CAD130CL	0.70				

This article describes a new stepping motor driver ic M5804 which offers higher power and more operation modes than the commonly used SAA1027. A full practical design is given to allow this chip to be used in all modes driven either from a computer or a simple pulse generator.

STEPPER MOTORS

Stepping motors are becoming more and more popular as a means of providing precise computer controlled movement. Their applications in plotters, printers, buggies, and scanners are well known, but there are many other applications – for example, greenhouse vent controls, and antenna positioning systems, where stepping motors are ideal. In the hobby and educational fields low cost stepping motors find practically unlimited applications, particularly in technology, and cdt projects.

In order to drive a stepping motor from a computer output port, some form of interface is needed. The simplest is a set of four power transistors (usually high gain Darlington types) each connected between one output port line and one motor winding

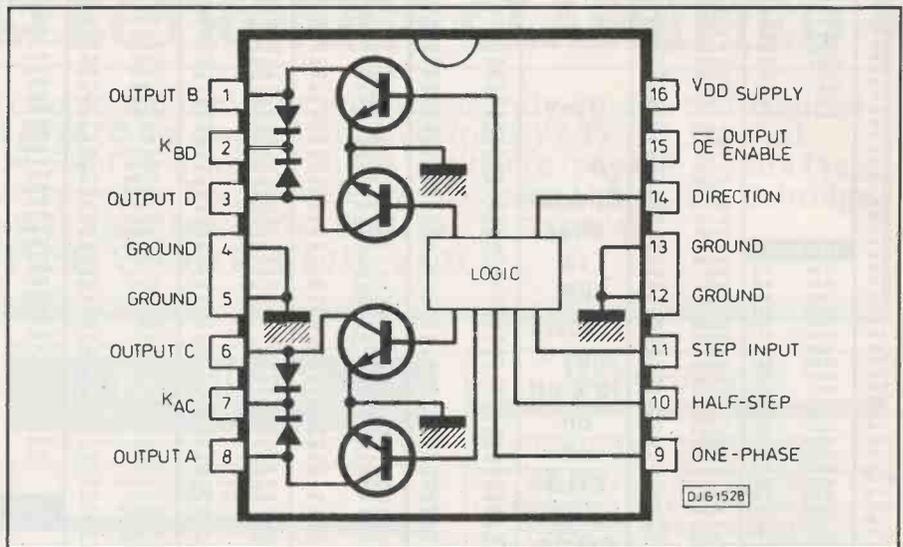


Fig.1. Simplified circuit of the M5804 stepper motor control ic.

connection. The computer is then programmed to switch the windings on and off in the correct sequence to rotate the motor. The necessary sequences for the various modes of motor drive are shown in Table 1. Although the hardware is simple,

operate in other modes – particularly half-step mode, limit its use. One difficulty with this ic is that it needs unusually high logic levels (logic 1 = 7.5V) on its inputs to perform correctly. High logic levels were once commonly used in industry because

STEPPING MOTOR DRIVER

TABLE 1
STEPPING SEQUENCE TABLES

WAVE-DRIVE SEQUENCE

Step	A	B	C	D
1	ON	OFF	OFF	OFF
2	OFF	ON	OFF	OFF
3	OFF	OFF	ON	OFF
4	OFF	OFF	OFF	ON

TWO-PHASE SEQUENCE

Step	A	B	C	D
1	ON	OFF	OFF	ON
2	ON	ON	OFF	OFF
3	OFF	ON	ON	OFF
4	OFF	OFF	ON	ON

HALF-STEP DRIVE SEQUENCE

Step	A	B	C	D
1	ON	OFF	OFF	OFF
2	ON	ON	OFF	OFF
3	OFF	ON	OFF	OFF
4	OFF	ON	ON	OFF
5	OFF	OFF	ON	OFF
6	OFF	OFF	ON	ON
7	OFF	OFF	OFF	ON
8	ON	OFF	OFF	ON

BY MARK STUART

The new M5804 becomes a very versatile single-chip stepper interface.

the programming is relatively difficult, and four lines of the output port are needed.

DEDICATED CHIPS

A better approach is to use a dedicated interface ic which works out the correct switching sequence for the motor and has four high power outputs which drive the motor directly. This approach simplifies the computer's job so that only two output port lines are required, one sets the direction of rotation and the other is programmed to change state each time a step is required. The most common dedicated ic for this job is the SAA1027 which handles up to 400mA at 12V on each output and provides bi-directional full step control.

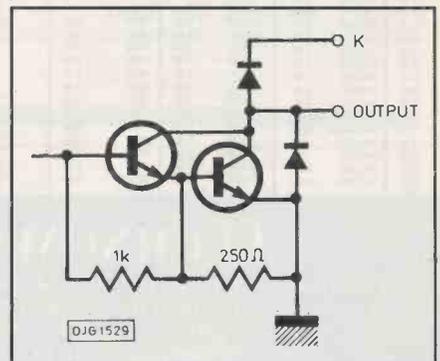
In many applications this ic is adequate, but its low output capability and inability to

they provide higher noise immunity than normal 5V circuits. To raise 5V levels to these higher levels takes additional circuitry.

Many stepping motor applications require higher performance drive circuits which are capable of half-step operation as well as the usual two-phase (full step) mode and can provide higher output power. Even simple applications benefit from half-step drive which gives smoother running as well as halving the step angle doubling the number of steps per revolution).

The M5804 ic introduced in this article is able to handle up to 35V and 1.25A per phase (50V 1.5A peak) and has three motor drive modes: half-step, one phase, and the standard two-phase. The inputs to the ic are compatible with standard cmos, pmos, and nmos circuits and with the addition of

Fig.2. Output transistor detail



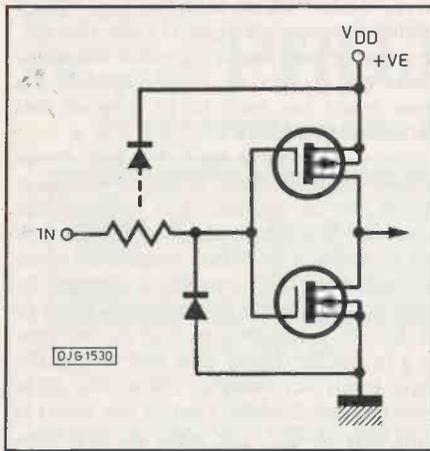


Fig.3. Input circuit details

appropriate pull-up resistors, ttl and lttl. This means that the ic can be connected directly to any computer parallel output port and drive a wide range of motors directly. Another excellent feature of this ic is internal thermal protection circuitry that disables all outputs when the chip temperature exceeds approximately 165° and re-enables them at 145°.

FUNDAMENTALS

A simplified circuit of the ic is shown in Fig.1. Four output transistors drive the motor windings. Each transistor is actually made up as shown in Fig.2, consisting of a standard power Darlington pair with a reverse connected parallel diode and another diode linked to a separate pin to be connected to the positive motor supply. The first diode clamps any negative voltage swings and so prevents the base-emitter junction of the output transistor from becoming forward biased. Without this, energy from the output can very easily be coupled to the input drive circuits – with dire consequences. The second diode provides an alternative path for the inductive motor winding current to flow as it decays when the transistor is turned off. This is an identical function to the familiar connection of a diode across a relay coil, it prevents high voltage spikes from breaking down the collector-base junction. The two diodes are sometimes called "ground clamp" and "flyback" diodes respectively.

The input circuits are the same as standard cmos logic as shown in Fig.3. These have the usual series protection resistor and shunt clamping diodes.

Fig.4. Zener stabilised logic supply.

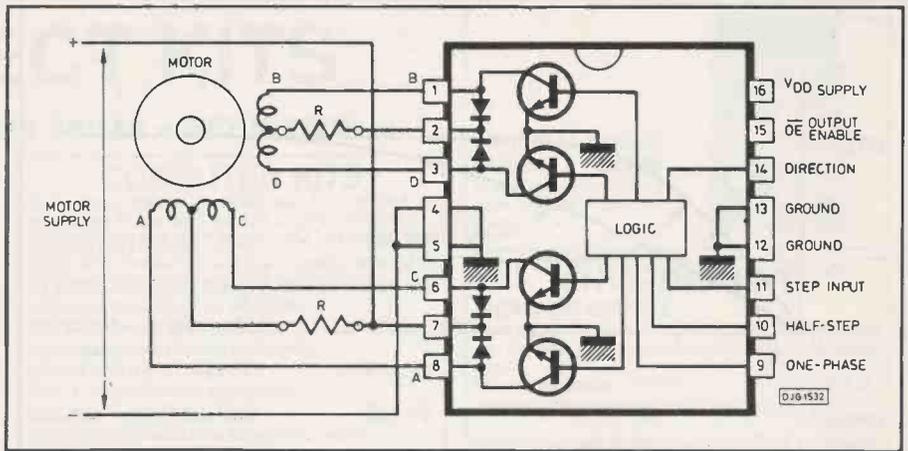
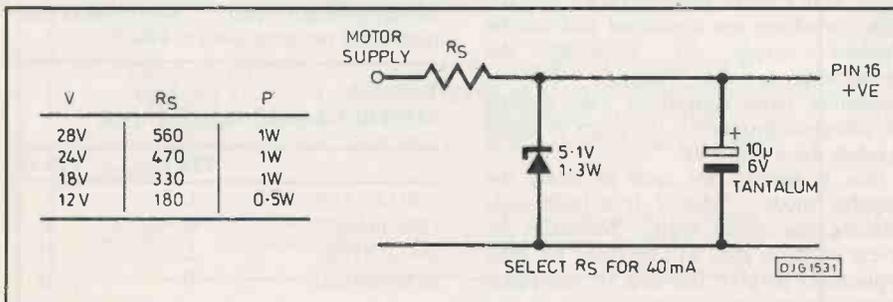


Fig.5. IC connected to motor. R = series resistors (see text)

The supply voltage to the logic section of the board can be separate from the motor drive supply and must not exceed 7V. As only 30mA (maximum) is drawn by the logic circuits it is likely that most computer systems can be tapped for the necessary current from their 5V rails. Alternatively a simple zener diode stabiliser can be run from the motor drive supply as shown in Fig.4.

MOTOR CONNECTIONS

A circuit of the ic connected to a motor is shown in Fig.5. Most standard unipolar stepping motors, such as the MD200 and MD35, have a pair of centre tapped windings. One winding connects to pins 1, 2 and 3, while the other connects to 6, 7 and 8. It does not matter which winding connects to which three pins, and provided the centre taps are connected correctly the two ends of each winding can be connected either way round. To make things simple, Fig.6 gives the lead colours for the popular MD200 and MD35 motors.

SERIES RESISTANCE

In many applications it is adequate to connect the motor supply directly to the winding centre taps, and operate the motor at, or even below its rated voltage. This arrangement gives adequate performance for many applications but does not extract anywhere near the full potential from the motors. When higher acceleration and speed are required it is possible to make substantial improvements by raising the

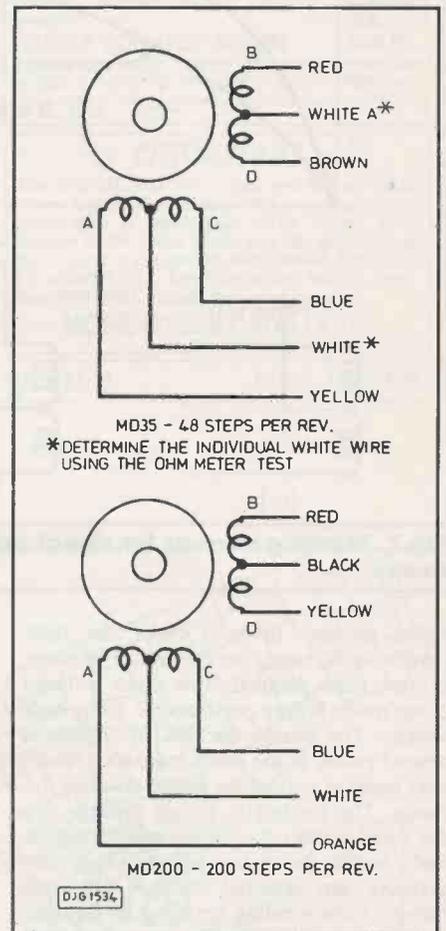


Fig.6. MD200 and MD35 winding colours

supply voltage and fitting series resistors as shown in Fig.5. The higher voltage forces the motor current to rise more quickly. If left unchecked this would lead to excessive current and a very hot motor, but the series resistors prevent this, so that the current rises much more rapidly, but stops rising when it reaches the motor's maximum rating.

Fig.7 shows the current in two cases for the MD35 and MD200 motors derived from actual oscilloscope measurements on a single winding. In the first case the motors are powered directly from 12V, and in the second case from 25V via a 33 ohm 5 watt

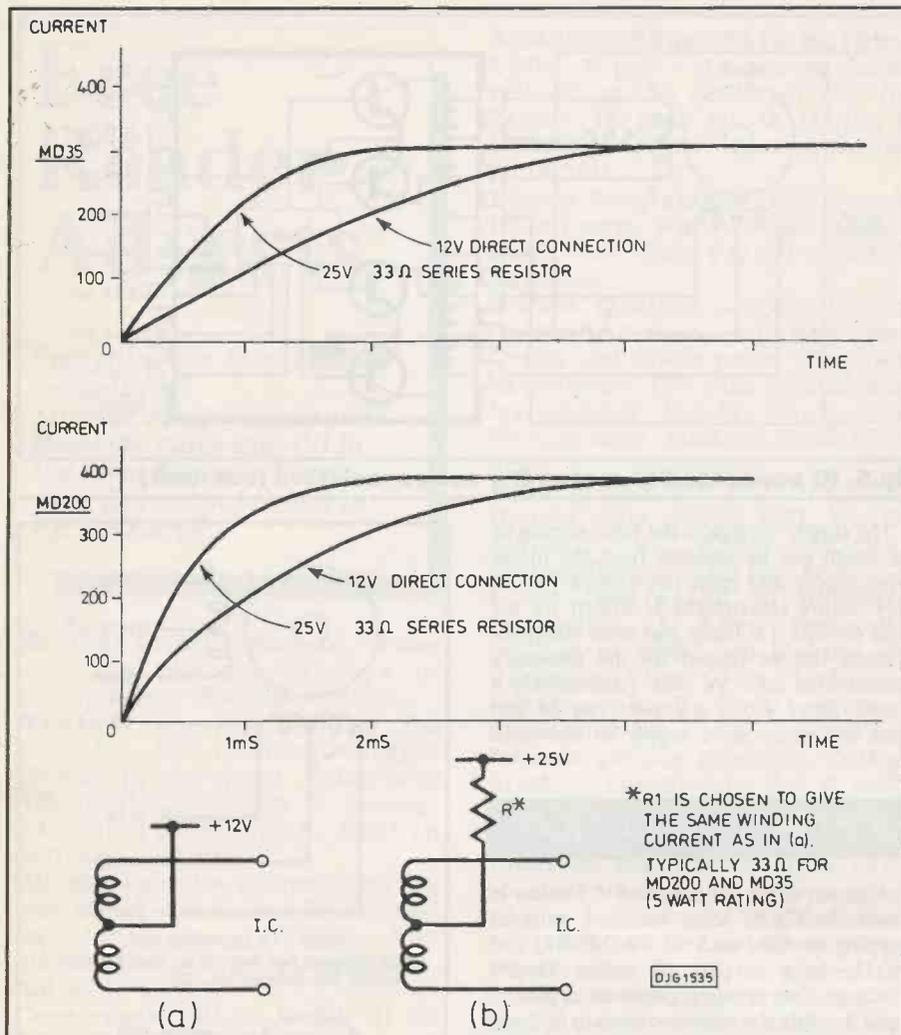


Fig.7. Winding current for direct connection and series resistance cases.

series resistor. In both cases the final current is the same, but the rate of increase is more than doubled. This rapid increase gives much higher performance from both motors. The penalty for this, of course, is wasted power in the series resistance which may equal or exceed the power reaching the motor. The method is simple though, and for small motors the improvement may be well worth the extra power. Only two resistors are required because the two halves of one winding are never on together (if they were, the opposing currents would cancel and the motor would draw its usual current but develop no torque – a condition which can occur if the two windings are mixed up).

ELECTRONIC CONTROLLERS

Other more sophisticated methods of current control may also be applied to this ic. Such methods as pulse control and chopper control use electronic circuits to allow the ultimate motor performance to be achieved while minimising power dissipation. These circuits are beyond the scope of this article.

OPERATION

Fig. 5 shows that the ic has five input pins. Pin 15, the output enable pin, turns off the output transistors when held at a logic 1. Its operation is completely independent of the stepping logic. In normal operation it would be connected to 0V. This pin can be used to reduce current consumption when the motor is stationary. Its main purpose is to allow the ic to be used with sophisticated chopper current control circuits.

Pin 14 sets the direction of the step sequence and hence the direction of motor rotation. Logic 0 produces one direction and logic 1 the other. Note that the actual direction of rotation depends on the way the motor windings are connected and can be changed simply by reversing the connections to one winding. This is sometimes more convenient than altering the computer program if the motor is found to rotate the wrong way.

Pins 9 and 10 are used to select the stepping mode. Table 2 is a truth table showing the circuit logic. Normally the levels on these pins will be fixed for each application to give full-step or one-phase

drive. When both are held at a logic 1 (Step Inhibit) step pulses (pin 11) are ignored. This feature is useful in some situations where two motors are being driven at the same speed but need to be stopped and started independently.

Step pulses can be applied to both motor drivers together from a single computer output line or oscillator and by using the step inhibit feature either or both motors can be stopped or started simply. In some circumstances it is desirable to change the stepping mode while in operation. This can be done by connecting each of the two pins to a computer output line, and setting the logic levels accordingly. Note that these lines and the direction control line (pin 14) must only change state when the step input (pin 11) is in the low state. This is necessary to prevent disruption of the step sequence which would result in lost or extra steps. It is easy to attend to this when driving the ic from a computer, but some sort of gating arrangement may be necessary when simpler drive methods are used.

Pin 11 is the Step Input pin. The outputs will advance one sequence position each time this pin changes from a logic 1 to logic 0. The minimum pulse width required is 500ns, there is no maximum limit but it is advisable to keep the pulse rise and fall times reasonably short (as with all logic circuits) to avoid problems caused by output transients being picked up by the input circuits.

STEPPING SEQUENCES

The step sequences for all three operating modes were shown earlier, in table 1. In each case the states (on or off) of the output transistor are given. Fig. 8 shows a simplified motor with just four steps per revolution. Practical motors have multipole rotors and stators but the principles are the same. Windings are energised by switching the four terminals to 0V according to the sequence in table 1 while the positive supply voltage is applied to the winding centre taps. For each step the rotor aligns with the energised stator poles as shown in Figs. 9a, b and c. Unmarked poles are not energised. The characteristics of each mode are as follows:

ONE-PHASE (or Wave Drive)

In this mode just one winding is energised at a time and the motor executes one full step for each pulse (Fig. 9). The current consumption is lower than any other mode, and the available torque is correspondingly less. Acceleration and maximum stepping rate are low.

**TABLE 2
CONTROL LOGIC TRUTH TABLE**

	PIN 9	PIN 10
TWO-PHASE	L	L
ONE-PHASE	H	L
HALF-STEP	L	H
STEP-INHIBIT	H	H

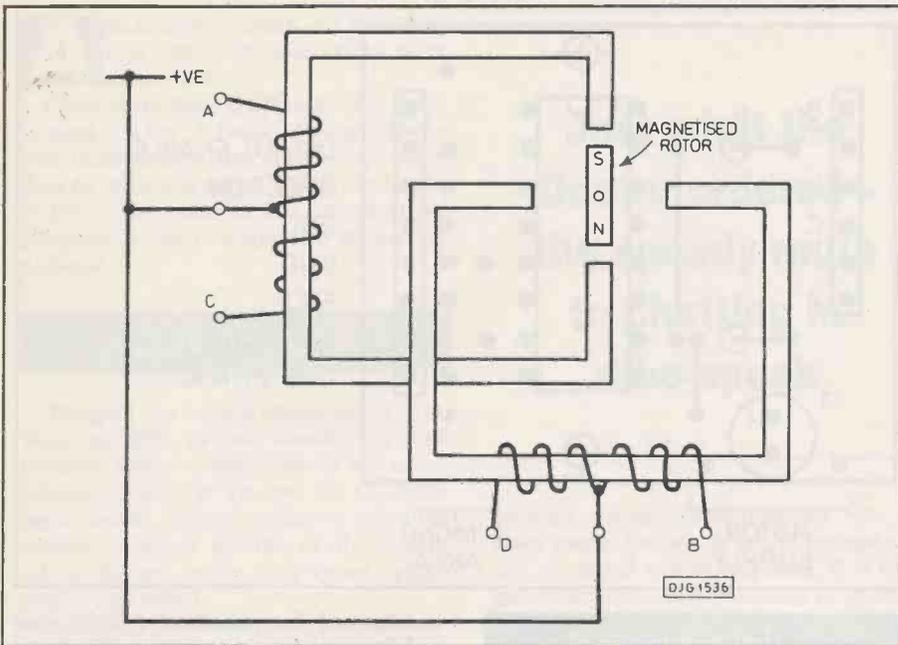


Fig.8. Diagram of simple 90° per step motor showing relationship of coil terminals to poles.

TWO-PHASE (or Full Step)

As the name suggests, in this mode the windings are energised in pairs so that the rotor aligns between the energised pair of poles (Fig. 9). Since two poles are energised at a time, the torque and hence the acceleration and maximum stepping rate are higher, and the current consumption is double that of one-phase drive. The motor executes one step per pulse.

HALF-STEP

By alternating between the above methods the rotor can be moved to alternately align with the poles and between them (Fig. 9). This doubles the number of rotor positions so that the motor now executes one half step per pulse. This mode is very popular because it gives finer resolution (96 steps with a 48 step motor and 400 steps with a 200 step motor). It also gives much smoother running and freedom from resonance effects which can cause unstable running under certain speed and load conditions in the other two modes. The current consumption changes between alternate steps and averages three-quarters of the full-step mode.

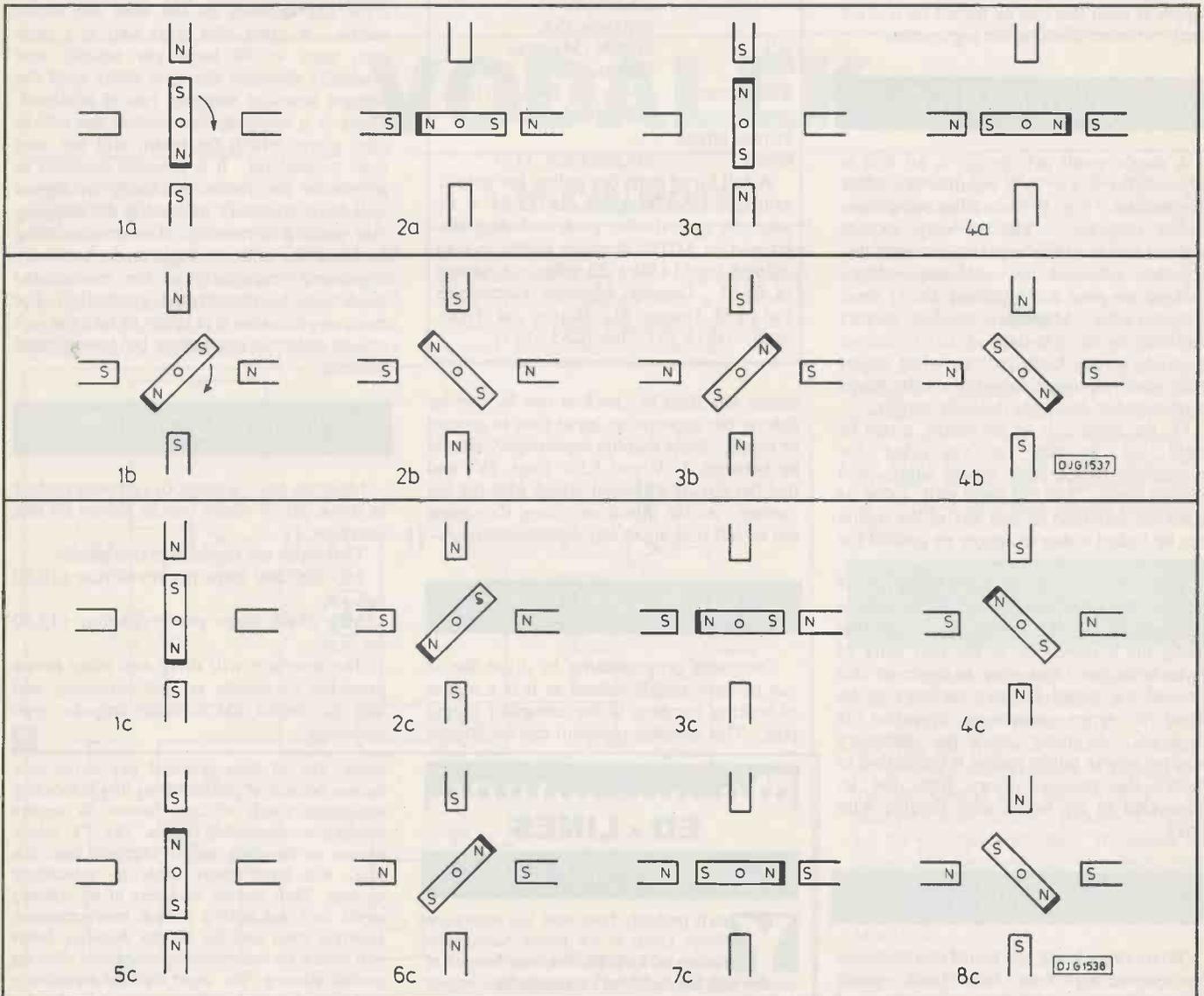


Fig.9. (a) Wave drive-one phase, (b) Full step-two phase, (c) Half step mode.

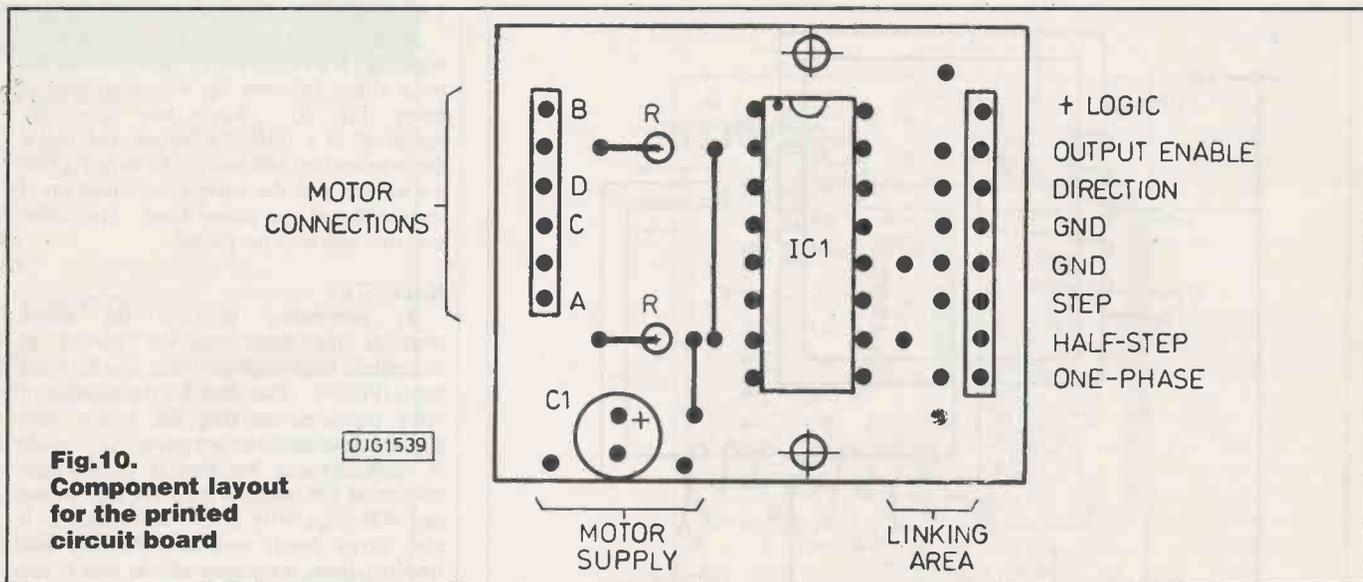


Fig. 10.
Component layout
for the printed
circuit board

DJG1539

POWER-ON RESET

When power is first applied to the logic section of the ic the states of the outputs are automatically set to those shown as step 1 in the tables. If a separate motor power supply is used this can be turned on and off freely without affecting the logic states.

CONSTRUCTION

A single small pcb design is all that is required for this ic as it requires few other components. Fig. 10 shows the component layout diagram. The ic may require heatsinking in some applications, and this can be achieved by soldering copper "wings" to pins 4, 5, 12 and 13. I have operated all of Magenta's standard motors (drawing up to 1A total at 12V) without heatsinks of any kind, and the ic has stayed quite cool. A single capacitor on the board is provided to decouple the logic supply.

On the input side of the board, a row of eight 0.1 in pins are provided for connection of the logic power supply and control inputs. Next to these pins, a row of holes are provided so that any of the inputs can be linked either to supply or ground for the particular application.

The output side of the board has a row of 6 pins, four of which connect to the output transistor collectors, with the other two being the connections to the two pairs of flyback diodes. Provision is made on this side of the board for two resistors to be fitted if series resistance operation is required. In most cases the necessary resistor power rating makes it preferable to mount the resistors away from the ic, connected to the board with flexible wire links.

TESTING

When completed, the board can be tested by connecting four leds (with series resistors) between the four output pins and the logic supply. The functions of the

COMPONENTS

C1	10µF miniature radial electrolytic or tantalum 35V
IC1	M5804 (Magenta Electronics)
Connectors	6-way and 8-p in line 0.1 in pin headers
Printed circuit board	Magenta Ref. 1124

A full kit of parts (including the pcb) is available from Magenta for £7.94 + £1 p&p. A special offer pack including this kit and an MD35 stepping motor is also offered for £14.99 + £1 p&p - A saving of £5.65. Contact: Magenta Electronics Ltd, 135 Hunter St., Burton on Trent, Staffs, DE14 2ST. Tel: 0283 65435.

circuit can then be checked one by one by linking the appropriate input pins to ground or supply. Note that the logic supply should be between 4.5V and 5.5V (max 7V) and that the circuit will need 30mA plus the led current. As the inputs are cmos, they must not be left floating in any circumstances.

PROGRAMMING

Computer programming to drive the ic can be very simple indeed as it is a matter of writing numbers to the computer output port. The simplest program can be written

in basic and just consists of a timing loop and Two instructions to write to the output port. The time delay must be long enough to give a stepping rate that the motor can follow. This is best determined by trial and error and depends on the load and motor inertia. A good idea is to start at a slow rate, such as 50 steps per second, and gradually decrease the time delay until the highest practical stepping rate is achieved. There is a stepping rate (called the pull-in rate) above which the motor will not start from a standstill. It is possible however to accelerate the motor gradually to higher speeds by smoothly increasing the stepping rate while it is running. The programming for this is more complicated, but very interesting, especially as the motor also must also be decelerated gradually. For many applications it is better to take the soft option and stick to constant but lower speed running.

MORE MOTORS

Magenta have a range of stepping motors in stock, all of which can be driven by this interface.

Two types are featured in this article:

MD 200:200 steps per revolution £16.80 inc. vat

MD 35:48 steps per revolution £12.70 inc. vat

The interface will drive any other motor provided its ratings are not exceeded, and that the motor has 4-phase unipolar type windings.

PE



ED - LINES

OUT-SMARTING PIRATES

You'll probably have read the section on Smart Cards in the Home Automation feature of May 89. I've now learned of another way in which they may make their impact felt, as a means to beat satellite pay-tv pirates.

Currently, French and US tv companies lose

about 30% of their potential pay-as-you-view income because of pirates selling illegal decoding equipment which enables viewers to receive encoded or scrambled signals. Sky TV, which intends to introduce pay tv channels later this year, will issue smart cards to subscribing viewers. They are the thickness of an ordinary credit card and have a built-in microprocessor. Inserting them into the set-top decoding boxes will unlock the unscrambling equipment allowing normal viewing. The smart card microprocessor will allow Sky to cut off any viewer who has not paid the monthly subscription.

HIGH GRADE COMPONENT PARCELS

COMPONENT PACKS

This month we have a delicious selection of top grade component packs for you. They all contain brand new components of the very highest quality – ideal for experiment, circuit design and development, or education. All the packs are £1 (+ VAT) each, but if you order five packs you can select another pack **FREE**. Order ten packs and you can have three extra packs **FREE**.

FOR THE EXPERTS

– Just look at those ICs! They are all at the very top of their class, made for peak performance without compromise. The kind of ICs it's a delight to design with.

Of course, there's no point in buying an expensive IC unless you know exactly how to use it, so each comes with its own data sheet, specifications, design ideas and circuits. The nicest thing of all is that any one of them could be yours in a few days time if you order right now!

PASSIVE COMPONENTS

- PACK 1 – 200 RESISTORS. Mostly 1/4W carbon film. Lots of E12 values with some E96.
- PACK 2 – 100 CAPACITORS. Ceramics, metallised film, all types. A fine selection!
- PACK 3 – 30 ELECTROLYTICS. Values to 500µF.
- PACK 4 – 15 LARGE ELECTROLYTICS. Values to 5,000µF.
- PACK 5 – 10 TANTALUM CAPACITORS. Values to 47µF.
- PACK 6 – 20 HIGH VALUE POLYESTER CAPS. Values to 2µF.
- PACK 7 – 15 DIL RESISTOR NETWORKS.
- PACK 8 – 20 CARBON AND CERMET TRACK PRESETS.

OPTO ELECTRONICS & DISPLAYS

- PACK 11 – 10 5mm LEDs: 4 red, 2 yellow, 2 orange, 2 green.
- PACK 12 – 10 3mm LEDs: 4 red, 2 yellow, 2 orange, 2 green.
- PACK 13 – 2 CQY89A high power infra-red emitters.

- PACK 14 – 2 HIGH POWER SENSORS. Matched to emitters in PACK 13.
- PACK 15 – 2 FND10 0.1" miniature 7-segment CC LED displays.
- PACK 17 – 20 NEON BULBS (use 100k series resistor for mains).
- PACK 18 – 2 INFRA-RED COMPONENTS. Emitter and phototransistor.
- PACK 19 – 3 FLASHING LEDs. A built-in IC makes the LED flash.
- PACK 21 – 1 SLOTTED INFRA-RED OPTO SWITCH.
- PACK 23 – 10 RECTANGULAR GREEN LEDs. For bar graph, etc.

SEMICONDUCTORS

- PACK 26 – 3 TAG136D MAINS TRIACS (400V, 4A).
- PACK 27 – 30 IN4000 SERIES RECTIFIERS.
- PACK 28 – 30 MIXED SEMICONDUCTORS. Transistors, diodes, SCRs, ICs, FETs, etc.
- PACK 29 – 20 ASSORTED ICs. CMOS, TTL, linear, memory, all sorts.
- PACK 30 – 20 TRANSISTORS. High grade general purpose NPN.

- PACK 31 – 1 CF 585 CALCULATOR IC. With data.

MISCELLANEOUS

- PACK 36 – 4 12V BUZZERS.
- PACK 37 – 3 PANEL NEON LAMPS.
- PACK 39 – 5 'BEEHIVE' TRIM CAPS.
- PACK 40 – 3 VDRs. Mains transient suppressors – just wire between L and N of plug.
- PACK 42 – 12 PP3 BATTERY CONNECTORS.
- PACK 43 – 100 MYSTERY PACK. At least 100 top grade components.
- PACK 44 – 1 MINI BIO-FEEDBACK KIT. With PCB, components and instructions.
- PACK 45 – 1 MINI DREAM MACHINE KIT. With PCB, components and instructions.

EXTRA PACKS

- PACK 50 – 12 BC212 TRANSISTORS. General purpose PNP.
- PACK 51 – 12 BC213 TRANSISTORS. General purpose PNP.
- PACK 52 – 2 PIEZO BUZZERS. Use as microphone, speaker or buzzer.

HI-FI PRE-AMPLIFIER IC

£2.80! + VAT

The HA12017 is a top grade Hi-Fi pre-amplifier, turning in a THD of less than 0.002% over the entire audio bandwidth! The low noise, wide dynamic range and excellent power supply ripple rejection make this IC the first choice for an audio pre-amplifier of formidable specifications.

Each IC is supplied with its own data sheet giving performance figures and graphs, the circuit for a top flight pre-amplifier and a PCB foil pattern and component layout.

SPECIFICATIONS

THD = 0.002% typ. (f = 20Hz to 20kHz, V_{out} = 10V RMS, RIAA)
Input noise V_n = 0.185µV typ. (IHF-A network, R_s = 43R, RIAA)

Supply rejection:

SVR₊ = 56dB typ.
(f = 100Hz, R_s = 43R)
SVR₋ = 45dB typ.
(f = 100Hz, R_s = 43R)



POWER AMPLIFIER IC

£3.90! + VAT

As easy to use as an ordinary op-amp, the L165V's massive ±3A current handling make it the ideal choice for a minimum component Hi-Fi amplifier.

This IC's data sheet includes circuits for a basic amplifier, a motor controller and a power oscillator. A separate sheet gives circuits and construction details for two high quality audio amplifiers, one giving 20W and the other 50W output. All information comes free with the IC. PCBs for the amplifiers are available separately, if required.

SPECIFICATIONS

Output current: ±3A Frequency range: DC to 200kHz
Supply voltage: 12V to 35V Input noise: 2µV (10Hz to 10kHz)

ACCESSORIES 20W Hi-Fi amplifier PCB £1.20 + VAT
50W Hi-Fi amplifier PCB £1.60 + VAT

UHF AMPLIFIER

£12.20! + VAT

The OM335 is a high gain wideband amplifier (10MHz to 1.4GHz) for VHF and UHF signals. It can be used as a masthead amplifier for better TV reception, a booster for indoor aerials, a distribution amplifier, and so on. The only external component needed is a decoupling capacitor for the power supply!

Each amplifier is supplied with a data sheet giving specifications, design hints and performance figures. A separate leaflet, also supplied with the IC, gives a complete design for a TV aerial booster, with layout and construction details. A PCB for the amplifier is available separately, if required.

SPECIFICATIONS

Frequency range: 10MHz to 1.4GHz Noise figure: 5.5dB typ.
Mid-band gain: 26dB at V_s = 24V Supply voltage: 9V to 26V

ACCESSORIES

PCB for TV aerial booster
£1.80 + VAT
Screening piece
80p + VAT



BAR GRAPH DISPLAY

£3.60! + VAT

For visual impact, there's nothing to beat a bar graph display – you can see at a glance exactly what's going on. The LM3915 needs only ten LEDs and a few resistors to make a moving dot or expanding bar display. The logarithmic response means that the graph will automatically be scaled in dBs and will cover a wide dynamic range – ideal for audio work.

The data we supply with the IC gives circuits for a peak detector, VU meter, vibration meter, light meter, audio power meter, and a dozen more project ideas!

SPECIFICATIONS

Range: 30dB in 30dB steps
Supply voltage: 3V to 25V
Outputs: direct LED drive (no series resistors needed).

A/D CONVERTER

£4.80! + VAT

Built-in clock generator, easy interface to microprocessors, outputs suitable for MOS and TTL, differential inputs – the ADC0804's got the lot! As a stand alone converter, it needs only one external resistor and one small cap. What could be easier?

The converter comes with its own data sheet, giving full specifications, design hints and over 25 circuit ideas! Stocks limited on this one I'm afraid, and at this price they'll be gone in no time, so reserve yours now.

SPECIFICATIONS

Resolution: 8 bits Access time: 135ns
Supply voltage: 5V Outputs: MOS and TTL

COMMUNICATION THROUGH THE MAINS

£6.20! + VAT

Messages through the mains is the function of the LM1893. Although intended for reliable, long distance data communication, it can just as easily become a powerful mains intercom – the instructions tell you how. Each IC contains a transmitter which sends an FSK modulated signal along the mains wiring of your house or office. The IC also has a receiver to pick up and decode the signals, so two ICs will give you full two-way communication without any wires or cables!

The instruction leaflet gives detailed design procedures, circuits, and everything you need to know to build a speech or digital communications system.

SPECIFICATIONS

Transmission rate: up to 4.8kbaud
Carrier frequency: selectable 50kHz to 300kHz
Power boost: optional x10 power boost with single transistor.

UK Orders: Please add 80p postage & packing and 15% VAT to the total (including postage).

Europe and Eire: Please add £2.50 carriage and insurance. No VAT.

Outside Europe: Please add £4.50 carriage and insurance. No VAT.

HIGH GRADE COMPONENTS LTD

UNIT 8, 8 Woburn Road, Eastville, Bristol BS5 6TT.

ELMASET INSTRUMENT CASE

300 x 133 x 217mm deep £10 ea (£2.20)

REGULATORS

LM317T PLASTIC TO220 variable £1
LM317 METAL £2.20
7812 METAL 12V 1A £1
7805/12/15/24V plastic 35p 100+20p 1000+ 15p
7905/12/15/24V plastic 35p 100+20p 1000+ 15p
CA3085 7099 variable reg 2/£1
LM338 5A VARIABLE £5

COMPUTER ICS

IM6402 UART £3
8086 processor equipment £2
USED 41256-15 £3.80
USED 41256-15 £4.20
4164-15 ex equipment £1
9 x 41256-15 SIMM MODULE NEW £36
8 x 4164-15 SIP MODULE NEW £8
41256-10 SURFACE MOUNT EX NEW BOARDS £4
HD146818 CLOCK IC £2
2864 EPROM £6
27128A 250nS EPROM NEW £3.20
FLOPPY DISC CONTROLLER CHIPS 1771 £10 ea
FLOPPY DISC CONTROLLER CHIPS 1772 £16 ea
68008 PROCESSOR EX-EQPT £5
ALL USED EPROMS ERASED AND BLANK CHECKED CAN BE PROGRAMMED IF DESIRED.

2764-30 USED £2
2716-45 USED £2 100/£1
2732-45 USED £2 100/£1
2764-30 USED £2 100/£1.60
27128-25/30 USED £2.50
27C256-30 USED £3
1702 EPROM EX EQPT £5
2114 EX EQPT 60p 4116 EX EQPT 70p
6264-15 8k static ram £6
4416 RAM £3.50
USED 4416-15 RAM £3.50
ZN427E-8 £3.50
ZN428E-8 £3.50

CRYSTAL OSCILLATOR

1.8342 MHz £1 each

CRYSTALS

2.77 MHz/4.9152 MHz/49.504MHz £1 each

TRANSISTORS

BC107, BCY70 PREFORMED LEADS
full spec £1 £4/100 £30/1000
BC557, BC548B 30/£1 £3.50/100

SIL RESISTOR NETWORKS

8 PIN 10k 22k 5/£1
8 PIN 22k 5/£1
10 PIN 68R 180R 22k 5/£1

POWER TRANSISTORS

OC35 (Marked CV7084) £1
POWER FET IRF9531 8A 60V 2/£1
2SC1520 sim BF259 3/£1 100/£22
TIP141/2 1 £1 ea TIP112/125/42B 2/£1
TIP35B TIP35C £1.50
SE9301 100V 10A DARL. SIM TIP121 2/£1
2N3055 EX EQPT TESTED 4/£1
PLASTIC 3055 OR 2955 equiv 50p 100/£35
2N3773 NPN 25A 160V £1.80 10/£16

QUARTZ HALOGEN LAMPS

A1/216 24V 150 WATTS £2.25
H1 12V 50W (CAR SPOT) £1.50

ZIF SOCKETS 2/£1.50
TEXTTOOL single in line 32 way. Can be ganged (coupling supplied) for use with any dual in line devices.

LARGE ELECTROLYTIC CAPACITORS COMPUTER GRADE

3300uF 350V SIC SAFCO FELSIC 037 £6 (£1.50)
2200uF 160V SIC SAFCO FELSIC CO38 £4 (£1.20)

TURNS COUNTING DIALS FOR MULTI TURN POTENTIOMETERS

all for 0.25" shaft
10 turn dial 21 mm dia. fits 3mm spindle £2
10 turn digital dial (3 digits) for 3mm or 6mm shaft £3.50
10 turn clock face dial for 6mm spindle £4

MISCELLANEOUS

SLOPING FRONT PLASTIC CASE 225 x 215 x £4.90 (£1)
76 mm WITH ALI FRONT PANEL 200 x 130mm
HUMIDITY SWITCH ADJUSTABLE £2
WIRE ENDED FUSES 0.25A 30/£1
NEW ULTRASONIC TRANSDUCERS 40kHz £2/pair
12 CORE CABLE 7/0.2mm OVERALL SCREEN..£1/3 metres
POWERFUL SMALL CYLINDRICAL MAGNETS 3/£1
OP AMP LM10CLN £2.90
BNC 50 OHM SCREENED CHASSIS SOCKET 3/£1

BNC TO CROC CLIPS LEAD 1 metre £1

MOULDED INDUCTOR 470µH

size of a 1 watt film resistor 5/£1

TO-220 HEAT SINK sim RS 403-162 10/£2.50

SMALL MICROWAVE DIODES AEI DC1028A 2/£1

D.I.L. SWITCHES 10 WAY £1 8 WAY 80p 4/5/6 WAY 50p

180 volt 1 watt ZENERS also 12v & 75v 20/£1

PLASTIC EQUIPMENT CASE 9 x 6 x 1.25 in. WITH FRONT AND REAR PANELS CONTAINING PCB WITH EPROM 2764-30

AND ICS 7417 LS30 LS32 LS74 LS367 LM311 7805 REG, 9 WAY D PLUG, PUSH BUTTON SWITCH, DIN SOCKET £1.90

VN10LM 60V 1/2A 50hm TO-92 mosfet 4/£1 100/£20

MIN GLASS NEONS 10/£1

RELAY 5v 2 pole changeover looks like RS 355-741 marked STC 47WB05T £1 ea

MINIATURE CO-AX FREE PLUG RS 456-071 2/£1

MINIATURE CO-AX FREE SKT. RS 456-273 2/£1.50

DIL REED RELAY 2 POLE n/o CONTACTS £1

PCB WITH 2N2646 UNIJUNCTION with 12v 4 POLE RELAY £1

400m 0.5w thick film resistors (yes four hundred megohms) 4/£1

MINIATURE CO-AX FREE PLUG RS 456-071 2/£1

MINIATURE CO-AX FREE SKT. RS 456-273 2/£1.50

STRAIN GAUGES 40 ohm Foil type polyester backed balco grid alloy £1.50 ea 10+ £1

ELECTRET MICROPHONE INSERT £0.90

Linear Hall effect IC Micro Switch no 613 SS4 sim RS 304-267 £2.50 100+ £1.50

HALL EFFECT IC UGS3040 + MAGNET £1

OSCILLOSCOPE PROBE SWITCHED X1 X10 £10

CHEAP PHONO PLUGS 100/£2 1000/£18

1 pole 12 way rotary switch 4/£1

AUDIO ICS LM380 LM386 £1 ea

555 TIMER 5/£1 741 OP AMP 5/£1

ZN414 AM RADIO CHIP 80p

COAX PLUGS nice ones 4/£1

COAX BACK TO BACK JOINERS 3/£1

4 x 4 MEMBRANE KEYBOARD £1.50

15,000uF 40V £2.50 (£1.25)

INDUCTOR 20uH 1.5A 5/£1

NEW BT PLUG + LEAD £1.50

1.25" PANEL FUSEHOLDERS 3/£1

CHROMED STEEL HINGES 14.5 x 1" OPEN £1 each

12v 1.2w small wire ended lamps fit AUDI VW TR7 SAAB VOLVO 10/£1

12V MES LAMPS 10/£1

STEREO CASSETTE HEAD £2

MONO CASS. HEAD £1 ERASE HEAD 50p

THERMAL CUT OUTS 50 77 85 120°C £1 ea

THERMAL FUSE 121°C 240V 15A 5/£1

TRANSISTOR MOUNTING PADS TO-5/TO-18 £3/1000

TO-3 TRANSISTOR COVERS 10/£1

STICK ON CABINET FEET 30/£1

PCB PINS FIT 0.1" VERO 200/£1

TO-220 micas + bushes 10/50p 100/£2

TO-3 micas + bushes 15/£1

PTFE min screened cable 10m/£1

Large heat shrink sleeving pack £2

CERAMIC FILTERS 6M/9M/10.7M 50p 100/£20

MAINS LEAD WITH MOULDED 13A PLUG AND IEC 50 CYCLES £1.50

SOCKET £3

IEC chassis plug rfi filter 10A

Potentiometers short spindles values 2k5 10k 25k 1m 5/£1

2M5 lin 4/£1

500k lin 500k log

40kHz ULTRASONIC TRANSDUCERS EX-EQPT NO DATA

PLESSEY INVERTER TRANSFORMER £1/pr

11.5-0-11.5V to 240v 200VA £6 (£3)

ZENERS

5.6V 1W3 SEMIKRON 50K AVAILABLE @£25/1000
SUPPRESSOR OF606 120V BI DIRECTIONAL ZENER IN 3 AMP W/P PACKAGE 5/£1

DIODES AND RECTIFIERS

1N4148 100/£1.50
1N4004/SD4 1A 300V 100/£3
1N5401 3A 100V 10/£1
BA158 1A 400V fast recovery 100/£3
BA159 1A 100V fast recovery 100/£4
120V 35A STUD 10/£1
BY127 1200V 1.2A 10/£1
BY254 800V 3A 8/£1
BY255 1300V 3A 6/£1
6A 100V SIMILAR MR751 4/£1
1A 800V BRIDGE RECTIFIER 4/£1
4A 100V BRIDGE 3/£1
6A 100V BRIDGE 2/£1.35
8A 200V BRIDGE £1.50
10A 200V BRIDGE 10/£18
25A 200V BRIDGE £2
25A 400V BRIDGE £2.50

SCRs

PULSE TRANSFORMERS 1:1+1 £1.25
2P4M EQUIV C106D 3/£1
MCR72-6 10A 600V SCR £2
35A 600V STUD SCR £2

TICV106D 800mA 400V SCR 3/£1 100/£15

MEU21 PROG. UNIJUNCTION 3/£1

TRIACS DIACS 4/£1

BT137-600 8A TO-220 2/£1
BT138-600 12A TO-220 70p
NEC TRIAC AC08F 8A 600V TO220 5/£2 100/£30
TXAL225 8A 400V 5mA GATE 2/£1 100/£35
TRAL2230D 30A 400V ISOLATED STUD £4 each

CONNECTORS

D25 IDC SOCKET FUJITSU £2
34 way card edge IDC CONNECTOR (disk drive type) £1.25
CENTRONICS 36 WAY IDC PLUG £2.50
CENTRONICS 36 WAY IDC SKT £4.00
BBC TO CENTRONICS PRINTER LEAD 1.5M £3.50
CENTRONICS 36 WAY PLUG SOLDER TYPE £4
USED CENTRONICS 36W PLUG+SKT £3

USED D CONNECTORS price per pair

D9 60p, D15 £1.50, D25 £2, D37 £2, D50 £3.50 covers 50p ea.

WIRE WOUND RESISTORS

W21 or sim 2.5W 10 of one value £1
R10 OR15 OR22 2R0 2R7 4R7 5R0 5R6 8R2 10R 12R 15R 18R
20R 22R 27R 33R 47R 56R 62R 91R 120R 180R 390R 430R
470R 680R 820R 910R 1K15 1K2 1K5 1K8 2K4 2K7 3K3 3K0 5K0
R05 (50 milli-ohm) 1% 3w 4 FOR £1
W22 or sim 6W 7 OF ONE VALUE £1
R47 R62 1R0 1R5 1R8 3R3 6R8 9R1 12R 20R 24R 27R 33R 51R
56R 62R 68R 100R 120R 180R 220R 390R 560R 620R 910R
1K0 1K2 1K5 1K8 2K2 2K7 3K3 3K9 4K7 8K2 10k 15k 16k 20k
W23 or sim 9W 6 of one value 4/£1
R22 R47 1R0 1R1 15R 56R 62R 100R 120R 180R 220R 300R
390R 680R 1K0 1K5 5K1 10K
W24 or sim 12W 4 OF ONE VALUE £1
R50 2R0 9R1 18R 22R 27R 56R 68R 75R 82R 100R 150R 180R
200R 220R 270R 400R 620R 1K0 6K8 8K2 10K 15K

PHOTO DEVICES

SLOTTED OPTO-SWITCH OPCOA OPB815 £1.30
2N5777 50p
TIL81 PHOTO TRANSISTOR 3/£1
TIL38 INFRA RED LED 5/£1
4N25, OP12252 OPTO ISOLATOR 50p
PHOTO DIODE 50p 6/£2
MEL12 (PHOTO DARLINGTON BASE n/c) 50p
RPY58A LDR 50p ORP12 LDR 70p
LEDs RED 3 or 5mm 12/£1 100/£6
LEDs GREEN OR YELLOW 10/£1 100/£6.50
LEDs ASSORTED RD/GN/YW + INFRA/RED 200/£5
FLASHING RED OR GREEN LED 5mm 50p 100/£35

STC NTC BEAD THERMISTORS

G22 220R, G13 1K, G23 2K, G24 20K, G54 50K, G25 200K,
G16 1M, RES @ 20°C DIRECTLY HEATED TYPE £1 ea
FS22BW NTC BEAD INSIDE END OF 1" GLASS PROBE £1 ea
RES @ 20°C 200R

CERMET MULTI TURN PRESETS 3/4"

10R 20R 100R 200R 250R 500R 2K 2K2 2K5 5K 10K 47K
50K 100K 200K 500K 2M2 50p each

IC SOCKETS

6 pin 15/£1 8 pin 12/£1 14/16 pin 10/£1 18/20 pin 7/£1,
22/24/28 pin 4/£1 40 pin 30p

SOLID STATE RELAYS

40A 250V AC SOLID STATE RELAYS £18

POLYESTER/POLYCARB CAPS

100n 63v 5mm 20/£1 100/£3 1000/£25
1n/3n/5n/6n/2/10n 1% 63v 10mm 100/£6
10n/15n/22n/33n/47n/68n 10mm rad 100/£3.50
100n 250v radial 10mm 100/£3
100n 600v sprague axial 10/£1 100/£6 (£1)
2u2 160v rad 22mm 100/£10
10n/33n/47n 250v ac x rated 15mm 10/£1
470n 250v ac x rated rad 4/£1
1U 600V MIXED DIELECTRIC 50p ea.

RF BITS

12 volt CO-AXIAL relays sim. RS 349-686 £6
65p Ex-equipment, with BNC tails
TRIMMER CAPS ALL 4/50p
8/£1 SMALL 5p/2 pin mounting 5mm centres
6/£1 SMALL MULLARD 2 to 22pF 4/50p
4/£1 SMALL MULLARD 5 to 50pF 4/50p
4/£1 grey larger type 2 to 25pF
3/£1 TRANSISTORS 2N4427 60p
2/£1 FEED THRU CERAMIC CAPS 1000pF 10/£1

MINIATURE RELAYS Suitable for RF

5 volt coil 1 pole changeover £1
5 volt coil 2 pole changeover £1
12 volt coil 1 pole changeover £1

MONOLITHIC CERAMIC CAPICITORS

£1 10n 50v 2.5mm 100/£4.50
£2 100n 50v 2.5mm or 5mm 100/£6

MAIL ORDER ONLY

MIN CASH ORDER £3.00 OFFICIAL ORDERS WELCOME
UNIVERSITIES COLLEGES SCHOOLS GOVT DEPARTMENTS
MIN. ACCOUNT ORDER £10.00

P&P AS SHOWN IN BRACKETS (HEAVY ITEMS)
65p OTHERWISE (LIGHT ITEMS)

ADD 15% VAT TO TOTAL
ELECTRONIC COMPONENTS
BOUGHT FOR CASH



KEYTRONICS

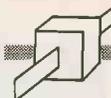
TEL. 0279-505543

FAX. 0279-757656

P O BOX 634

BISHOPS STORTFORD

HERTFORDSHIRE CM23 2RX



High frequency (hf) radio relies on radio waves being bent through the atmosphere for the signal to reach the distant end. The demarcation between low, high and very high frequency radio is a demarcation by frequency as shown in Fig. 1, and although hf radio will be concentrated upon here, the other forms will be touched on for completeness.

RADIO WAVE PROPAGATION

Radio energy can be visualised as rippling away from a point source like water rippling away when an object is thrown into a pond. The only difference is that radio energy ripples away three dimensionally, ie, in the shape of a spherical front unless deliberately suppressed in the backward and sideways directions so as to concentrate the energy in the forward direction.

Therefore the power decreases by the square of the distance as given by the formula

$$P = \frac{\text{Total power radiated}}{4\pi \gamma^2}$$

Where P is the power at distance γ .

The wavefront consists of an electrical component and magnetic component at

	Frequency	Wavelength	Application
Very low frequency (VLF)	3-30kHz	100,000-10,000m	Standard frequencies and time signals
Low frequency (LF)	30-300kHz	10,000-1,000m	Broadcast, mobile, navigation maritime
Medium frequency (MF)	300-3,000MHz	1,000-100m	Broadcast, mobile, navigation maritime
High frequency (HF)	3-30MHz	100-10m	Broadcast, mobile, maritime aeronautic, amateur
Very high frequency (VHF)	30-300MHz	10-1m	Radio navigation, radio and TV broadcast
Ultra high frequency (UHF)	300-3000MHz	100-10cm	Meteorological, space communication, mobile, maritime, aeronautic, amateur, radio location and navigation, TV broadcast
Super high frequency (SHF)	3-30GHz	10-1cm	Space and satellite, radio location and navigation, mobile

Fig.1 Radio frequency bands

THE GROUND WAVE

For horizontally polarised waves the electric field is short circuited at the earth's surface, therefore this method of propagation occurs only with vertical polarisation. The wave loses some of its energy to the earth and is therefore attenuated. The amount of energy lost depends on the terrain. For

the absence of the sun. The E layer helps mf propagation and reflects some hf.

Sometimes a thin layer of high density ionisation appears with the E layer and remains through the night. Although it does not assist long distance communication, it gives unexpectedly good reception.

Of the two F layers, F2 is the more important for reflecting hf radio and it persists at night. The height and ionisation

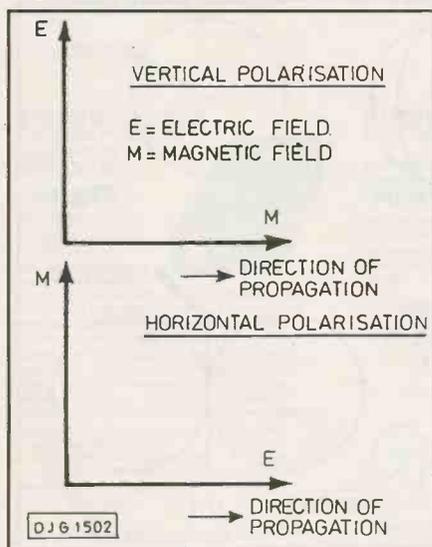
HF RADIO

right angles to each other which is referred to as a transverse electro-magnetic (tem) wavefront. The plane of the electric field determines whether the wave is horizontally or vertically polarised, Fig. 2.

In general, electro-magnetic waves travel in straight lines except where the earth and atmosphere change the path. There are three methods of propagation:

1. The ground or surface wave
2. The sky wave
3. The space wave

Fig.2. Polarisation



BY MIKE SANDERS

The first in a series on practical radio propagation, from aerials to atmospheric.

instance this is greater over rocky land than over the open sea.

Propagation by this means is limited to low frequencies 20kHz to 2MHz since attenuation increases with frequency.

THE SKY WAVE

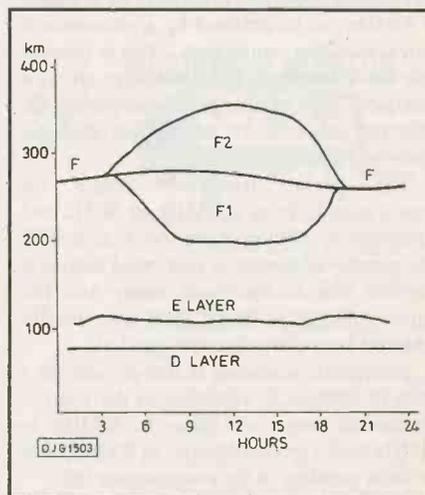
In the earth's atmosphere, where the pressure is lower (100km to 300km up), free electrons are produced as a result of ionisation by energy from the sun. From measurements of electron density the atmosphere has been divided into layers D, E, F1 and F2 as in Fig. 3. At night the F1 and F2 layers combine into a single layer.

The D layer depends on the latitude of the sun and disappears at night. It reflects vlf and lf waves but does not affect hf much. The E layer also disappears at night like the D layer owing to de-ionisation in

density of the F2 layer vary with the time of day, season of year and sunspot cycle.

HF waves are returned to earth not by reflection but refraction, Fig. 4. The wave is gradually bent so that it finally emerges from the atmosphere and returns to earth. The refractive index of the layer reduces with increased ionisation and there is a maximum usable frequency depending on the ionisation, height of the layer and the angle of incidence of the wave. Above this usable frequency, the wave escapes into space since it is not bent sufficiently to return to earth.

Fig.3. Ionisation layers



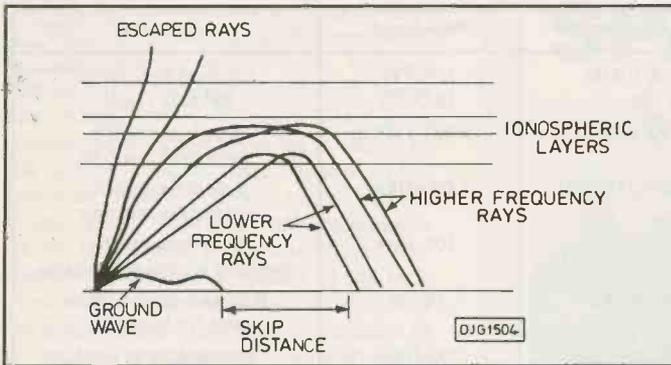


Fig.4. Refraction in the ionosphere

The dead space not served either by the ground wave or the sky wave is called the skip distance.

THE SPACE WAVE

Above 30MHz, the ground component is greatly attenuated and refraction in the ionosphere does not take place. Therefore propagation is direct, or line of sight, between transmitter and receiver. However the radio horizon is slightly greater than the optical horizon.

In the troposphere, Fig. 5, the lower part of the atmosphere, the temperature and density of air decrease with height. Therefore the radio waves travel slightly faster in the upper atmosphere compared to closer to the earth. The results in a curved propagation path and an increase in the effective horizon.

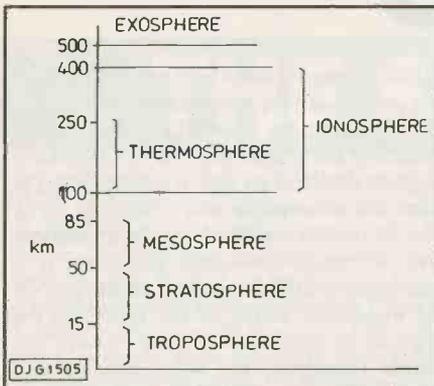


Fig.5. Atmospheric bands

Communications over distances greater than implied above and at frequencies in excess of 30MHz can be obtained by a phenomenon known as scatter propagation. This is because both the troposphere and ionosphere are in a continuous state of change. Consequently the refractive index of the atmosphere changes, scattering radio energy, Fig. 6.

The useful frequency range for troposcatter links is 400MHz to 5GHz and distances of 800km have been achieved. The penalty of course is that rapid fading is possible due to multipath delay and the signal strength is lower than that usually achieved by a direct line of sight link.

Ionospheric scattering is also possible as a result of changes in ionisation of the E layer. The useful frequency range is 30MHz to 70MHz over a ground distance of 200km, with the same penalties as for a troposcatter link.

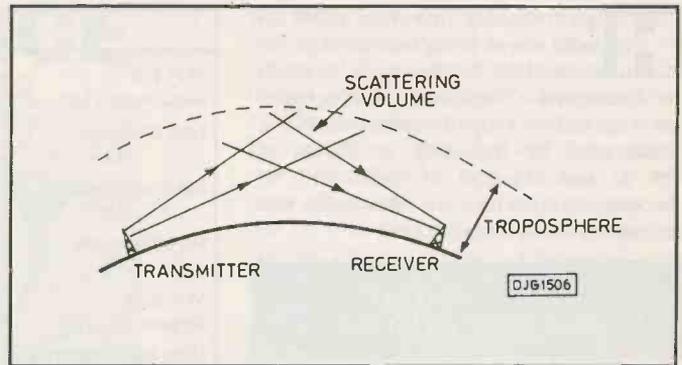


Fig.6. Troposcatter link

energy that is not reflected back at the open circuit escapes as radiation.

However, the radiation from the top wire cancels that from the bottom wire and only a little energy is radiated. If at the open circuited end the wires are parted, Fig. 8a, to give a horn shape, more energy is allowed to escape. Maximum energy radiates when the wires are bent at right angles to give what is called a dipole, Fig. 8b.

If the total length of the verticals is equal to half a wavelength, the aerial is called a half wavelength dipole. The horizontal radiation pattern of a vertical dipole is a circle, Fig. 9a, and the vertical pattern is a figure of eight, Fig. 9b, since the dipole radiates in both the forward as well as backward direction.

AERIAL RESONANCE

Resonant aerials could be described as opened out transmission lines such that the aerial is a half wavelength or a multiple of a half wavelength.

It was mentioned above that the vertical radiation pattern from a half wavelength dipole is a figure of eight. The vertical patterns for increasing lengths of aerial in free space are shown in Fig. 10. As the

THE WORK OF MARCONI

Guglielmo Marconi was born in Bologna, Italy in 1874 and died in Rome in 1937. He was a physicist and is accredited with much of the early work on radio. His early experiments with radio communication succeeded in detecting a signal 6km across Salisbury Plains and 14km across the Bristol channel.

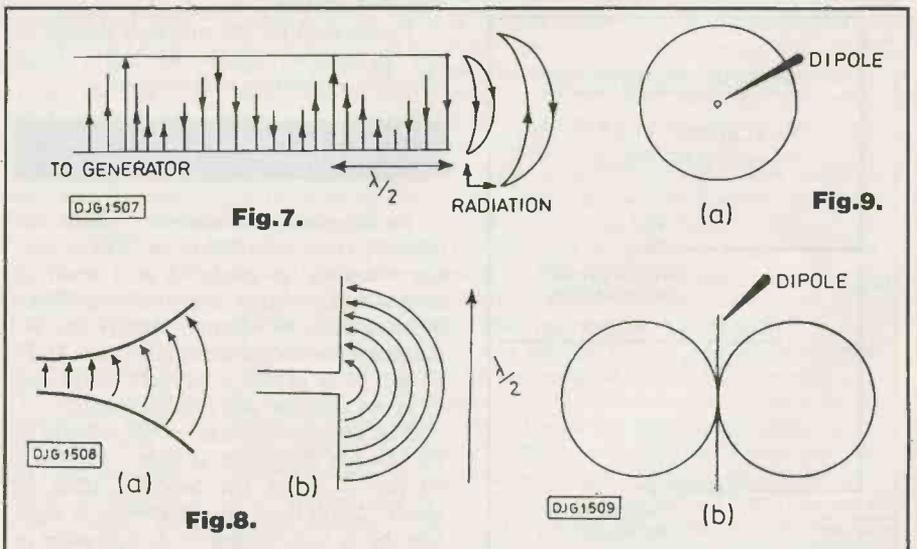
He founded a company which was renamed the Marconi Wireless and Telegraph Company in 1990. In spite of mathematicians who said that the curvature of the earth would limit radio communications to 322km, Marconi sent a signal from Poldhu in Cornwall to St John's in Newfoundland in 1901.

In 1918 he had improved his transmitters and receivers sufficiently to send a signal from England to Australia. His work also extended to the higher frequencies employing dish aerials for line of sight communications.

AERIALS

If an open circuited length of transmission line is considered, Fig. 7, forward and reflected waves combine to form a standing pattern as shown. The

Fig.7. Open circuited transmission line. Fig.8. (a) Horn shape, (b) Dipole. Fig.9. (a) Horizontal radiation pattern of vertical dipole, (b) Vertical radiation pattern of vertical dipole.



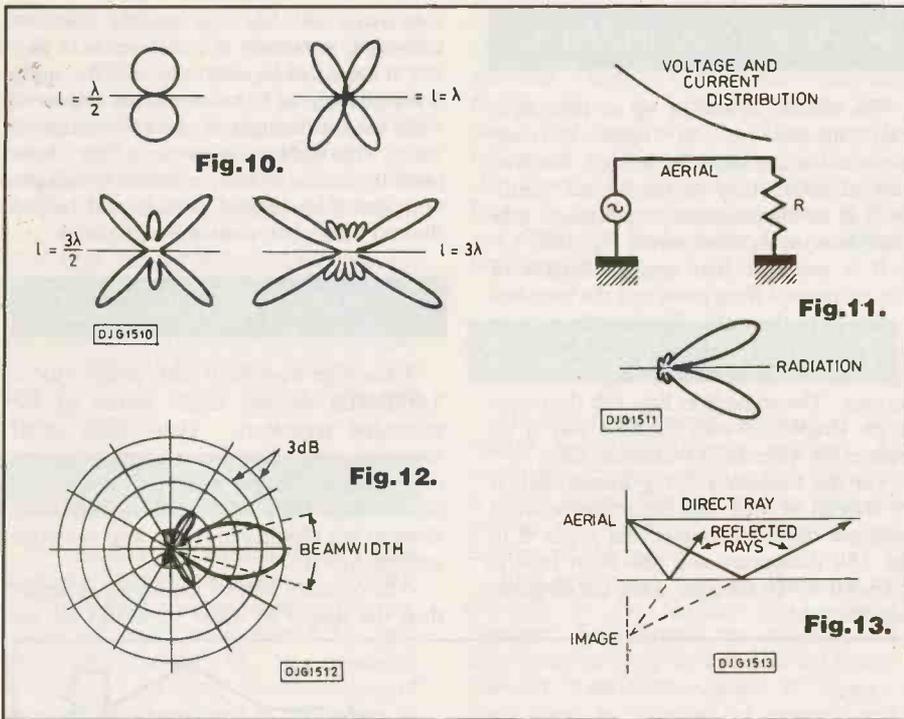
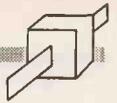


Fig.10. Pattern for increasing length of dipole.
Fig.11. The non-resonant aerial.
Fig.12. Beamwidth. Fig.13. Effect of the Earth.

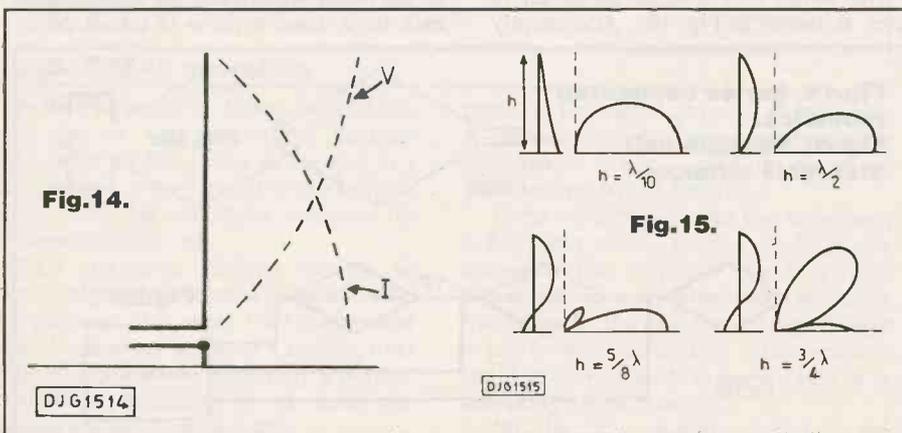
length of the aerial is increased the pattern builds up more lobes and the larger lobes come closer to the aerial.

Non resonant aerials on the other hand can be likened to non resonant transmission lines which are correctly terminated and therefore do not have standing wave patterns. Most of the forward energy is radiated and the remainder is dissipated in the termination, Fig. 11. Therefore the radiation pattern of the non resonant aerial is similar to that of the resonant aerial except that the former has only half the pattern, ie the forward pattern.

GAIN AND BEAMWIDTH

Since practical aerials are designed to radiate in the required direction some

Fig.14. An earthed dipole.
Fig.15. Aerial directivity with height.



means must be found of assessing their gain and beamwidth.

This is achieved by comparing the energy with that radiated by an isotropic radiator, ie, a theoretical aerial radiating uniformly in all directions.

The beamwidth can then be defined as the angle made by the two half power points of the main lobe, Fig. 12.

EARTH EFFECT

The earth may be thought of as a reflecting surface, Fig. 13, and some rays will be bounced off. Therefore the energy arriving at a particular point may be made up of a direct ray as well as a reflected ray and if these are in exact antiphase, no signal is picked up by the receiver at that point.

In considering reflected rays it is sometimes easier to visualise these as coming from a mirror image of the aerial, ie, an aerial located below the earth's surface.

LOW FREQUENCY AERIALS

These are restricted to frequencies up to 300kHz and therefore a vertical radiator is sufficient. If the previously described dipole of overall half wavelength is connected to a transmitter or receiver as in Fig. 14 so that one end is earthed, it has a voltage and current distribution as shown.

Although the aerial is theoretically resonant at a height of a quarter of a wavelength, in practice this occurs at a height of slightly less than $\lambda/4$ (where λ = wavelength).

Assuming that the resistance is negligible, the impedance of the aerial is capacitive for heights up to $\lambda/4$ and inductive between $\lambda/4$ and $\lambda/2$.

For economic reasons the height of the aerial may be limited to $\lambda/4$. For instance at 300kHz, this would be 800 feet which is quite an expensive tower. Since the aerial is capacitive for this height, it can be tuned by a series inductance.

Capacitance is deliberately added to the top of low frequency aerials and is achieved by turning the top half into an inverted 'L' or 'T' shape. The additional capacitance produces a uniform current distribution on the aerial and also reduces the overall capacitance of the aerial making a smaller tuning inductor possible.

MEDIUM FREQUENCY AERIALS

One of the most important applications of medium frequency aerials (used between 300kHz and 3MHz) is for broadcasting in the range of 550kHz to 1600kHz.

Early aerials for broadcasting in the 1920s were 'T' shaped with a piece of wire slung between two masts but insulated from the masts. There were many areas of fading where the ground wave neutralised the sky wave and therefore increasing the radiated power did not achieve anything.

It was left to Ballantine to show that there is a maximum height of aerial for maximum ground wave radiation. This led to the construction of a steel tower which acts as an aerial. It is on a ball and socket joint and insulated from earth, with stays to support the mast.

Fig. 15 shows the effect of increasing the height of the mast. At $\lambda/8$ a secondary lobe appears and predominates over the ground wave. Therefore in practice such aerials are limited to around $\lambda/2$.

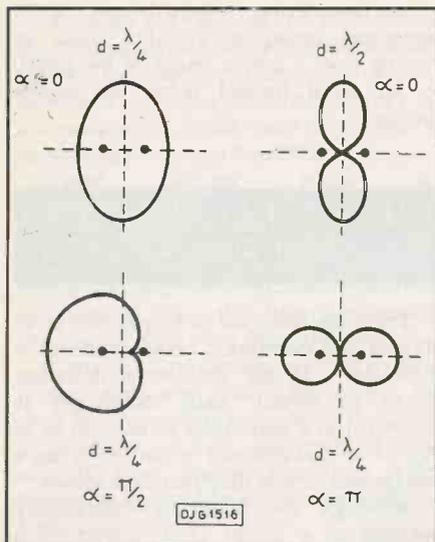


Fig. 16. Horizontal polar diagrams for two vertical aerials

HIGH FREQUENCY AERIALS

With frequencies of 3MHz to 30MHz the wavelengths are 100m to 10m and the aerial becomes small enough to point it in the direction of maximum signal. It also becomes small enough to place on roof tops.

Dipoles can be stacked together to form arrays. When they are placed side by side they are called a broadside array; placed one behind the other they are an end fire array; placed one above the other they are a collinear array.

Fig. 16 shows horizontal polar diagrams for two vertical aerials spaced a distance d apart and with the current in one aerial leading the current in the other aerial by angle α .

If a number of vertical aerials are placed the same distance apart, the radiation of the main lobes is perpendicular to the line formed by the aerials, Fig. 17, when the aerial currents are in phase. This is a broadside array and used quite a lot in practice in point to point working.

Since radiation is required only in the forward direction, the radiation in the reverse direction is suppressed by means of reflectors. The reflectors are similar to the aerials physically but they are not fed with power. If these reflectors are placed a distance of $\lambda/4$ behind the aerials the forward radiation is reinforced, and the backward radiation is cancelled, because of the currents induced in the reflectors from the main radiators.

In an end fire array the major lobe of radiation is along the axis of the array as shown in Fig. 16. In its simplest form a two element array will be spaced $\lambda/4$ and have a current difference of $\pi/2$. The width of the major lobe decreases as the array increases in length, but a broadside array of the same length provides a narrower lobe, and is often preferred.

AERIAL RESONANCE

The aerials described up to now have been likened to an open circuited transmission line radiating energy. Another class of aerials may be considered, terminated in its characteristic impedance. One example is the rhombic aerial, Fig. 18a.

It is made of four straight lengths of wire suspended from posts and the rhombus is parallel to the earth. The lengths may be from two to eight wavelengths long and the angle between them from 80 degrees to 150 degrees. The angle θ in Fig. 18b decreases as the lengths of wire increase and is 20 degrees for wires six wavelengths long.

For the frequency being transmitted, if the lengths of wire and the angle between them are chosen correctly, the angle θ in Fig. 18b disappears and one main lobe is produced which radiates along the diagonal from the feeder.

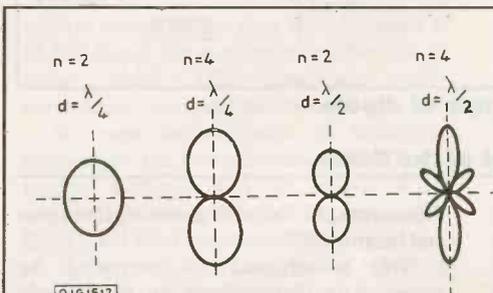


Fig. 17.

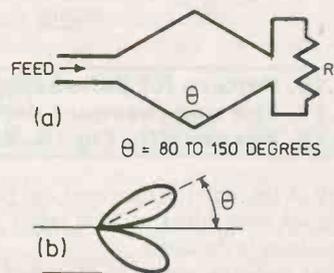


Fig. 18.

Fig. 17. Broadside arrays. Fig. 18. (a) Rhombic aerial, (b) Radiation pattern.

The rhombic aerial is used for both transmission and reception and is widely used in the hf range for point to point working. These aerials have replaced broadside arrays to a large extent because the input impedance and radiation pattern remain fairly constant over a wide range of frequencies.

A rhombic aerial also produces minor lobes and about half the power is dissipated in the termination. These problems are overcome by using two or more rhombics in parallel either on top of each other or side by side depending on the radiation pattern required.

The aerials may also be connected in series as shown in Fig. 19. Alternatively

they may still be in a straight line but connected separately to a receiver as in Fig. 20. If these can be steered to vary the angle θ then the signal to noise ratio is improved since the down angle of short wave signals varies throughout a twenty-four hour period. Such a system is called a multiple unit steerable antenna (musa) and helped the early days of transatlantic telephony.

AERIAL RESONANCE

Ultra high frequency (uhf) aerials (300 – 3,000MHz) employ small aerials as for television reception. These have small elements and produce a narrow beam depending on the number of directors used in the Yagi array of Fig. 21. The main element is a dipole and is the only one to be excited directly.

The reflector behind the dipole is longer than the dipole in order to reflect all the

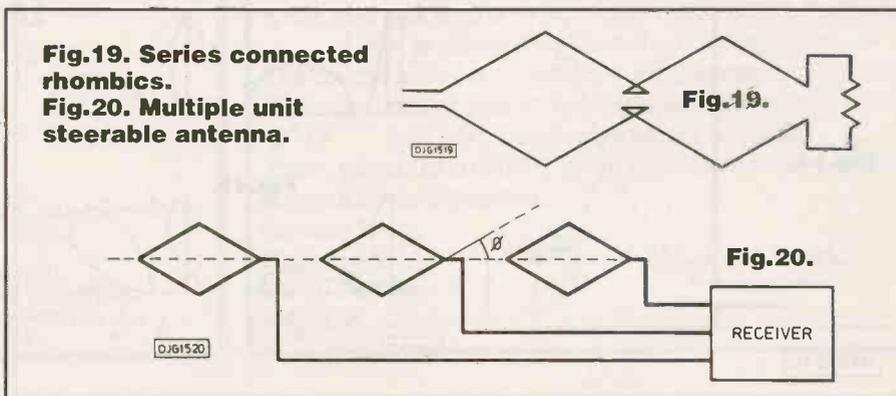
backward energy forward. The directors in front of the dipole are shorter than the dipole and assist beam shaping.

The object of all radio communication systems is to transmit the desired bandwidth and detect it at the receiver in spite of the noise in the atmosphere and thermal noise in the circuits. This means in general that the signal has to be above the noise level and merely increasing the receiver sensitivity will not improve signal detection. Therefore the transmitter output must be increased.

The stages of a radio receiver may be summarised as in the block diagram of Fig. 22 but before we examine the techniques of each stage, some revision of circuit theory

Fig. 19. Series connected rhombics.

Fig. 20. Multiple unit steerable antenna.



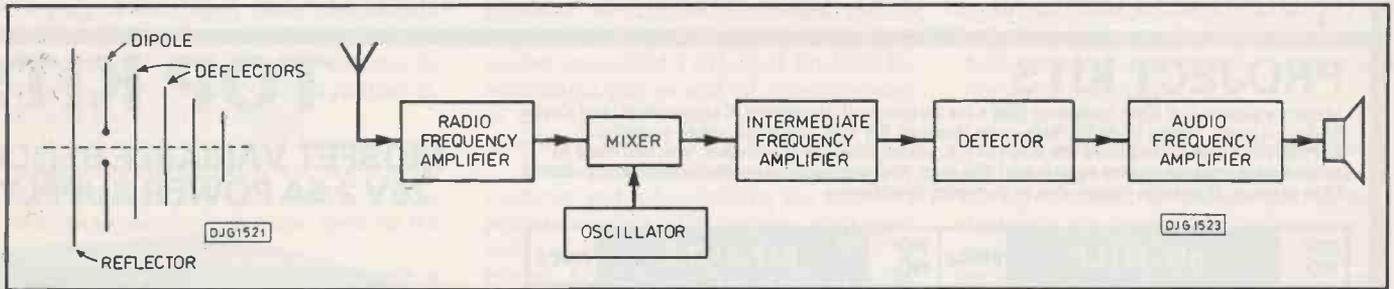
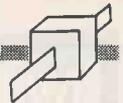


Fig. 21. (left) UHF aerial. Fig. 22. (right) Radio receiver block diagram.

would be useful. For instance thermal noise mentioned above is present in every circuit. Also tuned circuits are used extensively, particularly around the intermediate frequency stage to pass only the frequencies in the range of interest.

THERMAL NOISE

Thermal noise has a uniform spectrum up to 10^{13} Hz, as white light does. This can be likened to white light which has all colours. The noise voltage through a metallic resistor is given by:

$$V^2 = 4KTRB$$

where B = bandwidth in Hz

K = Boltzman's constant

T = temperature in Kelvin

The above equation implies that minimum bandwidth must be used to transmit the signal in order not to degrade the signal to noise ratio.

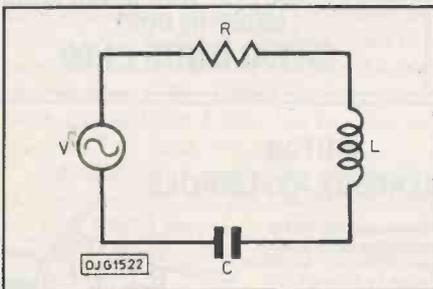


Fig. 23. Series tuned circuit

RESONANCE AND ENERGY COUPLING

Resonance may occur in series or parallel tuned circuits. In the series tuned circuit of Fig. 23, resonance occurs when

$$\omega L = \frac{1}{\omega C} \quad \text{or} \quad f = \frac{1}{2\pi LC}$$

Bandwidth is defined as the two frequencies on either side of the resonant frequency, at which the power drops to half or by 3dB.

The Q of a circuit is a figure of merit and the general definition is:

$$Q = \frac{2\pi \times \text{maximum instantaneous energy stored in the circuit}}{\text{energy dissipated per cycle}}$$

For the series circuit of Fig. 23

$$Q = \frac{\omega L}{R} = \frac{f}{B}$$

where B is the bandwidth.

In the parallel resonant circuit of Fig. 24, the same equation applies:

$$f = \frac{1}{2\pi LC}$$

$$Q = \frac{f}{B} = \omega CR$$

The equivalent circuit of a single tuned transformer is shown in Fig. 25 and the coupling efficiency called the coupling coefficient (k) is given by:

$$k = \frac{M}{L_1 L_2}$$

The equivalent circuit of a double tuned transformer is shown in Fig. 26 and the coupling co-efficient is given by:

$$k = \frac{M}{L_p L_s}$$

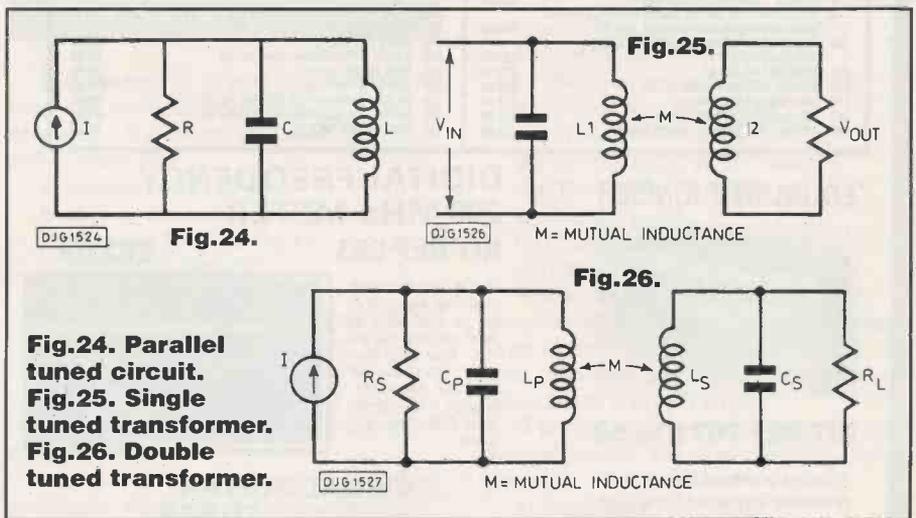


Fig. 24. Parallel tuned circuit. Fig. 25. Single tuned transformer. Fig. 26. Double tuned transformer.

The Q of a network can never be greater than the Q of the coil. For air cored coils the Q is 100 to 200 and for ferrite cores the Q is 50 to 100. In the vhf range (30MHz to 300MHz) helical resonators with a Q of 100 are used.

Capacitors behave as series LC circuits because of the internal inductance of the leads, and radio frequency coils behave like parallel LC circuits because of the distributed capacitance between the windings.

Since radio frequency chokes present a high impedance, the resonant frequency of the circuit needs to be less than the resonant frequency of the choke. The cores are usually iron, ferrite or phenolic.

The coupling of energy from one stage to another is usually by transformers particularly around the intermediate frequency (if) stages. The double tuned transformer is mostly used around the if stage with the single tuned transformer used around other stages like the rf stage.

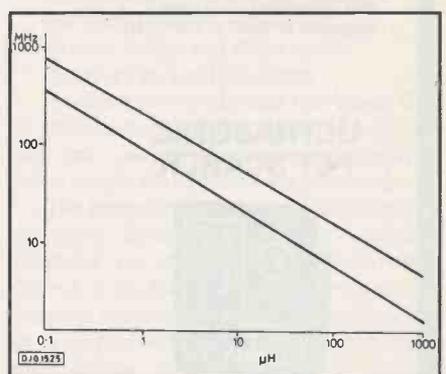


Fig. 27. Self resonant frequency range for a given inductor.

In the next part we shall look at the essential parts of a radio receiver.



MAGENTA ELECTRONICS Ltd

PROJECT KITS

Magenta supply Full Kits: Including PCB's (or Stripboard), Hardware, Components, and Cases (unless stated). Please state Kit Reference Number, Kit Title and Price, when ordering.
REPRINTS: If you do not have the issue of P.E. which includes the project, you will need to order the instruction reprint as an extra: 80p each. Reprints are also available separately - Send £1 in stamps. Magazine dates refer to Everyday Electronics.

REF NO.	KIT-TITLE	PRICE	REF NO.	KIT-TITLE	PRICE
812	ULTRASONIC PET SCARER May 89	£13.80	581	VIDEO GUARD Feb 87	£8.39
811	MIDI PEDAL Mar 89	£39.98	584	SPECTRUM SPEECH SYNTH. (no case) Feb 87	£20.92
810	MIDI MERGE Mar 89	£11.59	578	SPECTRUM I/O PORT less case Feb 87	£3.44
809	CALL ALERT Mar 89	£13.51	569	CAR ALARM Dec 86	£12.47
807	MINI PSU Feb 89	£22.71	563	200MHz DIG. FREQUENCY METER Nov 86	£62.98
806	CONTINUITY TESTER Feb 89	£10.28	561	LIGHT RIDER LAPEL BADGE Oct 86	£10.20
505	4 CHANNEL LIGHT DIMMER Feb 89	£37.99	560	LIGHT RIDER DISCO VERSION	£19.62
803	REACTION TIMER Dec. 88	£29.98	559	LIGHT RIDER 16 LED VERSION	£13.64
802	PHASOR (Light Controller) Dec 88	£25.61	556	INFRA-RED BEAM ALARM Sept 86	£28.35
801	DOWNBEAT METRONOME Dec 88	£17.57	544	TILT ALARM July 86	£7.82
800	SPECTRUM EPROM PROGRAMMER Dec 88	£26.97	542	PERSONAL RADIO, June 86	£11.53
796	SEASHELL SYNTHESIZER Nov 88	£24.99	528	PA AMPLIFIER May 86	£26.95
795	I.R. OBJECT COUNTER Nov 88	£29.83	523	STEREO REVERB Apr 86	£26.44
790	EPROM ERASER Oct 88	£24.95	513	BBC MIDI INTERFACE Mar 86	£27.94
786	UNIVERSAL NICAD CHARGER July 88	£6.99	512	MAINS TESTER & FUSE FINDER Mar 86	£8.82
780	CABLE & PIPE LOCATOR April 88	£15.35	497	MUSICAL DOOR BELL Jan 86	£18.72
775	ENVELOPE SHAPER Mar 88	£14.99	493	DIGITAL CAPACITANCE METER Dec 85	£41.55
769	VARIABLE 25V-2A BENCH POWER SUPPLY Feb 88	£49.73	481	SOLDERING IRON CONTROLLER Oct 85	£5.47
	CAR LAMP CHECKING SYST. Feb 88	£7.10	464	STEPPER MOTOR INTERFACE FOR THE BBC COMPUTER less case Aug 85	£11.68
763	AUDIO SIGNAL GENERATOR Dec 87	£13.64		1D35STEPPER MOTOR EXTRA	£14.50
739	ACCENTED BEAT METRONOME Nov 87	£20.95		OPTIONAL POWER SUPPLY PARTS	£5.14
740	ACOUSTIC PROBE Nov 87 (less bolt & probe)	£16.26	461	CONTINUITY TESTER July 85	£6.20
744	VIDEO CONTROLLER Oct 87	£9.70	455	ELECTRONIC DOORBELL June 85	£7.56
745	TRANSTEST Oct 87	£17.17	453	GRAPHIC EQUALISER June 85	£26.94
734	AUTOMATIC PORCH LIGHT Oct 87	£9.86	444	INSULATION TESTER Apr 85	£19.58
736	STATIC MONITOR Oct 87	£46.96	430	SPECTRUM AMPLIFIER Jan 85	£6.91
723	ELECTRONIC MULTIMETER Sept 87	£14.31	392	BBC MICRO AUDIO STORAGE SCOPE INTERFACE Nov 84	£36.25
728	PERSONAL STEREO AMP Sept 87	£13.57	387	MAINS CABLE DETECTOR Oct 84	£5.53
730	BURST-FIRE MAINS CONTROLLER Sept 87	£38.39	386	DRILL SPEED CONTROLLER Oct 84	£8.68
724	SUPER SOUND ADAPTOR Aug 87	£26.53	362	VARICAP AM RADIO May 84	£13.15
718	3 BAND 1.6-300MHz RADIO Aug 87	£26.53	337	BIOLOGICAL AMPLIFIER Jan 84	£24.14
719	BUCCAENEER I.B. METAL DETECTOR inc. coils and case, less handle and hardware July 87	£26.45	263	BUZZ OFF Mar 83	£5.68
720	DIGITAL COUNTER/FREQ METER (10MHz) inc. case July 87	£87.07	242	2-WAY INTERCOM no case July 82	£5.69
722	FERRICITAT July 87	£12.14	240	EGG TIMER June 82	£6.86
711	VISUAL GUITAR TUNER Jun 87	£22.99	205	SUSTAIN UNIT Oct 81	£17.63
715	MINI DISCO LIGHT Jun 87	£12.59	108	IN SITU TRANSISTOR TESTER Jun 78	£9.42
707	EQUALIZER (IONISER) May 87	£15.53	106	WEIRD SOUND EFFECTS GEN Mar 78	£7.82
700	ACTIVE I/R BURGLAR ALARM Mar 87	£35.65	101	ELECTRONIC DICE Mar 77	£6.26

'EQUALISER' IONISER



KIT REF 707 £15.53

A mains powered Ioniser that produces a breeze of negative ions in the air. A compact, safe, simple unit that uses a negligible amount of electricity.

ULTRASONIC PET SCARER



Produces high power ultrasound pulses. L.E.D. flashes to indicate power output and level. Battery powered (9V-12V or via *Mains Adaptor).

KIT REF 812 £13.80
***Mains Adaptor £1.98**

DIGITAL FREQUENCY 200 MHz METER

KIT REF 563

£62.98

An 8 digit meter reading from A.F. up to 200 MHz in two ranges. Large 0.5" Red LED display. Ideal for AF and RF measurements. Amateur and C.B. frequencies.



VISUAL GUITAR TUNER



Crystal controlled, with a super rotating LED display. Indicates high, low, and exact degree of mistuning. Use with pick-up or mic. Also has audible output.

KIT REF E711 £21.99

3 BAND SHORTWAVE RADIO

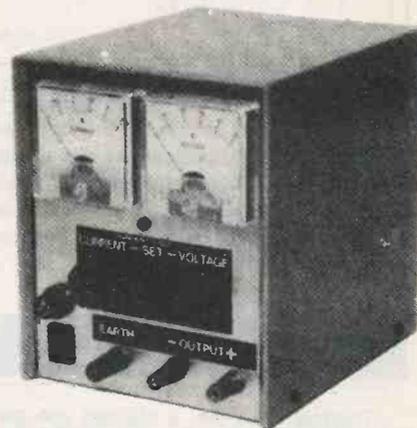


OUR KIT REF 718 £26.53

Covers 1.6-30 MHz in 3 bands using modern miniature coils. Audio output is via a built-in loudspeaker. Advanced design gives excellent stability, sensitivity and selectivity. Simple to build.

TOP KITS

MOSFET VARIABLE BENCH 25V 2.5A POWER SUPPLY



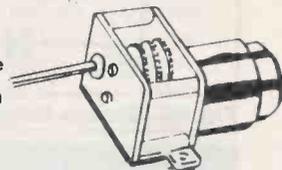
A superb design giving 0-25V and 0-2.5A. Twin panel meters indicate Voltage and Current. Voltage is variable from zero to 25V. Current-limit control allows Constant Current charging of NICAD batteries, and protects circuits from overload. A Toroidal transformer MOSFET power output device, and Quad op-amp IC design give excellent performance.

OUR KIT REF. 769 £49.73

COMPONENTS, KITS, BOOKS, TOOLS, MOTORS, GEARS, PULLEYS, OPTICAL FIBRES, ROBOTICS, AND MUCH MUCH MORE-IN OUR CATALOGUE £1.00

MOTOR-GEARBOX ASSEMBLIES

Miniature gearboxes complete with quality electric motor. Variable ratios by fitting 1 to 6 gears. 1.5-4.5v. 3-2200 rpm. Long 3mm shaft. Ideal for robots and buggies.



SMALL (MGS) £3.49 LARGE (MGL) £3.98

ADVENTURES WITH ELECTRONICS

BOOK £4.75 PACK £20.98
 An easy to follow book suitable for all ages. No soldering, uses an S DEC breadboard. Lots of clear diagrams and instructions to build 16 projects. Component pack includes S DEC and all components for the projects.

LEGO Technic Sets
 TEACHERS WE ARE STOCKISTS OF THE WHOLE RANGE. CONTACT US FOR BROCHURES. VERY COMPETITIVE PRICES AND QUICK DELIVERIES

STEPPING MOTORS 12 VOLT

48 STEPS 1035 £14.50
 200 STEPS MD200 £16.80

OPTICAL FIBRES TRIAL PACK OF 10 METRES. Nine assorted types & data.

£1.99

0283 65435



MAGENTA ELECTRONICS LTD
PE 13 HUNTER STREET,
BURTON-ON-TRENT,
STAFFS. DE14 2ST.
0283 65435, Mon-Fri 9-5 Sat 9-2
Access/Barclaycard (Visa) by
phone or post.
24 hr Answerphone for credit
card orders.
Our prices include VAT

ADD £1 P&P TO ALL ORDERS.
PRICES INCLUDE VAT.
SAE ALL ENQUIRIES.
OFFICIAL ORDERS WELCOME
OVERSEAS: Payment must be
sterling.
IRISH REPUBLIC and BFPO. UK
PRICES.

FROM MAGENTA

A SELECTION OF OUR BEST PROJECT KITS

As usual these kits come complete with printed circuit boards, cases, all components, nuts, screws, wire etc. All have been tested by our engineers (many of them are our own designs) to ensure that you get excellent results.

INSULATION TESTER

An electronic High Voltage tester for mains appliances and wiring. An inverter circuit produces 500 volts from a PP3 battery and applies it to the circuit under test. Reads insulation up to 100 Megohms. Completely safe in use.



OUR KIT REF 444 £19.58

DIGITAL CAPACITANCE METER

Simple and accurate (1%) measurements of capacitors from a few pF up to 1,000 uF. Clear 5 digit LED display indicates exact value. Three ranges -- pF, nF, and uF. Just connect the capacitor, press the button and read the value.



£41.55
OUR KIT
REF 493

MAGENTA

LOWCOST

68000

**CROSS-ASSEMBLER
FOR BBC. ALSO
AVAILABLE
£60.00
(DISK)**

**68020
PLUG-IN UPGRADE
NOW AVAILABLE
PLEASE ASK FOR DETAILS**

**USED
BY SCHOOLS
COLLEGES &
UNIVERSITIES
U.K & WORLDWIDE**

**MICROPROCESSOR
TRAINER
AND SINGLE
BOARD
COMPUTER**

***PERFECT FOR ROBOTICS
APPLICATIONS REQUIRING
POWER AND SPEED***

**KIT PRICE
£110 INC VAT**

**OTHER OPTIONS, DATA PACKS,
AND LITERATURE AVAILABLE
- SEND FOR DETAILS.**

- Full 8MHz 68000 Processor with 16 bit data bus.
- Top-class monitor program Included on two Eproms.
- Communicates via RS232 interface to terminal, BBC computer, P.C. computer etc.
- Use as a Trainer, or as a stand-alone computer system.
- Fast, powerful processing - Ideal for real time control systems.

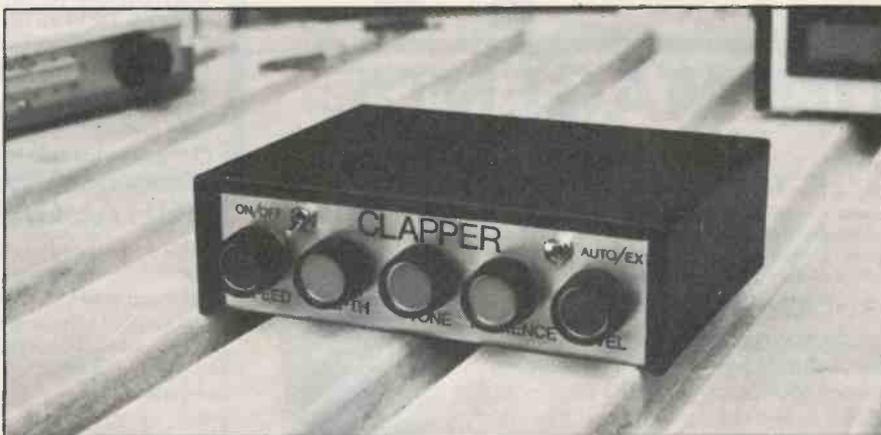
- Dual U.A.R.T. allows simultaneous connection of printer and terminal.
- Add-on options include: G64 Bus, 68230 P.I.T. 8k and 32K Ram upgrades, and line by line assembler.
- Available from stock now - with support literature and full technical back up.

STANDARD SYSTEM IN KIT FORM (Ref 600)	£410.00	68230 P.I.T. ADD ON OPTION (Ref 603)	£ 11.97
STANDARD SYSTEM BUILT & TESTED	£190.00	G64 BUS ADD-ON (Ref 604)	£ 5.49
LINE BY LINE ASSEMBLER PROGRAM (IN EPROM)	£ 27.00	8K x 16 RAM UPGRADE (Ref 605)	£ 19.25
POWER SUPPLY (Ref 609)	£ 13.99	32K 16 RAM UPGRADE Ref 606	Phone

Probably even before primitive man discovered the techniques of producing harmonic sounds with wind and stringed instruments, he would already have known that his body was a multipurpose musical instrument. With our mouths and vocal chords we can produce an astonishing range of musical tones, and with our limbs can create an equally varied range of percussion sounds.

APPLAUSIBLE

One of the most frequent sounds we produce, whether we are musical or not, is created by sharply bringing our hands together, the act of clapping. By clapping we can signify many states of emotion, ranging from approval or disapproval to rhythmic accompaniment. Strangely, approval and disapproval are differently interpreted by different races. In some countries the synchronised clapping by an audience signifies approval, whereas in others it can be a sign of derision. In Britain we seem to prefer slow synchronisation for expression of dissatisfaction and fast non-synchronisation, randomness, for approval. All cultures, though, seem to be in agreement about the use of clapping as a rhythmic expression of musical beat.



designing an oscillator that produces pulses on a regular basis. If the pulse generator is made to produce clicks at different rates, the sound, though uninteresting on its own, can serve as a

allowing the noise to decay in volume after the end of the click. We can even cater for the simulation of different clap reverb times by making the decay and amplitude variable.

HAND CLAPPER

In view of the universal use of handclapping as a musical beat it is perhaps surprising that electronic clapping machines have hardly ever been published in diy electronics journals. Most musical projects have been concerned primarily with the modification of sounds from existing instruments, or the creation of sounds that synthesise those of conventional instruments. Certainly, rhythm generators have been published from time to time, but these basically have been intended for simulating instruments such as drums, cymbals and gongs.

MONOTONY

Producing an electronic simulation of hand clapping is not very complex, although it takes a fair number of components since we ideally need to also create ambience, echo and tonal variation. However, I shall avoid the philosophical conundrum of attempting to simulate the sound of one hand clapping!

In its most basic form the sound of two hands coming together as a clap can be created by regularly feeding sharp transient pulses into a loudspeaker. In other words all you need is a click generator. This can be readily formed by

BY HARVEY KENT

A simple effects device which can be triggered by computer or signal, mike or midi, or just left to clap itself.

metronome, setting the basic beat which other instruments can follow.

Greater interest can be produced by varying the pulse length so that the clicks assume a different tone. But the result still lacks the reality we usually associate with hand clapping. Unless we are outside, there is always a degree of echo produced by a clap as its sound reflects off walls and furnishings, returning to the listener at slightly delayed rates. This reverberation could easily be produced by using an electronic echo or reverb unit, but there is an alternative, and less expensive method of simulating a similar effect. We can give the impression of clap reverb by keying in a white noise generator at the start of the pulse, and

SYNC AND DELAY

We can also create an even greater approach to reality by simulating echo as well as reverb. The same technique will also give the impression that more than one pair of hands is clapping on the same beat. Naturally precise synchronisation of several pair of hands will never occur and so the simulation can be enhanced if there is a brief delay between the claps. In our circuit then, we must have a sequence of pulses, occurring one after the other, all triggered by a common cause. This train of pulses is then mixed together, accompanied by the white noise ambience, or reverb, signal. In our full circuit we shall want to allow for the clapping to be repeatedly cycled through under automatic control, or for it to be triggered from an external source.

Having laid down the basic requirements for a clapping machine, let's look at the practicalities. I considered two approaches to producing a series of clicks triggered by a common source, one digital, the other analogue.

DIGITAL REPEATS

For the digital approach I could use a gated oscillator and a counter such as in Fig. 1. The oscillator output is fed to a

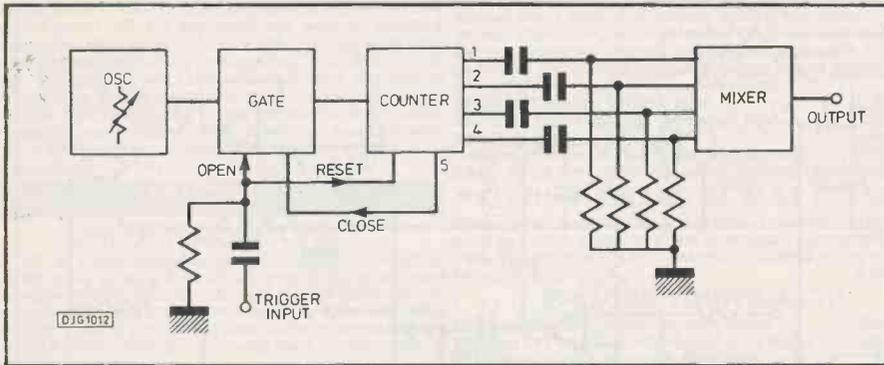


Fig.1. Digital pulse train generator.

gate which is controlled by two sources, the original starting pulse, and the final output of the counter. Each counter output has its pulse differentiated by the resistor-capacitor networks which are fed through to a mixer. The gate opens in response to a starting pulse, either from another, slower running, oscillator, or from an external trigger source. When open, the state allows pulses from the main oscillator to pass through to the counter. Each pulse triggers the counter on by one stage, each stage producing its own output click. When the counter reaches a predetermined output, in this case output five, the output causes the gate to close. Naturally, no more pulses will pass through, and no more clicks will be heard. On receipt of the next trigger pulse, the counter is reset, the gate reopens, and the cycle is repeated.

dividers. The voltage level at each resistance junction is of course different, becoming higher as we move up the chain from the bottom to the top. Consequently, each comparator will only change its output state when the input voltage is greater than the reference level. If the input voltage were to be a sudden change from minimum to maximum voltage, all four comparators would change state practically instantaneously. However, if we slowly increase the input voltage, there will be a delay between each comparator being tripped. Consequently, the output pulses will be heard as separate clicks. What we need, then, is for the starting pulse to initiate a ramped change in voltage level.

ANALOGUE COMPARISON

The analogue technique I have enclosed here instead shows how a series of comparators can be used to achieve the same results. Fig. 2. There are four main comparators used, each having a different reference level trip point. Each comparator output is fed through differentiators through to a mixer, as in the digital approach. The different reference levels are set by a chain of resistors coupled as a series of potential

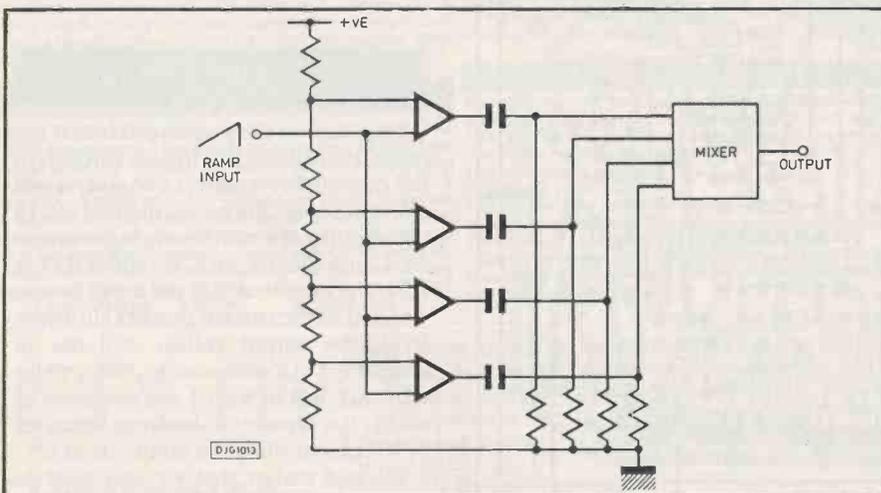


Fig.2. Analogue pulse train generator.

So, let's see how this is achieved in practice, in the block and main circuit diagrams of Figs. 3 and 4. For the moment we will assume that the initial trigger pulse comes from an unspecified source, through S1 to C1. IC1a is configured as a high gain amplifier which ensures that even quite low level input pulses will be amplified to a maximum output level swing.

EXTENDED TRAINING

This pulse creates the first of the clicks, being differentiated by C5 and R13 to pass via D4 to IC3. We'll look at IC3 presently. When the output of IC1a goes high in response to the trigger pulse, it also goes via D1 to charge up C2. The purpose of this capacitor is to extend the effective length of the trigger pulse so that we have time to make full use of its swing. Although the charge will eventually leak away via R39 it will remain high long enough for it to be fed via VR1 and R5 to charge up R3. The rate at which C3 will charge can be varied by VR1. The chain of reference level resistors consists of R6 to R10. As C3 charges up so its voltage level successively passes each trip point set by the resistor chain. Consequently, each comparator trips in a delayed sequence

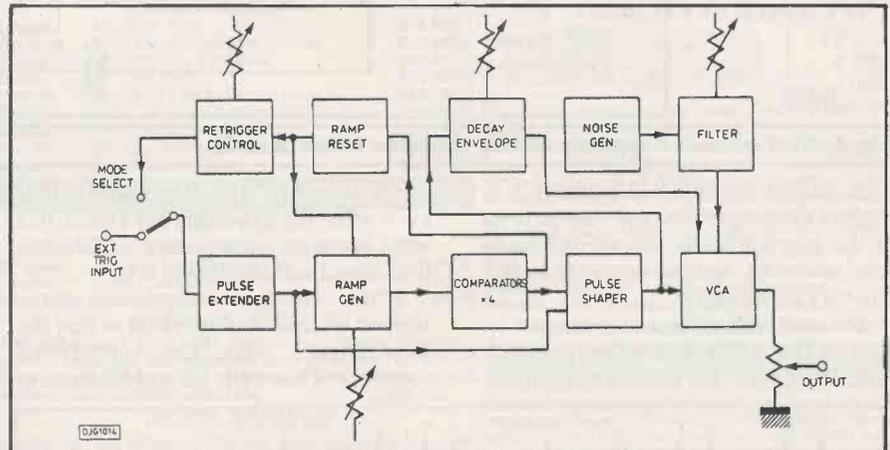


Fig.3. Block diagram of clapper effects unit.

as discussed above. Each of the four outputs is differentiated and fed via diodes to IC3. Each trigger pulse thus creates five pulses to be delivered to IC3.

IC3 is a voltage controlled amplifier. Ignoring for the moment its other control and input sources, IC3 will only open when a suitable voltage level appears at its control node pin 5. The output will then swing in sympathy allowing any signal input to pass through to C11 and the volume control VR2. The output from VR2 is intended for feeding to any normal amplifier system.

RAMPING SAWTOOTH

Each of the five generated pulses are summed at the junction of D4 to D8, and increasingly charge up C4. Between

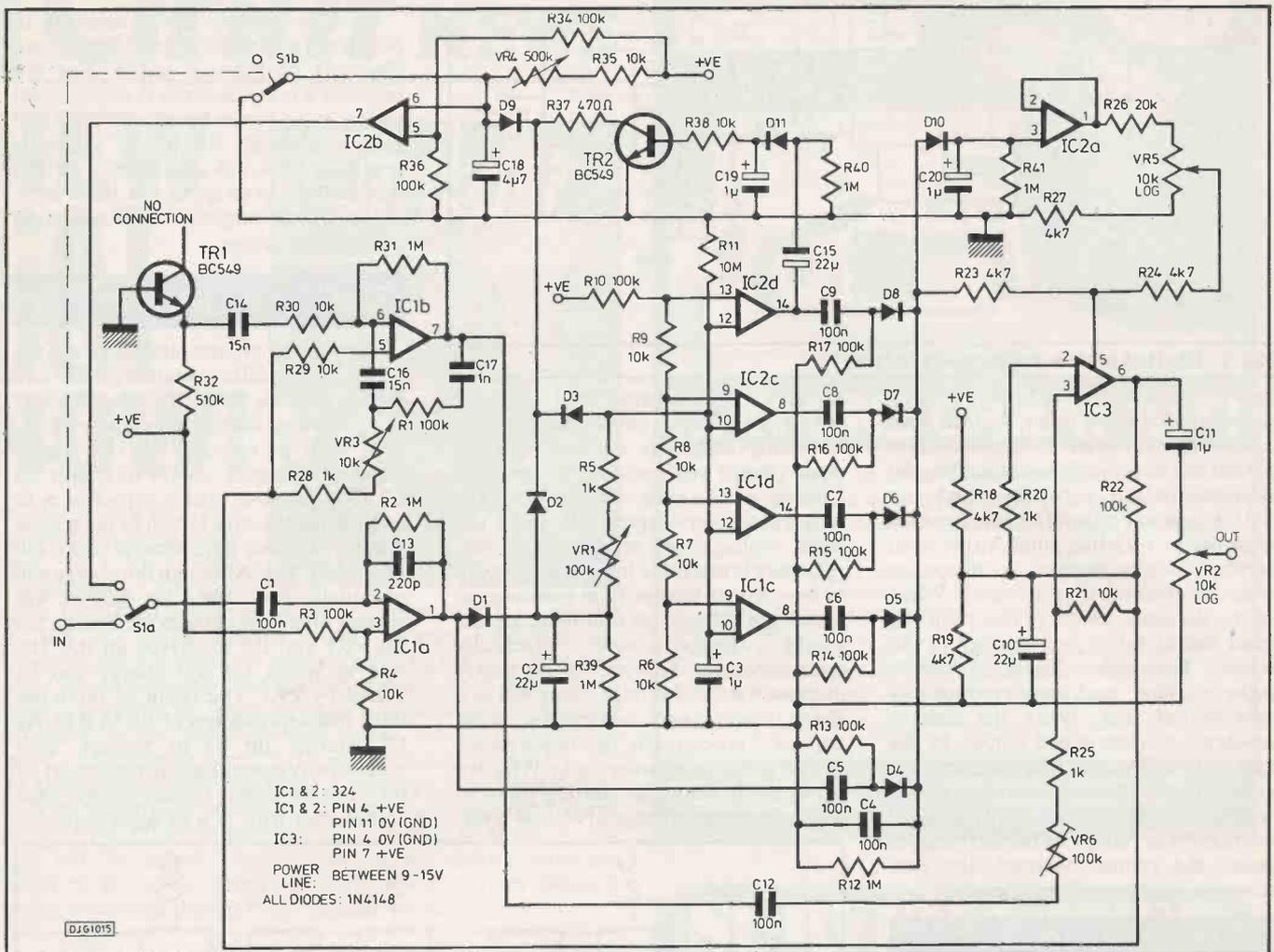


Fig.4. Full circuit diagram of the clapper effects unit.

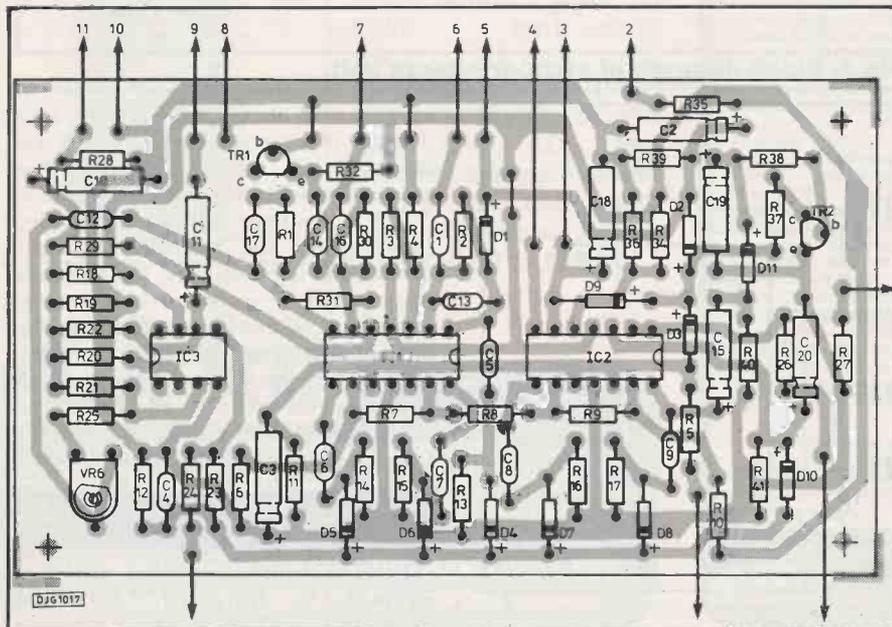
each pulse received, R13 causes C4 to slightly discharge. Thus the voltage level at the junction looks like an increasing level sawtooth, and the output from IC3 will vary accordingly.

The sawtooth voltage also charges up C20 via D10. IC2a then buffers the level, and also feeds to the control node of IC3

at a level set by VR5. The result is that even after the sawtooth has ended IC3 will remain open until C20 has discharged sufficiently via R41.

When all the comparators have tripped we need to reset them so that the next trigger pulse can repeat the sequence. Thus both C2 and C3 have to

be discharged. The output from the final comparator, IC2d, is fed via C15 and D11 to charge up C19. This causes TR2 to be turned on which discharges C2 and C3 via R37, D2 and D3. The value of C19 has been chosen to let TR2 remain open long enough to allow adequate discharge of C2 and C3. Without C19 you will see that TR2 could remain open only until IC2d had reverted to its low level state, a situation which would not necessarily sufficiently discharge C2 and C3.



PASSING OUT

Time now to see just what it is that the pulse train allows IC3 to pass through to the output. For a start, of course, it will effectively pass the pulses themselves. In the absence of a sufficiently high current on its control node pin 5, via either R23 or R24, the output at IC3 pin 6 will be low. As soon as the current reaches sufficient level, the output voltage will rise in sympathy. Consequently, the pulse sequence will be heard as a sequence of clicks, the separation between them set by VR1 controlling the ramp rate at C3.

We said earlier that we also want to introduce a certain amount of reverb, or ambience simulation from a white noise



COMPONENTS

RESISTORS	
R2, R12, R31, R39-R41	1M (6 off)
R1, R3, R10, R13-R17, R22, R34, R36	100k (11 off)
R4, R6-R9, R21, R29, R30, R35, R38	10k (10 off)
R5, R20, R25, R28	1k (4 off)
R11	10M
R18, R19, R23, R24, R27	4k7 (5 off)
R26	20k
R32	510k
R37	470
All resistors 1/4W 5% carbon film	
CAPACITORS	
C1, C4-C9, C12	100n polyester (8 off)
C2, C10, C15	22µ 16V electrolytic (3 off)
C3, C11, C19, C20	1µ 63V electrolytic (4 off)
C13	220p polystyrene
C14, C16	15n polyester (2 off)
C17	1n polystyrene
C18	4µ 763V electrolytic
POTENTIOMETERS	
VR1	100k mono rotary
VR2, VR5	10k log mono rotary
VR3	10k mono rotary
VR4	500k mono rotary
VR6	100k skeleton
SEMICONDUCTORS	
D1-D11	1N4148 (11 off)
TR1, TR2	BC549 (2 off)
IC1, IC2	324 (2 off)
IC3	CA3080
SWITCHES	
S1	min dpdt
S2	min spdt
MISCELLANEOUS	
Pcb clips (4 off), knobs (5 off), Phonosonics' PCB293A, 8-pin ic socket, 14-pin ic socket (2 off), mono jack socket (2 off), box 155 x 120 x 45mm.	

source. Obviously, IC3 is the place at which we introduce it.

AMBIENCE

Many of you will know that a reverse biased transistor will produce a certain amount of noise in response to its non-lethal distress under such conditions. Some types of transistor will behave more noisily than others, but in general an npn transistor such as the BC549 and its related families can be quite noisy under reverse biasing. Note though that the noise level can vary between types, and even between individuals of the same batch.

TR1 is the source used here, feeding the white noise through C14 to the filter and amplifier IC1B. The selected frequency band of noise is set by C16 and C17, and is additionally variable by VR3. The latter allows for panel control of the ambience tone. The output is fed to the input of IC3, with VR6 allowing for preset control of the level.

As IC3 is progressively opened by the sawtooth so greater amounts of white noise pass through, enhancing the ambience of the clap effect. The decay of the ambience level then follows the rate at which IC3 is closed, depending on the setting of VR5.

TRIGGER CHOICE

For control of the clapper from external sources, the pulses can be generated by a variety of devices. One possible source is from a microphone. In this instance plugging a mic into the input and then clapping above it will trigger the automatic clap response. Alternatively, the pulses could come from a signal generator or other repetitive pulse producer. And naturally, the pulses could come from the output of a computer or a midi instrument.

It is also possible to use the clapper as a self contained unit by switching over to automatic recycling mode. In this mode S1a is switched to the output of IC2a and S1b is open. The act of switching from external to internal control causes a

pulse to be generated across IC1a, so initiating the pulse train. At the end of the train, when TR2 opens to discharge C2 and C3, it also discharges C18 via D9. During the pulse train this has been held charged via VR4 and R35. As the charge on C18 drops below the reference level set by R34 and R36, so the comparator IC2a changes its output level state. It remains in this state until TR2 has closed and C18 recharged at the rate set by VR4. When C18 has passed the trigger level in the opposite direction, so IC2a again changes state, sending another trigger pulse to IC1a, and so the cycle goes on repeating until S1 is once more switched to external mode.

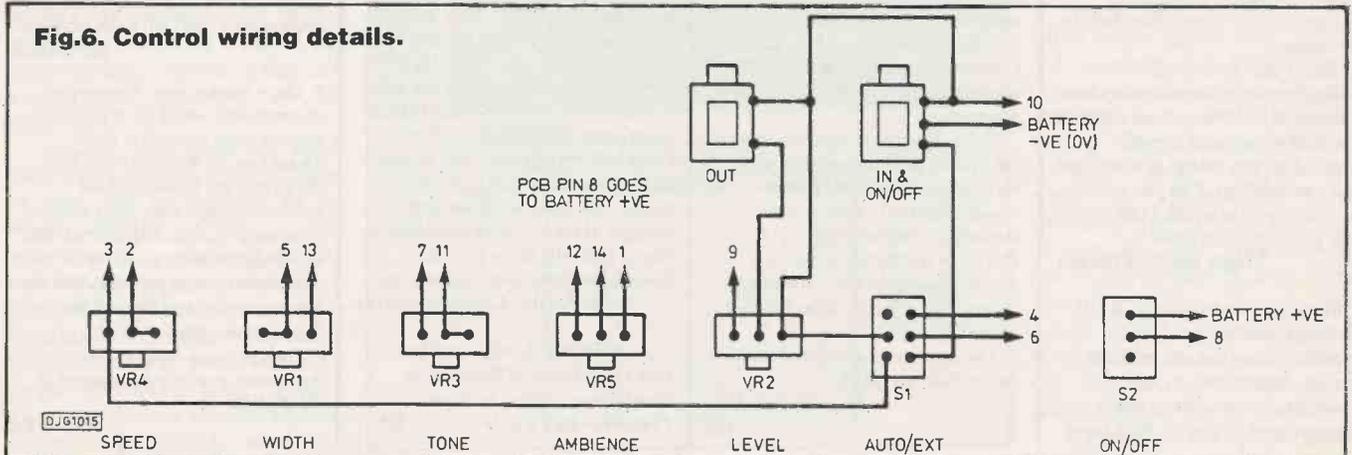
LIKE THE CLAPPERS

Construction of the circuit is very straight forward and it shouldn't take long to put together. Ensure that the correct polarities of diodes and electrolytic capacitors are observed, and that ICs and TRs are in the correct way round. The only setting up needed is the adjustment of VR6 to allow the white noise through at the desired level. The panel controls allow for selection of the other levels, relative clap rates, spacing and tone. The power supply needed is ideally suited for 9V battery use, though voltages up to 15Vdc could be used instead.

I am sure you will find this circuit an interesting addition to your effects line up. As a final suggestion, try feeding it into a separate echo or reverb unit as well - the results are astounding. **PE**

Don't miss our new workshop frequency counter and dual sig-gen test gear project next month!

Fig.6. Control wiring details.



DATABASE
RELATIONSHIPS

Dear John,

In his March 89 *Leading Edge* column, Barry Fox wrote about difficulties in understanding and defining relational databases.

Having tried to grapple with this subject from an application point of view, I feel it is probably a good idea to first study the underlying principles, the theory of relations, as found in text books on logic. These principles are not fundamentally difficult.

Anyone who can understand simple expressions like: "Mary (is the wife of) William" and "9 (is greater than) 5" has already got the basic idea. The words inside the brackets express the relations between the terms on either side of them. The relations and the terms can be expressed by symbols.

A non-specialist book I've found particularly helpful is *An Introduction to Logic* by Peter Alexander, Chapters 2 and 8 (Unwin, 1971). The author clearly explains the various types and logical properties of relations.

Although relational databases are a very modern development, the underlying theory of relations goes back a long way. The British mathematician Augustus de Morgan (1806-1871), who made valuable contributions to symbolic logic among other things, was the first person to develop relations as a systematic theory, in the second half of the 19th century. Bertrand Russell also wrote on this subject, in 1903.

Tom Ivall, Staines.

John (is grateful to) Tom.

ETHIOPIAN APPEAL

Dear Sirs,

It is unfortunate that my prodigious interest to have access to your monthly publications has failed due to the problem of getting foreign currency, which is restricted to exchange by the government here in our country.

Since I can obtain your publications only intermittently (and if not taken by others) from a British Council Library here in Addis Ababa, I am not always able to enter your competitions. Can you advise me of any way in which I can obtain your publication on time?

Moges Belete, Ethiopia.

We recognise that there is an exchange problem for a few countries. Some readers with this problem have friends in other countries who are able to send payment on their behalf. With some

If you have any comments, criticisms or suggestions, write and let us know. We are interested in what you think and say.

PITCH IN TIME

Dear Mr Becker,

As a long time reader of PE and dabbler in some of your projects over the years, I was interested to see your Editorial on vacuum tubes in PE Mar 89. I used to run one of the departments making valves at GEC and little thought to see them making a comeback some 30 years later, albeit in a rather different form.

It has prompted me to write to you for some advice concerning a small project which my family has been agitating me about for some time, but which may require someone of 40+ to solve because of the technology.

I have many tape recordings of our wedding and other family events, such as the children when young, made on a now-departed reel-to-reel tape recorder bought during the late 50s. Wishing to transfer them to modern cassettes, I recently bought an old 3-speed Collaro tape recorder at a jumble sale. Having tried my recordings on this and other recorders it appears that the original machine must have been running at the wrong speed. At 3.75 ips the voices are pitched too low, and at 7.5 ips they are too high. Is there some way I can modify the playback speed?

E.R. Goodwin, West Drayton, Middx.

countries it is also possible to go a local bank and ask for a Stirling cheque, drawn against a London bank, to be sent to the company from whom goods or services are required. In your own case it would also be beneficial to ask the British Council Library for their recommendation on how to make payment.

If you are able to find a method for making payment, then the best way for you to obtain PE on a regular basis is to have it sent through our subscription service. The price is £18.00 per year, for which you will receive 12 monthly issues. This price includes the cost of postage.

The address to write to is shown on the Editorial page.

Best wishes,
Ed.

What an interesting coincidence about GEC. But who has disclosed my age? They were being totally mendacious - I'm still only a youngster (at heart)!

Tape recorders of that era usually had their speeds controlled by the mains frequency of 50Hz (in Britain). There are units for changing ac power frequency to drive equipment like this, but I don't know the names of any companies who manufacture them. Your local reference library may be able to advise which directories might give the answer.

Alternatively, you could try modifying the inverter shown in the Battery to Mains articles of PE Jul-Aug 88. If you replace the 50Hz generator by another generator having a variable frequency, you will be able to tune it as required. The output current discussed in the article should be enough to drive the tape recorder.

There is another, very-low-tech possibility. Set the recorder on 3.75 ips, and wrap layers of Selotape, or similar, around the shaft that drives the tape transport wheel. As the effective diameter increases, so too will the tape drive speed. You will need to experiment of course, and any music may hiccup a bit where the Selotape end occurs, but for speech it should be ok. I used the method myself many years ago, while I was still only XX+!

Ed

EASI ON THE EAR

I am an aging geriatric whose hearing is not as good as it used to be, particularly where high notes are concerned. To make up for this I tend to adjust the tv volume to a higher level than that preferred by my wife. In addition I have somewhat bizarre programme preferences such as Open University maths and similar arcane subjects which similarly distract my good wife's train of thought. Have you ever published a circuit that will allow personal listening without domestic discord?

Dr R. Parfitt, Croydon, Surrey

A circuit which might suit you both is the Infrared Transceiver Headphones project by Robert Penfold in PE June 1987.

Ed.

BINGO ITALIANO
COMPUTERISSIMO

Dear Ed,

Your friendly magazine prompts me to write, somewhat belatedly, in response a letter published in PE Mar 88 concerning automatic bingo callers.

Bingo halls do not exist here in Italy, but at festive times of the year the family 'tombola', as we call it, is a tradition. A random number generator by itself is unsatisfactory for serious bingo and would never content our bunch of hyper-critical moppetts! I agree with you that a computer provides a better solution than a dedicated circuit design.

The generator must be capable of extracting only integral random numbers (no decimal fractions allowed) and each number only once during any game (no duplication of drawn numbers), as well as keeping within the limits set by the cards. In Italy, tombola has limits of 1 to 90. Our answer is to use a short Basic program, which we run on a Spectrum.

Thank you for a monthly 'read' of so many topics in the electronic environment (satellites to solder-tags) where there always seems to be something for everyone.

Ken Jones, Udine, Italy.

Nice to here from you again. I hope the grandchildren are not still pulling your leg over our April 1st 1988 report!

Ed.

CHIPPY-CHIPPY
BANG-BANG

Dear Mr Becker,

I want an opamp chip that does not damage itself when the output is shorted to GND, otherwise a circuit diagram that gives protection against overload if the opamp is shorted to GND. If this is unclear then try this: what happens if the output of the opamp is shorted to GND? (a) will it go BANG! (b) nothing happen (c) some makes will go BANG! while other makes don't (d) none of these?

R.P., Essex.

Once upon a time, there were opamps that would die if their outputs were shorted to GND. Thanks to the Wizard Hi-Tech, to the best of my knowledge all modern opamps have their outputs protected against short circuits and overloads, usually up to the maximum voltage permitted for the power supply. And they all live happily ever after.

I suggest you read Andrew Armstrong's article on opamps in PE Feb 88.

Ed.

GREENWELD

ELECTRONIC COMPONENTS

SALE

NEARLY EVERYTHING ON THESE PAGES IS
HALF PRICE OR LESS!!

We must clear last years surplus to make room for more parcels we are expecting soon!! So snap up these unrepeatable bargains now - most goods will not be

available once existing stocks are sold!! In order to sell at these low, low prices and cover our costs, the minimum order value is £10 & postage is £3.00 regardless of quantity (orders can be made up with non-sale goods if required) state "Sale prices" when you order, whether by post, phone or fax. See back page for more info.

KRAZY KEYBOARD KLEARANCE



Z8852 Keyboard: Superb brand new keyboard 392 x 181 with LCD displaying 1 line of 10 characters and a further line with various symbols. 100 keys, inc separate numeric keypad. Chips on board are 2x77H05, 80C48. LCD + driver chips are easily removable from board. Looks like it was used with a comms package. Has anyone any more info?

£15.00
SALE PRICE £7.50



Z8857 High quality Alphameric keyboard on aluminium frame 314 x 150mm. Contactless keys good for 20 million operations. Originally sold at over £100 each, they were used in a 'Printcom' portable terminal. Fully ASCII encoded output. Power supply + 5v and -12v @ 35mA supplied with comprehensive data.

£14.95
SALE PRICE £7.50



Z8856 Cherry computer keyboard. Very slim model 340 x 130 by only 14mm deep, including keys. Matrix output. 67 keys in pale/dark brown. No idea what computer they're from - but they're an absolute bargain at only £4.

SALE PRICE £2.00



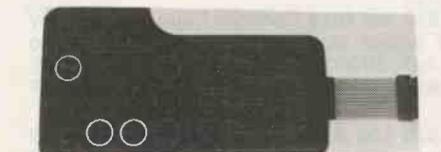
Z8848 Keyboard Alpha numeric separate numeric keypad. 104 keys. Also chips on board: LS373x2, LS374, LM3086x2. LS138x3, 555, LS08, 6805. Size 442x175mm.

£12.00
SALE PRICE £6.00



Z8863 Keyboard. High quality unit made by Micro Switch 69 pale grey and blue keys. 6 red 5mm LED's, 15 various LS chips and socketed D8048 by Intel. Output via 7 way plug and there's a 4 way edge connector too. Keyboard frame is 317 x 128mm. PCB on which it's mounted is 285 x 170mm.

Excellent value at £12.00
SALE PRICE £6.00



Z4116 24 way (8 x 3) membrane keypad. Large (200 x 90mm) area - these were originally used as a teaching aid. Overlay template and pinout supplied. Now only £2.00

SALE PRICE £1.00



Z8833 Tatung VT4100 Keyboard. As previously advertised on earlier bargain lists (but these do not have a lead attached). New stocks just received of this popular cased 85 key with separate numeric pad keyboard. Supplied with circuit diagram. 450x65x125mm.

£14.95
SALE PRICE £7.50

Z8842 Also available are some with broken keytops (usually 2 or 3) Only £9.95
SALE PRICE £5.00

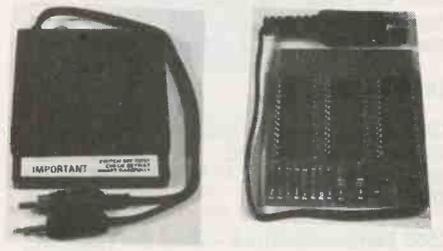


Z8835 Keytronic keyboard. We've had these before, too. PCB contains MCT210, 7406, INS8035, LS373, 2708. 95 x 405 x 180mm.

£14.95
SALE PRICE £7.50

CURRAH

μSPEECH & SPEECH 64



Z4140 New complete set for ZX. Spectrum unboxed. (They were bulk packed) £7.95
SALE PRICE £4.00

Z4142 Speech 64 for the C64 computer. Better than the Spectrum version as no software needed, and can be programmed in plain English! We only have the bare boards but these are new and working. A photocopy instruction book is included.

£6.00
SALE PRICE £3.00

Z4138 μSlot. 'T' connector (1 female, 2 male) for the Spectrum enabling 2 peripherals to be connected to one time. Further μSlots can be added allowing more peripherals to be added: New and boxed.

£2.00
SALE PRICE £1.00

**OUR 1989 PAGE
CATALOGUE +
SUPPLEMENTS GIVING
FULL DETAILS OF ALL
ITEMS IN THIS PULL OUT
COSTS JUST £1 POST
FREE BUT WE HAVEN'T
MANY COPIES LEFT, SO
BE QUICK!**

COMPONENT PACKS – ALL 1/2 PRICE

GREENWELD – THE PACK PEOPLE!

More packs – more in them – more value!
All our packs contain brand new, marked full-spec. components (unless otherwise stated) at a fraction of the normal price and offer constructors the widest range of parts at the lowest cost! How do we do it? By buying manufacturers end-of-run and surplus components. Because we purchase from many sources, we have an extremely wide range of top quality parts – too costly to sort hence the packs described below. Our larger packs are ideal for schools, groups or clubs.

SEMICONDUCTORS

K517 Transistor Pack – 50 assorted full spec. marked plastic devices PNP NPN RF AF. Type numbers include BC114 117 172 182 183 198 239 251 255 320 BF198 255 394 2N3904 etc., etc.

Retail cost £7+ Special low price £2.75
SALE PRICE £1.37

K547 Zener Diodes – Glass and plastic, 250mW to 5W ranging from 3V to 180V. All ready identifiable. 100 for £4.50
SALE PRICE £2.25

K537 I.C. Pack – a mix of linear and logic chips, from 6 to 40 pin. All are new and marked, but some may not be full spec.

100 £6.75
SALE PRICE £3.37

K538 Diode Pack – untested small signal diodes like 1N4148 etc. at a price never before seen!! 1000 £2.50
SALE PRICE £1.25

K560 Semiconductors – Over the years we have purchased many transistors, diodes, ICs etc which for one reason or another have accumulated in one of our stock rooms. Rather than spend weeks sorting and listing them, we have decided to make them into packs. All components are full spec marked devices. Some may be coded. We believe this to be one of the best value packs ever offered, as many high value components are included. Packs are made up by weight; this means contents are very approximate – if there are several bulky power devices, there will be considerably fewer parts than those packs containing all small signal items.

Normally **SALE PRICE**
Pack of approx 100 £5.00 £2.75
Pack of approx 250 £12.00 £6.00
Pack of approx 1000 £40.00 £20.00

RESISTORS

K540 Resistor Pack – mostly 1/8, 1/4 and 1/2W, also some 1 and 2W in carbon, film, oxide etc. All have full length leads. Tolerances from 5 to 20%. Excellent range of values. 500 £2.50 2,500 £11.00
SALE PRICES 500 £1.25 2,500 £5.50

K503 100 Wirewound Resistors – From 1W to 12W, with a good range of values.

£2.00
SALE PRICE £1.00

K523 Resistor Pack – 1000 – yes, 1000 1/4 and 1/2 watt 5% hi-stab carbon film resistors with preformed leads for PCB mounting. Enormous range of preferred values from a few ohms to several megohms.

Only £2.50
SALE PRICE £1.25

K531 Precision Resistor Pack – High quality, close tolerance R's with an extremely varied selection of values mostly 1/4 and 1/2w tolerances from 0.1% to 2% – ideal for meters, test gear etc.

250 £3.00 1000 £10.00
SALE PRICES 250 £1.50 10000 £5.00

K505 20 Assorted Potentiometers – All types including single, ganged, rotary and slider. £1.70
SALE PRICE £0.85

K572 Networks 7,8,9 pin SIL; 14 & 16 pin DIL. Lots of different values.

Pack of 100 £4.50
SALE PRICE £2.25

K554 Thermistors – Mostly disc, rod and some valuable bead types. Identification/data sheet included. Big variety up to 40mm dia! Catalogue value over £50.00

100 for £8.00
SALE PRICE £4.00

K525 Preset Pack – Big, big variety of types and sizes – submin, min and std, MP slider, multturn and cermets are all included. Wide range of values from 20R to 5M.

100 assorted £6.75 250 £12.95
SALE PRICES 100 assorted £3.37 250 £6.50

CAPACITORS

K549 Variable Capacitors – Mostly small trimmers – airspace, mica and polyprop dielectrics, but also included are a few full size tuning caps. 25 for £5.75
SALE PRICE £2.87

K544 Mullard Polyester Caps – Cosmetic imperfections, electrically OK. Wide range of values from 0.01 to 0.47µF in 100, 250 and 400V working. 200 for £4.75
SALE PRICE £2.37

K546 Polystyrene/mica/ceramic caps. – Lots of useful small value caps up to about .01µF in voltages up to 8kV. Good variety. 100 £2.75
SALE PRICE £1.37

K528 Electrolytic Pack – All ready cropped for PCB mounting, this pack offers excellent value for money. Good range of values and voltages from 0.47µF to 1000µF, 6V to 100V. £3.95 250 £8.95
SALE PRICES 100 £2.00 250 £4.50

K518 200 Disc Ceramic Caps – Big variety of values and voltages from a few pF to 2.2µF; 3V to 3kV. £1.00
SALE PRICE 50P

K530 100 Assorted Polyester Caps – All new modern components, radial and axial leads. All values from 0.01 to 1µF at voltages from 63 to 1000V!

Super value at £3.95
SALE PRICE £2.00

K558 Jumbo electrolytic pack – 10kg of screw top computer grade electrolytic capacitors. Values from 400µF to 83,000µF, voltages 15V to 200V. About 40 caps per parcel. Value if bought individually over £100! Our price? Just £20.00. Order now!
SALE PRICE £10.00

SWITCHES & RELAYS

K520 Switch Pack – 20 different assorted switches – rocker, slide, push, rotary, toggle, micro etc.... Amazing value at only £2.00
SALE PRICE £1.00

W4700 Push Button Banks – An assortment of latching and independent switches on banks from 2 to 7 way, DPCO to 6PCO. A total of at least 40 switches for £2.95 100 £6.50
SALE PRICES 40 £1.50 100 £3.25

K532 Relays – Wide selection of styles voltages and contacts. 4v-240v, AC/DC, SP and 4PCO 20 for £6.00
SALE PRICE £3.00

K542 Reed Relays

Mostly DIL, single pole & double pole also some changeover, these are manufacturers rejects, but a good proportion work. 5V-50V coils 50 assorted £3.30

SALE PRICE £1.65

K569 Reed Switch Pack. A selection of about 15 types of reed switch from submin 12mm long to 5A rated 50mm long, mostly form A (make), few form C (Changeover).

Pack of 30 £2.75
SALE PRICE £1.37

OPTO

K539 Led Pack – not only round but many shaped leds in this pack in red, yellow, green, orange and clear. Fantastic mix.

100 £5.95 250 £13.50
SALE PRICES 100 £3.00 250 £6.75

K524 Opto Pack – A variety of single point and seven segment LEDs (incl. dual types) of various colours and sizes, opto isolators, numicators, multi digit gas discharge displays, photo transistors, infra red emitters and receivers.

25 assorted £3.95
SALE PRICE £2.00

HARDWARE

K551 6BA screws – In a variety of lengths and heads from 3/16" to 20mm long. Steel.

200 £2.00
SALE PRICE £1.00

K559 Knobs – Wide selection of sizes, shapes and styles for various diameter shafts and sliders 25 for £1.95
SALE PRICE £1.00

K535 Spring Pack – approx. 100 assorted compression, extension and torsion springs up to 22mm dia. and 30mm long £1.70.
SALE PRICE 85P

K571 Cable Clips – 6 or 7 different sizes from 3.5mm to double T & E mostly black and grey. 100 assorted 99p
SALE PRICE 50P

K564 PCB stand-offs. A mixture of 8 different styles and sizes from 4.75 to 12.7mm high. 100 £2.40
SALE PRICE £1.20

K567 Wire Ties. 5 types to take 4-15mm dia cable bundles. 100 £1.70
SALE PRICES 85P

K565 Miniature PCB supports in nylon. 6 different styles – sizes from 6.35 to 13.24mm high. 100 £2.20
SALE PRICE £1.10

K566 Self adhesive cord clips in moulded nylon. 5 styles/sizes. Base size from 15.9 to 31.8mm square

Pack of 100 £2.70
SALE PRICE £1.35

K568 Giant Plastic Pack Approx. 1000 pieces – standard and miniature PCB supports, self adhesive ribbon cable clips, straps, ties, cord clips. This lot would normally cost around £50.00

Our Special Price £12.00
Sale price £6.00

K563 Cable markers (ident sleeving). Over 1000 pieces, all with either letter or number. Assorted colours and sizes from 1-5mm dia. over 50 different!

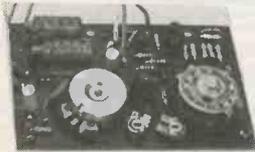
Pack of 1000 £2.50
SALE PRICE £1.25

Hi-Res Monitor



Z497 AM/FM Stereo Tuner Panel. Complete radio chassis with push-button selection for LW/MW/FM and ON/OFF. Ferrite rod for LW & MW selection, co-ax socket for FM aerial. Supplied with mains transformer and rectifier/smoothing cap, and wiring details. PCB is 330 x 90mm. Reduced to £7.95
SALE PRICE £4.00

1W Amplifier – mono



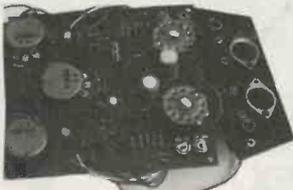
Z914 Audio amp panel 95x65mm with TBA820 chip. Gives 1W output with 9V supply. Switch and vol. control. Just connect batt. and speaker. Full details supplied.
 Only £1.50; 10 for £12.00;
 25 for £25.00; 100 for £75.00

SALE PRICES
 75p each; 10 £6.00;
 25 £12.50; 100 £37.50

1W Amplifier – stereo

Z915 Stereo version of above 115x65mm featuring 2xTBA820M and dual vol. control.

£3.50, 10 for £30,
 25 for £65, 100 for £200
SALE PRICES
 £1.75, 10 £15,
 25 £32.50, 100 £100



Z974 Mixer Amp Panel – 115x115mm and gives 1W O/P from a TBA820M chip. There are two inputs, one via a pre-amp, from phono sockets and separate volume controls. A third pot is used to fade from one input to the other. There are also 2 4p 3w rotary switches. Attached to the PCB by flying leads is a panel on which are mounted the 2 input skts, 2x5 pin DIN skts and 2 pin DIN speaker skt. A data sheet is supplied
 All this for just £2.50
SALE PRICE £1.25



Z4134 Speaker remote control box. This is a cream case 125x95x42mm housing a 57mm dia speaker and 2 control knobs, one for volume and one to switch main-remote-dual, the 3 core 6m long lead enables volume to be controlled from chair or bed. Simple to fit, instructions included.
 £3.95
SALE PRICE £2.00



Z4135 'STETHOPHONE' mini stereo head-phones, complete with stereo jack plugs, 8R. Hinged headband.
 £1.75
SALE PRICE 87P



Brand new and boxed, complete apart from case, the super high definition (1000 lines at centre) makes this monitor ideal for computer applications. Operated from 12V DC at 1.1A. Supplied complete with circuit and 2 pots for brilliance/contrast + connecting instructions. Standard input from IBM machines, slight mod (details included) for other computers.

Price £24.95 4 for £99.00
SALE PRICE £12.50; 4 FOR £45.00

Z494 Newbrain Motherboard. Micro-processor panel 265 x 155mm. Complete PCB for computer, Z80, EPROM, etc. 68 chips altogether + other associated components, plugs, sockets, etc. Brand new in original packing.
 £5.50
SALE PRICE £2.75

Z672 Newbrain motherboards. Complete but probably faulty.
 £3.50
SALE PRICE £1.75

Z620 68000 PANEL PCB 190 x 45mm believed to be from ICL's 'one per desk' computer containing MC68008PB (8MHz 16/8 bit microprocessor) + 4 ROMs all in sockets. TMP52220CNL, 74HCT245, HCT138, LS38 & LS08, also 2 x 20w SIL sockets & 2 x 14w SIL sockets.
 £5.00
SALE PRICE £2.50

Set Top Converter



Z8828 Made by Thorn EMI, this was used to receive cable television. 2 part aluminium case 211x158x82mm (no front panel) contains 2 PCB's: (a) control board with multiway switch, dual 7 seg plug in display, couple of chips. (b) main board with mains transformer, tuner, RF section etc. Rear panel has input and output sockets. 2m mains lead with moulded on 13A plug.
 £9.00
SALE PRICE £4.50



Z803 Auto Dialler. Sloping front case 240 x 145 x 90/50mm contains 2 PCB's: one has 4 keypads (total 54 switches) + 14 digit LED display. 2xULN 2004, ULN2033 and 4067; the other has 12 chips +4 power devices etc. Case contains speaker. For use with PABXs, could probably be modified for exchange line. Needs 12V ac supply
 £9.00
SALE PRICE £4.50

Prestel Unit



Z819 Brand new and boxed, complete with co-ax T connector, aerial lead and instruction book. Only one snag – the remote control hand-set is missing. Size of smart wooden case is 347x187x100mm. Mains operated. Old style BT plug. Made by Ayr Electronics, Model P
 £22.00
SALE PRICE £11.00



Z8862 Video game unit with 10 games, utilizing the AY-3-8610 chip. Consists of 2 handheld units 145 x 60 x 45mm made of light and dark grey high impact plastic. Unit 1 has a control panel with 0-9, serve and reset buttons, 3 switches for bat size, ball speed and sound on or off, and built in joystick. Unit 2 has a serve button and joystick. The two units have 2m of 5 core cable between them, and the 3m lead from unit 1 has 3 x 3.5mm plugs; 1) 7-5V input; 2) audio out; 3) composite video out. Worth what we're asking just for the cases!
 £9.95
SALE PRICE £5.00

Dual Sheet Feeder



Z8837EXXON DUAL SHEET FEEDER Z200. Overall 395x210x285mm. Brand new and containing some very high class electronics. Although of little practical use as it stands, it makes a great break down unit. It contains:
 3x12V 36R 7.5° stepper motors by Airpax and associated gear trains drive belt etc.
 2x12V Solenoids
 1x12V electronic buzzer
 2 extremely sensitive micro-switches.
 1 PCB containing 4xTIP115, 4xTIP110, 2x7407, LM3302 comparator + T's, R's, C's, plugs, sockets etc.
 1 control panel containing 4 LED illuminated push buttons + green LED on small PCB
 1xOPB703A opto coupler
 1xOPB7111 opto coupler

Obviously, a very expensive piece of machinery to produce – but once again our contacts in the trade have enabled GREENWELD to procure a few hundred for a fairly modest sum, allowing us to offer them at the bargain price of
 £24.95
SALE PRICE £12.50

Touch Pad



Z811 Cumana Touch Pad for the BBC computer. This remarkable add-on enables you to draw on the screen using a stylus with the touch sensitive pad. Supplied with 2 stylus, power/data connecting lead and demo tape with 4 progs. Contains state-of-the-art electronics. Originally being sold at £79.95 – but we can offer a limit quantity of these brand new and boxed for just
 £19.95
SALE PRICE £10.00

Fibre Optics



Scoop purchase of single and twin cable. For use with visible light or infra-red. Core 1mm dia, overall 2.25mm dia.

Single 50p/m; 20m coil £4.00
 Twin 90p/m; 20m coil £6.00
SALE PRICES
 20M SINGLE £2.00
 20M TWIN £3.00

JIMMY

the electronic football game of skill



Z817 Exciting electronic football game - Waddingtons' 'JIMMY'. Brand new models in full working order, but without plastic peripherals, stickers etc. Red plastic case 420mm long x 93mm wide contains keypad and seven segment LED's to keep score either end. The centre section 'players' are represented by red 5mm LED's, 14 altogether. The main chip is the TMS1000, programmed to make odd noises whilst playing and a tune when a goal is scored. Also inside are 13 plastic transistors, 57mm 8R speaker, power supply socket, R's, C's etc. Powered by 2xPP3 batts. Solo or dual play. Supplied with instruction sheet, playing field complete with coloured 'players'. Good fun to play as a game and good value for the electronics within. Originally retailed at £19.95.

Only £5.00

Sale price

£2.50

SPEECH CHIPS

SPO256A

Only £1.00

10 for **£7.00** 100 for **£50.00**

OTHER SEMICONDUCTORS:

See pages 82-83 of catalogue 25% off all prices!!

POWER FET'S

Pair of 140V 100W Hitachi devices 2SJ49 & 2SK134. List price **£10.72**

Our Price

£6.00

1989 CATALOGUE SALE PRICES BY PAGE NUMBER

P1-18	10% off	P72	All 1/2 price	P87	Relays 25% off
P25	10% off	P73	All 1/2 price		Rest 1/2 price
P31-34	10% off		except SB15	P88	All 1/2 price
P35-36	5% off	P74	All 1/2 price	P89	All 1/2 price
P55	10% off	P75	All 1/2 price		except:
P57-59	10% off	P76	All 1/2 price		Z4072 25% off
P62-63	20% off	P77	All 1/2 price		Z656 25% off
		P78	All 1/2 price		Z802 20% off
BARGAIN LIST PAGES		P79	All 1/2 price	P90	All 25% off
P68	All 1/2 price	P80	All 1/2 price	P91	All 25% off
P69	All 1/2 price	P81	All 1/2 price	P92	Z4100 £2.00
P70	SB17 £1.00	P82-83	25% off		Z488 £2.00
	Z8827 £2.00	P84	All 1/2 price		J001-3 £1.20/10
	Hi-Res Monitor	P85	All 1/2 price		Rest 1/2 price
	£12.50	P86	All 1/2 price	P93	All 1/2 price
	SB14 £1.50		except joysticks	P94	All 1/2 price
P71	All 1/2 price				

1989 SPRING SUPPLEMENT SALE PRICES

P3-10	10% off		Rest 1/2 price	P26	All 25% off
P12-13	10% off	P24	SB10 £2.00	P27	Z8862 1/2 price
P15-17	10% off		Rest 1/2 price		Rest 25% off
P18	20% off	P25	Z4162 20% off	P28	All 1/2 price
P19-22	All 1/2 price		Z4163 20% off	P29	All 1/2 price
P23	Z8858 20% off		Z4164 Sold out	P30	10% off
	Z4167 20% off		SB6 Sold out	P32	Headphones all given away
	Z8861 20% off		Rest 25% off		

SWITCH MODE PSU BARGAINS



ASTEC Model AA12531

I/P: 115/230V ac 50/60Hz

O/P: V1 + 5v 5A

V2 + 12v 0.15A

Size: 160 x 104 x 45mm

Partially enclosed panel with fixing holes in steel case on 120 x 125mm centres.

Inputs and Outputs are on colour coded leads; there is also an EEC socket on a flying lead.

£6.95



ASTEC Model AC9231

I/P: 115/230V ac 50/60Hz

O/P: 50Watt max:

V1 + 12v 2.5A

V2 + 5v 6.0A

V3 12v 0.5A (+ or -)

V4 5v 0.5A (+ or -)

Size: 203 x 112 x 60mm

Fully enclosed case with built in tapped mounting holes.

Inputs and Output pins on edge of panel.

£9.95

KNOCKOUT KNOBS!!

Sim to K9 - 19mm high x 20mm dia with coloured tops.

Pack of 25 **£3.00**

DISK DRIVE PSU KIT

Ideal for powering single 3 1/2" or 5 1/4" drive. Mains input, stabilized smoothed outputs, 5V@1A + 12V@1A. Simple, easy to assemble kit with all parts and full instructions. **£4.95**

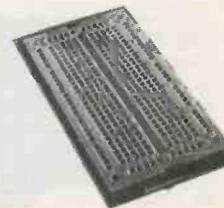
VEROBLOC

AMAZING OFFER!!

RRP **£6.69**

ONLY

£4.95



ANTEX

All Soldering Equipment 15% off!!

SOLDER

16g 500gm reels resin-cored solder. Only **£3.95**; 10 reels **£33.00**

PHONE YOUR ORDER THROUGH NOW - VISA & ACCESS ACCEPTED.

(0703) 772501



443C MILLBROOK ROAD, SOUTHAMPTON, SO1 0HX. ORDERING INFORMATION

All prices include VAT; just add £3.00 P&P; Min order value £10.00. Official orders from schools welcome - Min invoice charge £10.00. Our shop has enormous stocks of components and is open 9-5.30 Mon-Sat. Come and see us!

HOW TO CONTACT US:

By post using the address above; **by phone** (0703) 772501 or 783740 (ansaphone out of business hours); **by FAX** (0703) 787555; **by E Mail** Telecom Gold 72:MAG36026; **by Telex** 9312131093 (GWG)



NAUTEX AND SEA FAX

A dedicated video navtex receiver from Nasa Marine edits and sifts the information, accepting and storing messages only of the types of information and from which stations you have defined. The system has a high contrast data display screen and is based on a 68000 series microcomputer using the latest version of Alnor error correcting software. Lokata have a model using software routines which error-correct all messages before printing, and ensure that no message already received is reprinted.

The error correcting software seems as though it must be incredibly intelligent and sophisticated - I wonder how garbled messages are correctly interpreted without semantic error? Even the word processing software with which I'm writing now needs human intervention on its spell checking routines (especially for its Americanisms - ha!).



Hand held global position sensor

signal-noise is 20dB, sensitivity 2 μ V, and the image ratio better than 60dB. Evaporated aluminium dry recording paper is used for high contrast without odour or dust, and is activated by a single stylus.

RADIO DIRECTION FINDING

A low cost handheld rdf is available from Nasa Marine. It comprises a receiver covering 180-400kHz, headphones and a compass. The rdf beacons can be identified by their morse code signatures and the unit is simply turned and tuned until a null is received from the desired one, and its compass bearing noted. Readings are taken for three beacons, their directions plotted on the chart and normal triangulation determines the user's position.

An rdf that can be manually or automatically operated and covering a variety of vhf channels is manufactured by Furuno.

BOATING REVOLUTION

BY JOHN BECKER

Concluding our report on how Neptune's domain is turning hi-tech

Fax is now also all at sea (was it ever not?!). ICS Electronics is one of several companies offering radio facsimile. Their Fax 1 machine has a rty receiving terminal, handles Navtex, and prints out high quality weather maps, cloud cover photos and news reports from around the world. This information is of use not only to professional mariners, but also to small boat owners, farmers, aviators and many others who have outdoor interests. The Fax 1 requires the use of a standard communications receiver and a computer printer, such as an Epson FX80 compatible with parallel interface. The rty baud rates catered for are 45, 50, 75 and 100, with rty frequency shifts of 425Hz and 850Hz. The audio input can be from 15mV to 2V rms.

Furuno's fax receiver FAX208A takes all known 80-1650kHz and 2-25MHz fax frequencies. It has ten additional channels for user programming, a Navtex option, and a maximum capability of 371 channels.

Weather chart printouts which show cloud pictures in eight shades of black can be produced by the Kodak FX7181. It uses a fully automatic pll synthesised double-superhet receiver with an automatic start-print-stop action responding to standard WMO signals. Up to 23 frequencies can be preset within the ranges 80-200kHz and 2-25MHz. There is a manual channel function selectable in 100kHz steps, the

Weather maps can be directly received via many radio fax models

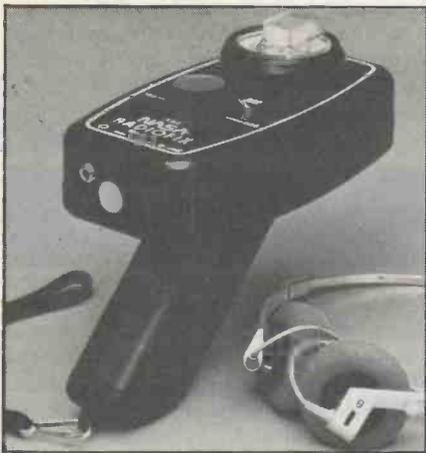


The selected channel and the bearings of incoming signals from ships, coastal stations and emergency position indicating radio beacons (EPIRBs) are shown on an lcd display. It covers channels A0, A1, A2, international vhf (1-28, 60-88 ship or coast), Scandinavian fishing channels (F1 155.6325MHz - Ch52, F2 155.775MHz - Ch55, F3 155.825MHz - Ch56), pleasure craft channel F4 (155.525MHz -Ch50), US weather (W1 162.55MHz - Ch39, W2 162.40MHz - Ch36), and distress channel 48 (121.5MHz). (I've given all these figures in case anyone wants to try a bit of rdngx.)

GLOBAL POSITIONING

Ampro offer a handheld GPS which reads signals from satellites and computes the information to determine the exact position anywhere in the world. It displays lat/long, range, bearing, speed and course over ground, and cross track error. An alphanumeric keypad allows the user to show way points by name, can store 50 of them, and has an auto position fix when started. The size is 8.75 x 3.5 inches, and it weighs only 1.5 pounds. Originally developed by the US government, it has now been released to the professional and leisure market.

The international aviation distress



A very portable radio direction finder

frequency of 121.5MHz is constantly monitored by commercial aircraft, the search and rescue satellites Cospas and Sarsat, and the majority of RNLI rescue craft which are also fitted with vhf/rf equipment. In an hour, a Nimrod aircraft can visually search only 1800 square miles; with radar it can cover 65,000 square miles, but if a distress beacon is being sought 384,000 square miles can be covered.

The Cospas/Sarsat system was put into operation in 1982, additionally monitoring on 406MHz, and typically offers a beacon distress location finding accuracy to within 2-5km. The system has the capability for a satellite to simultaneously monitor 90 beacons within its view.

Globally, mariners in distress can transmit directly to the satellites which retransmit the call to ground receiving stations, known as local user terminals (LUTs). In the UK, one is based at Lasham. The ground station processes the signal, records the location and passes it on to a mission control centre (MCC) - in the UK it is at Plymouth. MCC then sends the location to the appropriate land/sea rescue coordinating centre (RCC), and the rescue operation is commenced!

DISTRESS CODING

In 1979 the World Administration Radio Conference (WARC-79) recognised the limitations of the 121.5MHz system and allocated the new distress frequency channel on 406MHz. The channel is very stable and uses pulses which are phase modulated with digitally encoded messages. The transmission signal itself enables a distress location to be established, but in addition, the coded messages can provide information such as the vessel's country of origin and the nature of the distress. For example, (1) fire/explosion, (2) flooding, (3) collision, (4) grounding, (5) listing/capsizing, (6) sinking, (7) disabled and adrift, (8) abandoning ship.

Jotron's distress beacon, Tron 30S, operates on the 406MHz channel but also has the option for transmitting on the homing frequencies of 121.5MHz and 243MHz. It has 90 hours operational time, and incorporates a flash light. Lokata have their 406P(X) beacon

which includes the unique user selectable message capability, and also has the 121.5MHz homing signal for air/sea rescue services. Swiftech's GL90 operates only on the 121.5MHz channel but can be detected at 30,000 feet within a 200 mile radius. It is small enough to be attached to a life jacket or linked to a crew member by a lanyard, and it floats. It is lithium battery powered, with a shelf life of up to ten years.

INMARSAT

The International Maritime Satellite Organisation, Inmarsat, operates a system of satellites to provide telephone, telex, data and facsimile, as well as distress and safety communications services, to the shipping, aviation and offshore industries. Unlike some other communications systems, Inmarsat's links are unaffected by storms, sunspots, ionospheric or other radio propagation conditions, or congested traffic lists. With this system it is not only virtually impossible to eavesdrop on the content of transmissions, but also competitors cannot tell when or from where you are transmitting. (In the maritime business, often the ability of the competition to detect and locate a radio transmission is sufficient to give your secret away!)

Inmarsat began operations in 1982 and by the end of 1988 over 7700 ship earth stations or transportable versions were using the system. In the Standard-A system, Inmarsat operates via eight satellites in geostationary orbit, located above the Atlantic, Pacific and Indian Oceans at an altitude of 36,000km. They provide coverage of almost all of the world's surface, except the extreme polar regions. Of these eight, three are prime operational satellites and the others are maintained as "hot" spares.

Inmarsat are about to acquire a second generation of satellites, the first four of which are to be launched during 1989, and will become part of the new Standard-C system.

Standard-C will use a new range of microterminals. These will be light weight, of only a few kilos, and compact enough to be fitted to aircraft, vessels and land-based vehicles of any size. Some units are planned which will be small enough to be handheld, and fit in the pocket or handbag. As well as being of obvious benefit to commercial users, Standard-C units will have a powerful impact for office and personal users. In addition to offering position reporting data, they will enable two-way communications between mobile users and their homes or offices, on a global basis.

Information on the handheld units is not yet available, but at least one company has Standard-C terminals for marine users. Thrane and Thrane have a low cost unit, the TT3020A, whose applications range from merchant ships to private craft.

With the introduction of the new Standard-C service imminent, marine and land-based communications are on the threshold of one of the most exciting developments for many years.



This emergency radio beacon just clips to a life jacket

MICRO-RULING THE WAVES

Britain has long been a nation of boat owners. As one who observes the scene mainly from the shore, I believe that traditionally, boat owners have been conservative about introducing new technology. (Correct me if you think I'm wrong!) That appears to be changing rapidly. In so many areas of society, electronic technology is finding broader acceptance and this is permeating into the leisure marine market as well. There is no doubt that, as I said in the introduction, the coming of micro-computers and sub-miniature electronic devices is facilitating the expansion of marine-orientated electronic products. Britain has one of the largest areas of boat parks in Europe, and most craft in them are fitted with some of the latest marine instruments. Currently, marine electronic products can account for some 30% of a boat's total cost.

Regrettably, it is obvious that there a few manufacturers who believe in charging what the market will pay rather than what the product is actually worth. Some prices are much higher than I feel is reasonable. Nonetheless, the situation is changing. The 1980s saw the start of the boom in hi-tech marine control and monitoring for the leisure market. With more manufacturers now producing such products, and with more leisure boat owners wanting them, the prices will undoubtedly fall in real terms.

PE will keep a weather-eye on the trends and, from time to time, update you on their progress. Let me know how much this overview of marine electronics has interested you. **PE**

If anyone would like a list of relevant manufacturers and suppliers who were at the Boat Show please send a small stamped addressed envelope to me at the Editorial address.

THE ORIGINAL SURPLUS WONDERLAND!

SPECIAL PURCHASE V22 1200 baud modems

We got a tremendous buy on further stocks of this popular **Master Systems 2/12** microprocessor controlled V22 full duplex 1200 baud modem - we can now bring them to you at **half last advertised price!** Fully BT approved unit, provides standard V22 high speed data comm, which at 120 cps, can save your phone bill and connect time by a staggering 75%! Ultra slim 45 mm high. Full featured with LED status indicators and remote error diagnostics. Sync or Async use; speech or data switching; built in 240v mains supply and 2 wire connection to BT. Units are in used but good condition. Fully tested prior despatch, with data and a full 90 day guarantee. **What more can you ask for - and at this price!**

ONLY £69 (D)

MONITORS

COLOUR MONITORS

Decca 16" 80 series budget range colour monitors. Features include PIL tube, an attractive teak style case and guaranteed 80 column resolution, features which are only normally seen on colour monitors costing 3 times our price! It is absolutely ready to connect to a host of computer or video outputs. Manufacturers fully tested surplus, sold in little or hardly used condition with 90 day full RTB guarantee.

Decca 80 RGB TTL and sync input for BBC and similar type interface etc.
Decca 80 COMPO 75 ohm composite video input with integral audio amp & speaker. Ideal for use with video recorder or our Telexbox ST, or any other audio visual use.

Any type only £99.00 (E)

HI-DEFINITION COLOUR MONITORS

Brand new **Centronic 14"** monitor for IBM PC and compatibles at a lower than ever price! Completely CGA equivalent. Hi-res Mitsubishi 0.42 dot pitch giving 669 x 507 pixels. Big 28 Mhz bandwidth. A super monitor in attractive style moulded case. Full 90 day guarantee. Only £149 (E)

20", 22" and 26" AV SPECIALS

Superbly made UK manufacture. PIL all solid state colour monitors, complete with composite video & sound inputs. Attract-

**WRITE FOR OUR EIGHT
WEEKLY BARGAIN SHEET &
GET ON OUR MAILING LIST -
FREE!**

Ive teak style case. Perfect for Schools, Shops, Disco, Clubs. In EXCELLENT little used condition with full 90 day guarantee.
20"....£155 22"....£170 26"....£185 (F)

MONOCHROME MONITORS

Motorola M1000-1005" black & white compact chassis measuring only 11.6H x 12W x 22D. Ideal for CCTV or computer applications. Accepts standard composite or Individual H & V syncs. Needs 12vdc at only 0.8a. Some units may have minor screen blemishes. Fully tested with 30 day guarantee and full data. £29.00(C)

Fully cased as above in attractive moulded desk standing swivel. Dim 12 x 14.5 x 26cm. £39.00(C)
JVC 751 ultra compact chassis monitor for 12vdc 0.7a. Dim 11 x 14 x 18cm. Simple DIY data included to convert to composite video input. Full data. **BRAND NEW** £65.00(B)
20" Black & white monitors by Aztek, Cotron & National. All solid state, fully cased monitors ideal for all types of AV or CCTV applications. Standard composite video inputs with integral audio amp and speaker. Sold in good used condition - fully tested with 90 day guarantee. £85.00(F)

IBM KEYBOARD DEAL

A replacement or backup keyboard for IBM PC, PC-XT or PC-AT, all in one! It has a switch on the rear to connect between models! LED indicators for Caps, Scroll & Num Locks. Standard 10 function keys plus 56 on the main bank and 19 on the keypad, 85 in all. Made by NCR for the English & US markets. Absolutely standard. Brand new & boxed with manual and key template for user slogans on the function keys. Attractive beige, grey and cream finish, with the usual retractable legs underneath. A generous length of curly cord, terminating in the standard 5 pin DIN plug. A beautiful clean piece of manufacturers surplus. What a deal! **BRAND NEW AND BOXED ONLY..... £59 (B)**

COMPUTER SYSTEMS

TATUNG PC2000. Big brother of the famous Einstein. The TPC2000 Professional 3 piece system comprises: Quality high resolution Green 12" monitor. Sculptured 92 key keyboard and plinth unit containing 280A CPU and all control circuits. PLUS 2 integral TEAC 5.25 80 track double sided disk drives. Generous other features include dual 8" IBM format disk drive support. Serial and parallel outputs, full expansion port, 64K ram and ready to run software. Supplied complete with CP/M, Wordstar and Basic. Brand new and covered by our famous 90 day guarantee and backup. Normal price of this unit is over £1400!

Our Price ...only.....£299 (E)

FLOPPY DISK DRIVES BARGAINS GALORE!

NEW 5 1/4 inch from £29.95!

Massive purchases of standard 5 1/4" drives enables us to present prime product at industry beating low prices! All units (unless stated) are removed from often brand new equipment and are fully tested, aligned and shipped to you with a 90 day guarantee and operate from +5 & +12vdc, are of standard size and accept the standard 34 way connector.

SHUGART SA405. BRAND NEW £29.95(B)
TANDON TM100-2A IBM compatible DS £39.95(B)
TANDON TM101-4 80 Track DS £49.95(B)
CANON, TEC etc. DS half height. State 40 or 80T £75.00(B)
TEAC FD-55-F. 40-80 DS half height. BRAND NEW £99.00(B)

3 1/2 INCH BRAND NEW AT £19.95!!

Never before seen price for a 3 1/2" drive. Standard size believed to be by Canon. Brand new and packaged - mint condition! 40 track SS, run from +5 & +12vdc with standard power connector.....Only.....

CHOOSE YOUR 8 INCH!

Shugart 800/801 SS refurbished & tested £125.00(E)
Shugart 851 double sided refurbished & tested £195.00(E)
Mitsubishi M2894-63 double sided switchable hard or soft sectors. **BRAND NEW** £250.00(E)

SPECIAL OFFERS!!

Dual 8" drives with 2 megabyte capacity housed in a smart case with built in power supply! Ideal as exterior drives! **Only £499.00 (F)**
End of line purchase scoop! Brand new **NEC D2246 8" 85 megabyte** of hard disk storage! Full CPU control and industry standard SMD interface. Ultra hi speed transfer and access time leaves the good old ST506 interface standing. In mint condition and comes complete with manual. Only.....£399(E)

COOLING FANS

Please specify 110 or 240 volts for AC fans.

THIS MONTH'S SPECIAL!

Very high res, fully cased, mains powered 14" green screen monitor with non-glare screen & swivel/tilt base. The very latest technology at the very lowest price! Fully compatible PC type input to plug direct to HERCULES card outputs, enabling superb graphics and resolution at give away prices!! The many features include aux +5 & 12v DC output's to power at least 2 disk drives or other equipment. Supplied **BRAND NEW & Boxed.**

ONLY £69.00 EACH (E)

3 inch	AC 1 1/2" thick	£ 8.50(B)
3 1/2 inch	AC ETRI slimline. Only 1" thick.	£ 9.95(B)
4 inch	AC 110/240v 1 1/2" thick.	£10.95(B)
4 inch	AC 1 1/2" thick	£ 9.95(B)
10 inch	Round. 3 1/2" thick. Rotron 110v	£10.95(B)
82 mm	DC 1" thick. No. 812 for 6/12v. 814 24v.	£15.95(A)
92 mm	DC 12v. 19 mm thick.	£10.95(A)
4 inch	DC 12v. 12w 1 1/2" thick	£12.50(B)
4 inch	DC 24v 8w. 1" thick.	£14.50(B)

RECHARGEABLE BATTERIES

LEAD ACID

Maintenance free sealed long life, all type A300.
12 volts 3 amp/hours £13.95(A)
6 volts 3 amp/hours £ 9.95(A)
6-0-6 volts Centre tapped 1.8 amp hours £ 5.95(A)

SPECIAL OFFER!

100 amp/hours at 6 volt! Brand new Chloride Powersafe 3VB11. Leakproof with additional snap-on security lid. Perfect for uninterruptable power supplies, portable power source, caravans etc. Normally costs £80! **£39 (E)**

NICKEL CADMIUM

Quality 12v 4ah cell pack. Originally made for the Technicolor video company. Contains 10 GE top quality D nicad cells in a smart robust case with a DC output connector. Ideal for portable equipment. Brandnew. £19.95(B)
Ex-equipment NICAD cells by GE. Removed from equipment and in good, used condition: D size 4ah 4 for £5(B)
F size 7ah 6 for £8(B)

SPECIAL INTEREST

Racal-Redac real time colour drafting PCB layout system. Includes furniture and huge monitor. Complete ready to go! £3950
DEC VAX11/750 Inc. 2 Meg Ram DZ and full documentation, in brand new condition! £3900
Large Calcomp plotter £ 650
CHEETAH Telex machine. £ 550
1.5kw 115v 60hz power source. £ 950
Wayne Kerr RA200 audio real time freq. res. analyser. £3000
Tektronics 1411/R PAL TV test signal standard. £6900
Tektronics R140 NTSC TV test signal standard. £ 875
Versatek V80 Printer plotter £1500
DEC LSI11/02 CPU board £ 150

POWER SUPPLIES

All power supplies operate from 220-240vac. All power supplies are **BRAND NEW** unless stated. We have many other types ranging from 3v to 10kv always in stock.

Byte Drive BD301 Dual output 5vdc @ 1.6 amp & 12vdc @ 1.5 amp. Perfect for disk drives. Has standard Molex sockets. Attractively encased. Dim 15 x 12 x 7 cm. £19.50(B)
Plessey PL122 fully enclosed 12vdc 2 amp. Regulated and short proof. Dim 13.5 x 11 x 11cm. £16.95(B)
AC-DC Linear PSU with outputs of -5v @ 5.5a, -5v @ 0.6a, -24v @ 5a. Fully regulated and short circuit proof. Dim 28 x 12.5 x 7 cm. £49.50(C)
Power One PHC 24vdc 2 a. Linear & regulated £19.95(B)
Boehert 13080 switch mode ideal for drives or complete system. +5v @ 6a, +12v @ 2.5a, -12v @ 0.5a and -5v @ 0.5a. Dim 5.6 x 21 x 10.8 cm. £29.95(B)
Boehert 13085. Same as above but outputs of +5v @ 6a, +24v @ 1.5a, +12v @ 0.5a, -12v @ 0.5a. £39.95(B)
Greendale 19ABDE 60 watt switch mode outputs -5v @ 6a, +12v @ 1a, -12v @ 1a, +15v @ 1a. Dim 11 x 20 x 5.5 cm. Removed from equipment and tested. £24.95(B)
Conver AC130-3001. High grade VDE spec. Compact 130 watt switch mode. Outputs -5v @ 15a, -5v @ 1a, -12v @ 6a. Dim 6.5 x 27 x 12.5cm. Reg price £190! Ours new... £59.95(C)
Farnell G6/40A Compact 5v 40a switch mode and fully enclosed. £140.00(C)
Farnell G24 5S As above but 24v @ 5a. £95.00(C)

SPECIAL EXPERIMENTERS PSU'S

Built to BT's rigorous standards. We have no data so units are supplied for experimentation. EPSU1: +5v 2a, -12v 1a, +24v 1a, +5v fully floating 50ma. EPSU2: +5v 6a, +12v 1a, -12v 0.5a & 5 others. 30-70vdc input. Parts alone value!

EPSU1.....£16.95(C) EPSU2.....£9.95(C)

FLASH!

Lowest ever priced 8 mhz PC-AT 286 clone with 20 mb hard disk and one 5.25" 360k floppy. Complete with a regular type keyboard and very hi-res 14" mono green screen monitor and Hercules graphic card. Guaranteed for 90 days!

ONLY £799.00 (E)

**WRITE FOR ITEMS YOU
DON'T SEE, OUR SHOP AND
WAREHOUSE ARE FULL TO
BURSTING!**

THE AMAZING TELEBOX!

Converts your colour monitor into a **QUALITY COLOUR TV!!**



**TV SOUND
& VIDEO
TUNER!**

Brand new high quality, fully cased, 7 channel UHF PAL TV tuner system. Unit simply connects to your TV aerial socket and colour video monitor turning same into a fabulous colour TV. Dont worry if your monitor does't have sound, the TELEBOX even has an integral audio amp for driving a speaker plus an auxiliary output for headphones or HI FI system etc. Many other features: LED Status indicator, Smart moulded case, Mains powered, Built to BS safety specs. Many other uses for TV sound or video etc. Supplied **BRAND NEW** with full 1 year guarantee.

Telexbox ST for composite video input monitors.....£29.95(B)
Telexbox STL as ST but with integral speaker.....£34.95(B)
Telexbox RGB for analogue RGB monitors.....£59.95(B)

NOT suitable for IBM clone type colour monitors.

BRAND NEW PRINTERS

Epson MX-80 F/T One of the most popular printers around! Bi-directional printing with full logic seeking. 9 x 9 dot matrix for enlarged, bold, condensed etc. Standard parallel interface. Brand label removed from front. Handles tractor, fanfold and individual paper. OK with IBM PC and most others. A tremendous buy! £129.00 (E)

Hazeltine Esprint small desktop, 100 cps with RS232 and standard parallel. Full pin addressable and 6 user selectable fonts. Up to 9.5" paper. Sheet & tractor feed. £149.00(E)
Centronics 150 series. Always known for their reliability in continuous use - real workhorses in any environment. Fast 150 cps with 4 fonts and choice of interfaces.

150-SN up to 9.5" paper.....£155.00(E)
150-SW up to 14.5" paper.....£199.00(E)

Specify whether serial or parallel required.
**CALL FOR THE MANY OTHERS IN STOCK
INCLUDING DAISY WHEELS.**

Visit our Shop - Technical help always on hand plus many un-advertised specials. You can buy a colour television for as little as £29! Come and join the gang at 215 Whitehorse Lane!

DISPLAY

MAIL ORDER/OFFICES

Open Mon-Fri 9.30-5.30
32 Biggin Way,
Upper Norwood,
London SE19 3XF.

LONDON SHOP

100's of bargains for callers!
Open Mon-Sat 9.30-5.30
215 Whitehorse Lane,
South Norwood,
London, SE25 6BB.

DISTEL © The Original

Free dial-up database!
1000's of items on-line
300bd 01-679-1888, 1200/75
01-679-6183, 1200/1200
01-679-8769

ALL ENQUIRIES

01-679-4414
Fax 01-679-1927
Telex 894502

BANKCARD

VISA

ACCESS

MasterCard

-Electronics-

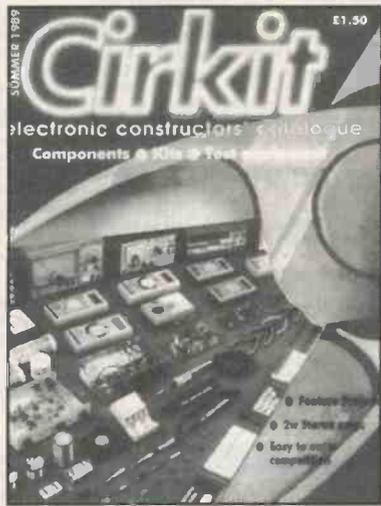
All prices for UK Mainland. UK customers ADD 15% VAT to total order amount. Minimum order £10. PO orders from Government, Universities, Schools & Local Authorities welcome - minimum account order £25. Carriage charges (A)=£1.50, (B)=£3.50, (C)=£6.50, (D)=£8.50, (E)=£12.50 (F)=£15. (G)=Call. All goods supplied subject to our standard Conditions of Sale and unless otherwise stated guaranteed for 90 days. All guarantees given on a return to base basis. We reserve the right to change prices & specifications without prior notice. Orders accepted subject to stock. Quotations will generally be given for higher quantities than those stated.

NEW CAT OUT NOW!

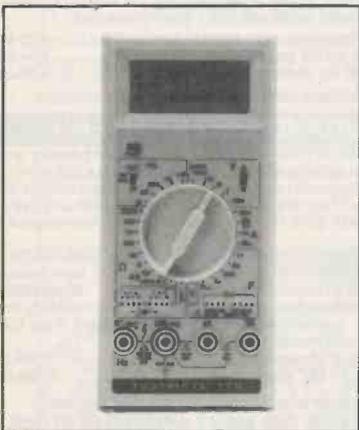
Over 3,000 product lines feature in the Summer 1989 edition of the Cirkit Constructors' Catalogue.

available from most larger newsagents or direct from the company priced at £1.50. The latest books, an RF frequency meter, two new PSU designs and a 3.5MHz converter are among the innovative new kits this issue, while our construction project - a 2 Watt stereo amplifier - is bound to prove an absorbing activity for dedicated constructors. In the test equipment section there's a whole new range of multimeters, a bench DVM and a triple output PSU.

For eagle-eyed readers who enjoy a challenge of a different sort, there is the opportunity of winning an audio signal generator worth more than £180.00 in the latest fiendish competition. All prices now include VAT for quicker, easier ordering; and Cirkit's same-day despatch of all orders, combined with value-for-money discount vouchers, makes the line-up even more attractive.



D-MM GOOD VALUE!



Cirkit's six new digital multimeters are packed with sophisticated extra facilities: capacitance measurement, frequency measurement up to 20MHz, temperature reading, transistor test and logic test in addition to the usual volts, current (DC and AC) and resistance measurement - and all unbeatable value with prices ranging from £20.00 to £55.00!

Cirkit

Cirkit Distribution Ltd

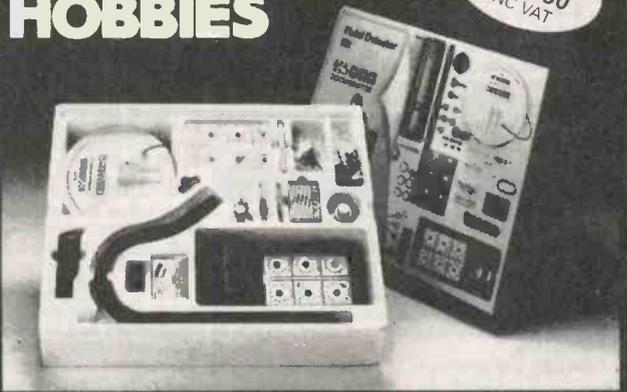
Park Lane Broxbourne Herts EN10 7NQ
Telephone (0992) 444111 Fax (0992) 669021

Also at

53 Burrfields Road Portsmouth Hants PO3 5EB
Telephone (0705) 669021 Fax (0705) 695485

TWO GREAT HOBBIES

ONLY
£124.50
INC VAT



...IN ONE GREAT KIT!

The K5000 Metal Detector Kit combines the challenge of DIY Electronics assembly with the reward and excitement of discovering Britain's buried past.

THE KIT — simplified assembly techniques require little technical knowledge and no complex electronic test equipment. All stages of assembly covered in a detailed 36 page manual.

THE DETECTDR — features Analytical Discrimination & Ground Exclusion, backed by the proven pedigree of C-Scope, Europe's leading detector manufacturer.

Ask at your local Hobby/Electronics shop or contact:—

CSCOPE

C-Scope International Ltd., Dept. PE
Wotton Road, Ashford, Kent TN23 2LN.
Telephone: 0233 629181.

SURVEILLANCE PROFESSIONAL QUALITY KITS

A range of high quality kits as supplied to leading UK security companies, all in-house designed and produced, not to be confused with cheap imports. All kits come fully documented with concise assembly and setting-up details, fibreglass PCB and all components. All transmitters are fully tuneable and can be monitored on a normal VHF radio or tuned higher for greater security. All units available ready built if required.

MTX Micro Miniature audio transmitter. 17mm x 17mm. 9V operation. 1000m range.	£10.95
VT500 Hi-power audio transmitter. 250mW output. 20mm x 40mm. 9-12V operation. 2-3000m range	£12.95
VOX75 Voice activated transmitter. Variable sensitivity. 30mm x 40mm. 9V operation. 1000m range	£15.95
CTX900 Sub-carrier scrambled audio transmitter. Cannot be monitored without decoder fitted to radio. 30mm x 40mm. 9V operation. 1000m range	£18.95
DSX900 Sub-carrier decoder unit for monitoring CTX900. Connects to radio earphone socket. Provides output for headphones. 35mm x 50mm. 9-12V operation	£17.95
HVX400 Mains powered audio transmitter. Connects directly to 240V AC supply. 30mm x 35mm. 500m range	£15.95
XT89 Crystal controlled audio transmitter. High performance. 100mW output. Supplied with xtal for 108MHz. Others available to 116MHz. 85mm x 28mm. 9V operation. 2-3000m range	£29.95
TKX900 Tracker/Beeper transmitter. Transmits continuous stream of audio pulses. Variable tone and rate. Powerful 200mW output. 63mm x 25mm. 9V operation. 2-3000m range	£18.95
ATR2 Micro size telephone recording interface. Connects between telephone line (anywhere) and cassette recorder. Tape switches automatically with use of phone. All conversations recorded. Powered from line. 10mm x 35mm	£10.95
TLX700 Micro Miniature telephone transmitter. Connects to line (anywhere) switches on and off with phone use. All conversations transmitted. 20mm x 20mm. Powered from line. 1000m range	£10.95
XML900 RF bug detector. Variable sensitivity. Triggers LED and beeper when in presence of RF field. Detects MTX 15-20 feet. 55mm x 55mm. 9V operation	£21.95
XL7000 Professional bug detector/locator. Variable sensitivity. Twin mode ten segment LED readout of signal strength with variable rate beeper. Second mode AUDIO CONFIRM distinguishes between localised bug transmission and normal legitimate signal such as pagers, cellular etc. 70mm x 100mm. 9V operation.	£49.95

UK customers please send cheques, PO's or registered cash. Please add £1.50 per order for P&P. Goods despatched ASAP allowing for cheque clearance. Overseas customers send sterling bank draft or Eurocheque and add £5.00 per order for shipment. Credit card orders accepted on 0827 714476. Full catalogue available on receipt of 28p stamp. Trade enquiries welcome.

**SUMS
DESIGNS**

THE WORKSHOPS
95 MAIN ROAD, BAXTERLEY
Nr Atherstone, WARCS CV9 2LE

1975A

WORKSHOP
FOR SALE

0827 714476

☎

DES MODES

The Data Encryption Standard allows for operation in four different modes:

- a) Electronic Code Book (ECB) which is a simple encipherment on a block by block basis, sometimes called the 'native' mode since it is so fundamental.
- b) Cipher Block Chaining (CBC) where the algorithm is used to scramble the blocks together.
- c) Cipher Feedback (CFB) which enciphers a string of characters dealing with each character as it appears, as from a teleprinter. This is a type of stream cipher.
- d) Output Feedback (OFB) which is another type of stream cipher.

Since electronic code book is the simplest, in 64 bit blocks, repeating a block would reveal useful information to an eavesdropper. For instance computer messages often repeat and worse still they are in a very standard formats with messages and headers always in the same place.

In addition, protocol designers usually leave large blank spaces so that various

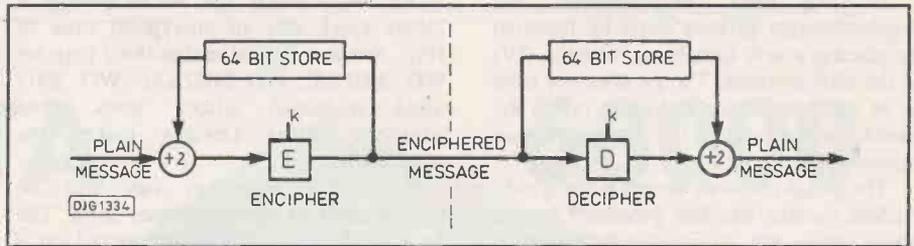
Corruption must be combatted at all levels, whether due to electronic instability, or criminal wilfulness

chains characters and is often known as "m-bit" cipher feedback where m is any number between 1 and 64.

In older message transmission systems 5 or 6 bit character codes were common, but present day systems use 7 or 8 character codes. The ISO (International Standardisation Organisation) 8 bit (octet) is a popular method. This comprises 7 information bits and 1 parity bit.

Fig.17 shows how the octets are added module 2 (XOR) to the output of the DES algorithm. For an on line system of this nature, each octet must be enciphered immediately by the transmitter and deciphered as soon as it is received by the receiver. CFB suffers the same problems of error extension as CBC does.

Fig.14. Cipher block chaining.



ENCRYPTION

facilities can be incorporated if required for a customer. If some of these facilities are not required, the spaces are left blank or filled with constants.

Therefore, ECB is not advisable for transmitting more than one block and a simple application is for transmitting a key since a key contains 56 bits of random digits. Short messages like acknowledgements can also be sent in the ECB mode but they must be padded out to 64 bits otherwise the contents may be obvious.

The padding can be carried out by including a serial number or stamping the acknowledgment with the date and time. The date and time occupy 48 bits, so there is still room for 16 bits of data.

In cipher block chaining, Fig.14, each block before encoding, is added to the cipher of the previous block. This makes the nth enciphered block C_n a function of the previous plain message blocks $M_1 M_2 M_3 \dots M_n$.

The problem is that for the first block, there is no 'previous block' so an initialising variable (IV) is sent but the IV must be random, otherwise an eavesdropper can analyse it.

One big disadvantage of CBC is that errors in one block are extended into other blocks because of the chaining. This is called error extension and in the case of speech, produces clicks or in the case of pictures, produces spots. Since speech and pictures have redundancy (excess

PART TWO
BY MIKE SANDERS

information) error extension is only just a nuisance, but in data transmission, the data could be corrupted excessively.

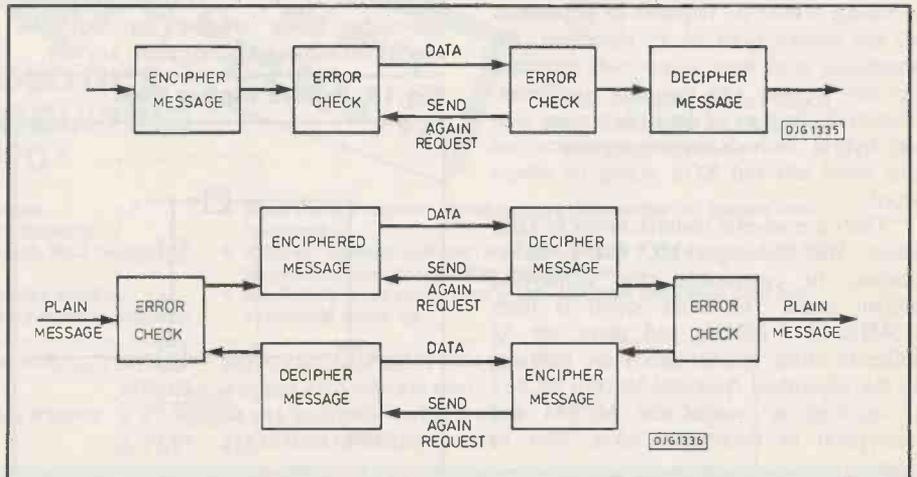
In order to prevent data corruption, error checks must be carried out and this must be carried out directly on the enciphered bit stream, Fig.15, not on the plaintext message, Fig.16.

Cipher feedback, Fig.17, is employed for chaining when the message is operated on in bits or characters. But instead of chaining whole blocks, cipher feedback

Output feedback (OFB), Fig.18, is similar to CFB except in the manner in which the feedback is obtained. But there is no chaining and therefore no error extension, so output feedback is used where CBC and CFB would be unacceptable. Since an error in the enciphered text is directly related to only one particular point in the plaintext message, OFB is similar to the Vernam cipher.

OFB uses a pseudo random number generator at each end, and these must be synchronised. Therefore, if characters are gained or lost, OFB will lose synchronisation, whereas CFB will not.

Fig.15. (upper) Error check on enciphered message.
Fig.16. (lower) Error check on plain text message.



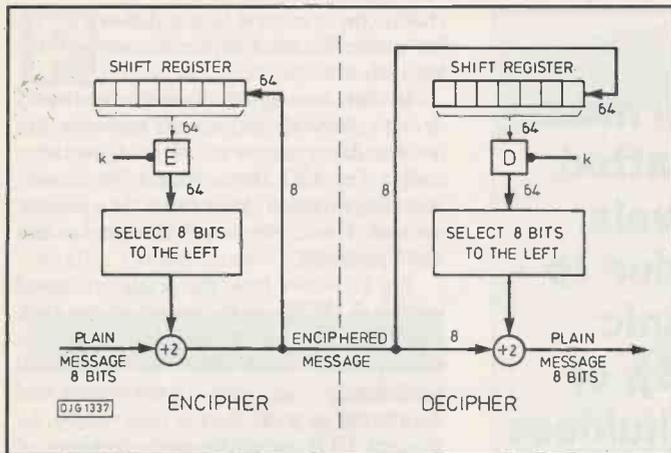


Fig. 17. Cipher feedback

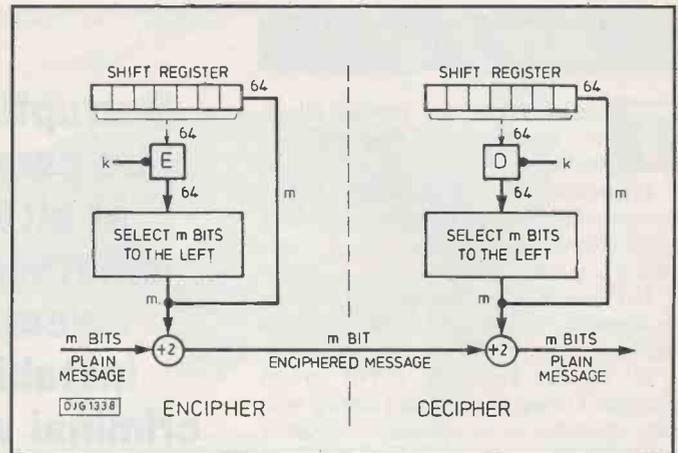


Fig. 18. Output feedback

If OFB loses synchronisation, the synchronisation process must be restarted by placing a new initialising variable (IV) in the shift registers. The IV does not have to be encrypted since it does to reveal the pseudo-random stream if intercepted by an eavesdropper.

The pseudo random stream is not a truly random number like that generated from a noise source but an artificially generated one using shift registers and XOR functions hence the name pseudo-random.

The pseudo random stream must not repeat. If it does then an eavesdropper can easily eliminate it by a simultaneous equation as follows:

Let X be the pseudo random stream

Let M be one plaintext message

Let N be another plaintext message

Then the first enciphered message is $X + M$

The second enciphered message is $X + N$

To eliminate X these two enciphered messages are added module 2 giving $M + N$ which is the same as enciphering M with N. The pseudo-random stream is also called the key stream.

DES HARDWARE

The transpositions required in present day ciphers are difficult to implement in terms of hardware. A small telephone exchange would be required to implement all the permutations of an algorithm. An alternative is to write a computer program, but this is slow and therefore inefficient. Therefore, the state of the art at present is to use hybrid methods employing operations like shift, add and XOR acting on whole words.

There are several manufacturers of DES chips. The Burroughs MC 884 is an n-channel ttl compatible chip employing silicon gates. The clock speed is from 0.5MHz to 1.25MHz and there are 32 different clock speeds which are required by the algorithm. A second lsi chip MC883 is required to control the MC884 and encryption or decryption takes 25us to 64us.

Motorola makes the MC6859 with a 2MHz clock and an encryption time of 10us. Western Digital makes the 3 chip set WD 2001E/F, WD 2002A/B, WD 2003 using n-channel silicon gates. And advanced Micro Devices makes the AmZ8068.

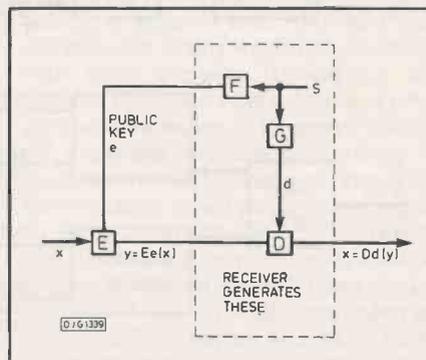
The DES algorithm can also be implemented in microprocessor form. The Intel 8294 uses a microcode stored on a prom (programmable read only memory). American Microsystems makes the S6894 which is a 2 chip microprocessor, and Texas Instruments makes the TMS 9940 with a 5MHz clock. Rockwell Collins and Motorola supply circuit boards for interfaces and key management.

PUBLIC KEY CIPHERS

In a symmetric cipher, the key is secret and is known only to the communicating parties. In an asymmetric cipher the sender has his own key and the receiver has his own. The latter are called public key ciphers and were developed by Diffie and Hellman in 1976.

Fig. 19. shows how a public key cipher works. For enciphering the message, key e and the algorithm E is used and to decipher the message, key d and algorithm D is used. A seed or starting key s is used to derive keys e and d using algorithms F and G. The algorithms D, E, F, G are all public knowledge since anyone can buy the encryption boxes and study them anyway.

Fig. 19. Public cipher key.



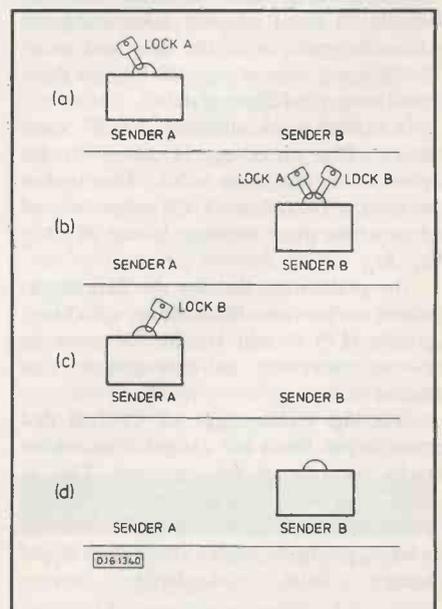
In order for the recipient to be the only one to decipher the message, he must be the one to derive both keys e and d using algorithms F and G. He then announces key e and keeps key d secret. The first publications did not detail the algorithms D, E, F and G to produce a working model.

It was left to Rivest, Shamir and Adleman in 1978 to produce the first working model and it is now the well known RSA method. F is known as a one way function since knowledge of the key e must not enable an unauthorised person to calculate keys s and d. E is also a one way function since knowing the ciphertext y should not enable calculation of the plaintext x.

Since e is now a public key, authentication is not provided since there is no point in proving that the sender is genuine.

The two key public method can be illustrated as follows. With reference to Fig. 20a, suppose company A wants to send company B a message in a case without sending the key. They apply padlock A to the case and send it with a courier, without sending the key. When it gets to B Fig. 20b

Fig. 20. Illustrating 2-key ciphers



company B also apply their padlock and return the case to company A, who remove their padlock Fig.20c. The case then travels to company B who remove their padlock B, Fig.20d, and read the message.

It may seem longwinded but when it is remembered that data travels up and down a communications link quite quickly, it is no problem to transfer it back and forth for the sake of security.

The RSA method is based simply on a number which is a product of two very large prime numbers. Suppose this product is $m = xy$, the recipient is the one who chooses x and y and then announces the number m which will be used as part of the public key.

Of course, m is of no use if it can be easily factorised and if m is small, it can be easily factorised. On the other hand if m is large, the factors are difficult to find. This is a well known problem in mathematics so it has been given considerable thought.

LEKTOR

In the Lektor system developed by British Telecommunications, the large prime numbers x and y are up to 128 bits in length. The number m is then up to 256 bits in length and is called the modulus. The numbers x and y are called relative prime, ie they cannot be factorised and their divisors are only themselves and one.

Since the public key cipher method is slow it is usually used only to distribute the session key. The parties can then revert to a faster real time transfer of data like B-Crypt also developed by British Telecommunications. In addition, Lektor has facilities for using DES for those who prefer DES.

Lektor employs user tokens in the form of a physical key and pin numbers as used by cash tills. Lektor can also be used to encode facsimile (still picture) transmission.

KEY MANAGEMENT

The distribution of keys and the control of keys is an art in itself since the security of a modern system depends not on the algorithm but on the keys remaining secret.

If s is a key used to encipher data for only one session it is called a session key. In order to send the key through the network, it is enciphered with another key t called a terminal key. Key t is used more often than key s so it is stored at the host computer under the care of a master key.

In order to generate the master key, a very mundane method is used. A dice is rolled or a coin is tossed in order to select each digit. This may seem a labour intensive method of generating a random number but it is reliable and in any case, a master key is not changed often.

In order to generate keys below the master key level a pseudo random number

generator or a random bit generator is employed. The latter could use a resistor as a noise source and a wideband amplifier for switching a gate on and off. Zero crossings of the signal are used and the output is sampled to give a 1 or 0 at fixed intervals.

Terminal keys can also be distributed by a courier and a key module the size of a pocket calculator. The module is plugged into the host computer and the key is loaded. Actually loading the keys into the destination computer must be carried out in the presence of reliable personnel.

The module presents a number of problems. An unreliable courier could copy a key or insert a false key. Copying the key can be defeated by arranging that reading the key erases the key from the module memory. Therefore if say three terminals require the same key, this key must be loaded three times into the module.

Installing a false key can be overcome by the use of a password, and it could be arranged such that say more than three attempts at guessing the password, activates the module so that the keys are erased.

AUTHENTICATION

It is interesting to note that enciphering data only prevents an enemy from adding new data. But there are other forms of active attack like:

- a) deleting blocks of data
- b) altering the sequence of blocks
- c) repeating previous blocks
- d) altering the destination
- e) falsifying an acknowledgement
- f) making the recipient think that the data originated at a location other than its true origin

So a fair bit of mischief can be perpetrated without actually breaking all of the code.

The need for authentication may well be questioned when one is using a secret key. However, there are many instances when encipherment may be inconvenient and the parties may rely on occasional authentication checks only.

For instances point to multipoint broadcast may be in progress as from a taxicab base station to all its mobile units. This may be in plain English for convenience with only one receiver checking the authentication digit fields to ensure someone is not sending out false messages.

Another instance may be a computer with a heavy work load. Here time wasted in deciphering every step of a program could be spent in running the program itself. Therefore, cipher security may be exchanged for an authentication field so that the computer can carry out a quick check and assure the programmer that all is well.

In the cipher block chaining mode of the DES, the authenticator is calculated from the final output block by taking the most

significant m bits. In the USA, the authenticator is called the Message Authentication Code (MAC) or the Data Authentication Code (DAC).

For financial transactions it is recommended that the MAC be greater than 32 bits long and for telecommunications, the MAC should be greater than 24 bits. Authentication protects the communicating parties against a third party but not against each other. For protection against each other, the parties require digital signatures, which will be dealt with later.

IDENTIFICATION

Identification is an essential part of data security. This is achieved by many methods some of which are more suitable than others for electronic scanning. Passwords for accessing computers and pin numbers for accessing cash bills are two such methods.

Personal characteristics which are highly individual can also be used for electronic scanning but are usually unacceptable for one reason or another. Such characteristics include finger prints, the voice, retinal patterns and the handwritten signature.

Passwords are of several kinds:

- (i) The most common are those that are unique for each person.
- (ii) Those that are not unique but aid identification, eg pin numbers.
- (iii) Passwords that are known to a group of people.
- (iv) Passwords which are used only once.

When a computer terminal fails to recognise a genuine person, this is called a Type I error, and when it gives access to a false individual, keying in the wrong code, this is called a Type II error.

If people were permitted to choose their own passwords, the most common choices would be:

- a) words spelt backwards
- b) car numbers, telephone numbers and social security numbers
- c) town names and street names
- d) surnames and first names

A recent survey showed that about 85% of passwords could be cracked because they fell into one of these simple categories when people chose their own passwords.

The most common form of identification on paper documents is by a signature. Forgeries are of three kinds: improvised, copied and traced. An improvised one happens when someone finds a cheque, and because the owner's name is now printed on each cheque, the finder makes a guess at what the signature might look like. This may fool a shopkeeper but not the owner's bank.

A copied signature is one where the forger has a copy of the owner's signature and after a few practice attempts, has a go at signing a cheque. A traced signature is the hardest to detect but for the copied signature, Nagel and Reosenfeld have

invented a machine which compares the angles of slant and dimension ratios with a specimen of the true signature.

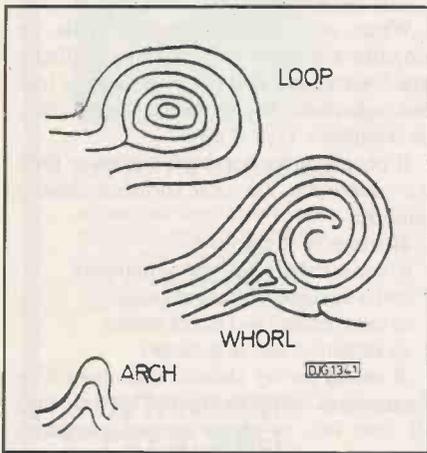
A signature verification system called VERISIGN has also been developed by the National Physical Laboratory. This uses a pad called CHIT and is made from two membranes which touch when the pen is pressed down on the surface. The x and y co-ordinates of the signature are then plotted by sampling at the rate of 50 times per second.

Ten different characteristics are assessed such as velocity and acceleration, turns, slopes and loops and the number of contacts. The time taken for an individual to sign his name varies very little and this in itself is a good check.

A voice verification system has been developed by Texas Instruments. The candidate is required to utter 16 words containing vowels and from this the machine produces 32 sentences. By sampling at 10ms intervals, a Fourier analysis detects the large amplitude regions and bands are selected in the range 300Hz to 250Hz. The information is stored and compared with samples from later visits. However, a cold or stress changes the voice and even asking the candidate to repeat words could lead to stress.

Finger prints are also highly individual. These are based on the loop, whorl and arch, Fig.21, and finger printing has developed by Sir Edward Henry in 1897, the Metropolitan Commissioner of Police.

Fig.21. Loop, whirl and arch.



Unfortunately, fingerprints are connected with crime and the public is not likely to embrace such a system, even though an ink-pad is not involved. The person requesting access has merely to place his fingers on a sheet of glass, and a light from underneath reflects off the fingertips.

The retinal pattern is also unique to individuals and provides another means of identification. Eyedentity of Oregon have invented an infra-red scanner which detects the pattern of blood vessels on the retina when one looks into the binocular eyepiece. The nodes and branches within the scanned area is then registered.

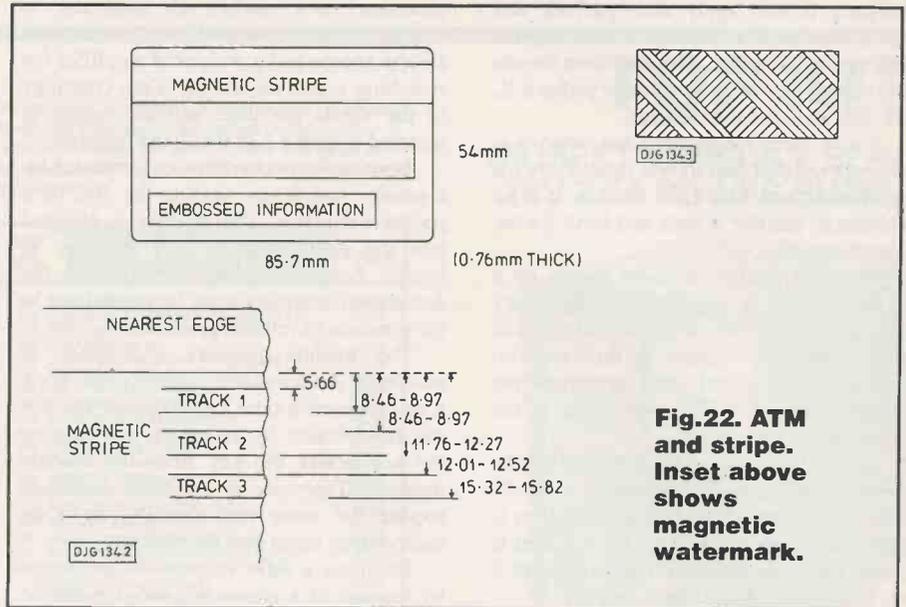


Fig.22. ATM and stripe. Inset above shows magnetic watermark.

ATMS AND PINS

Automatic Teller Machines (atm) are used to describe cash tills which do a bit more than just dispense cash. They also provide statements of the account and transfer between accounts. ATMs are of two kinds, on line and off line.

Off line atms are easier to fool since they are not updated till the next cycle, usually around midnight. Therefore, a stolen or forged card can be used many times. On the other hand an on-line terminal can detect excessive activity, either by the number of withdrawals or if the amount permitted has been exceeded.

The usual token for accessing an atm is a plastic card and pin number. The International Organisation for Standardisation (ISO) has defined the dimensions of this card, Fig.22, as well as the tracks on the magnetic stripe. The stripe itself can be "watermarked" to prevent forgery.

The Emidata/Malco system arranges for magnetic stripes angled at 45 degrees alternately, by means of a recording head. The stripe also carries between 50 and 100 bits of data. Given all this security it is little wonder that unscrupulous people prefer to steal a card and pin number rather than attempt to forge a card and pin number. A survey showed that an average US businessman carries something like 11 cards so it is not easy to memorise all the pin numbers.

The standards for pin management expect organisations to use pin numbers between 4 and 12 digits long. In practice, typical pin numbers are 4, 5 or 6 digits long perhaps to assist people to remember them without writing them down.

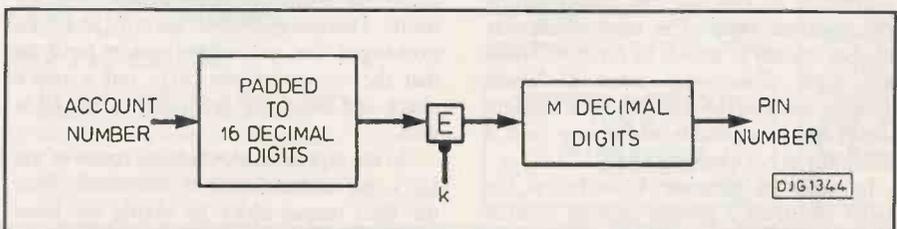
A pin number can be derived from an account number as shown in Fig.23. Using zeros or constants, the account number is padded out to 16 decimal digits. The 64 bit number produced is then enciphered using DES and a secret key and the 64 bit output is examined in groups of 4 bits starting at the least significant bit end. Those groups whose decimal equivalent is less than 10 are accepted and the required M digit pin number is obtained. In practice a slight adjustment is made if too many or too few decimal digits have been produced.

PIN numbers are typed by printers without ribbons so that an unscrupulous person cannot steal the ribbon and read it afterwards, hence security is improved. Instead a carbon type of paper which is already inside a sealed envelope is inserted into the printer and this envelope is posted separately from the plastic card.

Another method of choosing a pin number could be by a visit to the bank where customers would have the facility of typing their chosen number onto a computer terminal. Although the local bank staff may not see the pin number, it could be assessed by the systems operators.

A recent development is the so called smart card which is active and can, therefore, handle a certain amount of

Fig.23. PIN number from account number.



processing. (Smart cards were discussed in *Home Automation, PE May '89, Ed*) Its storage is 250 bytes compared to the 100 bits of the ordinary card. The information can be stored in a hologram and is used for such things as paying for phone calls and transport and viewing television, and the number of credit units held in the hologram is decremented each time it is used. The active card did not appear earlier because the requirements were to maintain the durability and dimensions of the previous card, therefore, fragile chips would have been unsuitable. Nevertheless cards with chips are also in use as well as cards with magnetic stores.

ELECTRONIC FUNDS

The Society of Worldwide Interbank Financial Telecommunications (SWIFT) was set up to speed international payments. It is a non-profit bank owned by 1000 shareholding banks in 50 countries. Passwords are used only once and tables of passwords are despatched in two halves so that if one half is intercepted, no harm is done.

There is no point in developing an international system if a national system does not exist to aid and support the international system. For this purpose the Clearing House Interbank Payment System (CHIPS) was established in the USA and Clearing Houses Automated Payment System (CHAPS) in the UK.

DES in the CBC mode is the authenticator used in CHAPS, and CHAPS operates over the part of the public telephone network called packet switchstream (PSS). The interface of CHAPS software with the banks software is called the gateway, Fig.25. The gateways must be reliable and the PSS network must have a high availability.

Both these aspects are essential since CHAPS offers same day settlement of accounts which is vital to those who are moving house for instance. On the final date called 'completion' the seller wants to be sure of receiving the money since he is also vacating the house. Thirteen settlement banks in London are linked into CHAPS and about 300 banks in the UK including foreign banks.

DIGITAL SIGNATURES

On paper documents, a signature has always been the ultimate authority. In electronic communications, authentication is useful against third parties, but does not provide security between the communicating parties.

Both sender and receiver have scope for cheating in the absence of a digital signature. For instance the sender could deny instructions to his broker if the shares suddenly look unfavourable. A receiver could cheat by altering the amounts and frequency of payment to himself.

A digital signature is a number which depends on all the bits of the message and also on the secret key. A digital signature can be checked by means of a public key whereas an authenticator requires a secret key.

A public communications system provides either authentication or secrecy and if both must be combined then signature methods as well as encipherment must be used.

A symmetric cipher can also be used for digital signature but an arbitrator must be employed. The arbitration service is called the 'authentication server' by Needham and Schroeder and is probably better suited to internal communications in a large firm.

The arbitrator must be trusted by all

masquerade particularly if he stands to gain by pretending to lose his key. In general digital signatures are more reliable than handwritten signatures, since they are automatically checked whereas handwritten signatures are accepted at face value. Therefore, digital signatures help automate business processes.

Enciphering used to require human skill and intuition and was an art. Now, computing can break the classical methods by brute force, first to identify the type of cipher and then to break into the combinations. In addition to finding the key and cracking the algorithm, the modulation of the transmission system and the plaintext language must also be found.

CIPHER STRENGTH

In estimating the strength of a cipher if the cryptanalyst does not have any idea of the plaintext and has only the ciphertext to work on, this is called a *ciphertext only* attack. It is impossible to find the key if the message is very short and without redundancy.

If there is redundancy like an arbitrary string of constants or known preamble as in computer or satellite communications then cryptanalysis becomes easier. This is called the *known plaintext* attack, and is possible in more situations than one would expect.

For instance political unrest would lead to a message from an embassy to its home country and spectacular changes on the stockmarket would cause a high activity of messages between banks and stockbrokers.

A bombing run on a lightbuoy during World War II led to the word *leuchttonne* appearing in Enigma messages. This was predictable and is called the *chosen plaintext* attack. If the attacker is crafty enough he can use his agents to slip his own words into his enemy for encipherment and this in another case of a chosen plaintext attack.

In modern ciphers the key and not the algorithm is the all important item. Suppose lsi hardware is used to search for the key and that the key is found after exploring only half the key space, Table 1 shows the time taken to search keys of varying size.

Table 1 also shows a machine beyond our present technology capable of doing a million tests in parallel and searching separate parts of the key space. Whereas the lsi is capable of μ s per test, the imaginary machine does a million tests in the same time and even a 64 bit key becomes insecure.

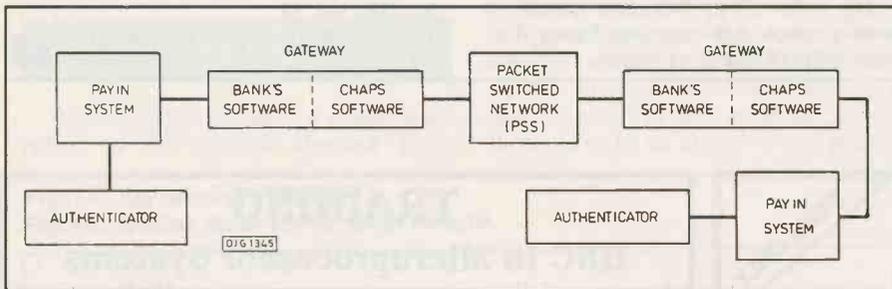


Fig.25. CHAPS operation

In the PSS network, data is chopped into fixed lengths and transmitted between nodes when the link is free as opposed to a dedicated link in a telephone network which carries traffic between those terminals for the duration of the call.

Each originating gateway receives an acknowledgement for each message sent. The gateways also apply time stamps and sequence numbers and keep a running total of the money. Therefore, not only is the link performance monitored at all times, the finances are also kept up to date.

parties to time and date stamp all messages. A random number or serial number in the transmission is also checked to ensure no one interferes with the message.

If the sender has lost his key or believes it has been stolen, he can recall all his messages. This may give rise to a fraud dispute but it is no worse than any other fraud dispute. If a sender is careless enough to lose his keys, he is likely to lose business and if he only pretends to lose his key, he is also likely to lose business.

So he can hardly continue the

TABLE 1

Key Size	Single Tests	One million tests in parallel
	1 μ s per test	1 μ s per test
32	35 minutes	2.15ms
48	4.46 years	2:35 minutes
64		107 days

Shannon put security in two classes: unconditionally secure and computationally secure. One time tapes with random keys or very short messages contained in a key are unconditionally secure since no amount of computing power can break them.

Those ciphers which are computationally secure are those which cannot be broken by today's computing power but may be broken in the future. If a step is defined as the work that lsi hardware can carry out in μ s, then today's technology cannot cope with more than 10^{25} steps.

Certainly, time can be cut down by large money stores and parallel processing, and these will be used increasingly in the future. To be on the safe side, assessment of cipher strength must assume conditions which favour the enemy like a chosen plaintext or known plaintext.

Shannon defined the 'unicity distances' as the minimum length of text which will provide a unique solution. That is, the redundancy in the plaintext must be greater than the information in the key.

Taking monoalphabetic ciphers as an example, the key size is 26! and $\log_2 26!$ is 88. Assuming that English is 80% redundant, each character provides 3.8 bits of redundancy. Hence a cipher with 88/3.8 or about 23 characters is the unicity distance.

Therefore, a text with more than 23 characters will contain redundancy. Shannon's calculations take into account text with spaces, therefore, text without spaces will need a bit for monoalphabetic substitution.

The DES algorithm can be strengthened by increasing the key space, but then the hardware would be more expensive. In a good algorithm the output is not linearly related to the input and changing, even one bit in the key would produce a bit change in the output.

Various estimates have been produced for the cost-time trade off of a machine capable of carrying out a search for a DES key. Cost estimates ranged from 20 to 200

GLOSSARY

ATM	Autobank Teller Machine
CBC	Cipher Block Chaining
CFB	Cipher Feedback
CHIPS	Clearing House Interbank Payment System
CHAPS	Clearing Houses Automated Payment System
DAC	Data Authentication Code
DES	Data Encryption Standard
ECB	Electronic Code Book
ISO	International Standardisation Organisation
IV	Initialising Variable
MAC	Message Authentication Code
NBS	National Bureau of Standards
OFB	Output Feedback
PSS	Packet Switchstream
SWIFT	Society of Worldwide Interbank Financial Telecommunications

million dollars an the time from 20 hours to 11,000 years. But it is not worth the time or effort since DES machines carry commercial, unclassified information.

To meet the challenge of improving technology the permutations, S boxes and keying methods can be improved in addition to changing the key size, data blocks and sub key generators.

Conducting an exhaustive key search on the 128 bit Lucifer system would take 10^{19} years, assuming one key is tested per picosecond, since there are 3×10^{38} keys.

Ultimately, both a thermodynamic limit as well as a limit on the storage must defeat an exhaustive key search. Suppose each step requires energy KT where K is Boltzman's constant and T is the absolute temperature. Assuming that the calculations will take place at 100°k and from calculations of the sun's rays heating the earth, 3×10^{48} calculations will take 1000 years.

The other important requirement is memory space. Assuming one binary digit needs only 10 atoms of silicon, 10^{45} bits

will cover all the dry land to a height of 1km. Alternatively a satellite of similar mass will have to be put in orbit.

When machines become too expensive for code breaking, more mundane methods will be adopted like merely stealing a card and pin or bribing a person in a position of trust.

CONCLUSIONS

Early ciphers depended on substitutions and transpositions, but when the two are combined, machines are required otherwise humans would be too slow and inaccurate.

The DES was described as an example of a modern cipher where the emphasis has changed from secrecy of the algorithm to secrecy of the key. With this change in emphasis, key management then becomes an art in itself.

Together with public key ciphers, other improvements have been introduced such as identification, authentication and digital signatures, all of which are essential for automating business using atms and CHAPS.

The security of a cipher is never guaranteed and hackers, when they are caught, do not have the same guilt feelings as those who steal money. Society probably looks on them with mild amusement and curiosity. However, damage of a varying extent can be caused by unauthorised people accessing medical records, financial records and military networks.

BIBLIOGRAPHY

- How Encryption Secures Data, H. Pollock, Can. Datasyst Vol. 19.
- Cryptanalysis, H.F.-Gaines.
- Security from Attack, R. Gibbs, Comm. Int (GB) Vol. 14.
- The Code Breakers, D. Kahn

PE

SOFTMACHINE
DISTRIBUTION LTD

386 MOTHER BOARDS

16/20MHz 386 M/B

16/20MHz 286 M/B

VGA CARD

Ex-stock Cash & Carry, from Computer Casing Specialist
Trade Hours: 10-6pm (Sat 10-1pm)

SOFTMACHINE DISTRIBUTION LTD.

Unit F, 18 Harbet Rd, Lea Valley, Hastingwood Trading Estate,
North Circular Rd, Edmonton, London N18 3LR
Fax: 01-807 2748 Tel: 01-803 6068

DEMS ONLY

TRAINING

HNC in Microprocessor Systems

A one year full time course, commencing on 4th September 1989, is offered by Milton Keynes Skillcentre.

The course includes 20 weeks work placement in Industry. This is a Training Agency funded equal opportunity course and training allowances will be paid.

Please phone 0908 670001 for an application form or write to:

Milton Keynes Skillcentre,
Chesney Wold,
Bleak Hall,
Milton Keynes,
MK6 1LX



Skills Training Agency

POWER CONDITIONER

FEATURED IN ETI
JANUARY 1988

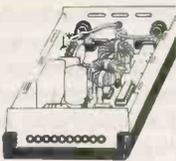
The ultimate mains purifier. Intended mainly for lowering the noise floor and improving the analytical qualities of top-flight audio equipment.

The massive filter section contains thirteen capacitors and two current balanced inductors, together with a bank of six VDRs, to remove every last trace of impulsive and RF interference. A ten LED logarithmic display gives a second by second indication of the amount of interference removed.

Our approved parts set consists of case, PCB, all components (including high permeability toroidal cores, ICs, transistors, class X and Y suppression capacitors, VDRs, etc.) and full instructions.

PARTS SET £28.50 + VAT

A low cost (but high performance) mains conditioner is also available.
MAINS CONDITIONER PARTS SET £5.40 + VAT
RUGGED PLASTIC CASE £1.80 + VAT



KNIGHT RAIDER

FEATURED IN ETI JULY 1987

The ultimate in lighting effects for your Lamborghini, Maserati, BMW (or any other car, for that matter). Picture this: eight powerful lights in line along the front and eight along the rear. You flick a switch on the dashboard control box and a point of light moves lazily from left to right leaving a comet's tail behind it. Flip the switch again and the point of light becomes a bar, bounding backwards and forwards along the row. Press again and try one of the other six patterns. An LED display on the control box lets you see what the main lights are doing.

The Knight Raider can be fitted to any car (it makes an excellent fog light) or with low powered bulbs it can turn any child's pedal car or bicycle into a spectacular TV-age toy!

The parts set consists of box, PCB and components for control, PCB and components for sequence board, and full instructions.
Lamps not included.

PARTS SET £19.90 + VAT

RAINY DAY PROJECTS



All can be built in an afternoon!

- JUMPIN' JACK FLASH (ETI March 1988)
Spectacular rock, stage and disco lighting effect! £6.90 - VAT
- CREDIT CARD CASINO (ETI March 1987)
The wicked pocket gambling machine £5.90 - VAT
- MAINS CONTROLLER (ETI January 1987)
Isolated logic to mains interface £6.20 - VAT
- MATCHBOX AMPLIFIERS (ETI April 1985)
Listen: 50W of Hi-Fi power from an amp small enough to fit in a matchbox!
Matchbox Amplifier (20W) £6.50 - VAT
Matchbox Bridge Amplifier (50W) £8.90 - VAT
L165V Power Amplifier IC, with data and circuits £3.90 - VAT
- TACHO/DWELL METER (ETI January 1987)
Turn your Metro into a Porsche! £16.40 - VAT
- HI-FI POWER METER (ETI May 1987)
Measures Hi-Fi output power up to 100W - includes PCB, components, meters
Mono power meter £3.90 - VAT
Stereo power meter £7.20 - VAT



FEATURED IN ETI
AUGUST 1988

There's nothing quite so encouraging as having a quantifiable result to show for your training efforts. If you are not particularly fit, your resting heart rate will be around 80 beats per minute. As your jogging, aerobics or sport strengthens your heart, the rate will drop dramatically - possibly to 60bpm or less. With the S101, you can watch your progress day by day.

Breathing is important too. How efficiently do you take up oxygen? How quickly do you recover from 'oxygen debt' after strenuous activity? The S101 will tell you how.

The approved parts set consists of: case, 3 printed circuit boards, all components (including 17 ICs, quartz crystal, 75 transistors, resistors, diodes and capacitors), LCD, switches, plugs, sockets, electrodes, and full instructions for construction and use.

PARTS SET £33.80 + VAT

Some parts are available separately. Please send SAE for lists or SAE + £2 for lists, circuit, construction details and training plan (free with parts set).



THE DREAM MACHINE

FEATURED IN ETI
DECEMBER 1987



Adjust the controls to suit your mood and let the gentle, relaxing sound drift over you. At first you might hear soft rain, sea surf, or the wind through distant trees. Almost hypnotic, the sound draws you irresistibly into a peaceful, refreshing sleep.

For many, the thought of waking refreshed and alert from perhaps the first truly restful sleep in years is exciting enough in itself. For more adventurous souls there are strange and mysterious dream experiences waiting. Take loud dreams, for instance. Imagine being in control of your dreams and able to change them at will to act out your wishes and fantasies. With the Dream Machine it's easy!

The approved parts set consists of PCB, all components, controls, loudspeaker, knobs, lamp, fuseholders, fuse, mains power supply, prestige case and full instructions.

PARTS SET £16.50 + VAT

Ben Swinford's best seller GROW RICH WHILE YOU SLEEP is now in stock. £2.95 (NO VAT)

THE MISTRAL AIR IONISER

The best ioniser design yet - this one has variable ion drive, built-in ion counter and enough power to drive five multi-point emitters. For the technically minded, it has nine main drive stages, five secondary drives, and a four section booster to give an output capability of almost fifteen billion (1.47 x 10¹⁰) ions every minute, or 2.45 x 10¹¹ ions per second. With extra emitters this can be increased still further!

PARTS SET £24.80 + VAT

The parts set includes case, printed circuit boards, 126 top grade components, all controls, lamps, hardware, a multi-point phosphor-bronze emitter and full instructions.

Some parts are available separately - please send SAE for lists, or SAE + £1 for lists, circuit and construction details and further information (free with parts set).



READY-BUILT MISTRAL

The Mistral ioniser (and most of our other projects) can now be supplied built, tested and ready to go. For details, please contact Peter Leah at P.L. Electronics, 8 Woburn Road, Eastville, Bristol BS5 6TT. Tel: 0272 522703. Evenings Only

INTERNAL EMITTER £2.69 + VAT

Can be used in place of the P-B external emitter, or both can be used together for the highest ion output. Parts set includes PCB, ion emitters, components and instructions.

IPA BOARD CLEANER

£0.98 + VAT

Essential for removing grease and flux residues from the Mistral PCB to achieve peak performance. Applicator brush supplied.

ION FAN

£9.80 + VAT

An almost silent piezo-electric fan, mains operated, to pump ions away from the emitter and into the room. Increases the effectiveness of any ioniser by five times!

TV BOOSTER

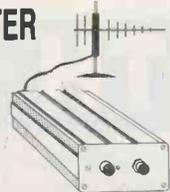
Good TV pictures from poor aerials is what this project is all about. Keith Brindley's Aerial Booster gives a massive 20dB gain to ensure good viewing for campers and caravaners, from indoor aerials, or wherever a properly positioned high-gain antenna is not practical.

Based on the OM335 hybrid amplifier, the booster has specifications to rival the best - wideband operation from 10MHz to 1.4 GHz, mid-band gain of up to 20dB and a wide supply range of 9V to 26V (it will run from car batteries for caravaners, dry batteries for campers, or a mains 'battery eliminator' in the home). No special UHF construction skills are needed - the project could be made by a careful beginner.

There are two parts sets for the project. AA1 contains the printed circuit board, OM335 hybrid amplifier, components and instructions. AA2 is the optional case set rugged screened box, front and rear panels, waterproofing gaskets, feet, sockets and hardware.

AA1 PARTS SET £12.80 + VAT

AA2 PARTS SET £4.80 + VAT



POWERFUL AIR IONISER

FEATURED IN ETI
JULY 1986

Ions have been described as 'vitamins of the air' by the health magazines, and have been credited with everything from curing hay fever and asthma to improving concentration and putting an end to insomnia. Although some of the claims may be exaggerated, there is no doubt that ionised air is much cleaner and purer, and seems much more invigorating than 'dead' air.

The DIRECT ION ioniser caused a great deal of excitement when it appeared as a constructional project in ETI. At last, an ioniser that was comparable with (better than?) commercial products, was reliable, good to build, and fun! Apart from the serious applications, some of the suggested experiments were outrageous!

We can supply a matched set of parts, fully approved by the designer, to build this unique project. The set includes a roller tinned printed circuit board, 66 components, case, mains lead, and even the parts for the tester. According to one customer, the set costs about a third of the price of the individual components. What more can we say?

PARTS SET WITH BLACK CASE £11.50 + VAT

PARTS SET WITH WHITE CASE £11.80 + VAT



Instructions are included

BURGLAR BUSTER

Be safe from intruders with our Burglar Buster alarm system! It has all the features you'd expect from a high-tech alarm: entry and exit delay, anti-tamper loop, delay warning and control-box protection.

The parts set includes all four PCBs and all components to go on them. Other parts (case, switches, etc.) are available separately, if you haven't got anything suitable in your spares box. Set contains 4 PCBs, ICs, transistors, relays, capacitors, resistors, diodes, regulator, piezo sounder and full instructions.

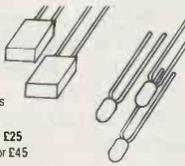
BB1 PARTS SET £12.80 + VAT

LEDs

Green rectangular LEDs for bar-graph displays.
50 for £3.50 500 for £25
100 for £6 1000 for £45

DIGITAL AND AUDIO EQUIPMENT LEDs
Assorted 3mm LEDs: red, green, yellow and orange.
25 of each (100 LEDs) for £6.80

U.K. orders: please add 80p post and packing and 15% VAT to total.
Ire and overseas: no VAT. Carriage and insurance £4.50.
Please allow up to 14 days for delivery.



BRAINWAVE MONITOR

FEATURED IN ETI
AUGUST 1987

The most astonishing project ever to have appeared in an electronics magazine. Similar in principle to a medical EEG machine, this project allows you to hear the characteristic rhythms of your own mind! The alpha, beta and theta forms can be selected for study and the three articles give masses of information on their interpretation and powers.

In conjunction with Dr. Lewis's Alpha Plan, the monitor can be used to overcome shyness, to help you feel confident in stressful situations, and to train yourself to excel at things you're 'no good' at.

Our approved parts set contains case, two PCBs, screening can for bio-amplifier, all components (including three P.M.I. precision amplifiers), leads, brass electrodes and full instructions.

PARTS SET £36.90 + VAT ALPHA PLAN BOOK £2.50
SILVER SOLUTION (for pacing electrodes) £3.60 + VAT

Parts set available separately. We also have a range of accessories, professional electrodes, books, etc. Please send SAE for lists, or SAE + £2 for lists, construction details and further information (free with parts set).



Specialist SEMICONDUCTORS LIMITED

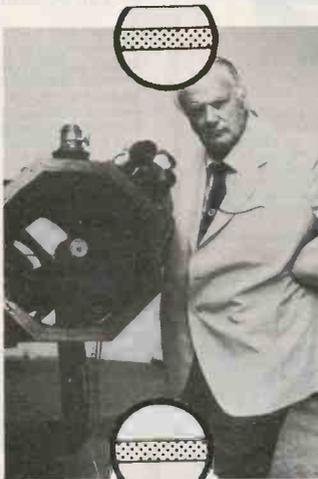
Tel: (0600) 3715
SALES DEPT., ROOM 108, FOUNDERS HOUSE, REDBROOK, MONMOUTH, GWENT.

Sadly, we must now give up all hope of re-contacting the Russian probe Phobos 2, which "went missing" soon after it had started to send back useful data. Some pictures of Phobos, Mars' inner satellite, were received, though it cannot be said that they rivalled those obtained by the American Viking probes more than a decade ago. However, one experiment carried on Phobos 2 does seem to have worked. It was master-minded by the Irish scientist Dr Susan McKenna-Lawlor, and was aimed at detecting charged particles in the region of Mars. Preliminary data indicates that the results were positive, in which case Mars does have Van-Allen type belts, albeit weak ones, and probably a magnetic field. It is a great pity that contact with Phobos 2 was lost at so early a stage.

There is still considerable doubt about the existence of the pulsar in the Large Cloud of Magellan, produced by the supernova which has caused such excitement. The presence of a pulsar was reported by observers at the Cerro Tololo Observatory in Chile, but so far nobody else has been able to see it, and at the moment it must be regarded as 'non proven'. There is every likelihood that a pulsar has been formed, but we must simply wait to see what happens next.

Also in Chile, the NTT or New Technology Telescope at the La Silla Observatory has been brought into use, and is proving to be every bit as good as had been hoped. It is of 'modern' design, with a

SPACE



WATCH

BY DR PATRICK MOORE CBE

One up, one down...
Telescopes come
and go

thin mirror, and an altazimuth mounting; its mirror has active optics, ie, the shape is controlled by computers as the mirror is moved around, thereby compensating for flexure, and although it is not the world's largest single-mirror telescope there seems every chance that it will prove to be the most effective. It has even been claimed that it will rival the performance of the Hubble Space Telescope which will, we hope, be launched early next year.

On the debit side, it has been established that the collapse of the 300-foot radio telescope at Green Bank, West Virginia, was due solely to metal fatigue. In the words of one of the investigators, "it just wore out". A replacement is already being planned, but will not be built for some years yet.

At the end of April a sad 'farewell party' was held at Herstmonceux Castle to mark the end of the Royal Greenwich Observatory's career there. The Observatory is to be moved to an office block at Cambridge, where we can only hope that it will manage to retain its separate identity.

THE CASSINI PROBE

Funds have now been definitely allocated for the Cassini Probe, which is to be launched toward Saturn. True, it will not arrive until early in the next century, but it

THE SKY THIS MONTH

Planetary observers have mixed fortunes this month. Mercury is to all intents and purposes out of view; Mars is visible low in the western sky after sunset, but it is now little brighter than the Pole Star, and no telescope will show much on its shrunken disk. We will not see Mars well again until late next year. Note, though, that Mars as well as the Earth has been having unusual 'weather'. The great dust-storms which usually occur there late in Martian summer have simply not formed, and even when the planet had moved far away from the Earth I was still able to see the dark markings on the disc which are generally hidden.

Venus is a brilliant object in the western sky after sun-set. If you have a telescope or binoculars, look at it on July 23; it is within 1 1/2 degrees of the bright star Regulus, and the two make up a beautiful 'pair'. Jupiter is now drawing away from the Sun in the sky, and is brilliant in the east before dawn; later this year it is hoped that the Galileo space-probe will be launched toward it, though unfortunately the journey will be a protracted one, and Galileo will not arrive near the region of Jupiter until 1995. Finally there is Saturn, which comes to opposition on July 2, when it will be 1,350,000,000 kilometre's away. The rings are wide open, so that a small telescope will show them as well as several of Saturn's satellites.

Saturn is in the constellation of Sagittarius (the Archer) and is inconveniently low down as seen from Britain. The two outer giants, Uranus and Neptune, are also in Sagittarius; Uranus is just visible with the naked eye if you know where to look for it, but Neptune requires optical aid. At the moment Voyager 2 is still on course for Neptune, and the rendezvous, next month, will be fraught with interest.

Do not forget Pluto, which comes to perihelion this year. It is in Libra, but as the magnitude is only 14 you need a fair-sized telescope to see it. We now know that it has an extensive, if tenuous, atmosphere; its surface has a coating of methane ice, whereas the

coating of its companion, Charon, appears to be water ice. It is a pity that no current space-probe is scheduled to go anywhere this strange little system.

An interesting periodical comet is coming into view. This is Brorsen-Metcalf, which has a period of 72 years - not very different from Halley's. However, Brorsen-Metcalf is not bright, and even at its best, in the early autumn, it is not likely to be above the fifth magnitude. Telescopic owners may care to look for it; the calculated position for July 23 is RA 0h 17m.3, dec. +14°35'.2, with magnitude of about 10. I will say more about it in the next Spacewatch.

July is the best time of the year to look at the lovely star-clouds of Sagittarius, which mask our view of the centre of the Galaxy. They are low down, but this year the presence of Saturn in the same region makes them particularly easy to identify. On a dark, moonless night they are superb; if you have binoculars, sweep around and enjoy yourself among the rich star-fields.

Vega in Lyra, the brilliant bluish star, is almost over-head; look too for the other members of the unofficial 'Summer Triangle', Deneb in Cygnus (the Swan) and Altair in Aquila (the Eagle). Arcturus in Boötes (the Herdsman) is dropping in the north-west, while the Square of Pegasus is making its entry in the east late in the evening. The Great Bear is in the north-west, still well above the horizon; from Britain, of course, it never sets.

At the end of July we will start to see the first of the Perseid meteors, which reach their maximum on August 12. Generally the Perseids can be relied upon to give a good display, and there is no reason to suppose that 1989 will be exceptional in this respect.

Because the Sun is now rising to the peak of its 11-year cycle of activity, we may well have some displays of aurora, though one can never be sure, and we will be lucky to have another display as good as that of March 13 this year, which was seen from much of Britain.

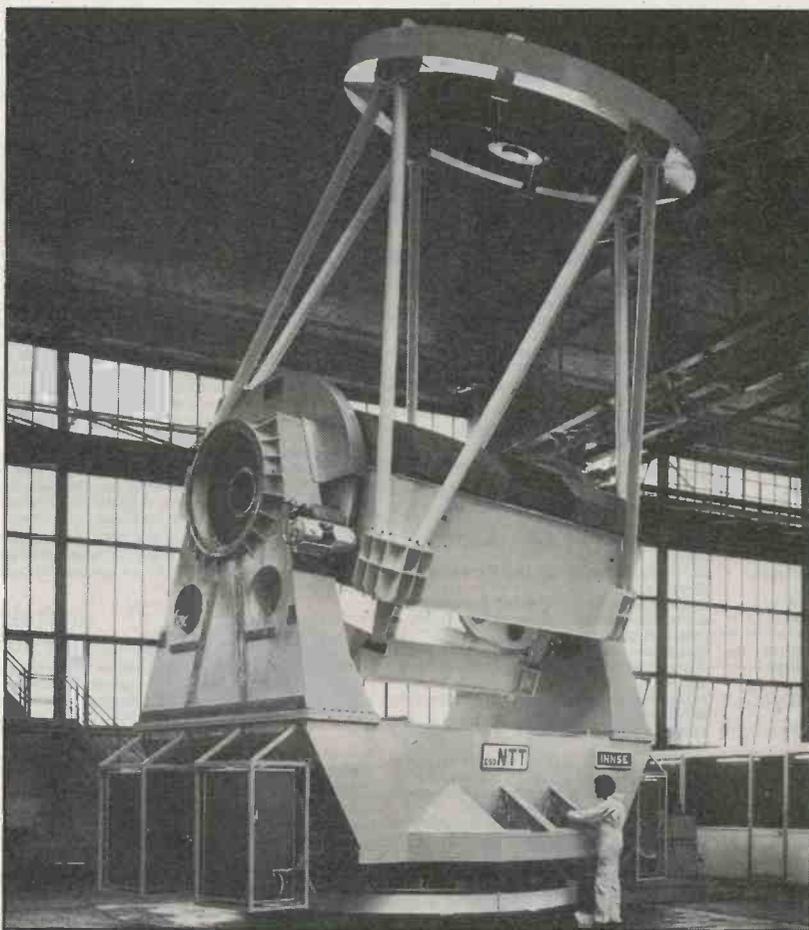
should prove to be among the most informative of the space-craft.

We know a good deal about Saturn itself, but not nearly so much about Titan, its senior satellite, which will be Cassini's main target. Titan, larger than our Moon and almost as large as the planet Mercury, has a dense atmosphere which is made up chiefly of nitrogen, with a good deal of methane. Organic compounds no doubt exist, and the main objection to the existence of life is the very low temperature.

But has Titan a liquid surface? This may well be the case. Of course, the liquid will not be of water, but it may be that much of the satellite is covered with a methane ocean, in which case Cassini's 'lander' may have to be capable of floating. Whether we will be able to find out before the probe is launched remains to be seen, but at any rate the Titan mission is something to which astronomers look forward with considerable eagerness!

PIE

The photograph shows the New Technology Telescope in the workshops of INNSE at Brescia, Italy prior to being installed at the La Scilla Observatory in Chile. The photo is reproduced by kind permission of Astronomy Now to whom it was supplied by courtesy of the ESO Information and Photographic service.



Do not miss a single issue of

Astronomy Now

Britain's leading astronomical magazine

Edited by well known astronomer and regular contributor to *Practical Electronics*
Dr. Patrick Moore CBE

Place a regular order with your newsagent or for £15-00 (overseas £18-00) take out an annual subscription from Intra Press, Intra House, 193 Uxbridge Road, London W12 9RA



TUTORKIT MICROELECTRONICS TUTORS

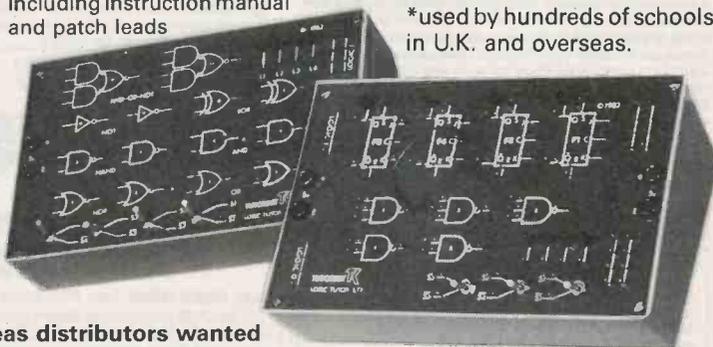
Logic Tutors
OP Amp Tutors
I.C. Patchboards
GCSE Units
Computer Interfaces

Prices from

**£27.50
PLUS VAT**

Including instruction manual and patch leads

*used by hundreds of schools in U.K. and overseas.



TUTORKIT PRODUCTS
(Div of Limrose Electronics Ltd)
Llay Industrial Estate
Wrexham, Clwyd, U.K.
LL12 0TU. Tel 097 883 2285

Overseas distributors wanted



No. 1 LIST BAKERS DOZEN PACKS

All packs are £1 each, if you order 12 then you are entitled to another free. Please state which one you want. Note the figure on the extreme left of the pack ref number and the next figure is the quantity of items in the pack, finally a short description.

- BD2 5 13A spurs provide a fused outlet to a ring main where devices such as a clock must not be switched off.
- BD7 4 In flex switches with neon on/off lights, saves leaving things switched on.
- BD9 2 6V 1A mains transformers upright mounting with fixing clamps.
- BD11 1 6 1/2" speaker cabinet ideal for extensions, takes our speaker. Ref BD137.
- BD13 12 30 watt reed switches, it's surprising what you can make with these - burglar alarms, secret switches, relay, etc., etc.
- BD22 2 25 watt loud speaker two unit cross-overs.
- BD29 1 B.O.A.C. stereo unit is wonderful breakdown value.
- BD30 2 Nicad constant current chargers adapt to charge almost any nicad battery.
- BD32 2 Humidity switches, as the air becomes damper the membrane stretches and operates a microswitch.
- BD42 5 13A rocker switch three tags so on/off, or change over with centre off.
- BD45 1 24hr time switch, ex-Electricity Board, automatically adjust for lengthening and shortening day original cost £40 each.
- BD49 10 Neon valves, with series resistor, these make good night lights.
- BD56 1 Mini uniselector, one use is for an electric jigsaw puzzle, we give circuit diagram for this. One pulse into motor, moves switch through one pole.
- BD59 2 Flat solenoids - you could make your multi-tester read AC amps with this.
- BD67 1 Suck or blow operated pressure switch, or it can be operated by any low pressure variation such as water level in water tanks.
- BD91 1 Mains operated motors with gearbox. Final speed 16 rpm, 2 watt rated.
- BD103A 1 6V 750mA power supply, nicely cased with mains input and 6V output leads.
- BD120 2 Stripper boards, each contains a 400V 2A bridge rectifier and 14 other diodes and rectifiers as well as dozens of condensers, etc.
- BD122 10m Twins screened flex with white pvc cover.
- BD126 10 Very fine drills for pcb boards etc. Normal cost about 80p each.
- BD132 2 Plastic boxes approx 3in cube with square hole through top so ideal for interrupted beam switch.
- BD134 10 Motors for model aeroplanes, spin to start so needs no switch.
- BD139 6 Microphone inserts - magnetic 400 ohm also act as speakers.
- BD148 4 Reed relay kits, you get 16 reed switches and 4 coil sets with notes on making c/o relays and other gadgets.
- BD149 6 Safety cover for 13A sockets - prevent those inquisitive little fingers getting nasty shocks.
- BD180 6 Neon indicators in panel mounting holders with lens.
- BD193 6 5 amp 3 pin flush mounting sockets make a low cost discop panel. Need cable clips.
- BD196 1 In flex simmerstat - keeps your soldering iron etc. always at the ready.
- BD199 1 Mains solenoid, very powerful, has 1 1/2" pull or could push if modified.
- BD201 8 Keyboard switches - made for computers but have many other applications.
- BD210 4 Transistors type 2N3055, probably the most useful power transistor.
- BD211 1 Electric clock, mains operated, put this in a box and you need never be late.
- BD221 5 12V alarms, make a noise about as loud as a car horn. Slightly soiled but OK.
- BD242 2 6in x 4in speakers, 4 ohm made from Radiomobile so very good quality.
- BD252 1 Panostat, controls output of boiling ring from simmer to boil.
- BD259 50 Leads with push-on 1/4in tags - a must for hook-ups - mains connections etc.
- BD263 2 Oblong push switches for bell or chimes, these can mains up to 5 amps so could be foot switch if fitted into pattress.
- BD268 1 Mini 1 watt amp for record player. Will also change speed of record player motor.
- BD275 1 Guitar mic - clip-on type suits most amps.
- BD283 3 Mild steel boxes approx 3in x 3in x 1in deep - standard electrical.
- BD293 50 Mixed silicon diodes.
- BD296 2 Car plugs fit into lighter socket.
- BD305 1 Tubular dynamic mic with optional table rest.
- BD400 4 Books, useful for beginners, describes amplifiers, equipment and kit sets.
- BD653 2 Miniature driver transformers. Ref. LT44. 20k to 1k centre tapped.
- BD553a 2 3.5V relays each with 2 pairs changeover contacts.

Most other packs still available and you can choose any as your free one.

CAMERAS. Three cameras, all by famous makers, Kodak, etc. One disc, one 35mm and one Instamatic. All in first class condition, believed to be in perfect working order, but sold as untested. You can have the three for £10 including VAT, which must be a bargain - if only for the lenses, flash gear, etc. Our ref 10P58.

675 VOLT MAINS TRANSFORMER PCB mounting, 20va. A very well made (British) transformer. Ideal for laser power supply, etc. Price £4. Our ref 4P38.

PRETTY CASSETTE PLAYER In handy carrying pouch with silk type shoulder cord. Ideal present for young girl. New, tested and in perfect order. Just needs headphones and batteries. Price £4. Our ref 4P35.

EXTRA SPECIAL CROC CLIPS Medium size, just right for most hook-ups. Normally sell for around 10p to 15p each. These are insulated and have a length of wire connected to them but this is very easy to snip off if you do not need it. 20 for £1. Our ref BD117A.

IONISER FOR YOUR CAR Experts say that positive ions predominate in a car and can cause you to feel sleepy so we now offer a car ioniser to counteract this. It plugs into the cigarette lighter socket. Price £12 for the complete kit. Our ref 12P8. Our famous transformer operated room ioniser is still available at £12.50. We claim this to have ten times more output of ions than the ETI, the Equaliser and in fact most other popular kits and ready built ionisers.

COPPER CLAD PANEL for making PCB. Size approx 12in long x 8 1/2in wide. Double-sided on fibreglass middle which is quite thick (about 1/8in) so this would support quite heavy components and could even form a chassis to hold a mains transformer, etc. Price £1 each. Our ref BD683.

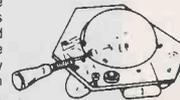
POWERFUL IONISER

Generates approx 10 times more IONS than the ETI and similar circuits. Will refresh your home, office, workroom, etc. Makes you feel better and work harder - a complete mains operated kit, case included. £12.50 plus £2 postage. Our ref 12P5/1.



MODERN TELEPHONES Two-piece push-button desk or wall mounting telephone. Fitted with standard BT flat plug for immediate use. Standard model £8. Our ref BP31. Or similar but with 10 memory feature £10. Our ref 10P68. If not collecting add £2 for special packing.

ORGAN MASTER Is there a three octave musical keyboard. It is beautifully made, has full size (piano size) keys, has gold plated contacts and is complete with ribbon cable and edge connector. Can be used with many computers. We can supply information sheet. Brand new, only £15 plus £3 postage. Our ref 15P15.



ELECTRONIC SPACESHIP Sound and impact controlled, responds for claps and shouts and reverses when it hits anything. Kit with really detailed instructions. Ideal present for budding young electrician. A youngster should be able to assemble but you may have to help with the soldering of the components on the pcb. Complete kit £8. Our ref 8P30.

DATA RECORDER FOR COMPUTERS For playing games or listening to music cassettes. It has a built-in condenser microphone and loud speaker (muted if you use the extension socket. Has the following controls: pause, stop/eject, last forward, rewind, play and record. Also have built-in tape counter, extension headphone and microphone socket and volume control. Built-in power supply enables it to run from the mains but provision also for battery operation. In 'as new' order condition, but customer returns so may have fault. Price only £10 and if you order 4 you get a fifth one free. Our ref 10P65.

BUSH RADIO MIDI SPEAKERS Stereo pair, BASS reflex system, using a full range 4in driver of 40hms impedance. Mounted in very nicely made black fronted walnut finish cabinets. Cabinet size approx 8 1/2in wide, 14in high and 3 1/2in deep. Fitted with a good length of speaker flex and terminating with a normal audio plug. Price £5 the pair plus £1 post. Our ref 5P141.

3 1/2" FLOPPY DISC DRIVE - DOUBLE SIDED, DOUBLE DENSITY, 80 TRACK Shugart compatible, has 34 way IDC connect and will interface with almost any computer. Made by the famous Japanese NEC Company. Price £59.50 plus £3 insured post.



ATARI 65XE COMPUTER

At 64k this is most powerful and suitable for home and business. Brand new, complete with PSU, TV lead, owner's manual and six games. Can be yours for only £45 plus £3 insured delivery.

65XE COMPENDIUM Contains: 65XE Computer, its data recorder XC12 and its joystick, with ten games for £62.50 plus £4 insured delivery.

AGAIN AVAILABLE: ASTEC PSU Mains operated switch mode, so very compact. Outputs: +12V 2.5A, +5V 6A, ±5V 5A, ±12V 5A. Size: 7 1/4" long x 4 3/8" wide x 2 1/4" high. Cased ready for use. Brand new. Normal price £30+, our price only £10. Our ref 10P34.

VERY POWERFUL 12 VOLT MOTORS. 1/3rd Horsepower. Made to drive the Sinclair C5 electric car but adaptable to power a go-kart, a mower, a rail car, model railway, etc. Brand new. Price £15 plus £2 postage. Our ref 15P8.

PHILIPS LASER

This is helium-neon and has a power rating of 2mW. Completely safe as long as you do not look directly into the beam when eye damage could result. Brand new, full spec. £30 plus £3 insured delivery. Mains operated power supply for this tube gives 1kv striking and 1.25kv at 5mA running. Complete kit with case £15. Battery operated P.S.U. now available at £16.

BATTERY DRIVEN LASER POWER SUPPLY This is available in three versions: *First* is a cased unit which holds the power supply and is fed from a separate 12volt battery and drives the laser through extension leads. Kit complete with ABS case. Price £15. Our ref 15P22. *Second* is a metal cased unit which holds the power supply and the laser but is driven from an external 12volt battery. This unit, in kit form, costs £18. Our ref 18P2. A conversion kit from 15P22 to 18P2 is £6. Our ref 6P14. *Third* is a metal cased unit which holds the laser, its power supply and 2 x 6volt rechargeable batteries which feed it, also the mains driven unit to recharge the batteries. Complete kit £24. Our ref 24P2.

HAND-HELD VIDEO LAMP. Main operated and will enable you to take professional standard videos. Made by the famous Ferguson Company, this uses a 1000w halogen lamp in a fan cooled, hand-held and hand switched metal housing. Comes complete with option of barn-door assembly and camera bar. Obviously intended to retail at over £60, we offer these as £30 each plus £3 insured delivery. Our ref 30P3.

HIGH RESOLUTION MONITOR. In black and white, used Philips tube M24/305W. Made up in a lacquered frame and has open sides. Made for use with OPD computer but suitable for most others. 5 and new. £16 plus £5 post. Our ref 16P1.

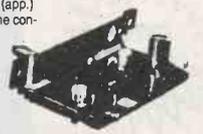
12 VOLT BRUSHLESS FAN. Japanese made. The popular square shape 1 1/2" x 4 1/2" x 17in). The electronically run fuse not only consume very little current but also they do not cause interference as the brush type motors do. Ideal for cooling computers, etc. or for a caravan. £8 each. Our ref 8P28.

MONO RADIO CASSETTE RECORDER AM/FM with all the normal controls. In 'as new' condition but customer returns or shop rejects, so may need attention. Price £10. Order 5 of these and get a sixth one free. Our ref 10P66.

FDD BARGAIN

3 1/2in made by Chicon of Japan. Single aided, 80 track, Shugart compatible interface, interchangeable with most other 3 1/2 in end 5 1/4in drives. Completely cased with 4 pin power lead and 34 pin computer lead £40. Plus £3 ins del. Our ref 40P1.

MINI MONO AMP on p.c.b. size 4" x 2" (app.) Fitted volume control and a hole for a tone control should you require it. The amplifier has three transistors and we estimate the output to be 3W rms. More technical data will be included with the amp. Brand new, perfect condition, offered at the very low price of **£1.15 each, or 13 for £12.00.**



J & N BULL ELECTRICAL

Dept PE, 250 PORTLAND ROAD, HOVE BRIGHTON, SUSSEX BN3 5QT

MAIL ORDER TERMS: Cash, PO or cheque with order. Orders under £20 add £1.50 service charge. Monthly account orders accepted from schools and public companies. Access and Bcard orders accepted minimum £5. Phone (0273) 734648 or 203500.

POPULAR ITEMS

Some of the many items described in our current list which will you receive if you request it

BATTERY OPERATED TRAVEL MECHANISM On a plastic panel measuring approx 9in x 3 1/2in. Is driven by a reversible 12v battery motor, fitted with pulley and belt which rotates a threaded rod and causes a platform to travel backwards and forwards through a distance of approx 5in. Price £5. Our ref 5P140.

MAINS OPERATED WATER VALVE with hose connection for inlet and outlet suitable for low pressure. Auto plant watering, etc. Only £1 each. Our ref BD370.

20 VOLT 4 AMP MAINS TRANSFORMER Upright mounting with fixing feet. Price £3. Our ref 3P59.

12 VOLT SOLENOID Has good 1/2in pull or could be made to push if fitted with a rod. Approx 1 1/2in long by 1in square. Price £1. Our ref BD232A.

180HM PM SPEAKERS Approx 7in x 4in. 5 watts. Offered at a very low price so you can use two in parallel to give you 10 watts at 8 ohms. £1 for the two. Our ref BD684.

EHT TRANSFORMER 4kv 2mA EX-unused equipment. £5. Our ref 5P139.

FOIL CAPACITORS Axial ended. 33uf 1,000v. 4 for £1. Our ref DB672. Many other sizes in stock, send for May newsletter.

4 CORE TINSEL COPPER LEAD As fitted to telephones, terminating with flat BT plug. 2 for £1. Our ref BD639.

EHT TRANSFORMER 8kv 3mA. £10. Our ref 10P56.

DOUBLE MICRODRIVES We are pleased to advise you that the Double Microdrives which we were offering at about this time last year as being for the 'QL', 'OPD' and several other computers are again available, same price as before namely £5. Our ref 5P113.

VERY USEFUL MAGNETS Flat, about 1in long, 1/2in wide and 1/4in thick. Very powerful. 6 for £1. Our ref BD274(a).

ACORN COMPUTER DATA RECORDER REF ALF03 Made for the Electron or BBC computers but suitable for most others. Complete with mains adaptor, leads and handbook. £10.00. £2 special packing. Ref 10P44.

FREE POWER! Can be yours if you use our solar cells - sturdily made modules with new system bubble magnifiers to concentrate the light and so eliminate the need for actual sunshine - they work just as well in bright light. Voltage input is .45 - you join in series to get desired voltage - and in parallel for more amps. Module C gives 400mA, Price £2. Our ref. 2P199 Module D gives 700mA, Price £3, Our ref. 3P42.

SOLAR POWERED NI-CAD CHARGER 4 Ni-Cad batteries AA (HP7) charged in eight hours or two in only 4 hours. It is a complete, boxed ready to use unit. Price £6. Our ref. 6P3.

METAL PROJECT BOX Ideal size for battery charger, power supply etc.; sprayed grey, size 8in x 4 1/4in high, ends are louvred for ventilation other sides are flat and undrilled. Order Ref. 2P191. Price £1.

4-CORE FLEX CABLE. Cores separately insulated and grey PVC covered overall. Each copper core size 7/0.2mm. Ideal for long telephone runs or similar applications even at mains voltage. 20 metres £2. Our ref 2P196 or 100 metres coil £8. Order ref 8P19.

6-CORE FLEX CABLE. Description same as the 4-core above. Price 15 metres for £2. Our ref. 2P197 or 100 metres £9. Order ref. 9P1.

13A PLUGS Good British make complete with fuse, parcel of 5 for £2. Order ref. 2P186.

13A ADAPTERS Takes 2 13A plus, packet of 3 for £2. Order ref. 2P187.

2BV 0-20V Mains transformers 2 1/2 amp (100 watt) loading, tapped primary. 200-245 upright mountings £4. Order ref. 4P24.

BURGLAR ALARM BELL - 8" gong OK for outside use if protected from rain. 12V battery operated. Price £8. Ref. 8P2.

CAPACITOR BARGAIN - axial ended, 4700µF at 25V. Jap made, normally 50p each, you get 4 for £1. Our ref. 613.

SINGLE SCREENED FLEX 7.02 copper conductors, pvs insulated then with cooper screen, finally outer insulation. In fact quite normal screened flex. 10m to £1. Our ref DB668.

M.E.S. BULB HOLDERS Circular base battery type fitting. 4 for £1. Our ref DB1275.

SPRING LOADED TEST PRODS - Heavy duty, made by the famous Bulgin company, very good quality. Price 4 for £1. Ref. BD597.

3-CORE FLEX BARGAIN No. 1 - Core size 1.25mm so suitable for long extension leads carrying up to 13 amps, or short leads up to 10 amps. 15mm for £2. Ref. 2P190.

3-CORE FLEX BARGAIN No. 2 - Core size 1.25mm so suitable for long extension leads carrying up to 13 amps, or short leads up to 25A. 10m for £2. Ref. 2P190.

ALPHA-NUMERIC KEYBOARD - This keyboard has 73 keys giving trouble free life and no contact bounce. The keys are arranged in two number pad, board size is approx. 13" x 4" - brand new but offered at only a fraction of its cost, namely £3 plus £1 post. Ref. 3P27.

1/4TH HORSEPOWER 12 VOLT MOTOR Made by Smiths, the body length of this is approximately 3in, the diameter 3in and the spindle 3/8th of an inch diameter. It has a centre flange for fixing or can be fixed from the end by means of 2 nuts. A very powerful little motor which revs at 3,000 rpm. We have a large quantity of them so if you have any projects in mind then you could rely on supplies for at least two years. Price £6. Our ref 6P1, discount for quantities of 10 or more.

3 VOLT MOTOR Very low current so should be very suitable for working with solar cells. £1 each. Our ref BD681.

MINI SPEAKERS to use instead of headphones with your personal stereos - simply plug in to earphone socket. Excellent sound quality, only £4 per pair. Our ref 4P34.

INNER EAR STEREO HEADPHONES Ideal for lady listeners as they will not mess up your hair! Come complete in a neat carrying case. Price £3. Our ref 3P56.

STEREO HEADPHONE AMPLIFIER Very sensitive. A magnetic cartridge or tape head will drive it. Has volume control and socket for stereo headphones. 3v battery operated. £1 each. Our ref BD680.

FET CAPACITOR MICROPHONE EAGLE CI.200 Output equivalent to a high class dynamic microphone while retaining the characteristics of a capacitor microphone. Price £1. Our ref BD646.

SUM-MIN TOGGLE SWITCH Body size 8mm x 4mm x 7mm SBDT with chrome duty fixing nuts. 4 for £1. Our ref BD649.

SUB-MIN PUSH SWITCH DPDT, Single hole fixing by hexagonal nut. 3 for £1. Our ref BD650.





Ask anybody, "Quick, off the top of your head, what does a robot voice sound like?"

Chances are that the first answer to come to mind will be, "A Dalek". Perhaps, after a little more thought, fans of *Star Wars* rather than *Dr Who* will offer, "R2D2", or maybe "C3PO". The voice of Hal, the deranged computer in *2001*, might also be another response.

VOCAL ROOTS

Though I too become enthralled by *Star Wars*, and *2001*, on each viewing, my mind certainly thinks of the infamous and exterminatory Daleks as the root for all mechanical voices. There's something about the vibratory clipped accents of the Daleks which, for me, makes their voices synonymous with robots.

Poor old R2D2, though capable of communicating with other computerised devices, could not communicate directly with Humanity. And the technology that created the voices of Hal and C3PO produced

Just what the Doctor ordered - the speedy route to chatting in robo-speak

basically created by three processes. First, an actor speaks the words into a microphone and the signal is duly amplified. It is then passed through a ring modulator to produce a metallic sound, and finally subjected to amplitude variation to give it its vibratory effect.

Ring modulators are really fascinating units to work and play with. The theory was

Rather, the process both adds and subtracts the two frequencies to and from each other, producing an output signal containing upper and lower harmonics of the originals. The technique, though, is beyond the scope of this simple project, which is based upon just the vibratory effect associated with the Dalek-type voice.

CLIPPED ACCENTS

In Fig.1 you will see that the circuit consists of four opamps, contained in one package, and a transistor. The purpose of IC1a is to control the gain of the input voice signal. Most ordinary high output crystal microphones will produce a signal strong enough to suit the circuit. Lower output level microphones will need to have their signal preamplified first before being sent through the unit. The output signal from most cassette recorders is likely to be sufficiently strong to suit the unit without additional preamplification.

The input signal strength can be given a small amount of gain by VR1. As I am sure

VODALEK

speech as perfect as that from any human, so in terms of novelty effects units for 1989, their voices are really non-starters.

Some years ago I rang the BBC and had a chat with one of the engineers involved in the *Dr Who* sound effects creation. He told me that the true Dalek voice, as produced by the BBC's Radiophonics Workshop, is

BY JOHN BECKER

examined in my constructional project published in PE Nov-Dec 84. In essence, an input signal is mixed with a secondary signal of a variable frequency, but not in the manner associated with ordinary mixers.

many readers will be aware, the gain is related to the value of VR1 plus R3, divided by the value of R2, plus 1. In this case the maximum gain is $((10k + 500k) / 10k) + 1 = 52$.

However, I have included two diodes, D1 and D2 in the feedback path across IC1a. These have the effect of restricting the maximum output level to about 0.6V peak. In other words they clip the signal, giving it a squarish shape if viewed on an oscilloscope. The effect is a harsher sound than would otherwise be experienced, and one which is more consistent in level. C2 is used to filter out some of the upper frequencies of the voice signal, so also changing its quality.

HIGHER EXTERMINATION

The signal is then fed through the section associated with the modulation process to the filter circuit around IC1b. This also modifies the frequency characteristics and the resulting sound quality. Although all of the components associated with IC1b play their part in the filtering process, C4 and C5 are the principle controllers. Increasing their value will decrease the frequency range, and viceversa, but it is preferable, though not essential, to keep their values within the same ratio.

From IC1b the modified signal is simply taken via C6 to the output level control VR3. From there it can be fed to any normal amplifier.

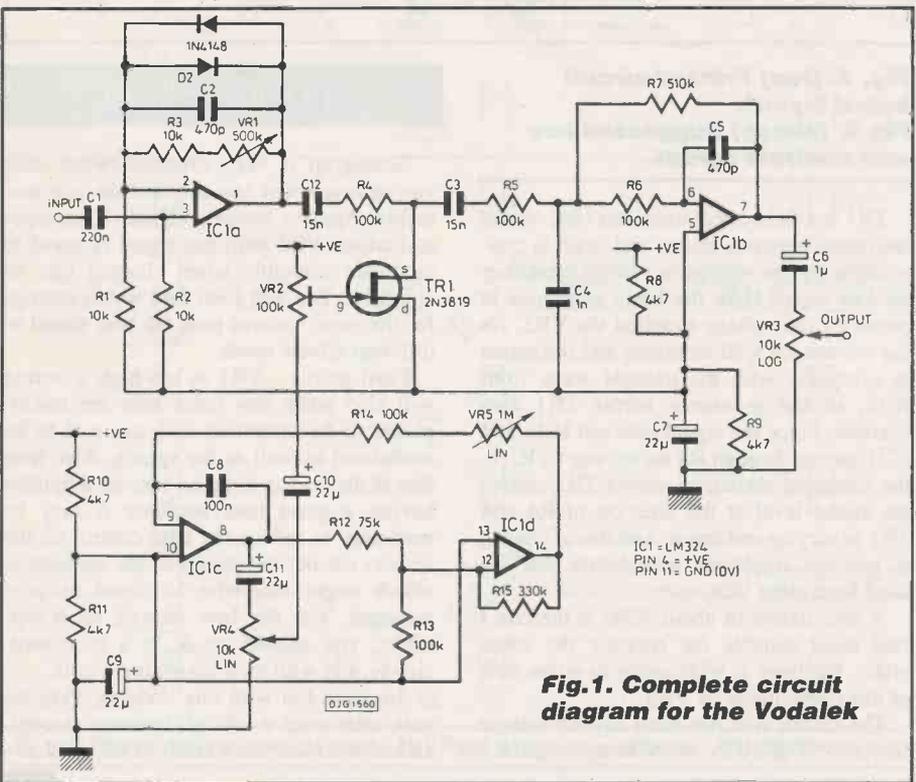


Fig.1. Complete circuit diagram for the Vodalek

COMPONENTS

RESISTORS

R1, R2, R3	10k (3 off)
R4-R6, R13, R14	100k (5 off)
R7	510k
R8-R11	4k7
R12	75k
R15	330k

CAPACITORS

C1	220n polyester
C2, C5	470p polystyrene (2 off)
C3, C12	15n polyester (2 off)
C4	1n polystyrene
C6	1µF 63V electrolytic
C7, C9-C11	22µF 16V elect (4 off)
C8	100n polyester

POTENTIOMETERS

VR1	500k lin mono rotary
VR2	100k skeleton preset
VR3	10k log mono rotary
VR4	10k lin mono rotary
VR5	1M lin mono rotary

SEMICONDUCTORS

D1, D2	1N4148
TR1	2N3819 fet
IC1	324 quad opamp

MISCELLANEOUS

PP3 battery clip, pcb supports (4 off), knobs (4 off), 14-pin ic socket, mono jack sockets (2 off), spst switch, Phonosonics' PCB type number 155A, box to suit, connecting wire and solder.

WOBBULATING

The modulating oscillator consists of the circuit around IC1c and IC1d. You've no doubt seen many circuits with oscillators that look similar to this one. If you haven't you can add it to your list of possible candidates for frequency generator sources. I gave two other types in the Wheeby-Jeeby project of PE June 89. The circuit oscillates at a rate set by the value of C8 and the feedback resistance across R14 and the rate controller VR5. I showed and described a similar circuit in the Oscilloscope articles of PE Nov 88 to Jan 89. The circuit oscillates because each time the output of IC1c rises above or drops below the reference level at the comparator IC1d, the comparator changes output state, so reversing the direction of charge for C8. You will see a more sophisticated variation on this theme in the forthcoming Combined Frequency Counter and Twin Signal Generator (scheduled for the Sept 89 issue).

The output at IC1d is a squarewave, which in this instance we don't need. What we are interested in is the triangular waveform produced at the output of IC1c. It is taken via C11, through the level control VR4, and to the amplitude controller around TR1.

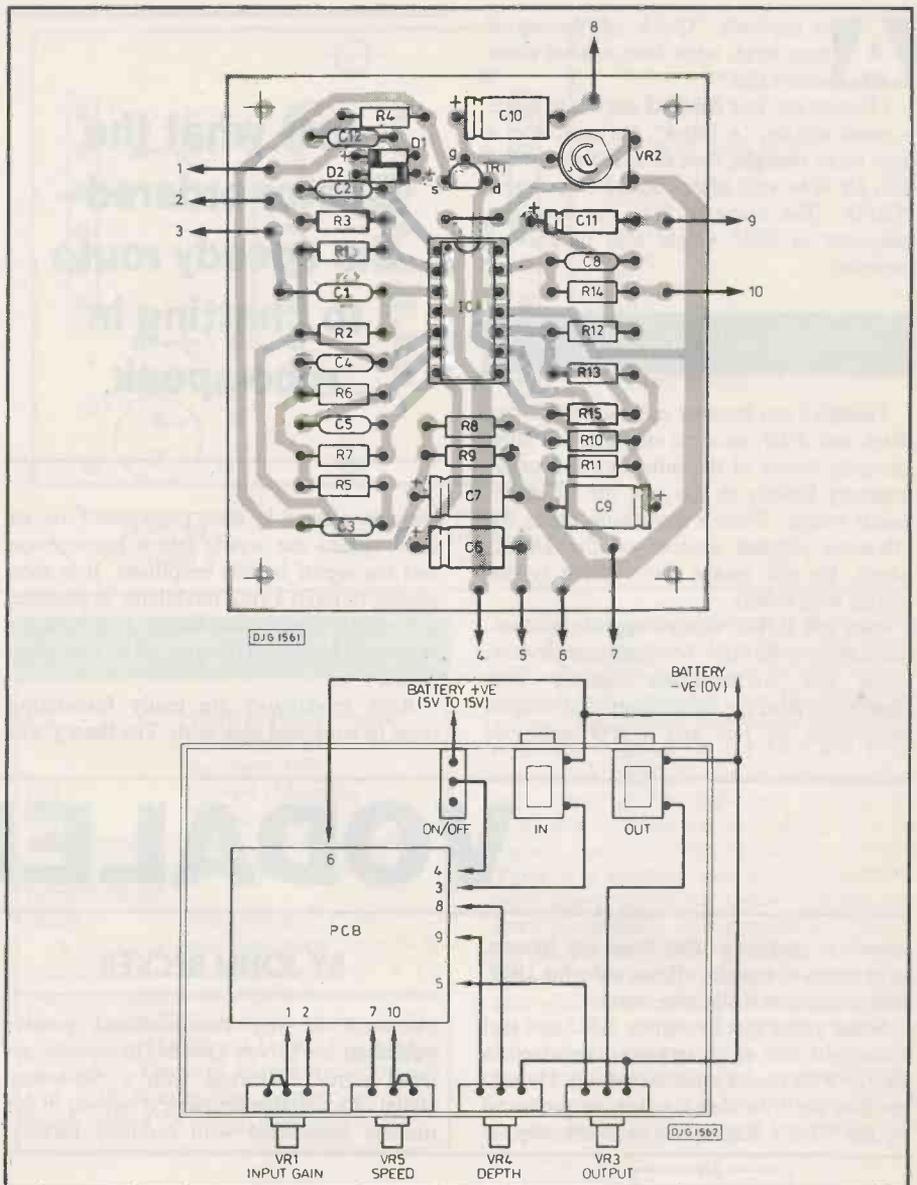


Fig. 2. (top) Printed circuit board layout.

Fig. 3. (above) Suggested box and controls layout.

TR1 is a field effect transistor (fet) whose resistance between source and drain is controllable by the voltage or current present at its gate input. Here the basic resistance is preset by the voltage supplied via VR2. As the current via C10 increases and decreases in sympathy with the triangle wave from IC1c, so the resistance across TR1 also changes. Since the signal between IC1a and IC1b passes through R4 on its way to IC1b, the changing resistance across TR1 causes the signal level at the junction of R4 and TR1 to vary up and down. And this of course, is just the amplitude modulation that we need for a robot type voice.

A modulation of about 30Hz is the rate I find most suitable for creating the robot effect, but there is wide range to either side of this controllable by VR5.

The circuit will run from any dc voltage between 5V and 15V. A 9V battery is ideal.

SETTING THE ACT

Setting-up is very straightforward once you've assembled and checked the pcb assembly. Apply a suitable signal to the input and adjust VR2 until the signal is heard to modulate smoothly when plugged into an amplifier. You will soon find which settings for the panel control pots are best suited to different effects needs.

Final points - VR1 at too high a setting will also allow any noise near the microphone to be amplified and cause it to be modulated as well as the speech. Also note that if the unit is plugged into an amplifier having a good bass response it may be necessary to reduce the bass control on the amp to cut out the sound of the modulator, which might otherwise be heard in quiet passages. For the best overall robot-type effect, you should speak in a monotone, slowly, and with long drawn out words.

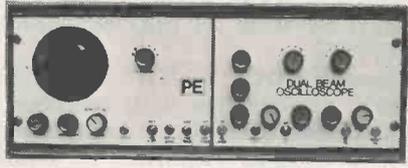
So, have fun with this Vodablek. Play the part, utter your words of dooming extermination, and even Time-Lords might tremble!



★ LEARN BY BUILDING ★ ENJOY BY USING ★

PROJECT KITS

★ BE CREATIVE ★ RAISE YOUR SKILLS ★ GET KITTED! ★



DUAL BEAM OSCILLOSCOPE
 2Y-amps, 6 ranges, variable level, DC to over 1MHz. 4 modes - Y1, Y2, Y1 & Y2, Y1 & Y2 to X. Time base variable from 0.05Hz to 20KHz. Variable sync level, polarity and source. Separate bright-line, brilliance and focus controls. Independent trace deflection controls. Details in catalogue.

BURGLAR ALARM CONTROLLERS

MULTIZONE CONTROL SET280 £23.90
 Two entry-zones, anti-tamper loop, personal attack, entry-exit timing, timed duration, automatic resetting, latching LED monitors.

SINGLE ZONE CONTROL SET279 £10.50
 With timed duration control and latching LED monitor. Both units can be used with any standard detection devices, such as contact or magnetic switches, pressure pads, tremblers, ultrasonics, infrared etc., and will activate standard bells, strobes or sirens.

COMPUTER KITS

The software listings published with the computer kit projects are for use with C64, PET and BBC computers.

- CHIP TESTER SET258F** £41.50
Computer controlled logic and chip analyser.
- EPROM PROGRAMMER SET277** £26.20
Computer controlled unit for 4K Eproms.
- MICRO-CHAT SET276** £69.50
Computer controlled speech synthesiser.
- MICRO-SCOPE SET247** £49.50
Turns a computer into an oscilloscope.
- MICRO-TUNER SET257** £57.40
Computer controlled, tuning aid and freq counter.
- MORSE DECODER SET269** £26.70
Computer controlled morse code-decoder.

PE EASI-BUILD SERIES PLUS PE HAND CLAPPER SEE CATALOGUE

VARIOUS

- VOICE SCRAMBLER SET287** £49.50
32 switchable channels to keep your communications confidential.
- STORMS!** £35.50 each unit
Raw nature under panel control! Wind & Rain SET250W. Thunder & Lightning SET250T.
- DISCO-LIGHTS SET245F** £69.50
3 chan sound to light, chasers, auto level.
- EVENT COUNTER SET278** £36.60
4-digit display counting for any logic source.

ASTRONOMY



SIDEREAL CLOCK SET295 £49.50
 Dual purpose star-time and solar-time digital clock with alarm.

ENVIRONMENT

WEATHER CENTRE
 Keep the Met Office in check and monitor the wind speed and direction, rain, temperature, soil moisture and sunny days.

- Six detector circuits - KIT 275.1 £18.50
- Automatic metered control monitor circuit - KIT 275.2 £41.50
- Optional computer control circuit - KIT 275.3 £15.50

ELECTRONIC BAROMETER SET285 £41.20
 Computer controlled unit for monitoring atmospheric pressure.

GEIGER COUNTER SET264 £65.50
 A nuclear radiation detector for environmental and geological monitoring. With built in speaker, meter and digital output. This project was demonstrated on BBC TV.

ORDERING

Add 15% VAT. Add P&P - Sets over £50 add £3.00. Others add £2.00. Overseas P&P in catalogue. Text photocopies - Oscilloscope £3.00, Geiger £3.00, Weather £2.00, others £1.00, plus 50p post or large SAE. Insurance 50p per £50. MAIL ORDER, CWO, CHG, PO, ACCESS VISA. Telephone orders: Mon-Fri, 9am - 6pm. 0689 37821. (Usually answering machine).

MORE KITS IN CATALOGUE

PHONOSONICS, DEPT PE98, 8 FINUCANE DRIVE, ORPINGTON, KENT, BR5 4ED.

MAIL ORDER

OUT NOW!

CRICKLEWOOD ELECTRONICS

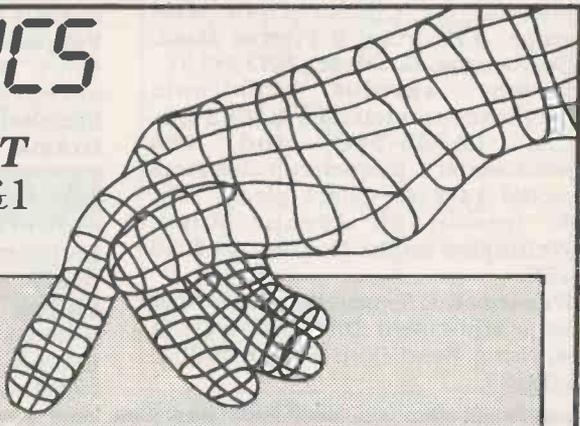
1989 100 PAGE COMPONENT CATALOGUE PRICE £1

SEND OFF FOR YOUR COPY TODAY...

- WE STOCK AN UNRIVALLED RANGE
- ALL OUR COMPONENTS ARE FIRST CLASS BRANDED ITEMS
- WE OFFER A SAME DAY SERVICE ON ALL STOCK ITEMS
- NO MINIMUM ORDER—IF YOU NEED ONE COMPONENT WE CAN SUPPLY ONE COMPONENT
- WE HAVE ADOPTED A NEW LOWER PRICING POLICY + QUANTITY DISCOUNTS
- FREE VOUCHERS WITH YOUR CATALOGUE—ORDER ONE NOW!...

JUST FILL IN THE COUPON OPPOSITE AND POST IT WITH YOUR £1 PAYMENT TO THE ADDRESS BELOW. YOU WILL RECEIVE NOT ONLY OUR SUPERB 100 PAGE CATALOGUE, BUT ALSO FREE VOUCHERS WHICH YOU CAN USE ON YOUR NEXT COMPONENTS ORDER.

CRICKLEWOOD ELECTRONICS LTD 40 CRICKLEWOOD BROADWAY LONDON NW2 3ET TEL: 01-450 0995/452 0161 FAX: 01-208 1441 TELEX: 914977



FREE VOUCHERS!

SEND OFF FOR YOUR CATALOGUE AND VOUCHERS TODAY.

I WOULD LIKE TO RECEIVE..... COPY(COPIES) OF THE 1989 CRICKLEWOOD ELECTRONICS COMPONENT CATALOGUE. I ENCLOSE £..... PLEASE ENCLOSE MY FREE VOUCHERS.

Tape your £1 coin here, or send a cheque or postal order for £1.00 for every catalogue you require.

NAME.....

ADDRESS.....



Free Reader Adverts

*Searching for that elusive component?
Surplus equipment to sell?
Read the rules and fill in the form below to have your free ad published in PE BAZAAR.*

Wanted: 41256 drams 16. Please must be cheap. Mondays or evenings only. Hastings 424382.

Wanted: service manual for Thandar SC110 oscilloscope. Photocopy accepted. Telephone A/H (+31) 239716. Mr. S. Beukes, #2, 340 Florida Road, Durban 4001, South Africa.

All my surplus components for sale. Good assortment £3 or send sae for lists. J. Allen, 150 Magheralane Road, Antrim, Co. Antrim BT41 2PD.

Constructor 59-80 R+EW 81-83 E.E. 78-83 P.E. 78-89. Wanted manual for Cossor 1049 MK4 scope. J.Rudrum, 2 Princes Road, Eastbourne, E. Sussex BN23 6HG.

Seven surplus Tektronix oscilloscope modules LA545-54-CA, LA545-54D and two northeastern frequency converters model 14-21C. Offers please. Mr. A. Ireson, 30 Avenue Road, Wellingborough, Northants NN8 4EP.

Wanted: E.H.T. unit or transformer for telequipment D.M. 64 'scope in working condition. Phone (0254) 662423.

AR88LF 6555s, 741s BC108s, LEDs, 8 pin + 14 pin sockets, connecting wire £5.25 per bag. No dealers. By post. Mr. D. Martin, 6 Downland Garden, Epsom, Surrey KT18 5SU.

Eprom Programmer/PLC/Panel. Brand new. Worth £500. Accept £175 ono. Tel: (0789) 295883 daytimes.

4-Data teletext adaptor for ZX Spectrum - view, store and print Ceefax and Oracle pages; download telesoftware. £79 with manual and transformer. Mr. W. Kurek, 150 Sandon Road, Stafford, Staffs ST16 3HG.

Rotary position encoder £20. Baudot code printer £20. Mr. G. Fisher, 9 Aspen Drive, Countesthorpe, Leics LE8 3SA.

I am interested in Satellite television. I have complete equipment and I am looking for partners. Ing Jan Luteran, Prostejovska 7, 08001 Presov, Czechoslovakia.

Superb quality monitor, Cotron PDM17, completely flat 6 inch tube, never used, offers around £600. Tel: Martin (0344) 427983.

Practical Electronics April 1976 to December 1980. Offers plus p&p. A.J. Chadwick, 36 Ella Street, Hull HU5 3AY. Tel: (0482) 445824.

PE Gemini amplifier stereo 30 watts £20. Goldring turntable £10, Sharp stereo cassette deck hardly used £30. P.J. Worden, 17 Brocket Close, Chigwell, Essex IG7 4ET.

Ferguson Video camera, recorder, tuner, spare battery. Cost £1400, accept £290. (0625) 24822 Macclesfield.

Drams: 4116 ex. eqpt. £1 each. 8251 USART £2. Z80A CPU £1 CTC £1.50. Full list available. 41 Aldworth Close, Bracknell, Berkshire. RG12 4AW. Tel: (0344) 51433.

Philips V2000 VCR 14-day timer, 8 hours per tape etc. for repair or parts £10. Mr. Clemow Tel: (0895) 53890.

Wanted: point contact and other early types of transistor. Write for lists and prices. Andrew Wylie, 2E Welbeck Mansions, Inglewood Road, London NW6 1QX.

Wanted: wide carriage printer for Atari ST 9 or 24 pm. Tel: (0909) 566695.

Cossor CDU 150/CT531/3 dual trace oscilloscope with handbook. Cost £242 SH but not used. Accept £100 ono. R. Harding, 10 Sands Farm Drive, Burnham, Slough SL1 7LD. Tel: (0628) 603048.

Swap Olympus OM10 SLR camera for WS2000 modem or similar W.H.Y. D. Rowlands, 7 Bro Silyn, Talysarn, Caernarfon, Gwynedd, North Wales LL54 6AU.

Wanted: meter movement for AVO valve. Characteristic meter. Grey case hinged lid sloping front black handles. P.J. Gallagher, 42 New Street, Macroom, Co. Cork, Ireland. Tel: 026 41131.

CBM 64 with JCL IEEE 488 interface. How does one load "Easy Script". Please tel: (0232) 642687 after 6pm. Mr. C. Salter, 19 Saintfield Road, Belfast BT8 4AF.

Apple IIE duodisk 128K green monitor 80COL Z80 card joystick dot matrix printer. Bargain £4.50 ono. S. Chowdhary, 62 Knightwood Crescent, New Malden, Surrey. Tel: 01-336 2307.

For Sale: video enhancer (Ken-multi). List price £39.95. Wanted £22.50. Tel: (Bath) 874138. Ask for Richard.

Tektronix 453 dual trace 50 MHz delay sweep oscilloscope in 1st class working order £250. Phone: (0293) 513787 eve.

Solartron dual beam oscilloscope, (valve type). Manual and/or circuit diagram, also test leads, wanted. State price. J.W. Dixon, 19 Salkeld Road, Penrith, Cumbria CA10 1ND.

Wanted: RPY58A photoresistor for dark activated switch. Edward Murray, Old Cardinham, Bodmin, Cornwall PL30 4ED. Tel: 020882 496.

PE BAZAAR

Name & Address			

Please publish the following small ad. FREE in the next available issue. I am not a dealer in electronics or associated equipment. I have read the rules.
Signature.....Date.....

RULES Maximum of 16 words plus address and/or phone no. Private advertisers only (trade or business ads. can be placed in our classified columns). Items related to electronics only. No computer software. PE cannot accept responsibility for the accuracy of ads. or for any transaction arising between readers as a result of a free ad. We reserve the right to refuse advertisements. Each ad. must be posted within one month of cover date. (One month later for overseas readers).

Send this form (or a photocopy of it) to:
PE Bazaar, Practical Electronics, 193 Uxbridge Road, London W12 9RA.

FORUM QUORUM!

IT'S TIME TO TELL WHO'S RUNG THE BELL IN OUR TELEPOINT TELEPHONE COMPETITION

AND HERE'S THE LINE UP OF THE FIVE
FORTUNATE WINNERS WHO HAVE EACH
WON A FORUM TELEPOINT PERSONAL
TELEPHONE :

Rem Plenzik of Broadstairs, Kent
S.A. Connolley of Blackpool, Lancs
Mick Jeffreys of West Melton, Rotherham
Andrew J. Bateman of London WC1
S.L. Hurcombe of Kerrys Gate, Hereford

**Congratulations and happy hi-tech
telecomms to all of you!**

THE ANSWERS

With questions one to three these are the answers for which I was looking :

The first communications satellite was launched in 1962 and was called Telstar. Alexander Bell is credited with inventing the telephone.

Most entrants had these three answers correct, though a fair number believed that 1955 was the launch date. A few suggested that 1969 and 1975 were the correct years. Almost unanimously Telstar was given as the answer to question two and only a very small minority believed that Astra and Buzbysat were the satellite names. Buzbysat is (so far as I know) a fictitious name invented by myself. Astra is the satellite recently launched for use by Sky Satellite TV.

Alexander Graham Bell seems to be universally acclaimed as the inventor of telephone. Very few of you fell into the trap of honouring Hans Fernsprecher or Guglielmo Marconi for the invention. Marconi, of course, should be honoured for the invention of wireless. Fernsprecher is a name I coined to confuse you - those who speak German may recognise the pun!

The answer to question four disturbed many of you. It



also disturbed me! My source book for the date was a somewhat ancient and cheap volume claiming to be an encyclopaedia. It quoted 1861 as the year in which Bell invented the telephone. A totally fallacious assertion! As so many of you pointed out, 1876 is the date acknowledged by history. However, a fair number of you seem to possess equally fallacious documentation, claiming that your books variously gave 1871, 1873, 1875, and even 1856.

The truth appears to be that the *microphone* (albeit, a very crude one) was invented in 1861, by a certain Johann Philip Reis. Bell first demonstrated the telephone at the Philadelphia Exhibition of 1876, and this is the same year in which he filed his patent, believed to be on March 7th under US patent number 174465. It's conceivable that he actually invented the telephone before 1876, but this is the year I now accept as factual. If anyone knows differently, please tell me! As far as the draw was concerned, both 1861 and 1876 were taken as valid answers.

Questions five to seven were survey queries and your answers played no part in the draw. Thank you all for your opinions.

Our thanks too to Shaye Communications for kindly making available the Forum Telepoint telephones.

PRACTICAL ELECTRONICS CLASSIFIED

Reach thousands of serious electronic and computer enthusiasts. Advertise in PE Classified pages: Rates 20p per word or £8.50 per single column cm (plus VAT). All classified advertisements must be pre-paid. Send your copy with the remittance (payable to Intra Press or payment by Visa or Access accepted) to: **Practical Electronics, Intra House, 193 Uxbridge Road, London W12 9RA. Tel: 01-743 8888. Fax: 01-743-3062**
LET PE WORK FOR YOU!

EDUCATION

FULL-TIME TRAINING COURSES

2 YEAR

BTEC NATIONAL DIPLOMA

Electronics and Communications Engineering

(TV, Computers, Programming, IT)

1 YEAR

BTEC NATIONAL CERTIFICATE

1. Electronic Equipment Servicing

(TV, Video, CCTV)

2. Computing Technology

(Microprocessors, DataComms, Interfacing)

3. Information Technology

(Telecomms, Satellite TV, Networks)

4. Software Engineering

(Assembler, BASIC, Pascal, CAD/CAM)

★ Those eligible can apply for E.T. grant support ★

★ An equal opportunities programme ★

COURSES COMMENCE

Monday 18th Sept. 1989

LONDON ELECTRONICS COLLEGE

Dep: AA, 20 Penywern Road, London SW5 9SU. Tel: 01-373 8721

Start training now for the following courses.

- Telecomms Tech C&G 271
- Radio Amateur Licence C&G
- Microprocessor
- Introduction to Television

Send for our brochure - without obligation or telephone us on 06267 79398 (Ref: PE5/89)
 Name.....

.....

Radio & Telecommunications Correspondence School,
 12 Moor View Drive, Teignmouth, Devon TQ14 9UN

RETAILERS

BATH

L.F. HANNEY

77 Lower Bristol Road, Bath, Avon.
 Tel: 0225-24811

Your electronics component specialist for

AVON, WILTS. & SOMERSET

Open every day, except on Thursday

EDINBURGH

OMNI ELECTRONICS

stock a wide range of electronic components at
**174 Dalkeith Road
 Edinburgh EH16 5DX**

Tel: 031 667 2611

Open Mon-Fri 9am-6pm

Sat. 9am-5am

Send 2x19 stamps for NEW CATALOGUE!

LONDON EAST

A & G ELECTRONICS LTD

If you are buying Electronics Components elsewhere you are almost certainly paying too much! Write to us for a free 1989 catalogue and start saving money. Please send two 19p stamps towards postage.

100 Park Avenue, London, E6 2SR. Tel: 01-552 2386

LONDON S.WEST

MULTILODE LTD

For electronics components, leads, aerosols, aerials, I.C.'s, diodes, video heads, tools, telephone accessories, books, magazines etc., etc., etc.,

Multilode Ltd. 7 Arlington Parade, Brixton Hill, SW2 1RH Tel: 01-326 1793

Open Mon to Sat 9am to 6pm

MANCHESTER

DEANS GATE ELECTRONICS

We stock a large range of electronic components, test equipment, telephone accessories, computer accessories, microphones, speakers, disc lighting, mixers, meters, stylus, so call in and have a look around.

263 Deansgate, Manchester
 Telephone: 061-834 1185

SOUTHAMPTON



BIG STOCK - KEEN PRICES!

See our display advertisement in this magazine!

SOUTHSEA

ELECTRONIC COMPONENTS

EVERYTHING FOR YOUR NEXT PROJECT
 THE BIGGEST DISPLAY IN THE SOUTH IS AT

FRASER ELECTRONICS

42 ELM GROVE ★ SOUTHSEA ★ HANTS
 Telephone: 0705-815584

Barclaycard

Access

STOKE-ON-TRENT

ANDOR ELECTRONICS

11 Victoria House,
 Paxton Street,
 Hanley,

Stoke-on-Trent, ST1 3SD

Tel: 0782 283642

SURREY

PLS

16 Central Road
 Worcester Park
 Surrey KT4 8HZ
 Tel: 01-330 6540

Programmable device specialists.
 (PAL's PROM's, PLD's etc). Many other components in stock

Resistors 1/4 W 5% carbon (E12) 1p metal film 1%3p
 Resistor Pack 85 different E12 values + zero ohm link total content
 1000 resistors£8.95
 LEDs red/green 3/5mm6p each. Yellow 11p
 Cable ties 7/5mm1p each £5.95/1,000 £49.50 per 10,000
 Stepping motor 4 phase 12v 7.5 step 50 ohms£8.95
 SAA1027 stepping motor driver chip£3.95
 FM transmitter Kit good quality sound£7.94
 High quality photo resist copper clad epoxy glass boards
 Dimensions single sided double sided
 3x4 inches £0.69 £0.76
 4x8 inches £1.64 £1.91
 6x12 inches £3.80
 12x12 inches £7.50

Special Offers
 Computer Grade Capacitors with screw terminals 38000uf 20v £2.50
 8700uf 10v £1.95, 68000uf 15v £2.95, 10000uf 16v £1.50
 7 segment Common anode led display 12mm£0.45
 LM2931A75.0 Low drop out 5V regulator T0220 package£0.85
 BS250 P channel MOSFET £0.45, BC559 transistor£3.95 per 100
 74LS05 hex inverter £10.00 per 100, used 8748 Microcontroller £3.50
 Stereo LW/MW/FM Tuner pre-amp assembly complete with
 volume/tone controls and tuning scale Brand new in makers carton
 £5.95, faulty £2.50

Circuit diagram description and setting up procedure for tuner
 assembly described above £0.50. 5 digit 6v electromagnetic counter
 £1.95
 Hour counter (used) 7 digit mains 240V AC 50Hz£0.95
 LCD display 16 digit 7x5 dots dot matrix£2.50
 Query keyboard 38 key good quality switches£5.00
 wide range of CMOS TTL 74HC 74F Linear transistors kits
 capacitors, resistors tools etc always in stock
JPG Electronics 276 Chatsworth Road Chesterfield S40 2BH
 Access orders (0246) 211202. Callers welcome

Carbon Film Resistors 1/4W E24 series 0-51R to 10M0 - 1p
 100 off per value - 75p 1000 off in even hundreds per value - £7
 Metal Film 1/4W 10R0 to 1M0 5% E12 series - 2p 1% E24 series - 3p
 1/2Watt metal/carbon film E24 series 1R0 to 10M0 - 1 1/2p
 1 Watt metal/carbon film E12 series 4R7 to 10M0 - 5p
 BC107/8/9 - 12p BC547/8/9 - 8p BC182L 184L - 10p
 BFY50/51/52 - 20p 2N3055 - 50p TIP31A,32A - 25p TIP41,42, - 40p

Tantalum head subminiature electrolytics (Mids/Volts)
 0-1.35, 0-2.25, 0-4.75, 3-3.16, 4-7.16 - 14p 4-7.35 - 15p
 2-2.35, 4-7.25, 10/5 - 15p 4-7.35, 6/8/16 - 16p 10/16, 22/6 - 20p
 22/16 - 30p 33/10 - 30p 47/10 - 35p 100/6 - 40p

Aluminium Electrolytics (Mids/Volts)
 1/50, 2-2/50, 4-7/25, 4-7/50, 10/16, 10/25, 10/50 - 5p 22/16, 22/25 - 6p
 22/50, 47/16, 47/25, 47/50 - 6p 100/16, 100/25 - 7p 100/50 - 12p
 100/100 - 14p 220/16 - 8p 220/25, 220/50 - 10p 470/16, 470/25 - 11p
 1000/25 - 18p 1000/35, 220/25 - 22p 4700/25 - 70p

Miniature Polyester Capacitors 250V Wkg. Vertical Mounting
 .01, .015, .022, .033, .047, .068 - 4p 0.1 - 5p 0.15, .22 - 6p 0.47 - 8p

Mylar Capacitors 100V Wkg. Vertical Mounting E12 Series
 1000p to 8200p - 3p .01 to .068 - 4p 0.1 - 5p 0.15, 0.22 - 6p

Subminiature Ceramic Plate 100V Wkg. E12 Series Vertical Mounting
 2%, 1P8 to 47P - 3p 56P to 330P - 4p 10% 390P to 4700P - 4p
 Ceramic plate/disc E6 Series 50V 22P to .047 - 2p

Polystyrene Capacitors 63V Wkg. E12 Series Axial Mounting
 10P to 820P - 3p 1000P to 10,000 - 4p 12,000P - 5p
 1N4148 - 2p 1N4002 - 4p 1N5404 - 14p W01 bridge - 25p
 OA91 - 6p AA143 - 8p W005 - 20p 1N4006 - 6p
 Zener diodes E24 series 3V3 to 33V 400mW - 8p 1 watt - 12p
 L.E.D's Red, Green & Yellow 3mm & 5mm - 10p 8mm - 35p
 20mm fuse 0.1A to 5A quick blow - 5p Anti Surge - 8p
 High Speed drills 0.8mm, 1.0mm, 1.3mm, 1.5mm, 2mm - 30p
 Expo Reliant drilling machines 12V d.c. with improved 3-jaw chuck 6.50
 Nicads AA - 80p HP11 - £2 PP3 - £4.20 Universal Chargers - £6.50
 Glass reed switches single pole make contacts - 8p Magnets - 12p

VAT inclusive. Return postage 25p (free over £5). Lists free.

THE C.R. SUPPLY CO.,
 127 Chesterfield Road,
 Sheffield S8 ORN. Tel. 557771.

>>>RESISTOR PACKS<<<

**1/4W 5% CARBON FILM
 E12 RANGE 10R to 10M
 10 of any 1 value 8p
 10 OF EACH VALUE
 Total 730 resistors
 £4.95**

Add 25p P&P & 15% VAT

**RMOS P.O. BOX 3
 USK GWENT NP5 2YF.**

TURN YOUR SURPLUS
 ICS transistors etc into cash, immediate
 settlement. WE welcome the opportunity to
 quote for complete factory clearance.
 Contact:
COLES-HARDING & CO.,
 103 South Brink, Wisbech, Cambs.
 ESTABLISHED 15 YEARS
 Tel:0945 584188 - Fax: 0945 588844

**Phone
 Richard Caplis
 with your
 classified ad!**

01-743 8888

We now accept payment by
 Access and Visa

**You can also use PE
 Fax Line:
 01-743-3062**

CAMBRIDGE COMPUTER SCIENCE LTD

5.25 inch Disk Drives, 80 Track DSDD £34.00 each
 3" Disk Drives, 40Tk, SSDD £28.00 each
 5.25" Disk Drives, 80Tk, DSDD Used, No Wty £15.00 each
 5.25" Disks, DSDD, 48tpi boxes of 10 £3.00/box
 Dual Disk Drive Power Supply £20.00 each
 Lead to connect one drive to psu £2.00 each
 50W PSU 5V 6A, 12V 2.5A, -5V 0.5A, -12V 0.5A £16.00 each
 Bench PSU 0-30V @5A Limited quantity only at £45.00 each
 Single Data lead (BBC Micro to Disk Drives) £2.00 each
 Dual Data lead (BBC Micro to 2 Disk Drives) £4.00 each
 Power lead (BBC Micro to Disk Drive) £1.00 each
 Dual leads (BBC Micro to 2 Disk Drives) £2.00 each
 68000 CPUs (The first orders get 12MHz chips) £3.50 each
 74LS TTL assortments. 10 different devices £1.20 pack
 8K Byte NV ram chips £3.00 each £10.00 four
 20 pin dil low profile IC sockets £0.50 (ten) - £ 4.00 (100)
 40 pin dil low profile IC sockets £0.60 (ten) - £ 5.00 (100)
 Keyboard, 100 keys on board LCD & micro i/f £8.00 each
 Toroidal mains transformer 12V 4A & 0.4A, 12-0-12 @0.1A & 2A ,
 9-09 @0.2A £4.00 each - £6.00 for 2 - £8.00 for 3

All items new unless stated. Add 15% VAT to all prices. Prices
 include postage. Add 50p to orders below £5.00. Send an SAE for our
 latest list or for more info.

Dept PE, 374 Milton Road, Cambridge, CB4 1SU
Tel: 0223 327602
SAE with all enquiries please!

ROBOTICS
 Use your home computer to operate servo based
 Robots of your own design. Suitable for ZX
 Spectrum, Tatung, Einstein and Amstrad CPC.
 Send SAE for details to:
**PRF Software Dept. PE, 26 Olton Road,
 Mickleover, Derby DE3 5PL.**

*Are you an electronics
 hobbyist?*
 If so, you will benefit from joining
 British Amateur Electronics Club!
**BAEC, C. Bogod, 26 Forrest Rd.,
 Penarth, South Glamorgan**

*** Series X Mixer Kits**
 * up to 1,000 inputs
 * 60+100 mm faders, pots,
 panels and audio switches
 * 6 auxiliaries
 * versions for recording PA,
 radio, disco
 * circuit diagrams
 * From £9.92



Send 19p for catalogue to: K. Tek, P.O. Box 172a,
 Surliton, Surrey KT6 6HN. Tel:01-399-3990

**SURPLUS/REDUNDANT ELECTRONICS
 COMPONENTS WANTED**
 ICs - Tuners - Transistors - Valves - Diodes etc - any
 quantity considered -immediate payment.
ADM ELECTRONICS SUPPLIES
 Tel 0827 873311 Fax: 0827 874835

Help PE Readers!
*Put projects into practice.
 Project your component image here!*
Phone PE on 01-743-8888

J.N. BULL ELECTRICAL
**Please note our correct
 numbers: 0273 734648 or
 203500**



*Languages, Operating Systems, Graphics, Databases, AI Experts
 Systems, Object Oriented Design, Parallel Computing and more.....*

all in

Program Now

The Advanced Programmers' Journal

The one tool every programmer should have!
 From all good newsagents or directly from Intra Press - price £1.50
From the publishers of Practical Electronics

SERVICES

**Printed Circuit Board Design, Using
Computer Aided Design
Photoplotting, Phototype PCB's**
Special reduction for new clients!

Call Neville Sanderson on: 0532-870253
N.C.A. DESIGNS

For Electronic Design and
PCB Manufacture
call

PROTO DESIGN

Unit 8, Ilford Trading Estate
Paycocke Road Basildon
Essex SS14 4DR
Tel: 0268 289923

MAKE YOUR OWN PCB'S

Just about everything from polishing blocks to
plated through hole equipment.
Very keen prices - discount on quantity.
S.A.E. for complete price list or telephone:
Ward Electronics,
27 North Street, Redruth, Cornwall TR15 1HJ
Tel: 0209 211050

Let Practical Electronics
work for you!
Phone our Advertisement Dept.
on: **01-743-8888**

TECHNICAL INFO SERVICES (PE)
76 Church St, Larkhall, Lanarkshire ML9 1HE
Phone 0698 884585 Mon-Fri, 9-5
any other time 0698 883334 FOR FAST QUOTES
WORLD'S LARGEST COLLECTION SERVICE MANUALS Most
unobtainable elsewhere. Prices range from only £4.50 - large s.a.e. any
quotation, no obligation to buy.
WORLD'S SOLE Suppliers of TV & Video Repair manuals, etc. from TV
TECHNIC, Thorn etc. Every published service sheet in stock, supplied
full size, not bits & pieces. CTV's or any combination £3.50 plus LSAE,
any other single item £2.50 plus LSAE. Complete Circuit Sets for most
Videorecorders only #7 set (no serv. shis made).
LSAE FOR QUOTATIONS plus GIANT CATALOGUE NEWSLETTERS
BARGAINS FREE 5/5ht as available.
Comprehensive TV Repair Manual £9.50. Complete Radio Service and
Repair Course £9.50. Complete Repair & Service Manuals Mono TV
£12.50; CTV £17.00; Video £19.50. Complete Repair Data with circuit-
Mono TV £9.50; CTV £12.50; Video £10.50.
£3.00 plus LSAE BRINGS THE ONLY COMPREHENSIVE SERVICE
SHEETS & MANUALS, CATALOGUES plus FREE CHASSIS GUIDE
and £4.00 OF VOUCHERS

WORKSHOP SERVICE MANUALS

Video Recorders - £12.50
Most Colour TV, Audio, Test, Vintage, Amateur etc. £6.00
Please state Make/Model/Type with order.
FREE Catalogue Unique Repair and Data Guides with all
orders or LSAE for your copy.
MAURITON ELECTRONICS LTD (PE);
8 Cherry Tree Road, Chinor, Oxfordshire OX9 4QY
Tel: (0844) 51694

**ELECTRONICS DESIGN
SERVICE**

FOR FULL DETAILS SEND S.A.E TO:
SPIRETRONIKS
2 Woodside, Chesterfield,
Derbyshire, S42 6SD

IS YOUR
CLASSIFIED AD
A TIGHT SQUEEZE?

**STRETCH
OUT**

in display pages of
**PE! Phone Sarah
Holtham on
01-743-8888 for details!**

BOOKS



**THE
HOMEBUILT
DYNAMO**
by Alfred T. Forbes
ISBN 0-9597749-0-4
Reviewed in P.E.
January, 1989 £42
including air mail
post.
(Brochure £3
refundable) Trade
enquiries welcome.
Todd-Forbes
Publishing,
PO Box 3919,
Auckland,
New Zealand.

"Satellite
Television -
Installation
Guide"
by John
Breeds.



Price- £11.95
Available from Practical
Electronics Book Service or
all good bookshops.

**73 AMATEUR
RADIO**

World's leading ham radio
magazine.
Annual subscription \$39.00 (US
Funds) from: 73 Amateur Radio,
P.O. Box 58866, Boulder,
CO 80322-8866, U.S.A.

SURVEILLANCE

NEW VHF MICROTRANSMITTER KIT, tuneable
80-115 MHz, 500 metre range, sensitive electret
microphone, high quality PCB. SPECIAL OFFER
complete kit ONLY £5 or assembled and ready
to use £8.95. POST FREE. Access orders
telephone 021 411 1821. Cheques/ P.O.'s to:
Quantek Electronics Ltd, (Dept P.E.), 45a
Station Road, Northfield, Birmingham, B31
3TE

Surveillance devices, lasers, Tesla coils,
scramblers, ultrasonic and many more,
over 150 designs. Send SAE to:
Plancentre, Old Wharf, Dynock Road,
Ledbury HR8 2HS

KITS MICROTRANSMITTER_VHF/FM,
received on standard radio, 25x15mm, free
microphone included - £4.50. Telephone
transmitter, amazingly uses no batteries -
£5.49. Bleeper transmitter vhf - £8.59 inc
p&p. SAE list. Remittance to: A.C.E. (PE),
99 Greenheath, Hedsnesford, Staffs. -
Access orders 05438 71902 - same day
dispatch

MISCELLANEOUS

Laboratory stock clearance equipment,
computers, ECG transducers, Geigers,
anemometers, spare meters etc. SAE list.
Laboratories, Maplehurst, RH13 6LL Tel:
0403 891 236

Make money in 1989! Use Practical
Electronics classified pages for your small
ads. For details phone Richard Caplis on
01-743-8888.

Small Press monthly - the guide to what
is happening in the Small Press world.
Latest issue out now. 50p (plus 20p p&p or
A5 SAE): SPG, BM BOZO, London WC1N
3XX (Full address).

Hightemp Super Conductors. Kit of all
chemicals needed plus instructions. Send
cheque/PO for £10 to: P. Catania, 15
Llanvair Drive, Ascot, Berks SL5 9HS.

VOICE/SOUND activated switches easy
to follow diagrams and uses only £10.00.
Components and P.C.Bs available:
Herrington, 63 Home Farm Road, Hanwell,
London W7 1NL.

Had a good idea? Ideas, designs and
inventions wanted. S.A.E. for more
information: Martin Bliss Prop. MD, Adapta
Plan, Dept. PE, 28 Clerkenwell Crescent,
Malvern, Worcs WR14 2TX.

Surface mount SRAMS/DRAMS
Surplus stock - Tel: Roger/ Sue on 01-
336-1104

IMPORTANT - Does anyone know the
whereabouts of MARK HUNT (ex. M.
Plaquets & Riverside Studios). Please
contact **BOB WEBB** on 01-675-0335.

Solar Eclipse 22nd July 1990 -FINLAND
For your travel and accomodation needs
phone Margaret at Salford Travel Agency
on 061-8329131. ABTA members. We are
Finland specialists. Other holidays
available.

Case Communications Ltd make a point of telling you proudly that all employees in their Watford, Herts, electronics factory have free access to computer terminals. To what extent this is utilised in the manufacturing processes I don't really know, but it certainly has interesting social implications.

The company makes data communications equipment – modems, concentrators, multiplexers, switching systems and the like. It also builds local-area and other datacoms networks for customers. You may remember that it got into the news a few months ago during Mr. Gorbachev's short visit to the UK. The Soviet president had asked to see a highly automated manufacturing plant while he was here. Lord Young, the DTI minister, took him to Case, partly because it is near London but mainly because the factory acts as a Government demonstration site for showing

INDUSTRY



NOTEBOOK

particular observation has been borne out by events. Over two centuries it has been seen working through industrialisation (concentration of manufacturing), mechanisation and computer-based automation.

More than ten years ago the National Computing Centre concluded from a case study that the introduction of a computer-based system in a factory "can change roles" in ways that cause workers to form different attitudes to their tasks and to the management. Now that CIM has developed a lot more it has become the subject of deeper analysis. In the USA, for example, Professor Shoshana Zuboff has shown in a recent book (*In the age of the smart machine*) that IT is progressively changing the meaning of work, the identities of workers and people's sense of themselves.

She says this is happening because IT cuts right across the traditional hierarchy of factory organisation. In the past managerial

CIM AND SOCIETY

the application of computer-aided design (CAD) and testing and computer integrated manufacturing (CIM).

Case are using CIM for much the same reason as other manufacturers. There is pressure on them from their owners, the shareholders of the Dowty group, to sell their products at a good profit to keep up group dividends and stock market value. This means being able to sell the products at competitive prices, which in turn means manufacturing efficiently to keep the production cost of individual items (unit costs) to a minimum.

Basically this is done by reducing waste – of time and materials. Individual processes – like component insertion in pcbs, flow soldering, board testing – are already speeded up by automatic machines. But there is still a possibility of waste occurring between these processes. In manufacturing generally this takes the forms of excessive inventory, work-in-progress and setting-up times, and rejected items and reworking. By integrating all the separate processes into a smooth overall flow without bottlenecks a company can minimise these sources of waste.

Nowadays this integration is achieved through the use of computer systems. CIM forms a bridge between CAD, the planning of manufacturing resources and individual computer-controlled machines (CAM – computer aided manufacturing). And here the 'manufacturing' in CIM embraces the complete range of a company's activities – specification, design, buying components and materials, assembly, testing and despatch out of the factory gates.

There is a continual exchange of data between the individual computer-controlled processes and a central database, allowing integration of the various business management tasks such as procurement, stock-keeping, marketing and accounting.

BY TOM IVALL

Full Marx, Karl – the manager shall sit down with the workers, and the worker with the machine

Using CIM reduces both the product development time and the time from the receipt of orders to the despatch of goods.

In discussing last month the possible impact of artificial intelligence (AI) on our lives I was really jumping the gun a bit. AI technology, which is largely based on non-numerical or symbolic computing, is farther into the future than current information technology (IT), which in the main uses conventional numerical computing. In fact IT is already affecting our lives, in the various ways I've been mentioning in previous reports over the years.

CIM is a particular application of IT which is likely to influence our lives not merely by its immediate effects on the kind of work done in factories but by modifying the very structure of industrialised societies. Way back in the Victorian era Karl Marx said that when new production technology comes into conflict with the existing social relations of production the conditions are set for social change. Whatever you think of Marxism as a political ideology, this

power to order things and people has rested on the distinction that managers do mental work (making decisions etc), which is mainly carried out through communication with people, while factory operatives do largely manual work on objects. CIM is changing this organisational structure by making the work on objects more mental than manual.

All the hard graft and even the skill content is being provided by software-controlled machines. Information, no longer the exclusive property of managers, is made available to workers through vdu screens of computer terminals instead of being accepted through spoken or written forms of communication.

This new structure, according to Professor Zuboff, encourages employees to take initiatives on the basis of information supplied by the computer terminals, rather than passively waiting for instructions from the managers. It will lead to more open and participative ways of working. But she also thinks it will require a lot of psychological adjustment. People won't want to give up the traditional idea of management being achieved by instruction and command through a hierarchy of distributed power, from the top down.

Already the old Victorian concept of the manager as a boss who tells you what to do is going out. Increasingly the manager is being seen not as a superior who sits above you but as a professional who sits beside you. The Japanese express it openly by dressing managers and workers in the same uniforms.

Undoubtedly CIM will accelerate this new trend in the social relations of the factory. But the ways we relate to each other anywhere are partly influenced by our occupations, and how these are perceived in the general pattern of an industrialised culture. So the effects of the new production technologies will certainly be reflected in the structure of society at large. **PI**

PRACTICAL ELECTRONICS BOOK SERVICE

Here is your Editor's choice of books he thinks will be of interest to electronics and computer enthusiasts

BEGINNERS AND EARLY STARTERS

NEW Mini-Matrix Board Projects.

R.A.Penfold. 112 pages. £2.50.
Order Code BP99

Shows a selection of 20 useful and interesting circuits that can be built on a mini-matrix board of 24 holes by 10 copper strips in size - an ideal book for early experimenters.

NEW From Atoms to Amperes.

F.A.Wilson. 160 pages. £2.95.
Order Code BP254.

For the absolute beginner, clearly explaining the fundamentals behind the whole subject of electricity and electronics.

NEW Electronic Projects for Beginners.

F.G.Rayer. 128 pages. £1.95.
Order Code BP48

Specially for the newcomer to electronics who is looking for a book containing a wide range of easily made projects. Some circuits need no soldering and many others show actual component and wiring layouts.

Electronics Build and Learn

R.A.Penfold. 128 Pages. £5.95.
Order Code PC 101

Combining theory and practice, the book describes a circuit demonstrator unit that is used in subsequent chapters to introduce common electronic components and circuit concepts, complete with practical experiments.

Practical Electronic Building Blocks

R.A.Penfold. There are two books -
Book 1 : 128 pages. £1.95.
Order Code BP117
Book 2 : 112 pages. £1.95.
Order Code BP118

Book 1 is about oscillators and gives circuits for a wide range, including sine, triangle, square, sawtooth and pulse waveforms and numerous others from voltage controlled to customised ic types.

Book 2 looks at amplifiers, ranging from low level discrete and opamp types to ic power amps. A selection of mixers, filters and regulators is included.

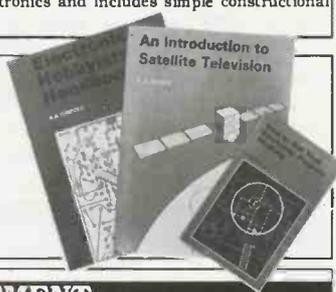
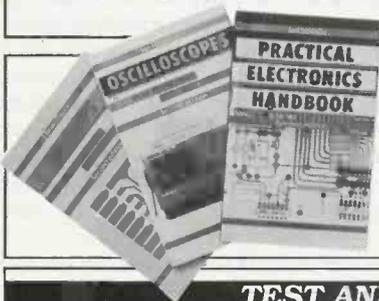
30 Solderless Breadboard Projects

R.A.Penfold. Two books each of 160 pages. Book 1 : £2.25. Order Code BP107. Book 2 : £2.25. Order Code BP113.

Each project is designed for building on a Verobloc breadboard and is accompanied by a description, circuit and layout diagrams and relevant constructional notes. Many of the components are common to several projects. Book 1 covers linear devices, and Book 2 covers cmos logic chips.

Beginners Guide to Building Electronic Projects R.A.Penfold. 112 pages. £1.95. Order Code BP 227

Shows the complete beginner how to tackle the practical side of electronics and includes simple constructional projects.



TEST AND MEASUREMENT

Getting the Most from Your Multimeter

R.A.Penfold. 112 pages. £2.95.
Order Code BP239

There's more to what you can do with a meter than meets the casual eye. The book covers the basics of what you can do with analogue and digital meters and discusses component and circuit testing.

NEW Test Equipment Construction

R.A. Penfold £2.95.
Order Code BP248

Describes in detail how to construct some simple and inexpensive, but extremely useful, pieces of test equipment.

Oscilloscopes

I.Hickman. £6.95.
Order Code NT3

Subtitled 'How to Use Them, How They Work' the book is illustrated with diagrams and photographs and is essential reading for any one who wants to know about scopes, from first principles to practical applications.

How to Get Your Electronic Projects Working.

R.A.Penfold. 96 pages. £2.50.
Order Code BP110.

Essential reading for anyone who wants first-time success in project assembly. Covers tracing mechanical faults as well as testing for failures of active and passive components of most types.

SATELLITE TV

***NEW* Satellite TV Installation Guide - 2nd edition John Breeds. £11.95. Order Code STV1**

Full of vital information for any competent diyer who wishes to install a satellite tv antenna and obtain optimum reception quality.

An Introduction to Satellite Television

F.A.Wilson. 112 pages. £5.95.
Order Code BP195

Informative answers to many of the questions about this communications revolution. The information is presented on two levels, one aimed at the complete beginner, the other at professional engineers and serious amateur enthusiasts.

AUDIO AND MUSIC

Introducing Digital Audio

I.Sinclair. 112 pages. £5.95.
Order Code PC102

A non-mathematical introduction to the new digital technology, discussing the principles and methods involved in devices such as cd, dat and sampling.

Electronic Music Projects

R.A.Penfold. 112 pages. £2.50.
Order Code BP74

24 practical constructional projects covering fuzz, wah, sustain, reverb, phasing, tremolo etc. The text is split into four sections covering guitar, general, sound generation and accessory projects.

More Advanced Electronic Music Projects

R.A.Penfold. 96 pages. £2.95.
Order Code BP174

Complementing BP74 by covering more advanced and complex projects including flanging, chorus, ring modulation, plus a selection of drum, cymbal and gong circuits.

NEW Computer Music Projects

R.A.Penfold. 112 pages. £2.95.
Order Code BP173

Shows how home computers can produce electronic music and covers sequencing, analogue and Midi interfacing, digital delay lines and sound generators.

Practical Midi Handbook

R.A.Penfold. 160 pages. £5.95.
Order Code PC103

A practical how-to-do-it book for musicians and enthusiasts who want to exploit the capabilities of Midi. Covers keyboards, drums, sequencers, effects, mixers, guitars, and computer music software.

Midi Projects

R.A.Penfold. 112 pages. £2.95.
Order Code BP182

Practical details of interfacing many popular home computers with Midi systems, and also covering Midi interfacing to analogue and percussion synths.

NEW Electronic Synthesiser Construction.

R.A.Penfold. 112 pages. £2.95.
Order Code BP185.

Even relative beginners should find the monophonic synthesiser described here within their capabilities if the book is thoroughly read. Individual aspects of the synth are dealt with separately and pcb designs are shown for the main modules.

DIGITAL AND COMPUTING

NEW A Concise Introduction to MS-DOS.

N. Kantaris. 64 pages. £2.95.
Order Code BP232

A ready-reference guide for those who need a quick insight into the essential command functions of this operating system, but who don't have the time to learn it fully.

An Introduction to Computer Peripherals

R.A. and J.W. Penfold. 80 pages. £2.50. Order Code BP170

Covers such items as monitors, printers, disc drives, cassettes, modems, etc, explaining what they are and how to use them with your computer and with each other.

Microprocessing Systems and Circuits

F.A. Wilson. 256 pages. £2.95.
Order Code BP77

A comprehensive guide to the elements of microprocessing systems, covering the fundamental principles behind this important subject.

Introduction to 6800/6802 Microprocessor Systems

R.J. Simpson and T.J. Terrell. 238 pages. £10.95. Order Code NT9

The book covers systems hardware, programming concepts and practical experimental work that will assist in understanding the 6800/6802 microprocessor, with additional information on the 6802D5E evaluation system.

NEW An Introduction to 68000 Assembly Language.

R.A. and J.W. Penfold. 112 pages. £2.95. Order Code BP184

Covers the fundamentals of writing programs that will vastly increase the speed of 68000 based machines such as the Commodore Amiga, Atari ST range, Apple Macintosh, etc.

Getting the Most from Your Printer

J.W. Penfold. 96 pages. £2.95.

Order Code BP181

How to use the features found on most dot-matrix printers from programs and popular wordprocessors, showing examples of what must be typed to achieve a given effect.

Micro Interfacing Circuits

R.A. Penfold. Two books, each of 112 pages.

Book 1 : £2.25. Order Code BP130.

Book 2 : £2.25. Order Code BP131

Both books include practical circuits and useful background information though pcb layouts are not included. Book 1 mainly covers computer input-output techniques. Book 2 deals primarily with practical application circuits.

NEW An Introduction to 6502 Machine Code.

R.A. and R.W. Penfold. 112 pages. £2.50. Order Code BP147

Covers the main principles of machine code programming on 6502-based machines such as the Vic-20, Oric-1/Atmos, Electron, BBC and Commodore 64. It assumes no previous knowledge of microprocessors or machine code and gives illustrative programming examples.

NEW A Z-80 Workshop Manual.

E.A. Parr. 192 pages. £3.50.
Order Code BP112

A book for those who already know Basic but wish to explore machine code and assembly language programming on Z80 based computers.

Practical Digital Electronics Handbook

M. Tooley. 208 pages. £6.95.
Order Code PC 104

Nine constructional projects introduce digital circuits, logic gates, timers, microprocessors, memory and interface circuits - an essential book for anyone interested in digital devices.

DATA AND INFORMATION BOOKS

Digital IC Equivalents and Pin Connections

A. Michaels. 320 pages. £5.95.
Order Code BP140

Linear IC Equivalents and Pin Connections

A. Michaels. 256 pages. £5.95.
Order Code BP141

Between them these two books show equivalents and pin connections of a popular user-orientated selection of European, American and Japanese ICs. They also include details of functions, manufacturer and country of origin. The Digital ICs book also quotes details of packaging and families.

Opamps

B. Dance. £6.50.
Order Code NT2

Subtitled 'Their Principles and Applications' this interesting book is written in a simple non-mathematical style and provides a source of practical circuits that use both commonplace and more sophisticated opamps.

Electronic Hobbyists Handbook

R.A. Penfold. 96 pages. £4.95. Order Code BP233

Provides a source of useful information that the amateur enthusiast is likely to need for day-to-day pursuance of hobby electronics.

Practical Electronics Handbook

I. Sinclair. £7.95.
Order Code NT1

A useful and carefully selected collection of standard circuits, rules-of-thumb and design data for enthusiasts, students and engineers involved in radio, computing and general electronics

Newnes Electronics Pocket Book

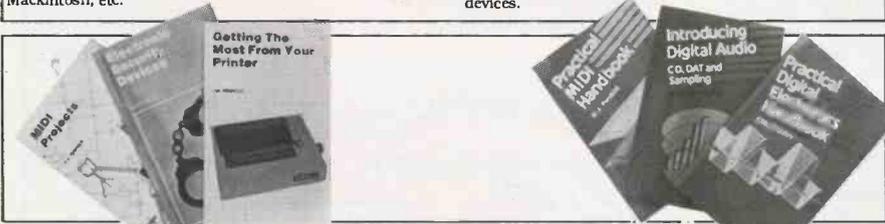
I.E. Parr. £6.95.
Order Code NT10

Presents all aspects of modern electronics in a readable and largely non-mathematical style, and is a good source of valuable information for enthusiasts and professional engineers alike.

NEW Key Techniques for Circuit Design

G.C. Loveday. £6.95.
Order Code BM 101

Tackles the problems of designing circuits from scratch, introducing the concept of target specifications, the design sequence, device selection, rules of thumb, and useful equivalent circuits.



GENERAL CONSTRUCTIONAL

NEW Electronic Science Projects.

Owen Bishop. 144 pages. £2.95.
Order Code BP104

A bumper bundle of experimental projects ranging in complexity and including a colour temperature meter, electronic clock, a solid state (led display) scope, an infra-red laser, a fascinating circuit for measuring the earth's electrical field strength, and many more.

Electronic Security Devices

R.A. Penfold. 112 pages. £2.50. BP56

Full of ideas for keeping your valuables safe. The circuits include designs for light, infra-red, ultrasonic, gas, smoke, flood, door and baby sensors.

NEW More Advanced Electronic Security Projects.

R.A. Penfold. 112 pages. £2.95. Order Code BP190

Follows on from where BP56 leaves off and describes a number of more up-to-date and sophisticated projects, such as pyro-sensors, infra-red and doppler-shift detection, fibre-optic loops, and many others.

NEW Electronic Projects for Cars and Boats.

R.A. Penfold. 96 pages. £1.95.
Order Code BP94

15 fairly simple projects that can be used with a car and/or boat. Stripboard constructional details are included, as are explanations of the circuit theory.

Power Supply Projects

R.A. Penfold. 96 pages. £2.50.
Order Code BP76

A selection of power supply designs, including simple unregulated, fixed voltage regulated and variable voltage stabilised, ni-cad charger, voltage step-up, and inverter.

More Advanced Power Supply Projects

R.A. Penfold. 96 pages. £2.95.
Order Code BP192

Covers more advanced topics than BP76 and includes precision supplies, switch mode and computer controlled supplies, plus a selection of miscellaneous circuits.

NEW Popular Electronic Circuits.

R.A. Penfold. 160 pages. £2.95.
Order Code BP80

Containing a wide range of circuit designs for experienced constructors who are capable of producing working projects direct from a circuit diagram without specific constructional details.

HOW TO ORDER

State your order code and your name and address clearly. Enclose a cheque, PO or international money order (add 50p postage per book - £1.00 for overseas surface mail), and send to:

**PE Book Service
Intra House
193 Uxbridge Road
London W12 9RA**

Books are normally delivered within 10 days but please allow 28 days for delivery.

READY-MADE P.C. BOARDS

Simplify your project assembly – use a ready-made printed circuit board. All are fully drilled and roller tinned. Just slot in the components as shown in the project texts, and solder them. PCBs are the professional route to project perfection.

MAIL ORDERING

Select the boards you want, and send your order to
**PE PCB SERVICE, PRACTICAL ELECTRONICS,
193 UXBRIDGE ROAD, LONDON W12 9RA.**

Prices include VAT and postage and packing. Add £2 per board for overseas airmail. Cheques should be crossed and made payable to **Intra Press**.

Quote the project name and PCB Code Number, and **print your name and address in Block Capitals**. Do not send any other correspondence with your order.

TELEPHONE ORDERS (OPEN 24 HOURS)

Use your Access card and phone your order to

0268 289923

clearly stating your name and address, card number, and order details.

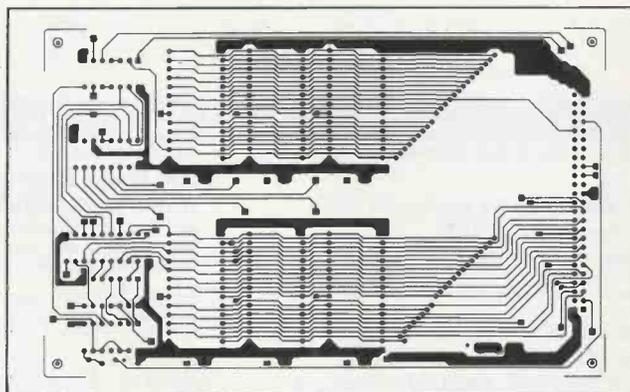
All orders receive priority attention, but allow 28 days for delivery in case a PCB is temporarily out of stock.

WE CAN ONLY SUPPLY THE PCBs LISTED HERE

**CHECK LATEST ISSUE FOR
PRICES BEFORE ORDERING**

PHOTOCOPIES OF THE TEXTS MAY BE BOUGHT FROM THE EDITORIAL OFFICE AT £1.00 EACH PART (£1.50 OVERSEAS), P&P INCLUSIVE.

COMPONENTS ARE AVAILABLE FROM ADVERTISERS.



OCT 87		
TEACHER LOCKER – digital lock control	155	£7.50
POWER SUPPLY – stabilised ±15V	156	£7.50
GUITAR TO SYNTH – music interface	157A/B	£9.95
NOV 87		
DUAL POWER SUPPLY – GCSE	158	£6.20
MIDI EXPANDER – Music Interface	159	£5.04
DEC 87		
RS 232C TO MIDI	160	£6.43
TEACHER RADIO – GCSE	161	£5.58
JAN 88		
LEGO BUGGY DRIVER	163	£6.42
FEB 88		
TEACHER TALKBACK – GCSE	164	£6.36
DC MOTOR SERVO	165	£7.53
MAR 88		
APPLIANCE TIMER	166A/B	£9.38
TEACHER LIGHTSHOW – GCSE	167A/B	£9.09
LOGIC ANALYSER – Double-sided	168	£20.65
APR 88		
LIGHT METAL EFFECTS	169	£7.10
TEACHER COUNTER	170	£4.95
	171	£4.92
MAY 88		
RF SPEECH PROCESSOR	172	£6.26
JUN 88		
AMSTRAD ROM EXPANSION	173	£10.80
MAINS MODEM	174	£4.27
JULY 88		
VOCALS ELIMINATOR	175	£4.31
AUGUST 88		
SPEAKING CLOCK	176	£16.75
SEPT 88		
BBC MULTIPLEXER	177	£4.50
OCT 88		
METAL DETECTOR	178	£6.50
DEC 88		
PLD PROGRAMMER	179	£9.90
	180	£4.90
PANNING MIXER	181	£7.80
JAN 89		
RUDOLPH'S NOSE	182	£6.25
ANGEL'S HALO	183A/B	£9.40
CANDLE FLICKER	184	£6.25
MAR 89		
CAMERA SHUTTER TIMER	187	£9.95
APR 89		
PC MULTIPOINT	188A/B	£20.55
MAY 89		
KIRLIAN CAMERA	189A/C	£10.50
JULY 89		
PROJECTOR SYNCHRONISER	190-E	£9.50

OCT 86		
DRUM SYNTHESISER	121	£7.67
MAINS DELAY TIMER – selectable 15 to 120 mins. Set of 2 PCBs.	122	£7.92
MAINS DIMMER – touch control up to 400W.	123	£3.90
NOV 86		
REMOTE JOYSTICK – infrared computer controller. Set of 2 PCBs.	124	£10.86
BABY ALARM – through-the-mains transceiver.	125	£10.71
DEC 86		
VIDEO ENHANCER – manually adjustable video improvement.	126	£8.76
JAN 87		
VIDEO FADER – simple inexpensive video mixer	127	£4.50
VOICE SCRAMBLER – confidential trans.	128	£8.06
MAR 87		
4 CHANNEL ENHANCER	135	£4.60
LIGHT PEN – uses fibre optics for accuracy	136	£4.10
ULTRASONIC TAPE MEASURE	138	£9.50
APR 87		
VIGILANTE CAR ALARM – keeps cars alert	139	£5.90
INDUCTIVE LOOP TRANSCEIVER – remote control for models:	143/144	£7.80
MAY 87		
BRIGHT FUZZ – Foot operated overdrive	145	£3.90
JUN 87		
AUDIO SIGNAL GENERATOR	146	£10.20
JUL 87		
WORD GENERATOR – 16-bit binary words	147	£13.42
SCOPE STORE oscilloscope add-on data storage	148	£11.94
SEP 87		
SPEECH PROCESSOR – clarifies speech	150	£5.86
GCSE TIMER UNIT – versatile variable delay	151	£5.18
FUNGEN – triple waveform signal generator	152/153	£9.69
LIGHT CONTROLLER – delayed switching	154	£4.64

PE COMPETITION

SHARPEN UP YOUR LIFE-STYLE!

WIN THE NEW SHARP IQ-7000 PERSONAL ORGANISER!

THREE TO BE WON -
EACH WORTH £170!

With 32KB memory, the Sharp IQ-7000 electronic personal organiser could transform your private or business life.

Direct keyboard access to :
199 year calendar Diary and appointments book. World clock for 212 cities. Multifunction calculator. 200+ entry phone and address directory. 12 page memo and report pad.

And its functions can be expanded using additional slot-in ic cards available from Sharp stockists - PC compatible interface, 8-language translator, Thesaurus, spell checker, etc. (Additional cards not included in prize award.)



SHARP IQ-7000 ENTRY FORM

WIMBLEDON TENNIS
WOODWORKING TOOLS
CHEESE PROCESSING
SOUTHERN COUNTIES
SCOTTISH KINGS
BLEAK COUNTRYSIDE
HUNTED ANIMALS

NAME AND ADDRESS (BLOCK LETTERS) :

.....
.....
.....

POST CODE :

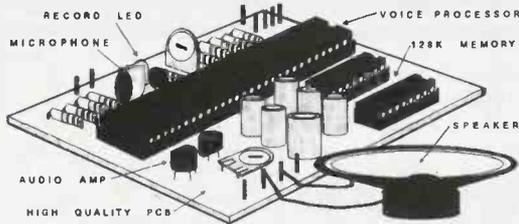
HOW TO ENTER:

Your Editor sometimes gets carried away with puns and word relationships - putting his unaided IQ to erroneous use he spotted relationships between author's surnames in this month's issue and the phrases in the box. Write alongside each phrase the author's surname you think is most appropriate. All correct entries will be put in a draw to take place on 31st August 1989, the first three names drawn will each win a Sharp IQ-7000 Organiser! 12 month's free subscription to PE will go to the next three names drawn. The Editor's decision is final!

Send your completed entry form to :
Practical Electronics, Sharp IQ Competition,
193 Uxbridge Road, London W12 9RA

**DON'T MISS ANOTHER
GREAT COMPETITION
NEXT MONTH!**

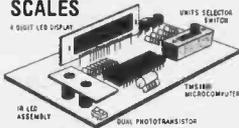
VOICE RECORD/PLAYBACK KIT



This simple to construct and even simpler to operate kit will record and playback short messages or tunes. It has many uses - seatbelt or lights reminder in the car, welcome messages to visitors at home or at work, warning messages in factories and public places, in fact anywhere where a spoken message is announced and which needs to be changed from time to time. Also suitable for toys - why not convert your daughter's £8 doll to an £80 talking doll!!

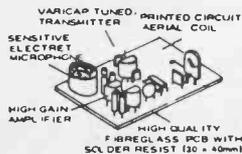
Size 78 x 60 x 15 mm
 Message time 1-5 secs normal speed, 2-10 secs slow speed
KX129 £22.50

ELECTRONIC WEIGHING SCALES



Kit contains a single chip micro-processor, PCB, displays and all electronics to produce a digital LED readout of weight in Kgs or Sts/lbs. A PCB link selects the scale - bathroom/ two types of kitchen scales. A low cost digital ruler could also be made.
ES1 £6.50

SUPER-SENSITIVE MICROBUG



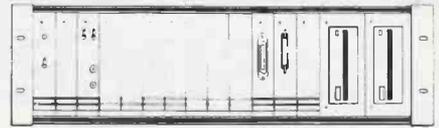
Only 45 x 25 x 15mm, including built-in mic. 88-100MHz (standard FM radio). Range approx. 300m depending on terrain. Powered by 9V PP3 (7mA). Ideal for surveillance, baby alarm etc. **£5.50**

TK ELECTRONICS, 13 Boston Rd, London W7 3SJ.

ORDERING INFORMATION All prices exclude VAT. Free p&p on orders over £50 (UK only), otherwise add £1+vat. Overseas p&p: Europe £3.50 elsewhere £10. Send cheque/PO/Barclaycard/Access No. with order. Giro No. 529314002. Local authority and export orders welcome. Goods by return subject to availability.

ORDERS: 01-5678910 - 24 HOURS

Interak 1 BUILD YOUR OWN COMPUTER



INTERAK can be commenced with the minimum of outlay. Bare boards from £10.95, beg borrow or steal the components, or buy from us - all parts available separately. No special or custom chips (ie PALs, ULAs, ASICs etc) used - no secrets.

Go as fast or as slowly as your funds and enthusiasm permit.

Made for those who must know what goes inside. Full circuit diagrams and descriptions are provided. And honestly, can you really use a computer effectively if you don't know what's inside and nobody will tell you?

Solid engineering construction - something to be proud of. 19" 3U rack mounting, plug in circuit boards and modular construction keeps obsolescence at bay.

Flourishing Independent Users Group, and newsletter. Hundreds of programs on disk at little or no cost from the Users Group.

Program in machine code (Assembler), Basic, "C", Forth, etc Database, Word Processing, Scientific applications.

Cassette tape operation or disk (up to 4 drives, 1 Megabyte 3.5" available from us, but you can add 3", 5.25", 8" if you want). Disk operating system CP/M Plus.

64K RAM, Z80 based at present with potential for expansion to a 16 Megabytes address space and Zilog's latest Z80280 in the future.

Needs no specialised knowledge to construct, and we will happily get you out of a jam if you get into one.

Availability of personal and individual after sales service, impossible to obtain from large companies, who are only after your money.

Security of supply - from Greenbank Electronics, established in 1970.

Greenbank

For more details write or phone us:
Greenbank Electronics, Dept (E6P), 460 New Chester Road, Rock Ferry, Birkenhead, Merseyside. L42 2AE. Tel: 051-645 3391

INDEX TO ADVERTISERS

A & G Electronics54	Magenta Electronics24, 25
A.D.M. Electronics Supplies55	Maplin ElectronicsOBC
Andor Electronics54	Mauriton Electronics56
Astronomy Now47	Multilode Ltd.54
B.K. ElectronicsIBC	N.C.A. Designs56
B.A.E.C55	Omni54
Bull J.48, 55	Phonosonics51
C-Scope38	PLS54
Cambridge Computer Science Ltd55	PRF Software55
Cirkit Distribution38	Program Now55
Classified Ads54-56	Proto Design56
Coles Harding55	Radio & Telecommunications Correspondence School54
Cricklewood Electronics51	RMOS55
C.R. Supply Co.55	Service Trading Co62
Deansgate54	Skills Training Agency44
Display Electronics37	Soft Machine44
Fraser Electronics54	Specialist Semiconductors45
Greenbank Electronics62	Spiretroniks56
Greenweld Electronics ..31-34, 54	Suma Designs38
Hanney, L.F.54	TandyIFC
High Grade Components17	Technical Info Services56
J.P.G. Electronics55	Technomatic10, 11
Keytronics18	T.K. Electronics62
K-Tek55	Todd Forbes Publishing56
Limrose Electronics47	Ward Electronics56
London Electronics College54	

PLEASE MENTION PRACTICAL ELECTRONICS WHEN REPLYING TO ADVERTS

VARIABLE VOLTAGE TRANSFORMERS

INPUT 220/240V AC 50/60 OUTPUT 0-260V
 200W 0.1 amp max £24.00 p&p £3.00 (£31.05 inc VAT)
 0.5KVA 2.5 amp max £26.50 £3.75 (£34.79 inc VAT)
 1KVA 5 amp max £34.00 £4.25 (£43.99 inc VAT)
 2KVA 10 amp max £49.00 £5.50 (£52.88 inc VAT)
 3KVA 15 amp max £65.00 £6.25 (£81.94 inc VAT)
 5KVA 25 amp max £115.00
 Carriage on request



VOLTAGE CHANGING TRANSFORMER

1250 Watt auto. Tapped 0-90V, 100, 110, 115, 120, twice to obtain voltages between 90 and 240V. Fitted in heavy duty louvered metal case. Fused input. Price incl VAT & p&p £39.50.

COMPREHENSIVE RANGE OF TRANSFORMERS-LT-ISOLATION & AUTO (110-240V Auto transfer either cased with American socket and mains lead or open frame type. Available for immediate delivery.

ULTRA VIOLET BLACK LIGHT FLUORESCENT TUBES

4ft 40 watt £10.44 (£12.00 inc VAT) Caller only
 2ft 20 watt £7.44 + £1.25 p&p (£9.99 inc VAT)
 13in 10 watt £5.80 + 75p p&p (£7.53 inc VAT)
 12in 8 watt £4.80 + 75p p&p (£6.38 inc VAT)
 9in 6 watt £3.50 + 50p p&p (£5.12 inc VAT)
 6in 4 watt £3.50 + 50p p&p (£5.12 inc VAT)

230V AC BALLAST KIT for either 6in, 9in or 12in tubes £5.50 + 55p p&p (£6.96 inc VAT)
 For 13in tubes £6.00 + 75p p&p (£7.75 inc VAT)



400 WATT UV LAMP

Only £28.00 + £2.50 p&p (£35.08 inc VAT)

175 WATT SELF BALLASTED BLACK LIGHT MERCURY BULBS

Available with BC or ES fitting. Price incl VAT & p&p £18.65.

12 VOLT BILGE PUMPS

Buy direct from the importers

500 GPH 15ft head 3 amp £16.00 inc

1750 GPH 15ft head 9 amp £19.25 + £2.00 p&p (£25.00 inc VAT)

EPROM ERASURE KIT

Build your own EPROM ERASURE for a fraction of the price of a made-up unit kit of parts less case includes 12in x 8 watt 2537 Angst Tube Ballast unit pair of bi-pin leads neon indicator on/off switch safety microswitch and circuit £14.00 + £2.00 p&p (£18.40 inc VAT)

SUPER HY-LIGHT STROBE KIT

Designed for Disco, Theatrical users etc. Approx 16 joules. Adjustable speed £48.00 + £2.00 p&p (£52.50 inc VAT)

Case and reflector £22.00 + £2.00 p&p (£27.60 inc VAT)

SAE for further details including Hy-Light and industrial Strobe Kits.

WIDE RANGE OF XENON FLASH TUBES

Write/Phone your enquiries

SOLID STATE RELAY

Single make will switch up to 250 V AC 10 amp operating voltage 3-32 V DC silent contactless opto-isolated. Fraction of maker's price £3.00 + 50 p p+p. Total inc VAT £4.03.

SPECIAL OFFER AC CAPACITORS

1.5 MFD 440V £2.00 5 MFD 440V £4.00
 2 MFD 440V £2.50 5.4 MFD 280V £2.00
 4.1 MFD 440V £3.50 5 MFD 660V £3.00
 12 MFD 400 V £4.00
 p+p 50p per unit plus VAT to be added to total.

TORIN CENTRIFUGAL BLOWER

230V ac 2,800 RPM 0.9amp 130mm diameter impeller outlet 63 x 37mm overall size 195 x 160 x 150mm long. Price £17.50 + £2.50 p&p (£23 inc VAT)

SHADED POLE GEAR MOTORS

In the following sizes:
 9 RPM 12 RPM 80 RPM 160 RPM 110V AC or 240V AC with capacitors (supplied). Price incl VAT & p&p £12.65

GEARED MOTORS

71 RPM 20lb inch torque reversible 115V AC input including capacitor and transformer for 240V AC operation. Price incl VAT & p&p £23.00.

12 V DC COOLER EXTRACTOR FAN

New brushless motor 92mm sq. Price incl VAT & p&p £11.50.

SOLID STATE EHT UNIT

Input 230/240V AC, Output approx 15KV. Producing 10mm spark. Built-in 10 sec timer. Easily modified for 20 sec, 30 sec to continuous. Designed for boiler ignition. Dozens of uses in the field of physics and electronics, eg supplying neon or argon tubes etc. Price less case £8.50 + £1.00 p&p (£10.93 inc VAT) NMS

COOLING FANS-BRAND NEW!

200-400V AC American Boxer 'Pewee' 7-bladed high efficiency cooling unit 80mm sq x 40mm deeps 40cm approx. Price incl VAT & p&p £10.35.

EX-EQUIPMENT FANS 120mm sq x 38mm deep in either 115V or 230V AC Tested and guaranteed. Price incl VAT & p&p £7.76.

Large selection of various speed geared motors from stock. Phone or write for details.

From stock at prices that defy competition

C/F Blowers Program Timers
 Microswitches Synch Motors
 write/phone your enquiries

NMS = NEW MANUF SURPLUS
 R&T = RECONDITIONED AND TESTED

Ample Parking Space
 Showroom open Monday/Friday

SERVICE TRADING CO
 57 BRIDGMAN ROAD, CHISWICK, LONDON W4 5BB
 01-995 1560
 ACCOUNT CUSTOMERS MIN. ORDER £10





POWER AMPLIFIER MODULES-TURNABLES-DIMMERS-LOUDSPEAKERS-19 INCH STEREO RACK AMPLIFIERS

OMP POWER AMPLIFIER MODULES

Supplied ready built and tested.

OMP POWER AMPLIFIER MODULES Now enjoy a world-wide reputation for quality, reliability and performance at a realistic price. Four models available to suit the needs of the professional and hobby market, i.e., Industry, Leisure, Instrumental and Hi-Fi etc. When comparing prices, NOTE all models include Toroidal power supply, integral heat sink, Glass fibre P.C.B., and Drive circuits to power compatible Vu meter. Open and short circuit proof.

THOUSANDS OF MODULES PURCHASED BY PROFESSIONAL USERS



OMP100 Mk 11 Bi-Polar Output power 110 watts R.M.S. into 4 ohms, Frequency Response 15Hz - 30KHz -3dB, T.H.D. 0.01%, S.N.R. -118dB, Sens. for Max. output 500mV at 10K, Size 355 x 115x65mm. PRICE £33.99 + £3.00 P&P.

NEW SERIES II MOS-FET MODULES



OMP/MF 100 Mos-Fet Output power 110 watts R.M.S. into 4 ohms, Frequency Response 1Hz - 100KHz -3dB, Damping Factor, >300, Slew Rate 45V/uS, T.H.D. Typical 0.002%, Input Sensitivity 500mV, S.N.R. -125dB. Size 300 x 123 x 60mm. PRICE £39.99 + £3.00 P&P.



OMP/MF200 Mos-Fet Output power 200 watts R.M.S. into 4 ohms, Frequency Response 1Hz - 100KHz -3dB, Damping Factor >300, Slew Rate 60V/uS, T.H.D. Typical 0.001%, Input Sensitivity 500mV, S.N.R. -130dB. Size 300 x 155 x 100mm. PRICE £62.99 + £3.50 P&P.



OMP/MF300 Mos-Fet Output power 300 watts R.M.S. into 4 ohms, Frequency Response 1Hz - 100KHz -3dB, Damping Factor >300, Slew Rate 60V/uS, T.H.D. Typical 0.0008%, Input Sensitivity 500mV, S.N.R. -130dB. Size 330 x 175 x 100mm. PRICE £79.99 + £4.50 P&P.

NOTE:- MOS-FET MODULES ARE AVAILABLE IN TWO VERSIONS, STANDARD - INPUT SENS. 500mV BAND WIDTH 100KHz PEC (PROFESSIONAL EQUIPMENT COMPATIBLE) - INPUT SENS. 775mV, BAND WIDTH 50KHz, ORDER STANDARD OR PEC



Vu METER Compatible with our four amplifiers detailed above. A very accurate visual display employing 11 L.E.D. diodes (7 green, 4 red) plus an additional on/off indicator. Sophisticated logic control circuits for very fast rise and decay times. Tough moulded plastic case, with tinted acrylic front. Size 84 x 27 x 45mm. PRICE £8.50 + 50p P&P.

LOUDSPEAKERS



LARGE SELECTION OF SPECIALIST LOUDSPEAKERS AVAILABLE, INCLUDING CABINET FITTINGS, SPEAKER GRILLES, CROSS-OVERS AND HIGH POWER, HIGH FREQUENCY BULLETS AND HORNS, LARGE S.A.E. (30p STAMPED) FOR COMPLETE LIST.

McKENZIE:- INSTRUMENTS, P.A., DISCO, ETC.

- ALL MCKENZIE UNITS 8 OHMS IMPEDENCE**
- 8" 100 WATT C8100GPM GEN. PURPOSE, LEAD GUITAR, EXCELLENT MID., DISCO. PRICE £28.59 + £2.00 P&P.
 - RES, FREQ. 80Hz. FREQ. RESP. TO 14KHz. SENS. 99dB.
 - 10" 100 WATT C10100GP GUITAR, VOICE, ORGAN, KEYBOARD, DISCO, EXCELLENT MID. PRICE £34.70 + £2.50 P&P.
 - RES, FREQ. 70Hz. FREQ. RESP. TO 6KHz. SENS. 100dB.
 - 10" 200 WATT C10200GP GUITAR, KEYBOARD, DISCO, EXCELLENT HIGH POWER MID. PRICE £47.48 + £2.50 P&P.
 - RES, FREQ. 45Hz. FREQ. RESP. TO 7KHz. SENS. 103dB.
 - 12" 100 WATT C12100GP HIGH POWER GEN. PURPOSE, LEAD GUITAR, DISCO. PRICE £36.66 + £3.50 P&P.
 - RES, FREQ. 45Hz. FREQ. RESP. TO 7KHz. SENS. 99dB.
 - 12" 100 WATT C12100TC TWIN CONE HIGH POWER WIDE RESPONSE, P.A., VOICE, DISCO. PRICE £37.63 + £3.50 P&P.
 - RES, FREQ. 45Hz. FREQ. RESP. TO 14KHz. SENS. 100dB.
 - 2" 200 WATT C12200B HIGH POWER BASS, KEYBOARDS, DISCO, P.A. PRICE £64.17 + £3.50 P&P.
 - RES, FREQ. 40Hz. FREQ. RESP. TO 7KHz. SENS. 100dB.
 - 12" 300 WATT C12300GP HIGH POWER BASS LEAD GUITAR, KEYBOARDS, DISCO. PRICE £85.79 + £3.50 P&P.
 - RES, FREQ. 45Hz. FREQ. RESP. TO 5KHz. SENS. 100dB.
 - 15" 100 WATT C15100BS BASS GUITAR, LOW FREQUENCY, P.A., DISCO. PRICE £53.70 + £4.00 P&P.
 - RES, FREQ. 40Hz. FREQ. RESP. TO 5KHz. SENS. 99dB.
 - 15" 200 WATT C15200BS VERY HIGH POWER BASS. PRICE £73.26 + £4.00 P&P.
 - RES, FREQ. 40Hz. FREQ. RESP. TO 4KHz. SENS. 99dB.
 - 15" 250 WATT C15250BS VERY HIGH POWER BASS. PRICE £80.53 + £4.50 P&P.
 - RES, FREQ. 40Hz. FREQ. RESP. TO 4KHz. SENS. 99dB.
 - 15" 400 WATT C15400BS VERY HIGH POWER, LOW FREQUENCY BASS. PRICE £94.12 + £4.50 P&P.
 - RES, FREQ. 40Hz. FREQ. RESP. TO 4KHz. SENS. 102dB.
 - 18" 400 WATT C18404BS EXTREMELY HIGH POWER, LOW FREQUENCY BASS. PRICE £167.85 + £5.00 P&P.
 - RES, FREQ. 27Hz. FREQ. RESP. TO 3KHz. SENS. 99dB.

EARBENDERS:- HI-FI, STUDIO, IN-CAR, ETC.

- ALL EARBENDER UNITS 8 OHMS EXCEPT EB8-50 AND EB10-50 DUAL 4 AND 8 OHM. BASS, SINGLE CONE, HIGH COMPLIANCE, ROLLED FOAM SURROUND**
- 8" 50 WATT EB8-50 DUAL IMPEDENCE, TAPPED 4/8 OHM BASS, HI-FI, IN-CAR. PRICE £8.90 + £2.00 P&P.
 - RES, FREQ. 40Hz. FREQ. RESP. TO 7KHz. SENS. 97dB.
 - 10" 50 WATT EB10-50 DUAL IMPEDENCE, TAPPED 4/8 OHM BASS, HI-FI, IN-CAR. PRICE £12.00 + £2.50 P&P.
 - RES, FREQ. 40Hz. FREQ. RESP. TO 5KHz. SENS. 99dB.
 - 10" 100 WATT EB10-100 BASS, HI-FI, STUDIO. PRICE £27.50 + £3.50 P&P.
 - RES, FREQ. 35Hz. FREQ. RESP. TO 3KHz. SENS. 96dB.
 - 12" 60 WATT EB12-60 BASS, HI-FI, STUDIO. PRICE £21.00 + £3.00 P&P.
 - RES, FREQ. 28Hz. FREQ. RESP. TO 3KHz. SENS. 92dB.
 - 12" 100 WATT EB12-100 BASS, STUDIO, HI-FI, EXCELLENT DISCO. PRICE £32.00 + £3.50 P&P.
 - RES, FREQ. 26Hz. FREQ. RESP. TO 3KHz. SENS. 93dB.
 - FULL RANGE TWIN CONE, HIGH COMPLIANCE, ROLLED SURROUND**
 - 5 1/2" 60 WATT EB5-60TC (TWIN CONE) HI-FI, MULTI-ARRAY DISCO ETC. PRICE £9.99 + £1.50 P&P.
 - RES, FREQ. 63Hz. FREQ. RESP. TO 20KHz. SENS. 92dB.
 - 6 1/2" 60 WATT EB6-60TC (TWIN CONE) HI-FI, MULTI-ARRAY DISCO ETC. PRICE £10.99 + £1.50 P&P.
 - RES, FREQ. 30Hz. FREQ. RESP. TO 20KHz. SENS. 94dB.
 - 8" 60 WATT EB8-60TC (TWIN CONE) HI-FI, MULTI-ARRAY DISCO ETC. PRICE £12.99 + £1.50 P&P.
 - RES, FREQ. 40Hz. FREQ. RESP. TO 18KHz. SENS. 89dB.
 - 10" 60 WATT EB10-60TC (TWIN CONE) HI-FI, MULTI-ARRAY DISCO ETC. PRICE £16.49 + £2.00 P&P.
 - RES, FREQ. 35Hz. FREQ. RESP. TO 12KHz. SENS. 86dB.

TRANSMITTER HOBBY KITS

PROVEN TRANSMITTER DESIGNS INCLUDING GLASS FIBRE PRINTED CIRCUIT BOARD AND HIGH QUALITY COMPONENTS COMPLETE WITH CIRCUIT AND INSTRUCTIONS

- 3W FM TRANSMITTER 80-108MHz, VARICAP CONTROLLED PROFESSIONAL PERFORMANCE, RANGE UP TO 3 MILES, SIZE 38 x 123mm, SUPPLY 12V @ 0.5AMP. PRICE £14.49 + £1.00 P&P
- 3 watt FM Transmitter
- FM MICRO TRANSMITTER (BUG) 100-108MHz VARICAP TUNED COMPLETE WITH VERY SENS FET MIC. RANGE 100-300m, SIZE 56 x 46mm, SUPPLY 9V BATT, PRICE £8.62 + £1.00 P&P

POSTAL CHARGES PER ORDER £1.00 MINIMUM. OFFICIAL ORDERS WELCOME FROM SCHOOLS, COLLEGES, GOVT. BODIES, ETC. PRICES INCLUSIVE OF V.A.T. SALES COUNTER, VISA ACCESS ACCEPTED BY POST, PHONE OR FAX.

*** PRICES INCLUDE V.A.T. * PROMPT DELIVERIES * FRIENDLY SERVICE * LARGE S.A.E., 30p STAMPED FOR CURRENT LIST.**

OMP VARISPEED TURNTABLE CHASSIS.



- * MANUAL ARM
- * STEEL CHASSIS
- * ELECTRONIC SPEED CONTROL 33 & 45
- * WARI PITCH CONTROL
- * HIGH TORQUE SERVO DRIVEN DC MOTOR
- * TRANSIT SCREWS
- * 12" DIE CAST PLATTER
- * NEON STROBE
- * CALIBRATED BAL WEIGHT
- * REMOVABLE HEAD SHELL
- * 1/2" CARTRIDGE FIXINGS
- * CUE LEVER
- * POWER 220/240V 50/60Hz
- * 390x305mm
- * SUPPLIED WITH MOUNTING CUT-OUT TEMPLATE.

PRICE £59.99 + £3.50 P&P.

OPTIONAL MAGNETIC CARTRIDGES

STANTON AL500
PRICE £16.99 + 50p P&P

GOLDRING G850
PRICE £6.99 + 50p P&P

OMP MOS-FET POWER AMPLIFIERS, HIGH POWER, TWO CHANNEL 19 INCH RACK

THOUSANDS PURCHASED BY PROFESSIONAL USERS



NEW MXF SERIES OF POWER AMPLIFIERS

THREE MODELS:- MXF200 (100w + 100w)

MXF400 (200w + 200w) MXF600 (300w + 300w)

All power ratings R.M.S. into 4 ohms.

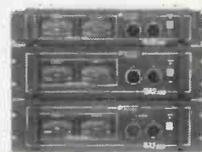
FEATURES: * Independent power supplies with two Toroidal Transformers * Twin L.E.D. Vu meters * Rotary indexed level controls * Illuminated on/off switch * XLR connectors * Standard 775mV inputs * Open and short circuit proof * Latest Mos-Fets for stress free power delivery into virtually any load * High slew rate * Very low distortion * Aluminium cases * MXF600 Fan Cooled with D.C. Loudspeaker and Thermal Protection.

USED THE WORLD OVER IN CLUBS, PUBS, CINEMAS, DISCOS ETC.

- SIZES:-** MXF 200 W19" x H3 1/2" (2U) x D11"
MXF 400 W19" x H5 1/2" (3U) x D12"
MXF 600 W19" x H5 1/2" (3U) x D13"

PRICES: MXF200 £171.35
MXF400 £228.85
MXF600 £322.00

SECURICOR DELIVERY £12.00 EACH



OMP LINNET LOUDSPEAKERS

THE VERY BEST IN QUALITY AND VALUE



MADE ESPECIALLY TO SUIT TODAY'S NEED FOR COMPACTNESS WITH HIGH OUTPUT SOUND LEVELS, FINISHED IN HARDWEARING BLACK VYNIDIE WITH PROTECTIVE CORNERS, GRILLE AND CARRYING HANDLE. INCORPORATES 1/2" DRIVER PLUS HIGH FREQ. HORN FOR FULL FREQ. RANGE. 45Hz-20KHz BOTH MODELS 8 OHM, SIZE H18" x W15" x D12".

CHOICE OF TWO MODELS

POWER RATINGS QUOTED IN WATTS RMS FOR EACH CABINET

OMP 12-100 (100W 100dB) PRICE £159.99 PER PAIR
OMP 12-200 (200W 102dB) PRICE £209.99 PER PAIR

SECURICOR DEL:- £12.00 PER PAIR

OMP SLIDE DIMMER 1K WATT & 2.5K WATT

CONTROLS LOADS UP TO 1KW & 2.5KW. SUITABLE FOR RESISTIVE AND INDUCTIVE LOADS. BLACK ANODISED CASE. READILY FLUSH MOUNTED THROUGH PANEL/CABINET CUT-OUTS. ADVANCED FEATURES INCLUDE:-

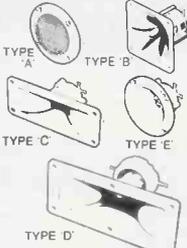
- * FULL 65mm SLIDE TRAVEL
- * NEON MONITOR/INDICATOR
- * FLASH OVERRIDE BUTTON
- * HIGH & LOW LEVEL PRESETS
- * FULLY SUPPRESSED TO BS 800

SIZES:-
1KW H128xW40xD55mm
2.5KW H128xW76xD79mm

PRICES:- 1K WATT £15.99
2.5K WATT £24.99 + 60p P&P

PIEZO ELECTRIC TWEETERS-MOTOROLA

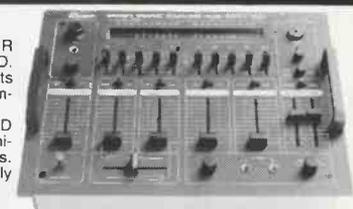
PIEZO ELECTRIC TWEETERS - MOTOROLA
Join the Piezo revolution. The low dynamic mass (no voice coil) of a Piezo tweeter produces an improved transient response with a lower distortion level than ordinary dynamic tweeters. As a crossover is not required these units can be added to existing speaker systems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



- TYPE 'A' (KSN2036A)** 3" round with protective wire mesh, ideal for bookshelf and medium sized Hi-fi speakers. Price £4.90 each + 50p P&P.
- TYPE 'B' (KSN1005A)** 3 1/2" super horn. For general purpose speakers, disco and P.A. systems etc. Price £5.00 each + 50p P&P.
- TYPE 'C' (KSN6016A)** 2" x 5" wide dispersion horn. For quality Hi-fi systems and quality discos etc. Price £6.99 each + 50p P&P.
- TYPE 'D' (KSN1025A)** 2" x 6" wide dispersion horn. Upper frequency response retained extending down to mid range (2KHz). Suitable for high quality Hi-fi systems and quality discos. Price £9.99 each + 50p P&P.
- TYPE 'E' (KSN1038A)** 3 3/4" horn tweeter with attractive silver finish trim. Suitable for Hi-fi monitor systems etc. Price £5.99 each + 50p P&P.
- LEVEL CONTROL** Combines on a recessed mounting plate, level control and cabinet input jack socket. 85x85mm. Price £3.99 + 50p P&P.

STEREO DISCO MIXER

STEREO DISCO MIXER with 2 x 5 band L & R graphic equalisers and twin 10 segment L.E.D. Vu Meters. Many outstanding features 5 inputs with individual faders providing a useful combination of the following:-
3 Turntables (Mag), 3 Mics, 4 Line including CD plus Mic with talk over switch Headphone Monitor. Pan Pot L & R. Master Output controls. Output 775mV. Size 360x280x90mm. Supply 220-240V.
Price £134.99 - £4.00 P&P



B. K. ELECTRONICS Dept PE
UNIT 5, COMET WAY, SOUTHEND-ON-SEA, ESSEX. SS2 6TR
TEL: 0702-527572 FAX: 0702-420243

