ELECTRONICS WORLD

+ WIRELESS WORLD

Denmark DKr. 63.00
Germany DM 13.00
Greece Dra. 680
Holland Dfl. 12.50
Italy L 6500
IR £2.97
Spain Pts. 700.00
Singapore S$ 11.25
USA $5.95

JUNE 1991 £1.95

SPACE

Solar powered orbit control?

PC REVIEW

Boardmaker: board design on the cheap?

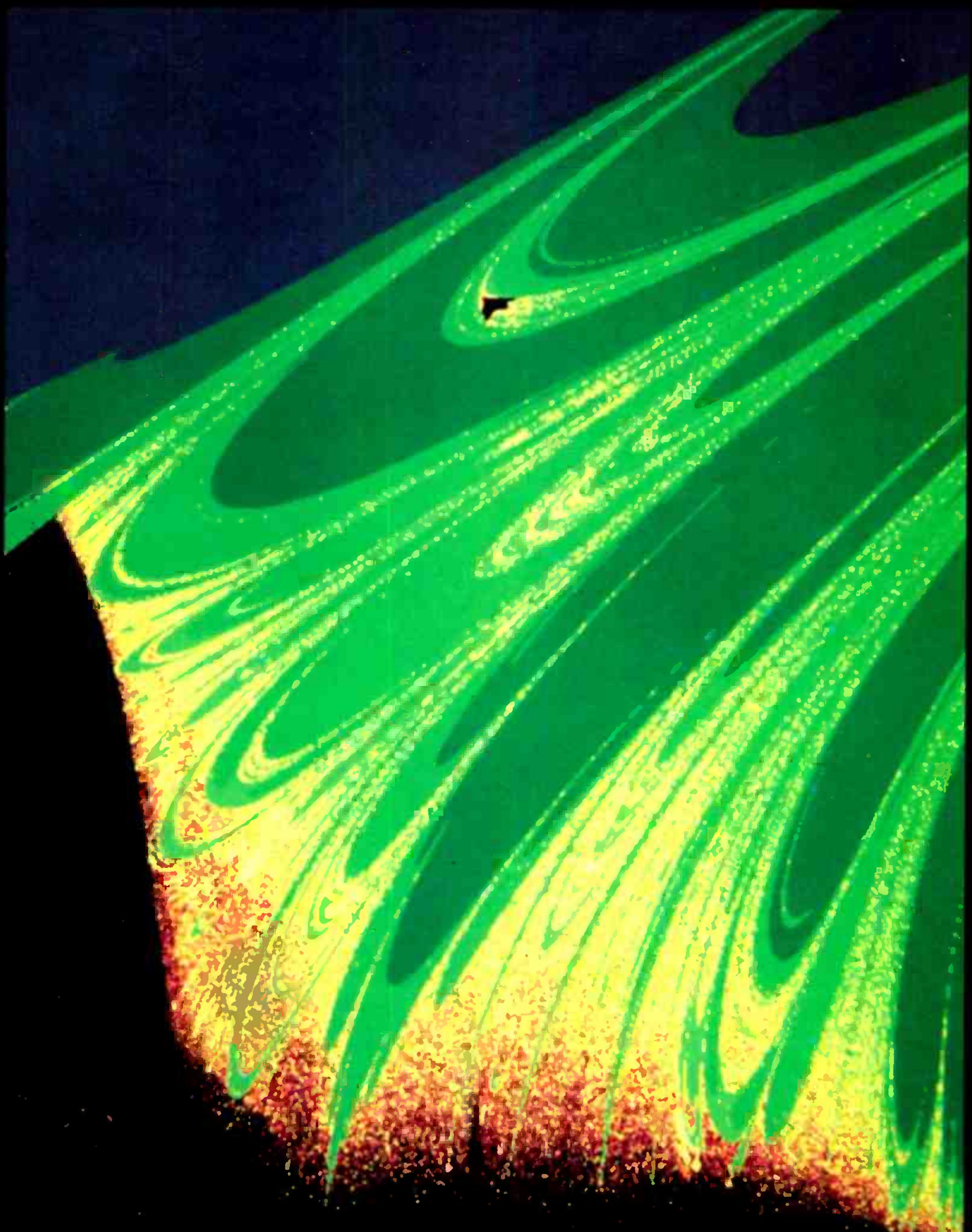
SigmaPlot: spreadsheet for science

HYPOTHESIS

Non-linear ionosphere?

NEW SERIES

Pictures from the past



SCIENCE

CHAOS IN ELECTRONICS

CONTENTS

FEATURES

REGULARS

In next month's issue. Audio design. Even the best electronic musical instruments may produce quantisation noise. Richard Brice reveals the design process for a professional quality noise gate. Plus John Linsley Hood on the driving of audio output valves.

Knowledge is power

EDITOR
Frank Ogden
081-661 3128

DEPUTY EDITOR
Jonathan Campbell
081-661 8638

DESIGN & PRODUCTION
Alan Kerr

EDITORIAL ADMINISTRATION
Lindsey Gardner
081-661 3614

ADVERTISEMENT MANAGER
Jan Thorpe
081-661 3130

DISPLAY SALES MANAGER
Shona Finnie
081-661 8640

ADVERTISING PRODUCTION
Una Russ
081-661 8649

PUBLISHER
Glyn Moody
081-661 3146

FACSIMILE
081-661 8939

Question. What do corporate computer departments, estate agents and superloos have in common?

Answer. They are all expensive conveniences.

Desktop computing has revolutionised the electronics industry. And a few others. A combination of IBM clones and off-the-shelf software gives instant access to design tools which, just a few years ago, would have required a mainframe computer system to run. And a commercial loan to finance.

Windows 3.0, which brings a friendly user interface to the grey world of dos, promises to deliver high powered personal computing to a wider audience although not everyone is happy about this.

Unix, which first appeared nearly fifteen years ago, is the antithesis of desktop computing. Its layered security and networking require a lifetime's career to fathom... which is at least part of the reason for its success. The luckless user needs the services of a full-time computer professional to unlock the power of Unix. And the computer department keeps the keys. It is no wonder that computer managers advise their corporate employers that risc based workstations — with Unix as the preferred operating system — are just the thing.

When individual users point out the usefulness of IBM desktop computing, the corporate computer departments immediately respond by disguising the inherent simplicity with a barrage of batch files, baud rates and technical fog.

Until Windows 3.0, which runs happily on a £1000 IBM clone, appeared, the only machine with a built-in intuitive user interface was the Macintosh. This apparently massive advantage is almost totally offset by the daft marketing and licensing policy of its sole maker, Apple Computer, which refuses to grant third party manufacturing licences. The company may yet pay dearly for the mistake.

The desktop computing industry could put corporate end users back in control if it really wanted to. Since Windows 3.0 presents a standard software interface in the same manner that IBM architecture offers standard hardware, it is a relatively easy task to develop a self-configuring network card which self-instals and operates in a totally transparent manner.

No computer professionals needed.

The network performance would depend solely on the technical characteristics of the external wiring. Other users simply look like extra drives to be accessed like any other.

Computer departments will point to the need for security... a bogus objection. File encryption systems using trap-door DES are virtually unbreakable. These, and other locks controlled by the user, offer at least as much security as the logon process which forms the principal layer of Unix security.

Simply stated, the technology exists to make workplace computing routine, cheap and highly effective. It is safe to predict that computer professionals will fight tooth and nail to prevent this.

Frank Ogden

REED BUSINESS PUBLISHING GROUP

Electronics World + Wireless World is published monthly. By post, current issue £2.25, back issues (if available) £2.50. **Orders, payments and general correspondence to L333, Electronics World + Wireless World, Quadrant House, The Quadrant, Sutton, Surrey SM2 5AS.** Telex:892984 REED BP G Cheques should be made payable to Reed Business Publishing Group.
Newstrade: Quadrant Publishing Services, 081-661-3240
Subscriptions: Quadrant Subscription Services, Oakfield House, Perrymount Road, Haywards Heath, Sussex RH16 3DH. Telephone 0444 441212. Please notify a change of address. Subscription rates 1 year (normal rate) £30 UK and £35 outside UK.
USA: $116.00 airmail. Reed Business Publishing (USA), Subscriptions office, 205 E. 42nd Street, NY 10117.
Overseas advertising agents: France and Belgium Pierre Mussard, 18-20 Place de la Madeleine,Paris 75008. United States of America: Jay Feinman, Reed Business Publishing Ltd, 205 E. 42nd Street, NY 10117.Telephone (212) 867-2080. Telex 23827.
USA mailing agents: Mercury Airfreight International Ltd Inc, 10(b) Englehard Ave, Avenel NJ 07001.2nd class postage paid at Rahway NJ Postmaster. Send address changes to above.

Valve failures open up photonic success

What may have struck most of us as just a rather rare form of valve failure has led scientists to announce a potential new way of making waveguides.

Brought up in the thermionic era, I can not myself remember valves failing because of electron bombardment of the glass. But the subject of "browning" failure, as it is called, was nevertheless studied in considerable detail around 1980. A paper by Gossink *et al* (*J. Non-Crystalline Solids* **37**, III) showed that under electron bombardment, a chemical migration process occurs in which certain elements migrate within the glass.

Migration, particularly of sodium and calcium, has an interesting local effect on the refractive index of the glass, and it is this which has led to the novel proposal for fabricating optical waveguides.

The principle is not new, since many of today's high-efficiency optic fibres rely on a grading of the refractive index to channel the light. But electron bombardment has only once been used experimentally to fabricate channel waveguides on a flat surface; in 1976 Houghton and Townsend produced slab waveguides in pure silica, though the process was probably different and change of index was ascribed to compaction of the silica.

J Bell of Mitsubishi Electric and CN Ironside of the University of Glasgow have now published the results of their work on various types of glass in which they report (*Electronics Letters*, vol **27** no 5) creation of optical waveguides by chemical migration.

What they did was to prepare some optically flat glass slides and coat them with a 10nm coat of NiCr to make the surfaces conductive. The slides were then loaded into a scanning electron microscope (SEM) arranged to draw electron beam lines across the surface. Beam patterns were generated by a PC.

After drawing the lines, the researchers stripped off the NiCr and tested the glass for presence of waveguides by firing a 633nm HeNe laser at the edge of the glass and studying emergent beam patterns.

Different types of glass produce different results, but Bell and Ironside were able to demonstrate some very convincing waveguiding, albeit with high loss compared to glass waveguides made by ion-exchange.

What seems crucial, judging from a comparison between different varieties of glass, is the presence of calcium. As yet the mechanism involved in these latest experiments remains to be confirmed by a microscopic chemical analysis of the changes going on in the glass.

Nevertheless, the ability to create what amounts to the optical equivalent of the copper tracks on printed circuits directly without photolithographic masks offers exciting prospects. We could be seeing the basis of quicker and cheaper fabrication for a whole range of new photonic devices.

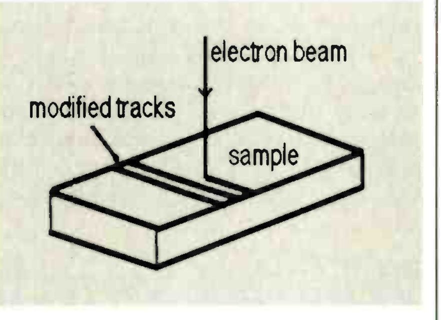


Fig. 1. PC controlled waveguide writing with SEM

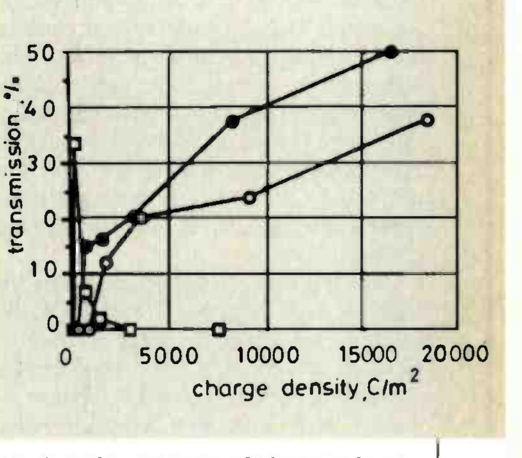


Fig. 2. Different types of glass produce different waveguiding results. ● Blue Star 1.0µm spot size ○ Blue Star 0.5µ spot size □ Corning 1.0µ spot size.

Plastic transistors — bending the barriers for organics

Writing recently in *Nature* **vol 349** no 6312, Professor David Bloor of Durham University describes a futuristic electronic device; a plastic transistor that can be bent without damaging its properties. Not merely a sort of rubberised TO92 package, the transistor is a device in which all the active semiconductor elements are also plastic.

Far from being just a novelty, the all-plastic transistor has a whole range of potential practical applications. This latest device, developed by Francis Garnier *et al* at the Laboratoire des Materiaux Moleculaires in France, is made entirely of organic molecules, principally an oligomer with the intriguing name of sexithienylene — like a polymer but with only six repeating units (monomers).

The "plastic" transistor is in fact a fet type of device in which a polymeric insulating layer separates the active sexithienylene from the gate electrode.

The French workers say that carrier mobility is very much higher with the polymer insulation than with the more usual silicon oxide. So the resulting transistor, though not comparable in performance with devices made of crystalline silicon, can at least match those of amorphous silicon.

As yet, organic materials have made few inroads into a market dominated by silicon and III-V materials. Liquid crystals are the only examples with widespread commercial significance.

But David Bloor reasons that the special properties of some of the latest organic devices may mark the beginning of the end of dominance of inorganic semiconductors in electronics.

The latest French transistor may not be the last word in speed, but it does have unique properties that will assure a big market niche for devices of its kind, particularly its flexibility. This ability to create large area conformable arrays means that semiconductors will be able to go where no rigid crystalline material has hitherto been practical.

New applications are also possible

thanks to the radically different way the organic semiconductors work. Because applied voltages move electrons from the valence band to the conduction band, polymeric materials can be made to change their optical properties. Materials normally transparent to infra-red become opaque, thus making possible an electro-optic modulator. Recent Japanese work has also produced blue light-emitting diodes based on similar principles using organic semiconductors.

Ultimately the greatest attraction of organic devices, typified by the latest French advance, must lie in their potential cheapness and ease of fabrication. As with human brain cells, it does not matter how slow they are if you can create and operate billions of them with relatively simple technology.

Will fast switching bring optical comms up to date?

Compared to its electronic equivalent, photonic technology and optical communications looks almost primitive and undeveloped. Advances in copper cables and complementary multiplexing equipment have gone hand in hand, to such an extent that growth of telephony and data traffic has been relatively steady. Neither cable technology nor electronics has been a limiting factor.

But with optical communications the story is very different. Potential bandwidth — and hence carrying capacity — of even the cheapest optical fibre far exceeds that of the terminal equipment — though this is hardly surprising when demand, in commercial terms, has been so recent.

Such is the pressure on communications capacity that leaps forward have been made in areas such as laser stability, heterodyne detectors and all-optical erbium-doped fibre amplifiers. Switching in the optical domain has also been the subject of a lot of research, much of it in the UK, aiming to develop a photonic switch that can turn on and off in around 1ps.

Most of us are familiar with liquid crystals which can switch their optical properties in a matter of milliseconds. Lithium niobate, a popular new material can perform similar tricks in response to an electrical stimulus within nanoseconds.

But in the search for picosecond switching, the preference is to have an optical, rather than electrical stimulus.

One method (of several currently being developed) involves splitting a light beam in two and sending one part through a non-linear material which, when acted on by another light signal, slows it down enough to retard the phase by 180° and cancel out the unretarded part of the beam; in effect switching off the whole beam.

Unfortunately materials with the largest non-linear coefficients often have the highest absorption factors, especially at the wavelength of maximum non-linearity. Materials like silica, which have low loss, require hundreds of metres of fibre to get much of a phase change.

Optimisation of these properties is currently being pursued actively at BTRL Martlesham Heath and Chris Winter *et al* (*App Phys Letters* **58**, 107) report considerable progress with new materials called nickel dithiolates.

Tests on solutions of these organic materials are already extremely promising. Good non-linear coefficients and low absorption are apparent, especially at the second harmonic of the laser light where, because of non-linearities at high intensities, additional absorption can occur.

Obviously this is very much preliminary work.

Any practical device will require the material to be produced in the form of a solid, either as a crystal or as a polymer. No one is yet certain either how well such materials will withstand constant high level irradiation without degradation (though organics are currently the best performers in this respect).

Nevertheless, in a field where switching technology is still one of the limiting factors, any progress of this kind is almost bound to produce benefits sooner or later. The ultimate goal of a practical ultra-fast all-optical switch can not elude us for much longer.

Prime purpose for 100 computer ring

A pet hobby among mathematicians is to search for ever bigger prime numbers. But while it is easy to test relatively small numbers it becomes much harder when the number of digits runs into thousands; imagine the effort to trying to divide such a number by every other smaller number!

The search for very big prime numbers inevitably takes a lot of time — often months on the world's biggest supercomputers — and since searching for these numbers has virtually no commercial significance, it is not something that usually rates a very high priority.

Mathematicians looking for huge prime numbers start off by calculating what are known as Fermat numbers (after the French mathematician) calculated from the simple formula:

$$2^{2^n} + 1$$

Suffice to say that by about the time you reach the 7th number in the Fermat series, it is bigger than the total number of atoms in the known universe.

Because of the sheer amount of computing power needed to process these mind-boggling numbers, there is little chance of mathematicians ever being able to obtain enough time on computers with the necessary power.

For that reason, Dr Richard Crandall of NeXT, has decided to try a different approach and make use, not of one big computer, but of all the spare capacity in some 100 networked workstations around the company offices.

A programme called Zilla polls all the workstations and repeatedly asks each one if it is free. If yes, then a small piece of the prime number calculation is fed along to the workstation and the answer fed back to a central point.

Zilla can make effective use of a workstation even if its owner has abandoned it for only ten minutes. Of course, if a terminal is needed for real business, Zilla can extract the calculation and restore normal working within a few seconds.

Crandall says that Zilla has effectively created a supercomputer that costs noth-

Continued over page

ing; it merely makes use of existing capacity that is sitting idle.

Already Zilla has confirmed that the 13th Fermat number:

$$2^{2^{13}} + 1$$

is not a prime number. When you consider that F13 (as it is called) has about 2500 digits, the full amount of arithmetic becomes apparent.

Zilla is now about to attack F22, which may yield the world's largest known prime number. Richard Crandall reckons it will take about six months to find the answer.

Flashes of insight into ball lightning

One of the most mysterious of all natural phenomena is ball lightning. Over the years thousands of people have reported seeing football-sized glowing objects floating through the air and then apparently disappearing.

Reports of ball lightning go back hundreds of years and have attracted a great deal of scientific curiosity. Sometimes the balls appear as benign objects that just drift through walls or else explode violently.

Sometimes they are greenish-blue, white and even orange in colour. Trying to investigate ball lightning scientifically is difficult because it does not occur regularly or to order.

But a search though the literature shows that ball lightning usually occurs during electrical storms (as with conventional lightning), has very little weight (being able to float) and may not always be hot (being able to pass through some materials without causing damage) and has frequently been seen moving against the direction of the wind.

Those observations have led to a number of theories, mostly involving electrical discharges or the presence of fuel gases such as methane in the atmosphere. One of the most interesting ideas, proposed as long ago as 1955 by the Nobel prizewinning Soviet physicist Peter Kapitza, proposed that ball lightning might form at antinodes of interference phenomena among naturally generated radio waves.

But until recently it has been impossible to carry out the definitive experiment and re-create ball lightning in the laboratory.

Now two Japanese physicists have described a series of experiments, *Nature (vol 350*, no 614) culminating in the creation of artificial ball lightning in a natural atmosphere. What is more, the artificial lightning seems to show many of the properties of the natural variety; its ability to pass through a wall intact and to move against the wind.

YH Ohtsuka, working at Waseda University and H Ofuruton at the Tokyo Metropolitan College of Aeronautical Engineering, describe a series of experiments using a 1·5kW source of microwave energy at 2.45GHz — in effect a rather big microwave oven.

When power was fed into the empty cavity of the device, several different types of plasma fires were observed, most occurring only when the apparatus was switched on, though not always at the expected electrical hot spots. But on a few rare occasions, a glowing ball punched a small hole in the aluminium foil that formed one end of the cavity.

After emerging through the hole it continued glowing for a second or two after the microwave power had been switched off.

In a final experiment, the Japanese team introduced a copper bar into the cavity. When the microwave energy was turned on, a ball-shaped glow was seen to move along the bar. Interestingly it moved in the opposite direction to a strong blast of air created in the cavity by a fan.

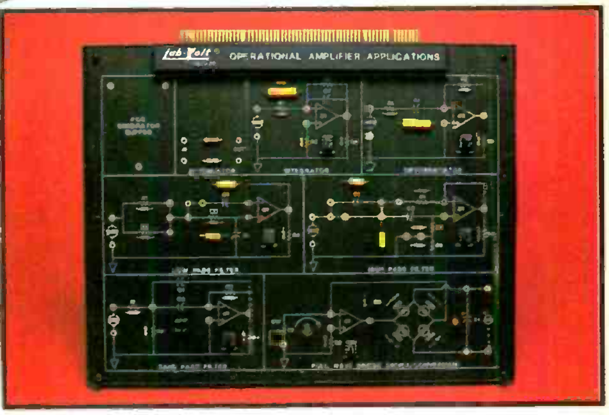
All these observed properties — the ability to pass through walls, the tendency to move against the wind — seem to indicate that what the Japanese scientists have created is similar to natural ball lightning. If so it suggests that Peter Kapitza was on the right theoretical track 35 years ago.

The Japanese are cautious, though, recognising that high-powered microwave radiation does not exist widely in nature (thankfully). But they do believe it can occur momentarily where, as in a thunderstorm, there is a rapid variation in atmospheric electricity. Such momentary bursts of energy could well be enough to create a lightning ball which — as the experiments have shown — can persist for several seconds after the energy source has been removed.

Precisely why that happens is still a mystery, though the chances of it being solved are vastly greater now that ball lightning can be created in the lab, more or less to order.

Editorial survey: use the information card to evaluate this article. Item A.

Lab-Volt® technology teaching technology



Each F.A.C.E.T. module comprises a number of clearly identified circuit blocks with with highly accessible circuit nodes. Connections are made with jumper leads.

The award-winning F.A.C.E.T. training system from Lab-Volt integrates software, hardware and courseware into a complete computer based training laboratory. It combines the best aspects of manual instruction with interactive, computer based learning.

F.A.C.E.T. means Fault Assisted Circuits for Electronics Training – learning through fault simulation and circuit modification. The modular hardware allows competency based teaching in all major areas of analogue and digital electronics from basics to advanced concepts. Your training department decides the curriculum.

Please complete the coupon for further information

NAME ....

ORGANISATION ....

POSITION ....

ADDRESS ....

....

....

PHONE ....

EWWO6/91

Lab-Volt (UK) Ltd, 28 Stephenson Road, Industrial Estate, St. Ives Cambs, PE17 4WJ England. Tel:(44) 0480 300695. Fax: (44) 0480 61654

CIRCLE NO. 159 ON REPLY CARD

Compatible computing?

Twenty one computer companies have got together to link the major operating systems. The group, which calls itself ace (Advanced Computing Environment) hopes to set a future standard by providing a common path from laptops through to large data centre machines.

Although Intel is a member, the show revolves around the US company Mips with its Unix optimised risc architecture. The ace companies, which include names such as DEC, Compaq, Bull, Prime, Wang, Pyramid and Silicon Graphics, have invited all vendors to join the fold providing they adopt Mips 64-bit R4000 technology. It conspicuously ignores the fastest selling sparc architectures as well as high performance processors from Hewlett-Packard and IBM.

Using Mips' risc in a scalable form, ace intends to blend together dos and Unix applications under two operating systems supplied by Microsoft and the Santa Cruz Operation (SCO). Connectivity tools will be built into the hardware and the group claims that software can be recompiled to make the leap from PCs to risc systems where necessary.

The ace initiative could offer a unified Unix following the split into two camps: originator AT&T and the dissenting Open Software Foundation. SCO will provide binary compatibility between OSF\1 and AT&T Unix applications under its revised Open Desktop product.

The convergence of PCs running DOS and more powerful machines running Unix on networks has been the spur behind ace. The same factor is also driving computer companies in general to find ways of bridging the various operating systems while including all the existing desktops.

Ace's industry critics maintain that the inevitable committees necessary to work out a shared standard will cause such a delay as to minimise any benefits to the user. They also claim it ignores the extensive investment already made in other implementations of Unix and risc.

There have been several recent deals to smooth incompatibility problems between rival computing techniques. For instance, the Open Document Architecture initiative between IBM, DEC and others allows unmodified transfer of documents between incompatible machines. On the Unix front, HP and Sun are now working together to develop shared object-oriented code for their operating software.

Companies outside the ace club are also pushing technology. Hewlett-Packard's new workstation exceeds 76mips. Hundred mips processors from other vendors are imminent.

Dom Pancucci

All politicians like to hear good news for a change and the opening of a £12million plant by Orbital Mobile Communications to manufacture cordless telephone products plainly brought a smile to John Major's lips. The Prime Minister officially opened the plant earlier this year.

Pig fanciers worrying that their prize porkers might be pig-napped can rest easier in their beds — thanks to Texas Instruments. TI's Tiris battery free responder with an antenna and a tamper-proof code built into its electronics (like the one above) can be injected just beneath the animal's skin. It can also track products through manufacture and distribution — so no more porkies over ownership.

Novel process for 2m transistor chip

Inmos, the UK's only microprocessor company, has finally unveiled the technical spec for its next generation of chips. The T9000 is such a powerful device, and on-chip communication so extensive, that the density of transistors has forced use of a new method of connection of the metal layers.

Embedded systems are the target markets for the T9000 range and Inmos says its capability will see it adopted in imaging equipment such as printers, HDTVs and scanners, and mobile and broadband ISDN communications systems. "Embedded computing"— hard disk arrays and applications accelerators — and fault tolerant or safety critical systems are two more potential markets.

But as yet there is no finished silicon. Given that the processing technology is new, this must cause some grey hairs at Inmos' Bristol headquarters. All the features are of little use if the silicon die ends up too large to process, so layout and design are critical.

The T9000 will have more than two million transistors, built on a 1 mm geometry but with three, rather than the more conventional two, layers of metal interconnection. The resulting die is around 180mm^2, and relies on the new way of connecting the metal layers. Inmos says the chip represents one of the highest packing densities yet achieved.

First silicon is promised by the middle of the year and until then, the T9000 range constitutes little more than an impressive computer aided simulation. But if fabrication technology measures up, and there is no reason why it will not, the chip could end up as the benchmark by which others are judged.

In preparation for the launch the last twelve months have been spent building up software support for the products, including Chorus Unix, a real-time operating system kernel, C, C++ and Fortran compilers. The chip will execute code developed for existing T8 products, so there will be compatibility

Far from being the usual UK "solution looking for a problem", the T9000 looks a usable product aimed at a definite market — saying much for the influence of Inmos parent, SGS Thomson.

The chip itself has a superscalar core to allow it to perform several tasks, such as instruction fetches, data fetches, and computations, simultaneously. It can issue several instructions in each clock cycle, using a five stage pipeline to decode different parts of an instruction at every stage, as well as grouping instructions to run at maximum speed.

Peak performance from the 32-bit integer processor is 200mips, while a 4-bit IEEE-compatible floating point unit gives 25mflops at 50MHz. The external clock runs at 5MHz and the chip uses smart phase locked loop technology to produce higher on-chip frequencies.

As always, there are four external serial communications links, but speed has been increased from 20Mbit/s in the T8, to 100Mbit/s for the T9. A separate on-chip communication processor VCP handles the communications protocols.

The chip is designed for multi-tasking, and the VCP can allocate a "virtual channel" to each separate process which is then mapped on to the appropriate physical connection when necessary.

To support targeting of embedded systems the chip has 16K on-chip memory, useable either as cache or part cache: part main memory. A programable memory interface means it can talk to ram, sram and eprom in the same system.

Inmos is claiming a total external memory bandwidth of 200Mbyte/s, and the chip needs to be able to handle all of this, plus any data arriving at the communications links. Four internal buses shunt data to where it is required

Andy Gothard

Lucky strike runs slow

Jim Luck, of King's College London, demonstrates the use of insulated gate gallium arsenside fets in building switched capacitor filters. The igfet has some odd characteristics which limits its use at low frequencies. However clocking the devices at an incredibly slow 25MHz has allowed researchers to build a circuit which consumes less than one thousandth the power of other implementations. With production device technology, claims Luck, circuits could be built which switch at up to 625MHz yet maintain the power saving.

Red, hot tech push

Communist China is engaged in a massive technology push, according to *China Report* published by the People's Republic. It is undertaking a programme to develop its own colour TV cad system and, secondly, it hopes to manufacture a greater proportion of set components. The cad system is based on 32-bit minicomputers and can be used for simulation, mechanical and PCB design work.

The country has also designed a two-chip IC set for its Zhonghua brand colour TV "by modifying the irrational internal parameters of imported ICs".

Chinese manufacturers can already produce components such as diodes, transistors, power devices, wire frames and packaging moulds.

The country's inscrutably named No. 15 Research Institute has developed an AT286 look-alike with a VGA display called the KT2500 which, the *Report* says, will exert a considerable impact on the domestic computer market "providing it is put into mass production". It has also developed a microprocessor based on the Motorola MC68020 which operates at a clock speed of 20MHz, complete with 32-bit data and address busses. It comes with Unix V as standard.

This work has apparently attracted interest from US firms; Stratus has said it will set up an office in Beijing in a partnership with Xin Tai Electronics.

The Tianjin Research Institute has developed a dual-channel FFT dynamic analyser based on an IBM PC board with a frequency range up to 100kHz. It uses the TMS320C25 DSP card and can do a 1024 point complex FFT process in 50ms. It has also developed a multi-standard modem which uses pal technology.

British Technology seeks sound funding

The British Technology Group is looking for licensees to develop a product for controlling and increasing the loudness of audio waveforms.

Called similar (simultaneous near-instantaneous and time averages response), it operates by combining the functions of a mean loudness controller and a wave shape compressor. The two processes are similar, differing mainly in the rate at which gain changes are applied to the input signal to control its amplitude.

Inventor Dr Louis Thomas claims wave shape compression can increase the loudness of an audio signal without increasing its overall amplitude, making it particularly useful for speech which has a low average power level compared with its peak power. Improvements in intelligibility are achieved by raising the level of the intelligence carrying and the quieter sounds such as consonants.

The measured quantity in the waveform is the peak amplitude of individual waveform half cycles between consecutive crossings of the zero axis. Only the magnitude is used, not the sign. Changes in gain are applied to the waveform at zero crossing instants and hence the input and output half cycles have the same shape and differ only in their peak amplitudes.

The technique can be applied to music or data waveforms and to wider bandwidth systems such as public address, broadcasting and hearing aids. A full report appears in *Electronics World* next month.

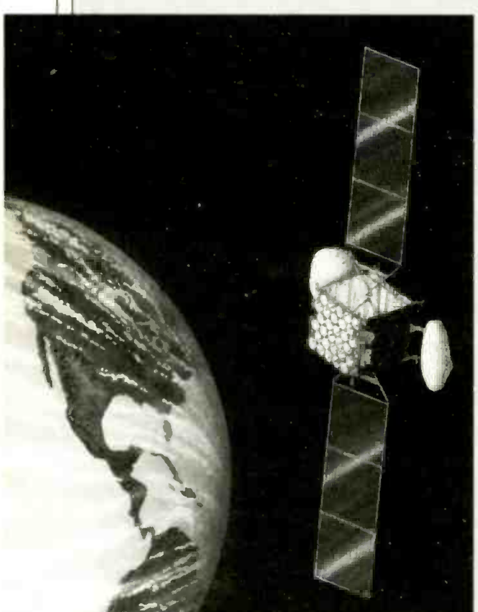
Space station faces cut

US budget cuts have forced Nasa to design a cut-price version of its Freedom space station.

The redesign was done in four months and has involved simplifying the modules, to make them easier to assemble in orbit, and reducing dimensions by up to 40%. It will also take fewer shuttle flights to build.

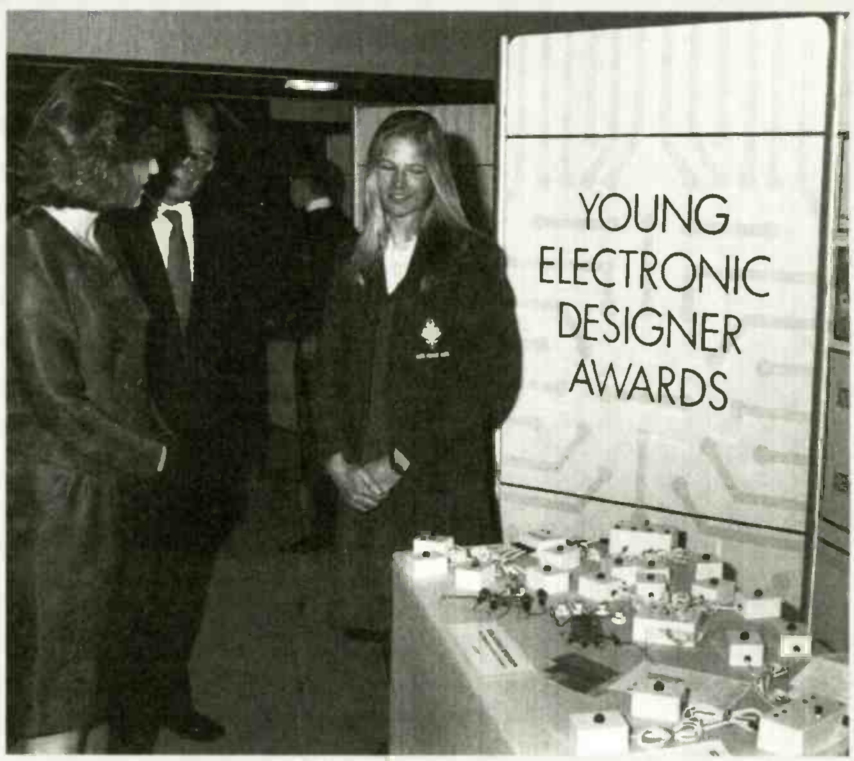
The station will be launched early in 1996 and will be ready for astronauts to work in mid 1997. They will be able to stay there for up to two weeks. It is hoped that the station will be permanently staffed by 2000.

■ One set of Freedom solar arrays will generate about 22kW of power of which a minimum of 11kW will be available to users.



Mexico is set to get two second-generation satellites to back up its existing Hughes Morelos system. Called Solidaridad, it will be based on two Hughes HS601 model spacecraft (like the one above) and will provide television, telecomms and business network services over C and Ku band and mobile comms with L band operation.

Quick off the mark: Fourteen year old Pollyanna Robinson's *Quizmaster* won her first place in the Junior category of the Young Electronic Designer Awards, and a visit from the Duchess of York. Her device, which shows the first contestant to respond in a quiz game, also won a TI award for commercial viability.



Astra flies into EC attack

By June 3, Commissioner Pandolfi, head of the EC's telecommunications directorate DGXIII, will have had to reach a decision on whether to make the mac transmission standard mandatory for satellite television. In attempting to do so he is faced with an apparently irreconcilable dilemma. Either he must anger millions of people by making their existing satellite receivers obsolete or risk being accused of pulling the plug on Europe's HDTV initiative opening the door to the Japanese, and letting the EC's authority be flouted with impunity.

The decision is needed to set the terms of the new EC directive on mac and the problems arise from the shortcomings of its predecessor issued in 1986 and due to expire at the end of this year.

That directive (86/529) specified the mac transmission standard for all direct-broadcast satellite TV. Unfortunately it also specified the frequencies to which it would apply, the so-called BSS broadcasting satellite service frequencies as allocated by WARC '77.

Thus, when Astra started up using a different set of frequencies it was under no obligation to use mac. Astra has always claimed with justification that mac was not ready when broadcasting started.

Huge additional costs

The result is that the most commercially successful satellite operation is outside the scope of the outgoing directive. To rewrite it to bring in the BSS frequencies is unrealistic.

It stands to alienate all owners of Astra dishes. There are now about three million in Europe (including 1.4 million in the UK) forcing them to buy mac converters costing at least £140 each. Huge additional costs would be imposed on broadcasters and cable operators.

The first EC meeting called to discuss the new directive took place in Brussels in February. It was attended by various interested parties including manufacturers — Philips, Thomson, Nokia and studio equipment specialist DTS (part Philips-owned) — satellite operators including SES (Astra's owners), broadcasters and state agencies.

Although there was a split between the pro-mac group (manufacturers and governments) and others like SES and commercial broadcasters, there was a general consensus that high definition TV, was desirable.

Anti-mac bias ?

Astra claims that it has always regarded its satellites as transparent as far as transmission systems are concerned and indeed there are four D2mac channels broadcasting to Scandinavia on Astra 1A/1B. Its position is that there is no particular logic in imposing mac in the interim for two main reasons. First, an HD-mac standard has not yet been defined; therefore a mac standard which would be compatible with it cannot be defined. Secondly, the BSS frequencies on which Astra transmits are unsuitable for HDTV so anyone broadcasting on them in Pal or mac would still have to simulcast to transmit in HDTV. Astra has applied for HDTV-suitable BSS frequencies for its 19.2° E orbital slot to be used by 1D.

A way out?

Commissioner Pandolfi has been following up the March meeting in an attempt to find a way out. Most people however are convinced that there isn't one. Astra is a fait accompli. To remould it now to fit what EACEM calls "the agreed European scenario" would simply cost too much money. It would also risk destabilising the growing but fairly fragile satellite TV market.

Pandolfi has reportedly ruled out making the consumer pay, but his only other option looks like being a fudge — the imposition of mac made conditional on some meaningless target.

This would be little help to the European HDTV effort. It is to be hoped that Astra is right after all, and it can succeed without mandatory mac.

Peter Willis.

MAC LOBBY PRESSURE

Mac's future still looks confused. Back in February (see next page) a working group was set up — including pro-mac Philips, Thomson and DTS and, in the "anti-imposition" camp, SES-Astra and ACT, the Association of Commercial Television of which BSkyB is a member. The group reported back at the end of March. Predictably, given its constituents, it failed to reach a unanimous conclusion. Equally predictably, there appears to have been an attempt to hijack the working party by the mac lobby. A paper presented at the report-back meeting which contained a specific timetable for the imposition of mac has been disowned and dismissed as a mere working document by SES and other working-group members. It follows on from a highly tendentious document *Satellite TV — the facts* put about under the banner of EACEM — the European consumer electronics manufacturers association — of which the mac-supporting manufacturers are key members.

As well as brow-beating the EC over its legal duty to extend the mac directive and fulminating that "those who tried to circumvent it are now facing the consequences of their own actions", the EACEM document proposes a five-year transition period — "a period of grace" — which would "ensure that ordinary viewers do not suffer in any way." Any way that is apart from having to buy a mac converter (from one of the EACEM members naturally) at a cost calculated elsewhere in the same document as an "inexpensive" 200 ecus (about £140).

The working-party working document is more specific: D2mac and *Eurocrypt* for Europe by 1994 and for the UK by 1996. It makes this conditional on "a certain threshold penetration" of mac receivers being achieved by these dates but leaves the question of what that level should be to a later date and another committee.

It also proposes that all TV sets above a certain size (to be established) and all satellite receivers sold after the directive comes into force must include a mac decoder. Mac/Pal receivers are already on the stocks: they were shown at the recent Cable Satellite Show in London; estimated price premium over Pal-only models was £80.

A subvention of cash for broadcasters who simulcast during the changeover period is mentioned but the cost of replacing home receivers is thought to be too high for subvention. It is reckoned to be between 800 million and 1.8 billion ecus (£600m - 1.3bn). Extra costs would be incurred upgrading cable networks — which currently account for many more viewers than the DTH market. These have been estimated at 10bn ecus.

Editorial survey: use the information card to evaluate this article. Item B.

Thank you to all those readers who have so far sent in their evaluations of *EW + WW* editorial items. We are currently processing your comments — so keep them coming..

THE SCIENCE OF CHAOS

Chaos suggests anarchic disorder although the word itself has a more subtle technical meaning. Nick Beard spells out the message in the noise.

Chaotic systems are absolutely predictable, at least in theory. The theory immediately breaks down in practice because chaotic systems are so sensitive to the initial circumstances from which predictions are made.

The classic example is the weather, the source of the so-called "Butterfly Effect" chaos example. The physical processes that determine the weather are not particularly mysterious: they fall largely into the category of explicable physics. If it were possible to measure to arbitrary precision all the variables involved in climatic development, it might - just - be possible to predict the weather from now on for ever.

Chaos foils such efforts. If absolutely everything were measured to sub-atomic detail, apart from the flap of a butterfly's wing, the predictions of subsequent climatic behaviour could be wildly wrong. Thus the unaccounted-for butterfly in Brazil is said to have "caused" a typhoon in Texas.

Of course, the butterfly in Brazil does not really carry any more of the responsibility for the storm than the people exhaling in Esher or shouting in Sheffield. It is simply that the essence of a chaotic system means the slightest error in the initial circumstances used to calculate a system's future behaviour results in predictions that are hopelessly inaccurate. *Chaos amplifies what we don't know.*

Chaos theory

Chaos theory is part of the wider discipline of non-linear dynamics. Not all non-linear systems are chaotic, and not all chaotic systems display chaos all the time. A classical feature of non-linear systems is that by varying some parameter, a *qualitative* change in dynamics is induced. Such changes are called *bifurcations*. A simple example is the dripping tap. As you slowly turn on the tap, a regular drip-drip-drip develops. With a further increase in flow, the dripping becomes irregular. It then becomes smooth again and continuous. Further increases prompt another change to turbulent flow, and so on. The maths underlying bath taps is complex - the sprawling equations of fluid dynamics - but examples of similarly chaotic behaviour can occur in simple equations.

A chaotic system can be expressed in simple mathematics. In the differential equation:

$$\frac{dx(t)}{dt} = f[x(t), r]$$

Bifurcation is said to occur at $r = r_0$ if qualitatively different dynamics occur for parameter values of r above and below r_0. Here r is referred to as a "control parameter" - it is the equivalent of the rate at which water leaves the tap in the example above. A bifurcation would be the shift from, say, irregular dripping to continuous laminar flow. Bifurcations can lead to chaos.

In a chaotic system, if a control parameter is gradually increased, a whole series of well defined bifurcations may occur. For example, in the logistic map:

$$X_{n+1} = rX_n[1-X_n]$$

As r is increased, a series of period doubling occurs, where the attractor changes from a stable point through successive stable cycles of period 2, 4, 8 and so on - up to a point (around r=3.5) at which "chaos" ensues (*see screen illustrations p465, 466*).

This behaviour can be seen in real-world systems too. The capacitance present in the junction of a reverse biased semiconductor diode can behave in a chaotic fashion when driven from an AC voltage in a circuit with series inductance and resistance. Normal capacitors exhibit a linear relationship between voltage and charge; varactors behave altogether differently through the non-linear relation between charge q, and voltage V:

$$V(g) - \left[1 + \frac{V(q)}{0.6}\right]^{0.43} \times \frac{q}{C_o}$$

The relationship for the time dependence of charge, q, is given by the differential equation:

$$Lq + Rq + V(q) = V_o \sin(2\pi f_1 t)$$

In this system, the voltage V_0 serves to function as the control parameter - like the rate at which water flows through the tap - and as it is increased, the system displays a bifurcation route to chaos similar to that shown by the logistic map discussed above. Alternatively, plotting the currentversus-voltage phase portrait shows that as voltage increases, the period of oscillation repeatedly doubles until a chaotic signal appears.

The bifurcation sequences found in various non-linear systems can be grouped into quite a small number of categories. These recur in many different situations: a collection of so-called routes to chaos. It is this sort of observation which has prompted so much speculation about universality in chaos.

Note that the variables in the equations can be vector-valued, which means that each variable in the system is in fact described by a collection of independent values, rather than just one. In these cases the equations might look like this:

$$\frac{dx_1(t)}{dt} = f_1\left[x_1(t), x_2(t), \ldots\right]$$

$$\frac{dx_2(t)}{dt} = f_2\left[x_1(t), x_2(t), \ldots\right]$$

Phase space

In cases with many independent variables, the system can be said to describe motion in a phase space of many dimensions. For instance, the behaviour of a pendulum can be observed in two dimensions; if the cord is of fixed length, the motion can only be on a surface (albeit a spherical one). If there are more degrees of freedom, such as where the pendulum weight is made of gradually melting ice, the number of dimensions increases. As each new dimension is considered as being plotted at 90° to each other one, an abstract hyperspace develops - phase space.

Earlier we observed that a chaotic system is so sensitive to its initial state that in practice, this state cannot be specified with sufficient precision for long term predictions to be made. The "initial set of circumstances", then, refers to a point in phase space. The system's behaviour may then be considered as a trajectory through phase space from this point. The definition of chaos can now be understood as *the degree to which nearby trajectories come together or separate.*

During chaotic behaviour, the system may have many trajectories through phase space that follow each other very closely for a while, but which then veer wildly off in different directions. It is easy to see how a prediction of such a system's behaviour could go wrong. The specification of a starting point need only be very slightly wrong to place it at a point on a trajectory that swiftly diverges from the one which describes the particular future of interest: this, again, is the Butterfly Effect.

A crucial concept, then, is of sensitivity to initial circumstances. Examples of this sensitivity are almost unbelievable. Crutchfield *et al*(1986) describe a hypothetical snooker robot, that is able to play with absolute, perfect accuracy, on a very low friction table. It is linked to a hypothetical computer, something like a hypercube of Crays - almost unimaginable computer power. The starting point for the robot, the state of the snooker table, the positions of the balls etc, is specified in

ATTRACTORS

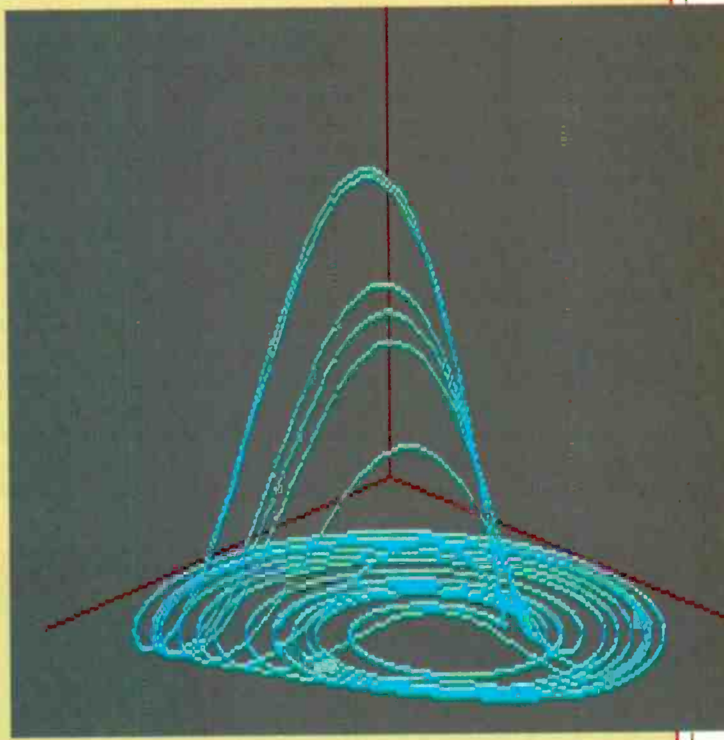
An attractor is a simple but important notion in dynamics. It indicates the point to which the system is attracted in time. For example, consider a simple pendulum. No matter where you start it swinging, it finishes its to-and-fro session in the same place: at rest, with its string precisely vertical.

It can help to consider the state of the system at any particular time as a point in phase space - the space defined by the dimensions of the system in question. This point will move around phase space until - in the case of the pendulum - it finally comes to rest at a particular point. This point is the attractor - the state in which the system ends up if left to settle.

The pendulum - or rather an idealised version of it - was studied by 19th Century French mathematician Henri Poincaré and Swedish mathematician Ivan Bendixson. Together they gave their names to the Poincaré-Bendixson theorem. This posits that for a system represented by a differential equation in a plane (ie with two degrees of freedom - like a pendulum) there are typically only four types of behaviour - called sinks, sources, saddles and limit cycles. These are steady states, though with different types of stability. A limit cycle is a repeating sequence which, once started, goes on forever. Other types of behaviour exist, but are vanishingly rare. However, Poincaré and Bendixson could not prove their theorem for higher dimensional systems.

In the 1960s, Stephen Smale joined in. He couldn't either — but he succeeded in finding a new type of attractor in systems of higher dimension. These attractors - neither points nor circles - were called strange attractors by mathematicians Floris Takens and David Ruelle. They have become a hallmark of chaos. Strange attractors have complex shapes in high-dimensional space. The important point is that although the trajectories of the system remain bounded by a region of phase space, they never converge onto a unique closed curve or limit cycle.

How do we know that these things exist and have any meaning for real dynamical systems? How do we get to see a strange attractor? The mathematical description of a strange attractor developed by Takens and Ruelle is abstract - it is not built of measurable variables. You cannot take the equations that describe some real physical system (like the Navier-Stokes equations for fluid dynamics) and mathematically derive a topological description of a strange attractor. Instead, Takens derived a strange attractor from an experimental time series. The principle is simple. The signature of the overall (multi-dimensional) system behaviour is visible in each of its single dimensions. This is not unlike being able to guess what someone is doing in three dimensions from a silhouette. To reconstruct a 3-D image of an attractor from a time series, two dimensions of dummy measurements are derived by using three successive values along the time series as coordinates: the actual coordinate and its two neighbours. This is a process of embedding the data in higher dimensions. Surprisingly, this gives a good approximation of the attractor shape. This is sometimes called reconstructing the phase portrait. Ideally, the results of embedding the data in successively higher dimensions should converge on similar dynamical properties.



courtesy Dynamical Software

Dynamical Software: Henon attractor. The colours represent the velocity of the trajectories.

almost unimaginable detail. Even the impact of the Butterfly in Brazil is taken into account though the snooker tournament, as ever, is in Sheffield.

With such computing power and such detailed knowledge of the state of the world as the cue ball is hit and hurled into the triangle of reds, for how long into the future would the motion of all the balls be computable? According to Crutchfield et al, *if the gravitational attraction of a single electron at the edge of the Solar System is neglected in the sums, the predictions will be wrong within one minute.*

The Real World

Where else does chaos turn up in the natural world? Since the early efforts of theoreticians, chaotic dynamics have been found in many systems. Examples occur in physics, electronics, and biology. The behaviour of fluids near the onset of turbulence, classical many-body systems (rather like the snooker table mentioned above), plasma physics, biological models of population dynamics, and natural oscillators - like the heart - all exhibit chaos.

One should note that the indeterminacy of chaotic systems is not due to external noise, nor to the uncertainty of quantum mechanics, nor the system having an infinite number of degrees of freedom. The unpredictability arises solely from the propensity of chaotic systems to include many phase space trajectories that start close together but rapidly diverge exponentially.

Extracting dynamics

Connect a person to an oscilloscope via a suitable amplifier and the electrical activity associated with their beating heart can be measured - as in an electrocardiograph, or ECG. The result nearly always seems to be wrapped up in a lot of apparently random interference but chaos analysis has changed our views on a healthy cardiac pattern. Indeed, a measured cardiac beat with a high degree of regularity can indicate heart disease. Healthy hearts beat "irregularly".

The fuzziness that seems to dance around all measured signals might not always be noise. A signal so messy that it looks as though it could never reveal its true dynamics might in fact have quite a simple set of functions at the root of it. The problem is getting at those functions. There are a number of techniques for extracting dynamics from data series, such as the simplest of curve fitting procedures. However, remember the Butterfly Effect? It works in reverse too.

Once you extract the underlying dynamics, you can predict a system's behaviour for ever. However, with chaotic systems, there is no room for approximation. Remember: *chaos amplifies what we don't know.*

Consider the simple equation $y=ax^2+b$. Knowing the values of a and b, from some starting value of x, we can predict the values of y at any point in the future. Chaotic systems are different. An equation describing a chaotic system, when written on paper, is clearly deterministic - its behaviour can apparently be plotted on graphs from here to eternity. However the same equation is almost meaningless in determining the real future. Unless the function is specified exactly, the error in the predictions will rise exponentially with time. This helps to explain why we cannot predict the weather very far into the future, or the stock market's behaviour.

The good news...

All this might sound as though chaos is an impossible limit foiling efforts to advance knowledge. While it certainly sets limits, it also has a positive aspect: many systems once thought random could in fact be chaotic. For instance, better predictions might be possible than statistical methods would suggest.

Alan Lapedes and Robert Farber attempted to extract the dynamics of a non-linear system. They chose the Glass-Mackey equation, which describes the aspects of the physiology of blood cell development. This may seem a rather specialised application, but it serves as a good example of a chaotic and extremely unpredictable (in practice, of course, not in theory!) system.

To do this, they generated a series of point values from the equation, and then attempted to make a prediction about the system's future behaviour from this time

CHAOS AND FRACTALS

Fractals were first described by Benoit Mandelbrot, working at the IBM Thomas Watson Research Center. The term fractal means fractional dimensional, an abstract concept whereby complex structures can be characterised according to a non-integer number of dimensions. The equations of these complex structures are, however, very simple. Fractals, in spite of their complexity, have a very low information content.

The fine structure of chaotic system trajectories in phase space can be fractal, and one of the crucial measures of the degree of chaos of a non-linear system is its Hausdorff dimension - its fractal dimension. As ever, life is not simple. Not all chaotic attractors have a fractal dimension, and indeed, not all strange (fractal) attractors are chaotic.

Fractals can seem rather esoteric, and of little practical value beyond producing pretty computer graphics. Wrong. Fractals are already paying dividends in image encoding. Transmitting large volumes of data associated with high quality computer graphics is expensive. Data compression techniques help. A novel approach, based on fractals, has been devised by Michael Barnsley, a professor of mathematics at the Georgia Institute of Technology. The system uses fractal algorithms to compress images and can achieve compression ratios of over 10,000 to 1. The technique can be combined with conventional algorithms to achieve further compression yields.

series - or to get the equation back from the samples.

Lapedes and Farber used a back-propagation neural network, set up so as to learn what past leads to what future in this system. (For more details on neural computing see *Harnessing Neural Networks, Electronics World, December 1990*). Surprisingly, the network was able to learn the mapping required to predict the behaviour of the time series with accuracy an order of magnitude higher than would be achievable with conventional statistical methods.

The Stigmata of Chaos

If your system is chaotic, you want to know about it. There are numerous signs of chaos which provide clues to system behaviour. Distinguishing between deterministic chaotic dynamics and noise-prone regular activity requires analytical methods such as spectral analysis, autocorrelation function, and phase-space reconstruction, all of which are qualitative methods; correlation dimension, Lyapunov exponents and Kolmogorov entropy are quantitative. Spectral analysis involves constructing a power spectrum - a plot of frequency against amplitude for the signal or time series under scrutiny. An exponential decay in the power spectrum at higher frequencies is strongly suggestive of chaos.

The autocorrelation function indicates the average value of a signal after a specific delay. It measures the correlation

Screen dump from CITC illustrates the period doubling which precedses chaos. The box section is magnified over page.

between points which are apart in time. For periodic activity, the autocorrelation function is periodic. In chaotic processes, the autocorrelation function decays with time. It helps to know to what extent a system is chaotic. Chaos workers refer to dimensionality of a system's dynamics. High dimensional chaos - from an experimental viewpoint - merges with randomness. At lower dimensions, useful predictions can be made. This is true even in systems of infinite degrees of freedom such as in fluid mechanics. If the system is not too chaotic, the attractor for the dynamics can be represented in a lower number of dimensions, and useful calculations made.

More substantive evidence for the presence of chaos comes from reconstruction of the phase space portraits (see box on strange attractors) and from evaluation of such things as Hausdorff dimensions,

CHAOTIC SOFTWARE

Not surprisingly, dynamics is a topic that benefits from visual images. Motion is explained better by pictures than text. The dynamics of chaotic systems can be studied directly with the aid of a PC, and Dynamical Systems Inc produce a range of programs to help. There are three packages. Two are simpler with an educational bias, whereas the larger package is a serious research tool.

Chaos In The Classroom I & II are packages designed to help users explore the visual mathematics of chaos and fractals. The illustrations of the bifurcation diagram of the logistic map are taken from the screen of CITC 001. I won't cover the fractal package here.

The chaos program is entirely menu driven. After selecting from the list of chaotic functions, there are a series of options, such as screen resolution (which has an impact on plotting speed) and what information the screen will show. The choice is between the bifurcation diagram alone, or the phase portrait, or a combination of these two plus a two-dimensional projection of the attractor.

Having completed a screen plot, the user can then selectively magnify parts of it, to reveal the fractal structure of the dynamics.

The program is very easy to use, and comes with a well written manual that covers much of the basic maths of chaos. This is a good starting point for getting to grips with the topic.

Dynamical Software. This is serious stuff. It comes in two parts. DS 1.4 provides the basics: a map driver and an integrator, facilities for two- and three- dimensional plotting with Poincaré sections, and programs to construct one dimensional maps and circle maps. DS 2.2 is more advanced, offering further programs for calculating eigenvalues and eigenvectors, power spectra, Lyapunov exponents and fractal dimensions. I only had access to DS 1.4.

A few of the programs require a fortran compiler, though only those that link to external sub-routines, such as for entering user-defined equations. The package will run on any IBM compatible, though with fairly substantial and intensive mathematics demanded of the machine, even a 286 is likely to appear lumbering. It benefits from co-processors and exotic video modes.

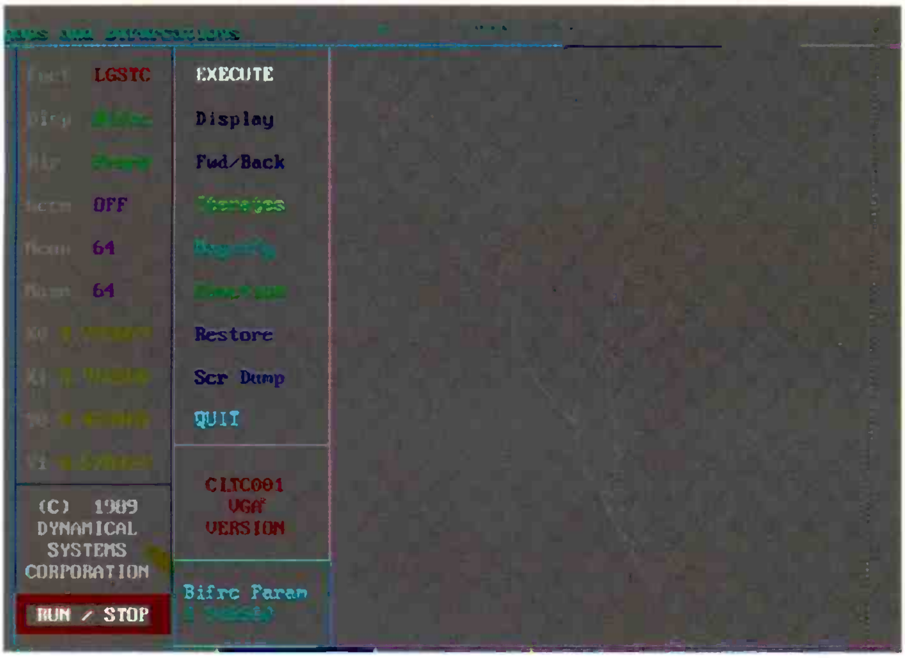
A collection of data files are included, generated from many standard chaotic equations. There is also a program called *Scanner,* which parses equations entered at the keyboard to enable experiments with novel functions. Experimental time series data can also be used. A program, *Lagger,* is included to enable users to embed univariate time series data in up to ten dimensions.

The user interface can seem rather primitive at times. The *Chaos in the Classroom* packages are far easier to use. There are menus at certain points, but much of the option selection required is still via terse text entry requests, which are not very forthcoming if erroneous entries are made. The manual is likely to be needed on your lap for a good while. Nevertheless, this is a serious tool, and well worth the effort.

Producing 3-D images of attractors is easy, and the system allows images to be scaled, rotated and shifted to get the desired view of a particular part of an attractor. Screen dumps are in .PCX format, which makes importing them into other packages easy.

This is a highly recommended suite of programs for any maths or physics department with an interest in non-linear systems, or indeed for the adventurous amateur, who would like to join in the search for chaotic systems.

NB



Stable state wedged between two periods of chaos. Note the binary progression

Lyapunov exponents and Kolmogorov entropies. These indicators also measure the extent of chaos.

The Lyapunov exponents indicate the average rate at which nearby trajectories separate or converge. For a system to be chaotic, it must have at least one positive Lyapunov exponent. The Kolmogorov (or Kolmogorov-Sinai) entropy is the rate at which information is gained by observing a trajectory to a given precision. Alternatively, this is equal to the rate at which information on a system is lost with time. For one-dimensional systems (such as the logistic map) Kolmogorov entropy is equal to the Lyapunov exponent.

Measuring Dimensionality

Dimensionality is measurable in many ways. One of the confusing features of non-linear dynamics is the number of different definitions of dimension-like quantities. Perhaps the best understood - and most widely used - is the Hausdorff-Besicovitch (or fractal) dimension. The basic idea is of a particular dimension at which the volume of a shape changes from zero to infinity. This number, not necessarily an integer, captures the irregularity of a shape or space. When applied to a time series, it measures the extent to which the attractor is irregular.

The Hausdorff (poor Besicovitch's name is often omitted) dimension, D, gives a clue as to the complexity of the trajectories within the attractor. The lower the value of D, the more coherent the dynamics. If D is greater than 2 and is non-integer, then the attractor is *strange*. In practice, it is more convenient to measure the correlation dimension, $D2$, which gives the lower bound for D.

The Meaning of Chaos?

Chaos has had such an impact on science that some people have suggested that we are in the midst of a paradigm shift - a period during which basic questions of science are redefined. Chaos has also been described as the end of determinism: the Butterfly Effect means that, in practice, the future can only be predicted rarely.

Chaos can also affect the view of randomness. Perhaps randomness is just high-dimensional chaos? The definition of randomness is often no better formed than the folk-meaning of chaos.

Science has for years been dominated by the notions of determinism and existence uniqueness. These notions are so pervasive that simple knowledge of the existence of a unique solution to an equation is sufficient to give scientists confidence in writing the exact solution. Precise science has even constructed a general equation to determine system dynamics: $S(t) = f(S_0,t)$, where S is the exact state of the system at time t, evolving from an initial state S_0 via a functional rule (often unstated) defined through existence uniqueness. Physicists had assumed that, in principle, variables S, S_0 and t could be measured to arbitrary precision, and mathematicians had assumed that, in principle, that which exists can always be constructed. Chaos foils these efforts too, and joins the ranks of this century's many assaults on the comforts of certitude, such as the work of Heisenberg, Gödel and, latterly, Chaitin's algorithmic information theory contribution.

The author is an information technology consultant in the health IT group at management consultants Price Waterhouse.

FURTHER READING

Ian Stewart. *Does God Play Dice?* Blackwell, 1989. *Accessible, wide ranging, light on alarming equations, humorous and thorough. Recommended.*

H G Schuster. *Deterministic Chaos,* Second Edition. VCH. *Page after page of alarming equations! One of the definitive texts on the mathematics of chaos.*

JP Crutchfield, JD Farmer, NH Packard, RS Shaw. *Chaos.* Scientific American, 254(12): 46-57. 1986. *Beginning to date, but a readable and concise introduction to the topic.*

YC Lee. *Evolution, Learning and Recognition,* World Scientific*A remarkable collection of papers on systems neural nets and genetic algorithms, with much discussion of the links to general non-linear dynamics.*

GJ Chaitin *Information, Randomness and Incompleteness,* World Scientific 1990. *A collection of papers on algorithmic information theory, looking at randomness in the some of the most unexpected places, such as the mathematics of number theory. A surprising and wide ranging book that covers introductory material through to advanced presentations. Excellent.*

Michael Barnsley and Stephen Demko. *Chaotic Dynamics and Fractals,* Academic Press, 1986. *A fascinating collection of papers from the (rather fractal) interface between fractals and chaos.*

A. Babloyentz & A Destexhe. *Is the normal heart a periodic oscillator?* Biol. Cybern. 58, 203-211 (1988). *Specialised topic, but with a good overview of the practicalifies of chaos-spotting.*

SOFTWARE SUPPLIERS

Dynamical Systems Inc.
PO Box 35241, Tucson,
Arizona 85740. USA.
Phone 602 292 1962

UK distributor:

Far Communications
5 Harcourt Estate
Kibworth
Leicestershire LE8 0NE
Phone 0533 796166

CITC 001 £40, CITC 002 £45
DS 1.4 £199, DS 2.2 £249

Editorial survey: use information card to evaluate this article. Item D.

Chaos in electronics

Chaos occurs in electronics. Its presence usually brings grief to design engineers in the form of unpredictable parasitics and distortions. Computers handle chaotic models badly. Simple analogue models do it rather better. They can even turn chaos to advantage. Jim Lesurf explains.

Electronic engineers are used to dealing with devices which display various forms of electronic non-linearity. It is virtually impossible to find a radio or microwave system which does not contain a non-linear resistance (ie an ordinary diode). Varactor diodes are also widely used as capacitors whose value may be controlled by an applied voltage. Yet outside of a few well-defined applications such as frequency multiplication, non-linearity has generally been an unwelcome guest.

Engineers are frequently asked to suppress unwanted non-linear behaviour in electronic systems. Circuits displaying non-linearity or unpredictable oscillations are likely to be labelled as 'useless'.

It will probably be some time before we realise the full range of benefits arising from understanding chaotic systems. Mostly the obvious advantage is negative: know your enemy. If you can define just what produces chaotic behaviour in a given system then you are half-way to avoiding it! This can be valuable in preventing system failures. More positive results may be expected in the future although it is a bit soon to predict just what they might be.

At present, the most positive application seems to be in improving the performance of existing non-linear circuits: frequency multipliers, mixers, etc. Beyond that, there are few obviously new applications, although work is beginning on some ideas; for example, the use of non-linear systems to produce chaotic oscillators. These may prove useful as broadband sources, replacing noise sources for some applications, providing spread spectrum signals for communications or radar, and complex deterministic signals for signal encryption. Given these developments it is probably time for engineers to begin familiarising themselves with the new toolkit for chaos.

Chaotic diode

A diode is the simplest form of non-linear device. In general, diodes have a conductivity and reactance that are voltage dependent. One could build virtually any sort of non-linear system from a suitable set of diodes along with passive linear components, and amplifiers to provide gain.

The main properties of an ordinary diode can be defined in terms of how the current passing through the device depends upon the applied voltage. The non-linear properties of a varactor (the junction capacitance of a reversed biased diode which varies inversely with applied voltage) are less obvious, but can be explained by comparison with an ordinary capacitor.

The voltage, V, of a normal capacitor is proportional to the charge, Q, it holds. If we start with a discharged capacitor and add an amount of charge, Q, the capacitor acquires a voltage

$$V = Q/C \qquad (1)$$

To change the voltage by a small amount, dV, we must add an extra amount of charge

$$dQ = C.dV \qquad (2)$$

We may now define the capacitance using expression 1 or 2. Either way we will get the same value, irrespective of our choice of V.

If we repeat the same process with a varactor we find that the voltage produced is not simply proportional to the charge. To change the diode voltage by dV we must now add a charge

$$dQ = C\{V\}.dV \qquad (3)$$

where $C\{V\}$ depends upon the device voltage. To take a discharged varactor and charge it to a voltage, V, we need a charge

$$Q = C\{V\}.V \qquad (4)$$

where

$$C\{V\} = \left(\frac{1}{V}\right)\int_0^V C\{V\}\cdot dV \qquad (5)$$

Unlike an ordinary capacitor, expressions 3 and 4 *won't* now provide the same capacitance value for any randomly chosen value of V.

This situation is analogous to the resistance of a normal diode which may be given either as a static value ($R=V/I$) or as a dynamic or slope value ($r=dV/dI$). Here we can define a static capacitance, $C\{V\}$, or a dynamic one, $C\{V\}$.

In general, these devices are used to carry out fairly basic functions like frequency conversion and tuning. Their analysis as presented in most textbooks seems straightforward. Yet, surprisingly, even quite simple arrangements containing these devices can behave in ways which are very complex — even chaotic.

One should be able to explore the behaviour by building circuits, experimenting with component values and watching what they do with applied signals. Unfortunately, this approach isn't

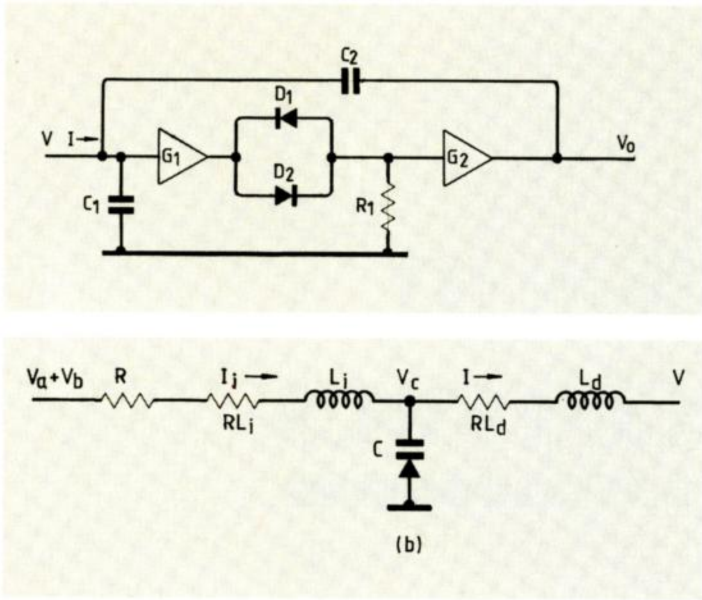


Fig. 1a. (top left) Circuit used to determine non-linear capacitance. It is connected to a T-network, Fig. 1b. (middle), to examine properties of the system as a function of the applied signal voltage.

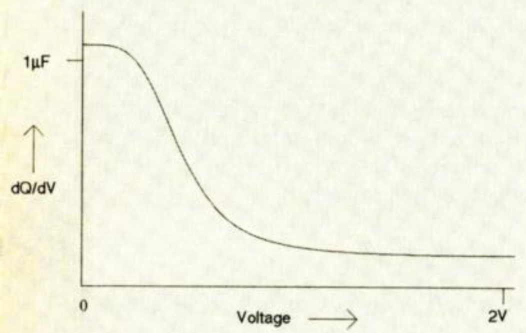


Fig. 1c. (left) shows variation of "dynamic" capacitance dQ/dV with V for Fig. 1a.

always practical. For example, millimetre-wave engineers have to deal with signals of 70 — 100GHz or more. At these frequencies it can be quite difficult to define the electrical properties of any circuit you have built. Measuring the details of output signals can — unless they are simple — also prove difficult and expensive.

In some cases we are also faced with the question, "What would this new sort of device do if we were to make one?". Solid state engineers can now manufacture a wide range of low dimensional structure devices which, although they only have two terminals like the humble 1N4148, can have complex electrical properties. Naturally, the people who develop them would like some advance idea of device characteristics.

When asked "what if" questions, engineers and scientists usually resort to a computer model, based upon a software algorithm running on a digital computer. This technique is a very powerful one, but it presents problems of its own. These can be roughly divided into three categories: is the program right? Is the computer fast enough? Is there a problem with computational error?

The problem of finite computer precision is particularly important when modelling circuits which may become chaotic.

Imagine a non-linear circuit or system whose state at any moment can be defined by the values of, say, just four quantities (perhaps two voltages and two currents). The properties of the circuit will determine how these quantities change with time in response to some given input signal. If the process is periodic, the quantities will return to a previous set of values after some appropriate time. The process then repeats its behaviour over and over again. A chaotic process cannot, by definition, be periodic. Hence if the process is chaotic the quantities which describe the state of the circuit will never repeat any set of values.

Expanding the example further, a digital computer model of this circuit will store information about the state of the process in terms of four values. Each of these will be recorded in the computer as a finite number of bits. For standard IEEE floating point precision a number is recorded as four 8-bit bytes ie 32 bits. Hence a set of four variable values will be stored as 4x32=128 bits.

A finite number of bits, N, can only have $M=2^N$ possible arrangements. So far as the computer is concerned, the simple digital representation we have described above must always be in one of the 2^{128} states which the computer model can distinguish. As a result, any process whose state we represent in terms of N bits must repeat itself after — at most — 2^N recalculations since the computer will have run out of fresh patterns of bits.

We can, of course, use extended precision values to increase N. Complex circuits and systems will also require more than four quantities to describe their state. Hence we can produce computer models where M is very large indeed — but it can never be infinite. This problem is made worse by the possibility that rounding errors during a calculation may force an accidental repeat of a set of values long before M model state updates. In short, as processes approach the chaotic, it becomes increasingly difficult to use a computer model. An analogue model of a non-linear device may be more useful and can also be used to cross-check the computer predictions.

Analogue of chaos

In general, we can define two basic types of non-linear device, a non-linear resistance and a non-linear reactance. These can then be treated as building blocks to assemble non-linear systems. To see how they can be used to explore the behaviour of complex or chaotic processes we can concentrate on just one type in the form of an artificial varactor. **Figure 1a** shows a circuit which behaves as a voltage dependent capacitance.

For simplicity, we can assume that the gains, G_1 and G_2, of the two amplifiers are both unity i.e. they act as buffers. In practice these gains may be chosen to have some other value (they may also, of course, be voltage dependent). In this way the voltage dependence of the system may be controlled.

The diodes, D_1 and D_2, are ordinary silicon signal diodes (eg 1N4148 or similar). When $|V|$ <0.5 volts the diodes will have a high effective resistance and V_0 will be held at about 0 volts. Any input current, I, must charge both C_1 and C_2 in order to alter the voltage, V. Hence the circuit behaves as if it were a capacitance

$$C\{V \approx 0\} \approx C_1 + C_2 \qquad (6)$$

When $|V| >> 0.5$ volts any change in V_d will produce a corresponding alteration in V^o. ie no charge need flow into or out of C_2. Hence the circuit behaves as a dynamic capacitance

$$C\{|V| >> 0.5\} \approx C_1 \qquad (7)$$

At intermediate voltages, the effective capacitance depends upon the behaviour of the diodes and the chosen value of R_1. As $|V|$ increases from zero, through 0.5 volts, the effective capacitance tends to fall smoothly from (C_1+C_2) to C_1.

To compare digital and analogue modelling, circuit Fig. 1a was built using a pair of TL081 operational amplifiers. D_1 and D_2 were a pair of 1N4148s, R_1 = 5kΩ. The nominal capacitor values used were $C_1 \approx 0.1\mu F$, and $C_2 \approx 1\mu F$.

The $C\{V\}$ behaviour of the circuit was determined by connecting it in series with a known inductor and then noting how the series resonance frequency varied with an applied DC voltage. From these measurements it was found that the capacitance behaviour was essentially of the form

$$C\{V\} = C_1 + C_2/(1+(\alpha V)^4) \quad (8)$$

where $C_1 = 0.14\mu F$, $C_2 = 0.94\mu F$, and the coefficient, $\alpha = 2.2$/volt.

This artificial varactor was then connected to a T-network consisting of a pair of inductors and a capacitor (**Fig 1b**). The properties of this system could then be examined as a function of the applied signal voltage.

The actual network used consisted of two inductors whose values were L_i = 3.24 mH, and L_d = 3.38mH. The DC resistances of these were $R(L_i)$=6 and $R(L_d)$=4Ω. The shunt capacitor had the value, C_i = 2.03μF. These particular components were chosen nearly at random: slight selection ensured that effects of interest would be likely to arise in the 100 Hz — 10 kHz frequency range and thus be easy to observe on a normal oscilloscope. An input sinewave, V_a, and nominal DC bias level were coupled into the circuit via a 100Ω series resistor.

A computer program was also produced to act as a comparative digital model. This was written in BBC *Basic V* and run on an

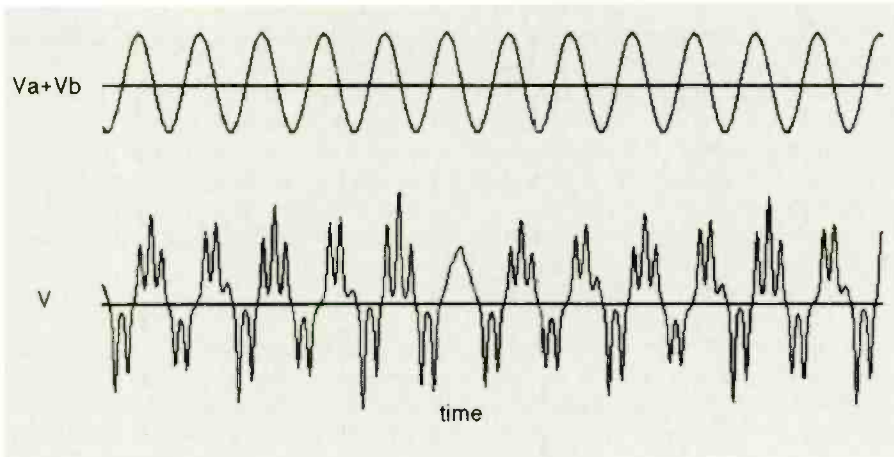
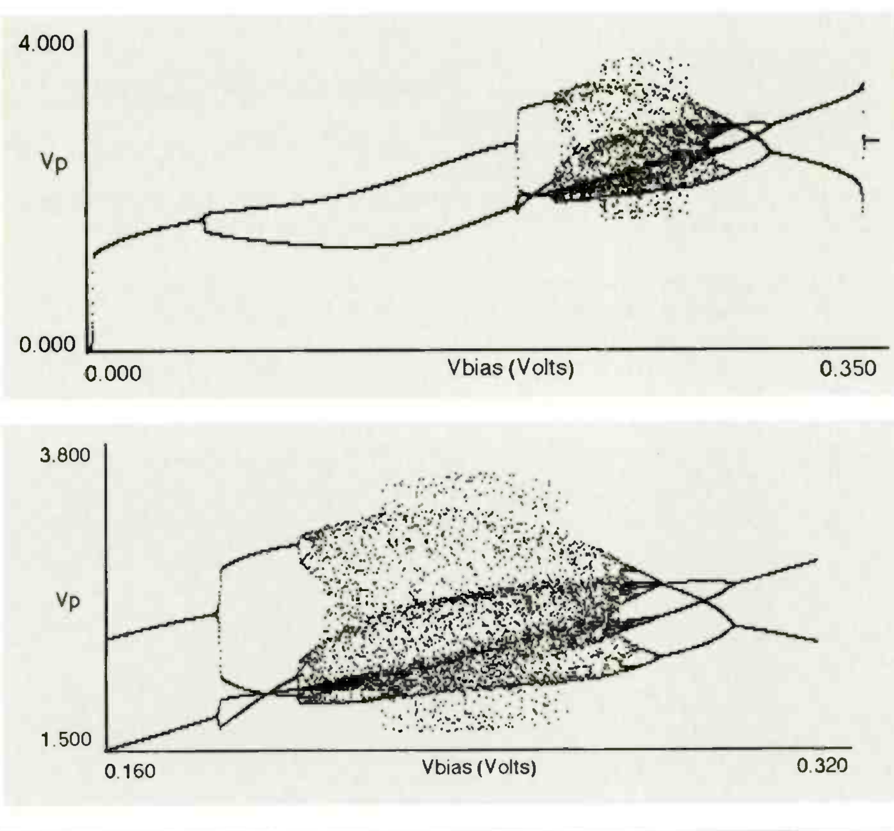


Fig. 2. Typical input and output waveforms for the system shown in Fig. 1; f=1300Hz, V_a=3.5, V_d=0.25

Archimedes 410 with a 30Hz Arm3 processor:

```
REPEAT
Vi=Va*SIN(W*t)+Vb
V+=I*dt/FNcap
Vc+=(Ii-I)*dt/C
I+=(Vc-RLd*I-V)*dt/Ld
Ii+=(Vi-Ii*(R+RLi)-Vc)*dt/Li
t+=dt
UNTIL FALSE
:
DEFFNcap =C1+C2/(1+(2.2*V)^4)
```

Fig. 3a. Phase plot showing pattern of bifurcations and Fig. 3b. (bottom), close up of the pattern. Computer plots derived from model shown in Fig. 1. L_{in}=3.24 L_{dev}=3.38mH RL_i=6.0 RL_d=4.0 C_1=0.14 C_2=).94 C_i=2.03μF f=1300 R-100 V_{ac}=3.5 C%=128 S%=256



where V_a is the half-peak magnitude of a nominal input sinewave at the frequency, W. V_b is the DC bias level; dt is the time-step increment (here normally set to 1/256th of a cycle at the chosen input driving sinewave frequency).

The possible effects of finite precision and time-step value were tested by compiling a double precision (to IEEE standard) version using the *ABC Basic* compiler and running this with smaller dt values. This gave results visibly identical to the normal interpreted basic program, as viewed by plotting V_d against t on the computer display.

When plotting a useful output display, the computer program ran at an actual drive waveform rate of just a few cycles per second. The analogue system operated in real time and provided essentially identical behaviour with drive frequencies in the kHz range. Hence the analogue system operated around 1000 times faster than the computer program.

Phase of chaos

The correspondence between analogue and digital models allowed a rapid exploration of the system behaviour using the analogue system. Detailed analysis of interesting regions of operation could then be carried out using the computer model without having to spend considerable time checking a wide range of conditions which produce less interesting results.

An example of interesting complexity was found, using the analogue system, to occur for a drive frequency of around 1300Hz at V_d=3.5 volts (half-peak) combined with a DC bias level of around 0.25 volts. **Figure 2** illustrates some typical results for the time variation of V in this region. This figure was obtained from the computer model, but identical results could be obtained using an oscilloscope connected to the analogue circuit.

We are accustomed to examining signal

variations on the screen of an oscilloscope, but in this case, such a display does not tell very much about what is happening. Fortunately, various methods have been developed for examining complex and chaotic processes. We can adopt one of these — a phase diagram — to explore the behaviour of a non-linear system.

The concept of a phase plot is simple: drive a non-linear arrangement with a periodic signal and note the value of its output at a particular phase of each drive cycle. Alter one of the system parameters and repeat the measurement.

In this case, we drive the system with a sine wave

$$V = V_a . sin\{\omega t\} \qquad (9)$$

and note the output voltage (i.e. the voltage on the non-linear capacitor), V_p, at some chosen phase angle, $\psi = \omega t \ mod 2\pi$, of each cycle. We can now plot how V_p varies with, say, the DC bias voltage.

Figures 3a and **3b** show a typical phase plot for the circuit. At low DC bias levels, the output appears simply to be a distorted version of the input. Each cycle is identical to the next. If one were to look simply at the output it could be concluded that its period was identical with that of the input drive signal.

When the DC voltage reaches about 0.05 volts the situation suddenly changes. Now the output level alternates from input cycle to cycle, back and forth between two values. The output signal appears to have a period which is double that of the input. The phase plot shows a bifurcation, a place where one line splits into two. Another bifurcation occurs when the bias voltages reaches about 0.18 volts. V_p then cycles around four values and the basic period of the output appears to be four times that of the input. These bifurcations are also referred to as period doubling for obvious reasons.

As doubling continues, the bias increase required to produce extra bifurcations rapidly decreases and the circuit goes into a cascade of bifurcations. The basic period rises rapidly and, in principle, may go to infinity. If that occurs the system becomes chaotic and the output waveform never produces any two cycles which are identical.

The number of bifurcations appears to reach a maximum value at a DC bias level around 0.25 volts. Any further increase in bias causes a reduction in the periodicity. Figure 3b shows an enlarged view of the complex pattern which occurs around a bias level of 0.25 volts.

Model Gunn

We could continue to examine the behaviour of this system in more detail, exploring the effects of altering other variables, and applying other analytic methods. However, the purpose of looking at the complex behaviour of this circuit was to demonstrate the principle that an analogue system may replace a digital computer model easily and cheaply. To understand how the approach may be extended we can use the example of an artificial non-linear resistance shown in **Fig. 4**. This represents a rough approximation to a Gunn diode

Gunn diodes are widely used at microwave and millimetre-wave frequencies as oscillators and amplifiers. Although they are two-lead devices, they provide gain through the property of negative resistance. (Strictly speaking, this is more correctly termed negative differential conductance, but the label negative resistance is more commonly used.)

Imagine a potential divider made of two resistors, R_1 and R_2 connected in series. When we apply an overall voltage, V, the voltage across, say, R_2, will be

$$V_2 = V.R_2 / (R_1+R_2) \qquad (10)$$

Normally we will expect $R_1+R_2 \geq R_2$, so $V_2 \leq V$. If, however, R_1 or R_2 is negative we may find that $|R_1+R_2| < R_2$, which means that $V_2 \geq V$. The potential divider will then act as an amplifier.

But the power which is added to an amplified signal must come from somewhere. For a two-terminal device like a Gunn diode, static resistance must always be positive, but the dynamic (slope) resistance can be negative over some range of applied voltages. This means that an input bias signal must be applied to act as the source of power which can be added to amplify signal variations.

In **Fig. 4** some extra components — zener diodes and resistors — have been added in between the amplifiers. These enable the circuit to mimic a Gunn device more reliably. Apart from these, however, the circuit illustrated in Fig. 4 is essentially the same as was previously used to make a non-linear capacitance except that the resistors, R_1 and R_2, replace C_1 and C_2.

The behaviour of the circuit may be divided into three sections:

Low voltage. $|V| \leq V_D/G_1$, where V_D is the turn-on voltage of the diodes, D_1 and D_2:

Medium voltage. $[\ V_Z/(G_1A) - V_D/G_1\ ] \leq |V| \leq V_D/G_1$, where V_Z is the turn-on voltage of the zener diodes, and $A = R_4/(R_3+R_4)$:

High voltage. $|V| \geq [\ V_Z/(G_1) - V_D/G_1\ ]$.

In the low voltage range the apparent dynamic input resistance, $r\{V\}$, will be

$$r\{low\ V\} = R_1.R_2 / (R_1+R_2) \qquad (11)$$

In the medium range, a change in input voltage, dV, will alter the current flowing through R_1 by an amount

$$dI_1 = dV/R_1 \qquad (12)$$

and that through R_2 by an amount

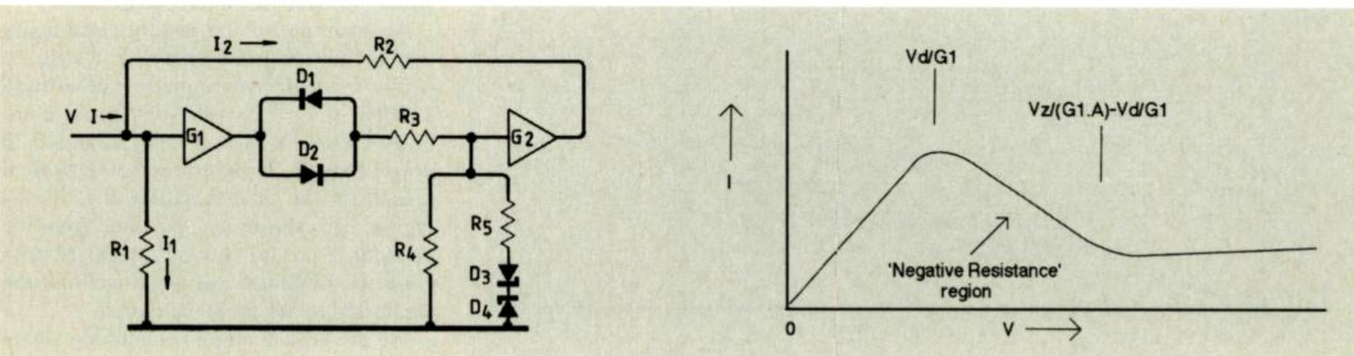
$$dI_2 = (dV\text{-}G.dV)/R_2 \qquad (13)$$

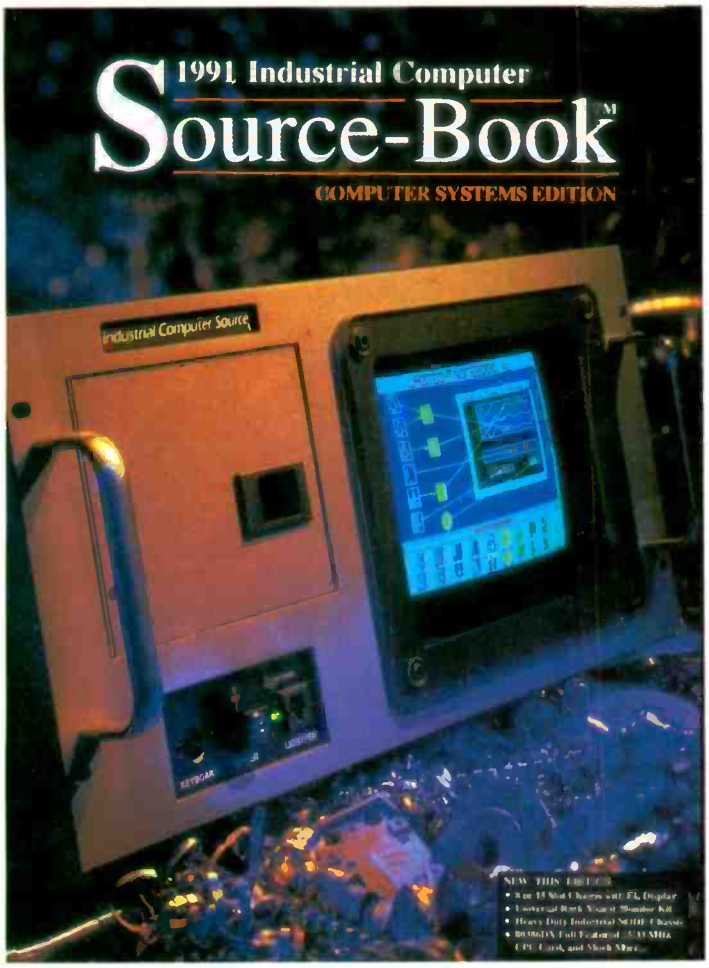
where $G = G_1AG_2$. The dynamic resistance in this range will therefore be

$$r\{mid\ V\} = dV / (dI_1+dI_2) = R_1R_2 / [\ R_2 + (1\text{-}G)R_1\ ] \qquad (14)$$

Both the magnitude and sign of r depend upon the overall gain, G. If we choose a

Fig. 4a. (left). Artificial non-linear resistance representing a rough approximation to a Gunn diode. Fig. 4b. (right) is a typical I/V curve for this form of circuit.





INDUSTRIAL PC PRODUCTS & I/O CARDS
1991 COMPUTER SYSTEMS EDITION

Industrial Computer Source (UK) Ltd., suppliers of the largest range of Industrial PC equipment available from a single supplier, announce the release of their 1991 Industrial Computer Source Book.

New products for 1991 include 8 and 15-slot chassis with built-in lexan protected Electro Luminescent VGA-compatible display, a universal rack mount monitor kit which allows users to mount their own choice of 12″ or 14″ monitors in a 19″ rack, 6, 8, 10 and 15-slot OEM chassis designed specifically for OEMs to mount a PC into their own equipment as a very powerful enhancement.

Also included in this latest edition is a powerful new range of Industrial CPUs, ranging from a single board 286 complete with on-board VGA, IDE and floppy controllers through 386SX and 386DX, 25 and 33 MHz to a single board Industrial 486, complete with on-board video, mouse and disk controllers, memory cache controller and serial and parallel ports, all capable of running from 0–60°C.

This combination of over 1000 Industrial PC-related products means that the simplest to the most complex of problems can be solved by a single supplier.

For a free copy of the 1991 Industrial Computer Source book, contact **Mark Ponsford** at Industrial Computer Source on **0243-533900**.

1991 I/O PRODUCTS EDITION

The Industrial Computer Source Book – I/O Products Edition had been introduced due to the rapidly expanding number of I/O products available from Industrial Computer Source.

The range of products includes a whole new series of digital, A/D, D/A, Counter timer, Watchdog and optically isolated RS422/485 cards with a lifetime guarantee.

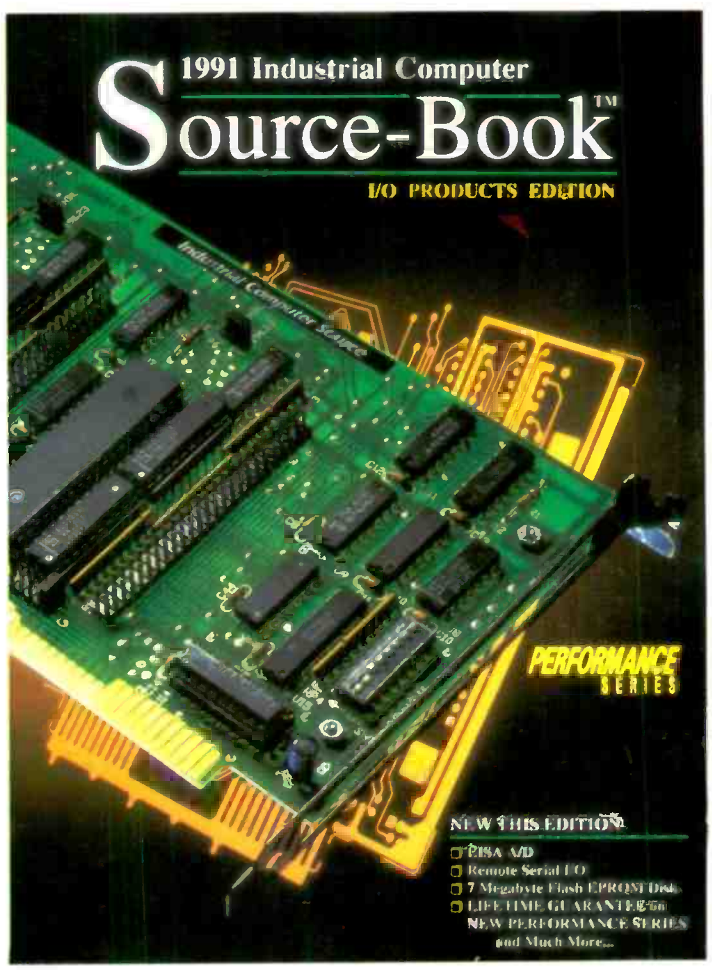
Other products in the I/O products edition include a range of Microchannel interface boards. This comprises a whole series of boards giving optically isolated digital I/O, very high speed Counter timers, high-density single-slot digital I/O, A/D, D/A, GPIB and intelligent serial communication boards.

As well as the range of high speed A/D and D/A boards is a very high speed, 2.6 Megasamples/second, EISA A/D card.

To complement the range of Industrial PC Products is a new 7MB Flash Eprom/SRAM Solid State disk. This does away with the need for rotating disk media and has a reliability some 20 times greater.

For engineers wishing to locate I/O remote from the PC, a range of serial I/O has been introduced. The range includes the standard analog and digital-type devices, but has the flexibility of being able to be located anywhere on an RS485 link.

The I/O Products Edition is free to qualified users. For your copy, call Mark Ponsford at Industrial Computer Source on **0243 533900**.



INDUSTRIAL COMPUTER SOURCE UK LTD

PO Box 81, Chichester, West Sussex PO20 7SP. Tel: 0243 533900. Fax: 0243 532949.

CIRCLE NO. 128 ON REPLY CARD

Channel 5:

Interfering with business?

Raw data on the likely interference which will result from the new channel 5 television service suggests that the operators will face a large bill for retuning the nation's videos.

The findings, released by the Independent Television Commission, were from research carried out by National Transcommunications Limited, formerly the IBA's laboratory in Winchester.

NTL's brief was to try to quantify the interference which a new fifth TV service— transmitting either side of UHF channel 36—will cause to existing video recorders. Companies bidding for the Ch5 franchise need to know this because the Broadcasting Act 1990 says they must pay to retune or modify any equipment suffering interference from Ch5 transmissions.

Member companies of the British Radio and Electronic Equipment Manufacturers' Association (Brema) have warned that the cost of sending engineers to homes around the UK to retune or modify affected equipment to avoid interference will be astronomical — it could well reach several hundred million pounds.

The DTI has secretively given potential franchise holders bland reassurances that costs will be less than £20 million although it has refused to go public on this, fearing later claims for compensation. Worried potential applicants have been badgering the IBA, and ITC, for hard facts, warts and all. Ch5 will use two frequencies in the middle of the UHF band, identified as TV Ch35 and 37, the allocation being made because

The national bill for retuning videos following introduction of Channel 5 will far exceed current DTI predictions, says Barry Fox — with serious consequences for franchise holders

Ch35 is used for radio microphones in theatres and Ch37 for airport radar. The radars are moving to an existing radar frequency, Ch36, and the microphones will leave the TV band altogether.

Domestic video equipment such as recorders, satellite receivers, video games and budget computers have used these spare channels to connect with TV sets. When Ch5 starts broadcasting at high power on Ch35 and 37, it will inevitably cause interference to any domestic equipment which uses these frequencies; video recorders in particular suffer from a high level of feedthrough from aerial to TV even when operating in playback mode. This is likely to happen even though Ch5 signals will be vertically polarised.

The Broadcasting Act obliges any Ch5 broadcaster to pay for remedial service. The only loophole is that viewers will not get free help if they have brought the problem on themselves by erecting a new aerial to receive Ch5. This could deter people from trying to receive Ch5, at least until after they have had their free service.

NTL noted that the nominal frequency to which most video recorders are set at the factory is Ch36. A few are tuned to Ch37. NTL then logged the actual frequencies used in three areas of the UK, each with different practical circumstances.

In Oxford there is no local radar using Ch36, so owners can leave their recorders tuned to the factory setting. Out of 127 recorders checked, nearly 30% were tuned to the frequency. But most of the remainder were tuned on or around Ch37.

In Slough, where Heathrow airport radar operates on Ch36, 149 recorders were checked and 25% were working on or near Ch36. The rest had been retuned to Ch37 or other frequencies which owners found to be free from radar interference.

In the Southampton area NTL looked at 147 recorders. Again most had been retuned away from Ch36 and onto channel 37 because the local TV transmitter, on the Isle of Wight, broadcasts on Ch27 and its harmonics (known as the image channel) interfere with Ch36.

The ITC has not yet drawn conclusions from the results. But it published the raw data to give potential Ch5 franchise applicants a chance to form their own opinions. The data clearly shows that several millions of video recorders are already tuned to frequencies (especially Ch37) which are likely to clash with Ch5 broadcasts. Surprisingly, NTL has not yet tested video games and satellite receivers, many of which will be tuned to frequencies other than Ch36 to allow the connection of both a recorder and game or satellite receiver to the same TV set.

There are already well over a million satellite receivers in the UK and likely to be several million more by the time Ch5 goes on air. There is a resurgence of interest in video games and the ITC is realising that the NTL must test these too.

The ITC will refuse any attempt to predict a retuning bill, on the grounds that no one knows what engineers will charge per visit to viewers' homes. It seems certain though that, by the time CH5 is on air, there will be several million pieces of video equipment in need of retuning. Engineers will be unlikely to charge less than £30 for a home visit. This puts the nationwide retuning bill for Ch5 far higher than the DTI's "under £20 million" predictions.

Editorial survey: use the information card to evaluate this article. Item F.

Pure vs applied science

Is it not reprehensible that a leading technical journal can reflect so shallow an appreciation of the vital role of technology in modern civilization ("Comment", *EW + WW*, April, p. 267), and of its debt to the honest, painstaking striving of scientists and philosophers against ignorance, superstition, prejudice and tyranny? Is this really less true now than in the past? It may be fashionable in some quarters to discount philosophy and, by virtue of its essential association, to include pure science in the process.

To recapitulate: "...an aspect of ersatz religion which, one suspects, big science has become". And again: "...the really useful things of life don't require obscure explanations of their worth". Well, what constitutes a really useful thing depends on the purposes of those who may adopt it, and, methods of scientific repression apart, we are surely now aware of the over-use and deleterious effects of quite a few really useful things.

It is also only fair to recognise the difference between what is big and what is pure science; the former would seem appropriate to the costly programmes of "ritualistic" ersatz research raised by the power of large-scale technologies in order to reaffirm accepted "truths", while the latter, applied to philosophical curiosity, may tend to make a reappraisal of these "truths" in its quest for deeper insights. The scientist/philosopher is informed by a venerable tradition set by his predecessors, questing beyond the acquisition of really useful things.

To argue for the flourishing of pure science, inspired by philosophy's honest, sometimes constraining yet always impelling ideas, perhaps the example of ancient China's science may serve as a warning. It failed to acquire the insight of nature as the font of rich resources to be explored, mapped, and systematically studied in a coordinated endeavour. When confronted with the scientifically liberated culture of the West, that of the Chinese collapsed into subservience.

Possibly the ancient Chinese culture was commendable, and *EW + WW* would champion its admiration; in which case its readership ought to know of such an editorial policy. But there is a counter-argument, that modern civilization might rise to a greater challenge, if only to manage the dwindling resources of the planet and to tame the puerile passions of mankind. But even the really useful things would require examination and religion, ersatz or genuine, would be open to doubt; or is the vital exercise of thought, and its expression in research, to be decried if its ways are not immediately yielding to the creation of really useful things? Is the fate of our scientific heritage in jeopardy? Is our modern civilization going wobbly? Surely *EW + WW* could offer something better than a plea for the standards of commercialisation?

C. Francksen
Farnborough
Hants.

Crossed field antenna

A clever man once remarked that when you have eliminated the impossible, then what remains, no matter how improbable, is the truth. The unfortunate (but perhaps not so improbable) truth in this case is that the electromagnetic radiation from a CFA can be calculated accurately using classical antenna theory. If the dimensions of the structure are made small compared with the wavelength, then either the radiation is inefficient, or the bandwidth is narrow, or both.

It is important to define here what we really mean by "small in relation to wavelength" and "inefficient radiation". One-twentieth of a wavelength is small and is a typical size for a "working" CFA including feeders. Five percent efficiency is low and yet quite enough to account for all the claims so far made for the CFA, including the large bandwidth.

I must admit to being impressed by the report of audible transmission at 90km in Egypt. And surely 25kW would make a bonfire of even the most indomitable ATU should the power not be radiated! However, the CFA in this location appears to have used a single, vertical (!) open wire feeder from the transmitter to the roof of the building , and I would venture to suggest that this, in conjunction with the "earthing" arrangements from roof level to ground, formed a crude type of loop aerial which was responsible for the majority of radiation. CCIR curves show that 5% of 25kW (1.25kW) radiated would give a signal of about 48dBμV/m (0.25mV/m) at 90km range which is more than adequate for satisfactory daytime reception using a good quality portable radio.

There is a simple test, which is interesting to carry out and which really can prove to anyone's satisfaction, that crossing two E fields in space with the "correct" phase does not produce an electromagnetic wave. This is to construct a small CFA and to feed each plate in such a way that the phase of each can be varied. Now monitor both plate voltages simultaneously using a fast dual-trace 'scope (don't forget to use "chop" mode, not "alternate"). Also, keep all the feed wires short, and under the ground plane to minimise unwanted fields. Monitor the radiated field strength (or even the "near" field) as the relative phase of the voltages on the two plates is varied. The interesting point is that there is no sign of a sudden peak in radiation as the D plate goes through -90 degrees (or any other angle) relative to the E plate. My CFA was about one-hundredth of a wavelength high and proved quite easy to adjust, but was over 20dB down on a reference aerial at 500m range, implying an efficiency of less than 0.1% (the reference aerial itself was under 10% efficient). Best radiation and lowest return loss from the phasing unit were coincidental, but for this condition the two plates were virtually in-phase. Transmitter power is mostly dissipated in the phasing unit.

Incidentally, it may be of interest to D.A. Bell and others that a conductor one-twentieth of a wavelength long or even shorter makes a very efficient radiator as long as the RF power is fed into it and not dissipated in the matching unit or the immediate surroundings. Commercial aerials of this type achieve around 5-50% efficiency, depending on the efficiency of other design targets.

Prof. Bell makes a good point in stating that the current in the distant antenna wire is irrelevant to the propagating wave, but surely the current in the wire is directly responsible for the generation of the wave, one cycle at a time. At the end of each cycle the lines of E and M field are closed loops which then expand without regard to anything that may happen subsequently in the aerial. My experience, such as it is, certainly leads me to believe that it is the current conduction current flow alone which causes the radiation. I disagree therefore with both his and Mr Hateley's description of how the dipole radiates. Some antennas have low RF voltage at all points and still work well.

The Crossed Field Dummy Load affair can only leave one staggered at how much we can achieve by manipulating electromagnetic waves, without understanding the basic forces involved. If anyone feels affronted by this statement, please write an article for *EW + WW* immediately; I am sure it will make fascinating reading

Martin Spencer
Evesham
Worcs

Some time ago I purchased the advertised kit for a ground-plane crossed field antenna (described in EW + WW, December 1990), to use particularly on the 40 and 80m amateur bands; it sits in my loft over a shack, just above a cats cradle of house wiring, and behaves much as would be expected by a reader of the article. Since no other antenna is practicable here on 80m I could claim infinite gain! However, I continue to encounter quite widespread scepticism about it and a notion has gone abroad that the CFA only radiates a small fraction of the energy supplied to it. Being disconcerted by such aspersions upon my investment I conducted a simple test. I set up for the 80m band, on which there is little activity in daytime, and applied a 100W carrier on a clear frequency (3.742MHz) for 1 hour, with brief pauses for station identification and frequency monitoring. No heating could be felt in any part of the installation, but the air temperature in the phasing unit was measured at 22.6°C compared with an ambient temperature of 20.1°C. The presence of rf on the E and D plates could certainly be felt. It is possible to find

Continued over page

"false" settings of the phasing unit switches at which power is accepted at a low standing wave ratio but little seems to be radiated. One of these was set up and the test repeated otherwise identically. The air temperature in the phasing unit rose to 44.4°C, and no rf could be felt on the antenna. It seems clear that almost all of the 100W was dissipated in the phasing unit in the second instance, and most of it went to the feeders in the first.

I cannot accept the idea that significant radiation takes place from the two 12ft feeders, twisted around each other, since that concept would imply effectively a short (λ/20) end fed antenna, which firstly would have narrow bandwidth and secondly, as bitter experience with end fed wires has shown, would cause all sorts of trouble with rf in the shack, in the house, and next-door. So, most of the energy arrives at the D and E plates. If they do not radiate it what do they do with it?

Alexander Dick
Dundee
Scotland

Research in crisis

Support for basic scientific research in Universities comes mainly from Government funds via two routes: the Universities Funding Council (UFC) and the Research Councils. Both sources seem to be drying up, with the UFC becoming less able to provide basic support, and the Research Councils facing a severe reduction in funding for 1991/92. The Science and Research Engineering Council (Serc) is constructing a programme with 10% cuts in all ares and must put them into effect immediately.

There is no sense in separating "big" and "small" science and preserving one at the expense of the other; modern research in all areas needs access to large facilities. In astronomy, for example, most researchers work on a small scale, in groups dispersed among at least half of our universities. They need access, however, to large telescopes sited overseas, and to large central computers.

All the major research tools needed for basic science are now available as part of international collaborations. Again, astronomy provides obvious examples, with international observatories in Hawaii, the Canary Islands, Australia, and in space telescopes provided by the European Space Agency and other partnerships. These programmes have been remarkably successful, providing examples of international collaboration which should be the envy of all other social groups. "Big" science is now an essential part of our research; it is not so easily disposable to meet a sudden cut in resources.

Nuclear physics is especially under threat because of its heavy dependence on Cern, which takes two thirds of its Serc funds, but whose subscription costs cannot be reduced. The 10% cut falls on the remaining third, and forces a major economy at the Daresbury Laboratory. The Serc has decided to close the Nuclear Structure Facility, despite its recent successes and the research it promises to its many clients in the universities. The Serc also says it will, as far as possible, protect the jobs of the Daresbury staff. To the users of the NSF this is the wrong way round: there are too many staff anyway, and the cut should fall on them rather than on the NSF itself which could continue to provide a service at lower cost.

The real practical problem, however, is the need to make economies as a single drastic step. There is almost no possibility of smoothing the transition by carrying over funds or a deficit from year to year. No decent commercial enterprise would be expected to work like this. The result is the worst upset in UK science for decades, and the further erosion of our standing both as scientific leaders and as good international partners.

Sir Francis Graham-Smith
University of Manchester

Subectively batty view

A lesson from the humble bat. When it was first suggested that bats could "see" using sound, the idea was laughed at by the scientific establishment. Early sonar came along, and then bats were allowed to do the same. "Contours from sound? Piffle!". Then radar came along, and bats were graciously allowed the same facility. "3-D sound pictures? Poppycock!" Thankfully, someone finally invented holograms, much to the bats' relief...

Even the most sophisticated audio analytical equipment operates over a very limited time frame. The ear analyses a signal over seconds, minutes, hours, even years, and (in conjunction with the brain) interprets it; a violinist would be amused to be termed "golden eared" simply because he could identify the rich intensity of a Stradivarius coming out of his pocket tranny at 10% THD. No signal analyser can manage this degree of discrimination (even with a perfect signal).

Colour vision is now understood as the eye identifying that quality of an object that remains constant regardless of ambient lighting or one's viewpoint, not a spectral wavelength. When dealing with the ear, therefore, is it so surprising that people consistently say that they can hear things that seem unmeasurable (eg. loudspeaker cable directions), or prefer things that some would argue are worse (eg. Haffler vs all comers)? The ear may be detecting differences in parameters we're not yet aware of, and therefore aren't even looking for.

The argument that people are merely "conned" into preferring things because they're told they're better, is, of course, a completely indiscriminate weapon applicable to anyone who disagrees with you on this subject. Perhaps it reflects that objectivity remains a theoretical concept only, when applied to people.

Stuart J. Leask
Northampton

Triple tone awareness

In his letter in the April issue about my article "Trial by three tones" (*EW + WW* February 91), Richard Black suggests, incorrectly, that I am unaware of the work of Paul Miller. His methods do use three or more signals to evaluate the performance of amplifiers, but there are important differences between our approaches.

Paul described his work in the July 88 issue of *Hi-Fi News and Record Review*. His signals are all sinusoids, either steady-state, or with swept amplitude or frequency. To show fine detail a narrow measurement bandwidth is necessary, so the sweeping has to be done at a very slow rate. Effectively all the signals can be considered as steady-state. The method is a direct extension of harmonic and intermodulation distortion measurement. The result is an elegant, computer-generated, 3-D presentation giving information that would otherwise require many separate spectral graphs.

The differences as I see them are:

- my large low-frequency signal is gated to form tone burst, so placing considerable stress on the power supply, while assessing the behaviour of the amplifier to higher frequency signals;
- distortion signals about -120dB with respect to the peak signal can be revealed. The amplitude scale on the 3-D plots only goes down to -96dB. The triple-tone method is still being developed to make it more sensitive;
- apart from an audio spectrum analyser, not a cheap item I admit, the rest of the system is easily constructed or will be found in most electronics laboratories. This is in contrast to the need for an FFT analyser and low distortion bus controlled oscillators.

The methods measure similar, but by no means identical features of amplifier performance, and should be considered complementary rather than equivalent.

Finally, I wonder if this is the same Richard Black who has reviewed some amplifiers in the April 1991 issue of *Hi-Fi News and Record Review*. If so, it is surprising that he has not included any 3-D plots. He does however mention that the crosstalk between channels of one of the amplifiers is rather large and distorted. The triple-tone method appears to be very suitable for assessing this feature of amplifier performance.

Ivor Brown
Brunel University

Nut note

So American cosmologists are puzzled by the galactic clustering disclosed by the Iras data (Is lumpy universe theory half-baked?, *EW + WW* April p.269). The clear reason for the inhomogeneity is that the universe is not composed of CDM (cold dark matter) but of a certain manufacturer's Fruit and Nut.
This can be proved by examining

Continued over page

COLOURJET 132

COLOUR INK JET PRINTER

Compatible with:–
- IBM pc
- Archimedes
- Nimbus
- BBC Micro
- Amiga
- Apple Mac (serial version)

LOW COST
LIST PRICE
from £636 + VAT

Low Operating Cost

Windows 3 Driver Available

EMULATES OTHER COLOUR PRINTERS EG. IBM 3852, Canon PJ1080A, Quadjet
PRINTS OVERHEAD TRANSPARENCIES
EDUCATIONAL DISCOUNTS AVAILABLE

INTEGREX LTD., CHURCH GRESLEY, SWADLINCOTE
DERBYS. DE11 9PT
Tel (0283) 551551
Fax (0283) 550325
T/x 341727 INTEGX

CIRCLE NO. 140 ON REPLY CARD

the correspondence columns, and often editorial content, of some journals, particularly those concerned with "high quidelity" (where the purchase price is far more important than the totally-discredited technical specification).
John Woodgate
Essex

Astro-mystics.

M.G Wellard's wry comment in the January issue of *EW + WW* that "...exact science was infiltrated by a school of mystics at the turn of the century" comes dangerously near the truth.

The infiltration began in 1905, when Einstein proposed his Special Theory of Relativity in an attempt to unify Newtonian mechanics and Maxwell's e-m wave theory of light. At that time, most of the optical experiments could best be described in terms of photons - which can be regarded as localised concentrations of energy. But the concept of photons could not be reconciled with e-m theory, so for the next 20 years the theory of light was in a state of confusion.

In 1927, Heisenberg proposed his "uncertainty principle", which allowed the theories of e-m waves, photons and relativity to be unified in the theory of quantum mechanics. So the latter theory was adopted as the new theory of light.

Scientific mysticism flourished for several decades, but even then a number of leading scientists had begun to suspect that relativity theory contained flaws.

Some years ago, while unaware of the controversy, I wrote to a learned society suggesting that a partial return to pre-relativistic physics might help to solve some of the problems then facing astronomers such as quasars, "black holes", anomalous red-shifts, etc.

As an alternative to "big bang" cosmology, I proposed a theory that systems of galaxies were circulating in vast orbits at high velocities. But a galaxy's velocity transverse to the line-of-sight can cause its appearance to be distorted. The reason is that while light from stars at the rear of the galaxy is crossing space towards us, the galaxy can move a large distance in its orbit.

So a globular-shaped galaxy with a high transverse velocity appears to us to be shaped like a rugby football. And a disc-shaped galaxy of diameter, say, 120,000 light-years, appears to have "spiral arms" and a central "bar".

The theory can explain the shapes of all the galaxies, but it conflicts with Einstein's theory so it is regarded as "heretical"

In recent years the growing use of electro-optical devices - such as lasers, optical gyros, computers, etc - has created renewed interest in optical systems, and the more mystical theories are having to be re-assessed.

The policy of EW + WW has always been to publish new ideas, even the controversial ones. As an indirect result, the long-awaited updating of the theory of light is now being much more freely discussed by all concerned.
John Ferguson
Camberley
Surrey

Enough is Enough

I've read with interest and utter dismay John W Ecklin's article regarding the laser Doppler effect in the March '91 issue. The last impression I want to give is one of a blind Einstein flag-waver, but enough is enough. I should think that over three quarters of a century would have been more than adequate time for most of us to absorb what Einstein was trying to tell us. When it comes to electromagnetic radiation (light), it makes no sense to talk about
$c' = c \pm v$ because empirically this phenomenon does not exist. Light does not obey the Newtonian principle of addition of velocities and what's more since frequency is inversely proportional to wavelength the product λf is always equal to c, and therefore $wv - c = \pm d = 0$. The phenomenon described by Ecklin simply does not exist. The velocity of the wavefront is independent of both frequency and wavelength, and vice versa. Nobody ever said (Einstein included) that SR is intuitive or that it makes sense, and anyone making such an assertion is either mad or doesn't understand scientific methods. After all, if we don't learn from experiment, then what use is science or anything else.
Frank La Tella
Sydney
Australia

Editorial survey: use the information card to evaluate this article. Item H.

TELEVISION VILLAGE

The people of Waddington, Lancs, were cast in the role of couch potatoes to test the future impact of television and television technology. Peter Willis reports.

Waddington (pop 1100) is a picturesque, rather middle-class village in Lancashire's Ribble Valley, apparently inhabited by people with better things to do than watch TV. Ownership of VCRs in 1990 was less than half the regional average, and this time last year satellite dish penetration was less than one per cent - a quarter of the national figure.

Yet for five weeks in the spring of 1990, Waddington became the Television Village, bounced into a 21st century viewing experience of mega-multi-channel choice, including a soft-porn channel and a taste of wide screen viewing and even of HDTV. And, at the other end of the scale from pan-European satellite broadcasting, Waddington enjoyed its own community television, produced in the village Sunday School hall and transmitted from a mast in a nearby field.

The Scope of the project was devised by Granada Television and its aim was to give a small, self-contained community a taste of the future shape of television, and assess their reactions to it.

Thirty-two homes, 10 per cent of the village, were cabled-up to receive 25 channels. A further 14 were fitted with microwave (MVDS) receivers to pick up the five BSB channels, and one was issued with an HDTV receiver (though since this was an 18in monitor, it can hardly have done full justice to the transmission quality!). In addition, nearly all the homes in the village were able to pick up the village channel through their existing UHF TV aerials.

The channel - known as WVTV, Waddington Village Television - was originally a small part of the project, intended to reflect the plans of some cable companies and interest expressed by some local authorities. However, perhaps because it was the only part to involve the whole village, it ended up dominating the experiment, achieving a 97 per cent viewership.

This has been taken as an overwhelming argument for more local TV, though whether the homely mix of known faces, amateur presentation and parish-pump stories (some of which were censored anyway) would maintain interest once the novelty had worn off remains unproven. The channel went out, mostly live, for an hour each evening from an improvised studio in the Sunday School - loaned sofas and an old Granada backdrop (of Manhattan by night, hurriedly overpainted with Magnolia emulsion by a man who was redecorating the pub), using S-VHS cameras loaned by JVC. There were repeats the following morning, and a Saturday morning children's show, entirely made by the children.

Alright on the night?

The channel developed through the enthusiasm of the village, assisted by journalism and media students from local colleges, and, to begin with, largely unnoticed by, and without help from, the Granada team, which was immersed in getting the rest of the project set up.

All that changed on the first night as soon as the first taped insert was reached. Two VCRs, left connected together in edit mode, produced corrupted sync references giving unviewable picture slip. The station closed immediately with the immortal line "What a cock-up" from one of the presenters. From then on, Granada engineers made proper technical checks and there were no more technical problems.

However, the channel gave the IBA's North West regional officer virtually a full-time job monitoring progress.

The IBA had taken responsibility for the channel, with assurances to the Home Office and the DTI that the Broadcasting Act and the IBA Guidelines would be followed.

Since the village steering committee had little idea of what these constraints involved, and made up much of its programming as it went along, this proved no easy task. One of the several instances about which the IBA felt less than happy was, oddly, the broadcasting of a public meeting with the Home Secretary himself (as it happened, eponymous local MP David Waddington). Another complication was the decision to carry advertising, which in theory put the channel in conflict with Granada itself as the local exclusive licence-holder.

Local channel a hit.

On the whole the IBA was pleased with the project. The eagerness of the villagers to participate grew continuously through its lifetime, and people in surrounding villages were reported to be moving their TV aerials in order to pick it up.

Command centre for the village channel was a Granada trailer surrounded by scaffolding to support aerials and with a tall tower for the MVDS transmitter.

Transmitting the village channel was achieved by the simple expedient of erecting a temporary mast in-line with the local terrestrial transmitter, Winter Hill, and finding an available channel within the same group. Channel 67 was eventually selected. The transmitter, housed in an IBA cross-country vehicle, and with a single log-periodic aerial on a 17 metre telescopic mast, was sited in a field 1. 5 km south of the village. Mains power was provided from the farm. Signal levels in the village centre were about 75dBμV/m. Since this was some 20dB weaker than the existing Winter Hill signals, homes with poor aerials or badly-adjusted receivers found the pictures barely viewable. Engineers from Granada TV Rental, which provided all the cabled homes with identical, modern sets to ensure a uniform reception standard, also went round the other homes, tuning in channel 67. Where they came across poor installations ("salmon-pink pictures" was just one horror-story) they made improvements. So successful was this that at least one resident assumed he was now getting high-definition TV.

Eagerness of the villagers to participate grew continuously through its lifetime, and people in surrounding villages were reported to be moving their TV aerials in order to pick it up.

The village channel was fed to the transmitter by a 2.5GHz microwave link from the Command Centre. This, the hub of the project, was a Granada trailer around which was erected a scaffolding rig to support the satellite aerials, and a tall tower for the MVDS transmitters. Waddington is a T-shaped village, set on gently rising ground. The main pub, *The Higher Buck*, is on the crossbar of the T, looking straight down the main road which forms the upright. Since this is the highest point of the village, the car park behind the pub suggested itself as a suitable location for the Command Centre. It was also handy for the village hall and the Sunday School. Satellites pulled in were: Astra (lA), Eutelsat (l. F4 and l. F5), Intelsat VA FII, DFS-I Kopernicus, TDF-1A and BSB's Marcopolo 1, which started transmission during the experiment. Programmes provided included all Astra English-language channels, all BSB, plus CNN, Children's Channel and Discovery on Intelsat, Superchannel and Worldnet (US Government news) on Eutelsat, plus German, French, Italian and Dutch channels. Two channels were provided from tape: Vision, a Sundays-only religious channel, and Home Video Channel, "adult" films.

The Command Centre used Triple Crown modulators to convert the signals to VHF, with saw (surface acoustic wave) filters to provide adjacent channel performance. It was distributed on a wideband (50-550MHz) trunk. Cable losses were made up by 34dB gain bridging amplifiers, powered from cable-borne 55V AC, which overcame the problem of providing local power feeds.

Waddington is a strikingly pretty, and obsessively tidy village, and in laying the cable, Granada engineers used considerable ingenuity to minimise visual disruption. The main trunk was half-inch co-axial, with quarter-inch co-axial between the tap-offs and the chosen households.

Everybody asked for the porn channel (it was a standing Cable Authority condition that this was only supplied on request) but only eight households watched it in any given week and nobody had much to say in its favour.

An additional, reverse, run of cable had to be included to carry the monitoring data, collected from specially-adapted remote-control readers, back to computers in the Command Centre.

On initial tests, some patterning, due to intermodulation between T sets, VCRs and cable receivers, was found, and with a large number of signals present, proved a complex problem. Attenuating the terrestrial signal, with a pad in the aerial down-lead, proved to be the solution though this gave rise to further problems in some cases because of the relative weakness of the village channel. Richard Ellis, Granada's chief engineer, noted: "In retrospect, it might have been better to convert the four terrestrial UHF signals to VHF at the Command Centre and pass them down the cable with the 25 satellite channels."

One problem the team had not foreseen was loss of signal due to sheep chewing through the cable. It is this sort of difficulty, and others to do with way-leave and installation, that microwave distribution is so good at avoiding.

MVDS system

For the MVDS (microwave video distribution system) part of the experiment, a fair amount of improvisation was necessary. Although government had indicated 12.5 and 40GHz as possible frequencies for future systems, the only available equipment (borrowed from BT's Racenet bookmakers' service) operated at 29GHz. The aerials were encased in plastic domes about 12in in diameter - larger than a 40GHz aerial would be, but reasonably unobtrusive and entirely acceptable to the householders. The aim was to provide a wide-bandwidth (27. 5MHz) service capable of carrying PAL, MAC and W-MAC (16:9 screen ratio).

Since MVDS is a line-of-sight system, homes had to be selected with care. The five transmitters were mounted on the 30ft gantry at the Command Centre, which gave a clear view over the village. Once BSB started transmitting, the MVDS was

Young TV reporters for Waddington TV interviewed their local MP at the time, David Waddington.

used to carry its programmes - delivered to BSB receivers in the 14 homes. However, signal lock was lost in a number, due to the combined drift with temperature of the transmitter and local oscillator being, at 6MHz, outside the capture range of the BSB receiver.

One solution - offsetting the frequencies of the transmitters and the MVDS receivers - was rejected as impractical, since the latter were attached to the aerials, by then on the roofs and chimney pots of the houses.

Eventually, it was noticed that the BSB receiver circuits had an adjustment for the pull-in range of the AFC; once this was widened, the problem was solved. "A good example of experienced engineers finding a practical solution under extreme pressure and in a short time without resort to the research laboratories who would have had to come up with a solution to improve the oscillator circuits," commented Richard Ellis.

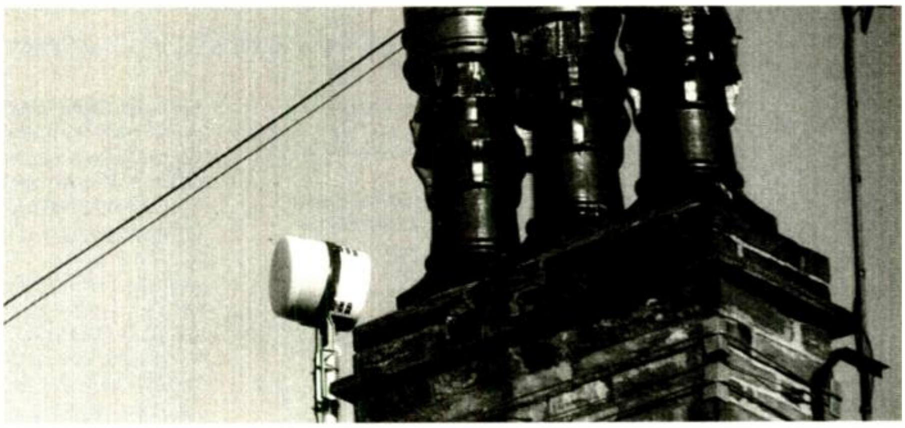
The 14 MVDS homes were therefore among the very first in the UK to experience D-MAC transmission standards (the cable homes had their BSB channels converted to PAL).

Questionnaires were issued, of which eleven were returned. Seven thought the picture quality better than normal television - more lifelike and with greater detail, clarity and brightness. However, only three were definitely interested in having MAC - two were prepared to pay £800; one would only pay £350.

Widescreen television

Widescreen television (16:9 aspect ratio) was also demonstrated in Waddington - the Command Centre had its own D-MAC encoder, so was able to make its own programmes, including village material and converted HDTV footage. A bigger problem proved to be finding ways of getting it seen. Only two prototype proper dimension HDTV sets were available in the country at the time - one went to Waddington, but had to be borrowed for a few days when the other, which was to be displayed at the London Cable & Satellite show, was dropped and put out of action.

What was striking about the project was the immense enthusiasm it generated, both among the villagers and the incoming professionals... particularly so of the village TV channel.



Microwave video distribution system aerials attached to roofs and chimney pots brought the first D-mac transmissions to UK homes

For the other four homes which were favoured with widescreen reception, two had masked 4:3 33in CRT sets, and two had masked 46in rear-projection receivers. Viewer-response to the picture was overshadowed by reaction against the physical bulk of the sets. An urgent problem posed for broadcasters by widescreen is how best to display 16:9 format material on 4:3 sets. Twenty people in the cabled homes took part in an experiment, watching the same material displayed in three different ways: (1) Using the full 4:3 screen, and losing the side portions of the 16:9 picture; (2) Full 16:9 "letterbox", showing the whole picture, between two black, horizontal bands; (3) A compromise display (1.54:1) which more nearly fills the screen; it loses some of the sides of the picture, but reduces the thickness of the black bands top and bottom. Most viewers (74 per cent) preferred the full 4:3 display to the 16:9 letterbox; however they were divided 50-50 over whether they preferred 4:3 to the compromise, 1.54:1, picture.

HDTV

To demonstrate HDTV, a closed-circuit system was set up, using a four metre screen and a Barco 1001 projector, plus two Philips 54in back-projection receivers in the village club (and the 18in monitor in a nearby house). Material shown included the ITV "Winchester" footage, some Eureka 95 material produced by RAI and showing "breathtaking" scenes of Italian architecture, football (1989 Cup Final) and Wimbledon tennis. In addition, ITV's HDTV vehicle visited the village; eight feature films were transferred from 35mm, using its telecine and colour grading facilities. Its HDTV cameras recorded scenes of the village. The villagers were undeniably impressed by HDTV, but, again, no-one would spend more than £800 on it, and the house with the monitor, although "very interested" in a set up to 36in, wouldn't be prepared to spend more than £350.

Epilogue

Quite what the whole project proved is not immediately clear. The amount of viewing, in the cabled households, was nearly double the national average. The number of channels tuned in fluctuated wildly. Everybody asked for the porn channel (it was a standing Cable Authority condition that this channel be only supplied on specific request) but only eight households watched it in any given week and nobody had much to say in its favour.

Zapping was more prevalent among children than retired people. What was striking about the project was the immense enthusiasm it generated, both among the villagers and the incoming professionals.

This was true of all aspects, but particularly so of the village TV channel. Quite possibly the point was the taking part. More than anything else, it proved to ordinary people the adage of the chattering classes - that television is for being on, not watching.

A book on the project, *The Television Village*, published by Granada, is available, price £9.50, or £27.50 with a 10 minute VHS videotape, from: TV Village, PO Box 4000, London W3 6XJ; cheques payable to Granada Television.)

Editorial survey: use the information card to evaluate this article. Item I.

PCB design on the cheap?

John Anderson tests cost-conscious Boardmaker.

Does £500 really buy scematic entry, component placement and autorouting?

Boardmaker 2.30, latest PCB design product from Cambridge based Tsien (UK), is an integrated schematic capture and layout package with autorouting. Nothing new in that. But the price for the whole package is under £500. So what compromises have been made to provide such a comprehensive product at that low price?

Installation is straightforward and an install program moves the files — 1.4Mbytes of disc space including libraries — onto hard disc.

Operation is claimed to be possible on a dual floppy system, but with this amount of data speed must be seriously compromised.

Starting up

Boardmaker starts up with a menu offering schematic, PCB or library editors. Selection leads to a working environment of standard banner and pull-down windows, and a data line across the bottom of the screen. Access to the functions at the banner is either by mouse clicking or by typing control with the key letter of that menu.

Windows are fast and responsive, though it is not possible to move directly from one to the next by simple cursor movement.

Draw and redraw

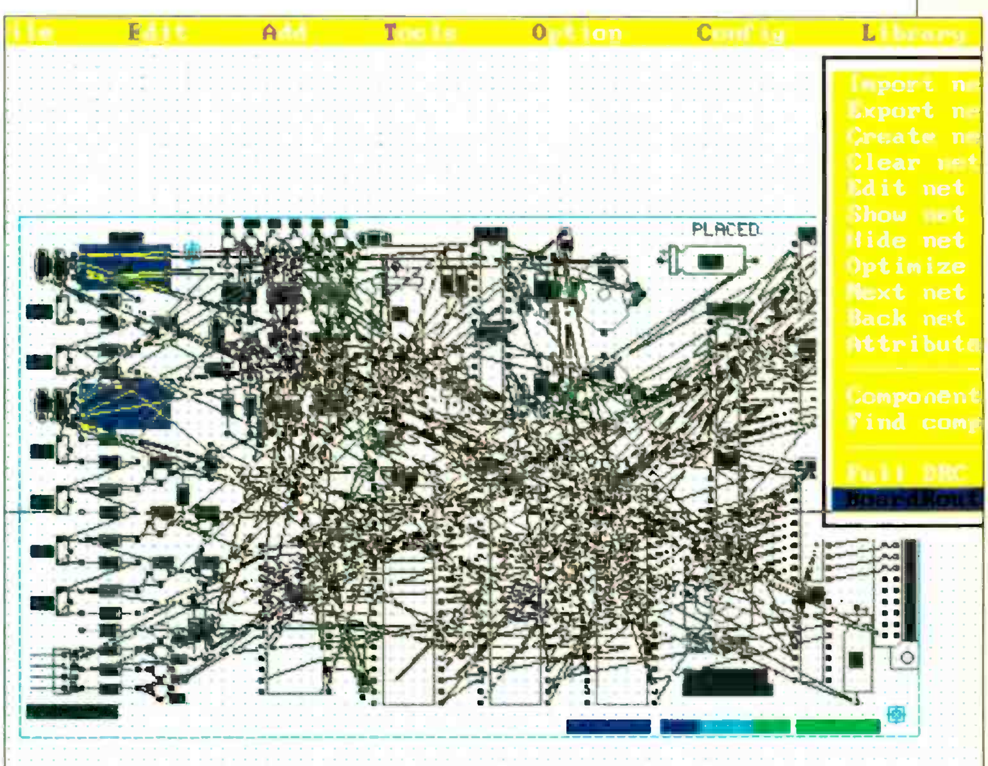
Drawing speed of Boardmaker is excellent, handling quite complex PCBs in only a few seconds. A particular zoom level is chosen by pressing one of the number keys, 1 to 8 (seen this scheme somewhere before?) and its only weakness is that the program insists on completing the redraw even if a different zoom has been keyed. If the redraw speed had been slower, this slavish following of keystroke to action could have been tedious.

Auto pan across the PCB can be switched off and on, but unfortunately panning only responds to the cursor key and not to the mouse.

Simple editing

Simple editing of, say, a PCB is fast and easy, with the cursor snapping to the pad, rubber banding as the track is laid, and the track identified by cracks as it changes direction. The command structure puts Boardmaker in particular mode, eg track laying, and continues in it until cancelled by a new mode.Text placement is initially on the silk screen layer. But text may subsequently be moved to another layer with text edit; boardmaker is smart in moving text and components between layers, mirroring both if they are transferred to the bottom layer.

Fig. 1. Rat's nest and net menu



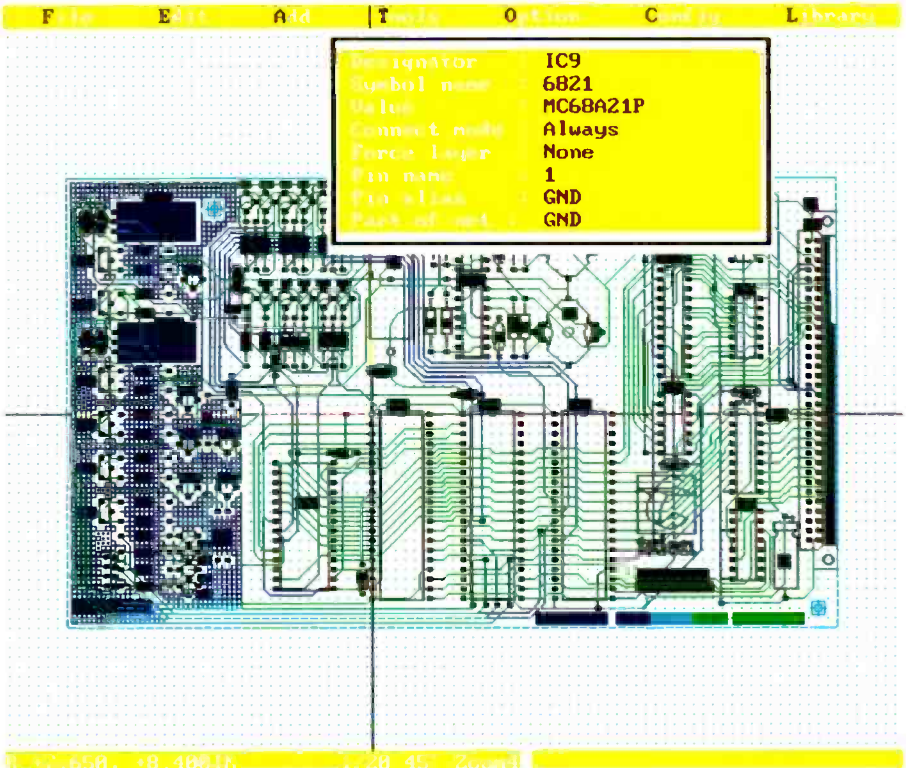


Fig. 2. Routed PCB with node view

A reservation is that it achieved only a 99% routing, when routing that last track would have been a simple matter with a shove router (where tracks already laid are shoved to one side).

To remove the rat's nest of nets for tracks already placed by the autorouter, a full DRC must be run and this means more wasted minutes while the program sorts out something it "knew" already.

Living with boardmakerSchematic capture looked and felt like a PCB editor. Not only were the lines tracks and the junctions pads, but any pad size could be used, including drill hole on the schematic.

No net labelling and capture functions available in this part of the program. Indeed the net pull-down menu announces "no net facilities available in schematic editor" and this is a serious shortcoming

This smartness also extends into the block mode of operation.

A block, defined in the normal way by identifying one corner and dragging a box to the opposite corner, can be moved, deleted, repeated and mirrored. This latter command logically inverts all the layers so that, for example, a group of top surface mount devices will be moved to the bottom, and mirrored (as seen from the top), including any text.

Boardmaker has a reasonable footprint library suitable for most simple designs, covering ICs — including surface mount — connectors and devices. Selection of the required device is assisted by a useful library browse facility.

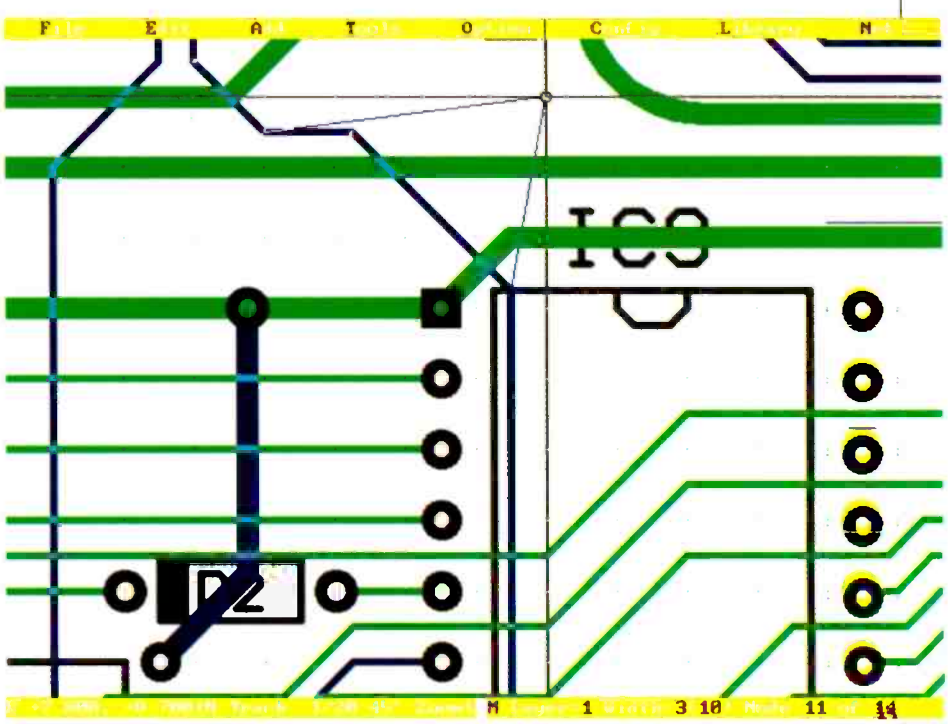


Fig. 3 Edit track — note rubber banding and track codes

Autoroute and check

Design rule check (DRC), integrated into the program, means that before allowing autoroute to proceed, the checker reviews all the nets and this takes several minutes. Eventually the user is presented with the autoroute banner, and routing options can be selected.

Autorouting strategy is not specified, and the only set-up options available are select direction of routing on a particular layer and whether to route a net or the whole board.

The autorouter is completely re-entrant allowing the user to interrogate the system while routing is in progress. What advantage this gives is not clear as all that is required from an autorouter is a routed PCB. Watching an autorouter work is no better than watching paint dry, and actual routing is painfully slow. On an 8MHz AT it took about 5s simply to route adjacent pins. Complex nets can take several minutes, and a complete board about 20min.

Good results?

What about the results? Well they are really quite good: minimal backtracking, no stubs or complete loops — a very creditable performance.

as there seems little point in having an integrated schematic and PCB layout package if the components and connectivity which describes the job are not transported between integrated components of the program.

On the PCB side of the equation, Boardmaker looks very competent. The area fill — termed flood fill — is better handled by Boardmaker than competing packages with a much higher price tag.

Set-up allows selection of the type of

fill, then Boardmaker, with a degree of intelligence, fills the area following design rules, and missing already placed circuit elements.

Another nice touch is the power to point to a particular node and carry out interrogation, to determine relevant details about its net, pin number, pad size etc in a pop down window (Fig. 1).

PCB files are stored in Boardmaker's proprietary format, so that the only way to interrogate the database is through Boardmaker itself.

Real weaknesses

Schematic capture does not build the netlist for the PCB for import at the PCB edit and route stage — the autorouter imports either from a text file generated by hand, or from a netlist generated by a schematic package such as Tango, OrCad or Protel. Thus one of the most important aspects of generation of a PCB, maintenance of connectivity between schematic and PCB layout , is lost.

Further, the PCB part of the package offers component renumber, which for an un-netted PCB will produce a very professional looking result.

But competitive products provide this sort of feature with back annotation to the schematic so that one to one correspondence is maintained.

Boardmaker does produce a file containing a list of old and new annotations, but implicit in this is manual update of the circuit diagram, and intervention of the operator in doing, by hand, what should be accomplished by computer.

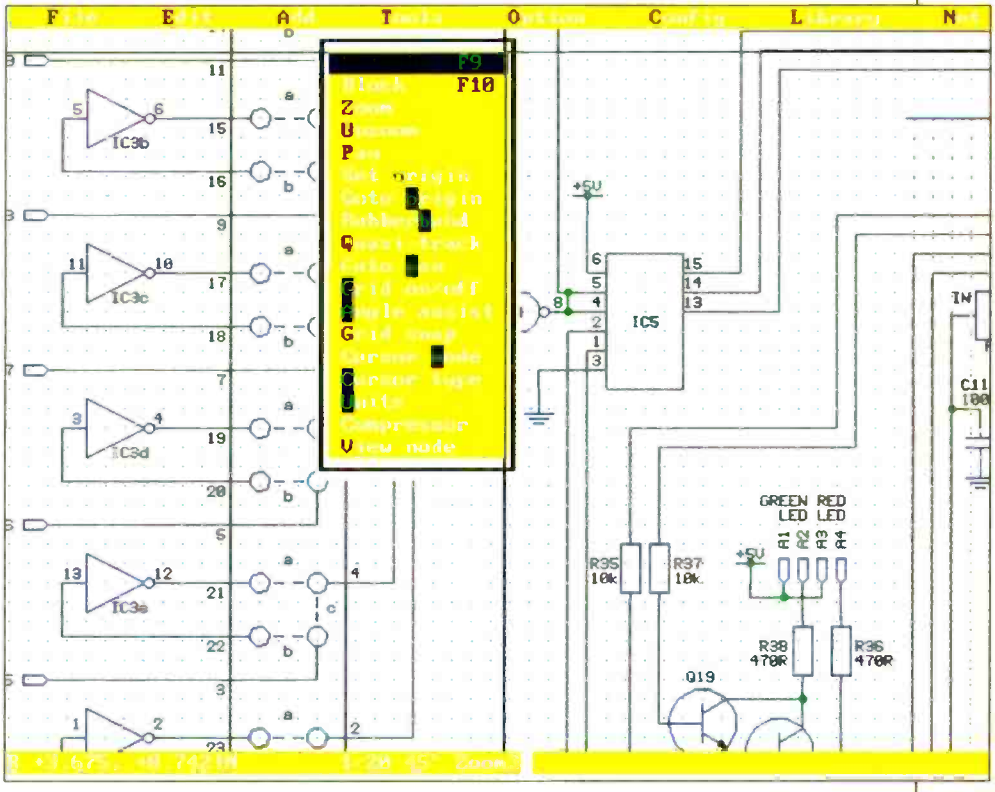


Fig. 4. Schematic capture with the tool menu

Compromise, competition and conclusion

Working with this product gives a definite feeling of "double-take", as ideas under-pinning operation of the program are very similar to that of another British PCB package, Easy-PC — though the whole product does have a very much more professional feel. So it came as no surprise to find the two packages are written by the same person, Lawrence Rao.

Certainly in some tasks the package was slow, particularly autorouting and design rule checks. But this is offset somewhat by the seemingly ever-increasing processing power of today's PCs, though I would not recommend the package for large boards on say an XT.

The DRC facility, though slow, is a very important part of any PCB cad. It is advent of this function that provides the quality assurance required, guaranteeing that it is possible to make the PCB and that it corresponds to the input netlist.

There have been compromises in attempting to combine the functionality of library editing, schematic capture and PCB edit all in, notionally, the same operating environment. Requirements of the three functions are rather different and I feel this has been missed, particularly with schematic capture. Better functionality would be achieved if the package were combined with a dedicated schematic capture package such as OrCad. But if you are forced into this; why use Boardmaker?

All in all this is a good product with a high functional specification supplied with an excellent manual, though the speed issue could force you to have a second cup of coffee while those larger PCBs are being routed.

BOARD MAKER SPECIFICATION

Requires: PC, XT or AT compatible computer
At least 512K ram, running dos 2 or later.
Parallel printer port (for the dongle)
Graphics screen supported are: CGA, EGA, VGA and Hercules
Options: Epson compatible printer, mouse, HP LaserJet II or compatible HPGL plotter
Gerber photoplotter and Excellon NC drilling supported
Boardmaker 2 and autorouter £495
Boardmaker 2 only £295
Boardmaker 1 entry level £95
5.25 and 3.5-in media with professionally printed manual and parallel port dongle.

Product support for Boardmaker is free for three months. Additional support is available for a further 12 months at £69.

Supplier: Tsien (UK) Ltd. Cambridge Research Labs, Huntingdon Road, Cambridge

Editorial survey: use the information card to evaluate this article. Item F.

Digital potentiometers

New from Dallas is the DS1267 dual digital potentiometer IC, which contains two digitally controlled 256-position pots connectable in series for higher resolution. Resistance and resolution values of each section of the -10, -50 and -100 versions are 10kΩ/39Ω, 50kΩ/195Ω and 100kΩ/390Ω.

Figure 1 shows the arrangement of the DS1267, which is adjusted to the required value by selecting resistive elements digitally, tapping points accessible to the wiper being provided at each element junction; wiper position is set by an 8-bit register, which is read or written to by data bits at a three-wire serial port and which controls a 256:1 multiplexer to select the tapping point. If the resistors are to be in series for higher total resistance, a STACK SELECT bit determines which wiper is seen by the output.

Data is entered and read via a 17-bit I/O shift register, loaded by the three wires RST\, DQ and clock and updated by transferring all 17 bits, as in **Fig. 2.**, serially at the DQ pin when RST\ is high. To read the data, DQ floats and, when RST\ is high, bits are fed back to DQ through an isolating resistor serially until they have all shifted back to the original state, being read at C_{out}.

Wipers are taken straight to output pins, non-linearity being less than ±0.5LSB for all settings and -3dB points 40kHz for the -100 version, 250kHz for the -10.

Dallas Semiconductor Corporation, Unit 26, West Midlands Freeport, Birmingham B26 3QD. 782 2959.

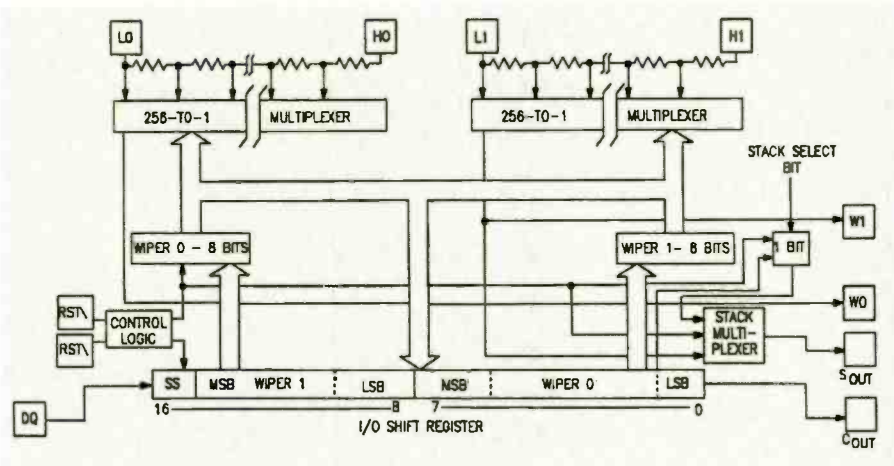


Fig. 1. Internal block diagram of Dallas's DS1267 dual digital potentiometer.

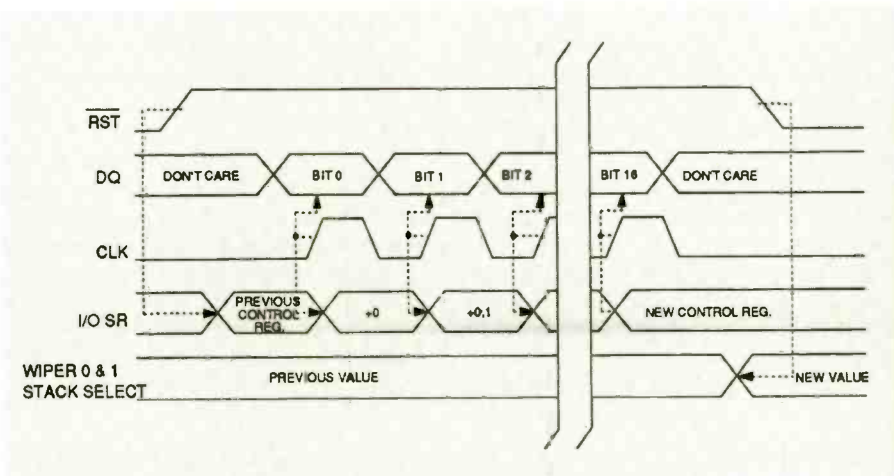


Fig. 2. Writing control data to the potentiometer. While RST\ is high, the original state is preserved during data entry, changing to its new value when RST\ goes low.

Microstepping drive circuits

A note from Analog Devices by John Wynne briefly reviews permanent-magnet stepper motors and discusses some of the problems involved in driving them: in particular, the errors introduced by D-to-A conversion and load torque are examined, as are the pros and cons of open and closed-loop control.

Two practical circuits illustrate the argument, one using fixed-frequency PWM and the other a frequency-modulated PWM technique. Both use dual 8-bit D-to-As for phase current control and an 8-bit A-to-D for closed-loop position control. It is assumed that an optical encoder on the motor shaft will produce quadrature triangular outputs, although other types are also used with motors that provide velocity windings.

Figure 1 shows the fixed-frequency circuit which uses an AD7628 and an AD7820. Output power is provided by the Sprague UDN2998W, which is a dual H-bridge driver.

The NE555 gives 2.5µs low-level pulses at 45kHz, a high enough frequency to avoid audible noise while being low enough to reduce losses. The pulses reset the flip-flops and enable the phase currents through the output driver, their values being monitored by sense resistors R_{SA} and R_{sB}. Resulting voltages are noise filtered, amplified in the first op-amps and compared with the D-to-A control voltages in the second pair of op-amps. If either amplified sense voltage exceeds the D-to-A control voltage, the comparator goes low, sets the flip-flop and turns the driver off. Phase current falls slowly until the next pulse resets the flip-flop.

Voltage switching is used in the 7628s. Reference is taken to out_A and out_B, the output coming from V_{REFA} and V_{REFB}. Positive reference gives a positive voltage (not a current) at constant impedance. This configuration exhibits virtually no gain error and output matching between D-to-As is better than 0.4% The display in

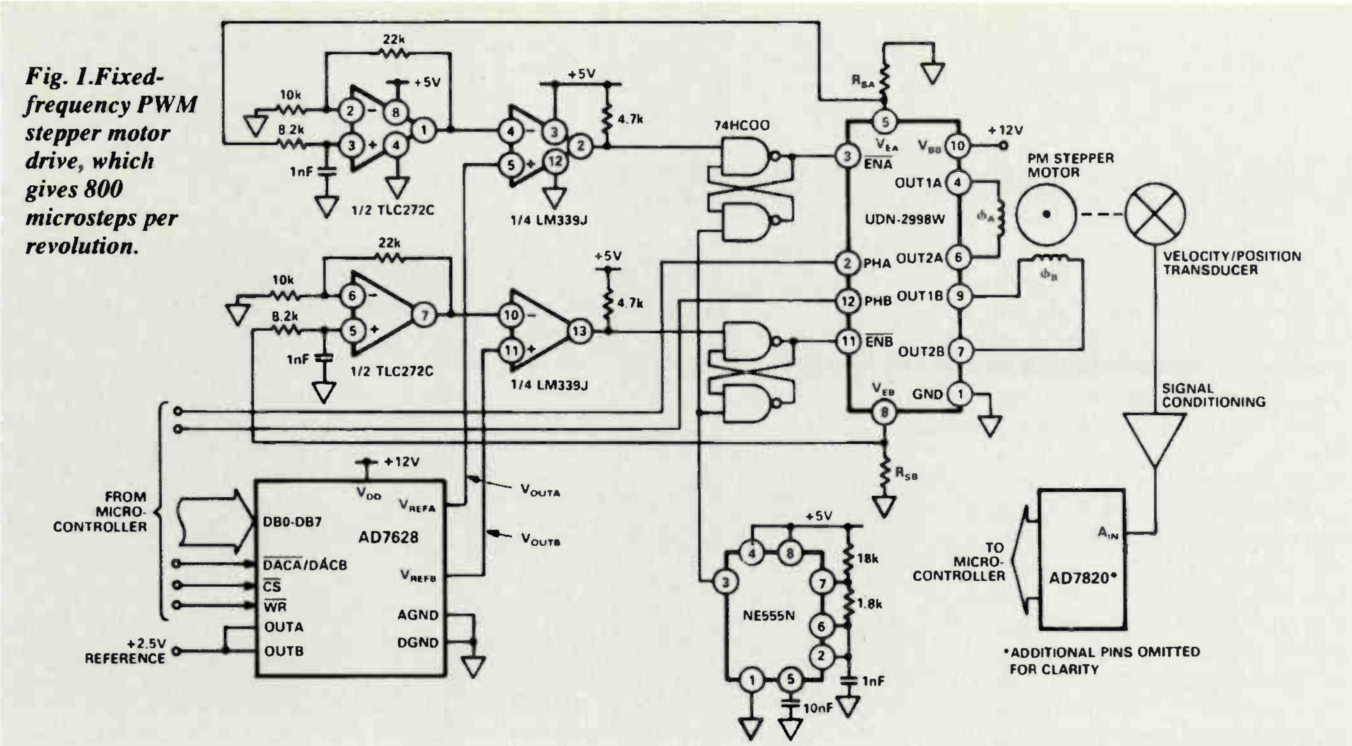


Fig. 1. Fixed-frequency PWM stepper motor drive, which gives 800 microsteps per revolution.

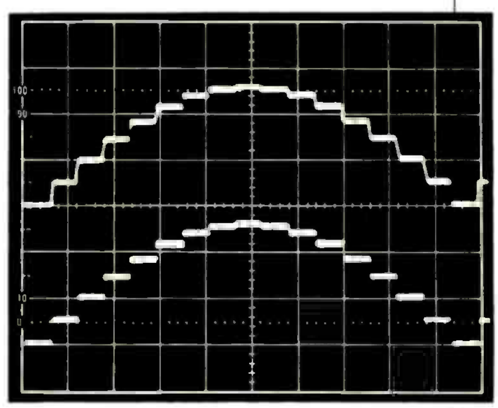
Fig. 2 shows the D-to-A output (bottom), covering two full steps with eight microsteps per full step. The top trace is the amplified sense voltage at 1V/div. Time for eight microsteps is 12.8ms so that, with the Portescap P530 motor used, which has a step size of 3.6°, microsteps are of 0.45° to give 800 microsteps per revolution.

In the circuit of **Fig. 3**, a single IC contains both the dual D-to-A and the single A-to-D and the flip-flops are removed to produce an FM configuration.

In this case, after the phase current is turned off, the comparator output stays low until the decaying current is low enough to force the comparator output high again to restart the cycle. Both phases have separate loops, but it is found that the lock together in practice at about 25kHz and no beats are caused.

Analog Devices, Station Avenue, Walton-on-Thames, Surrey KT12 1PF. 932 253320.

Fig. 2. Amplified sense voltage (top) and D-to-A output at 1V/division, (right) showing eight microsteps for each full step.



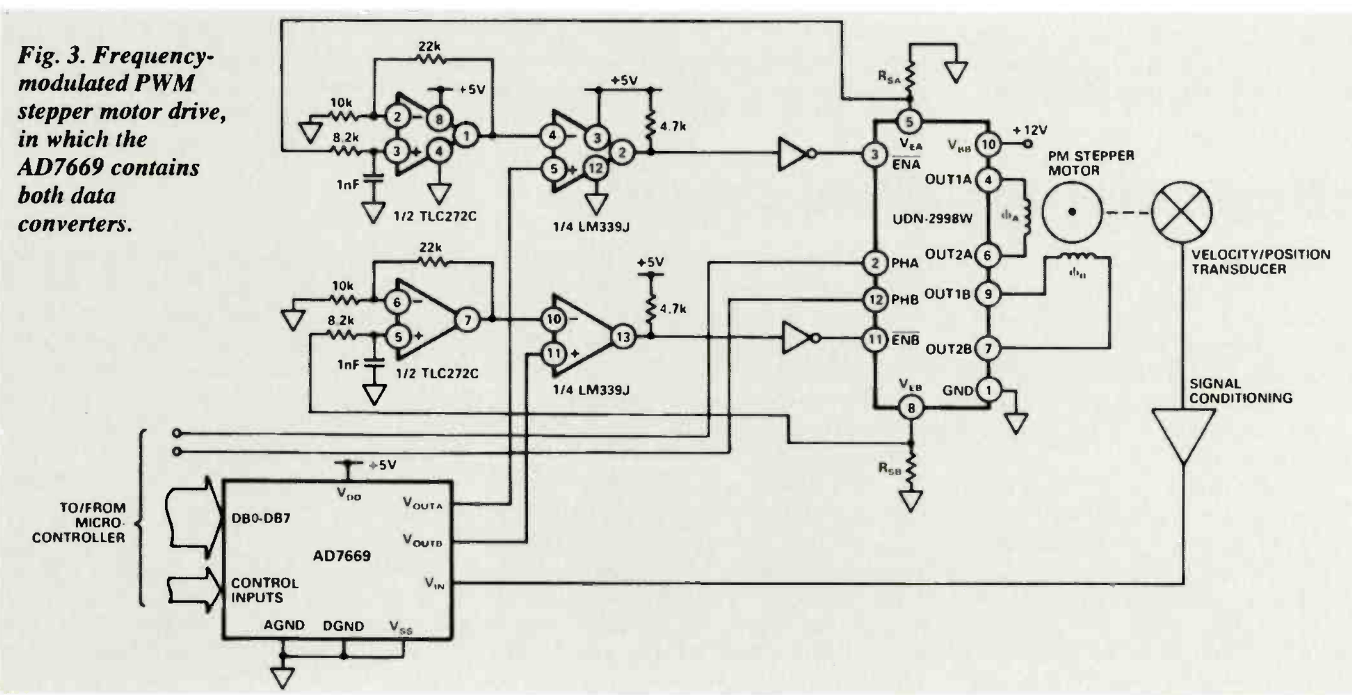


Fig. 3. Frequency-modulated PWM stepper motor drive, in which the AD7669 contains both data converters.

DC motor controller

MPM3004 from Motorola contains pairs of p-channel and n-channel mosfets in an H-bridge arrangement and is meant to drive stepper motors or the DC motors in disk drives and servos. The package is an ICePAK isolated to 2kV and will handle 25A peak with an ON resistance in the region of 0.2Ω.

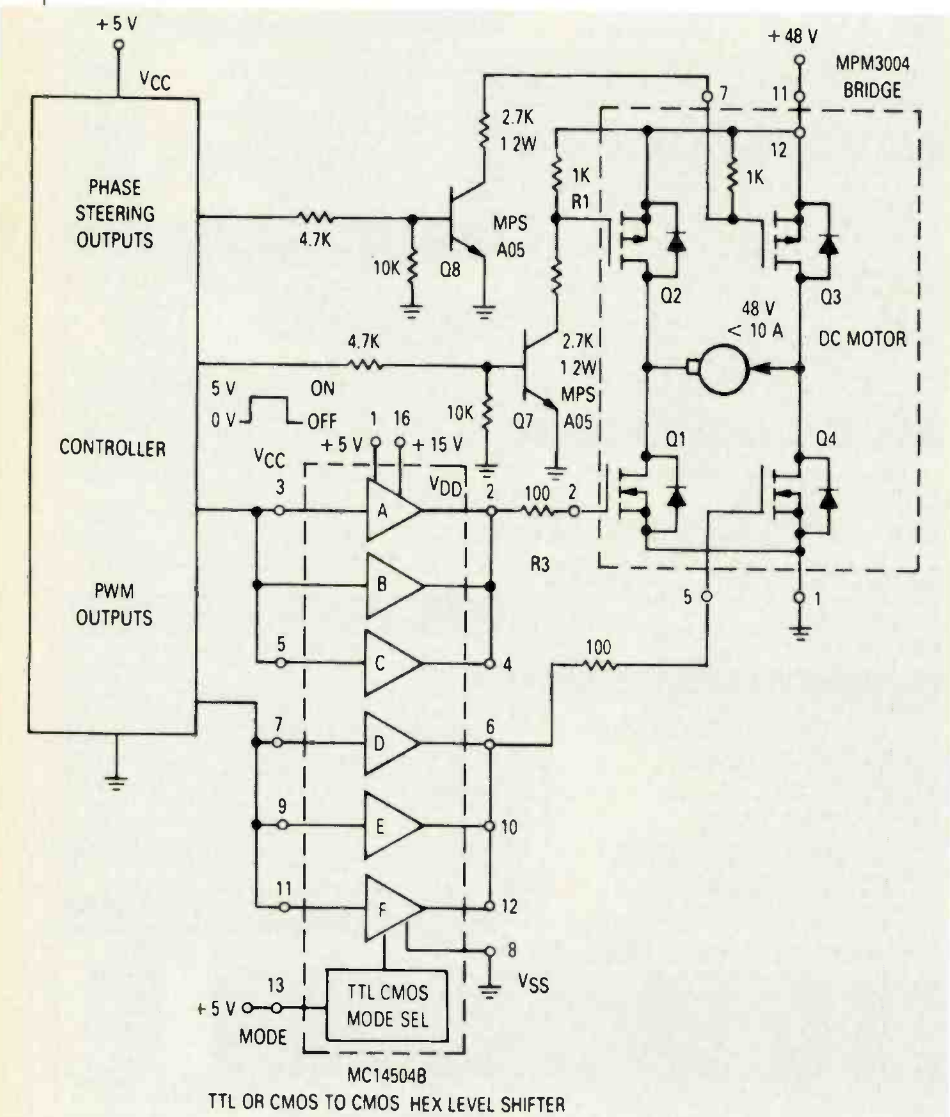
Since the four complementary mosfets are integrated, the bridge IC offers a very simple motor controller, using two ICs and a pair of small-signal transistors.

In an arrangement referred to ground, as shown in the diagram, the lower pair of n-channel mosfets is easily driveable directly by ordinary cmos gates, when switching needs are not severe. In normal circumstances, this lower half of the bridge is pulse-width-modulated, the capability of the driver gates determining switching speed. In the case illustrated, a MC1450B hex level shifter moves the 5V output of the gates to the required 15V level needed by the fet gate. Each mosfet uses the output of three gates in parallel to obtain a greater source/sink capability, the 100Ω gate resistors and the $r_{DS(on)}$ of the p-channel and n-channel cmos gates limiting the current to ±70mA and allowing the power mosfets to switch efficiently at up to 15kHz. Higher speeds need higher currents.

To drive the upper pair of direction-steering power mosfets is also simple and fast switching is not needed. Since the microcontroller will probably produce positive-going steering pulses, a pair of small-signal n-p-n level-shifting transistors of the MPS ADS type will suffice — one for each direction control. A 60V rating is needed for these devices, because the bridge is to drive a 48V DC motor and is rated at 60V. The level translation is done by turning on the transistors, pulling down the p-channel gates to a level set by the 1kΩ and 2.7kΩ potential dividers — 13V in this case. If the microcontroller used has n-p-n open-collector output, the MPS ADS transistors need not be used.

Motorola Ltd, European Literature Centre, 88 Tanners Drive, Blakelands, Milton Keynes MK14 5BP. 0908 614614.

DC motor controller using the Motorola MPM3004 power bridge. If the micro-controller is up to it, the small-signal



Decoupling op-amps

The tone of Analog Devices's application note on this subject may be seen from its far from succinct, but extremely pertinent title: *An IC amplifier users' guide to decoupling, grounding and making things go right for a change*, by Paul Brokaw.

Language in general use for this kind of publication is firmly cast aside and the note is clearly in the "Plain man's guide to..." class of writing — very refreshing indeed.

As the author points out, it is hardly possible to cover the whole subject in a general way, but he has quite obviously suffered himself from thinking that ground is exactly that, with no resistance or inductance, and is well placed to advise fellow sufferers on valid ways out of their problems.

The depth of his suffering can be gauged from the author's final comment: "...remember that you can always trust your mother, but...".

Analog Devices Ltd, Station Avenue, Walton-on-Thames, Surrey KT12 1PF. 932 253320.

Editorial survey:use the information card to evaluate this article. Item G.

SigmaPlot: spreadsheet for scientists

Powerful graphing, multiple regression analysis, curve fitting, statistics and DTP; SigmaPlot can do the lot says Don Bradbury.

Workers in scientific disciplines often need to graph and publish data in ways which are simply not available in standard computer software such as the ubiquitous spreadsheet and its supplementary add-ons. But SigmaPlot from Jandel Scientific could help fill that gap.

In fact, among computer programs typically employed for data analysis and graphing, spreadsheets are the most ready comparison with SigmaPlot. Both bring a large data entry worksheet and various forms of numerical analysis and spreadsheets invariably provide sundry graphic outputs. But these are really needed in more universal activities such as general accounting and commercial computing.

Some of the latest spreadsheets also provide publishing facilities to improve document presentation and SigmaPlot's graphic output will inevitably be compared with these. But it is the style of graphic presentation that suggests suitability for more esoteric applications involving multiple regression analysis, curve fitting and data transformation .

Try to make an ordinary spreadsheet use split data axes with variable intervals in the two halves; or calculate confidence limits and plot them with customised quality control lines to a graph, fit a high order polynomial to the data, and use logarithmic or probability scales for the plot. In these, SigmaPlot excels.

Certain stand-alone programs and spreadsheet templates can also be used for data analysis and feature regression and general statistical analysis. A few also include automatic modes of data modelling for users uncertain of their ground.

But these can leave much to be desired in terms of user options and output quality, and automatic analyses risk inaccurate deductions when used by the inexperienced.

Jandel Scientific's program is aimed squarely at users needing specialist modes of statistical analysis, powerful graphing and all the options for output manipulation. It is also for those who are prepared to devote time to mastering these options. General commercial forms of data presentation are not its aim. There are no three dimensional graph styles, nor hi-lo-close-open, filled line, bubble, or other common modes of representing that type of data. Instead the program's scatter, bar, stacked bar, box, and pie forms are geared more to types of graphing encountered in trend analysis and statistical applications.

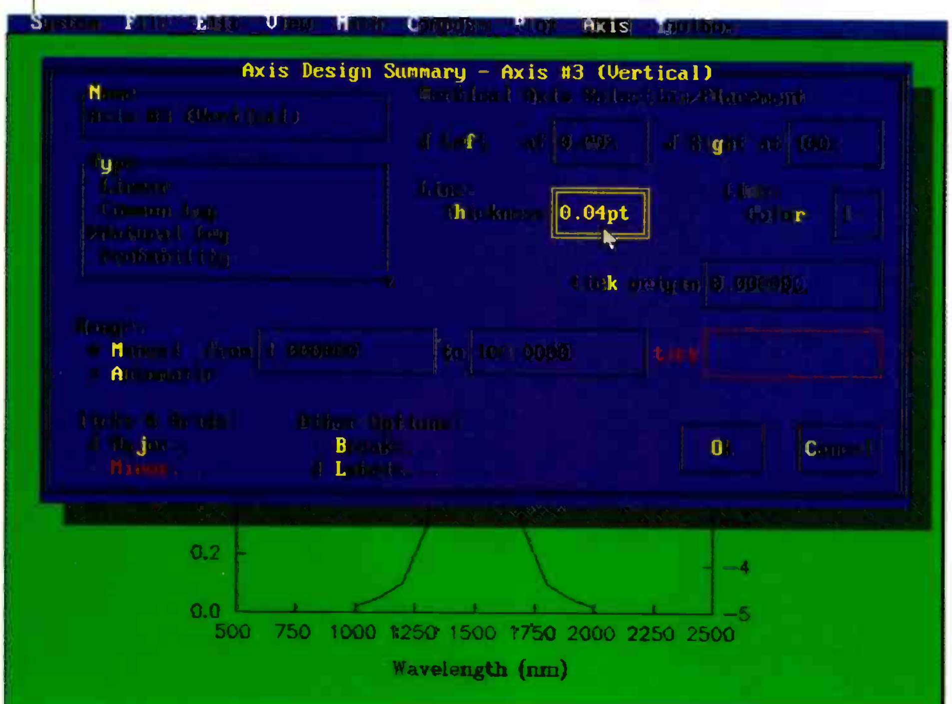
Data handling

SigmaPlot's huge 16,000 column by 65,000 row data area is used like a spreadsheet. Both sets of axis labels are simple numeric progressions and can be used as data points in appropriate plots. "Cell" may not be the best description of the data points, because although use is made of the range principle for highlighting data, formula entries are not available, and a data block can not be named for reference.

But SigmaPlot does feature its own statistical functions which automatically summarise individual columns of data. These include the mean of the values, standard deviation (using the informal n-1 divisor), standard error, 95 and 99% confidence limits, highest and lowest values, number of data points and total number of any missing values in the range.

Most users will probably switch from the default insert mode to the more familiar overwrite mode; then successive data entries need a down cursor movement or carriage return to enter values and move to the next lower row. Left and right cursor keys can not be used in this way.

When one column is complete, the cursor is used to locate the first entry point in the second column. The home key first



Helpful setup: plotting a graph

moves the cursor to the top of the current column; a second press places it in the true home position.

There is no range erase facility in the menus. Users must highlight the superfluous data and then press the del key. Cut and paste is available, and any data, or graphic plot, deleted in this way is not lost but is placed in a buffer to be replaced by the next pasted or deleted matter.

Deletions can be made with a mouse, or with the keyboard by holding down the shift key and highlighting the range with the cursor arrows.

Extensive use is made of dialogue screens containing default settings for every imaginable feature of graphic plots.

Certain user prompts are included too such as preferred colour settings, graph redraw mode, scientific notation on demand or in permanent use, and number of columns and decimal places shown in the data entry area.

But the multiple dialogue boxes do make demands on the memory if the user is to avoid constant references to the manual or on-line help system.

Many users will choose to switch off the novice user prompts at an early stage because the prompts or menu boxes obscure part of a graphic display, and clearing the overlay does not redisplay all thegraph — that is if automatic screen refresh has been turned off for speedier operation. Screen redraws generally have to be forced to see results of amendments.

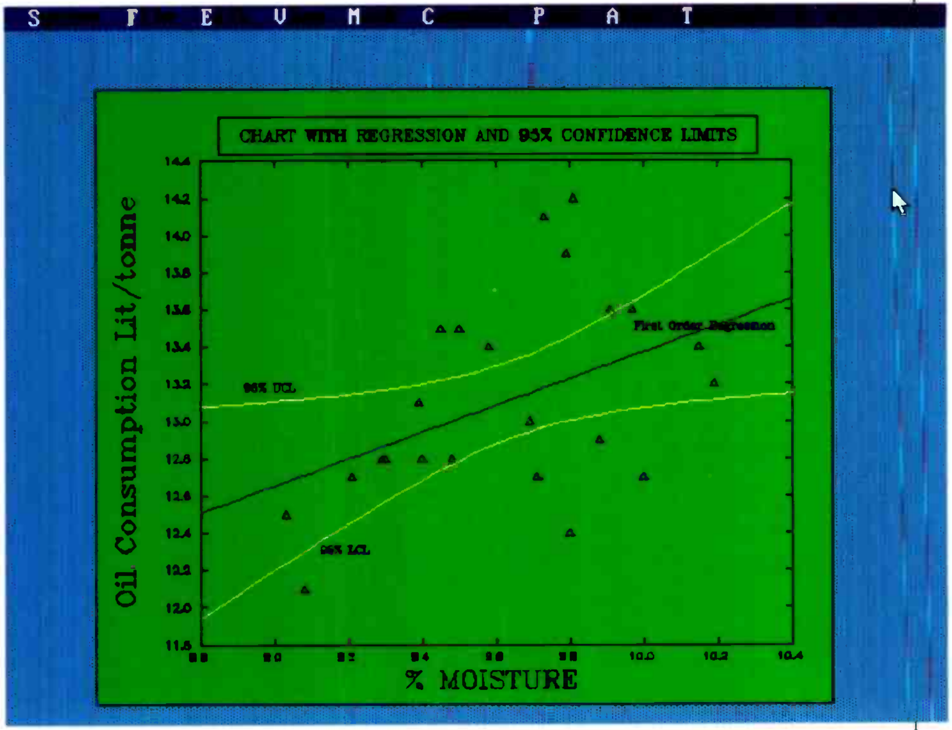
A second, rapidly learned, mode of operation is to avoid the menu system altogether (when possible) and use the keyboard shortcuts or mouse pointer. Most important of these shortcuts are function key F7 which redraws the current graph, and F4 which returns to the data entry worksheet. Other convenient hot keys include those for saving a file, and also graphic preference boxes.

Menus and dialogue screens are well laid out, as are the excellent, context-sensitive help screens, but dialogue boxes are operated in a "distinctive manner" and it takes a little time to remember that progressing with the cursor keys has to be followed by a carriage return to select the option box before an entry can be made.

After the entry, another carriage return confirms the change and closes the box before a move can be made to any other that needs to be changed.

In some cases the default or current entry must be deleted before making a change in the box; in other cases it can be overtyped, depending on cursor location.

Using a mouse is easier than the keyboard. Indeed, although the manual makes clear in a special section the alternative keyboard stokes, it is written with mouse control in mind.



Not an ordinary spreadsheet: the contents of the cells do more in Sigmaplot

Most dialogue boxes have a cancel option as well as an OK box which must be selected to confirm any changes because using the escape key leaves any intended changes inactive.

Clicking and dragging is used not only for menu operation and dialogue box navigation, but also graphic manipulation. For example, reshaping or resizing a graph is achieved by selecting pointing mode and dragging on handles which appear in the edges and corners.

Moving a graph, also in pointing mode, involves sliding the image to a different part of the screen and can be useful because SigmaPlot can accept several graphs on one page. For multiple graphs, a compose option allows additional plots to be included.

Zoom mode will toggle the size of the current graph, though a graph viewed in zoom-in mode is always centred, so zoom-out again to judge its size and position relative to the full page.

The compose menu can set the precise height and width of a graph in the design summary dialogue screen. Location for the graph can be entered within the page, if preferred, to see the actual coordinates rather than drag the image and place it by inspection.

Customising options in graphic displays include switch between portrait and landscape orientation, modify plot lines and symbols, alter line thickness for axes and lines (on individual objects or universally), choose between various axis scale types and ranges, and even select the colour of plot and axis lines.

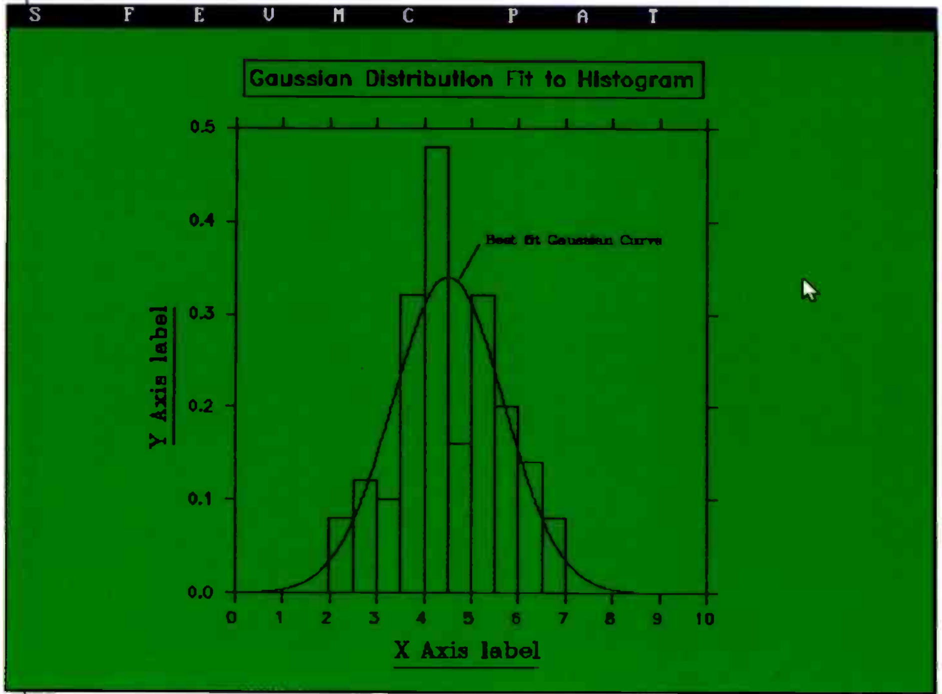
Of course labels and axis intervals can be selected ("tick marks" in Jandel parlance), or the default intervals and labels chosen. Axis titles can be generated automatically from the text in the name box of the axis design summary screen. An axis can be switched off, and it is possible to select minor (intermediate) tick marking from the ticks and grids option in the axis design summary screen.

Graphs can be copied and deleted with a deleted graph replacing the current contents of the clipboard. So apart from possible loss of previously pasted matter, copying many graphs via the clipboard involves multiple cutting and pasting.

But time can be saved because one graph might need to be presented in a simple mode, with a second building on this, perhaps with a multi-plot graph adding further dimensions of information. The basic graph style does not have to be reconstructed from scratch if it is copied first. There is also a template extraction option which can save time by recalling predetermined layouts.Finally, SigmaPlot can export to ascii and dif files for use with other programs such as DTP.

Graph styles

The compose menu presents the most comprehensive dialogue for creating a new graph. Cartesian plots require the pick-XY-column-dialogue to indicate the columns of data to be used, with the axes option able to modify these if required. Range can be specified. The axis can also be split, with a choice of markers to be placed in the axis break.



Scientific functions: automatic conversion from bar graph to Gaussian plot

Design summary screen can be modified directly, as a dialogue box, to indicate the required height and width as well as the distance from the top and left of the page. Plot menu gives access to most of the graphing features of SigmaPlot, used to set the columns to plot, assign axes, set data point symbols and their size and fill, and select the type of plot from scatter/line, bar (of specific width), stacked bar, pie (with the usual options), and box plot. The latter shows information about the distribution of data, horizontal lines marking the 10th, 25th, 75th, and 90th percentile points of the data. The box encompasses the 25th to 75th percentiles, and can show the mean of the data outside the 10th and 90th percentiles.

Mixed plots are available for multi-range graphs, and datapoint sampling is possible, with only a stipulated range of data points in any column included in the plot. There is the option to select line only, symbol only, or both; insert any regression line between first and tenth order; add 95 or 99% confidence limits if required; include bad points; show vertical or horizontal error bars; set colours to highlight these (1 to 15 with an incrementing option); indicate a heavier line thickness for further emphasis, and select fill patterns for appropriate plots.

Quality control lines can be added, including upper and lower specifications, upper and lower control lines, and a mean line, each with calculation, line, label, and colour settings. The calculation can be according to various methods: fixed constant, standard deviation, standard error, or 95% or 99% confidence.

Labels can, of course, be added to these lines, and the line type, colour, thickness, and orientation can be set. Regression lines may be placed either through the data points alone, or be made to extend to the axes of the graph.

If coefficients of the regression equation need to be stored, the column number to house them can be indicated within the data worksheet. Eleven coefficients and R value are then written to the column.

A second order regression, for example, would show three coefficients followed by eight zeros and then the R value in the stipulated column. Coefficients are shown in increasing polynomial order. Axis scales can be linear, common log, natural log, probability, probit, or logit.

Probit is similar to the probability scale, graphing the Gaussian cumulative distribution function as a straight line, and the scale is linear.

Logit uses a ln(y/a-y) transformation, and this is another scale that will straighten out a sigmoidally shaped curve. Axis tick marks can be given either a prefix or a suffix of up to five characters, and tick labels may be numeric, time series, or be generated from data worksheet column text. They may also be factored by a specified amount (default 1). Precision can be set automatically or manually, and the display may be in scientific notation either permanently or only when the data falls outside a specified range. Many other options are available for tick marks, including the font, size, colour, thickness, rotation, and just the exponent or both exponent and base in the case of natural and common logarithmic axes.

Axis breaks can be incorporated by specifying break datapoints and position of the break in terms of percentage along the axis. A different tick interval can follow a break if necessary, the break symbol itself can be specified, and the thickness, length, and colour set.

Mathematical transformations

Math menu includes three options which can be used to carry out mathematical operations. Data can be generated or modified using transforms; non-linear curve fitting can be applied which can then be graphed along with own data, and Student's t-tests can be performed on any two columns of data.

Transforms involve entering an equation in the edit window of the transform dialogue, with many predefined functions available spanning arithmetic, statistical, trigonometric, and random number-generating. Further, functions can be defined, and supported operators include arithmetic, relational, and logical, with range, accumulation, precision, and area/distance functions as well.

Miscellaneous functions encompass histogram, interpolation, polynomial, "runavg", sort, factorial, and choose. Runavg produces a range of running averages from a window of predetermined size, and choose determines how several objects are selected from a larger group.

Curve fitting, or non-linear regression, determines an equation for a data series by selecting best fit values by applying a series of iterative passes through the data, using a least squares procedure. 25 parameters, 25 parameter constraints, and ten independent variables can be handled in equations, and the very important "if" statement can be included to allow different equations to be fitted to different ranges of the data series. Data for the resulting curve can be placed in the worksheet for comparison with the original.

Curve fitting options are explained by examples, and notes on possible pitfalls, weighting the fit, multiple independent variables and so on are in the manual.

Toolbox options

Toolbox is available only in page mode and is used to add text and various graphic shapes to the page. Graphs can be customised with descriptive or explanatory text and symbols, arrows and a range of other symbols or non-standard characters placed or moved at will. Only the simplest graphs will make use of the defaults and while changes are being made it is best to switch off the automatic redraw of graphic screens if many modifications are contemplated because screen redrawing is not rapid — though the particular video card employed as well as central processor speed, will determine the rate of screen refresh. If screen redraw has been left on, a halt can be called at any time by a mouse click or entering ctrl/break.

To enter a label, toolbox is selected, then the text option chosen, with location of the text addition indicated by clicking on the mouse or striking enter. After typing, a further press of the return key concludes the label and drops the cursor down one line for the start of another line, classed as a separate label. When complete, the text cursor is switched off.

Added text can be edited, additions rotated through successive 90° steps (for Y axis labels, for instance), and label characters automatically resized by using numeric keypad + and - keys to increase or decrease them.

Labels are moved with the select object option, clicking and dragging the label to its new location with the pointer inside a box surrounding the label.

Text additions cannot be stretched or shrunk as with page objects, and their size remains fixed if the size of a graph is modified — though resizing of text characters is still available as a separate function. But the font of text additions can be changed as can orientation. Superscript or subscript fonts can be set in multiple stages within text additions, so that complex mathematical and chemical symbols can be constructed.

Possible global modifications of text additions means individual labels do not have to be reset separately — again reminiscent of DTP facilities — though not by a series of fixed descriptions; the appropriate dialogue box description has to be changed. Box, ellipse, or line addition options can be made via the toolbox and can be selected, pasted, relocated or deleted, either singly or in groups. Text additions can be simplex, duplex, complex, or triplex, and a text options dialogue box enables setting of point size, colour, and default orientation of the text.

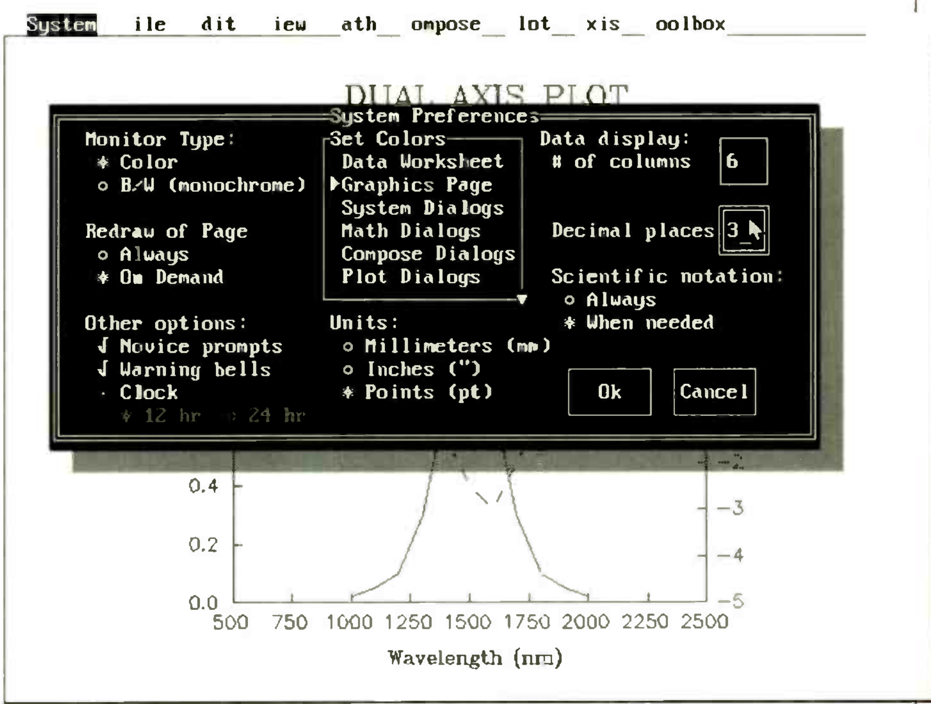
Italic and Greek modifications can be superimposed, and special symbols and built-in fonts are available, the latter coming with support for Postscript printers.

The program runs on IBM PC, XT, AT, PS/2 and compatible computers, and supports VGA, EGA, CGA, Hercules monochrome, Hercules InColor, and AT&T 6300 or compatible video modes.

Owners of certain video cards such as the ATI Wonder EGA/VGA can select 800 x 560 or 800 x 600 display modes respectively, as can Genoa Super, Orchid Designer, Paradise Professional, and STB Systems board owners.

IBM 8514/A is supported in 1024 x 728 mode. A list of supported digitising tablets is provided, together with some update information concerning these and other factors such as running the program under Desqview/QEMM and Windows 386, all in a disk 'readme' file.

Help is offered on importing graphs into word processors and PageMaker and Ventura DTP programs.



Old fashioned dos interface: the system preferences dialogue box.

Impeccable help

SigmaPlot's on-liner help system is quite superb, making use of the hypertext principle where certain words are highlighted for optional cross-referencing. A good index section will guide the novice user through essential modes of operation, and backtracking is possible, screen by screen, to return to the index or to review previous material.

SigmaPlot help is the most comprehensive help system I have ever encountered in a program for the PC. Its use avoids the need for too frequent reference to the manual, though this also is excellent with a good reference section and a useful tutorial — recommended for newcomers.

The useful trouble-shooting section in the manual is usually only required when the program configuration has been set inappropriately or memory is insufficient.

Well worth the study

A powerful program like SigmaPlot involves a certain amount of learning. But it is worthwhile study for anyone who has complex data to analyse and publish.

The degree of versatility on offer is outstanding.

Preparation of papers and reports which need graphic illustrations is eased considerably, and researchers will value the powerful data analysis, curve fitting, transformation, and graphing options. The ability to have several curves within one plot, multiple plots in a graph, and a number of graphs on one page, gives excellent flexibility.

At £425, SigmaPlot will be a good buy for the type of potential user I have outlined.

More general commercial application might be appropriate where the current crop of data graphing programs is found wanting on the publishing front, or where they fail to offer the type of options which are the special forte of this program.

REQUIREMENTS

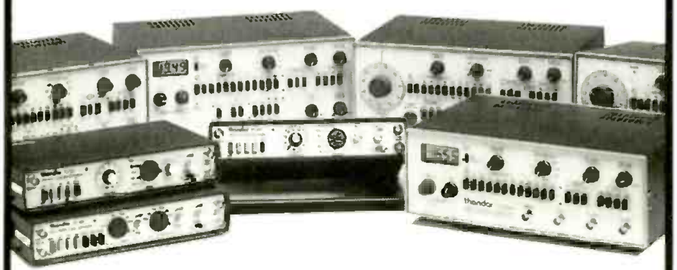
PC, XT, AT, PS/2 and compatible computers,540K. It will automatically use up to 64K of expanded memory. Display VGA, EGA, CGA, Hercules monochrome, Hercules InColor, and AT&T 6300 or compatible video modes.

UK agent for Jandel Scientific is The Core Store Ltd, The Studio, Hawthorn Cottage, Marbury Road, Comberbach, Northwich, Cheshire CW9 6AU. Tel 0606 891980.

UK price £425 plus VAT.

Editorial survey: use the information card to evaluate this article. Item H.

THURLBY THANDAR

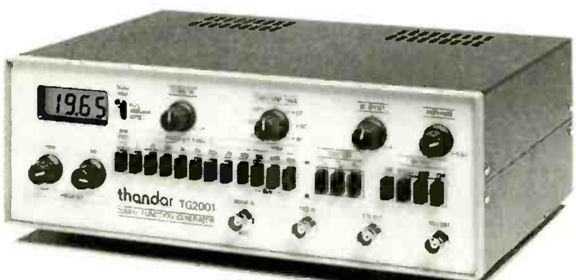


For Function Generators

Whatever your need in function generators, Thurlby-Thandar can supply it.

The range covers maximum frequencies from 200kHz up to 20MHz and includes models with full sweep facilities and models with pulse generator facilities. Prices start from £110 plus VAT.

All our function generators feature high setting accuracy (including digital display on some models), low distortion and precision attenuators.



TG2001

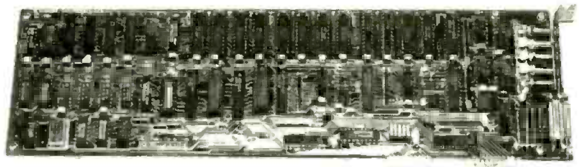
This 20MHz function generator features digital readout of frequency, amplitude and offset, variable symmetry, variable start/stop phase and full trigger facilities. It costs £595 + VAT.

Contact us now for full details of all our generators.

Thurlby-Thandar Ltd.
Glebe Rd., Huntingdon, Cambs. PE18 7DX
Tel: (0480) 412451 Fax: (0480) 450409

CIRCLE NO. 106 ON REPLY CARD

PC WAVEFORM GENERATOR



FEATURES

★ Powerful complex waveform generator
★ Four analogue outputs
★ Five TTL outputs
★ External trigger input
★ Up to 6MHz clock rate
★ Comprehensive software included
★ Standard waveform library
★ User definable waveform library
★ Full graphical editor
★ Time delay, continuous & single shot
★ Example microcode and assembler also included for OEM applications.

APPLICATIONS

★ Arbitrary waveform simulator
★ Low cost ATE
★ Process control
★ Robotics

FREE DEMO DISK ON REQUEST

We also supply a full range of DIY parts for PCs and clones. Call us for more information or a free catalogue.

Designed and manufactured by us in the UK. Full technical support from the designers!

BLACKMORE ELECTRONICS LIMITED

Unit 14A,
Sunrise Business Park,
Blandford Forum,
Dorset. DT11 8ST.
Telephone (0258) 451347
Fax (0258) 456046

CIRCLE NO. 108 ON REPLY CARD

CVC

Chelmer Valve Company

30th Year!

Can we supply the part you need?
Our stocks are very large but if we do not have it we do our best to get it and we know that cost and service count.

Worldwide supplier of
ELECTRONIC VALVES/TUBES, SEMICONDUCTORS AND OTHER COMPONENTS
FOR
SPARES OR PRODUCTION
ANCIENT OR MODERN • SIMPLE OR SOPHISTICATED

AIRBORNE · AUDIO · COMMUNICATION · INDUSTRIAL · AMATEUR · BROADCAST · ENTERTAINMENT · MICROWAVE · OPTO · POWER · PROFESSIONAL · RESEARCH · SHIPBORNE · TRANSMITTER

FAX, PHONE, POST OR TELEX YOUR REQUIREMENTS

130 NEW LONDON ROAD, CHELMSFORD, ESSEX CM2 0RG, ENGLAND
Telephone: (0245) 355296/265865
Telex: 995398 Fax: (0245) 490064

CIRCLE NO. 107 ON REPLY CARD

Understanding NiCds

Why doesn't the terminal voltage determine the health of a NiCd cell? Roy Hill explains.

An electro-chemical cell exhibits an EMF (E) which depends on the energy of the chemical reaction of the cell and falls when the cell discharges. On discharge, the cell voltage (V) is less than E by an amount called the polarisation voltage, which increases with discharge current. This is partly an ohmic voltage drop due to electrode resistance, and partly an EMF due to complex reactions on the surface of the electrodes. The amount of material involved in polarisation reactions must be rather small, since, when the current is stopped, the polarisation voltages soon disappear.

On charge, polarisation voltages are positive, and the cell voltage is higher than E. As the charging reaction approaches completion, the polarisation voltages rise if current is maintained. In the case of lead-acid accumulators this may amount to 20% of the total voltage providing a good indication that the cell is fully charged. It is easy to devise automatic chargers which switch off, or reduce the charging current, when the voltage of a 12V accumulator rises to, say, 14V.

If this is not done, the voltage may rise further, so allowing unwanted secondary reactions of higher E to occur. The decomposition of water to hydrogen and oxygen in the Lead-acid cell is an example: this reaction cannot occur at less than 2V per cell, and requires a rather large extra voltage (overvoltage) to take place at an appreciable rate.

Nickel-cadmium cells

While, in principle, nickel-cadmium cells are similar to lead-acid cells, they involve chemical reactions which behave rather differently, and so require different charging methods.

An important practical difference is that polarisation is much less with nickel-cadmium and, for this reason, the voltage on charge cannot be used to control the charging current. Moreover, it is practically impossible to induce "gassing" in NiCd cells, since E is only 1.2V. Thus, in the absence of a secondary chemical reaction, all the charging energy put into a fully charged cell appears as heat, which may damage the cell through an unacceptable rise in temperature. As a consequence, uncontrolled charging is usually kept to a low rate; about 10% of the ampere/hour capacity.

This practice carries the disadvantage that the performance of the cell may slowly deteriorate in service, particularly so if the charged cell is stored for an appreciable time, or if discharge is slow and intermittent. The reason for this is that the solid reagents of the cell have a tendency to crystallise into larger crystals and aggregates which, having a smaller surface area, become progressively more unreactive. Sometimes large crystal aggregates bridge the cell internally.

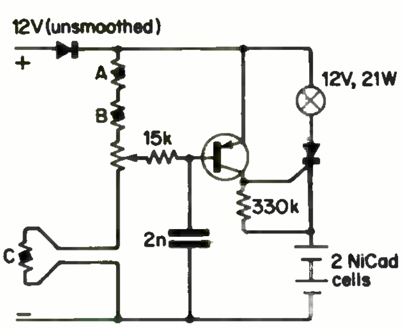
It is a general principle of solid-state chemical reactions, and of solid-state physical transformations, that rapid change promotes the formation of a highly reactive mass of small crystals, whereas slow change favours the growth of existing crystals with a corresponding loss of surface area. High current, high temperature electrolysis favours the formation of a finely divided electrode with good energy storage. It is therefore preferable to charge NiCd cells rapidly, at a rate of one or two times the ampere-hour capacity with charge termination controlled by cell temperature rise.

A CHARGED SITUATION

In a fully charged NiCd cell excess charge appears as heat. The circuit shown, only one of many possibilities, is effective for charging two NiCd cells from a 12V charger.

Thermistor C is attached to one of the cells, conveniently with Blutack, while thermistors A and B afford ambient temperature compensation. The two cells are placed in a battery holder and, after allowing a short time for the temperature to stabilise with the thermistor C is attached to one of them, the potentiometer is advanced until the required charging current is drawn.

When charge is complete, the cells warm up, and the charging current falls to a value which keeps the cell temperature about 12°C above ambient; it should not be allowed to rise above 35°C. This arrangement has been used for AA, C and D type cells, with an average charging current of 1A in each case



HIGH POWER AMPLIFIER For your car, it has 150 watts output. Frequency response 20HZ to 20 KHZ and a signal to noise ratio better than 60db. Has builtin short circuit protection and adjustable input level to suit youe existing car stereo, so needs no pre-amp. Works into speakers ref 30P7 described below. A real bargain at only £57.00 Order ref 57P1.
HIGH POWER CAR SPEAKERS. Stereo pair output 100w each. 4ohm impedance and consisting of 6 1/2" woofer 2" mid range and 1" tweeter. Ideal to work with the amplifier described above. Price per pair £30.00 Order ref 30P7.
PERSONAL STEREOS Customer returns but complete with a pair of stereo headphones very good value at £3.00 ref 3P83.
2KV 500 WATT TRANSFORMERS Suitable for high voltage experiments or as a spare for a microwave oven etc. 250v AC input. £10.00 ref 10P93
MICROWAVE CONTROL PANEL. Mains operated, with touch switches. Complete with 4 digit display, digital clock, and 2 relay outputs one for power and one for pulsed power (programmable). Ideal for all sorts of precision timer applications etc. £6.00 ref 6P18
FIBRE OPTIC CABLE. Stranded optical fibres sheathed in black PVC. Five metre length £7.00 ref 7P29
12V SOLAR CELL. 200mA output Ideal for trickle charging etc. 300 mm square. Our price £15.00 ref 15P42
PASSIVE INFRA-RED MOTION SENSOR.

Complete with daylight sensor, adjustable lights on timer (8 secs -15 mins), 50' range with a 90 deg coverage. Manual overide facility. Complete with wall brackets, bulb holders etc. Brand new and guaranteed. £25.00 ref 25P24.
Pack of two PAR38 bulbs for above unit £12.00 ref 12P43

VIDEO SENDER UNIT Transmit both audio and video signals from either a video camera, video recorder or computer to any standard TV set within a 100' range! (tune TV to a spare channel) 12v DC op. £15.00 ref 15P39 Suitable mains adaptor £5.00 ref 5P191
FM TRANSMITTER housed in a standard working 13A adapter (bug is mains driven). £26.00 ref 26P2
MINATURE RADIO TRANSCEIVERS A pair of walkie talkies with a range of up to 2 kilometres. Units measure 22x52x155mm. Complete with cases. £30.00 ref 30P12
FM CORDLESS MICROPHONE. Small hand held unit with a 500' range! 2 transmit power levels reqs PP3 battery. Tuneable to any FM receiver. Our price £15 ref 15P42A

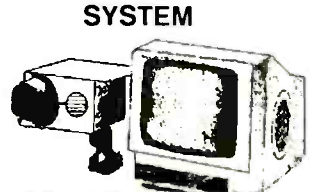
---

10 BAND COMMUNICATIONS RECEIVER. 7 short bands, FM, AM and LW DX/local switch, tuning 'eye' mains or battery. Complete with shoulder strap and mains lead **NOW ONLY £19.00!! REF 19P14.**

WHISPER 2000 LISTENING AID. Enables you to hear sounds that would otherwise be inaudible! Complete with headphones. Cased. £5.00 ref 5P179.
CAR STEREO AND FM RADIO Low cost stereo system giving 5 watts per channel. Signal to noise ratio better than 45db, wow and flutter less than .35%. Neg earth. £25.00 ref 25P21.
LOW COST WALIKIE TALKIES. Pair of battery operated units with a range of about 150'. Our price £8.00 a pair ref 8P50

7 CHANNEL GRAPHIC EQUALIZER plus a 60 watt power ampl 20-21KHZ 4-8R 12-14v DC negative earth. Cased. £25 ref 25P14.
NICAD BATTERIES. Brand new top quality. 4 x AA's £4.00 ref 4P44. 2 x C's £4.00 ref 4P73, 4 x D's £9.00 ref 9P12, 1 x PP3 £6.00 ref 6P35
TOWERS INTERNATIONAL TRANSISTOR SELECTOR GUIDE. The ultimate equivalents book. Latest edition £20.00 ref 20P32.
CABLE TIES. 142mm x 3.2mm white nylon pack of 100 £3.00 ref 3P104. Bumper pack of 1,000 ties £14.00

VIDEO AND AUDIO MONITORING SYSTEM



£99.00

Brand new units consisting of a camera, 14cm monitor, 70 metres of cable, AC adapter, mounting bracket and owners manual. 240v AC or 12v DC operation complete with built in 2 way intercom. £99.00 ref 99P2.

1991 CATALOGUE AVAILABLE NOW IF YOU DO NOT HAVE A COPY PLEASE REQUEST ONE WHEN ORDERING OR SEND US A 6"X9" SAE FOR A FREE COPY.

GEIGER COUNTER KIT. Complete with tube, PCB and all components to build a battery operated geiger counter. £39.00 ref 39P1
FM BUG KIT. New design with PCB embedded coil. Transmits to any FM radio. 9v battery req'd. £5.00 ref 5P158
FM BUG Built and tested superior 9v operation £14.00 ref 14P3
COMPOSITE VIDEO KITS. These convert composite video into separate H sync, V sync and video. 12v DC. £8.00 ref 8P39.
SINCLAIR C5 MOTORS 12v 29A (full load) 3300 rpm 6"x4" 1/4" O/P shaft. New. £20.00 ref 20P22.
As above but with fitted 4 to 1 inline reduction box (800rpm) and toothed nylon belt drive cog £40.00 ref 40P8.
SINCLAIR C5 WHEELS 13" or 16" dia including treaded tyre and inner tube. Wheels are black, spoked one piece poly carbonate. 13" wheel £6.00 ref 6P20, 16" wheel £6.00 ref 6P21.
ELECTRONIC SPEED CONTROL KIT for c5 motor PCB and all components to build a speed controller (0-95% of speed) Uses pulse width modulation. £17.00 ref 17P3.
SOLAR POWERED NICAD CHARGER. Charges 4 AA nicads in 8 hours. Brand new and cased £6.00 ref 6P3.
MOSFETS FOR POWER AMPLIFIERS ETC. 100 watt mosfet pair 2SJ99 and 2SK343 £4.00 a pair with pin out info ref 4P51. Also available is a 2SK413 and a 2SJ118 at £4.00 ref 4P42.
10 MEMORY PUSH BUTTON TELEPHONES. These are 'customer returns' so they may need slight attention. BT approved. £6.00 each ref 6P16 or 2 for £10.00 ref 10P77.
12 VOLT BRUSHLESS FAN 4 1/2" square brand new ideal for boat, car, caravan etc. £5.00 ref 5P206.
ACORN DATA RECORDER ALF503 Made for BBC computer but suitable for others. Includes mains adapter, leads and book. £15.00 ref 15P43
VIDEO TAPES. Three hour superior quality tapes made under licence from the famous JVC company. Pack of 10 tapes £20.00 ref 20P20.

ELECTRONIC SPACESHIP. Sound and impact controlled, responds to claps and shouts and reverses when it hits anything. Kit with complete assembly Instructions £10.00 ref 10P81.

PHILIPS LASER. 2MW HELIUM NEON LASER TUBE. BRAND NEW FULL SPEC £40.00 REF 40P10. MAINS POWER SUPPLY KIT £20.00 REF 20P33 READY BUILT AND TESTED LASER IN ONE CASE £75.00 REF 75P4.

SOLDER 22SWG resin cored solder on a 1/2kg reel. Top quality. £4.00 a reel ref 4P70.
600 WATT HEATERS Ideal for air or liquid, will not corrode, lasts for years. coil type construction 3"x2" mounted on a 4" dia metal plate for easy fixing. £3.00 ea ref 3P78 or 4 for £10.00 ref 10P76.
TIME AND TEMPERATURE MODULE A clock, digital thermometer (Celcius and Farenheit (0-160 deg F) programmable too hot and too cold alarms. Runs for at least a year on one AA battery. £9.00 ref 9P5.
Remote temperature probe for above unit £3.00 ref 3P60.
GEARBOX KITS Ideal for models etc. Contains 18 gears (2 of each size) 4x50mm axles and a powerful 9-12v motor. All the gears etc are push fit. £3.00 for complete kit ref 3P93.
ELECTRONIC TICKET MACHINES These units contain a magnetic card reader, two matrix printers, motors, sensors and loads of electronic components etc. (12"x12"x7") Good value at £12.00 ref 12P28.
JOYSTICKS. Brand new with 2 fire buttons and suction feet these units can be modified for most computers by changing the connector etc. Price is 2 for £5.00 ref 5P174.
GAS POWERED SOLDERING IRON AND BLOW TORCH Top quality tool with interchangeable heads and metal body. Fully adjustable, runs on lighter gas. £10.00 ref 10P130
SMOKE ALARMS Ionization type 5 year warranty complete with battery only £5.00 ref 5P206
ANSWER MACHINES BT approved remote message playback, intergral push button phone, power supply and tape. Exceptional value at £45.00 ref 45P2
CAR IONIZER KIT Improve the air in your car! clears smoke and helps to reduce fatigue. Case required. £12.00 ref 12P8.
6V 10AH LEAD ACID sealed battery by yuasha ex equipment but in excellent condition now only 2 for £10.00 ref 10P95.
12 TO 220V INVERTER KIT As supplied it will handle up to about 15w at 220v but with a larger transformer it will handle 80 watts. Basic kit £12.00 ref 12P17. Larger transformer £12.00 ref 12P41.
VERO EASI WIRE PROTOTYPING SYSTEM Ideal for designing projects on etc. Complete with tools, wire and reusable board. Our price £6.00 ref 6P33.
MICROWAVE TURNTABLE MOTORS. Ideal for window displays etc. £5.00 ref 5P165.
STC SWITCHED MODE POWER SUPPLY 220v or 110v input giving 5v at 2A, +24v at 0.25A, +12v at 0.15A and +90v at 0.4A £6.00 ref 6P59
TELEPHONE AUTODIALLERS. These units, when triggered will automatically dial any telephone number. Originally made for alarm panels. BT approved. £12.00 ref 12P23 (please state telephone no req'd).
25 WATT STEREO AMPLIFIERc. STK043. With the addition of a handful of components you can build a 25 watt amplifier. £4.00 ref 4P69 (Circuit dia included).
LINEAR POWER SUPPLY Brand new 220v input +5 at 3A, +12 at 1A, -12 at 1A. Short circuit protected. £12.00 ref 12P21.
MAINS FANS Snail type construction. Approx 4"x5" mounted on a metal plate for easy fixing. New £5.00 5P166.
POWERFUL IONIZER KIT. Generates 10 times more ions than commercial units! Complete kit including case £18.00 ref 18P2.
MINI RADIO MODULE Only 2" square with ferrite aerial and tuner. Superhet. Req's PP3 battery. £1.00 ref BD716.
HIGH RESOLUTION MONITOR. 9" black and white Phillips tube in chassis made for OPD computer but may be suitable for others. £20.00 ref 20P26.

BARGAIN NICADS AAA SIZE 200MAH 1.2V PACK OF 10 £4.00 REF 4P92, PACK OF 100 £30.00 REF 30P16

CB CONVERTORS. Converts a car radio into an AM CB receiver. Cased with circuit diagram. £4.00 ref 4P48.
FLOPPY DISCS. Pack of 15 31/2" DSDD £10.00 ref 10P88. Pack of 10 51/4" DSDD £5.00 ref 5P168.
SONIC CONTROLLED MOTOR One click to start, two click to reverse direction, 3 click to stop! £3.00 each ref 3P137.
FRESNEL MAGNIFYING LENS 83 x 52mm £1.00 ref BD827.

BULL ELECTRICAL

250 PORTLAND ROAD HOVE SUSSEX BN3 5QT TELEPHONE 0273 203500
MAIL ORDER TERMS: CASH PO OR CHEQUE WITH ORDER PLUS £2.50 POST PLUS VAT.
PLEASE ALLOW 10-14 DAYS FOR DELIVERY

FAX 0273 23077

LCD DISPLAY. 4 1/2 digits supplied with connection data £3.00 ref 3P77 or 5 for £10.00 ref 10P78.
ALARM TRANSMITTERS. No data avaliable but nicely made complex transmitters 9v operation. £4.00 each ref 4P81.
100M REEL OF WHITE BELL WIRE figure 8 pattern ideal for intercoms, door bells etc £3.00 a reel ref 3P107.
TRANSMITTER RECEIVER SYSTEM originally made for nurse call systems they consist of a pendant style transmitter and a receiver with telescopic aerial 12v. 80 different channels. £12.00 ref 12P26
CLAP LIGHT. This device turns on a lamp at a finger 'snap' etc. nicely cased with built in battery operated light. Ideal bedside light etc £4.00 each ref 4P82.
ELECTRONIC DIPSTICK KIT. Contains all you need to build an electronic device to give a 10 level liquid indicator. £5.00 (ex case) ref 5P194.
UNIVERSAL BATTERY CHARGER. Takes AA's, C's, D's and PP3 nicads. Holds up to 5 batteries at once. New and cased, mains operated. £6.00 ref 6P36.
ONE THOUSAND CABLE TIES! 75mm x 2.4mm white nylon cable ties only £5.00 ref 5P181.
PC MODEMS 1200/75 baud modems designed to plug into a PC complete with manual but no software £18.00 ref 18P12
ASTEC SWITCHED MODE POWER SUPPLY 80mm x 165mm (PCB size) gives +5 at 3.75A, +12 at 1.5A, -12 at 0.4A. Brand new £12.00 ref 12P39.
VENTILATED CASE FOR ABOVE PSU with IEC filtered socket and power switch. £5.00 ref 5P190.
IN CAR POWER SUPPLY. Plugs into cigar socket and gives 3,4,5,6,7.5,9, and 12v outputs at 800mA. Complete with universal spider plug. £5.00 ref 5P167.
CUSTOMER RETURNED switched mode power supplies. Mixed type, good for spares or repair. £2.00 each ref 2P292.
DRILL OPERATED PUMP. Fits any drill and is self priming. £3.00 ref 3P140.
PERSONAL ATTACK ALARM. Complete with built in torch and vanity mirror. Pocket sized, req's 3 AA batteries. £3.00 ref 3P135
POWERFUL SOLAR CELL 1AMP .45 VOLT only £5.00 ref 5P192 (other sizes avaliable in catalogue).
SOLAR PROJECT KIT. Consists of a solar cell, special DC motor, plastic fan and turntables etc plus a 20 page book on solar energy! Price is £8.00 ref 8P51.
RESISTOR PACK. 10 x 50 values (500 resistors) all 1/4 watt 2% metal film. £5.00 ref 5P170.
CAPACITOR PACK 1. 100 assorted non electrolytic capacitors £2.00 ref 2P286.
CAPACITOR PACK 2. 40 assorted electrolytic capacitors £2.00 ref 2P287.
QUICK CUPPA? 12v immersion heater with lead and cigar lighter plug £3.00 ref 3P92.
LED PACK. 50 red leds, 50 green leds and 50 yellow leds all 5mm £8.00 ref 8P52
FERRARI TESTAROSSA. A true 2 channel radio controlled car with forward, reverse, 2 gears plus turbo. Working headlights. £22.00 ref 22P6.
ULTRASONIC WIRELESS ALARM SYSTEM. Two units, one a sensor which plugs into a 13A socket in the area you wish to protect. The other, a central alarm unit plugs into any other socket elsewere in the building. When the sensor is triggered (by body movement etc) the alarm sounds. Adjustable sensitivity. Price per pair £20.00 ref 20P34. Additional sensors (max 5 per alarm unit) £11.00 ref 11P6.
TOP QUALITY MICROPHONE. Unidirectional electret condenser mic 600 ohm sensitivity 16-18khz built in chime complete with magnetic microphone stand and mic clip. £12.00 ref 12P42.
WASHING MACHINE PUMP. Mains operated new pump. Not self priming. £5.00 ref 5P18.
IBM PRINTER LEAD. (D25 to centronics plug) 2 metre parallel. £5.00 ref 5P186.
COPPER CLAD STRIP BOARD 17" x 4" of .1" pitch "vero" board. £4.00 a sheet ref 4P62 or 2 sheets for £7.00 ref 7P22.
STRIP BOARD CUTTING TOOL. £2.00 ref 2P352.
3 1/2" disc drive. 720K capacity made by NEC £60.00 ref 60P2
TV LOUDSPEAKERS. 5 watt magnetically screened 4 ohm 55 x 125mm. £3.00 a pair ref 3P109.
TV LOUDSPEAKERS. 3 watt 8 ohm magnetically screened 70 x 50mm. £3.00 a pair ref 3P108.
BBC TRACKBALLS Once again in stock only £4.00 ref 4P86
CROSS OVER NETWORKS 8 ohm 3 way Japanese made units Excellent units avaliable at only £2.00 for a pair! ref 2P363
SPEAKER GRILLS set of 3 matching grills of different diameters. 2 packs for £2.00 (6 grills) ref 2P364
50 METRES OF MAINS CABLE £3.00 2 core black precut in convenient 2 m lengths. Ideal for repairs and projects. ref 3P91
4 CORE SCREENED AUDIO CABLE 24 METRES £2.00 Precut into convenient 1.2 m lengths. Ref 2P365
TWEETERS 2 1/4" DIA 8 ohm mounted on a smart metal plate for easy fixing £2.00 ref 2P366
COMPUTER MICE Originally made for Future PC's but can be adapted for other machines. Swiss made £8.00 ref 8P57. Atari ST conversion kit £2.00 ref 2P362.
6 1/2" 20 WATT SPEAKER Built in tweeter 4 ohm £5.00 ref 5P205
5" X 3" 16 OHM SPEAKER 3 for £1.00!! ref CD213
ADJUSTABLE SPEAKER BRACKETS Ideal for mounting speakers on internal or external corners, uneven surfaces etc. 2 for £5.00 ref 5P207
PIR LIGHT SWITCH Replaces a standard light switch in seconds light operates when anybody comes within detection range (4m) and stays on for an adjustable time (15 secs to 15 mins). Complete with daylight sensor. Unit also functions as a dimmer switch! 200 watt max. Not suitable for flourescents. £14.00 ref 14P10
2 MEG DISC DRIVES 3 1/2" disc drives made by Sony housed in a 5 1/4" frame 1.2 meg formatted. £66.00 ref 66P1
360K 3 1/2" DISC DRIVES 1/2 height £25.00 ref 25P26
40 CHANNEL TRANSCEIVER 4 WATT OUTPUT, HANDHELD SQUELCH CONTROL ETC £70.00 EACH REF 70P1
OR AVALIABLE AS A PAIR WITH NICAD BATTERY PACKS FOR £150.00 REF 150P1
Illuminated channel display, 10 section aerial, Hi-Low power switch, external aerial socket, DC charger socket, 12v DC power socket, carrying strap and owners manual.

SOME OF OUR PRODUCTS MAY BE UNLICENSABLE IN THE UK

CIRCLE NO. 123 ON REPLY CARD

pcengineering

Acquiring the capability

Before a PC can analyse the data, you need to capture it first. Andy Gothard investigates the data acquisition market.

Raw facts and figures can often be difficult to turn into useful information, with a context, a relevance, and usefulness.

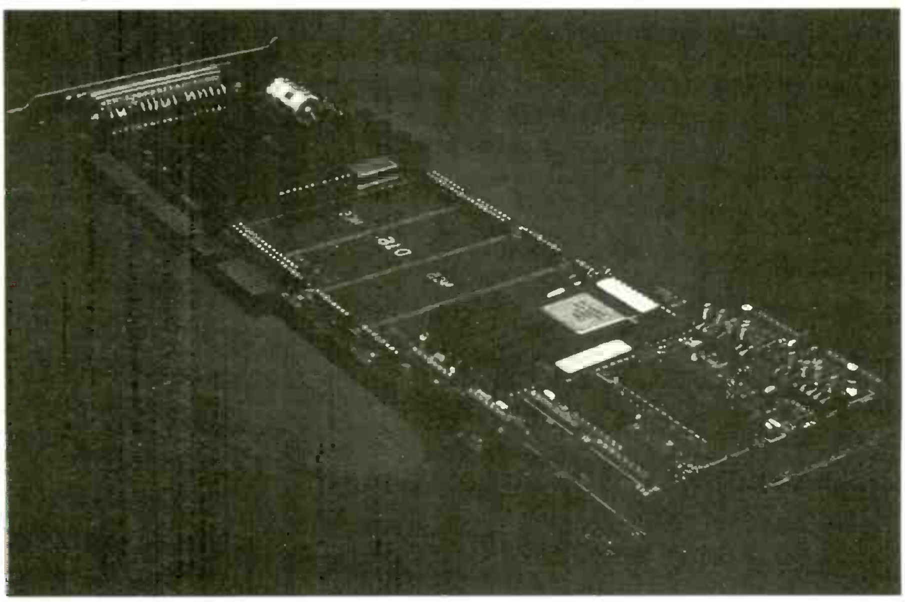
Fortunately, computers are very good at turning big chunks of data into something meaningful, and that explains why the familiar desktop PC now has so many extras available to enable it to collect data automatically. Data goes in; and — bingo! — out comes information, without anyone ever having to worry about all that troublesome data.

Or that's the theory. In practice, someone has to decide how the computer will do the conversion, and then produce relevant software: lesson one of data acquisition for personal computers - no matter how powerful your hardware, results will only be as good as the software which supports it.

This month's data acquisition buyer's guide surveys some 60 companies supplying hardware and software.

Representatives of all the common equipment types are there; from dedicated

PC board with a miniature transputer module on the top from Sunnyside Systems, demonstrating some of the creative solutions now possible with PC plug-ins.



instrumentation to send data down an RS232 serial link; to equipment which the computer can control via the general purpose instrumentation bus (GPIB, or IEEE488) protocol; to PCbus and Nubus cards plugging directly into the computer and having circuitry to convert outside-world signals into computer data.

On the software side, packages can create an instrument front panel on the computer screen; collect data and produce statistics, trends and graphs; or are just basic code merely allowing the operating system to talk to installed hardware.

As computer expansion slots can incorporate the necessary acquisition hardware directly in the machine, it may seem irrelevant to look at systems which put the electronic signal conditioning circuitry in a separate unit.

But often a system will be dealing with data from several different physical locations, and so it makes sense to turn the data into something the computer can understand on site, and then transmit it over a link. Separate units may also be desirable to keep high voltage signals, or signals susceptible to external interference — such as spikes, out of the computer box itself, if only for safety's sake.

Remote data collection can be performed either by rack mounted data acquisition modules, or by traditional standalone instruments.

In the latter category, many counters, oscilloscopes and analysers include a GPIB or RS232 interface to receive commands, and send back data. Computers can be equipped with a GPIB controller card for less than £200, or an RS232 add-in for around £100.

Manufacturers such as Hitachi Denshi are now producing PC software to handle real-time and post acquisition processing. Packages allow the computer to display rise and fall times, and perform fast Fourier transforms and other mathematical tricks (such as summing, scaling, and trig functions) on data captured by a standard oscilloscope.

Hitachi says its experience in producing stand-alone instruments means that the software itself is intuitively easier to understand, and more closely tuned to the data provided by the hardware.

Just as techniques vary, so do applications. Tasks can span single engineers trouble-shooting with a pair of probes; production testing of refrigerators, or control and monitoring of power stations.

There is also a growing market for cards which talk direct to the bus.

Digital I/O is about the simplest function to perform, and plug-in hardware is available to cope with anything between four and 200 lines of input/output. Incidentally, in high channel-count applications, the physical technique used to connect the card to the outside world is important as there is little point in choosing a, neat, integrated solution which leaves hundreds of unidentified wires strewn about the place.

Hardware is cheap, so there is surprisingly little variation in prices.

Digital I/O cards cost from under £100 to £300, but most of the differences indicate different levels of support, rather than real function.

SUPERVISORY ROLE FOR THE PC

The PC and its dos operating system were not designed for control applications, so it often makes little sense to give a PC ultimate control of a critical process.

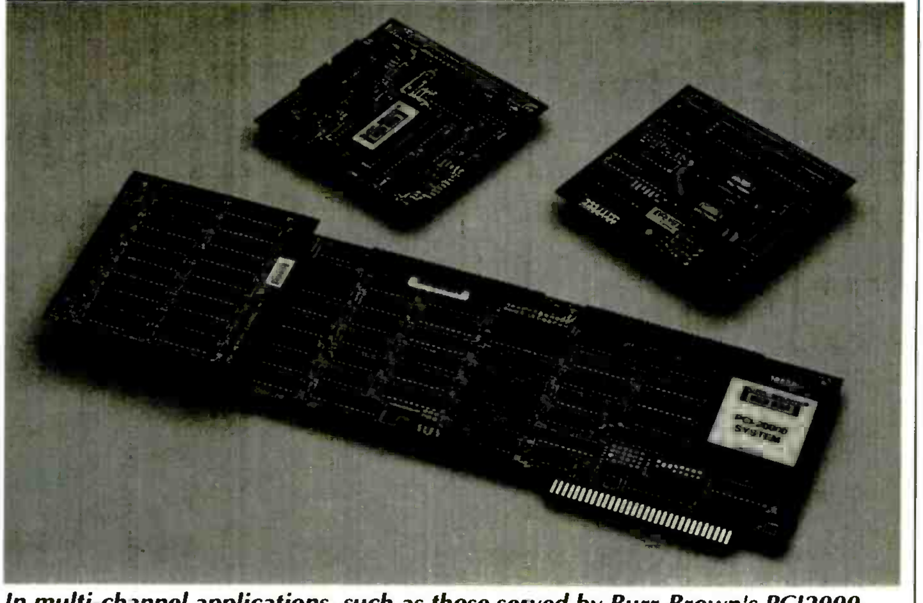
Where the PC does come into its own is when data analysis and an operator interface are required, a role known as scada (supervisory control and data acquisition).

For example, a power station's furnaces might be controlled by some form of programmable logic — the PC would not be trusted to prevent the furnace running out of control when a fault develops.

But the control room might well be provided with PCs and screens, for collection and display of data on the average temperature of the furnaces, for instance. This data could be used to make sure the station is using fuel efficiently, producing power when required, and so on.

The PC lends itself to these applications not only because it can provide an easily understood interface, but also because of the wealth of statistical analysis software available off the shelf.

Aside from dedicated scada software packages, many data acquisition programs will provide data in a form which can be passed to standard spreadsheets and databases for off-line analysis.



In multi-channel applications, such as those served by Burr-Brown's PCI2000 system, the physical technique used to connect the card to the outside world is important if birds' nests of trailing wires are to be avoided.

DIGITAL SIGNAL PROCESSING

Digital signal processing is one of electronics' growth areas, and much of the post-acquisition work to be done on data falls into this broad category. Many processing packages can make use of a host's maths co-processor, but if the burden of coping with data acquisition becomes too heavy, the ordinary functions of the computer itself may suffer.

A dedicated application accelerator card can be used to ease the burden on the host, but these are relatively expensive, often costing over £1000. They contain their own processor chip, memory, and application code, leaving the host to deal with file management and the user interface. An extra DSP may also be included, for instance the Motorola 56K, designed to execute routines such as Fourier transforms with efficiency.

As with general purpose application accelerators, application code can be generated using C, Fortran, or Basic, and a set of library functions is often included. Aside from the more general-purpose application accelerators, boards for acquisition and processing will include analogue and digital inputs, and a smaller number of corresponding outputs.

Library functions include time-stamping, averaging, maximum and minimum detection, and digital filtering.

Amplicon's effort in this field also includes a set of display routines, allowing the production of bar and line graphs and scatter plots, as well as facilities for passing data to common analysis packages such as Lotus 1-2-3 and Labwindows.

Using application accelerators in this way can allow large amounts of real-time data to be handled in the same way that the host would cope with a data file, without degrading the PC's performance.

Could the growth in PC cards see the PC becoming a familiar sight on the manufacturing shop floor?

Some cards are intended to be installed like computer peripherals - the user sets them up via dos in much the same way that a fax card or extra disk drive can be included. Others need device drivers, and rather more complex mappings into the computer bus I/O space.

But various ways can make the integration process easier, from the provision of identity registers on-card, which the computer can interrogate, to full "plug in and drive" front-end software. For example one vendor has a high channel-count digital I/O board, intended for production test applications, costing around £250. High level support software, which allows the user to write routines containing loops, alarm points etc costs an extra £650.

Analogue cards cost a little more, at

USEFUL ADDRESSES

ABA Electronics
4, Hunting Gate
Eastport Way
Andover
Hants
SP10 3SJ
0264 335025
Hardware

Aces
Aces House
St George's Avenue
Poole
Dorset
BH12 4ND
0202 723373
Hardware, software, systems integration

Adaptive Computing
Crabtree Farm Estate
Skiff Lane
Wisborough Green
West Sussex
RH14 0AD
0403 753333

Adept Scientific
6, Business Centre
West Avenue One
Letchworth
Herts
SG6 2HB
0462 480055
Acquisition software and hardware

Amplicon
Centenary Industrial Estate
Brighton
East Sussex
BN2 4AW
0273 608331
Hardware, acquisition software

Anville Instruments
Watchmoor Trading Centre
Camberley
GU15 3AJ
0276 684613
Hardware, software, systems integration

Arcom
Unit 8
Clifton Road
Cambridge
CB1 4WH
0223 411200
Hardware, systems integration

Aries Electronics (Europe)
Unit 3
Furtho Ct
Towcester Road
Old Stratford
Milton Keynes
MK19 6AQ
0908 260007
Hardware

Artistic Licence
Unit 28
Bridge Park
Brentford
Harrow Road
London NW10 0RG
081 961 9520
Hardware

F W O Bauch
49, Theobald Street
Borehamwood
Herts
081 953 0091
Video hardware

Belstock Controls
10, Moss Hall Crescent
Finchley
London
N12 8NY
081 446 8210
Hardware, software

Biodata
10 Stock Street
Manchester
M8 8QJ
061 834 6688
Hardware, software, systems integration

Blue Chip Technology
Hawarden Industrial Park
Manor Lane
Deeside
Clwyd
CH5 3PP
0244 520222
Hardware, SCADA software

Burr Brown/Intelligent Instrumentation
1, Millfield House
Woodshots Meadow
Croxley Centre
Watford
Herts
WD1 8YX
0923 33837
Hardware, software

Calcomp
0462 436161
Graphics hardware

Calex Instrumentation
PO Box 2
Leighton Buzzard
Beds
LU7 8WZ
0525 373178

Chronos
Upton Bishop
Ross on Wye
Hereford
HR9 7UL
0989 85471

Computer General
13, Campbell Court
Bramley
Basingstoke
Hants
RG26 5EG
0256 882760

Consort Electronics
Rosebank Parade
Reading Road
Yateley
Camberley
Surrey
GU17 7RN
0252 871717
Hardware

Control Universal
137 Ditton Walk
Cambridge
CB5 8QF
0223 244447
Hardware, software

Craft Data
92 Broad Street
Chesham
Bucks
HP5 3ED
0494 778235

Datrontech Ltd
Grosvenor House
33 Grovenor Road
Aldershot
Hants
GU11 3DP
02252 31315

DCA Technology
Systems House
Petersfield Business Park
Petersfield
Hants
GU32 3QA
0730 60699
Test and analysis hardware and software

DDC UK Ltd
Mill Reef House
9 Cheap Street
Newbury
Berks
RG14 5DD
0635 40158
Hardware

Dean Microsystems
11 Horseshoe Park
Pangbourne
Berkshire
RG8 7JW
0734 842165
Hardware, software, systems integration

Data Translation
The Mulberry Business Park
Wokingham
Berks
RG11 2QJ
0734 793838
Hardware, software

Diamond Point International
9 North Point Business Estate
Enterprise Close
Medway City Estate
Rochester upon Medway
Kent
ME2 4L4
0634 722390
Hardware, software, systems integration

DIAN Micro Systems
Bredbury Business Park
Bredbury Parkway
Bredbury
Stockport SK6 2SN
061 406 6766
Control software

Digithurst Ltd
Newark Close
Royston
Herts
SG8 5HL
0763 242855

DSP Design
1 Apollo Studios
Charlton Kings Road
London
NW5 2SB
071 482 1773
Hardware

Emulex
Mulberry Business Park
Fishponds Road
Wokingham
RG11 2QY

Continued on page 508

upwards of £200, though some low cost versions could set the buyer back as little as £125.

Once again, software and support is the key.

Combination digital/analogue cards also carry a slight price premium and cards and software for the Macintosh tend to be considerably more expensive than their IBM PC equivalents.A common technical difficulty is when more than one card is installed in the same computer.

Neither the Mac nor PC are set up to act like an industrial bus system so compatibility problems can arise. This is particularly the case when using interrupts, and where the acquisition card needs to take over the bus to transfer large amounts of data to main memory using DMA.

The problem is a good argument for sticking to a single supplier if the system itself is to be any more than a convenient addendum to a single engineer's bench; if two vendors' cards refuse to work in tandem, who solves the problem? Buyers who stick to one vendor then, at least in theory, know who to complain to when things go wrong.

In addition to various speed and channel count analogue and digital I/Os, specialist cards are available for functions such as pulse counting and timing, thermocouple input, and synchro-to-digital conversion.

Some hardware/software combinations aim to produce a virtual instrument, making the computer work as a digital multimeter, or storage oscilloscope; prices are extremely variable. Amplicon has oscilloscope software which sells at around £300; Blue Chip Technology offers a hardware/software DMM weighing in at below £500.

Software prices are similarly unpredictable. User interfaces which allow programming of a system, either via a text editor or interconnecting icons on the screen, can cost anything between a few hundred and a couple of thousand pounds.

The application-specific nature of analysis software to process data means it is often supplied as a custom product, or offered in modular form.

Larger projects often rely on the services of a systems integration house to provide the custom software, or modules from a standard suite, and ensure all the component parts fall into a working system.

Editorial survey: use the information card to evaluate this article. Item J.

USEFUL ADDRESSES

ERS
36-38 St Peter's Gate
Stockport
Cheshire
SK1 1HD
061 476 5750
SCADA software

Fairchild
Eastpoint
Burgoyne Road
Thornhill
Southampton
SO2 6PB
0421 216527
Hardware, software

FCC Systems
The Old Armoury
Court Barton
Crewkerne
Somerset
TA18 7HP
0460 73442

Foxboro GB Ltd
Churchill Court
Manor Royal
Crawley
W Sussex
RH10 2PN
0293 526000

Furnace Instruments
Harwood Street
Sheffield
0742 731608
Temperature measurement and profiling

Gothic Crellon
3, The Business Centre
Molly Millars Lane
Wokingham
Berks
RG11 2EY
0734 788878
Hardware

Hexatec
The Courtyard
Ochrelands
Hexham
Northumberland
NE46 1SB
0434 605575
SCADA software, systems integration

Hitachi Denshi
13, Garrick Industrial Centre
Irving Way
Hendon
London
NW9 6AQ
081 202 4311
Instrumentation hardware, software

Instrumatic
Globe Park
Marlow
Bucks
SL7 1YA
0628 476741
Hardware

Integrated Data Systems
2 Hall Road
Hemel Hemstead
HP2 7BX
0442 65256

Integrated Measurement Systems
306 Solent Business Centre
Millbrook Road West
Southampton
SO1 0HW
0703 771143

Keithley Metrabyte
The Minster
58, Portman Road
Reading
Berks
RG3 1BR
0734 575666
Hardware, software

Laplace Instruments
Masters House
Bexton Road
Knutsford
Cheshire
WA16 0BU
0565 50268
Hardware

Lee Dickens
Rushton Road
Desborough
Kettering
Northants
NN14 2QW
0536 760156
Hardware, software

Lighthouse Electronics
Norfolk House
Norfolk Way
Uckfield
East Sussex
TN22 1EP
0825 768849
Hardware, software

Loughborough Sound Images
The Technology Centre
Epinal Way
Loughborough
Leicester
0509 231843
Hardware, software

Lyons Instruments
Ware Road
Hodd
Herts
EN11 9DX
0992 467161

Microsol
Unit 28
IDA Centre
Dublin 2
Ireland
010 3531 716255
Hardware, software

Microway
32 High Street
Kingston upon Thames
Surrey
KT1 1HL
081 541 5466
Hardware, software

Nano Computing
2-4 Theatre Ct
Northwich
CW9 5HB
0606 49937

National Instruments
Unit 21
Kingfisher Court
Newbury
Berks
RG14 5SJ
0635 523545
Hardware, software

Nevin
48 Charlton Road
Andowver
Hants
SP10 3JL
0264 332122

Nucleus Software
Unit 1
Arkwright Road
Bedford
MK42 0LQ
0234 273133
SCADA software

Oasis Data Converters
The Street
Old Costessey
Norwich
NR8 5DF
0603 747887
Data acquisition harware, software and DSP boards

Professional Solutions
18, Dalston Gardens
Stanmore
Middx
HA7 1DA
081 206 2095
Hardware

Protech Instruments
241 Selbourne Road
Luton
LU4 8NP
0582 596181
SCADA software

Racal Instruments
480 Bath Road
Slough
Berks
SL1 6BE
0628 604455

Rotork Activation
Brassmill Land
Lower Weston
Bath
BA1 3JQ
0225 428451
SCADA software

Status Instruments
Green Lane
Tewkesbury
Gloucester
GL20 8HE
0684 296818
Analysis software

Sunnyside Systems
Rosebank Nursery
Kirkton Campus
Livingstone
EH54 7AN
Scotland
0506 460345
Hardware, software

Test Data Systems
St John's Innovation Centre
Cowley Road
Cambridge
0223 421162
Hardware

3D Digital Design and Development
Interface House
Chelmsford Road
Southgate
London
N14 4JN
081 886 3668
Hardware, software

Xycom Europe
21 Tenter Road
Molton Park
Northampton
NN1 8AX
0604 790767
SCADA software

Cross-modulation in the sky?

RF engineers are well aware that non-linearity breeds cross modulation. But Anthony Garrett suggests it can also occur in the ionosphere.

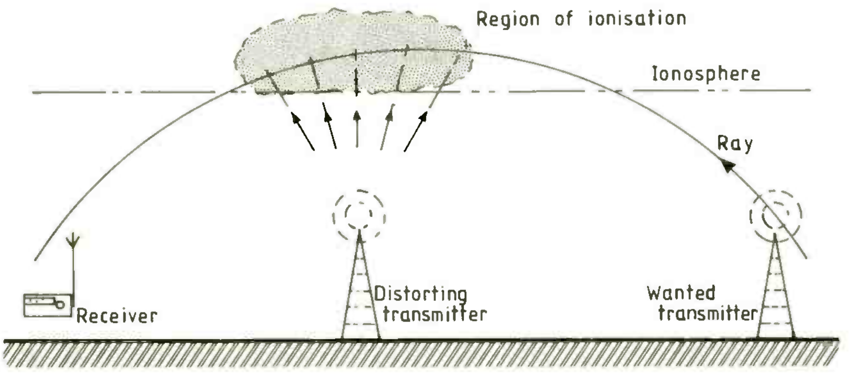
If you have ever been irritated by hearing one radio station superimposed on top of another of a different frequency, you have been listening to cross modulation.

The effect is distinct from, and rarer than, overhearing one station on top of another on the same frequency. Two stations of the same frequency are always picked up simultaneously, but if broadcasting authorities are cooperating properly, one signal will be so strong in its area of intended reception that the ear generally cannot distinguish the other. Sometimes freak propagation effects cause the signal of the second to be channelled through the ionosphere to the receiver with much less attenuation, and it will be overheard.

But this is not cross-modulation, which involves stations of different broadcasting frequencies. To tell the difference you need a radio ham's list of stations and frequencies. To explain why cross modulation takes place we should first look at how the ionised plasma in the ionosphere interacts with electromagnetic waves.

Since charge is the source of electric fields, a plasma has a large effect on an electromagnetic wave propagating through it.

The ionospheric plasma is not uniform in density, because the sun's rays are more powerful higher up and there are more atoms available to be ionised lower down. The effect is to bend radio waves so that they eventually return to Earth and make long-distance radio transmission is possible.



Non linear system?: the principle of ionospheric cross modulation can be explained by this illustration sent in to EW + WW by Anthony Hopwood. A powerful transmitter along the signal path varies reflectivity of the ionosphere causing cross modulation of incident radio waves. Hopwood first floated the idea of artificial ionospheric reflectors in a letter published in EW + WW last year.

IONOSPHERIC ACTIVITY

Above the stratosphere and the weather, from about thirty kilometres up, is the ionosphere where the sun's rays are powerful enough to strip negatively charged electrons away from the positively charged nuclei around which they orbit in an atom.

Energy is needed to pull the charges apart because they are of opposite sign, and opposite charges attract. The result is a free electron and a positively charged ion, and the process is called ionisation.

There is a balance between the number of electrons and ions pulled apart by the sun's rays and the number which spontaneously recombine under their own attraction.

A medium containing many charged particles is called a plasma, and it has very different properties from an un-ionised gas, because the forces between charges retain their strength over far greater distances than the forces between atoms having no net charge.

(Even the weak forces between atoms are due to forces between the charges within the atoms.)

The clue to ionospheric cross-modulation is that the unwanted or disturbing transmitter always lies between the receiver and the wanted transmitter. This strongly suggests that it is an interaction between the signals which takes place within the part of the ionosphere where both waves co-exist.

Normally, a single wave propagating through the ionospheric plasma disturbs it to an amount proportional to the size of the wave. Two or more waves propagate independently, each disturbing the plasma as if the others were not there.

Total disturbance of the plasma is found by adding the disturbances caused by each wave separately. The waves deposit no net energy in the plasma, and the energy of the waves just passes through. But if a wave is powerful enough, it does now transfer energy to the electrons, which in turn pass it on to neutral atoms and molecules with which they collide.

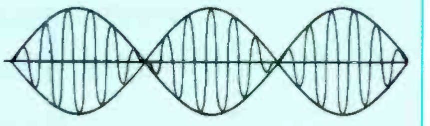
This energy transfer modifies the plasma over and above the usual disturbances ("non-linearly"), and any other wave propagating through it feels this.

If the powerful disturbing wave is modulated, this modulation is imprinted on the rate at which energy is transferred to the electrons and so on to the fundamental properties of the plasma; and then on to any other wave passing through.

THE SIGNS OF CROSS MODULATION

Intermodulation results when two discrete signals pass through a non-linear system such as an semiconductor junction, multiplier mixer circuit. The author hypothesises that the ionosphere may also operate as a non-linear system.

In the conventional sense, the ionosphere acts as a patchy, rather imperfect mirror of incident radio waves reflected by the electrically conductive plasma of which it is comprised. The characteristics of a reflected signal are frequent lapses into deep fading and envelope distortion, the result of multipath refections and phase cancellations. A standard AM broadcast signal with sinusoid modulation typically degenerates into the envelope shape shown (right). There can be brief periods of total cancellation.



The author hypothesises that a second, high powered signal could cause the degree of ionisation to vary with its modulation envelope and thus cause a modulation of the path loss suffered by a reflected low power signal. One would expect the interfering signal to have its greatest effect (as recorded at the receiving station) during periods of what would normally be a deep fade in the reflected signal path: any change at all in the composition of the ionosphere would have a disproportionate effect on the degree of cancellation. The interfering signal would be very much in the background at other times - if it can be heard at all.

Any form of non-linearity in the front end of the receiver system might cause two (or more) signals to be heard simultaneously. However, this effect is totally predictable and, one supposes, discountable. **FO**

This is the basis of the effect. Energy typically takes about one thousandth of a second to work its way from the wave to the molecules by collisions with electrons.

In 1959 David Layzer and Donald Menzel in the US worked out a kinetic theory of cross-modulation in the ionosphere — though their theory did not include the important effect of the Earth's magnetic field.

If a permanent magnetic field is present, electrons orbit round its direction at a definite frequency, and a wave whose fundamental frequency is close to this will kick the electrons in phase at each revolution and transfer much more energy than otherwise — resonance. Inclusion of the Earth's magnetic field is lengthy but is ultimately only a matter of detail. It is of course essential in order to compare with experiment.

Since the effect takes place in the ionosphere, there is no way of designing a transmitter and receiver to eliminate it. The only good advice is not to broadcast really powerful signals on or near to the resonance, or gyro-frequency.

The news is not all bad, though: the effect has been used as a tool for learning more about electron collisions in the ionosphere, and this tells us more about radio wave attenuation, and how powerful a transmitter would be needed to reach given parts of the world.

Dr Anthony JM Garrett is attached to the Department of Physics & Astronomy, University of Glasgow.

Editorial survey: use the information card to evaluate this article. Item K

FIRST REPORTS

Cross-modulation was reported in 1933 by BDH Tellegen of the Philips Laboratories in Eindhoven, Holland, in a brief letter to the scientific journal Nature published on 10 June.

Tellegen had overheard the nihile listening to several other stations whose transmitters, heard from Eindhoven, lay beyond Luxembourg.

Tellegen took pains to eliminate possible causes within the receiver used, and made a low-key suggestion that the effect had its origin somewhere between transmitter and receiver. His caution was because no interaction between radio waves propagating through the ionosphere had been observed before.

Almost simultaneously a report appeared in *World-Radio*, the weekly technical and overseas magazine of the British Broadcasting Company, then conveying very much a pioneer spirit and a stiff upper lip.

A subscriber called AG Butt, in Plymouth reported overhearing Radio Paris while tuned to Radio Luxembourg. Butt also listed some stations over which Paris could not be heard, most of them in very different directions from that of Paris. Unlike Tellegen, he made no attempt to eliminate effects from within the commercial receiver used .

FIRST THEORIES

Victor Bailey, a physics professor at the University of Sydney, together with DF Martyn, a physicist with the Radio Research Board who worked in the University's Department of Electrical Engineering, applied JS Townsend's ideas on electrons in gases and explained what was happening in the ionospheric plasma to cause cross modulation.

Their joint paper was published in the *Philosophical Magazine*, a prestigious physics publication, in 1934 and the theory predicts that higher harmonics of the modulation frequencies, in particular the second harmonic at double a frequency, will also be overheard.

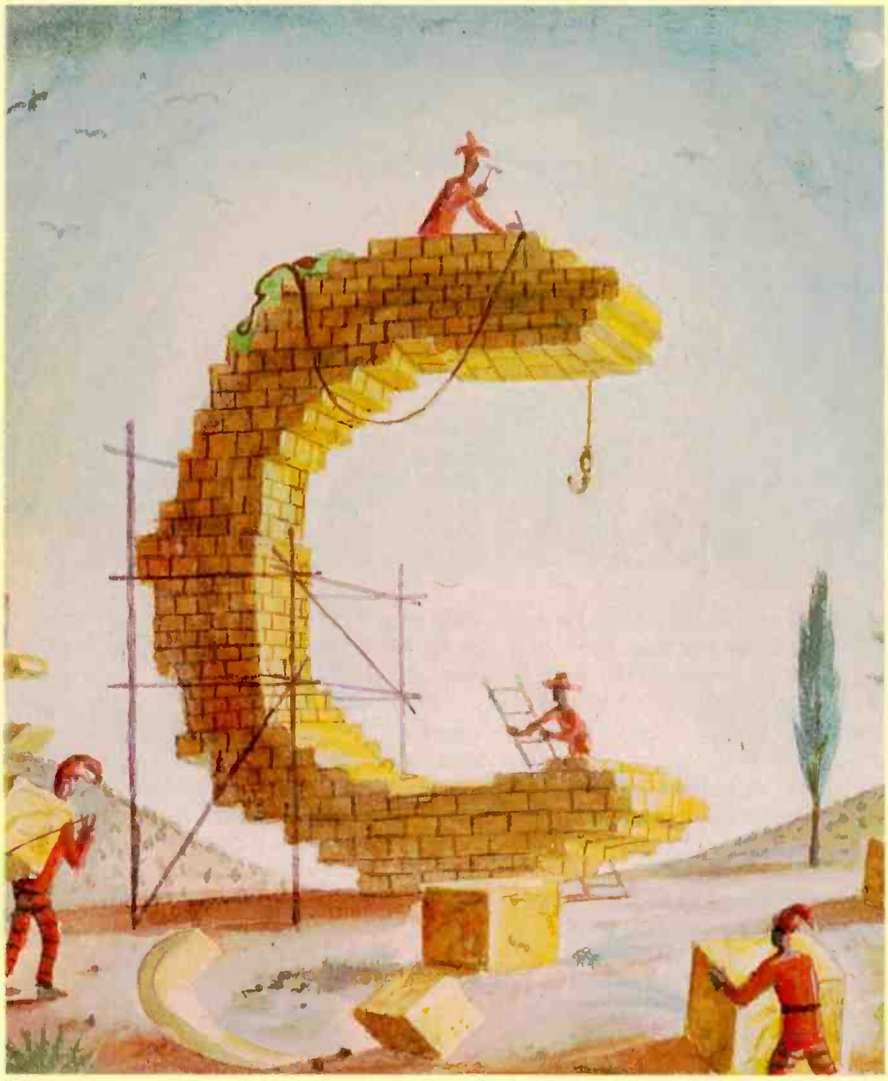
Later in the 1930s, Bailey refined his theory and enlisted the help of the BBC to test it.

It was what we call today a "fluid" theory, meaning that it treats electrons as a continuous fluid with all the electrons near any one point moving in the same direction at the same speed.

But as with air molecules this is not so. Air molecules move around with speeds typically of some hundreds of metres per second, and so do electrons. We feel the motion of air molecules as air pressure, as molecules bounce off the skin. They move in all directions, and any net excess moving in one direction is perceived as the fluid motion — wind.

Fluid motion is therefore an average of molecular motion.

Kinetic theory, which takes the particle motion into account, is deeper and more accurate.



INTERFACING WITH C

by

HOWARD HUTCHINGS

Interfacing with C can be obtained from Lindsey Gardner, Room L333, Quadrant House, The Quadrant, Sutton, Surrey SM5 2AS. Please make cheques for £14.95 (which includes postage and packing) payable to Reed Business Publishing Group.

Alternatively, you can telephone your order, quoting a credit card number. Telephone 081-661 3614 (mornings only, please).

A disk containing all the example listings used in the book is available at £25.50 + VAT. Please specify size required.

C HERE!

If you have followed our series on the use of the C programming language, then you will recognise its value to the practising engineer.

But, rather than turning up old issues of the journal to check your design for a digital filter, why not have all the articles collected together in one book, Interfacing with C?

The book is a storehouse of information that will be of lasting value to anyone involved in the design of filters, A-to-D conversion, convolution, Fourier and many other applications, with not a soldering iron in sight.

To complement the published series, Howard Hutchings has written additional chapters on D-to-A and A-to-D conversion, waveform synthesis and audio special effects, including echo and reverberation. An appendix provides a "getting started" introduction to the running of the many programs scattered throughout the book.

This is a practical guide to real-time programming, the programs provided having been tested and proved. It is a distillation of the teaching of computer-assisted engineering at Humberside Polytechnic, at which Dr Hutchings is a senior lecturer.

Source code listings for the programs described in the book are available on disk.

Switching oscillator

Two op-amps in a ring configuration, one used as a comparator and the other as a unity-gain buffer, and two RC lag networks form a very low-cost function generator. The circuit, shown in **Fig. 1**, generates three simultaneous waveforms — square, sine and triangle, as shown in the oscilloscope photographs.

The waveform at X approximates to a square wave, since the first op-amp operates as a zero-level switching comparator. Slew-rate limiting determines the switching times, amplitude being set by the supply voltages and op-amp saturation characteristics.

Lag network R_1C_1 integrates the sine wave to produce the waveform at Y, which is an approximate triangular wave, while lag network R_2C_2 filters the triangle to produce the sine wave at Z.

The square and triangular waves are at low impedance and the sine wave is not significantly affected by load capacitance less than C_2.

RWJ Barker
BL Hart
Nottingham Polytechnic

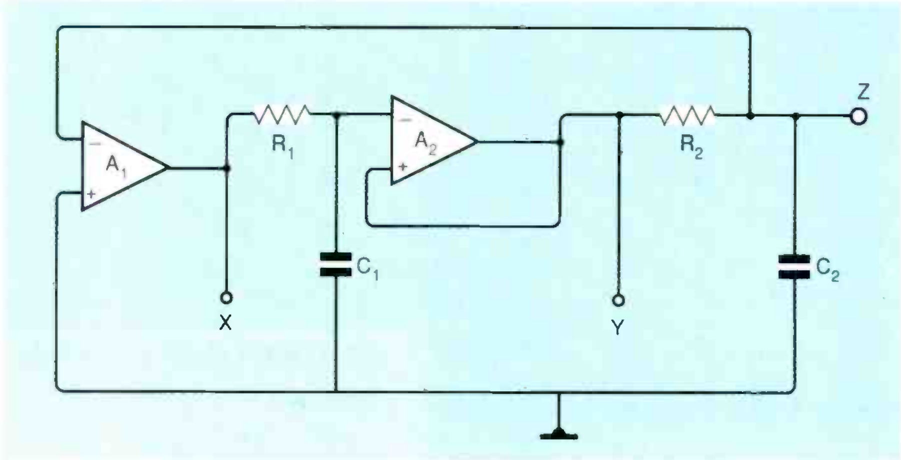


Fig. 1 shows the oscillator circuit. Components used to give results shown: $A_{1,2}$ 741; $R_{1,2}$ 33k; C_1 100nF; C_2 10nF. Supplies 15V.

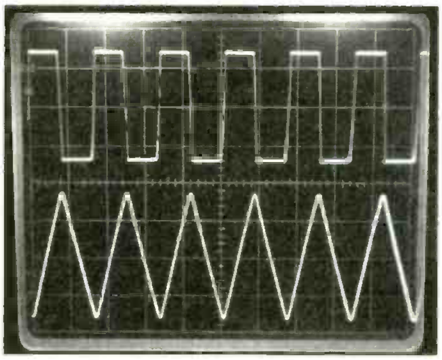


Fig. 2. Upper trace: vertical scale 10V/cm. Lower trace: 500mV/cm. Horizontal scale: 0.5ms/cm.

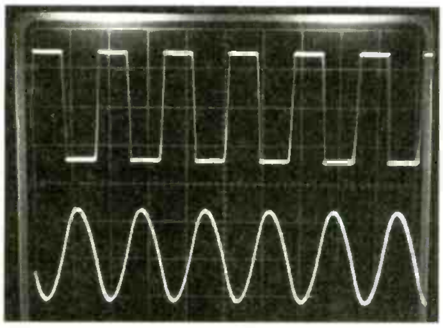


Fig. 3. Lower trace: 200mV/cm, 0.5ms/cm.

Linear current transfer

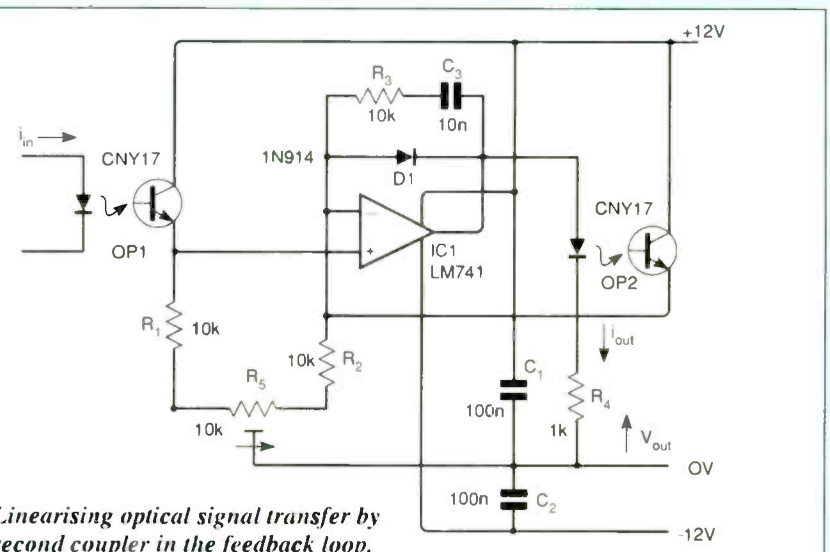
"Straight-line" input-output current transfer is provided by this arrangement.

It is sometimes necessary to transfer a control or measurement signal between two points in a circuit at different voltages. Optical methods offer good high-voltage isolation, but care is needed for precision transfer; the current transfer characteristics of standard opto-couplers are wildly non-linear, exhibiting a sag of around 50% at half-scale.

The circuit shown balances the non-linearity of the sender unit OP_1 with the non-linearity of a similar device OP_2 in the op-amp feedback loop. Potentiometer R_5 calibrates the circuit, compensating for the difference in gain of the two couplers. It is not difficult, using the inexpensive devices shown, to reduce non-linearity to 1% over 0.05 to 1mA.

The voltage across R_4 will drive a chart recorder and the circuit has been used as a control element in multiple-output, switched-mode power supplies.

CJD Catto
Cambridge



Linearising optical signal transfer by second coupler in the feedback loop.

While we are not short of Circuit Ideas to publish, it would be agreeable to see some fresh input from the vast, untapped bank of talent that our thousands of readers represent. Please, don't be reticent; we would love to see your favourite circuit for a scratchet-converter, so send your ideas in. We pay a mod-

Versatile VCO

A conventional free-running multivibrator, shown in **Fig. 1**, suffers from the disadvantage that its output waveform is asymmetrical, the rise time of the off transistor being much slower than its fall time at switch-on.

Figure 2 shows a method of counteracting this defect, using push-pull transistors

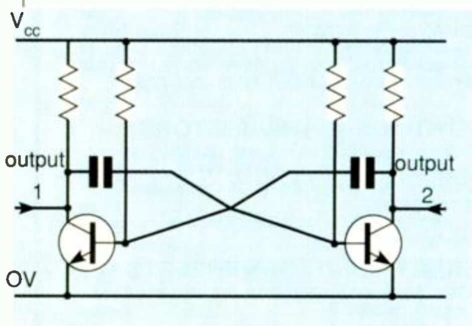


Fig. 1. Conventional multivibrator produces asymmetrical, distorted square waves.

to give a symmetrical output with unity mark/space ratio. The circuit works with a supply greater than 1V, current consumption being 100A at 1.5V.

The circuit of **Fig. 3** takes advantage of

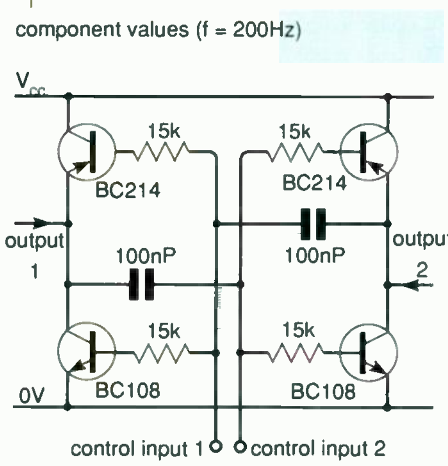


Fig. 2. Modification cleans up output wave shape and renders frequency control feasible.

this modification to produce voltage-controlled frequency. With the control voltage at mid-rail, the frequency is 200kHz, a variation of +5V yielding a 10:1 increase in frequency.

Applying different control voltages to R_1 and R_2 will control mark/space ratio.

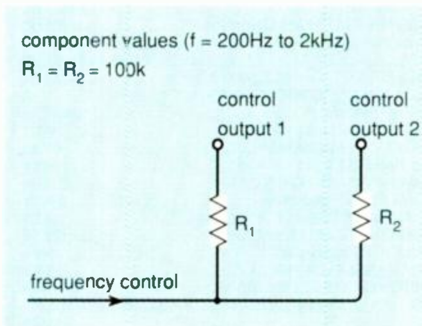


Fig. 3. Frequency control voltage can also be used to provide variable mark/space timing by feeding two resistors with differing voltages.

Applications envisaged for the circuit are phase-locked loops, function generators, switched-mode power supplies and musical effects generators.

Ian M Wiles
IPR Technology
Basingstoke
Hampshire

Z80 peripheral interface

There are two varieties of microprocessor read/write logic: Intel and Zilog devices use separate READ and WRITE lines, whereas Rockwell and Motorola provide a combined RD/WR line. This circuit will interface a Z80 to the latter type of peripheral.

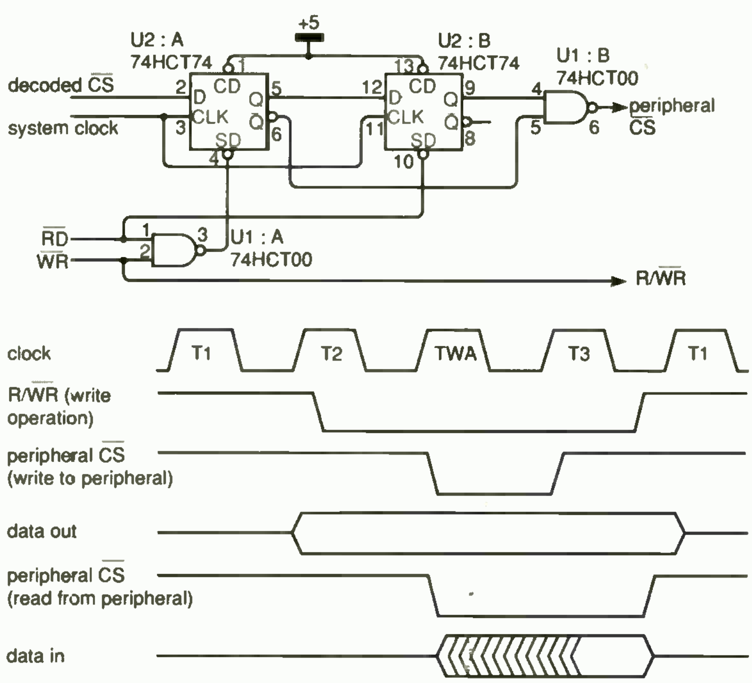
The difference between the two types of equipment is that, with the Z80, it is unimportant in which order the chip-select and read/write controls are asserted; a combined line must be set up before the chip-select and held after it.

An easier solution to the problem than using an amount of combinational logic which would possibly present timing problems is to decode the address normally and to use one of the address lines as a peripheral RD/WR line. Although this arrangement meets the setup and hold requirements, it does mean that the peripheral has different addresses for reading and writing.

The circuit shown provides the answer. It uses the wait cycle which is automatically inserted by the Z80 processor in all I/O requests and is therefore not suitable for memory operations unless a wait cycle is inserted.

R.Townsend
Moston
Manchester

Interfacing a Z80 microprocessor to a peripheral with a combined read/write



COMPUTER ICS

80C31 MICRO £2
P8749H MICRO £5
BBC MICRO PARTS
VIDEO ULA 201647 .... £10 ea, 10+ £8
6845 CRT £5
6522 PIA £3
DM88LS120 .... £4.50
AY3-1015D UART £2.50
USED 41256-15 .... £2
USED 4164-15 ex equipment £1
9 × 41256-15 SIMM £10
8 × 4164 SIP MODULE NEW £8
HD 146818 CLOCK IC £2
2864 EPROM £3
27128A 250ns EPROM USED .... £2 NEW £2.30
27C1001-20Z NEW 1M EPROM £6
FLOPPY DISC CONTROLLER CHIPS 1771 .... £10 ea
68000-8 PROCESSOR NEW £6
HD6384-8 .... £5
ALL USED EPROMS ERASED AND BLANK CHECKED CAN BE PROGRAMMED IF DESIRED
2716-45 USED .... £2 100/£1
2732-45 USED .... £2 100/£1
2764-30 USED £2 100 £1.60
27C256-30 USED £2
27C512 USED £3.50
1702 EPROM EX EQPT £5
2114 EX EQPT 50p 4116 EX EQPT 70p
6264-15 8k STATIC RAM £2
SN76489AN £3
D8751H MICRO £10
GR281 NOW VOLATILE RAM E6116 .... £5

REGULATORS

LM317T PLASTIC TO220 variable £1
LM317 METAL £2.20
7812 METAL 12V 1A £1
7805/12/15/24V plastic .... 25p 100+ 20p 1000+ 15p
7905/12/15/24 plastic .... 25p 100+ 20p 1000+ 15p
CA3085 TO99 variable reg 2 £1
LM338 5A VARIABLE £8
L387 5v ½A WITH RESET OUTPUT £1ea £50/100

CRYSTAL OSCILLATOR

1.8342 16.00 MHz .... £1.50 each

CRYSTALS

2.77MHz, 4.00MHz, 4.9152MHz, 20MHz, 49.504MHz, 8M, 16.588M

TRANSISTORS

BC107 BCY70 PREFORMED LEADS
full spec £1 £4/100 £30/1000
BC557, BC546B, BC238C, BC308B £1 30 £3.50/100

POWER TRANSISTORS

P POWER FET IRF9531 8A 60V 3 £1
N POWER FET IRF531 8A 60V 2 £1
2SC1520 sim BF259 .... 3 £1 100 £22
TIP 141 2 £1 ea TIP 112 125 42B 2 £1
TIP35B TIP35C £1.50
SE9301 100V 1DA DARL SIM TIP121 .... 2 £1
2N3055 EX EQPT TESTED 4 £1
PLASTIC 3055 OR 2955 equiv 50p 100 £35
2N3773 NPN 25A 160V £1.80 .... 10 £16
2N3055H .... 4 for £2

QUARTZ HALOGEN LAMPS

A1 216 24V 150 WATTS £2.25
H1 2V 50W (CAR SPOT) £1.50
14-WAY AMP ZIF SOCKET 2 £1
TEXTOOL single in line 32-way. Can be ganged (coupling supplied) for use with any dual in line devices 2 £1.50
28-WAY TEXTOOL ZIF SOCKET EX NEW EQUIPMENT £2.50
40-WAY TEXTOOL ZIF SOCKET £5
12v 50w LAMP TYPE M/32 .... £1 ea £70/100

CAPACITORS COMPUTER GRADE

2200µF 160V SIC SAFCO FELSIC CO38 .... £4 (£1.20)
24,000µF 50V £3 (£1.30)
10,000µF 100V SPRAGUE 36D £6
TOROID 350VA 35V+35V AND 15V+15V 24VA £12

MISCELLANEOUS

LEMAG EARTH LEAKAGE TRIP 35A 35mA TRIP £9
FANS 240V 120MM £6 (£1.50)
(OTHER VOLTAGES/SIZES USUALLY AVAILABLE)
AMERICAN 2 3 PIN CHASSIS SOCKET 2 £1
HUMIDITY SWITCH ADJUSTABLE £2
WIRE ENDED FUSES 0.25A 30 £1
NEW ULTRASONIC TRANSDUCERS 32kHz .... £2 pr
12-CORE CABLE 7 0.2mm OVERALL SCREEN 70p/metre
POWERFUL SMALL CYLINDRICAL MAGNETS 3 £1
OP AMP LM10CLN £2.90
BNC 50OHM SCREENED CHASSIS SOCKET 2 £1
MAINS ADAPTOR 9V DC 200mA £1.25
SMALL MICROWAVE DIODES AE1 OC1026A 2 £1

D.I.L. SWITCHES 10-WAY £1 8-WAY 80p 4/5/6-WAY 80p
180VOLT 1WATT ZENERS also 12V & 75V 20 £1
PLASTIC EQUIPMENT CASE 9×6×1.25 WITH FRONT AND REAR PANELS CONTAINING PCB WITH EPROM 2764-30 AND ICS 7417 LS30 LS32 LS367 7805 REG, 9-WAY D PLUG, PUSH BUTTON SWITCH, DIN SOCKET £1.90
VN 10LM 60V ½A 5 Ohm TO-92 mosfet 4 £1 100 £20
MIN GLASS NEONS 10 £1
RELAY 5V 2-pole changeover looks like RS 355-741 marked STC 47WBost .... £1 ea
MINIATURE CO-AX FREE PLUG RS 456-071 .... 2 £1
MINIATURE CO-AX FREE SKT RS 456-273 .... 2 £1.50
DIL REED RELAY 2 POLE n/o CONTACTS £1
PCB WITH 2N2646 UNIJUNCTION WITH 12V 4-POLE RELAY £1
400m 0.5W thick film resistors (yes four hundred megohms) 4 £1
STRAIN GAUGES 40 ohm Foil type polyester backed balco grid alloy .... £1.50 ea 10+ £1
ELECTRET MICROPHONE INSERT £0.90
Linear Hall effect IC Micro Switch no 613 SS4 sim RS 304-267 .... £2.50 100+ £1.50
HALL EFFECT IC UGS3040 + magnet £1
OSCILLOSCOPE PROBE SWITCHED ×1 ×10 .... £12
CHEAP PHONO PLUGS 50 £2 1000 £10
1 pole 12-way rotary switch 4 £1
AUDIO ICS LM380 LM386 TDA 2003 .... £1 ea
555 TIMERS £1 741 OP AMP 6 £1
ZN414 AM RAIDO CHIP 80p
COAX PLUGS nice ones 4 £1
COAX BACK TO BACK JOINERS 3 £1
4×4 MEMBRANE KEYBOARD £1.50
INDUCTOR 20µH 1.5A 5 £1
1.25" PANEL FUSEHOLDERS 3 £1
CHROMED STEEL HINGES 14.5×1" OPEN .... £1 each
12V 1.2W small wire ended lamps fit Audi VW Saab Volvo 10 £1
STEREO CASSETTE HEAD £2
MONO CASS. HEAD £1 ERASE HEAD 50p
THERMAL CUT OUTS 50 77 85 120°C .... £1 ea
THERMAL FUSES 220°C/121°C 240V 15A 5 £1
TRANSISTOR MOUNTING PADS TO-5/TO-18 .... £3/1000
TO-3 TRANSISTOR COVERS 10 £1
STICK-ON CABINET FEET 30 £1
PCB PINS FIT 0.1" VERO 200 £1
TO-220 micas + bushes 10 50p 100 £2
TO-3 micas + bushes 15 £1
PTFE min screened cable 10m £1
Large heat shrink sleeving pack £2
CERAMIC FILTERS 6M/9M 10.7M 60p 100 £20
IEC chassis plug filter 10A £3
Potentiometers short spindles values 2k5 10k 25k 1m 2m5 lin 4 £1
500k lin 500k log 4 £1
40kHz ULTRASONIC TRANSDUCERS EX-EQPT NO DATA £1/pr
LM3352 TEMP SENSOR 10°C PER MV £1
LM2342 CONST. CURRENT I.C. £1

DIODES AND RECTIFIERS

1N4148 .... 100 £1.50
1N4004/SD4 1A 300V 100 £3
1N5401 3A 100V 10 £1
BA158 1A 400V fast recovery 100 £3
BY127 1200V 1.2A 10 £1
BY254 800V 3A 8 £1
BY255 1300V 3A 6 £1
6A 100V SIMILAR MR751 .... 4 £1
1A 600V BRIDGE RECTIFIER 4 £1
4A 100V BRIDGE 3 £1
6A 100V BRIDGE 2 £1
8A 200V BRIDGE 2 £1.35
10A 200V BRIDGE £1.50
25A 200V BRIDGE £2 .... 10 £18
25A 400V BRIDGE £2.50 .... 10 £22

SCRS

PULSE TRANSFORMERS 1:1+1 .... £1.25
2P4M EQUIV C106D 3 £1
TICV1C5D 800mA 400C SCR 3 £1 .... 100 £15
MEU21 PROG. UNIJUNCTION 3 £1

TRIACS .... DIACS 4/£1

BT137-800 8A TO-220 .... 2 £1
NEC TRIAC ACO8F 8A 600V TO220 .... 5 £2 100 £30
TXAL225 8A 500V 5mA GATE 2 £1 100 £35
TRAL2230D 30A 400V ISOLATED STUD .... £4 each
BTA 08-400 ISO TAB 400V 5mA GATE 90p

CONNECTORS

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

USED D CONNECTORS price per pair

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

WIRE WOUND RESISTORS

W21 or sim 2.5W 10 of one value £1
R10 0R15 0R21 2R0 4R7 5R0 5R6 8R2 10R 12R 15R 18R 20R 22R 27R 33R 47R 56R 62R 91R 120R 180R 390R 430R 470R 680R 820R 910R 1K15 1K2 1K5 1K8 2K4 2K7 3K3 3K0 5K0
R05 (50 milli-ohm) 1% 3W .... 4 for £1
W22 or sim 6W 7 OF ONE VALUE £1
R47 R52 1R0 1R5 1R8 3R3 6R8 9R1 12R 20R 24R 27R 33R 51R 56R 62R 68R 100R 120R 180R 220R 390R 560R 620R 910R 1K0 1K2 1K5 1K8 2K2 2K7 3K3 3K9 4K7 8K2 10K 15K 16K 20K
W23 or sim 9W 6 of one value £1
R22 R47 1R0 1R1 56R 62R 100R 120R 180R 220R 300R 390R 680R 1K0 1K5 5K1 10K
W24 or sim 12W 4 OF ONE VALUE £1
R50 2R0 9R1 18R 22R 27R 56R 66R 75R 62R 100R 150R 180R 200R 220R 270R 400R 620R 1K0 6K8 8K2 10K 15K

PHOTO DEVICES

HI BRIGHTNESS LEDS CQX24 RED 5 £1
SLOTTED OPTO-SWITCH OPCOA OPB815 .... £1.30
2N5777 .... 50p
TIL81 PHOTO TRANSISTOR £1
TIL38 INFRA RED LED 5 £1
4N25, OP12252 OPTO ISOLATOR 50p
PHOTO DIODE 50P 6 £2
MEL12 (PHOTO DARLINGTON BASE n/c) 50p
LED's RED 3 or 5mm 12 £1 .... 100 £6
LED's GREEN OR YELLOW 10 £1 .... 100 £6
FLASHING RED OR GREEN LED 5mm 50p 100 £40
HIGH SPEED MEDIUM AREA PHOTODIODE RS651-995 .... £10 ea

STC NTC BEAD THERMISTORS

G22 220R, G13 1K, G23 2K, G24 20K, G54 50K, G25 200K, RES 20°C DIRECTLY HEATED TYPE .... £1 ea
FS22BW NTC BEAD INSIDE END OF 1" GLASS PROBE RES 20°C 200R .... £1 ea
A13 DIRECTLY HEATED BEAD THERMISTOR 1k res. ideal for audio Wien .... £2 ea

CERMET MULTI TURN PRESETS ¾"

10R 20R 100R 200R 250R 500R 2K 2K2 2K5 5K 10K 47K 50K 100K 200K 500K 2M .... 50p ea

IC SOCKETS

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

SOLID STATE RELAYS

40A 250V AC SOLID STATE RELAYS £10

POLYESTER/POLYCARB CAPS

100n, 220n 63V 5mm .... 20/£1 100/£3
1n/3n3/5n6/8n2/10n 1% 63V 10mm 100 £5
10n/15n/22n/33n/47n/66n 10mm rad 100 £3.50
100n 250V radial 10mm 100 £3
100n 600V Sprague axial 10/£1 .... 100 £6 (£1)
2µ2 160V rad 22mm, 2µ2 100V rad 15mm 100 £10
10n/33n/47n 250V AC x rated 15mm 10 £1
1µ 600V MIXED DIELECTRIC .... 50p ea
1µ0 100V rad 15mm, 1µ0 22mm rad 100 £6

RF BITS

TRW 50watt 50ohm DUMMY LOADS £50
TRIMMER CAPS .... ALL 4 50p
SMALL 5pF 2 pin mounting 5mm centres
SMALL MULLARD 2 to 22pF 4 50p
SMALL MULLARD 5 to 50pF 4 50p
Larger type grey 2 to 25pF black 15 to 20pF
TRANSISTORS 2N4427 .... 60p
FEED THRU CERAMIC CAPS 100pF 10 £1

MINIATURE RELAYS Suitable for RF

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

MONOLITHIC CERAMIC CAPACITORS

10n 50V 2.5mm 100 £4.50
100n 50V 2.5mm or 5mm 100 £6
100n ax short leads 100 £3
100n ax long leads 100 £5
100n 50V dil package 0.3" rad 100 £8
1µF 50v 5mm £6 100

STEPPER MOTORS

2 CENTRE-TAPPED 9 VOLT WINDINGS 7.5° STEPS £4

KEYTRONICS

TEL. 0279-505543
FAX. 0279-757656
P O BOX 634
BISHOPS STORTFORD
HERTFORDSHIRE CM23 2RX

MAIL ORDER ONLY
MIN. CASH ORDER £3.00. OFFICIAL ORDERS WELCOME
UNIVERSITIES/COLLEGES/SCHOOLS/GOVT. DEPARTMENTS
MIN. ACCOUNT ORDER £10.00
P&P AS SHOWN IN BRACKETS (HEAVY) ITEMS
65p OTHERWISE (LIGHT) ITEMS
ADD 15% VAT TO TOTAL
ELECTRONIC COMPONENTS BOUGHT FOR CASH

Access VISA

CIRCLE NO. 141 ON REPLY CARD

Colour-bar generator

This circuit will produce NTSC or, with slight modification, Pal colour bars with audio, video and RF outputs, using six ICs. Taking the NTSC case first, with its 15.75kHz line frequency, the clock oscillator is composed of IC_{3a}, L_1 and $C_{1,2}$ and produces a 157.5kHz signal for IC_1, a BCD counter; L_1 adjusts the frequency. Horizontal sync is available at point A and RGB at B, C and D; **Fig.2** shows the relevant waveforms.

The horizontal sync. pulse drives 12-bit counter IC_4, which is reset by IC_{2b} when the count reaches 262, so that a vertical sync. pulse is formed at point E. A composite sync signal is produced by IC_{3b} at point F.

Pal/NTSC encoder/modulator IC_5, the MC1377, contains an encoder matrix, burst-pulse generator, subcarrier oscillator, 90 phase shifter, R-Y and B-Y modulators and one or two other functions. It merely needs 1V pk-pk RGB signals and a TTL-level composite sync to provide the composite video at pin nine.

MC1374 is an RF modulator, accepting video (pin 11) and audio (pin 14) inputs to give a 100mV pk-pk RF output. Audio comes from IC_4 in the form of a 1kHz signal from Q4. Tuned circuit L_3C_4 sets the output frequency and the output filter reduces high-order harmonics.

In the case of Pal, L_1 must be adjusted to give 156.25kHz, the reset circuit of IC_4 must operate at a count of 312 and pin 20 of the MC1377 should be open-circuit. Adjust L_2 to the required audio IF.

Yongping Xia
West Virginia University
Morgantown
USA

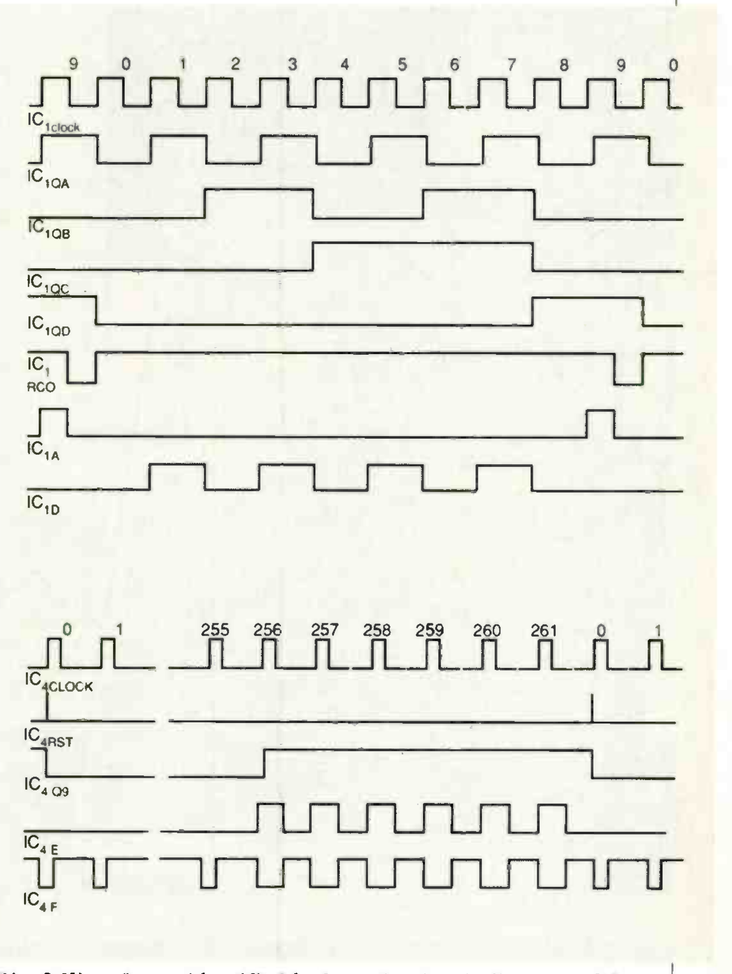


Fig. 2. Waveforms identified by letter in circuit diagram of Fig. 1 for the NTSC version.

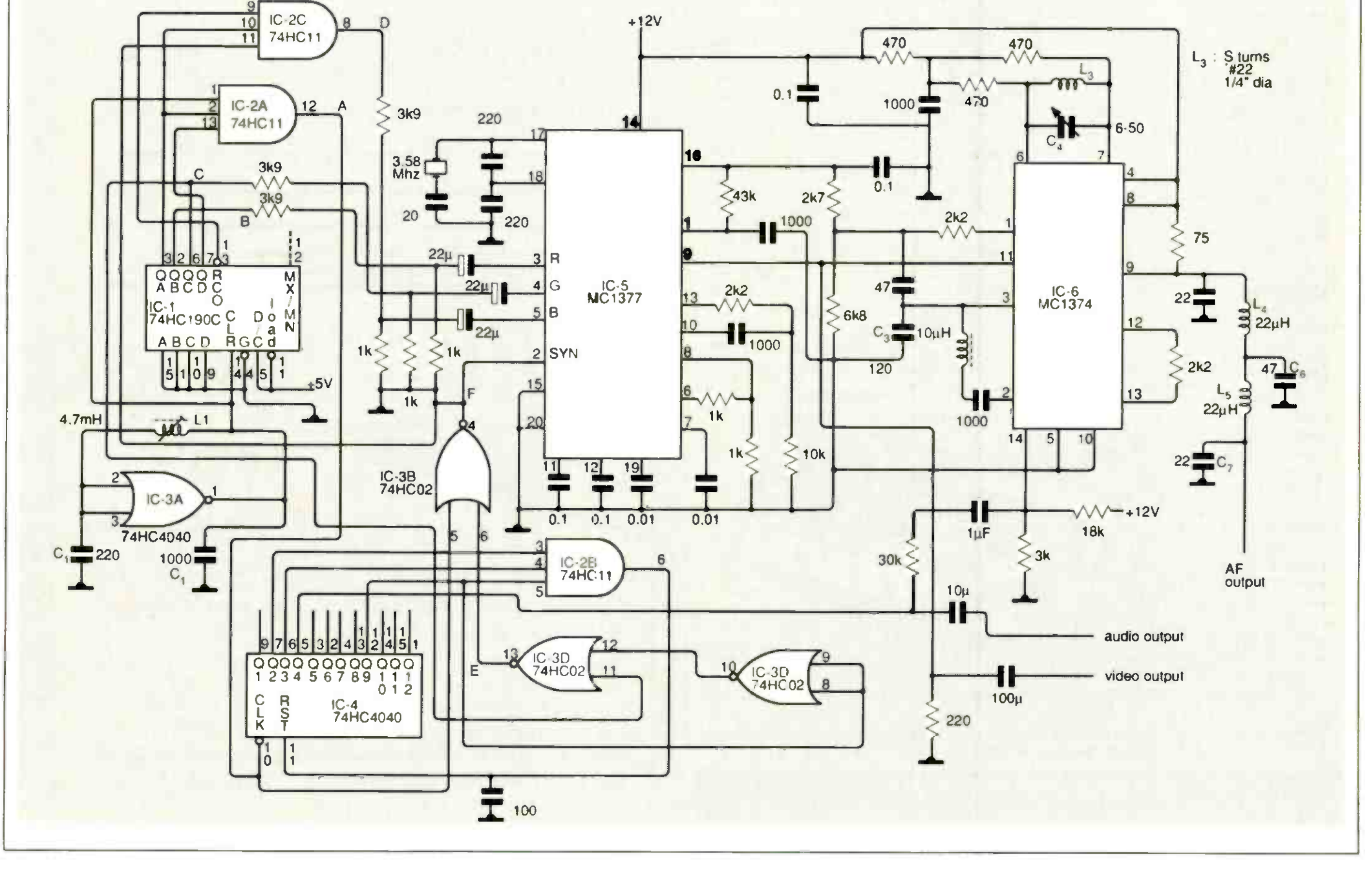
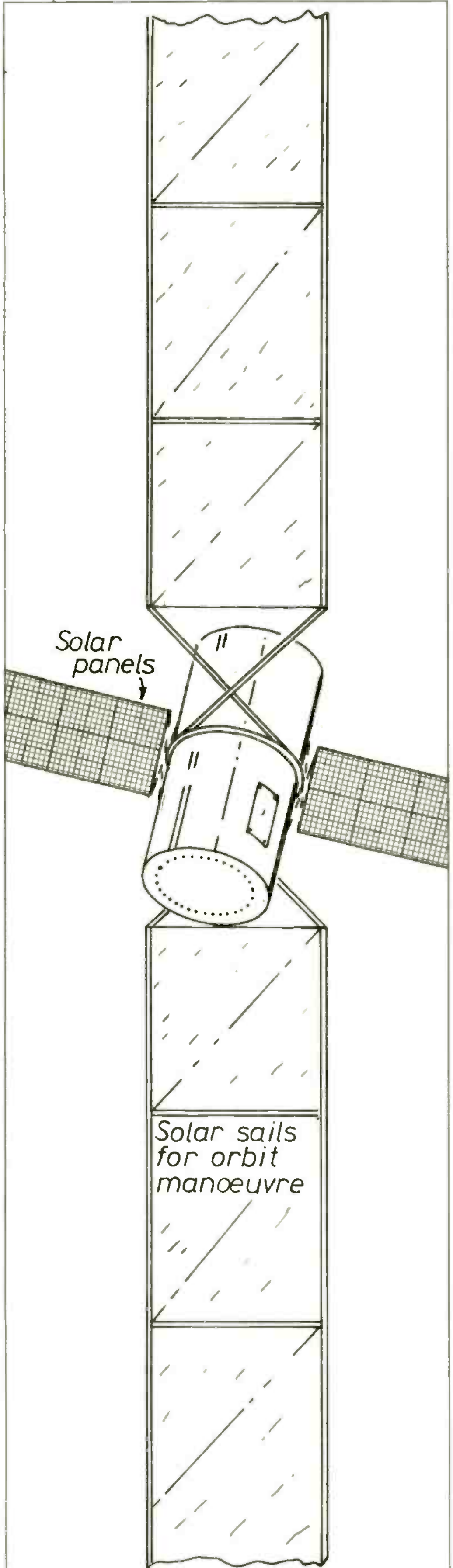


Fig. 1. Complete circuit of simple and economical colour-bar generator.

CIRCLE NO. 142 ON REPLY CARD

CIRCLE NO. 143 ON REPLY CARD

CIRCLE NO. 144 ON REPLY CARD



Could satellites fitted with solar sails combine built-in orbit-holding with a free flying capability — at no fuel cost?

Satellites ride the solar wind

A satellite with solar sails, propelled through space by the force of solar light, could maintain its orbital position indefinitely argues Paul Birch

Above our heads scores of geostationary satellites, civil and military, are going about their business — and the geostationary arc is getting crowded.

The problem is that all geostationary satellites have to slot into that thin line in the sky directly above the equator. It is not that the satellites are in any danger of bumping into one another. But they are close enough so that radio interference between neighbours on the arc can upset operation.

Bigger antennas, in space or on the ground, can help. But they are expensive, and when it comes to direct broadcasting television, the receiving antennas have to be small.

A further drawback is that a geostationary satellite can not be seen very well much above a latitude of about 70°, where its elevation in the sky is about 10°. So big chunks of the globe, mostly in the arctic and antarctic, are not covered at all.

Sailing by sunlight

Solar sailing makes use of the weak, but not insignificant, pressure of light from the Sun to push a vehicle through space.

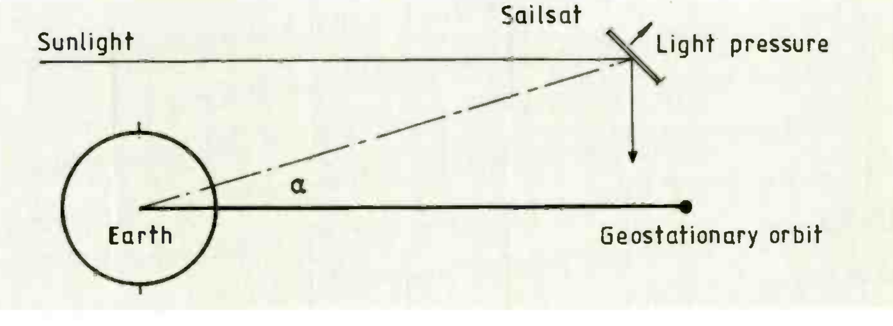
Solar sails are simply mirrors, generating a force through photon impact perpendicular to the sail. By tilting the sails the direction of thrust can be controlled, and very interesting possibilities open up when this effect is combined with the idea of the geostationary satellite.

To exploit them I have devised a new kind of geostationary satellite — I call it a "sailsat" — which does not need to be situated directly over the equator, because a solar sail maintains its orbit away from the equatorial plane.

Take a solar sail in geosynchronous orbit, and tilt it to the Sun (**Fig. 1.**) — we can spin it on its axis to stiffen it and orient it relative to the direction of the Sun. Light pressure elevates it above the equatorial plane.

Ignore for the time being the nuisance sideways force away from the Sun, and ignore the effect of the Earth's axial tilt. Now, there is a force holding up the satellite against the component of gravity trying to pull it back into the equatorial plane; but the component acting inwards towards the Earth's axis remains and holds the satellite in this elevated orbit.

Fig. 1. Elevated geostationary orbit of Sailsat.



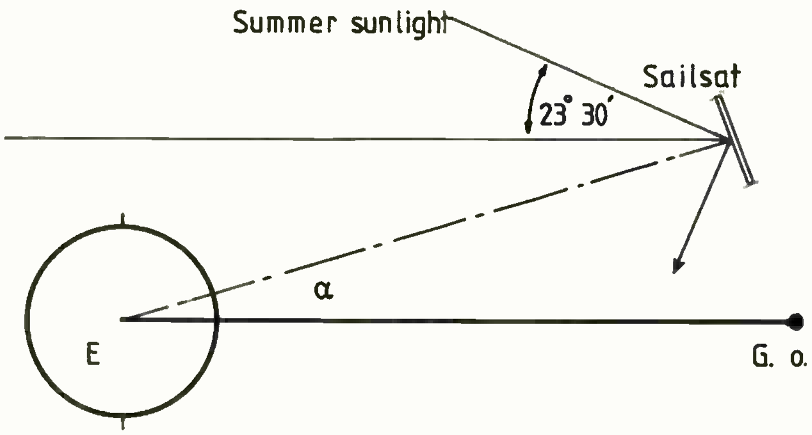


Fig. 2. Reduced lift at summer solstice.

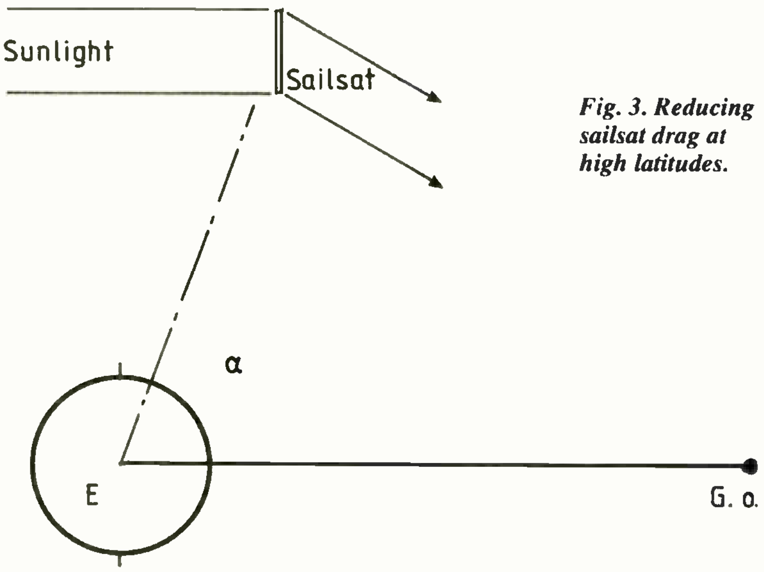


Fig. 3. Reducing sailsat drag at high latitudes.

Taking the radial distance of the satellite from the centre of Earth as 42,000km, if α is the latitude or elevation angle of the orbit above the equatorial plane, the radius of orbital gyration is reduced by the factor $\cos\alpha$, the inwards gravity component by the same factor, and so too is the orbital velocity — since $v^2 = rg$.

The period of the orbit is thus unaltered.

It follows that geostationary orbits elevated above the equatorial plane lie along the lines of latitude of a sphere of radius 42,000km centred on the Earth.

Force elevating the sailsat is determined by the angle of the sail to the Sun and the areal density of the sail material. But the force required to maintain an elevated orbit increases with the desired latitude, being zero on the equator.

Maximum achievable latitude obtains when:

$\sin\alpha = (3/8)(P/rg)$.

where P is the available light pressure (9N/km2 at the distance of Earth from the Sun), g is the acceleration due to gravity (0.22m/s in geostationary orbit) and r is the areal density of the sail (values as low as 0.15kg/m^2 have currently been realised). Plugging in the numbers, we find that with present technology the maximum latitude is about 5°—just beginning to be useful.

The Earth's axial tilt is an irritation. For part of the year the Sun lies above the plane, tending to push the sailsat back down. The worst case is at summer solstice (**Fig. 2.**), when the net lift of the sail is reduced by a factor of two.

So if we want a truly geostationary satellite all the year round our latitude of 5° is cut to about 2.5.

Future development of solar sail technology — including manufacture in space of unbacked perforated aluminium film — should squeeze down the minimum areal density, and may then enable geostationary satellites to be elevated to the higher latitudes. More modest improvements, say by a factor of four, would permit continuous global coverage to be achieved — including the north and south poles.

But what of the sideways component of the light pressure? For part of each orbit it pushes the sail towards the Earth; for part it pushes it away.

The net effect is an eccentricity in the orbit, which is displaced slightly away from the Earth, away from the Sun. Nevertheless, a geosynchronous orbit can still be maintained.

At low latitudes, the effect will be small. But at high latitudes we need to reduce the sideways component relative to the desired lift, to prevent the sailsat from being blown away (**Fig. 3.**). This is what prevents us positioning a simple sailsat directly above the pole throughout the year (there are ways round this).

Sailsats could be used in a variety of ways, greatly increasing the class of orbits available, not only about the Earth, but also throughout and beyond the Solar System. At one end, they start as satellites with built-in orbit-keeping capability; at the other, they are free-flying solar probes.

If a sailsat is launched into low Earth orbit (a few hundred kilometres high), then it can solar sail the rest of the way to its operational orbit, with considerable savings in launch costs.

Even a small sail would enable satellites to make orbital corrections without on-board rocket motors. This suggests that an economical way to prove and develop the sailsat concept and technology, prior to the deployment of fully elevated geostationary communications satellites, would be through the interim employment of solar sails for orbit-keeping, for orbital manoeuvring, and in use as integral upper stages.

GEOSTATIONARY 50 YEARS ON

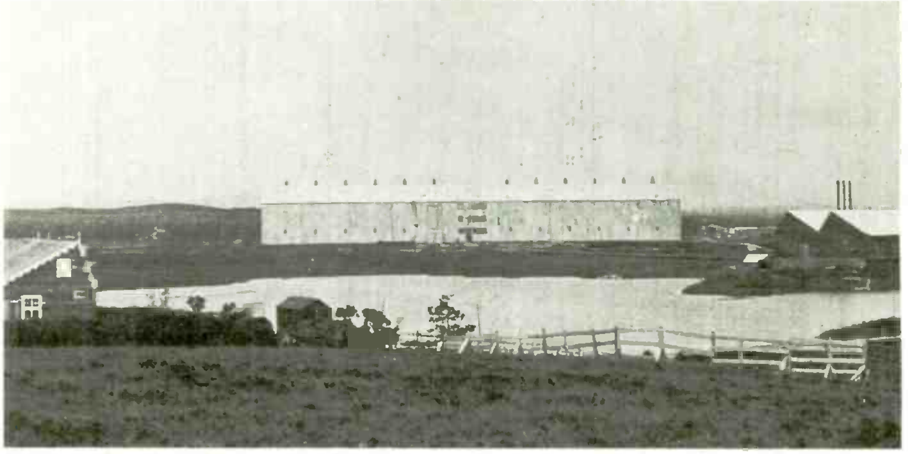
Almost half a century ago in an article in Wireless World (Nov 1945) Arthur C Clarke introduced the concept of the geostationary communications satellite. He pointed out that a satellite placed some 36,000km above the equator will orbit the Earth once every twenty-four hours (23h 56m 04s to be precise) and therefore remain above exactly the same spot on the globe.

A communications antenna transmitting to— or receiving from — such a geostationary satellite, can be anchored like a TV aerial, pointing at a fixed spot in the sky. This is a much cheaper option than using the tracking antennas used for low altitude satellites.

Clarke is also a good source for more information on solar sails in which he has had an interest for many years. His classic story, 'The Wind From The Sun" is still the best introduction to the subject.

Editorial survey: use the information card to evaluate this article. Item M.

This year marks our eightieth anniversary. Initially launched in 1911 as the *Marconigraph*, the magazine has faithfully mirrored the electronics industry over the intervening years. In this, the first of a series of historical articles, we open our archives to present a picture of the past.



Clifden, the site of Marconi's historic transatlantic transmission pictured in 1907

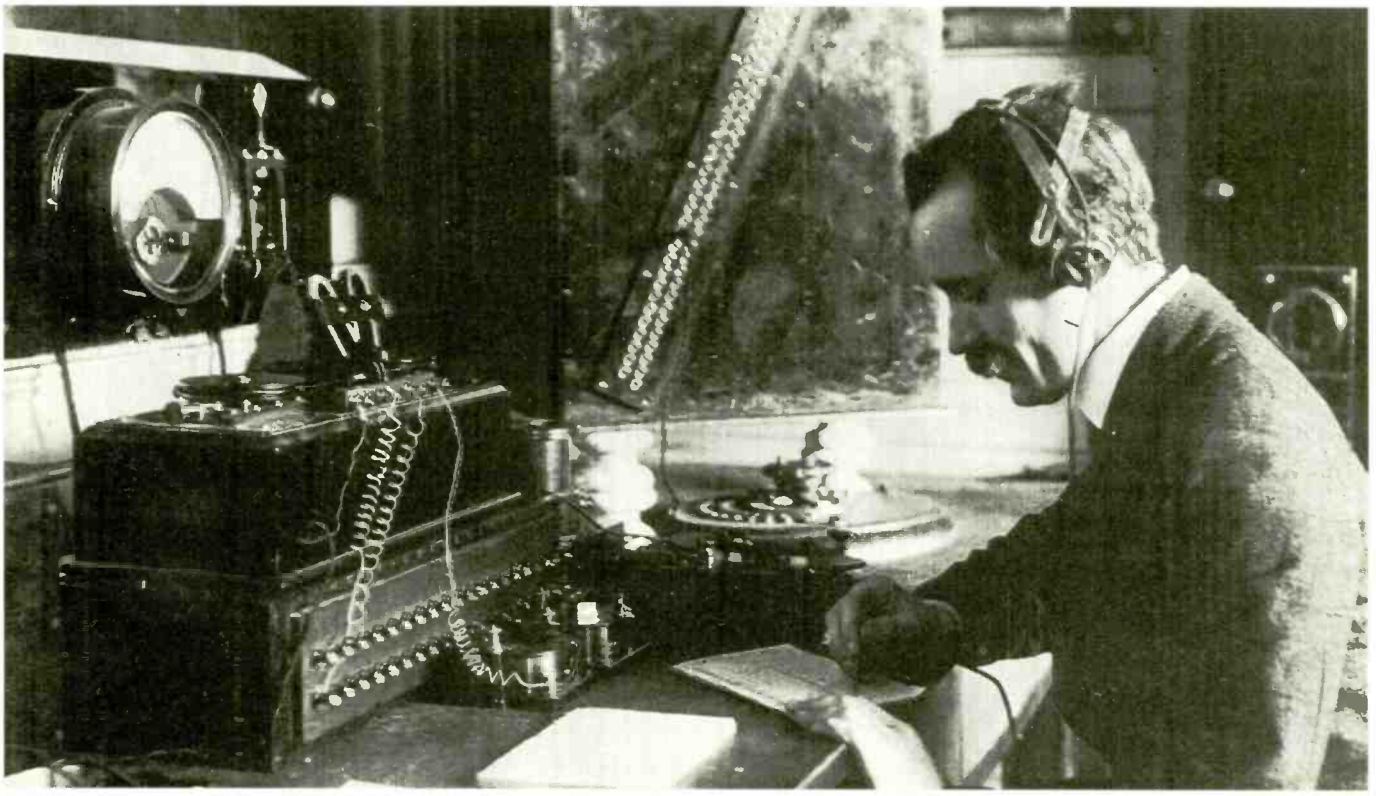
Sparks over the Atlantic

What appears to be some kind of aircraft hangar full of large objects drying out is in reality the air-dielectric capacitor (condenser, as it was then known) of the Clifden transatlantic spark transmitter of 1907. We have no record of its value, or of the inductance it tuned, but it cannot have been more than a few hundred picofarads, the plates being separated by one foot. It is impossible to guess at what the man in roof is doing.

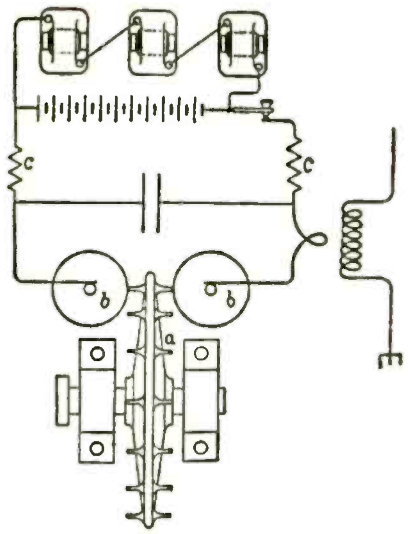
The Clifden spark station was regarded as one of the wonders of the world, being far and away in advance of anything possessed by Germany or the USA. The receiver, subsidised by the Canadian Government, was in Glace Bay in Nova Scotia and was of a comparable standard of design and performance.

Power was supplied at DC, the source being a huge battery of 6000 cells giving 15kV and supplying 300kW to the transmitter. Three, series-connected, high-voltage generators driven by a steam engine charged the batteries, which explains the picture of a railway: it is bringing peat for the boiler from a nearby peat bog.

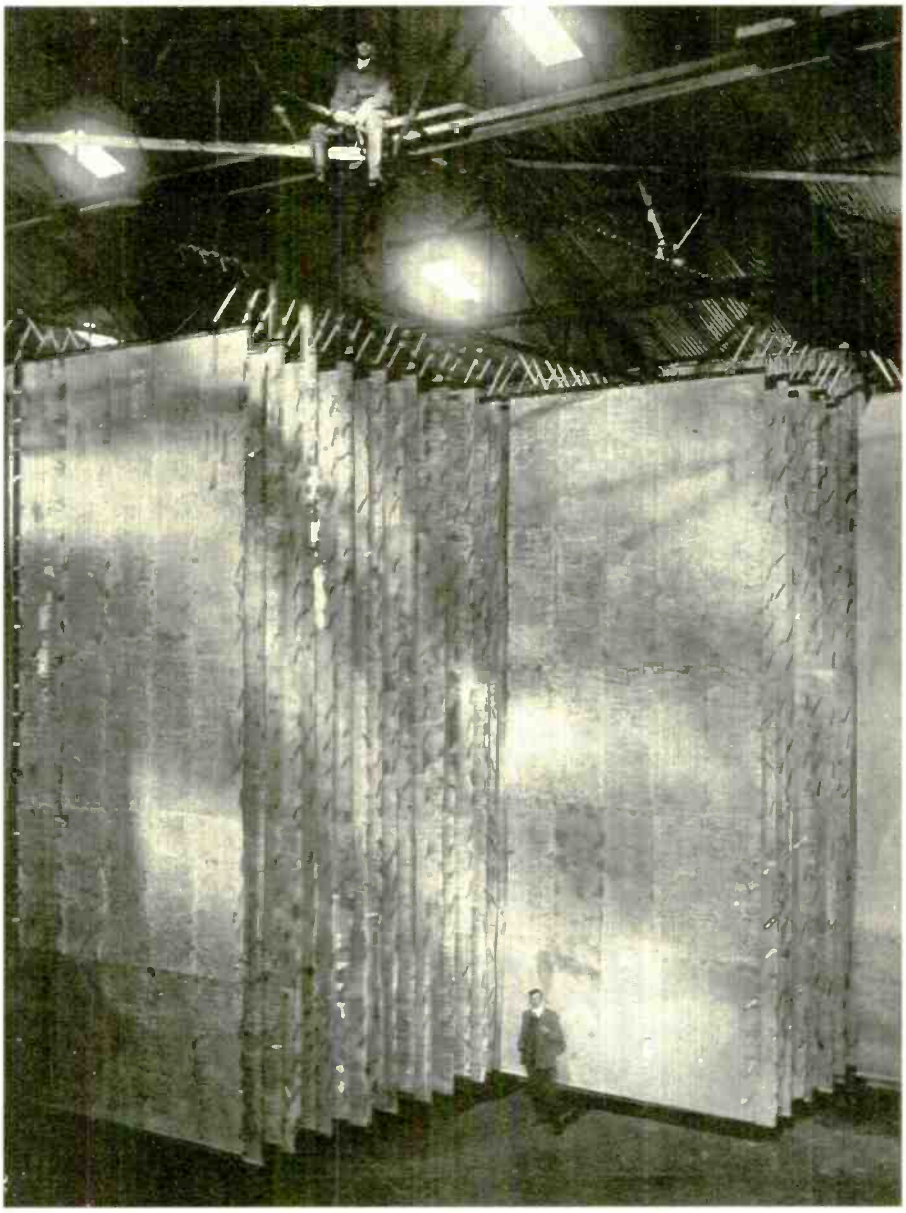
Our third picture shows the station buildings, with the peat-burning power



At work in Clifden, Eire, 1907. The Marconi station successfully challenged the transatlantic cable operators in reliability



Circuit diagram of the Clifden transmitter. The power supply charged the condenser, which then discharged itself across the spark gap, the resulting current being taken straight to the aerial through the step-up transformer, or "jigger". Notes thus produced were harsh and very like ordinary noise, so the rotary discharger was used. Studs on a wheel passed through the spark gap, causing a spark for each stud at a higher, more constant rate and giving a musical tone.

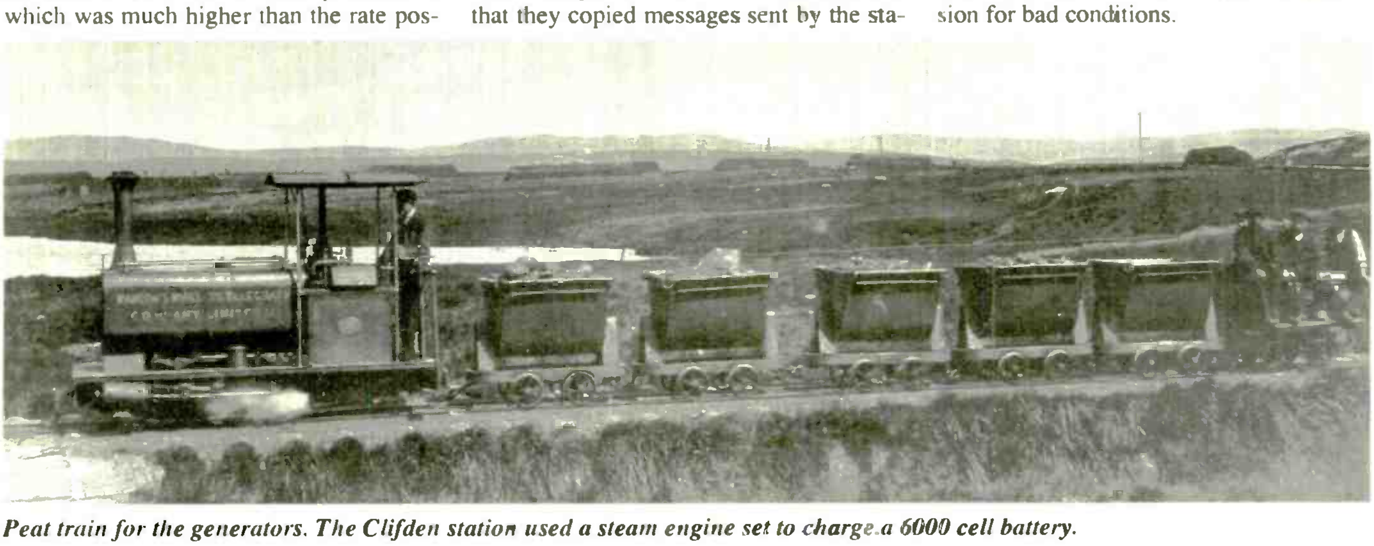


Giant capacitor bank at Clifden. The hanging plates were separatedby 12in of air

station on the right. The Irish "troubles" of 1922 saw the end of the Clifden station when it burnt down completely. Unlike the earlier (1901) site at Poldhu, Clifden has no memorial.

Lastly, the Clifden wireless operator is using a "Maggie" - the Marconi magnetic detector. A soft iron wire passed through a coil carrying the received signal, its hysteresis changing according to the signal. A pair of permanent magnets provided the field and a secondary on the signal coil fed a headset. This detector allowed traffic to flow at around 30 words per minute, which was much higher than the rate possible with a coherer - the other popular detecting device.

Clifden's performance so alarmed the cable companies that there were rumours that they copied messages sent by the station and published the interesting ones as advertisements in the US newspapers, in particular the messages that advised users that there was to be a break in transmission for bad conditions.

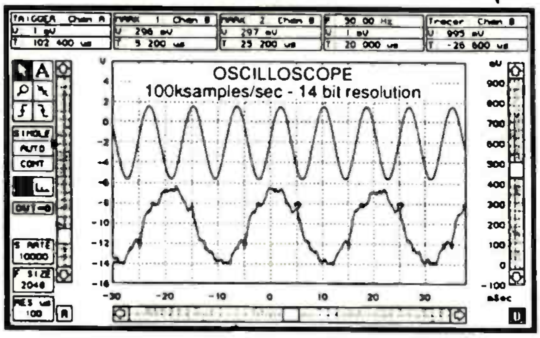


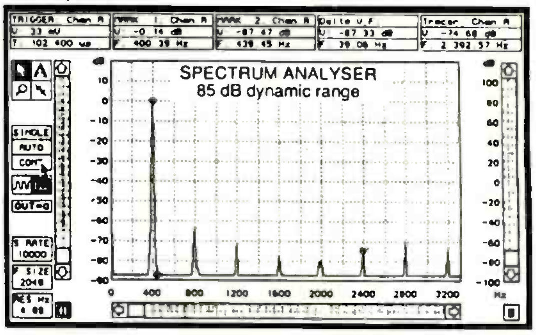
Peat train for the generators. The Clifden station used a steam engine set to charge a 6000 cell battery.

★ NEW ★ AFFORDABLE SPECTRUM ANALYSER

ANNOUNCING THE FIRST FULLY FEATURED SIGNAL ACQUISITION AND FFT ANALYSER PACKAGE FOR UNDER £1,200

INCLUDES ALL THE BITS (2×14 ACTUALLY) THAT THE OTHERS LEAVE OUT





- Runs with your PC or Macintosh.
- Complete two-channel system, synchronous 100kHz sampling & 40kHz spectrum.
- 14-bit adc!! 85dB dynamic range.
- Anti-alias filters.
- Frequency and time domain zoom.
- FFT up to 16384 lines, with or without weighting, log or linear scaling, exp or linear averaging.
- Smart, fully featured trigger enables transient analysis, time averaging etc.
- Hard copy output with full annotation and custom legends.
- Archive results, either manually or automatically.

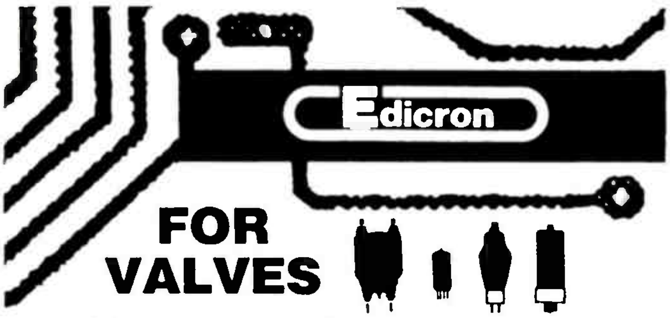
Complete system, including stand-alone signal capture unit, application software, manuals and cables for **only £1150**.
This is the best value for money, professional system in the UK.

Laplace Instruments Ltd
Tudor House, Grammar School Road, North Walsham, Norfolk NR28 9JH. Tel: 0692 500777. Fax: 0692 406177.

Send off for a FREE demonstration disc using the form below or ring 0692 500777

Please send by return:
☐ Information on PC-Acquisition. ☐ Free Demo disk. ☐ Details of FFT training courses.
☐ Complete system (Enclose cheque for £960+VAT to Laplace Instruments Ltd).
Details of your computer: ☐ Macintosh. Model: ____________
☐ IBM-compatible PC or AT. Make & model: ____________
Name: ____________ Telephone No: ____________
Organisation: ____________
Address: ____________
____________ Post code: ____________
Post to: Laplace Instruments Ltd, Tudor House, Grammar School Road, North Walsham, Norfolk NR28 9JH

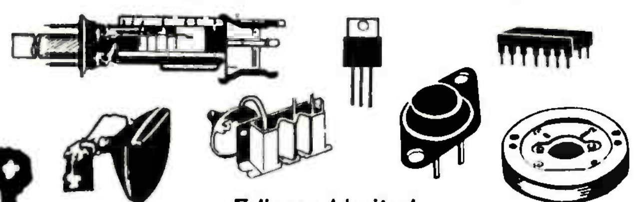
CIRCLE NO. 148 ON REPLY CARD



Edicron, having over 30 years experience of supplying electronic components and exporting to some 40 countries worldwide, offers:-

- **High quality products**
- **The best prices**
- **Rapid delivery**
- **Technical back-up**
- **Comprehensive stocks**
- **No minimum quantities**

To find out more about what Edicron can offer you — or for details of any of the products shown below — ring, fax, telex or write to us today.



Edicron Limited
9, Bethune Road, London NW10 6NJ
Tel: 081 961 2020
Telex: 265531 EDICRN G Fax: 081 961 2285 GRP 3

CIRCLE NO. 149 ON REPLY CARD

SYSTEMS BUILT TO SUIT

Main Product Lines
MOTHERBOARDS
DISPLAY CARDS
MULTIFUNCTION CARDS
I/O CARDS
MEMORY BOARDS
CASES/PSU
KEYBOARDS
FLOPPY/HARD DRIVES
TAPE STREAMERS
MONITORS
PERIPHERALS
SYSTEMS

All of our systems are built to your specification at NO EXTRA, and come fully tested to the highest standards with FREE 12 months o.s.m.

80486-25MHz CACHE	80386-33MHz CACHE	80386-25MHz	80386-16MHz SX	80286-16MHz	80286-12MHz
8MB 180MB VGA Colour	4MB 135MB VGA Colour	4MB 80MB VGA Colour	2MB 40MB VGA Colour	1MB 40MB VGA Colour	1MB 40MB VGA Colour
£2975	**£1695**	**£1395**	**£968**	**£850**	**£795**

All above prices exclude VAT and delivery charges.
FOR SYSTEM QUOTE & COMPONENT PRICE WRITE, PHONE OR FAX FOR A FREE CATALOGUE

PANRIX ELECTRONICS
93 KENTMERE APPROACH, LEEDS LS14 1JW
TEL: 0532 650214. FAX: 0532 300488
OPEN MON–SAT 10AM–6PM

CIRCLE NO. 150 ON REPLY CARD

ACTIVE

Asic

Design generator. An asic synthesiser has been introduced that can generate complete asic chips including the pad ring direct from the hardware definition language inputs. It implements optimised data path and memory as well as random and sequential logic letting full chips be produced instead of just netlists. It can run on Vax, DEC station, Apollo, HP9000 series 3, Sun-3 and Sun-4 computers. Compass Design Automation, 0908 667595.

Cmos 1μm process. ES2 has introduced its second 1μm process which gives a 31% increase in density over the previous process. An average density of 750gate/mm^2 for random logic or 2800bit/mm^2 for an Sram can be achieved using a standard place and route system. The ECPD10 process is supported by a full standard cell library.

Gate array. A field programmable gate array from Micro Call can achieve system clock rates in excess of 40MHz, 20% faster than earlier models in the same series. The Xilinx 2000-gate XC3020-125 is in production now and other members of the family are due out soon. Micro Call Ltd, 0844 261939.

Bicmos gate arrays. TI has introduced a family of seven submicron Bicmos gate arrays including a 150,000 gate device. The TGB1000 devices are made using a 0.8μm (drawn) Epic triple-level metal, sea-of-gates process. The firm claims 75% use of available gates. Dual and single port ram blocks can be integrated by metal customisation. A datapath compiler allows integration of elements such as adders, ALUs, multipliers and barrel shifters. Unloaded gate delays are typically 150ps and loaded 320ps. Texas Instruments, 0234 223252.

A-to-D & D-to-A converters

20bit dac. The PCM63 is a monolithic 20bit D-to-A converter for digital audio. It guarantees an idle channel signal-to-noise ratio of at least 116dB. A linear dual dac architecture is used to eliminate glitches and other nonlinearities around bipolar zero. The output has no glitch energy around zero. The design avoids signal-to-noise, channel separation and intermodulation distortion problems associated with sigma-delta and similar 1bit dac techniques. Burr-Brown International Ltd, 0923 33837.

A-to-D converter. Maxim's 8μs 12bit adc has the same pin configuration as the industry standard 574A. The MAX174 uses the Bicmos process to keep power consumption to 150mW. It has an internal 10ppm/°C buried zener reference, an on-chip clock and a microprocessor interface. External components are limited to decoupling capacitors and fixed resistors. Dialogue, 0276 682001.

Discrete active devices

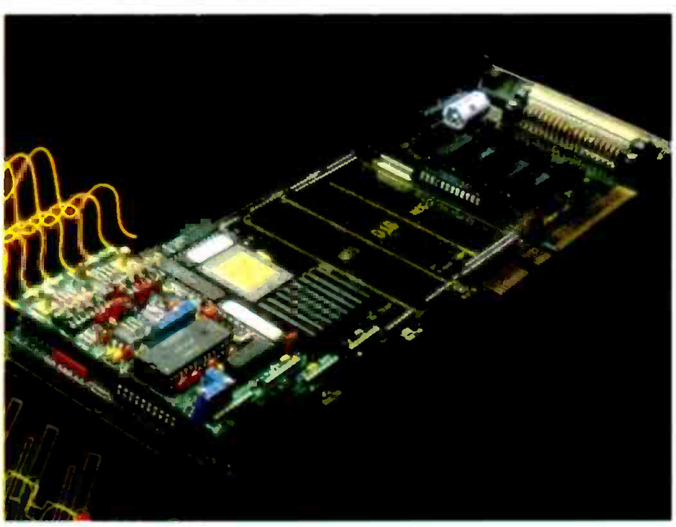
Micropower precision references. The GEC Plessey range of precision voltage references uses the bandgap principle to provide a precise stable reference voltage without the need for an external shaping capacitor. The 2.5V references include the REF25 in a two-pin TO18 metal can, the REF25Z in a plastic three-pin TO92, and the REF25D in an MP8 miniature surface mount package. Recommended operating current range is 60μA to 5mA. There is a similarly packaged 5V range. GEC Plessey Semiconductors, 0793 518000.

Digital signal processor

DSP modems. DSP multimode terminal units from AEA have all the modem functions implemented in firmware. They have all the popular PK232 modem functions as well as satellite modems covering data rates up to 9600baud. They also include fax and SSTV modems. ICS Electronics Ltd, 0903 731101.

Data acquisition module. The adt156 A-to-D module provides a no glue logic high speed 16bit data acquisition interface for DSP devices from Motorola, AT&T, TI and Analog Devices. When combined with the spt156 Tram (transputer module) it can provide the basis of a data capture and analysis system for real time digital signal processing applications. Sunnyside Systems Ltd, 0506 460345.

The adt156 A-to-D Module provides a no glue logic 16bit acquisition interface for popular DSP devices



Linear integrated circuits

Telephone circuit. The AS2530 is a speech transmission circuit with LD/DTMF repertory dialler on a single chip. During on-hook the repertory number store is maintained by an on-chip low power voltage regulator which draws less than 30μA from the line. Standard operating range is 20 to 100mA but it can work down to 5mA with reduced performance. There is a 32 digit last number recial and an 18 digit repertory store for nine numbers. Austria Mikro Systeme, 0276 23399.

PWM controller. The Siliconix Si9120 is a current mode PWM controller IC with an input range of 50 to 450V that lets it work directly from rectified 110 or 220V AC power lines. Integrated in the chip are high voltage start-up circuitry, oscillator, error amplifier, voltage reference and noninverted cmos output driver for the external mosfet. Quiescent current is 1.5mA. Frequency capability is 500kHz. It comes in a 16-pin plastic DIP. Barlec-Richfield Ltd, 0403 50111.

Instrumentation amp. The INA120 monolithic instrumentation amp has a maximum nonlinearity of 0.005% (gain = 1) of full scale and, with ±15V supplies, a current requirement of only 2.7mA typical or 4mA maximum. Internal gain-setting resistors let precise gains of 1, 10, 100 or 1000 be set by pin strapping. Burr-Brown International Ltd, 0923 33837.

Bus driver and receiver. Cherry is developing a bus driver and receiver IC for analogue class A multiplex bus networks that can withstand short circuit, thermal overloads, reverse battery voltages and various voltage transients that are found in hostile automotive applications. The CS8425 interfaces between the system microprocessor and sensors and control elements to provide information or functions on command. Cherry Semiconductor Corp, 0101 401 823 3995.

Frequency synthesiser. The Qualcomm Q3036 is a single chip solution for phase locked loop frequency synthesiser applications for RF designers. It needs a single +5V supply and has all the needed elements, except for the VCO and loop filter components, to build a PLL frequency synthesiser which will operate from DC through to the L band. The 44-pin unit is available in a PLCC or CLCC package. Chronos Technology Ltd, 0989 85471.

Quad video op amp. The HA2444 four-channel switched-input video op amp has a unity gain bandwidth of 45MHz and differential phase. Gain is 0.03° and 0.03%, respectively. It incorporates four differential op amp type input stages, digital selection logic, and output buffer with enable function. It comes in 16-pin SOIC and plastic/ceramic DIPs. Harris Semiconductor, 0276 686886.

Power drivers. Harris has introduced the SP600 series of high voltage half-bridge driver ICs for driving power MOS devices in half-bridge topologies. They can interface direct to n-channel power mosfets or IGBT devices. They are rated at 500V DC and can work directly from standard rectified 240V AC mains. Harris Semiconductor, 0276 686886.

Linear amplifiers. Motorola has introduced two wideband 10MHz to 1.2GHz high linearity amplifiers, the CA5900 and 5915. They are thin film hybrid amps that use an all gold metallisation system and are for operation in 50Ω units. Gain is 15dB and output power is typically 1W at 1dB compression point. Typical third order intercept is 41dBm. Motorola Ltd, 0908 614614.

Frequency generator. The SC11410 is a programmable frequency generator. The chip contains a set of eight mask programmed frequencies used in PC graphics adaptor boards. The user can either select a frequency from the mask programmed set or program another frequency on the fly by entering an 18bit word through the serial interface. No external voltage regulator is needed and frequency jitter is kept to less than 150ps. Sierra Semiconductor Ltd, 0793 618492.

Bus line drivers. A series of high output drive devices from TI have a specified drive capability of I_{ol} = 188mA and I_{oh} = 80mA. The series comprises 16 drivers, transceivers and transceivers with registers. The first two released are the BCT25245 octal transceiver and the BCT25642 octal transceiver with open collector outputs. Texas Instruments, 0234 223252.

Drive and transmitter duo. The UC3725 and 3724 provide all the needed features to drive an isolated mosfet from a TTL input signal. A modulation scheme is used to transmit power and signals across an isolation boundary with a minimum of external components. They are suitable for driving the high-side devices on a high-voltage H bridge. The 3724 transmits drive logic and drive power and the 3725 receives power and signal across the isolation boundary and provides a pulsed output of 2A. Unitrode (UK) Ltd, 081 318 1431.

Interface and FIFO IC. A single IC from VLSI has on board four PC/AT compatible serial data I/O interfaces including data FIFO and associated logic. The VL16C554 has four NS16550 serial ports each with its own 16byte FIFO to reduce CPU interrupts. It can accommodate 5, 6, 7 or 8bit characters with 1, 1.5 or 2 stop-bits and even, odd or no parity. VLSI Technology Ltd, 0908 667595.

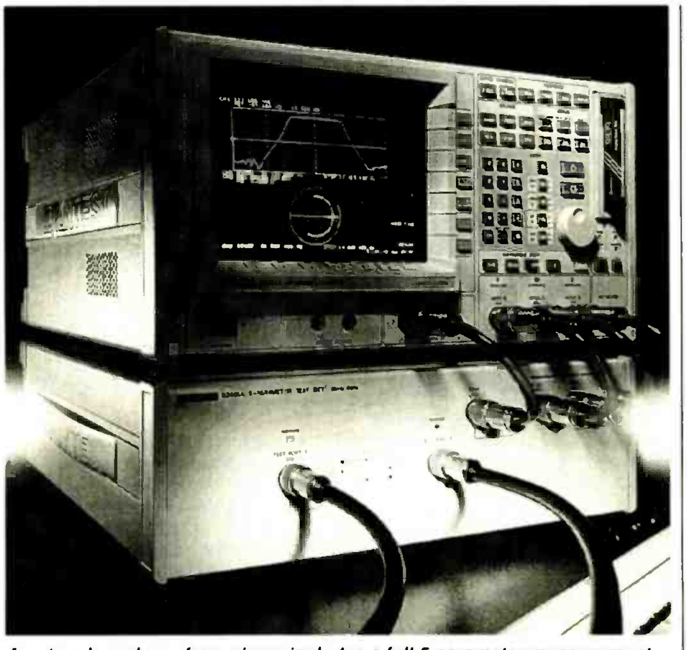
Memory chips

4Mbit EPROM. Dialogue has expanded its range of Hitachi UV-erasable EPROMs with the introduction of the 4Mbit HN27C4096 configured as 256K x 16bit. Programming time is 3.5s and access time 100ns. The cmos device has a write pulse width of 50µs which, when combined with a page programming mode that lets 64bit be written in a single write mode, cuts the programming time to a quarter. It works from a 5V supply with a typical operating current of 40mA at 10MHz and standby current of 20µA maximum. Dialogue, 0276 682001.

Ferroelectric ram. Ramtron's ferroelectric ram can use storage capacitor techniques to let it work like a conventional Dram. But, when high voltage pulses are applied, the ferroelectric films can be polarised to form long-lasting bistable storage elements preserving data when system power is lost. The first of these nonvolatile Drams is the FMX1208 512 x 8bit chip. Read/write cycles are 200ns. Mogul Electronics, 0732 741841.

Microprocessors and controllers

Colour look up table. Inmos has available the IMS G177 power down colour look up table. In standby mode it is totally powered down and consumes 200µA. In review mode the clut can be accessed through the microport while the rest of the device is powered down. In this mode it consumes 500µA. In normal mode it works like the G176 VGA clut providing a VGA output for driving a monitor. The device has anti-sparkle circuitry which reduces snow or sparkle effects on screen generated when some software reads or writes operations to the palette during active video. Inmos Ltd, 0454 616616.



A network analyser from chase includes a full 5 parameter measurement capability

Video decoder. A single-chip moving pictures experts group (MPEG) video decoder and processor from C-Cube can decompress digital video in real time. This can be done at four times the pixel resolution specified by the base-level MPEG mode. Kudos Thame Ltd, 0734 351010.

Graphics display chip. Music Semiconductors and Avasem are jointly developing a graphics display chip which they hope will be the industry's first combination colour palette and frequency generator to fully support super VGA and other common graphics standards. The product is scheduled for sampling in August. Music Semiconductors Inc, 0101 719 570 1550.

Low power microprocessors. Two high speed microprocessors from NEC can work at any clock speed from DC to 16MHz with a current demand of a few microamps. The V20HL and V30HL have a 6mA/MHz maximum power consumption. These cmos chips are for mobile instruments, industrial control, telecomms and office automation. They come in 40-pin DIL, 52-pin QFP and 44-pin PLCC packages. NEC Electronics (UK) Ltd, 0908 691133.

Optical devices

Surface emitting LEDs. GCA has introduced two surface emitting LEDs for analogue video transmission over fibre. The 1A184 is a linear high-speed LED for modulated carrier-wave video. The high linearity is expressed by the second and third harmonics which are suppressed by 40 and 45dB, respectively, at 10MHz. Bandwidth is 140MHz. It couples 35mW into a 50/125mm fibre at 100mA. A high power 45mA coupling version is also available. The 1A255 is a highly linear LED for base-band video. It works linearly even in the low-frequency range which minimises signal distortion. It couples 80µW into a 62.5/125µm fibre at 80mA and has a bandwidth of 55MHz. GCA Electronics Ltd, 0993 82 2252.

Programmable logic arrays

Timing generator. Altera has introduced a function-specific erasable programmable logic device, the EPS464 synchronous timing generator for use in the imaging and display market. The 50MHz unit integrates control logic needed by CCD image sensors, video cameras and various graphic display devices. The 660mW device has 64 programmable macrocells for waveform generation, 32 programmable I/O pins, and noise immune inputs with 250mV hysteresis and quiet output buffers. Altera Corp, 0844 275285.

PASSIVE

Connectors and cabling

Cable equalisers. A series of negative slope equalisers from Inmet have a frequency range of 2 to 18GHz and are for in-line equalisation of long coaxial cable runs. They can exhibit a characteristic from 5 to 20dB attenuation at 2GHz and an insertion loss of 1.5dB maximum at 18GHz. Linearity of ±0.5dB over the entire frequency band is achievable and a low VSWR of 1.4:1 is guaranteed. Pascall Electronics Ltd, 081-979 0123.

Displays

Miniature lamps. Three types of miniature lamps for electronics equipment are available from Electroustic. First are single filament lamps with a range of 6 to 70V and current from 20 to 200mA. Secondly, single neon and green fluorescent lamps have a range of 60 to 220V and a current from 0.3 to 3.5mA. The third range comprises multi LED lamps which have four or six high luminosity chips available in red, green or yellow with a rating of 6 to 48V DC and a current of 10 to 35mA. Electroustic Ltd, 0264 333664.

LCD module. Toshiba has introduced the TLX1741-C3M 240 x 128 LCD module for EPOS and instrumentation applications. The black and white display uses a compensation film approach which with thin light guide technology keeps the thickness to 14mm. A cold cathode fluorescent lamp is used for back lighting. The on-board T6963C controller chip can store graphics screens, characters and full European fonts. Toshiba Electronics (UK) Ltd, 0276 694600.

LCD module. Trident claims its TRMod-34 is the smallest 16 x 2 LCD module available at 74 x 30 x 8mm. Viewing area is 45 x 14mm and the two lines of 16 are five by seven dot matrix characters each measuring 4.9 x 2.1mm. Supertwist and twisted nematic types are available and it can be supplied with an EL backlight. An optional panel mounting kit is available with scratch resistant window. It is suitable for hand held instruments. Trident MicroSystems Ltd, 0737 765900.

Filters

Interference suppression. The Microslim range of RFI/EMI interference suppression filters from Oxley is claimed to save 40% space compared with similar units. The body is threaded for either tapped hole or

Continued on page 528

SPICE• AGE

Non-Linear Analogue Circuit Simulator £245 complete

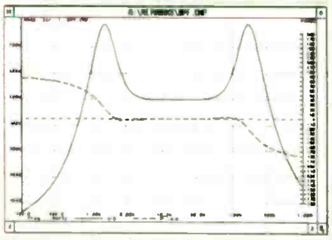
or £70 per Module

Those Engineers have a reputation for supplying the best value-for-money in microcomputer-based circuit simulation software. Just look at what the latest fully-integrated SPICE Advanced Graphics Environment (AGE) package offers in ease-of-use, performance, and facilities:

SPICE●AGE performs four types of analysis simply, speedily, and accurately:
- Module 1 – Frequency response ● Module 3 – Transient analysis
- Module 2 – DC quiescent analysis ● Module 4 – Fourier analysis

NEW VERSION 3.00 JUST RELEASED

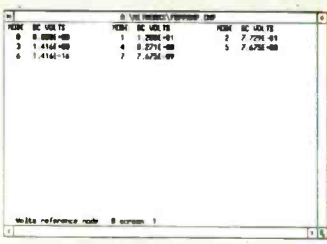
FEATURES: New manual with introductory text on Fourier analysis, Fourier Zoom window. **UPGRADES £65.**



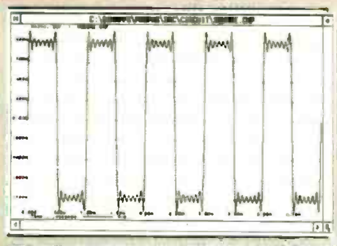
Impedance sweep

1 Frequency response
SPICE●AGE provides a clever hidden benefit. It first solves for circuit quiescence and only when the operating point is established does it release the correct small-signal results. This essential concept is featured in all Those Engineers' software. Numerical and graphical (log & lin) impedance, gain and phase results can be generated. A 'probe node' feature allows the output nodes to be changed. Output may be either dB or volts; the zero dB reference can be defined in six different ways.

2 DC Quiescent analysis
SPICE●AGE analyses DC voltages in any network and is useful, for example, for setting transistor bias. Non-linear components such as transistors and diodes are catered for. (The disk library of network models contains many commonly-used components – see below). This type of analysis is ideal for confirming bias conditions and establishing clipping margin prior to performing a transient analysis. Tabular results are given for each node; the reference node is user-selectable.



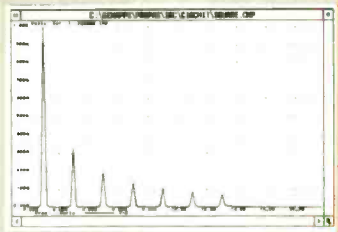
DC conditions within amplifier circuit



Square wave synthesis (transient analysis)

3 Transient analysis
The transient response arising from a wide range of inputs can be examined. 7 types of excitation are offered (impulse, sine wave, step, triangle, ramp, square, and pulse train); the parameters of each are user-definable. Reactive components may be pre-charged to steady-state condition. Up to 13 voltage generators and current generators may be connected. Sweep time is adjustable. Up to 4 probe nodes are allowed, and simultaneous plots permit easy comparison of results.

4 Fourier analyses now with Hanning window option
SPICE●AGE performs Fourier transforms on transient analysis data. This allows users to examine transient analysis waveforms for the most prevalent frequency components (amplitude is plotted against frequency). Functions as a simple spectrum analyser for snapshot of transients. Automatically interpolates from transient analysis data and handles up to 512 data values. Allows examination of waveform through different windows. Powerful analytical function is extremely easy to use.



Spectrum of synthesised square wave (Fourier analysis)

If your work involves designing, developing or verifying analogue or digital circuits, you will wonder how you ever managed without Those Engineers circuit Simulation Software.

A good range of properly supported and proven programs is available and our expert staff are at your service.

Telephone: Charles Clarke on 071-435 2771 for a demonstration disk.

Those Engineers LTD

106a Fortune Green Road West Hampstead
London NW6 1DS
Tel: 071-435 2771 Fax: 071-435 3757

CIRCLE NO. 151 ON REPLY CARD

KESTREL ELECTRONIC COMPONENTS LTD

☆ All items guaranteed to manufacturers' spec.
☆ Many other items available.

'Exclusive of V.A.T. and post and package'

	1+	100+		1+	100+
Z8530	0.60	0.30	2716	2.60	1.70
Z80A CPU	0.80	0.65	2764A-25	1.80	1.30
Z80A CTC	0.50	0.30	27C64-25	1.80	1.35
Z80B CTC	0.60	0.35	27C128-25	2.20	1.45
Z80A PIO	0.60	0.40	27128A-25	1.80	1.38
Z80B (CMOS) CTC	0.70	0.45	27256-25	2.20	1.40
Z80A DMA	0.95	0.65	27C256-25	2.20	1.55
Z80A DART	1.20	0.90	6116LP-120ns	2.00	1.00
1488	0.16	0.12	6264LP-100	1.60	1.10
1489	0.16	0.12	62256LP-100	3.60	2.45
LM324	0.25	0.14	628128LP-120	24.00	POA
LM339	0.25	0.14	ICL7660CPA	1.00	0.80
ILQ-74	1.20	0.85	8085A	1.80	1.30
ULN2803A	0.55	0.35	80C85	2.20	1.60
6502P	2.20	1.56	8155	2.20	1.60
6522P	2.20	1.56	82C43	1.70	1.25
65C02P2	3.60	3.00	8251A	1.10	0.80
65C21P2	3.00	2.60	8253-5	1.40	0.95
65C22P2	3.10	2.66	8255-5	1.40	0.95
ICM75551PA	0.42	0.34	82C55A	1.40	0.95
MM58174AN	4.50	3.70	8259A	1.50	0.80
74HCT04	0.12	0.09			

All memory prices are fluctuating daily, please phone to confirm prices

178 Brighton Road, Purley, Surrey CR2 4HA
Tel: 081-668 7522. Fax: 081-668 4190.

CIRCLE NO. 152 ON REPLY CARD

ALL-MODE WIDE-BAND IC-R7100 RECEIVER

THE IC-R7100 FEATURES:
- 25 to 2000 MHz continuous coverage allowing you to receive VHF, UHF, amateur, marine, CB, utility bands, FM and TV broadcasts
- All-mode capability.
- 900 memory channels in 9 banks.
- 20 Scan edge memory channels.
- Dual scan with over 40 combinations.
- High sensitivity and reliable frequency stability
- 0.1, 1, 5, 10, 12.5, 20, 25, 100 kHz and 1 MHz tuning steps available
- Built-in 24-hour system clock with 5 ON/OFF timers.
- Effective 20dB attenuator for strong signals.
- Automatic recording so important programmes can be caught when away from receiver.
- Dial lock function.
- Noise blanker circuit for eliminating pulse noise.
- Noise squelch and S-meter squelch
- CI-V system for computer control through an optional CT-17.
- Frequency announcement in English with an optional UT-36.
- Large function display with selectable LCD backlighting brightness.
- Easy-to-read S-meter plus FM centre indicators.
- AC and DC power operation.

ICOM Post to: Icom (UK) Ltd. Dept WW Sea Street Herne Bay Kent CT6 8LD Tel:0227 741741 (24hr). Fax: 0227 360155

Name/address/postcode ....

....

Call sign: .... Tel: .... Dept: WW

CIRCLE NO. 153 ON REPLY CARD

nut retention. It comes in C, L-C and Pi configurations and has capacitances from 330 to 22,000pF with insertion loss at 10GHz. Working voltage is up to 200V and maximum current rating is 10A. Oxley Developments Ltd, 0229 52621.

Instrumentation

Network analyser. A network analyser with a full S parameter measurement capability is available from Chase. Menu driven software prompts the user through a full two-port calibration procedure using simple on-screen messages. All four S parameters can be measured without disturbing the connections to the device under test. Results can be used for CAD, quality assurance and archiving. Chase Electronics Ltd, 081-878 7747.

LCR meter. The LCR815 meter has selectable test frequencies of 120Hz and 1kHz. Features include autoranging, autoparallel and series circuit mode selection. Information is shown on two four-digit seven-segment LED displays. Basic accuracy is 0.2%. Inductance ranges are 190µH to 1900H, resistance from 1900mΩ to 19MΩ, and capacitance from 190pF to 19mF. Flight Electronics Ltd, 0703 227721.

The LCR815 LCR meter from Flight has selectable test frequencies of 120Hz and 1kHz

Chart recorder. The Easygraf oscillographic recorder from Gould is a portable unit for shop floor or field use. It has high-frequency thermal-array recording, extensive annotation capabilities, plug-in signal conditioning, and 18 chart speeds from 0.01 to 100mm/s. It can monitor up to four analogue inputs and six event channels. It measures 19.4 x 38.1 x 38.1mm and weighs 10kg. It comes in two and four channel versions. Gould Electronics Ltd, 081-500 1000

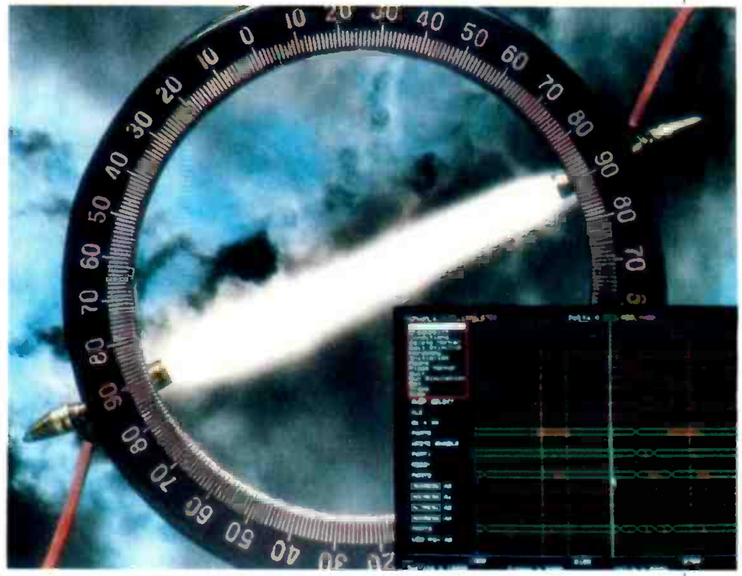
Real-time scopes. The VC6023 and 6024 are real-time oscilloscopes aimed at engineers who need a storage capability. The 6023 has a real-time bandwidth and repetitive signal storage bandwidth of 20MHz and the 6024 50MHz. Both have sampling rates of 20Msample/s (two channel alternate) or 100Ksample/s (two channel chopping). Memory capacity is 2Kword (x2 channel) at 50ns/div to 2µs/div. Hitachi Denshi (UK) Ltd, 081-202 4311.

Current calibrator. A portable current calibrator with a range from 0 to 20mA is available from Intek. The TEK300 is for process control use and as a general purpose signal injector. This hand-held battery powered unit can work as a current source, current sink or monitor for the current in a process loop. It has a 3.5 digit LCD with LEDs to show battery state and operational error. Intek Instruments Ltd, 0942 227735.

DC energy meter. The DC101 is a DC power transducer and energy meter with an accuracy of ±1% which is not affected by ripple and noise on the supplies. It is for use with DC drives, DC systems and variable speed AC drives. It comes in an IP54 enclosure and gives measurements in kWh, MWh or J with a volt free pulse output per energy unit. An optional 4 to 20mA output is available. Display is via a seven digit electromechanical counter. Northern Design Ltd, 0274 729533

Modulation analyser. The FMA modulation analyser from R&S covers 50kHz to 5.2GHz. It includes RF measurements to 0.1Hz, AM/FM and phase measurements with an error less than 0.5%, balanced and unbalanced AF voltage and frequency measurements, and a precision power meter with an accuracy of <0.5dB. Various psophometric weighting filters are provided as standard with special filters available as an option. Rohde & Schwarz UK Ltd, 0252 811377.

100MHz scope. The Leader 2100AR is a 100MHz three-channel six-trace oscilloscope with digital CRT readout. Control settings for on-screen readout include sweep time and vertical sensitivity. A cursor measurement facility comprises four horizontal and vertical cursors supported by two extra cursors for further measurement. Thurlby-Thandar Ltd, 0480 412451.



Orcad/VST release 4 digital simulation tool from ARS is easily accessible from the ESP desktop.

Literature

ICs and discretes. The Allegro Databook gives details of the firm's range of mixed signal ICs and discrete semiconductor devices. It also contains applications information covering their use in computer peripheral, industrial control, military, automotive, consumer and aerospace applications. Allegro Microsystems, 0932 253355.

Production equipment

Cold light of day. The Schott electronic cold light source provides controllable shadow free illumination of subjects with multiple light outputs. The electronic control system protects the halogen lamp from surges at switch on and during operation. It comes with one, two or three light output swan-neck guides which are self supporting. Flexible guides are also available which may be clamped to equipment for fixed illumination. It can be used with zoom type microscopes for inspecting small components and assemblies. A vacuum adaptor is available for clean room use. Hunter Equipment Sales Ltd, 0420 473723.

Desoldering wick. A desoldering wick is available for the capillary removal of solder from conventional and surface mount circuit boards. Its pure copper fine braid construction provides a large surface area to improve absorption and retention of excess solder. The rosin flux is mild, noncorrosive, non-hygroscopic and non-activated. Tech Spray EC Ltd, 0423 520699.

Power supplies

DC/DC converters. The 2PKV series of 2.5 to 3W DC/DC converters are made using thick-film hybrid technology and boast an efficiency of 85%. Input range is either 9 to 36V DC or 18 to 72V DC. Input current is 3 to 5mA at nominal input voltage. Standard outputs are 5, 12 and 15V DC. Ericsson Components AB, 0203 553647.

Bench supply. The AX321 and 322 bench power supplies from ITT have digital display of voltage and current output. The dual output 322 has output voltage tracking up to ±30V as well as series and parallel outputs. Total power output is 140W. The single output 321 has an output range of 0 to 30V at up to 2.5A with adjustable current limit and a total power rating of 70W. ITT Instruments, 0753 511799.

Uninterruptible supply. The Accupower UPS range is claimed to provide off-line and standby power at 50p to £1 per VA. There are five units in the range from 150VA to 1400VA, the low power unit being enough to protect most XT type computers with the high power unit for network file servers and multiple PCs. Backup at full load is 8 to 10 min. Thame Power Ltd, 0844 261300.

Programmable supply. Thurlby has introduced a fully programmable quad-mode power supply with active discharge circuit. The TSP3222H has two 0-32V 0-2A dual-tracking outputs which can be used in parallel to give 0-32V 0-4A or in series for 0-64V 0-2A. A nonvolatile memory can store 25 set-ups and user-definable overvoltage protection is included. It comes in stand-alone or rack mount formats. Thurlby-Thandar Ltd, 0480 412451.

Production test equipment

Appliance tester. Seaward has launched a dual voltage portable appliance tester for batch testing electrical and electronic equipment on production lines. The PAT2000 needs a 240V supply for testing 110 and 240V appliances. A repeat function lets the user repeat a test function without a continuous input of information. A bar code reading facility allows the user to input serial numbers of test codes by a bar code wand. It can record up to 1000 test results. Seaward Electronic Ltd, 091-586 3511.

Radiocomms

Synthesiser. The VDS100 from Sciteq is a phase-lock-loop synthesiser for use as a crystal replacement source for satellite communications systems. Phase noise is -20dBc/Hz at 1kHz offset and -150dBc/Hz at 300kHz, and spurious -95dBc (100kHz to 1MHz). The unit can be offered for any 15% span in the 50 to 150MHz range. Resolution is about 2.6kHz to provide 125kHz steps after multiplication by 48 to C band. Lyons Instruments Ltd, 0992 467161.

Transducers and sensors

Pressure transmitter. From Control Transducers is the XPRO pressure transmitter for OEM use in refrigeration, process control, flow measurement and liquid level management systems. It has a 4 to 20mA output and an accuracy of 1%. The pressure ranges are from 0-0.4 to 0-3.5bar vented gauge and from 0-6.9 to 0-345bar sealed gauge. Control Transducers, 0234 217704.

Piezo transducers. The HPE range of piezo transducers from JPR Electronics comprises three compact audible annunciators in three-lead chassis mounting or three-pin PCB version. Each provides a feedback output. They have a self drive capability so they only need one external circuit and a DC power supply of 4.5 to 20V at between 10 and 20mA. Audible outputs at 30cm with a 9V DC input are 75dB at 6.6kHz, 80dB at 4.7kHz and 85dB at 2.8kHz. JPR Electronics, 0582 410055.

Multi-transducer. The Yokogawa 2479 power-line multi-transducer from Martron Instruments has the six measuring functions needed for power line testing - voltage, current, power, reactive power, phase, and frequency in a unit measuring 176 x 127 x 95mm. It works on single and three phase systems. Accuracy is said to be 0.5% and frequency range is between 45 and 400Hz. Outputs are 0-5V, 0-1mA and 4-20mA. Martron Instruments Ltd, 0494 459200.

COMPUTER

Computer board level products

PC-AT board. The PC12/14 is an analogue input board for PC use in industrial or scientific data acquisition, process control and factory automation. It will accept 32 single ended and 16 differential inputs with a common mode voltage range of ±11V to analogue ground. Analogue ranges are selectable from ±5 and ±10V bipolar, +5 and +10V unipolar. There are three A-to-D converter options - 200kHz 12bit, 1MHz 12bit and 300kHz 14bit. Datel (UK) Ltd, 0256 469085.

VMEbus CPU board. The HK68/V3F 68030-based VMEbus CPU board from Diamond Point can be easily upgraded to a 68040 board. It also uses Heurikon's Corebus architecture which allows movement to Futurebus+ without a major redesign. It works at up to 50MHz and there is the option of a 68881 or 68882 floating point coprocessor. Standard memory support includes 2 or 8Mbyte 70ns dual-access Dram (optional parity), up to 1Mbyte EPROM, and 512byte non-volatile ram. Diamond Point International, 0634 722390.

AT bus card. Flash has designed a PC plug-in card to control up to four emulator pods allowing real time emulation and program/data trace for any 8, 16 or 32bit microprocessors via the memory sockets of the target system. By combining Flash emulators with existing third party universal integrated cross assemblers such as ECAL or from MPE, users can set up to two hardware breakpoints and trace program/data flow in real time. Flash Designs Ltd, 0293 551229.

Tram subassembly. The IMS B428 Tram subassembly (combining transputers, memory and peripheral devices) from Inmos has a processing power of 25MIPS and 3.5MFLOPS. This credit card sized module has separate address and data buses. It uses the IMS T801 25MHz 32bit transputer with four 20Mbit/s communication links. The Tram integrates 2Mbyte of zero wait state Dram at 80ns cycle time and 50Mbyte/s memory interface bandwidth. Inmos Ltd, 0454 616616.

DSP board. The DPV30 dual processor VME board provides a general purpose digital signal processing system for the VMEbus. It has a 66MFLOPS processing engine using two TI TMS320C30 processors. Standard global memory is 128K x 32word Sram but the user can specify either 512K x 32word Sram 1M x 32word Dram or 4M x 32word Dram. Software support includes Assembler/Linker, C compiler tools, Spox DSP operating system, debug monitors and interface libraries. Applications can be developed in Dos or Unix. Loughborough Sound Images Ltd, 0509 231843.

PC chipset. METL has available full design details for UMC's 486 chipset, the UM82C480 for use with Intel's 50MHz 486 processor. The three-chip unit delivers 22.4MIPS with a landmark speed of more than 200MHz. The set has a built in cache controller with write back operation. Up to 256Kbyte of cache is supported with 16 byte line size for the 80486. The built-in maskable cache controller supports burst read for the 486 and hidden refresh to boost system performance. There is up to 64Mbyte of on-board Dram arranged in four banks. Microelectronics Technology, 0844 278781.

PC instrument card. A plug-in card and software package from Blue Chip can turn a PC into an intelligent DMM, chart recorder and data logger. The VIP gives 4.5 digit resolution, 0 to 2A AC/DC, 0 to 20MΩ resistance, 0 to 2μF capacitance and ±55dB functions. It is for quality assurance, automatic testing, data recording and proof testing applications. STC Instrument Services, 0279 641641.

Computer systems

Industrial PC. Burr-Brown has introduced an 80386SX based version of its industrial PC, the VIPc which lets users specify internal circuitry, mechanical form and interfacing options. The core is an 80386SX based PC with a clock speed of 16MHz. It supports VGA and EGA graphics and an optional 80387SX maths coprocessor. An internal bay can accommodate an EMI-shielded card cage for standard boards, custom circuitry, small printer or magnetic card reader. Burr-Brown International Ltd, 0923 33837.

Computer peripherals

PC expansion box. The EXT12 expansion box from Blue Chip adds 11 PC/AT slots to any IBM PC compatible system. Two versions are available which add either 8bit PC slots or 16bit AT slots. It is packed in a steel 19in rack mounting chassis with neoprene seals and a front panel sealed to IP54. Inside is a 150W power supply and fan. Blue Chip Technology, 0244 520222.

3.5in floppy drive. The Mitsumi 4Mbyte D352T2 3.5in floppy disc drive is 1in high and powered from a single 5V supply. It measures 101.6 x 150 x 25.4mm and weighs 410g. The 160 track design has a 135track/in density which, with a disc speed of 300rev/min, provides a data transfer rate of 1000Kbit/s in 4Mbyte mode. Track to track access time is 3ms and average access time is 94ms with a settling time of 15ms. Southern Peripherals, 0256 819221.

Computer security

cmos lock IC. The UA3730 made by UMC is a single chip cmos electronic lock which can accept 12-digit passwords. If an incorrect password is entered an external alarm or security system can be alerted. It has a 60s pulse output and a direct drive 4kHz buzzer output. It works in the 3 to 6V range and consumes 4mA operating or 5μA standby. Microelectronics Technology, 0844 278781.

Software

Logic device tool. A programmable logic device tool, Orcad/PLD release IV, is available from ARS. Improvements over the previous release include integration of PLD into the ESP framework, an open architecture output from PLD, a new compiler with greater capacity, and the ability for tri-stated outputs to be tested as inputs. It supports 32bit signal sets for the compiler and Vectors tool. It runs on any IBM PC, XT, AT, PS/2 or compatible. ARS Microsystems, 0276 685005.

Digital simulation tool. The Orcad/VST release 4 is an upgraded version of ARS' digital simulation tool. It is accessible from the ESP desktop. It also benefits from the port of the code to Modula 2. Error handling has been improved including trapping mechanisms. It identifies the device, gate or pin where the problem occurred and is reported when the error message is displayed. Other improvements include better netlisting, increased capacity, browse command and integration with input from the schematic. ARS Microsystems, 0276 685005.

High level debugger. The DB30 high level language debugger is for system and processor boards which use TI's TMS320C30. It lets engineers debug digital signal processing applications at either the C source or assembly level. It has a user configurable graphical user interface with data or command input via keyboard or mouse. It allows multiple windows to be opened simultaneously displaying C source, program disassembly, data memory and internal register contents. Loughborough Sound Images Ltd, 0509 231843.

Editorial survey; use the information card to evaluate this article. Item O.

Digital systems set timetable for HDTV

NHK in Japan is now transmitting regular, if limited, 1125-line analogue HDTV broadcasts through its BS-2 direct-to-home satellite. The system uses *muse* digitally-processed bandwidth reduction.

But the number of HDTV receivers is still small, virtually limited to public-viewing sites. Only recently have *muse*-to-NTSC converters become available enabling some viewers with NTSC receivers to view these programmes, though not as HDTV.

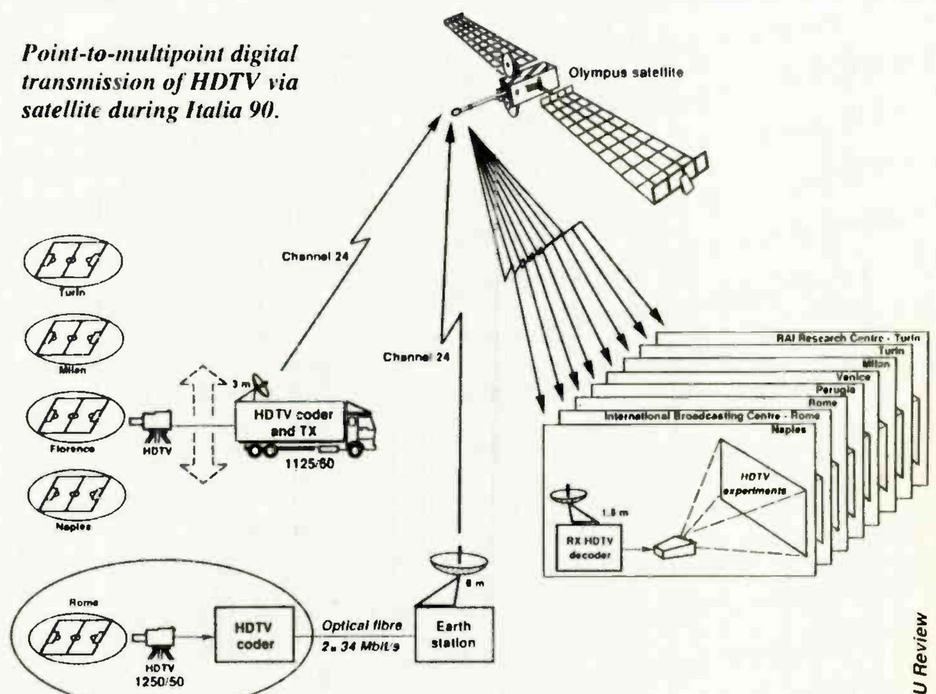
Despite the research effort being put into HDTV in Japan, Europe and North America, there is a growing feeling that HDTV transmission standards are evolving with increasing emphasis on digital rather than analogue transmission to homes.

We have already seen the future of D-mac, based on analogue-components, following on from mac and then wide-screen enhanced-mac thrown into doubt, at least in the UK, by the debacle of BSB. However after ITC persuasion BSkyB will fund part of the NTL continuing research on D-mac for the European EU-95 project.

European broadcasters still hope to register HD-mac as a CCIR HDTV transmission standard, compatible with the mac/packet-family of standards (C-mac, D-mac, D2-mac). But that does not imply that it will come to be widely used for operational HDTV DBS. George Waters, EBU Technical Director, has stated that Europe will probably adopt D-mac as an emission standard, "provided it meets appropriate quality targets".

Continues over...

Point-to-multipoint digital transmission of HDTV via satellite during Italia 90.



EBU Review

HOME TEAM CHALLENGES...

RAI's HDTV coverage of the World Football Cup included not only HD-mac transmissions but also experimental point-to-multipoint digital HDTV transmission with both 1250/50 and 1125/60 picture origination.

HDTV signals were digitally-encoded at 70Mbit/s and transmitted with QPSE modulation through channel 24 of the high-power Olympus satellite to a number of large-screen projection receivers with digital decoders in eight Italian cities.

Key element was the digital HDTV codec developed for Eureka project EU256 (supported by the governments of Italy and Spain) and built by Telettra SA. This codec is intended primarily for point-to-point transmission at 140Mbit/s contribution circuits but is capable of reducing an HDTV signal from about 1.2Gbit/s to 70Mbit/s, using redundancy-reduction techniques in space and time domains, with error protection. The Olympus satellite can handle 70Mbit/s through its transponders.

...GERMANY HITS BACK

A more advanced digital HDTV system than that used for the RAI World Cup project is under development by the German broadcasting R&D centre IRT. This is seen as a means of conveying to some viewers full studio-quality HDTV signals at a bit rate of about 125Mbit/s which with housekeeping, error protection and up to eight channels of musicam-encoded digital sound, can fit into the ISDN 140Mbit/s hierarchy.

Additional forward error correction might be used in the satellite sector at an overall bit-rate of 160Mbit/s. This would require satellite channel spacing of from 50MHz (16-qam), 87.5MHz (C8-PSK) to 100MHz (4-PSE etc).

"Hybrid DCT" (discrete cosine transformation) picture coding has been implemented by IRT in close collaboration with Siemens AG who have provided most of the coder software. The prediction values of a DPCM loop are subjected to DCT with the resulting coefficients coded in Huffman variable-length code. Hybrid DCT uses interfield coding with motion compensation, with the motion vectors transmitted.

The 27MHz channels of the 12GHz DBS band are too narrow to carry 140 or 160Mbit/s signals and IRT is currently contracting a demonstration unit operating in real time with the aim of convincing Warc-92 of the need for a broadcast satellite service (BSS) frequency band in the region of 20GHz for Region 1 (21.4 to 22GHz is already available in North America (Region 2).

IRT believes that the results so far of its studies show that a digital HDTV satellite and cable transmission system is technically feasible despite the difficult propagation conditions at 20GHz, but unlikely to be operational until about the year 2005. There is still need to develop such hardware as high-power TWTs for 20GHz satellites and fast Viterbi decoders for DTV receivers.

emission standard, "provided it meets appropriate quality targets".The system was demonstrated during the 1990 Football World Cup and further experimental broadcasts are planned.

Original marketing strategy relied on mac being firmly established as a DBS standard by the time of the first HDTV broadcast services. Delays in satellite launches, transponder allocations and receiver availability, have meant the assumed timescale has not materialised, undoubtedly affecting momentum and the time when regular HDTV programme services will be available to the public.

In the meantime digital technology will play an increasingly important role in broadcasting. In the US and Europe all-digital transmission systems for HDTV have been demonstrated and we can surely look ahead to the next century being an age of HDTV cameras, large flat domestic displays, and an all-digital environment from studio to the home.

Brief-case terminals carry satellite news

Demand for up to the minute news during the Gulf war underlined broadcasting value of "portable" satellite terminals able to send video and sound from remote locations. It also focused attention on recent developments by CBS News to perfect a briefcase-sized go-anywhere system.

Air-transportable TV satellite-news-gathering (SNG) terminals have been used operationally for more than a decade, but they still remain bulky, with terminal and associated equipment often carried in about 20 bulky carrying cases and dependent on local power supplies and access to a satellite.

This led CBS, back in 1986, to start development of a briefcase terminal, complete with antennas, weighing about 14.5kg and capable of delivering good-quality speech and data (and later still-picture facilities) into the public-switched telephone network (PSTN) over satellite channels from most areas of the globe.

A proof-of-concept prototype was ordered from SkyWave Electronics Ltd in 1988 and provided simplex operation.

But subsequent appearance of lightweight duplexers has allowed the terminal to be upgraded to full duplex operation.

Communication is via Inmarsat satellites with portable links (up and down) in the 1.5 to 1.6GHz band and the hub earth-station links using 4 and 6GHz. Teleglobe Canada (signatory to Inmarsat) has submitted the system as a non-standard land-based satellite communications service.

Dimensions of the terminal and case are about 46 by 33 by 11cm. Antennas, two flat patch array microstrip units (gain 17dBi), are fixed to the top lid of the case, which is oriented in azimuth and elevation with a hinge locking device, using the satellite beacon signal as a guide. Antennas are circularly polarised.

Amplitude-companded single-side-band (ACSSB) modulation is used with a 20W power amplifier, giving an EIRP of some 27dBW in a 5kHz bandwidth of the 25kHz Inmarsat channel (permitting use of two terminals simultaneously through the same channel). Data is transmitted at 2400 bit/s using differential minimum-shift keying. Power is from 110/230V 50/60Hz supplies or from internal 12V nicad batteries.

The hub-station (typically with an 18m dish) can patch the terminal's handset directly into a public telephone system. Once set up, the terminal can receive calls, with a distant operator dialling first the hub terminal's number followed by the briefcase terminal's code.

CBS News are currently developing even smaller and lighter terminals for use with higher-power satellites, including the use of Quixpix (Eastman Kodak Company) for transmission of pictures taken with an electronic still-picture video camera.

Where low-cost TV stops culture shock

Very small television companies can find great difficulty in financing the making of their own local programmes. Smallest of the ITV regions is Channel Television. Yet serving as it does rather more than 100,000 residents, plus a substantial number of holiday visitors in an affluent society, puts the problems faced by Cook islands Broadcasting Corporation (population 10,000) firmly in perspective. But Cook Islands too has now found a way to provide its own off-air service, with local origination for at least part of the time

The system adopted, based on low-cost technology, is being attempted in a number of Pacific Island territories supported by a sustaining service provided by Television New Zealand (TVNZ) with live events using satellite delivery.

Such an approach could meet the desire of many Pacific communities to protect and preserve their own cultures and values at a time when reception of international or domestic US channels threatens their own cultures. The fear is that cultures can change or even disappear as a result of indigenous populations coming to depend on television for information and entertainment.

Jon Blomfield (TVNZ) in *Combroad* describes how TVNZ has devised and put into operation the concept that currently provides assistance and participation in cost-effective services in Nieu (population 2000) and Cook Islands.

He explains that the client-country manages programming and scheduling, exercising full control over what is shown. International programmes are acquired through TVNZ, with news bulletins and some sports programmes transmitted via satellite.

But local production is encouraged — particularly local news, news magazines and current affairs — using low-cost video equipment such as camcorders, S-VHS tape formats and TVRO receivers derived, at least partly, from the consumer market, and with second-hand professional antennas for the TVROs.

There is also an unconventional solution to transmitter coverage. On Rarotonga (Cook Islands), for example, there are seven low-power, roadside translators around the island at sea level, avoiding "daunting costs" associated with high-altitude site development.

The arrangement allows the Cook Islands Broadcasting Corporation to operate both a local radio station and the TV service with a total staff (radio and TV) of about 15. Islanders can receive a daily local cultural entertainment for TV and a daily local news programme in Cook Island Maori and English.

Editorial survey: use the information card to evaluate this article. Item P

CLASSIFIED

081 661 8469 — 081 661 8640

ARTICLES FOR SALE

VALVES AND C.R.T.s

(also Magnetrons, Klystrons, 4CX250/350)

One million valves in stock. Obsolete types a speciality! Fax or phone for quote.
Special prices for wholesale quantities.
Orders from government departments, overseas etc. most welcome.
Many other types in stock. Please enquire re any type not listed.

CATHODE RAY TUBES 400 different types in stock.
Please enquire if your requirements are not listed below.

						M28.13LG	£45.00
1CP1	£29.50	D13.611GH	£59.00	F16 101GM	£75.00	M31.182GV	£45.00
12CSP4	£35.00	D13.630GH	£59.00	F21 130GR	£75.00	M31.184W	£55.00
1074H	£45.00	D14.200GM	£75.00	F31.12LD	£75.00	M31 190GR	£45.00
3078Q	£95.00	D16.100GH97	£65.00	LF708	£75.00	M31 191W	£55.00
8931 (W.H)	POA	DG7-5	£45.00	M7 120W	£19.50	M31 325GH	£35.00
CME822W	£7.00	DG7-6	£45.00	M14 100GM	£35.00	M38 100W	£59.00
CME1523W	£9.50	DG7-32	£55.00	M17 151GVR	£175.00	M40 120W	£59.00
CRE1400	£29.50	DG7-36	£55.00	M21 11W	£55.00	MV6 5 (Mul)	£50.00
D9.110GH	£45.00	DH3-91	£50.00	M23 112GV	£45.00	SE5FP31	£45.00
D10.220GH	£45.00	E723 (EEV)	POA	M24 121GH	£55.00	T975D	£75.00
D10.230GM	£45.00	ECR35	£39.50	M24.122WA	£55.00	VLS429AG	POA

VALVES Prices on application. Please enquire re any type not listed below.

A2426	ECC804 Maz	M8136 Mul	VL5631	6BJ6
A2521	ECC81	M8162 Mul	Z759	6BM6
C1149-1	ECC81 Spec Q	M513B	Z803U	6CH6
C1166	ECC82	Magnetrons	Y644	6CJ6
CCS1	ECC82 Spec Q	PC900	1B35A	6F33
CV TYPES: Many	ECC83	PCC89	2K25	6L6GC
in stock. Not all	ECC83 Spec Q	PD500	3B28	6SL7GT
listed below. Please	ECC88	PL509	3C/800E	6SN7GT
inquire.	ECC88 Spec Q	QQV03-10	3J-160E	12BH7
CV488	ECC804	QQV03-10 Mul	4-65A	12E1
CV1881	EF39	QQV03-20A	4-125A Eimac	13E1
CV2355	EF73	QQV03-20A EEV	4-400A	19AQ5
CV4014	EF91	QQV06-40A	4C28	211
CV4024	EF92	QQV06-40A Mul	4CX250B	805
CV6087	EF86 Siemens	QY3-125	4CX250BC	807
CV7180	EF93	QY4-250	4CX350A	811A
CX1140	EF95	QV04-7	4CX1000A	813
DA42	EL34	R10	4CX5000A	4635
DET22	EL38	SU2150	5B-254M	5763
DET23	EL81	TT21	5B-255M	6336A
DF91	EL81 Mul	S11E12	5B-257M	6973
E80L	EL84	TD03-10E	5B-258M	8056
E83F	EL5070	TY4-400A	5U4G	8122
E88CC	GY501	U19	5V4G	*Sockets:*
E180F	Klystrons	UBC41	6AK5W	B9A PCB
E810F	KT61	UCL82	6A56	B9A chassis
EC158	KT81	UL41	6B4G	Octal chassis
ECC35 Mul	KT88/6550	UY85	6BH6	Many others
		VA222A		

Testing to special quality – Military/CV, industrial etc available on request

BILLINGTON VALVES

Unit F2, Oakendene Industrial Estate, Near Horsham, Sussex FH13 8AZ.
Callers by appointment only.
Fax: 0403 865106 Telex: 87271 PRODSS G
Telephone: 0403 865105
Min. UK order £20 + VAT. Min. Export order £50 + carriage.

WE HAVE THE WIDEST CHOICE OF USED OSCILLOSCOPES IN THE COUNTRY

TEKTRONIX 2445A Four Trace 150MHZ Dual TB	£1200
TEKTRONIX 2235 Dual Trace 100MHz Delay Sweep	£1000
TEKTRONIX 2225 Dual Trace 50MHz Delay Sweep	£600
TEKTRONIX 2215 Dual Trace 60MHZ Delay Sweep	£450
TEKTRONIX 475 Dual Trace 200MHZ Delay Sweep	£550
TEKTRONIX 465 Dual Trace 100MHZ Delay Sweep	£450
SCHLUMBERGER/ENERTEC 5218 Three Trace 200MHZ Delay Sweep	£550
SCHLUMBERGER/ENERTEC 5220 Dual Trace 100MHZ Delay Sweep	£400
PHILIPS PM3217 Dual Trace 50MHZ Delay Sweep	£400
HITACHI V650F Dual Trace 60MHZ Delay Sweep	£450
HITACHI V352F Dual Trace 35MHZ	£250
HITACHI V212 Dual Trace 20MHZ	£250
LEADER 1020 Dual Trace 20MHZ	£260
TRIO CS1022 Dual Trace 20MHZ	£225
GOULD OS1100 Dual Trace 30MHZ TV Trig	£180

GOULD OS300 – 20MHZ Dual Trace
2mv/cm Small, Light weight. **NOW ONLY £215**
(Far better than some of the New Rubbish available)

SCOPEX 14D15 Dual Trace 15MHZ	£150
GOULD 1421 Digital Storage Dual Trace 20MHZ	£650
GOULD 1425 Digital Storage Dual Trace 20MHZ	£650
TEKTRONIX 434 Dual Trace 25MHZ, Tube Storage	£250

THIS IS JUST A SAMPLE – MANY OTHERS AVAILABLE

BRADLEY Oscilloscope Calibrator 192 with Cal Cert	£800
DATRON 1061 Auto Cal DMM True RMS etc	£650
SOLARTRON 7075 DVM up to 7½ digit, AC/RMS/DC/OHM	£700
MARCONI TF2008 AM/FM 10KHZ–510MHZ Sig Gen	£400
MARCONI TF2015 AM/FM 10–520MHZ Sig Gen with TF2171	£400
MARCONI TF2015 without Synchroniser TF2171	£250
MARCONI TF2016 AM/FM 10KHZ–120MHZ Sig Gen with TF2173	£350
MARCONI TF2016 without Synchroniser TF2173	£175
MARCONI TF2356/2357 Level Osc/Meter 20MHZ	the pair £950
HP 8620C Sweeper Main Frame 10–1300MHz	£800
MARCONI SANDERS 6055B Sig Source 800–2150MHZ	£400
MARCONI SANDERS 6070A Sig Source 400–1200MHZ	£400
RACAL 9009 Mod Meter 10MHZ–1.5GHZ	£350

TEKTRONIX 491 Spectrum Analyser 1.5–12.4GHZ	£750
HP 141T Spectrum Analyser System with 8555A & IF Plug-in 10MHZ–18GHZ	£3250
HP 140 Spectrum Analyser System with 8554 & IF Plug-in 500KHZ–1250MHZ	£1750
HP 140 Spectrum Analyser System with 8553 & IF Plug-in 1KHZ–110MHZ	£1400
HP Spectrum Analyser 182 with 8558B 0.1–1500MHZ	from £2250

BRUEL & KJAER SOUND LEVEL METER
2206-½" MIC
WITH CARRYING CASE £160 each
OTHER B&K EQUIPMENT AVAILABLE

DERRITRON TA120 with VP3 Vibrator	£1300
Uninterruppable PSU Unused	from £250
TEKTRONIX Waveformer Monitor Type 528	£300
RACAL INSTRUMENTATION RECORDERS Store 4d and Store 7D	from £750
PHILIPS PM2525 Digital Multifunction Multimeter 4½ to 5½ digit	£325
KEITHLEY 224 Programmable Current Source	£1000
FERROGRAPH RTS2 Recorder Test Set with ATU.	As New £600
FERROGRAPH RTS2 Recorder Test Set	from £150
AVO VALVE CHARACTERISTIC METER VCM163	£300
THURLBY PSU PL320MD 30V 2A Quad Mod Digital	£200
THORN Bench PSU 0–40V, 0–50A Metered	£300
FARNELL PSU H30/100 0–30V 0–100A	£750
GOULD K40 Logic Analyser 32 Channel	£500
TELEQUIPMENT CT71 Curve Tracer	£250
MARCONI TF2700 Universal LCR Bridge Battery from	£125
MARCONI TF2337A Automatic Distortion Meter 400HZ/1KHZ 0.01%	£175
MARCONI MOD Meters TF2300, TF2300B, TF2303 from	£100
RACAL 9915 Freq Counter 10–520MHZ Crystal Oven	£150
MANNESMAN TALLY Pixy 3 XY Plotter RS232	£300
CUB COLOUR MONITOR 14" RGB/TTL	£75

AVO 8 & AVO 9 MULTIMETERS
Good working order – physically not brilliant
Supplied with batteries & leads – ONLY £30
Other available Test Set No.1 8Mk5, 8Mk6 from £65 to £120

PHILIPS PM6622 Universal Timer/Counter 80MHZ 9-digit	£130
FEEDBACK SFG606 Sweep Fun Gen Sine/Sq/Tri 0.01HZ–1MHZ	£140
FEEDBACK FG600 Fun Gen Sine/Sq/Tri 0.01HZ–100KHZ	£55
AVO VALVE TESTER CT160. Suitcase style. 22 Bases (Valve Data NOT INCLUDED)	£40

LEADER LMV186A Two Ch MVmeter 5HZ–500KHZ, 1mV–300V	£100
KIKUSUI AVM23 AC Vmeter Dual Ch 10HZ–500KHZ 300µV–100V	£75
SOLARTRON 7045 Multimeter 4½ digit 30 ranges Auto/Man	£95

Large range of BENCH POWER SUPPLIES available	from £40
X-Y PLOTTERS Various models	from £25–£400

SOME BRUEL & KJAER EQUIPMENT ALWAYS AVAILABLE. PLEASE ENQUIRE

NEW EQUIPMENT

HAMEG OSCILLOSCOPE HM1005 Triple Trace 100MHz Delay Timebase	£792
HAMEG OSCILLOSCOPE HM604 Duel Trace 60MHz Delay Sweep	£610
HAMEG OSCILLOSCOPE HM203 7 Duel Trace 20MHz Component Tester	£338
HAMEG OSCILLOSCOPE HM205 3 Duel Trace 20MHz Digital Storage	£610

All other models available – all oscilloscopes supplied with 2 probes

BLACK STAR EQUIPMENT (P&P all units £5)	
APOLLO 10 100MHz Ratio Period Time interval etc	£222
APOLLO 100 100MHz (As above with more functions)	£295
METEOR 100 FREQUENCY COUNTER 100MHz	£109
METEOR 600 FREQUENCY COUNTER 600MHz	£135
METEOR 1000 FREQUENCY COUNTER 1GHz	£178
JUPITOR 500 FUNCTION GEN 0.1Hz–500KHz Sine Sq Tri	£110
ORION COLOUR BAR GENERATOR Pal TV Video	£209
All other Black Star Equipment available	

OSCILLOSCOPE PROBES Switched X1X10 (P&P £3)	£11

This is a very small sample of stock. SAE or telephone for LIST of OVER 700 ITEMS. Please check availability before ordering. CARRIAGE all units £16. VAT to be added to total of goods and carriage.

STEWART OF READING

110 WYKEHAM ROAD, READING, BERKS RG6 1PL
Tel: 0734 268041 Fax: 0734 351696
Callers welcome 9am to 5.30pm MON–FRI (UNTIL 8pm THURS)

VISA — Access

Cooke International

Ailtech 727 RF Spectrum Analyser .001–20.0GHz	£2500
H.P. 8410B Network Analyser	£3000
H.P. 8743A Reflection/Transmission Test Set	£500
H.P. 8745A S Parameter Test Set	£500
H.P. 745A AC Calibrator with 746A High Voltage Amplifier	£650
Systron Donner 6057 Microwave Freq. Counter 20Hz–18GHz	£1200
H.P. 8690B Sweeper Oscillator Main Frame	£345
H.P. 8694B BWO RF P/In for sweeper 8–12.4GHz	£240
R&S SMBI SHF Signal Generator 1.7–5GHz AM/FM	£650
Solartron 7055 Microprocessor Digital Voltmeter AC/DC/Ohms	£600
Tektronix 7704 Oscilloscope Main Frame 250MHz	£300
Tektronix suitable Plug Ins for above from	£230
Cossor 4100A Dual Trace Portable Scope 75MHz with delay	£450
Telequipment D83 DC–50MHz Dual Trace Scope with delay	£250

MUCH MORE AVAILABLE IN OUR S/ROOM OR VISIT OUR WALK ROUND BARGAIN STORE. PRICES FROM £5 UPWARDS!!!!
All prices exclude VAT and CARRIAGE

Contact: Cooke International, Unit 4, Fordingbridge Site, Main Road, Barnham, Bognor Regis, West Sussex PO22 0EB.
Tel: 0243 545111. Fax: 0243 542457.

Field Electric Ltd. Tel: 081-953 6009. 3 Shenley Road, Borehamwood, Herts. WD6 1AA. Fax: 081-207 6375, 0836 640328

SPECIAL OFFERS

EGA 8 bit cards special offer £17.95.
Hi res graphics card IBM PC:XT:AT & compatible computers. 721x350 Hercules compatible graphics with software disk & data **£28**. New & boxed.
5" green screen monitors. Composite video input. 12 VDC approx 1.2 amp uncased. £27.50.
12" swivel & tilt low voltage monitor mono new special offer £31.50.
Philips 12" mono Model 3617-04 new IBM compatible **£69**.
XT turbo motherboard built in f/disk interface printer + CGA or mono port. C/with PSU on board clock 720K ram. Sub assembly frame. No top, special offer £125 C/P £13.
IBM computers with h/drive etc from **£285 + VAT**.
NEC 3½" floppy disk drive new & boxed full height model FD 1135C 1.0/1.6Mb £57 – C/P **£2.00**.
NEC 3½" floppy disk drive new unboxed ½ height model FD 5037A 1.0Mb in 5¼" adpt. frame £59.00 C/P £2.25.
NEC 5¼" floppy disk drive new & boxed 1Mb ½ height FD1055 £49 C/P £2.75.
COPANET-1 network Interface card B650A for IBM PC, XT, AT or compatible computer. New & boxed with data & software disk **£59**.
Tektronix 465B O'scope 100 MHz in cal: **£460 C/P £24**.
Tektronix 191 constant amplitude sig-gen **£195 C/P** £10.
Tektronix standard amplitude calibrator 067-502 **£120** C/P £10.
RS sig-gen 17A 611-133 450 MHz **£100** C/P £7.50.
H.P. 3406 A broadband sampling voltmeter £150 C/P £10.
H.P. 4328A milliohmeter **£490 C/P** £10.
H.P. 3400A RMS voltmeter **£250 C/P £10**.
Farnell G12-10S. 12VDC 10amp. 240/110VAC input **£42 C/P** £3.50. Switch mode PSU.
Fujisu dot matrix printer 220 characters per second N.L. quality parallel interface IBM character set, new £140 C/P £15.50.

AMERICAN EXPRESS — DINERS CLUB INTERNATIONAL

We would like the opportunity to tender for surplus equipment
Official orders credit card telephone orders accepted with Access, Amex, Diners, Visa cards. Overseas enquiries welcome c/p rates U.K. mainland only.
Please ring for c/p rates not shown.
All prices inc. V.A.T. unless stated. Stock list available.

TO MANUFACTURERS, WHOLESALERS, BULK BUYERS, ETC.

LARGE QUANTITIES OF RADIO, TV AND ELECTRONIC COMPONENTS FOR DISPOSAL

SEMICONDUCTORS, all types, INTEGRATED CIRCUITS, TRANSISTORS, DIODES, RECTIFIERS, THYRISTORS, etc. RESISTORS, C/F, M/F, W/W, etc. CAPACITORS, SILVER MICA, POLYSTYRENE, C280, C296, DISC CERAMICS, PLATE CERAMICS, etc. ELECTROLYTIC CONDENSERS, SPEAKERS, CONNECTING WIRE, CABLES SCREENED WIRE, SCREWS, NUTS, CHOKES, TRANSFORMERS, ETC **ALL AT KNOCKOUT PRICES**
– Come and pay us a visit ALADDIN'S CAVE

TELEPHONE 081 445 0749/445 2713
R. HENSON LTD
21 Lodge Lane, North Finchley, London N12 8JG.
(5 minutes from Tally Ho Corner)

ARTICLES FOR SALE

Auction Announcement

of Electronic Test Equipment & Microcomputers
on Wednesday 29th May 1991
at Woodhouse College, Woodhouse St,
North Finchley, London N22
at 12:00 noon
800 lots of: Oscilloscopes, Analysers, Plotters,
Thermal Image systems, Recorders, etc, etc.
By all leading manufacturers,
and at 6:30pm
350 lots only of leading edge
microcomputers & peripherals
Viewing 12:00–6:00 May 28th & on sale day.

The London Computer Auction Rooms Ltd
Woodhouse Sixth Form College,
Woodhouse Road, Finchley, London N12

Telephone **071 794 1116** For a Catalogue

WANTED

SCRAP & SURPLUS ELECTRONIC EQUIPMENT, COMPONENTS, VALVES, PCB's ETC (SENSITIVE EQUIPMENT SMASHED AND SCRAPPED). I AM ALL SQUARED UP FOR COMPLETE DISCRETION AND IMMEDIATE SETTLEMENT.

CONTACT: BERNARD WELLING OF MUNICIPAL METALS AND SUPPLIES, 21 WILSHAW STREET, NEW CROSS, LONDON SE14 6TN. 081 692 6509.

SURPLUS STOCK CLEARANCE

100,000 electrolytic capacitors for sale

Type	Qty
160V 10μF	10,000
100V 1μF	50,000
100V 10μF	20,000
16V 1000μF	14,000
35V 220μF	12,000

£1200 to CLEAR

Also: 800 QTY. – Miniangle Stepper Motors
Type:
4.0V/phase
1.1A/phase
1.8 degree step
£1500 to CLEAR LOT or £2 each if split

RING DAVE ROBERTS 0274 636116

Technical & Scientific Supplies

POWER SUPPLIES Dual 15–30V 3A, with 350VA C core trans'r. 10 secondaries, 100 to 250 input. Open Frame. Used £33
Gould PMG24-3. 24V 3A 220–240 in. Unused. Boxed £30
±25V 2A, RS 591-843. Not stabilised. Fused. Boxed £15
Tek. 422. Portable Scope. 12v or mains £170
Level, Bubble, Hilger and Watts. Cased £85
Lens, C-Mount Canon motorised 6:1 zoom. Tested £45
Microphone RS249-946. Unused, boxed £40
Chart Recorders, Rustrak, 12v motor, 1"/hr £28
Autotransformer unit with 235/240/245v out, meter £8
AC Stabiliser Lyons BTR-SF. 240V. 1.2KVA. Used £80

All prices exclude carriage and VAT
LISTS AVAILABLE
Please write/fax/phone (any time)
Technical & Scientific Supplies, PO Box 19, Hythe, Southampton, Hampshire SO4 6XQ

GOLLEDGE
ELECTRONICS

CRYSTALS OSCILLATORS FILTERS

Comprehensive stocks of standard items. Over 650 stock lines. Specials made to order.
OEM support: design advice, prototype quantities, production schedules.
Personal and export orders welcome.
SAE for our latest product Information sheets.
GOLLEOGE ELECTRONICS LTO **Tel: 0460 73718**
Merriott, Somerset, TA16 5NS **Fax: 0460 76340**

APPOINTMENTS
☏ 081 661 8640

The EISCAT SCIENTIFIC ASSOCIATION performs research on the polar upper atmosphere and ionosphere by means of the incoherent scatter radar technique. For this purpose high-power, advanced technology radar systems are operated in Tromsö/Norway, Kiruna/Sweden and Sodankylä/Finland. EISCAT plans an additional radar site on the island of Spitsbergen in the polar cap. To work in the planning team of this new EISCAT Polar Cap Radar project we will install a

RADAR ENGINEER

We look for an electronics engineer having thorough experience in three or more of the following:

- ★ High power UHF transmitter design,
- ★ UHF distribution and duplexing systems,
- ★ High gain reflector and phased-array antennas,
- ★ Radar instrumentation and receivers.

Additionally, a good background in digital engineering is required. Fluency in English is necessary.

This position is initially available for a one year's period with possibility for extension over the whole project. The salary payable will depend on qualifications and experience and will follow the corresponding Scandinavian scales.

More information on EISCAT and a detailed job description can be obtained from EISCAT Headquarters, att. Dr. J. Röttger, Director, P.O. Box 812, S-981 28 Kiruna, Sweden (Tel. +46-980-79153; Fax +46-980-79161). Applications should be sent to the same address by the closing date of 15 June 1991.

Garibaldi - RF & Microwave

We are the specialist agency for 'Radio Frequency' design or test Engineers working from 1MHz to light! We have hundreds of top positions throughout the UK, working on RF mobile comms (GSM, PCN, CT2), opto, satellite, mm-wave & microwave projects. Please contact our consultant **Simon Luttrell MSc** on **0494 792592**
160 Bellingdon Road, Chesham, Bucks. HP5 2HF.

ARTICLES WANTED

STEWART OF READING
110 WYKEHAM ROAD,
READING, RG6 1PL.
TEL: 0734 68041
FAX: 0734 351696
TOP PRICES PAID FOR ALL TYPES OF SURPLUS TEST EQUIPMENT, COMPUTER EQUIPMENT, COMPONENTS etc. ANY QUANTITY.
103

WANTED

Receivers, Transmitters, Test Equipment, Components, Cable and Electronic, Scrap, Boxes, PCB's, Plugs and Sockets, Computers, Edge Connectors.
TOP PRICES PAID FOR ALL TYPES OF ELECTRONICS EQUIPMENT
A.R. Sinclair, Electronics, Stockholders, 2 Normans Lane, Rabley Heath, Welwyn, Herts AL6 9TQ. Telephone: 0438 812 193. Mobile: 0860 214302. Fax: 0438 812 387
780

WANTED

Cash paid for all types of Oscilloscopes working or not. We also offer a Repair & Calibration service for Scopes.
LEN COOKE ENTERPRISES
179 Northolt Rd, South Harrow
Middx HA2 0LY
Tel: 081-864 5551 or 0831 630820
Fax: 081-423 6678

WANTED: VALVES, TRANSISTORS, I.Cs (especially types KT66, KT88, PX4, PX25). Also plugs, sockets and complete factory clearance. If possible, send written list for offer by return. Billington Valves, phone 0403 865105. Fax: 0403 865106. See adjoining advert.

WANTED

Test equipment, receivers, valves, transmitters, components, cable and electronic scrap and quantity. Prompt service and cash.
M & B RADIO
86 Bishopgate Street, Leeds LS1 4BB.
Tel: 0532 435649
Fax: 0532 426881
9956

INDEX TO ADVERTISERS

OVERSEAS ADVERTISEMENT AGENTS
France and Belgium: Pierre Mussard, 18–20 Place de la Madeleine, Paris 75008.
United States of America: Jay Fenman, Reed Business Ltd., 205 East 42nd Street, New York, NY 10017 – Telephone (212) 867 2080 – Telex 23827.

Printed in Great Britain by Riverside Press, Gillingham, Kent, and typeset by Marlin Graphics, Sidcup, Kent DA14 5DT, for the proprietors, Reed Business Publishing Ltd, Quadrant House, The Quadrant, Sutton, Surrey SM2 5AS. *Electronics and Wireless World* can be obtained from the following: AUSTRALIA and NEW ZEALAND: Gordon & Gotch Ltd. INDIA: A.H. Wheeler & Co. CANADA: The Wm Dawson Subscription Service Ltd.; Gordon & Gotch Ltd., SOUTH AFRICA: Central News Agency Ltd.; William Dawson & Sons (S.A.) Ltd.; UNITED STATES: Worldwide Media Services Inc., 115 East 23rd Street, NEW YORK, N.Y. 10010. USA. *Electronics & Wireless World* $5.95 (74513).

Radio at its Best

TAYLOR

STEREO FM RADIO (88-110MHz) MODULATORS TRANSMITTERS & TRANSPOSERS

P30 902P BAND 2 FM STEREO MODULATOR.

19" Rack Mounting 2μ 350mm deep
Any specified frequency .88-110MHz.
Crystal controlled IF-RF frequency stability < 5ppm
Temp controlled VCO, frequency stability ± 2.5KHz
Audio Input .7V 600Ω Balanced (isolating transformer) XLR Sockets
Audio bandwidth 40Hz-15KHz
Pre-emphasis 50μs & 75μs
Crosstalk <40dB 1KHz
L&R volume controls with 2 analogue level meters
Deviation level control with analogue deviation meter
1KHz tone generator switchable L or R, L & R.
IF Loop on front panel
Voltage 220-240V AC 50Hz (110-120V AC no cost option F)
Output level 63dBmV(1500mV) 75Ω (IEC Connector)
OPTION G 50Ω no cost (N Connector)

OPTION A Output Level 1 Watt 50Ω £190.00

OPTION B Output Frequency 420-460 MHz /900-920 MHz Specify Frequency £ 80.00

£540.00

P30 -30VF 30WATT BAND 2 POWER AMP WITH AGC

19" Rack Mounting 2μ 425mm deep
Gain 30dB +20dB AGC. Enables power amplifier to be sited remote from modulator linked by coax cable with attenuation up to 20dB.

Input Impedance 75Ω. (IEC Connector)
Output Power 30 Watts into 50Ω (N Connector)

Voltage 220-240V AC 50Hz (110-120V no cost option F)

£901.00

P30 30VFT 30 WATT BAND 2 TRANSPOSER WITH AGC

Power: Specification as P30-30VF
Input: 88-110MHz/420-460MHz/ 900-920MHz 50Ω
(N Connector) Specify Frequency

Crystal Controlled Frequency Stability <5ppm
Gain 93 dB
AGC 40dB(± 20dB).

£1261.00

P30 -300VF 300 WATT BAND 2 POWER AMP WITH AGC

19" Rack Mounting 3μ 500mm deep
Gain 42dB +20dB AGC. Enables power amplifier to be sited remote from modulator linked by coax cable with attenuation up to 20dB.

Input Impedance 75Ω. (IEC connector)
Output Power 300 Watts into 50Ω (N Connector)

Voltage 220-240V AC 50Hz (110-120V no cost option F)

£2668.00

P30-300VFT 300 WATT BAND 2 TRANSPOSER WITH AGC

Power: Specification as P30-300VF
Input: 88-110MHz/420-460MHz/ 900-920MHz 50Ω
(N Connector) Specify Frequency

Crystal Controlled Frequency Stability <5ppm
Gain 103dB
AGC 44dB (±22dB).

£2928.00

ALL PRICES EXC VAT & EX-WORKS

Taylor Bros.(Oldham) Limited. Tel:061 652 3221, Tlx: 669911, Fax: 061 626 1736

CIRCLE NO. 101 ON REPLY CARD