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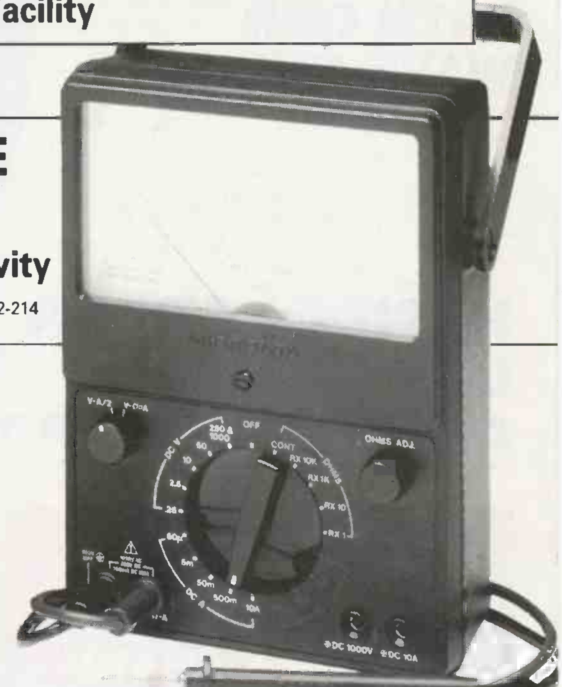

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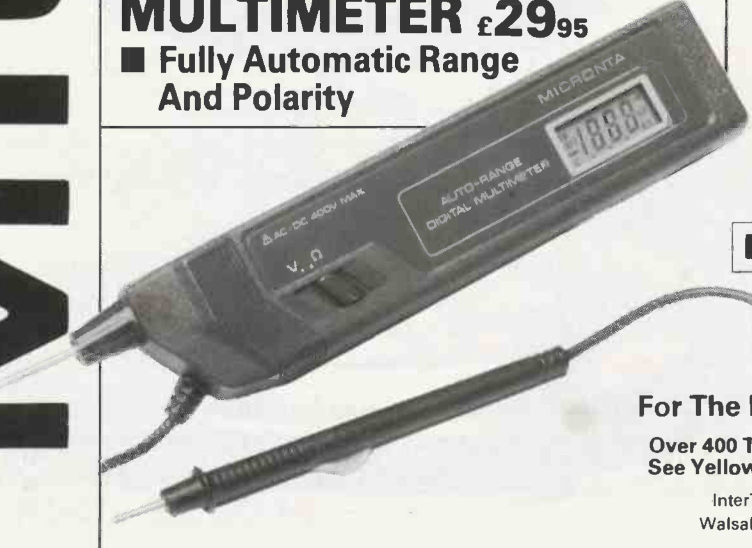

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PRACTICAL ELECTRONICS

VOL 25 NO 8 AUGUST 1989

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PE TAKES TECHNOLOGY FURTHER - BE PART OF IT!

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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 ...

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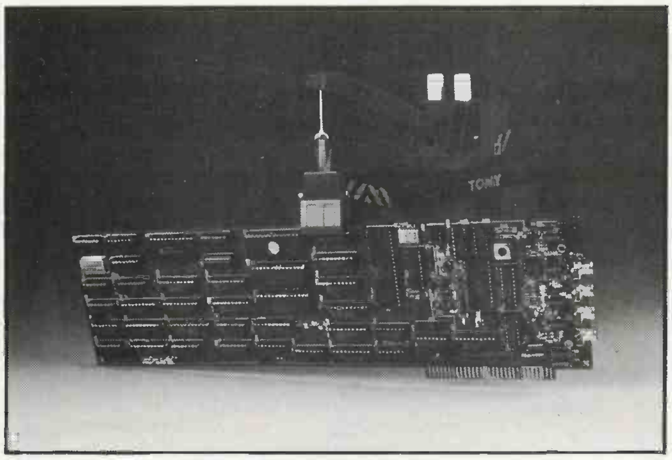
★ AND STILL AT ONLY £1.25

★ 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

Ts 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, Wembly, Middx, HA9 7PJ. Tel: 01-908 3355.

CATALOGUE DATABASE

We have recently received the following literature:

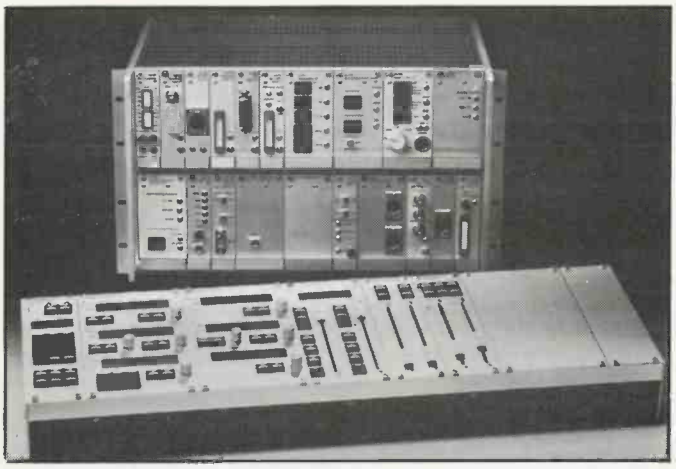
We've been inundated with catalogues from many of our advertisers - we start them here in alphabetical order, and shall continue next month.

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**.

NEWS



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.

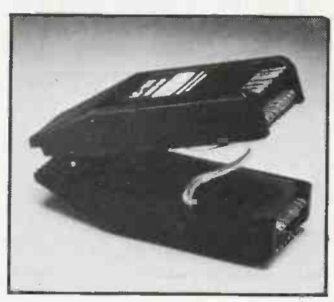
Both amplifiers have an input sensitivity of 500mV for full power output. The CA110 provides 115 watts into 4 ohms and 105 watts into 8 ohms, whilst its larger brother boasts 215 watts into 4 ohms and 150 watts into 8 ohms (All power being watts rms). The power bandwidth (-3dB) is 1Hz-50kHz. Both models are realistically priced at £79.00 + £4.00 P&P for the CA 110 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.

SAFE CLIPPING

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



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.

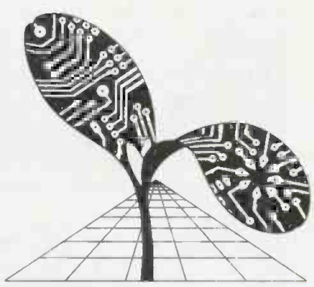
DEBORAH'S TRIBUTE

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 acknowledge 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.

On of the key requirement 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 simulataneous 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.

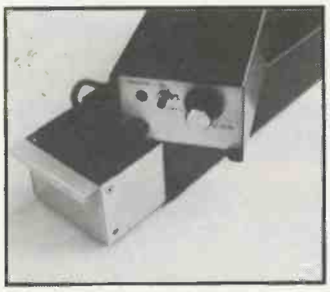
After transmission through the fibre the four signals were separated at the receive end using a commercially available, singlemode, fibre-tailed grating demultiplexer, each laser wavelength being temperature tuned to the centre of the grating pass band.

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 Dumphries 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

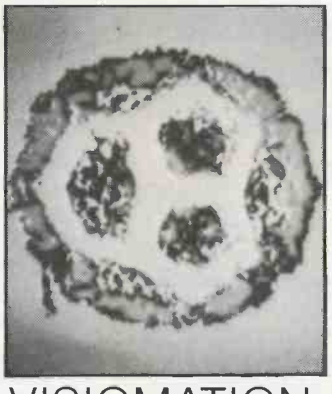
The latest product from The Switch Electronics stable is the BIT PHAXswitch which enables a phone and a fax to operate, problem-free, on a single telephone line. Thought to be ideal for small businesses or use at home, the unit is convenient, fully automatic and cost effective.

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

The 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.

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.

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 that 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 (Vio) 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 Vio 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 Vio, often moving Vio 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 300μV average shift down to 60μV.

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.

MAC SCRAMBLING

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?

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 scrambling more accurate, encryption system from Sky, Eurocypher instead of Videocrypt (previously called Palcrypt). Eurocypher was developed by General Instruments, in the USA, from the Videocypher 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 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 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. 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.

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

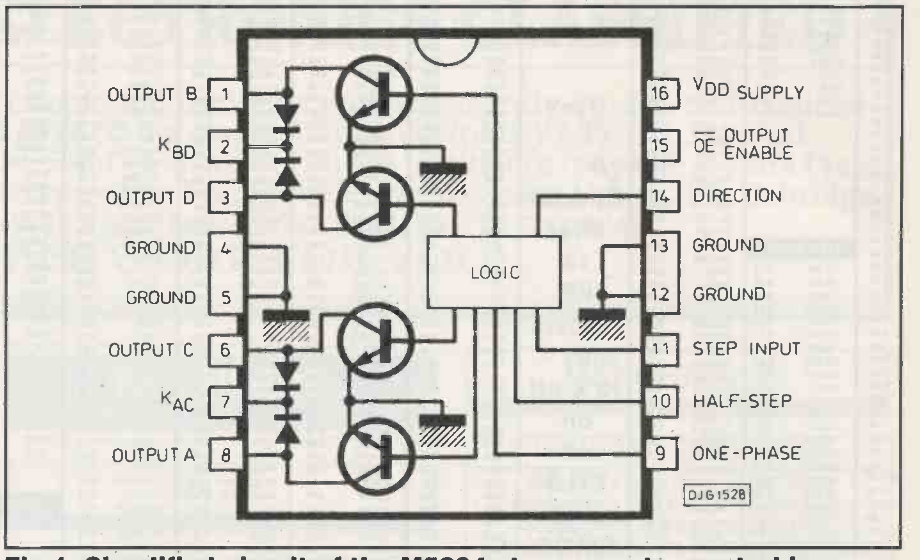


Fig.1. Simplified circuit of the M5804 stepper motor control ic.

STEPPING MOTOR DRIVER

BY MARK STUART

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

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 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 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

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

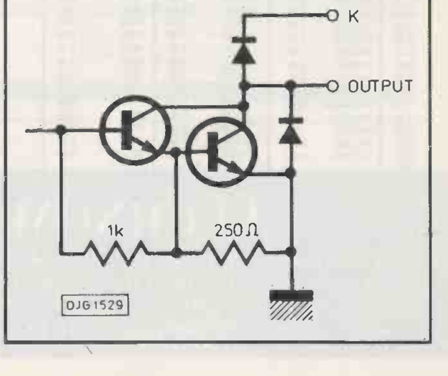
TWO-PHASE SEQUENCE

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

Fig.2. Output transistor detail



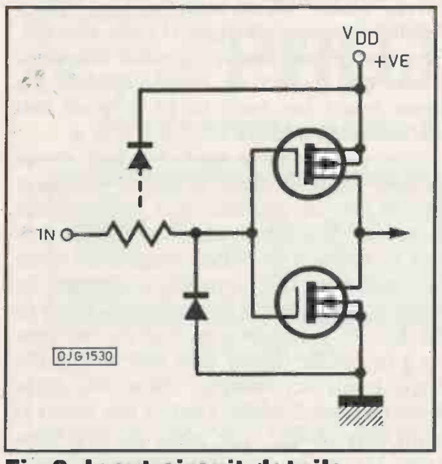


Fig.3. Input circuit details

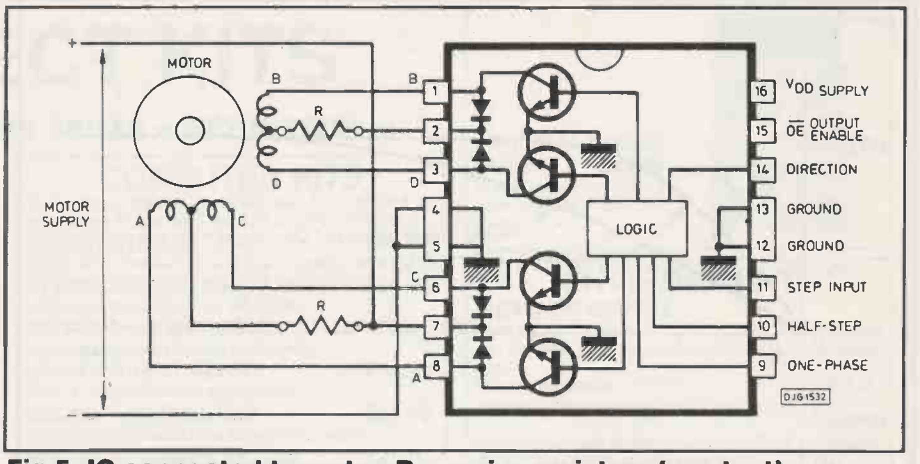


Fig.5. IC connected to motor. R = series resistors (see text)

appropriate pull-up resistors, ttl and lsttl. 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.

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

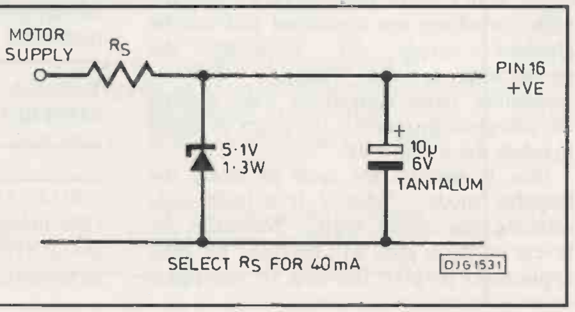
A circuit of the ic connected to a motor is shown in Fig.5. Most standard unipolar stepping motors, such as the MD200 and MD35, have a pair of centre tapped windings. One winding connects to pins 1, 2 and 3, while the other connects to 6, 7 and 8. It does not matter which winding connects to which three 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.4. Zener stabilised logic supply.

V	RS	P
28V	560	1W
24V	470	1W
18V	330	1W
12V	180	0·5W



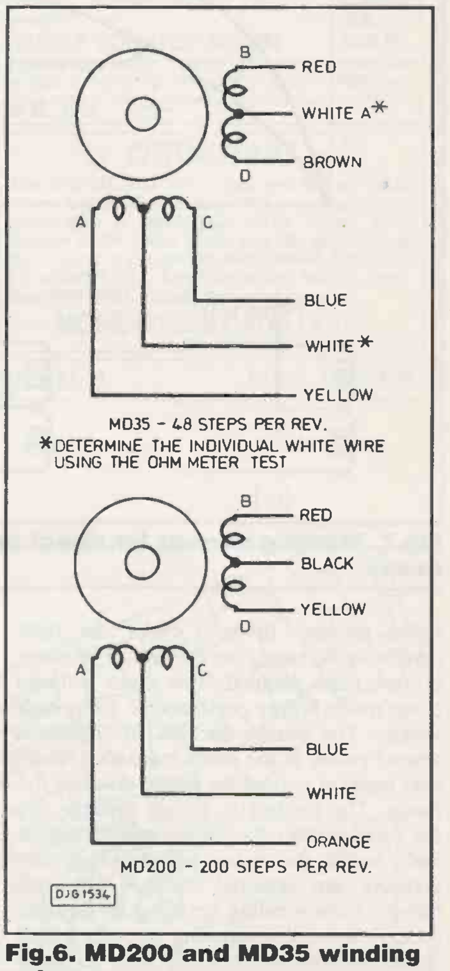


Fig.6. MD200 and MD35 winding colours

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

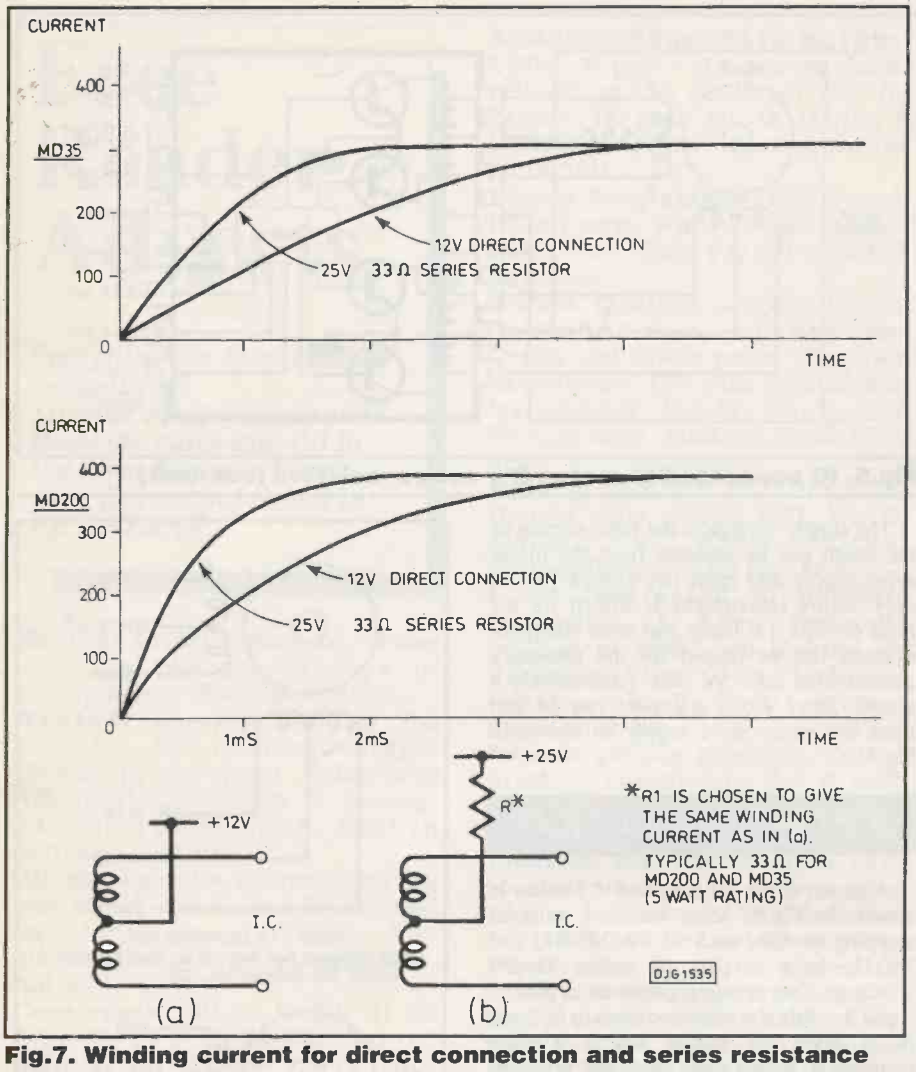


Fig.7. Winding current for direct connection and series resistance cases.

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

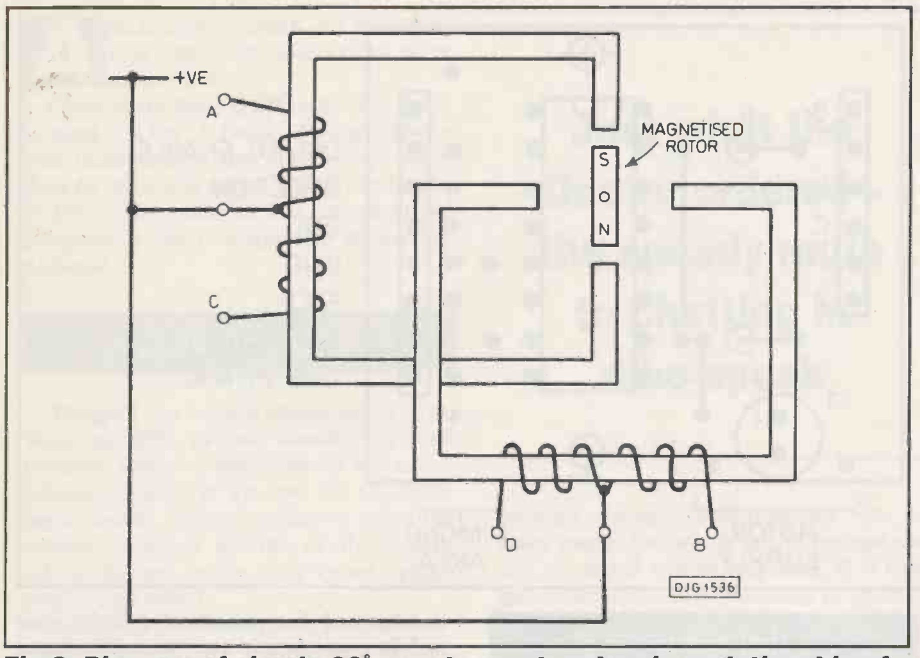


Fig.8. Diagram of simple 90° per step motor showing relationship of coil terminals to poles.

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.

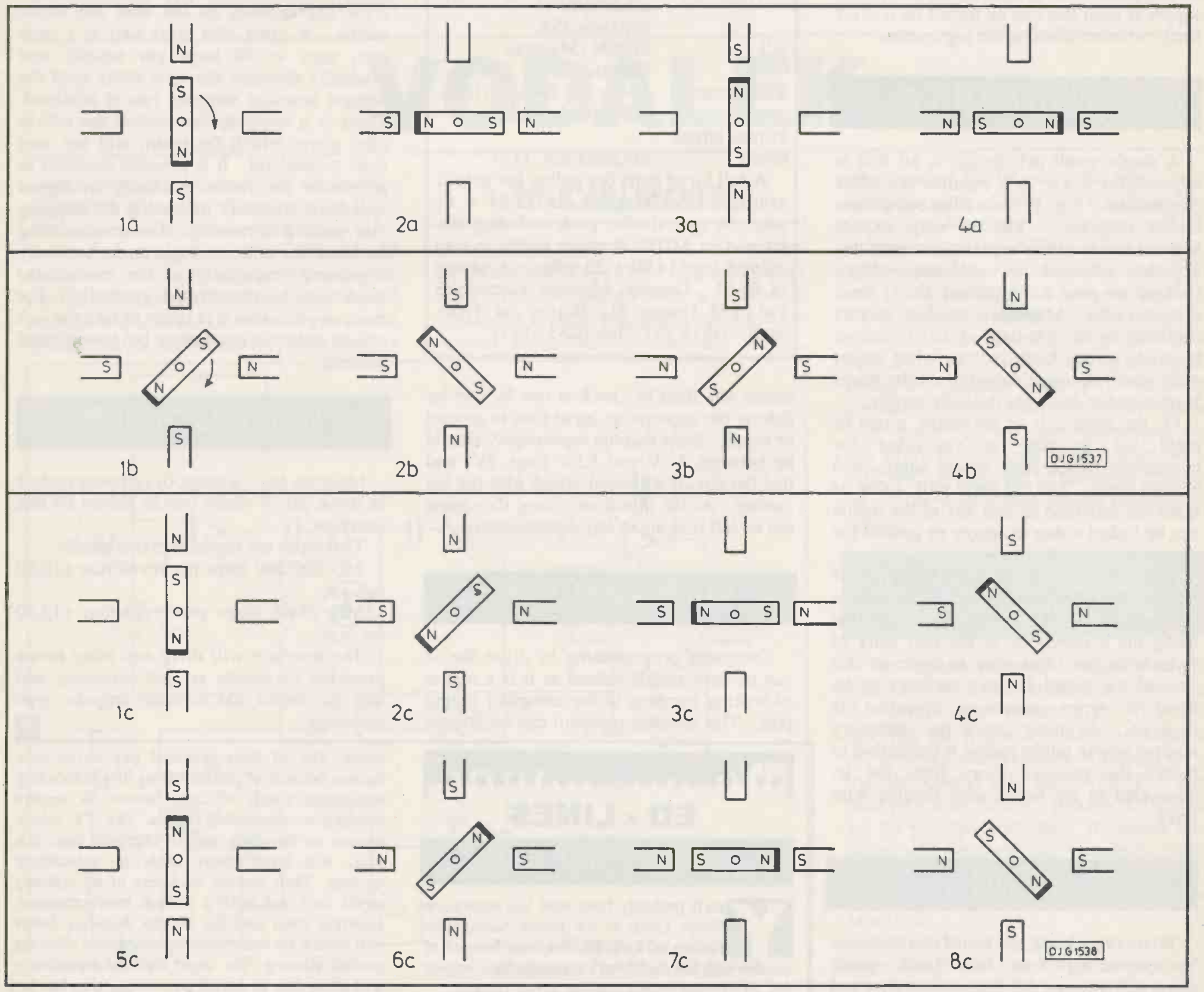


Fig.9. (a) Wave drive-one phase, (b) Full step-two phase, (c) Half step mode.

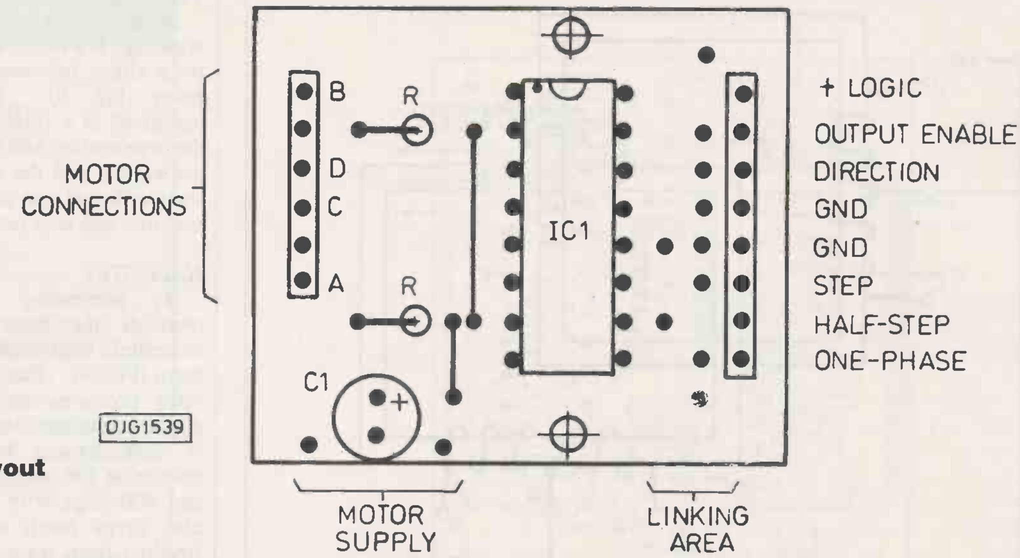


Fig.10. Component layout for the printed circuit board

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 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.

COMPONENTS

C1	10µF miniature radial electrolytic or tantalum 35V
IC1	M5804 (Magenta Electronics)
Connectors	6-way and 8-way 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.

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.

HF RADIO

BY MIKE SANDERS

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

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

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

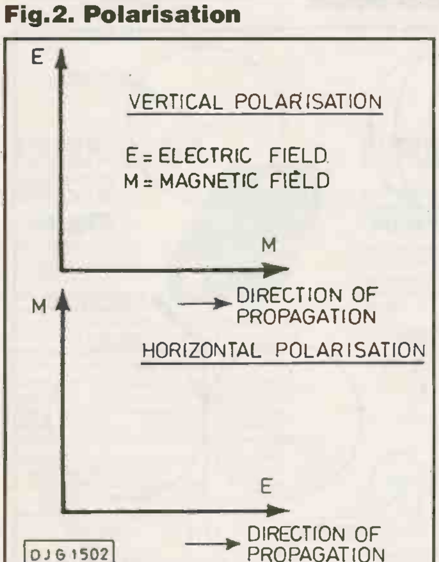
Where P is the power at distance γ.

The wavefront consists of an electrical component and magnetic component at 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



	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 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.

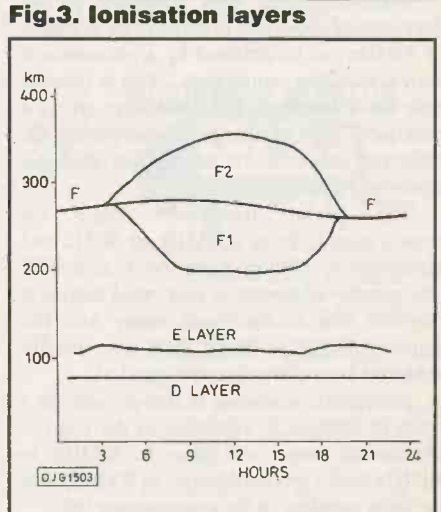
The D layer depends on the latitude of the sun and disappears at night. It reflects vlf and lf waves but does not affect hf much. The E layer also disappears at night like the D layer owing to de-ionisation in the absence of the sun. The E layer helps mf propagation and reflects some hf.

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 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



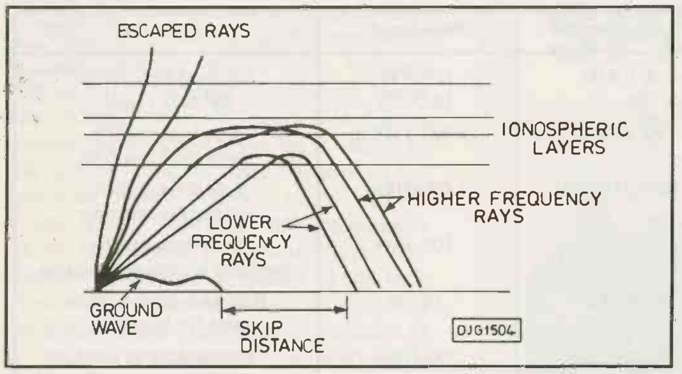


Fig.4. Refraction in the ionosphere

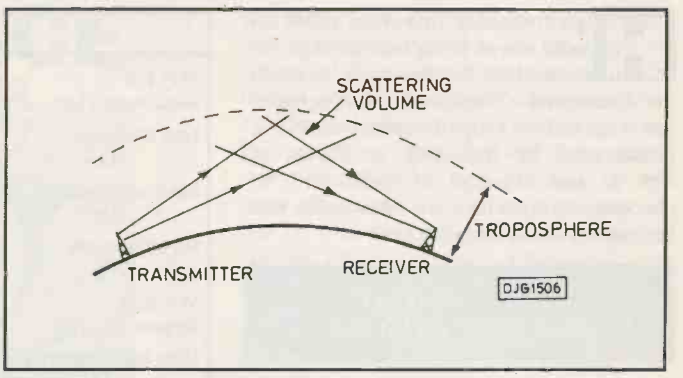


Fig.6. Troposcatter link

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.

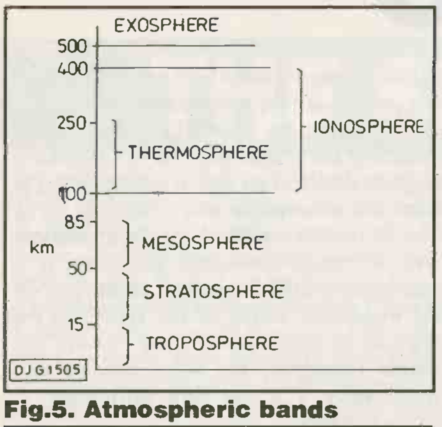


Fig.5. Atmospheric bands

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.

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 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.

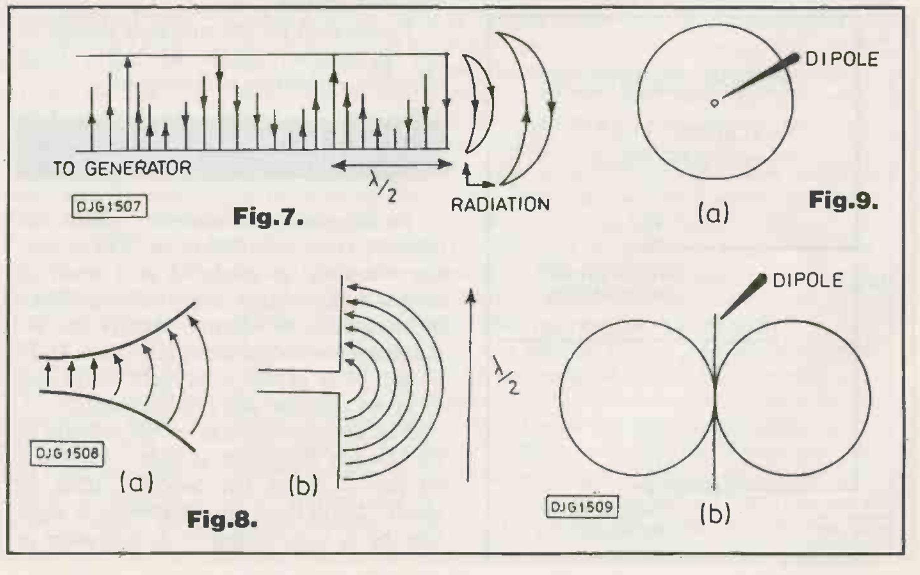
If the total length of the verticals is equal to half a wavelength, the aerial is called a half wavelength dipole. The horizontal radiation pattern of a vertical dipole is a circle, Fig. 9a, and the vertical pattern is a figure of eight, Fig. 9b, since the dipole radiates in both the forward as well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

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.



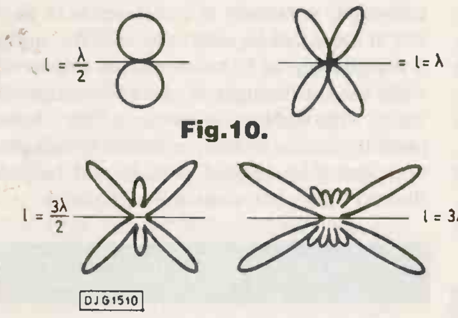


Fig.10.

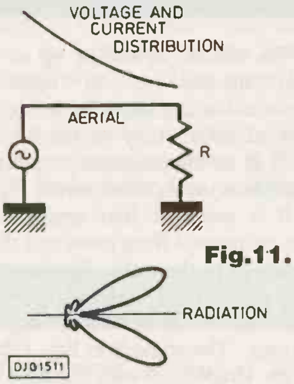


Fig.11.

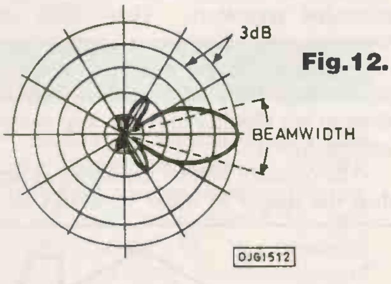


Fig.12.

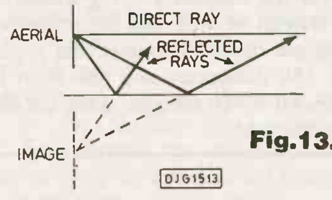


Fig.13.

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 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.

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

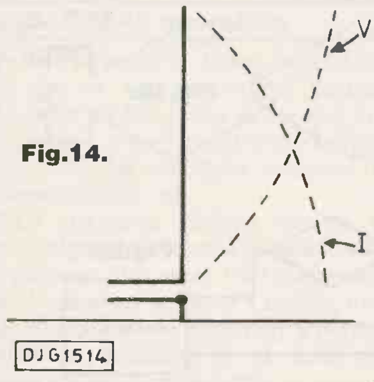


Fig.14.

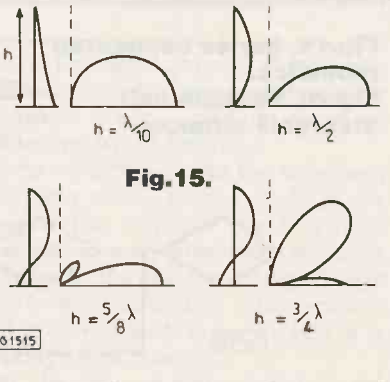


Fig.15.

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 $\lambda 5/8$ a secondary lobe appears and predominates over the ground wave. Therefore in practice such aerials are limited to around $\lambda/2$.

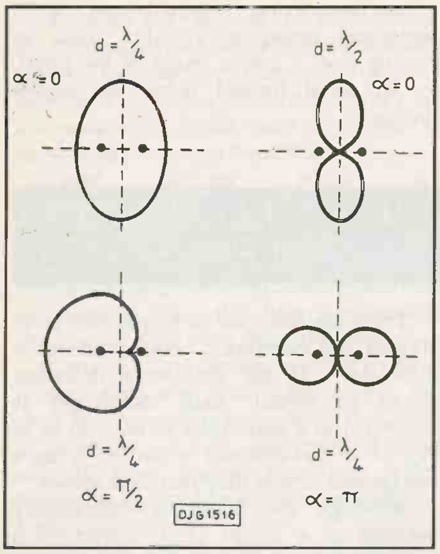


Fig.16. Horizontal polar diagrams for two vertical aerials

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 a.

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.

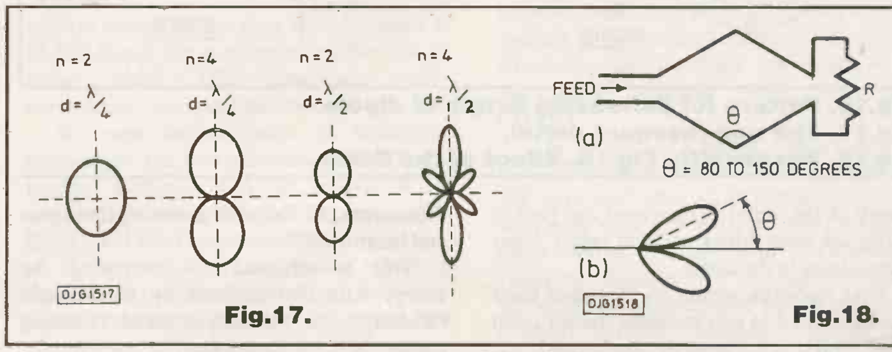


Fig.17. Broadside arrays. Fig.18. (a) Rhombic aerial, (b) Radiation pattern.

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

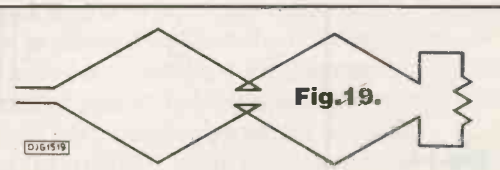
Ultra high frequency (uhf) aerials (300 – 3,000MHz) employ small aerials as for television reception. These have small elements and produce a narrow beam depending on the number of directors used in the Yagi array of Fig. 21. The main element is a dipole and is the only one to be excited directly.

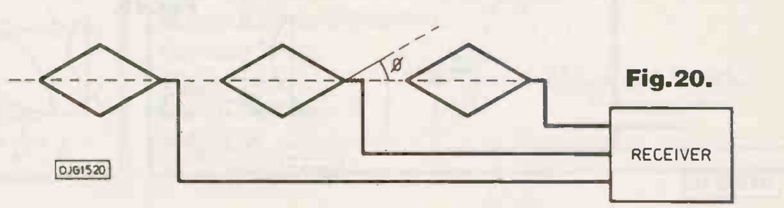
The reflector behind the dipole is longer than the dipole in order to reflect all the backward energy forward. The directors in front of the dipole are shorter than the dipole and assist beam shaping.

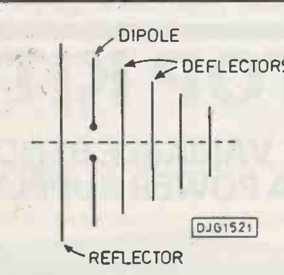
The object of all radio communication systems is to transmit the desired bandwidth and detect it at the receiver in spite of the noise in the atmosphere and thermal noise in the circuits. This means in general that the signal has to be above the noise level and merely increasing the receiver sensitivity 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.







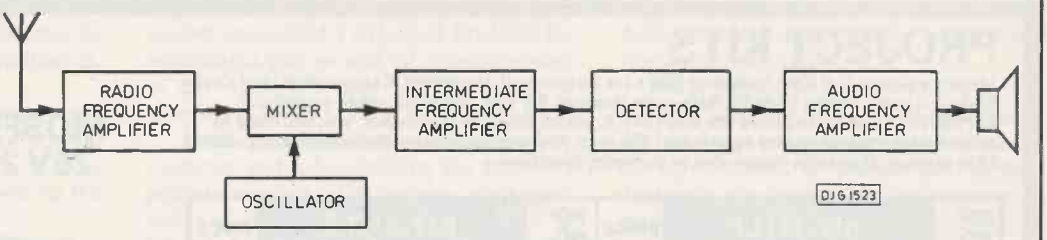


Fig.21. (left) UHF aerial. Fig.22. (right) Radio receiver block diagram.

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 noise 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.

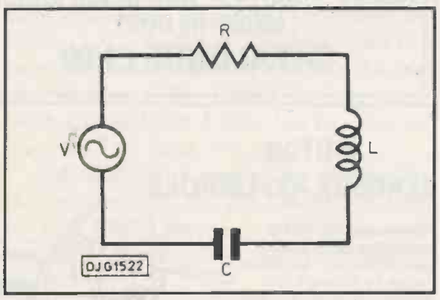


Fig.23. Series tuned circuit

RESONANCE AND ENERGY COUPLING

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

$$wL = \frac{1}{WC} \quad \text{or } f = \frac{1}{2\pi\sqrt{LC}}$$

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:

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

For the series circuit of Fig. 23

$$Q = \frac{wL}{R} = \frac{f}{B}$$

where B is the bandwidth.

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

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

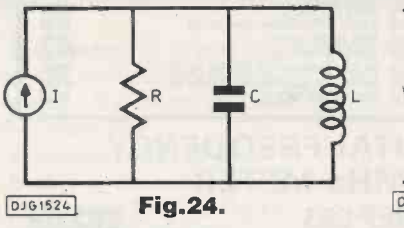
$$Q = \frac{f}{B} = w\,CR$$

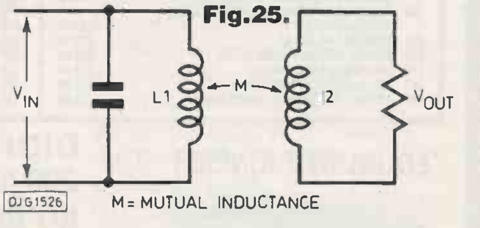
The equivalent circuit of a single tuned transformer is shown in Fig. 25 and the coupling efficiency called the coupling co-efficient (k) is given by:

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

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

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





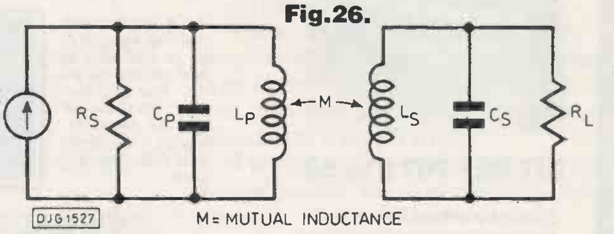


Fig.24. Parallel tuned circuit. Fig.25. Single tuned transformer. Fig.26. Double tuned transformer.

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.

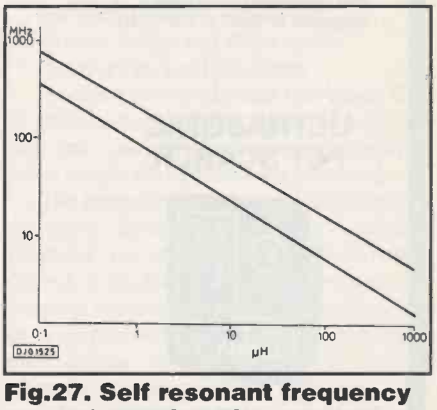


Fig.27. Self resonant frequency range for a given inductor.

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

HAND CLAPPER

BY HARVEY KENT

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

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 muscial 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.

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 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 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 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.

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

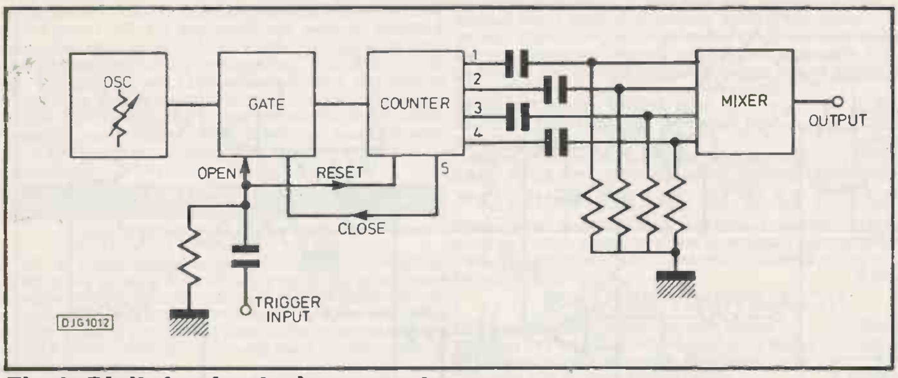


Fig.1. Digital pulse train generator.

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 osciallator 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.

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 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.

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 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.

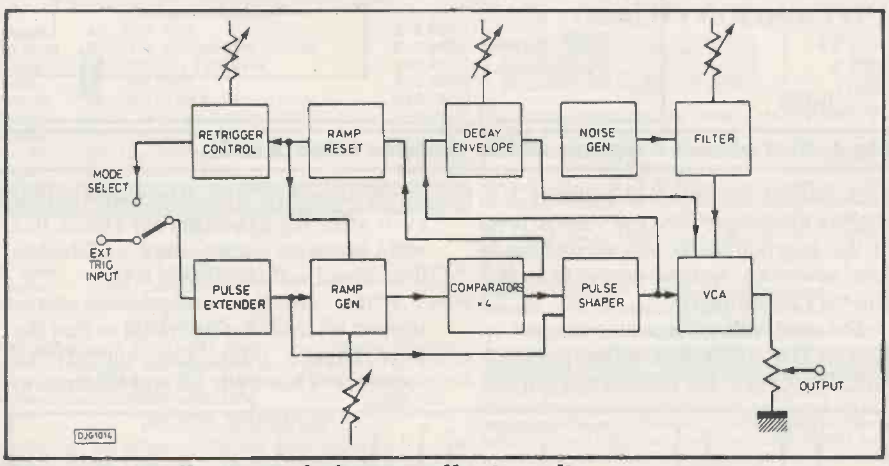


Fig.3. Block diagram of clapper effects unit.

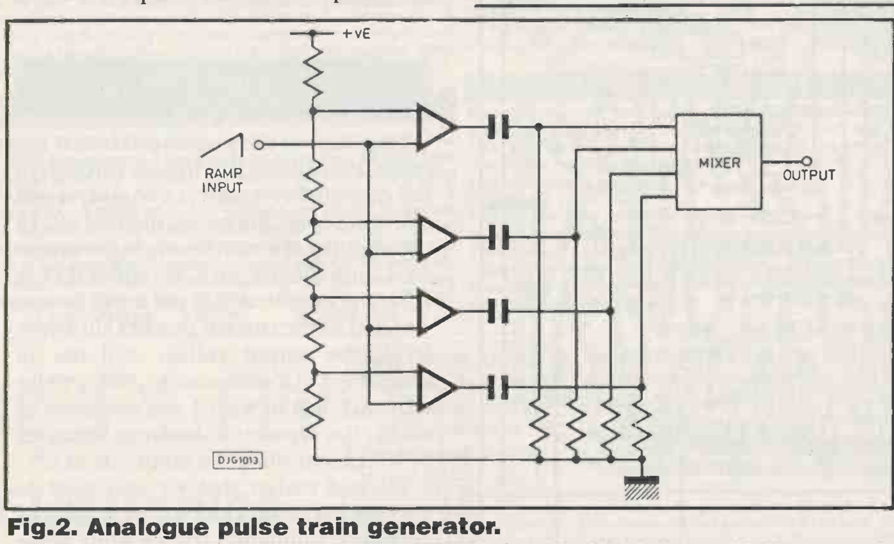


Fig.2. Analogue pulse train generator.

RAMPING SAWTOOTH

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

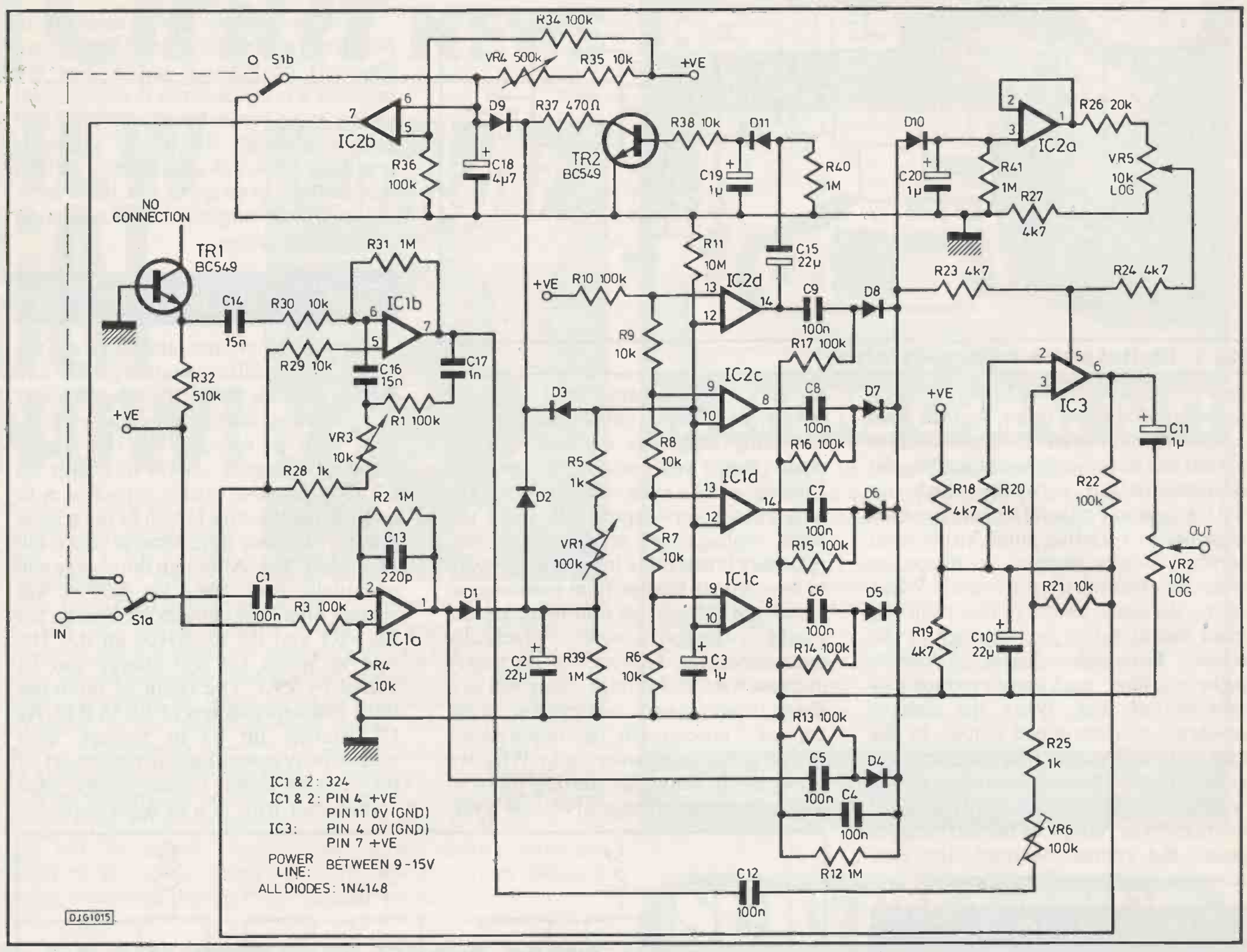
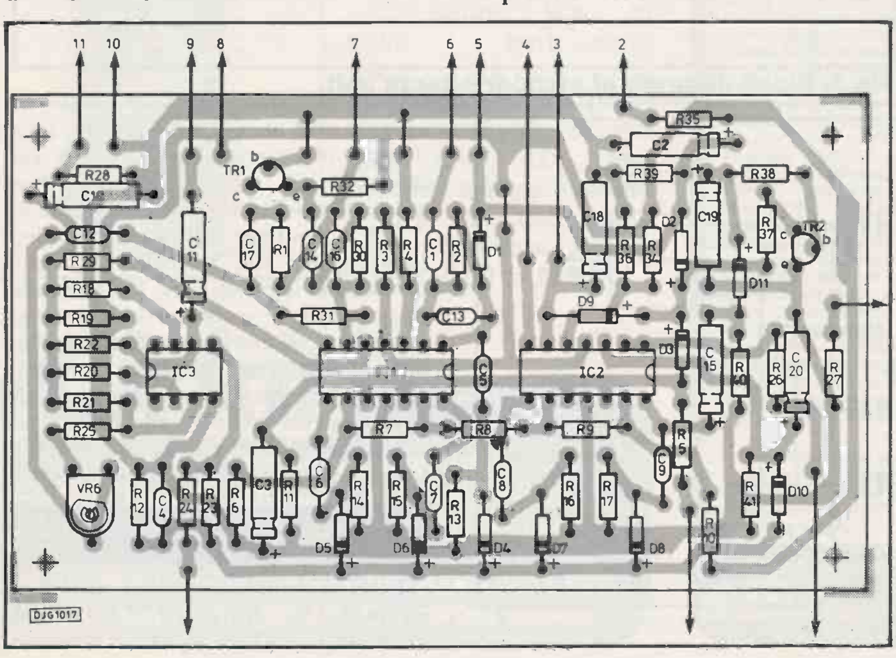


Fig.4. Full circuit diagram of the clapper effects unit.

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 absense of a sufficiently high current on it 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 ¼W 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	4µ7 63V 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.

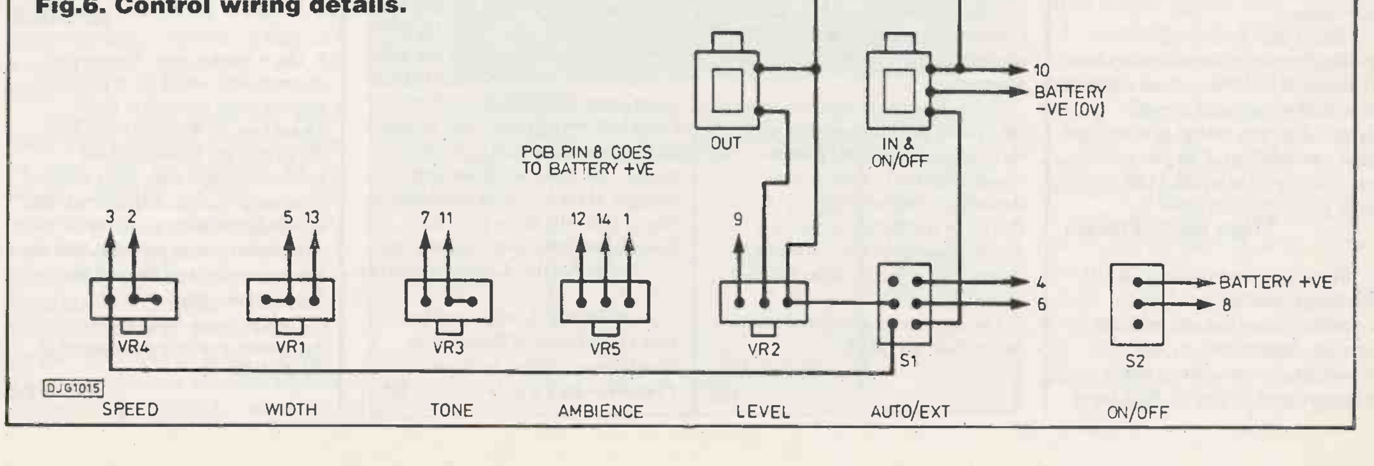
LIKE THE CLAPPERS

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 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.

If your 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.

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 goes 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

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HALF PRICE OR LESS!!

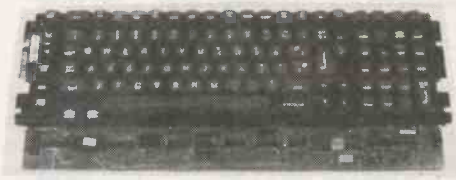
We must clear last years surplus to make room for more parcels we are expecting soon!! So snap up these unrepeatable bargains now – most goods will not be available once existing stocks are sold!!
In order to sell at these low, low prices and cover our costs, **the minimum order value is £10 & postage 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 2x77HO5, 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

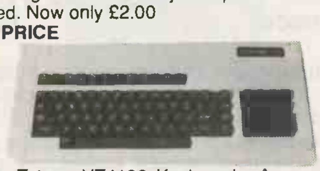
Z8856 Cherry computer keyboard. Very slim model 340 x 130 by only 14mm deep, including keys. Matrix output. 67 keys in pale/dark brown. No idea what computer they're from – but they're an absolute bargain at only £4.
SALE PRICE £2.00



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

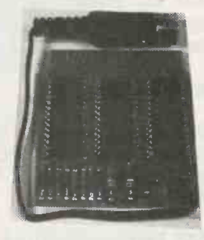


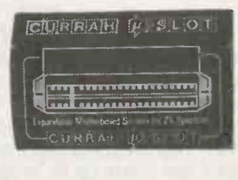
Z8833 Tatung VT4100 Keyboard. As previously advertised on earlier bargain lists (but these do not have a lead attached). New stocks just received of this popular cased 85 key with separate numeric pad keyboard. Supplied with circuit diagram. 450x65x125mm. £14.95
SALE PRICE £7.50

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
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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.
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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.
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K538 Diode Pack – untested small signal diodes like IN4148 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**
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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
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K503 100 Wirewound Resistors – From 1W to 12W, with a good range of values.
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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
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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
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100 assorted £6.75 250 £12.95
SALE PRICES 100 assorted £3.37 250 £6.50

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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
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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
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K546 Polystyrene/mica/ceramic caps. – Lots of useful small value caps up to about .01µF in voltages up to 8kV. Good variety.
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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 luf at voltages from 63 to 1000!!
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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!
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K520 Switch Pack – 20 different assorted switches – rocker, slide, push, rotary, toggle, micro etc.... Amazing value at only £2.00
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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
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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
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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
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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
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K551 6BA screws – In a variety of lengths and heads from 3/16" to 20mm long. Steel.
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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
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K567 Wire Ties. 5 types to take 4-15mm dia cable bundles. 100 £1.70
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K565 Miniature PCB supports in nylon. 6 different styles – sizes from 6.35 to 13.24mm high. 100 £2.20
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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
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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
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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
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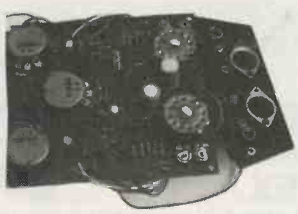
1W Amplifier – mono

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**

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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 MC68008P8 (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 PCBs: 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

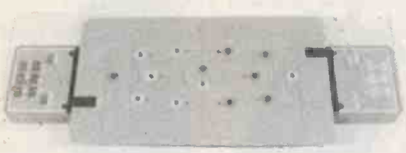
Z811 Cumana Touch Pad for the BBC computer. This remarkable add-on enables you to draw on the screen using a stylus with the touch sensitive pad. Supplied with 2 stylii, power/data connecting lead and demo tape with 4 progs. Contains state-of-the-art electronics. Originally being sold at £79.95 – but 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**

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10 for **£7.00** 100 for **£50.00**

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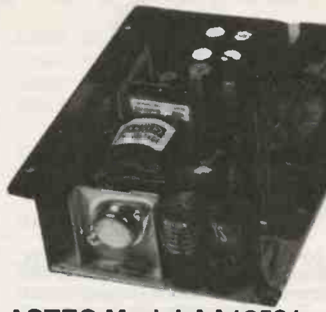

ASTEC Model AA12531

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

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

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	Hi-Res Monitor	P84	All 1/2 price		J001-3 £1.20/10
	£12.50	P85	All 1/2 price		Rest 1/2 price
	SB14 £1.50	P86	All 1/2 price	P93	All 1/2 price
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P15-17	10% off		Rest 1/2 price		Rest 25% offf
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		

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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 2μV, 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. 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 rdxing.)

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 rtty 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 rtty baud rates catered for are 45, 50, 75 and 100, with rtty 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 Koden 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

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/rd 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 that 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.

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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)

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Motorola M1000-100 5" 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)

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SHUGART SA405. BRAND NEW	£29.95(B)
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CANON,TEC etc.DS half height.State 40 or 80T	£75.00(B)
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3½ INCH BRAND NEW AT £19.95!!

Never before seen price for a 3½" 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...................... £19.95(B)

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4 inch	AC 1½" thick	£ 9.95(B)
10 inch	Round.3½ thick. Rotron 110v	£10.95(B)
62 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 1½" thick	£12.50(B)
4 inch	DC 24v 8w. 1" thick.	£14.50(B)

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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)

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Racal-Redac real time colour drafting PCB layout system. Includes furniture and huge monitor.Complete ready to go!	£3950
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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)

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ENCRYPTION

PART TWO
BY MIKE SANDERS

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

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 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 Cn a function of the previous plain message blocks M_1 M_2 M_3...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 information) error extension is only just a nuisance, but in data transmission, the data could be corrupted excessively.

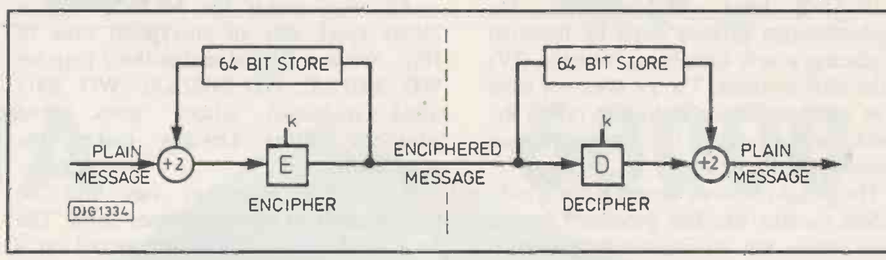
In order to prevent data corruption, error checks must be carried out and this must be carried out directly on the enciphered bit stream, Fig.15, not on the plaintext message, Fig.16.

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 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.

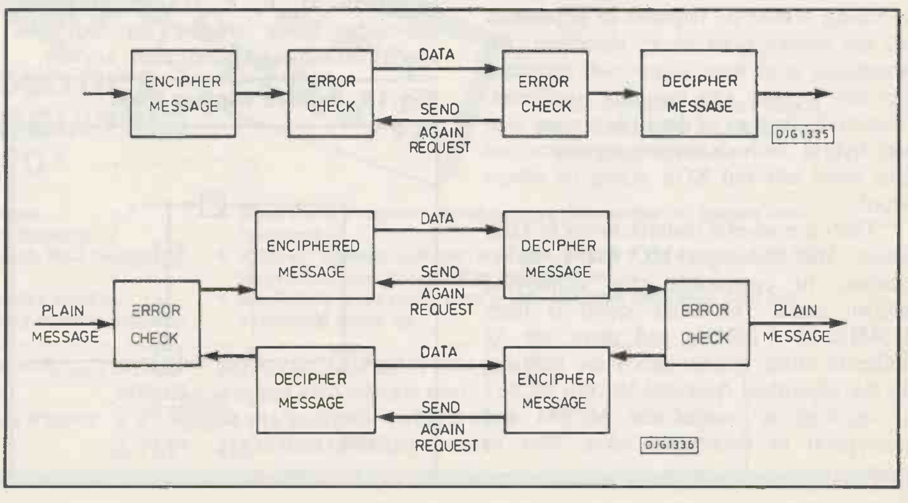
Fig.14. Cipher block chaining.



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 by 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.



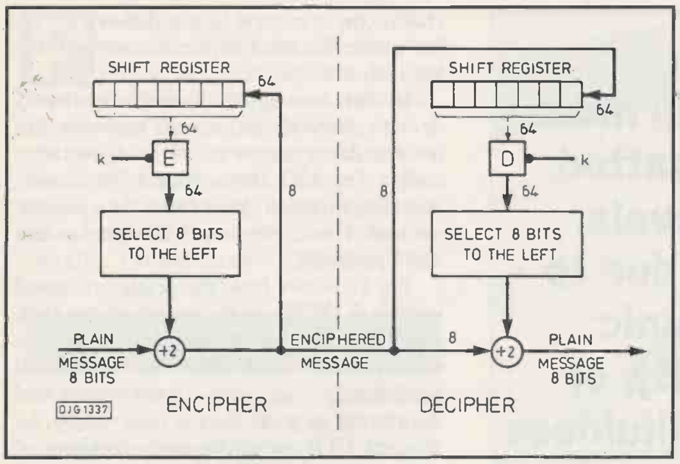


Fig.17. Cipher feedback

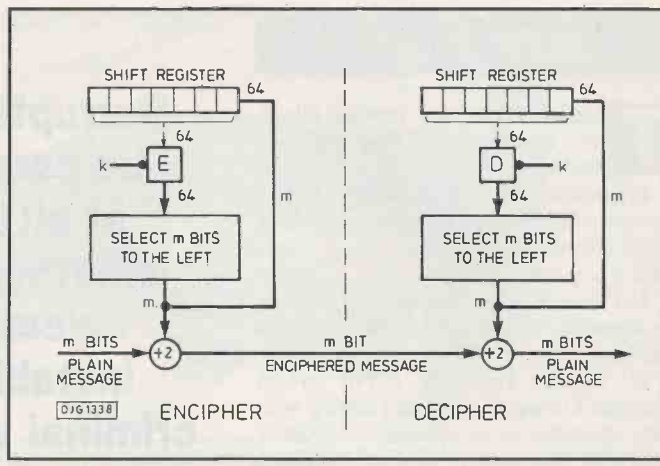


Fig.18. Output feedback

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 10μs. 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.

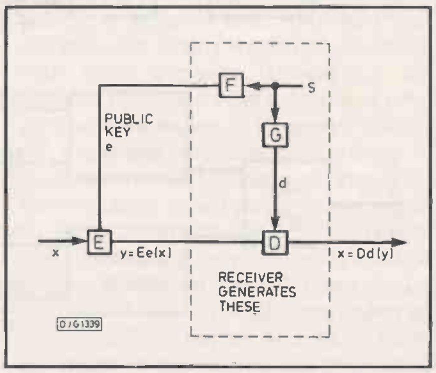
The DES algorithm can also be implemented in microprocessor form. The Intel 8294 uses a microcode stored on a prom (programmable read only memory). American Microsystems makes the S6894 which is a 2 chip microprocessor, and Texas Instruments makes the TMS 9940 with a 5MHz clock. Rockwell Collins and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



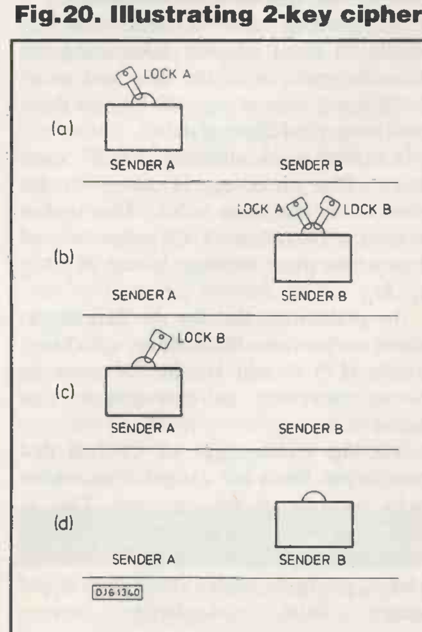
In order for the recipient to be the only one to decipher the message, he must be the one to derive both keys e and d using algorithms F and G. He then announces key e and keeps key d secret. The first publications did not detail the algorithms D, E, F and G to produce a working model.

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 geniune.

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 is 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.

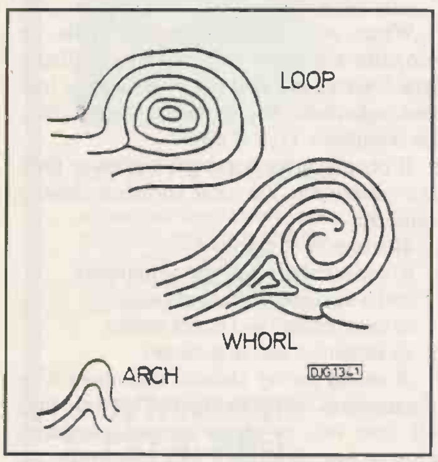
A signature verification system called VERISIGN has also been developed by the National Physical Laboratory. This uses a pad called CHIT and is made from two membranes which touch when the pen is pressed down on the surface. The x and y co-ordinates of the signature are then plotted by sampling at the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

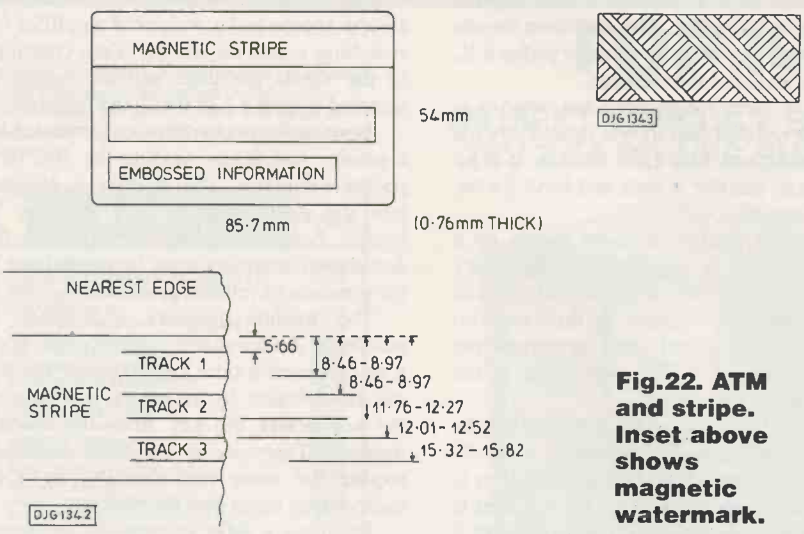


Fig.22. ATM and stripe. Inset above shows magnetic watermark.

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.

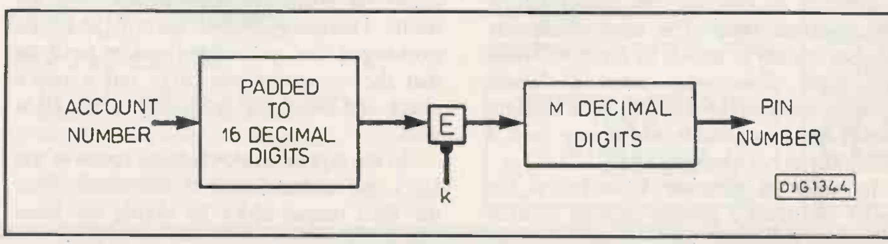
A pin number can be derived from an account number as shown in Fig.23. Using zeros or constants, the account number is padded out to 16 decimal digits. The 64 bit number produced is then enciphered using DES and a secret key and the 64 bit output is examined in groups of 4 bits starting at the least 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.

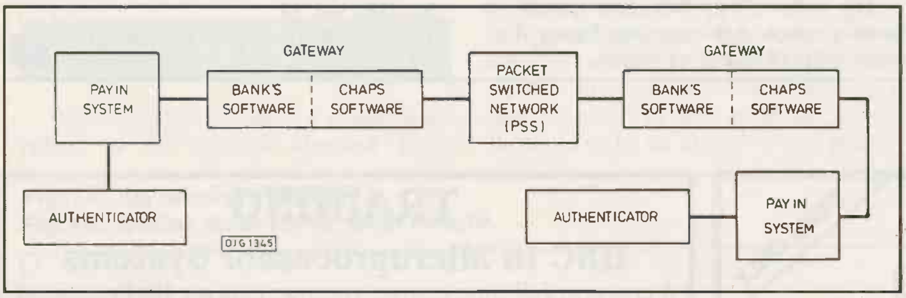


Fig.25. CHAPS operation

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.

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 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 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 1µs per test, the imaginary machine does a million tests in the same time and even a 64 bit key becomes insecure.

TABLE 1

Key Size	Single Tests	One million tests in parallel
	1 µs per test	1 µs 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 1μs, 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 log2 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 redundnacy. 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 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.

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

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 x 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 x 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.

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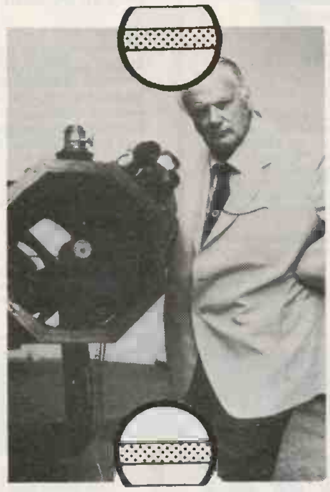
SPACE WATCH



BY DR PATRICK MOORE CBE

One up, one down... Telescopes come and go

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 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 kilometres 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.

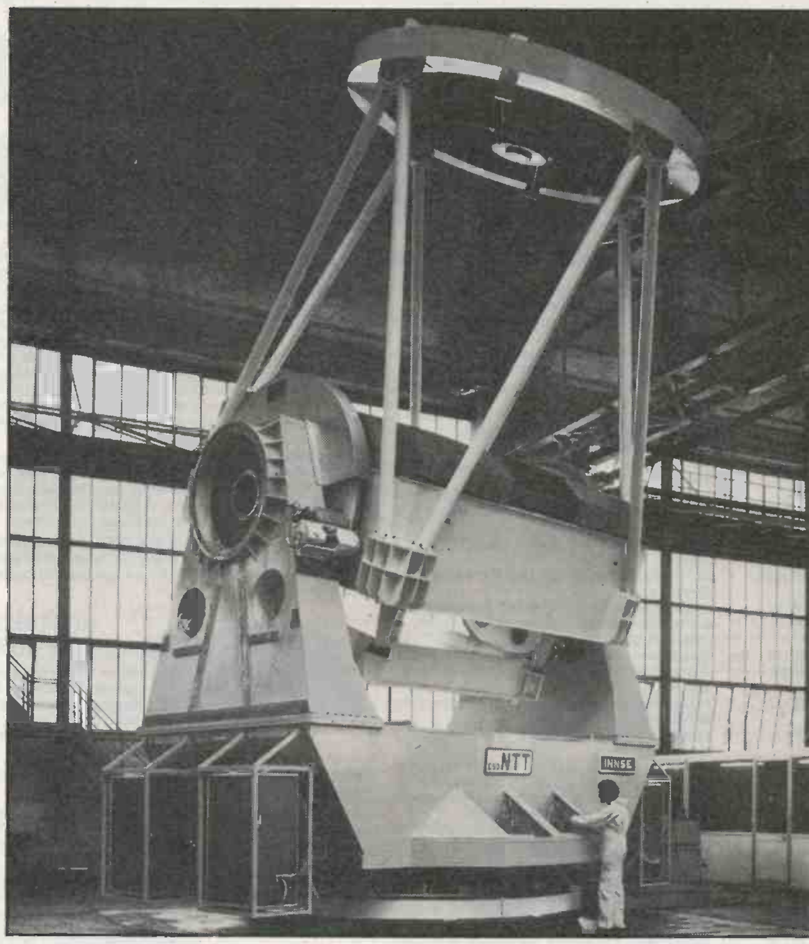
Because the Sun is now rising to the peak of its 11-year cycle of activity, we may well have some displays of auroræ, though one can never be sure, and we will be lucky to have another display as good as that of March 13 this year, which was seen from much of Britain.

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! PE

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.



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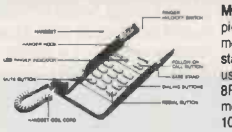

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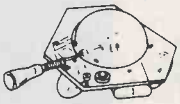

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VODALEK

Just what the Doctor ordered – the speedy route to chatting in robo-speak

BY JOHN BECKER

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 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 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 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. 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 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 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 to 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.

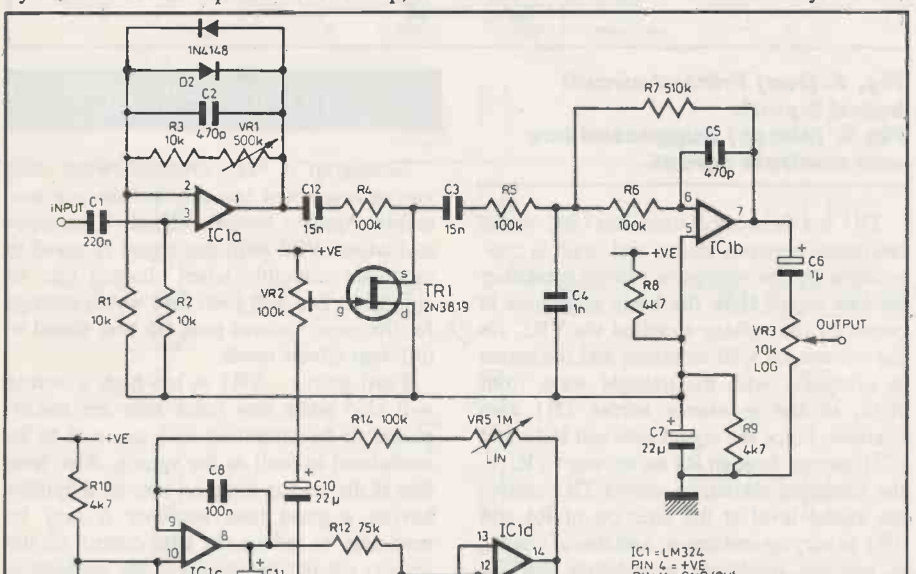

Fig.1. Complete circuit diagram for the Vodalek

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.

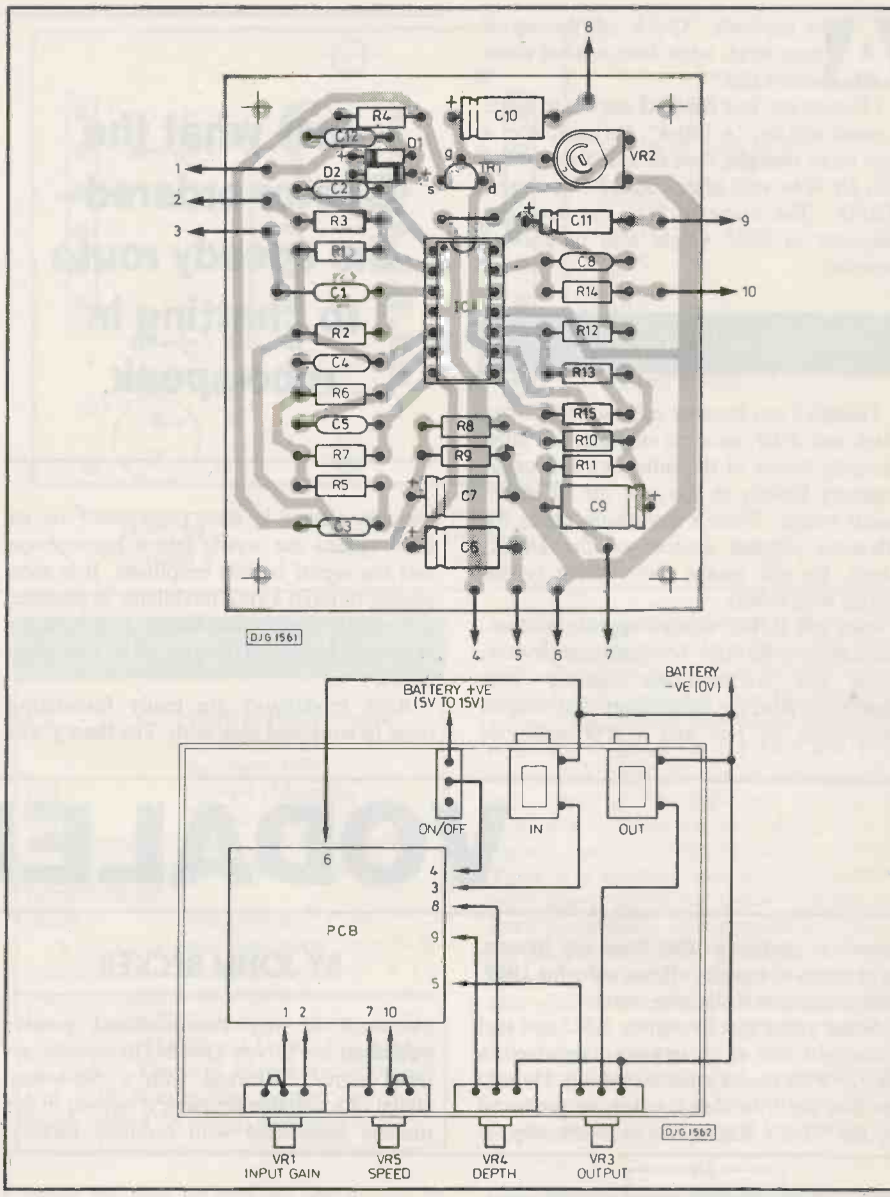

Fig. 2. (top) Printed circuit board layout.
Fig.3. (above) Suggested box and controls layout.

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.

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 Vodalek. Play the part, utter your words of dooming extermination, and even Time-Lords might tremble!

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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 Gugliemo 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.

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INDUSTRY

NOTEBOOK

CIM AND SOCIETY

BY TOM IVALL

Full Marx, Karl – the manager shall sit down with the workers, and the worker with the machine

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 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. 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 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 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. PE

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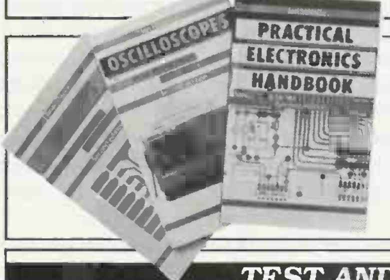

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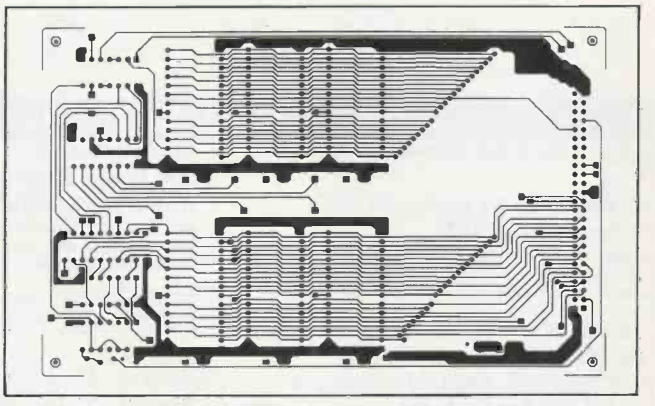

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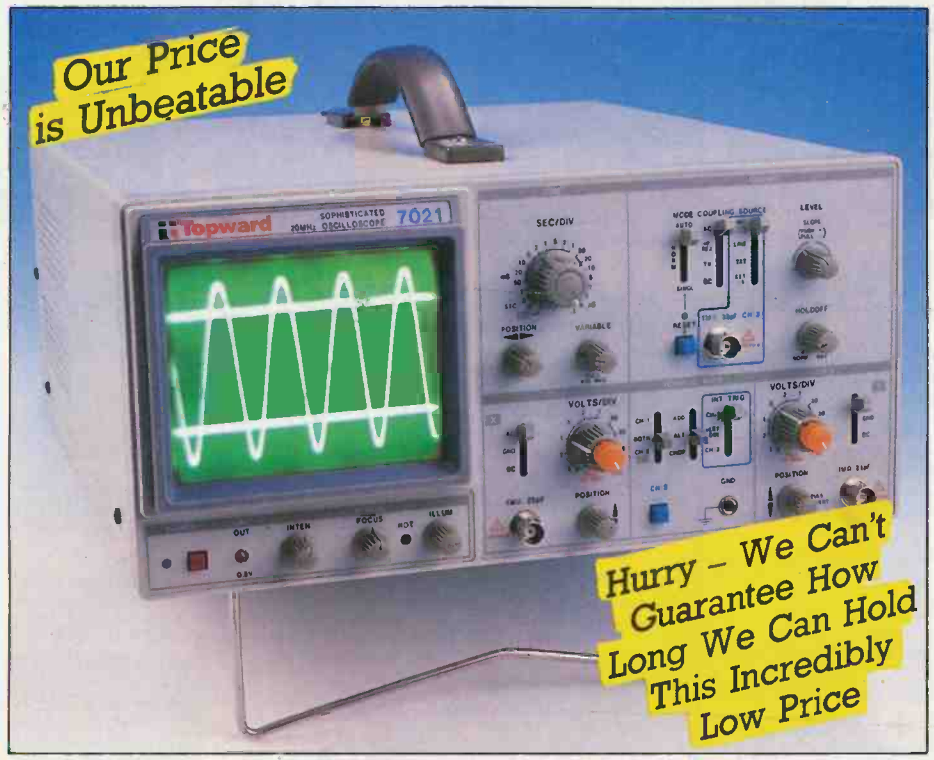

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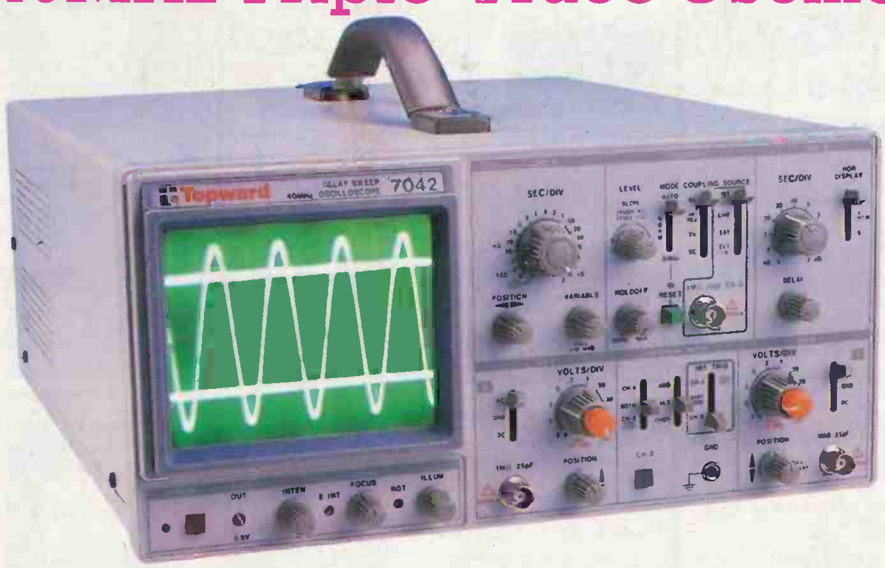

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