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MAPLIN ELECTRONICS

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★ Radioactivity ★ Electric & Hybrid Cars
★ Audiophile Hi-Fi ★ Removable Media
★ Mindstorming ★ CD-ROM Catalogue
★ Maplin New Products

THE MAPLIN MAGAZINE

# ELECTRONICS and Beyond

November 1998 Vol. 17 No. 131

## Projects



## Features



## Regulars



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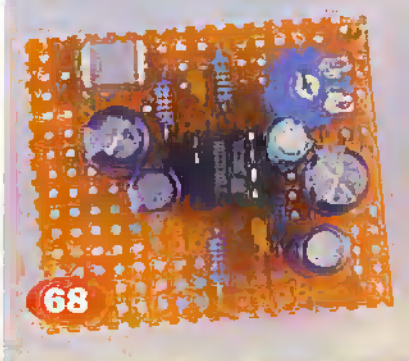


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# ELECTRONICS and Beyond

This month we have included the second CD- ROM, which includes over 1000 datasheets, Demon Turnpike and Internet Explorer 4 software plus McAfee Antivirus software. If you take up the Demon 30-day trial offer included on the CD-ROM, then you will be entered in to the draw for a fabulous 400MHz, Pentium II PC worth over £2,000! And, we are also giving you the chance to win a Velleman Digital Storage Oscilloscope for the PC worth £279.99!

There are many diverse topics covered in this issue. George Pickworth's series Electronics in Agriculture resumes with a look at precision crop spraying, and the frightening working conditions that exsisted after World War II that would be total unacceptable today. Stephen Waddington explains the benefits of ionisers, and Douglas Clarkson tells the story of deep sea oil exploration in the Atlantic ocean.

By the time you read this 25, readers and their friends will have, hopefully, had a pleasant day out at the Hi-Fi Show 98 that was held at the Excelsior Hotels in Heathrow. Next month we will publish the winners of the 'FactFinders' and Making Music with Digital Audio book draws.


**Britain's Best Magazine for the Electronics Enthusiast**

# NEWS REPORT


## Music Launches Chip-Based Networking Engine

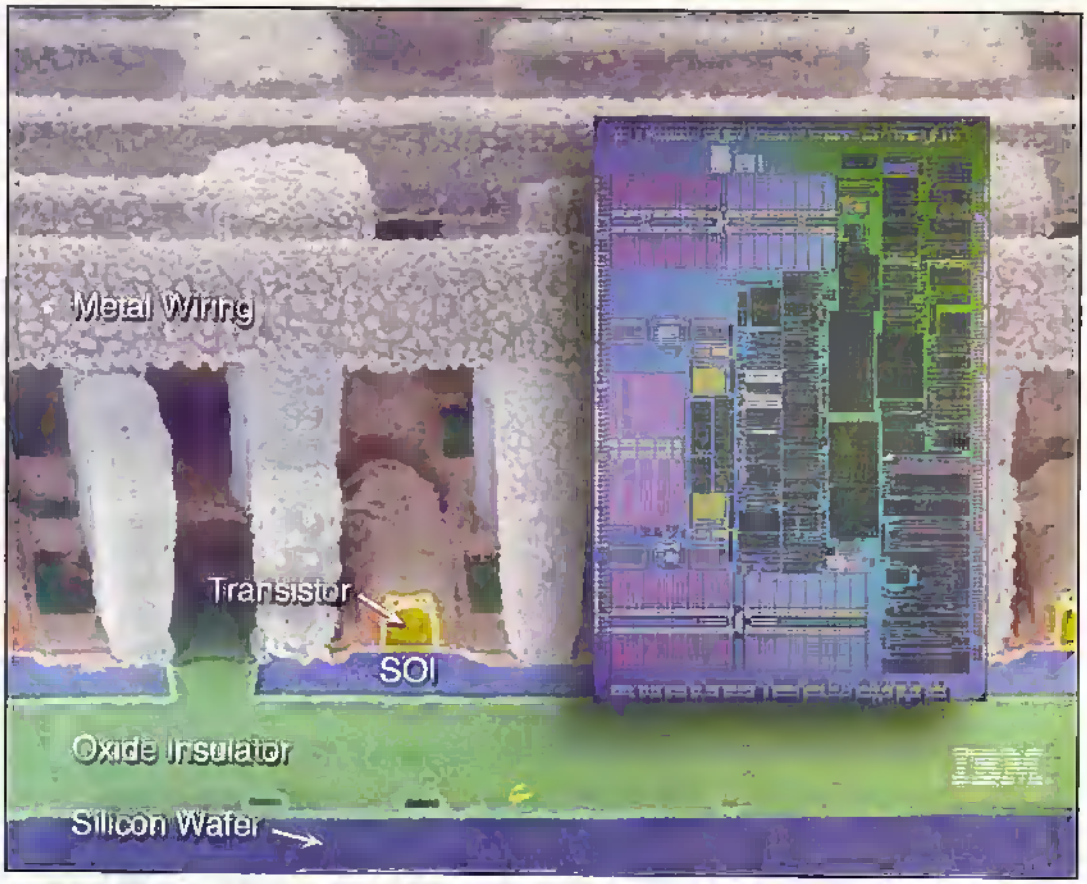
Music Semiconductor has announced the RCP MUAA; a chip based switching solution for the networking industry. Traditionally networking manufacturers have based routing and switching products on a microprocessor solution with switching and routing handled in software. The Music Semiconductor device is one of the first dedicated hardware solutions that will enable networking manufacturers to crank up the speed of their products. The RCP MUAA device is capable of handling up to 17,000,000 data packets per second.

For further information, check: <www.music.com>.
Contact: Music Semiconductor, Tel: +31 45546 2177.

## IBM Slashes Thinkpad Prices

IBM has announced price cuts of up to 36% on select ThinkPad 310, 560 and 600 models with immediate effect Entry-level prices start at £778 for a ThinkPad 310 model equipped with a 166MHz Pentium with MMX technology, 16MB RAM and 2.1GB Hard Drive.

For further details, check: <www.ibm.com>.
Contact: IBM, Tel: (0870) 6010136.




# IBM Perfects Processor Process

IBM has perfected a process for building high-speed transistors that can be used to deliver higher performance microchips for servers and mainframes, as well as more power-efficient chips for battery-operated hand-held devices. The technology, called 'silicon-on-insulator' (SOI), represents a fundamental advance in the way chips are built.

IBM's SOI process protects the millions of tiny transistors on a chip with a 'blanket' of insulation, reducing harmful electrical effects that sap energy and hinder performance. IBM engineers have manufactured SOI chips that improve performance by up to 35% - translating into faster computers and communications gear.

A microprocessor designed to operate at 400MHz could instead be built using SOI and could achieve speeds over 500MHz. At the same time, if performance levels are held constant, SOI chips can require as little as one-third the power of today's microchips.

For further details, check: <www.ibm.com>.

Contact: IBM, Tel: (0990) 426426.

# Apple Performance at Almost PC Prices

As the countdown to the September launch of the Apple iMac computer advances, Apple has announced speed enhancements, aggressive prices, and new features for its existing Power Macintosh G3 line. The Pentium-toasting Power Macintosh G3 line now starts at £1,089 and includes a mini-tower model with a 333MHz PowerPC G3 processor-based model, priced at £2,129.

Taking advantage of the expandability of the Power Macintosh G3 line, new third-party 256MB DIMMS, based on 128-bit technology, are now available from third-party vendors. The new DIMMS enable all Power Macintosh G3 desktops and mini-towers to support up to 768MB of onboard memory; up from a previous maximum memory of 384MB.


The Power Macintosh G3 is available in numerous configurations via the Apple Store at <www.apple.com/ukstore>, in addition to standard configurations available through retail and reseller channels. The new Power Macintosh G3 266MHz and 300MHz desktop models are available immediately, and the 300MHz and 333MHz mini-tower models are expected to be available from September.

For further details, check: <www.apple.com/uk>.

Contact: Apple, Tel: (0181) 218 1000.

# NEWS BYTES

## IBM Drives Diagnostics

Keeping hard drives 'fit' saves customers time and money IBM claimed as it announced a new technology called Drive Fitness Test (DFT) that lets users easily and quickly test the health of their IBM desktop PC and notebook hard disk drives.

Research done with system manufacturers shows that the majority of the time when hard drives are sent in for replacement because a problem is suspected, the drives are fine. DFT can reduce this unnecessary inconvenience of returning a healthy drive. It is stored in a 'secret compartment' on the drive, and can be invoked even if the PC's system software is not working properly.

For further details, check: <www.ibm.com>.

Contact: IBM, Tel: (0990) 426426.

## Microchip Chips in at Number Two

**Microchip Technology has taken the number two slot in the worldwide shipments of 8-bit microcontrollers, according to a report released by industry analyst Dataquest. To date, Microchip has shipped more than 600,000,000 8-bit RISC microcontrollers and 122,000 development environments.**

**For further details, check: <www.microchip.com>.**

**Contact: Microchip, Tel: (01189) 215800.**

## Survey Reveals Consumer Interest in DVD

Consumers say that they were most interested in purchasing digital televisions (HDTVs), DVD players, and NetTVs within the next twelve months, according to a new survey report published by International Data Corporation (IDC).

By contrast, consumers were much less aware or ready to purchase products such as Internet smart handheld devices, Internet screen phones, and on-line gaming consoles.

NetTVs fell squarely in the middle of the range of market awareness and intent to purchase, with 26% of consumers stating they are familiar with the concept and 7% stating they were likely to purchase one in the next 12 months.

For further details, check: <www.idc.com>.

Contact: IDC, Tel: (0181) 987 7100.

## BT Cleared of Overcharging

**BT customers are not being overcharged according to the European Union (EU). An investigation by the EU's competition authority into BT's charges for transferring calls to other EU countries found that BT is not overcharging in contrast to other European telecom operators.**

**For further details, check: <www.bt.com>.**

**Contact: BT, Tel: (0800) 800150.**

# NEWS BYTES

## Panasonic Launches Audio Visual Monitor

Few PCs ship today without multimedia features of some sort. At the very least a CD-ROM drive will be fitted, and usually a sound card as well. Panasonic's latest monitor, the PanSync SM70 is designed to compliment any multimedia PC.

It incorporates two dome style stereo speakers into the casing that deliver crystal clear high quality output. Its image quality is also excellent thanks to a 0.27mm dot pitch tube that makes use of Panasonic's Crystal Pigment phosphor and A-AGRAS coating to reduce eyestrain-inducing reflections from the light. The downside? At almost £400, the PanSync is an expensive piece of kit.

For further details, check: <www.panasonic.co.uk>.

Check: Panasonic, Tel: (0500) 404041.

## Apple Toys With Lucky Dip

**If reports on the Internet are correct, Apple is believed to be considering the idea of hiding a golden ticket in five of its new iMac consumer PCs – one per continent. But in a departure from the script of 'Charlie and the Chocolate factory', the lucky finders won't get the chance to visit Apple headquarters and meet Apple founder and interim CEO Steve Job. Instead they'll get a new Mac of his/her choice every year for five years.**

**For further details, check: Apple, Tel: <www.apple.com>.**

**Contact: Apple, Tel: (0181) 218 1000.**

## Cornell Chosen to Develop Next Generation Circuitry

Cornell University soon will be putting its electronics expertise to work as part of a US consortium of seven universities chosen to take part in an ambitious national semiconductor research effort. The venture's aim is to develop a new generation of more powerful computer chips by devising new methods to connect microchip components.

The national effort, known as the Focus Centre Research Program, will ultimately involve six consortia of universities, supported by industry and government funds, seeking both to pioneer new integrated circuit design and to support the £40 billion-a-year US chip industry. The first two groups chosen in this effort are the team that includes Cornell and a consortium, coordinated by the University of California at Berkeley and Carnegie Mellon University, that will concentrate on computer chip design.

For further details, check: <www.cornell.edu>.

Contact: Cornell University, Tel: +1 607 2553651.

# Tiger Gets Children up to Speed on the Web

Children can learn about the Internet, without going online with Tiger.Webstart Computer, a self-contained educational computer that simulates the Web, in a secure environment. With its full stroke QWERTY keyboard and real mouse, kids can hyperlink from one activity to another with the click of a mouse.

They can travel to Australia just by clicking on the Digital Atlas icon or learn about healthy food recipes or exercises when visiting the Health Club site. And then its possible to send and receive pre-programmed e-mail messages. The new machine is expected to reach the UK in time from Christmas, and will cost approximately £100.

For further details, check: <www.tigertoys.com>.

Contact: Tiger Toys, Tel: +1 847 913 8100.

# Vodafone in Recycling First

Vodafone has launched a scheme for recycling mobile phone batteries. Committed to environmentally friendly policies, Vodafone Corporate is believed to have become the first service provider to actively seek, promote and implement the recycling of mobile phone batteries.

Working in partnership with S Grundon (Waste), Vodafone believes that over 90% of mobile phone batteries in the marketplace can be recycled in an environmentally friendly manner. This initiative has been set up in anticipation of impending EU directives and provides customers of Vodafone Corporate with a clear audit trail for all equipment that is sent for disposal.

Unwanted or expired batteries are collected directly from the customer's premises by Vodafone Corporate. Once sufficient quantities have been collected they are checked and packaged by S Grundon (Waste) prior to despatch for recycling in France.

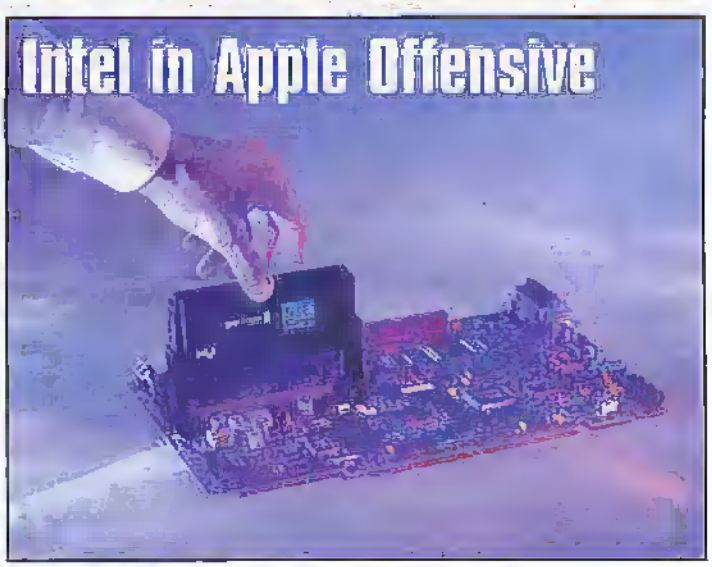
A rigorous recycling process extracts the cadmium and nickel from used NiCad batteries and the nickel from used NiMH batteries. The resulting cadmium which is 99.99% pure is then returned to the industry's raw materials supply chain, to produce new batteries and the recovered nickel, in the form of ferro-nickel, is utilised by the stainless steel industry.

vodafone

For further details, check: <www.vodafone.co.uk>.

Contact: Vodafone, Tel: (01635) 33251.

# Intel in Apple Offensive



In a bid to counter the publicity that Apple is enjoying around the launch of its iMac, Apple has announced its fastest ever processor for mainstream PCs, entry-level servers and workstations. A new 450MHz Pentium II processor provides the highest levels of computing performance for a wide range of productivity and entertainment applications, while 333MHz and 300AMHz versions of the Celeron processor enable reliable basic PC systems.

The Pentium II processor 450MHz delivers up to a 10% performance improvement over the Pentium II processor 400MHz, and it provides maximum investment protection to business and consumer users. Meanwhile the Intel Celeron processors 333MHz and 300A MHz include 128KB of integrated Level 2 cache on the processor core.

For further details, check: <www.intel.com>.

Contact: Intel, Tel: (01793) 403000.

# Digital Services Kill Other Media Channels

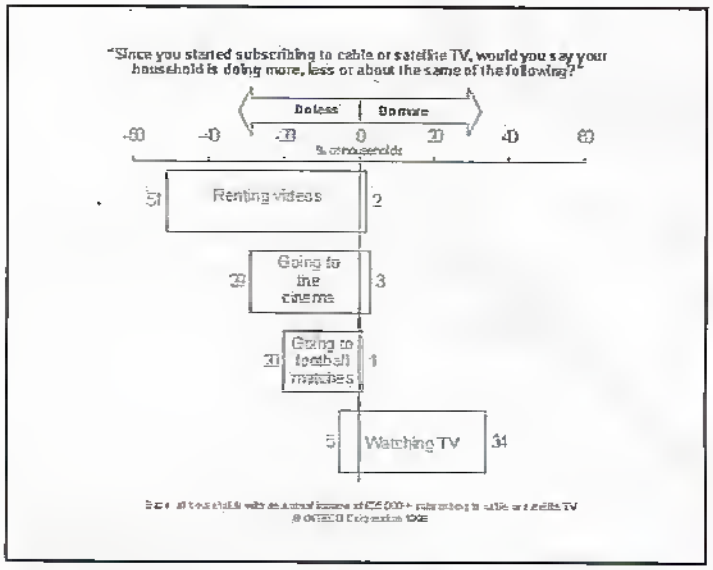
A recent survey by Woking-based Inteco of 1,000 higher-income households in the UK reveals the dramatic effect pay-TV has had on other forms of entertainment.

20% of subscribing households admitted that they went to fewer live football matches since taking cable or satellite TV. The report claims that while the Premier League has benefited from its relationship with BSkyB the likely long-term success of BDB's digital terrestrial offering will make for an interesting second half of the soccer-on-pay-TV saga.

"There is a clear drop in match attendance among pay-TV households," said Adam Daum, principal analyst, Inteco. "Only a small minority have access to premium sports channels so this hasn't been a major concern. But as the cost barriers fall, and take-up increases, the negative effect on gate receipts will become much more noticeable."

Video rental has suffered even more visibly at the hands of pay-TV, with more than 50% of subscribing households saying they now rent fewer videos.

"The combination of increased quality of digital services plus more pay-per-view offerings is likely to cannibalise rental even further, particularly of top-ten movies - which account for an increasing majority of rentals," said Daum. "Increasingly, video rental will be seen as an inconvenient and low-quality method of watching this class of movie."




Previous Inteco research indicates that PPV movies will prove attractive even to households that have no intention of taking a traditional pay-TV subscription. This latest research reveals that regular video renters are twice as likely to subscribe to digital TV as households in general.

Unsurprisingly, more than a third of current cable or satellite households admitted watching more TV since subscribing. Though given that many probably wouldn't openly admit to doing so, the real figure is likely to be much higher.

For further details, check: <www.inteco.com>.

Contact: Inteco, Tel: (01483) 751777.

# V.90 Upgrades Available for Hayes Modems


Hayes has caught up with the crowd announcing V.90 upgrades for its 56K modems this month. All current ACCURA 56K external units shipping in the UK are flash-upgradable to the new V.90 standard at no cost. The V.90 upgrade code for the ACCURA 56K external modem is now available from Hayes' Web site, together with guidance for users on how to download and implement the V.90 code.

For further details, check: <www.hayes.com>.

Contact: Hayes, Tel: (01276) 704400.


# Pioneer Restructures for the Millennium and Beyond

Pioneer obviously feels left behind by the likes of Microsoft, Intel and Apple continually coming to market with innovative products. The company has brushed off its corporate cobwebs and announced 'Vision 2005', a plan to targeting aggressive sales growth, streamline worldwide operations, enhanced customer service, and continued innovation in leading-edge convergence products.

As part of its commitment to Pioneer's vision for 2005 and beyond, the company identified four business objectives to harness its heritage of superior optical and display technology: establish global leadership in DVD; achieve a successful business in next-generation display systems; secure a leadership role in home networks; and continue strategic development of key technologies and components.

For further details, check: <www.pioneer.co.uk>.

Contact: Pioneer, Tel: (01753) 789789.

# Xerox Attacks HP Market with Printer Launch

Xerox has introduced a new colour inkjet printer for the Small office/Home office (SoHo) market traditionally the domain of Hewlett Packard. The Xerox DocuPrint XJ6C comes with four separate inkjet cartridges, unique to products in this class, and is available at a list price of around £149. Separate tanks allow the user to replace only the colour tank they need, which eliminates the expense of wasted ink associated with three-colour cartridges found in most competitive models.

For further details, check: <www.xerox.com>.

Contact: Xerox, Tel: (0800) 454 197.


E-mail your views and comments to: AYV@maplin.demon.co.uk

Write to: *Electronics and Beyond*, P.O. Box 777, Rayleigh, Essex SS6 8LU

## Lack of Projects?

**Dear Sir**

An electronic constructor for over 60 years and a reader of your magazine since 1985, like Dave Marsden (August issue) I too am disappointed with its limited range of contents.

The old 'Electronics' magazine covered a wide spectrum before it went 'Beyond'. Your reply to the number of computer based projects based it on the number of computer magazines sold, and yet a survey of buyers would probably reveal that only a small percentage of computers are connected to home-built peripherals. Also at todays prices it is cheaper to buy a computer under warranty with plenty of free software than to assemble one from prefabricated units – a practical exercise in limited terms only. You include informative articles which are interesting but only in proportion to a better balance of practical projects, while these are often a range of Maplin based kits. Items like kit specifications and advertisements are simply covered in the Maplin catalogue.

If as you say the constructor is a dying breed then it may be partly due to component prices some of which have to be purchased in bulk or at inflated one off prices.

L. Smith
Stoke-on-Trent

**Your criticism of having to buy in bulk, or at inflated one off prices, is justified, and has been addressed in the latest Maplin Catalogue where you will find resistors, for instance, quoted in one off prices and at a non-inflated price. However, I would have to disagree with your implication that the projects featured are 'often a range of Maplin based kits'. For some months now we have not included any Maplin based kits, all the projects featured have not, and are not available as kits. In many cases construction has been on stripboard, using components that can often be found in the hobbyist component box. It obviously makes sense for us to quote the Maplin order code, where possible, so that a constructor knows he will be able to complete the project.**

**As a constructor for over 60 years I am sure you have moved from valves to transistors to ICs, and possibly from analogue to digital. It is natural that constructional projects now will very much have a computer/microprocessor bias for which we receive requests – see Ian Gardner's letter. A high proportion of the adverts in the computer magazines are for suppliers of computer components, similarly a large part of Maplin business is from the computer section of the catalogue, so there has to be many people building their own PC. There are many arguments for constructing ones own computer, e.g. easier to upgrade, it can be built in stages to spread the cost etc.**

**As we have said before, we try to balance the content of the magazine, so if you would like to see a specific project, do write and tell us and, if possible, we will attempt to oblige.**

## PC IrDA Serial Adaptor

**Dear Sir**

I have been a subscriber now for quite some time and enjoy your publication. Please could you feature a DIY PC IrDA serial adaptor in the Magazine. Many people have Psion Organisers or portable PCs with IrDA ports and there are relatively few devices on the market that save the conventional serial to connect to a PC. Those that are available seem to be expensive when you consider this is a published standard and IR component prices are not particularly high.

Ian Gardner
ian@duckland.prestel.co.uk

**Thank you for your kind comments and we are looking at the possibility of project.**

## Registered Trade Mark KODAK

**Dear Sir**

We refer to the article 'Words of Science' appearing in the September 1998 issue. On page 67 there is reference to the registered trade mark KODAK, with the remark 'It began life as a trade mark, being used to describe almost all cameras or types of photographic film.' Please note that this is incorrect: the word KODAK was newly-invented/coined (as the article correctly points out) by the founder of Eastman Kodak Company, Mr George Eastman, and was thereupon immediately registered by him as a trade mark throughout the world including the U.K. It has ever since been used as a trade mark to denote exclusively the goods and services of Eastman Kodak Company and its various subsidiaries.

It has never been used to refer to the films or cameras of other companies unconnected with those of the Kodak group, and its is quite wrong to suggest, as Gregg Grant does in his article, that it has been so used. You will appreciate that any such use would be quite at odds with its status as a trade mark, i.e. as a sign of origin.

John Draper
Manager, Trade Marks & Corporate Identity
Kodak Ltd.

**Gregg Grant Replies**

**I apologize for not making my intentions clearer in the article. In using the expression '...to describe almost all cameras and types of photographic film,' I meant to illustrate how universal the KODAK trademark not only has become, but how close it is associated with all things photographic.**

**A good example of what I wished to highlight where Kodak is concerned is the Hoover Company. There are few cleaners who do not refer to 'hoovering' the carpet etc., regardless whether they actually use a Hoover product or not.**

**Kodak has the same reliable, innovative image in the photographic supplies field. It was this facet I was attempting to illustrate in the sentence. I apologise unreservedly to Kodak and Mr. John Draper for giving the wrong impression. I also extend my thanks to them for putting me right on the matter.**

**Gregg Grant**

## CORRIGENDA

Due to a production problem in the October 1998 issue 030, in Ray Marston's feature on Practical LED Indicator and Flasher Circuits, certain values should have read *micro* instead of *milli*.

P72, Column 1, should be 0.1µs

P74, Column 1, should be 2µA, 150µA

P75, Column 1, should be 10µA, 0.67µA, 86µA, 12µA, 75µA

P75, Column 2, should be 2µA, 12µA

P75, Column 4, should be 86µA, 12µA, 320µA, 48µA

P75, Figure 19, should be 12µA.

# MEMORY PRICES

## MEMORY MARKET UPDATE

The situation is not getting any better with the Fujistu Semiconductor factory closure in Newton Aycliffe at a cost of £800 million and 600 jobs following hard on the heals of the closure by Siemens. Samsung who have a 19% market share of the world market for memory are still predicting either flat or falling prices for the rest of the year despite the attempts by the major producers to cut production and raise the market price. Maplin Electronics Plc has been able to hold prices static. The upgrade route is beginning to change as people are requiring ever greater amounts of memory. Not that long ago PCs were sold with 8Mb of RAM and now most are sold with either 32Mb or 64Mb which means that DIMM's are being sold in increasing numbers for around £1.00 per Meg. A price unheard of a year ago !


MAPLIN ELECTRONICS

A range of DRAM modules for use as memory expansion in computers including PCs, Apple MACs and Amigas, is available. All parts supplied are original and unused. SIMMS supplied by Maplin are branded manufacturers, chips on selected third party boards.

They are sold with a 'no questions asked' lifetime guarantee and all modules are stored and handled in anti-static environments.

### 72-PIN SIMMS

| Code | Size | ExVAT | IncVAT |
|---|---|---|---|
| NT00A | 16M | £17.10 | £19.99 |
| NT01B | 32M | £26.37 | £30.99 |
| NT02C | 32M | £25.52 | £29.99 |

### EDO - TYPE

| Code | Size | ExVAT | IncVAT |
|---|---|---|---|
| NT03D | 4M | £6.80 | £8.00 |
| NT04E | 8M | £9.35 | £10.99 |
| NT05F | 16M | £14.45 | £16.98 |
| NT06G | 32M | £26.37 | £30.99 |

### UNBUFFERED 3-3V 168-PIN DIMMS

| Code | Size | ExVAT | IncVAT |
|---|---|---|---|
| NM25C | 16M | £18.71 | £21.99 |
| NM26D | 32M | £26.37 | £30.99 |
| NM27E | 64M | £59.56 | £69.99 |
| NM28F | 128M | £113.18 | £132.99 |

### PC100 DMMS

| Code | Size | ExVAT | IncVAT |
|---|---|---|---|
| VG55K | 32M | £38.30 | £44.99 |
| VG56L | 64M | £63.82 | £74.99 |
| VG57M | 128M | £123.40 | £144.99 |

**CONTACT MAPLIN SALES ON 01702 554000 FOR LATEST PRICES**

# PSYCHO-KINETIC BIO-FEEDBACK TRAINER & MOVEMENT DETECTOR

Photo 1. Complete Unit

PART 2

*In part 2, David Aldous describes the technical aspects of the project.*

## General Description

The complete electronics processing unit is built into a large size standard 'Black Box.' This gives a compact unit with plenty of room inside for the electronics, and the shape and size allows for the incorporation of two small loudspeakers for 'open room' listening. The sensing head can be plugged directly into the output socket, where it is clamped by means of a rubber strap for stability. The connectors on both the main processing and sensing head units are aligned so that when fitted together in this manner, the system can be used for simple, non-critical experiments and testing. In full operation, the sensing head can also be connected by means of a 4m extension cable, thus allowing remote operation and also totally screened PK experiments to be made. Photo 1 shows the complete unit with the sensing head attached directly to the processing unit.

## How It Works

As outlined in part 1, the unit uses sound waves for the observation function and, since the wavelength of signals at high audio and ultrasonic frequencies is in the equivalent microwave region (mm - cm), it is possible to measure and indicate even very small movements. The unit responds to the phase difference between the transmitted signal (used as a reference) and the received signal. The unit is in fact four times more sensitive to movement than one might expect from a simple calculation of acoustic wavelength and the reason for this is quite interesting. Recalling the calculation for the wavelength of a 40kHz ultrasonic signal from part 1, this yielded a wavelength of 8.55mm. However, this would only hold true if the receiver were to be moved in relation to the transmitter, there being only one path involved. As the unit uses reflected waves, it is therefore easy to see that there are now actually two paths ('go' and 'return') to consider. As both paths are simultaneously lengthened or shortened by a target moving along the beam, then this can be considered the equivalent of moving the object only half as far for a given output. Alternatively, one can also consider that it is equivalent to doubling the frequency of the transmitted signal, thus halving the wavelength. Either way, sensitivity is doubled and measuring distance halved to 4.275mm. The next increase in sensitivity is caused by the fact that since two signals can only ever be fully in-phase or fully out of phase at the extreme. Phase comparison can therefore only work over half a wavelength (180°). Once again, the effect of this is equivalent to doubling the frequency of the transmitted signal and halving the wavelength once more. This now yields an equivalent measuring distance of 2.1375mm. This corresponds to an equivalent ultrasonic frequency of 160kHz

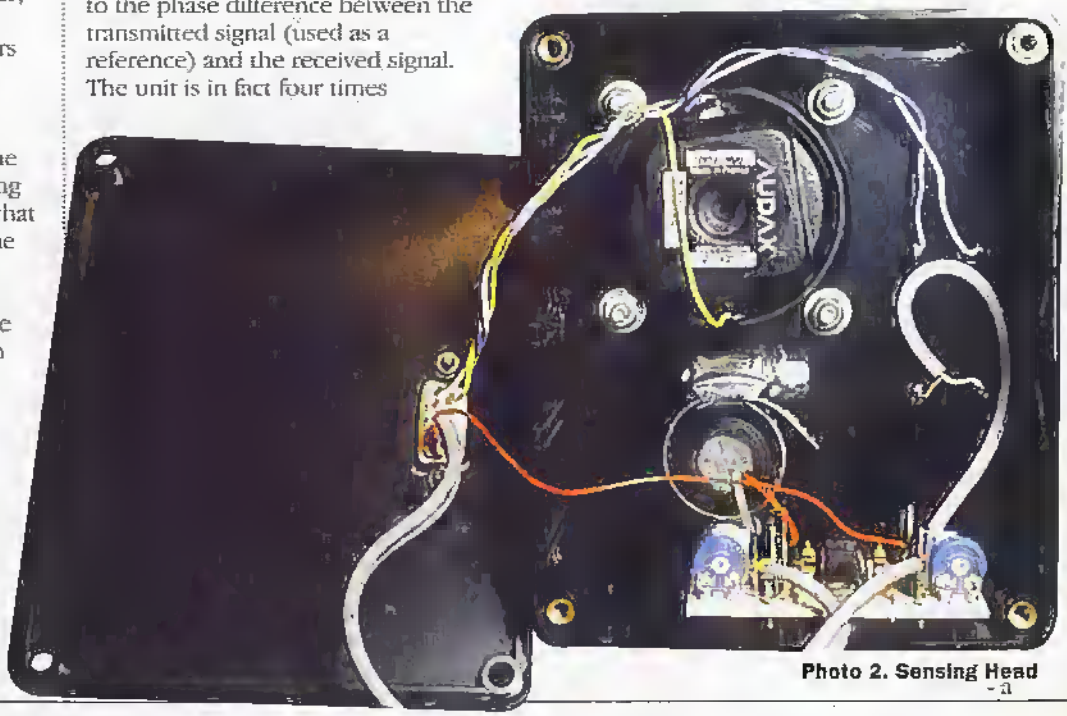



Photo 2. Sensing Head

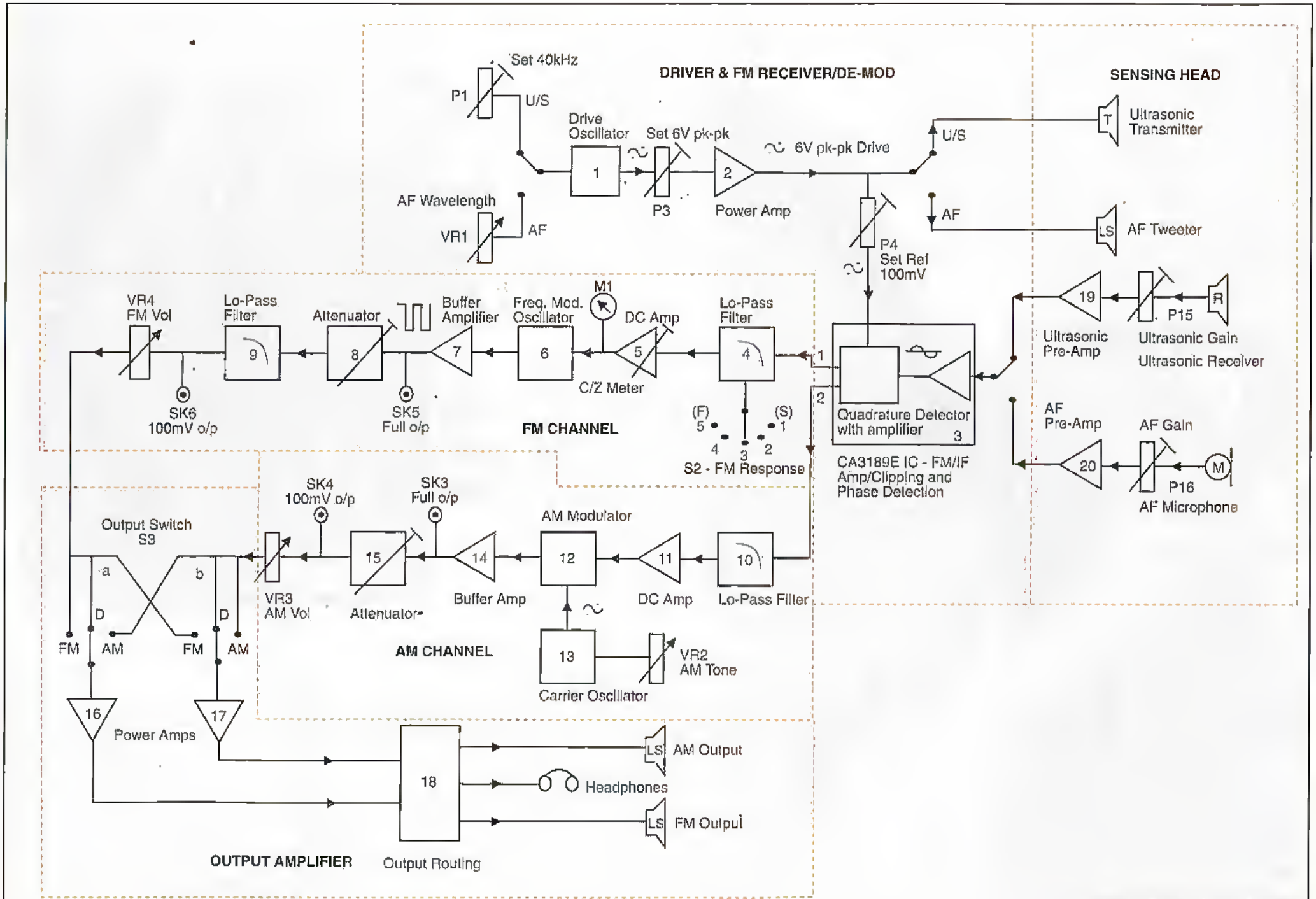



Figure 1. System Block Diagram

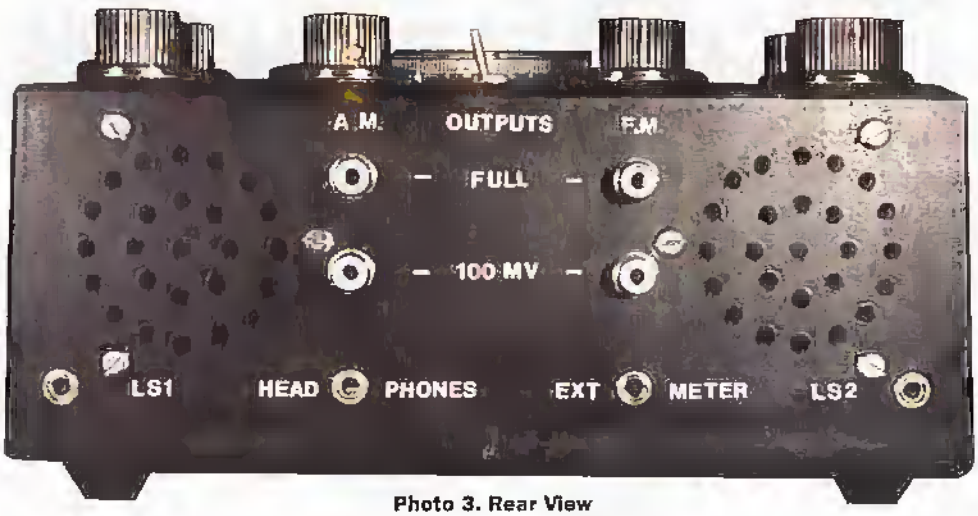



**Photo 3. Rear View**

signal which if considered in radio frequency terms, actually lies in the lower part of the long waveband! The authors concept of 'acoustic microwaves' should now be more clearly understood. I will return later to the concept of phase comparison and the sometimes difficult to grasp subject of phase angle, phasors (no, not the Star Trek kind!) and how this fits in with the operating principles of the unit.

To understand how the unit performs its functions, Figure 1 should be consulted. This is a block diagram of the complete system. Despite the large number of stages, and the ensuing apparent complexity, the system is actually quite simple. As with any system that one is trying to understand, the trick is to know what can be dispensed with until later. The main reason why the block diagram appears so complex is that the unit has been designed as a multi-functional investigation aid, operating in two identical modes, but on two different acoustic wavebands. The easiest way to understand the unit is to simply set some 'mental switches' to fixed positions in order to fix the internal relationships whilst an understanding is gained. If we consider that the unit is set to operate in the ultrasonic mode, and we take one channel at a time, then the following description will serve.

## Operating Description - Figure 1, the Block Diagram

Taking the FM channel first. A pure sine-wave signal is generated by block 1, the Wein bridge drive oscillator. This is amplified to 6V pk-pk by block 2, the power amplifier. This signal is fed to the ultrasonic transmitter transducer in the sensing head and converted to an acoustic signal. A portion of the drive signal is fed to block 3. This block performs several functions and is in fact a standard fm receiver IF amplifier, limiter, and phase detector, as found in some FM radio receivers. The component values have been adapted to suit the lower operating frequency used in this design, but the chip behaves in exactly the same way as in a radio receiver. Only about 2μV of signal is required in order for the internal amplifier to clip the waveform to become a high frequency square wave (yes, even RF signals can be made square!). The signal fed to block 1 is several times that level, thus efficient operation is guaranteed. The phase detection function is carried out by an internal double balanced quadrature detector (I will explain this later). In practical terms, this means that the detector can give two independent outputs simultaneously, thus allowing each to be dedicated to a specific function (in a radio receiver, one would be used to provide an Automatic Frequency Correction (AFC) signal to control a local oscillator, whilst the other would be dedicated to recovering the fm signal). In this design, one output is used to feed a voltage controlled oscillator in the FM channel and the other to feed a modulator chip in the AM channel. Taking the FM channel. Output 1 of the phase detector is fed to block 4, a low-pass filter, this removes the drive and reflected signal components and leaves a dc voltage directly proportional to the phase difference between the reference and received signals (I will cover the detailed operation later). In order that in-phase and out-of-phase signals can be discriminated, the chip also provided a dc reference voltage equal to the voltage which exists at 90 degree phase difference (5.76V). In-phase signals produce a lower voltage and out-of-phase signals a higher voltage. The output is ±4V, or 8V pk-pk centred on the reference voltage of 5.76V. Block 4 filter characteristics can be modified by S2 to damp out rapid fluctuations, or conversely, set to any one of 5 response speeds as required by experimental conditions. Block 5 is a variable gain buffer dc amplifier, used to reduce loading on the detector and also allow precise calibration of the FM deviation for full scale signals. The output is monitored by a small centre-zero meter, M1, and allows calibration to be checked. Block 6 is the frequency modulated oscillator and is controlled by the output voltage from block 5. A deviation of ±1kHz centred on 2kHz, is set up for full scale output. Block 7 is also a buffer amplifier and reduces loading on block 6. Block 8 is an attenuator to reduce the output signal at SK6 to a standard 100mV line level. Block 9 is a second low-pass filter to remove some of the higher order harmonics from the square-wave FM output signal, in order to render it more acceptable to the ear of the operator. The signal then goes to block 16, the output power amplifier, via a volume control and output switch. Block 18 is simply a switching system to allow feeding the output signals either to headphones, or an internal loudspeaker,


**Photo 4. Side View**

Photo 5. Top Layout

or external speaker. This completes the general description for operation of the FM channel.

Taking the AM channel next. Output 2 is fed to block 10, a low pass filter which performs exactly the same function as block 4 in the FM channel. Only a single filter value is used here and this is set to give a fast response. Block 11 is a dc buffer amplifier to reduce loading on the detector output. Block 12 is the AM modulator chip and is actually a transconductance op-amp. A carrier tone signal is injected from block 13, a Wein bridge sine-wave oscillator. The frequency of the carrier tone can be varied to suit the hearing requirements of the operator and covers a wide range of tones from about 365Hz to just under 2kHz, thus encompassing several musical notes for easy listening. Block 15 is an attenuator and performs the same function as block 8 in the FM channel, but this time allowing a standard 100mV line level to be set at SK4. The signal now goes to block 17, the output power amplifier, via a volume control and output switching and thence also to block 18, the output headphone/speaker switching system. This completes the description of the AM channel.

## Sensing Head

The sensing head (see photo 2) is easily understood, since on ultrasonic mode, it simply consists of an ultrasonic transmitter and receiver and the associated pre-amplifier, block 19. On AF mode, the active parts are the AF tweeter loudspeaker and the microphone (M), which feeds into block 20, the AF pre-amplifier. Whichever mode is selected, only one output signal at a time is fed back to the main processing unit. Using the AF mode allows the wavelength of the transmitted signal to be changed to suit different experimental requirements. The drive oscillator frequency on AF mode ranges from just under 5kHz, to just under 21kHz. This corresponds to a measuring wavelength of approximately 4mm to approximately 16mm. The wavelength control is wired so that 0 corresponds to the shortest wavelength and 10 to the longest. It is therefore possible to calibrate the control to allow setting of precise wavelengths.

Next month in Part 3 we will look at the circuit diagrams.

# TECHNOLOGY WATCH

**with Martin Pipe**

In the beginning -well, 1982 – there was the compact disc. This early application of digital technology was the first to find its way into widespread domestic acceptance. Today, few western homes are without at least one. The potential 74 minutes – sometimes more – of high-quality digitally-encoded music offered by this silver disc eventually spelt out the demise of the vinyl LP. In the late 1980s, the inventors of CD saw that the medium could also be used to store digits of a slightly different variety – computer data, in other words. The 'Yellow Book' standard – better known as CD-ROM – was born, and the vast majority of the computer software you can now buy requires a compatible reader for installation. Hardly surprisingly, it is now virtually impossible to buy a new desktop computer without a CD-ROM drive. Their price has fallen from several hundred pounds – in 1988 – to £30 or so. Because a CD-ROM drive will also read conventional ('Red Book') audio discs – and will hence allow personal computers to play them – there's a good argument for saying that the CD-ROM drive was an early example of a 'convergent' technology.

The maximum capacity of a CD-ROM is 650Mb. When the format was launched, this was a stupendous figure. At that time, a high-end PC would have a 40Mb hard disk. File sizes generated by the applications of the day were small, primarily because there were none of the multimedia embellishments that we now take for granted. The first purposes of the CD-ROM were databases of scientific papers and archives of newspaper articles. In most cases, the data was stored as plain ASCII – this explains why you could fit a year's worth of Guardian editorial onto a single platter. In these days of bloated applications and multimedia-enrichment, multi-gigabyte hard disks are the norm. Accordingly, 650Mb no longer seems quite as impressive as it did ten years ago. Software producers, notably those involved with games, have to spread out their wares over two or more discs. The upshot is that the poor consumer has to eject one CD-ROM, and replace it with another, before moving to the next level (or whatever).

Technology has an answer, in the form of a new CD-sized (and backwards-compatible) medium. In the same way that the Government builds (or did) more roads to accommodate longer traffic jams, we now have more read-only capacity for developers to clog up with yet more data. Wisely, we hope. And what a lot of capacity it is; this new medium – DVD, or digital versatile disc – will, at its humblest and simplest level, provide us with up to 4.7 gigabytes. An impressive-sounding figure today, although it undoubtedly won't seem quite so good in a decade's time. On the horizon, however, are DVDs of much higher capacity. By using slightly different laser wavelengths and two recording layers, the capacity of a disc is increased to 8.5Gb. If both sides of the disc are employed, then you could get 17Gb. This has rather more long-term potential than today's 4.7Gb single-layer, single-sided discs. Most, if not all, current DVD-ROM drives will be capable of reading the new discs as, and when, they start appearing.

Today, there are very few DVD-ROMs currently available; it's probably true to say that there are more DVD-ROM drives out there than discs to read on them. Many new PCs are shipping with DVD-ROM drives in the name of future-proofing; drives are available from Toshiba, Matsushita and Hitachi amongst others. Precisely the same criticism applied, until recently, to DVD's domestic relative. DVD 'Video', as this system is known, has been mooted as a replacement for laserdisc, rental VHS tapes and even the audio CD (if a proposed 20-bit 96kHz standard ever takes off). As regards DVD-ROM, however, various companies – including Microsoft and Dorling-Kindersley Multimedia – have imminent plans to deliver software via DVD media. One can only imagine what DVD's capacity will bring to Microsoft's Encarta encyclopedia, for example, in terms of detail. Information should be more in-depth, and no doubt we'll see more video and audio clips – perhaps with better quality than we've experienced previously.

The cost difference between a PC with DVD-ROM drive, and one with a regular CD-ROM drive, is now relatively insignificant. As a result, most PC buyers are opting for the former to avoid the need to upgrade in the future. The situation with DVD Video is, however, rather different. Here, the self-contained players – which sell for £400 or more – are bought on the strength of the available software. The reason for the player's expense is the technology contained within. In addition to a mechanism – basically, the same one found inside a DVD-ROM drive – is a MPEG audio/video decoder. DVD Video employs the same MPEG-2 compression system that forms the basis of digital TV broadcasting. Such compression is essential to fit an entire movie onto a single-sided single-layer 4.7Gb disc. There is still room on the disc for multiple stereo soundtracks, which are compressed to MPEG standards. These provide multi-lingual capability, or movie director commentaries. Some discs also offer high-quality discrete multi-channel surround-sound. The Dolby Digital/AC-3 system employs MPEG-type DCT-based compression techniques. A fundamentally-similar competing system, MPEG Multichannel, appears to have fallen by the wayside.

Some of the more upmarket DVD players, such as the JVC D2000 and Panasonic A350, include Dolby Digital decoders built in. These have six phono sockets on the back, which are intended to feed the six discrete channels – left and right front/stereo, left and right rear surround, centre and subwoofer – to home cinema AV equipment or power amplifiers. These digital surround-sound systems are referred to as '5.1' because the subwoofer (low frequency effects, or LFE) channel occupies very little bandwidth (it's the '0.1' channel) relative to the five remaining full-bandwidth (20Hz to 20kHz) ones. Some surround-sound TVs, AV amplifiers and receivers have Dolby Digital decoders built-in, and are hence suitable for partnering with DVD players that don't have the decoder circuitry built in (they are, incidentally, also compatible with imported NTSC laserdiscs, which were the first media to offer Dolby Digital soundtracks – note


**JVC D2000 DVD Player.**

reliance on MPEG invariably leads to 'blocky' picture artifacts. These are particularly noticeable on dark backgrounds. Some discs – notably those mastered from noisy sources, and ones that cram in a long movie or multiple soundtracks – are worse than others. Video quality will, however, excel over what we'll get from digital TV. Pictures from the latter could get quite atrocious, as more and more channels compete for channel bandwidth and up their compression ratios accordingly. Although the hype merchants claim that digital broadcasts will give you 'better picture and sound quality', I wouldn't bet any money on it.

DVD Video's biggest disadvantage, however, is that of 'regionalisation'. In order to maximise profits, and ensure that consumers don't get to watch a movie before it is officially released in their home country, the DVD world is 'split' into six regions. Each DVD has its intended region

that compatible laserdisc players should have an AC3 RF output on the back – if your's doesn't, there are several Web sites telling you how to add one yourself). Most of the DVD movies now available in the UK have a Dolby Digital soundtrack. It offers a stunning improvement over the old Dolby Pro-Logic matrixed surround-sound system.

DVD Video also promises new features and conveniences. You can select different viewing angles – basically, different MPEG streams – although very few discs support this. There is also high-quality still-frame and slow-motion as standard – although laserdisc did this, it was only with a restricted number of 'CAV' titles. DVD Video supports a 'rating' system that allows concerned parents to restrict what children can see; unfortunately, not all discs subscribe to this system. Widescreen is also fully-supported by the DVD Video standard. In most cases, the aspect ratio can be switched from 4:3 to 16:9. However, there are downsides to DVD Video. For a start, every disc has a Macrovision encoder built-in, to prevent the discs from being used as high-quality masters for pirate videotapes. Apart from adding a cost to the player – I can imagine that there's a royalty paid on each unit – you have to link the player directly to the TV set.

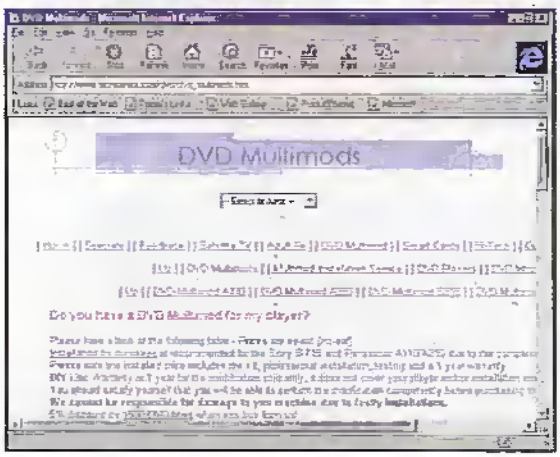
Still images from DVD Player.

If you were to feed the DVD player's inputs to your TV via the VCR because of a lack of available Scart sockets, then you would experience fluctuations in video level and occasional losses in sync. Even if the DVD player is connected to the TV directly, I can't imagine that Macrovision does much for picture quality. On which subject, DVD's

code imprinted somewhere on the disc, and if it doesn't tie up with the region code of the hardware, the player will spit it out. Europe is Region 2, while the US – the biggest source of DVDs to date – is Region 1. Regionalisation is not the only step being taken to restrict viewings. One system being developed in the States is something called DIVX. Here, discs are cheap to buy initially, but can only be watched a limited number of times. Further screenings have to be bought on a 'pay-per-view' basis. Needless to say, the DIVX concept hasn't gone down too well with the American public. It remains to be seen whether it is adopted by the DVD software companies.

With the price of players still high, the only consumers taking to DVD Video have been well-heeled home cinema enthusiasts looking to replace or augment their laserdisc players. Takeup of the format has been very slow – and there has been a good reason for this. When DVD was launched in the UK last year, the 'official' Region 2 software was very scarce and this situation is only now beginning to improve. Most consumers are taking a 'let's wait and see' approach before parting with their hard-earned loot. Ironically enough, some of the home cinema stores in bigger cities are bursting to the seams with a wide variety of DVDs. These are, however, of the imported Region 1 variety. To play these, you have to acquire 'grey-import' US

Creative Labs DVD ROM Drive, order code PQ83E, £179.99




hardware, and have the power supply modified. In some cases, you can have European Region 2 players modified to handle Region One discs. Indeed, one UK home cinema magazine described how you could hack a Panasonic A100 by disabling the EEPROM chip that stores its region code. More recent players are harder, but not impossible, to modify. The Internet carries quite a few adverts for 'code-free' upgrade services and DIY kits. Unfortunately, you'll invalidate any guarantee.

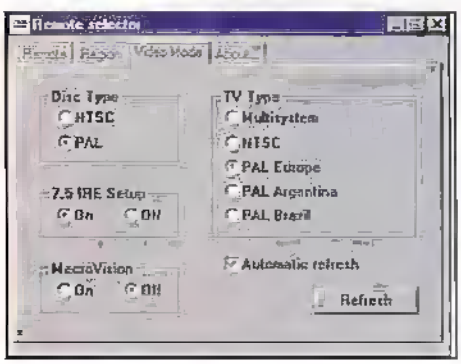
The most flexible DVD Video solution I have so far seen is a PC upgrade kit that takes the convergence idea one step further than CD-ROM. The Creative Labs PC-DVD Encore – which Maplin sells for a discount £200 (order code PQ83E) – includes a DVD-ROM drive, and a hardware MPEG decoder built onto a PCI expansion card. The Matsushita DVD-ROM, which replaces or supplements the existing CD-ROM, is backwards-compatible with other media, including audio CDs, VideoCDs, CD-ROMs, CD-RWs (yes, it's 'multi-read') and CD-Rs. The vast majority of current DVD Video players – including those made, ironically enough, by Matsushita subsidiary Panasonic – won't read CD-R discs. The IDE-interfaced drive is quite well-specified. It will read regular CD-ROMs at 20-speed, or DVD-ROMs at twice-speed, and has a S/PDIF digital audio output terminal.

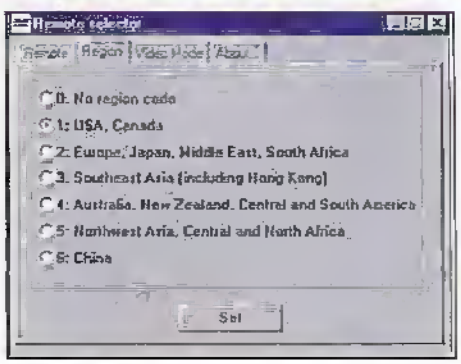
The decoder card allows DVDs to be viewed on the computer monitor, but also has S-video (separate chrominance and luminance signal paths for better quality) and regular composite video outputs for AV equipment. Picture quality is up to the standard of the average DVD Video player. A phono socket on the decoder card provides a S/PDIF Dolby Digital feed for a decoder or receiver – an excellent inclusion. Hardware-decoded MPEG audio is fed to the soundcard via its 'CD input' terminal; the Creative card, in turn, accepts the CD audio output from the drive. Careful routing of the cables is needed to prevent stray noise from introducing distracting PC-derived 'whining' noises. There is probably logic in bringing out the MPEG audio output directly to a pair of phono sockets, and feeding those directly to a hi-fi or AV system. Interestingly, I couldn't get Encore to play MPEG layer 2 (.MP2) and layer 3 (.MP3) audio-only files, of the variety I discussed in a series of articles published in 'Electronics' earlier this year. Creative Labs claims that the latest Encore drivers remedies this situation.

The supplied software provides a remote handset-like user interface, from which various parameters can be set, and segments (or 'chapters') of the movie accessed. The most interesting Encore program out there wasn't written by Creative Labs, but works in conjunction with its supplied software. Remote Selector, written by Erwin van den Berg, provides several functions. Firstly, you can operate the Encore via one of the comparatively-rare breed of PC infra-red remote control or via the keyboard. Remote Selector has generated interest for other reasons, however. First of all, you can select the region code to match any movie being played – I had no problems with Region 1 discs, such as Sphere, at all. Note that some of the most recent Encores are, according to Creative Labs, incompatible with this aspect of Remote Selector. Secondly, you can defeat Macrovision. Finally, you can play NTSC discs in colour on a PAL TV, provided that the set's timebases will lock into a 60Hz field rate. Most recent TV sets are suitable partners. Details on Remote Selector can be found at Erwin van den Berg's home page (http://www.xs4all.nl/~evdberg/). At the time of writing, the link to the software didn't work; however, Remote Selector can still be downloaded from a Spanish mirror site (http://personal.redestb.es/pkooiman/).


Encore does have quite a lot going for it, then. It offers good pictures and sound, coupled with the flexibility and upgradability that PC-based solutions are famous for. Oh yes, and it's much cheaper than a DVD Video player, provided that you've already got the PC. Even if DVD Video was to flop, you've still got the ability to read DVD-ROMs. There are some disadvantages to using an Encore-equipped PC to play movies, however. First of all, the power consumption of a PC can be anything up to 250W – and that's without the monitor switched on. JVC's latest DVD Video player (pictured) consumes a mere 37W in operation. Another problem is that most people don't keep their PCs in the same room as their TVs and AV equipment. You'll have to relocate the PC whenever DVD playback is required, or assemble and appropriately route some video and audio extension cables. The latter is perhaps the better approach, largely because the whirring disk drives and fans inside a PC make quite a racket.

E-mail your comments or suggestions to Martin Pipe at whatnet@cix.compulink.co.uk




# ISDN - Join The REVOLUTION

***Paul Hargreaves of Ackermann Ltd., describes a new, versatile system.***

ISDN (Integrated Services Digital Network) is a technology that is designed to combine Voice, Data and Video signals over a single telephone line as a digital signal as opposed to the conventional analogue signal. The ISDN service which is capable of carrying up to four times as much traffic, is supplied over the ordinary telephone network.

Although ISDN has been available for over a decade, it was primarily used by larger organisations as a means of networking different sites. The service is mainly available from telecommunication companies like BT. In recent years several independent cable service providers have also introduced ISDN facilities.

ISDN is now being used by small businesses and even by people working from home. This trend has been driven by a number of factors such as the growth in the use of the Internet as well as an ever-increasing number of people operating from home and requiring remote access to their corporate network. There are currently at least 1,5000,000 teleworkers in the UK and this figure is escalating all the time.

BT is presently introducing a number of new initiatives to allow ISDN to become within the budgets of small businesses and homeworkers and these developments include the newly-introduced BT Home and Business Highway service.

There are two types of ISDN service available – the basic rate Interface (ISDN2) and the primary rate interface (ISDN30).

The primary rate interface provides 30 'B' channels and one 'D' channel (30B+D). This service is used by larger businesses where there is a combination of data and telephony requirements. The basic rate interface provides two 64k (B) channels plus one 16k (D) channel. Since the two 'B' channels are independent of each other it is possible to have two simultaneous Data and Voice facilities or a combination of both.

This article will focus on the basic rate interface and its applications.

EURACOM

## Installation

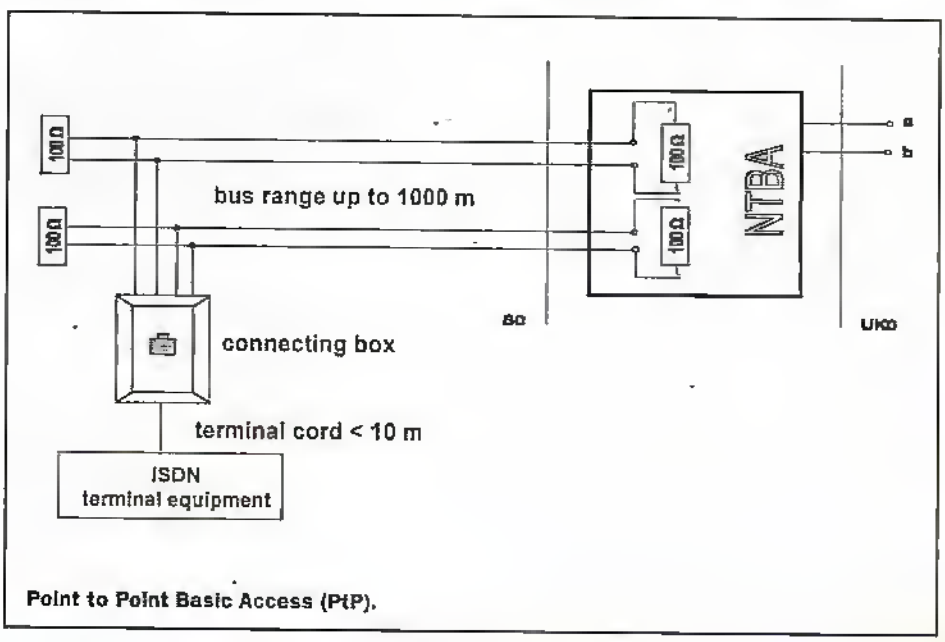
When the service is ordered, the telephone company will install a device called an NTBA. This unit provides the means for the user to connect to the network. Typically this would involve the use of an RJ45 type connector which enables the user to connect up to eight devices onto the ISDN bus. The bus is simply made up of two pairs of twisted data cable and connected to the NTBA. Up to eight RJ45 sockets are connected in parallel, with the final socket fitted with 100Ω termination resistors.

An important point to note is that any device that is connected to the bus in a point-to-multipoint mode communicates over the telephone network, even if it is adjacent to it. This configuration is typical when a user may have a PC adaptor card connected and does not have any internal communication requirements. The devices on the ISDN bus can be individually called using multiple subscriber numbering (MSN) as an extra option from the telephone company.

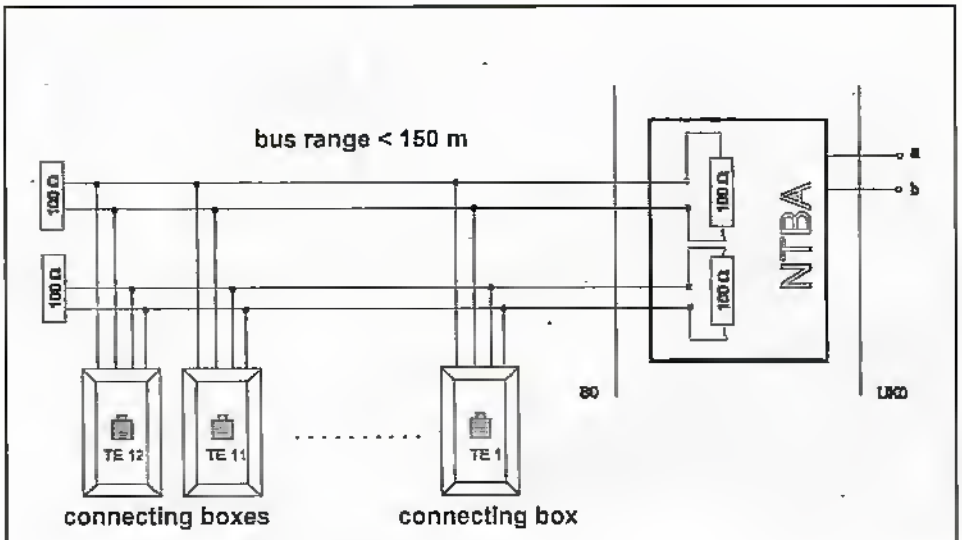
Illustrated below is a point-to-point connection which is utilised when a single device is connected. This could be an ISDN adaptor card or, more desirably, an ISDN PBX.

## Integrating Your Communication Needs

So why is ISDN so interesting and exciting? As indicated earlier, the technology is designed to combine Voice and Data. Yet for most users the demand tends to be more commonly for Data or Voice only applications and this is partly due to the absence of integrated solutions. This is now set to change with a new generations of products such as ISDN PBX. These products are specially designed to make available all the benefits of ISDN that are




**Point to Point Basic Access (PtP).**




**Point to Multipoint Access (PtMP).**

equally useful for small businesses and people working from home.

Using traditional technologies such as analogue modems, quite often means slow connection times and long delays whenever there is a need to transmit data files.

In considering your communication requirements at home, it is quite likely that you will have a least the need for a telephone, fax, an answering machine and some method of transmitting data. The most simple way of doing this might be to purchase an ISDN adaptor card with digital and analogue adaptor ports. These can be fitted internally to a PC or as external powered devices. Using MSN a call can be directed to any of the ports.

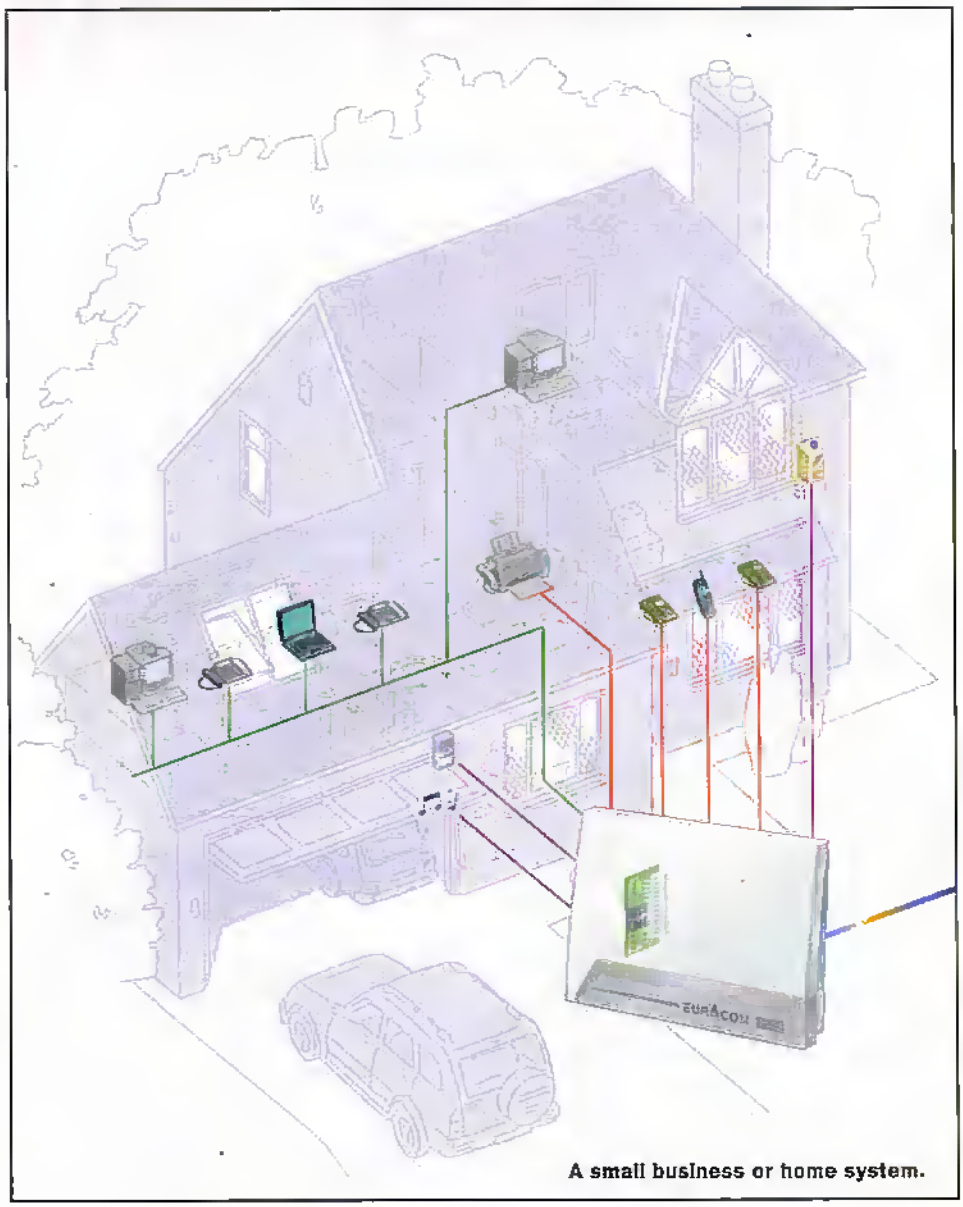
An ISDN PBX provides a more integrated approach to communication, giving you the power to connect additional equipment, but more importantly, it provides you with the ability to transfer calls between internal extensions – a capability that can only be achieved by going through the telephone network when using the conventional adaptor approach.

The type of PBX system that you should use will depend on your needs. When considering ISDN PBX's there are several types available. The most basic ones will have an external ISDN interface that connects to the telephone network, with analogue telephone extensions for internal connection. These units provide the benefits of voice communications and allow the user to connect existing telephones and faxes. However, without an internal ISDN bus connection this arrangement can be restrictive, particularly when there is a need to integrate data communications. It is the only route to go, then try and select a unit that can be upgraded to provide an internal ISDN bus connection. Ideally, even an entry level PBX will have the provision for the connection of internal analogue and digital equipment. The illustration to the right indicates the possible applications of an integrated PBX employed in a small business. This could also be applicable to a domestic application.

In addition to the internal ISDN bus, the unit should have the ability to connect devices such as door entry phones, even alarm systems. A good system will allow activation of relay contacts remotely. This feature will give you the power to switch devices such as central heating or lighting remotely. Some PBX units can be very difficult to program because of complex configuration procedures. Here again a good system should be provided with a PC interface and a Windows-based program. This approach means that the system should be 'plug-and-go'- easily installed and configured by the user alone without the need to employ a specialist. There should be a broad range of telephone management features such as call forwarding whereby calls can be diverted to your mobile or an answering machine, cost centre pin code call charging, programming or hundred's of speed dial numbers, telephone books holding up to 1,000 numbers, external music on hold, different levels of night service and subscriber call barring.

Computer Telephony Integration (CTI) has previously only been available with large systems and within the budgets of big businesses. CTI is now becoming available on the better small systems. Again, this feature allows the user scope for increase flexibility.

The PBX system should be capable of being remotely serviced via the ISDN line. Problems caused by erroneous configuration or operation of the system are thus quickly solved at low cost – usually without an engineer having to be in attendance.



**A small business or home system.**

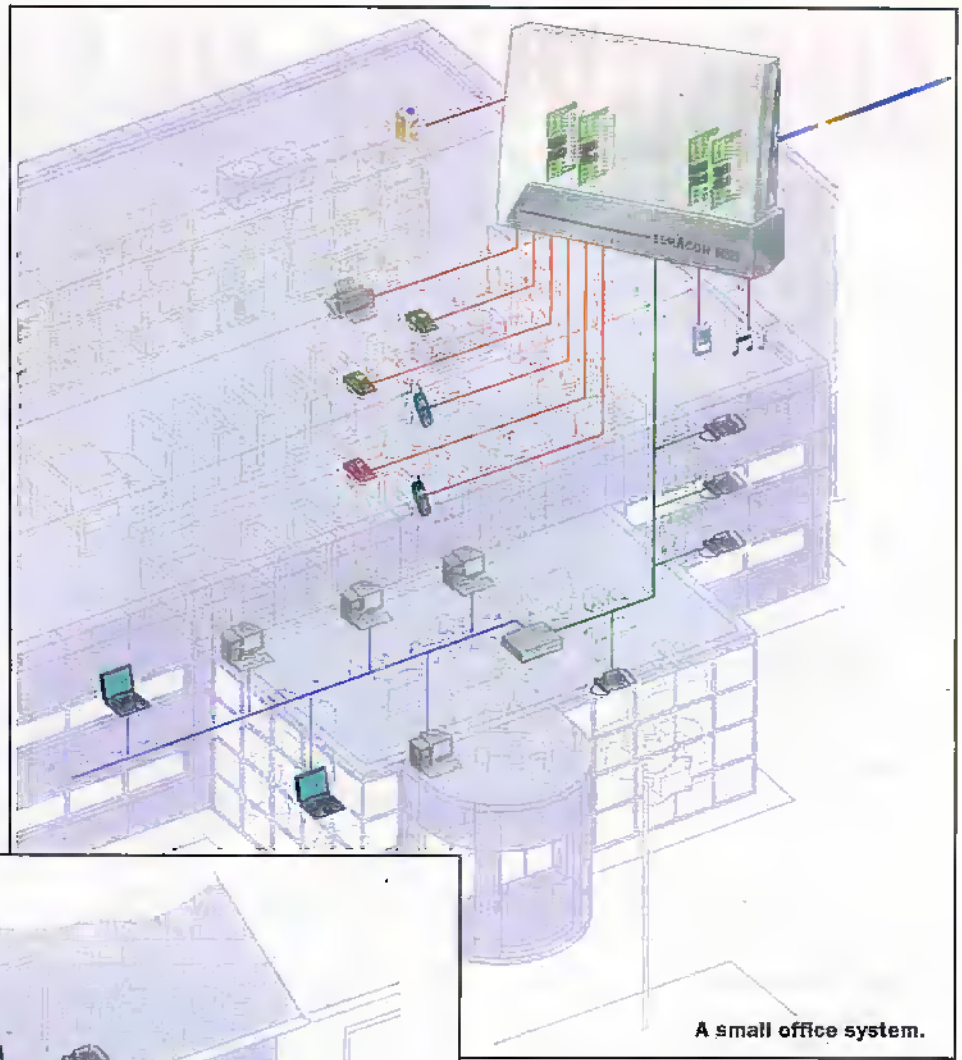
## Flexible Approach

The PBX provides a very flexible approach to integrating communications.

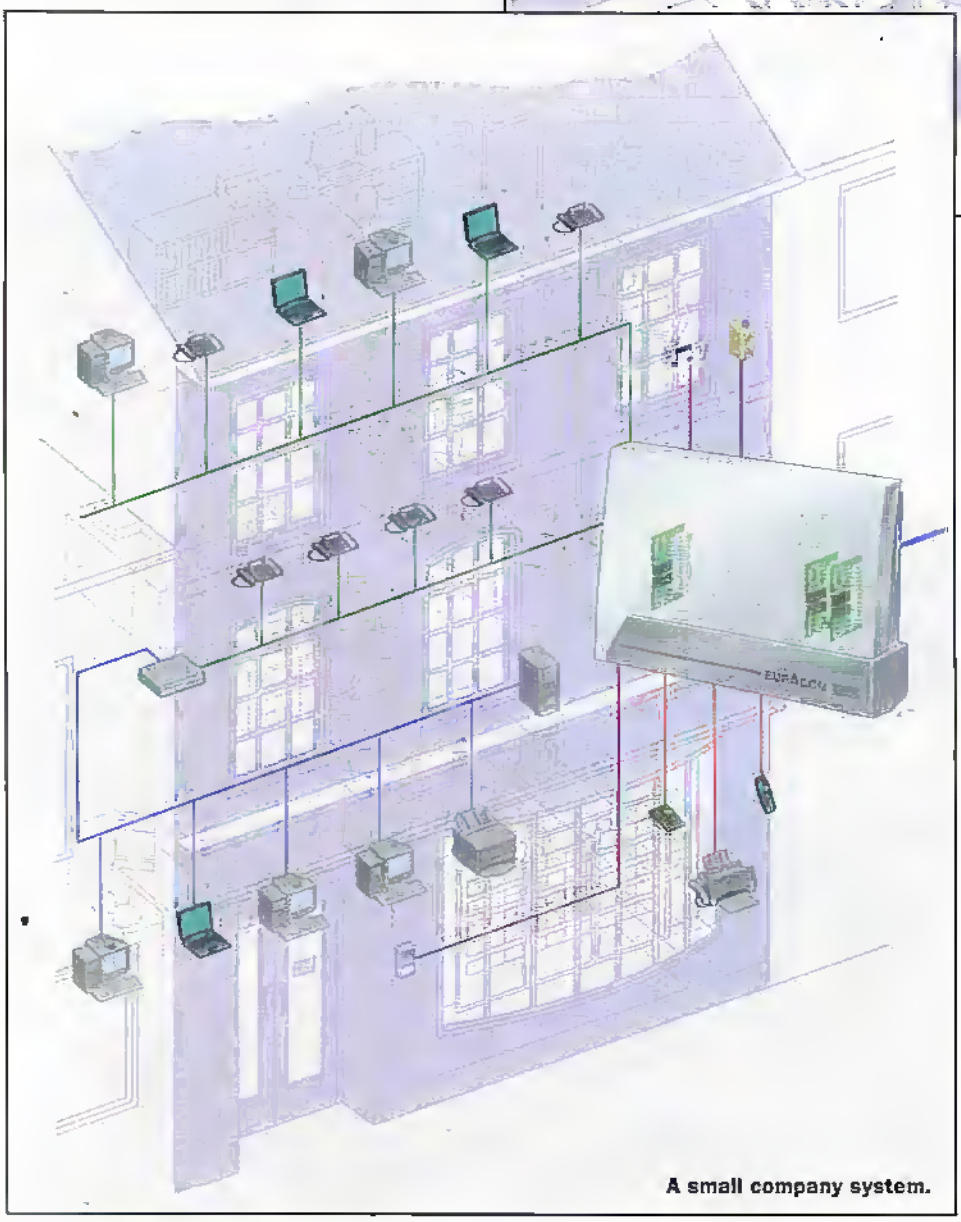
Imagine being able to forward telephone calls from you home office to your mobile as you relax and sip a sangria in a deck chair on a Costa del Sol beach, or having the power to switch off the alarm system and open the front door of your house to admit Granny while at the 8th tee or the golf course. Or as you drive home from a business appointment on a cold winter's day to have the capability of switching on your central heating or being able to open the garage door via your car phone. Or imagine being able to make three party conference calls, allowing you to speak to two internal or external partners simultaneously without have to switch back and fourth.

Maplin Electronics can now offer the EURACOM ISDNZe-compatible PBX system from Ackermann which has repeatedly demonstrated that it saves small businesses, teleworkers and homeworkers money and at the same time boosts the speed, efficiency, producivity and flexibility of their operations.

Specifically designed for the SoHo (Small office, Home office) market, this basic rate system has internal ISDN ports to which up to eight digital devices can be connected.



A small office system.



A small company system.

These devices can comprise both PC cards for exchanging data as well as ISDN telephones. Existing analogue telephones and fax machines can also be connected. The increased user need for remote access for both teleworking and branch office applications has been catered for too.

EUROCOM is now available direct from Maplin and through the superstores. Two basic configurations are available with modules for system expansion.

EUROCOM 141 provides one ISDN 2-line (2-channels) plus four analogue extensions and one ISDN bus that allows up to eight digital extensions i.e 2-line/12 extension system.

EUROCOM 180 provides one ISDN 2-line (2-channels) plus eight analogue extensions. This system is modular and can be expanded to include extra line capacity or digital extensions by adding up to two more ISDN bus modules. These modules are available from Maplin.

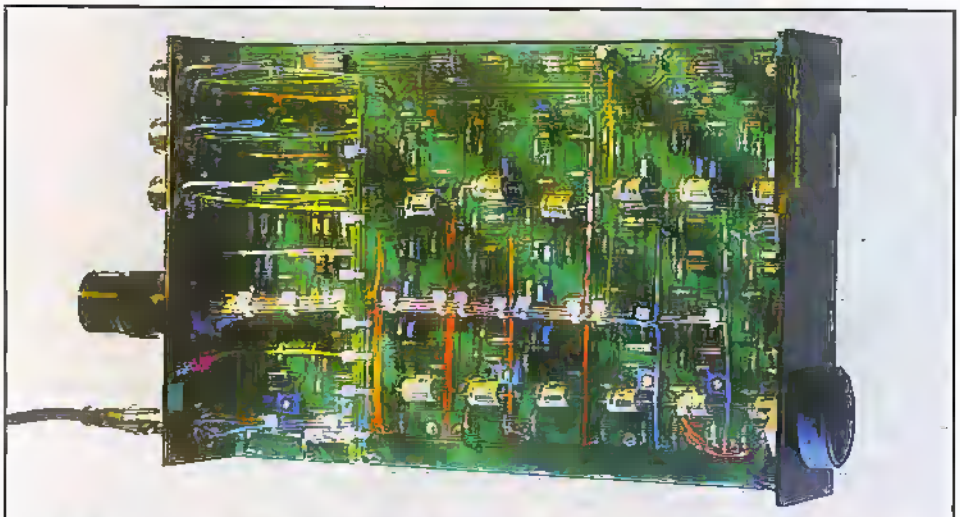
Both the systems include, as standard, installation manual, user manual, Windows configuration, CTI and call management software (on two disks), mains cable and plug and PC interface card. Telephones, wiring cable and extension sockets are not included but are available from Maplin, see Telecommunications section of the latest Catalogue.

| Type | Maplin Order Code | Price inc. VAT |
|---|---|---|
| EURACOM 141 | PU14Q | £469.99 |
| EURACOM 180 | PU15R | £587.49 |
| ISDN Expansion card | PU16F | £176.24 |

# AUDIOPHILE HI-FI

## PART 2

***In part 2 Mike Bedford helps you spend your hard earned cash on the very best in hi-fi.***



**NAIM SNAXO active cross-over unit. Like much of NAIM's kit, this doesn't have a built-in PSU so you can choose your own. These range from £350 to over £2,000!**

## Other Sources

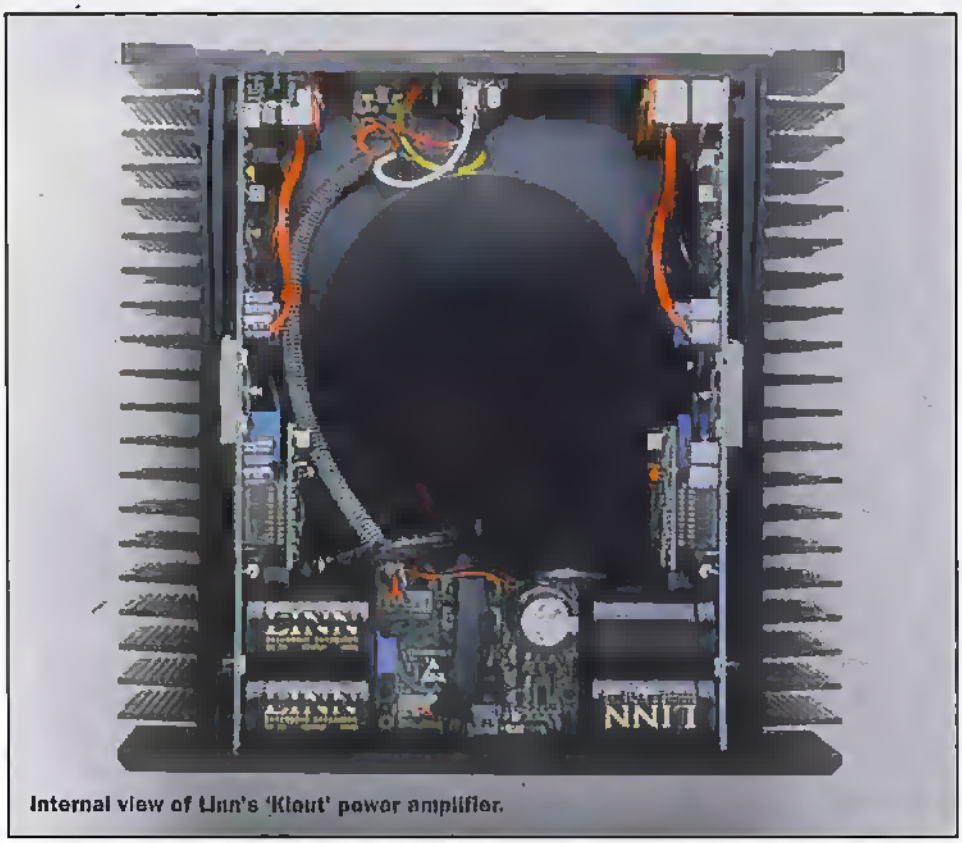
Last month we've majored on CD and vinyl records as sources because one or the other or both of these are the primary sources for most audiophile enthusiasts. However, that does leave cassettes – both the conventional analogue variety and the digital variety (DCC and DAT) – and tuners to talk about. First of all cassettes and we can quickly deal with this topic. Despite the fact that the traditional audio cassette is one of the few audio formats which allows you to record your own material, this is about its only redeeming feature. It really isn't a hi fi medium, let alone something which audiophile addicts would be satisfied with. Sure, you can spend a fair bit of money on a cassette desk but it's never going to rival CD or vinyl. The DCC and DAT formats are another matter entirely, at least from a quality viewpoint. The quality of the sound you can get from these digital tapes is just as good as that available from a CD. But from a convenience point of view, disks are much better since you can access any track almost instantly. Just as importantly, these formats haven't managed to reach 'critical mass' – pre-recorded DAT tapes are few and far between and DDC, although better, certainly isn't a match for CD in this respect. We also have to question why anyone would need DAT, DDC – or Mini-disk (MD), for that matter – when all do essentially the same thing as CD. If, instead, you concentrate on just the one format, you can afford to spend more on it and so enjoy better quality music. So, the bottom line is that audiophile kit for these other formats is very much of a rarity.

Finally, we come onto tuners. Surprisingly – with the possible exception of an external power supply – no new aspects appear here when we compare audiophile with standard hi fi equipment. It's simply a matter of better and more expensive boxes. However, you'll sometimes find that manufacturers produce VHF FM-only tuners on the grounds that you'll never get decent quality audio from the MW or LW broadcast bands. What this does mean, however, is that if you do decide to buy one of these top-end VHF-only tuners and still want to listen to stations which are on the other bands, you'd have to buy a separate tuner for MW and LW. Well, what's one more box? The only other thing to say about audiophile radio reception is that if you're paying a few thousand for the tuner, it's a false economy to make do with a wire dipole antenna stuck to the lounge wall. Hi fi dealers selling this sort of kit will recommend in the strongest possible terms that in order to get the most out of your system, you really need a good quality high gain external antenna, complete with rotator. (N.B. This may well change with the arrival of digital radio... Ed.)

## Amplifiers

In a standard hi fi line-up, the amplification comes from a single unit referred to as an amplifier or – to differentiate it from the audiophile equivalent – an integrated amplifier. What the integrated amplifier integrates is a pre-amplifier and a power amplifier and, in the realm of super hi fi,

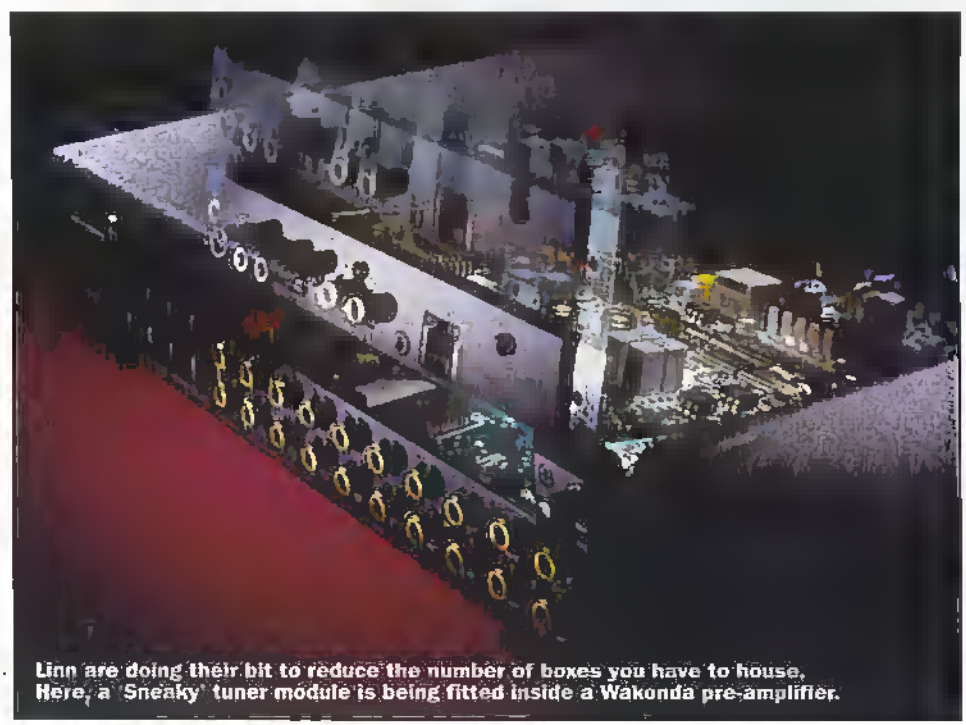
**A complete NAIM line-up. If you go for NAIM's top-end gear, you'll end up with six boxes for the power amplification alone – this means a large lounge and a reinforced floor.**



Internal view of Linn's 'Klout' power amplifier.

these are sold as separate units.

The job of the pre-amplifier is to provide control. It allows you to select between different sources – CD, turntable and tuner, for example – it allows you to control the volume, it probably provides a balance control and it also makes sure that the signal levels from the various sources are equalised before being passed to the power amplifier. What the pre-amplifier won't have, however, are many of the bells and whistles which are found on cheaper units. So, there'll be no graphic equaliser, there'll be no dancing LED displays, there'll be no DSP to manipulate the sound and there'll probably be no treble and bass controls either. And to the uninitiated, this may sound rather odd. After all, if a £500 all-in-one mini system can provide this level of sophistication, then surely a company producing a pre-amplifier which will sell for £3,500 could afford to include all these goodies. Well of course they could but they've decided not to for a variety of reasons. Bells and whistles like multi-coloured displays are driven by digital electronics which, by definition, produce electrical noise – not the sort of thing you want in a pre-amplifier. Certainly, if it's essential that some digital electronics is included – in a CD player, for example – then the manufacturer will find ways to cope with it. But how much extra is the customer going to pay for the designer to sort out the difficulties associated with including something which isn't really needed. The answer is 'not a lot'. And this underlines the difference between buyers of packaged systems and buyers of audiophile equipment. All-in-one systems are often bought by people who have only a passing interest in music. They'll often buy it without listening to it first from a non-specialist shop. And as such, spectacular extras will catch the eye and differentiate one unit from another. Hi fi enthusiasts, on the other hand, will often buy from a specialist shop after having auditioned various systems. The decision about which to buy will, therefore, be normally on the basis of which sounds the best, not the one which looks the most spectacular. And even treble and bass controls will, to a degree, compromise the design aim of true hi fi equipment – transparency. And why should anyone want to alter the tonal quality after all? The record or CD will have been mixed by someone who understands these things inside out. The mixing engineer is paid to know exactly how much to boost the various frequency bands so, when you buy the recording, it should be close to optimum. All treble and bass controls allow you to do is upset all that hard work.



Linn are doing their bit to reduce the number of boxes you have to house. Here, a 'Sneaky' tuner module is being fitted inside a Wakonda pre-amplifier.

The power amplifier does pretty much what you'd expect – it boosts the level of the signal from the pre-amplifier to a level at which it can drive a pair of speakers. And I guess that's really about as much as we can say about that. So, once again, I guess we'd better address the question of why split a component – in this case the integrated amplifier – into two units. Even without knowing anything about the finer points of audio design, most people should recognise that the pre-amplifier handles low-level signals, that the power amplifier handles high level signals and that the two don't mix. If you're at all concerned about feedback, then putting the two in separate boxes is an obvious answer. And consumer choice is important here too. Whereas it's unusual to pair a pre-amplifier from one manufacturer with a power amplifier from another, it is common for manufacturers to provide quite a range of both pre- and power amplifier, all of which may be interconnected. Naim, for example, offer no less than five pre-amplifiers varying in price from £485 to £3,450 and five power amplifiers over a similar range of prices. Furthermore, with some companies, there is an easy route to a pre-/power combination from an integrated amplifier as there sometimes is from an integrated CD player to a transport/DAC combination. In this case, that route involves keeping the integrated amplifier and using it as a pre-amplifier in conjunction with a separate power amplifier and later upgrading the original amplifier to a new pre-amplifier. And finally, the pre-/power amplifier arrangement is a necessary element of an active speaker system as we'll see shortly.

While on the subject of amplifiers, let look at power supplies in a bit more detail. Not all pre-amplifiers have their own mains power supplies. None of the Naim pre-amplifiers, for example, have built-in power supplies. The rationale is that power amplifiers have hefty power supplies which


**Photo 7. Meridian Digital Controller which adopts a different aproach – to keep everything in the digital domain until the speakers.**

could easily supply the small amount of power needed by the pre-amplifier. And that's true – it places virtually no stress on the power amplifier's supply to tap off a little power for the pre-amplifier. However, this is only part of the picture. The power amplifier places a very significant load on its power supply, especially during peaks in the music and this, in turn, can cause fluctuations on the supply. Admittedly those fluctuations will be very small – assuming that the power supply is properly designed – but remember that the pre-amplifier is designed to handle low-level signals. Fluctuations on the power can have a detrimental effect on performance. The answer adopted by Naim is to offer, as an option, an external mains power supply for the pre-amplifier. In fact, they offer no less then three external power supplies which can be used with pre-amplifiers and active cross-over units. Linn take a quite different view, including a mains power supply in all their active products. Unlike Naim's supplies which are of a conventional design, operating at 50Hz, Linn use switched mode power supplies. If you've ever picked up a Naim power supply or power amplifier, you'll know that the conventional approach to power supply design results in a very bulky and heavy unit, one reason, no doubt, that power supplies aren't fitted into every bit of kit. Whereas Naim will tell you of the increased consumer choice which external power supplies provide, Linn will tell you that the best performance comes by having the power supply physically close to the load, which is quite possible with a small switched mode design.

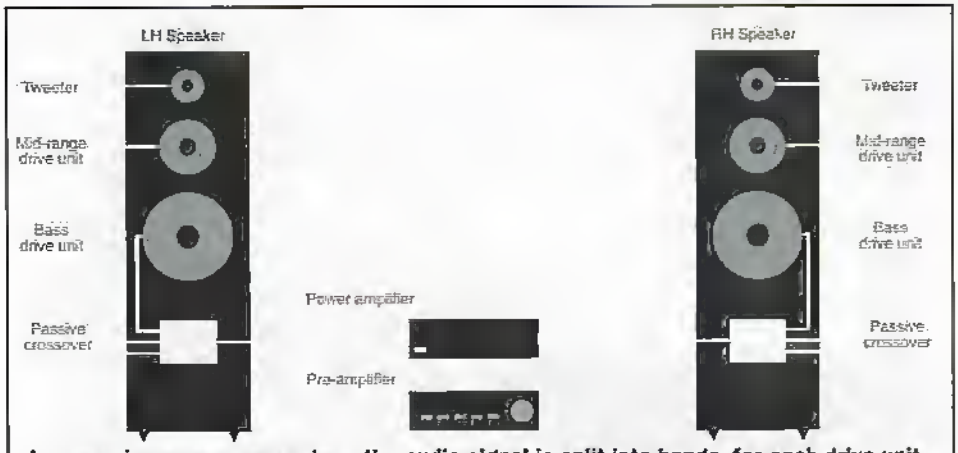
So we've seen that in the realm of audiophile hi fi, the single box integrated amplifier could end up as two boxes – a pre-

/power combination, three boxes – with the addition of a separate power supply, or even four boxes – if an external phono stage is added. In fact, it can even end up as five boxes because, if you want the absolute best, you'll probably find that you can't buy a good enough stereo power amplifier and would, instead, have to buy a pair of mono power amplifiers. And if you thought that five boxes is more than enough for an amplifier, just wait until we look at active speaker configurations.

## Speakers

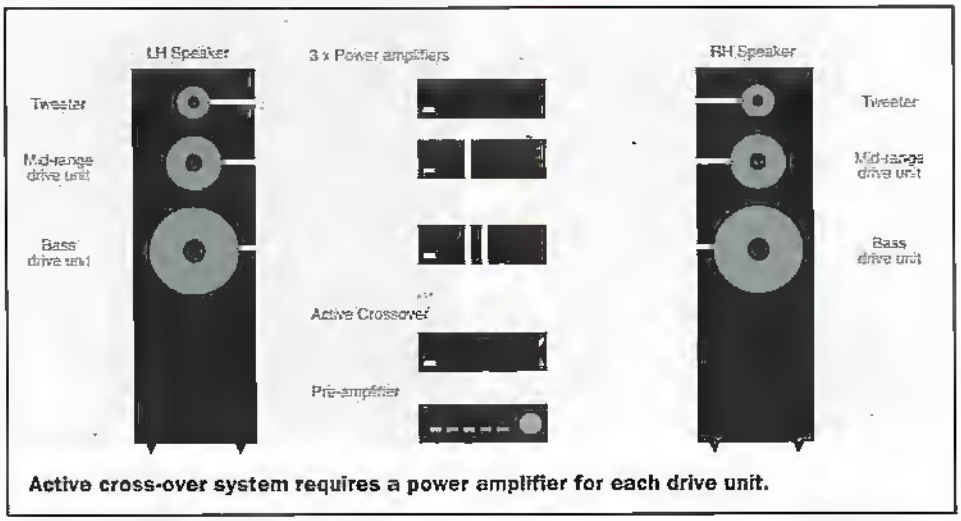
As we've already seen, if you're serious about your hi fi, you're going to need some serious real estate in which to house your kit. This isn't because audiophile components are necessarily bigger than their more modest counterparts but simply because you end up buying more boxes. And if good means big for CD players and amplifiers, then the sentiment applies all the more to speakers – in a phrase really good speakers tend to be massive. Sure we've seen huge gains in the performance achievable from a tiny speaker enclosure, but if you want the absolute best then size matters. Naim's DBL speakers, for example, stand 1.2m height, are 650mm wide and 400mm deep. That's a serious looking bit of kit and at £8,810 a pair, I guess they ought to be.

If you've ever taken more than a passing interest in loudspeakers, you'll be aware that they contain, at the very least, one bass unit and one treble unit which is known as a tweeter. Some speakers have mid-range units and some also have multiple bass units. And the reason for this, of course, is that no one drive unit can adequately reproduce sounds over the complete frequency range of human hearing. What you probably also know is that these various drive units aren't just connected up in parallel but a bit of circuitry called a cross-over unit is used to split the signal up into the various frequency bands and pass the signals for the appropriate frequency to each drive unit. Failure to do this will cause distortion as drive units try to cope with frequencies for which they weren't designed. What you may not know, however, is what the limitations are of conventional cross-over units and what can be done to improve matters. The alternative approach is the active speaker and, within the realm of top-end hi fi, this means something quite different from what it means in the realm of multi-media PCs. To a PC user, an active speaker is a very cheap and nasty speaker which just happens to have the audio amplifier and mains power supply built-in. But, to the audiophile enthusiast, an active speaker is much more sophisticated.

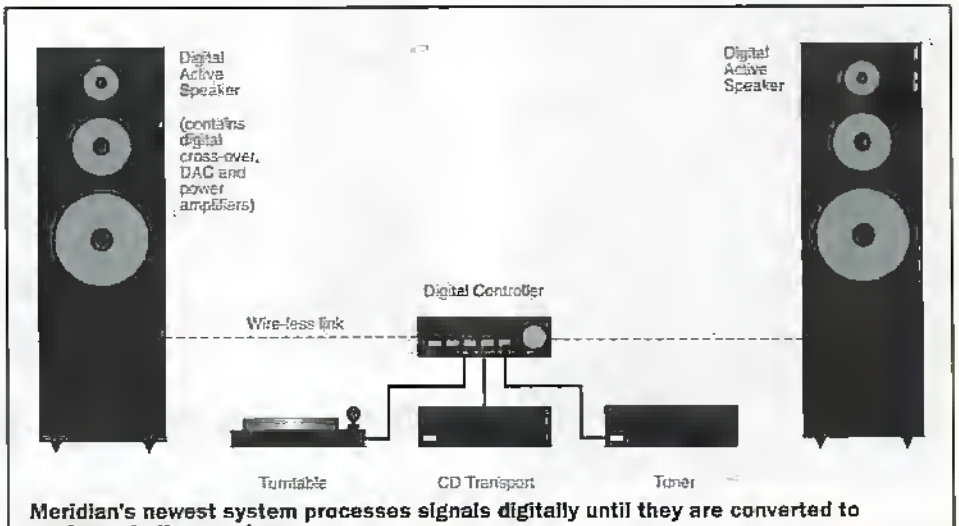



**In a passive cross-over system, the audio signal is split into bands, for each drive unit. However, the passive cross-over introduces distortion.**

The cross-over unit which is fitted inside most speakers is, more accurately, a passive cross-over unit. In other words, it has no powered electronics, and consists of various audio tuned circuits composed primarily of large inductors and large capacitors. But, of course, any circuitry built out of inductors and capacitors is going to have some undesirable effects on the signal. A large series inductance, for example, will produce distortion in the drive unit. Another problem is that the magnetic field produced by one inductor can induce a signal in another thereby causing cross-talk between the frequency bands. The alternative approach is to use active filters based around op-amps. These eliminate virtually all of the problems associated with passive cross-overs but, of course, they operate at low signal levels. Specifically, they operate at the sort of signal level which is found on the output from the pre-amplifier, and split the signal into feeds for each of the drive units in the speakers. What this means, however, is that one stereo power amplifier or a pair of mono power amplifiers is no longer sufficient. Depending on the number of drive units in the speakers you may need two, three or four stereo power amplifiers or, if you're looking towards the absolute top-end, four, six or eight mono power amplifiers. This will take up a lot of room and, at up to £1,700 for a mono power amplifier, it'll cost you an arm and a leg too. However, using multiple power amplifiers produces further improvements. Perhaps the most significant of these is that each amplifier handles only a portion of the audio spectrum with a further reduction in cross-talk due to interference on the power supply.




**Active cross-over system requires a power amplifier for each drive unit.**



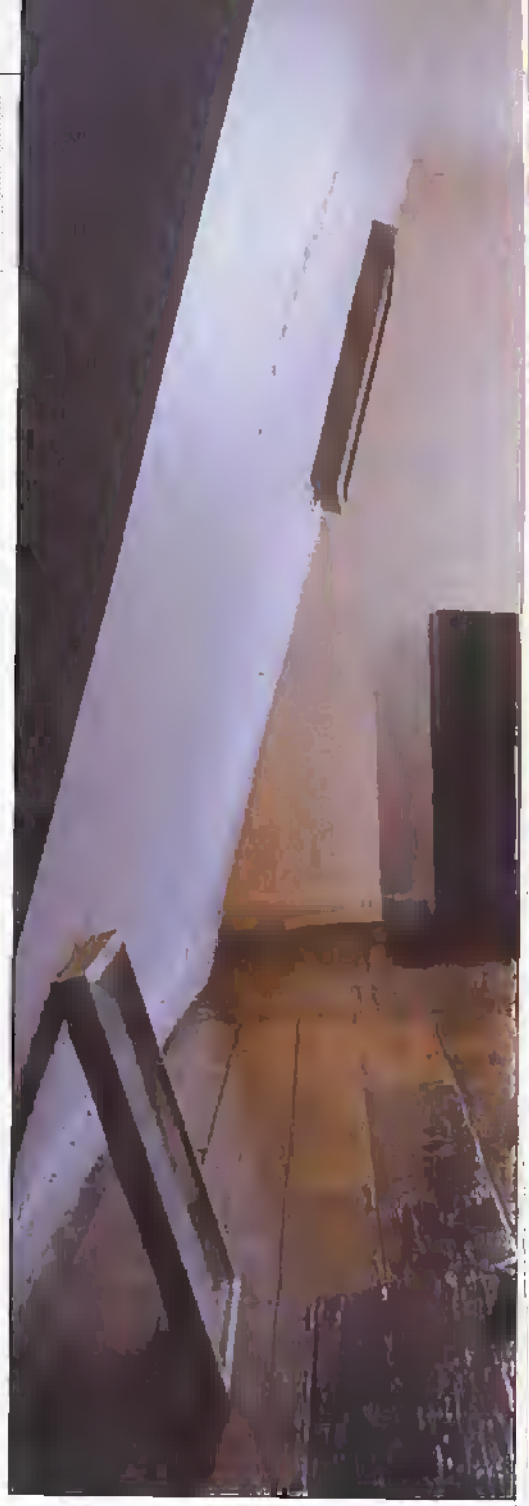

**Meridian's newest system processes signals digitally until they are converted to analogue in the speakers.**

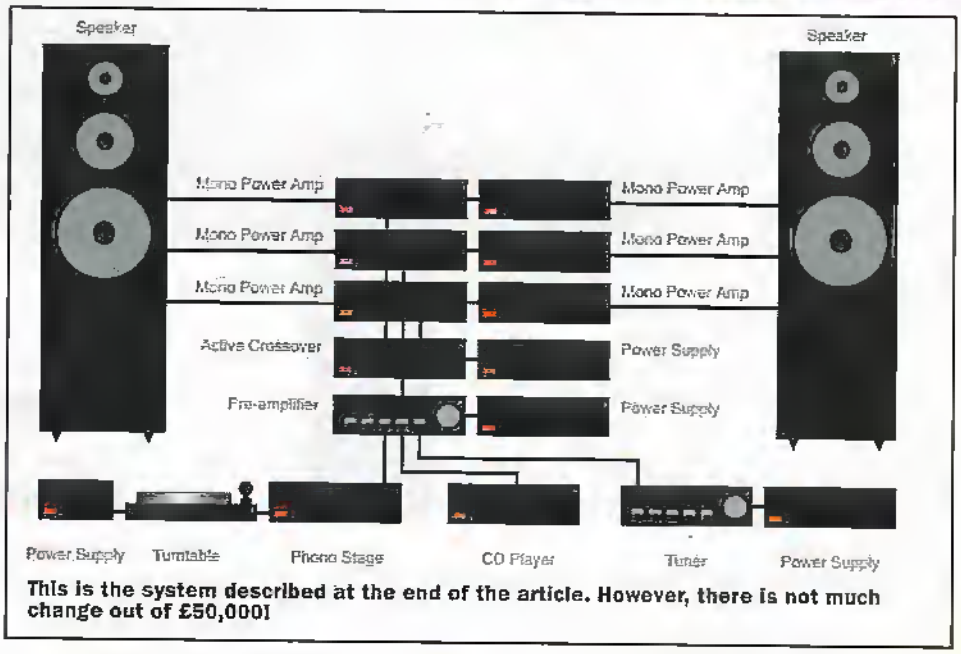
## An Alternative Approach

What we've seen so far is a fairly conventional approach to top-end hi fi. Not all manufacturers offer active speaker technology – some put all their effort into optimising the actual speaker itself – but in other respects, the approach we've seen is followed by most hi fi companies which specialise in audiophile gear. And to summarise the approach – the signals from analogue sources remain in the analogue domain throughout the signal path, and digital signals are converted to analogue at the earliest opportunity so that they can be handled by equipment which is totally analogue. This seems so obvious that you may be surprised that there's another way of doing things. The alternative technology is being promoted by Meridian and involves keeping signals in the digital domain for as long as possible, even converting analogue signals to digital for processing by the rest of the system. Let's see how this works.

If you look at the diagram of a Meridian digital system you'll notice that it has far fewer black boxes that the conventional systems we've looked at. And when I point out that, despite appearances to the contrary, this system employs active speakers, you'll see that the difference is quite staggering. The whole rationale is that, since digital signals can be copied without degradation, that they should remain in the digital domain for as long as possible. So, for example, the equivalent of the pre-amplifier is a digital control unit, and the analogue active cross-over of a conventional active speaker system is replaced by a digital cross-over unit which uses a DSP. Only after the cross-over is the signal converted to analogue for amplification. And the reason that the box count is so dramatically reduced? Well, just about everything goes in the speaker cabinet – cross-over, DAC, and power amplifiers. The resultant box is referred to as a digital active speaker and communicates with the digital controller using a wireless link. And without a doubt, this seems a sensible approach for a digital source. The advisability of doing the same with an analogue source seems much more questionable. In a fully digital system, the only way to handle analogue sources is first to convert the signal to digital in an ADC, then process it digitally and finally convert it back to analogue in the DAC in the speaker. Admittedly I've never listened to such a system, and I might be pleasantly surprised, but the concept of multiple conversions between analogue and digital does seem a little suspect.

**Meridian Digital Active Loudspeaker to partner the digital controller.**






**This is the system described at the end of the article. However, there is not much change out of £50,000!**

This photo illustrates the simplicity of a Meridian digital solution. Just two boxes, the speakers (with no cables) and a remote control unit.

## So How Much Does an Audiophile Set-up Cost?

Throughout this article, I've given price indications for various bits of kit and, as you've seen, you can pay far more for just a single component of an audiophile set-up than you can for a complete integrated system. But what's a complete system going to set you back? To close, I thought I'd design an absolute top-end system and work out how much it would cost. So, I've gone through the price lists and picked the most expensive option for each component. This doesn't mean it's necessarily the best, however, and you'd need your head examining if you were to spend this sort of money on the basis of nothing more than a price list. However, as an exercise in finding out what you could spend, if you had the inclination and an understanding bank manager, here goes. The sources are a Linn CD12 integrated CD player, a Linn Kremlin tuner, and a Linn LP12 turntable with Lingo power supply, Ekos tone-arm, Arkiv moving coil cartridge and Linto phono stage. For amplification we have a Naim 52 pre-amplifier with Super-Cap power supply, a Naim SNAXO active cross-over also with a Super-Cap, and six Naim 135 power amplifiers. And to complete the line-up, there's a pair of Naim DBL speakers. OK, I could spend more if I picked units that are intended primarily for studio use but for a home system, I don't think that's a bad set-up. And the price? You're not going to see a lot of change out of £50,000!

## Taking the Plunge

Hopefully the last paragraph hasn't put you off the idea of top-end hi fi completely. After all, it was only an exercise in finding out how much you could spend - you can design an extremely good system for far less than this and the separates approach means that you can build your system up as and when you can afford it. So, if you would like to experience some seriously good music, how should you go about it? The first thing to point out is that equipment of this sort is available only from specialist hi fi shops and these are comparatively few and far between. These shops are nearly all members of BADA, the British Audio Dealers' Association which means that they'll have trained staff, they'll allow you to audition equipment in their listening rooms, they'll install equipment in your home and they'll give you a two year guarantee. And if you're thinking of spending a lot of money, it makes sense to avail yourself of all this. Don't be in a hurry, ask their advice and, above all, listen to different systems. Don't be unduly concerned with figures on a specification sheet, rely instead on what your ears tell you.

# Electronics in AGRICULTURE

PART 6

## Crop Protection

*George Pickworth returns to agriculture to look at computer managed crop sprayers.*


Photo 1A. A modern self-propelled, computer-managed, crop sprayer. Note that cab is supplied with filtered air. (Courtesy of Knight Farm Machinery Ltd.)

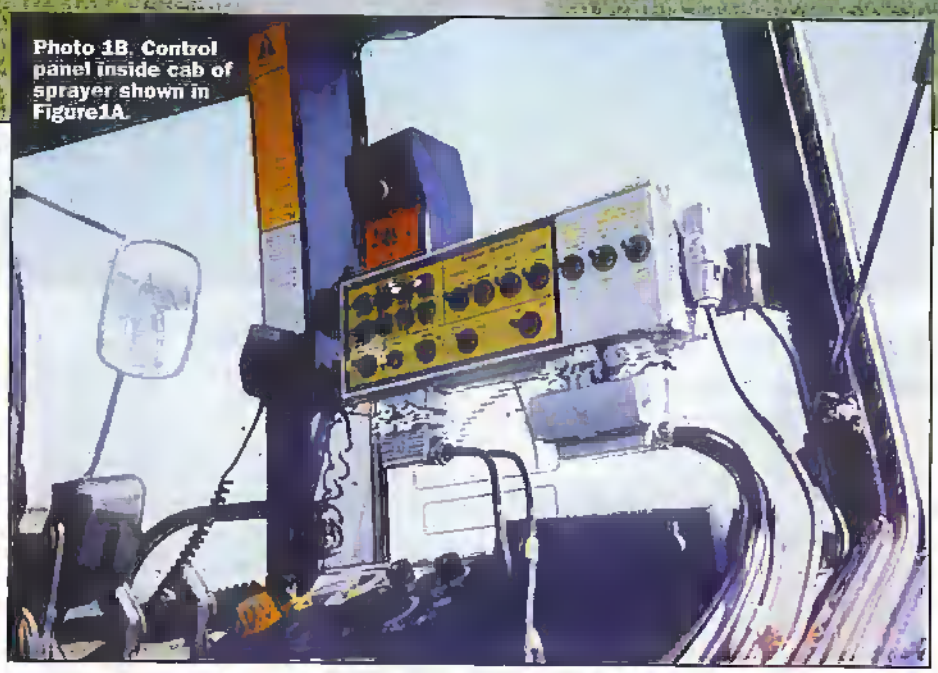


Photo 1B. Control panel inside cab of sprayer shown in Figure1A.

### Introduction

Crop protection is the science and practice of protecting crops against ravages of pests, diseases and competition by weeds. Agrochemicals provide the most convenient and cost effective method of crop protection and are invariably applied as a liquid spray; see photo 1a & 1b.

All agrochemicals are to a greater or lesser degree environmentally undesirable and in recent years much attention has been given to minimizing the amount of chemical applied by accurately targeting the weeds or pests.

In this study we look at the evolution of computer managed spraying machines which are vital for the efficient, safe and speedy application of agrochemicals.

### Philosophy

The evolution of modern crop sprayers went hand-in-hand with the development of more efficient and safer pesticides. So, to enable readers to better appreciate the design philosophy of a modern computer managed crop spraying machine, notes on pesticides and selective herbicide are included in this study.

In this first part we look at the development of selective herbicides, i.e. those which selectively control weeds in a growing crop. We also look at the role these played in maintaining food rations during the Second World War and immediate post war years when the country was bankrupt and could not afford imported food. However, to fully appreciate the significance of selective herbicide sprays, we must first go back to look at traditional farming methods.

Traditionally, weeds and pests were controlled by crop rotations which not only allowed weed control by cultivation to be integrated with growing crops, but as several years elapsed before the same crop was planted in a particular field, the incidence of pests was greatly reduced. However, crop rotations could not completely prevent weeds appearing in cereal crops so these were removed by hand labour. A typical rotation is shown in Figure 1.

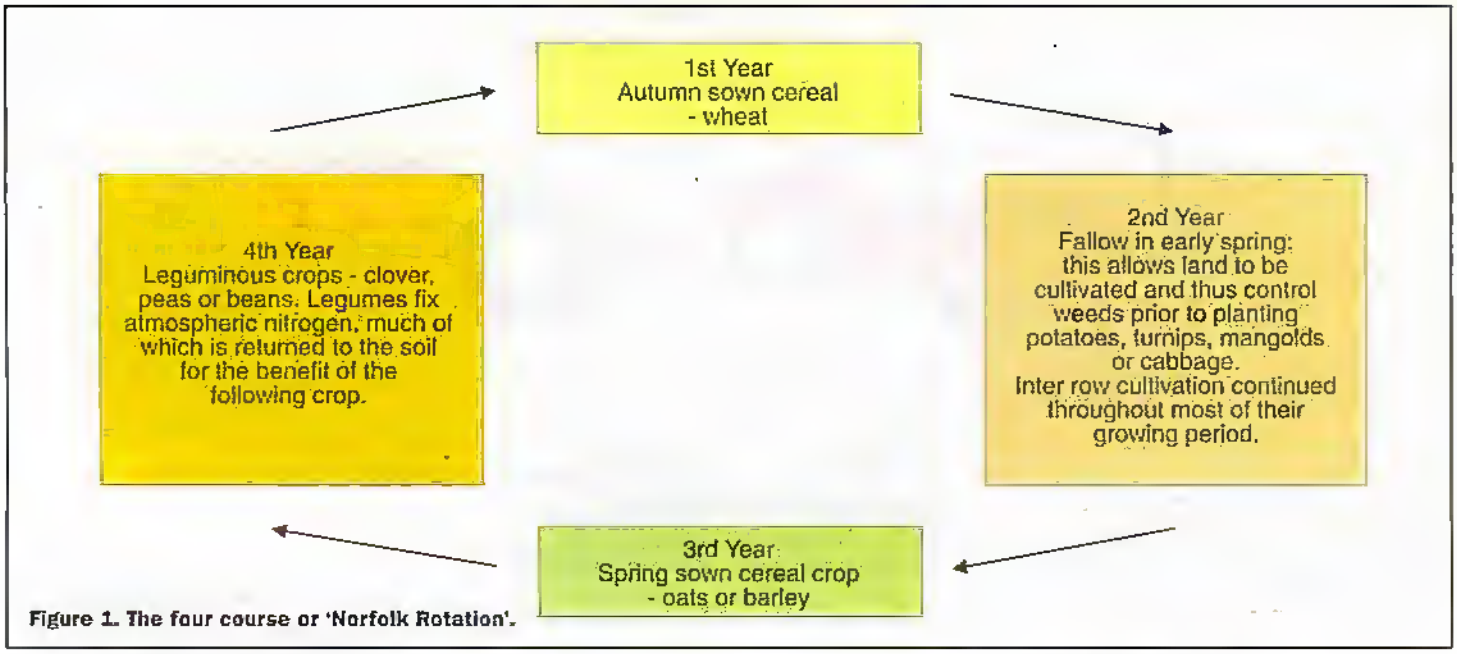



**Figure 1. The four course or 'Norfolk Rotation'.**

## Industrial Revolution

Following the industrial revolution and the increase in the population and demand for food, the amount of land under cultivation in the UK increased to a level, and according to some authorities, which was not exceeded until the 1970's. But, in order to efficiently manage this large area of arable land, farmers had to be innovative and one of their great innovations was selective control of weeds in cereal by means of chemicals.

Good results were obtained with solutions of copper sulphate or dilute sulphuric acid. The spray film adhered to weeds the hairy leaves, such as charlock and poppy, to cause a burning effect which destroyed plant tissue. On the other hand, the spray ran off the smooth leaves of cereal crops. Moreover, unlike typical weeds, the growth point of a cereal plant is at its base and therefore protected from the spray. Selectivity was therefore a mechanical effect.

## Imports

Until the middle of the 19th century, Britain had grown sufficient grain to feed its population, but, following the extension of railways into the great grain growing areas of North America and the Argentine, these countries were able to export vast amounts of grain much of which arrived in Britain.

British farmers could not compete with these cheap imports; the industry fell into decline and much arable land was put down to pasture to be grazed by livestock. Only a limited amount of land was retained for arable crops and this was managed under crop rotation regimes. Chemical control of weeds all but ceased.

Even the need to maximize home grown food production during the First World War, when much of the pasture was ploughed up and planted with cereal crops, failed to regenerate an interest in chemical weed control. In fact, interest continued to decline and at the beginning of the Second World War, and I doubt if there was an operational weed control sprayer in the country.

## Fertility Bank

It is perhaps cynical to suggest that governments were content with the reversion in arable land to pasture during the inter-war years, but, the fact remains that the pastures built up an enormous reserve of fertility and it was thanks to this that we were able to withstand Hitlers attempts to starve this country into submission.

Under the Emergency Food Production Plan introduced during at the outset of the war, crop rotations were abandoned and all land which could be brought under cultivation with available machinery was planted with food crops, particularly cereals, under a virtual mono-culture regime.

However, it seems that the governments had anticipated a war lasting only about three years and that fertility accumulated by the pastures would maintain an intensive virtual mono-culture system over this period without weeds and pests becoming a serious problem. Unfortunately, this proved

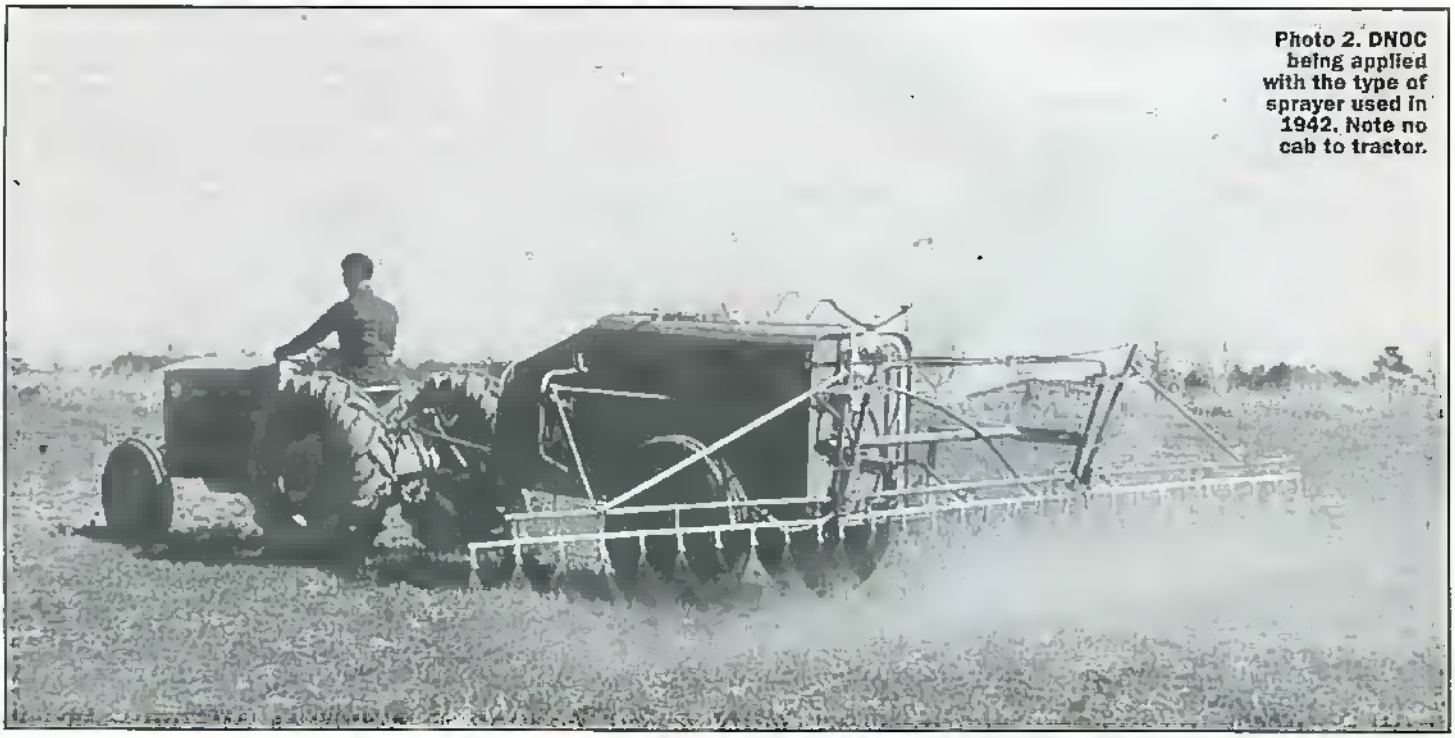


**Photo 2. DNOC being applied with the type of sprayer used in 1942. Note no cab to tractor.**

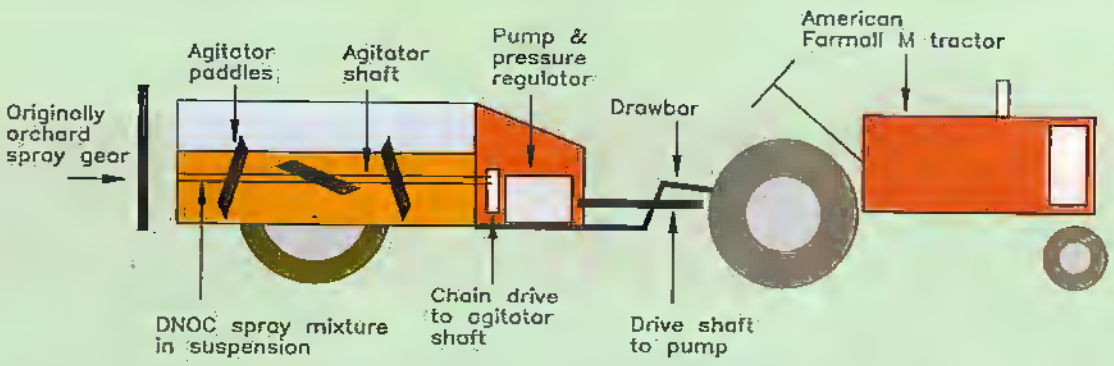



**Figure 2. Simplified sketch of a 'bean' spraying machine. 1944. Only imported Farmall tractors had sufficient power to tow the sprayer and drive the pump.**

| | |
|---|---|
| **Tank capacity:** | **500 gallons** |
| **Pump:** | **3-cylinder, porcelain lined cylinders, rubber cup pistions.** |
| **Operating pressure:** | **300psi** |
| **Output:** | **15gallons/minute** |
| **Spray boom width:** | **35-40 feet (see figure 3)** |
| **Spraying rate:** | **9-10acres/hour** |

to be wishful thinking.

Whilst fertility was maintained by application of fertilizer, much of which came from the USA, there was a dramatic increase in the weed population during 1942 and this presented a very serious threat to food production. To add to our problems, the war lasted six years and the weeds problem continued well into the post war years.

Fortunately, before the war, a number of agricultural scientists had foreseen a prolonged mono-culture regime creating serious problems with pest and particularly weeds.

In April 1939, Dr. Ripper a far sighted scientist, was instrumental in forming a science based crop protection company known as Pest Control Ltd (PCL) which provided expertise on pest and weed during the war. The long established firm of J. W. Chafer also made a substantial contribution to pest and weed control technology.

## From France

Dr. Ripper realized that copper sulphate and dilute sulphuric acid sprays were no match for weeds during a prolonged war and the best chemical would be dinitr-o-cresol (DNOC) but this was only available from France.

Unlike the UK farmers, French farmers were sprayer orientated, presumably because vineyards had to be sprayed with fungicide. So, as machines were on hand, it was logical to extend spraying operations to control potato diseases and to apply to selective herbicides to cereal crops.

In 1930 French farmers found that DNOC was far more effective than copper sulphate and sulphuric acid. Moreover being non corrosive, DNOC could be used with ordinary sprayers employing mild steel tanks, but sprayers for applying dilute acid had wooden tanks. So, shortly before the fall of France, PCL obtained a large quantity of DNOC from the French manufactures, Truffaut.

Meanwhile, PCL produced a number of spraying machines for applying DNOC and in 1942. these were employed on a contract spraying operations in East Anglia: this was the first time that DNOC had been used in the UK. Unfortunately, shortage of materials severely limited the number of sprayers that could be produced.

The effect of DNOC on weeds was similar to sulphuric acid, so virtually 100% coverage of the weeds was essential; hence the need to apply the chemical in 100 gallons of water/acre. But, because DNOC was applied as suspension in water, the mixture had to be constantly agitated in the sprayer tank, otherwise the chemical settled out, so farmers were happy to leave spraying to specialist contractors.

The French product was a powder formulation of the sodium salt of DNOC and being very unstable, periodically it burst into flame when being loaded into the sprayers. Moreover, it was also an unpleasant yellow substance which stained operators a deep yellow colour. The same applied to any person or creature that ventured into a sprayed field.

Supplies of the French DNOC were obviously limited and in 1943 it was apparent that vast quantities of DNOC would be required to have any significant control of weeds which were increasing at alarming rate. So PCL set up a factory to produce DNOC at Hauxton, near Cambridge. However, to avoid inhalation of DNOC dust and the danger of fire, or even explosion, the PCL product was produced as a slurry.

## Acid Sprayers

Early in the war, PCL had developed a sprayer to apply concentrated sulphuric acid (Brown oil of vitriol BOV) which unlike dilute acid, did not attack the steel tanks of the sprayer. The acid was forced through the sprayer nozzles by compressed air, similar to a Primus stove, thus avoiding acid coming in contact with the pump. See Figure 3. The same technique was applied

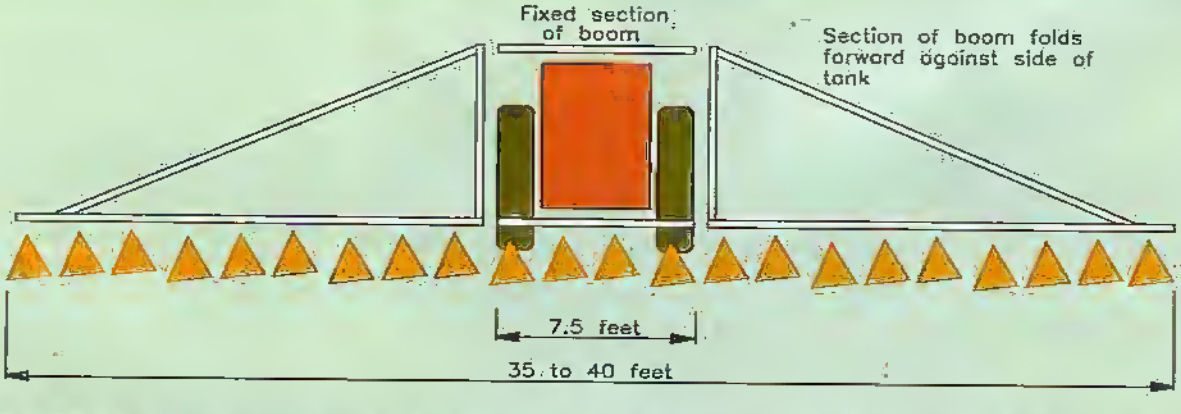



**Figure 3. Simplified sketch of a 'bean' sprayer with orchard spray gear replaced by a crop sprayer boom. When turning on headlands, spray was stopped by driver disengaging the tractor PTO shaft. High pressure was repaired to cause nozzles to produce fine spray droplets and this caused problems with spray drift.**

to transferring acid from rail tankers to road tankers and ultimately into the spraying machines. It was an extremely hazardous operation. Remarkably, the acid sprayers were originally designed to burn off areas of grass on airfields so that the burnt off areas appeared to German airmen as areas of ploughed fields!

However, by reducing the acid application rate to about 20 gallons/acre it was found that the acid sprayers gave a good selective control of many troublesome weeds in cereal crops. Later, the acid sprayers complemented the DNOC sprayers.

In 1943, PCL acquired five 500 gallon capacity orchard sprayers from the American Bean Sprayer Co. together with International Farmall M tractors to tow them, under the Lease Lend Arrangement. See Figure 2. Crops spraying was not a feature of American farming but orchard spraying was and the large orchard sprayers were ideal for conversion to crop sprayers by replacing the orchard spray gear with 30 – 45 feet wide spray booms. See Figure 3.

## Weed Population Explosion

Despite tremendous efforts of the small number of the crop sprayer crews during the war years, a weed population explosion occurred in 1945. Food production was dramatically reduced and rationing was even more severe than during the actual war years.

Ironically, plenty of food was available on the world market and it would have seemed logical to revert to traditional farming systems and resume food imports. But the country had no money to pay for imported food; all of our overseas reserves had been spent on the war effort and the country was virtually bankrupt. There was no alternative other than to extend the Emergency Food Production Plan and dramatically increase production of spraying machines and herbicides.

## Clones

In 1945, PCL started to make clones of the American Bean sprayers; this caused a confrontation with the American company who held the patent rights. But because spraying was a matter of national security the government turned a "blind eye" and the matter was eventually resolved through diplomacy.

Nonetheless, because of steel shortage, only a limited number of clones could be produced and they had to be deployed where they could be used at maximum efficiency; again the logical place was the flat land and large fields of East Anglia. Here, each sprayer was capable of treating up to 100 acres/day, but this taxed the operators to their limits.

On average, a 'Bean' sprayer with a 40 feet boom treated about 70 acres/day and used 7,000 gallons of water. Fortunately, ex army trucks, particularly AEC four wheel drive Matadors, were readily available and were fitted with 1000 gallon water tanks and 3in. Ransome Rapier pumps; these were used for drawing water from convenient streams and for re-filling the spraying machines.

Meanwhile, J W Chafer Ltd. had established a DNOC production plant at Doncaster and provided an extensive contract crop spraying service to farmers in the midlands and more northern parts of England. Nonetheless, even in 1950, when DNOC spraying reached its peak, the combined total number of sprayers in the whole of the country was probably less than 100 machines. The spraying period lasted only about two months and although the machines operated all daylight hours, the total acreage that could be treated was only a fraction of that becoming infested with weeds. Despite innovations, such as the self propelled sprayer – see Photo 4 – and machines with 60 feet wide booms, the weed problem continued to increase..

## Hazards

Until about 1950, the spray operators had little protection, the tractors did not have cabs so the drivers were exposed to spray drift. Even the support crews did not escape spray drift or being splashed with DNOC when refilling the machines. The result was that skin of every member of the spray

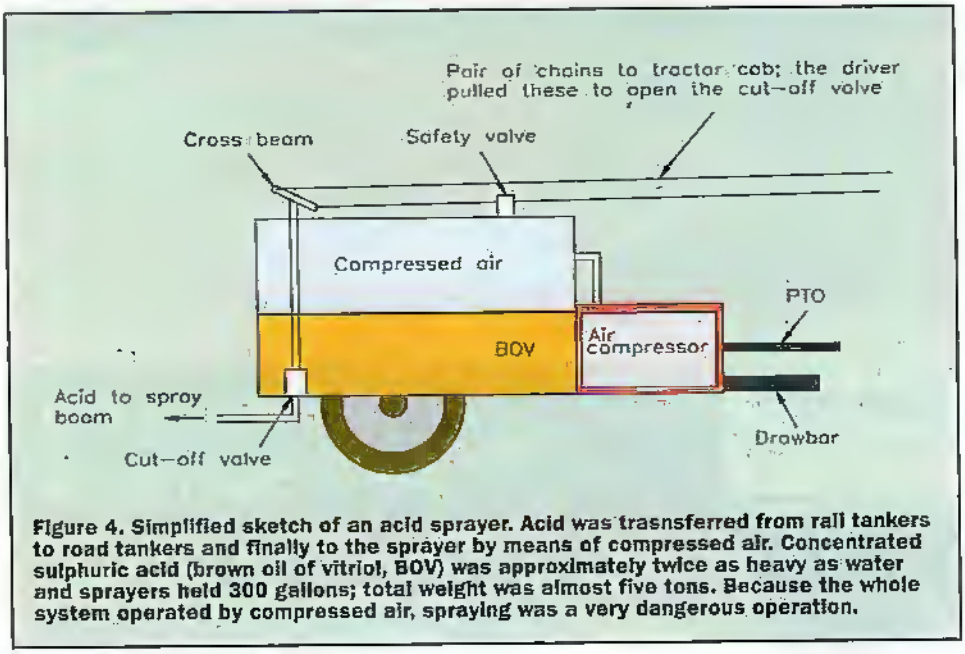



**Figure 4. Simplified sketch of an acid sprayer. Acid was trasnsferred from rail tankers to road tankers and finally to the sprayer by means of compressed air. Concentrated sulphuric acid (brown oil of vitriol, BOV) was approximately twice as heavy as water and sprayers held 300 gallons; total weight was almost five tons. Because the whole system operated by compressed air, spraying was a very dangerous operation.**

**Photo 3. Bean sprayer being towed by American Farmall 'M' tractor; Both tractor and sprayer are the same as when first used in 1943. The air filtered cab was not fitted until 1949. (Courtesy of ArgEvo UK Ltd.).**

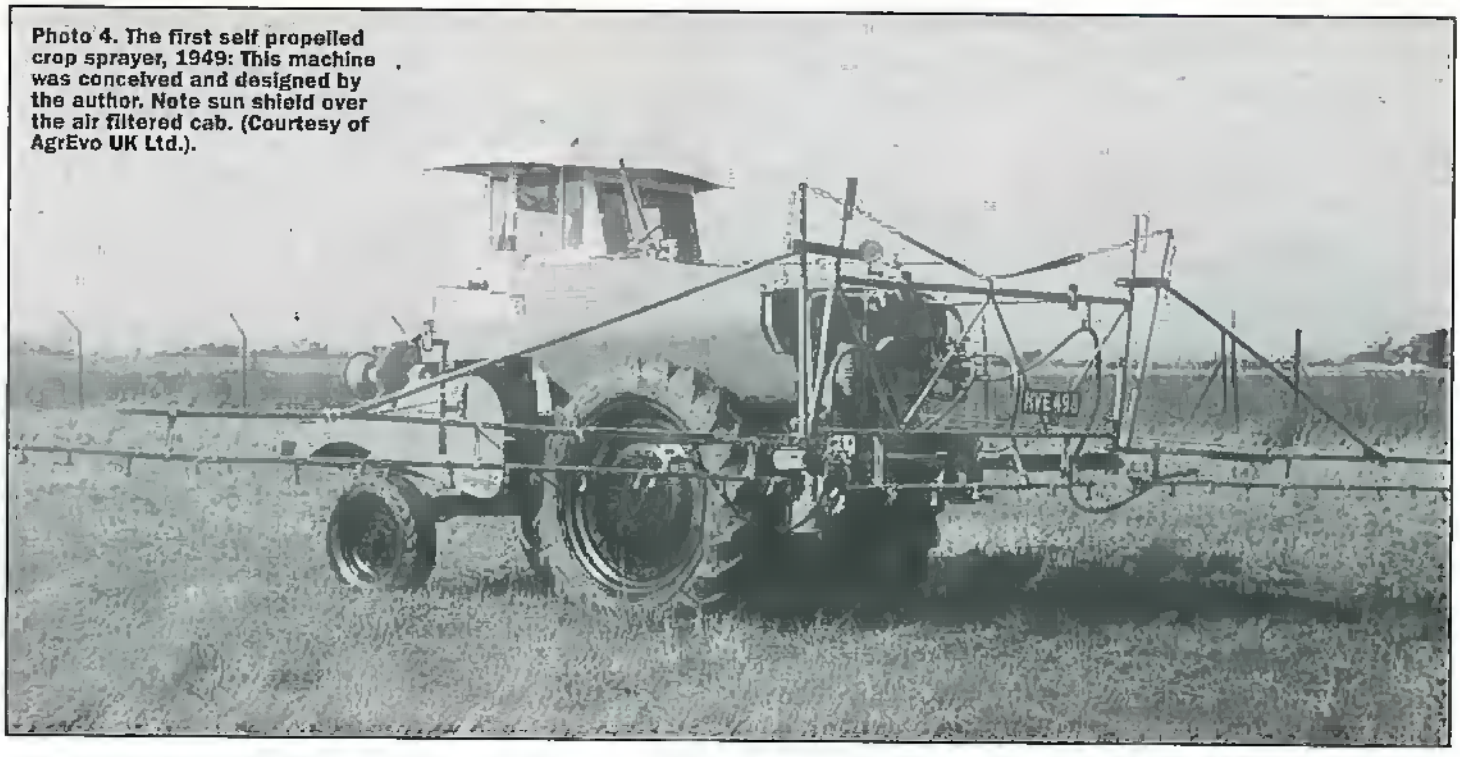


**Photo 4. The first self propelled crop sprayer, 1949: This machine was conceived and designed by the author. Note sun shield over the air filtered cab. (Courtesy of AgrEvo UK Ltd.).**

teams was stained deep yellow colour; they were often referred to as canaries and they caused great consternation amongst the public. Indeed, being itinerant workers, they terrified landladies when turning up at lodgings booked in advance by the company. PCL managers did not dare let the landladies first see their guests. Worse still, the DNOC was exuded during the night and this stained the bed sheets.

It is therefore not surprising that between 1945 and 1950 eight men died from DNOC poisoning. As a result, agricultural workers were for the first time brought within the Heath & Safety at Work Regulations; the tractors were then fitted with sealed cabs where air was drawn in through charcoal filters. See Photos 3 & 4.

In addition, spray crews were issued with freshly laundered snow-suits and in the presence of the supervisor were required to drink half a pint of milk and take a variety of vitamin pills before setting off to work.

DNOC was a powerful oxidising agent which literally oxidised the human body so to determine if this was happening to operators, their metabolic rate was checked every week by means of a Sanbora Metabolic Rate Calculator. Remarkably, French actresses were said to have taken DNOC as a slimming agent! Yellow cats, dogs, wildlife became a common sight in sprayed area and this caused great consternation. However, the fact that DNOC was highly toxic was lost sight of during those critical years when it was vital to maintain food production.

## Superseded

Fortunately, by the 1950's DNOC was being superseded by a new generation of systemic herbicides which were absorbed and transported via the sap stream throughout the weed. Hence their name. As complete

**Photo 5. New generation low-volume sprayer: 1000's of these machines were produced and ultimately won the war of weeds. (Courtesy of AgrEvo Ltd.).**

weed coverage was no longer necessary, the volume of spray could be reduced from 100 to about 20 gallons/acre. Moreover, as the newer herbicides were applied as a solution, the need for mechanical agitators in the sprayer tank was eliminated. Sprayer design was enormously simplified and this spawned a new generation of 'low volume' farmer-owned spraying machines; it was a classic example of a new chemical bringing about a revolution of crop spraying technology.

By now, materials for their manufacture were more readily available and thousands of sprayers were produced. Moreover, as the newer herbicides had relatively low toxicity, air filtered cabs were not considered necessary, see Photo 5.

To promote the use of the newer herbicides, PCL actually gave away a low-volume machine to any farmers who bought a certain amount of their product: this was vigorously opposed by the contracting departments but the end of the large contractor machines and the 'yellow men' was inevitable. Numerous farmer-owned machines enabled virtually all weed infested land to be sprayed, more or less at the optimum time, so at long last, the weed problem was brought under control.

**Photo 6. A modern trailed, computer-managed; compare with Photo 3. (Courtesy of Knight Farm Machinery Ltd.).**

## The Nations Appeal To Farmers

American aid was tapering off and exports fell short of what was required to pay for our imports. To economize on imported food Britain urgently needed to produce every ton of food our soil could produce and in 1950, the government launched a new slogan – "Plough for Plenty and do a Sterling Job" and now that the weed problem was mastered, farmers now had the means to meet this challenge.

More powerful tractors enabled a greater area of cereals to be planted at the optimum time. Crop rotations were no longer necessary so farmers could now grow the most needed, and usually the most profitable crops – especially grain – indefinitely under a virtual mono-culture regime.

However, the numerous small sprayers became obsolete and were replaced by fewer and larger machines which evolved into the highly sophisticated sprayers used today as shown Photo 6.

The outcome was that the country changed from being a net importer of food to a net exporter. Ironically, it also brought about food surpluses and ultimately taking land out of production under the set-aside scheme.

In part 2 we will look at organo-phosphorous insecticides.

# Diary Dates

Every possible effort has been made to ensure that information presented here is correct prior to publication. To avoid disappointment due to late changes or amendments, please contact event organisations to confirm details.

## October 1998

**12 to 13 Oct.** Practical Fieldbus and Device Network Protocols for Engineers, Bath. Tel: (0181) 335 4014.

**12 to 13 Oct.** Workshop on Practical Local Area Networks (LANs) for Engineers, London. Tel: (0161) 335 4014.

**12 to 14 Oct.** Second International Conference on the Detection of Abandoned Land Mines, Edinburgh, IEE. Tel: (0171) 240 1871.

**13 to 15 Oct.** Information Management 98, NEC, Birmingham. Tel: (0181) 742 2828.

**14 to 16 Oct.** Second International Conference on Partial Discharge, Edinburgh. Tel: (0171) 240 1871.

**15 Oct.** Medical Equipment Alarms: the Need, the Standards, the Evidence, Colloquium, Savoy Place, London, IEE. Tel: (0171) 240 1871.

**15 Oct.** Dark Side of the Internet, Colloquium, Savoy Place, London, IEE. Tel: (0171) 240 1871.

**15 to 16 Oct.** Practical Fieldbus and Device Network Protocols for Engineers, Birmingham. Tel: (0181) 335 4014.

**15 to 16 Oct.** Workshop on Practical Local Area Networks (LANs) for Engineers, Birmingham. Tel: (0161) 335 4014.

**19 to 20 Oct.** Practical Fieldbus and Device Network Protocols for Engineers, Manchester. Tel: (0181) 335 4014.

**19 to 20 Oct.** Workshop on Practical Local Area Networks (LANs) for Engineers, Newcastle. Tel: (0181) 335 4014.

**20 Oct.** Intelligent Control in Medical Applications, Colloquium, York, IEE. Tel: (0171) 240 1871.

**21 Oct.** Innovative Manufacturing Centre, Technical Visit, University of Nottingham, IEE. Tel: (0171) 240 1871.

**22 Oct.** Neural Networks in Interactive Multimedia Systems, Colloquium, Savoy Place, London, IEE. Tel: (0171) 240 1871.

**22 to 23 Oct.** Practical Fieldbus and Device Network Protocols for Engineers, Leeds. Tel: (0181) 335 4014.

**22 to 23 Oct.** Workshop on Practical Automation and Process Control Using Programmable Logic Controllers, London. Tel: (0181) 335 4014.

**23 Oct.** Update on Developments in Intelligent Control, Colloquium, Savoy Place, London, IEE. Tel: (0171) 240 1871.

**26 to 27 Oct.** Workshop on Practical Automation and Process Control Using Programmable Logic Controllers, Manchester. Tel: (0181) 335 4014.

**26 to 27, Oct.** Practical Fieldbus and Device Network Protocols for Engineers, Newcastle. Tel: (0181) 335 4014.

**29 to 30 Oct.** Workshop on Practical Automation and Process Control Using Programmable Logic Controllers, Glasgow. Tel: (0161) 335 4014.

## November 1998

**2 to 3 Nov.** Practical Digital Signal Processing (DSP) for Engineers, Glasgow. Tel: (0181) 335 4014.

**3 Nov.** Commercial Use of Software and Process, Metrics: Problems, Solutions and Experiences, Colloquium, Savoy Place, London, IEE. Tel: (0171) 240 1871.

**5 to 6 Nov.** Practical Digital Signal Processing (DSP) for Engineers, Newcastle. Tel: (0161) 335 4014.

**9 Nov.** Pressure and force Measurements: Sensor Technology and Applications Colloquium, Savoy Place, London, IEE. Tel: (0171) 240 1871.

**9 Nov.** Gilding Is a Mark of Quality?, Colloquium, Savoy Place, London, IEE. Tel: (0171) 240 1871.

**9 to 12 Nov.** Trends in Distribution Switchgear Conference, Commonwealth Institute, London, IEE. Tel: (0171) 240 1871.

**9 to 10 Nov.** Practical Digital Signal Processing (DSP) for Engineers, Leeds. Tel: (0181) 335 4014.

**10 Nov.** Optimisation in Control: Methods and Applications Colloquium, Savoy Place, London, IEE. Tel: (0171) 240 1871.

**10 to 12 Nov.** Fifth International Conference on Trends in Distribution Switchgear 400V to 145kV for Utilities and Private Networks, the Commonwealth Institute, London, IEE. Tel: (0171) 240 1871.

**11 Nov.** Alternative Teaching Methods, Colloquium, Savoy Place, London, IEE. Tel: (0171) 240 1871.

**12 to 13 Nov.** Practical Digital Signal Processing (DSP) for Engineers, Manchester. Tel: (0181) 335 4014.

**16 to 17 Nov.** Practical Digital Signal Processing (DSP) for Engineers, Birmingham. Tel: (0181) 335 4014.

**18 Nov.** Exploring Learning Technology: Issues for Educators and Trainers, Colloquium, Savoy Place, London, IEE. Tel: (0171) 240 1871.

**18 Nov.** Working Experiences in Europe, Colloquium, University of Sheffield, IEE. Tel: (0171) 240 1871.

**Please send details of events for inclusion in 'Diary Dates' to: News Editor, *Electronics and Beyond*, P.O. Box 777, Rayleigh, Essex SS6 8LU or e-mail to swaddington@cix.compulink.co.uk.**

# What's On?

## 3Com Predicts Converged Network Future

30% of companies will be taking advantage of converged data, video and voice networks by the millennium. Eric Benhamou, 3Com chairman and CEO made this claim during a recent keynote address at the Enterprise conference in San Francisco.

"This convergence of networks will generate up to £6 billion in annual savings that can be reinvested in customer service, new business opportunities and new technologies," said Benhamou.

According to Benhamou, most corporate enterprises employ multiple network infrastructures to support applications, including voice, video and data transmissions. By converging and integrating the parallel networks, corporations will be able to substantially reduce communications, operations and network management expenses.

3Com, a leader in developing and implementing next-generation networking technology, recently estimated the global market for capital equipment to enable convergence technology in the enterprise to be £9 to 12 billion a year by 2003.

A typical enterprise could potentially reduce its long distance telephone expense by 30% to 50% by placing its voice traffic on the data network.

"The technologies used to build data networks are now far more sophisticated and better adapted to handle multiple types of communications, including voice," said Benhamou. "We have added intelligence to our data networks – not just in the core, but also in the access infrastructure and at the network access points – to handle multiple classes of service over a common TCP/IP-based protocol infrastructure."

The trend toward network convergence is accelerating the strategic alignment of telecommunications vendors and data networking companies. This close working relationship will yield more coherent architectures supporting converged network services across the enterprise, small business, and consumer markets.

Network convergence will also lead to the development of more integrated networked applications. Benhamou predicted new uses and efficiencies for many industries, include retail, finance and education.

"Among other emerging applications, network convergence will enable distance learning to deliver real time video, voice and instructional text from a classroom to a remote student, and even allow collaboration on a virtual white board," said Benhamou.

For further details, check: <www.3com.com>.

Contact: 3Com, Tel: (0118) 9228200.

## Keynote Speaker Announced for Voice Europe Conference

VOICE Europe 98 Europe's leading conference and exhibition dedicated to computer telephony and voice technologies has announced its keynote speaker for this year's conference programme will be voice over IP pioneer Jeff Pulver. The conference will take place alongside the main VOICE Europe 98 exhibition at Olympia, London from 19 to 22 October.

Entitled Internet Telephony Solutions for the Enterprise, Pulver's sessions will be the first major workshops to focus on specific implementation solutions for enterprises that use IP technologies.

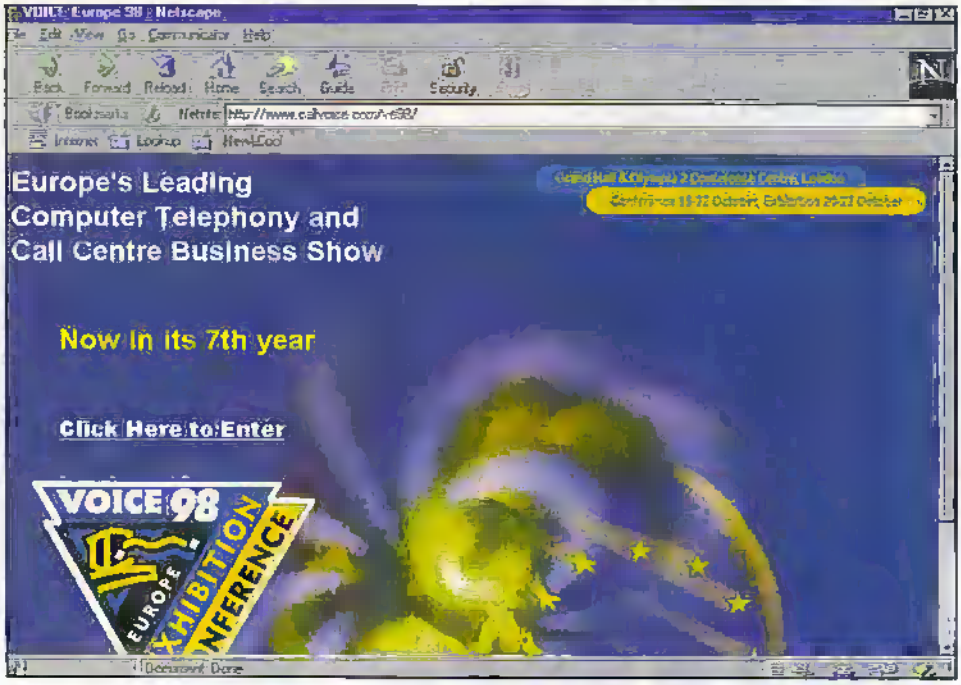
Aimed at high level data networking professionals with telecom responsibilities, it will encourage delegates to take a long hard look at Internet telephony and applications that will make IP voice the killer application for the Enterprise during 1999. Other topics to be discussed include voice over IP basics, key terms, its uses, product demonstrations, case studies and other applications.

Jeff Pulver is president of Internet based consulting firm Pulver.com. He is also the chairman of the Voice on the Net (VON) Coalition and in December 1997 was named one of the top 10 people to watch by Telephony Magazine. Pulver.com publishes Internet technology related research and provides consulting services to the telecommunications, financial services and radio/TV industries.

VOICE Europe 98 is Europe's leading exhibition and conference dedicated to computer telephony. Now in its 7th year, VOICE Europe attracted 7,365 visitors to the 1997 event, an increase of 15% on the previous year's show. With more than 200 exhibitors showing products and services for the corporate market, this year's event will focus on computer telephony, call centres, Internet telephony and speech technologies. The VOICE Europe conference and exhibition will be held at the Grand and West Halls, Olympia, London between 19 to 22 October 1998.

For further details, check: <www.callvoice.com/ve98>.

Contact: Voice Europe, Tel: (01244) 378888.




sensational or dramatic about this and I certainly do not intend to become a doom-monger, but we are now at the 11th hour and averting a potential disaster is what we must achieve."

Professor Mike Smith said, "The NHS has tried hard to come to terms with the Year 2000 problem, but the size and scope of it is so massive that it needs vast resourcing to deal with it effectively. The NHS does not have the know-how or the resources to deal with this problem alone – and the disturbing thing is that we are in the lead internationally. The results of this situation could well be disastrous for many families up and down the country."

The millennium bomb is a legacy of the early computer industry when years were stored by just two digits, so 1997 becomes 97. But this means that computers will be unable to distinguish between 1900 and 2000 as both years would be stored as 00. As a result appliances as diverse as microwaves and washing machines, as well as computers, run the risk of failing when

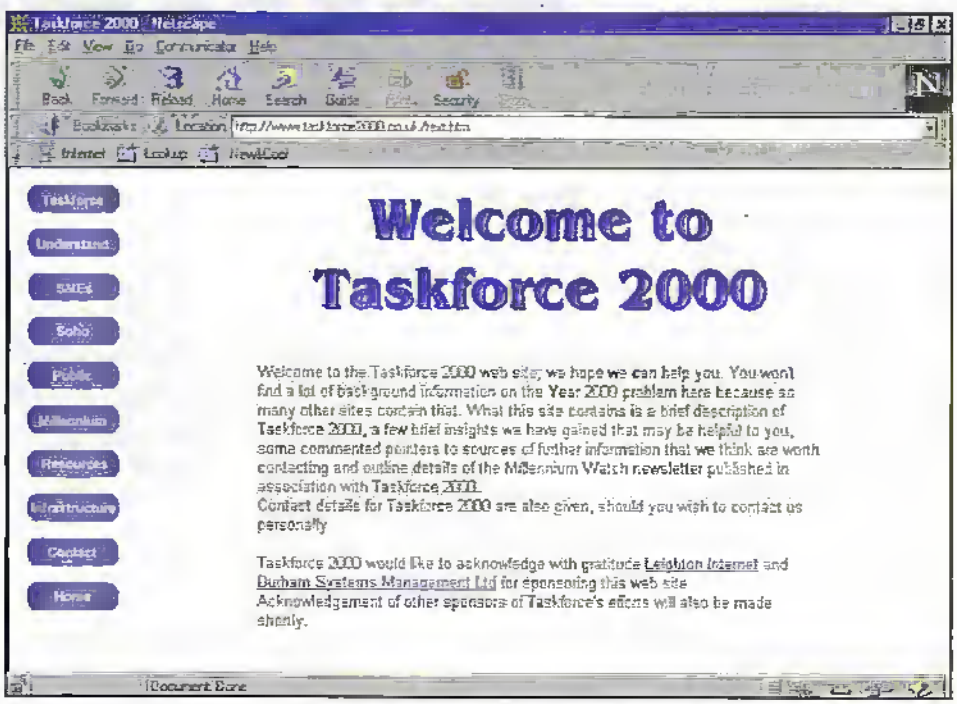
## NHS Will Suffer Millennium Bug Difficulties

500 days and counting to the turn of the new century. Taskforce 2000 this month unveiled a study of National Health Service (NHS) attitudes to the 'Millennium Bomb' undertaken by Professor Mike Smith from the Department of General Practice and Primary Care, St Bartholomew's and the Royal London School of Medicine and Dentistry.

The study demonstrates that recent Government announcements about the readiness of the NHS to tackle the 'Millennium Bomb' are either astonishingly complacent or show a total misunderstanding of the scale of the problem, according to Robin Guenier, executive director of Taskforce 2000.

This analysis is supported by the content of a recent letter from Alan Langland, chief executive of the NHS, in which he warns, "The Year 2000 problem could cause serious disruption to NHS organisations and ultimately patients. In extreme circumstances, failure or malfunction of equipment could be life-threatening."

Robin Guenier said, "We have been urging the Government for some time now to listen to our warnings about how far




behind schedule the public sector is. The National Health Service faces massive problems and doesn't have the money to deal with them. I do not wish to be

midnight strikes on December 31 1999.

For further details, check: <www.taskfoce2000.com>.

Contact: Taskforce 2000, Tel: (0171) 562 7650.

# PROJECT

# Light OPERATED SWITCH

*Gavin Cheeseman describes a simple, but versatile project for the home.*

## Introduction

For some time now, automation of equipment within the home has been commonplace. We set our video recorders to record when we are out, our washing machines are happy to go through their wash cycle while we are tucked up in bed and so on. In order to keep up with the requirement for more comprehensive control systems, technology is constantly changing. For the electronics enthusiast, who may not be familiar with the latest generation of microcontrollers, it can appear that there is little that isn't already available off the shelf. However, basic control circuits are still as useful as they always were and can still be enjoyable to construct. Such circuits may not have all the frills of commercial units but nevertheless can provide a simple and often cheaper solution.

This article describes a simple circuit with a relay output that changes state when exposed to a predetermined level of light. At first this concept may seem too simple, almost to the extent that it hardly deserves a mention. However, this type of device can be put to many uses in and around the home both on its own and in combination with other apparatus. The circuit doesn't require any special PCB, is easy to construct and if built correctly, should give reliable performance.

## The Circuit

Referring to Figure 1, it may be seen that the circuit is based around IC1, the ubiquitous LM311 comparator. This is a relatively low cost device which provides good performance and unlike some comparators operates well from a single rail power supply. The operation of the circuit is as follows:

The power supply is applied between P1 (+V) and P2 (0V). Diode D1 is included for reverse polarity protection, helping to prevent damage to the circuit if the power supply is accidentally reversed. Supply rail decoupling is provided by capacitors C1 and C2. C1 performs general supply filtering whereas C2 is specifically intended to remove high frequency noise that may otherwise adversely affect the operation of IC1. The sensor used to detect the ambient light level is LR1, a Light Dependant Resistor or LDR. The resistance of LR1 is directly related to the level of light falling on the sensor. In the dark, the resistance of the device is very high but when exposed to light this value drops significantly. LR1 is connected in series with R1, VR1 and R2 forming a potential divider. This results in a varying voltage at IC1 pin 3 which is heavily dependant on the level of light incident on LR1. The more light the sensor is exposed to, the higher the voltage present at pin 3. Pre-set variable resistor VR1 allows the standing voltage at IC1 pin 3 to be adjusted, thereby allowing the sensitivity of the circuit to be varied to suit different applications. Resistors R3 and R4 set the switching threshold voltage of IC1 to approximately half the supply voltage. When the input voltage at IC1 pin 3 is above this threshold the output at pin 7 is in a low state. Conversely, when the input voltage is below the switching threshold, the output is high. R5 provides some positive feedback, giving the circuit a degree of hysteresis. Without this, the output of the IC would tend to 'chatter' when the voltage at pin 3 is around the switching threshold. Changes in the supply rail voltage due to the IC output switching,

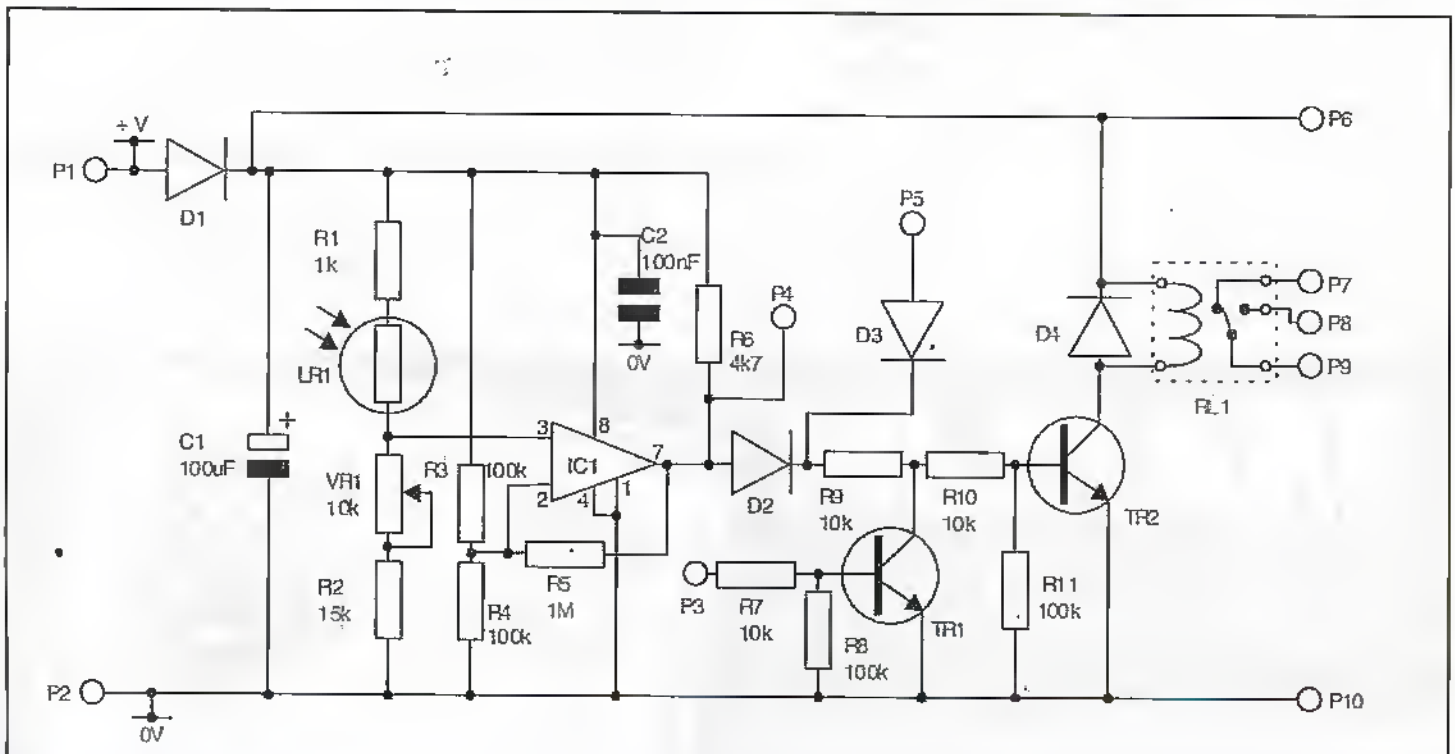
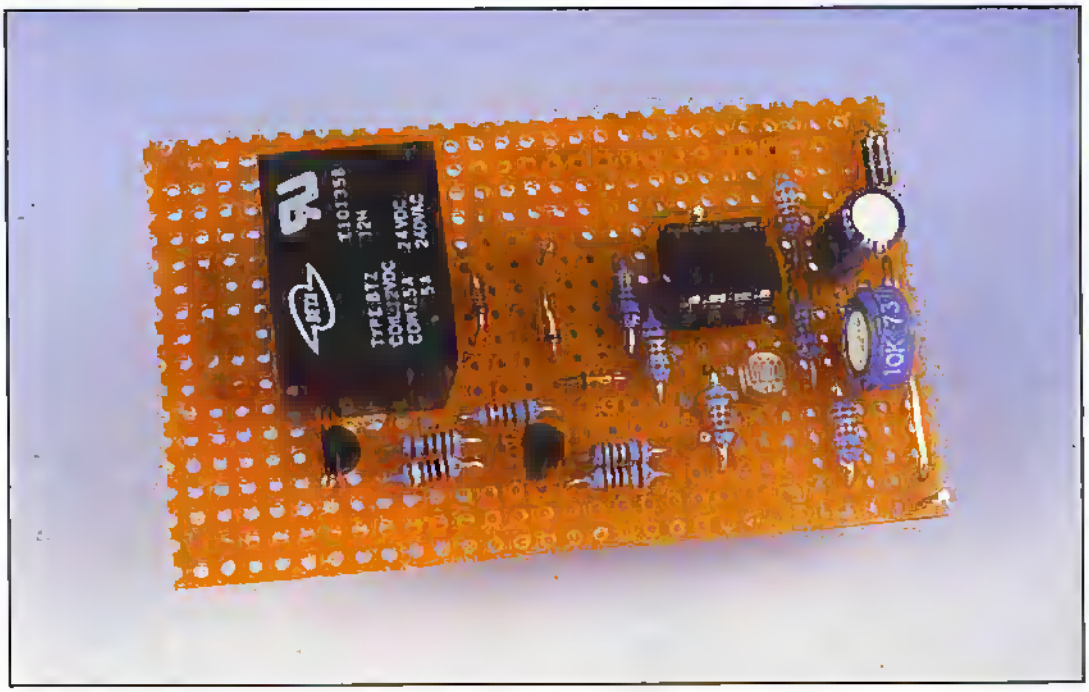



**Figure 1. Circuit Diagram.**



although quite small, can vary the input voltage enough to cause the output of the device to revert to its previous state. This effectively sets up a kind of oscillation. The inclusion of R5 makes sure that when the output of IC1 changes state, the reference voltage at IC1 pin 2 is slightly altered in the direction of the output. This ensures that any slight change in the supply voltage is not enough to cause the device to switch back to its previous state. As a result of this arrangement, the light level required to switch IC1 pin 7 from high to low is slightly different to that required to switch from low to high. In practice this does not normally present a problem.

The output of IC1 is effectively open collector and is pulled up by R6. For some applications it may be possible to switch loads directly from the IC and terminal P4 is provided to this end. This terminal also provides a useful test point if fault finding is necessary.

IC1 pin 7 is connected via a network of resistors and diodes to the base of transistor TR2. Resistors R9 and R10 serve to limit the base current to an acceptable level. R11 ensures that the transistor switches off properly. When the output of IC1 is in a low state, TR2 is turned off and relay RL1 is inactive. If IC1 pin 7 switches high, current flows in the base of TR2 and the transistor switches on energising the relay coil. Diode D4 helps to protect TR2 from transient voltage spikes produced when RL1 switches.

It is possible to override the automatic operation of the circuit via terminals P3 and P5. P3 is effectively an output inhibit line. Applying a logic high to P3 results in transistor TR1 turning on, holding the base of TR2 low and preventing RL1 from being energised. R7 limits the current to the base of TR1 whereas R8 helps to ensure the transistor switches off fully. Applying a high condition to P5 has the opposite effect, ensuring that TR2 is switched on even if the output of IC1 is low. Diode D2 prevents IC1 pin 7 being pulled high with P5 which could otherwise result in damage to the IC. It is worth noting that a high input at P3 overrides both the output of IC1 and the output enable line at P5.

Terminals P6 – P10 bring out the normally open, normally closed and common contacts of RL1 as well as providing a separate set of power supply pins to allow easy connection of loads to the relay output. The intention is to make the circuit as versatile as possible to allow for different output requirements. It should be noted that P6 is not connected directly to +V but is taken from the cathode of D1. This is to provide a degree of reverse polarity protection for the low current loads which may be connected to P6.

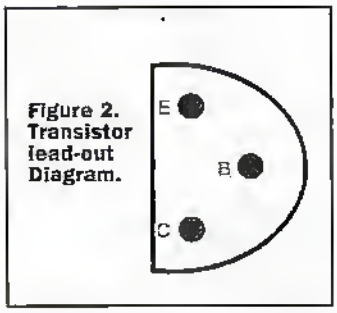



**Figure 2. Transistor lead-out Diagram.**

## Constructing the Light Operated Switch

As mentioned, the Light Operated Switch is a relatively simple circuit and does not use high frequency oscillators or very high impedances. Therefore, the component layout is not particularly critical and the circuit can be built on matrix board with or without copper strips.

As with all circuits there are some points to look out for during construction. It is recommended that a DIL socket is used for IC1. This prevents possible damage to IC1 due to soldering and can make life easier if it is ever necessary to replace the IC. Pay attention to component polarities where applicable as components fitted incorrectly will, at the very least, not function properly and may even explode. The polarity of the IC is indicated by a notch at one end of the device. The diodes are marked with a band at one end indicating the cathode. Transistor lead-out information is shown in Figure 2. The electrolytic capacitors are polarised. The negative lead of the capacitor is usually marked by a negative symbol on one side of the component case and is normally the shortest of the two leads. LR1, C2 and all of the resistors are not polarised and therefore may be fitted either way round. When fitting C2, try to connect the capacitor as close as possible to the power supply pins of IC1 (pins 8 and 4). This helps to ensure that the component is effective in reducing any high frequency noise on the supply rail that may impair the clean switching action of the IC. For the same reason, it is best to run a separate supply line to the coil of RL1 joining as close to D1 as possible. C1 should be connected immediately after D1 as shown in the circuit diagram. The photo gives an idea of the type of layout that can be used for the circuit based on using standard matrix board without copper strips. 26 SWG bare tinned copper wire may be used to make connections

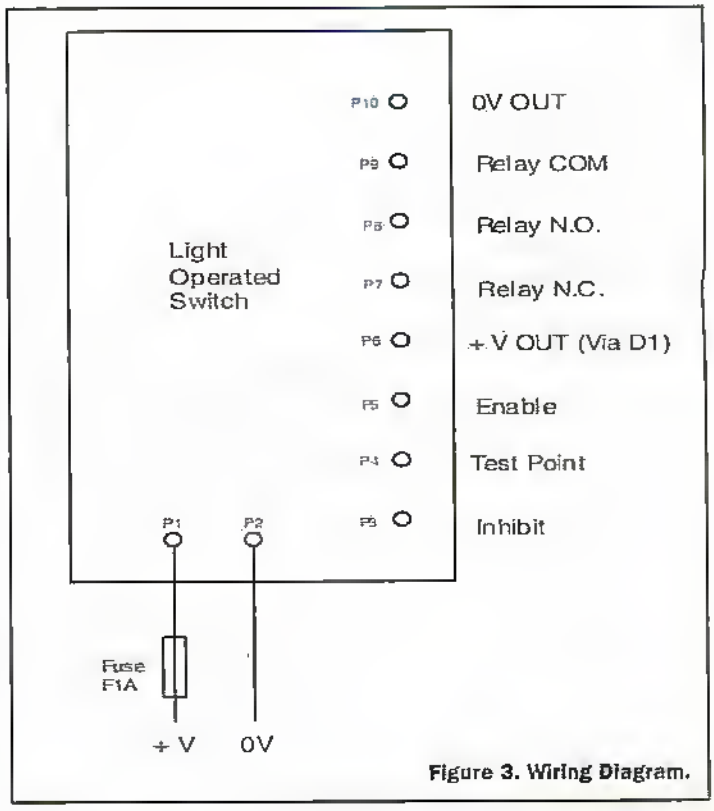



**Figure 3. Wiring Diagram.**

between the components but it is recommended that 20 SWG wire is used for the supply rails to provide a good low impedance path. If you decide to use strip board instead, it may be an idea to solder a piece of tinned copper wire in parallel with the supply rails to reduce the overall impedance of the line and increase the current handling capability of the tracks.

When you have finished constructing the board double check that the components are connected correctly and that the soldering is OK.

Figure 3 shows the wiring diagram for the unit. Connect the power supply between P1 (+V) and P2 (0V). Don't forget to fit the correct fuse in series with the +V supply rail as this can limit the amount of damage if there is an error or fault in the circuit. The fuse can be mounted in several different ways. A PCB mounting fuse holder such as stock code KU29G can be attached to the matrix board or a chassis mounting holder (stock code KC01B) can be fixed to the inside of the case. Alternatively an in-line fuse holder such as stock code (DR79L) can be used. The rating of the fuse is shown as 1A as this is normally the maximum current drain if a load is being switched to P6. However, if you are using a lower current power supply you may wish to reduce the fuse value in line with the power supply output current rating.

Depending on the type of load you are switching, you may also wish to fit a fuse in series with the relay contacts. The type and rating of the fuse will be determined by the current levels in the circuit being switched. Of course some devices will already have their own fuse.

## Testing the Completed Board

It is best to test the operation of the circuit before installing it into a case. The circuit is designed to operate from a nominal power supply voltage of 12V. The current consumption of the circuit is just a few mA and the unit can be powered from an off the shelf regulated adaptor such as stock code MG81C (maximum current 400mA) if you do not intend to drive high current loads from the same power supply.

To test the circuit you will need some method of indicating the output state of RL1. A multimeter set to the resistance or continuity range is ideal but if you do not have one of these you can use a 12V lamp or LED as shown in Figure 4. Before applying power to the circuit set VR1 to the centre of its travel using a small screwdriver or trim tool.

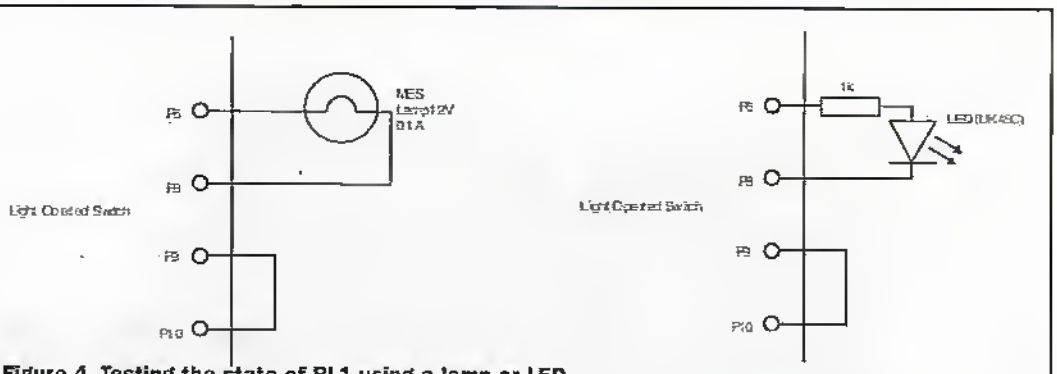



**Figure 4. Testing the state of RL1 using a lamp or LED.**

Switch on the power and observe the state of RL1. If the circuit is exposed to relatively bright light, the relay should be inactive. Under these conditions terminal P7 should be connected to P9 through the relay and P8 should be open circuit. If you are using the test circuit, the lamp should not light. You may wish to check the output at terminal P4 using a multimeter set to the voltage range or an oscilloscope. P4 should pull low when light is falling on LR1. Cover the LDR so that it is no longer exposed to light. The circuit should then switch states and you should hear a click from the relay as it is energised. This time P8 should be connected to P9 by the relay and P7 should be disconnected. If you are using the test circuit the lamp should now be illuminated. If all is well, try adjusting VR1 to a different setting. This should change the sensitivity of the circuit resulting in the relay switching at different light levels.

It should be possible to manually override the circuit by connecting P3 or P5 to +V. This can be tested as follows: Expose LR1 to light such that the relay is switched off. Temporarily connect P5 to P6(+V). This should force the relay to switch on. Remove the connection between P5 and P6 and the relay should return to the off condition. Now cover LR1 so that the relay switches on. This time, briefly connect P3 to P6 (+V). Whilst the connection is in place, RL1 should switch to the off state. Once testing is complete, don't forget to remove the temporary connections and test circuit.

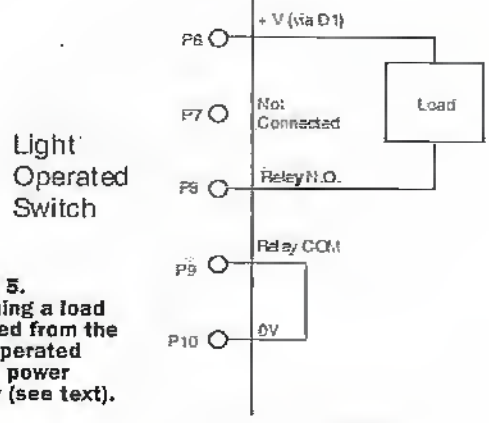



**Figure 5. Switching a load powered from the light operated switch power supply (see text).**

## Housing the Light Operated Switch

How you decide to house the unit will depend wholly on your application. There are several points to consider. You may be using the device to control another circuit that already has enough room in its case for the Light Operated Switch board. You also need to think about the environment where the unit is going to be housed. The circuitry must not be exposed to moisture or extremes of temperature as this will, at the very least, adversely affect the circuit and may result in corrosion or be hazardous.

Whatever your application, it will be necessary to ensure that sufficient light can fall on the LDR sensor, otherwise the circuit clearly will not operate. It is normally sufficient to drill a hole in the case above LR1. One advantage with constructing the circuit on matrix board is that, if you choose the case before starting, it is possible to plan the component layout to fit the case rather than having to find a case to fit a fixed PCB size. For general purpose use, where the circuit is not exposed to environmental extremes the

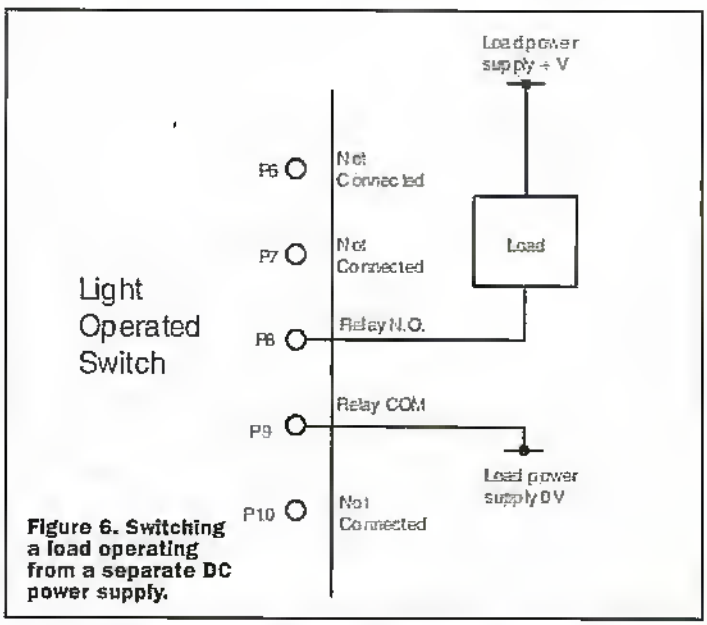



**Figure 6. Switching a load operating from a separate DC power supply.**

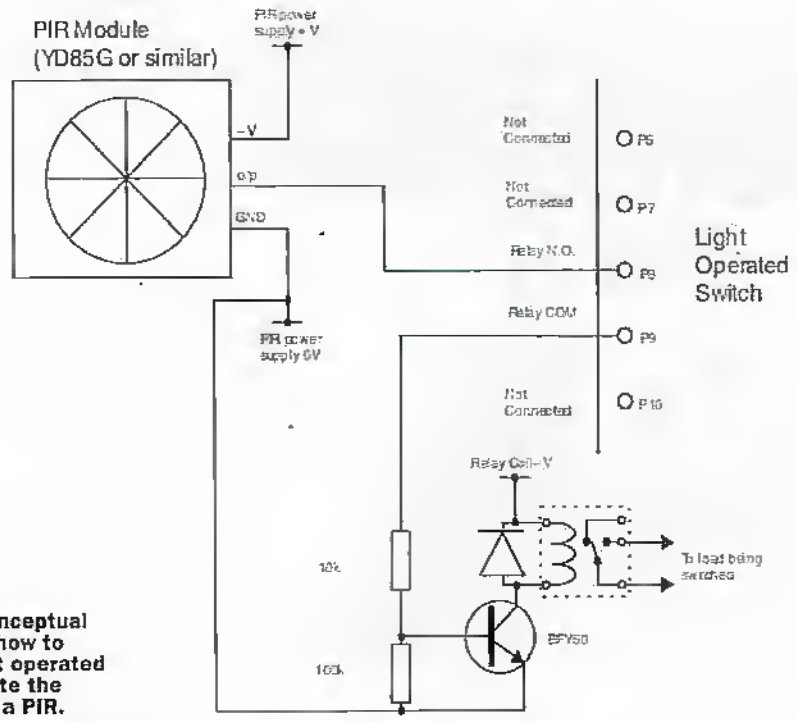



**Figure 7. Conceptual example of how to use the light operated switch to gate the output from a PIR.**

unit may be housed in a small plastic case such as stock code LH20W. An alternative is to use a case which is transparent to light such as stock code YU94C. It should be noted that because this box is made from smoked plastic the response of the circuit will be modified. This can be compensated for and should not present a serious problem.

## Applications

The Light Operated switch lends itself to a wide range of applications so when using the unit you need to consider the voltage and current levels that you intend to switch. For low current 12V applications you can derive the +V power supply from terminal P6 as shown in Figure 5. The maximum current including the current drain of the Light Operated Switch circuit should not exceed 1A.

**When powering the light operated switch from a power supply with a maximum current output rating of less than 1A do not exceed the maximum rating of the power supply.**

Figure 6 shows how to connect a load derived from a separate supply. In this case the maximum current is determined by the relay contact rating circuit wiring.

Probably the most obvious use for the unit is to automatically switch on lighting during darkness and to switch it off in daylight. Theoretically, there is no reason why the output from the device cannot be used directly for this purpose subject to the maximum current and voltage specifications of the relay. However, lighting apparatus often operates from the 230V mains supply and can therefore present an electric shock hazard. For safety reasons, it is recommended that you do not attempt to directly switch voltages in excess of 50V. One of the reasons for this is that the insulation resistance and dielectric strength characteristics of matrix boards may vary with composition, rendering the material unsuitable. To avoid this problem, the unit may be used to drive an off-board relay which is suitable for switching high voltages.

When used to switch voltages in excess of 50V, the installation must be constructed to comply with current European safety legislation. Readers who are not fully familiar with the requirements of the relevant safety standards are advised to consult a qualified engineer for advice before proceeding.

The Light Operated Switch may also be used in combination with other control equipment. An example of this is use with a passive infrared detector or PIR. These are commonly used to switch on lighting when someone enters the detection area. Normally the lighting is only required to operate during hours of darkness and continued operation during daylight it results in an unnecessary waste of power. The Light Operated Switch may be used to gate the output from the PIR in such a way that the lighting is no longer triggered in daylight. This is illustrated in Figure 7.

You may also wish to consider using the Light Operated Switch in combination with more complex control systems, connected to the input of a microprocessor. It will be necessary to ensure that the voltage levels are compatible to avoid possible damage to the control system.

## Modifications to the Circuit

Under some circumstances, it may be necessary or advantageous to modify the circuit to suit a specific use. For example, if you are using the circuit in low voltage low current applications, it is possible to take the output drive directly from the collector of TR2. This can result in a lower current drain but care must be taken not to exceed the maximum voltage and current ratings for the transistor. If you do not need to use the enable and inhibit terminals, and you are driving a high impedance input, it is also possible to use the output at P4. In this case, D2 – D4, R7 – R11, TR1, TR2 and RL1 may all be omitted resulting in a considerable reduction in operating current.

It is possible that the circuit may not switch at the most appropriate point for some applications. For example, you may wish the relay to switch when the LDR is exposed to a very small amount of light and the required switching point may be outside the range of VR1. In this case, it is possible to modify the point at which the circuit switches by changing the values of R1, R2 or VR1. For example, increasing the value of R2 should result in the relay switching off at a lower light level. It is recommended that the values are not reduced below 100W.

As mentioned the circuit has a degree of hysteresis. If you wish you can increase the difference between the switch-on and switch-off thresholds by slightly reducing the value of R5.

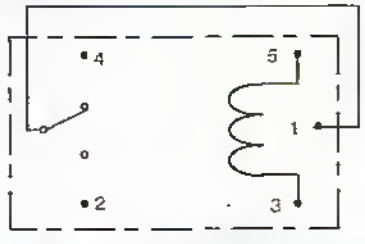



**Figure 8. JM18U 12V/5A relay pin arrangement, viewed from below.**

## PROJECT PARTS LIST

| | | | |
|---|---|---|---|
| **RESISTORS** | | | |
| R1 | Min Res 1k | 1 | M1K |
| R2 | Min Res 15k | 1 | M15K |
| R3, 4, 8, 11 | Min Res 100k | 4 | M100K |
| R5 | Min Res1M | 1 | M1M |
| R6 | Min Res 4k7 | 1 | M4K7 |
| R7, 9, 10 | Min Res 10k | 3 | M10K |
| VR1 | Vit Encl Preset 10k | 1 | UH16S |
| LR1 | LDR 11k | 1 | AZ81C |
| **CAPACITORS** | | | |
| C1 | Genelect 100µF 16V | 1 | AT40T |
| C2 | Minidisc 0.1µF 16V | 1 | YR75S |
| **SEMICONDUCTORS** | | | |
| TR1, TR2 | BC548 | 2 | QB73Q |
| D1 | 1N4001 | 1 | QL73Q |
| D2 – D4 | 1N4148 | 3 | QL80B |
| **MISCELLANEOUS** | | | |
| P1 – P10 | Pin 2145 | 10 pins | FL24B |
| RL1 | 12V/5A Min Relay | 1 | JM18U |
| | 8 Pin DIL Socket | 1 | BL17T |
| | Matrix Board | | |
| | Fuse See Text | | |

Approximate cost: £9.50

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**ARS** (Aberdeen Amateur Radio Society) meets on Friday evenings in the RC Hall, 70 Cairngorm Crescent, Kincorth. For details contact: Martin, (CM0JCN), Tel (01569) 731177.

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**Bury St. Edmunds Amateur Radio Society.** Meetings held at Culford School, 7.30pm for 8.00pm on the third Tuesday of each month, unless otherwise stated. Further details from Kevin Waterson, (G1GVI), 20 Cadogan Road, Bury St. Edmunds, Suffolk IP33 3QJ. Tel: (01284) 764804.

**Crystal Palace and District Radio Society** meets on the third Saturday of each month at All Saints Church Parish Rooms, Beulah Hill, London SE19. Details from Wilf Taylor, (G3DSC), Tel: (0181) 699 5732.

**Derby and District Amateur Radio Society** meets every Wednesday at 7.30pm, at 119 Green Lane, Derby. Further details from: Richard Buckby, (G3VGW), 20 Eden Bank, Ambergate DE56 2GG. Tel: (01773) 852475.

**Electronic Organ Constructor's Society.** Details of programme magazine and membership from: Don Bray (Hon. Sec.), 34 Etherton Way, Seaford, Sussex BN25 3QB. Tel: (01323) 894909.

**E.U.G.** User group for all 8-bit Acorn Micros, since 1991. Still going strong. Programming, news, information, sales. Contact: E.U.G., 25 Bertie Road, Southsea, Hants. PO4 8JX. Tel: (01705) 781168.

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**SEEMUG** (South East Essex Mac User Group), meet in Southend, every second Monday of each month. For details Tel: Michael Foy (01702) 468062, or e-mail to mac@mikefoy.decon.co.uk.

**Southend and District Radio Society** meets at the Druid Venture Scout Centre, Southend, Essex every Thursday at 8pm. For further details, contact: P.O. Box 88, Rayleigh, Essex SS6 8NZ.

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**Wakefield and District Radio Society** meet at 8pm on Tuesdays at the Community Centre, Prospect Road, Ossett, West Yorkshire. Novice, Morse & R.A.E. tuition. Well equipped station, library and licensed bar. Further details from Ian Roberts MOBFO, Tel: (01924 216502.

**The (Wigan) Douglas Valley Amateur Radio Society** meets on the first and third Thursdays of the month from 8.00pm at the Wigan Sea Cadet HQ, Training Ship Sceptre, Brookhouse Terrace, off Warrington Lane, Wigan. Contact: D. Snape, (G4GWG), Tel: (01942) 211397 (Wigan).

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# RESEARCH NEWS

by Dr. Chris Lavers

## Designing Digital Audio Broadcasting Chips for the New Millennium

Philips Research in Holland are racing to design and develop single-chip systems for the reception of Digital Audio Broadcasts (DAB) and multimedia broadcasts from satellite and terrestrial sources for installation in their consumer products. Their latest chip is mixed analogue/digital and is based on an Orthogonal Frequency Division Multiplexed (OFDM) modulation scheme, performing all the necessary signal processing required to demodulate and decode all likely data streams. The challenge is to develop single chip operator systems, meeting the demands of both portability and size reduction, which require innovative solutions for power saving and the ability to distribute power from one supply to different parts of the designed chip (power sharing). The only disadvantage of such a passive power distribution architecture is that supply failure leads to total system failure or what is commonly referred to as 'catastrophic failure'.

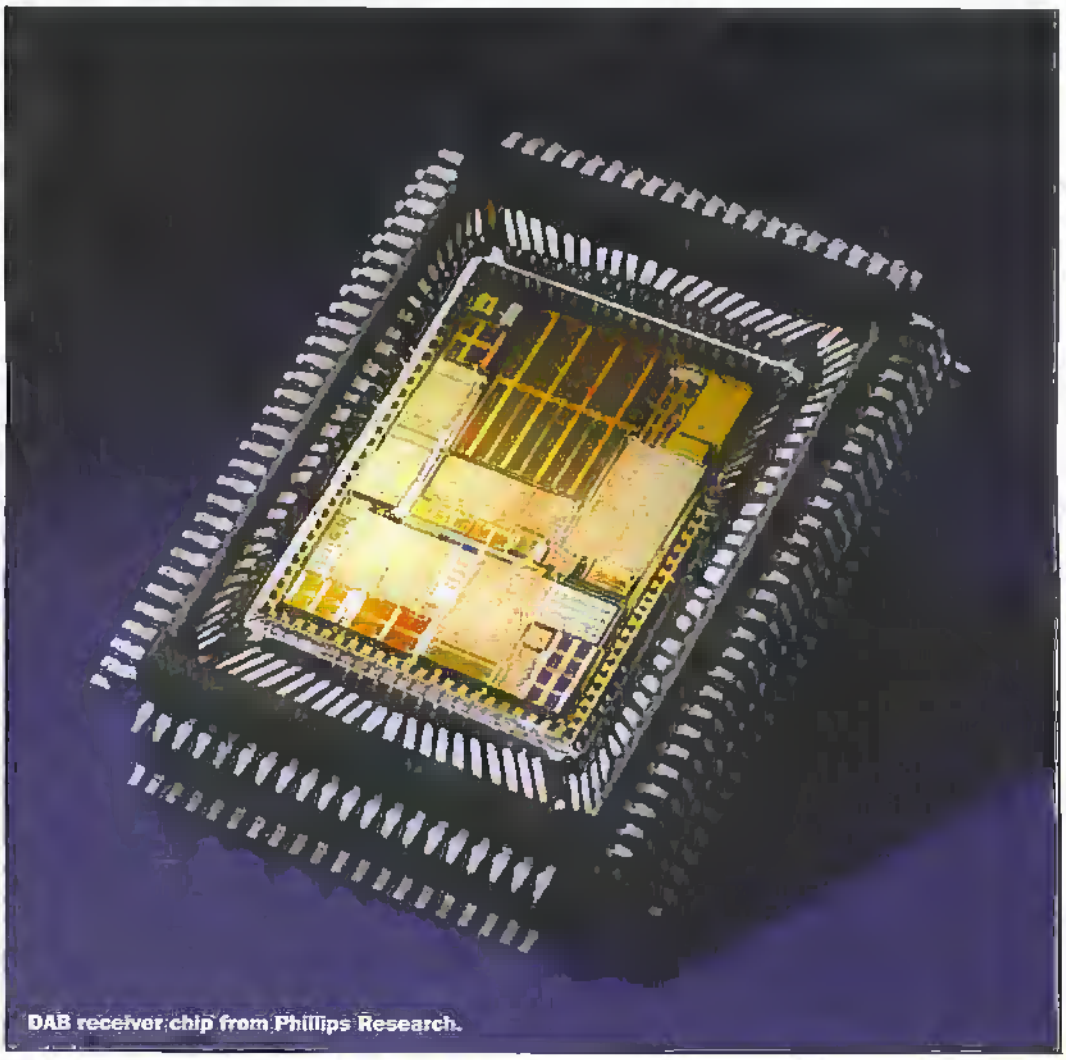
The Philips chip contains a remarkable 4,500,000 transistors and is made with a state-of-the-art 0.5μm, three layer metallisation process which when compared alongside its competitors' circuit designs is currently not only the smallest but also has the lowest power dissipation, (only 150mW with 2.2V applied voltage)! The so called DABchip has a receiver area of 127mm² and has already been implemented in car radio receivers allowing the operation of interference-free, CD quality reception of sound in several European countries.

Philips Research scientists have also designed a synchronised Integrated Chip (IC), one of the elements necessary for an integrated television receiver for the terrestrial reception of digital video broadcasts, something that will be standard practice within the UK by 2010. This receiver has been developed by a collaboration between Philips and its partners in the European Community under the involved project title of 'Digital Video Broadcasting Integrated Receiver Decoder' (DVBIRD)! At the present moment, the television receiver consists of four 0.5μm CMOS chips, of which the OFDM demodulation chip is a part. In the near future Philips researchers say that it will be possible to use their latest 0.25μm research fabrication process which will allow the integration of all the necessary DVBIRD chips (four in total) into one IC with a total combined area of less than 1cm²!

**For further information contact:**
Dr Marianne Vincken
E-mail: vincken@natlabl.research.philips.com

## Science R&D gets a Wellcome Boost!

A cash 'injection' of £1.1 billion for Britain's engineering and scientific community was announced recently by the Government in a new partnership with the Wellcome Trust, the world's largest research charity. The combined investment of £700m from the Government between 1999 and 2002 and a further £400m from the Wellcome Trust will help to keep Britain at the forefront of the biomolecular technology revolution which it has helped to create. The money will continue the upgrading of university laboratories involved in molecular science projects and the now almost routine unravelling of genetic codes. The money will pay for new life science projects in the main but also for a new high intensity X-ray source for genetics experiments. The scale of the investment has taken most researchers by surprise but all agree on the good sense of pooling vast resources together to undertake co-operative biotechnology research in an innovative partnership.



DAB receiver chip from Phillips Research.

# New Frontiers FOR ENERGY

***Douglas Clarkson looks at the problems drilling for oil in waters off the Shetland Isles.***

## Introduction

Seen in a global perspective, the world is still very much an oil based economy – no matter what people may say about signing the Kyoto greenhouse gas accord. As finite known reserves are recovered and consumed at finite rates, there is pressure to recover oil using more expensive and potentially risky methods. This will usually involve recovering oil and gas from deeper and deeper waters and often associated with adverse surface weather conditions.

These developments are very well known within the oil industry itself but much less so outside it. For example, the Brazilian company Petrobras during 1997 successfully produced from a well at a sea depth of 1709 metres in the Corpas Basin in Brazilian coastal waters. Previously the record had been held at 1027 metres by the same company. Also in the nearby South Marlin field, a floating production unit achieved production in 1420 metres of water. There is pressure, also, to develop technology to recover oil and gas from even deeper waters of 2000 metres and beyond.

In the search for oil around UK waters, exploration has been going on for quite some time in the area west of Shetland – the so called 'Atlantic Frontier' with BP Exploration as one of the main active companies. This area of operation represents a quite different challenge compared with the fields of the North Sea where the majority of production sites in the UK sector are based on production platforms secured to the sea bed. The Department of Trade and Industry estimate that the whole region of the Atlantic Frontier contains up to 1240 million barrels of oil. The Scottish sector of the Atlantic Frontier is shown in Figure 1.

The advance of exploration/production to these deeper waters is a demonstration of the technology now available to meet the energy needs of the 21st century – though there are many that would indicate a more balanced approach – a more sustainable order should be established in the recovery of finite but significant oil/gas reserves.

Production technology in oil/gas recovery relates to management of recovery processes to maximise yields. Production platforms, for example, can extract oil and gas under natural geological pressures but have often to undertake additional processes such as pumping sea water at high pressure and also gas back into well producer systems to maintain recovery rates. When oil and water are recovered together, they have to be separated effectively, with oil in water concentrations required to be lower than 40 parts per million. In terms of, say a modest site production of 25,000 barrels of oil per day, this amounts to the spillage of a single barrel of oil. It is common practice to use production stimulating chemicals injected into production areas to enhance recovery rates of oil and gas.

Modern methods of satellite image processing can also be used to detect oil where it rises to the surface to form thin slicks of hydrocarbon material which change slightly the optical properties of the ocean/sea surface. Satellites so far utilised in this mode include Landsat, ERS-1 and SPOT. There is also alteration of radar backscatter images due to formation of such thin oil slicks. Complex image processing technology utilising fuzzy logic ranking systems are used to process such image data.

Landsat satellite images are also processed to determine favourable geological features. Specific areas around the world feature in such land based studies and include Mongolia, China, Egypt and Pakistan.

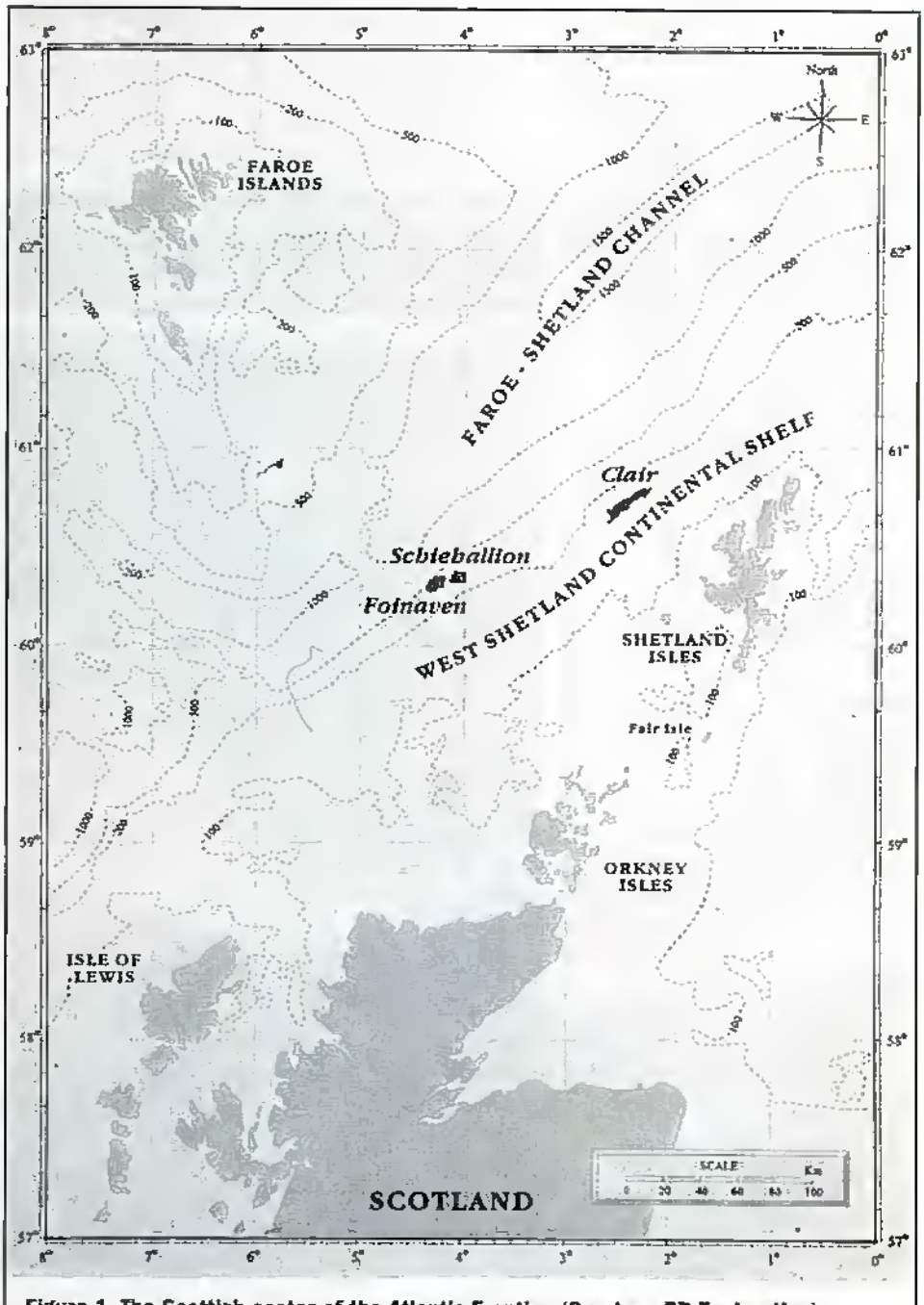



**Figure 1. The Scottish sector of the Atlantic Frontier. (Courtesy BP Exploration)**

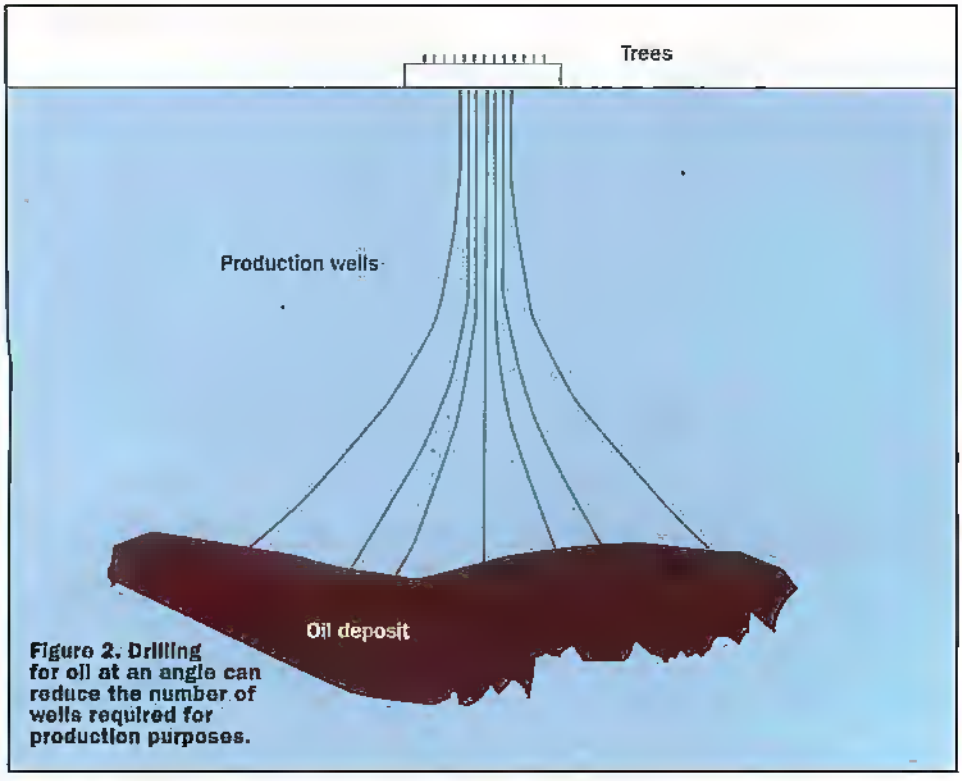



**Figure 2. Drilling for oil at an angle can reduce the number of wells required for production purposes.**

## Origins of Oil

While coal represents the fossilised remains of plants that lived in swampy areas on land, oil was formed from plants and microscopic animals (plankton) in the environment of seas and oceans. In the equilibrium of life in the seas and oceans over countless millennia, organic material would fall down to the sea bed where it would be covered with layers of sediment. The absence of oxygen in this mode of deposition would have been the key to preserving such carbon containing material.

Over time the forces of pressure and heat would transfer such material into oil – which initially would have been present as small droplets in the pore spaces of sedimentary rocks. With such rocks having a porous nature, migration of oil would tend to take place, with oil (and gas) eventually becoming concentrated at interfaces with non-porous rocks such as shales. Gas usually accompanies oil in discoveries, and consists typically of a mixture of methane, ethane, propane and butane.

## Drilling Technology

Drill bits have the potential to cut through softer rocks at more than 100 metres per hour – but at much slower rates where the rocks are hard – such as with basalts which have been encountered in the Atlantic Frontier area. In drilling technology, the drill bit requires active cooling and is undertaken by a special fluid called drilling mud. One of the components of this compound can be mineral oils which are known to have adverse environmental impacts.

The process of drilling wells can now be simplified by drilling at an angle – as indicated in Figure 2. While previously, several vertical wells would require to be drilled and then connected together on the sea bed, several producing wells can be drilled at angles from a single multiple head to pass through the oil producing volumes.

## The Foinaven Story

The line of Shetland – Orkney mirrors the direction of the Faroe-Shetland channel whose depth can in parts exceed 1500m. On the west Shetland continental shelf, there is a gradual increase in water depth towards this channel.

While initial exploration for oil commenced in 1972, it was only some 20 years later in 1992 that discovery of the Foinaven field took place some 190km west of Shetland and in water depths between 400m and 600m. The Clair field had previously been discovered in 1977 but thought not to contain oil in significant amounts. The Shiehallion field was subsequently discovered in 1993. However, there is the suggestion that the reserves in the Clair field have been significantly revised upwards and that future exploitation will


**Figure 3a. Drilling of various options for oil recovery from offshore sites utilising floating systems. (Courtesy BP Exploration)**

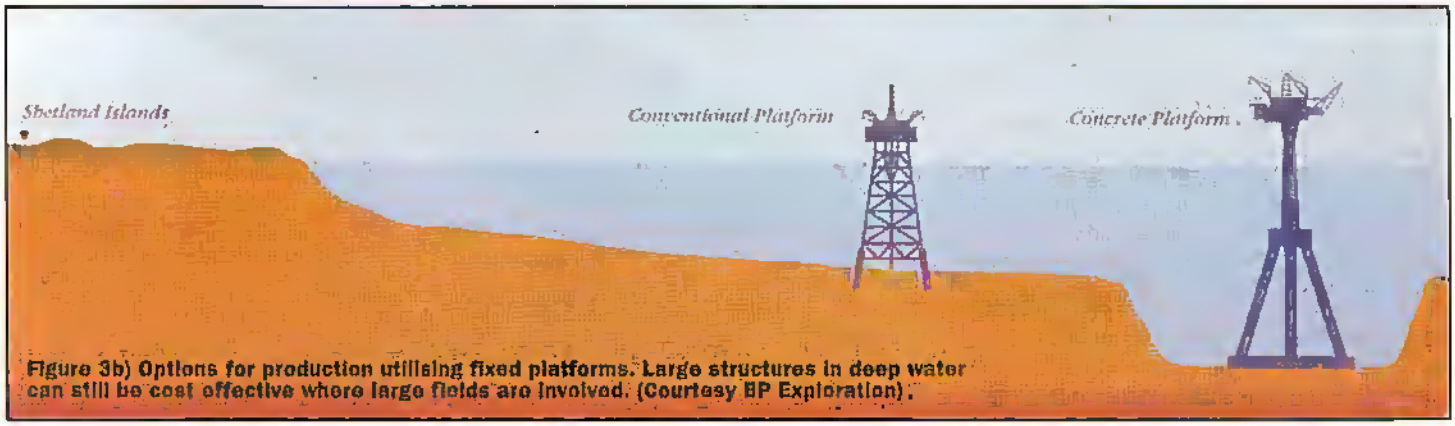



**Figure 3b) Options for production utilising fixed platforms. Large structures in deep water can still be cost effective where large fields are involved. (Courtesy BP Exploration).**

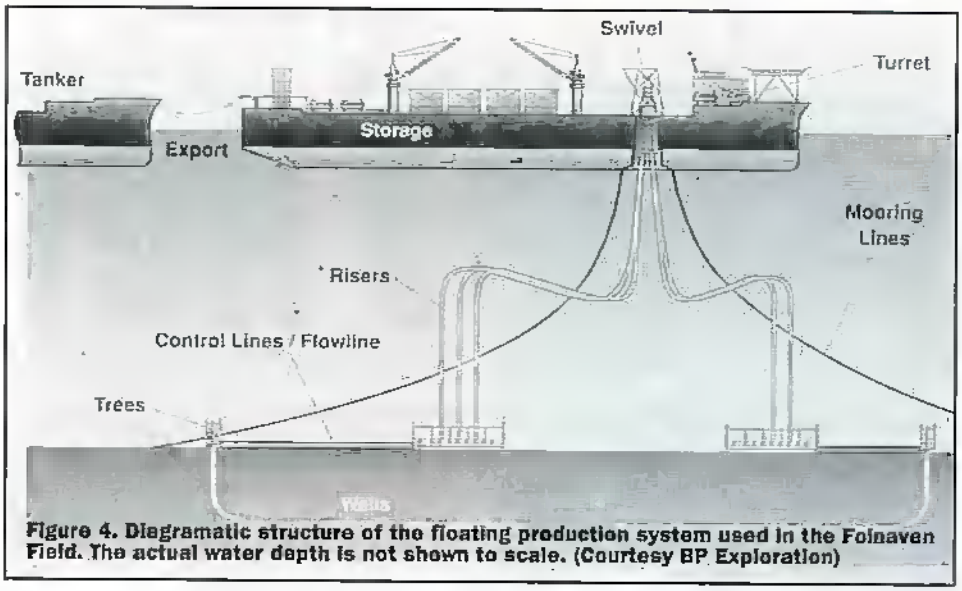



**Figure 4. Diagramatic structure of the floating production system used in the Foinaven Field. The actual water depth is not shown to scale. (Courtesy BP Exploration)**

require the establishment of an oil pipeline on the sea bed to recover these reserves.

Basic options for offloading of oil include semi submersible, floating production stage and offloading vessel (FPSOV) and tension leg platform as indicated in Figure 3a. While the initial capital cost of such methods is less compared to pipeline technology, they do cost more to operate. Generally fields of less size than one billion barrels of recoverable oil are suitable for offshore loading. Figure 3b shows how large producer platforms can be economic for very large recoverable reserves. While with floating production systems, the systems move vertically and laterally, this requires that the pipelines are flexible. While the technology of making connections to small diameter pipelines has been successful, the technology to link floating systems to large diameter high pressure export pipelines does not yet exist.

The method of oil recovery in use at Foinaven is by means of a FPSOV vessel as indicated in Figure 4. The producer ship, the Petrojarl Foinaven is in fact able to pivot about the central swivel unit to which are attached the risers connected to the production wells.

The design of the FPSOV Petrojarl Foinaven is seen in Figure 5. The pivot unit is also connected to ten anchors each of some 35 tonnes weight. The ship can swivel as required by direction of wind to achieve required orientation. The main body of the ship is therefore not itself anchored.

The Petrojarl Foinaven is a highly specialist vessel. A significant amount of expertise in offshore technology has been derived from experience of operation in the Norwegian sector of the North Sea where the imposition of the Norwegian Trough in depths of 300 metres renders pipeline solutions impractical. Her sister ship the Petrojarl I, operated by Golar-Nor of Norway in the period 1986 to mid 1995 has recovered 1000 cargoes without mishap.

The system of thrusters at port and starboard can maintain position and orientation of craft over the turret. Separation of sea water and oil is achieved within the separation unit with reduction of oil in water concentration to less than 40 parts per million. A compressor facility pumps seawater down production system to maintain pressure within the oil recovery areas. Recovered gas is used to power generators to operate the separator and compressor facilities and with surplus gas being flared as necessary. A number of diesel generators are also incorporated into the facility design.

The FPSOV has five double hulled crude oil storage tanks which can provide 310,000 barrels of storage. Offloading is undertaken using shuttle tankers that utilise the Flotta Oil terminal in Orkney. The first oil flowed from the Foinaven fields on the 26th of November, 1997 – with production initially at 15,000 barrels per day but expected to rise as additional wells are brought on stream. The total investment before the first drop of oil was produced, however, was £1 billion.

One of the reasons for the 18 months delay was, among other things, mysterious cracks in sea bed equipment which had to be lifted for repairs at high expense. The west Shetland port of Scalloway is being used as a base for the purpose built emergency response vessel Grampian Frontier.

## Future Atlantic Frontier Developments

The second field in the Atlantic Frontier – Schiehallion is expected to start producing during 1998 – with oil being taken to the Sullom Voe terminal in Shetland. The oil from the Foinaven field is being largely taken to the Elf Aquitaine Flotta Oil terminal on Orkney.

The production from the much larger Clair field, however, will probably require the investment of a dedicated pipeline, since the expected large volumes of oil could not be coped with by FPSOVs alone. Figure 6 shows the exploration and appraisal drilling history within the UK sector of the Atlantic Frontier – indicating significant increased activity in the 1990's.

## Environmental Inputs

While the UK government and oil companies such as BP Exploration focus on the economic and strategic significance of the Atlantic Frontier development, the significance of the development is not lost on environmental groups such as Greenpeace. It was in 1997 during the summer 'weather window' that Greenpeace staged a number of confrontations with BP Exploration in its development at Foinaven. This brought a significant deal of media exposure of the project though the complexities of environmental considerations are not trivial either in their consequences or in their detail.

The principal argument of Greenpeace was to leave the oil where it was out of simple respect for global warming considerations. Quoting current UN environmental impact studies, only something like a quarter of identified oil and gas reserves can be burnt with safety in order to prevent the worst implications of global warming. The oil industry apparently wants to burn it all – as soon as it can. However, this argument would apparently

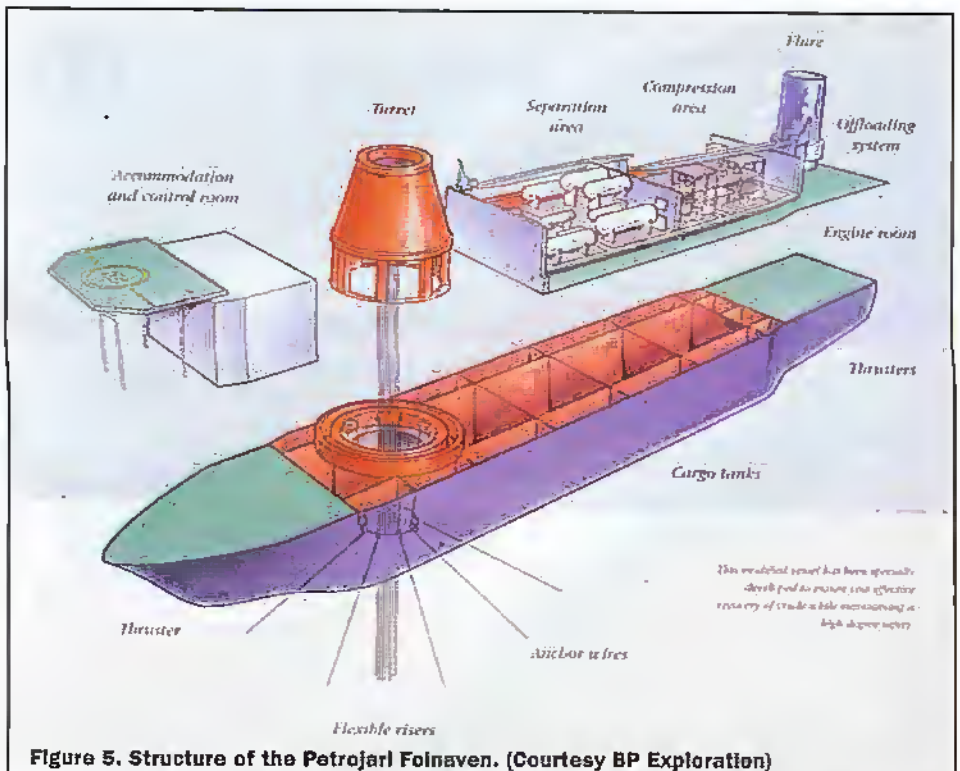



**Figure 5. Structure of the Petrojarl Foinaven. (Courtesy BP Exploration)**

**Photo 1. Greenpeace inflatables disrupting seismic testing in the Atlantic Frontier. (Courtesy Greenpeace)**

be a valid one for the entire world oil industry – not just a single major national UK oil company such as BP.

It is not appreciated, that the process of well drilling requires the discharge of significant amounts of water based mud (WBM) and synthetic mud (SM). For a typical well, around 1500 tonnes of rock cutting, 2800 barrels of WBM and 2200 barrels of SM will be discharged from the drilling rig. The use of synthetic mud provides for a degree of biodegradability of constituent chemicals. High efficiency 'shale shakers' separate the mud from the cuttings in order to reduce to a minimum the component of discharged mud. These environmental impacts are associated with the drilling phase. During the production phase, sand is also recovered with the oil/water mixture and has also to be recovered, processed and dumped overboard.

The general lack of data of the life forms and environmental tolerance of the enthic community around the Foinaven field places a high degree of uncertainty over the likely environmental impact. Thus statements which would tend to be over optimistic could be missing vital dependencies and conversely, statements of doom and gloom may be also unrealistic. It is only now, however, that more detailed studies of this area are being undertaken by the Scottish Association for Marine Science (SAMS) based at Dunstaffnage near Oban.

One of the species prominently referenced is the unusual cold water coral Lophelia pertusa which grows at a rate of about 2cm per year. Large reefs located on the sea bed at depth are thought to be several thousand years old. Also, such reefs are probably associated with complex local eco systems of fish, crustaceans and anemonies.

Such reefs have probably already suffered due to the activity of deep sea fishing boats. Anxieties exist that drilling muds from exploration and production wells will ultimately damage such coral colonies. Tropical reefs around the world such as the Great Barrier Reef are now discovered to be highly sensitive even to low levels of environmental pollution.

The weather window afforded by the 1998 summer provided Greenpeace with opportunities to draw attention to oil industry activity in the Atlantic Frontier area. While during 1997, there was specific action against BP Exploration in relation to the Foinaven field, currently attention was being directed towards the Norwegian sector of the Atlantic Frontier where Statoil, the Norwegian State owned oil company is active. However, the Norwegian coastguards seem relatively proactive in restraining Greenpeace from disrupting such activity. One reason for this is perhaps that the Norwegian sector of the Atlantic Frontier is geographically closer to the mainland. Statoil, however, is a major producer of oil and gas – producing daily around two million barrels of oil equivalent and similar in amount to that of the entire UK sector of the North Sea.

Previously in 1997, Greenpeace activists have attempted to disrupt the activity of seismic survey vessels such as the Geo Explorer and the Malene Ostervold. Such vessels use an array of microphones encased in long streamers. Each vessel can draw behind it as many as 8 such streamers each up to 3600 metres long. A separate array of air guns emit explosions underwater of up to 250dB every 7 seconds. The returning echoes can be subsequently processed to detect rock/sediment characteristics under the sea bed. It is likely that such signals will be readily detected by whales within the region – with possible adverse effects.

## Claims and Counter Claims

There remains, however, an element of uncertainty over territorial claims in the Atlantic Frontier area with lack of agreement between the UK, Ireland, Iceland and Denmark (Faroe Isles). Part of this argument is the claim on Rockall, a barren outcrop of rock some 289 miles off the Scottish Mainland. Greenpeace established a camp there on the 10th of June, 1997 – using a bright yellow survival capsule powered by solar and wind power. The occupation of Rockall lasted a record 48 days, with the team leaving on the 28th of July.

The Faroe Isles, granted limited self government by Denmark in 1948, are keen to resolve a 20 year old border dispute with Britain over the rights to oil and gas reserves. This could in time lead to the Faroe Isles taking their case to the International Court at the Hague.

## Environmental Provisions

Unless one is an oil industry expert, it is difficult to objectively assess the environmental record of the oil industry – particularly that of the offshore component.

There is the perception, however, that the oil industry in the UK and Norwegian sectors is taking more direct action with environmental factors. According to Smith Rea Energy, for example, environmental protection is now estimated to amount to 3.2% to 4.9% of capital expenditure and 4% of operating costs for any project. Sums in the region of between £234 and £340 million are probably being spent each year by the UK and Norway in its oil producing areas.

It is hoped that as environmental standards are improved in the UK and Norway, other countries with extensive offshore developments such as Angola, Brazil and Australia will adopt equally effective environmental practices and perhaps utilise the services already developed by the UK and Norway.

While the oil companies see each barrel of oil safety brought ashore as a triumph, environmental groups would view this as a failure, as sooner or later it contributes to an increase to the carbon dioxide in the atmosphere. The increased expenditure on environmental aspects is more than offset by significant cost reductions brought about through new geosciences and drilling technologies. Trends in technology and economic of production, for example, has moved the emphasis to module production units – away from expensive fixed platform systems.

The oil industry is very much a barometer of world economic activity and passes through phases of rising and falling demand for new production/drilling facilities. During 1997 the demand for drilling facilities in the North West European Continental shelf (NWECS) was running at a 40% increase. But with the demise of several of the tiger economies and economic uncertainty in Japan, the status of the oil industry is less certain – particularly when oil prices have fallen to almost an all time low: Brent Crude at $13 a barrel represents a 25 year low. Have the methods of production become too cost effective?

| Category |
|---|
| Drilling and Drilling Services Engineering and Contracting Hydrographic positioning and survey Inspection Maintenance and Repair Logistics: Bases, boats and aviation Offshore construction |
| Pipelines and umbilicals |
| Sub Sea |

**Table 1. Major sections of offshore industry.**

## The Octopus of Technology

The oil industry accounts for a large sector of UK industry and as such represents a market which is exceedingly diverse and which is becoming increasingly dependent on modern technology.

A subset of various categories of economic activity listed in table 1.

Each of these major headings can be subdivided into numerous smaller ones. The characteristic of the offshore oil/gas industry is that so much of its activity is out of sight of the majority of individuals. This tends to hide its true economic relevance and also give only limited exposure of new technologies used in both exploration and production. There are of course also sensitivities of technical knowhow.

The experience of developments in the Atlantic Frontier is characteristic of a global perception that deep water production of oil can supply the world with additional multi billion barrels of oil. This has stimulated demand for deep water exploration vessels – those able to operate in depths of greater than 500 metres.

## Planning for Disaster

The Shetland Isles know all about disastrous oil spills. The tanker Braer foundered on Shetland on the 5th of January 1993 and 85,000 tonnes of oil were spilled directly onto the coast. By the 5th of January 1998, a total of £47 million had been paid out of a contingency fund but with another £70 million remaining outstanding in claims and unlikely to be resolved. A serious oil spill in the Atlantic frontier could result in oil coming ashore at Shetland in as little as three days and would probably be spread over a large area of sea surface.

**Photo 2. Greenpeace's occupation of Rockall in 1997 showing the solar panels/windmills used to provide power for the accommodation module. (Courtesy Greenpeace)**

There is anxiety, however, that the nearest government salvage tug is situated in Stornoway – some 250 miles away which in the event of a serious incident involving a tanker off the coast of West Shetland would be of little value. Oil tankers pass through the critical channel at a frequency of one per day – though there is no compulsory fitting of radar transponders to track potential rogue tankers and there is no local dedicated radar facility for tracking positions of tankers in the vicinity of the exposed channel. Thus when it comes down to it, the technology exists to allow for greater safety but so far the government has not implement the improved safety features which the local community see as essential

With expansion of production in the Atlantic Frontier underway, this will result in increased traffic in and around Shetland, with the chance of a repeat of the Braer incident more likely. The key factor in all of this assessment is the treacherous weather conditions that can cause initial problems and often render emergency assistance ineffective or impossible to render.

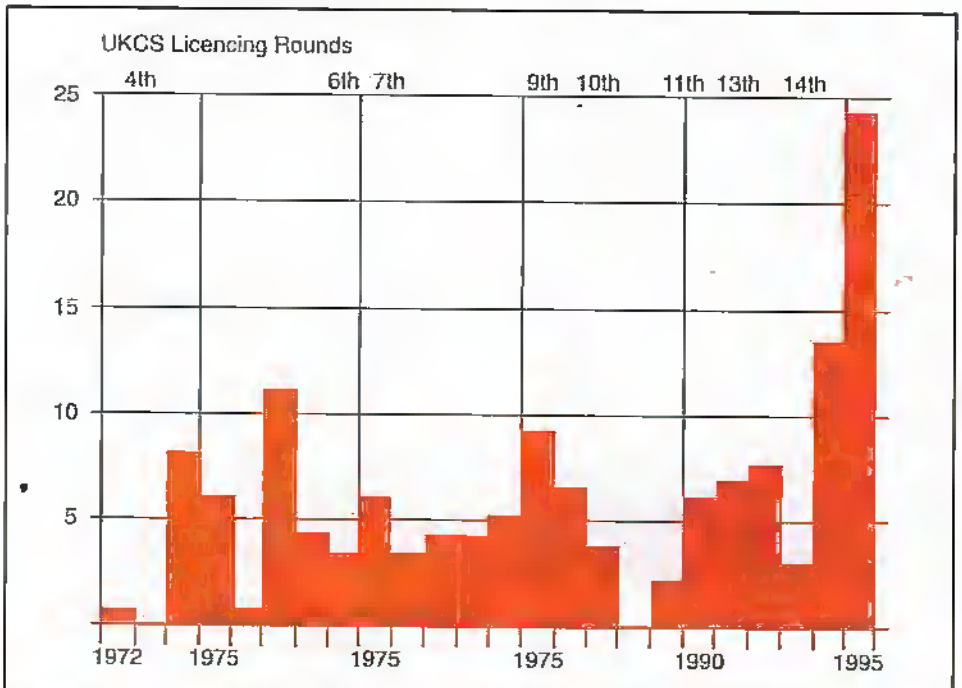



**Figure 6. Exploration and drilling history within the UK sector of the Atlantic Frontier. (Courtesy BP Exploration)**


## Wave Watch

The very incident of the Brae, however, emphasises the wildness of the weather found within the region of the Atlantic Frontier. There is now an awareness that weather conditions are actually worse than in the northern North Sea. There is also general agreement, however that the weather west of Shetland is probably among the worst weather conditions experienced by the offshore industry on a global basis. The tales of the deep sea fishermen were indeed true. In order to better inform operators in the area, the Met Office are now supplying advance warning of wave height, frequency, speed and direction in order to optimise efficiency of oil drilling and production.

This sombre reflection on the need for better wave information has come from dramatic experience of the wild power of the sea. The bows of the 300,000 tonne tanker Mimosa were severely damaged by huge seas in February 1995 with also a rig in the vicinity being damaged. Two years later the same rig lost two anchors in a severe storm while waves more than 70 feet high caused minor damage to the deck rail of the production vessel

Petrojarl Foinaven. One of the things to emerge from such experience is that rig structures are vulnerable to the frequency of waves as well as to their height. This has placed importance on determining swell period and direction as well as significant wave height. Wave patterns are inherently complex and can initially be reported into two main types – waves beneath active storms where the waves are 'locally generated and the swell which may be generated by storms days previously several thousand miles away. Matters are further complicated by the fact that waves of different frequency travel at different speeds. While the local type of wave is much more visible and predictable, the unexpected arrival of distant swell poses problems for the whole offshore oil industry.

## Summary

On a global scale, a wide range of technologies are being harnessed to recover oil and gas from increasing depths of ocean/sea and in so doing increase substantially the reserves of fossil fuels available for burning. This has represented a massive investment in new drilling/production systems and required the integration of a broad range of technologies to control and monitor installations. These developments have tended to take place out of the gaze of the public eye – with environmental groups such as Greenpeace managing to grab to occasional headlines relating to the Atlantic Frontier but without the media appearing to appreciate the fundamental reasons for Greenpeace's involvement.

The massive investments in oil/gas recovery is an example where the investment required has come from the industry itself – paid for in the end by the consumer. A vast network of companies and consultancies would appear to be engaged in moving forward rapidly new techniques to implement new challenges. The total global investment budget for developing new technology in this sector must indeed be vast. There would in particular appear to be considerable scope to make the recovery of oil and gas even more cost effective in the short term and prolong the age of oil beyond previous set limits. The oil companies at any rate see it that way. What is going, therefore, to tip the balance between 'brown' technology and 'green' technology?

### Points of Contact

BP Exploration,
Government and Public Affairs,
Farburn Industrial Estate, Dyce,
Aberdeen, AB21 7BP

# Removable MEDIA

## PART 3

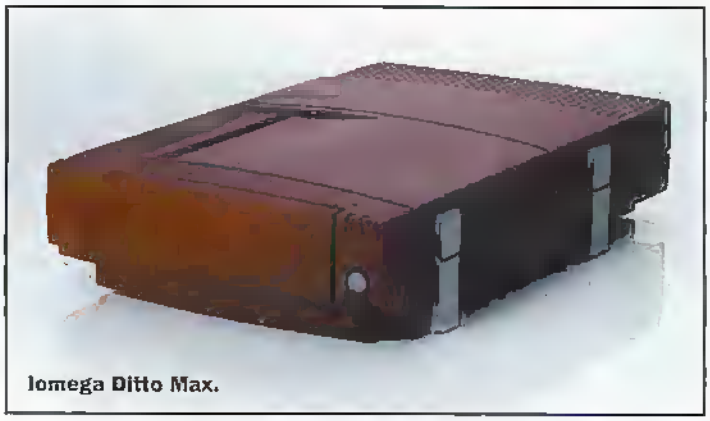
***Martin Pipe continues his look at the different types of removable media.***

Last month, we examined various removable storage peripherals from Avatar and Iomega. In this issue, we take a close look at the Imation/Lexus Superdisk, and products from Syquest and Panasonic.

In the last two articles, we've discussed the importance of removable media. Today's products offer a high capacity, and are hence ideal for backing up your data, removing less-used data from your hard disk, boosting your PC's storage capacity or transporting large amounts of data from one machine to another. To summarise, there are two routes that you can take. The first is the disk – as exemplified by systems like the Iomega Zip and Syquest SparQ. Because of their random-access nature, disks are relatively fast, but quite expensive in terms of capacity-per-pound. Of course, there are exceptions – CD-R disks store 650Mb of data, and can be bought for less than a pound. The disks cannot be rewritten to, however, although they can be read by any CD-ROM drive. As a result, they're ideal for archiving purposes.

The second route is tape which is cheap and capacious: a £25 Ditto Max cartridge, for example, will store up to 7Gb. A Panasonic PD disk, which costs the same, will only store 650Mb. Unfortunately, tape is a serial-access medium and cannot hope to compare with disk as far as transfer speeds and seek-times are concerned. Tape is hence ideal for applications where absolute performance is less important than capacity. For this reason, tape systems are commonly used to back up a hard disk. Most tape drives are supplied with back-up scheduling software that automatically copies files to the tape during overnight sessions, when the PC is unlikely to be in use. Just as well – backing up a modern average hard disk can take several hours. If a 'verify' operation is to be carried out, to ensure that the data is correctly written to tape, then the procedure will take twice as long. Back-up schedulers generate reports that can be examined at more socially-acceptable hours.

In this article, we'll take a look at the Imation Superdisk, courtesy of a Mitsubishi drive distributed in the UK by Nexus Peripherals. The 120Mb LS120 is also backwards-compatible with the more established low-capacity 720k and 1.44Mb 3.5in. floppy disks – this is one of this system's main benefits. We'll also examine the Panasonic PD system, which employs phase-change technology to store 650Mb on a caddy-enclosed CD-sized disk. The PD drive reviewed will also read audio CDs, and CD-ROMs at up to 24x speed. Rounding off our look at disk media are two products from Syquest. The first is the old 44/88/200Mb 5.25in cartridge system, which is still popular in certain circles nearly ten years after its original introduction. Syquest's newest product, the SparQ, uses very similar technology. However, the SparQ cartridges are smaller, cheaper and will store up to 1Gb.



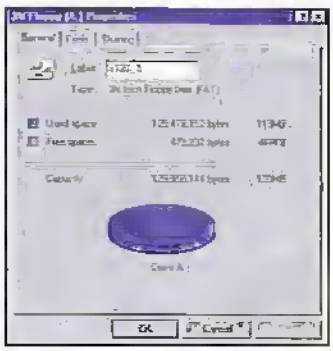
Iomega Ditto Max.

## LS-120/SuperDisk

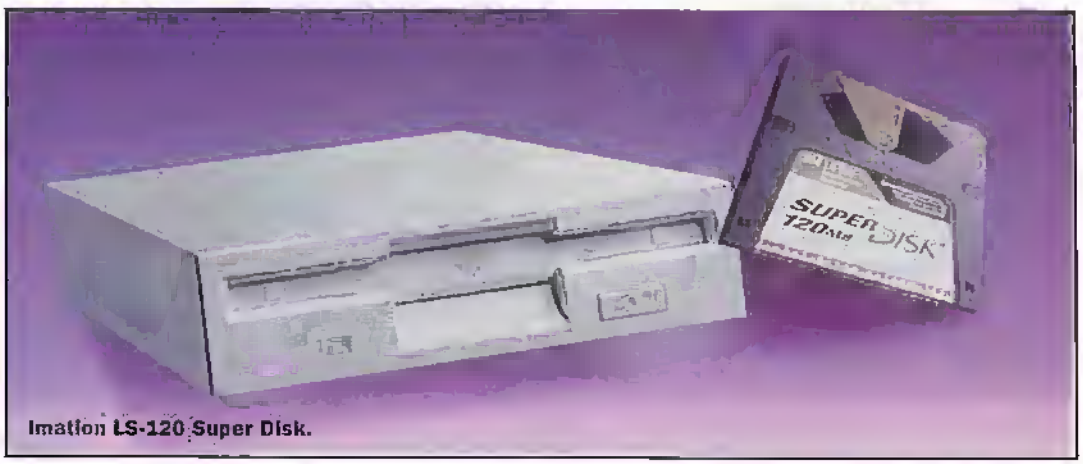
The SuperDisk, originally known as the LS-120, is seen by many as the replacement for the good ol' 3.5in. floppy. After formatting, the media holds 120Mb (against Zip's 100Mb). Rather more key in its list of benefits, however, is the drive's read/write and format compatibility with older 1.44Mb and 720k disks. Imation, the developer of this format, deliberately gave the new high-capacity media the same dimensions as the conventional floppy. Although the SuperDisk hardware is backwards-compatible with older floppies, you obviously cannot read or write to the SuperDisk media on standard drives. Backwards-compatibility with floppies is, however, winning the SuperDisk many new friends – particularly those amongst the PC manufacturing fraternity.

PC vendors love the fact that you can simply replace the conventional floppy drive with the SuperDisk. Conversely, those who integrate Zip drives into their machines have to retain the floppy drive, since the two formats are fundamentally incompatible. Most people, after all, still need the ability to read floppies – whether to access archived data or install software. The difference in price between otherwise-identical new machines equipped with and without SuperDisk is minimal – after all, the cost of the original floppy drive can be offset against that of the SuperDisk hardware. Fujitsu/ICL, NEC and Compaq, amongst others, are offering SuperDisk as an option. Mitsubishi has designed a low-profile drive, the PCMCIA-interfaced Travel120, specifically for integration into notebook PCs. Some models, meanwhile, are offered with an optional in-built slimline SuperDisk drive.

For this review, we opted for the internal Mitsubishi drive distributed in the UK by Nexus Peripherals – the same company, incidentally, that imports the Avatar Shark we examined last month. This drive – which, for upgrading, has the



LS-120 properties displayed under Windows.




Imation LS-120 Super Disk.

same dimensions of a regular 3.5in. floppy unit, hooks up to the PC via an IDE interface. There are no plans to introduce a SCSI version (or write Macintosh drivers, for that matter). Other forms include an external drive that hooks up to a parallel port – this model is suitable for all desktop and notebook PCs. The Nexus kit includes, drive apart, an IDE cable and driver CD-ROM. Also on the CD-ROM are old versions of Norton Utilities and Norton AntiVirus – quite useful if you don't have this software. What you don't get, however, is a blank disk..

The SuperDisk – and internal Zip drives, for that matter – are capable of acting as boot drives in the same way that a conventional floppy can. However, your PC needs to have a compatible BIOS. Most PCs bought in the last year or so should be OK – if it is, then the drive will be automatically recognised by the BIOS's 'IDE hard disk recognition' utility and you'll be able to specify 'ZIP/LS120 then C:', or something to that effect, in the boot order sequence configuration setting. If your PC is an older model, then you won't be able to boot from the SuperDisk and you might need to retain your existing floppy drive – being able to boot up from a removable disk is an essential diagnostics feature. Fortunately, there are alternatives to this clumsy state of affairs.

You could replace the motherboard (cheap enough these days, and you'll probably also get an overall performance boost into the bargain if the motherboard is more than three years old), upgrade the BIOS, opt for the external parallel port-connected drive or invest in a dedicated controller card – the Promise SuperMax. The latter is an ISA card that sells for £30 or so. I found that there were various problems, at least as far as my original system (built around an Intel P133 processor and Triton-based SuperMicro P55CMS motherboard) was concerned. Similar problems could occur with non-compatible systems. Trying to access the SuperDisk – which appeared as a 'removable drive', rather than drive A – occasionally made the system crash. When the system was upgraded to a much more (and powerful!) recent Intel TX-based motherboard and AMD K6/266 – at a combined cost of around £150 – the SuperDisk became (the bootable) drive A – as it should be. All then worked well.

**Performance**

| | |
|---|---|
| Windows '95: | 0.20Mb/sec (write), 0.35Mb/sec (read) |
| DOS: | 0.11Mb/sec (write), 0.07Mb/sec (read) |
| Drive cost (inc. VAT): | £81.08 |
| Media cost (inc. VAT): | £10 |
| Media cost per megabyte: | 8.3p |

In most cases, the SuperDisk drive will be connected to the secondary IDE port – the same one that the CD-ROM is attached to. For best performance, the primary IDE port should be dedicated to hard disk drives. The CD-ROM drive is likely to be configured as a primary device – in such cases, the SuperDisk should be set to 'slave' – there are jumpers for this purpose. With recent systems, that's it – reboot the machine, and the extra capacity of the SuperDisk will be available. You'll only need to install software drivers if the system BIOS is incompatible (unless you're using a Promise SuperMax) or you're running any version of Windows older than the OSR2 release of '95.

One of the SuperDisk's problems is that of media cost – its street price is similar to that of the Zip, despite the fact that its physical build quality (and appearance, for that matter) makes one think of a 40pence HD floppy. In comparison, the Zip cartridge is a massive construction. Part of the SuperDisk's expense is undoubtedly associated with the complex magneto-optical media inside. This flexible disk has a servo pattern, in the form of 900 special tracks, etched into it at the factory. SuperDisk drives employ a laser to read this servo pattern and align the read/write head – the 'LS' part of the original name, if you haven't already guessed, stands for 'laser servo'. The use of a laser servo system allows precise head positioning, and hence narrower tracks can be written and read. Zip also uses servo tracks, albeit a conventional magnetic one. The SuperDisk media itself is composed of two layers of high-density metal particle (MP) material.

The other problem is that of speed. The SuperDisk is not very fast in its own right at all – a transfer rate that's only five times faster than a floppy, and a ponderous average seek time of 70ms. It does make regular floppies run faster, however. Fortunately, caching software – the 'LS120 Performance Accelerator – is now available for Windows '95. Sounds good?

In theory, yes. The downside is that you have to buy this software separately, and even then you have to live in the US to purchase it from the web site (http://www.superdisk.com) operated by Imation, the format's inventor. SuperDisk's main advantage is that of backwards-compatibility with older media – indeed, Imation reckons that it will replace the floppy disk entirely. Just don't tell any Macintosh enthusiasts that, though! That said, there are rumours that a third party is developing a SCSI interface for SuperDisk hardware. It is anticipated that the media price should fall with time; Zip disks, meanwhile, have held their price fairly well since 1995.

Software bundle: DOS (5.0 or newer) and Windows 3.x/'95 drivers, Norton Utilities 2.0, Norton Antivirus 4.0

Contact:Nexus Peripherals, (01491) 413663. Web: `http://www.nexusp.com`, `http://www.superdiskdrive.com`, `http://www.superdisk.com` or `http://www.ls120.com`

## Panasonic LF-1097 PD/ CD-ROM drive

The PD system was originally launched back in 1995, and was a functional precursor to the CD Rewritable format that is now becoming popular. Indeed, there are many similarities. Panasonic's PD drive will read CD-ROMs and audio discs, or store up to 650Mb (632Mb, after FAT-formatting under Windows '95) on special removable media. The rewritable media is also conceptually very similar to CD Rewritable (CD-RW), being based on phase change technology. Here, the material that forms the disk's recording surface can be in two states or 'phases' – hence the term 'phase (change) dual', from which the 'PD' name is derived. This property is entirely responsible for the format's rewritable nature. In its original state, the material has a polycrystalline structure.

When heated by the laser to create the pits, it goes into an amorphous (non-crystalline) state that has a lower reflectivity (by a factor of 10%) than the unwritten crystalline areas. It is this difference in reflectivity between the two states that forms the basis of subsequent reading operations. As with CD-RW, erasure involves localised heating to around 200°C. The PD drive, like modern CD-RW drives, supports 'random erase'. Here, the write and erase procedures are combined 'on the fly'. As a result, the drive behaves just like a hard disk as far as the user is concerned. It is possible to replace one file with another – there's no need, as there was with earlier CD-RW drives, to wipe the disk completely in order to reclaim the full capacity.

This latest-generation PD drive doesn't look much different from the first model, and indeed closely resembles a regular CD-ROM drive. There's a front-loading drawer that accepts CDs or PD media, an eject button and a pair of LEDs that indicate drive status and media type. The tray is particularly interesting. There are a couple of retaining clips that have to be pushed upwards whenever CDs are inserted. These clips are not required for PD media – they're pushed down so that they're flush with the tray when PD disks – because the media is encased in a rigid plastic 'envelope'. A shutter on the envelope allows the drive to access the media. The envelope also features a write-protect lug. An upshot of the PD drive's tray design is that the drive can be mounted horizontally or vertically – in particular, those clips prevent CDs from falling out.

Audio CDs aren't particularly well catered for – there's no headphone socket, volume control or S/PDIF digital audio output. Round the back of the drive are a 50-way header – this drive has a Fast SCSI-2 interface – SCSI ID and termination jumpers, and a stereo CD audio output for a soundcard. Installing the PD drive posed no problems – our PC had an Adaptec 2940 and EZ-SCSI 4.1 utilities, which supports removable media. The drive is, however, supplied with CorelSCSI – a set of SCSI utilities for DOS, Windows 3.x and Windows '95 (NT provides inherent support for SCSI devices). There's also an OS/2 driver, but Macintosh support is only available through third-party utilities. CorelSCSI includes drivers that allow your PC to recognise the drive. When

installed, the PD drive gives you two drive letters. The first 'read-only 'drive' is exclusively for CD-type media, while the second – which supports read and write operations – is exclusively for PD media

The CD-ROM read performance of this latest drive – the LF-1097 – is 24x speed – in other words, pretty fast. As a result, you can get rid of your existing CD-ROM drive and free up a drive bay if necessary. Previous PD drive models were relatively sluggish with CD-ROMs. It's good to see that the LF-1097 is multi-read compatible, and will hence read CD-RW disks – even if it can't write to them. The laser wavelengths involved during the writing process are too different, according to Panasonic, and so we're unlikely to see a PD/CD-RW/CD-R/CD-ROM drive. A shame, really! The drive will also read CD-Rs, PhotoCDs, VideoCDs, and multi-session discs in addition to CD-ROMs and audio CDs. CD-R audio junkies will be pleased to learn that the LF-1097 handles CD audio extraction at 510kb/sec – in other words, just over 3x speed.

We found that the PD system is also reasonably fast – under Windows '95, a 228Mb folder, containing many files of varying sizes, was copied from the hard disk in just over eight minutes. Access times are quoted as 90ms for PD, and 83ms for CD media. Nowhere near a good hard disk, but perfectly acceptable for most applications. Panasonic also claim that PD disks can be read by the company's latest DVD-RAM drives. Unfortunately, nothing else – apart from another PD drive – is compatible. And therein lies the problem with PD – for the same price, you can purchase a CD-RW drive. CD-RW media costs about the same – or slightly less than PD media, and can be read by the latest 'multi-read' DVD-ROM and CD-ROM drives. That said, the PD enclosure provides added protection to the media, and that's distinct advantage over CD-RW.

**Performance**

| | |
|---|---|
| Windows '95: | 0.20Mb/sec (write), 0.35Mb/sec (read) |
| DOS: | 0.5Mb/sec (write), 1.1Mb/sec (read) |
| Drive cost (inc. VAT): | £316 |
| Media cost (inc. VAT): | £15 |
| Media cost per megabyte: | 2.3p |

Software bundle: CorelSCSI, drivers for Windows 3.x/DOS/Windows '95/OS/2, Seagate BackupExec

Contact:

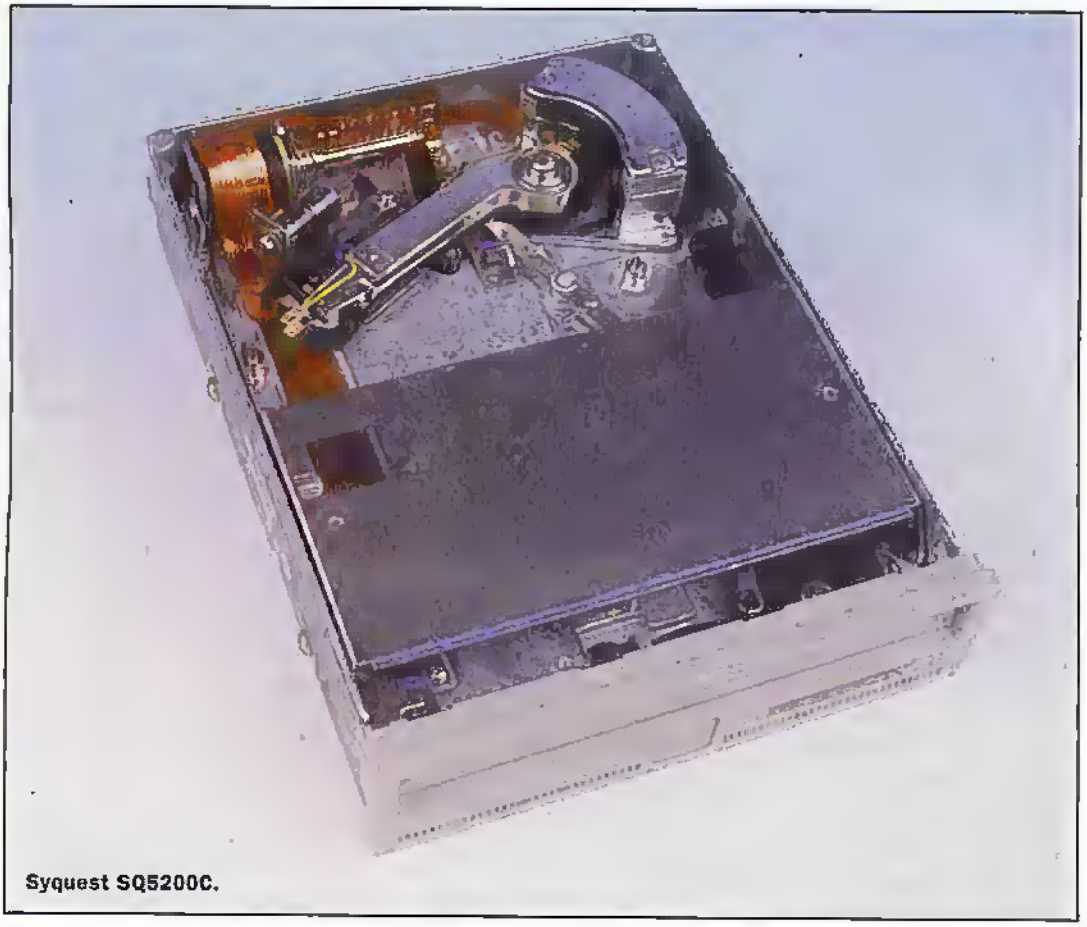
Panasonic Industrial Europe, Willoughby Road, Bracknell, Berks RG12 8FP. Tel: (01344) 853193. Web: http://www.panasonic.com

Panasonic LF1097 PD/CD-ROM drive.

## Syquest SQ5200C

This is the last in a line of removable 5.25in.media systems, produced by Syquest since the late 1980s. All of them are SCSI-interfaced, which reflects their professional status. The first had a capacity of 44Mb, and was one of the first affordable removable disk systems introduced. Then came an 88Mb version, followed by a 200Mb model – the latter SQ5200C being examined here. The later drives are read/write compatible with earlier media, although they won't format all disks. You can still purchase the SQ5200C from some vendors, although it is no longer being made in large quantities. Production of the 44 and 88MB variants has long since ceased, although technical information and drivers are still available on the Syquest web site (http://www.syquest.com) The early appearance of the Syquest removable cartridge, and its Mac-friendly SCSI interface, led to some industries standardising on it as a means of transporting it from one location to another.

For example, publishers would stick Quark Xpress page layouts, fonts and scans onto a disk, and send it to the company responsible for producing the high-resolution films needed by the printer. Not so long ago, this magazine was in Syquest form at some point. Creative industries are loath to let go of their 5.25in Syquest



**Syquest SQ5200C.**

drives – or their Apple Macs for that matter. Slowly, however, these drives are being replaced by more capacious (and cheaper) media – notably CD-R. 'Electronics' is now sent to the repro house in this form, the disks being returned to the editor who retains them as reference 'archives'.

The SQ5200C looks identical to the earlier drives, with a pair of status LEDs and some prehistoric-looking mechanical controls. And indeed in terms of use, the 5200 and its predecessors are quite clumsy. Yet the procedures must be followed correctly, or the disk and/or heads might be damaged. Pressing a 'stop' button disengages the heads and brings the platter to a halt. After this, an 'eject' lever is pushed to the right to release the cartridge. Inserting a new cartridge brings the lever to a half-way position – when it's pushed to the left, the heads and drive engage and the 'stop' button returns to its original 'press-able' position. Doesn't sound very high-tech, does it?

Conventional hard disk technology forms the basis of the 5.25in. Syquest. There are two heads, which are mounted on an 'fork'. This is positioned by an electromagnet that's very similar to a loudspeaker's voice coil. Each of the two heads reads from, or writes to, one side of the 5.25in. sputtered-aluminium platter. The latter is enclosed in a smoked-plastic write-protectable cartridge with a spring-loaded shutter. Inserting the cartridge opens this shutter, thus providing an aperture for the heads to get into. Unlike hard disks, the 5.25in. Syquest isn't a hermatically-sealed system. It doesn't need to be, according to the manufacturer, because the recording density isn't particularly high. In addition, the heads don't move as close to the disk surface as they do within a hard disk. Those heads are quite large by modern standards, and workable signals are induced in them by the media during read cycles. In addition, the write current is quite high.

The Syquest 5.25in. system is very reliable, and this has undoubtedly counted towards its long-term acceptance. I have an old 44Mb disk that was last written to some time in 1991, and the data is still readable with my SQ5200C. Such reliability has endeared it to creative busy-bodies – after all, once an idea is lost, it cannot easily be recreated. Drivers are universally available, and most SCSI utilities packages (such as Hard Disk Toolkit for the Mac, and EZ-SCSI for the PC) provide support for it as a 'removable hard disk'. Data transfer speeds reflect the age of the system's design. Although we had no trouble writing and reading sustained-rate CD-quality digital audio streams to an 88Mb disk under Windows '95, overall DOS and Windows transfer rates were quite low during write operations. Reading was, however, a good deal faster.

The average seek times claimed for the SQ5200C – a mere 19ms – are quite impressive for a format of its size and age. Indeed, a much more recent Syquest design – the SparQ, which is based on a 3.5in. disk – only improves on this figure by 7ms. However, the SparQ offers a superior data transfer rate, and this was particularly noticeable when copying large files under Windows '95. The biggest downfalls of the SQ5200C, though, are undoubtedly the high cost, limited capacity and physical size of the media. Some industries, such as multimedia development and printing, need to have at least one of these drives around to cater for client media. Outside of these interests, you're best advised to go elsewhere these days. Nevertheless, in terms of technology, the 5.25in Syquest is a 'golden oldy' that's stood the test of time remarkably well. Many aspects have found their way onto the SparQ, as we'll discover.

Software bundle: None

Contact: Syquest Technology Limited, Wyvois Court, Swallowfield nr. Reading, Berks RG7 1PY. Tel: (01189) 880207. Web: `http://www.syquest.com`

**Performance**

| | |
|---|---|
| Performance Windows '95: | 0.10Mb/sec (write), 0.65Mb/sec (read) |
| DOS: | 0.12Mb/sec (write), 0.70Mb/sec (read) |
| Drive cost (inc. VAT): | £276 |
| Media cost (inc. VAT): | £52 (for 200Mb cartridge) |
| Media cost per megabyte: | 26p (with 200Mb cartridge) |


**Syquest 5-25in disks have been around for some time.**

# Syquest SparQ

The recently-launched SparQ is designed to compete head-on with the Iomega Jaz, and has the same formatted capacity of 1Gb. Indeed, the 3.5in. disks are physically very similar. Instead of a SCSI-2 interface, however, the SparQ relies on an IDE (Mode 4) interface. Currently, the SparQ is PC-only; the support operating systems are DOS/Windows 3.x, Windows '95 and NT 4.0. Syquest plan to introduce a version with a USB (Universal Serial Bus) interface - one of the first storage products to support this new standard. This new version is primarily intended for Apple's new iMac, which places a great deal of emphasis on USB. The IDE version can be configured as a boot device if the BIOS is configured appropriately. It has the same dimensions as a floppy drive, and will fit into a 3.5in. bay. There is also a laptop-friendly 'external' SparQ available for the same price as the IDE-interfaced version - this hooks up to a PC via its parallel port. Parallel port usage reduces overall performance - you get a burst transfer rate of only 2Mb/sec, which doesn't get close to the 16Mb/sec possible through IDE.

The Jaz, which is also available in external and internal variants, is rather more expensive than the SparQ in terms of both drive and media. The SparQ has much in common with the Syquest 5.25in. cartridge system described above. Indeed, the same basic hard disk-type technology is employed. Each cartridge-protected SparQ disk has a single sputtered-aluminium platter with two lubricated recording surfaces. A spring-loaded shutter on the front of the cartridge opens when inserted into the drive. The heads, which are mounted on a hard disk-type voice coil-driven positioning arm, enter into this aperture during use. Compared to the SQ5200C, the heads move much closer to the platter. In addition, the data is packed much more tightly - after all, it does fit half a gigabyte onto each side of the 3.5in platter. As with Jaz and SuperDisk, an embedded servo track arrangement on the disk platter aids precise head positioning. Access time is quoted as 12ms.

Dust and other airborne contaminants could pose a problem, particularly since hard disk-type hermetic sealing isn't possible here. Syquest has taken various measures to avoid such problems. First of all, the drive door 'flap' shuts whether or not a disk cartridge is inserted. It provides a good seal, and hence helps to prevent dust from getting into the drive. For the same reason, the drive body is coated by a protective covering to reduce the risk of dust being blown into the drive by the PC's fan. When the disk is inserted, the platter is spun at a high initial speed (7200rpm), before settling down to 5400rpm. The higher speed causes any dust particles to 'fling' outwards. They are then directed, via a series of moulded channels inside the cartridge housing, to the head aperture and hence into the drive itself. According to Syquest, any dust inside the drive itself is collected by a filter with a life of 20 years. Syquest claims high reliability - 250,000 hours MTBF (mean time between failures), and a data error rate of 1 in $10^{12}$.

Setting up the SparQ is straightforward enough. Round the back of the drive are jumpers that allow it to be configured as a slave or master device. Most modern PCs have two IDE channels that support up to four devices. Because most such PCs only have a hard disk and CD-ROM drive, you get two spare channels. As a result, most PCs should be able to support the SparQ, provided that they have a spare hard disk-type power connector and vacant drive bay. Although the SparQ is a 3.5in. device, it is supplied with an adaptor that allows it to be fitted snugly into a 5.25in drive bay. For some reason, the 5V and 12V pins of the SparQ's power connector are recessed relative to the 0V pins. This is downright stupid, because the contact surface area is reduced and reliability could suffer. I noted this on two samples of the internal SparQ.

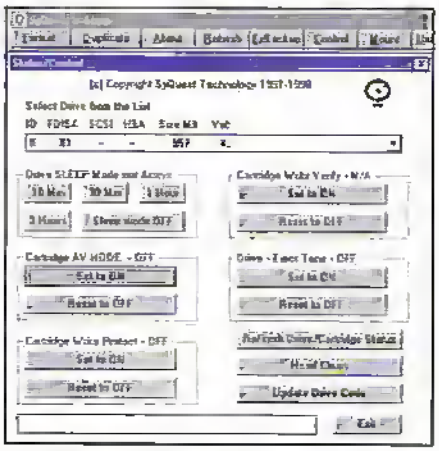
Ah yes, two samples. The first we had failed on power-up. After the disk was clicked into position, the drive spun up. As it did so, a loud and worrying grating noise was heard. It appears that one of the heads hadn't been secured properly to its mountings, and it skated across the disk surface. Hardly surprisingly, the media was also ruined - a subsequent format on a functional drive returned loads of bad sectors. Quite worrying, it has to be said. A second sample of the SparQ presented no such problems, and upon reboot the drive was accessible. It appears in 'My Computer' as a removable drive. The 'starter' SparQ disk contains a variety of 'free' software, for tasks that include back-up, off-line Web-browsing and virus protection. Also supplied with the drive, on a floppy, is a Syquest utility that allows disks to be mounted/unmounted, write-protected and formatted. This disk also contains drivers that allow the SparQ to be recognised by MS-DOS. We found the SparQ's performance to be excellent - it's roughly the same as an older IDE hard disk. In addition, it's great value for money.

Software bundle: Syquest Utilities utilities diskette (for DOS/Windows 3.x/95/NT 4.0), SegaSoft Heat.Net (Internet gaming), Novastor Novadisk SE (hard disk backup), Serif DrawPlus SE (drawing/graphics), Netresults WebVCR (off-line web browsing), AltaVista Howdy (multimedia e-mail), Sprynet (US-specific Internet trial), McAfee WebScan (virus protection).

Contact: Syquest Technology Limited, Wyvois Court, Swallowfield nr. Reading, Berks RG7 1PY. Tel: (01189) 880207. Web: `http://www.syquest.com`

**Performance**

| | |
|---|---|
| Windows '95, IDE: | 1.85Mb/sec (write), 4.25Mb/sec (read) |
| DOS, IDE: | 0.92Mb/sec (write), 2.92Mb/sec (read) |
| Drive cost (inc. VAT): | £170 |
| Media cost (inc. VAT): | £33 |
| Media cost per megabyte: | 3.2p |



**Syquest SparQ utilities.**


**Syquest SparQ and Ditto Jazz - very similar!**

# You're onto a Winner WITH DEMON INTERNET

***Try our service for FREE and give yourself a chance of winning a top spec PC.***

Electronics & Beyond is pleased to offer our readers an extra-special deal in conjunction with Demon Internet – the UK's biggest Internet Service Provider. Not only can readers use the cover CD to try the service for 30-days for FREE, but simply by taking out the trial, you will automatically be entered into a prize draw to win a top-notch PC.

Provided courtesy of Demon Internet, this will be a system that will make you the envy of computer owners everywhere. A 400MHz Pentium II processor, 64MB memory, a 6GB SCSI disk, an AWE 64 soundcard, 4MB AGP graphics, a V90 modem, a 17" monitor.... the list is almost endless. In fact, it is the perfect system to use in conjunction with your Demon Internet account. For just £10+VAT a month, Demon provides you with all these exciting benefits:

- A passport to the World Wide Web – thousands of pages of information, pictures, movies and sound files, on every subject under the sun. Great for business and great for education!
- Unlimited Email boxes – enabling everyone in your family or office to communicate with far-flung relations, old acquaintances, business colleagues and new friends across the globe
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- Online Gaming – pit your wits against other Demon Internet customers on our new, fast and dedicated game servers. As well as featuring the most popular multi-player games, this service will also showcase the most exciting new releases
- Local call access wherever you are in the UK – we were the first Service Provider to offer 100% local call access in Britain
- 15MB Web space – set up your own web site that everyone can see and hear!
- D-Fax – have faxes sent to your email account and banish those lost-bits-of-paper blues. After an initial set-up charge, this service is included in your tenner a month
- Discounted membership of LineOne. Not only can you take advantage of a free trial of this premier information service, but you even get a special subscription deal that's exclusive to Demon Internet customers
- Round-the-clock support from our dedicated team of specialists who are committed to ensuring your Demon account is trouble-free and enjoyable

## Who are Demon Internet?

Established in 1992 with the goal of bringing low-cost Internet access to the general public, Demon Internet is now the UK's largest, most experienced provider of fast, dependable access to the Internet.

Now part of the ScottishTelecom group of companies, we pride ourselves on providing the highest quality service, with the best infrastructure, software, support and facilities so that our customers – both at home and in the office – can use the Internet to maximum advantage. We invest heavily in our resources to ensure that we stay number one in the industry and we continuously monitor and implement new technological developments to keep us at the cutting edge.

Of course, we realise that not everyone can be an expert and no matter how advanced the technology, things can still go wrong. That's why we have established a friendly team of experienced Helpdesk staff – and as the Internet never sleeps, our technical support service is available to Demon Internet customers 24 hours a day, 7 days a week. It is even open on Christmas Day.

It is precisely this high level of service that has attracted so many customers to Demon Internet. In just six years, our subscriber base has grown to around 200,000, approximately 50,000 of which are corporate customers. In addition, we have the largest base of web space clients in Europe, and we currently host almost half of all registered .co.uk domains.

## So what are you waiting for?

Load the CD now and follow the on-screen instructions. Should you need any assistance in setting up, just give Demon's Helpdesk a call on 0181 371 1010.

## Happy surfing!

### Prize Draw Terms & Conditions

1. No purchase necessary.
2. Trials must commence before 1st November 1998 using the code indicated on the CD.
3. The Prize Draw will take place on 16th November and the winner will be informed by post.
4. There is no alternative to the prize on offer of a PC (specifications of which are subject to change without notice, depending on availability).
5. Confirmation of the winner can be obtained by sending a stamped-addressed envelope to the Prize Draw Administrator at the usual Demon Internet address.

Demon Internet

**(System may differ from that shown in picture).**


**WORTH OVER £2,000**


# DIGITAL STORAGE SCOPE

***John Mosely has a play with this new piece of test gear from Velleman, and offers you a chance to win it!***

Velleman have introduced a compact digital storage oscilloscope, the PCS64i, that conveniently connects to your PC and monitor to display waveforms. Digital storage 'scopes have distinct advantages compared to analogue 'scopes, for as the name implies the measured signal can be frozen, or stored, for subsequent examination or comparison with other signals, plus the additional advantage that the waveform can be scientifically analysed. Connection to your PC is very simple - via the parallel port - and the scope is completely optically isolated from the computer port. Software is supplied on two 3.5in disks, (for running under Window 3.11/95 and DOS) and allows the unit to offer all standard oscilloscope functions - with function operations via the mouse, including voltage and frequency markers. Additionally, the unit can be used as a spectrum analyser up to 16MHz, and as a transient signal recorder, for recording voltage variations, or for comparing two voltages over a longer period - a year in fact!

The oscilloscope and transient recorder have two independent channels with a sampling frequency up to 32MHz in real time, and oversampling of 64MHz if operated under Windows. Any waveform displayed on the screen can be stored for later use in documents or for comparison of waveforms.

The front panel layout could not be easier, with just two independent BNC channel inputs with individual vertical (Y) position pots, and the input selector switches for ac, dc and earth. Plus, off course, the power on/off switch. Power requirements are 9V at 800mA via the supplied mains adaptor.

## Installation and Operation

Connection to a PC and loading the software was accomplished very quickly. The display image was very clear and detailed, and operation of the unit was easy and very self evident, just clicking the mouse over the desired button to select range, function etc. Two toggle buttons allows switching between digital storage mode and spectrum analyser.

Photo 1 shows a 10kHz sine wave displayed on both channels - channel 1 is yellow and channel 2 is green. The selected timebase and the input sensitivity are displayed at the top of the 'CRT'. By using the markers, which are available from the View menu, amplitude and frequency can be displayed painlessly - simply click and hold the left mouse button over the marker and drag it to the desired point. The vertical markers are used to measure frequency, and the horizontal ones for amplitude. Once the markers are in place the relevant reading is displayed at the bottom of the 'CRT' display. A very useful feature is that the rms value can also be displayed along with the frequency and peak-to-peak voltage. Results can be easily stored in an image format, or stored as data in a text file format.

Photo 2 shows the unit operating as a spectrum analyser. Again the input is a 10kHz sine wave, with the marker indicating the peak at 10kHz.

The transient recorder is a separate program and is selected from the WinDSO folder that is created during installation, and obviously cannot be run simultaneously with the DSO programme. This is simply an oscilloscope with a very slow timebase, the main advantage being that the signal can be stored on disk for analysis at a later time. By making the timescale very slow, and by selecting an automatic save function signals can be

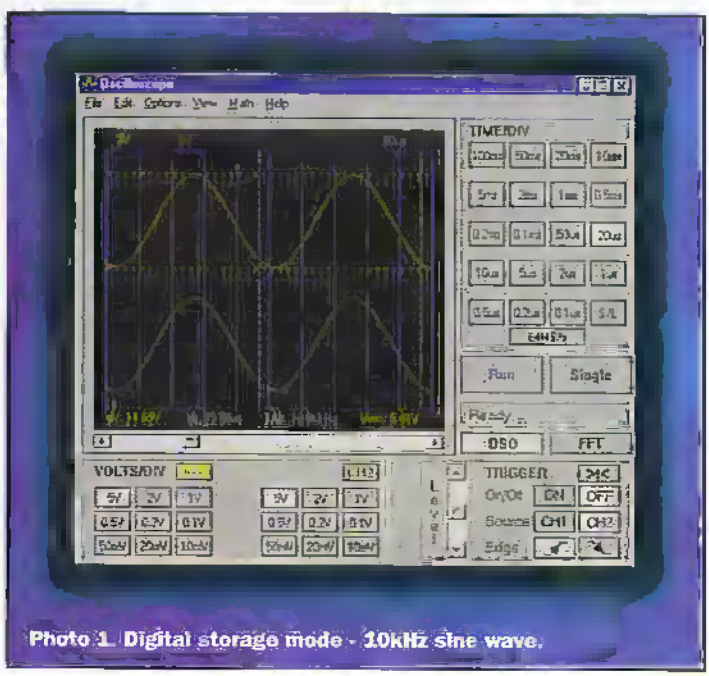


Photo 1. Digital storage mode - 10kHz sine wave.

## TECHNICAL SPECIFICATION

**GENERAL**

| | |
|---|---|
| Inputs: | 2-channels |
| I/p impedance: | 1MW/30pF |
| I/p bandwidth: | 13MHz |
| I/p voltage: | 100V (ac + dc) |
| Max readout error: | 2.55% |
| I/p coupling: | dc, ac or GND |
| Vertical resolution: | 8-bit |
| Real-time sampling frequency: | 32MHz (max) |
| Oversampling: | 64MHz (only under Windows) |
| Memory: | 4kb/channel |
| Supply voltage: | 9V @ 800mA |

**OSCILLOCSOPE**

| | |
|---|---|
| Timebase: | 100ns to 100ms per division |
| I/p sensitivity: | 10mV to 5V/division |
| Trigger source: | CH1, CH2 or free run |
| Trigger edge: | rising or falling |
| Step interpolation: | linear or smoothed |

**SPECTRUM ANALYSER**

| | |
|---|---|
| Frequency range: | 0..800Hz to 16MHz |
| Operating principle: | Fast Fourier Transform (FFT) |
| FFT resolution: | 2048 lines |
| FFT I/p channel: | CH1 or CH2 True rms readout (ac component only) |
| Linear or log timescale | |

**TRANSIENT RECORDER**

| | |
|---|---|
| Timescale: | 20ms/div to 200s/div |
| Max record time: | 9.4hours/screen |
| Max number of samples: | 500/s |
| Min number of samples: | 1 sample/20s |
| Automatic storage of data | |
| Zoom function | |
| Data format: | ASCII |

monitored over a very long time. By using the markers it can also be accurately determined when a change occurred, and how large. Photo 3 shows a 1Hz sine wave being displayed with a 0.5s timebase. The frequency markers are spaced at 5s, and naturally show five cycles.

## Conclusion

Anyone wishing to use a digital storage scope will almost certainly have access to a suitable PC, and this makes this unit from Velleman an extremely attractive proposition, being affordable and very easy to use and install. The unit is small, measuring just 225 x 175 x 45mm, so will take up very little bench space., and is a very desirable piece of test gear.

## System Requirements

An IBM compatible PC using a 386 or higher, running Windows 3.11/95 or MS-DOS, with a VGA display (800 x 600 for Windows) and mouse, 486kb of conventional memory. A maths co-processor is required for true rms and spectrum analyser mode.

The Velleman PCS64I is available from Maplin, (**Order code VX93B**) and retails at £279.99 including VAT.

**You have a chance to win this superb piece of test gear, simply complete the coupon and return to us by the 9th October 1998 to be entered into the draw.**

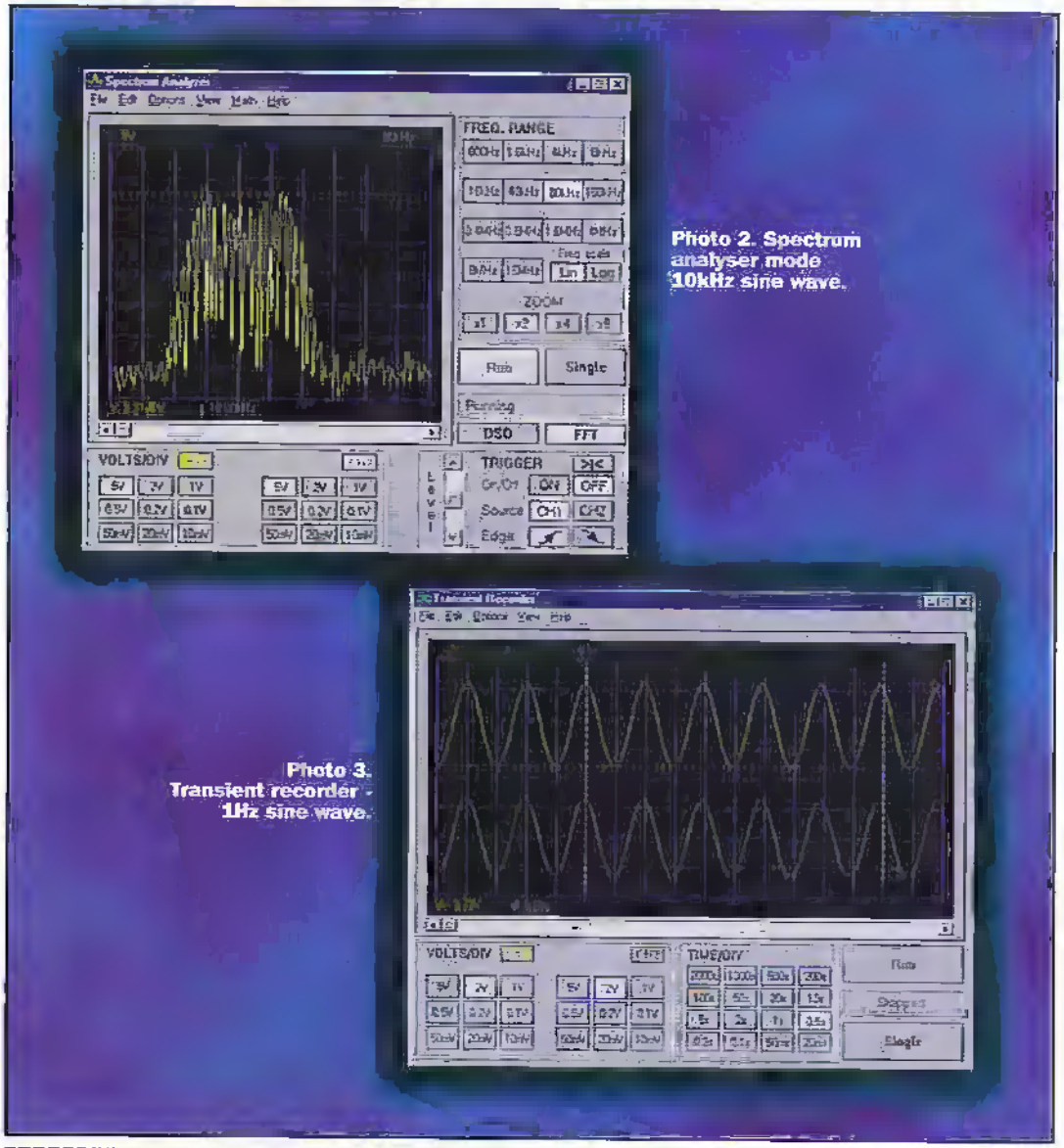


**Photo 2. Spectrum analyser mode 10kHz sine wave.**

**Photo 3. Transient recorder - 1Hz sine wave.**

Send your entries to: The Editor, Electronics & Beyond, PO Box 777, Rayleigh, Essex, SS6 8LU.

Multiple entries will be disqualified. You may photocopy this coupon.

Name _____

Address _____

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_____

Post Code _____

# *Mars Update 2*

# A YEAR ON, WHAT HAS BEEN LEARNED?

***Chris Lavers looks back at the Mars Pathfinder discoveries.***

Mars Pathfinder (renamed the Carl Sagan Memorial Station) reached Mars on July 4th 1997 deploying a small rover named Sojourner. Data was collected from three main instruments, the Imager for Mars Pathfinder (IMP), the Alpha-Proton X-ray Spectrometer (APXS) and the Atmospheric Structure Investigation METeorology Package (ASIMET), with a number of technology experiments. Mars Global Surveyor (MGS) entered Mars orbit on September 11th 1997 and after aerobraking has

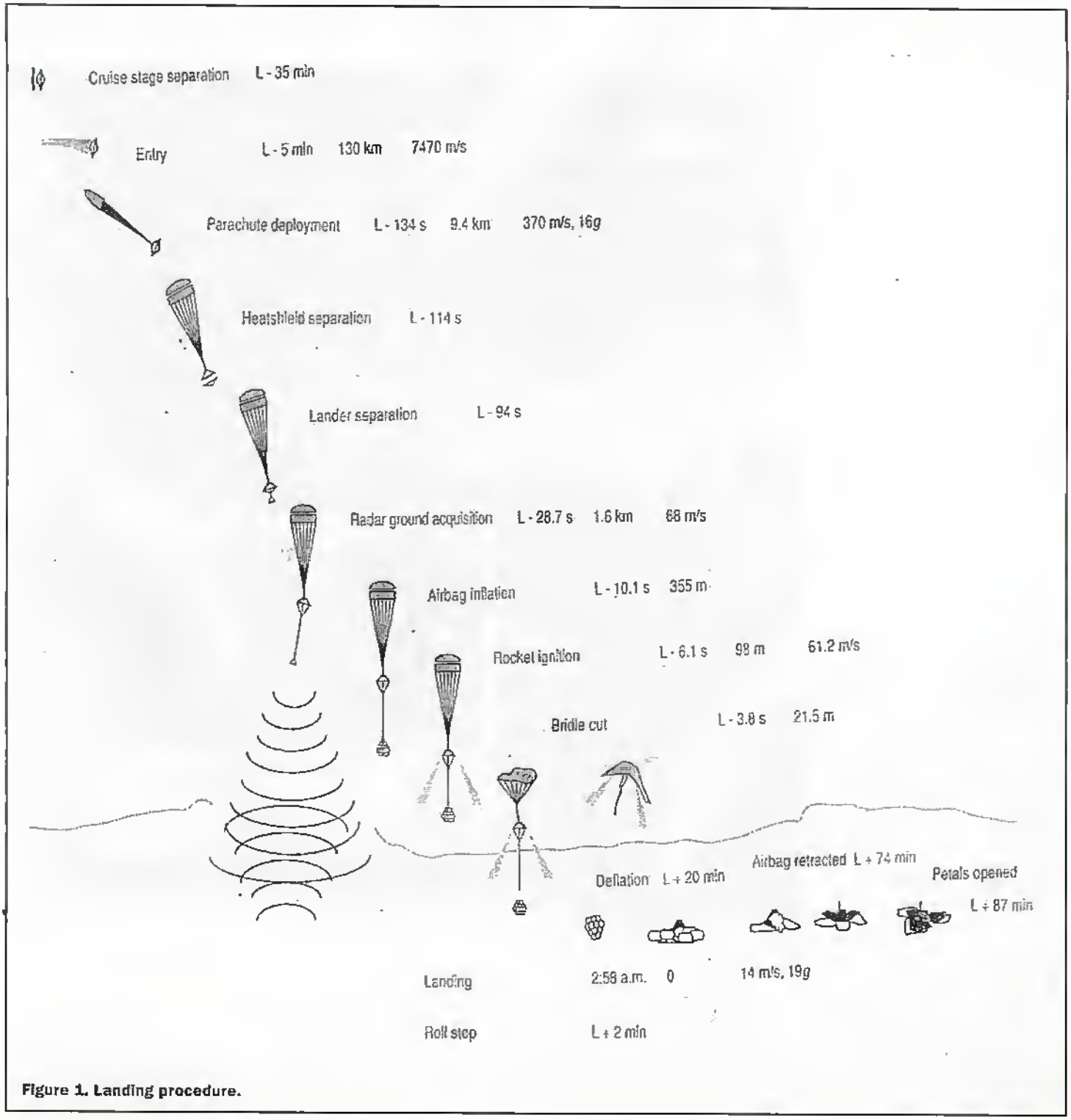



**Figure 1. Landing procedure.**

Figure 2. View including a rock called 'Yogi'

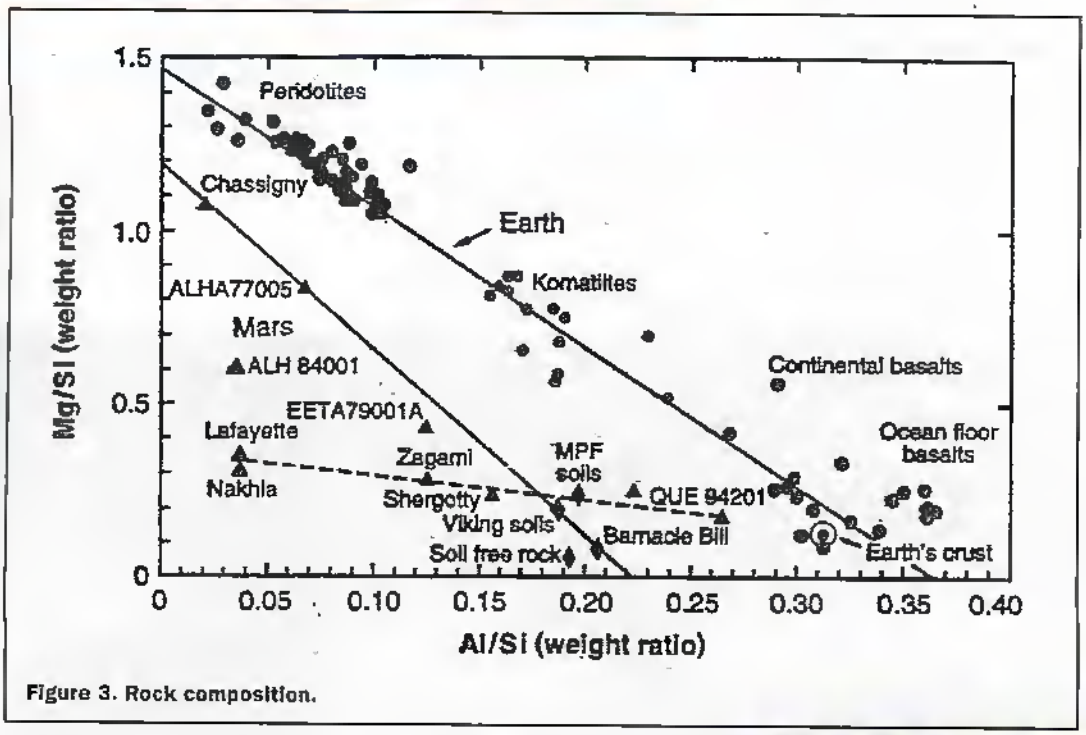



Figure 3. Rock composition.

are red. The first APXS soil analyses recorded measurements close to those from the Viking sites; subsequent analyses showed variability. Pathfinder data has higher aluminium and magnesium concentrations, but less iron, chlorine and sulphur. One rock, 'Scooby Doo', appears to be a sedimentary rock of compacted soil. Pathfinder APXS rock analyses lie somewhere between igneous rocks of magnesium-iron silicate, feldspar, quartz and other minerals. Rocks exhibit significant colour variation from dark grey rocks such as 'Cradle' to dark red ferric soils around rocks like 'Lamb'. Dust is bright red and has a magnetisation consistent with maghemite. Wheel track and soil mechanics measurements recorded surface densities similar to Earth approximately 1.2-2gcm$^{-3}$. The low reflectance of some rocks is consistent with iron minerals in igneous rocks.

A picture of two rock classes has emerged, one composed of rocks high in silica such as 'Barnacle Bill', and rocks such as 'Yogi' high in sulphur content. According to Dr Matthew Golombek, JPL Project Scientist, the high silica content of some rocks suggests more past heating in the Martian crust than previously thought.

## Atmosphere

The sky is generally pale pink, similar to that seen by the Viking Landers. Beautiful sunsets have been recorded (Figure 4). Data shows that dust is uniformly mixed in a warm lower atmosphere with both diurnal and rapid fluctuations of temperature and pressure. Early morning temperature variations (10-15K), absent in the afternoon, suggest cold morning air warmed by the surface and convected up in small eddies. Winds are light and variable, below 10ms$^{-1}$, yet able to generate dust devils. The time averaged ASIMET surface pressure over the first few sols is shown in Figure 5. The diurnal variation of atmospheric temperature between is also shown over this period Figure 5.

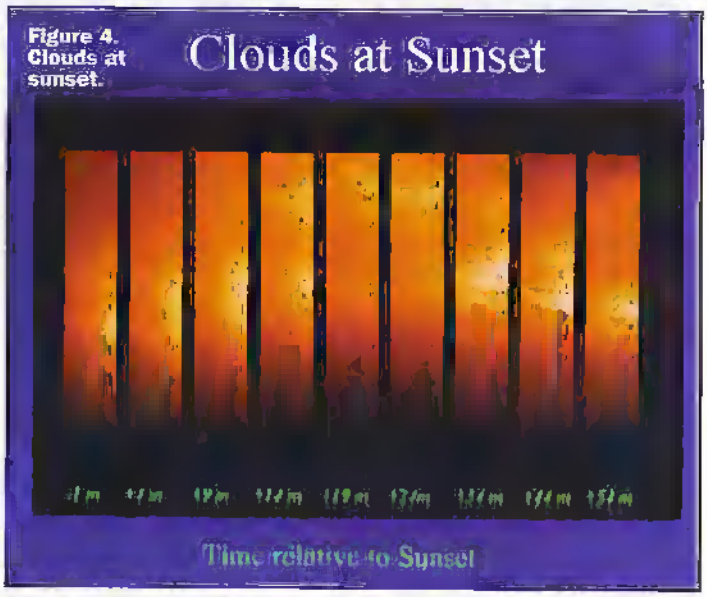



Figure 4. Clouds at sunset.

begun to take high quality pictures. These probes have produced a wealth of data from an impressive array of remote sensors. The Mission to Mars Program and the targeting of space exploration goals has lead to an era of space renaissance unseen since the Apollo missions.

Pathfinder was launched in December 1996 from Kennedy Space Centre and after a seven month cruise and four trajectory correction manoeuvres, entered the atmosphere by parachute (Figure 1). Pathfinder's 'soft-landing' within 13 miles of the aim point used a 36 foot parachute and inflatable 'aerobags'; the Lander bounced 15 times and up to 12m in height without bag rupture! A thumb sized antenna communicated the successful landing to a waiting world three minutes after touchdown.

The initial 30-day Pathfinder Mission Phase was completed on August 3rd fulfilling all its objectives including the first of a generation of roving prospectors on the Martian surface. During the Primary Phase 9,669 lander pictures of the landscape were returned in monochrome, colour and 3D, totalling 1.2Gbits of data, including 384 rover images (Figure 2), and 4,000,000 temperature, pressure and wind measurements. The rover traversed 52 metres, explored over 100m$^2$, circumnavigated the Lander, performed 10 soil and rock chemical analyses, and additional soil mechanics and technology experiments.

"The data returned from the Sagan Memorial Station and Sojourner has been nothing short of spectacular, and it will help provide a scientific basis for future Mars missions, including a sample return," said Dr Wesley Huntress, NASA Associate Administrator for Space Science.

## Mineralogy

In general, rocks are dark grey but broken coatings or weathered surfaces appear bright red. Undisturbed soils appear dark, areas disturbed by the rover and deflated airbags terrestrial rocks and Viking and meteorite results. Mg/Si vs Al/Si diagrams of Martian meteorites, Viking soils and Pathfinder soils are compared with terrestrial samples (Figure 3). The Aluminium contents of Pathfinder soils mimics those of nearby rocks.

'Barnacle Bill' and 'Yogi' appear to be fully crystallised

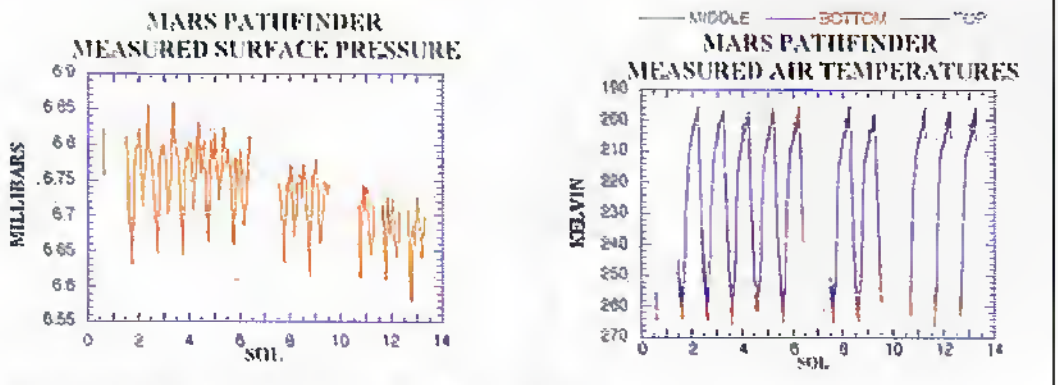



**Figure 5. Temperature and pressure variations (in mbar).**

## Chemical composition of rocks and soils

The APXS team, lead by Dr Rudolph Riexder of the Max Planck Institute for Chemistry, at Mainz in Germany, has made the first in-situ rock measurements. The Ares Vallis landing site has many characteristics consistent with formation by catastrophic flooding. The rocky surface is reminiscent of a depositional plain (rocks, boulders and semirounded pebbles cover 16% of the area).

APXS was designed to obtain the chemical composition of rocks and soils. The APXS technique is based upon three interactions of alpha particles from a radioactive source with matter, Rutherford backscattering, where alpha particles cause nuclear reactions within light elements (proton mode), and generation of characteristic x-rays in the sample through ionisation (x-ray mode). In alpha-mode APXS measures elements heavier than helium, and is sensitive to C,N,O, but deteriorates above Si. In x-ray mode elements heavier than sodium are measured with increasing resolution. The proton-mode provides complementary data. Concentrations are measured to a few tenths weight percentage for all elements except H and He. The x-ray spectra of rock A-3 (Barnacle Bill), was obtained on July 6th 1997 (figure 6).

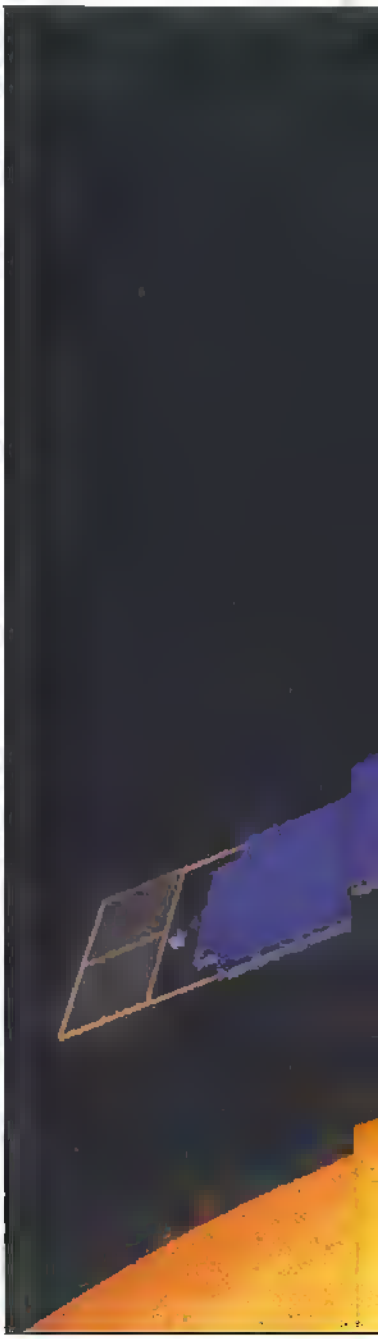
## The Beginning of the End

After 83 days of atmospheric, soil and rock studies, Pathfinder moved into its extended mission plan. "The Lander and rover performances continues to be nothing short of extraordinary," said Brian Muirhead, JPL Pathfinder Manager. The rover had just completed its last APXS results from a rock named 'Chimp' behind the 'Rock Garden' and Sojourner had begun a 164ft circuit around the Lander to perform a series of technology experiments and hazard avoidance exercises when disaster struck.

The rover had survived ten times beyond its one week primary mission with Lander operation already 250% longer than expected. Both were solar powered and batteries had to keep key systems warm at night. The rover's non-rechargeable batteries were limited to daytime operation, and the Lander battery at 30% of its original capacity had several months of likely operation left. However, on September 27th/28th (Sol 83) difficulties in communication with Pathfinder were encountered.

The operations team re-established a brief 2-way link on September 30th using the Lander's auxiliary antenna. On Sol 88, an attempt was made to use the auxiliary antenna to acquire engineering data to assess the communications problem. Meanwhile the rover executed a contingency plan to stand still rather than trek round the Lander. A final Lander signal was received on Sol 93 (October 7th). The communications failure is now believed to be due to battery deterioration causing the Lander to fail to keep accurate time. As time progressed the spacecraft hardware got colder. From late September temperatures dropped to -50°C in early morning. The lower temperatures caused the radio to operate outside the usual frequency range and the team spent three weeks transmitting at lower frequencies and sweeping through a wider range (a technique used on other missions) in an attempt to 'lock' the Lander receiver onto the transmitter signal without success.

The Pathfinder computer was a variant of IBM's 'Deep Blue' which was victorious against World Chess Champion Gary Kasparov. The rover used an 8-bit Intel chip, and communicated with the Lander at 9,600 baud speed. JPL engineers are working on rovers that will last a year, communicate directly with Earth (avoiding problems caused by relay station failure) and need little interaction from controllers. A 4-wheeled rover, 'Nomad' has covered over 200km in field trials in the Chilean Atacama Desert, for potential future missions to Mars, the moon, or even Antarctica. The 750kg robot utilises stereo vision and human-eye resolution for tele-robotic geological observations. With autonomous driving, the robot sees obstacles and chooses its own route, allowing exploration over greater distances, and incorporates the first 360° panospheric camera. The European Space Agency also has advanced plans for semi-autonomous rover operation, such as the French



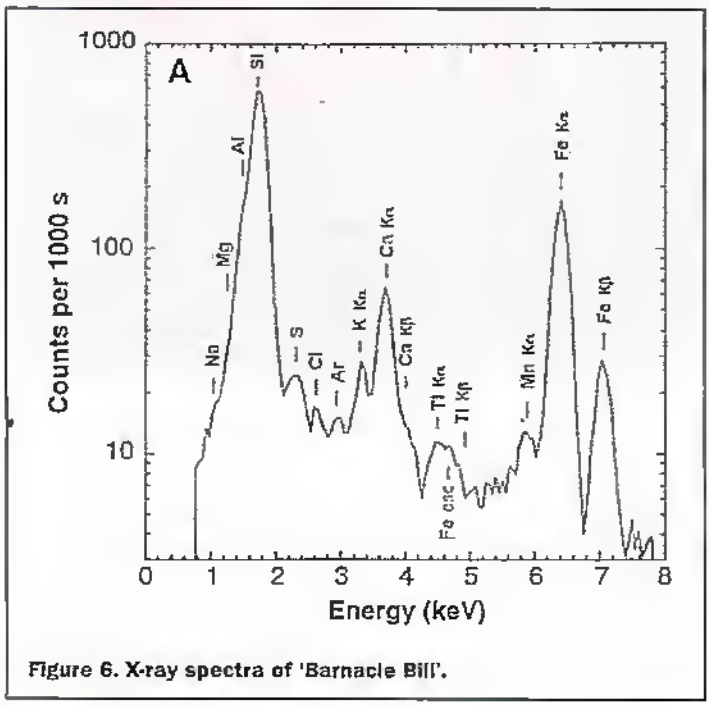



**Figure 6. X-ray spectra of 'Barnacle Bill'.**

GEROMS vehicle and another Experimental Vehicle for Exploration (EVE). Both robots will depend upon reference communications from Earth, remote trajectory control, and autonomous navigation using an acquired synthetic digital terrain model generated in real time on board the vehicle. Currently the computing time needed to generate the trajectory is about 30 seconds compared to the 90 seconds needed to follow it.

MGS, the second in a series of NASA spacecraft (Figure 7) has already produced notable results. As early as September 15th 1997, having only just achieved orbital insertion. MGS confirmed the existence of a magnetic field. "Preliminary evidence of a stronger than expected magnetic field of planetary origin was collected and is now under detailed study," said Dr Mario Acuna, principal investigator for Goddard Space Flight Centre's magnetometer. Current observations suggest a field with a similar polarity to Earth with a maximum strength 1/800th of Earth's. The magnetic field has important implications for Mars. Planets like Earth, Jupiter and Saturn generate magnetic fields by means of a dynamo made up of moving molten metal at the core, which is a good conductor of electricity. The rotation of the planet creates electrical currents deep within the planet generating a magnetic field. A molten interior suggests the existence of internal heat sources, giving rise to volcanoes and a flowing crust. A magnetic field also shields a planet from fast-moving electrically charged particles from the sun which may affects its atmosphere.

## AeroCapture and Aerobraking

On September 11th aerocapture was achieved unlike Mars Observer five years before. Orbital insertion burn was achieved with a 150lb main engine thrust, burning about 283kg or 73% of the initial propellant. A crucial point during the inbound and postburn flight was hidden behind Mars during aerocapture. At 6.43pm during the rocket burn contact was lost, but successfully reacquired at 6:57pm. .

On September 16th at its farthest point in orbit (apoapsis) the spacecraft fired its main engine for 6.5 seconds, slowing MGS velocity by 4.41ms$^{-1}$. The manoeuvre lowered its orbit so that when the spacecraft dipped at its lowest point (periapsis), upper atmosphere drag on the solar panels would start the long aerobraking process to circularise the orbit. A short halt to braking was made on October 11th after data indicated that one of the two 11ft solar panels had made unexpected movements during and after aerobraking. The panel had been improperly deployed since shortly after launch; a 93° inclination mapping orbit overcame the problem. MGS aerobraked for four months until achieving its aimed circularised orbit at 243 miles altitude. Lander atmospheric data was regularly available and important for MGS aerobraking. NASA's Hubble Space Telescope also monitored atmospheric conditions during this phase. Hubble pictures by Phil James at Toledo University and Steve Lee at Colorado University taken with the Wide Field Planetary Camera on

Figure 7 Mars Global Surveyor Spacecraft. Pictures courtesy of NASA

September12th may be seen on the Internet at **//oposite.stsci.edu/pubinfo/Pr/gif/** and **../jpeg/**

Malin Space Science Systems and the California Institute of Technology (CALTECH) built the Mars Orbiter Camera (MOC), acquiring images one line at a time. Late afternoon clouds and hazes concentrated within canyon systems have been observed. The first orbital images of Mars in over 20 years have shown stunning geological features. Initial data has revealed a canyon deeper than Arizona's Grand Canyon and mountains taller than Everest. The MGS camera has noted two regions of special interest, a highland valley network called Nirgal Vallis, and Labyrinthus Noctis, an area west of Valles Marineris. Nirgal Vallis is about 9 x 27 miles, with small sand dunes and various aged craters. Scientists are interested in the processes that helped shape the canyon. Labyrinthus Noctis has large 6,500ft canyons bounded by faults, with huge amounts of debris fallen from its steep slopes. Surprisingly large areas from the Northern plains down to the equator are extremely flat, varying only a few metres every 100km; the only place on Earth with similar flatness is the deep ocean floor which indicates that these regions may be ancient seabeds. If this is the case they will be targeted for future exploration. It is thought that vast amounts of water are still stored within the porous Martian crust beneath a layer of surface ice.

MGS was launched from Florida on November 7th, 1996 weighing 1062kg and built by Lockheed Martin Astronautics. The mapping phase began in mid-March 1998; during mapping the spacecraft circles Mars every 118 minutes at an average altitude of 235 miles. After mapping finishes in January 2000, the spacecraft will function as a relay satellite for data back to earth from future landers. Dr Gerald Keating of the George Washington University Atmospheric Advisory Team has shown that upper atmospheric density varies between day and night by up to 70% with densities 500% higher than when Pathfinder entered the upper atmosphere. Density profiles were acquired daily to aid aerobraking. According to Dr Arden Alba at CALTECH, "The initial science data we've obtained from the walk-in phase of aerobraking are remarkable in their clarity, and the combined measurements from all of the instruments over the next two years are going to provide us with a fascinating new global view of the planet." The spacecraft's thermal spectrometer detected a high of -7°C during October over the warmest part of the planet and also recorded sub-freezing temperatures at the south pole, a chilly -129°C!

Pathfinder's successfully demonstrated low cost lander delivery and a free-ranging Martian rover. Further rovers and landers will share the same designs and technologies tested during this 'pathfinding' mission. In-situ rock measurements taking about 10 hours to obtain were made. By comparing APXS analysis with rock coloration MGS may spot large regions with the same characteristics from orbit.

## "Better, Faster, Cheaper" Design Philosophy

It is easy to compare Pathfinder with the two Viking missions 21 years ago. Viking cost $3 billion in 1997 dollars and was as customised as Pathfinder was built off-the-shelf. Pathfinder cost $171,000,000, Sojourner only M$25,000,000, and even MGS carried a price tag of only $152,000,000. Of course Viking's main goal was to search for life, and so each Lander carried a $50,000,000 biology lab with 40,000 components fitted in a 1ft3 box. In one test, the famous Gas Exchange Experiment (GEX), soil dampened with nutrient broth gave off a large burst of oxygen, but it was concluded that the event was due to an exotic artefact of alien soil chemistry rather than living organisms.

When Goldin took over NASA in 1992 he knew that big budget spending was no longer an option. In the place of grandiose missions new ships would be stripped down to the bare minimum and built from available off-the-shelf parts containing only a handful of systems. The result was felt immediately, with the average cost of a single unmanned spacecraft plunging from $590,000,000 between 1990/1994 to $190,000,000 today; Goldin hopes that this may be reduced to $74,000,000 early next decade. "Because the spacecraft costs less, we do them faster and we have more in number." Three Lander/Orbiter pairs will be sent to Mars in 1998, 2001, and 2003. In 2005 a rover will collect its own samples but NASA has delayed the launch of its first round trip mission which was to return to Earth a few handfuls of rocks and soils.

The 3rd probe in the Discovery series that supported Pathfinder is the $62,000,000 4ft Lunar Prospector launched on January 5th, built within the three year start to launch plan and derived from the Iridium low-Earth orbit satcom system. According to Goldstein 'We are going to have the most aggressive exploration of our own solar system in the history of the human species.' The probe was sent to search for conclusive evidence of water, suggested from a 70 day radar mapping by the Clementine probe launched in 1994. Original data indicated a body of ice, possibly 50km², enough to supply water, fuel and oxygen for future moon scientists. In addition to searching for water Prospector carries a Gamma Ray Spectrometer (GRS) providing maps of the major surface elements which emit g-rays, and neutrons with a Neutron Spectrometer (NS) from elements like aluminium, titanium and uranium. Prospector also contains an alpha particle spectrometer (APS) and orbits every 118 minutes. It uses a sensitive MAGnetometer and Electron-Reflectometer (MAG/ER) to map magnetic fields likely to be associated with economically viable ore bodies. Compositional mapping will be made over a year using GRS. APS will measure the outgasing of radon and polonium from volcanic activity, whilst MAG/ER determines the direction and strength of the distributed field, and NS measures the fingerprint of water ice.

The 660lb Lunar Prospector was launched on an Athena 2 rocket and confirmation of water was found in the Aitken South Polar crater and at the North pole shortly after mapping began. According to Bill Feldman, Spectrometer team leader at Los Alamos, if there is sufficient water there will be a land rush. Water is the key source for life support as well as for travel from the moon to the planets.

NASA would also like to send a probe to Jupiter's moon Europa. Pictures from the Galileo space probe suggest a water ocean beneath Europa's icy surface. A probe could photograph the surface from 60 miles up and take radar soundings for water. If the radar detects the characteristic water signature another spacecraft may be sent to release a small probe to drill through the ice and look for signs of aquatic life.

The next NASA Discovery mission is Stardust, launch date February 1999, whose aim is to bring back dust from comet Wild 2 in 2004. A further two missions have been added since the Discovery series was created. Genesis will collect charged particles from the solar wind and return them to Earth. The last mission, Contour, will return cometary data over a five year period from its aimed launch data in July 2002.

Goldstein believes people could land on Mars before 2010, but to do so new technologies must be developed to cut mission costs. According to Robert Zubrin, a former senior engineer at Lockheed Martin and author of The Case for Mars, The Plan to Settle The Red Planet and Islands in the Sky a Mars Mission could be achieved for $20-30billion, or 10% of NASA's current budget over a 20 year period.

NASA has advanced plans for its Mars Surveyor Orbiter 2 and Lander 2 missions for launch in December 1998 and June 1999 respectively. Lander 2 will carry a small advanced rover capable of travelling 100km. The rover will transport a package called Athena, an integrated suite of instruments to conduct in-situ surface analysis. It will collecting core samples for possible future return and a GRS. Athena will investigate geological and climatic history of the ancient Martian highlands where conditions may preserve fossil evidence. Stereo imagery will help identify mineral composition; a Mossbauer spectrometer will measure the fine-scale texture of the surface, and a mini-corer will 'bore and store' samples for future collection.

A new probe is currently on its way to Mars, the Planet-B, launched from Japan. This is the first Japanese interplanetary mission and has generated some excitement among the Japanese public – although dulled by the recent economic crash and election. The launch states Japan's bold ambition to develop lunar colonies and promote space tourism. However, the Asian recession, combined with a shrinking scientific budget will restrict this plan severely. Evidence of this is seen in the postponement of Japan's first space shuttle launch until 2003. Planet-B carries instruments from Japan and four other countries which will take data over a two year period to try and discover what has become of the 'missing water' that should be there. Even after Pathfinder's 2.3Gbits data and 17,050 pictures Mars is only now just beginning to give up its secrets!

See websites: **/www.jpl.nasa.gov** and **www.marsweb.jpl.nasa.gov** for MGS and Mars Pathfinder information and Science Vol 278, 5 December 1997.

# COMMENT

**by Keith Brindley**

We are about to be bombarded with television channels. They are about to be thrown at us with all the power that the broadcasting barons can muster – as if our lives depended on them as, indeed, theirs probably do. Digital television, as you might have already guessed is what I'm talking about here, is probably the single most effective euphemism for wall-to-wall pap that has ever graced the English language.

In 1979, Pink Floyd's excellent album *The Wall* told the story in music of an English pop star who toured the US. One track *Nobody Home* sets the scene of the pop star having the misfortune of watching hotel cable where there are no less than thirteen channels of trash on the TV to choose from. Actually, trash wasn't quite the word used to describe the channels' content, but I'm sure the lyricist Roger Waters won't mind me slightly misquoting the song for the purposes of the *Electronics and Beyond* readership. But, the idea stands. Too much of anything good is a bad thing.

In the UK we have the fortune of having five high quality mainstream non-digital television channels. Yes, I know that there's rarely anything on these five channels that anyone in particular wants to watch at any particular time (and this really proves my upcoming point, when you think about it) but high quality they remain. These are delivered by terrestrial means, that is, a land-based transmitter broadcasts the signals for these channels to land-based aerials positioned close to users television sets. On top of this there are over twenty UK television channels of a non-digital nature broadcast from satellite – several satellites actually – at geostationary orbital positions around the earth. Some of these non-digital satellite television channels are also mainstream, but some segment off into subdivisional areas such as several sports channels, a few news channels, a handful of movie channels, and so on. So here we are with already approaching thirty television channels which by any standards is a significant choice. After all, you can't watch more than one at the same time. OK, you can record one channel on a videocassette recorder to watch at a later time if you wish, but that means you're missing the live channels while you're watching your recorded programme, anyway. True also, digital offers picture-in-picture abilities (where another channel can be viewed in small window in the corner of the main television screen), but to watch what's in that picture-in-picture window you're not actually watching the main picture are you? So, the fact that no-one can deny is, you can only watch one channel at a time!

However, after these facts, things now start to get a bit woolly. For all this choice, do we have any more on these channels that we actively want to watch. Possibly for sports enthusiasts. With the best will in the world, the five terrestrial channels probably can't cope with the range of sports the extra satellite channels offer. Maybe movie enthusiasts can't get enough of good quality movies on the five earth-bound channels too. News coverage on a 24-hour basis suits some people also. But after this, what else do we want? What else can we possibly require of television channels?

More sports: a soccer channel, a cricket channel, a rugby league channel, a rugby union channel, a basketball channel, a chess channel? More news: UK news channels, world news channels, financial news channels, sports news channels (after all, if you're not actually watching a sports channel you might still want to know who won). Leisure channels: a front garden channel, a back garden channel, a house decorating channel, a DIY channel (that's a channel for DIY enthusiasts, not how to make your own channel, if you see what I mean), a how to make your own channel channel?

Daft as it seems, these are the sorts of choices digital television will bring to us all. BskyB's digital service (*service* is possibly another one of those broadcasting euphemisms) will offer well over 100 channels from its outset. Terrestrial digital television channels from *OnDigital*, when its service (there's that euphemism again) starts, will account for many more. Eventually, we are told, there will be some 500 digital channels available for us to watch.

But will we want to watch any of them? The problem, and we have already seen this starts to occur with BskyB's non-digital television channels, is that the programming budget is limited. This means that good quality programmes are thin on the ground in between the not-so-good (and the downright poor) quality programmes that fill up the ever-increasing space between the first-rate movies, the premier league football matches and, oh yes, we musn't forget the *another chance to see* (yes! another broadcasting euphemism) repeats of last year's (and last decade's, for that matter) good quality and not-so-good (and the downright poor) quality programmes.

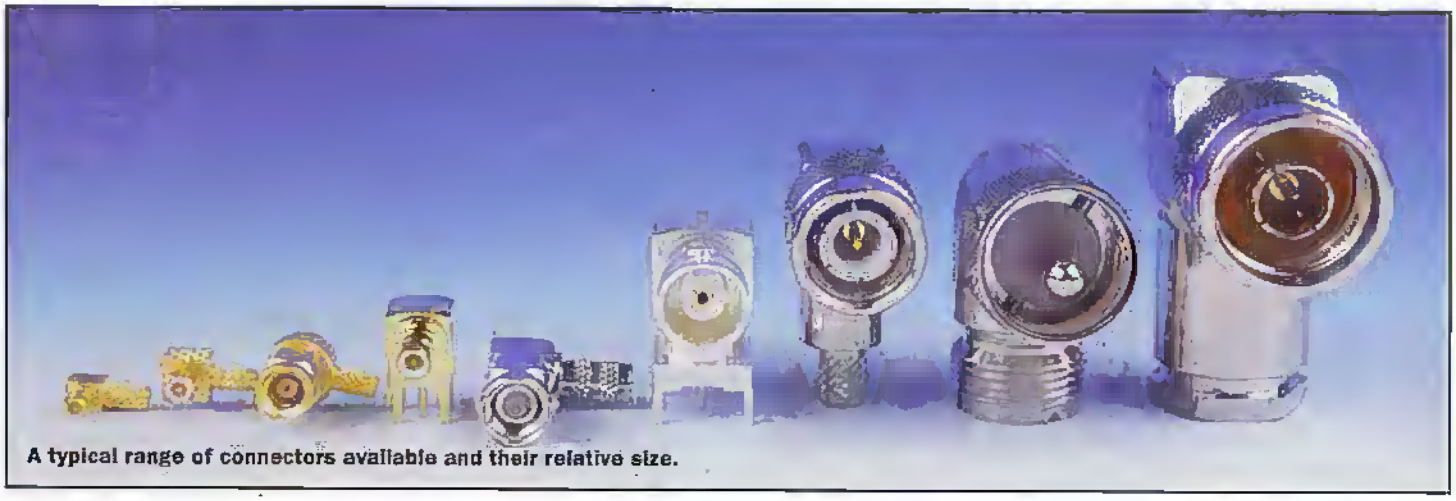
Finally, it should be remembered that these extra channels come at a price. Somebody's got to pay for them, after all. BskyB's existing pricing structures are already quite high. Currently, well over £20 a month for even pretty basic packages. To pay for more than a hundred the price will be even greater. I'm not talking about now. There'll be all sorts of special deals and low pricing structures to grab the consumer over the next year or so, but the eventual price consumers pay could be significantly higher. If you've followed (and even paid for) BskyB's pricing over the years you'll have noticed a roughly three-fold increase in monthly subscriptions since it started broadcasting. Nobody will convince me that such a rate of increase won't be similarly applied to digital television channel subscriptions over the coming time.

And, if consumers buy into one digital television system, why not buy into the other? And why not cable too? What is the price when consumers feel they have good value for all these channels? £30 a month? £50 a month? What is the price when consumers feel they don't have good value for money? £60 a month? £100 a month? For all the headlong rush into digital television these are all important questions broadcasters have left unanswered.

I'll leave you with Brindley's law to sum up this month's column. This states that '*the more channels there are the thinner the programming becomes*'. This is apparent with only thirty existing non-digital channels. How thin can it get? Watch a digital television screen near you to find out.

# Making The Right CONNECTION

*Bruce Burton, Managing Director Vitelec Electronics Ltd, explains some of the coaxial connector choices available.*



A typical range of connectors available and their relative size.

RF coaxial connectors are commonly used for the interconnection of high frequency signals in products such as cellular communications, data telemetry, personal communication systems and global positioning systems. Vitelec Electronics Ltd offer engineers whose own products are demanding high frequency performance, connectors that provide mechanical integrity and reduced product size and production costs.

Prior to 1960, only two classes of coaxial connectors existed. These were standard (N, UHF, etc.) and miniature (BNC, TNC, etc.). Whilst the BNC has become the most widely used and known, these connector types were developed for much larger cables (typically RG58, RG59, RG11, etc.) and circuit enclosures than those used in many of today's RF and microwave applications. Subminiature connectors were developed following the creation of the MIL-C-39012 specification which gave manufacturers the freedom to develop innovative ideas whilst still adhering to industry accepted standards. Subminiature connectors now have the highest volume demand of all coaxial types, the most recognised being SMA, SMB, SMC and MCX.

The SMA type is the most popular of the subminiature connectors and has a threaded coupling which provides excellent mechanical integrity and high frequency electrical performance up to 18GHz. It has become a standard input/output connector for many RF and microwave products and can be terminated on small cables such as RG174, RG316 and RG178. SMB and MCX connectors have snap-on mechanisms. The SMC has an identical interface to that of the SMB but has a threaded coupling nut which increases its operating frequency from 4GHz to 10GHz. Vitelec's range of subminiature connectors are often gold plated, as high frequency signals travel very close to the outside of the connector body and an excellent conducting material is therefore required. At lower frequencies (2 to 3GHz) this is not so important and the connector body can be nickel plated, allowing a reduction in the connector cost. Figure 1 shows the operating frequency range of subminiature coaxial connectors. Figure 2 shows the typical voltage working.

## Cable Fixing Connectors

The performance of a system involving coaxial cable is usually determined by the cable specification, and the connector is then chosen accordingly. Most small, flexible coaxial cables perform well up to 2 or 3GHz which is adequate for many video and data applications. The connector can be terminated on the cable by the equipment manufacturer using crimp or soldering tools. For maximum performance in high frequency applications, connectors can be terminated to semi-rigid cable and this is then shaped to fit the specific equipment enclosure or environment. SMA connectors

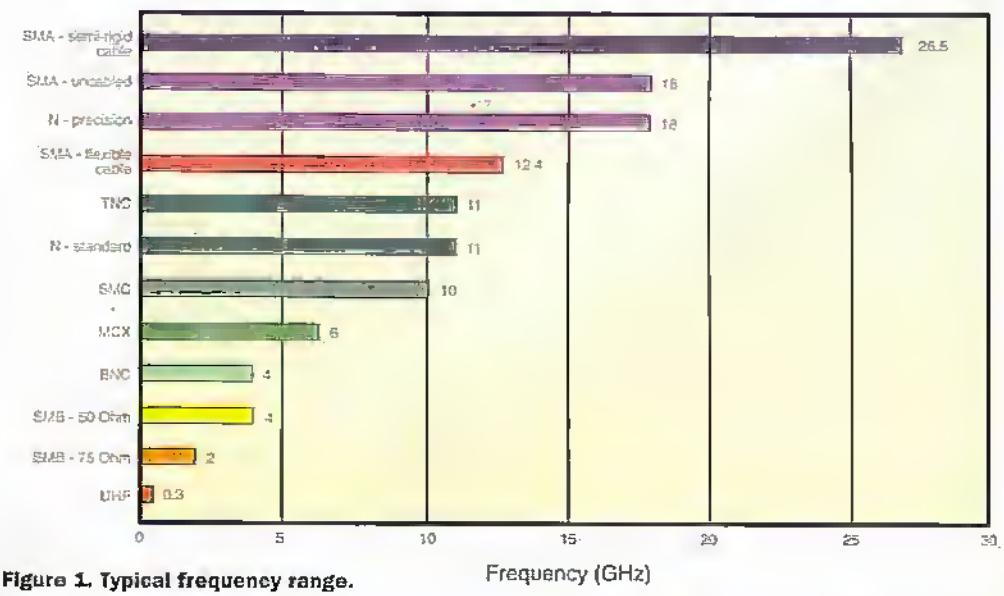



Figure 1. Typical frequency range.

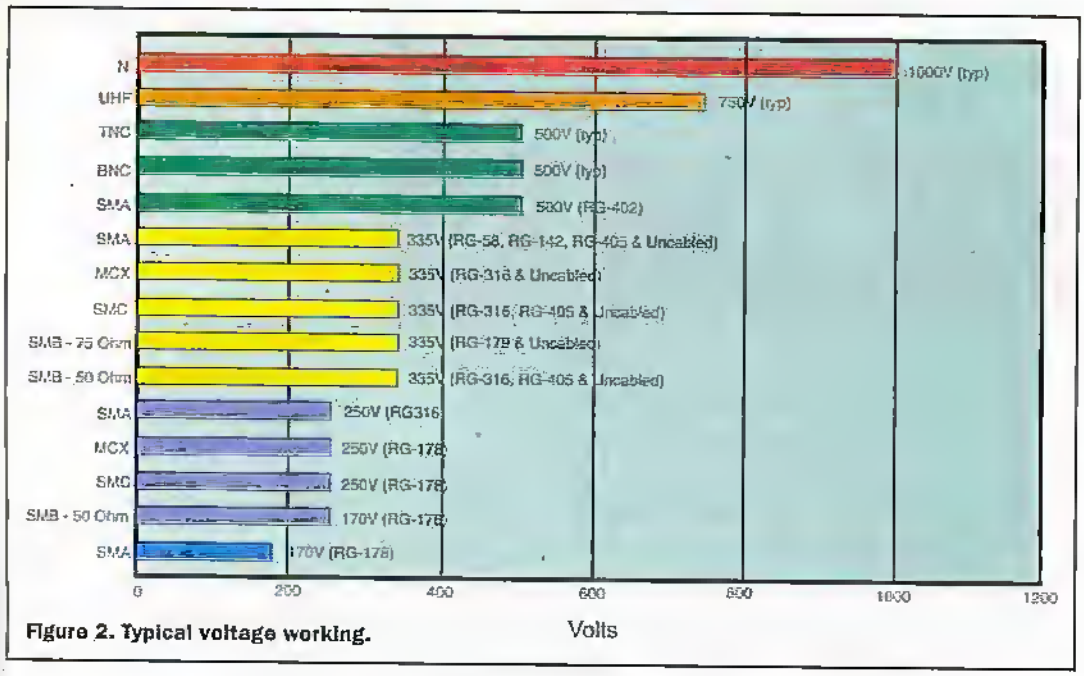



**Figure 2. Typical voltage working.**

are best suited for semi-rigid cable because of their high frequency capabilities. They are also well suited to test and measurement applications where individual flexible cable assemblies need to be supplied with performance plots to ensure accurate monitoring and calibration. This group of cable assemblies are produced by the connector manufacturer, as special production tools and test equipment are required.

## Board Level Connections

Traditional methods for connecting high frequency signals to a printed circuit board use panel mount or flange mount connectors. These are mounted on the equipment casing and coaxial cable is then used to run from the back of the connector to the PCB. Very good electrical and electromechanical results can be achieved if the integrity of the coaxial connection to the board is maintained, but the production process must be carried out by hand and may require a skilled operator. Mounting the connector directly onto the PCB and passing the coupling face through a cut-out in the chassis is now the most popular method for volume production. Miniature and subminiature connectors are available in right angle or vertical PCB mounting variations. Vertical PCB mounting connectors offer the best VSWR characteristics because there is no bend in the centre contact and therefore a constant impedance is easily maintained. However, many equipment housings require inputs/outputs at the rear or front and this is often at right angles to the main PCB. Drilling the board is currently the most popular method of fixing the connector to the PCB. The connector mounting posts and centre conductor are then soldered to the board either by hand or as part of the automated process.

## New Design Solutions

Vitelec has developed a range of surface mount subminiature connectors in response to the growing trend in surface mount production automation. This connector is also available in vertical and right angle variations and is fixed to pads on the PCB using a flow solder process, therefore eliminating the need for board drilling and reducing the overall cost of installing the connector. A new 'End Launch' variation has recently been developed which also uses the surface mount technique for connecting to the PCB. This connector straddles the edge of the PCB and is fixed to pads on both sides of the board providing a rugged connection and preserving valuable space on the board. The centre conductor approaches on the horizontal plane and is aligned with the signal trace on the PCB without travelling through a right angle. This results in a reduced VSWR and optimum performance over the connector frequency range.

## Future Applications

A new group of RF coaxial connectors has appeared over the last five years and are classified as microminiature. As the name implies, they are smaller than subminiature connectors and in many cases are scaled down versions of them. Industry standards do not yet exist, however wireless communications such as cellular and global positioning are accelerating the demand for microminiature connectors. Vitelec has developed a new range of MMCX microminiature coaxial connectors to meet this growing requirement.

**Maplin stock a wide range of Vitelec connectors. Please see the 'connectors' section of the latest Maplin Catalogue/ CD-Rom for types and prices.**

**Close-up of BNC plug with gold centre pin.**

**Close-up of PCB mounting BNC socket showing nickel plated connector.**

# Electrical SICKNESS

***Scientists have identified a lethal electrical sickness within the atmosphere caused by an imbalance of positive and negative ions. The bad news is that in our increasingly industrialised society, the situation is getting worst. Here Stephen Waddington investigates its effects and examines ways of redressing the balance.***

Always be suspicious of an article that starts with a note of caution from the author. This article is one such example. The subject of ionisation is complex. It is a topic that has so far baffled the scientific community with the effects of ionisation on human beings explained in subjective rather than theoretical terms. But there is now a huge body of evidence suggesting that a certain of type of net charge in the atmosphere has a positive effect on human beings.

This evidence cannot be ignore, even if scientists have failed so far in their attempts to prove a theoretical connections between electrical imbalances in the atmosphere and biochemical effects on human beings and other life forms. This article examines the evidence and leaves readers to draw their own conclusions.

## What is an Ion?

Ions are charged particles in the air that are formed when enough energy acts upon a molecule such as carbon dioxide, oxygen, water, or nitrogen to eject an electron from the molecule, leaving behind a positively charged ion as shown in Figure 1. The displaced electron attaches itself to a nearby molecule, which then becomes either a negatively or positively charged ion depending on the original charge.

Outdoors, ions occur naturally at typical levels of 3,000 positive and 4,000 negative ions per cubic centimetre. Indoors there are very few negative ions and the balance is mostly positive ions. The reason for this is that negative ions exist for a short length of time. They are destroyed by air pollution, while hot electrical discharges such as sparking, electric motors and furnaces generate an excess of positive ions. Figure 2 summaries typical levels of positive and negative charge in a series of common situations.

Prior to the industrial revolution, scientists believe that the net charge of the atmosphere was negative – today there is no doubting that it is positive. Scientists are in agreement with the fact that the release of air pollutants has resulted in a positive charge in the surrounding atmosphere. Even the air in open country areas is predominantly positive because of the spread of pollutants in the wind from town and city areas.

## Effects on People

When certain kinds of winds, know as 'witch winds' blow throughout the world such as the Foehn in Austria or central France and the Desert Wind in Australia, hospital admissions, suicides, and crime rates skyrocket. These notorious desert and sea winds are also linked to minor illnesses and malaise epidemics. Victims' claims range from sleeplessness to irritability and from palpitations to migraines.

But it's within towns and cities that the lethal doses of positive ions truly lie. Car exhausts, factory fumes, tire dust, cigarette smoke, cooking and heating fumes, dust and soot all suck-up negative ions, either neutralising or positively charging them. Inside, steel and concrete buildings act as electro-magnetic Faraday cages, absorbing the charges of negative ions. Synthetic building materials, clothing and furniture coverings eat up more as do the metal ducts covering heating and air conditioning outlets. The resultant negative ion count may be below 100 per cubic centimetre.

## Humidity

In humid areas, such as the London underground or the centre of Birmingham during the summer, part of the familiar discomfort is caused by the fact that air becomes ion-depleted. Really humid days are distressing for anyone suffering from asthma or any respiratory allergy, and the fact that such people find it difficult to breath in hot, humid air may have less to do with the amount of oxygen in the air than with the massive negative ion depletion. Electricity in the atmosphere is quickly conducted to the ground by the moisture in the air, and what negative ions there are attach themselves to particles of moisture and dust and lose their charge.

## Pollen

The ion count is always low in cities where there's precious little open ground to generate them. Pollution makes a bad situation worse, since it tends to deplete the negative ion count even more. The high pollen count in certain parts of the South of England each summer cuts even further into the negative ion count, since pollen has the same effect as dust. The end result is that the total ion count in cities is always down to what many scientists consider perilously low levels.

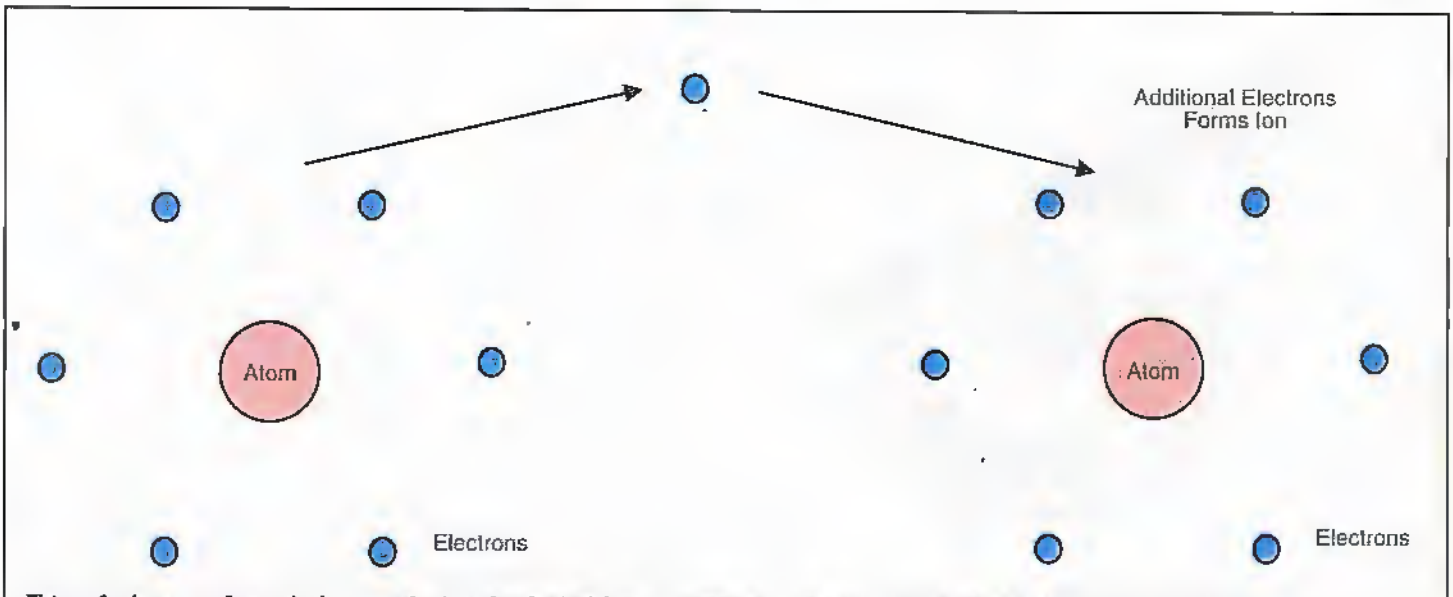



**Figure 1. Ions are formed when an electron is ejected from a molecule, and then reattaches itself to another molecule.**

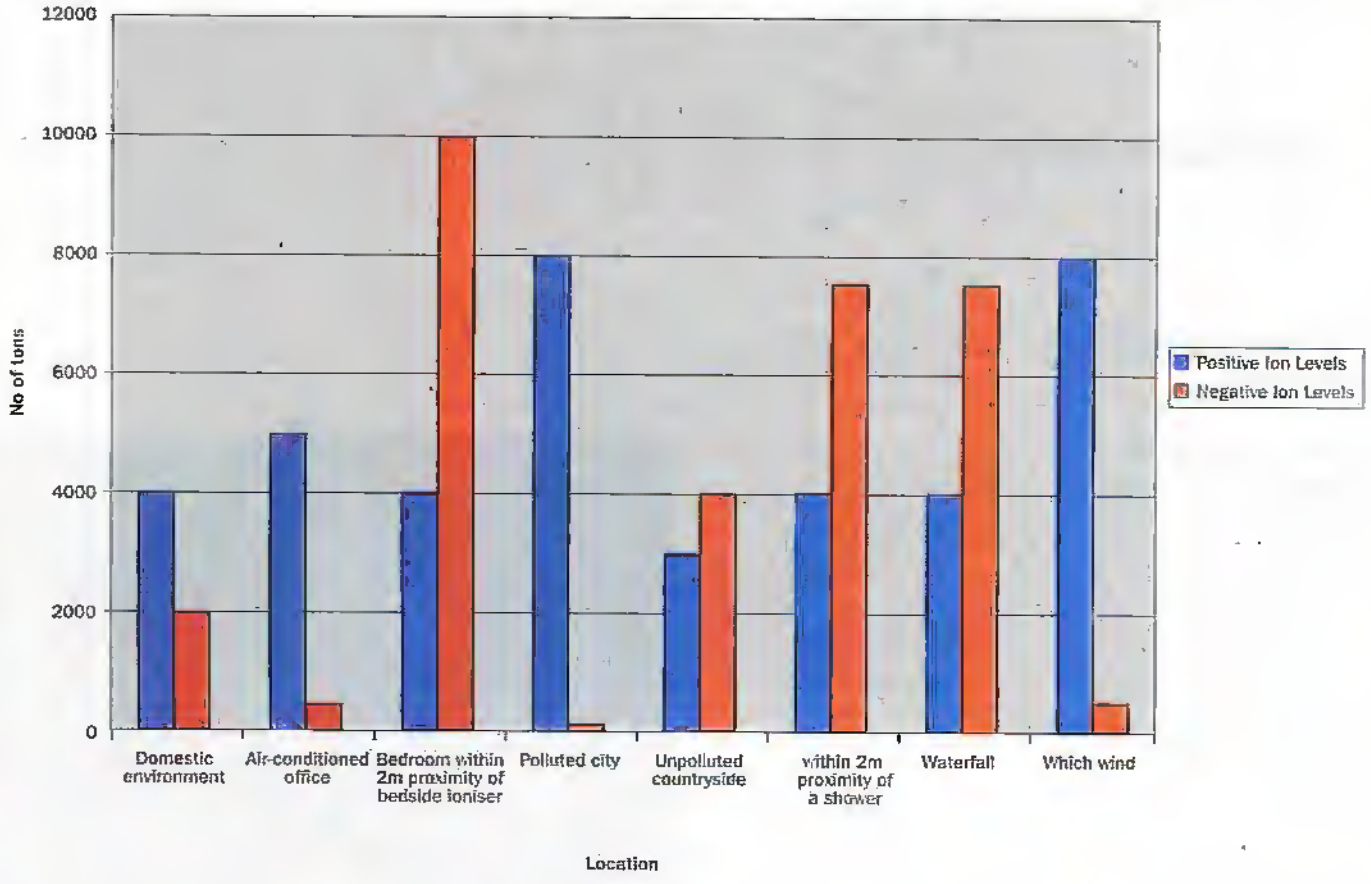



**Figure 2. Typical levels of positive and negative charge in a series of common situations.**

## Central Air Conditioning and Heating

Hot or cool air forced through the duct work of most central heating and air-conditioning systems sets up friction that results in the loss of almost all the negative ions and also draws most of the positive ions out of the air as well. This air with some positive and virtually no negative ions is forced out through vents in to rooms, offices and passages – and as it passes through the vents more friction is set up that generates an additional overload of positive ions. What finally comes out of most heating or air-conditioning systems is likely to be an overload of positive ions which will upset the mental and physical equilibrium of everyone, not only those of us who are ion sensitive.

## Body of Evidence

Do you feel good when you're in the country? Most of us have experienced this positive effect, regardless of our proximity to waterfalls or the ocean. Every home has a built in, natural ioniser in the form of a shower. Our daily bathing rituals can be, in effect, the practice of preventive medicine. Research has shown that falling water creates thousands of negative ions by splitting otherwise neutral particles of air, freeing electrons to manifest their vitalising function. These electrons join up with smaller air particles, thus giving them a predominantly negative charge.

Negative ions promote alpha brain waves and increase brain wave amplitude, which translates to a higher awareness level. Induced alpha waves spread from the occipital area to the parietal and temporal and even reach the frontal lobes, spreading evenly across the right and left brain hemispheres, creating an overall calming effect. On the physical side, negative ions have given relief from hay fever, sinusitis, bronchial asthma, allergies, migraine and burn and post-operative pains. They lessen infections, dry the burns faster and heal them more quickly and leave less scarring.

| Product | Code | Price |
|---|---|---|
| Classic Ioniser | WC11M | £19.99 |
| Pyramid Ioniser | WC12N | £22.99 |
| Pyramid Ioniser with dust trap | WC29G | £39.99 |

**Table 1. Ionisers available from Maplin**

## Biochemical Analysis

You could be forgiven for believing that this article is the analysis of New Age proponents or alternative medicine fanatics – it's not. But there is still the question, why are ions therapeutic?

There is no one answer to this question. Negative ions are therapeutic partly because they kill germs. Back in the 1930s. A Russian team of scientists found that large ion doses of either polarity retarded bacteria colony formation on plates. Ionisation also sterilised enclosed air. Latter experiments duplicating work noted an exponential bacteria decay rate of 23% per minute for untreated air 34% per minute for air with positive ions and 78% per minute for negatively charged air.

Animals larger than microbes find negative ions beneficial. Rats learn better and are less anxious. Mice live longer. Silkworm eggs hatch earlier, larvae grow faster, spinning begins sooner, and cocoons are heavier. Chickens lay more eggs and grow plumper. Sheep grow faster and supply more wool. And in the vegetable kingdom plant seedlings grow up to 50% more when charged. Fruit stays fresh longer, after 10 days, ionised tomatoes were still fresh while untreated controls rotted.

Convinced yet? One of the reasons that individuals have difficulty grasping the concept of ionisation and its potential effects on human beings is because scientists have failed to prove – or explain – any direct connections. The majority of the justification to date is all based on circumstantial evidence.

In humans, most researchers think that negative ions act on our capacity to absorb and utilise oxygen, accelerating the blood's delivery of oxygen to our cells and tissues. A research team at the University of Milan says they make wider cell nuclei with more volume, and test negative ions sound too much like a cure-all. testers report that negative-ions work only so long as they're being inhaled. As the charge is most readily absorbed through the olfactory nerves, you need to breathe them in through your nose, not your mouth.

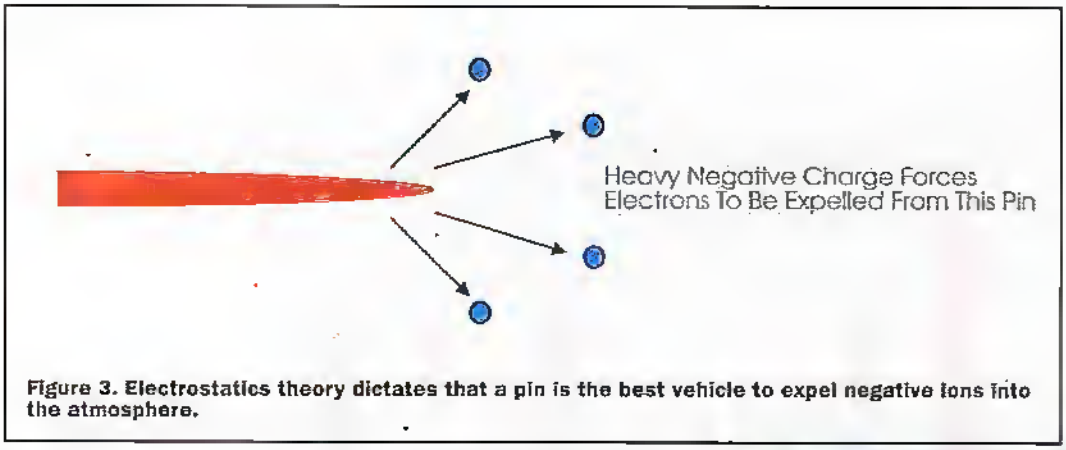



**Figure 3. Electrostatics theory dictates that a pin is the best vehicle to expel negative ions into the atmosphere.**

Negative ions are released into the atmosphere via a series of sharp pins on the ioniser. Because of the relatively large surface area, but small volume, negative ions build up on the top of the pin, until it becomes saturated, at which point they are expelled into the atmosphere as shown in Figure 3. This process is assisted by virtue of the fact that the surrounding atmosphere is likely to have a net-positive charge and thus negative ions are attracted away from the ioniser pins towards the positive source.

## Redressing the Balance

So what can be done to redress the balance of negative ions in the atmosphere? In nature, ions are formed in a variety of ways. About half are created by radioactive gases. Radioactive substances in the soil, cosmic rays, ultraviolet rays, air flow friction, falling water and plants all produce the other half. For example, they stream off the leaves of plants, most notably pines and asparagus ferns.

The artificial addition of negative air into the atmosphere has the potential to reduce the concentration of airborne microorganisms. The effect appears to result from the ionisation of bio-aerosols and dust particles that may carry microorganisms, causing them to settle out more rapidly. Settling tends to occur on horizontal surfaces, especially metallic surfaces, and generally in the area near the ionisation unit.

## Artificial Ion Generation

Just as positive ions can be generated artificially by pollution, so negative ions can be man made with negative ion generators. Indoors, the artificial production of negative ions by a device called an ioniser or an ion generator is a highly effective means of adding negative ions into the local atmosphere and thus redresses the balance between negative and positive ions.

One of the challenges for the designers of ionisers is that by their very nature, ions do not travel much beyond the emitting orifice of the device. Recombination occurs so close to the source of generation that they have little or no effect several feet away.

In the UK, Charles Topley, a retired electrical and mechanical aircraft designer has patented several inventions and developed a negative ion generator, which he believes is the most effective yet devised.

In the home, Topley claims that the viewing surface of a television set gives off into a room, electric emissions ranging in magnitude from about 7,000V to about 11,000V. These emissions, he says, have the effect of producing a positive charge into the air and on the surface of all items within immediate range of the TV.

But upon switching on a negative ion generator, and measuring the ratio of small air ions in the room, Topley claims that the meter moves gradually away from a positive reading, towards neutral, and eventually registers a full negative reading as the negative ion saturation of the room becomes complete.

Although most people in the UK are not ion-wise, generators have been popular elsewhere in the world for decades. In World War 11, Luftwaffe planes were negatively ionised by electric field generators, in order to reduce pilot fatigue. And it's believed to have worked. Electric field generators are like female ion generators: instead of ejecting ions, they attract them.

**Photo 2. Maplin Order Code: WC12N.**

## Commercial Products

Ionisers use a series of diodes and capacitors in a voltage charge pump arrangement to amplify mains voltage up to 5,000V or more. While a high voltage is needed to generate ions, literally zero current is required to release the ions into the atmosphere. Ionisers therefore include a series of protective resistors to ensure the current is reduced the fractions of a micro or even pico amp.

**Photo 1. Maplin Order Code: WC11M.**

If you check out your Maplin catalogue or CD-ROM, you'll see that Maplin stock a whole series of ionisers as shown in Table 1. The most popular is the Classic Ionise as shown in Photo 1, which injects ions into the atmosphere from a series of pins, hidden behind a grill. It has an effective range of 5m and features very low running cost, typically less than 1p a week. The Pyramid Ionise meanwhile as shown in Photo 2, is a powerful pyramid-shaped device with five high output ionisation streams. The device has an effective range of 5m and is also available with a combined dust trap.

## Measurement

Finally, there is the issue of determining their effectiveness. A typical generator may supposedly churn out 100 billion ions per second. But how many of them survive a yard past the machine? Ionisers need to be used carefully. Within a room the ion concentration varies a lot depending on how far you are from the generator, from conducting walls, from charge build-up on insulating walls, and from curtains etc.

# Software HINTS & TIPS

***In a break from our usual tips on how to make time on your PC more productive, Mike Bedford takes a light-hearted look at Easter eggs.***

In the main, this column is all about the serious business of getting the most from your software tools. However, there's also a less serious side to personal computing and I don't just mean games and multimedia applications. Most serious applications include some undocumented features which have been cunningly hidden by the application developers. Knowing about these so-called Easter eggs won't make you any more productive but I trust you'll find this month's column no less fascinating.

## Why are they there?

You might well wonder why applications contain undocumented features. In the early days, Easter eggs were called gang screens and listed 'the gang' i.e. the development team. Software houses didn't want the About window to be cluttered up with dozens of names so they didn't allow the gang to credit themselves. But the developers found their own way of getting into the limelight, with or without their employer's approval. Whether the convoluted means of causing these screens to be displayed was to prevent their employer finding out about the screens until it was too late, or whether it was to provide a curiosity for the user is unsure. What I can say, however, is that many of them would never have been discovered by the user community had the developers not leaked details. Today, software houses seem to tolerate the practice.

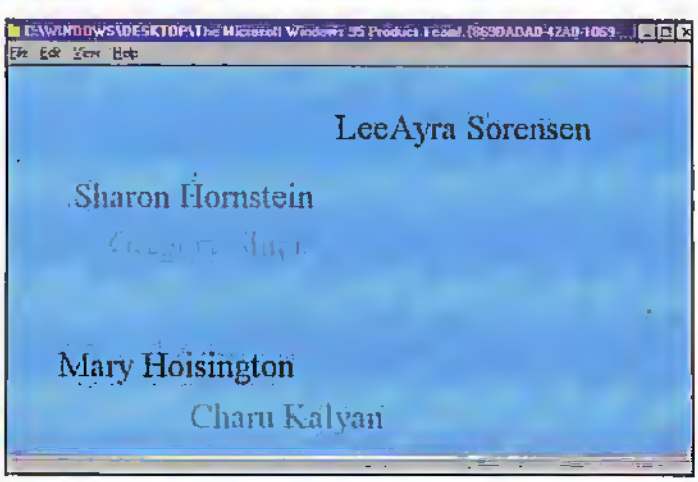
## A Simple Example

If you've got a copy of CorelDraw you can easily find a list of the people responsible for its creation. With minor variations, this works with most versions. From the Help menu, select the About CorelDraw!... option to display the About window. Now double click on the hot air balloon logo. If nothing happens, try holding down some combination of shift, control and alt first – there are slight differences between versions. All being well, the screen will clear and a hot air balloon will appear at the bottom. Hold down the left mouse button and, after a while, the balloon will rise, dragging with it a list of the team. With later versions, pressing the right mouse button will cause a firework display. Oh, and if you click on the square icon to the right of the About screen rather than the balloon at the left, clicking the right mouse button will cause Elvis to parachute down the screen instead of the firework display.

## Convoluted Commands

OK, perhaps the CorelDraw! Easter egg is undocumented and perhaps it requires a mildly unusual sequence of commands but if you suspected it was there you'd probably have found it eventually. This is the one Easter egg which I found for myself. But this doesn't apply to all Easter eggs. Unless you were told how to find the Windows 95 gang screen, I'm pretty sure you'd never find it. In fact, it lives in a folder called "The Microsoft Windows 95 Product Team!" (without the quotes) but you won't find it on your PC – you've got to create it yourself. And what's more, you've got to create it in a very specific manner. If you want to have a go, here's what to do. Click with the right mouse button on the desktop and select New and then Folder from the menu which is displayed. A new folder with a default name is created. Now, rename the folder as "and now, the moment you've all been waiting for". Next rename it to "we proudly present for your viewing pleasure". And finally, rename it a third time, now to "The Microsoft Windows 95 Product Team!". In all these names, do make sure you use the exact text shown, together with any capitalisation and punctuation. Double click on the folder and you'll see the credits as shown below, complete with musical accompaniment.

If you want something even more bizarre, how about trying the Excel 97 Easter egg? Start with a new workbook. Press F5 and in the Go To window which is displayed, type 'X97:L97' and click on OK. Now press the Tab key once, then hold down the left shift and control keys and click on the chart wizard icon. You'll be whisked away into a purple landscape which you can fly around using the mouse and amidst which you'll find a huge screen with rolling credits.




The commands to display the Word 97 gang screen are only slightly less arcane. Start with a new document and type the word 'Blue' (without the quotes but with a capital B). Make the text blue (as opposed to dark blue) and bold. Put the cursor at the end of the word and type a space. Now, select the About option from the Help menu and click on the logo to the left of the About window. I won't tell you exactly what happens – try it for yourself to find out.

## Accidental Eggs

Whereas many of the undocumented features in applications are put there for a bit of fun, others appear to be test features which the developers have forgotten to remove. I suspect the next one comes into this category.

If you have difficulty in winning at the Minesweeper game which comes with Windows and you happen to be using Windows 3.11 still, then the next example might just be what you've been looking for. Unfortunately it doesn't work with Windows 95 or 98.

Before you start playing the game, hold down the shift key and type XYZZY. Release the shift key and press it again. Now, if the reports are correct (I don't have Windows 3.11 anymore) the top left hand pixel on the screen will go dark whenever you move the cursor over a square containing a mine.

## Finding New Eggs

In most of these columns, I've given detailed instructions to give you a feel for the facilities offered in a particular area. I've then concluded by suggesting that you experiment yourself to discover further features. I'm loathe to do that in this case since there's scope for wasting vast amounts of time without actually doing anything useful.

However, if you do find the idea of hidden functionality in your applications to be an intriguing one, then you'll find that there's a wealth of information of the Web to cater for your 'habit'. Just fire up your favourite search engine and type in 'Easter eggs' or 'gang screens' and you'll find plenty of interesting pages detailing exactly how to get them to reveal themselves.

# YOUR BATTERY GUIDE

***The photograph above right shows a voltaic cell. This curious device consists of a brass screw and an aluminium screw inserted into a strawberry. It generates almost one volt but allows virtually no current to be drawn. Just as the strawberry battery is not very useful for most jobs, Mike Bedford guides you into getting the right battery for the right job.***

**Rechargable Alkaline Manganese cells.**

The fact that any pair of dissimilar metals placed in a conducting ionic electrolyte will generate an electric current has been known for well over 100 years – you probably remember learning about the Leclanché cell in school physics lessons. And whereas today's common zinc carbon cells are little different from the Leclanché cell, a lot of water has passed under the bridge since the 1860s. If you browse through the batteries section of the Maplin catalogue you'll soon discover that there's a bewildering array of other types of battery on the market today. So what of zinc air cells, of primary lithium cells, of silver oxide cells and of lithium ion rechargeable batteries? How do these various types of battery compare? Are the well-established technologies still the best or are some of the less well-known types of batteries set to take their place? This article aims to answer these question covering both primary and secondary (i.e. rechargeable) batteries and cells. Although this feature is introductory by nature, this doesn't mean that it will be of interest only to novices. This is a constantly changing field and my aim is to pull together a summary of the current state of play which will form a useful reference to all users of battery-powered equipment.

## The Basics

The main part of this article consists of discussion of a number of important types of cell. A comparison table is also presented. As a preliminary, however, we need to set the scene by taking a look at various general issues.

### Battery Sizes

Figure 1 shows a comparison of the common standard cell sizes – N, AAA, AA, C, and D – and the one common battery size – PP3. By the word 'size', I mean the physical size and shape only. The capacity of batteries (in Ampere Hours) of a particular physical size varies significantly depending on the battery chemistry and type. Even the terminal voltage of a given size of cell differs with the chemistry. These common sizes tend to be used for cells and batteries which – broadly speaking – are interchangeable. This includes the common primary cells with a 1.5V nominal voltage and NiCd/NiMH cells which have a 1.2V nominal voltage.

For chemistries with a significantly different nominal cell voltage (e.g. Lithium primary cells, some of which have a nominal voltage of 3.0V or higher), completely different sizes – cylindrical, prismatic and coin – are often employed. However, this

practice is not universal. Some manufacturers do, indeed, house Lithium primary and Lithium ion rechargeable cells in common cases such as AA. Clearly these cells are not interchangeable with 1.5V or 1.2V cells and care must be taken that they are not, accidentally, used in equipment designed to accept lower voltage AA cells.

Other cell and battery sizes tend to be designed with a particular application in mind. Such cells tend to be used in cameras, watches, hearing aids, and for backing-up digital circuitry. Small cylindrical and coin cells are common for these applications. Cells and batteries are also available with terminals for circuit board mounting.

### Energy Capacity

The capacity of a cell or battery will usually be quoted in terms of Ampere Hours (Ah). However, this is not, of course, a measure of the amount of energy stored in the battery. The energy capacity of a battery is given in terms of Watt Hours (Wh) and – to a first approximation – this is equal to the capacity in Ah multiplied by the nominal terminal voltage. In practice, the energy capacity will be less than this since the terminal voltage usually drops as the cell is discharged.

For portable equipment weight and size is particularly important. So an important measure of a battery is its energy capacity per unit weight (Wh/g) and energy capacity per unit volume (Wh/l).

### Nominal Voltage

The nominal voltage is fixed for a given cell chemistry. So all cells of a particular type will have an identical nominal voltage. With batteries, of course, there is scope for variation of the voltage by altering the number of cells incorporated into the battery.

The actual voltage monitored on the terminals of a cell or battery will often differ from the nominal voltage. Specifically, a new battery or an off-load battery will have a higher voltage whereas a partially discharged or heavily loaded battery will have a lower voltage. The degree of stabilisation – that is, the degree to which the voltage fluctuates with load and with amount of discharge – is highly dependant on the battery technology. Voltage stability is usually shown as a discharge curve of voltage against time. The shape of this curve will often be dependent on the current drawn from the cell. A graph comparing the discharge curves of various primary batteries is shown in Figure 2. Electrical equipment such as a torch is non-voltage critical. So batteries with very poor stabilisation can be pressed into service here. Electronic equipment, on the other hand, is much more sensitive to voltage

fluctuations so a battery with a flat discharge curve would be preferable. Alternatively, some form of constant voltage power supply could be used.

## Current Capacity

The current sourcing capacity of a cell or battery depends, to a large degree, on the size of the cell or battery, not just its chemistry. For some technologies (NiCds, for example) the current capacity is given in terms of C, the current which will cause the cell or battery to be discharged in one hour. As such, the current capacity is directly proportional to the capacity in Ah. For other chemistries, the relationship between the current capacity and the size of the battery is much less well-defined. In alkaline primary cells, for example, the AA and the D cell have similar current capacities. I'm told that the primary reason for this is that AA cells – being the most common by far – have been the subject of the greatest development effort. Nevertheless, in general, the current which a battery can supply will increase with its physical size.

It has to be said, however, that it's difficult to state exactly what is meant by the current capacity. Certainly the internal resistance of a battery or cell will place an upper limit on the current which may be drawn from it but most manufacturers will suggest a lower limit than this. In fact, manufacturers tend to be rather vague about this aspect of the specification. The reason, of course, is that a high current can often only be drawn at the expense of voltage or the total amount of energy which can be extracted from the cell. Also, with some chemistries, a high current can only be drawn for a short duration.

## Temperature

The operation of a cell involves a chemical reaction and since, as a rule of thumb, chemical reactions double in speed with each 10°C rise in temperature, it's hardly surprising that cells are temperature sensitive. What probably is surprising, however, is that some cell chemistries provide for operation over such a wide temperature range. However, this is not universal and some types of cell show much reduced performance by reducing the temperature to 0°C. Specifically, these cells will supply a lower current and have a lower capacity at low temperatures. Some rechargeable cell types cannot be reliably charged at low temperatures.


Figure 1. Common cell and battery sizes.

## Battery Storage

A battery's self-discharge rate is a particularly important characteristic. No battery will keep its charge forever, although some of the primary cells come close, having a shelf life of many years. On the other hand, some types of battery can loose up to 30% of their charge per month. Temperature and other storage conditions can have a significant impact on the self-discharge rate with self-discharge increasing with temperature.

## Discharge-charge Cycles

Primary cells are, by definition, designed for a single cycle. In other words, they are supplied with a full charge, are discharged in use and are then disposed of. Secondary cells, on the other hand, are designed such that the chemical reaction can be reversed by charging. There is, however, a limit to the number of times a cell can be discharged and re-charged. This is referred to as the number of discharge-charge cycles.

## Charging Methods

Charging methods is a subject in its own right and is too lengthy a subject to handle in depth here. As such, I'll make only passing reference to charging in this article. Specifically, I'll refer to the overall charge regime (i.e. constant voltage or constant current) and give some indication of the charge time.

# Common Cell Types

In the remainder of this article, we'll investigate a number of the more important cell chemistries. Many of the cell types discussed are designated as general purpose although a few are more specialised having characteristics suitable for certain niche applications.

Much of the information provided here will be somewhat vague – there are a number of reasons for this. Firstly, even if a battery chemistry remains constant, there are often a number of variants available. In the realm of NiCds, for example, different families are available with widely differing charge and discharge characteristics. And secondly, as I've already pointed out, some questions, such as 'what is the maximum current capacity of this cell?' are remarkably difficult to answer. To answer such a question you'd have to place constraints on the voltage, the life of the cell, the duration of the load and so forth. So, although this article will give some valuable tips on which cell types are suitable for which applications, it would be wise to get more detailed specification information for a proposed cell before committing to it for a major project.

# Zinc Carbon & Zinc Chloride

Zinc carbon cells are the ones usually just referred to as 'standard' or 'general purpose' cells and have remained little changed for many years. Zinc chloride cells are often put into the same category and offer marginally improved characteristics. Sometimes it won't be obvious which particular chemistry a particular standard cell or battery employs, indeed the two are at opposite ends of a spectrum – most are partially zinc carbon and partially zinc chloride.

Zinc carbon and zinc chloride cells have a lower energy density than most other primary cells and are not able to supply as high a current. Of the two, zinc-carbon is better for intermittent discharge and zinc chloride for continuous discharge. Both cell types have poor voltage stability. Despite the nominal 1.5V a typical off-load voltage is 1.64V whereas the on-load voltage will range from 1.3V to 0.8V at the end point. In other words, the discharge curve is far from flat.

The only advantage these cells offer is one of cost – the price per Watt hour is little more than half that of an equivalent alkaline cell. It is, therefore, an attractive proposition in non-demanding applications (i.e. low current, non-voltage critical) in which it is not particularly inconvenient to have to swap cells.

# Alkaline

Alkaline manganese dioxide cells, usually referred to as just alkaline cells are a higher performance, 100% compatible replacement for zinc carbon or zinc chloride cells. By

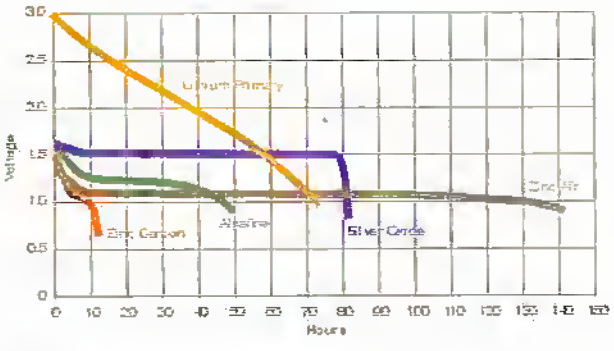



Figure 2. Discharge curves for various primary cells.

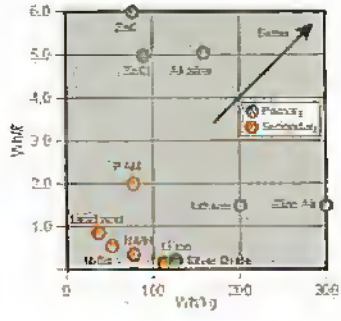



Figure 3. Battery characteristics.

this, I mean that the nominal voltage is the same but the discharge curve is slightly flatter and the energy density is higher. Alkaline cells also provide better low temperature performance than zinc carbon cells. Whereas the latter only deliver about 10% of their service life at 0°C, alkaline cells will deliver 70% at this reduced temperature. The available current is also higher but not dramatically so. For many applications, this can be an advantage – as we'll see when we come to look at NiCds, cells with very high current capacities aren't always interchangeable with more modestly rated cells.

Despite the fact that the alkaline cell is normally considered a primary cell, the reaction is reversible by the application of an electric current. In other words, alkaline cells are rechargeable – but only to a degree. The number of discharge-charge cycles is very limited and safety concerns have been voiced. The topic of recharging standard alkaline cells is raised on an occasional basis but mainly by hobby users. Safety and performance issues have generally precluded the practice on a commercial basis.

However, a number of manufacturers have now released alkaline cells specifically intended for recharging. Referred to as RAM cells (rechargeable alkaline manganese), the limited number of cycles (typically 25) still applies, but safety concerns have, presumably, been addressed. The energy capacity also decreases noticeably with each cycle. On the positive side, RAM cells have a much lower self-discharge rate than most other types of rechargeable cells.

## Zinc Air

Zinc air cells have the highest energy density of any common chemistry by a significant margin. They have a 1.45V nominal voltage so, in this respect, would be compatible with equipment designed for zinc carbon or alkaline cells, and the discharge curve is very flat. Furthermore, currents of up to a few hundred milli-amps can be supplied, the shelf life is very long and the price per Wh is lower than for most other chemistries. At first sight, therefore, zinc air might seem an ideal general purpose technology. Unfortunately, however, there are some significant drawbacks.

As supplied, zinc air cells and batteries are sealed to prevent the inlet of air. In this condition, the cells have an extremely long shelf life but do no generate an electric current. Before use, the seal must be removed after which the full voltage will be achieved within 15 minutes. However, once the seal is broken the life of the cell drops to about three months due to poisoning of the zinc. Actually, this is an over-simplification – with zinc air batteries there is a pay-off between the current capacity and the lifetime. A high current is provided by a large air inlet but at the expense of a short lifetime. A smaller inlet will increase the lifetime but at the expense of current.

Because of this drawback, zinc air is produced mostly in the form of coin cells for use in hearing aids where weight is paramount. Duracell do produce a PP3 zinc air battery, however, with a fairly modest current capacity. Nevertheless, manufacturers don't envisage that zinc air will become a general purpose technology, despite its undoubted advantages.

## Lithium Primary

Lithium primary cells is a phrase which encompasses a number of different chemistries, the most common of which are lithium manganese dioxide (3.0V) and lithium thionyl chloride (3.6V). Lithium primary cells should not be confused with lithium ion cells which are rechargeable.

Despite the different chemistries, most lithium primary cells share similar properties. The energy density is high, the cells can deliver a moderate current and the shelf life – at ten years – is extremely high. The discharge curve is flat at low current drains but slopes significantly at higher currents. For this reason, lithium primary cells are used primarily in low to medium current applications requiring a long operating life. Battery back-up of computer memory or other digital circuitry is a common application. Although the large cylindrical cells can deliver a current of a few hundred milli-amps, the highly sloping discharge curve under these conditions and the fact that these higher voltage cells are not interchangeable with other primary chemistries have restricted their use as general purpose cells.

Fairly new on the scene is Lithium Iron Disulphide which is quite different from the other lithium primary technologies. The cell has a 1.5V nominal voltage, is available in common sizes such as AA and has twice the energy density of alkaline cells. It is being promoted for general purpose use.

## Silver Oxide

Silver oxide cells yield a 1.6V nominal voltage, a very flat discharge curve and a high energy density. They also offer extremely good low temperature operation. On the reverse side of the coin, they can only supply modest currents and are expensive compared to most other primary technologies.

As such, this chemistry is one which is destined to niche applications for coin cells. Traditionally, silver oxide cells have been used in calculators, photographic equipment and watches. Of these, most markets are declining with the possible exception of watches. The main factor which has contributed to its use here is its flat discharge curve and 2 year lifetime. However, since modern watch electronics is less susceptible to voltage fluctuations, less expensive cell chemistries are now being used.

## Nickel Cadmium

For many years the number one rechargeable technology, nickel cadmium cells and batteries – commonly called NiCds – are being phased out in favour of more environmentally acceptable alternatives such as nickel metal halide or lithium ion. Nevertheless, they will remain in use in older laptop PCs, cellphones and camcorders for some time and are still available for general purpose use.

NiCds have a nominal voltage of 1.2V and a discharge curve which is somewhat flatter than the common primary cells. For many applications, the drop from 1.5V to 1.2V is irrelevant and NiCds are sometimes used interchangeably with primary cells such as zinc carbon or Alkaline. However, in equipment designed to accept four AA alkaline cells, the substitution of NiCds would result in a drop in the total voltage from 6V to 4.8V. This might not be acceptable for some electronic equipment and for this reason, equipment often has to be designed specifically for NiCds (i.e. it must operate from a lower voltage supply or take a greater number of cells).

The current capacity of NiCds is very high, depending on the particular cell family. At the best, up to 30C can be drawn from a NiCd cell which, for a D cell, equates to 120A. There is, however, a drawback to the NiCd's high current capability which can further restrict its use in equipment designed for primary cells. Cheaper photographic flashguns, for example, use the internal resistance of the primary cells to limit the current during charging. The circuit will, therefore, draw a much higher current from NiCds and this can result in the destruction of the unit.

Originally, NiCds were specified to be charged at the C/10 rate for 14 hours but many of the more modern NiCd families permit accelerated charging, in as little as one hour in some cases. NiCds can be damaged by over-charging, especially at fast charge rates so the end point must be accurately determined. Various methods are available, most of which involve monitoring the terminal voltage, the cell temperature or both. NiCds are also hampered by the well-known 'memory effect'. If NiCds are only partially discharged before recharging, they can adapt to this shallow discharge cycle such that the full capacity of the cell is no longer available. The solution is to make sure the cell is fully discharged before re-charging – some advanced chargers will do this.

Another significant drawback with NiCds is that the self-discharge rate is high. 20% loss of charge per month is typical at room temperature although this can be even higher at elevated temperatures.

## Nickel Metal Halide

In many respects the nickel metal halide cell (NiMH) is similar to the NiCd cell. The nominal voltage is identical (1.2V), the discharge curve is moderately flat and the chemistry can deliver a reasonably high current. The current capacity isn't as high as with NiCds – 3C is typical – but for the majority of applications this is perfectly adequate. The charge density is 60% higher.

The charging requirements are similar, indeed the same chargers can often be used for NiCds and NiMH cells. However, NiMH cells don't exhibit the memory effect so discharging prior to charging is not necessary. One negative aspect of the chemistry is that the self-discharge rate is even higher than that for NiCds – up to 30% per month at room temperature.

Because of the similarity of NiCd and NiMH cells, they tend to be produced in the same sizes and they are considered to be interchangeable for most applications.

## Lithium ion

Lithium ion cells, not to be confused with lithium primary cells, are the up-and-coming rechargeable technology. Distinguished from NiCd and NiMH cells by their significantly greater energy density, lithium

ion is now the technology of choice for notebook manufacturers.

Like lithium primary cells, however, the nominal voltage (3.6V) is significantly higher than that of most other cell types and the discharge curve is highly sloping at moderate to high currents. The implication of this, of course, is that equipment must be designed specifically for lithium ion batteries. And this doesn't just involve taking account of the higher voltage but providing electronic voltage stabilisation.

Unfortunately, because of these reasons, and because of safety concerns, lithium ion is considered by most battery manufacturers to be for OEM use only. Battery manufacturers prefer to work with the equipment manufacturer to ensure that safety considerations are met. Admittedly some manufacturers do produce standard size lithium ion cells, but in the main, production is of customised battery packs for notebook PCs, cellphones and camcorders. I was told by one battery manufacturer that lithium ion cells would never be made available as general purpose products off the shelf. He later admitted that he'd have made the same statement of NiCds some years ago but still suggested that general purpose lithium ion cells are not likely to be available in the near future.

## Lead Acid

Despite being the first widespread rechargeable battery technology and despite the energy density being lower than for most other type of battery, lead acid remains an important technology. Advantages include a significantly lower self-discharge rate than most other rechargeables, low-cost and ease of charging (i.e. no memory effect, immune to overcharging, etc.). Lead acid batteries are critical of storage condition, however. Unless they are stored in the charged state sulphating of the anode will take place and capacity will be permanently lost. Conventional lead acid batteries require maintenance but much of the production is now of sealed or gelled-electrolyte maintenance-free batteries.

The cell voltage is 2.0V and the discharge curve is relatively flat. A few manufacturers offer single cells in standard sizes such as the D size but these are not, of course, interchangeable with common primary D cells because of the difference in nominal voltage. More commonly, 6V or 12V batteries are offered with capacities from 1 to 65Ah. A huge current, up to hundreds of Amps, can be drawn from the larger batteries.

Accordingly, lead acid batteries tend to be used in applications requiring a reasonably high capacity backup supply. Examples are burglar alarms and un-interruptible power supplies for computers.

## In the Research Labs

In the main, this article has been concerned with batteries which are available today. However, to close, I thought it would be interesting to take a brief look at what's likely to come out of the research labs over the next few years. Certainly the existing common chemistries will be improved but completely new battery types are also under development.

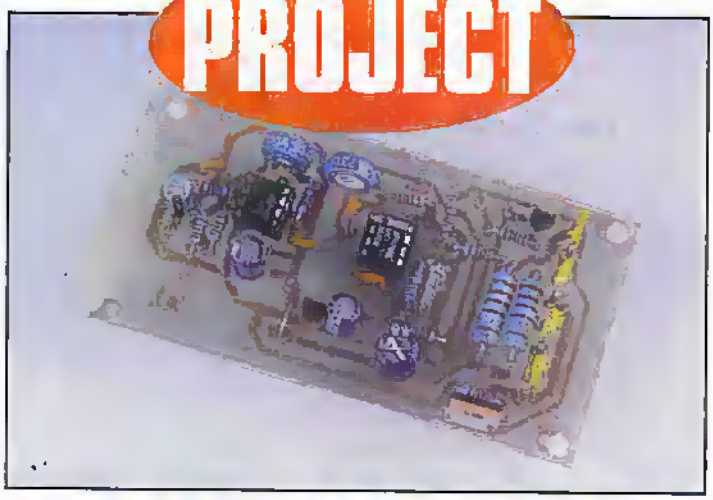
The up-and-coming technology which, perhaps, we hear the most about is the lithium polymer cell, otherwise known as the solid-state lithium ion cell, which is a progression from the regular lithium ion rechargeable cell. The main difference between a standard lithium ion cell and the solid-state variant is that the liquid electrolyte is replaced by a conductive polymer electrolyte. A significant advantage is that the energy density in Whr/kg is further improved compared to ordinary lithium ions. See Figure 3. An even greater advantage is that these cells can be made only 0.02in thick or could be moulded to virtually any shape. So, rather than produce lithium polymer cells in standard sizes, battery manufacturers expect to produce batteries to fill the irregular spaces not occupied by electronic components in a laptop or cellphone. This will greatly improve space utilisation. Ultralife batteries are already sampling solid-state lithium ion batteries to major notebook manufacturers although it's likely to be the year 2000 before we see these batteries in real products.

Even more innovative than a battery with a plastic electrolyte, however, is the all-polymer battery which was unveiled at the Johns Hopkins University in 1996. The battery contains foil-like sheets of plastic sandwiched with a polymer gel film, permitting exceptional flexibility and thinness. Although the prototypes don't yet compete with more conventional batteries in terms of their energy density, researchers believe that the all-polymer batteries could me a major force in the future. According to professor Poehler at Hopkins University, the team is still working with a lot of new polymers, leaving open the possibility of a range of polymer batteries specifically optimised for desired features such as light weight, small size, or long recharge cycles. Conventional batteries are designed around metals of which – once we've discounted the unstable ones, the vastly expensive ones and the radioactive ones – there are only a handful. By way of contrast, there is an almost infinite number of possible polymers so the era of the designer battery may soon be upon us.

| | Lead acid | NiCd | NiMH | Lithium ion | RAM | ZnC | Zn Cl | Alkaline | Zinc air | Li $MnO_2$ | Silver oxide |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Sizes available | Few cylindrical cells, 6V & 12V batteries | Most standard sizes + F + packs + coins | Most standard sizes + packs + coins | Mainly Custom packs | AAA, AA | Most standard sizes | Most standard sizes | Most standard sizes | Coins & PP3 | Coins and cylindrical cells (some stand alone) + PP3 | Coins |
| Voltage | 2.0 | 1.2 | 1.2 | 3.6 | 1.5 | 1.5 | 1.5 | 1.5 | 1.45 | 3.0 | 1.6 |
| Discharge | Flatish | Flatish | Flatish | sloping | sloping | sloping | sloping | sloping | flat | sloping | flat |
| Whr/kg | 35 | 50 | 80 | 115 | 75 | 80 | 90 | 160 | 300 | 200 | 125 |
| Whr | 70 | 150 | 260 | 300 | 220 | 140 | 180 | 400 | 1300 | 550 | 550 |
| Whr/$cm^3$ | 0.83 | 0.58 | 0.34 | 0.17 | 2.0 | 6.0 | 5.0 | 5.1 | 1.5 | 1.5 | 0.22 |
| Discharge rate | Up to hundreds of Amps for large batteries | Up to 30C depending on family | 2C | 2C, continuously or 4C intermittently | Just under 1A for AA | A few Amps intermittently for larger cells | A few Amps intermittently for larger cells | A few Amps continuously | Up to a few hundred milli-amps depending on the load | Up to a few hundred milli-amps intermittently | ~50mA for coin cells |
| Cycles | 500 | 2,000 | 600 | 1,200 | 25 | 1 | 1 | 1 | 1 | 1 | 1 |
| Memory | No | Yes | No | No | No | N/A | N/A | N/A | N/A | N/A | N/A |
| Charge method | Constant voltage | Constant current | Constant current | CC then CV | Constant voltage | N/A | N/A | N/A | N/A | N/A | N/A |
| Charge time | 16 hours | 1 hour | 1 hour | 3 hours | 1-10 hours (1 for pulse) | N/A | N/A | N/A | N/A | N/A | N/A |
| Temp range | -20° – 50° | -20° – 60° | -20° – 60° | -20° – 60° | -30° – 70° | -15° – 60° | -15° – 60° | -30° – 70° | 0° – 60° | -20° – 60° | -40° – 80° |
| 20° Self discharge rate or shelf life | 3%/month | 20%/month | 30%/month | 10%/month | 1%/month | 3 years | 3 years | 85% after 5 years | 92% after 4 years with seal intact, 3 months after seal broken | 10 years | 2 years, 90% after 1 year |

* The energy per unit cost figures are based on current retail prices for AA cells where possible. However, not all the battery types are available as AA cells and in these cases, a closest equivalent was chosen. For some chemistries – silver oxide, for example – melding even approximating to AA is available and in such cases, the energy per unit cost isn't really comparable to those of the other chemistries since more expensive form factors such as coin cells have been used to calculate this data. Also, the lithium ion figure is only a rough guide since these cells are not available off the shelf.

PROJECT



# INFRARED LINK

## PART 2

***In part 2, Gavin Cheeseman investigates possible applications and considerations.***

In part 1, we looked at the construction of a general purpose infrared transmitter and receiver modules. This month we investigate some possible applications and cover some important points to consider when using the circuits. The applications shown are intended to provide a starting point and may require some additional development to obtain optimum performance.

## Remote Control

It is possible to set up a simple single channel remote control system using the modules. This is very easy to achieve and requires very little in the way of additional components. As can be seen from Figure 1, all you need to do to the transmitter is add an on/off power switch. This effectively acts as an 'operate' switch and is used to control the switched output of the receiver at P5. The type of switch used will depend on the application but in most cases a momentary action push to make switch is the most appropriate choice.

At the receiver end the output at P5 can be used directly for low current loads (recommended under 50mA maximum). However, for most purposes it is best to drive a relay from P5 using a transistor, as shown in Figure 2, as this allows the switching of much higher current loads. When configured in this way the relay coil is energised whenever a carrier of the correct frequency is detected by the receiver PLL (corresponding to power being applied to the transmitter). Of course if a momentary action switch is used at the transmitter, the relay will only be powered during the time that the switch is depressed. A toggle action can be achieved by connecting a flip flop between P5 and the relay driver stage. An example of this type of circuit is shown in Figure 3 for guidance.

If you are driving a relay from the receiver take care to ensure that the relay you have chosen is appropriate for the voltage and load requirements of the appliance you are switching. The arrangement shown is not recommended for directly switching mains or high voltage supplies unless steps are taken to ensure that the installation meets relevant EC safety standards. Unless you are entirely familiar with these requirements, advice should be obtained from a qualified engineer. It may also be necessary to fit arc suppression components to the relay contacts.

The relay coil must be suitable for the receiver supply voltage. A 12V relay is usually OK but check the voltage range if you are powering the circuit at 9V as some 12V relays may not operate reliably at this voltage.

When used for remote control applications where power is only applied for short periods, the transmitter may be powered from a suitable 9V battery. If the transmitter is in operation for longer periods, it will be necessary to use a high capacity battery or power supply.

If the receiver fails to respond to the transmitter or operates erratically, this may be due to incorrect alignment of the phase locked loop oscillators. Try adjusting the setting of VR1 on the receiver to achieve the most stable and reliable operation.

More experienced constructors may like to try interfacing remote control encoder and decoder IC's to the modules allowing several different devices to be controlled from the same transmitter. The 'Semiconductors' section of the Maplin catalogue contains several different IC's that are suitable for this type of application. A typical example is the HT12 series. The data output from the remote control encoder would be applied to terminal P13 of the transmitter. The data input to the decoder would be connected to the receiver output at P5. As we will discuss later, care is required to ensure that input and output levels are suitable to avoid damage to the infrared link circuitry or devices that it is connected to.

## Beam Break Detector

The modules may be used to make a simple beam break detector which can be used to indicate when a person, or object, passes through the infrared beam. Systems of this type are useful to indicate unauthorised access or for counting the number of objects passing a given point. The transmitter and receiver are set up on opposite sides of the area to be covered.

A typical arrangement is shown in Figure 4 where the units are set up on either side of a doorway. For this application the power supply is continuously applied to the transmitter and receiver units. Whilst the infrared beam is unbroken, the receiver

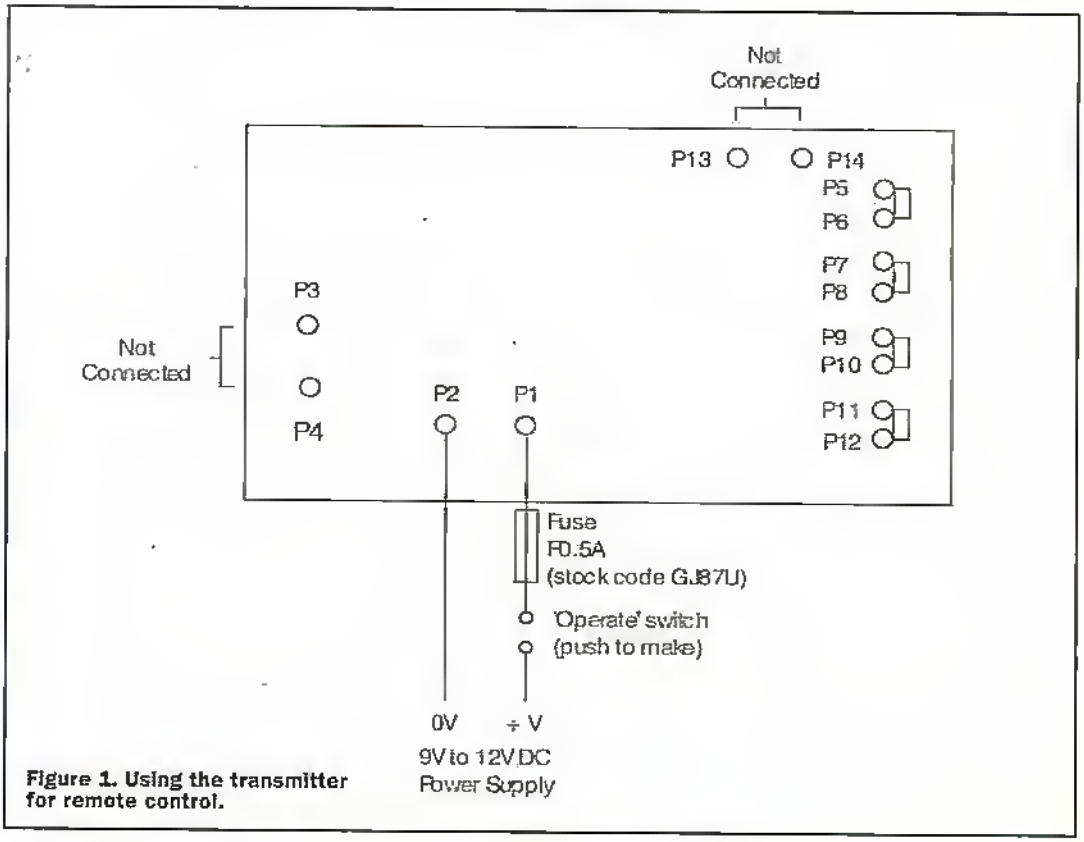



**Figure 1. Using the transmitter for remote control.**

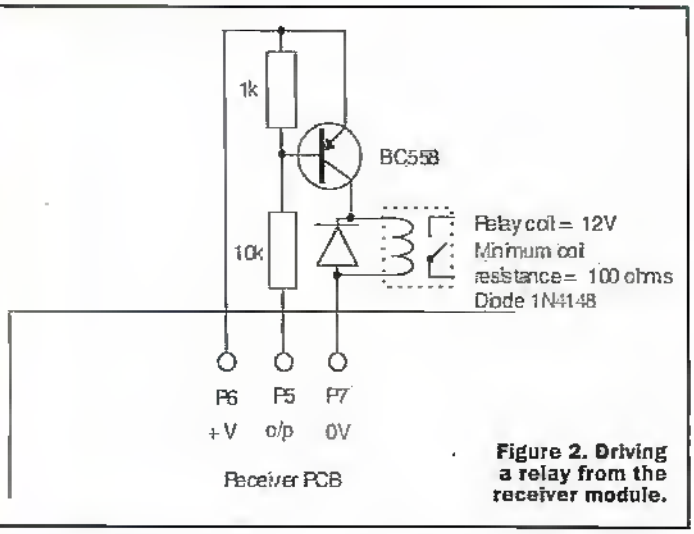



**Figure 2. Driving a relay from the receiver module.**

transmitter diverges, the receiver will sometimes respond to reflections. This is undesirable for this application and can result in unwanted effects. The effect can be minimised by limiting the effective viewing angle of the receiver. A simple way to do this is to mount the receiver diode inside a small length of opaque plastic tubing. The length and diameter of the tubing should be such that the viewing angle is limited to the area of the transmitter module. A typical arrangement of this type is shown in Figure 5. If necessary, the leads of RD1 may be extended slightly using screened lead. However, it should be noted that excessively long lengths may result in instability.

## Audio Transmission

As mentioned previously, another application for the circuits is the transmission of audio frequency signals. Using the modules in the basic form, it is possible to transmit limited bandwidth audio over short distances. The output is capable of driving high impedance headphones but if you need more volume or want to drive a

PLL remains locked to the incoming signal from the transmitter. In this state, the output at P5 on the receiver is low. When the beam is interrupted, the PLL loses lock and P5 switches to a high condition.

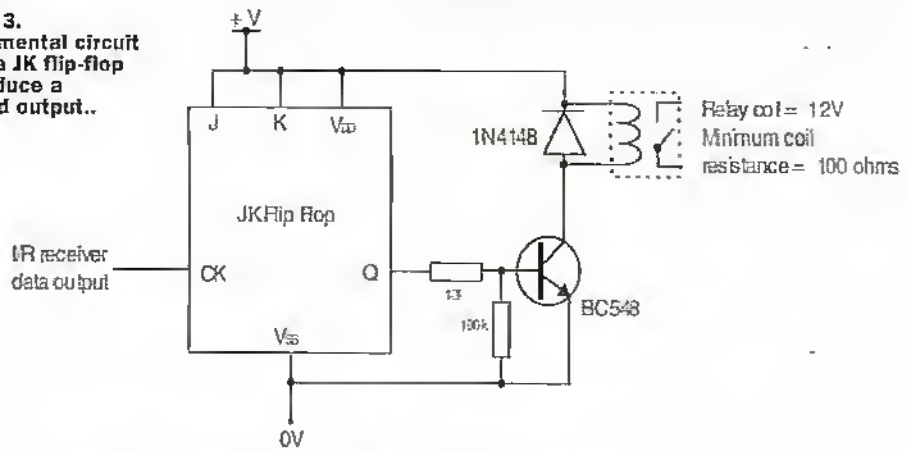
In a similar way to the remote control system mentioned above, the output from P5 may be used directly or via a relay depending on the voltage and current consumption of the load. The output could be used for a variety of purposes, for example, to operate a doorbell or to trigger an alarm. Alternatively the output could be attached to a counter via any necessary de-bounce circuitry allowing the number of people passing through the doorway to be counted.

In some cases, it may be necessary to use additional interface circuitry between the output of the infrared receiver and the appliance that it is driving. For example, some devices may require a 5V or dry contact input so it may be necessary to use a relay.

In the normal configuration, the current consumption of the transmitter module is unnecessarily excessive for a short range beam break detector operating over a range of one or two metres, not to mention the amount of heat developed. In these circumstances, it is desirable to reduce the current consumption of the circuit and this can be achieved by increasing the value of resistors R10 and R11 on the transmitter unit. The actual value required will depend on the distance that the infrared beam is required to cover but a value of 1k is typical. If necessary, a further reduction in current can be achieved for both the transmitter and receiver circuits by omitting unused components as mentioned in last months article.

Because the beam from the

**Figure 3. Experimental circuit using a JK flip-flop to produce a toggled output..**




JK Flipflop must be capable of operating from 12V supply (CMOS 4027 or similar).
Set and reset pins should be tied low where applicable.

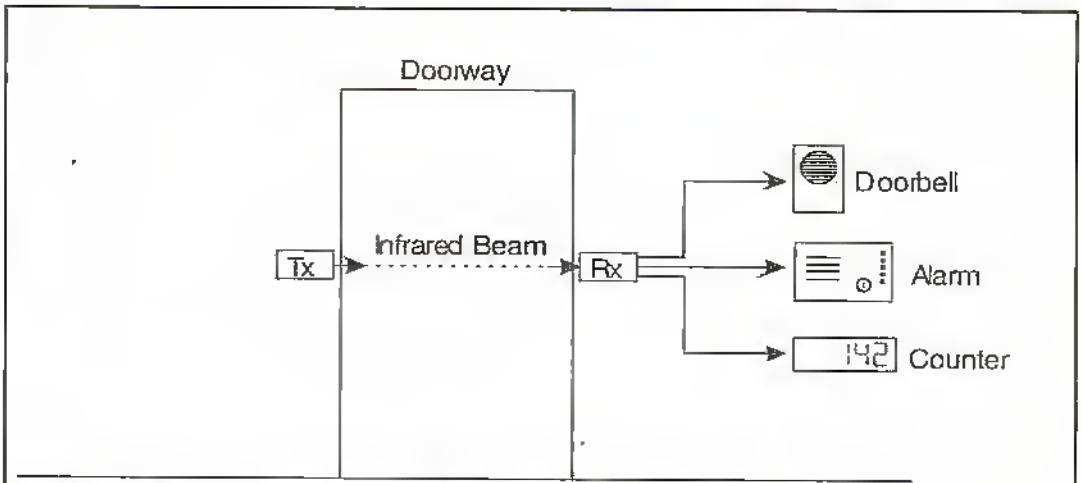



**Figure 4. Typical arrangement and possible applications for beam break detector.**

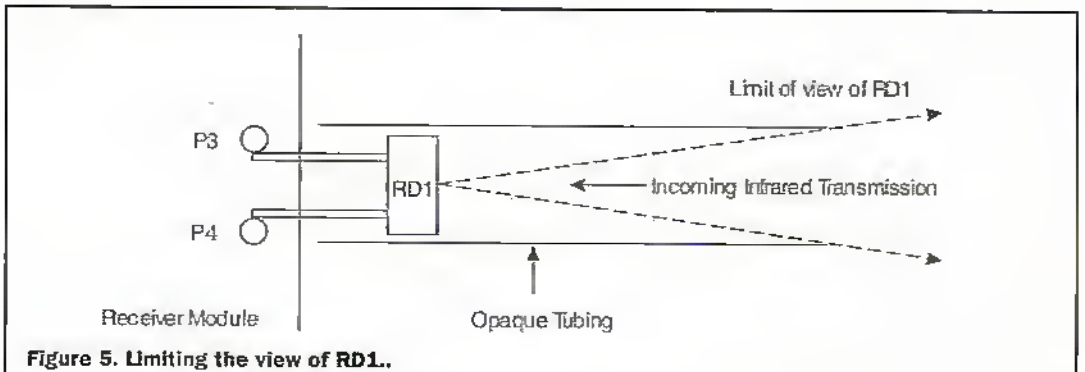
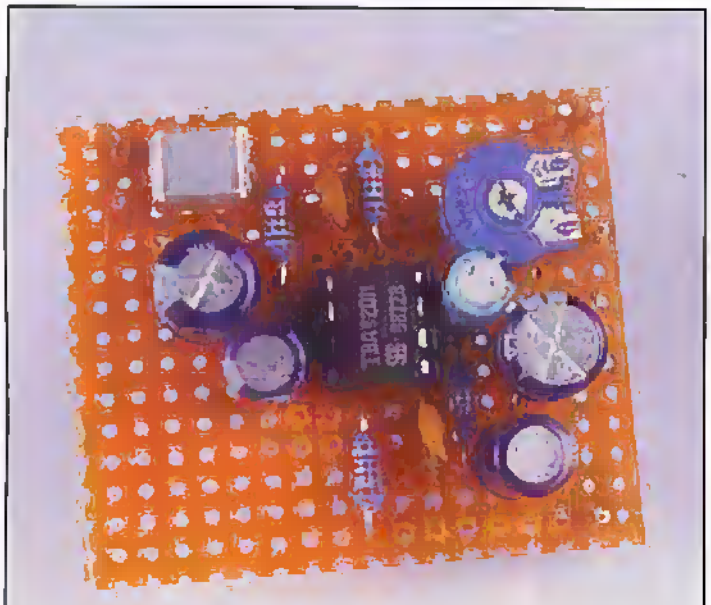



**Figure 5. Limiting the view of RD1..**



Amplifier Module

loudspeaker, it will be necessary to use an additional power amplifier. If you are using headphones always take care to limit the volume to a safe level. The type of amplifier used is dependant on the application but in many cases a simple 1W or 2W unit will suffice.

## A Simple Power Amplifier

The circuit diagram of a simple audio power amplifier is shown in Figure 6. Based around the TBA820M IC, this circuit can be connected to the output of the infrared receiver module to enable a loudspeaker to be driven. The amplifier will operate from a 9 to 12V supply. The circuit may be constructed on matrix board and if set up correctly is capable of giving good performance. When building the circuit, try to keep all lead lengths as short as possible to help to avoid instability problems. As always, take care to ensure that polarised components such as the IC and electrolytic capacitors are connected observing the correct polarity. It is recommended that a DIL socket is used for IC1 to prevent damage to the device during soldering and facilitate easy substitution of the IC if replacement is necessary. High frequency de-coupling capacitor C3 should be connected as close as possible IC1.

The power supply to the amplifier is applied between terminals P1 (+V) and P2 (0V). The amplifier should be protected by a 400mA F-type fuse in series with the +V supply to help limit any damage if a fault occurs. The input should be connected using screened lead to minimise stray signal pickup. The amplifier is capable of driving into 8Ω loads but care must be taken to ensure that the power dissipation and operating temperature of the device do not exceed specified maximum limits. At low power levels under 1Ω, the device does not normally require an external heat sink. Above this level, additional heat sinking may be required to ensure absolute maximum ratings are not exceeded. If required, the power dissipation can be limited by using a higher impedance speaker but inevitably there will be a reduction in volume. Variable resistor VR1 acts as a volume control adjusting the input level to the power amplifier. A horizontal pre-set variable resistor has been specified for this application; however, a standard panel mounting potentiometer of the same value could be used if user adjustable volume is required. Capacitor C5 has been included to provide improved ripple rejection. If the amplifier is being powered from a clean, well regulated supply, C5 may be omitted without serious degradation. The amplifier should be connected to the infrared receiver module as shown in Figure 7.

The transmitter AF input is very sensitive and is easily overloaded. When driving the unit from a high level source, VR1 on the transmitter module should be set for minimum gain

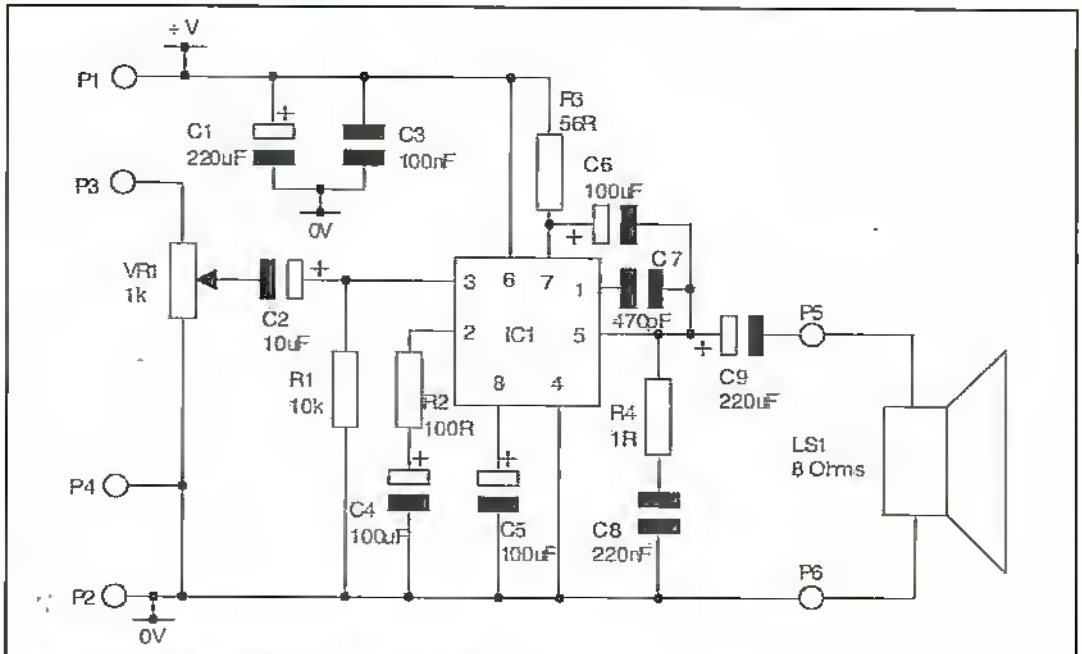



**Figure 6. Circuit diagram of power amplifier.**

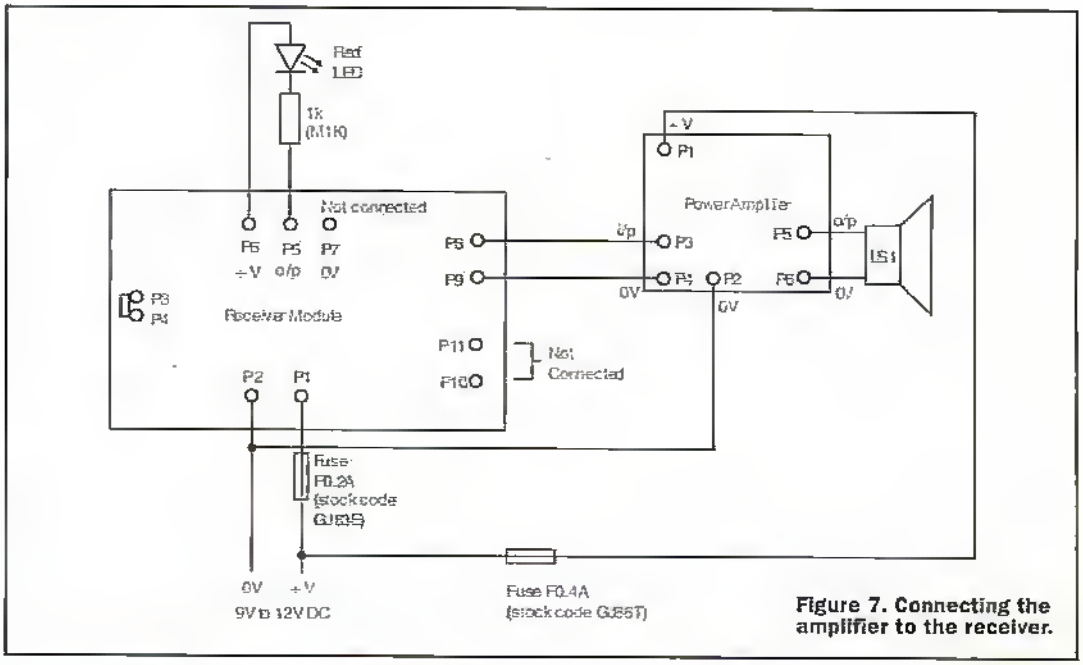



**Figure 7. Connecting the amplifier to the receiver.**

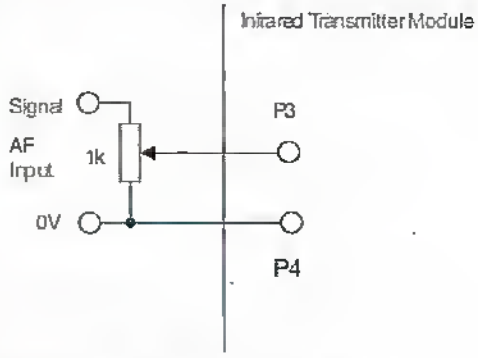



**Figure 8. Fitting an attenuator to the AF output.**

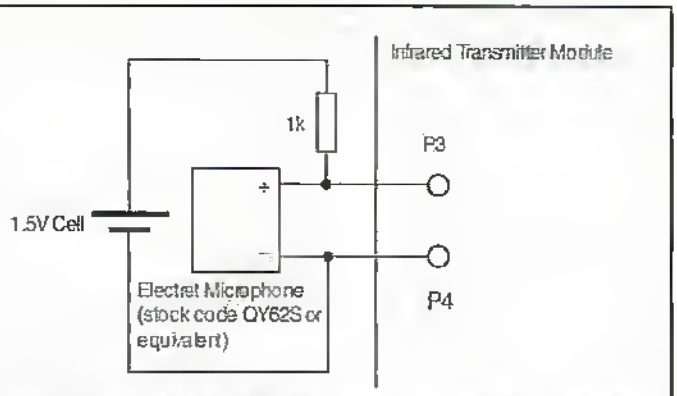



**Figure 9. Wiring an electret microphone to the transmitter module.**

to minimise distortion. Even with the gain set to minimum, the signal level may be excessive. If necessary an additional potential divider may be fitted at the input as shown in Figure 8. If you need to do this, there is no need for an additional PCB; as only one pre-set variable resistor is required this may be soldered directly to the input pins of the transmitter module.

It is possible to drive the transmitter directly from a microphone, if required. Electret microphones are ideal for this due to their compact dimensions and good sensitivity. Figure 9 shows how to attach an electret microphone to the input of the transmitter module. It will be necessary to adjust VR1 on the transmitter module for maximum achievable gain without clipping. The microphone may be powered from a 1.5V battery as shown or may be derived from the supply to the infrared transmitter module via a regulator. It is recommended that the DC voltage at transmitter input terminal P3 is not allowed to exceed 4.5V as this may reverse polarise input capacitor C1.

## Data Link

The infrared modules can be used to set up a simple data link. Serial data at standard 5V logic level can be applied between P13 (Data) and P14 (0V) on the transmitter module. When the system is set up and aligned, the corresponding data is output between P5 and P7 on the receiver module. The output at P5 on the receiver is pulled up to the +V supply and the level may therefore be as high as 12V. As a result, it is necessary to convert this output to 5V if you wish to drive TTL or other 5V logic devices. It should be noted that a logic high output at P5 corresponds to a 'no carrier' condition so the output defaults to this condition when no signal is present. Because the circuit has not been fully optimised for this application, data rates are limited to the low kilobaud region. The maximum achievable speed will partly depend on the ability of the decoder or software to handle timing errors. With some experimentation, it should be possible to modify the circuit to transmit considerably higher data rates.

## Using Multiple Links

The infrared link described here is primarily designed for single channel operation. However, it may be possible to transmit more than one channel using additional modules. Although most multi-channel links use high speed multiplexing techniques, some readers may wish to experiment with multi-channel or duplex links using additional infrared transmitter and receiver boards. It should be possible to use more than one infrared link at the same time as long as different carrier frequencies are used and signal levels are not excessive. However, depending on the arrangement, there may be some degradation of performance. The carrier frequency of the transmitter can be altered by modifying the value of R7 and/or C10. On the receiver, VR1 adjusts the frequency of the PLL oscillator. If the adjustment range of VR1 is insufficient for a particular purpose the value of R9 and/or C14 can be modified to give a different frequency range. It is recommended that the value of R7 on the transmitter and R9 on the receiver is between 2k and 20k.

When using more than one infrared link in this way certain frequencies should be avoided. In particular the PLL may respond to harmonics of the frequency that it is tuned to producing unwanted effects. In addition, strong signals may overload the receiver, effectively making the system unusable so avoid close coupling between transmitter and receiver. Fitting appropriate value capacitors in positions C5 and C8 on the receiver can help to reduce the response of the circuit a high frequencies. It may also be possible to add additional filtering at the receiver input to produce a sharper response.

## Obtaining Greater Range

As it stands the range of the infrared link is limited to a few metres. If you are using the link between two fixed points, the range can be significantly increased using lenses. As with ordinary light a lens focuses more of the infrared energy to where it is needed producing a narrower beam. This arrangement is shown in Figure 10. A lens can be fitted to either the transmitter, the receiver or both. It is arranged such that the infrared emitter diode/ phototransitor is positioned at the point of focus. As the transmitter has four diodes there is some compromise when it comes to positioning. In practice, set up the transmitter and receiver modules at the required operating distance and adjust the position of the lens until optimum performance is achieved.

In general, the bigger the lens is, the better the range will be. For general purpose use, Maplin stock code FA95D can provide good performance at low cost.

If you want coverage over a wider angle, it is possible to fit additional infrared emitter diodes to the transmitter module. These can be fitted in series with the existing diodes as shown in Figure 11. A further 4 diodes can be easily accommodated. If you do this it will be necessary to reduce the value of R10 and R11 to compensate for the increased voltage drop from the additional emitter diodes. If four additional diodes are fitted, a suitable value for R10 and R11 is 68 ohms when using a 9V supply and 100 ohms for a 12V supply. In both cases the resistors should be 2W types.

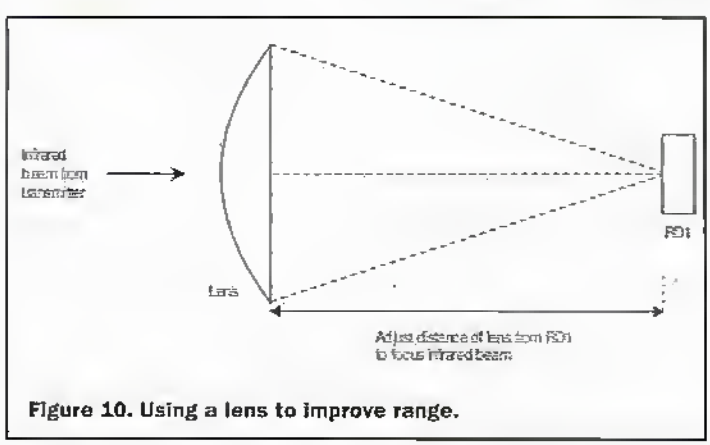



**Figure 10. Using a lens to improve range.**

## Effects of Ambient Lighting

Ambient light levels can have a considerable effect on the performance of the infrared link. In particular, strong light sources can result in saturation of the phototransistor and this affects the maximum range. If it is necessary to mount the receiver in an area where it is exposed to bright lights, some improvement can sometimes be obtained by adjusting the phototransistor bias. This may be carried out by reducing the value of resistor R1 on the receiver. However, this may also result in reduced sensitivity in

## PARTS LIST FOR ADD-ON AMPLIFIER

| | | | |
|---|---|---|---|
| **RESISTORS** | | | |
| R1 | Min Res 10k | 1 | M10K |
| R2 | Min Res 100R | 1 | M100R |
| R3 | Min Res 56R | 1 | M56R |
| R4 | Min Res 1R | 1 | M1R |
| VR1 | Hor Encl Preset 1k | 1 | UH00A |
| **CAPACITORS** | | | |
| C1, 9 | Gen Elect 220µF 16V | 2 | AT41U |
| C2 | Gen Elect 10µF 63V | 1 | AT77J |
| C3 | Minidisc 0.1µF 16V | 1 | YR75S |
| C4, 5, 6 | Gen Elect 100µF 16V | 3 | AT40T |
| C7 | Ceramic 470 | 1 | WX64U |
| C8 | Poly layer 0.22 | 1 | WW45Y |
| **SEMICONDUCTORS** | | | |
| IC1 | TBA820M | 1 | WQ63T |
| **MISCELLANEOUS** | | | |
| P1 – P6 | Pin 214 | 6 pins | FL24B |
| | DIL Socket 8 Pin | 1 | BL17T |

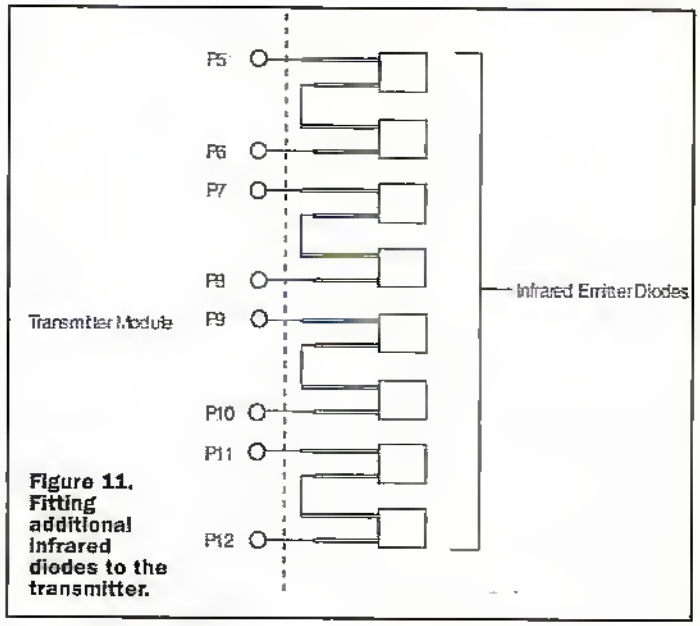



**Figure 11. Fitting additional infrared diodes to the transmitter.**

conditions of low ambient illumination so should be tried only as a last resort. In order to keep the current through RD1 well within acceptable levels, it is recommended that the value of R1 is not reduced below 1k.

If wide angle coverage is not required it is probably best to limit the viewing angle of RD1 as described for the Beam Break Detector application. This limits the amount of unwanted light falling on the device and can be an effective method of dealing with problems due to bright illumination.

## Temperature Effects

The operation of the circuit may also be affected by large changes in temperature. The main affect is a drift in the frequency of the PLL oscillator. The components used are fine for use in environments where the temperature remains fairly stable but some problem may be experienced in locations where there are drastic temperature variations. This point should be considered when determining the suitability of the link for a specific use although in some cases it may be possible to circumvent the problem by using higher stability components in the oscillator.

Significant heat is generated in the transmitter circuit by R10, R11, TR2 and TD1 – TD4. This is generally not a problem as long as free airflow is allowed around the circuit. When mounting the module in a case, ensure that you allow sufficient ventilation to this area of the circuit board.

## Finally...

There are a variety of ways in which the system could be enhanced and many variations on the ideas discussed. It is hoped that the applications covered in this article will provide a good starting point for readers who wish to develop the ideas further.

# in the pipeline

# ELECTRONICS and Beyond

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### Project Ratings

Projects presented in this issue are rated on a 1 to 5 for ease or difficulty of construction to help you decide whether it is within your construction capabilities before you undertake the project. The ratings are as follows:


Simple to build and understand and suitable for absolute beginners. Basic of tools required (e.g. soldering, side cutters, pliers, wire strippers, and screwdriver). Test gear not required and no setting-up needed.


Easy to build, but not suitable for absolute beginners. Some test gear (e.g. multimeter) may be required, and may also need setting-up or testing.


Average. Some skill in construction or more extensive setting-up required.


Advanced. Fairly high level of skill in construction, specialised test gear or setting-up may be required.


Complex. High level of skill in construction, specialised test gear may be required. Construction may involve complex wiring. Recommended for skilled constructors only.

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# Words of SCIENCE

## PART 3

***In part 3, Greg Grant looks at new words for new discoveries***


## Introduction

The electrical industry as we know it today began in the opening decades of the nineteenth century. The earliest form of electrical power was the Voltaic Pile, named after its discoverer, the Italian physicist Alessandro Volta. Its construction was indeed a pile, paired plates of dissimilar metal – in this case silver and zinc – separated by a pad soaked in a solution of brine, stacked one above the other. However, this 'battery' gave a very small output and was totally inadequate as a continuous current source.

By 1820, the Danish physicist Hans Christian Ørsted had discovered the link between electricity and magnetism. Although he took his discovery no further, others did, principally the British electro-chemist Michael Faraday. In 1831, he found that an electric current was set up in a copper disc when it was rotated between the poles of a magnet, the reverse of Ørsted's discovery.

## Electrical Motion

The conclusion to be drawn from this was obvious: if a way could be found to rotate a coil of wire in a magnetic field, you could tap off the electricity as it was produced. More to the point, it made no difference whether the coil turned and the magnet remained stationary, or vice versa.

The coil can be turned continuously by a turbine, run by either water or steam, thus converting mechanical energy into electrical energy. What's more, in its modern form, it can be done in quantities large enough to power factories, warm and illuminate homes and supply energy to whole cities. This device of course is termed a Generator, from the Latin *gignere*, meaning 'to produce.' Faraday however termed his original device a Dynamo, from the Greek *dynamis*, meaning 'power.'

This description proved, in one respect at least, an unfortunate one. When it was first suggested to the Sultan of Turkey that his capital Constantinople – present-day Istanbul – should have its own electric power supply, he appeared to agree. When, however, he was told that supplying the power would involve dynamos, he turned the idea down flat.

To the Sultan, dynamo sounded dangerously like dynamite and, however limited the old boy's scientific education may have been, he most certainly knew what dynamite was! Consequently, Constantinople had to wait several more years before it caught up with other capital cities where electric power was concerned.

## Electrolysis

Volta's battery of course – despite its meagre output – enabled chemists to pass an electric current through a variety of liquids and solutions and observe what changes took place, either to the current, the liquid or the solution.

Consequently chemists found that, as a general rule, the molecules of the substances in the solution or liquid separated into smaller particles. Dissolved copper sulphate for example deposited copper, whilst hydrochloric acid in solution would break down into hydrogen and chlorine. Even water – the ubiquitous $H_2O$, one of the very few chemical formulae remembered by virtually every schoolboy – split into its basic constituents. All the indications were that, under the impact of an electric current, the molecules loosened and broke up.

Faraday of course was deeply involved in such experiments, carrying on where his former employer Sir Humphrey Davy had left off. He was anxious to develop a terminology for the processes he was both experimenting with and developing further.

What he needed was a nomenclature – from the Latin *nomenclatura*, meaning 'list of names' – for the discoveries and revelations he had made. In 1834 therefore, he wrote to William Whewell, at that time a Fellow and Tutor at Trinity College Cambridge, for advice.

Like Faraday, Whewell had risen from humble beginnings. The eldest of seven children of a master carpenter, he had so impressed the headmaster of Lancaster Grammar School that he offered to teach the young Whewell for nothing. The headmaster's judgement proved sound: his protégé won a place at Cambridge, where he'd remain for most of his career, as professor of both Mineralogy and Moral Philosophy.

Noted for his writings on ethics and the theory of induction, Whewell saw scientific progress as a historical process, in fact he was one of the first academics to do so. At the time Faraday wrote to him, Whewell had already helped the geologist Charles Lyell to construct an appropriate nomenclature for his own field.

Faraday and Whewell began with the solution used in the conduction of electric currents. The Greek word *lysis* means 'a loosening' and so the process of *electrolysis* is a 'loosening by electricity.' A fluid which allows an electric current to produce electrolysis Faraday and Whewell termed an *electrolyte*, from the Greek word *lutos*, meaning 'soluble.'

An electric current entered a solution through one metal rod and exited it through another, as indeed is still the case – by and large – in battery technology. At this time however – 1834 – it was thought that the current travelled from the battery's positive rod, through the electrolyte, to the negative rod. The most common analogy used at the time was that of a river, flowing from its source to the sea.

The positive pole Faraday suggested should be termed the Anode, from the Greek *anodos*, meaning 'a way up,' or 'the high road.' The negative pole on the other hand he termed the Cathode, from the Greek *kathodos*, meaning 'a

descent' or – put another way – 'the low road.' The poles themselves, they suggested, should be called *electrodes*, from two Greek words meaning 'the road to electricity.'

This meant that electricity, following the suggestion of Benjamin Franklin, flowed from the 'height' of the anode to the 'depth' of the cathode. Although this would subsequently prove to be a fallacy it did not much matter. Faraday now had a nomenclature from which to work, and promptly rewrote his Laws of Electrolysis using the new terms.

Another expression which resulted from experiments with electricity as applied to chemistry was *ion*. It comes from the Greek word *ienai*, meaning 'to go.' This was another of Faraday and Whewell's originations, naming the parts of the broken-up molecules.

The Greek word *ion* means 'going' and so those ions travelling to the cathode were termed *cations*, whilst those heading for the anode were called *anions*. In the case of water for example, the anions would be negatively-charged ions of oxygen, the cations positively charged ions of hydrogen. What those ions actually *were* however would remain a mystery until 1903.

Whewell was the first man to use the term scientist to describe a person engaged in the study of what was then known as Natural Philosophy. It stems from the Latin *scientia*, meaning 'knowledge,' and first saw the light of day in Whewell's book *Philosophy of the Inductive Sciences*, published in 1840.

## Magnetism

Another field in which Faraday was an investigator of genius was the phenomenon known as magnetism. In 1845, he passed a beam of plane-polarised light through a piece of heavy glass, subjecting this arrangement to a powerful magnetic field. He detected that the plane of polarisation had been affected. This was the Faraday Effect, which proved a connection between light and magnetism.

Shortly after he'd announced his results, Faraday realised that the dense piece of glass he'd used was, in essence, a new type of magnetic substance. Unlike other magnetic materials, this type aligned itself *across* the line linking the magnetic poles, when suspended between them. Faraday called such materials *diamagnetic* materials, from the Greek prefix *dia*, meaning 'across.' These substances moved towards regions of less magnetic force.

The general type of magnetic materials – those that aligned themselves in parallel with the line connecting the poles – Faraday termed *paramagnetic*, from the Greek prefix *para*, meaning 'alongside,' or 'beyond.' Here, we're talking of substances such as nickel and cobalt, whose long axes of their crystalline or molecular structure were parallel to the lines of force. They moved towards the more intense magnetic fields.

Magnetic substances such as steel and iron, Faraday called *ferromagnetic*, from the Latin *ferrum*, meaning 'iron.' Magnetite is another example of this type of material, an electrically-charged substance which strongly attracts other substances.

Michael Faraday died in 1867, having contributed more almost than any other man to the ultimate triumph of electricity as a power source. By the turn of the century, there was another field in which it was beginning to make a mark: entertainment. Here too, new words, catch-phrases and initials would shortly be the order of the day. Next month, we'll look at how some of the more familiar words of the entertainment game were derived.

# @Internet

## W3C says DOM for XSL

If there's one thing the Internet is, it's a great leveler. Effectively, it doesn't matter what computer you've got, and it doesn't matter what operating system runs on it, as long as you follow a few simple (well, not that simple, but relatively less complex than the computers themselves, anyway) protocols, you can be on the Internet, surfing the information superhighway waves as quick as you like. Your computer doesn't have to be that powerful either. Despite manufacturers' claims that you need the latest in computer technology to get on the Internet, actually being there uses far less computing power than, say, creating a spreadsheet to make up your household accounts. Millions of people worldwide have computers significantly older than the World Wide Web itself.

Nevertheless, the World Wide Web Consortium (W3C) has released proposals for recommendations to upgrade the existing protocols that the World Wide Web runs on. First is the proposal for the document object model (DOM). This is to be (like existing protocols) platform-neutral (that is, it doesn't matter what computer you've got) and language-neutral (likewise, the operating system doesn't matter), and is set to replace dynamic hypertext markup language (HTML - the current protocol) as the means whereby Web pages are created and used. Second is the first working draft of extensible stylesheet language (XSL) - the manner styles of text on a Web page can be set up by the page designer.

These look as though they'll be taken on board the World Wide Web very quickly, simply because they add power to the elbows of the very designers who will use them to create Web pages. To date HTML is seen as a restrictive protocol (it was originally designed back in the 1980s, when the Internet was a mere stripling) that is holding back World Wide Web development. However, once Web pages using DOM and XSL are created, it's up to the browsing software to be able to use their new features. To this end, Microsoft and Netscape intend to support the new protocols as soon as possible. Soon-to-be-released versions 5 of both Internet Explorer and Communicator are expected to have some (possibly not all, mind you) support implemented.

## iMac has landed

Unless you managed to miss the radio, television, billboard, newspaper and magazine advertising over the last few weeks, you'll know already that Apple's new Internet-ready computer was released on 5th September. Priced at £999, the iMac is (in Apple terms, at least) quite a cheap computer, particularly if you take into account its specification. It's powered by a 233MHz PowerPC microprocessor that Apple says is upto 40% faster than the fastest Pentium you can buy on some tasks. If this is true, and no-one's come up with evidence to the contrary yet, then this actually makes the iMac much cheaper than its PC equivalent rivals compared on a like-for-like basis. However, while technically that's good news, it's not the most important aspect of the iMac. Instead, it's the iMac's design that puts it way ahead of the average personal computer. Apple has always been a company that sets the standards in personal computing, and if the iMac's no different to other Apple products over the last few years, we can expect to see dozens of cuddly little one-piece, cool-coloured, me-too PCs from other personal computer makers over the years to come. Take a look at the coolest-looking but hottest personal computer on the planet at Apple's Website: <http://www.apple.com>


As to its ability to access the Internet, the in-built 56K modem and connection scripts takes care of that. One reporter has already gone on record to say that it took 12 minutes to access his Internet service provider - and of that, much time was spent looking for his password.

iMac promises to be a real winner for Apple in the run-up to Christmas and beyond, which is good news for us all. Without Apple we'd all be still typing in commands onto a black computer screen with green letters on. (What? Some of us still are?) We'd all still be writing batch files to do our work. (Some still doing this too, huh?) And there wouldn't be a World Wide Web in the first place.

## Women Online with Horse Whisperer

Web browsers can get the inside story on The Horse Whisperer, Robert Redford's romantic blockbuster based upon the best selling novel and chat exclusively live to one of its stars Kristin Scott Thomas at <www.horsewhisperer.co.uk>.

But this is not a trailer for the film. Definitely not. If the marketing hype is to be believed the Horsewhisperer Web site is part of a planned initiative to attract women to the Internet. Web site content will be regularly updated.


Over time the Web site's hosts, Cable & Wireless will expand the site to offer women a complete introduction to the Internet, including a directory of women's interest sites and women's information forum Connect Women.

This is a marketing trick that might just work. The UK user base of women has risen from 32% to 37% in the last 18 months according to a NOP Business Survey for KPMG, published in March 1998. Meanwhile, the same survey claims that the number of women going on-line over the next 12 months could increase by up to 69%, compared to an extra 41% of men, which will bring the UK gender ratio closer to parity.

## BBC Online Records 64% Usage Increase


BBC Online remains the most visited UK content Web site, recording a total of 35,000,000 page hits a month, according to official figures from the Audit Bureau of Circulations. The ABC electronic audit for the month of June 1998 shows an overall increase of 64% in the number of page impressions from visitors to BBC Online since March 1998. Data from BBC Research and Development shows at least 1,300,000 users access BBC Online each month. It is estimated that around 5,000,000 people in the UK have access to the Internet.

Speaking to Electronics and Beyond, Mark Frost, Head of BBC Online, said, "BBC Online has achieved incredible success in just eight months. Feedback from the recent public consultation process indicates huge demand for BBC public service content on the Internet. Over the coming months BBC Online will focus on addressing specific requests raised in the consultation, as well as making the site more intuitive in terms of navigation."

BBC Online's public service presence on the Internet at <www.bbc.co.uk> registered 31,000,000 page hits. Included in this figure is 17,000,000 page impressions for BBC News Online at <www.bbc.co.uk/news>, a 106% increase since March. In addition, beeb @ the BBC at <www.beeb.com>, the joint commercial venture between BBC Worldwide and ICL, recorded 4,000,000 page impressions.

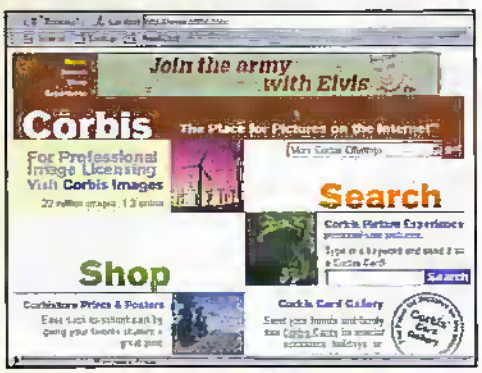
## Corbis Launches World's Largest Online Picture Agency

Corbis, the international picture library, has joined forces with AltaVista to bring consumers the world's largest and most comprehensive online picture search featuring Corbis imagery.

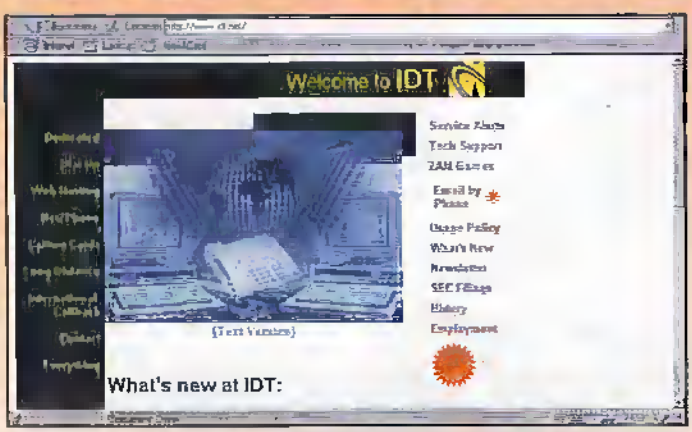
For the first time, online consumers can conduct an interactive picture search of the world-famous Corbis Collection. The Corbis Picture Experience accessible from either the Alta Vista and Corbis Web sites at <www.altavista.digital.com> and <www.corbis.com>, allows users to search nearly 500,000 high-quality Corbis images and send them as online greetings. This service is the first in a series of online utilities – including downloads, and print and purchase options – which will allow customers to fully interact with Corbis pictures.

The Corbis Picture Experience also allows users to search for and view some of the world's most popular and recognisable images from the Corbis Collection, including Albert Einstein sticking his tongue out, the Hindenburg explosion and Leonardo di Vinci's Mona Lisa.

From the AltaVista home page, the Corbis Picture Experience is accessible by clicking on 'Create a Card' located in the 'Services' section. Search results from the Corbis Collection are presented as small images with a brief description and the option to send a Corbis Card. By clicking on the image itself, users go to the home page of the image, where they can see the full caption and information, access Corbis' online print and poster shop, go to the Corbis Card Gallery or view other Corbis offerings.




## Excite and IDT's Net2Phone in Internet Telephony Deal




Phoning home - or anywhere else in the world for that matter - has never been cheaper. Excite at <www.excite.co.uk>, together with IDT's Net2Phone division at <www.idt.net>, has announced a two-year agreement to bring Internet telephony to the desks of every Excite user in the UK, Germany, France, Australia, Netherlands, Japan and Sweden.

Net2Phone enables Internet users to place calls to any telephone in the world via the Internet, transforming multimedia computers into full service communications tools. The Net2Phone icon will be seamlessly integrated through many of Excite's channels giving customers a one-click access to download the service, subscribe and then simply make calls anywhere in the world.

Recipients of the call need not be online as calls are routed directly to traditional telephones. Because calls are placed through the Internet, phone rates are not based on the country of origin, but on the low-cost pricing structure set by IDT for the number being called. This results in cheaper long-distance phone calls both nationally and internationally for users of the Net2Phone service.

Excite is also planning on offering a click to dial service, by fully incorporating Net2Phone into Excite's personalised directory. Users will be able to look up a telephone number in their directory and then automatically call that person by clicking on the phone number.

## First Virtual Acquires Internet Broadcaster

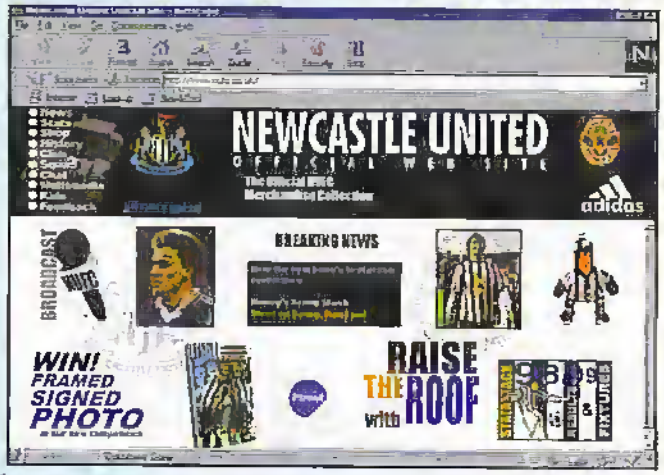
First Virtual is set to acquire ICAST, a developer of Internet Protocol (IP) voice and video broadcast solutions. With this acquisition, First Virtual will be able to deliver video broadcast products to the 100,000,000 Internet-equipped PCs worldwide.

According to FVC.COM chief executive officer Ralph Ungermann, the technologies developed by ICAST are complementary to FVC.COM's existing product portfolio.

"Our focus has been on providing end-to-end solutions for the new broadband Next Generation Internet. ICAST's line of broadcast solutions for today's Internet brings video streaming to Web-enabled PCs worldwide. As a result, FVC.COM will be the only one-stop provider of managed video solutions for high-end through low bit-rate video applications," said Ungermann.

In tandem with the acquisition, First Virtual intends to change its name to FVC.COM to more accurately reflect the company's role in developing NGI and Internet applications for interactive, broadcast-quality video.


## Newcastle Scores Record Hits With Official Web Site



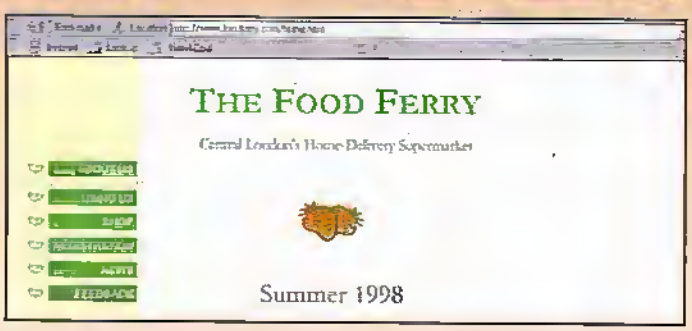

Response to Newcastle United Football Club's official Web site at <www.nufc.co.uk> is taking off. In the first week of the premiership week, the site recorded over 3.6 million hits. And that's before Daglish made his dramatic exit from the club.

Newcastle has seen a significant increase in sales of club merchandise placed via the Web site. Purchases are made from all over the world offering a faster order placing service to the fans than traditional methods.

The Club attributes the dramatic rise to a combination of factors. Alec King, Marketing Director of Newcastle United said, "Although the site was only launched in April, interest has been building since the Cup Final in May and the recent signings from Peru, France and Germany have also increased our international support."

Supporter comment has been enthusiastic, and particularly so from overseas. Nearly 65% of the hits during this time have come from outside the UK. The club is trying to build an International Supporters Club and is finding the Internet the most effective way to do this.

## Food Ferry Goes Online with BT Labs




BT has begun the trial of a new Internet storefront with The Food Ferry, a London-based direct delivery grocery store.

The Food Ferry, which has been in business for over seven years, sees Internet shopping as a natural extension to its home delivery service. In addition to the existing paper-based catalogue and telephone ordering service, customers can now order groceries via the Internet using an on-line catalogue. Once processed, The Food Ferry delivers the order direct to the customer.

The BT Labs-designed on-line storefront is suitable for any small to medium sized business and can be 'stocked' by uploading an existing product database of over 2,000 items. Its key benefits are a fast updating shopping basket, product search and the ability to re-use and edit previous orders. Additional features include a variety of special offer and discount options, reward points, and delivery time selection.

This storefront is designed to be managed entirely by the merchant, without the need for specialist IT skills and the start-up costs are kept low by using the merchant's existing electronic product database as input. The system should be suitable for a range of small to medium sized business selling up to several thousand-product items.

BT already offers Web hosting and storefront facilities on BT WebWorld. This technology trial is part of an on-going programme that will extend BT's services to establish a comprehensive set of e-business solutions for companies of all sizes.

Further information on the trial can be found at <scenic.labs.bt.com> or <www.foodferry.co.uk>.

## NewsNow Take Two

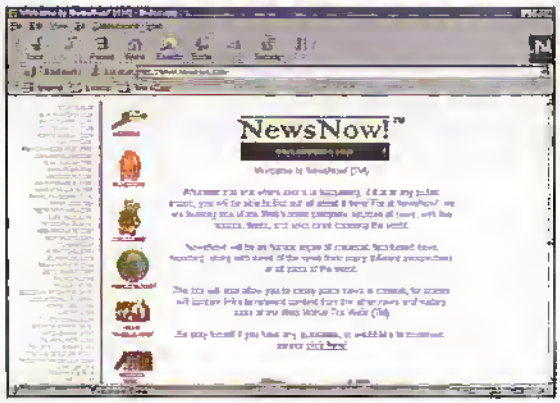
UK news portal site NewsNow at <www.newsnow.com> has completed two months of re-coding for the launch of NewsNow Version 2.0, the second incarnation of its Web spidering technology. The new software is designed so NewsNow will exceed other top sites in terms of speed, flexibility, reliability and robustness.

"Speeding up the search was very important in terms of NewsNow's Search Link strategy," explained Bartlett. "With a growing number of companies providing customised NewsNow searches via their Intranets and Web sites, it was crucial to provide a faster search. People will not tolerate slow sites these days," he added.

NewsNow's Search Link can be used to track clients, competitors, subjects and generic areas of interest. It is already proving popular with technology companies - one is using Search Link on an Intranet to track competitors, while football sites are offering their users customised searches of over 75 separate news sources for a word or string of words.

Meanwhile, NewsNow also announced the addition of twelve news sources to the site, including daily news from Silicon News, which will bolster the Technology section. Sports fans will notice newfeeds from the Daily Mirror, Daily Express, Football 365, FootballNet and Sporting Life Divisions 1 and 2 while in the Entertainment section, feeds from Mr Showbiz, This is Lancashire, Entertainment Online and dotmusic have also been added.

NewsNow is the UK's first news portal site. Completely free, it works like a TV remote control, allowing both professionals and casual surfers to flick easily and quickly between latest headlines from 38 leading news sites without visiting individual each site separately. NewsNow is designed to be UK-relevant, making it ideal for a UK audience.

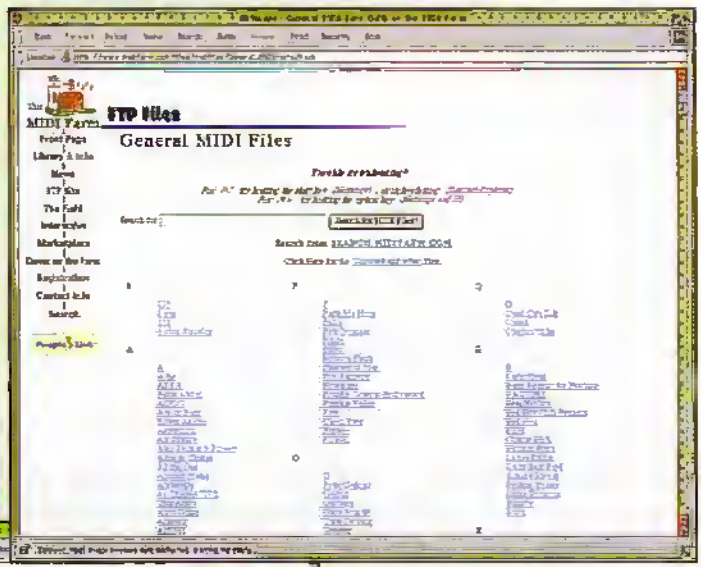



# Site Survey

## The month's destinations

The World Wide Web Consortium is not the only body wanting to make sure standards on the World Wide Web remain open for all computer users. The Web Standards Project (WaSP) is a collective partnership of web developers and users - the very people who create World Wide Web pages and sites, and the very people who use them. There's a growing feeling among such people that the standards in place either aren't far-reaching enough, or aren't being followed too closely by the Web browser makers. Now, the Web browser makers (and there's really only two players at the moment - Microsoft and Netscape) aren't likely to listen to individuals requesting that standards be made and kept, but a few thousand individuals together as a body may make some headway. Hence the Web Standards Projects. Check out the WaSP Website at: **http://www.webstandards.org** and sign the support form if you agree with the principal of Web standards for all.

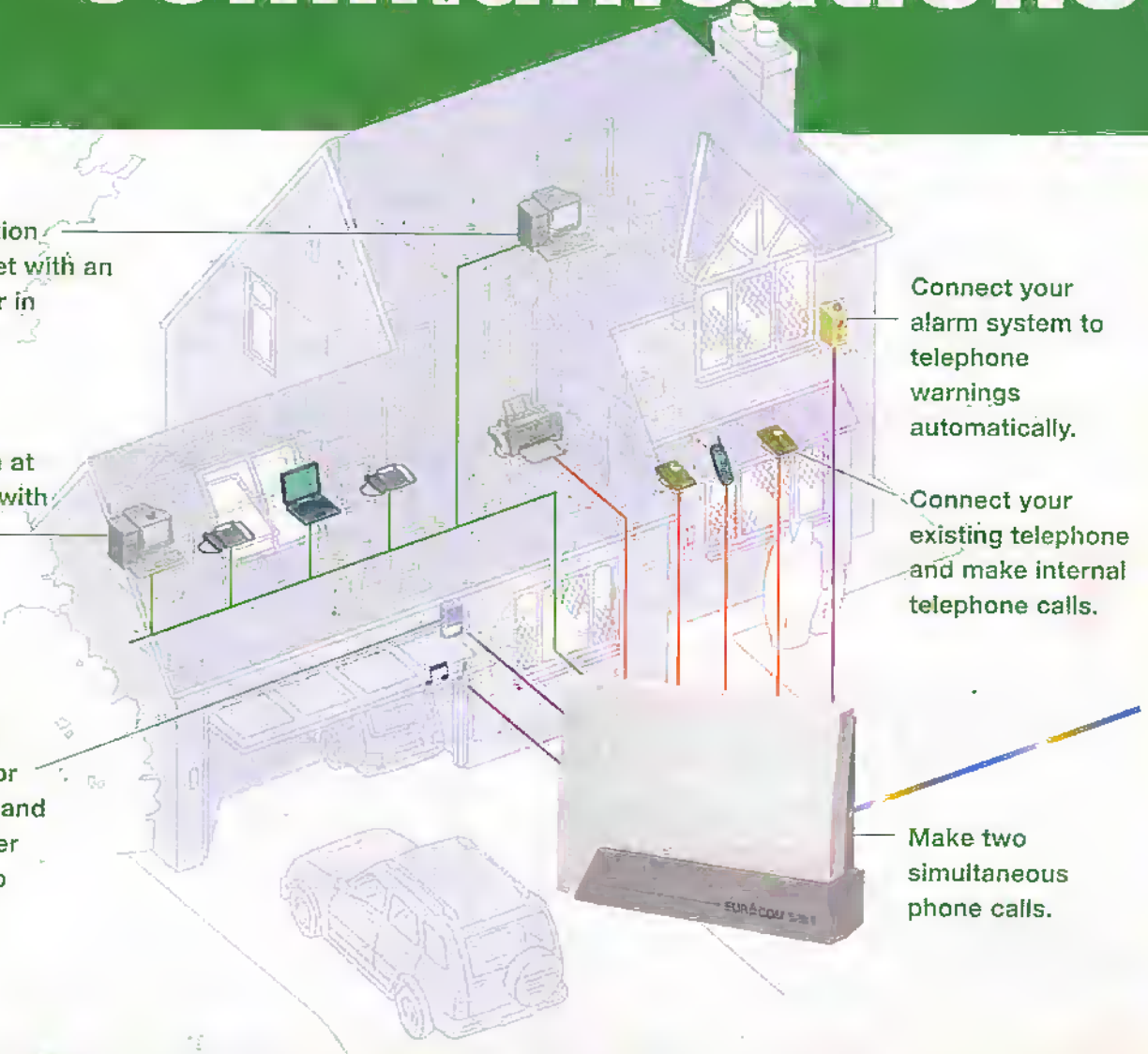
Always on the lookout for a good search engine? I mean, a really good search engine! They're few and far between these days. But try Snap, at: **http://www.snap.com** where you'll find a refreshingly quick yet pretty powerful new engine to help you scour the Internet for the information you want.



If you're into digital music of the MIDI form, you might like to take a gander at the MIDI Farm Website. There are literally thousands of MIDI files you can listen to with the help of your Web browser, or even download to play on your computer, of hundreds of artists and plenty of musical genres (nice word, huh?). The URL: **http://www.midifarm.com/files/midifiles/General_MIDI/default.asp** will take you to a general page of rock, pop and modern music.

# One clear route for communications

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