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THE MAPLIN MAGAZINE

ELECTRONICS and Beyond

January 2000 Vol. 20 No. 145

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Published by Maplin Electronics plc., P.O. Box 777, Rayleigh, Essex, SS6 8LU. Tel: (01702) 554155. Fax: (01702) 554001.
Lithographic Reproduction by Planagraphic Studios, 18 Sirdar Road, Brook Road Ind. Estate, Rayleigh, Essex SS6 7UY.
Printed by St Ives (Gillingham) Ltd., Grant Close, Gillingham, Kent, ME8 0QB.

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Maplin Electronics plc., P.O. Box 777, Rayleigh, Essex, SS6 8LU. Tel: (01702) 554155. Fax: (01702) 554001.

UK Newstrade Distribution
Maplin Electronics PLC.

Export Distribution
Comag Magazine Marketing Tavistock Road, West Drayton, Middx, UB7 7QE

ELECTRONICS and Beyond

Christmas is fast approaching, so for those of you who prefer to shop from the comfort of your trusted computer we have provided a varied source of Internet suppliers to tempt you with Christmas goodies. You can now buy everything from the complete Christmas meal, supplied by the large supermarket chains, to a mult-million pound Lear Jet - all from the tap of a keyboard! Many would argue that this is not the way they want to shop, preferring the personal approach, but then can we stop the march of progress? Retailers and organisations (big and small), including Maplin, know that they have to go with this new technology and cater for all types of customer.

It has been many years since I used logarithmic tables, an indispensable tool during the 60s when studying mathematics, along with the trusted slide rule. The early 70s saw the introduction of the calculator and this brought about the decline in their use. Do remember that 'logs' had been in use for over 350 years! Douglas Clarkson in his article, On the Trail of e: Napier's Logarithm, recounts the work of Scotsman John Napier who gave logarithms to the world.

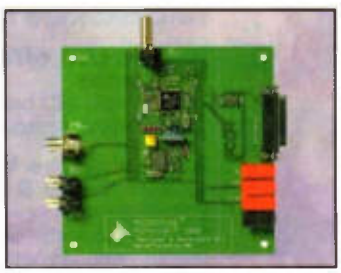
Although it would be ridiculous to suggest that thermionic valves will ever make a come-back for general purpose use, it would also be wrong to consider them as totally outdated. Valves are still with us today and they look likely to remain the preferred choice of component in certain important niche applications, such as audio, for some time yet. This month Mike Bedford starts a new series looking at valve history and development.

Finally, we wish all our readers a merry Christmas and a prosperous new year with the thought that the new millennium will certainly bring new scientific wonders - for us all to marvel at.

Britain's Best Magazine for the Electronics Enthusiast

NEWS REPORT

Microtune Introduces Reference Kit



Microtune has launched a designer's reference kit for its single-chip broadband tuner, the MicroTuner 2000.

The kit enables engineers, even those with no RF design or layout experience, to integrate its tuner/receiver into a tuner-on-board solution, a first for the industry. It is intended to accelerate the transition of manufacturers to solid-state tuners and next-generation digital consumer electronics. Featuring the MicroTuner 2000, the designer's reference kit consists of a single-board, containing all input and output connectors and test points, a demodulator for baseband audio and video, and a Windows-based application that allows designers to test and evaluate all performance parameters.
For further details, check: <www.microtune.com>.
Contact: Microtune, Tel: +1 972 673 1600.

IBM Reaches Copper Milestone

IBM has sold its millionth copper PowerPC chip, just a year after shipping the first device. IBM's copper PowerPC processors are helping to fuel the company's growth as a major supplier to makers of networking gear.
The company recently announced the industry's highest performance embedded processor to date, the copper-based PowerPC 440, which can be used to boost the flow of traffic in the routers, hubs and switches that power networks like the Internet.
The PowerPC 440 is the newest addition to IBM's rapidly growing Blue Logic library of chip cores - pieces of chip design that can be combined quickly to create new chips for a wide range of markets including communications, servers, storage systems, and pervasive computing devices.
The new core, based on IBM's leadership copper technology, provides about three times the performance of the PowerPC 405 core introduced by the company just last year. It is well suited for a variety of applications - including printers, RAID controllers, cellular base stations and set top boxes, among others.
For further details, check: <ww.ibm.com>.
Contact: IBM, Tel: (0990) 426426.

Presario Line Blends Form and Functionality

Apple's Steve Jobs was the first to recognise that PC users wanted more than a dull grey box when he launched the iMac. Since then a host of PC manufacturers has jumped on the bandwagon and launched cute looking PCs for the style conscious consumer.

Now Compaq has introduced the Presario 3550 - a sleek Internet PC that blends modern styling, space-saving design and colour with the power of today's technologies.

In addition to the Presario 3500 Series, an entire new line of Presario Internet desktops and notebooks is available today.

New desktops, ranging from the entry-level Presario 5400 Series to the 5900Z Series that can be configured with the AMD Athlon/700MHz processor, provide consumers a variety of choices for Internet access, digital entertainment and personal creativity.

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

Contact: Compaq, Tel: (0845) 2704222.

IBM Targets Audiophiles with Removable Hard Drive

IBM has announced a new device that allows mobile users to easily add an extra 10 gigabytes of hard drive capacity to their notebook PCs.

Travelstar E is a compact, lightweight device comprised of an IBM hard drive, rugged container and a cable that easily plugs into a standard PC Card slot in any notebook. Its introduction marks IBM's entrance into the marketplace for high-capacity external hard drive devices.

Travelstar E weighs less than a pound yet it can hold up to 10 GB, about the equivalent of 10,000 novels or 10 symphonies in high-fidelity sound.

Rigorous testing has shown Travelstar E is five times more rugged than a standard notebook hard drive.

There are three software programs bundled with Travelstar E. The first two are used for drive back-up and encryption. The third is RioPort.com's digital audio jukebox software that allows consumers to easily encode, organise, and download MP3 or Microsoft's Windows Media Audio (WMA) files from the Internet or a CD for playback on the PC or portable MP3 players.

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

Contact: IBM, Tel: (0990) 426426.

NEWS BYTES

Lucent and E Ink to Develop Electronic Paper

Lucent Technologies and E Ink Corporation have announced a joint development agreement that aims to move electronic books and newspapers resembling flexible plastic sheets one step closer to reality.

The two companies plan to develop electronic paper, which would be the first flexible, plastic electronic display entirely made with a process similar to ink-on-paper printing, rather than the more costly silicon-chip manufacturing process.

The same technology, which allows for instantaneous updating via computer link, may also lead to ultra-thin, lightweight displays for next-generation consumer electronics, such as cellular phones and personal digital assistants.

The key elements of electronic paper would be plastic transistors, developed at Lucent's Bell Labs, which have the same properties as conventional silicon chips but are flexible and can be printed, and E Ink's electronic ink.

Electronic ink is comprised of millions of tiny microcapsules filled with a dark dye and light pigment. When charged by the electric field created by the plastic transistors, the microcapsules will change color and create images.

The objective of the Lucent/E Ink collaboration is to print the plastic transistors onto a flexible plastic film coated with electronic ink

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

Contact: Lucent, Tel: (01252) 391600.

Alliance Targets Pen-based Products for Smart Phones

Nokia and Palm Computing are set to create a new pen-based product category. Nokia is licensing the Palm Computing operating system – Palm OS – so it can implement the user interface and applications to run on the Symbian platform. Resulting devices will run both Palm and Symbian applications.

This co-operation will make it possible to deliver to consumers the benefits of pen-based wireless devices with superior ease of use, that integrates telephony with data applications, personal and professional information management and other value-added services.

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

Contact: Nokia, Tel: (01480) 434444.

NEWS BYTES

Cypress Announces Development of BiCMOS Process

Cypress Semiconductor has announced the development of a 3.3V, double-layer-metal, 0.25-micron BiCMOS process to be employed in next-generation products in areas including high-speed physical-layer devices and wireless communications products for high-frequency applications.

The new BiCMOS process is anticipated to provide an optimal mix of speed, power, and cost relative to competitive processes. It will allow Cypress to efficiently integrate mixed-signal, memory, and high-speed logic circuits.

Among the first products scheduled to use the new technology is a high-performance transceiver that is expected to attain speeds of 2.5 gigabits per second.

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

Contact: Cypress,Tel: (01707) 378700.

Desktop Mirroring Software Matches PCs

New software, known as ThinPATH Desktop Mirror from Network Computing Devices, enables complete access to personal computers in a network as if the authorised person were sitting right at the individual user's desk. Unlike other screen shadowing products available in the market today, Thin PATH Desktop Mirror views the entire desktop rather than just the Window sessions.

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

Contact: NCD,Tel: (01491) 848300.

Philips Semiconductors Moves Cars Into Fast Lane

Philips has announced the Nexperia Car Infotainment Platform (CIP), an innovative approach to electronic systems design that will give the automotive industry a fast, flexible way to tap into the vast emerging market for connecting cars online.

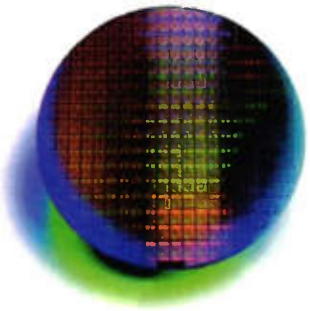
The Nexperia CIP allows quick development of complex systems that combine many entertainment and telematics functions. For example, the platform facilitates the creation of an in-car mobile office with features such as Internet and e-mail scheduling, as well as state-of-the-art in-car audio entertainment.

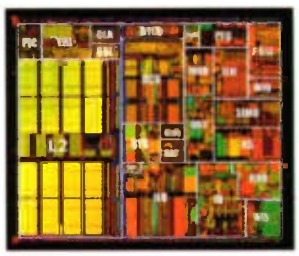
Additional applications could include GPS route guidance and navigation to help drivers avoid traffic jams, download local maps and receive up-to-date travel information.

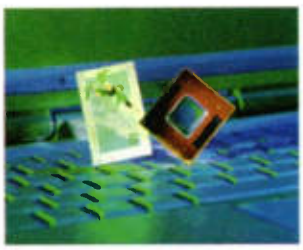
For further details, check: <www.semiconductors.philips.com>.

Contact: Philips. Tel: (0181) 754 8421.

Intel Unveils Newest, Fastest Chips







Intel has introduced 15 new Pentium III and Pentium III Xeon processors, all built using advanced Intel 0.18-micron process technology that enables faster processor speeds, new performance enhancing features and lower power consumption.

The new processors feature an advanced transfer cache that delivers a performance boost of up to 25% when compared to earlier Pentium III processors running at the same clock speed.

New packaging options enable a wide choice of system configurations including ultra-thin and light mobile PCs and small form factor desktop PCs.

With this product introduction, Intel has brought all the benefits of Pentium III processors to mobile PCs for the first time, offering the best combination of performance, mobility and choice.

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

Contact: Intel, Tel: (01793) 403000.

Wind River Systems and Integrated Systems Join Forces

Wind River Systems is to acquire Integrated Systems Inc (ISI) in a deal which will see the new company provide embedded systems software for a broad range of industries including telecom/datacom, consumer electronics, automotive, and aerospace.

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

Contact: Wind River Systems, Tel: (0121) 359 0999

Kodak Snaps Satellite Photos of Earth

The release of the first picture from Space Imaging's IKONOS commercial remote sensing satellite marks the beginning of commercial satellite photography.

The digital camera system was designed and built by Kodak for US based Space Imaging.

The satellite's camera is able to distinguish objects on the ground as small as one metre in size from 400 miles above the Earth.

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

Contact: Kodak, Tel: (01442) 261122.

RSL COM Deals Results in Largest Independent Mobile Provider

RSL COM, has acquired Advanced Telecom, a provider of fixed line and mobile telephony in the UK. Together with the purchase of Motorola Tel.co last year, this purchase makes RSL COM the largest independent supplier of mobile telephony in the UK, with nearly 250,000 customers, and strengthens its position as a one-stop shop for fixed and mobile services.

For further details, check: <www.rslcom.com>.
Contact: RSL COM, Tel, (01483) 457300.

Siroyan Announces Architecture Optimised For System-On-A-Chip

Siroyan, the UK-based silicon intellectual property (SIP) start-up, has announced its intention to develop a System-on-a-Chip (SoC) soft core solution for digital applications. The architecture, codenamed Rubicon, will address the market for combined microprocessor and digital signal processing (DSP) solutions.

Siroyan has identified that design engineers creating products for digital environments require two key features - high performance digital signal processing (DSP) capability to handle signal processing in real time, and microprocessor functionality to handle general purpose processing tasks.

The Rubicon architecture will be optimised for applications that require both microprocessor and DSP functionality and will be designed from the ground-up as a soft core solution. Siroyan anticipates a full product release by the third quarter of 2001.

"Microprocessors are struggling to handle digital signal processing in real time. And DSPs can't handle general microprocessor functions. Engineers are being forced to cobble together solutions which is inevitably a compromise and causes problems with hardware and software design," said Adrian Wise, technical director, Siroyan.

For further details, check: <www.siroyan.com>.
Contact: Siroyan, Tel: (0181) 956 2233.

Digital TV Receiver for PCs Launched

Hauppauge has launched a digital TV receiver board, WinTV-D, which enables PCs to receive a full range of broadcast services, including both digital and analogue television and high-speed data transmissions.

WinTV-D is the first digital TV receiver board for PCs, allowing the reception, decoding and display of digital TV formats in a resizable window on the PC display.

The AC-3 Dolby Digital audio portion of the digital broadcast is also decoded, and outputs are provided to drive up to 5 speakers, to correctly reproduce the full surround sound effect.

For further details, check:
<www.hauppauge.co.uk>.
Contact: Hauppauge, Tel: (0171) 378 1997.

Cordless Keyboards Feature Reliable Radio Technology

Logitech has announced its next generation of radio-based cordless keyboards. All members of the new keyboard family feature easy Internet and multimedia access and control via special dedicated buttons. In addition, all are designed with detachable palm rests that provide comfort during typing breaks, yet are easily removed to save desk space.

For further details, check:
<www.logitech.com>.
Contact: Logitech, Tel: (0181) 308 6582.

NEWS BYTES

Cryptographic Processor Protects PCs

Atmel has announced the availability of a hardware security solution for PCs developed in conjunction with IBM.

The hardware core of the security system is a cryptographic processor developed by Atmel that can both store secret keys in non-volatile memory, and compute public key functions using those secret keys.

Among these functions are a generation of signatures, secure storage and transmission of various secret keys. The integrated circuit protects against many of the kinds of breaches that hackers might use to gain secret information.

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

Contact: Atmel,Tel: (01276) 686677.

New Chip Simplifies Internet Connectivity

Israel start-up Connect One has announced iChip, an Internet connectivity peripheral chip for existing and next-generation, cost-sensitive devices.

iChip is a family of low cost, application-specific peripheral chips that speeds time-to-market of implementing Internet connectivity in a range of remote devices.

For further details, check:
<www.connectone.com>.
Contact: Connect One,
Tel: +972 9 766 0456.

Cadence Designs First Single-Chip Processor for Internet

Cadence has announced the first single-chip processor for Internet telephony and audio. The chip, named TRIO, was developed by Cadence for Aplio, a leading provider of Internet appliances and their enabling, embedded communications technologies.

The high-performance Aplio/TRIO chip was developed by the Cadence design services team at the Cadence SOC Design Centre, located within the Project Alba Centre in Livingston, Scotland.

Based on an Aplio-created board design that utilised lower-performance discrete processors, the chip was created for use by manufacturers of Voice-over-Internet Protocol (VoIP) telephones, and audio-on-demand appliances utilising MP3 technology, such as Internet radios and digital music players.

For further details check: <www.cadence.com>.

Contact: Cadence, Tel: (01344) 360333.

NEWS BYTES

HP Unveils Web 'Plug'

Hewlett-Packard has introduced an Ethernet-ready module that can be embedded into a wide range of products to allow them to be remotely monitored and controlled from any Internet browser.

The new embedded measurement and control 'plug' is designed to accommodate a virtually unlimited number of measurement and automation applications.

The matchbook-sized smart module provides an easy, low-cost commercial way to make products as varied as weather stations, blood analysers and fitness machines usable via the Internet.

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

Contact: HP, Tel: (0990) 474747.

Microchip Technology Introduces Internet-Ready Demonstration Board

Microchip Technology has introduced Internet-ready capability for its PICDEM-2 Demonstration Board supporting the company's PIC16CXXX family of 8-bit RISC microcontrollers.

PICDEM-2 incorporates emWare's evaluation software, allowing PICmicro designers to create products that can be accessed, monitored and controlled remotely over the Internet using a Web browser, personal digital assistant, telephone, spreadsheet, custom application or database.

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

Contact: Microchip, Tel: (0118) 921 5869.

Zoom Pioneers Home Phoneline Networking in UK

The Zoom HomeLAN PCI card is the first CTR21 compliant HomePNA product to be marketed in the UK. With a HomeLAN PCI card installed, the PCs to be networked are plugged into a standard phone jack. Family members around the home can then share simultaneous Internet access, swap files, share data drives, printers and other equipment, and play networked games.

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

Contact: Zoom, Tel: (0870) 720 0060.

Lego funds £3 million Media Lab

Lego is to fund a £3 million Lego Learning Lab at MIT's Media Laboratory. The new lab will focus on the development of new learning technologies for children – and also on the development of new theories about children's play, learning and creativity.

"The Media Laboratory and Lego share a deep respect for children and a fundamental belief that our investment in their learning and imagination will bear significant fruit for future generations," said Kjeld Kirk Kristiansen, chief executive of the Lego Company.

"Today's children are the world's first truly digital generation," said Nicholas Negroponte, co-founder and director of the Media Lab. "Establishing this laboratory provides an exciting opportunity to help redefine how children learn in an online world."

The Lego Learning Lab is the latest stage in a 15-year collaboration between the Lego Company and the Media Laboratory. This collaboration has led to a new generation of learning materials, based on "programmable bricks" with electronics embedded inside. With these new kits,

commercialised last year in the Lego Mindstorms product line, children can build and program their own robots and other computerised contraptions.

The establishment of the Lego Learning Lab will enable MIT students and faculty to extend and expand their research efforts in the field of learning and education. Research will be guided by the Media Laboratory's constructionist approach, in which children learn through a process of designing, inventing and experimenting.

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

Contact: Lego, Tel: (01978) 290 900.

Picture Provides Computer-less Solution for Digital Printing

The Kodak Personal Picture Maker from Lexmark enables digital picture-takers to crop, personalise, print or store their digital images without having to connect cables to a computer or digital camera.

The Personal Picture Maker by Lexmark incorporates an onboard digital camera card reader that loads, manipulates and prints digital photos, without having to connect cables to a computer or digital camera.

The user simply pops in the camera card and prints. The card reader accepts both CompactFlash cards and Smart Media.

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

Contact: Kodak, Tel: (01442) 261122.

HP and Nokia Partner to Develop WAP Solutions

In a move that could change the landscape in the mobile Internet market, Hewlett-Packard and Nokia have announced a global agreement to jointly develop and promote business-critical mobile Internet solutions for enterprises. The alliance will enable customers to access e-services over the Internet with mobile handheld devices, such as Nokia phones.

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

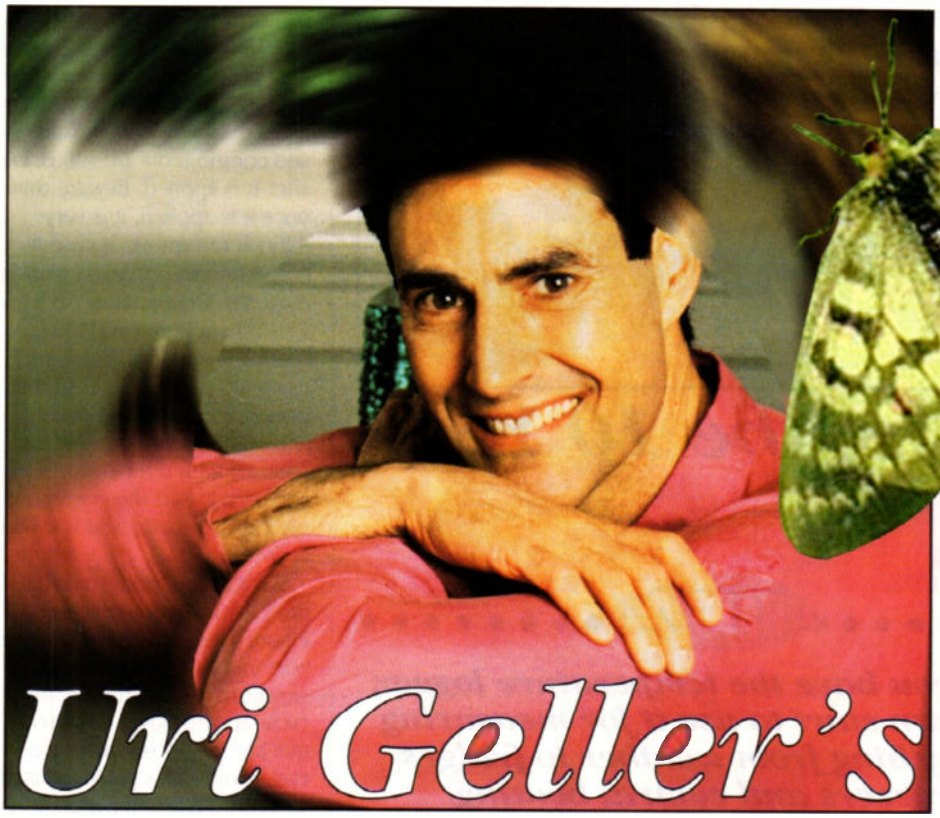
Contact: Nokia, Tel: (01480) 434444.

Nokia Plans To Put the Internet in Every Pocket

Nokia has demonstrated its Wireless Application Protocol (WAP) 1.1 compliant solutions which enable secure access and instant interaction with Internet/intranet information and other advanced telephony services over a mobile phone.

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

Contact: Nokia, Tel: (01480) 434444.

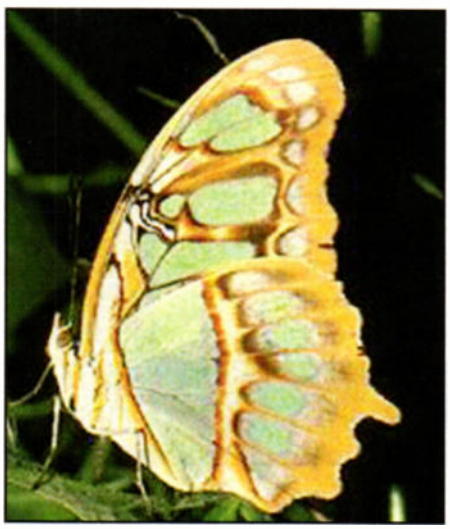


Uri Geller's EXTENDED REALITY

Animal Mimicry

One of the strangest phenomena in nature is what is called mimetism, or mimicry by plants, insects and animals, by which they adopt a kind of camouflage to fool their predators into not attacking them or gobbling them up. Well known examples include beetles that look exactly like treebark, seahorses that pretend to be bits of seaweed, or the praying mantis that becomes virtually invisible when it hides in the right plant.

Butterflies are especially good at mimicry. Some can look exactly like the leaves of their tree, and not only that - when the leaves darken in autumn and come out in spots, so does the butterfly. When the leaves fall, the clever creatures fly around as if they too were falling leaves.



Insects of one species can mimic members of another species that are immune from attack from local predators. Moths, for instance, turn themselves into bees or wasps - one smart moth can even 'become' a piece of bird-dropping.

Even flowers can be ingenious mimics although as far as we know they don't have any brains at all and so cannot think. Those that have no nectar can imitate those that do so as to attract pollinators, and there is even an orchid that can con bees into thinking they are female bees!

It was studying this kind of phenomena that helped Alfred Russel Wallace make his contribution to the theory of natural selection which he and Charles Darwin presented together in 1858, after each had worked it out on his own. According to this theory, now regarded by many as engraved in stone, all species evolve by adapting to their environment so that the best equipped members of their species gradually form a larger proportion of it from one generation to the next. Thus only the fittest survive.

Even Wallace would have been amazed by an insect called Laternaria servillei (the South American lantern fly) which was first described ten years after his death in 1913 in Vol. 43 of the Proceedings of the Royal Entomological Society in an article called 'The terrifying appearance of Laternaria... founded on the most prominent features of the alligator.'

It certainly is terrifying, although it's only about nine centimetres long. It has somehow grown a structure in front of its head that looks uncannily like the head of an alligator. It has a big pair of false eyes which even have white dots on them as if reflecting light, and its long artificial snout is partly open to reveal a menacing row of 'teeth.' The theory is that it scares off predatory birds because they mistake it for an alligator, which eats birds.

How can one species be so dumb as to mistake an insect for an alligator, while another is not imitating its own predator (the bird) but its predator's predator? This seems to me to be pushing the natural selection a bit far!

Are we really supposed to believe that this realistic mini-monster just evolved after successive generations 'naturally selected' themselves by looking a bit more like that big thing in the river that ate birds! It's fashionable nowadays to ascribe all evolution to chance mutations in the genes, which eventually come up with a design that leads to better survival prospects.

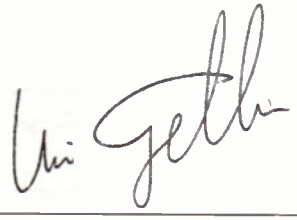
Fair enough, for we know a lot more about genes today than Wallace and Darwin could have known in 1858, but there is something else going on here. When you think about it, it is fairly mind-boggling. What it amounts to is that biological growth is being influenced by nothing more than information. A visual image of an alligator was all the lantern-fly needed to end up looking like one.

The important lesson to be learned from all this animal magic is that we too can alter our bodies with information - not to the same extent as in the examples given here, to be sure, but all the same we know it can be done. When a sick person is hypnotised and given a suggestion (and no medicine at all) and is then cured, what has happened? The most dramatic recent case was that of the boy suffering from ichthyosis, or fish-skin disease who was at least partly cured after just one session of hypnosis. (For the details, see the British Medical Journal for 23 August 1952).

Wallace, who was a prominent member of the Society for Psychical Research by the way, once wrote that the only primary cause of force that we know of is the human mind, or will. "It does not seem an improbable conclusion," he went on, "that all force is will force". The animal kingdom seems to know this already. It is time we realised it too.

Uri Geller's new magazine Beyond is now on sale at £2.99. His latest book MindMedicine is published by Element Books at £20.00, and his novel Dead Cold is published by Headline Feature at £5.99.

Visit him at **www.uri-geller.com**
and e-mail him at **urigeller@compuserve.com**



PROJECT

Using the 10 Year DATA LOGGER

PART 2

Now you have the temperature logger, you can start to use it for measuring everything from weather to fridges, freezers and central heating. Dr. Richard Whitaker explains how.

At last I have a temperature logger which can be left to its own devices for several days without having to think about batteries failing or needing to read it every day.

Although I first wanted the logger to investigate what happens in my greenhouse, it has proved invaluable for a number of other uses. It must be one of the unwritten laws of the universe that as soon as you have a new gadget you look for new ways to use it. It's always hard to justify buying something, but once you have it, it can be put to use for all kinds of things.

I guess the difference between the logger and a thermometer is similar to the difference between a photograph and a video. You get to see things changing, not just what things are like at a particular time. Now I get to see how the temperature changes, not just what it is now and again.

I started looking in my fridge! Not at the food, but at a small liquid crystal thermometer that I'd had for a while. I always thought it seemed to read a bit high, but I could never work out how much difference having the fridge door open when I read the thermometer would make. There is also the point that I don't like to admit that the temperature really is a bit high.

The Fridge

I decided to be a little scientific about the measurements. I know that cold air is heavier than warm air so it would seem that the bottom of the fridge should be colder than the top. I'd also made a second logger so I put one in the top of the fridge and the other near the bottom.

The first test didn't work very well. When I took the loggers out of the fridge they were cold enough to have moisture condense on the circuit. This stopped them working altogether, though they did recover when dried out. I guess there are different ways to get round the condensing moisture problem.

One would be to put the logger in a sealed container to prevent moisture getting in. This sounds simple but is really very difficult when you think about it in more detail. All air will have some moisture in it. So when you seal the logger in a plastic box the air with it is still moist. At the temperatures in the fridge, this condenses out onto the circuit and shorts out the signals. You could put silica gel in the box to absorb the water but it is not always easy to get hold of. It is also quite large. We should all have seen the little 'tea bag' packets, which come in electronic goods these days. It will also need to be refreshed when it has become exhausted.

The more conventional approach is to prevent the condensation from stopping the circuit working. You can buy conformal coatings, (try Maplin order code YT50E) which come in spray cans, and are used like paint or varnish. The coating is usually clear so that the circuit and components are still visible after it is applied. Beware that once it is applied, it is very difficult to remove, so use it only when the circuit is working correctly. Drying takes perhaps a couple of hours and the coating is a little sticky. It is designed to flex a little so that it does not crack as the circuit and components expand and contract with temperature changes. I used the coating on my logger boards, and it works very well.

Back to the fridge and this time the loggers worked OK. Figure 1 shows the plot for the bottom of the fridge. I didn't expect to see the temperature cycle up and down quite so quickly. I suppose the more cycles, the more power is used, so a more efficient fridge would cycle less frequently. Figure 2 shows the plot for the top of the fridge, which shows it is slightly warmer than the bottom by about 0.5°C. This difference could just be the difference between the two loggers. They measure temperature in 0.5°C steps so they could easily be that different. The more general comment is that the top and bottom of the fridge do not seem to be different. So much for my cold air theory, perhaps the fridge isn't big enough to show any effect of heavier cold air. If any fridge experts read this, could they comment on the cycling and the top to bottom temperature differences?

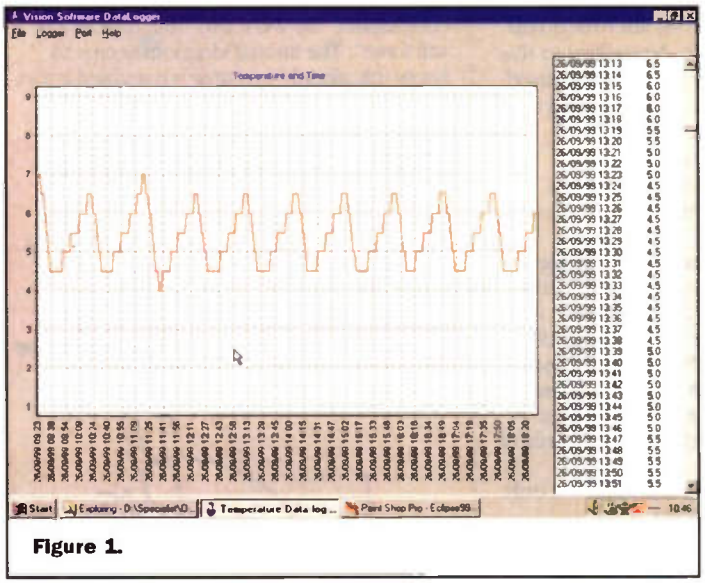


Figure 1.

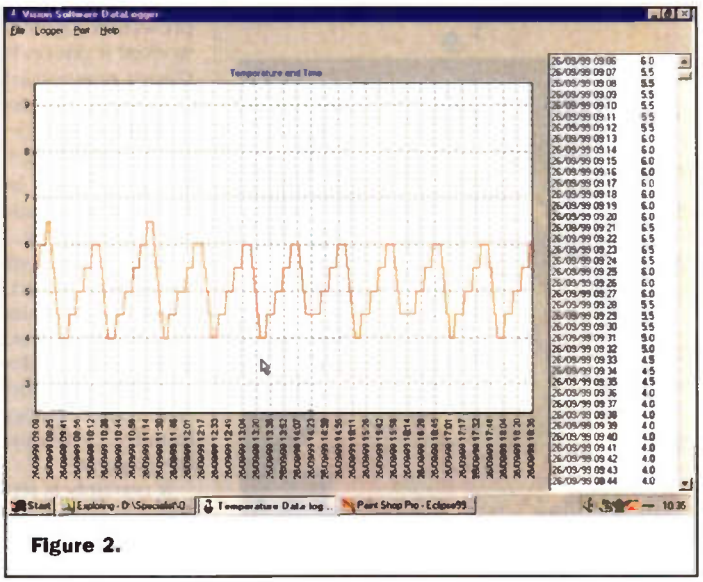


Figure 2.

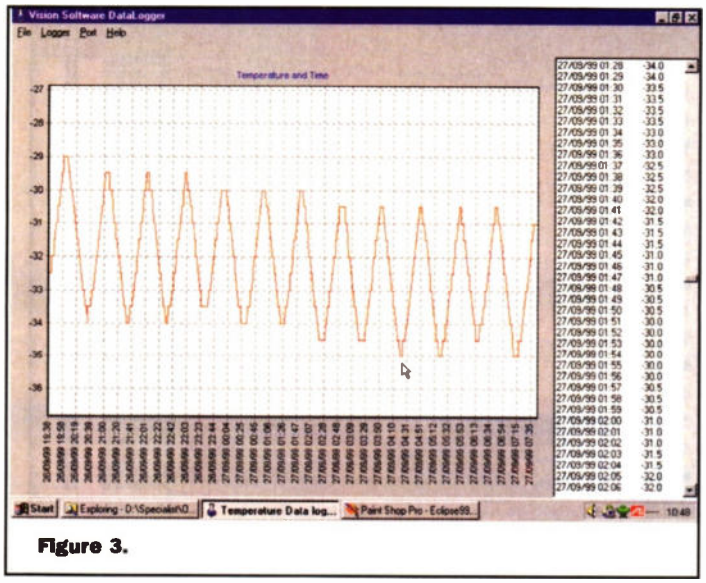


Figure 3.

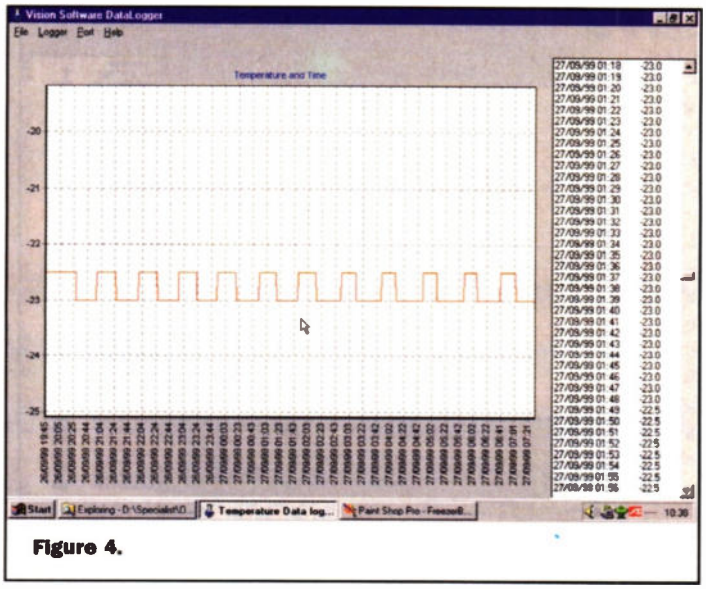


Figure 4.

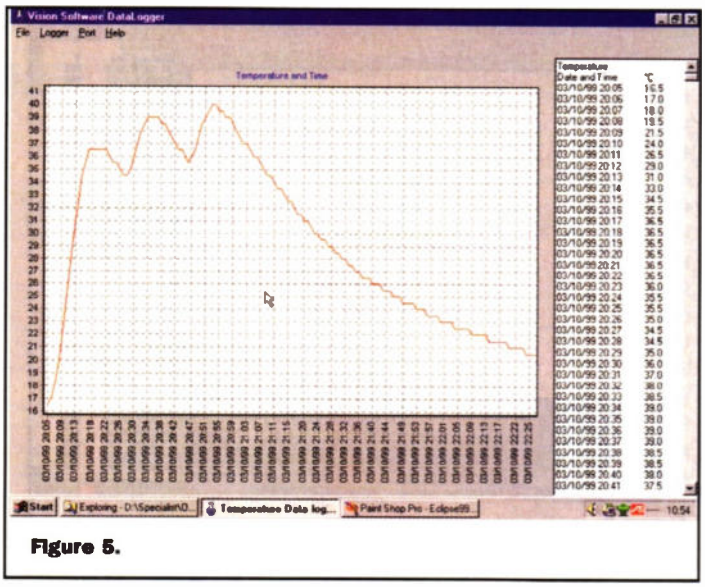


Figure 5.

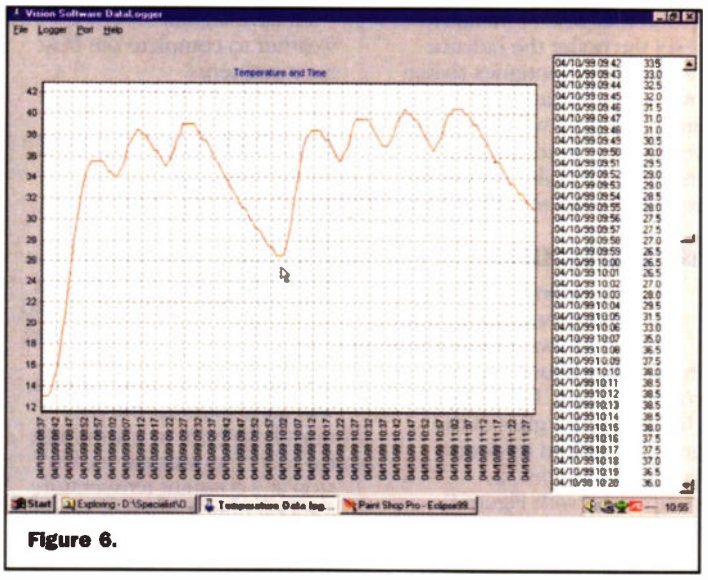


Figure 6.

The result of all my tests show that the thermostat should be set a little colder. Fridges should be colder than 4°C to preserve the food for a reasonable time.

Freezer

After seeing that the fridge needed to be a bit colder I started to worry about the Freezer, so the loggers ended up in the top and bottom of the freezer. It seems that a freezer should be at about -18°C or colder. The freezer differs from the fridge by having cooling plates at the bottom and the top of the freezer, where the fridge has one cooling plate down the back of the inside of the fridge.

Figure 3 shows the plot of the top of the freezer. It shows a similar cycling effect to the fridge but the temperature difference is about 4°C compared with about 2°C for the fridge. The temperature is well below the -18°C target so the food should be OK. Figure 4 is a plot of the bottom of the freezer. It shows only a 0.5°C cycle so perhaps my cold air is showing its effect by falling to the bottom of the freezer! Any experts, could you please comment?

Central Heating

Fired by the results of the cold side of the house I turned to the hot side - the central heating.

The logger works up to 85°C so I should be able to put it on a radiator and see the temperature rise as the boiler heats the water in the heating system. I need to protect the bare circuit board, since it will not work if it is shorted out. I used a piece of cardboard for electrical insulation but angled the whole thing so that the warm air from the radiator metalwork would bathe the circuit with heat. Figure 5 shows the result of a start from cold at 8.00pm. The system warms up quite quickly, certainly more quickly that the fall in temperature as the boiler turned off at 9.00pm. Again the cycling of the boiler from on to off is clearly visible. The overall temperature rises over the hour; with the peaks continuing to rise.

There is a fault with my boiler, which shows as the boiler turning off for no apparent reason. Figure 6 shows this happening in the middle of the plot where the mouse pointer shows. I wondered if the over temperature sensor was

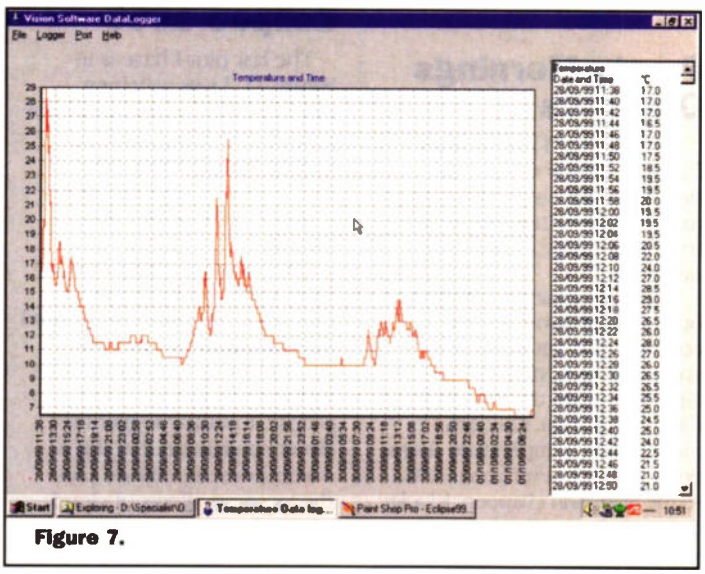


Figure 7.

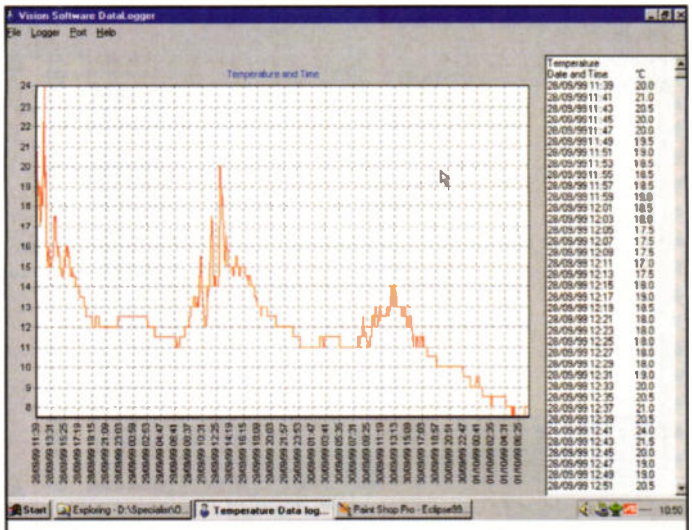


Figure 8.

tripping early but the plot shows that when I manually reset the boiler the radiator temperature continues to rise over time. I'll have to build another logger which can read voltage inputs so that I can monitor the boiler sensors to see which part may be failing!

Greenhouse

Back to my first reason for making the temperature logger.

Figure 7 shows temperatures in the greenhouse over a couple of days. There is no shading on the glass of the greenhouse and its door is open. Despite this, a comparison with Figure 8, showing the temperatures outside for the same period shows that the inside temperature is between 1 and 5°C warmer than outside. The lowest temperatures happen just before dawn and peak near the middle of the day, but there is considerable change caused by cloud cover reducing the amount of direct solar heating.

Closing the door should give much bigger changes particularly in the depths of winter.

Frosty Mornings Outdoors

When I heard the weather forecast was for a potential frost I rushed out to the garden to leave one of the loggers to try and see how long the frost might last.

I chose a position, which was out of direct sunshine, on a concrete slab about 50mm above the level of the grass. Figure 9 shows the plot over three days or so. On each morning the temperature drops below 4°C but never gets to 0°C, so the frost didn't happen. It looks as though the time just before dawn is the most likely time for the frost to form.

I'll have to wait for colder weather to complete the frost measurements.

Postal Transport

One of the more unusual measurements is shown in Figure 10. It shows the temperature of the logger I sent to be photographed by Maplin.

It went through the post and shows the temperature varying widely from 15°C, to 28.5°C. The weather, as I remember it, was quite warm so the post must have been in a warm van for part of its journey. It didn't stop at a constant temperature for long until it reached Maplin. I guess their office is kept at about 19°C.

One of the manufacturers declared uses for the DS1615 chip is to monitor temperatures during transport of various materials. I guess sensitive food would be kept in a refrigerated vehicle and monitoring would be needed. Frozen food would suffer most from any temperature variation.

Eclipse 1999

The last plot I have is in Figure 11. I was watching television on the run up to the eclipse of the Sun, and saw several people measuring temperature during previous eclipses. Why not try this myself?

The day of the eclipse in Macclesfield didn't promise very good weather. As it turned out the cloud was not very thick and the Sun was clearly visible during most of the eclipse. I put the logger in direct sunlight so that the maximum temperature plot shows some effects of cloud where the temperature produces peaks and dips in the

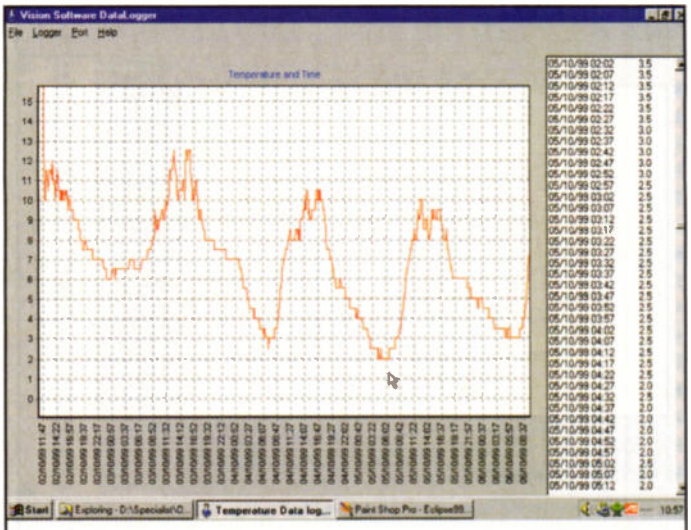


Figure 8.

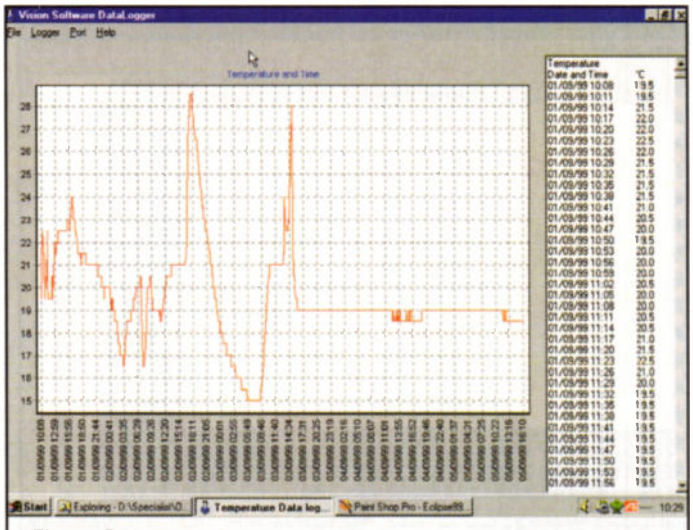


Figure 9.

plot. The overall shape shows the temperature falling until about 11:18a.m., which is the time of maximum cover from my garden. I don't know if it is important, but the chickens on the allotments next to the garden started crowing as the light fell at peak cover! Did they think it was night falling?

Have A Go!

Well these applications of the logger may encourage you to have a go at using one. It would be interesting to see what you end up measuring. Good luck.

Full constructional details of the 10 year logger was published last month (December 1999).

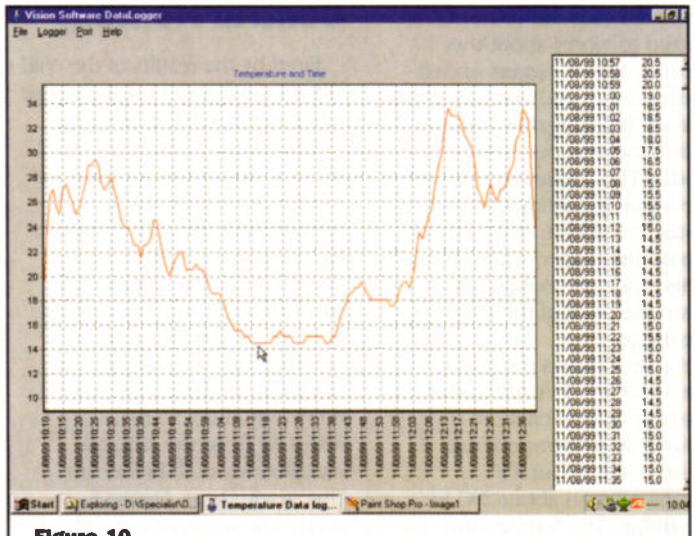


Figure 10.

On the Trail of e:
NAPIER'S LOGARITHMS

Douglas Clarkson recalls the work of this great mathematician

Introduction

In the traditional approach to learning about mathematics there is never enough time to 'grow organically' as it were into the way in which mathematics evolved over time. We can also put back the start of the process of the development of mathematics at least six thousand years. In learning mathematics, we are required to assimilate the key elements of mathematical practice within a few short years at schools and colleges. It has been fashionable of late to take a more leisurely look at mathematics in general - appreciating in the process insights into mathematical thinking that have become obscured. In particular logarithmic function and origin of the number 'e' is attracting increasing interest.

Merchiston Castle.

Napier Logarithms

Like a bolt from the blue, as it were, John Napier announced his system of logarithms in 1614 and was to provide essentially the means for arithmetic calculation for the next 350 years. When writing about his invention Napier indicated "Seeing there is nothing that is so troublesome to mathematical practice, nor that doth more molest and hinder calculators, than the multiplications, divisions, square and cubical extractions of great numbers ....I began therefore to consider in my mind by what certain and ready art I might remove these hindrances."

John Napier was born in 1550 at Merchiston Castle near Edinburgh was the son of Sir Archibald Napier. He was sent to St Andrews University to study Theology at the age of 13 but appears not to have taken a degree. After spending a time abroad, which was encouraged in this period, he returned to Scotland in 1571 and shortly after married Elizabeth Stirling. After the death of his father in 1608, John Napier became the eighth laird of the estate, remaining at Merchiston till his death on April 4th, 1617.

Described as 'a passionate and uncompromising Protestant', his successful publication of 'A Plaine Discovery of the Whole Revelation of Saint John (1593)' contained a strong anti-Catholic bias and ' predicted the end of the world would occur sometime between 1668 and 1700. He was also interested in military technology - artillery devices, tank like devices and also submarines. After the successful publication of his 'religious work', Napier focused his energies on developing systems for making calculations easier.

Some care is required, however, in writing about Napier's contributions. The focus of some of his first published tables related to trigonometric functions, so that logarithms were primarily introduced as a means of evaluating expressions with complex trigonometric data. Some facsimile copies of Napier's works and tables exist on the Internet, so it is possible now to access the original documents.

The significance of the introduction of logarithms was not really the discovery of just another mathematical function to engage the curiosity of mathematicians. It provided a means of relatively rapid calculation of numeric quantities in an era of emergent science and certainly as a key factor in responding to the growth in trade and commerce which was current at this time. There is an especial relevance in the financial sector. In particular, in the calculations relating to astronomy, it assisted Kepler in the derivation of his laws of planetary motion.The initial structure of logarithms that Napier provided was soon to be revised to resemble the more familiar form of base ten logarithms that we use today. Its quite informative, however, to piece together exactly what Napier did initially discover and place our current definitions of logarithms in perspective.

We can readily develop an arithmetic sequence and an associated geometric sequence as in Table 1:

n	0	1	2	3	4	5	6	7	8	9
2^n	1	2	4	8	16	32	64	128	256	512

Table 1: Arithmetic sequence n and geometric sequence 2n.

0	1	1	1.01	2	1.020	3	1.030	4	1.040	5	1.051
5	1.051	6	1.061	7	1.072	8	1.082	9	1.093	10	1.104
10	1.104	11	1.115	12	1.126	13	1.138	14	1.149	15	1.160
15	1.160	16	1.172	17	1.184	18	1.196	19	1.208	20	1.220
20	1.220	21	1.232	22	1.244	23	1.257	24	1.269	25	1.282
25	1.282	26	1.295	27	1.308	28	1.321	29	1.334	30	1.347
30	1.347	31	1.361	32	1.374	33	1.388	34	1.402	35	1.416
35	1.416	36	1.430	37	1.445	38	1.459	39	1.474	40	1.488
40	1.488	41	1.503	42	1.518	43	1.533	44	1.549	45	1.564
45	1.564	46	1.580	47	1.596	48	1.612	49	1.628	50	1.644
50	1.644	51	1.661	52	1.677	53	1.694	54	1.711	55	1.728
55	1.728	56	1.745	57	1.763	58	1.780	59	1.798	60	1.816
60	1.816	61	1.834	62	1.853	63	1.871	64	1.890	65	1.909
65	1.909	66	1.928	67	1.947	68	1.967	69	1.986	70	2.006
70	2.006	71	2.026	72	2.047	73	2.067	74	2.088	75	2.109
75	2.109	76	2.130	77	2.151	78	2.173	79	2.194	80	2.216
80	2.216	81	2.238	82	2.261	83	2.283	84	2.306	85	2.329
85	2.329	86	2.353	87	2.376	88	2.400	89	2.424	90	2.448
90	2.448	91	2.473	92	2.497	93	2.522	94	2.548	95	2.573
95	2.573	96	2.599	97	2.625	98	2.651	99	2.678	100	2.704

Table 2: Pairs of values (n 1.01^n)

If we wanted to evaluate the expression $2^a \times 2^b$, then this would be given by 2^{a+b}. Thus the term 32 times 16 can be calculated as two raised to power 9 or 512.

While this may suggest a method, it is obviously very limited where n is restricted to integer values. One option is to use a value of base b close to unity, so that b^n changes slowly for increasing integer values of the exponent. If, for example we choose a base 1.01, Table 2 indicates pairs of values (n, b^n) that can be produced for increasing values of n.

Note that we have 1.01^{100} as a value 2.704. If we look at values produced by smaller bases and higher power values as indicated in Table 3, we see a pattern emerging.

It was only later that the value of e was expressed in this way. In the early days of development of logarithms by Napier and later Briggs, this pattern was not anticipated.

Base	Power	Value
1.01	100	2.704814...
1.001	1000	2.716924...
1.0001	10000	2.718146...
1.00001	100000	2.718268...
1.000001	1000000	2.718280...

Table 3: Limit value of expression $(1 + 1/m)^m$ approaches the value of e.

Using the values of Table 2 we can produce some more sensible calculations. Using elements (22, 1.244) and (55, 1.728) we can produce the product 2.151 by adding the values 22 and 55 and looking up 1.01^{77}.

Similarly, to determine square roots of numbers using (54 1.711), the square root is given approximately by 1.01^{27} or 1.308. Thus we are looking for the term with half the exponent value. It was the derivation of these two sequences that was at the cornerstone of Napier's approach. Another option to generate an arithmetic and a geometric sequence of numbers where the geometric series would diverge slowly would have been to have used fractional powers of numbers such as $2^{0.5}$ and using a convenient base value that was not close to unity. In the time of Napier, however, fractional powers of numbers were not in general use, so the option of a base value close to unity and with integer powers was the practical option available to him.

In fact Napier chose the base value 0.9999999 or $1 - 10^{-7}$ and Napier laboured to express numbers N in the format:-

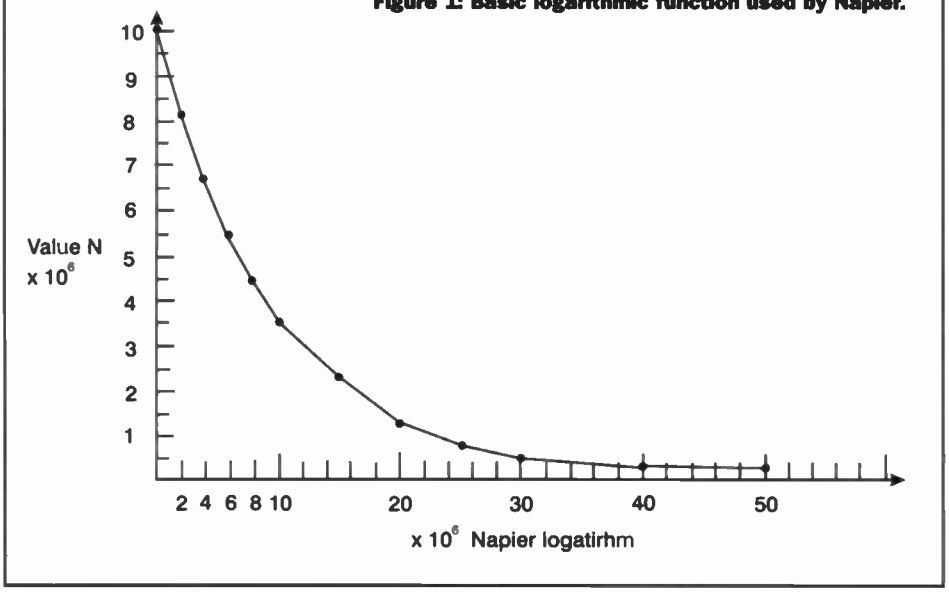
$$N = 10^7 (1 - 10^{-7})^L \quad \text{.....(1)}$$

This meant that numbers N decreased as the Naparian logarithm L increased. With the base value very close to 1, large numbers of L are required to derive values of N distant from the starting value of 10,000,000. In fact L has to assume values of around 7,000,000 to reduce the initial value to half its initial value. In Napier's definition, L was the logarithm of N - or 'ratio number'. Figure 1 indicates the essential function which Napier was using.

The Original Logarithm Definitions

A significant part of Napier's first publication 'Mirifici Logarithmorum canonis Descriptio' related to describing the origin of an arithmetic sequence and a geometric sequence. Figure 2 indicates the diagram Napier referenced to explain how he derived his logarithms. There is a line ACDEFG etc and a line aZ. Initially a point b appears at the left hand end of each line, moving with a common velocity proportional to the length aZ. The line ACDEFG continues to cut off equal increments in equal time interval but on line aZ, the velocity of the point b is proportional to the distance of the point from Z and the distance travelled in equal time intervals is therefore reduced as in the diagram. In this definition of logarithms, the distance AC is described as the logarithm of the line cz - that is the remaining distance along the line. At the start conditions, the logarithm of the whole line whose value is set to 10,000,000 is therefore 0 because the point has not travelled any distance at time zero. Also, in looking at limit values around point z on the lower line, point c can be considered to reach z only in respect of a limiting condition.

Figure 1: Basic logarithmic function used by Napier.



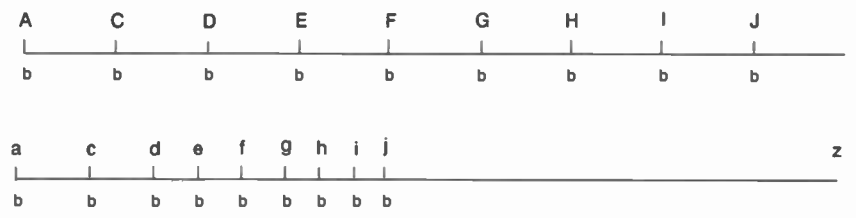


Figure 2: Napier's original 'twin track' model of origin of logarithmic function.

Applying the Calculus

It is interesting to note that when this description is put into the framework of the modern differential calculus, the function described by Napier is intrinsically correct. For Napier, however, the fact that he could undertake useful calculations with his system was the essential proof that his methods were sound.

Figure 3: Napier's original 'twin track' model of origin of logarithmic function adapted for derivation of function from differential calculus.

Resetting the problem in the notation of Figure 3, the line AB has a point P so that PB = x. The Line CD has a point Q. Initially points P and Q move out at a similar speed but the velocity of point P decreases in proportion to the distance PB. In this definition, y is the Napierian logarithm of x. Thus initially when both points are starting off together, x is at the maximum value but y equals zero. In the scaling of initial values therefore, x is 10000000 and y is zero.

Introducing some simple maths to this, the speed of P and Q can be defined as 10^7.

Since the speed of y is constant,

$$dy/dx = 10^7 \quad \ldots.(2)$$

Also the rate of change of x is proportional to x,,

$$dx/dt = -x \quad \ldots\ldots\ldots(3)$$

Dividing (2) by (3), therefore

$$dy/dx = -10^7/x$$

The solution of this equation is:-

$$y = -10^7 \ln x + c$$

where ln is the logarithmic function to base value e (natural logarithms). Using the start conditions, this can be expressed as:-

$$y = -10^7 \ln (x/10^7)$$

$$y = 10^7 \log_{(1/e)}(x/10^7)$$

$$x = 10^7 (1 - 10^{-7})^y \quad \ldots\ldots\ldots(4)$$

Thus Napier had in fact derived logarithms to the base 1/e, though accounts indicate that he was not aware of this. For Napier, the basic equation (1) provided the mathematical means of calculating the logarithmic functions.

Trigonometric Table Format

The original description of logarithms 'Mirifici Logarithmorum canonis Descriptio' (Description of the Marvellous Canon of Logarithms) was published in 1614 in Latin. An English translation appeared in London in 1616 and can be inspected on the Internet (see points of contact). Also facsimile copies of the main trigonometric tables can also be inspected on the Internet. After his death more details of the construction of logarithmic tables were contained in 'Mirifici logarithmorum canonis constructio' published in 1619.

Napier was in fact mindful to publish logarithmic details in the context of functions of trigonometry and where specific tables would refer to set extents of angles. This focus may have been influenced by his work in spherical trigonometry where he developed systems to reduce the number of equations required to express trigonometric relationships.

Each table related to a sequence of 30 minutes of angle between 0 degrees and 45 degrees. An extract from a reconstructed table would have appeared as indicated in Table 4 which shows a fragment from the table relating to 4 degrees to 4 degrees 30 minutes. In the way in which the table is constructed, it folds back from right to left to give details of 85 degrees 30 minutes to 86 degrees. Sounds complex, doesn't it?

In this definition of columns, column 1 gives the degree and column 2 the corresponding minute. Column 3 gives the value of 10000000* sin (angle). Column 4 gives the logarithm of this value in accordance with equation (1). Starting from the right side, values are given for the corresponding angle of the assumed right angle triangle. Thus columns 8 and 9 define the angle in this case as 80 degrees for the first entry. Column 7 gives the value of 10000000*sin(80) and column 6 gives the corresponding logarithm of this value in accordance with equation (1). Column 5 gives the difference of column 4 and column 6. This is used to define the tangent of the angle since tan = sin/cos. Column 7 as sin(80) is also cos(10) from basic relationships. Thus in subtracting logarithms of column 4 and 6, the value of logarithm of tan (10) is also created. The involvement of tan functions may explain why the tables are split in one direction from 0 to 45 degrees in moving left to right and 90 to 45 degrees in moving from right to left since tan (45) = 1.

With these tables Napier could readily compute expressions incorporating complex trigonometric expressions. In the 'Descriptio' Napier describes the great scope and versatility of the tables for calculating a broad range of trigonometric functions.

The Logarithmic Tables

Napier in the 'Mirifici logarithmorum canonis constructio' published posthumously in 1619 described a series of tables.

The structure of Napier's first table is indicated in Table 5.

Number	Napier Logarithm
10000000	0
9999999	1
9999998	2
9999997	3
9999996	4
9999995	5
. .	
. .	
9999905	95
9999904	96
9999903	97
9999902	98
9999901	99

Table 5: Napier's table 1 of the Mirifici logarithmorum canonis constructio and with small fractional parts not shown. This is therefore using smallest proportion of 0.9999999.

LOGARITHM TABLE

1	2	3	4	5	6	7	8	9
deg	min	sines	logarithm	+-diff	logarithm	sines	min	deg
10	0	1736482	17507232	17354143	153089	9848087	60	
	1	1739346	17490753	17337151	153602	9847572	59	
	2	1742211	17474295	17320179	154116	9847066	58	
	3	1745075	17457869	17303238	154632	9846558	57	
	4	1747939	17441471	17286323	155147	9846050	56	
	.	.	.	.	.	.	.	.
	.	.	.	.	.	.	.	.
	29	1819495	17040255	16871925	168330	9833079	31	
	30	1822355	17024549	16855679	168869	9832549	30	

Table 4: Extract from table of 10 degrees/10 degrees 30 minutes: 80 degrees/79 degrees 30 minutes.

The structure of Napier's second table is indicated in Table 6.

Number	Logarithm
10000000	0
9999900	100
9999800	200
9999700	300
9999600	400
. .	
. .	
9995201	4800
9995101	4900
9995001	5000

Table 6: Napier's table 2 of the Mirifici logarithmorum canonis constructio and with small fractional parts not shown. This is using a proportion of 0.99999.

The structure of Napier's third table is indicated in Table 7.

Number	Logarithm
10000000	0
9995001	5000
9990005	10000
99850111	5000
9980020	20000
. .	
99054509	5000 9900498 100000

Table 7: Napier's table 3 of the Mirifici logarithmorum canonis constructio and with small fractional parts not shown. This is using a proportion of 0.9995.

Further tables were derived from elements derived from table three and with a proportion of 0.99.

Use of Pascal Triangle

There is also a fair chance that Napier could have used the relationship known as Pascal's triangle to evaluate some of the tedious arithmetic of the expansion series of these tables. Although Pascal was not to make the structure widely known till after Napier's death, the structure of the expansion of (a + b)n had been known in Europe from about 1527.

$(a + b)0$	=	1
$(a + b)1$	=	$a + b$
$(a + b)2$	=	$a^2 + 2ab + b^2$
$(a + b)3$	=	$a^3 + 3a2b + 3ab^2 + b^3$
$(a + b)4$	=	$a^4 + 4a2b + 6a2b^2 + 4ab^3 + b^4$

Table 8: Construction of Pascal's triangle.

The expansion of $(a + b)^n$ can be shown in Table 8.

It is possible to anticipate the coefficients of the expansion. In this triangle, a coefficient is the sum of the two numbers immediately to its left and right in the row above.

There is also an expression that allows such coefficients to be calculated. Thus for a term $a^{n-k}b^k$, the coefficient is given by:- n!

$$ {}^{n}C_{k} = \frac{n!}{k!\,(n-k)!} $$

where e.g. 6! = 6.5.4.3.2.1 = 720

For all the tables, a = 1 and b takes on various values. Thus for table one, b = -10^{-7}, for table two, b = -10^{-5} and for table three b = - 0.0005. The use of this means that the calculation would have saved considerable time is establishing the tables.

In the expansion of $(1-10^{-7})^{10^7}$, for example, the coefficient of the term in b is -100 and that of b^2 is 4950 which provides a true value of 9999900.0004950.

Using the Tables

It is clear from the set of tables that Napier required to work from numbers to logarithms and back again over a wide range of number ranges. It is not always obvious from the literature how he did this.

Suppose it was required to calculate a number whose Napier logarithm was equal to 5352511. The basic calculation required is that of:-

$$10000000*(0.9999999)^{5352511}$$

What Napier could have done is evaluate the product of the expressions:-

$(0.9999999)^{5352511\ 11}$
$(0.9999999)^{10\ 5000}$
$(0.9999999)^{25*100}$
$(0.9999999)^{11}$

where the individual terms could be looked up as elements in various of the standard set of tables he had calculated. This would relate to the 11th entry in the table one, the 25th element in table two, the 10th element in table three and a relevant entry from a derived forth table.

In looking up elements in these tables, the number would be given by the expression:-

10000000*0.5886043*0.9950126*0.9997500*0.9999989 = 5855216

After the laborious work of deriving the tables, these terms would have to be multiplied to obtained the derived number. It would not have been necessary, however, to have multiplied four expressions each time. Work could have been undertaken with a product of three terms and with changes in a single term depending on the range of values being calculated.

If we wish to multiply two numbers N1 and N2 where these are expressed as L1 and L2 in equation (1), then the product will be given by:-

10000000 * 10000000 * (1-10^-7)^(L1+L2)

The appropriate term is given by the N value associated with the value of L1 + L2.

Instant Fame

Napier had essentially devised a means of reckoning rather than a branch of new functions in mathematics. Napier's invention took the whole world by storm and was especially appreciated by astronomers such as Kepler who used it extensively to compute the orbit of planetary bodies. In the words of Pierre Simon Laplace, 'by shortening the labours, the invention of logarithms doubled the life of the astronomer.'

Common Logarithms

One enthusiastic devotee of Napier's discovery was a certain Henry Briggs - a professor of geometry at Gresham College in London. He travelled all the way to Edinburgh to meet Napier whereupon after some deliberation, a modification to the structure was devised to make the system more appropriate.

The agreed structure was essentially to have :-

$N = 10^1$

and to have the logarithm of 1 equal 0 and the log 10 equal to 1. It must have been quite a rare treat for Napier to have one's discoveries so much appreciated. At this time, however, Napier was advanced in years's and in fact died in 1617 so that it was Briggs who took up the challenge of determining the set of common or base ten logarithms. It was rather a strange turn of events, however, for someone who had laboured for twenty years to develop a system of calculation to translate over to a parallel but different set of logarithmic functions. In a mammoth task of computation, Briggs determined the logarithms to base ten of all integers from 1 to 20,000 and from 90,000 to 100,000 to an accuracy of fourteen decimal places - publishing the results in 1624. The gap from 20,000 to 90,000 was later filled by Adriaan Vlacq a Dutch publisher whose data appeared in the 1628 edition of Arithmetica logarithmica.

Summary

In determining the work of Napier, we find that so much of what we assume today was derived from insight tempered with excessive patience and fortitude. There is no doubt, however, that the availability of logarithms was a key factor in the subsequent development of science. Formulae predicted by science could be readily calculated and compared with observation, so that the foundation of science as essentially experimentally based was strengthened.

However, Napier did not encounter the value of e in his deliberations in a direct form. It was not long before its origin and derivation would be taxing the sharpest mathematical minds....

Further Reading

The Story of a Number, Eli Moor, Princeton paperbacks, 1998

Points of Contact

http://www-math.sci.kun.nl/math/werkgroepen/gmfw/bronnen/napier1.html

(English translation of 'Descriptio')

http://www-math.sci.kun.nl/math/werkgroepen/gmfw/bronnen/napiertabellen.html

Tables of 'Descriptio'

http://www.napier666.demon.co.uk

Useful resource site for reconstructed table data and explanation of formats.

PROJECT

PROJECT RATING 2

Velleman Kit

METAL DETECTOR

John Mosely constructs a simple kit from Velleman that will find hidden water and gas pipes.

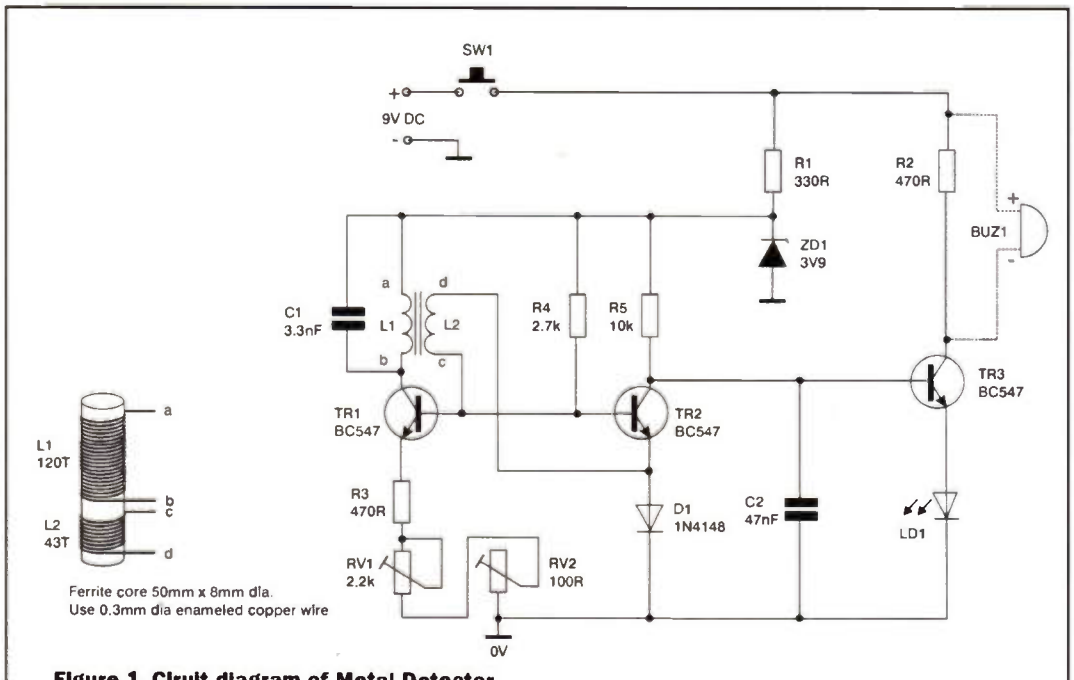


Figure 1. Ciruit diagram of Metal Detector.

SPECIFICATION

Proximity range adjustable up to 80mm

LED indication and optional sounder

9V PP3 Battery, only 30mA max. current

Dimensions 56 x 64mm

Last month we looked at a kit from Velleman for detecting mains cables, so this month to complete the set, we look at a metal detector intended for finding metal water and gas pipes that are hidden behind walls, floors and ceilings etc. An LED illuminates when the detector comes into the vicinity of metal objects. As with the mains detector kit featured in last month's magazine, again, a space is provided on the board for a piezo sounder - a suggested sounder is Maplin order code **FL39N**.

Construction

First you will need to wind the two coils. The kit comes with a ferrite former and sufficient wire to wind the coils. To make life a little easier, wind a single layer of double-sided tape round the ferrite former. I used 50mm carpet tape which is the same length as the former. Start L1 at about 5mm from one end and start winding as neatly as possible until you have covered about two-thirds of the length of the former. Then work back and continue building up layers until you have wound the required 120 turns. Hold the winding in place with a layer of adhesive tape. Leave a gap of about 5mm on the former and start L2, winding in the same direction as L1, and in a similar fashion until you have wound 43 turns. Again hold the winding in place with tape. You should allow yourself about 30mm of wire on the ends of each winding. Carefully place on the PCB and the scrap away the protective lacquer on the wire ends so that you can solder to the board – be very careful as the wire is quite thin and easily damaged. You will need to check that the former does not obstruct the holes for C3, which is mounted very close to the coils.

Now solder the resistors, diodes, capacitors, transistors and LED to the board - the height of the LED above the

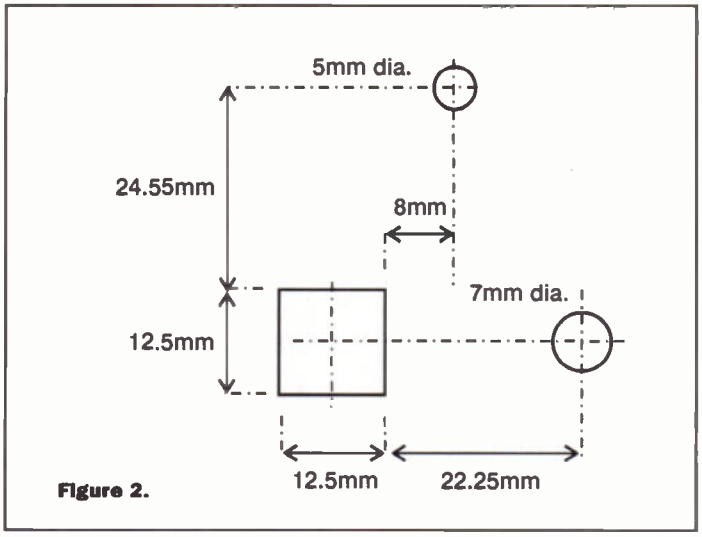


Figure 2.

board will depend on the box you use. Finally, solder the variable resistors, the push switch and the PP3 battery connector (which is supplied with the kit) to the board. Please ensure that diodes etc. are inserted with the correct polarity - if you carefully follow the Velleman instructions then there should be no problems. Velleman always provide comprehensive and easily followed instructions - even a beginner should find the kits straightforward to build. One last check of the board for dry joints, track bridges etc., and if all is OK, we are ready to set up and test.

Testing

Connect a 9V battery and find a place that is not near to metal objects. Turn RV1 fully clockwise and RV2 fully anticlockwise. Depress and hold during this final alignment procedure.

Initially, turn RV1 anticlockwise until the LED is just out, now adjust RV2 until the LED is weakly illuminated, this is set for maximum sensitivity. When the detector comes near to a metal object the LED will glow more brightly. This effectively gives an indication of the distance and/or size of the metal object. RV2 can be adjusted to lower sensitivity if required. Now all that is left is to mount the PCB in a suitable box. Figure 2 shows the cut out dimensions.

Conclusion

This is another excellent little kit from Velleman that works very well, and is suited for beginners and the more experienced hobbyist.

Order Code **VF64U** cost **£9.99** inc. VAT - a suitable sounder is **FL39N** cost **£1.99** inc. VAT.

ELECTRONICS

PROJECTS PART LIST

RESISTORS	
R1	330Ω
R2, 3	470Ω
R4	2.7kΩ
R5	10kΩ
RV1	2.2kΩ
RV2	100Ω
CAPACITORS	
C1	3.4nF Ceramic
C2	47nF Ceramic
SEMICONDUCTORS	
LD1	Red 5mm LED
ZD1	3.9V 500mW Zener
D1	1N4148
TR1, 2, 3	BC547
MISCELLANEOUS	
SW1	1-pole Push-to-make
	PP3 9V Battery and Connector
	Suitable Box
	Ferrite Rod 8mm dia x 50mm
	0.3mm SWG Copper Enamelled Wire
OPTIONALS	
	Sounder

COMMENT

by Keith Brindley

Mac users around the world have something new to talk about. It's the worldwide release of the Mac's latest operating system - Mac OS9.

OS9 is marketed by Apple as being 'your Internet co-pilot', and it certainly has several new features (in fact, there are over 50 across the whole system) that make Internet life with a Mac much more powerful, yet increases the lead the Mac has in ease-of-use over any other operating system.

The new Internet power in OS9 comes from just a handful of features, which includes Sherlock 2, the latest version of the Mac's search tool. The original Sherlock allows Mac users to locate information and files both on their computers or across a network (and the network can be the Internet if you want) - you simply enter a phrase or keyword and do the search. Sherlock 2 extends this power, incorporating search areas into 'channels.' So, the Files channel searches your computer and its accessible hard drives (including those of other servers on your network), the Internet channels searches the Internet, the People channels locates people listed on Yahoo, Bigfoot and Four11 LDAP server, and so on. The default channels are Files, Internet, People, Apple, Shopping, News, Reference, and My Channel, although you can add your own to suit your own purposes. There's no doubt, Sherlock 2 is a lot more powerful than the earlier version, and - for anyone who regularly looks for information on the Internet - probably justifies the operating system upgrade by itself. It's certainly one of the best reasons for binning a PC and replacing it with a Mac I know of.

Multiple users of a Mac now have an extremely slick voice-operated method of logging in to the computer. To log in you simply say a password or pass-phrase, whereupon the Mac identifies you and presents you with your personalised settings - bookmarks, email accounts, browser, applications, game settings and so on. Your voice verification password or pass-phrase can be whatever you want (by default it is 'My voice is my password'). Whatever the password or pass-phrase, to use the feature you have to have first record the phrase four times, so your Mac can later identify you.

Speech recognition also takes a new turn altogether within a Mac with the latest version of Speech, included with Mac OS9. For years the Mac has had the facility where users can control the system with speech commands, but the range of commands you can do this with has been upgraded enormously in the new operating system. If you've not used speech recognition since its early days on the Mac, try it now - you'll be amazed at what's now possible.Security is a strong point within Mac OS9. The Keychain is a secure place to store passwords to Internet and other servers, digital signatures, certificates, and other sensitive information - all accessed with a single password. Applications running on your Mac can access the Keychain directly, so in theory you only have to remember one password to access any Keychain data. Current versions of many popular Mac applications like Eudora, Anarchie, Fetch, and Web Confidential already work with the Keychain, as do many inherent utilities within Mac OS9 itself - the Finder, Apple File Security, and AppleShare services. The Keychain file itself is reasonably secure, as it never stores the Keychain password on disk. Its encryption key is derived from the primary password the user enters, and it uses 128-bit encryption for storage. Also, it resists repeated attempts to guess a password by increasing a delay between failed authentication attempts - the more often someone guesses an incorrect password, the longer the period that must be waited before being allowed to have another go.

Encryption is built-in to Mac OS9. Personal and private files can be protected with passwords, and files are encrypted with a 56-bit key. While this will not deter the most determined hackers from accessing the file held within (a 56-bit encryption was first hacked in 1997), it is the best encryption the US government permits for export, so is as secure as it can get for the meantime.

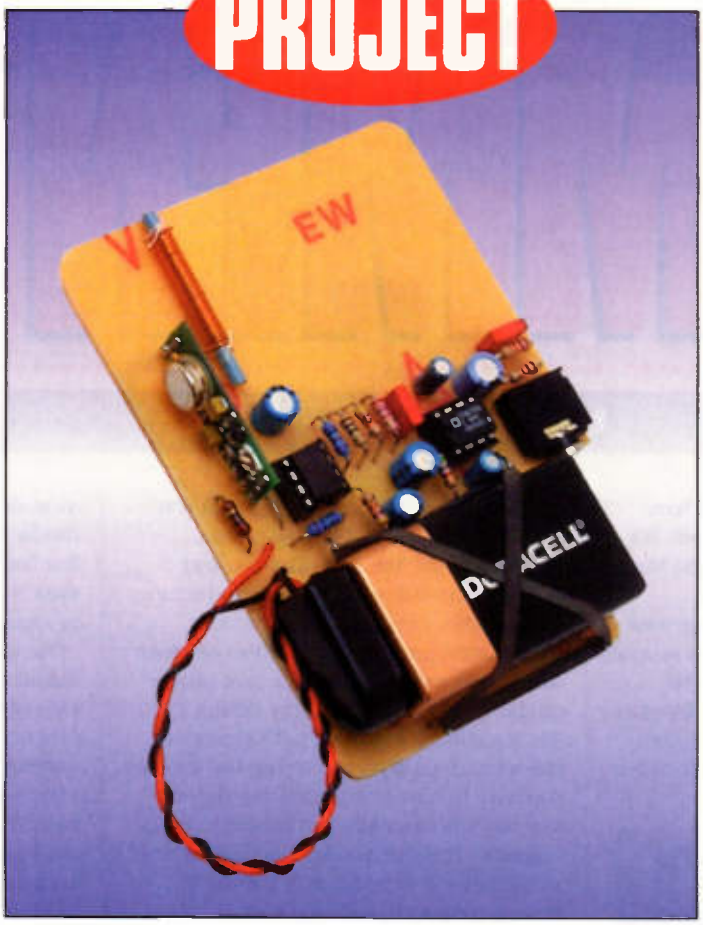
Back on the Internet, some other new features of Mac OS9 are worthy of note. One of the Mac's long-time advantages over other computers has been its built-in ability to network with other Macs - called AppleTalk - you just add a cable, turn it on, and you're away. Mac OS9 lets you use AppleTalk over the Internet too. In other words, you can access other Macs connected to the Internet, and other Macs can access yours, just as if they were present on your local network. It's all protected by password security of course, and you don't have to use it if you fear a potential security problem, but the simple fact is, it's simple.

The Mac's in-built scripting ability - AppleScript - gets a boost with Internet-capable AppleTalk too. As AppleScript scripts can interact with applications and features on a Mac, the idea is that a Mac can be remote controlled over the Internet. You could, for example, open a database on a Web server, launch applications and perform tasks, indeed, anything that can be AppleScript-controlled (which means most things on a Mac). Imagine, you could control your office Mac, while sitting at home. Open programs, performs functions, even send your boss an email to let him think you're hard at work at your desk. While this has for a long time been the case with the Mac, it's only been possible with the purchase of third-party tools. Now it can be done right out of the box.

All-in-all, Mac OS9 is a great upgrade. If a Mac can run it (only PowerPC-based Macs, with at least 32MB of RAM and at least 150MB of free disk space can - and Apple doesn't certify its use on Mac-clones, although some may be able to upgrade to it) it's certainly worth the cost (approximately £70). There's a rebate of £12 for users who have bought a Mac recently, too. The new interface features complement a Mac's existing interface.

PROJECT

413MHz Radio MICROPHONE



C.J. Dakin describes a radio microphone based on the 418MHz transmitter/receiver modules.

Introduction

This design for a radio microphone can be built for less than half the cost of a commercial unit. It is based on 418 MHz transmitter and receiver modules, Maplin types AM27E and AM28F respectively. These modules are designed for the transmission of analogue and digital data. Speech is one form of analogue data, so in this application only the analogue output from the receiver is used.

There are many uses for radio microphones. One example arose when my daughter got married recently. We had arranged for a video to be made of the event. The Rector of the parish, where the wedding took place, ruled, reasonably, that videoing must be confined to a balcony at the rear of the church so as to prevent interference with the service. The balcony was 25m from the altar, and to make things more difficult, he also banned the use of overhead or floor mounted microphones. As I was keen to hear clearly the words of the Rector, my daughter and the groom throughout the service, I proposed the use of a radio microphone, which was readily agreed. It was worn by the groom and performed very well, considering, as usual in weddings, there was the normal amount of crying babies and fractious children which did not interfere with the clarity of the words of the main participants.

Circuit Description - The Transmitter

The circuit is shown in Figure 1a. A miniature electret microphone is used as the transducer. The lead from the microphone plugs into a 3.5mm socket, SK1, on the transmitter PCB, and DC power is supplied to the microphone from R1 and R2. The audio signal is fed via C2 to the input of IC1, a SSM 2165. This IC is a microphone pre-amplifier with adjustable compression and noise gating. The compression ratio is set by the value of R4 which was set at 5k6Ω to give a compression ratio of about 2, which was found to be suitable for this application. The ratio can be varied from 1:1 to 15:1 by changing the value of R4. With input levels above a certain value the output is limited to a maximum of about 300mV rms. Note that this limiting action does not 'clip' the signal but steadily reduces the gain of the voltage-controlled amplifier, which forms part of IC1. The output of IC1 is therefore always a faithful reproduction of the input with little distortion.

The output of the SSM 2165 at pin 7 is fed via C6 to IC2, a TL071 operational amplifier. The values of R5 and R7 set the gain of this stage at 5, so the output of IC2 has a maximum value of 1.5V rms due to the limiting action of IC1. This is important as the transmitter module will severely distort the

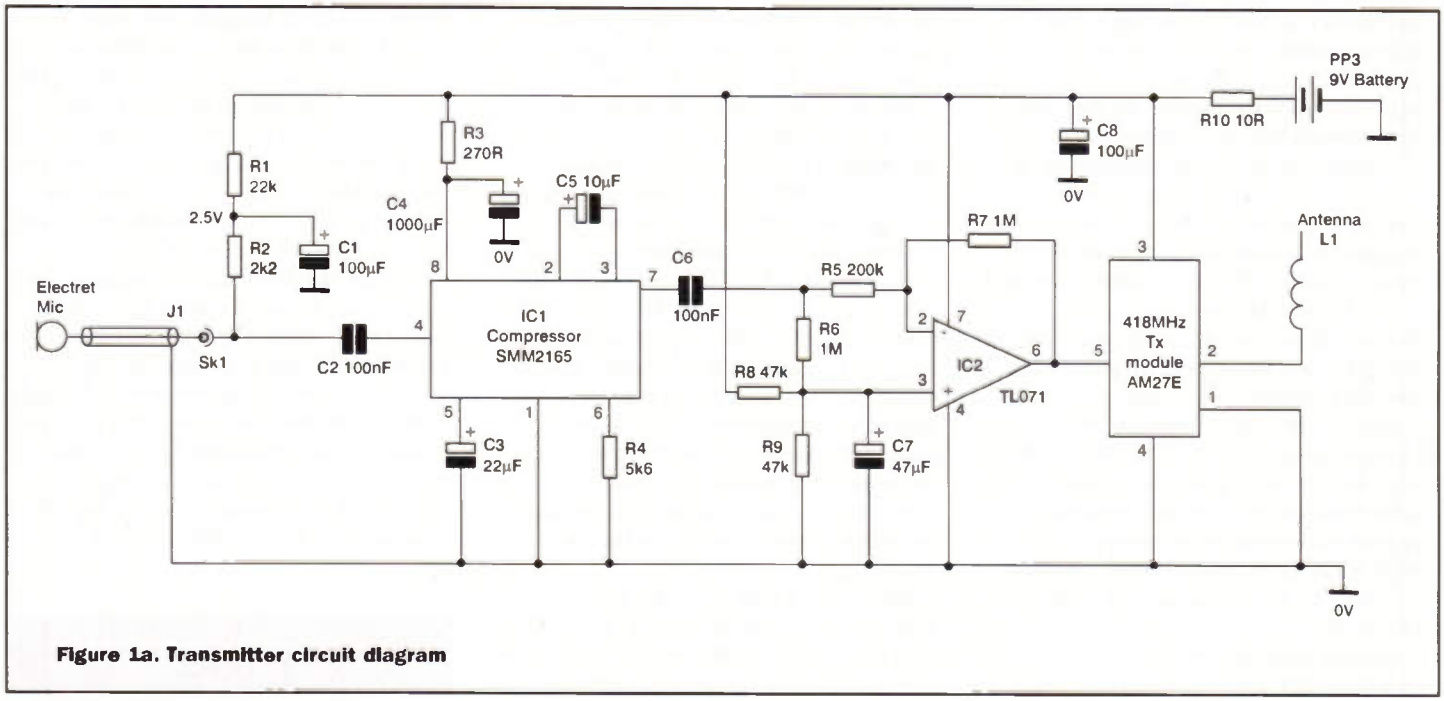


Figure 1a. Transmitter circuit diagram

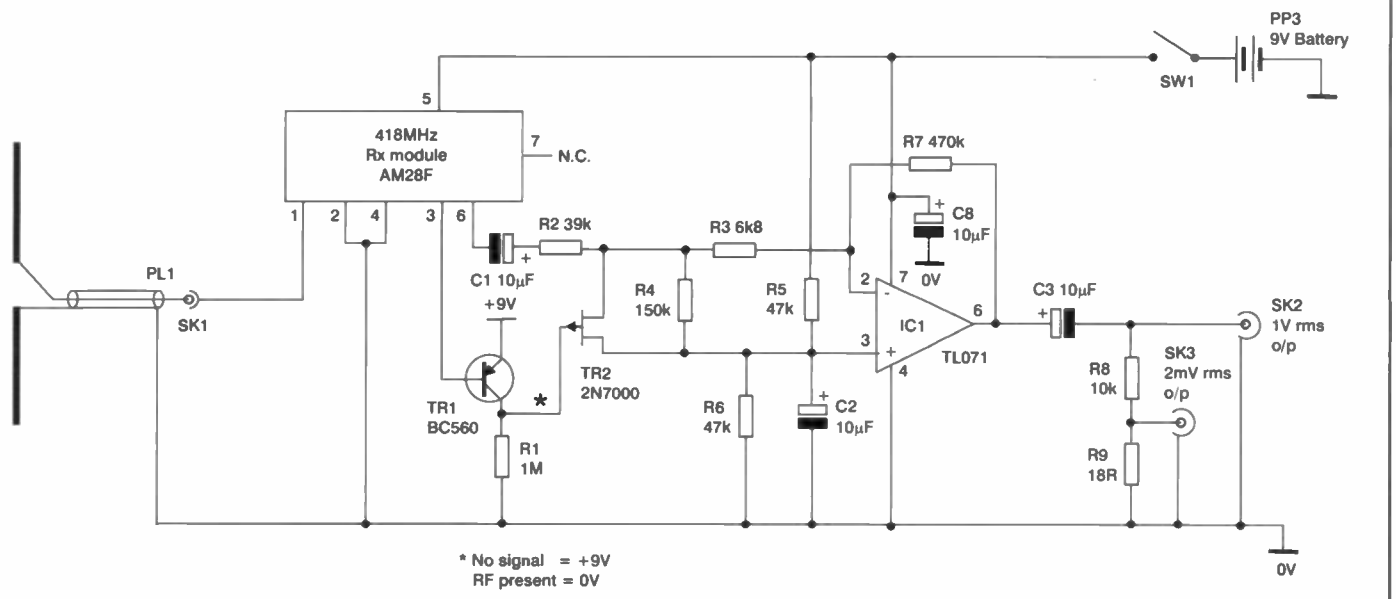


Figure 1b. Receiver circuit

audio signal if the input to it exceeds 1.5V rms. The DC level of the output of IC1 is +4.5V which is set by R8 and R9 applying +4.5V to the positive input terminal of IC1.

The output of IC2 is taken from pin 6 and is applied directly to the transmitter module modulation input terminal, pin 5.

The transmitter module is powered from the +9V PP3 battery. With this value of supply voltage the RF power output of the transmitter is typically –8dBm or 158µW. The 418MHz output on pin 2 is fed to the helical antenna, L1.

Note that no on/off switch is included in the transmitter circuit. This prevents the user from accidentally switching the transmitter off at a critical moment. Simply connecting the battery turns on the transmitter. The transmitter draws about 20mA so that a 500mAh PP3 battery will give up to 25 hours of operation.

Circuit Description - The Receiver

The receiving antenna is connected to SK1, a BNC socket, and then on to pins 1 and 2 of the receiver module - see Figure 1b. The audio output is taken from pin 6 of the module and has a maximum value of 100mV rms. Note that pin 7 is the digital output terminal, which is not required in this application.

The signal is fed to an amplifier stage formed by IC1, R2, R3 and R7, and has a voltage gain of 10. The output of IC1 at pin 6 is thus 1V rms maximum, and is fed to SK2, a phono socket, via C3. This output is suitable for use with most amplifier systems. R8 and R9 attenuate the 1V rms output to 2mV rms at SK3 which is a standard 3.5mm jack socket and so suitable for use with most camcorders. R5, R6 and C2 set the DC level of the positive input of IC1 at +4.5V and so prevent the output limiting on either positive or negative excursions.

Q1 and Q2 perform a muting function when no RF signal is being received. With no carrier present pin 3 of the receiver module falls 0.7V below the +9V rail. This turns Q1 and Q2 on. The audio input to IC1 is then clamped to +4.5V. When the carrier is present pin 3 rises closer to the +9V rail and Q1 and Q2 turn off. This removes the clamp and allows the audio signal to pass to the amplifier stage. The receiving antenna can be one of two types: A 160mm wire rod inserted into the inner connection of SK1.

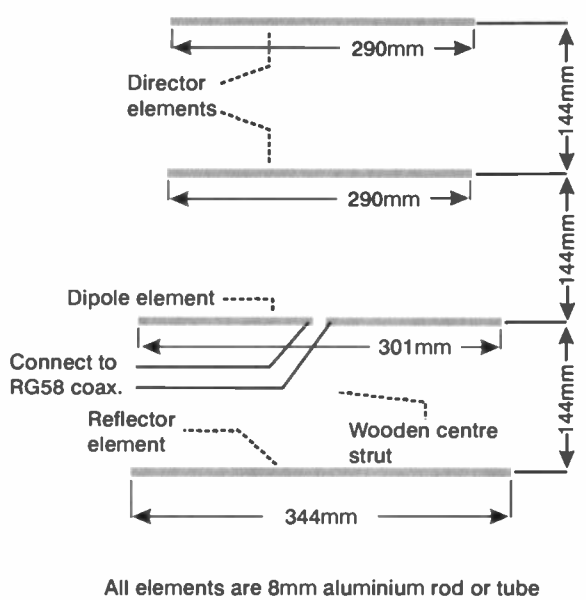


Figure 2. Yagi antenna

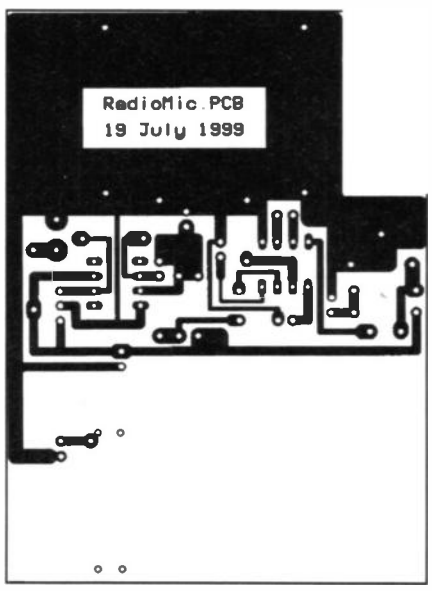


Figure 3a. Transmitter PCB foil

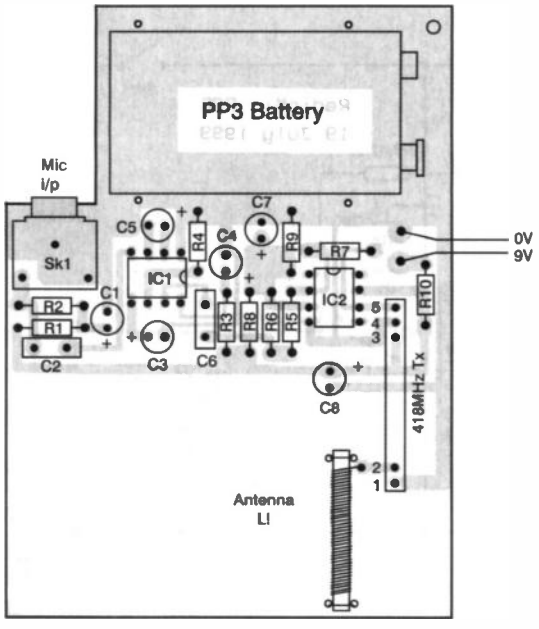


Figure 3b. Component layout for Transmitter

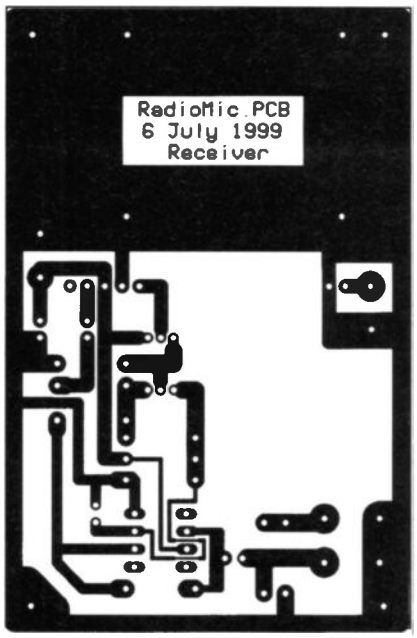


Figure 4a. Receiver PCB foil

This is suitable for short-range use up to 15m. A Yagi antenna as shown in Figure 2. This is suitable for use at longer ranges up to 50m.

Construction

The complete radio microphone system comprises six items:

The transmitter PCB.
The transmitter pouch.
The receiver PCB.
The receiver box.
The microphone lead.
The receiving antennae.

The Transmitter PCB

Figure 3a shows the copper pattern of the transmitter PCB. Figure 3b shows the component layout of the transmitter PCB.

Construction of the transmitter starts with fitting all the resistors, capacitors, microphone socket, SK1, and the 8-pin DIL sockets, SK2 and SK3, for IC1 and IC2. The electrolytic capacitors C1, C3, C4, C5 and C7 must be inserted with the positive terminal in the positions shown in Figure 3b. SK2 and SK3 should also be inserted with the correct orientation - the 'notch' to be as shown in Figure 3b.

The leads of the rigid PP3 clip (Maplin order code NE19V) should now be connected to the PCB. The red lead to the '+9V' pad and the black lead to the '0V' pad.

Figure 3b shows the antenna, L1, is on a clear area of the board well away from any metal, such as the copper foil of the PCB. The antenna is a helical type and is made with 34 turns of 0.5mm diameter enamelled copper wire wound on a 2.5mm diameter former. A 30mm length of plastic knitting needle of the correct diameter makes a suitable former. Remove the enamel from 5mm at The 'hot' end of the winding and solder it to the pad adjacent to pin 2 of the transmitter module. The antenna former is secured to the PCB by two lengths of nylon thread tied around each end of the former and through the two pairs of holes provided in the PCB. It is essential that nylon, or other low loss material, is used to hold the antenna to the PCB. Wire must not be used, as it will drastically reduce the efficiency of the antenna.

Fit four steel wire clips in the four holes around the PP3 battery. These are used with a rubber band to hold the battery in position. The clips are made from paper clips and are soldered to the copper foil of the PCB. See Figure 5. A single rubber band is used to hold the battery as shown in Figure 5.

At this stage check that all the components assembled so far on the PCB are in their correct positions and with the correct orientation where relevant. When all is well, connect a PP3 battery to the rigid clip. Measure and record the voltage of the battery at the + terminal of C8. Assume the battery voltage is 9V. Measure the voltage at the junction of R8 and R9. It should be half the battery voltage, i.e. about +4.5V. Disconnect the battery. If the voltage reading was wrong, recheck the values of R8 and R9 and the orientation of C7. When the voltage reading is OK fit the 418 MHz transmitter module (Type AM27E) to the PCB. Insert IC1 (SSM 2165) and IC2 (TL071) in SK2 and SK3 respectively. Take care to plug them in with the correct orientation. Clip a PP3 battery to the PCB with a rubber band. Do not connect the rigid PP3 clip yet. This completes the assembly of the transmitter PCB.

The Transmitter Pouch

The pouch is intended to slip into an inside jacket pocket or shirt pocket and carries the transmitter, so should prevent the PCB and it's components catching on the inside of the pocket. The pouch can be

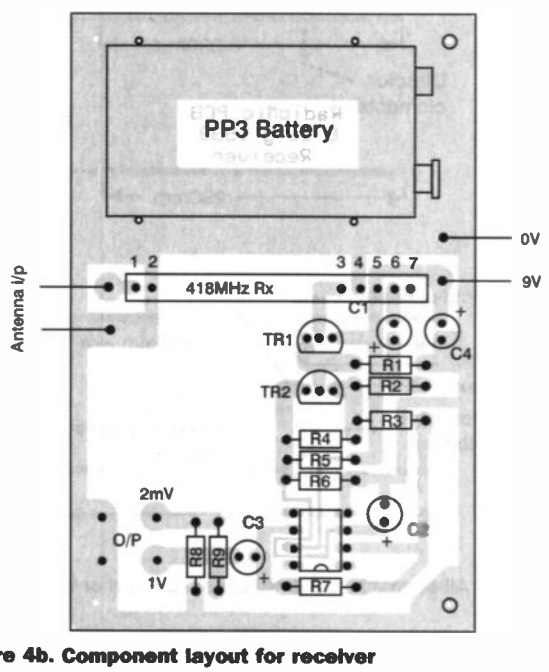


Figure 4b. Component layout for receiver

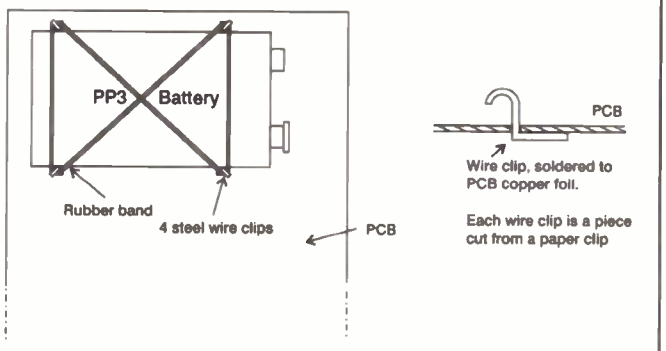


Figure 5. Battery securing arrangements

made from soft felt or a similar material, but a commercial product can be used - a size of 110mm x 95mm was found to be convenient.

The Receiver PCB

Figure 4a shows the copper pattern of the receiver PCB. Figure 4b shows the component layout of the receiver PCB.

Construction of the receiver starts with fitting all the resistors, capacitors and the 8-pin DIL socket SK4. Take the same care with electrolytic polarities and the SK4 'notch' as for the transmitter. Fit TR1 and TR2 ensuring that they are correctly oriented.

Fit four steel wire clips in the four holes around the PP3 battery as for the transmitter. See Figure 5. Fit the 418MHz receiver module (Type AM28F) to the PCB.

The Receiver Box

The receiver PCB is fitted to the inside of the lid of an ABS MB8 box (Maplin order code KC90X). See Figure 7. SK1, SK2, SK3 and SW1 are also to be fitted to the inside of the lid. Before fitting these items to the lid carry out the following:

1. Connect 90mm of RG58 50Ω coaxial cable to the two PCB pads adjacent topin 1 of the receiver module. The innerconductor connects to the pad nearest to pin 1 and the braid connects to the other pad.

2. Connect the black lead of the rigid PP3 clip to the 0V pad on the PCB. Connect 100mm of red wire, of a similar size to the black lead on the PP3 clip, to the +9V pad on the PCB. Extend the red lead of the rigid PP3 clip with 100mm of the sametype of red wire. Cover the joint with insulting sleeving. Twist together the two red wires and tin the ends ready for connection to SW1.

3. Connect 70mm lengths of miniature screened cable (Type XR15R) to the PCB output pads. The braids are connected to the pads nearer the edge of the PCB and the inner conductors are connected to the pads furthest from the edge of the PCB.

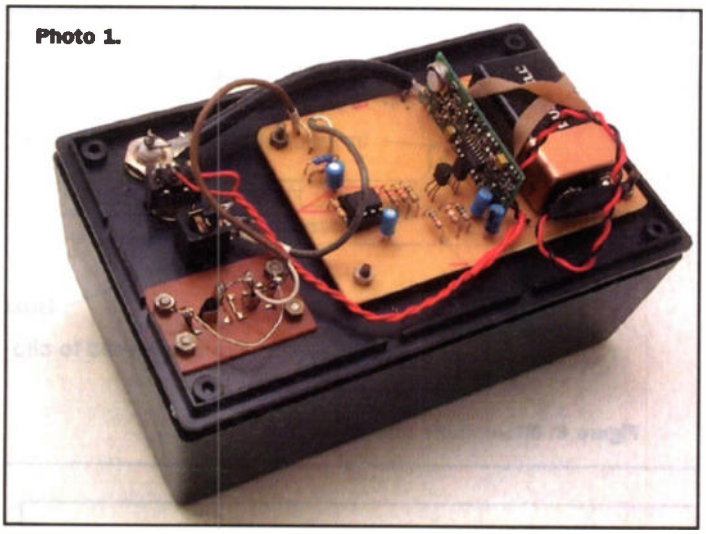
4. Check that all components on the PCB are correct in position, orientation and value.

5. Drill the lid of the box to receive the PCB, SW1, SK1, SK2 and SK3.

Fit the PCB, SW1, SK1, SK2 and SK3. Connect the two red wires from the PCB to the 'Common' and 'normally open (NO)' terminals of SW1. Connect the free end of the RG58 cable to SK1. The braid to the outer connecting tag and the inner conductor to the centre pin. Connect the screened cable from the 1V rms pad to SK2. The braid to the outer connection and the inner conductor to the inner tag. Connect the screened cable from the 2mV pad to SK3. The braid to the 'ring' terminal and the inner conductor to the 'tip' terminal. Finally, check that all connections are correct.

Insert IC1, a TL071 opamp, into SK4 on the receiver PCB. Clip a PP3 battery onto the PCB with a rubber band. Check that SW1 is 'off'. Connect the rigid PP3 clip to the battery. This completes the assembly of the receiver PCB and it's box lid.

Photo 1.



Microphone Lead

The microphone, lead and jack, J1, assembly is shown in Figure 6. By using black sleeving and a black crocodile clip an inconspicuous microphone unit is obtained which is hardly noticeable when clipped on the lapel of the wearer. The sub-miniature electret microphone (Type FS43W) is particularly suitable as it is very small and comes supplied with a black cloth cover over the input port. Prepare one end of the connecting lead (Type XR15R) by removing 30mm of the outer sheath and separating the screening braid from the inner conductor. Twist the braid wires together and reduce the length of braid to 7mm. Tin the end of the braid. Strip the insulation from the last 3mm of the inner conductor. Tin this also. Remove the black sheath from the crocodile clip (Type FK34M) and thread it onto the prepared end of the connecting lead. While the sleeve is removed, tin one side of the crocodile clip. Thread the prepared end of the connecting lead through the back of the crocodile clip and solder the braid to the clip. Put the inner conductor through the jaws of the clip. Pull the black sheath over the clip. Cut a section of the sheath away over the tinned side of the clip. Solder the earthy side of the microphone carefully to the exposed section of the clip. While carrying out this step the two ends of the plastic sheath should be stretched to open up a wide enough gap to get the soldering iron into the area. Draw the end of the inner conductor of the connecting lead through the hole in the sheath and solder the end to the 'live' terminal of the microphone. A short length of black heat shrink sleeving is fitted over the microphone to hide the metallic colour. Fitting a 3.5mm jack (Type JM23A) to the other end of the connecting lead completes the assembly. In use the microphone lead is run to the transmitter in an inside pocket out of sight.

Photo 2.

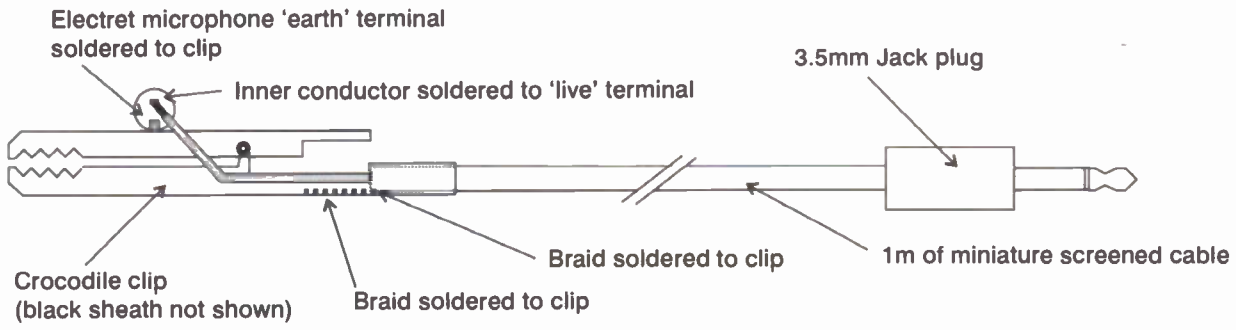
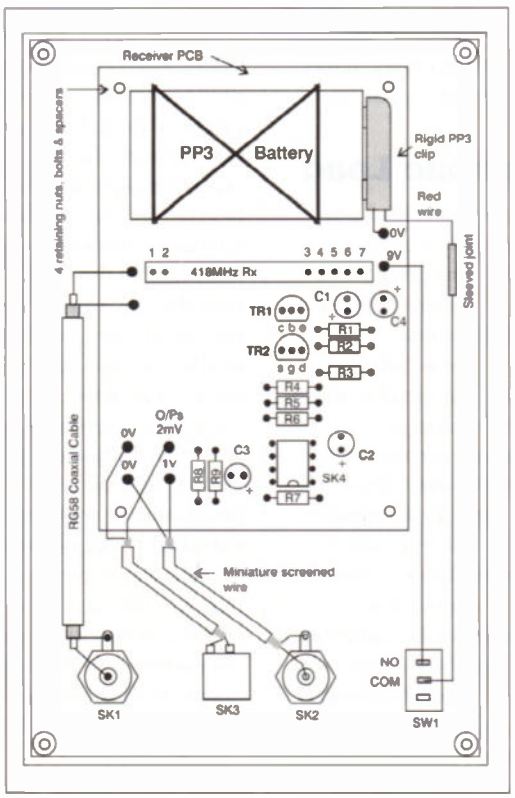


Figure 6. Microphone arrangements



ABS MB8 Box Lid
View from inside

Figure 7.

The Receiving Antennae

As previously mentioned, one of two types of receiving antennae can be used with the system:

1. For short-range work a 160mm length of 1mm² copper wire plugged into the centre of the BNC socket SK1 is satisfactory.
2. For longer-range work a Yagi antenna is required. A suitable design for use at 418MHz is shown in Figure 2.

The Yagi antenna is constructed from a 500mm length of softwood with a section of 20mm x 50mm forming the central member of the antenna. The elements are made of 8mm diameter aluminium rod or tube to the dimensions shown and are pushed through holes in the central member at the specified spacing. The dipole elements have a 5mm gap between the inner ends of the rods. A hole is made in the wood to allow access to these ends. 3mm diameter clearance holes are made in the inner ends of the rods. Solder tags are bolted to these holes with 2.5mm bolts and nuts and 2m lengths of RG58 coaxial cable are connected to the tags. The cable is laid along the wooden member towards the reflector element and fixed to the wood with two cable ties. A BNC plug is fitted to the other end of the RG58 cable for connection to SK1 on the receiver box. A camera tripod is a convenient way of mounting the Yagi, but a matching shoe must be fitted underneath the wooden central member.

Testing

No adjustments are required for the system. If the circuits have been correctly assembled they can be expected to work satisfactorily. The following testing procedure will allow any faults to be identified:

1. Place the transmitter in one room and the receiver in an adjacent room.
2. Fit a 160mm wire antenna into SK1 of the receiver. Switch on the receiver.
3. Check the DC voltages in the receiver circuit are as shown in the circuit diagram, Figure 1b. With the transmitter off, there should be no RF signal being received and the collector of TR1 should be at +9V. If it is 0V there is a fault in the receiver PCB.
4. Plug the microphone lead into the transmitter PCB. Connect the transmitter to its battery.
5. The voltage at the collector of TR1 in the receiver should now be 0V. If it is still +9V there is probably a fault in the transmitter.
6. Check the DC voltages in the transmitter circuit are as shown in the circuit diagram, Figure 1a.
7. Connect a phono lead from SK2 on the receiver to an audio amplifier. Switch on the amplifier.

Sounds originating near the transmitter should now be heard from the amplifier. Check that the compression circuit is working by inputting loud sounds to the microphone and noting that the amplifier output remains undistorted. The volume control on the amplifier should be set at a low level for this test to avoid distortion in the amplifier itself.

When all checks are satisfactory, fit the lid to the receiver box and the transmitter in its pouch. Ensure both the receiver and transmitter are turned off until they are required for use!

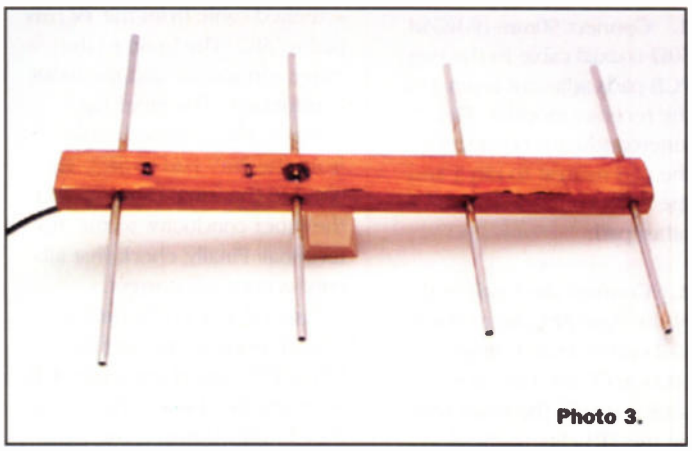


Photo 3.

TRANSMITTER PARTS LIST

RESISTORS		
R1	22kΩ	G22k
R2	2k2Ω	G2k2
R3	270Ω	G270R
R4	5k6Ω	G5k6
R5	200kΩ	G200k
R6,R7	1MΩ	G1M
R8,R9	47kΩ	G47k
R10	10Ω	G10R
CAPACITORS		
C1,C4,C8	PC Elec 100μF	VH36P
C2,C6	0.1μF MiniEster	CX21X
C3	PC Elec 22μF	VH26D
C5	PC Elec 10μF	VH22Y
C7	PC Elec 47μF	VH32K
SEMICONDUCTORS		
IC1	SSM2165	VQ88V
IC2	TL071	RA67X
	418 MHz Transmit Module	AM27E
MISCELLANEOUS		
	Electret Microphone, Sub-min	FS43W
	Black Croc Clip	FK34M
	Miniature Screened Cable, 2m	XR15R
J1	3.5mm Mono Jack	HF80B
SK1	PCB 3.5mm Jack	JM23A
SK2,SK3	8-pin DIL Socket	BL17T
	Rigid PP3 Clip	NE19V
	PP3 Battery	ND65V
	Enamelled Wire. 24swg, 50gm	BL28F

RECEIVER PARTS LIST

RESISTORS		
R1	1MΩ	G1M
R2	39kΩ	G39k
R3	6k8Ω	G6k8
R4	150kΩ	G150k
R5,R6	47kΩ	G47k
R7	470kΩ	G470k
R8	10kΩ	G10k
R9	18Ω	G18R
CAPACITORS		
C1,C2,C3,C4	PC Elec 10μF	VH22Y
SEMICONDUCTORS		
TR1	BC560	UL50E
TR2	2N7000	UF89W
IC1	TL071	RA67X
	418MHz Receiver Module	AM28F
MISCELLANEOUS		
SK1	BNC Round Socket	HH18U
SK2	Chassis Phono Skt	YW06G
SK3	Jack Socket 3.5mm	HF82D
SK4	8-pin DIL Socket	BL17T
	Coaxial Cable RG58 50Ω, 2m	XS51F
	Box, ABS MB8	KC90X
SW1	SPST Ultra Min Toggle	FH97F
	Rigid PP3 Clip	NE19V
	PP3 Battery	ND65V

Software HINTS & TIPS

by Mike Bedford

Tired of the same old font formatting in all your documents? Here we look at what's on offer in MS Word 97.

For some time now we've been investigating the features of Windows 95 and 98. We're now going to turn our attention from the operating system to some of the more popular applications and, to start the ball rolling, we'll take a look at font formatting in Microsoft Word 97. We'll assume that you're familiar with all the features available on the default toolbars, but what about the options hidden away in the various menus? As we're about to see, Word probably gives you a lot more options than you might have thought.

Before we start, though, a quick word on using these facilities. In common with most word processing packages, Word offers lots of options. If we were to multiply the number of fonts by the number of available point sizes by the number of formatting options, we'd end up with a vast number of combinations. For some people, the temptation to try to use them all is overwhelming, so my advice is to resist that temptation. Certainly there are occasions when you will need to use some of the options we'll look at here, but with the exception of italicising and emboldening, these occasions will be few and far between. If you over-use many of the formatting options, your documents will look very amateurish and tacky.

Formatting Options

You'll be familiar, of course, with three of the ways of formatting text - emboldening, italicising, and underlining - since these appear on the default toolbar as shown illustrated. As a passing comment on these, though, I'd advise against making extensive use of underlining. Many people use it for titles but it looks very unprofessional. Really this is just a throwback to hand-written text and to what was easily achievable in the days of line printers and dot matrix printers. In properly typeset text, a larger size and possibly a different font is used.

These familiar text formatting options are just three of the many available in Word. To try out some of the remaining ones select a portion of text and then select Format > Font and make sure the Font tab is selected. The top half of the Font Formatting window just repeats what you can do from the default toolbar - so pick a font, a font size, and select italicisation and emboldening. However, there are some interesting new features in the bottom half. Did you realise, for example, that there are actually nine ways of underlining text ranging from the normal single underlining to bold, dotted or wavy underlining? Also, there are eleven formatting options, selected using the tick boxes, in addition to the common three. The illustration is an example of some of the bizarre effects achievable using the options found here.

Most of the effects you'll find on the Font Formatting window will be used only occasionally. However, in some applications you may find that you need to use some of them frequently. If you're a mathematician or scientist, for example, you could well find that superscript and subscript are needed reasonably frequently, and having to select these effects this way will be unnecessarily time consuming. However, there is a better way. Toolbars are customisable so you could put buttons for superscript and subscript alongside the buttons for bold, italics and underline. Let's see how this is done. Select Tools > Customise and make sure that the Commands tab is selected.

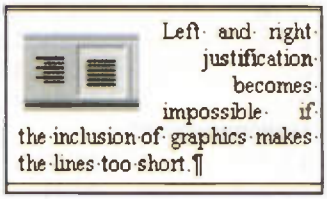
Select Format in the Categories list box and the entries in the Commands list box will change to show all the formatting options. Now scroll down until you find the superscript button and drag it into the Formatting toolbar at your chosen position. Obviously you can add as many buttons as you like this way and you'll also find that you can remove buttons just by dragging them off the toolbar. Here's how I changed my Formatting toolbar – underlining has been removed whereas superscript and subscript have been added.

Animated Effects

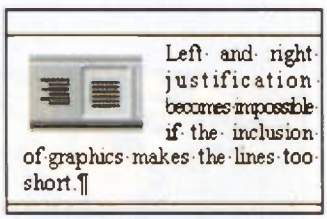
If you haven't already discovered them, you'll undoubtedly find the next set of font formatting options to be even more strange than wavy underlining, embossing or double strike-through. These are the animated effects and you can find them at Format > Font > Animation. The following shows one of these effects, Sparkle Text, but the printed page doesn't do justice to the effect - you'll really have to try it out for yourself. Suffice it to say that the coloured blocks, lines and crosses remain in constant motion around the text. Clearly these effects are only of value if you intend the document to be read on-screen rather than printed out. There's more scope for going over the top here than with the static effects. Use them sparingly or the novelty value will be lost!

Character Spacing

OK, that's enough of strange effects. Let's now move onto something which is not nearly as exciting but probably far more useful to the average user - character spacing. If you only ever use Word to type letters, memos and the like, you can probably get away without using these facilities. However, if you use Word for creating brochures, newsletters and the like, formatting becomes much more important. With multiple narrow columns on the page, text flow round illustrations, and right justified text - all common in newsletters and easy to do in Word - it's easy to get into the sort of situation shown in the following shot.


Left and right justification becomes impossible if the inclusion of graphics makes the lines too short.¶

When there is only space for a single word on a line, the justification effect is totally lost. To a degree it may be possible to correct this using hyphenation but adjustment of the spacing between the characters in certain words can be used to effect. To do this, select the word or words in question and select Format > Font > Character Spacing. Adjust Spacing until you get the desired effect. The following shows how I corrected the problem in the earlier screen shot. The spacing in the word 'justification' has been increased and the spacing in the words 'becomes' and 'impossible' has been decreased. Perhaps I've over-done it slightly but this is a matter of personal taste.


Left and right justification becomes impossible if the inclusion of graphics makes the lines too short.¶

That's all that I'm going to describe in any detail but this month's column has by no means exhausted the possibilities. I'll conclude in my habitual way, that is by suggesting that you have a good play around with the character formatting facilities and learn how to use them. Some of the effects are much more subtle than the formatting options we've looked at here but that doesn't mean they're not worthwhile. Kerning, for example, doesn't make a vast difference but it can put the finishes touches to your document. If you don't know what it means, take a look at Word's help.

Valves in the 21ST CENTURY

PART 1

In Part 1 Mike Bedford looks at basic principles

Nostalgia rather than technological wonderment is what most people feel when the word 'valve' is mentioned. Rather than suggesting leading edge technology, a more familiar picture is of the family sitting around the old wireless set listening to Family Favourites.

Semiconductors are for today and valves are most definitely yesterday's technology according to public perception. But although it would be ridiculous to suggest that valves will ever make a come-back for general purpose use, it would also be wrong to consider them as totally outdated. Valves are still with us today and they look likely to remain the component of choice in certain important niche applications for some time yet. This is the first of a series of articles introducing valve technology to those who have been brought up on a diet of transistors and integrated circuits. For some, this series will appeal at the level of general interest - after all, it's good to be aware of our technological heritage even if we're only ever going to use semiconductors. But for others, a knowledge of valves will lead to building or designing valve circuits - indeed circuits including valves have appeared in these pages during the last few months. To start our tour of the world of valves we'll look at the various types of valve which are available, describe how they work and how they are constructed. Then in the remainder of the series we'll investigate how and why valves are used today.

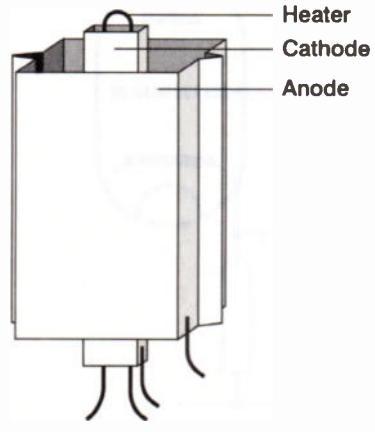


Figure 1. Construction of thermionic diode.

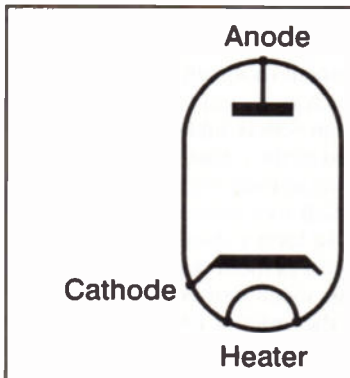


Figure 2. Symbol for thermionic diode.

Basic Principles

If you have difficulty in visualising the migration of electrons and holes through crystalline lattices - as you have to in order to understand the operation of transistors - you'll find the operation of valves to be very intuitive. To set the ball rolling, we'll take a look at the simplest possible type of valve - the diode - to see how it works. In fact, the basic principles we'll see in our investigation of the diode apply to all virtually all types of valves so we'll then be in a position to build on these foundations and look at the operation of more complicated valves.

Figure 1 is a simplified mechanical diagram showing the construction of a thermionic diode. In passing, you'll notice that I used the word 'thermionic' to differentiate this type of diode from a semiconductor diode. In fact, every time we use the word valve in electronics we should really refer to it as a thermionic valve but, since there's no likelihood of confusion with fluid valves in this article, we'll stick with the abbreviated version here. Note, also, that you may also come across the word 'tube' or more fully, 'electron tube' or 'vacuum tube' which this tends to be the terminology used on the other side of the Atlantic. The diode is contained in a glass envelope from which virtually all the air has been removed. For clarity, the glass envelope is not shown on the diagram. It's necessary to create a vacuum for electrons to flow unimpeded and, as we'll see, the flow of electrons through free space is key to the operation of the valve. The cathode is

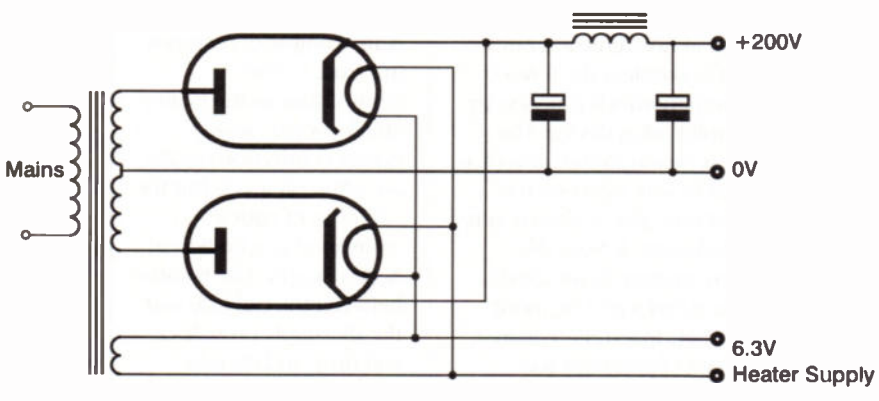


Figure 3. Using diodes as rectifiers.

a metal cylinder which has been coated with barium oxide. Inside the cathode is a heating element (normally just called the heater) which glows red hot when a low voltage, often 6.3V, is applied across it. The heat applied to the cathode causes the oxide coating to emit electrons into the vacuum which surrounds it. Normally, the electrons just form a cloud around the cathode, most of them don't have sufficient energy to go much further. But if a high voltage, of the order of 100V or more, is applied to the anode, another cylindrical electrode which surrounds the cathode, electrons are drawn to the anode through the vacuum and an electrical current flows. Clearly if the polarity is reversed, that is if the anode is made negative with respect to the cathode, the electrons will be repelled by the anode so no current will flow. What we have, therefore, is a diode, a component which allows current to flow in one direction only. Presumably the derivation of the word 'valve' comes from this, the very first valve, the thermionic diode. The parallel with a physical non-return valve which allows fluid to pass in one direction only is obvious.

Figure 2 shows the symbol for a thermionic diode, as used in a circuit diagram, and Figure 3 shows how a couple of diodes can be used as rectifiers in a power supply like those which, at one time, would have been used for valve circuits. Note that because thermionic diodes were significantly more expensive than semiconductor diodes now are, this type of circuit would usually have been used in preference to one involving a bridge rectifier since this would have needed four diodes. Note also, that instead of the pair of diodes shown here, a double diode - essentially two diodes with a common cathode in the one glass envelope - would often have been used. And finally, these double diodes often had a directly heated cathode rather than the indirectly heated one we've seen. Here, the cathode connection is actually made to one side of the heater since there is no separate cathode. Because of the prevalence of semiconductor diodes thermionic diodes now find few uses but they are a stepping stone to our next topic, the triode.

The Triode

So far, we've got a valve which will allow the flow of current in one direction but we have no means of controlling the flow of that current, something which is necessary to produce an amplification device. The triode provides this means in the form of a loosely wound coil of wire between the anode and the cathode. This is shown in red in Figure 4 to differentiate it from the elements which are present in the diode. This coil of wire is called a grid or, more specifically, a control grid to differentiate it from the other types of grid we'll see shortly. Just placing a coil of wire between the cathode since the gaps between the windings are more than adequate for the vast majority of electrons to pass unimpeded.

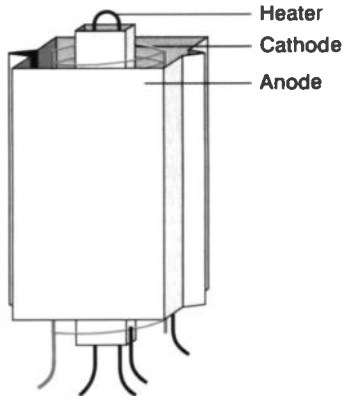


Figure 4. Construction of triode valve.

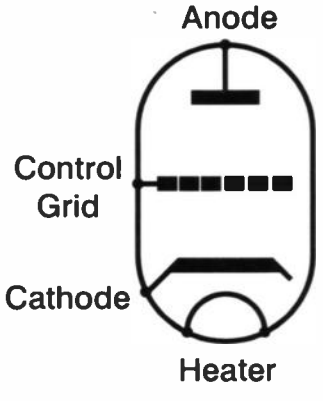


Figure 5. Symbol for triode.

However, if we arrange for the grid to be negatively charged with respect to the cathode, electrons will be repelled and so no current will flow even if the anode has a sufficiently high positive charge. The negative potential required on the grid to inhibit the flow of electrons between the cathode and the anode is only of the order of a few volts. Since a low voltage on the grid affects the flow of a high current signal between the cathode and the anode, we have a device which provides amplification. The symbol for a triode is shown in Figure 5, and its use as a simple amplifier is shown in Figure 6. The connections to the heater aren't shown - just as power connections to ICs are often omitted - but the heater is, of course, connected to a dedicated heater supply. The resistor between the cathode and the 0V supply provides a volt drop and thereby allows the control grid to be more negative than the cathode when no signal is applied to the grid. The parallel capacitor bypasses this dropper resistor at the signal frequency. Under normal circumstances, no electrons will flow. However, if a positive low voltage signal is applied to the input terminal, the grid is made less negative with respect to the cathode and the flow of electrons will resume. So a small change in the voltage applied to the control grid causes a significant change to the current flowing in the anode circuit.and the anode will have virtually no effect.

The operation of a valve is summed up by various curves, the two most common ones showing the relationship between the anode current and the control grid voltage and the relationship between the anode current and the anode voltage. Typical curves for the triode are shown as Figures 7 and 8 respectively. Both graphs show a family of curves, in Figure 7 the various curves relate to different anode voltages and in Figure 8 it's grid voltage which differentiates the curves. Figure 7 is pretty much what we'd hope for, that is for a significant range of control grid voltages the curve is a straight line which means that it ought to be possible to achieve linear amplification.

We'll investigate this in more detail later when we look at classes of amplification. However, the relationship between the anode current and the anode voltage is far from ideal. Let's interpret this curve in the light of the operationof our simple triode amplifier. As the control grid voltage increases and the anode current increases in response, a voltage drop will be generated across the anode load which is a transformer in the circuit in Figure 6. In other words, the voltage on the anode decreases. Now it's clear from Figure 8 that this will have the result of reducing the

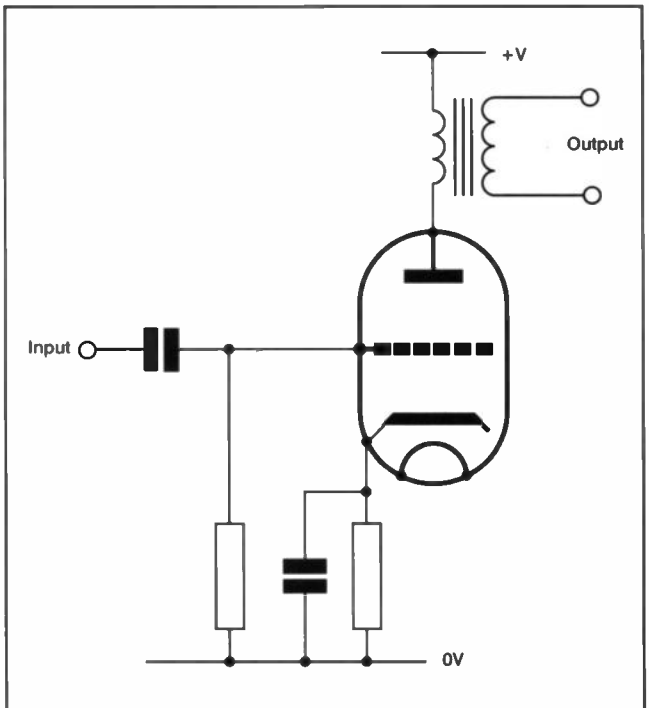


Figure 6. Simple triode amplifier.

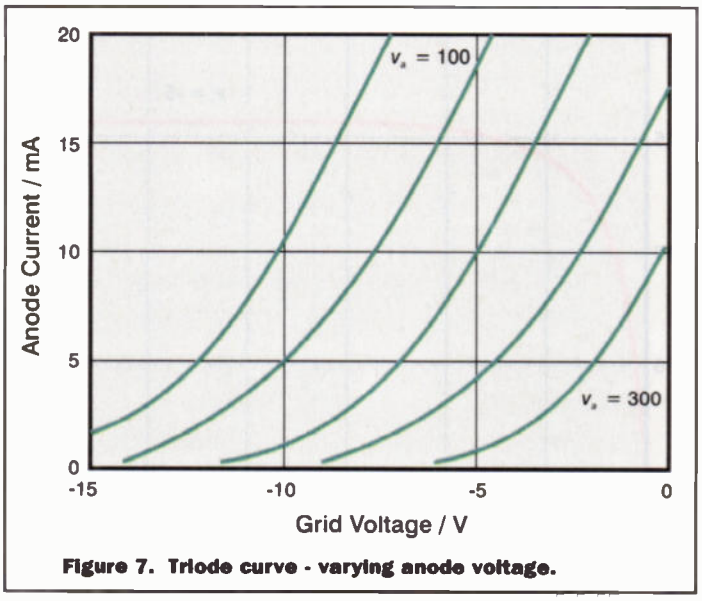


Figure 7. Triode curve - varying anode voltage.

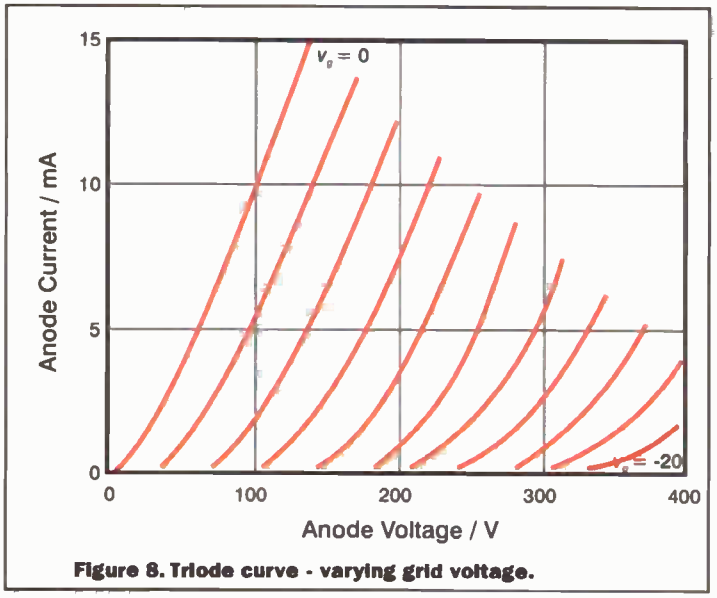


Figure 8. Triode curve - varying grid voltage.

anode current and so, to a degree, the effect of increasing the control grid voltage will be cancelled out. This is not a problem for small signal operation e.g. a receiver, but it makes the triode quite unsuitable for use as a power amplifier, perhaps in the output stage of a radio transmitter or an audio amplifier. Clearlywhat would be needed here is a valve for which the anode current is largely independent of the anode voltage.

More Grids...

Unfortunately, there's another problem with the triode too. Although triodes are suitable for use as oscillators and they're suitable for use as low power audio amplifiers, the appreciable capacitance between the control grid and the anode is problematic at radio frequencies. Typically, attempts to use a triode as an RF amplifier will result in feedback from the anode to the control grid and this, in turn, will produce unwanted oscillations. This is overcome by adding a second grid, called the screen grid, between the control grid and the anode. The resultant valve is called a tetrode, the symbol for which is shown as Figure 9. We won't attempt to show the construction of a tetrode since it will look rather confusing, but suffice to say that the additional grid is pretty much the same as the control grid, a loosely wound wire coil supported by two wire pillars. In fact, the screen grid has a wider spacing between the turns of the coil than in the control grid. Now, if the screen grid is made positive, but less so than the anode - typically the screen grid is fed from the positive supply via a dropper resistor and it is decoupled to 0V using a capacitor - the tendency toward instability is overcome. So far so good, but unfortunately the tetrode has characteristics which make it unsuitable for use as a linear amplifier. The effect of the screen grid is to accelerate the electrons to a velocity significantly greater than in the triode and this, in turn, results in electrons being dislodge from the anode. We could view this as high speed electrons bouncing off the anode with some of these electrons being captured by the screen grid. This is called secondary emission and it has some unfortunate consequences.

The graph of anode current against control grid voltage for a tetrode is not too dissimilar from that for the triode which is shown as Figure 7. However, the graph of anode current against anode voltage is quite different as you'll see from Figure 10. For a significant range of anode voltages, the anode current is largely independent of the anode voltage which, as we've already seen, is ideal for a power amplifier. However, at voltages below the screen grid voltage, the curve shows a negative response. The effect of this kink is to provide very non-linear operation. Also, the loss of anode current at

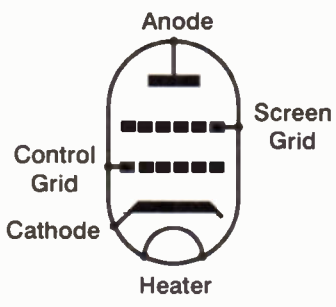


Figure 9. Symbol for tetrode.

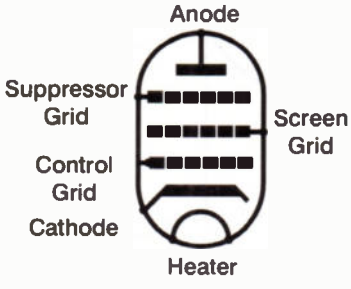


Figure 11. Symbol for pentode.

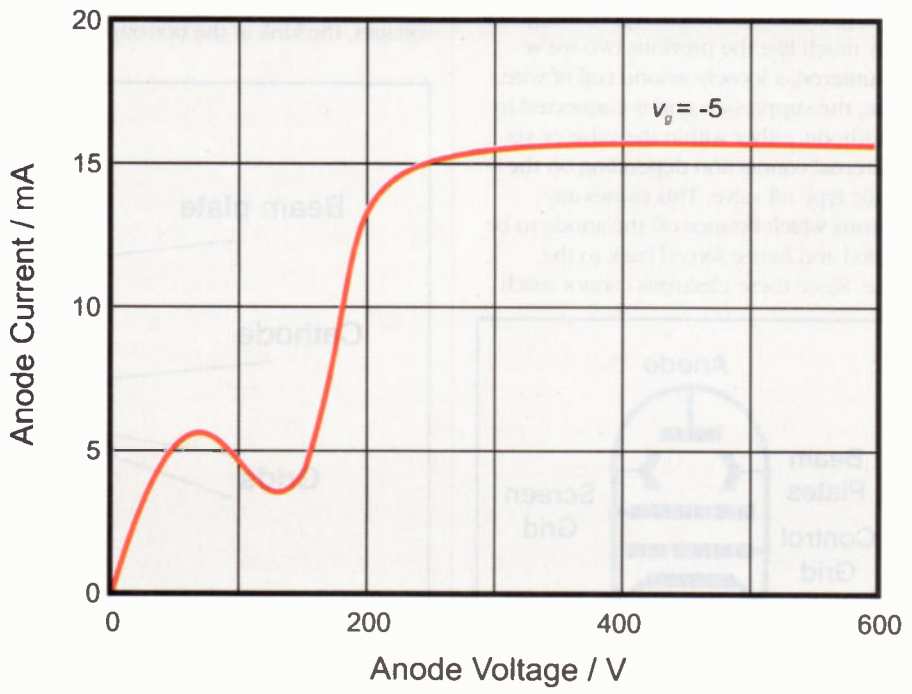


Figure 10.Tetrode curve - anode current vs anode voltage.

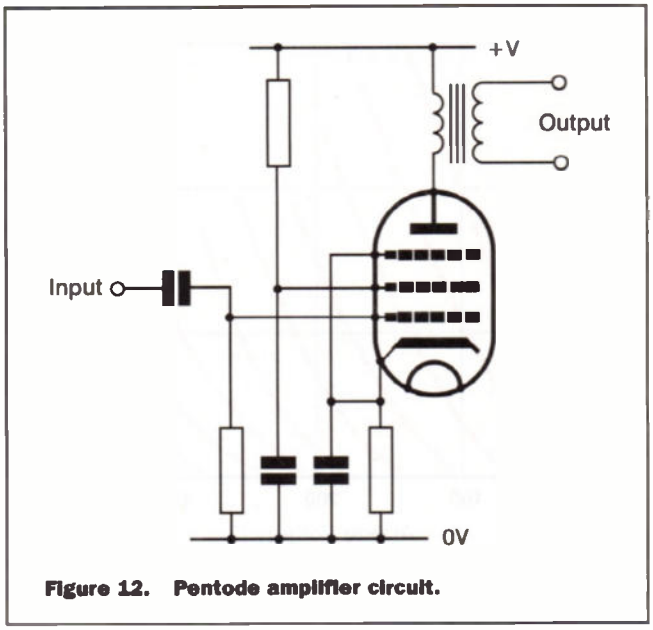


Figure 12. Pentode amplifier circuit.

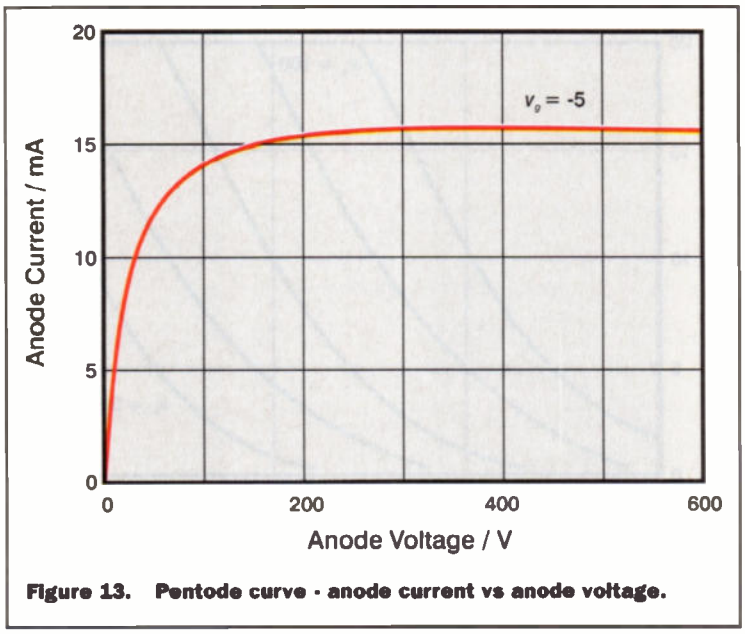


Figure 13. Pentode curve - anode current vs anode voltage.

low anode voltages is offset by a significant increase in screen grid current. Since grids aren't designed to handle this sort of current, the lifetime of the valve could be severely reduced. For these reasons, ordinary tetrodes are rarely used. However, our discussion of tetrodes is not as futile as this comment would suggest since they are a further stepping stone to the ideal valve. Actually, there are two separate ways of building on the principle of the tetrode and, in so doing, overcome its non-linearity. We'll look at each in turn.

The first method is probably what you'd expect. Just as we moved from the triode to the tetrode to overcome a deficiency in the triode, we can move from the tetrode to the pentode to overcome the tetrode's deficiency. You might also hazard a guess at how a pentode may be constructed and you'd probably be correct. A further grid, the suppressor grid, is placed between the screen grid and the anode. Again, this grid is pretty much like the previous two we've encountered, a loosely wound coil of wire. In use, the suppressor grid is connected to the cathode, either within the valve or via an external connection depending on the specific type off valve. This causes any electrons which bounce off the anode to be repelled and hence forced back to the anode. Since these electrons cannot reach the suppressor grid, the non-linearity is prevented. Figure 11 shows the symbol for a pentode and Figure 12 is the amplifier circuit we saw earlier, re-worked to make use of a pentode. Let's now consider the various graphs for the Pentode. The relationship between the anode current and the control grid voltage is similar to that of both the triode and the tetrode and is, therefore, adequately summed up in Figure 7. Figure 13 is the curve of anode current versus anode voltage for the pentode and, as you'll see, it's quite different from that of either the triode or the tetrode. For a significant range of anode voltages, the anode current remains virtually constant. This is exactly what we need for a high power amplifier – we saw the effect of a sloping curve in our discussion of why the triode is unsuitable for power applications. However, unlike the tetrode, which also has this flat response for quite a range of anode voltages, the kink at the bottom end is missing so linear operation is achievable.

The alternative method of correcting the tetrode's secondary emission problem is to place a couple of so-called beam plates close to the anode. This results in a type of valve called a beam tetrode – the physical construction is shown in Figure 14. We won't go into all the mind-numbing details concerning potential gradients, but let's say that the two beam plates, of which you can see one in the diagram, are connected to the cathode potential and effectively focus the electrons onto the anode. In so doing, the beam plates have a similar effect to the suppressor grid in the pentode. Figure 15 shows the symbol for the beam tetrode. Using either the pentode or the beam tetrode, high power linear amplifiers can be constructed and these can be made to operate at radio frequencies in addition to audio frequencies. As such, you might think that there's no need for any more complicated valves - but you'd be wrong as we're about to see.

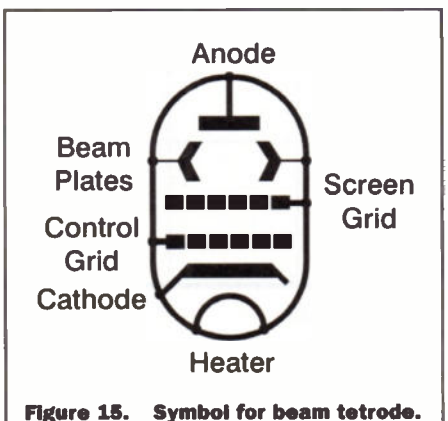


Figure 15. Symbol for beam tetrode.

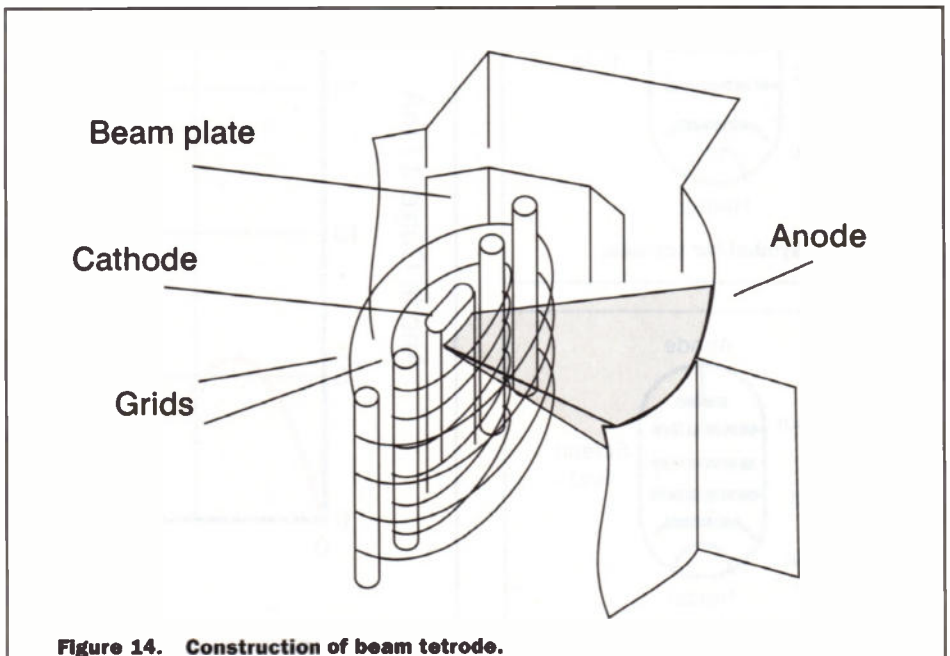


Figure 14. Construction of beam tetrode.

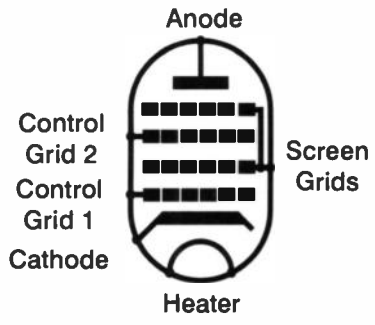


Figure 16. Symbol for hexode.

...and Yet More Grids

So far we've seen the use of valves as rectifiers and amplifiers and we've made passing reference to their use as oscillators. However, there's one more important use of valves in radio circuits which we haven't touched on - frequency conversion. As you'll know if you've ever dabbled with radio circuitry, a common type of radio receiver is called the superhetrodyne or super het for short. Here, incoming radio signals from the antenna are inverted to a single intermediate frequency as this simplifies the design of the filters which provide selectivity. Conversion from the original radio frequency to the intermediate frequency is achieved by mixing. As the receiver is tuned, the frequency of a so-called local oscillator is adjusted such that it's always separated by 455kHz (a common intermediate frequency) from the signal frequency. Now, if the radio frequency signal, after initial amplification, is mixed with the local oscillator, it will be converted to the 455kHz intermediate frequency. One of the most common means of mixing the signal with the local oscillator is to use a valve with two control grids - one which is driven by the radio frequency signal and the other by the local oscillator. Needless to say, capacitance between these two control grids would be problematic and so, in addition to the normal screen grid between the control grid and the anode, a further screen grid is placed between the two control grids. This gives rise to the hexode. For this application, the suppressor grid isn't normally needed although a few mixer valves with suppressor grids were produced which were called heptodes or sometimes, in the USA, pentagrid tubes. The symbol for a hexode is shown in Figure 16 but you could probably have made a guess at this one, even if you haven't encountered valves before.

Multiple Valves

Our discussion of hexodes and heptodes still doesn't bring us to the end of the road in our investigation of the basic types of valves. You'll recall that I made mention of the fact that double diodes were produced for use in power supplies in place of the two separate diodes which would otherwise have been needed. This practice of putting two separate valves into the one glass envelope as a space-saving measure, is by no means an uncommon one. In a way, this concept was a predecessor of the integrated circuit which contains multiple transistors in the one package. One especially interesting double valve which was particularly common in the days of valve radio receivers was the triode-hexode. We've already seen that the hexode was designed as a frequency converter and that it operates by putting the radio frequency signal on one control grid and the local oscillator on the other. We've also seen that triodes are eminently suitable as oscillators. So by putting both a hexode and a triode in the one glass envelope, we have all the active components we need for the frequency conversion stage of a superhet receiver in a single component. Normally, the control grid of the triode was connected internally to one of the control grids of the hexode so that the local oscillator was connected through without any external wiring. Figure 17 is a circuit of a product detector which uses a triode-hexode. In this particular valve, the triode's control grid doesn't have a direct connected to one of the hexode's control grids so an external connection is made from the triode's anode via a capacitor. We'll now bring our discussion of ordinary valves - as opposed to the various very specialised valves we'll look at later in the series - to a close. However, we should mention in passing that there are lots more types of valves we haven't looked at. In particular, there are also, octodes, and a whole range of multiple valves including double triodes, double diode triodes, triple diode triodes, triode-pentodes, double tetrodes and double pentodes.

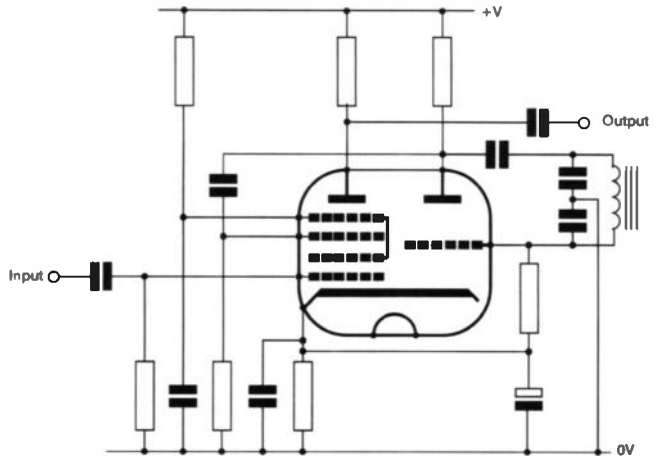


Figure 17. Product detector circuit using a triode hexode.

Voltage Stabiliser

So far, all the valves we've seen have been closely related one to the other. So we saw how the pentode built on the tetrode which itself built on the triode which, in turn, built on the foundations laid by the diode. However there is, or rather was, one commonly used type of valve which has very little in common with those we've seen so far. So to conclude our first foray into the world of valves, let's take a quick look at this valve - the voltage stabiliser. For many valve circuits, the degree of voltage stabilisation achieved using a simple LC smoothing network such as that in Figure 3 is adequate. However, to achieve reasonable frequency stabilisation, the supply to oscillators in radio receivers had to provide a rather better degree of voltage stabilisation. The device used was a special two-terminal valve which, unlike all the others we've seen so far, didn't have a heated cathode nor did it have an evacuated envelope. Instead, the envelope was filled with an inert gas like those used in discharge tubes. In fact, a voltage stabiliser is not dissimilar from a discharge tube as it glows when a sufficiently high voltage is applied across it. Once the discharge has started, so long as the current passing through the tube is kept within specified limits, the voltage across it remains reasonably static. The stabilising voltage depends on the type of the inert gas and, to a degree, on its pressure. Clearly this gives some scope for manufacturing a range of stabilisers with different voltages. It's also possible, as it is with Zener diodes, to use multiple stabilisers in series to stabilise at a higher voltage. Figure 18 shows the way in which a voltage stabiliser valve would be used. Something like this could be added onto the end of our power supply circuit in Figure 3.

Next Month

As we continue our tour of the world of valves next month we'll look at valve numbering and go on to look at how to obtain valves. We'll then put various modern day applications of valves under the spotlight.

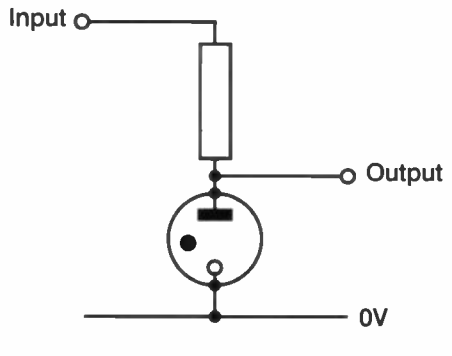


Figure 18. Voltage stabiliser circuit.

Electrifying CENTURY

By Greg Grant

In this first part, Gregg Grant goes back to 1900 and looks at the evolving technology.

Introduction

The last one hundred years has been the century of electricity and electronics. If, as they have done for ages past, historians and archaeologists were to name the twentieth century after a material - such as in the Bronze Age for example - they could do worse than term it the 'Particle Period.'

The century opened, presciently, with the discovery of the Nickel-Cadmium battery, by Junger and Berg of Sweden. However, the majority of the basic electrical components were already in place, for the last quarter of the nineteenth century had been a period of prolific invention and discovery, not only where components were concerned, but also in the construction of equipment, as Table 1 illustrates.

Nineteenth century scientific technology was a small-scale affair: twentieth century science and technology would become anything but! In fact, one scientist has calculated, some 90% of all the scientists and engineers who have ever lived are alive and practising today! Be that as it may, not only has the size and nature of both disciplines changed markedly, so also has their influence on society in general.

Throughout the last four centuries from the Renaissance, through the Baroque and the Enlightenment, to the Victorian era science made a considerable impression on man's philosophical outlook, although little - if any - impact on society. In the present century however, matters have been very different, and nowhere more so than in electronic science and electrical technology.

Whilst Table 1 - majoratively - salutes the individual inventors and developers in specialist areas of electrical research and engineering, it also points to the future, to the new century just dawning. Piezo electricity, the power transformer and the carbon film resistor pointed the way to the research team, as opposed to the lone inventor or developer.

Component	Inventor and Country	Date
Mica Capacitor	Manfred Bauer (Germany).	1876.
Rolled Paper Capacitor	D.G. Fitzgerald (UK).	1876.
Telephone	Alexander Graham Bell (USA).	1876.
Gramophone	Thomas A. Edison (USA).	1877.
Carbon Microphone	Thomas A. Edison (USA).	1877.
Moving Coil Loudspeaker	E. W. Siemens (Germany).	1877
Carbon Granule Microphone	H. Hunnings (UK).	1878.
Piezo Electricity	Jean and Pierre Curie (France).	1880.
Quick-Break Switch	J. H. Holmes (UK).	1884.
Power Transformer (Hungary).	C. Zipernowski, M. Deri, O.T. Blathy	1885.
Moulded Carbon Resistor	C. S. Bradley (UK).	1885.
X-Rays	W. K. Röntgen (Germany).	1895.
Electrocardiograph	A. D. Waller (UK).	1887.
Antennas	H. R. Hertz (Germany).	1887.
Quick Make-and-Break Switch	J. H. Holmes (UK).	1887.
Induction Motor	Nicoli Tesla (USA).	1888.
Automatic Telephone Exchange	A. B. Strowger (USA).	1889.
Wireless Telegraphy	G. Marconi (Italy).	1896.
Cathode Ray Oscillograph	Ferdinand Braun (Germany).	1897.
Carbon Film Resistor	T. E. Gambrell and A. F. Harris (UK).	1897.
Electron sub-atomic Particle	J. J. Thomson (UK).	1897.
Magnetic Recording	Valdemar Poulson (Denmark).	1898.
Ceramic Capacitor	L. Lombardi (Italy).	1900.

Table 1: Component Development 1876 - 1900

Electrical Power Developments

The progress made thus far had been the result of one very important revelation: Michael Faraday's discovery of the Laws of Electromagnetic Induction. This resulted in the Dynamo, whose further development enabled electricity to become a power source.

The first experimenter in the field was a French instrument-maker, Hippolyte Pixii, in 1832. His 'generator' - shown in Figure 1 - gave an Alternating Current (AC) output which, it has to be said, was hardly stable. The horseshoe magnet was driven by the crank, so that the poles were rotated under the coils.

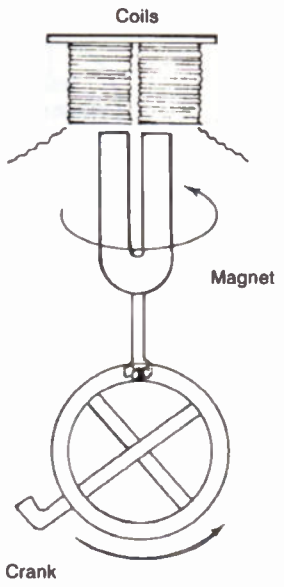


Figure 1. Pixii's Generator of 1832.

Two years later the British engineer E. M. Clarke looked at the problem of power generation from the opposite perspective. He left the heavier magnet in a stationary position and rotated the coils, as illustrated in Figure 2.

This method was adopted by others, in particular the German physicist Stöhrer. His 1844 design, illustrated in Figure 3, employed six rotating coils and three magnets! But, more complicated still was the British experimenter Millward's generator, which came out in 1851, the year of the Great Exhibition. He used eight magnets and no less than 16 rotating coils, as shown in Figure 4. The nearest thing to a truly commercial generator at this time was the small devices made by Clarke, which were used mainly in laboratory work.

As confidence in design techniques grew, electric generators began to be used to power lighthouses, although even as late as 1880, there were only ten electricity-powered lighthouses in the world.

The first important step forward in power generation came with the development of the dynamo electric generator, in which electromagnets were used to generate the magnetic field. In 1856, the German electrical engineer Werner Siemens invented the Shuttle armature, which was followed four years later by the Ring armature, the invention of the Italian experimenter Antonio Paccinotti.

Eleven years later, the practical, self-exciting dynamo appeared, developed by S. A. Varley and Charles Wheatstone in Britain, Moses Farmer in

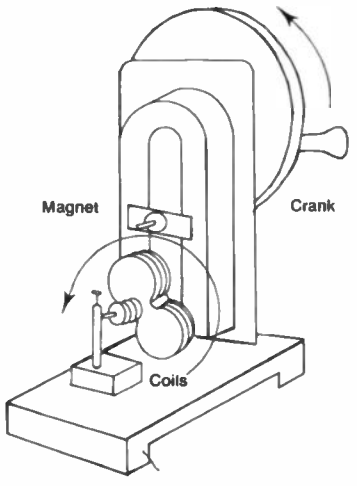


Figure 2. Clarke's Generator of 1834.

America and Werner Siemens in Germany. Although these dynamos were an improvement on Faraday's original experimental model, even the best among them delivered only around 40% of their input energy as an output.

Paccinotti's armature would be improved upon by the Belgian-French inventor Zénobe Gramme, who built the first commercially practicable AC generator in 1867. He followed this a year later with a similar machine for DC generation.

This was the period of debate between the merits of AC and DC where power generation was concerned. The advantages of the former only became apparent when the problems associated with AC transformers were resolved, in 1883. This was the result of the Frenchman Lucian Gaulard and the Briton J. D. Gibbs working together to produce the series connected transformer system. In America meanwhile, George Westinghouse, the foremost advocate of AC in power applications, began investigating Gaulard and Gibbs transformers.

By 1891, Westinghouse had installed the earliest American AC power distribution scheme in Telluride, Colorado and in the following year, the company gave an impressive demonstration of AC power distribution at the Chicago World Fair.

In Britain, a young man called Sebastian de Ferranti - who had formed his own company at the early age of 19 to exploit an alternator of his own design - began to use parallel operated transformers for his redesign of the supply system at London's Grosvenor Gallery.

By the opening of the new century, electricity as a public power source was firmly established.

'Wireless' Communication

In 1865 the Scottish physicist and mathematician James Clerk Maxwell published a research paper entitled A Dynamical Theory of the Electromagnetic Field, a ground-breaking work which expounded,mathematically, the theory of electromagnetic waves.

There matters rested for almost a quarter of a century. In 1888 however another research paper, published in Annalen der Physik by a young German researcher called Heinrich Hertz, described the creation and detection of the waves Maxwell had described mathematically. Hertz's discovery aroused great interest in the scientific community and in 1892, the British physicist Sir William Crookes suggested that such waves could - perhaps - be used to communicate intelligence.

Meanwhile, a young Italian amateur experimenter from a well-to-do family began to take an interest in electromagnetic radiation. During a family holiday he read a scientific paper on Hertz's experiments and, on his return home, immediately began his own experiments to determine if such waves could be used to communicate at a distance.

Guglielmo Marconi shortly began to achieve what all other, more learned, experimenters had achieved thus far: a range of a few metres or so. In order to improve on this, the young man began investigating the detection of electric storms using a lengthy, elevated wire. Concluding that he had been lead down a dead-end, Marconi shortly returned to the investigation of Hertzian waves. In the course of this he decided, on impulse, to combine his thunderstorm antenna with Hertz's apparatus. His arrangements are illustrated in Figure 5.

He did this by replacing the Hertzian dipoles at the transmitter and receiver. He linked one terminal of his induction coil to a metal cylinder, placed at the top of a long pole. The other induction coil terminal he connected to a metal plate, placed flat on the ground. The result was a most impressive improvement in range. Marconi continued his investigations and found that equipment range was directly related to the height of the cylinders above the ground and their dimensions.

Having offered a demonstration of his equipment to the Italian government and been turned down, Marconi decided to try his luck in Britain. On the 2nd June 1896, he applied for the world's earliest wireless telegraphy patent, British Patent No. 12,039.

Throughout July and August Marconi demonstrated his equipment to the British Post Office (BPO). On the 2nd of September, he demonstrated his apparatus to both the Royal Navy and the British army, achieving a range of one and three quarter miles. By March of the following year, Marconi was attaining ranges in excess of four miles.

In 1899 Marconi bridged the English Channel by radio, when he gave a demonstration of his equipment to the French military, naval and telegraphic authorities. He then transmitted the first message from Wimereux to his receiving station on the South Foreland. One year into the new century Marconi, having set up a wireless station at the aptly named Signal Hill, Newfoundland received the letter S, transmitted from Britain.

This - the first trans-oceanic wireless signal - indicated that the century ahead would have a new, infinitely speedier, method of communication than any that had gone before.

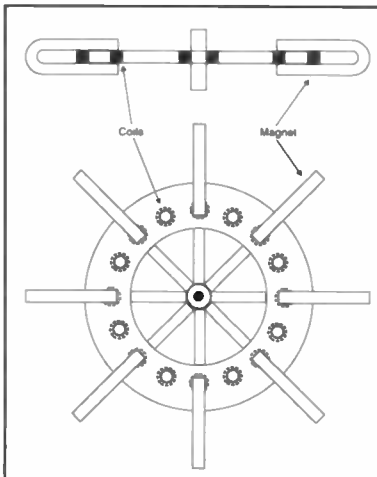


Figure 4. Millward's Generator of 1851.

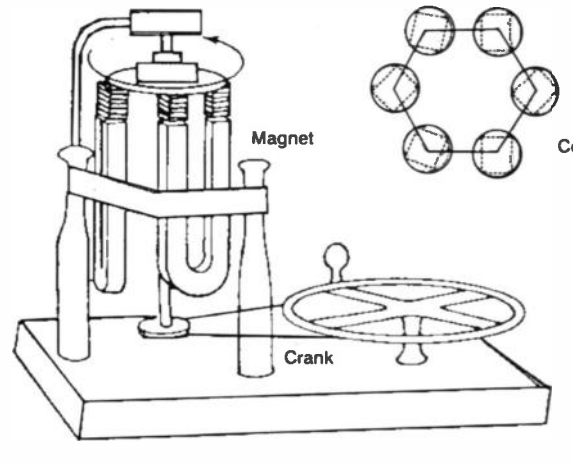


Figure 3. Stohrer's Generator of 1844.

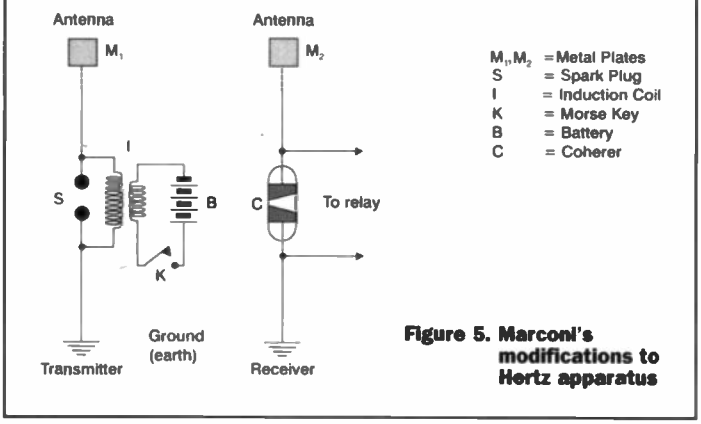


Figure 5. Marconi's modifications to Hertz apparatus

Liquid Crystal DISPLAYS

Dr. Chris Lavers looks at the latest developments in liquid crystal displays

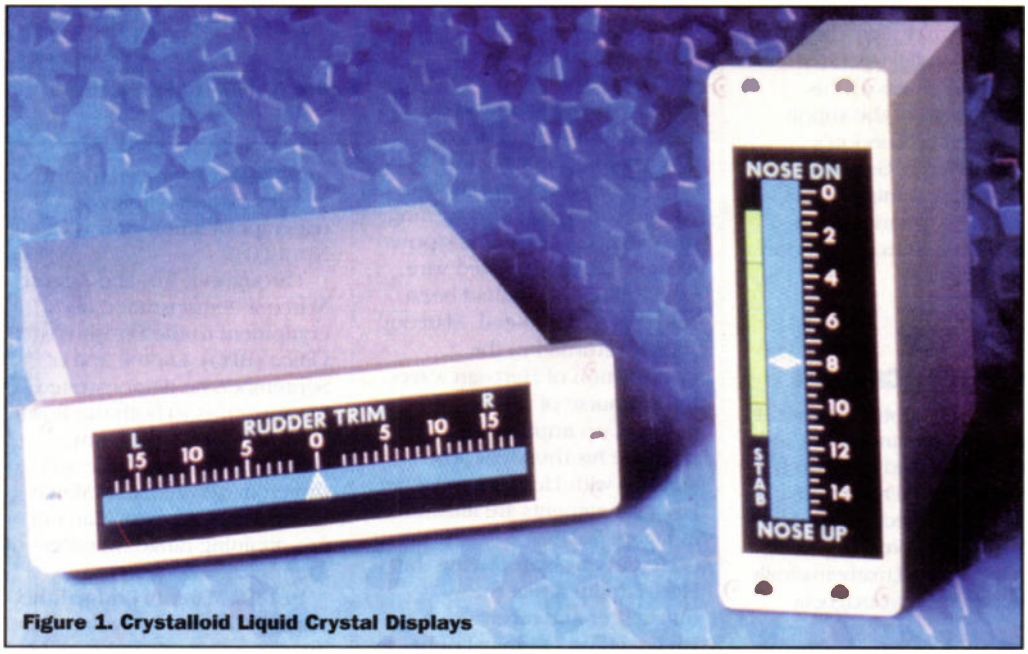


Figure 1. Crystalloid Liquid Crystal Displays

Researchers at the Institute for Network and System Theory at Stuttgart University in Germany have demonstrated a prototype display for cash dispensers which can be switched between a wide viewing angle mode for commercial advertising to the general public and a narrow viewing angle mode for individual customer privacy.

There have been a number of high quality liquid crystal products introduced into the commercial market place recently, including a new liquid crystal display with wider viewing angle and higher contrast from Crystaloid in the United States. Crystaloid's use of computer modelling and application of specialist compensating thin films has allowed a high contrast Reverse Contrast Twisted Nematic (RCTN) LCD to be developed with wider viewing angles than ever before (Figure 1). Crystaloid's RCTN displays have been widely used in the avionics industry since their invention in 1994. Coupled with relatively sensible pricing and wide temperature range, the large viewing angle of a RCTN display also makes it a good choice for industrial and commercial applications. However, there are times when it may be advantageous to alternate between both a wide viewing angle mode and a narrower viewing angle mode for private viewing, such as at a cash dispenser or Automatic Teller Machine (ATM). According to Thomas Kallfass at the University of Stuttgart their device (Figure 2) consists of a conventional light source and diffusing film for equal back illumination and two crossed brightness enhancement films to direct the light into a small viewing cone. Between the Light Enhancement Films (LEFs) and the standard LCD a special light guiding unit is added, two Light Control Films (LCF) and a single Polymer Dispersed Liquid Crystal (PDLC) or Reverse Mode cell is inserted. The LCF is an optical plastic film which strongly limits the transmitted light to narrow angles. When the PDLC is switched transparent, the light cone is narrow resulting in a restricted viewing angle for the LCD. When the cell is scattering, it acts again as a diffuse backlit source in a wide viewing angle. Photographs of the prototype with a Reverse Mode cell and a 8.4in. VGA colour LCD are given in Figure 3. The upper row shows the wide viewing angle state, the lower row the restricted viewing angle state. The photographs in the four columns were taken under angles of 0°, 30°, 45° and 60° incidence respectively. Clearly this demonstrates a significant difference between the two switched states in all but direct normal incident viewing. The adjustment of the viewing angle of displays in public interactive terminals, especially in ATMs for security purposes is clearly of paramount importance. The Stuttgart system controls the viewing angle distribution to achieve a restricted viewing angle for privacy as well as a wide viewing angle. Their proposed light guiding unit can be incorporated into existing systems, because it works with all transmissive LCDs and only needs an additional couple of millimetres space between the backlight and the display.

Figure 2

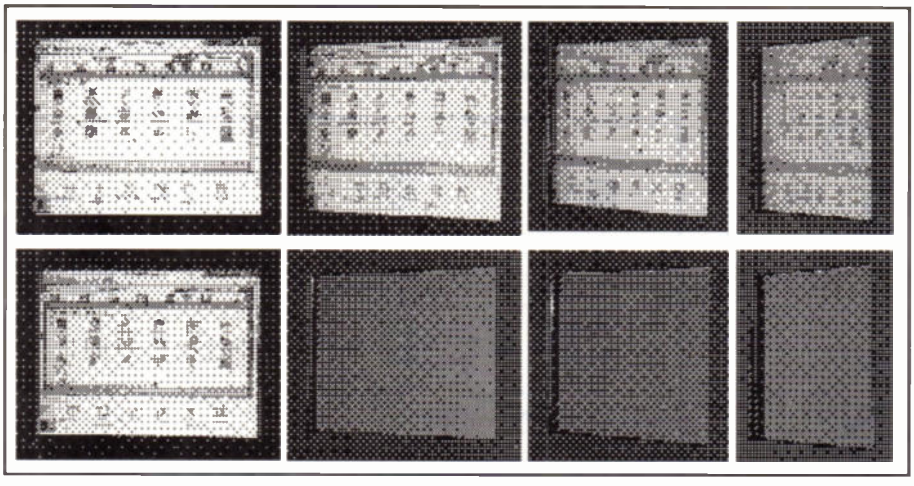


Figure 3. Photographs of the prototype under 0° (left column), 30°, 45° and 60° (right column) for the wide (upper row) and narrow (lower row) viewing angle state. The prototype uses an RM-PSCT cell and an 8.4" AMLCD-syatem from EMCO

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@Internet Xmas Special

UK Gears Up For First Cyber Christmas

Santa is set to head online instead of the high street to complete his Christmas shopping this year. Here we review the results a festive e-commerce survey and take a look at some of the best places to shop online this Christmas.

Almost a third of British Internet users (31%), representing 3.6 million individuals, are looking to use the Internet to do their Christmas shopping this year, according to a MORI poll commissioned by online video and DVD retailer BlackStar at <www.blackstar.co.uk>.

MORI surveyed more than 500 British Internet users on behalf of BlackStar to ascertain their attitudes towards buying Christmas presents over the Internet, and how much they were likely to spend.

Those planning to buy Yuletide gifts online are considering spending around £130 each, representing just over a third of their total Christmas shopping budget of £446.

Britain has an estimated 11.5 million Internet users, a penetration of 25% of the total population. According to BlackStar, if all Internet users who were considering using the Internet this Christmas spent £130 each online, the total expenditure on online Christmas presents in Britain this year would top £450 million.

Jeremy Glover, co-founder and director of BlackStar said, 'Santa has swapped his sleigh for a surfboard this year. This doesn't just represent a step up for Christmas cyber shopping compared to last year, it's a gigantic leap. 1999 will truly be Britain's first cyber Christmas.

Why Online?

The case for shopping online this Christmas is compelling. More than a third (35%) of survey respondents expect to save time and 20% expect to save money. Men are more likely to see the benefits of online shopping than women and are twice as likely to see potential costs savings as a benefit.

Surprisingly, only 5% of respondents plan to shop online to avoid shopping on the High Street with their partner. The most popular goods Britain's Internet users are likely to buy online this Christmas are CDs (27%) and books (27%); followed by cinema, theatre and concert tickets (14%), videos and DVDs (13%), flights and holidays (13%) as well as computer equipment (13%).

Shopping for toys is likely to be contained within the High Street. Most people shopping online this Christmas will do so from the comfort of their armchairs, with only 7% of respondents considering using the Internet to shop from work.

Web sites would have to offer cheaper prices than the High Street and free delivery in order to make online shopping more appealing, said a half and a third of Internet users respectively. They would also be encouraged to shop online more frequently if Web sites had fewer hidden charges such as VAT (28%) and offered assured delivery dates (26%), a no quibbles exchange policy (25%) and a wider range of products than available on the High Street (21%).

Regional Variances

Internet users in the north will spend the most on Christmas shopping this year. Average budgets are £520 in the north compared to £436 in the south and £439 in the Midlands.

22% of Midlanders buying online anticipate spending more than 45% of their total Christmas shopping budget over the Web, compared to 19% of Southerners and 12% of Northerners.

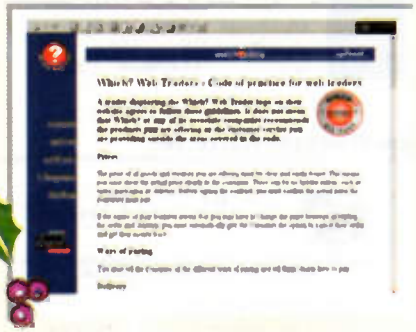
40% of northerners expect to save time using the Internet for Christmas shopping compared to 27% of Southerners and 39% of Midlanders. 27% of Midlanders expect to save money by using the Internet for Christmas shopping compared to 16% of Northerners and 17% of Southerners.

Gender and Age Variances

Men are more likely to see the benefits of shopping online this Christmas, with time (38%) and money savings (25%) viewed as important, compared to responses of 30% and 13% respectively from women to the same questions. People of all ages and social classes are planning to shop online this Christmas.

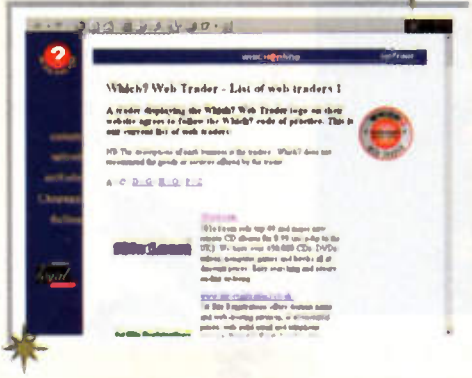
Where to Shop Online this Christmas

With new e-commerce sites launched daily the Internet is a great way to beat the crowds this Christmas. But if you're concerned about shopping at new sites, visit the Which? site at <www.which.net>.



Which? has launched a Code of Practice at <www.which.net/Webtrader/code_of_practice.html> for online traders to encourage the highest possible standards and make sure that users are treated fairly. The code covers a range of e-commerce related issues ranging from advertising to refunds and pricing to guarantees.

Companies that agree to keep to the code can display the Which? logo. There are currently over 200 Web sites signed up to the scheme which can be found at <www.which.net/Webtrader/list_of_traders.html>. Here we profile our 25 favourite Which? accredited sites.



<www.bargainholidays.com>

Bargainholidays.com is Britain's biggest online travel store with over 70,000 travel offers available every day.

<www.bluemango.co.uk>

Blue Mango sells a range of fine foods such as hot mustards, spicy chutneys, jams and marmalades.

<www.bookshop.blackwell.co.uk>

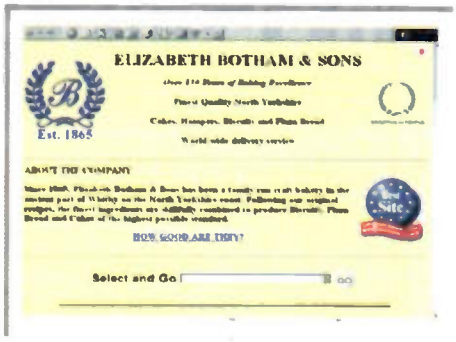
Blackwell's offers over 1.5 million titles, prompt worldwide delivery, secure ordering and fast search facilities.

<www.borroworrob.com>

Borroworrob has over 750,000 album titles for sale with free delivery. Top 10 Chart albums from the UK and US are priced at £8.63 each.

<www.botham.co.uk>

Botham is a family run craft bakery in the ancient sea port of Whitby, North Yorkshire, producing preserves and confectionery.



<www.chipsworld.co.uk>

Chipsworld is a virtual games store, stocking Playstation, Nintendo 64, and Sega Dreamcast products, both new and second hand.

<www.dawson-and-son.com>

A truly excellent site that stocks wooden toys and puzzles for all ages.

<www.entexpress.com>

Entertainment Express sells CD's, Videos and Computer Games at discount prices with free and fast delivery in the UK.

<www.flowersdirect.co.uk>

Flowers Direct deliver flowers direct by courier anywhere in the UK with free delivery.

<www.gamesterminal.com>

Games Terminal is where you can buy new games on PlayStation, PC, Dreamcast and Nintendo. Second Hand games to buy, sell or swap on line.

<www.gardensupply.co.uk>

The Garden Supply Company offers a vast range of gardening products. Significant discounts up to half the usual retail price.

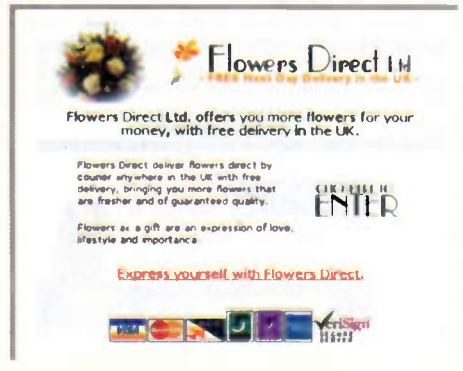
<www.gourmet-world.co.uk>

Gourmet World offers superb food, chosen for its high quality - no preservatives, colouring or genetically modified ingredients.

<www.hutchisons.co.uk>

Hutchisons Direct offers a huge range of electrical products at prices substantially lower than the high street.

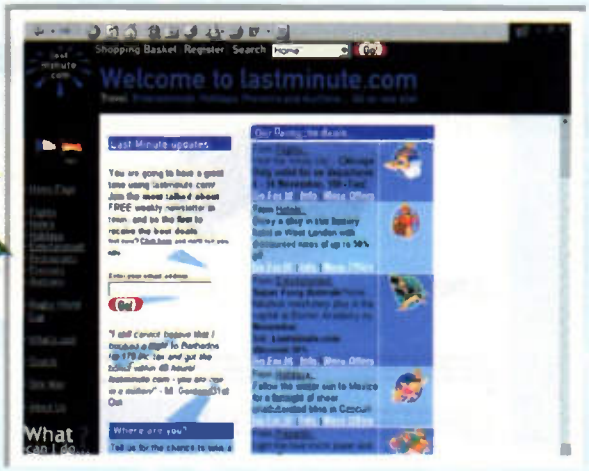
<www.gardengifts.co.uk>



A family run garden centre that offers seeds, bulbs, gift vouchers, garden related books and clothing, quality gardening gifts and garden buildings.

<www.lastminute.com>

Lastminute.com answers all your last minute needs. Exclusive deals on a wide selection of flights, holidays, hotels, entertainment and gifts.

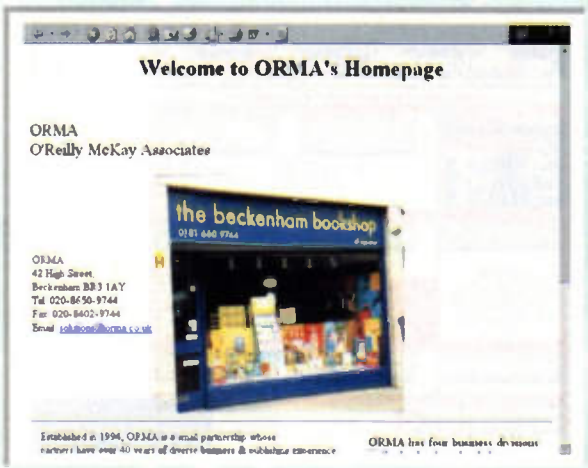


<www.miah-telecom.co.uk>

Miah Telecom stocks an impressive selection of mobile phones, accessories and the very latest mobile data products.

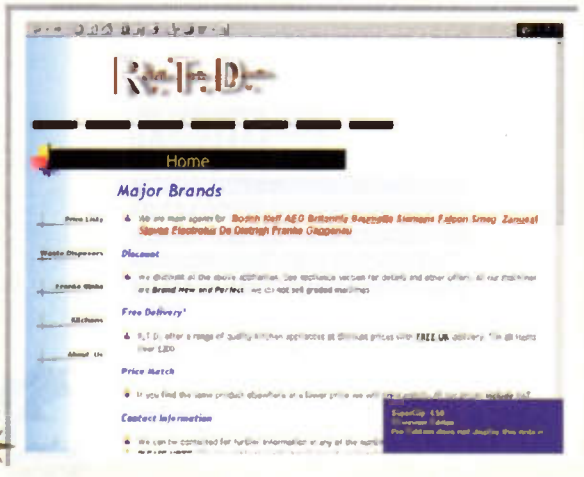
<www.orma.co.uk>

The Internet Talking Bookshop is a specialist mail order service for audiobooks.

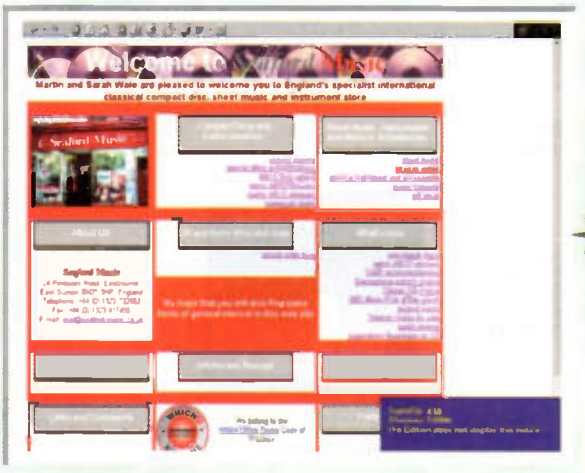


<www.recollections.co.uk>
Recollections, the Web shop for rock music memorabilia.

<www.retail-trade-domestic.co.uk>
Kitchen appliances from manufacturers including Bosch, AEG, Neff, Siemens, Britannia, Smeg and Zanussi.



<www.seaford-music.co.uk>
Seaford Music is a specialist classical compact disc, sheet music, musical instrument and accessories store.



<www.shopscotland.net>
Scottish gifts including silver, amber and pewter jewellery, tartans, clan crests and collectable teddy bears.

<www.singletrack.co.uk>
Singletrack Bikes are specialist Mountain, Dirt, Street, and BMX bike shops.

<www.smalltalk.co.uk>
Small Talk Communications offer discounted Orange mobile phones and related accessories at up to 70% off typical high street prices.

<www.videoshop.co.uk>
The Video Shop has a selection of over 26,000 Videos and every DVD published (Region 2).

<www.maplin.co.uk>
And finally, look out for some last-minute christmas presents on offer at Maplin Electronics.

Burstware to Debut Live Video and Audio

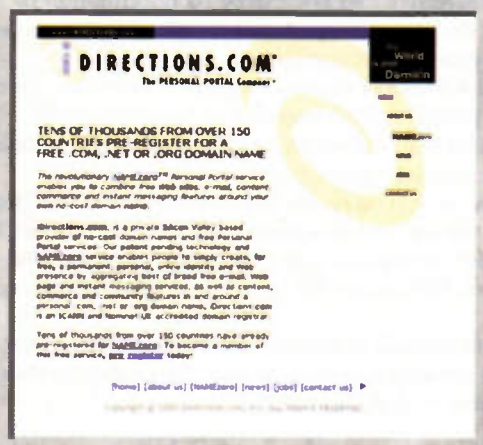
Burstware at <www.burst.com> claims to deliver high-quality, jitter-free video and CD-quality audio across any IP-based network including the Internet.

If this claim is accurate, Burstware would be the first media delivery solution to fully optimise network performance, as well as enabling industry players to greatly improve media quality over both broadband and narrow band.

Internet users will have to wait until the beginning of 2000 to test Burstware's claims when the product is formally launched.

Historically, live or time-based media could only be delivered in two ways: downloading or streaming. Each method has fundamental limitations. While downloading maintains picture and sound quality, the time that it takes to download is prohibitive. The second option, real-time streaming, allows for media viewing but sacrifices quality.

iDirections.com Provide No-cost Domain Registration



iDirections.com at <www.idrections.com> has announced pre-registration for its NAMEzero no-cost domain name and free Personal Portal service. Internet users can pre-register now at <www.namezero.com>.

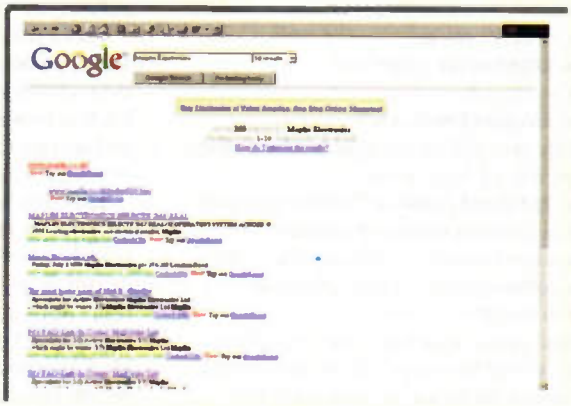
For the first time ever, NAMEzero eliminates the costly registration and hosting fees that people must pay to create a permanent, personal online identity with a .com, .net or .org Web address.

Before NAMEzero, registering a Web Address typically cost £45 or more from Network Solutions for the two-year registration fee, plus additional hosting and e-mail fees.

Once launched, NAMEzero members can choose an easy to remember, permanent Web Address such as <www.yourpersonalportal.com > and e-mail address such as you@yourpersonalportal.com and NAMEzero will pay the .com, .net or .org Web Address registration fees.

Members will also receive free Web Address hosting and e-mail.

Search Site Provides Unprecedented Ease of Use



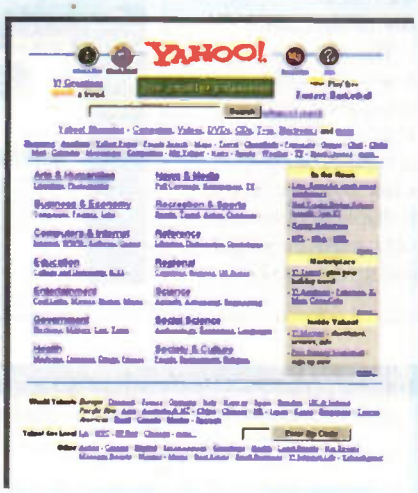
Google, one of the fastest growing search destinations on the Web, has announced GoogleScout at <www.google.com>, a new feature that expands a user's access to related information beyond the results of a basic search query.

GoogleScout is designed to make finding information and navigating the Web faster and easier. Links are provided with each returned Web site result. Clicking on GoogleScout instantly provides users with an additional list of URLs that contain related information.

As the growth of the Internet continues at an unprecedented rate - Forrester Research estimates that 1.5 million pages are added to the Internet each day - the average search returns an overwhelming number of results for users to sort through. Search engines that incorporate 'intelligence' such as Google helps consumers save time by delivering targeted results that narrow the time spent searching the Web.

Yahoo! Pagebuilder Makes Home Page Building Easy

Now even total novice Internet users can create professional-looking, interactive Web pages complete with photos and creative graphics using Yahoo! Pagebuilder at <www.yahoo.com>, an easy-to-use free Internet based home-page builder.



Yahoo! Pagebuilder allows consumers with an Internet connection to quickly and easily build and publish Web pages without installing any software. Once a user launches Yahoo! Pagebuilder, they can choose from one of more than 50 templates or they can create a page from scratch.

Yahoo! Pagebuilder allows people to see what they are building while they work on their pages and use their mouse to arrange and size items before publishing the page on the Web. Yahoo! Pagebuilder also offers users the ability to incorporate several of Yahoo!'s existing features as add-ons to their Web pages, including a Yahoo! Search box and a Yahoo! online presence indicator to notify others that the Web page author is currently online.

Internet.com Increases Page Views by 25% With Acquisitions

Internet.com has acquired TheCounter.com at <www.thecounter.com> and TheGuestbook.com at <www.theguestbook.com>.

Both sites will be incorporated into the Internet.com Network at <www.Internet.com> of 70 Web sites and related Internet media properties, increasing Internet.com's page views by approximately 25% to more than 60 million hits per month.

Total 'views' which include total page views, e-mail newsletter views and e-mail discussion list views are now over 100 million per month.

TheCounter.com and TheGuestbook.com, both based in Stockholm, Sweden are leading providers of site analysis and service tools geared for Web developers and Webmasters.

The sites have grown at astounding rates since their launches last year and now record more than 13 million page views per month in aggregate. TheCounter.com and TheGuestbook.com have more than 80,000 opt-in e-mail subscribers and serve over 400,000 registered subscribers worldwide.

CallWave Announces Free Internet Call Answering

CallWave at <www.callwave.com> has launched a free Internet Answering Machine that makes it possible to hear who's calling while you are surfing the Internet. Internet users no longer need to order, install or pay for a separate telephone line to make sure that they don't miss important calls whilst online.

The Internet Answering Machine works with the Busy Call Forwarding feature of your phone line to answer calls while you are on-line. Once activated, callers no longer get annoying busy signals when you are online. Instead, callers will hear a brief CallWave greeting after which they can leave a short message at the tone - that you will be able to hear instantly.software.

The service which currently available in the US and Canada only is expected to be launched in the UK early in the New Year. A new version of the Internet Answering Machine is being developed for users outside of the US and Canada. Readers that would like to hear about this service when it's available should register their e-mail address at <www.callwave.com>.

The Internet Answering Machine occupies a small window on the user's computer screen while they are online. It displays incoming calls, plays messages and saves them for later.

Evil, First Trojan Programmed in ActiveX

Evil, the first backdoor Trojan programmed in ActiveX, has just been discovered. Thanks to the Internet-based technology it uses, the new threat opens up a whole new field in the development of malicious code that act through the Internet.

Infection can be produced simply by visiting a Web page that features the Trojan. As soon as the page is downloaded, the ActiveX application is executed, thereby leading to the installation of the Trojan on your system.

Another attack route is through e-mail, as the latest versions of e-mail clients support HTML pages. In other words, the code can be activated by opening a message written in HTML. What's even worse, if you have the AutoPreview option enabled on your e-mail reader, infection can be produced simply by receiving the mail message containing the HTML page carrying the malignant ActiveX application.

What Evil does to a victims computer is to execute a previously assigned program. This program may be automatically downloaded from the Internet by the Trojan itself, without the user ever realising what is going on.

The effects depend on the payload assigned to the Trojan. For example, through Evil it is possible to install an Internet Trojan that enables a malicious user to remotely administer the victim computers. This means that he will have total control over that machine.

The only solution to Internet and PC users is to ensure that anti-virus software is kept up to date. Latest updates should be downloaded on a weekly basis.

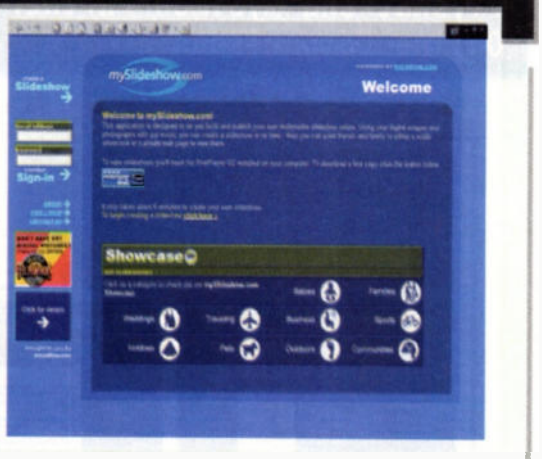
Beyond.com to Acquire SoftGallery

Internet software superstore Beyond.com is to acquire SoftGallery, a European online software reseller offering digitally downloadable products.

SoftGallery at <www.softgallery.com>, based in Paris, brings local publisher and portal relationships as well as local customer acquisition and merchandising expertise to Beyond.com. SoftGallery's strategic marketing partnerships include Wanadoo, a subsidiary of France Telecom, AOL France and Club-Internet.

In March 1999, Beyond.com acquired BuyDirect.com, an online software reseller that focused on software distribution over the Internet. With the acquision of SoftGallery, another leader in digital download technology, Beyond.com is extending this digital strategy into Europe.

Share Photographs Online



Sharing digital photos with friends and family, or anyone with access to the Web, has just been made simpler and more fun with the introduction of mySlideshow at **<www.myslideshow.com.>**

mySlideshow is an online streaming media application that allows users to create and share streaming slideshows from their own digital photographs. Unlike other online slideshow applications, mySlideshow offers users the option to publish their slideshows to the Web for either public or private access.

mySlideshow enables consumers with a Web browser and digital images, such as .jpeg or .gif files, to easily create streaming media slideshows. The creation process is fully automated and does not require users to download any software onto their PC in order to create or share a slideshow.

To share a slideshow, a unique URL is provided to e-mail to friends and family where they can link to the slideshow

HotLinks Launches Service to Organise and Share Links

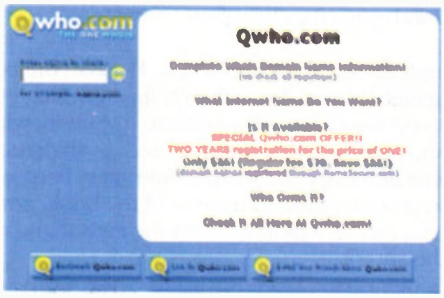
HotLinks has unveiled a new service at **<www.hotlinks.com>** where Internet users can create a personal Web site of their favorite links that can be easily organised, shared and accessed from any computer, anywhere.

Visitors to HotLinks can view the public links of members to get ideas about the best Web sites to visit on the Internet. As HotLinks' membership grows, the company will offer a directory populated by its members' links that will provide a better way for people to find what they need on the Web.

When a member joins HotLinks, the service creates a personal Web site called Personal HotLinks. Members can automatically import links from their own Bookmarks.

Personal HotLinks becomes a member's own directory of notable Web sites where they can add, move, sort and delete links, and organise them into categories. Because members' Personal HotLinks are located at **<www.hotlinks.com>**, they can be accessed from any computer, anywhere.

Qwho.com Tells All About Domain Name Registrations



Qwho.com at **<www.qwho.com>**, a service from NameSecure.com, claims to be only streamlined stand-alone service consumers can use to find out if their favorite '.com,' '.net' or '.org' is available, who owns it and how to secure the name if it's not already registered.

With the deregulation of the domain name industry and the addition of new registrars on the Internet, tracking down information about domain names is becoming more complex.

Like a Yellow Pages directory of domain name status and availability curious Internet namestakers need only go to Qwho.com's Web site to learn a current domain owner's name, phone number, fax, e-mail and mailing address, or alternatively to learn if they can stake their claim to a specific domain name.

Dataquest Says Consumer E-Commerce to Become a £240 Billion Industry

Lessons learnt from the US model of consumer e-commerce are being implemented on a worldwide basis, according to Dataquest at **<www.dataquest.com>**. Analysts estimate the worldwide business-to-consumer e-commerce market to reach £18 billion in 1999, up from £7 billion in 1998. The market will experience explosive growth through 2003 when revenue will surpass £240 billion.

The US is on pace to have business-to-consumer e-commerce in 1999 total £13 billion, and by 2003, the US consumer e-commerce will reach £92 billion. The European business-to-consumer e-commerce market is projected to grow from £3.5 billion in 1999 to more than £69 billion in 2003

Britannica.com Site Launched

Britannica.com has made the entire contents of its Encyclopaedia Britannica available free online at **<www.britannica.com>**. The Web site delivers an integrated presentation of top-quality, relevant content from a wide array of respected publishers, as well as a full line of general information and community services such as e-mail, weather forecasts, and financial market reports.

Britannica.com is a rich source of trustworthy and relevant information on a broad range of topics, including up-to-the-minute coverage of the issues of the day. The site dynamically combines content from highly respected newspapers, magazines, reference works, and Web sites to deliver an unmatched Internet experience.

The stringent editorial standards applied to all content by Britannica.com's staff makes a visit to the site both enlightening and dependable.

Flyswat and mySimon Partner to Offer Online Comparisons

A deal between Flyswat at <www.flyswat.com> and mySimon at <www.mysimon.com> is set to enable consumers to make online shopping comparisons from every Web page they visit.

For example, in an article about 'The Hobbit', the book's name is highlighted as a flycon flyswat link. Clicking on the title raises a pop-up menu featuring a link to mySimon, which will allow the shopper to review prices, as well as shipping costs and shipping time at more than 30 different online booksellers. Flyswat also provides links to reviews of the book, news about the upcoming movie, a biography on the author and other books by the author.

Flyswat is pioneering Deep Navigation - the ability to simultaneously cut through millions of Web pages and link directly to the most relevant information, while quickly surfing from page to page. The company's key product – flyswat - creates automatic links from within the text of any Web page a user visits, directly to related content and commerce elsewhere on the Web.

mySimon allows users to comparison shop from more than 1,700 online merchants for the best deals on more than 10 million different products. mySimon is the premier Internet e-commerce hub focused on comparison-shopping. mySimon's easy-to-use Web shopping service, powered by Virtual Learning Agent technology, helps consumers find the best values for anything sold on the Web.

Yodlee.com Launches Online Organiser

Yodlee.com is reckoned to be the first online service to help consumers manage and access all their personal accounts on the Internet. The service takes personalisation to a new level, providing consumers a consolidated view of their personal information across 12 categories – including e-mail, news, travel, shopping, banking, bills, investments, calendars, mileage programs, and more - all from one central place online. A public beta version of the service is now available, free to users, at <www.yodlee.com>.

Jet Sale Is Largest E-Commerce Transaction

Gulfstream Aerospace has sold its first aircraft over the Internet. With a retail price of $14 million, the purchase of the second-hand Gulfstream IV aircraft, is believed to be the largest e-commerce transaction ever conducted over the Internet.

Capable of flying 4,200 nautical miles and cruise at speeds up to .88 Mach, the Gulfstream IV is the world's best-selling large-cabin business jet. More than 350 Gulfstream IV/IV-SP aircraft are currently in-service worldwide.

Gulfstream sold the aircraft to Elite Aviation, a worldwide charter and aviation management company based in Van Nuys, California. Elite Aviation manages a fleet of 14 corporate jets, including six Gulfstream aircraft, with locations in the US and Europe.

Gulfstream became the first aircraft manufacturer to offer its aircraft online when it launched a Web site devoted to online pre-owned sales in June, 1999. Prospective customers are able to obtain technical specifications and view the pre-owned aircraft in the company's inventory at both the company's Web site at <www.gulfstream.com>.

Using state-of-the-art viewing technology, visitors can visually inspect all aspects of an aircraft's interior, eliminating the time and expense required in travelling to the aircraft's location. A complete maintenance history is also available online. During the first four months of operation, Gulfstream featured 13 aircraft on the site.

Fatbrain.com Revolutionises Publishing with eMatter

eMatter at <www.fatbrain.com> is claimed to be the first-ever secure digital publishing solution that allows authors and publishers to publish and sell their works online, earning royalties of at least 50% on every copy sold.

The eMatter program provides a new global distribution channel for works of all kinds, including books, magazines and articles. In addition, eMatter is ideal for specialty documents, which may include articles that are longer than a magazine but shorter than a book and out-of-print materials.

A growing number of authors and publishers continue to sign up to deliver content, taking advantage of the financial opportunity and delivery options of this new digital publishing model. In the six weeks since the eMatter service was first introduced, more than 3,000 writers - including notable authors Richard Bach, Riane Eisler, Catherine Lanigan, Geoffrey Moore, Ira Pohl and Dan Poynter – have registered to sell their work as eMatter content.

In addition, publishers including CAP Ventures, The Coriolis Group, Fawcette Technical Publications, Hampton Roads Publishing, Macmillan, Marketing Technology, McGraw-Hill, O'Reilly & Associates, Publish Magazine, Red Herring, Salon.com and The Industry Standard also have signed up to provide eMatter content.

eFax.com Launches New Web Site

eFax.com, the Internet provider of fax-to-e-mail services has re-designed its Web site at **<www.efax.com>**.

eFax allows users to get a personal, telephone number that will receive all of their faxes, convert them and deliver them to their chosen e-mail address.

With a new look and navigational system, the site has been re-designed to enhance the user experience on the site and speed the addition of new products.

The new design incorporates enhancements in order to improve the overall user experience of the eFax.com Web site including graphical site changes and a simplified user interface.

In addition, there is a new, intuitive 'remember me' option where users need only type in their eFax number and PIN once. For future use the user can simply click on the 'remember me' button in the 'My Account' section.

AOL Calls on UK Companies to Join Battle for Unmetered Internet Access

AOL Europe at **<www.aol.co.uk>**, the leading pan-European multinational Internet, online and e-commerce service provider, has issued a call for UK business leaders to unite behind the company's campaign against the high cost of metered Internet telephone calls charged by the minute.

Presenting the keynote speech at the Jupiter Consumer Online Forum in London in October, AOL Europe's president and CEO Andreas Schmidt warned that the UK economy will suffer unless metered per-minute telephone tariffs - cited by many industry experts as the greatest barrier to e-commerce growth in the UK - were replaced with a flat-rate Internet telephone pricing structure.

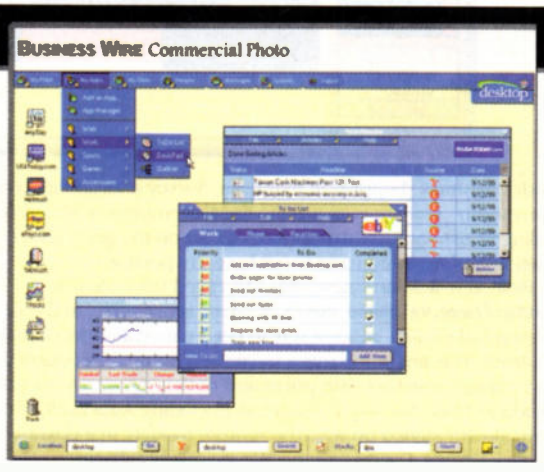
UK consumers are charged a variable tariff of up to 4 pence per minute at peak rates for the cost of dialling up an ISP. A survey of 11,000 AOL members found that 92% of respondents said per-minute telephone call costs were the biggest single factor dissuading them from spending more time online.

UK Internet users currently spend 17 minutes a day online, just one-quarter the amount of time spent online by users in the US. AOL Europe believes that continuing low Internet usage levels fundamentally undermine the UK Prime Minister Tony Blair's vision of the UK at the centre of the European e-commerce revolution.

Schmidt demonstrated how, when AOL introduced a flat-rate pricing structure in the US in 1996, usage doubled within three months to the present level of an average 30 hours a month.

"If you let consumers stay online as long as they want, you will turn the Internet into a consumer mass medium - where people are comfortable about buying online. If you leave the clock ticking, the e-commerce revolution will not happen. Who would buy goods on a High Street where shoppers were charged for every minute they spent looking through shop windows and browsing the shelves?"

Desktop.com is First Free Internet Desktop



Desktop.com at **<ww.desktop.com>** has unveiled the first Internet desktop, a free Internet service that allows users to quickly and easily create their own desktop online for integrating their favorite sites, services, and files.

Desktop.com is a new Internet home, a user's customised view to the Web and his or her stored information that can be accessed from any net-connected PC. Logging on from anywhere is quick and easy - no downloads, plug-ins, or installations required.

Users can store their personal files and their favorite Web sites appear as icons on their online desktop. These icons can be arranged in any fashion or dragged and dropped into folders.

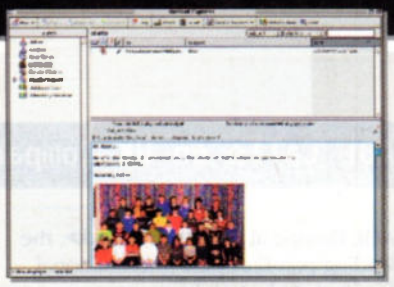
Desktop.com will automatically log users into Web sites that require passwords, avoiding repetitive typing of usernames and passwords. When users initially sign up for Desktop.com they will be greeted by a default desktop that shows them an example of how an online desktop can be arranged.

Later this year, Desktop.com has said that it will roll out the platform's application programming interface (API) to the public, enabling anyone to write an application that runs on Desktop.com.

Free at last

The UK's first fully free Internet service providers opened its doors at the beginning of November, offering free accounts along with a free 0800 dial-up telephone access number to users. CallNet0800 is the Internet service, launched by North American Gateway (NAG), which hopes to attract customers to the parallel discounted telephone service (offering 30% discounts on all telephone calls) by offering Internet access via the 0800 number. Whether it works remains to be seen, but at the time of writing — just three days into the new service — the 0800 system hasn't yet been able to keep up with demand. You can view the portal site, at: **<http://www.callnet0800.com/>** and register (or, at least, attempt to register) there.

Email Looking Good



Mac users have much to tryout on the email front this month. Microsoft has just released the latest Mac version of its free email program Outlook Express. Version 5 adds several snazzy new features such as Address AutoComplete (a feature that's been a long time coming), a much better method of handling email attachments, a powerful Advanced Find ability, a junk mail filter, and the ability to synchronise contacts with a Palm handheld personal digital assistant. Multiple mail accounts are handled much better than before, and support is now built in for POP, IMAP and Hotmail accounts. If you use an earlier version Outlook Express for your email, then you should definitely upgrade to this latest version, although it is a massive download from the Microsoft Website, at **<http://www.microsoft.com/mac/>**, so it might be worth waiting a month or so until it starts to appear on magazine cover disks.

Site Survey

The months destinations

With Christmas shopping in mind, Site Survey is all about ecommerce this month - you know, that thing the Government is always on about, telling British industry that it needs to get on the gravy train before the train leaves the station and we all have dry potatoes.

First off is Walmart's new sales site, called Value Mad, at: **<http://www.valuemad.com/>**. Walmart is of course, in the process of buying Asda, so it's an ideal way to get a national outlet onto the Internet. The aim of the site is to create a listing of products that anyone can request, together with prices and outlets where you can buy the products from. Several retail outlets (including Asda itself, of course) have already signed up with the venture though, in a possible fit of sour grapes, Dixons, Currys and the like are notably absent.

Another venture aims to gather together as many retail outlets as possible into one portal Website, to ease the burden of shopping altogether. ShopsOnTheNet, at: **<http://www.sotn.co.uk/>** has literally thousands of shops worldwide (with over 1300 alone from the UK). You can search for products online and make your purchases directly. Value Mad and ShopsOnTheNet aim to locate home products for you to buy, but for bigger ones like cars you'll have to go elsewhere. Vauxhall has a new site open for business, where you can locate the car of your dreams (well, at least you can if it's a Vauxhall), at: **<http://buypower.vauxhall.co.uk/>**. Vauxhall's BuyPower site includes the ability to find a car you want, get a quote for a car you want to trade-in, buy your new car, and have it delivered within a week.

If it's the smaller pleasures in life you're after, like CDs, try 101cd, at: **<http://www.101cd.com/>**, where you'll find just about every CD you could ever wish for, at incredibly low prices. If videos are more your scene, try BlackStar, at: **<http://www.blackstar.co.uk/>**. And, if you've got a bright and shiny new DVD player from Value Mad, or a Pentium-toasting Mac from the Apple Store, take a look at DVDplus, at: **<http://www.dvdplus.co.uk/index2.htm>**, where you'll find bargains galore on DVDs.Long-time television shopping store QVC has its own Website too at: **<http://www.qvcuk.com/>**, where you can browse and buy the very same products that are displayed on the QVC television channel. Of course, ecommerce is not just about buying things on the Internet. There's nothing to stop anyone selling things that way too. Amazon, the Internet-based bookshop, has recently launched a new service called zShops, where users can actually sell things on the Amazon Website. Just log onto the Amazon site, at: **<http://www.amazon.co.uk>** and click the Sell Items button at the top-right of the window. There's a small commission fee when you sell your items, but that's easily offset by the fact that your products have a prospective worldwide shop window based on the Amazon dealership.

A new shopping site - so new it's not going online until the beginning of December - is ybag, at: **<http://www.ybag.com/>**. This will give the same level of functionality as ShopsOnTheNet, but aims to make selling a product for a supplier as easy as buying is for customers.

In short, ecommerce is actually alive and well in Britain, despite what the Government tells us. What's pretty obvious is that the ecommerce gravy train is probably already pulling away from the station - those companies which don't get ecommerce rapidly on board will simply be left standing on the platform, as the Internet takes over as the natural place to locate and buy things this Christmas, and forever more.

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.

December 1999

29 Nov to 1 Dec 99. TMA32 - Telecommunications Managers Assoc Exhibition, Brighton Centre, Brighton. Tel: (01372) 361000.

7 to 8 Dec. Digital Signal Processing & Data Acquisition, Sandown Exhibition Centre Esher. Tel: (0208) 547 3947.

7 to 9 Dec. Online Information, Olympia, London. Tel: (01865) 388 000.

19 Dec. Scottish Computer Fair, SECC Glasgow. Tel: (01706) 299 902.

January 2000

26 to 27 Jan. Computer Trade Show, NEC, Birmingham. Tel: (0208) 541 5040.

February 2000

2 to 3 Feb. Legal IT 2000, Business Design Centre, London. Tel: (0207) 221 1155.

8 to 9 Feb. Accounting IT, G-MEX Centre, Birmingham. Tel: (0171) 221 1155.

9 to 10 Feb. Communications for Business, Barbican Centre, London. Tel: (01923) 676 867.

9 to 10 Feb. Softworld in Human Resources & Payroll, Wembley Exhibition Centre, London. Tel: (0181) 541 5040.

10 Feb. Video Forum - Video Equipment Trade Show, Wembley Exhibition Centre, London. Tel: (01273) 836 800.

15 to 16 Feb. Digital Mapping Show, Barbican Centre, London. Tel: (01883) 652 661.

16 to 17 Feb. Image Processing & Optic Technology, NEC Birmingham. Tel: (01822) 614 671.

22 to 24 Feb. PC@HOME - Small Office & Home User Computer Show, Donington Exhibition Centre, Derby. Tel: (01895) 630 288.

March 2000

6 to 9 March. Electrex 2000 - International Electrotechnical Exhibition, NEC Birmingham. Tel: (01483) 222 888.

9 to 10 March. Softworld in Accounting & Finance, Olympia, London. Tel: (0181) 541 5040.

14 to 16 March. Service Management Europe, NEC Birmingham. Tel: (0208) 232 1600.

29 to 30 March. Softworld Supply Chain, NEC Birmingham. Tel: (0208) 541 5040

April 2000

30 March to 1 April. Apple Expo - Apple Platform Show, Olympia, London. Tel: (0117) 904 9388.

4 to 5 April. Electronic Design Solutions, NEC Birmingham. Tel: (0181) 910 7934.

4 to 6 April. NEPCON - Electronics & Semiconductors, NEC Birmingham. Tel: (0208) 910 7910.

10 to 13 April. Automation & Robotics, NEC Birmingham. Tel: (01737) 768 611.

10 to 14 April. Engineering Lasers, NEC Birmingham. Tel: (01737) 768 611.

11 to 13 April. Infosecurity - Info Security & Network Management, Olympia, London. Tel: (0208) 910 7910.

18 to 19 April. Government Computing Conference & Exhibition, Business Design Centre, London. Tel: (0207) 608 0900.

18 to 20 April. WebCom 2000 - Corporate Intranet Technology, Olympia, London. Tel: (0208) 742 2828.

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?

Internet Conference Highlights Challenges for e-Commerce

For companies attempting to build successful businesses on the web in the new millennium, Internet performance and quality of service are the top priority. This was the key finding of the Global Internet Performance Conference held in the US in October.

Keynote, the Internet performance authority, hosted the Internet industry's first conference focused solely on Internet performance and Quality of Service (QoS) issues, challenges and solutions.The conference highlighted the fact that providing an exemplary online user experience is a serious challenge faced by a growing cadre of e-commerce companies hoping to build leading Web-based businesses in the new millennium.

Several industry luminaries participated in the event, including Patricia Seybold, founder and CEO of The Patricia Seybold Group, who kicked off the conference with a keynote address regarding the paramount importance of paying attention to online-customer loyalty.

Additional featured speakers included Umang Gupta, chairman and CEO of Keynote and Bill Finkelstein, Senior Partner, Internet Business Solutions Group of Cisco Systems, who spoke about the challenges of achieving end-to-end service quality on the Internet.

Orange Boss Gives Vision of a Wire free Internet

In a keynote address to the Telecom 99 conference forum held in Geneva in October, Hans Snook, Orange's chief executive, stated that the power of the Internet will only be realised when users are able to access it wherever, however and whenever they want to – and as such this can only be delivered on a wire free network.

Snook believes that, despite its exponential growth, Internet adoption has been restricted - until now access is limited to fixed wires. Orange believes that wire free access will be the key medium for the future growth of the Internet. It believes that by 2005 the number of wire free devices with Internet access will exceed the number of fixed ones.

"If you can deliver the content of the Web without the need for a wired connection, then infrastructure and delivery issues no longer matter; there will be no digital apartheid based on the lottery of where you live - connected versus the unconnected," said Snook.

"I believe that the wire free network will become the infrastructure of nation-wide digital delivery in the future. The wire free network will enable the true democracy for a connected society. Orange will be among the pioneers to bring true mobility to the Internet for the first time," added Snook.

Orange is developing advanced radio and data compression technologies so that the Internet becomes genuinely accessible to one and all on a wire free terminal.

In addition to deploying high speed circuit switched data (HSCSD), it is also working exclusively with Strathclyde University to deliver advanced data compression technologies.

At the beginning of October, Orange announced a strategic partnership with the Sun-Netscape Alliance as part of its strategy to be a major Internet service provider and central portal to the Web.

Orange intends to be one of the first networks in Europe to launch a range of multimedia services, using the Wireless Application Protocol (WAP) open global standard. Orange is also pioneering the development of the world's first GSM videophone, which it will unveil later this year and launch commercially in the second quarter of 2000.

Anywhere, Anytime Access is Driving Service Provider Industry

3Com Chairman and CEO Eric Benhamou said that consumer demand for high speed access to information anytime and anywhere will help drive increasing demand for the network service provider (NSP) industry.

In a keynote address to the ISP conference ISPCON 1999 conference in San Jose, US, at the end of October, Benhamou said that service providers will have to meet growing consumer demand for wireless access to the Internet and corporate networks beyond the office and the home.

"Service providers will have to add significantly more wireless services, not as a supplement to, but as an integrated part of users' connected lifestyle," Benhamou said.

"Mobile access to information is quickly becoming a requirement for many users, and service providers will need to accommodate this personal and professional shift."

In addition to benefiting from increased demand for mobile access, service providers also stand to gain from the trend toward enterprise outsourcing of network services and the availability of complete solutions bundled from separate vendors.

Service providers that initially focused on providing only traditional Internet access are now offering enterprises services that deliver a higher level of connectivity and management of network traffic.

"Since more complete offerings are now available, more organisations, especially the small-to-medium enterprises, are outsourcing their IT infrastructures to service providers," Benhamou said.

"And this is only a stepping stone on the way to full end-to-end offerings that will include management of an enterprise's converged network and desktop applications."

Under this evolving landscape, Benhamou believes that a new business model based on jointly provided offerings that deliver a multitude of enterprise solutions has become more effective.

ASTROBIOLOGY

PART 3

In the final part of this series David Clark looks at the science and technology behind the search for signs of extra-terrestrial life, and at where this life might be found.

Astrobiology has given new impetus to the exploration of space and in many ways we are about to step into a new era. There are a range of projects and missions currently underway or planned for the near future, focused on the search for life on other planets not only within our own solar system but also in deep space. The methods of obtaining data by these projects can be broadly divided into three groups:

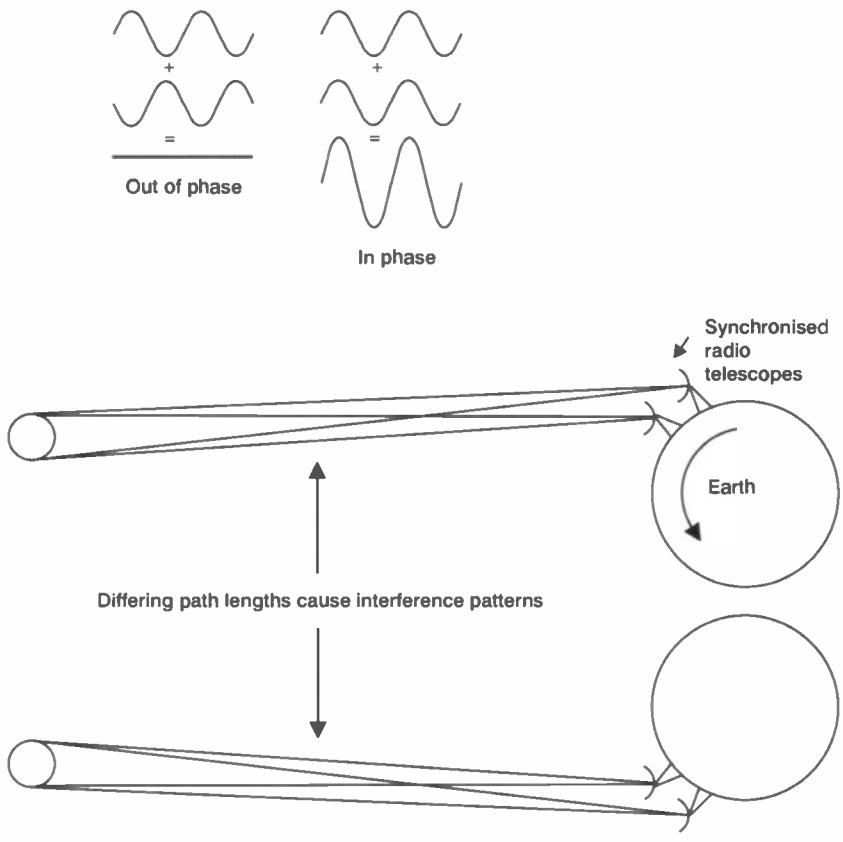
Earth Instruments
Remote Probes
Sample Return Missions.

Beyond The Solar system

There are many Earth based instruments, optical and radio telescopes, which have been gathering information for many years; one such project looking for extra-terrestrial life is the SETI project (Search for Extra-Terrestrial Intelligence) which scans the skies for radio signals which could not be created by natural phenomena but which must be being beamed at Earth either by a technically advanced civilisation deliberately trying to contact us, or as a by-product of their ordinary activity, such as our TV transmissions or military defence activity. In the 1960s attempts were made to quantify the likelihood of the possibility of this kind of contact, resulting in a formula known as the Green Bank equation. This is based on factors such as the average rate of star formation in a galaxy, the proportion of stars with solar systems, the proportion of solar systems with intelligent life etc; the uncertainties in this are enormous and as yet nothing has been heard.
Recently improved technology has increased the likelihood of finding more definite evidence for the existence of Earth-like planets in other galaxies, and of course extending the search to include any form of life, however primitive, inevitably increases the chances of success. A great deal of information can be gained through optical, spectrometric and interferometric measurements made away from the limitations (natural and pollution induced) of the Earth's atmosphere, and these are based primarily on infrared (IR) and interferometry techniques. Probably the best known base for these instruments is the Hubble Space Telescope, but this is only the beginning. Other projects of this type planned in the next ten years include the Space Observatory For Infra Red Astronomy (SOFIA), the Space Infra Red Telescope Facility (SIRTF), the Kepler Mission, the Space Interferometry Mission (SIM), the Next Generation Space Telescope and the Terrestrial Planet Finder (TPF) project.

Using the two basic techniques for IR spectroscopy and interferometry this group of projects will gain information on star and planet formation, the origin and evolution of the elements and molecules associated with life, and the constituents of the atmospheres of the planets of other stars. Distances are such that planets cannot be observed directly and so indirect methods are used; these rely on the paths of stars 'wobbling' due to the change of position of the centre of mass of a system of small planets orbiting a large star. Interferometry can detect these 'wobbles' and has already demonstrated the existence of one such system; there appears to be at least three planets

Figure 1 - The Principle Of Interferometry



Interferometry is a technique that uses the principle that two waves arriving at the same point in phase add, and out of phase ones cancel each other out. For light waves this means either brightness or darkness. Light is a form of electromagnetic radiation with a certain very small frequency range, and the same principle applies to visible and non-visible radiation. Using this principle large distances and small angles, or the separation of two point sources, can be measured very accurately, to the order of the wavelength of the radiation that is involved. By using two or more synchronised telescopes and exploiting the rotation of the Earth, interference patterns caused by the slightly different path lengths of the radiation from distant stars can be recorded; powerful computer processing generates distance information from this data.

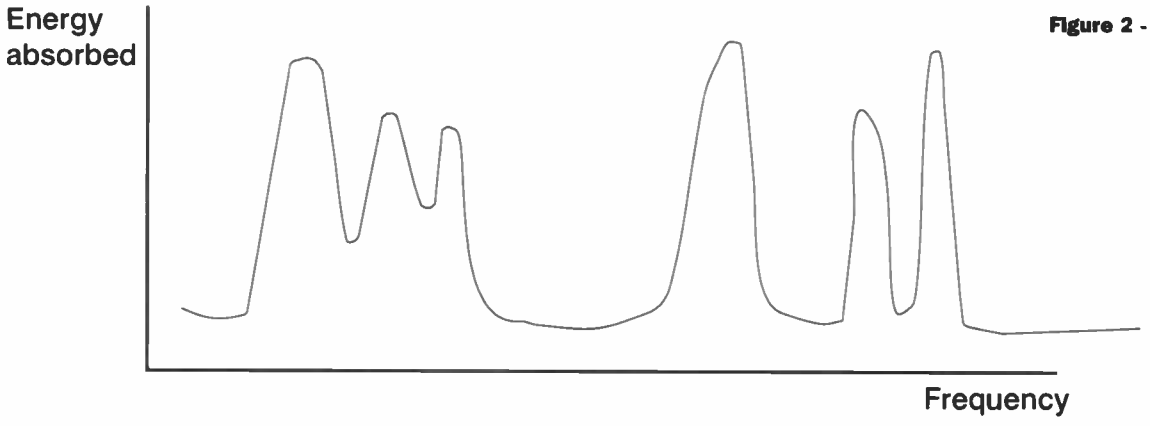
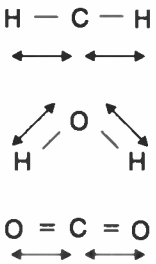


Figure 2 - IR Spectra.



Different types of chemical bonds absorb energy at different frequencies

As well as use for imaging (IR light is not scattered by dust in space to the same degree as visible wavelengths) IR spectra can provide details about the molecular composition of gases. However the same reason that makes the technique useful means it cannot be used from the Earth's surface as atmospheric water vapour and gases absorb the radiation. The bonds between atoms in a molecule vibrate because they have thermal energy. Each type of bond vibrates at a different frequency due to the different masses of the atoms and the strength of the bond between them. These frequencies lie in the infrared (IR) region of the electromagnetic spectrum, and by analysing the IR spectrum of a body, or gas, the types of bond present can be found and hence the types of atom present.

orbiting the star Upsilon Andromedae, 44 light years away. Analysis of the infra-red (IR) spectra of these planets should provide evidence of whether habitable conditions are present ie is there water, but should also give an indication of the presence of any life through the effect of any biosphere on the atmosphere and surface, for example the presence of carbon dioxide and oxygen.

IR Spectra

The significance of IR spectroscopy is that not only is IR radiation less scattered by interstellar dust than visible light, but also that its frequency range covers those values associated with the energies of chemical bonds, in particular those of the gases composed of hydrogen, carbon, oxygen and nitrogen, the compounds of particular interest to astrobiology. This of course includes water vapour, which means that the work cannot be done from the Earth's surface as these frequencies are absorbed by the Earth's atmosphere; the projects mentioned above are all space based except the SOFIA one which is based on high flying aircraft. The techniques themselves have been known for many years, the technological leaps being made are based on improved sensitivity and resolution because of the materials used, for example charge coupled devices (CCDs) designed to be specially sensitive at the frequencies of interest and IR detectors which need to be cryogenically cooled with frozen nitrogen ice. Powerful computers enable the rapid extraction of useful information and images from the data obtained.

Remote Probes and Sample Return Missions

Knowing that such planets exist and where they are does not make it any easier to reach them. At 44 light years away Upsilon Andromedae is effectively physically unreachable for the time being! However there are several exciting destinations much closer to home which are more accessible and which are likely to hold some surprises according to recent discoveries. Both remote probe and sample return missions to comets, asteroids, planets and planet moons are either already under way or are planned. These investigations take the form of flypasts, planet surface rovers and under-surface probes.

Miniaturisation

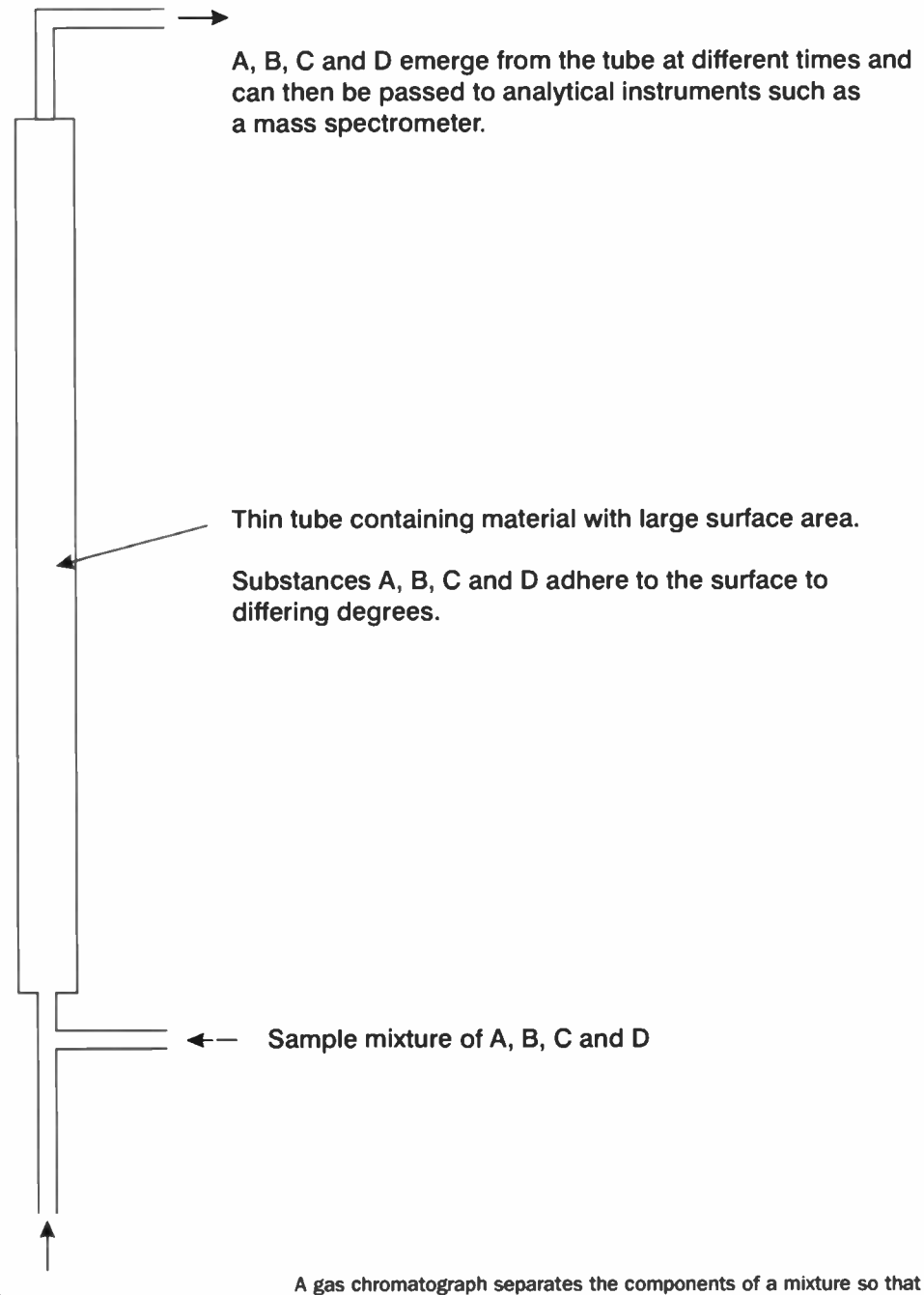
Making instruments small is obviously the key to getting information 'at source' as well as getting samples back to Earth for analysis. Modern technology is such that complete analytical instruments for example spectrometers, chromatographs and imaging systems can be made small enough to launch into space, and even a 'laboratory' that can analyse DNA has been made in a miniature version. Work is underway to develop instruments that can be operated by remote control in hydrothermal vents, undersea and in caves, or in drilling systems, and also mobile systems that can move about on or under land and liquid environments. However, there are obviously difficulties in controlling these in 'real time' due for example to the time delay in sending and receiving signals, so some kind of automated or 'intelligent' system will be useful. Despite this, the success of the recent Mars rover demonstrates what can already be achieved.

Destinations

So where are these sophisticated instruments headed? Effort is concentrated in the search for more or less Earth-like environments, even if extreme, and carbon-based systems, as it is difficult of course even to know what to start looking for in a non-carbon based system as we have no experience of it. Thus the search for liquid water is a prime interest, particularly as some scientists believe that one day, through choice or necessity, man may leave the Earth and set up 'home' on another planet. A source of water is a pre-requisite here. Obtaining that on another planet is a long way off, though there seems to be potential sources quite close to home on the Moon and Mars, and possibly on Jupiter's moon Europa.

Titan, Saturn's moon, has a thick nitrogen based atmosphere, like that of the Earth, and an organic (carbon-based) chemistry. Jupiter has an atmosphere of hydrogen, helium, methane, ammonia and possibly water vapour like the atmosphere of primitive Earth, and Venus, although the surface is very hot, has clouds that are very Earth-like and contain carbon dioxide, possibly water vapour, and, with plenty of sunlight, the conditions necessary for

Figure 3 - Gas Chromatography.



A gas chromatograph separates the components of a mixture so that each component can be individually identified.

photosynthesis. Could this be the place where a non-carbon based life might exist?

The destinations and instruments are examined in the following sections; a description of the equipment is placed where it is first mentioned, but of course a particular type of instrument will be used on more than one mission depending on the particular area of interest and the limitations of the spacecraft payload capability.

The Moon

The Moon would seem to be a neglected body for analysis in recent years, but the search for water and valuable minerals, and the possibility of using the Moon as a 'jumping-off' point for exploration of the solar system has brought it to the forefront again. The Lunar Prospector mission is searching for (and finding) evidence of water at the Moon's poles. The key to the detection of water on the Moon is the neutron detector carried by the Prospector craft which scans the Moon's surface. This is the first time a neutron detector has been used to search for water on an interplanetary mission, and so there is no 'reference' to say exactly how accurate this method of detecting water is. Estimates indicate that there could be up to 26 billion gallons present; however this is perhaps not the good news it might seem; the water appears to be in the form of ice crystals spread not only over most of the Moon's surface (at the poles and in meteorite craters) but possibly up to two meters deep as the result of meteorite impacts. There is a further uncertainty in that the neutron detector only detects water up to about a half metre deep.

The Neutron Detector, or Neutron Spectrometer (NS), is used alongside a Gamma Ray Spectrometer (GRS) and as might be expected, these two devices detect gamma rays and neutrons, and measure the energy they have; this energy is a distinct indicator of which type of atom they were emitted from. This enables a map to be made of the abundance of different elements on the lunar surface. In particular, they enable the detection of water since the GRS also detects a different type of neutron to the NS, and so it can be determined whether the neutrons are from water or some other source.

Another instrument used on the Moon is the Magnetometer (MAG). The magnetometer detects the magnetic field around itself and hence can be used to measure the magnetic field of the body it is orbiting i.e. an asteroid or the Moon. The device used in spacecraft measures the field in three different directions and so measures its direction as well as strength. Its principle of operation is the familiar one of the induction of a current in a wire as it passes through a magnetic field.

An Electron Reflectometer (ER) is a further device used on the Moon and can measure magnetic field at a distance i.e. the magnetic field at the surface of the body it is orbiting. This is done by measuring electrons reflected off the surface by the magnetic field. Knowledge of a body's magnetic field gives information about its internal structure and hence provides clues about its origin.

The Doppler Gravity Experiment (DGE), an experiment rather than instrument, measures, from Earth, the speed at which the Lunar Prospector orbits the Moon, using the Doppler principle of measuring the change of frequency of Prospector's radio transmission as it moves towards or away from Earth. Since it is the Moon's gravity that keeps Prospector in orbit, any changes of speed over short distances must be due to local changes in the Moon's gravity. By mapping this gravity (gravity is a consequence of the mass of a body) local variations in mass can be determined which gives clues about, for example, the thickness of the lunar crust.

Yet another instrument deployed on the Moon is the Alpha Particle Spectrometer (APS). This device obviously measures alpha particles, or more particularly the energy they have. As with neutrons and gamma rays, this energy is unique for the atom that emitted it, and this technique is used to detect the radioactive gases 'leaking' from the surface

giving an indication of what might be occurring below the surface.

Asteroids and Comets

Asteroids and comets seem to be rich in organic material, and both flyby and sample return missions are underway to these types of body. These missions will involve for the first time a launch from an aircraft and the first orbits of non-planetary bodies. The NASA Near Earth Asteroid Rendezvous (NEAR) project carries a Multispectral Imager System (MSI), an X-ray/Gamma-ray Spectrometer (XGRS), a Near Infra-Red Spectrometer (NIS), a Magnetometer and a NEAR Laser Rangefinder (NLR). The XGRS measures the abundance of the elements magnesium, aluminium and silicon, and the Near-Infrared Spectrograph measures the spectrum of reflected sunlight. The MultiSpectral Imager uses a CCD for detecting visible and near IR radiation, and is coupled with seven different filters which will enable different iron silicates to be distinguished from each other. Used together these instruments will enable the composition of surface materials on the asteroid Eros to be established, hopefully indicating where it originated.

The NEAR Laser Rangefinder is a relatively straightforward device that uses a laser to measure distance and which will be used to measure the altitude of the spacecraft from the asteroid surface.

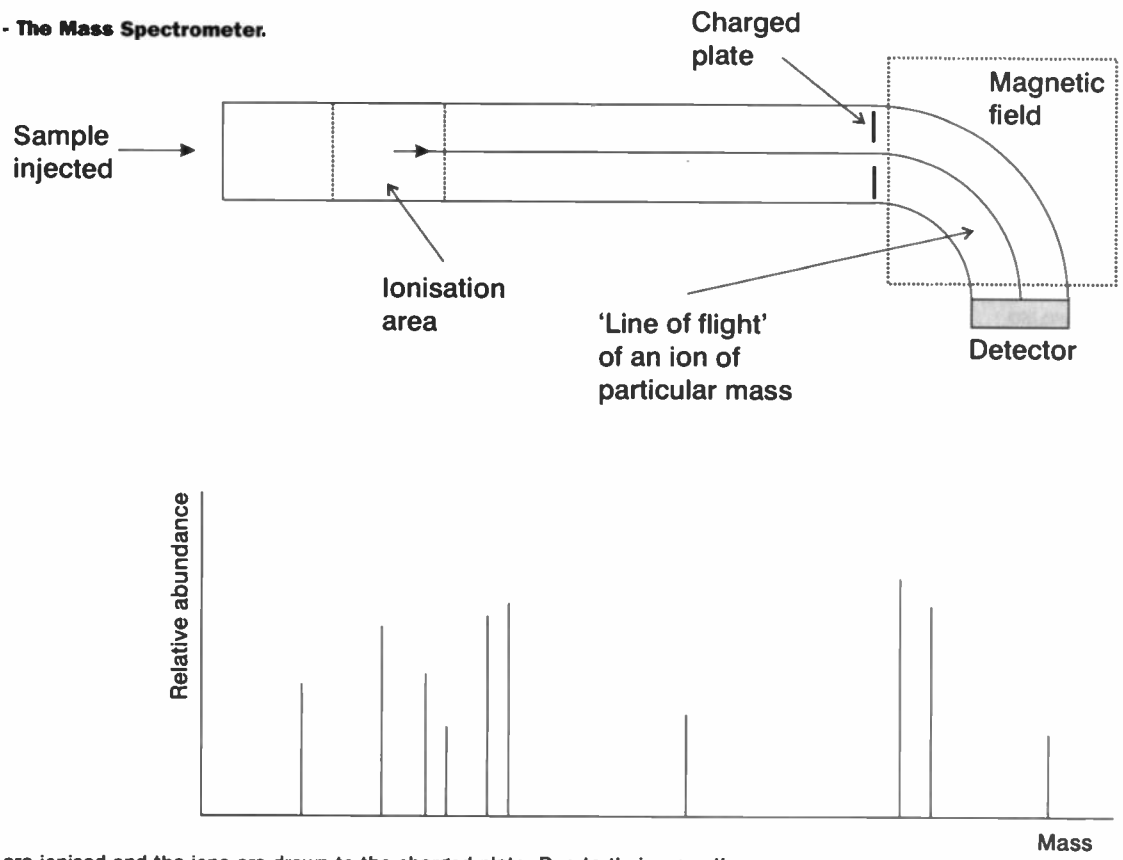
Wirtanen and Wild-2

The Rosetta mission is a European Space Agency (ESA) project, which intends to land a rover on the comet Wirtanen as it orbits the solar system. The Stardust project will capture dust grains and volatile particles from the surface of the comet Wild-2 and return them to Earth for analysis, and there are various encounters planned with the different types of comet in existence. These are the active comets, dormant comet nuclei, possible fragments of destroyed planets and material which is thought to be the primitive material from which the planets were initially formed. The Japanese Institute of Space and Aeronautical Science (ISAS) Muses-C project is a sample return mission currently being planned, this one being to the asteroid Nereus.

Titan

Titan is the largest moon of Saturn, and the second largest moon in the solar system (the largest being Jupiter's Ganymede), with a diameter of around 3200 miles (the diameter of Earth's Moon is 2160 miles), and is of particular interest because it has an atmosphere of nitrogen, methane, hydrogen, carbon monoxide and carbon dioxide, plus some of the organic gases. The atmospheric pressure is similar to that of Earth (1.5 atmospheres) and the surface temperature, at around -179°C is not that extreme in astronomy terms. All this and the fact that solar ultra-violet light falls onto the rich atmosphere means that many organic compounds have been detected. It seems there may also be an extensive liquid ocean and these conditions may well closely match those of the Earth when life started four billion years ago. Might life forms be frozen somewhere on this moon? The Cassini mission to Saturn and Titan intends to release a probe, the Huygens probe, in November 2004, which will analyse Titan's clouds, atmosphere and surface. The probe, nearly three metres in diameter, carries a laboratory that will analyse not just temperature and pressure and physical parameters but also the organic chemicals encountered using on-board instruments such as a gas chromatograph and a mass spectrometer. Gas chromatography is a simple but very sensitive method of separating small traces of different substances in a sample which can then be analysed by a detector dedicated to a particular substance, or passed to a mass spectrometer for a more complex analysis. The mass spectrometer is a device that is capable of identifying a wide range of substances by virtue of separating them by electric and/or magnetic fields. In a similar way to atoms being identified by the different energies of sub-atomic particles or radiation emitted by them, gases, organic molecules, ions, and even isotopes of the same

Figure 4 - The Mass Spectrometer.



Samples are ionised and the ions are drawn to the charged plate. Due to their mass they pass through a hole in the plate and then are deflected by a magnetic field to different degrees according to their mass. The ions are effectively 'sorted' according to mass. By comparing the detector output to reference spectra the ions present can be determined and so the structure of the molecules in the original sample can be inferred.

material can be separately identified because of their unique paths through a magnetic or electric field. Using this device organic molecules, concentrations and types of gases, ions and different isotopes of hydrogen, carbon, nitrogen and oxygen can all be identified. It can also be used to determine the age of minerals from the relative concentrations of radioactive constituents.

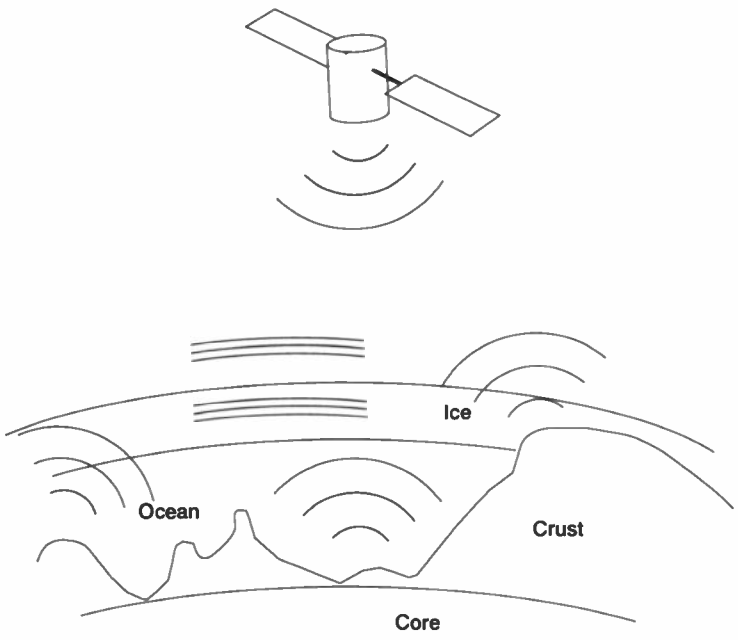
Mars

Exploration of Mars is already extensive; the Mars Global Surveyor and surface rover Sojourner has been collecting images and data since July 1997. It is believed that there was water on Mars in its early life and that there may have been extensive oceans, so based on geological evidence on Earth that micro-organisms evolved on Earth in a relatively short time (less than a billion years), life could have evolved on Mars and then become extinct. If this were the case there should be some fossil evidence in sedimentary material in what were once ocean and river beds. It is also believed there may be water beneath the surface of Mars, and again knowing that life on Earth can exist in harsh conditions there may be some life forms still in existence on Mars. Additionally the Martian atmosphere, although thin, contains a large amount of carbon dioxide plus nitrogen and water vapour.

Experiments already carried out on the surface of Mars in the search for organic material have been inconclusive, so there are plans to return Martian material to Earth to analyse for possible fossil and organic evidence. Recent claims that 'fossilised' bacteria were found in a Martian meteorite are disputed, one of the grounds being the size of the structures, although Earth bacteria size ranges enormously from 20nm (thousand millionths of a metre) to 0.75mm. Eventually, it is hoped to be able to send equipment to Mars which is capable of drilling for samples below the surface.

The next generation of instruments that will go to Mars includes a Mini-Thermal Emission Spectrometer (Mini-TES) on the Mars Surveyor '01 Lander due to reach Mars in January 2002. This is one of a package of instruments composing the Athena Precursor Experiment (APEX) which will analyse the Martian surface in this and the Athena Surveyor (due in 2003) missions; these will select and store samples ready for return to Earth for analysis. The Thermal Emission Spectrometer (TES), and the Mini-TES instruments are used to give an IR map of the surface of Mars as the orbiter scans the planet. Just as IR telescopes can give long distance spectra of a planet's molecular make-up and hence provide indications of what gases, water vapour, organic molecules etc. are present, this device gives a close-up view and will identify for example the IR emissions of any chlorophyll that might be present in plants or certain algae, water on the surface as ice, and even different types of rock which reflect different spectra of IR radiation. IR radiation is effectively a measure of thermal energy.

Figure 5 - The Europa Orbiter.



Radar measurements will enable the orbiter to determine if and where there is an ocean beneath Europa's ice surface so that an under-sea probe can be sent to search for life.

Europa

Perhaps the most dramatic and ambitious project is the one planned for Europa - the fourth largest of Jupiter's moons. Europa is of particular interest as it is believed there may be an ocean beneath an icy surface, and life might be fuelled by thermal vents like those found beneath the Earth's oceans. It could be the most likely place to find evidence for the evolution of extra-terrestrial life forms. Although the surface is icy (the atmosphere is not thick enough to prevent heat loss), having a temperature of around -160°C, it is believed there is a liquid ocean below this ice, heated from the interior possibly by the friction of the rocks flexing caused by the gravity interactions between Europa, Jupiter, and Jupiter's other moons. This also means there could be underwater vents which release minerals and heat like the deep sea vents or 'black smokers' at the bottom of Earth's oceans, providing conditions suitable for similar organisms to evolve. The mission to Europa would be in two parts. The first, planned for 2003 is the Europa Orbiter which will include an altimeter capable of detecting any tidal changes in the height of the possibly one kilometre deep ice layer, indicating the presence of the liquid ocean, and radar which will penetrate the surface to determine whether the ocean completely surrounds the centre of the moon or if there are land masses. This Radar Sounder instrument uses the same principle as normal radar (Radio Detection And Ranging) used in creating the screen images familiar in ground-aircraft airport control. A transmitter emits radio waves aimed at the surface of interest. These radio waves are reflected and scattered by different objects at and below the surface. By analysing the radiation reflected back to a receiver, and its relative timing, information about the shape and material of the layers and objects can be inferred.

If an ocean is present then a second mission will send a probe and a robot submarine system which will be landed on the surface using a retro rocket and balloon system like that already used to land a rover on Mars. The probe, using power from a nuclear generator and solar panels would melt its way through the ice and the submarine would be free to roam the under-ice ocean, using temperature, pressure and chemical sensors to follow gradients to an undersea vent. Searchlights, cameras and microscopes would look for life around the vent on the ocean floor, possibly providing pictures of our first encounter with extra-terrestrial life.

Conclusion

Within the next ten years we might have encountered life on another planet, found evidence of extinct life on yet another, and grounds to believe it exists around another star. Space based astronomy will have told us in more detail how galaxies, stars and solar systems are born, develop life, die and are re-born. Astrobiology is the beginning of a new age of discovery.

Web Sites

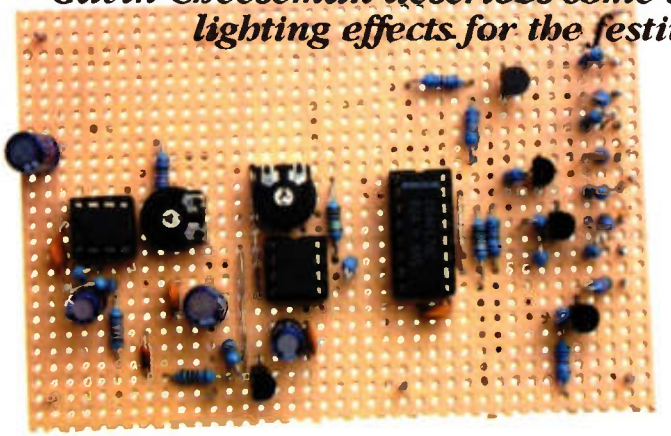
An indication of the current interest in astrobiology is the number of web sites on the subject. A straightforward search for 'astrobiology' will yield many interesting sites.

Acknowledgements
Encyclopaedia CD ROM.

PROJECT

Simple LED effects FOR CHRISTMAS

Gavin Cheeseman describes some simple LED based lighting effects for the festive season



With the festive season upon us, it is once again time to sort out the decorations and look at some ways of introducing a little seasonal cheer. Lighting effects are always popular and can be a good way of adding some additional sparkle to decorations.

LEDs have been chosen primarily because they are low power, low voltage devices and do not pose the same potential hazards as mains operated lamps. A variety of effects may be created by flashing the LEDs, sequencing or triggering them from an external source such as music.

Basic Effects

A simple on/off flashing effect, this can be quickly and easily created using ordinary flashing LEDs. These devices incorporate the control circuit in the LED itself and are ideal for small displays where only a few LEDs are required. No additional circuitry is needed other than a basic power supply. LEDs are available in a variety of colours. These devices are ideal for simple applications such as use with small decorations but if you require more complex effects such as switching LEDs in sequence, a different approach will be necessary.

Sequencing

A variety of effects can be created by flashing the LEDs in a preset sequence. Simple sequencing effects may be produced using off the shelf logic ICs as illustrated by the block diagram in Figure 1. The final effect depends on the physical arrangement of the LEDs. For example, ten LEDs may be arranged in a circle and driven from a decade divider IC preferably using the appropriate buffer. This creates a rotating effect. If the LEDs are arranged in sequence in a straight line a 'scanning' effect may be produced.

Arranging LEDs in a matrix allows graphics and text to be displayed. A microprocessor based system is often used to control this type of display.

Sound Operated Systems

Sound-to-light effects used in discos. These normally use coloured mains powered spot lamps but there is no reason why similar effects cannot be produced on a smaller scale using LEDs. Again there are a large number of variations on this type of effect. The circuit may be arranged to light different LEDs depending on the volume of music or the frequency content. Alternatively, a sequenced lighting effect may be designed to trigger to the beat of the music.

Before we do this we need to couple the sound source to the lighting effect circuit. There are two ways to achieve this.

The first involves connecting the input of the control circuit directly to the output of the power amplifier via an appropriate audio transformer or other suitable coupling device. The signal can often be tapped off at the loudspeaker terminals, and because of the high signal level available, the input to the control circuit does not have to be particularly sensitive. It is possible to power the whole LED effects circuit from the audio equipment avoiding the need for any additional power supply. Making a direct connection to the amplifier will inevitably effect the audio to a greater or lesser degree and for this reason may not be popular with audiophiles.

A second method is to keep the lighting effect separate from the audio source using a microphone. With this arrangement no direct electrical connection to the sound source is required. The circuit does need its own power supply and an additional input preamplifier is required ahead of the trigger circuit.

Choice of LEDs

As a quick browse through the Optoelectronics section of the Maplin Catalogue demonstrates, there is an enormous range of different LED types. Specifications vary considerably with LED type and colour. For example, a typical standard LED will operate happily at 10 to 20mA. However a low current type may only require 2mA or less to produce a similar level of brightness. Blue LEDs usually have a considerably higher forward voltage drop than the other types and it may be necessary to adjust the value of current limiting resistors to allow for this.

Practical Circuits

The following circuits are simple but still create some interesting effects. The circuits are relatively easy to construct and use common components. In fact many people may already have sthe components in their junk box.

LED Sequencer

This circuit will drive up to 32 LEDs arranged in four groups. The unit lights each group in succession. The operating frequency of the on-board clock may be adjusted to give the most desirable switching rate. The clock rate is also varied by a second oscillator so that the switching rate is continuously changing. The circuit will also accept a trigger input from an external source.

Circuit Description

The circuit diagram of the LED sequencer is shown in Figure 2. Capacitors C1, 3, 4, 6 and 8 provide supply rail decoupling. IC1a and associated components form a simple low frequency oscillator. Two outputs are taken from the oscillator. The analogue output from IC1 pin 2 is buffered by IC1b and fed to the voltage control input of the clock oscillator based around IC2. A second (square wave) output, taken from IC1 pin 1 is used to switch TR1. At periodic intervals, TR1 effectively connects C5 in parallel with C7 (the timing capacitor for IC2). As a result the operating frequency of IC2 is continuously changing, and, in addition, periodically switches from low speed to high speed. The output of IC2 is made available on terminal P6. In normal circumstances the output at P6 is connected directly to the input of IC3, a decade divider. The outputs of IC3 switch in strict numerical sequence each

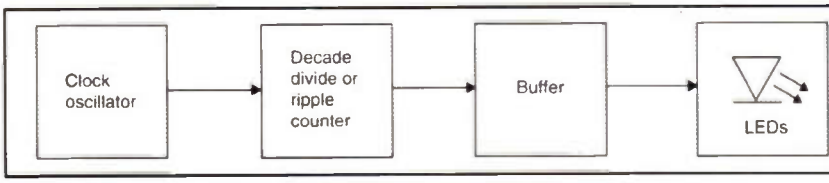


Fig 1. Block diagram of an LED sequencing circuit.

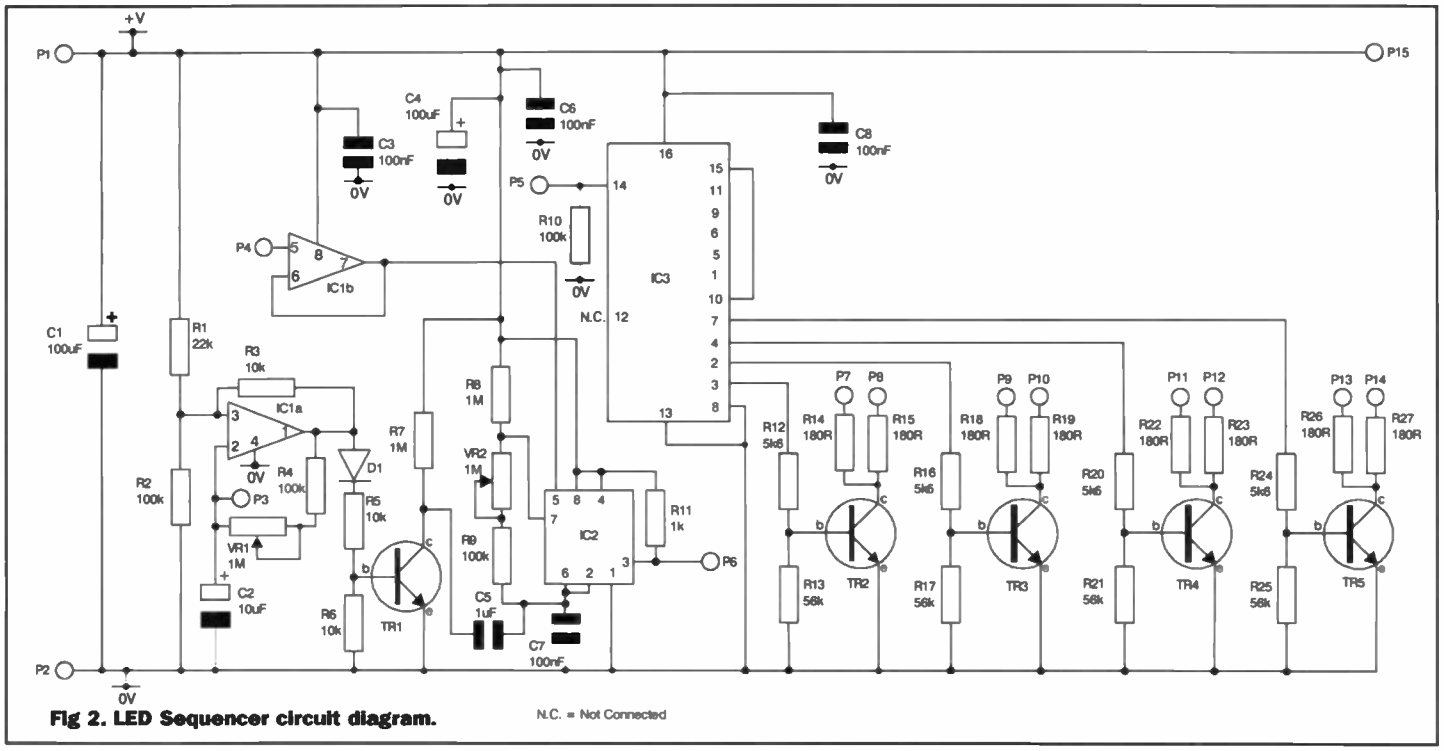


Fig 2. LED Sequencer circuit diagram. N.C. = Not Connected

time a clock pulse is applied to the IC input. Normally the device will sequence through outputs 0 to 9, but for the LED sequencer only four outputs are required. For this reason, the device is wired to reset to 0 when output 5 (IC3 pin 10) switches high. Each of the four outputs (0 to 3) are connected to a transistor switch. The value of the collector resistors has been selected to allow four LEDs to be connected to each output. Each transistor handles two outputs and will therefore switch eight LEDs.

Construction

All of the circuits detailed in this article can be constructed on matrix board or printed circuit board. It is sensible to use DIL sockets for the ICs.

It is recommended that all connections between components are as short as possible. If instability problems are going to occur they will probably originate in the operational amplifier stages due to the high voltage gain in these sections of the circuit. Try to avoid unwanted coupling between op-amp outputs and inputs, and run a separate set of power supply connections to each stage from the power supply input pins.

Decoupling is important so a 100nF ceramic disc capacitor should be connected across the power supply rails close to each IC (C3, 6, 8). In addition, a 100μF 16V electrolytic capacitor (C4) should be connected across the supply close to IC2 (NE555). This device draws pulses of current and if not correctly filtered these can find their way into other sections of the circuit.

As always, observe the correct polarity when connecting electrolytic capacitors and semiconductors. Reverse polarised ICs and electrolytic capacitors will normally be damaged irreparably so please take time to double check all connections. The polarity of LEDs is indicated by the length of the leads and the shape of the case. The cathode (negative) is normally the shortest of the two leads and is also often indicated by a flat edge on the LED case.

LED Connection and Other Wiring Issues

The physical arrangement of the LEDs will depend on the final application and is probably as important as the circuit design itself. Basic connection information for the LED sequencer circuit is shown in Figure 3. Please do not forget the fuse; this provides an important safeguard if there is a fault in the circuit. You may also wish to fit a power on/off switch in series with the +V power supply line. Most single pole switches are suitable but check the rating before buying.

Use ordinary hook-up wire for the LEDs. As can be seen from the wiring diagram, the +V return on terminal P15 is common to all LED groups. It is not necessary to run a separate wire from P15 to each group. The positive (anode) end of each group can be connected at different points along the same conductor as shown in the wiring diagram. The value of the series resistors are calculated for groups of four LEDs in series. The number of LEDs in series in each group may be changed but only if the value of the series resistors is adjusted so as to maintain the same current. If the resistor values are not changed, fitting less LEDs will result in a higher current through the LED and may result in damage.

Terminals P3 and P6 are oscillator outputs and P4 and P5 are external inputs. When these are not in use P3 is linked to P4 and P5 is connected to P6. If there is no intention to use these inputs the connections can be made permanent without the need for any physical terminals.

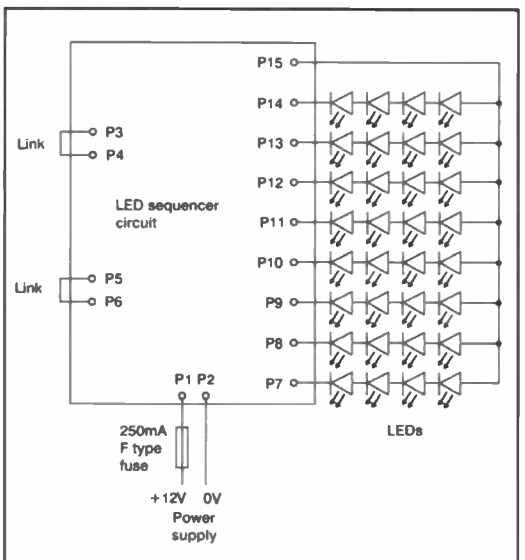


Fig 3. LED Sequencer wiring diagram.

Power supply requirements

The circuits described in this article are designed to run from 12V DC supplies. The power supply must have enough current capability. A 12V 500mA DC supply will run all of the circuits with room to spare. The power supply must be able to deliver enough current to blow the fuse quickly in the event of a short circuit. If not, alternative protection must be provided to prevent damage to the circuit/power supply should a fault occur. The DC output of the power supply must be fully isolated from the mains supply for safety reasons. Batteries may be used for installing a lighting effect where no mains supply is available.

Testing

Before applying power, double check all connections. The positive power supply line (+V) connects to terminal P1 and the negative supply line (0V) connects to P2. When power is applied,

the circuit should start to switch on LEDs in sequence.

The average current consumption can be checked with a meter and should not exceed 100mA when the circuit is working correctly. If a higher current level is measured, disconnect the power supply and check over the circuit looking for short circuits and reverse polarised components.

When the circuit is operating correctly try adjusting the variable resistors to check that they have the correct effect on the operation of the circuit. First adjust VR2 which adjusts the frequency of the on-board clock oscillator so varying the relative rate at which the LEDs sequence. In addition, the frequency of the clock oscillator is continuously varied by IC1. This operates in two ways. Firstly, the clock oscillator is periodically switched between high and low frequency settings every few seconds. In addition to this effect, the frequency is gradually adjusted by an analogue waveform applied to the voltage control input of IC2. The rate at which the frequency of the clock oscillator is varied is set by VR1. The overall effect is that the circuit sequences through the four groups of LEDs at a varying rate.

Housing

The LED sequencer circuit may be housed in a small plastic case of suitable dimensions. The case should be fitted with an appropriate power socket to suit the output connector on your power supply. Wiring from the circuit to the LEDs may either be soldered directly to the terminals or via a suitable socket. DIN sockets are quite useful in this application.

Applications

The LED sequencer can be used in a wide range of applications. For example, you can create your own Christmas decoration designs incorporating LEDs. Firstly draw a design on a piece of board (Figure 4). The LEDs may then be mounted through holes drilled in the board at suitable points. The control circuit may be mounted on the back of the board so avoiding the need for long wiring runs to the LEDs.

The effect created is very much dependant on the LED positioning. For example, a group of eight LEDs may consist of devices of one colour with a different colour used for each group, or aternatively, LED colours may be mixed. Similarly, the LEDs may be positioned in the same sequence that they are switched or arranged randomly.

Modifications and Additions

The LED sequencer circuit may be triggered from an external source instead of the on-board oscillator. An interesting effect can be created by triggering the circuit from a music source. This may be easily achieved by removing the connection between terminals P5 and P6 of the LED sequencer circuit, and connecting the output of the Sound Trigger circuit shown in Figure 5 to P5. The wiring diagram is shown in Figure 6. Although the sound trigger circuit and LED sequencer are shown as separate units, there is no reason why both circuits cannot be constructed on a single circuit board.

A switch is fitted to P5 to allow selection of either the internal or external trigger source. The circuit is a simple preamplifier with an unsymmetrical output. A crystal microphone is used to pick up the sound from the music source and therefore no direct electrical connection is necessary. Switch S1 on the wiring diagram is used to select different frequency response characteristics. This effects the way in which the unit triggers from an audio source. With the switch closed, the gain of the amplifier is reduced at high frequencies and the circuit responds more to the bass content of the music.

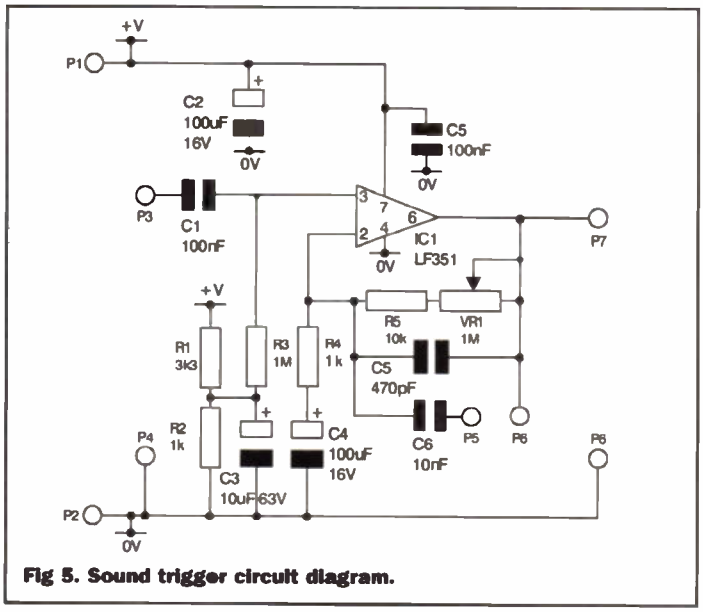


Fig 5. Sound trigger circuit diagram.

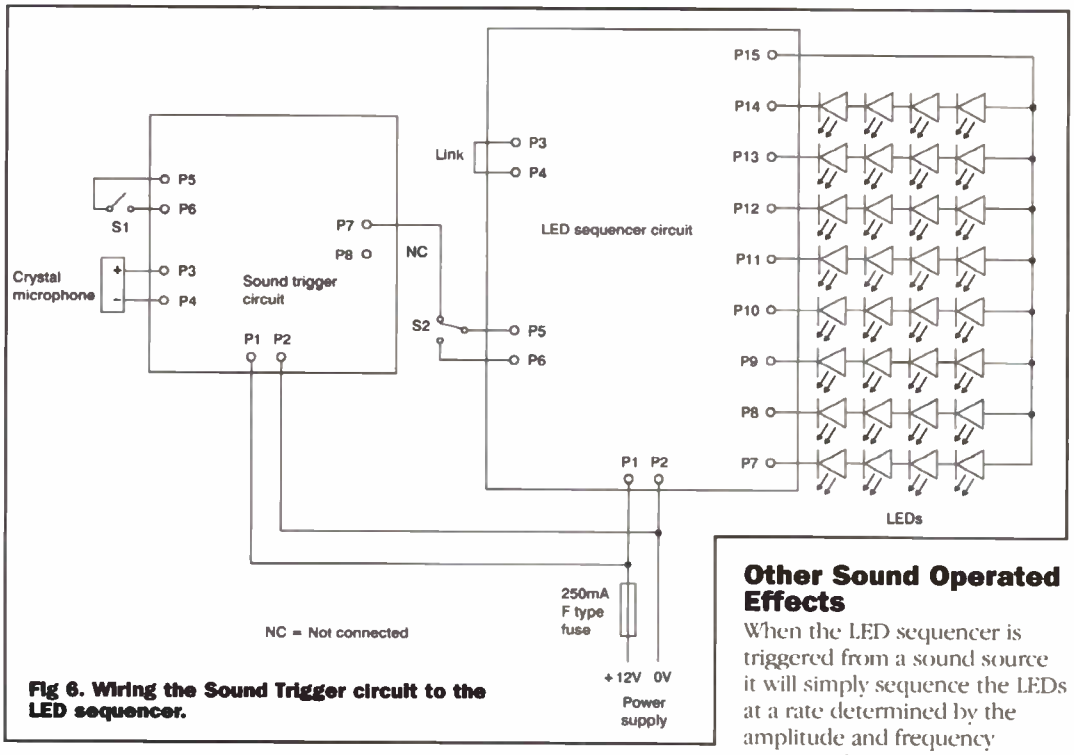


Fig 6. Wiring the Sound Trigger circuit to the LED sequencer.

With the addition of the sound trigger circuit, the LED sequencer can be used to create mini lighting effects.

Driving More LEDs

More experienced constructors may wish to increase the number of outputs available from the LED sequencer circuit. This may be done relatively simply by connecting additional transistor switch stages to the unused outputs of IC3 (pins 1, 5, 6, 9, 10 and 11 of the device). In this case the connection between IC3 pins 10 and 15 should be removed and pin 15 connected to 0V. Up to ten groups of LEDs may be sequenced. Do not attempt to carry out these modifications unless you are fully familiar with the operation of the circuit.

Other Sound Operated Effects

When the LED sequencer is triggered from a sound source it will simply sequence the LEDs at a rate determined by the amplitude and frequency content of the music. Another LED effect that can be simply created are groups of LEDs in a similar manner to that of a bargraph display dependant on ambient sound level.

Bargraph Effect Circuit

This circuit may be used on its own or in combination with the

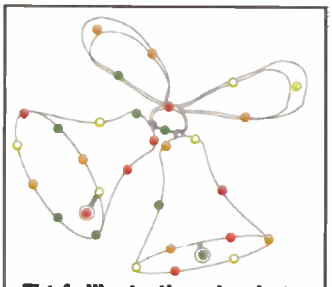


Fig 4. Illustration showing how LEDs may be positioned using a simple line drawing.

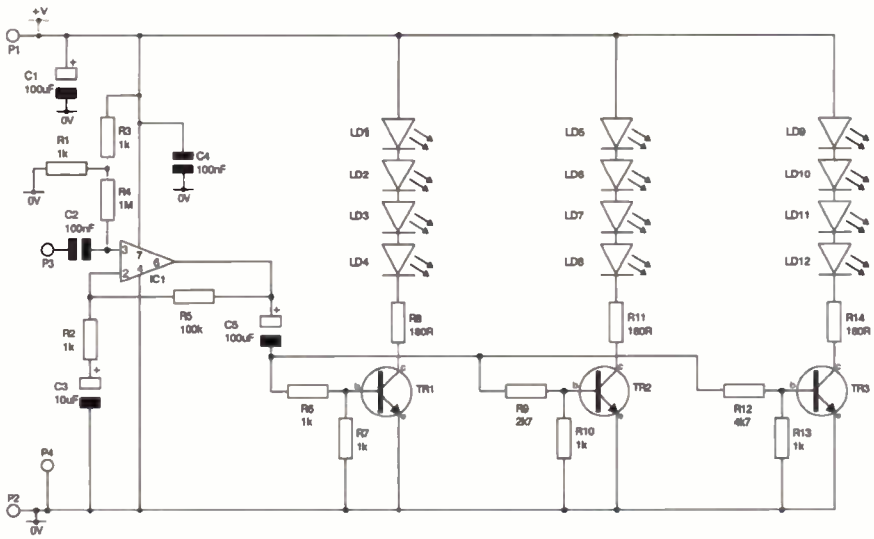


Fig 7. Bargraph Effect circuit diagram.

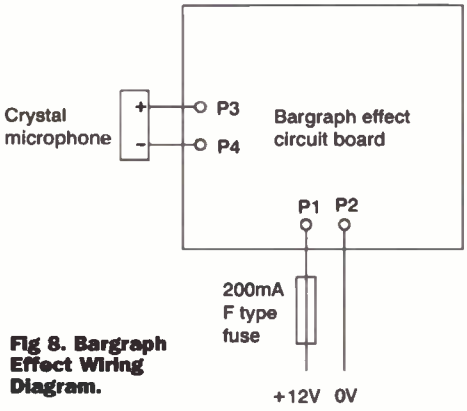


Fig 8. Bargraph Effect Wiring Diagram.

LED sequencer circuit described above. The circuit is intentionally simple but can be quite effective.

How It Works

The circuit diagram of the bargraph effect is shown in Figure 7. The signal from a microphone connected between terminals P3 (input) and P4 (0V) is fed to a simple amplifier comprising IC1 and associated components. The output of the amplifier is fed to three transistor switching stages, each controlling a group of four LEDs. The transistors switch on when there is sufficient voltage at the base to forward bias the base-emitter junction allowing current to flow. The point at which this occurs is controlled by the value of the resistors connected to the base of the transistor and is different for each of the three switching stages. Hence, TR1 switches on at a lower sound level than TR3.

Construction and Testing

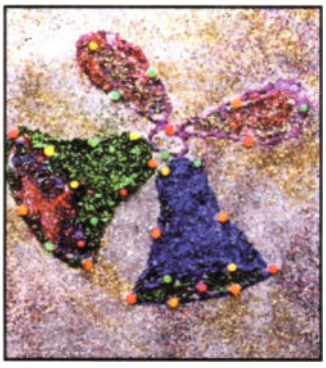
Most of the constructional requirements discussed above for the LED sequencer also apply to the bargraph effect. Please read this section before constructing the circuit.

The circuit has the same power supply requirement as the LED sequencer (12V DC) and may be powered from the same supply when the two circuits are being used together (as long as the power supply can deliver enough current). Terminal P1 connects to +V and P2 connects to 0V. A wiring diagram is shown in Figure 8.

To test the circuit you will require a suitable sound source; a radio or the home hi-fi are fine. Apply power to the circuit and observe the LEDs. With no sound input the LEDs should not be lit. Slowly increase the volume of your sound source. LEDs LD1 - LD4 should be the first to light. As the volume is increased still further LD5 - LD8 should begin to light followed by LD9 - LD12 (the least sensitive). If the sound source is continuously changing (music or speech) the LEDs should flash on and off continuously depending on volume.

Using the Bargraph Effect

The simplicity and relatively low cost of this circuit make it ideal for use with small decorations. A number of these units thoughtfully scattered around the room provide extra sparkle to a party. The unit may be powered from a battery for portability, but because of the current drain of IC1, the power should be disconnected when not in use. The switching thresholds of the transistor stages may be adjusted by modifying the value of resistors R7, R10 and R13. Increasing the resistor value will make the unit more sensitive and decreasing the value will reduce the sensitivity. The values shown are not optimised and some adjustment may be necessary to suit different operating environments.



BARGRAPH EFFECT CIRCUIT PARTS LIST

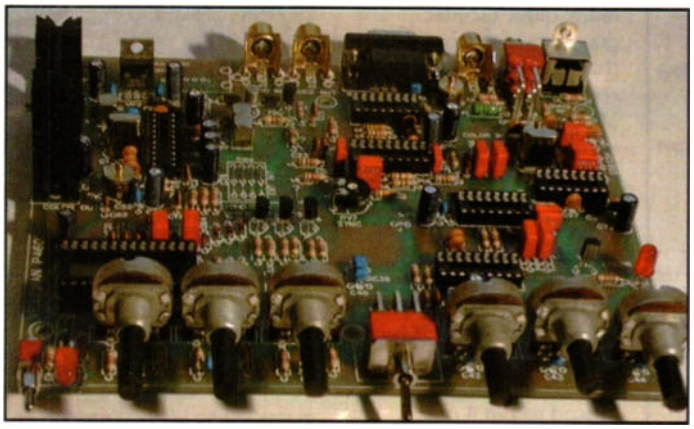
RESISTORS			
R1, 2, 3, 6, 7, 10, 13	1k	7	M1K
R4	1M	1	M1M
R5	100k	1	M100K
R8, 11, 14	180R	3	M180R
R9	2k7	1	M2K7
R12	4k7	1	M4K7
CAPACITORS			
C1, 5	GenElect 100µF 16V	2	AT40T
C2, 4	Minidisc 0.1µF 16V	2	YR75S
C3	GenElect 10µF 63V	1	AT77J
SEMICONDUCTORS			
IC1	LF351N	1	WQ30H
TR1-3	BC547	3	QQ14Q
	5mm Red LED	4	WL27E
	5mm Green LED	4	WL28F
	5mm Yellow LED	4	WL30H
MISCELLANEOUS			
P1-4	Pin 2145	4 Pins	FL24B
	DIL Socket 8-Pin	1	BL17T

LED SEQUENCER PARTS LIST

RESISTORS			
R1	22k	1	M22K
R2, 4, 9, 10	100k	4	M100K
R3, 5, 6	10k	3	M10K
R7, 8	1M	2	M1M
R11	1k	1	M1K
R12, 16, 20, 24	5k6	4	M5K6
R13, 17, 21, 25	56k	4	M56K
R14, 15, 18, 19, 22, 23, 26, 27	180R	8	M180R
VR1, 2	Hor Encl Preset 1M	2	UH09K
CAPACITORS			
C1, 4	GenElect 100µF 16V	2	AT40T
C2	GenElect 10µF 63V	1	AT77J
C3, 6, 7, 8	Minidisc 0.1µF 16V	4	YR75S
C5	Poly Layer 1µF	1	WW53H
C6	Ceramic 100nF	1	BX030
SEMICONDUCTORS			
IC1	TL082CN	1	RA71N
IC2	NE555N	1	QH66W
IC3	HCF4017BEY	1	QX09K
D1	1N4148	1	QL80B
TR1-5	BC547	5	QQ14Q
5mm Red LED	8		WL27E
	5mm Green LED	8	WL28F
	5mm Orange LED	8	WL29G
5mm Yellow LED	8		WL30H
MISCELLANEOUS			
P1-P15	Pin 2145	15 Pins	FL24B
	DIL Socket 8-Pin	2	BL17T
	DIL Socket 16-Pin	1	BL19V

Video & RGB PROCESSOR

Martin Pipe improves upon to this popular Velleman video processor kit



The constructed Velleman board, before modification

Take half a day or so to construct a Velleman K4600, and you'll end up with quite a handy video tool. Among its most important facilities is the ability to modify the individual red, green and blue levels of a composite or S-video input signal. Why would you want to do this? There are, in fact, two applications here. If the white balance of your camcorder wasn't set properly, then your movie might have a red or blue colour cast. The K4600 allows you to tweak out the tint, resulting in a more natural picture. Sometimes, though, a deliberate colour imbalance can be used for creative effect - the K4600 can help here too. Adding a red tint gave the impression of a Martian landscape, or the interior of a submarine at full 'red alert'. Turning up the blue level gives the illusion of cold, while a tweak in green level helps to make human faces more alien. If RGB colour correction isn't needed, it can be switched off with a front-panel toggle switch. The K4600's brightness, colour saturation and contrast controls, which cannot be switched off, have similar corrective and creative benefits. Brightness and contrast adjustment could, for example, enhance movies shot in low-light, while colour adjustment could either accentuate pale colour or - with the control turned the other way - eliminate it completely and give movies (or flashback/dream sequences) an 'old-time' feel.

Internals

Basically, the K4600 splits up a standard 625-line 50 field-per-second PAL colour video signal into separate red, green and blue components. These are modified by the front-panel controls, and then combined back into a colour video signal. The internal topography of the K4600 - reproduced in Figures 1 and 2 - lends it to other applications, too. For a start, you get an output that contains the separate red, green, blue (and synchronisation) signals before they go back into the recombiner (a MC1377 PAL encoder chip, IC7). Although Velleman intended this feature to be used with its video digitiser, these outputs could also feed a RGB monitor, thus converting it into a display capable of handling composite and S-video signals. I have, for some time, partnered the K4600 with a professional Barco monitor - which doesn't have an S-video input. Remember that many TVs, particularly older ones, don't have an S-video input and won't deliver the full benefit from DV, S-VHS and Hi-8 equipment. As long as the TV in question has a RGB-connected Scart (or some other form of RGB input) you should be OK.

Other Possibilities

The path between the RGB signals and the PAL encoder can be broken in another way. Velleman has made provision for an external 625/50 RGB source - home computers, satellite decoders and teletext boards - to be converted into PAL form. To this end, there are details in the instructions, drill-out markings on the rear-panel label and component positions on the PCB. The PAL encoding circuitry built into the BBC computer was awful, which is possibly why so many serious users plumped for an RGB monitor. If you still have your Beeb, get better pics from the K4600's PAL encoder - and give your old RGB monitor composite and S-video inputs into the bargain! To take advantage of this, you'll need to buy a 4-pole (R,G,B and sync) changeover switch that allows you to feed IC7 from the internal PAL decoder or an external RGB source. I have found Maplin's FH08J ideal for the purpose. There's little space on the back panel for a Scart RGB input socket - but I find a 9-pin 'D' socket is more than adequate. If the encoder is to be fed from an RGB source via Scart, the appropriate cable could always be made. On the subject of cable, I find XR23A (four individually-screened cores) ideal for making up RGB cables.

That's not to say that the K4600, as supplied, isn't without its limitations. The most obvious? Although it has composite and S-video inputs (switchable from the rear panel), the output is composite-only. In other words, the full pictorial benefit from your digital or high-band camcorder is not realised, particularly if your VCR is a high-band model. Fortunately, the circuit around IC7 can be easily modified to deliver separate chroma and luma outputs of the appropriate level. There's an added bonus too, if you modify the K4600 to accept an external RGB input. Some entry-level DVD players, many free-to-air enthusiast-grade digital satellite receivers and all of the currently-available Sky Digiboxes only give you an RGB and composite output. Feed the K4600 with the unit's RGB output, and you'll get an S-

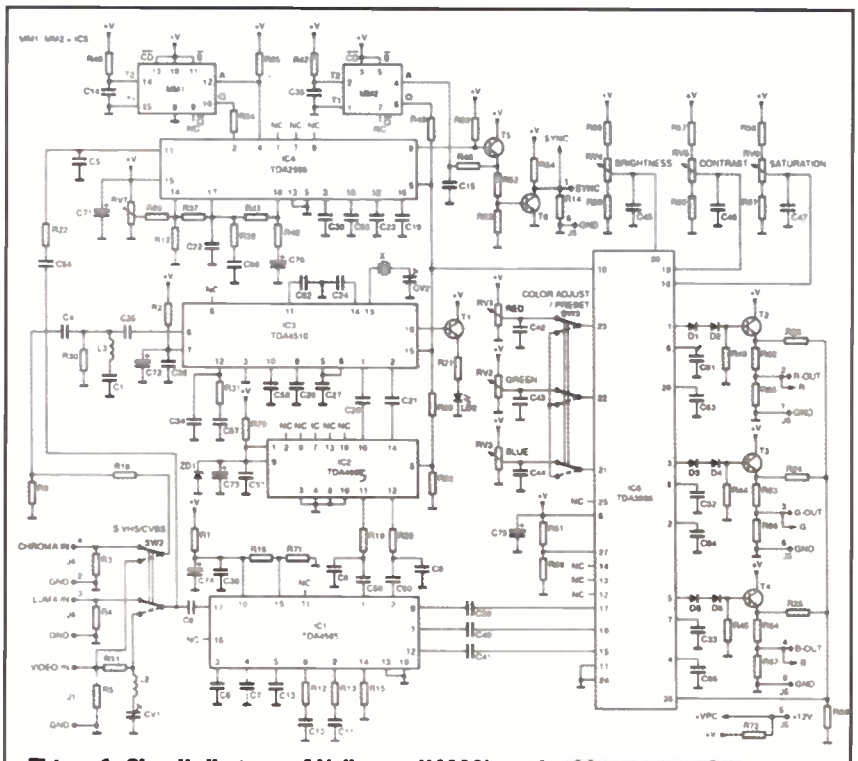


Figure 1. Circuit diagram of Velleman K4600's main video-processing section

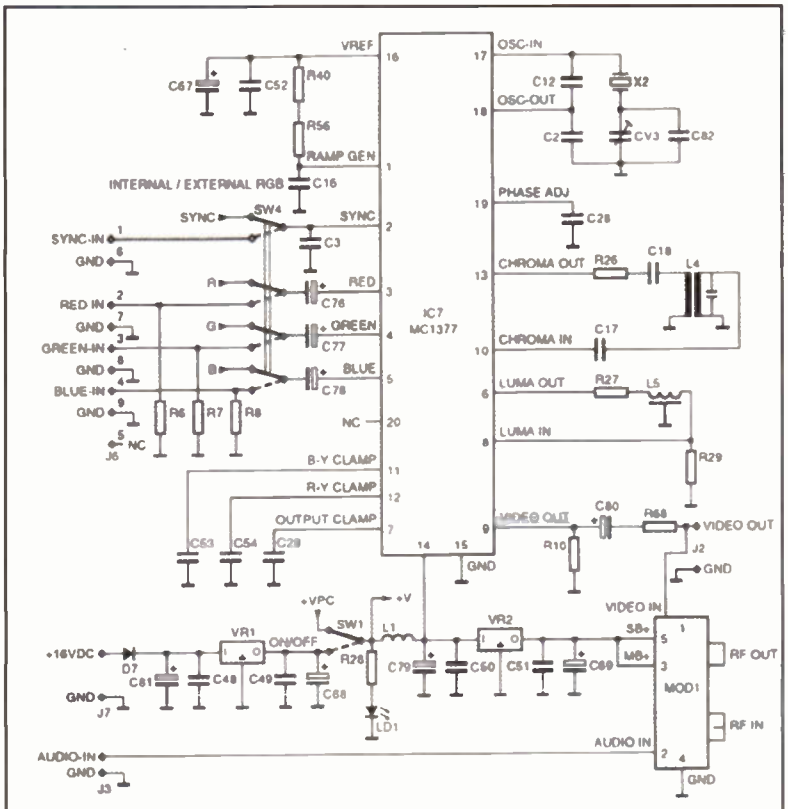


Figure 2. Circuit diagram of Velleman K4600's PAL-encoding section

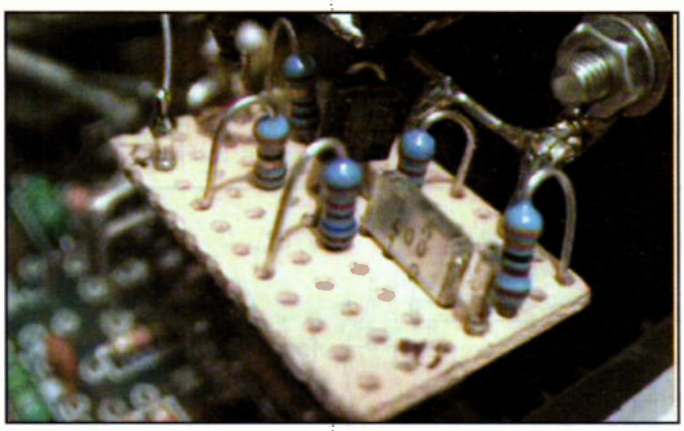
video output that can be routed to a Super VHS VCR. Note that most DVDs, and all Sky Digital pay-per-view broadcasts, are Macrovision-encoded, and will result in an unstable picture.

This is a pity, since being able to route an other AV source into your TV via the VCR's line input could be useful, particularly if your TV is only equipped with one Scart socket. There's a fix for this, which we'll describe shortly. Note that most of Sky Digital's output is not Macrovisioned, and can be recorded without these problems - worth bearing in mind if you want to build up your own collection of Friends, Simpsons or X-Files episodes.

Buffer Board

Many older D2-Mac decoders, notably those that started life as BSB receivers, employ the MC1377 for RGB-to-PAL conversion, and this modification can be applied to such equipment. The change essentially involves taking the chroma from the output of IC7's bandpass transformer (L4 in Figure 2), and buffering it. This buffered signal can be passed to pin 4 of a standard S-video mini-DIN socket. A simple changeover switch (Maplin FH98G, for example) determines whether the chroma is fed back into IC7 (in this position, you get a colour composite output through J2, as before), or whether it's passed to the buffer. In the latter position, no chroma is returned to IC7 and its composite video output (which is passed to J2) becomes a luma-only output instead. Pin 3 (luma) of your S-video mini-DIN is hence wired in parallel with J2. The buffer, the schematic of which is reproduced in Figure 4, can be constructed on a tiny piece of stripboard (I used a small section of JP54J).

The board could be easily attached to the S-video socket. Indeed, in the prototype, PCB pins were used as both board support and ground connection. The 12V supply could be derived from the positive side of C79 (47_F). In the prototype, the chroma in/out connections were easily obtained by simply removing C17 (1µF), and soldering the wires to the vacant pads. To prevent loading,



In the prototype, the buffer board was held in place by the SVideo terminal's ground pins. The pins used as the fasteners serve another function - they are connected to the buffer's ground points

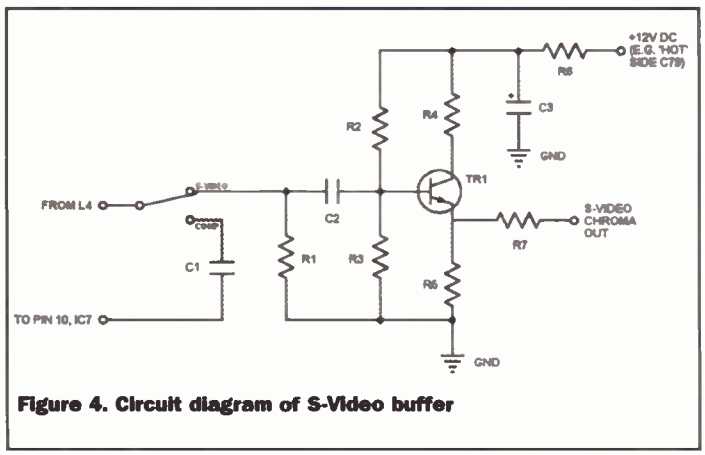


Figure 4. Circuit diagram of S-Video buffer

Close-up view of S-Video socket and composite/S-Video switch wiring

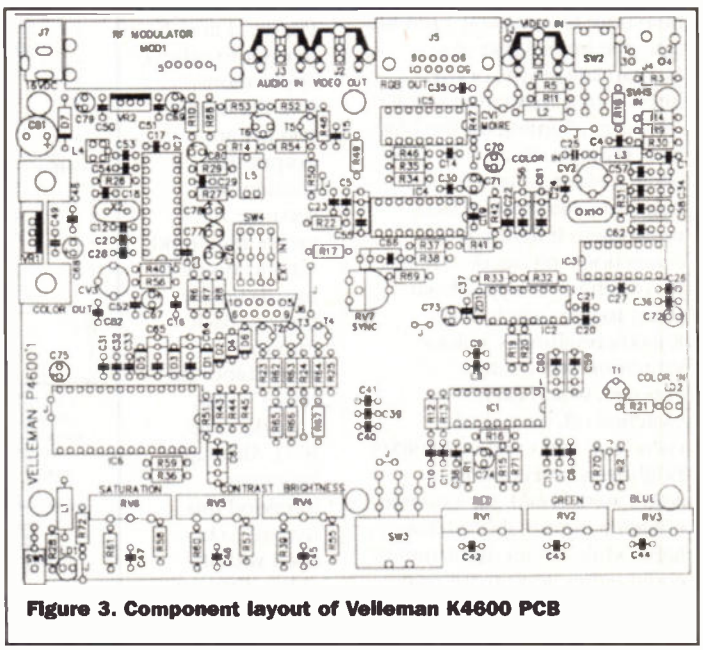
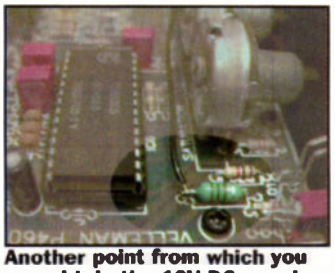
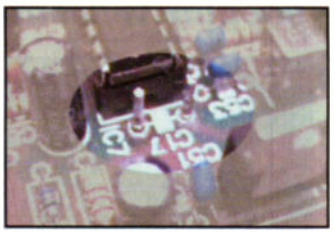


Figure 3. Component layout of Velleman K4600 PCB



Another point from which you can obtain the 12V DC supply for the buffer board



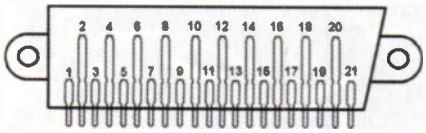
In my unit, I replaced C17 with PCB pins - the wires to the buffer and switch would, in turn, be connected to these

S-video mini-DIN connections
(View from solder side of socket)

Pin 1: Luminance (Y)
Pin 2: Luminance (Y) ground
Pin 3: Chrominance (C) ground
Pin 4: Chrominance (C)

Figure 5. The pin-out of the 4 pin mini-DIN socket, as used for S-Video applications. Plugs and chassis sockets are available from Maplin

Scart connections
(View from solder side of connector)



Pin 01: Audio output R
Pin 02: Audio input R
Pin 03: Audio output L
Pin 04: Audio ground
Pin 05: RGB Blue ground
Pin 06: Audio input L
Pin 07: RGB Blue input
Pin 08: AV mode switching
Pin 09: RGB Green ground
Pin 10: Data/RGB vertical sync
Pin 11: RGB Green input
Pin 12: Data/RGB horizontal sync
Pin 13: RGB Red ground
Pin 14: Data ground
Pin 15: S-video chrominance/RGB Red input
Pin 16: Fast blanking
Pin 17: Composite video output ground
Pin 18: Composite video/S-video luminance input ground
Pin 19: Composite video output
Pin 20: Composite video/S-video luminance input
Pin 21: Ground (shield)

Figure 6. Pin-out of the Scart connector, which is common on TVs, VCRs and other AV equipment

don't connect equipment to both S-video and composite outputs! In any case, you wouldn't get Y/C and composite simultaneously anyway! The S-video socket wiring is given in Figure 5, while the Scart pin-out is shown in Figure 6. S-video connectors are nothing more than 4-pin mini-DINs, which are available from Maplin. The order code for the socket is JX08J, while the plug is JX02C. Note that Scart plugs are also available from Maplin - the order code here is FJ41U. DC voltage interconnects were made via standard 7/0.2 insulated wire (e.g., black BL00A), while the high-quality XR88V screened cable was used for video interconnects.

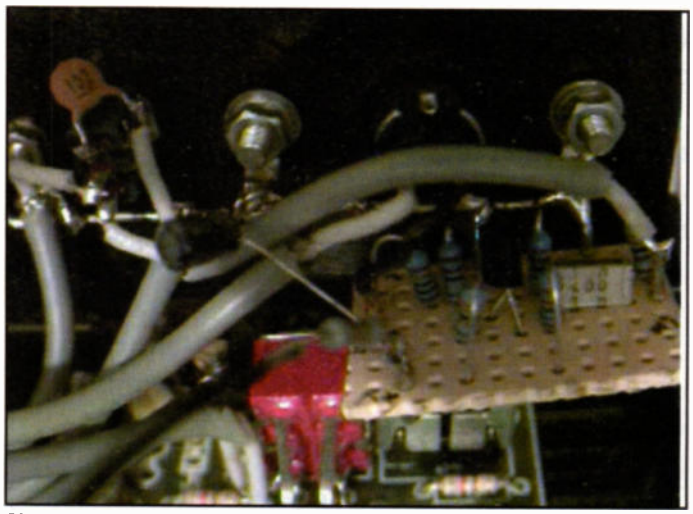
The K4600 will defeat the Macrovision copy-protection action applied to some composite video sources, thanks largely to the sync processing conducted by IC4 (described later). It is also possible to defeat Macrovision on sources capable of providing an RGB output. The external input, as recommended by Velleman, involves passing the R, G, B and sync channels directly to via an optional four-pole switch (see SW4 in Figure 2). To defeat Macrovision, the circuit has to be modified so that the sync channel of the RGB device (from Scart pin 19) is passed through the K4600's TV processing circuitry. The R, G and B channels are passed directly, as before, to IC7 from the switch. The internal/external RGB switch, SW4, simultaneously switches the four signals, including syncs. Bypass the latter with a wire bridge, so that IC7's sync input (pin 2) is always fed from T6 (which buffers the sync from IC4). The portion of the internal/external RGB switch that once switched syncs - we'll call this SW4d - should now be used to select which source (external RGB sync, or internal S-video/filtered-composite luma) feeds IC1 (via C61) and IC4 (via C56 and R22). The luma signal path should be broken just after the rear-mounted S-video/ composite source switch. The output of the switch should be fed to the pole of SW4d that corresponds to its 'internal' selected position. The sync channel from the external RGB input should be routed to the other pole of SW4d, which is switched in when SW4 is flicked to its 'external RGB input' position. The common output of SW4d should be fed to the other side of the broken signal path (i.e. C61/C56-R22). Once you've done this, you'll be able to enjoy all of the original features of the K4600, plus trouble-free monitoring of DVDs and Sky Box Office via your VCR. **It has to be said that such sources can be recorded, but you should - of course - be careful to observe copyright restrictions where they apply.**

How the K4600 Works

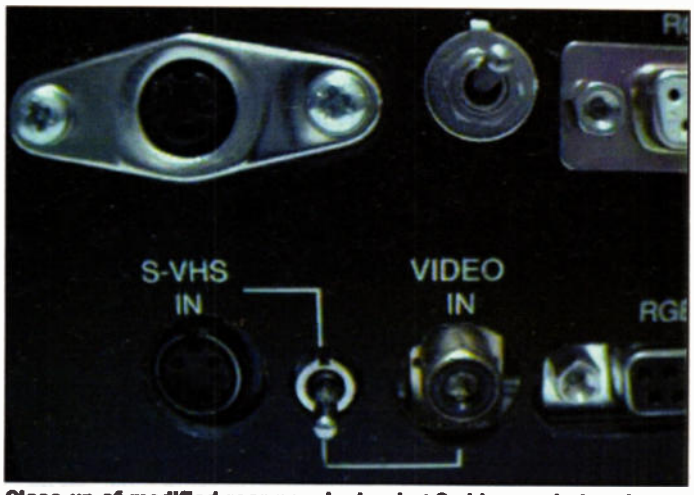
This kit makes considerable use of TV chips in its signal processing department. As a result, spares are universally available (check out the ads in specialist magazines like 'Television'). The composite video signal is fed into a passive filter (made up of R5, R11, L2 and CV1) that removes the chroma (colour) information to yield a luma-only (black and white) signal. Half of SW1 selects either this filtered signal, or the luma component of the S-video input, and passes it to IC1 (TDA4565 - we'll discuss this device shortly) and IC4 (TDA2595). Although IC4 - a 'horizontal combination' - has many functions within a TV set, its main one here is to strip out the video sync signals, which are used to provide a timebase for the other components. The horizontal oscillator, which is phase-locked ('flywheel' line sync, as it's known in the TV trade) to the incoming sync, is fine-tuned by RV7. Interestingly, the not-inconsiderable amount of sync processing within IC4 explains why the K4600 is so resilient to input signals - and why the unit can quite happily defeat Macrovision-protected video sources.

Most of the other TV chips (IC2, 3 and 6) are timed by an amalgam of sync and vertical blanking information, which is known as the 'sandcastle' pulse. This is also provided by IC4. Because the TDA2595 is a TV chip, some of its feedback signals are intended to be derived from the set's high-voltage vertical and horizontal output stages. This isn't possible in low-voltage video processor units - simulation, however, is. Monostable multivibrator MM01 (half of IC5, 4528) generates the vertical blanking pulse from the TDA2595's horizontal sync output. Another monostable (MM02, the other half of IC5), is used to derive the composite sync signal from the sandcastle pulse. This is brought to the correct level, and buffered by T5/T6. Composite sync is needed to drive the PAL encoder chip (IC7, MC1377), or any RGB monitor.

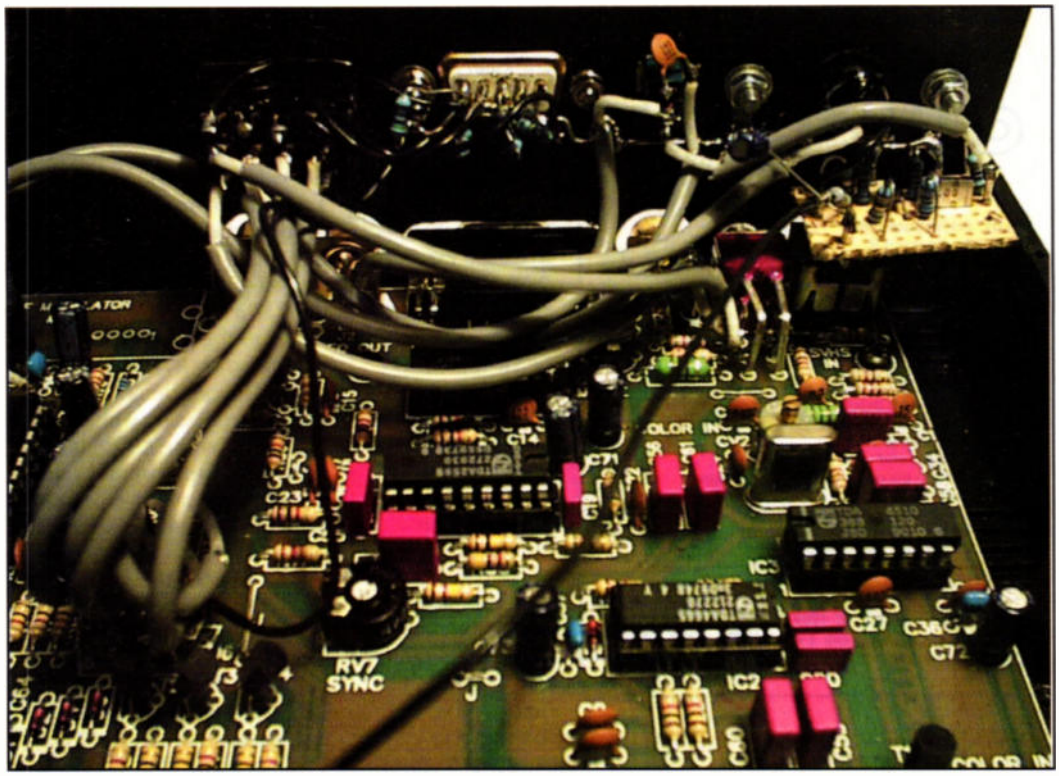
The other half of SW2 selects the composite video signal, or the S-video chroma, and passes it to the colour decoder IC3 (TDA4510) via a filter made up of C1/C4/C25/R30/L3. This filter



Close-up view of the buffer and switch wiring



Close-up of modified rear panel, showing S-video socket and output selector



The completed modification. Note also the external/internal RGB switch and external RGB socket

is designed to remove the luma component, and one asks whether it would perhaps better placed prior to the input selector switch - on the composite side. After all, the chroma signal of an S-video feed doesn't (or shouldn't!) have any luminance content in the first place. To aid set-up of the 8.86MHz PAL reference oscillator (tuned by CV2), there's a board-mounted 'colour lock' LED driven by T1. As an alternative, you could use a scope. On a similar subject, we would recommend setting up IC7's 4.43MHz PAL reference oscillator fine adjustment (CV3) with a scope, should you have one. Otherwise, it's a case of adjusting it empirically for the most reliable colour lock on a standard PAL TV.

Interestingly, the decoder chip is (semi-) pin-compatible with a multi-standard decoder (the TDA4555). If you were to specify one of these - plus some extra components - you could convert Secam to PAL, and generate quasi-PAL signals from NTSC sources like DVD and laserdisc players. The decoded output from IC3 takes the form of a pair of colour difference signals, known as B-Y (or 'V') and R-Y (or 'U'). They're then passed through a semiconductor delay line (IC2, TDA4665) - 64µs (the duration of one video line) of delay is needed, as part of the PAL decoding process. The next stage isn't essential, but it does result in better pictures with less colour smear. Here, the delayed signals are treated to a process known as colour transient improvement (CTI) by IC1 (TDA4565). CTI is a method of making the effects of the PAL system's limited chroma bandwidth less noticeable by sharpening the edges whenever sudden changes in chroma content (transients, in other words) are experienced.

The process introduces some chroma delay, which is also compensated for by IC1 (the luma signal input, from SW2, is treated to a corresponding amount of delay). The modified U and V signals, and the delayed luma, are fed into IC6 (a TDA3505 output 'combination' circuit) where they're decoded by a matrix to provide the red, green and blue components. In a TV set, these would drive the guns via amplifiers. Indeed, the TDA3505 has a feature that's intended for TV grey-scale tracking (in other words, ensuring that colour levels are correctly balanced, compensating for possible tube variations). To this end, there are red, green and blue level adjustments. In this design, they're brought out to front-panel controls rather than the presets found in TVs. IC6's brightness, contrast and colour saturation controls are also brought out to the front panel - just as they are with TV sets that employ the chip. The R, G and B outputs are buffered by T2/T3/T4, which provide feedback to the TDA3505's internal amplifiers.

More importantly, you get drive signals for the colour encoder (IC7). The latter recombines the processed signals - and the sync from T6 - into a PAL composite one that can be recorded, or displayed on a monitor. Elsewhere in this article, you'll find out how to add an S-video output to IC7. The buffers also provide a RGB/sync feed that can drive an RGB monitor - Velleman provide a 9-way 'D' socket for this purpose. if you've got a TV with RGB Scart, you might find that the K4600 gives you better picture quality than the set's own decoder - it's also a nice easy way of adding a S-video input to your equipment. If you were to modify the circuit around the TDA4555, then you could convert any RGB-connected TV into a multi-standard one. Most modern TVs will quite happily lock into the 525-line 60Hz line/field rate of an NTSC signal, while SECAM uses the same 625 lines and 50Hz of the UK's PAL system anyway. Without the appropriate colour decoding, though, all you'll see with a SECAM source is a monochrome picture.

PARTS LIST FOR S-VIDEO MODIFICATION

RESISTORS

R1	3k3	(M3K3)
R2	16k	(M16K)
R3	8k2	(M8K2)
R4	33ohm	(M33R)
R5	6k8	(M6K8)
R6	6.8ohm	(M6R8)
R7	75ohm	(M75R)

CAPACITORS

C1	1nF ceramic	(WX68Y)
	or use the original C17 removed from the main PCB)	
C2	1nF ceramic	(WX68Y)
C3	1µF/63V Electrolytic	(VH03D)

SEMICONDUCTORS

TR1	BC548	(QB73Q)

MISCELLANEOUS

	Single-pole Changeover Switch	(FH98G)
	4-pin Mini-DIN socket	(JX08J)
	Stripboard	(JP54J)
	Screened Cable	(XR88V)
	7/0.2 Black Hookup Wire	(BL00A)

K4600 Video RGB Processor, order code VF74R £109.99 inc. VAT

Using Low-Cost 'MELODY' AND 'SOUND-EFFECTS' GENERATOR ICS

Ray Marston presents - in this special feature article - basic usage details of a variety of popular low-cost 'melody generator' and 'sound-effects generator' ICs.

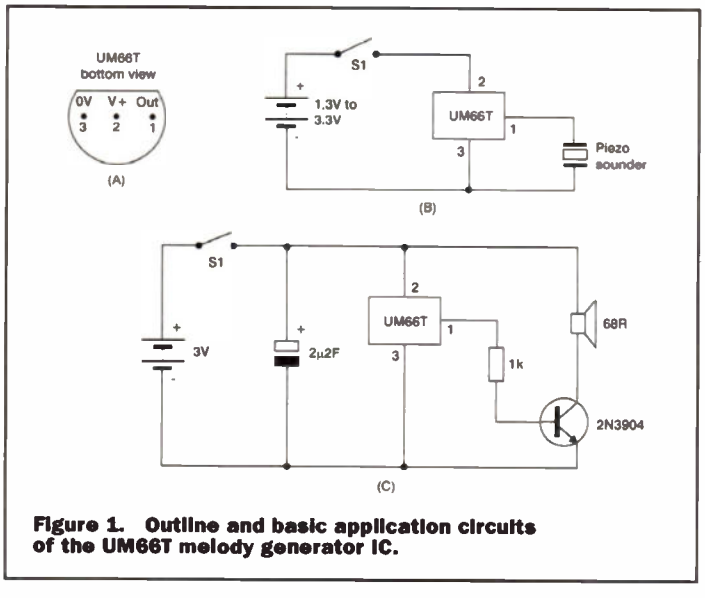


Figure 1. Outline and basic application circuits of the UM66T melody generator IC.

IC Part No.	Melody/Sound
UM66T01x	Jingle Bells + Santa Claus is Coming to Town + We Wish You a Merry Christmas
UM66T02x	Jingle Bells
UM66T04x	Jingle Bells + Rudolph the Red Nose Reindeer + Joy to the world
UM66T05x	Home Sweet Home
UM66T06x	Let Me Call You Sweet Heart
UM66T08x	Happy Birthday to You
UM66T09x	Wedding March (Mendelssohn)
UM66T11x	Love Me Tender, Love Me True
UM66T13x	Easter Parade
UM66T19x	For Elise
UM66T32x	Cuckoo Waltz
UM66T33x	Mary Had a Little Lamb
UM66T34x	The Train is Running Fast
UM66T68x	It's a Small World

Figure 2. Tune-play details of the five most popular English language sub-variants of the M66T IC

This special 'basic usage data' article looks at various low-cost melody generator and sound-effects generator ICs and circuits that are particularly useful in simple 'entertainment' or 'fun' applications. All of these ICs are pseudo-linear types that contain digital elements such as clock generators and ROM-controlled counter/dividers and tone/noise generators, but are configured to generate analogue-type output waveforms.

Note that most ICs of the various major types described in this article are manufactured in a wide variety of sub-types (which each generate specific sounds or tunes) that are intended mainly for use by bulk-purchasing commercial users, and that relatively few of these sub-types are available in one-off quantities, from a few specialist suppliers. All of the ICs used by the author were obtained directly from the manufacturers or from Maplin Electronics, PO Box 777, Rayleigh, Essex, SS6 8LU, in the UK.

Also note that most of the ICs described in this article are CMOS types with unprotected inputs, and are thus highly susceptible to catastrophic damage from electrostatic discharges when being handled; readers wishing to experiment with any of these ICs are strongly advised to take all normal 'CMOS handling' precautions, including the wearing of a grounded wrist strap.

Melody Generator IC Circuits

Melody generator ICs are sophisticated but inexpensive and easy to use low-fi 'tune player' devices, usually housed in 3-pin TO-92 packages, that are each capable of playing a simple (up to 64 or 128 notes) melody. They are often used as basic tune generators in greetings cards or gifts, in toys and games, and in telephones and various other electronic gadgets. The three most popular ranges of melody generator ICs are the UM66T series from UMC, the M66T series from Micro-E, and the HT381xx series from Holtek; the rest of this section presents practical usage information on ICs from these three particular ranges.

The UM66T Series (UMC)

Figure 1 shows basic details of the UM66T melody generator IC, which is housed in a 3-pin TO-92 package, can be powered from a 1.3V to 3.3V battery supply, consumes a quiescent current of less than 1µA, and can play a tune of up to 64-notes (determined by the IC's internal ROM). The diagram shows (in (b) and (c) basic ways of using the IC to make a complete melody generator with either a piezo sounder or a loudspeaker output. Note in these and most other melody generator IC circuits that, after connecting the supply by closing S1, the

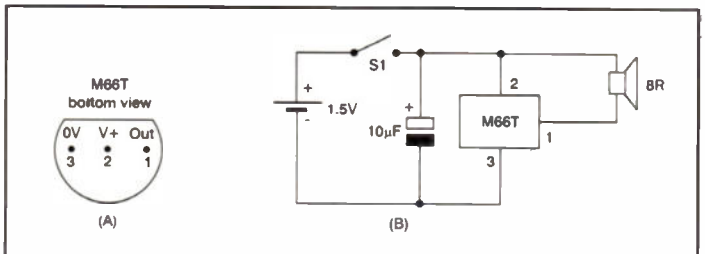


Figure 3. Outline and simple application circuit of the M66T melody generator IC.

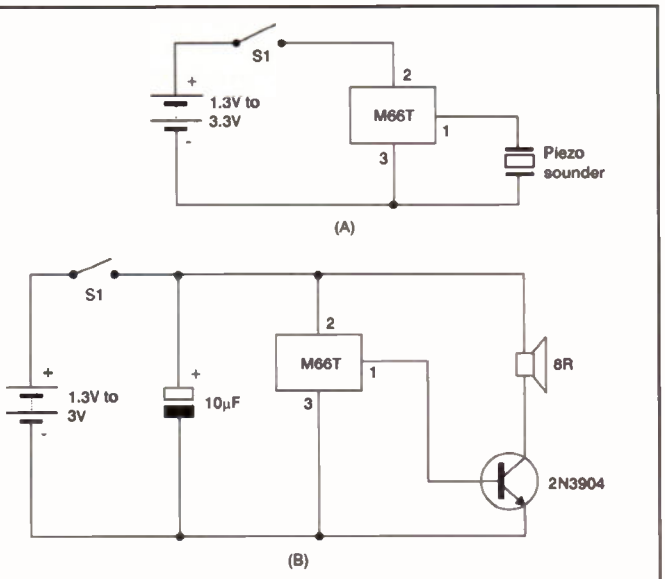


Figure 4. General-purpose application circuits for the M66T IC.

IC Part No.	Melody/Sound	Duration
M66T-02B	Twinkle, Twinkle Little Star	16.4s
M66T-11	Rock-a-bye Baby	21.6s
M66T-36	Old MacDonald Had a Farm	24.8s
M66T-205	I'd Like to Teach the World to Sing	20.4s
M66T-214	White Christmas	49.5s

Figure 5. Tune-play details of the five most popular English-language sub-variants of the M66T IC.

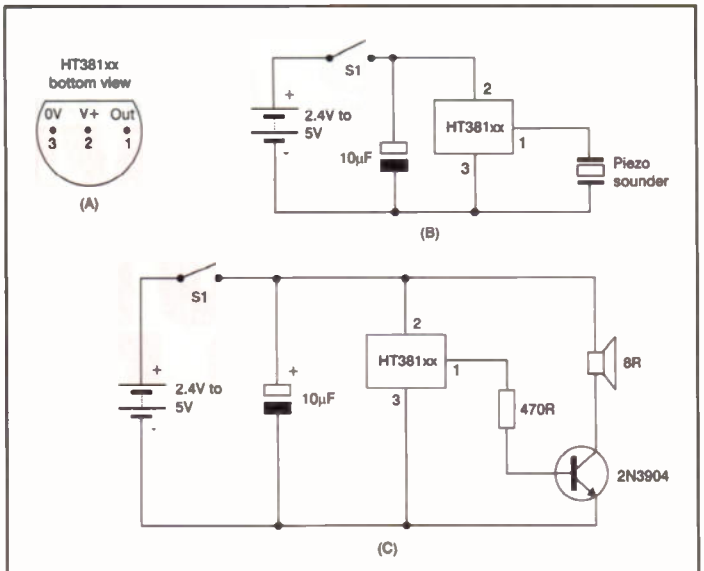


Figure 6. TO-92 outline and basic application circuits of the HT381xx melody generator IC.

IC Part No.	Song (Tune) Series	No. of Songs
HT3810A to HT3810Z	Children's Songs	25
HT3811A to HT3811G	Children's Songs	7
HT3812A to HT3812Q	Lyrical Songs	16
HT3813A to HT3813M	Christmas Songs	13
HT3814A to HT3814M	Popular Songs	13
		Total = 74

Figure 7. Relationship between HT381xx IC numbers and the general class of tune that they play.

melody plays once and then stops; the supply must be broken and then reconnected to retrigger the IC.

The basic UM66T-series IC is currently (at the time of writing) manufactured in a total of fourteen basic 'English-language Tune' sub-variants (indicated by the first two bits of a 3-digit/letter suffix to the main IC part number), each of which plays a different tune or abbreviated set of melodies, as indicated in the table shown in Figure 2. The two most popular of these sub-variants are the UM66T08x, which plays *Happy Birthday To You*, and the UM66T09x, which plays Mendelssohn's Wedding March.

The M66T Series (Micro-E)

Figure 3 shows basic details of the M66T melody generator IC, which is housed in a 3-pin TO-92 package, can be powered from a 1.3V to 3.6V battery supply, consumes a quiescent current of less than 1µA, generates an internally limited output drive current, and can play a tune of up to 64-notes (determined by the IC's internal ROM). The M66T IC has greater output driving power than the UM66T type, and Figure 3(b) shows a basic way of using it to directly drive an 8-ohm speaker when the circuit is powered from a 1.5V battery supply. Alternatively, Figure 4 shows basic ways of using the IC as a melody generator that uses a 1.5V to 3.5V supply and has either a piezo sounder or a loudspeaker output.

The basic M66T-series IC is manufactured in more than two hundred sub-variants (each indicated by a suffix to the main part number), each of which plays a different tune or abbreviated set of melodies. The table of Figure 5 presents basic 'tune' details of the five most popular and widely available 'English-language Tune' ICs in the range.

The HT381xx Series (Holtek)

The Holtek HT381xx series of melody generator ICs (strangely listed as the 'HT3810' series in the Holtek data book) is far more sophisticated than the UM66T-series or M66T-series devices, and is intended primarily for use in telephone and toys/games applications, rather than in greetings cards. The IC incorporates two tone generators and a 'CHA' sound generator, etc., and can play a tune of up to 128-notes; the IC needs a 2.4V to 5V DC supply, consumes a typical standby current of 10µA, and plays one complete tune each time the supply is connected to the IC.

The HT381xx series of ICs are produces in both 11-pad 'chip' form (for use by bulk-purchase companies) and in standard 3-pin TO-92 package form. Figure 6 shows basic details of the TO-92 package, plus two basic ways of using the IC as a melody generator that uses a 2.4V to 5V supply and has either (b) a piezo sounder or (c) a loudspeaker output.

The HT381xx series of ICs are currently produced in a total of seventy-four sub-variants, each indicated by a 2-part (one numeral plus one letter) suffix to the main part number; each IC variant plays a different English-language tune or abbreviated set of melodies. The available tunes are, for IC

IC Part No.	Song (Tune) Series
HT3810B	Happy Birthday to You
HT3810N	London Bridge is Falling Down + The Training is Running Fast
HT3810W	Old MacDonald Had a Farm
HT3811A	Popeye the Sailor Man
HT3811G	Mary Had a Little Lamb
HT3812A	Greensleeves
HT3812G	Love Me Tender
HT3813A	Jingle Bells
HT3813E	We Wish You a Merry Christmas
HT3813M	Hark, the Herald Angels Sing + The 12 Days of Christmas
HT3814A	You Are My Sunshine
HT3814K	I Just Called to Say I Love You

Figure 8. Tune-play details of twelve popular sub-variants of the HT381xx melody generator IC.

numbering purposes, classified in four basic 'class' groups; the table of Figure 7 shows the basic relationship between the IC numbers and the general class of tune that they play. Figure 8 shows specific tune-play details of twelve popular sub-variant ICs in the basic HT381xx range of devices.

Sound Effects Generator IC Circuits

Sound effects generator ICs are sophisticated but inexpensive and easy to use devices that (usually) contain both tone and white-noise generators and are intended mainly for use in toys and in domestic gadgets such as alarms and doorbells. Very simple ICs of this type generate only one specific type of sound; other - more sophisticated - types can generate several different sound effects.

Holtek are the leading producer of sound effect generator ICs, and produce the devices in both chip and encapsulated versions, and in both custom-programmed and general-purpose form. The rest of this section presents practical usage information on the most popular 'encapsulated' versions of various general-purpose CMOS sound effects generator ICs that are currently available from the Holtek range. When using these ICs, note that many of them have one or more 'TEST' (T) pins, which should be left open when the IC is in normal use. Readers seeking additional up-to-date information on the Holtek range of ICs can access it via the Holtek Web site at **http://www.holtek.com.**

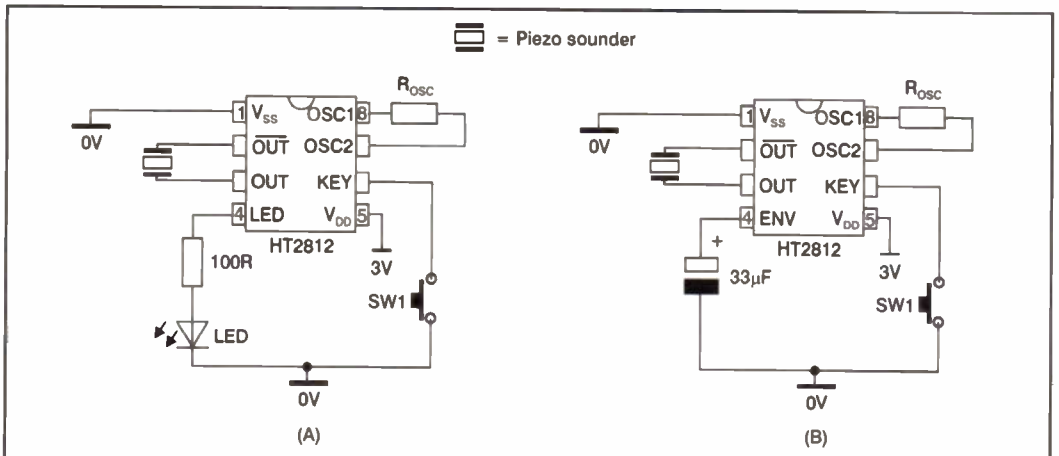


Figure 11. 8-pin DIL HT2812 piezo-output application circuits with (a) LED display and (b) envelope control.

The HT2812 Series (Holtek)

The HT2812-series ICs each generate a single sound effect in an external speaker or piezo sounder; they operate from a 2.4V to 3.3V DC supply, consume a typical standby current of 1µA, have their main oscillator frequency controlled by a single external 'ROSC' resistor, and feature built-in envelope control and automatic power-off action. The series is currently produced in nine popular sub-variants, each indicated by a one letter suffix to the main part number; each IC variant generates a different sound effect, as shown in the table of Figure 9, which also shows the nominal ROSC value for use with each IC variant.

The HT2812 series are produced in three alternative package forms, as shown in Figure 10. The 14-pin DIL type has both LED output and envelope-control (ENV) pins; the 8-pin DIL type has a LED output on pin-4 in the Figure 10(a) variant, or an ENV pin in the Figure 10(b) variant. The

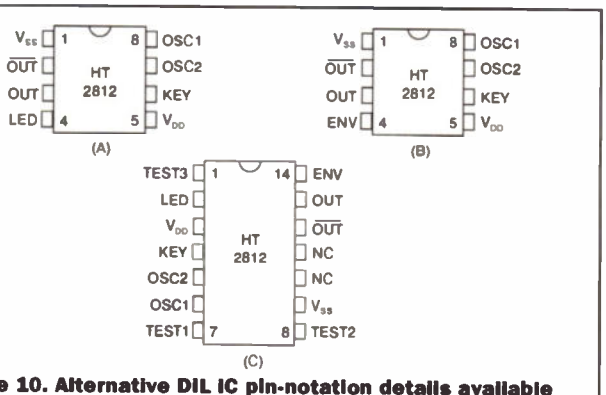


Figure 10. Alternative DIL IC pin-notation details available on the HT2812 range of ICs.

basic action of the HT2812 is such that - with the DC supply wired to the IC - the IC generates one complete sound-play sequence each time the IC's KEY pin is briefly connected to ground (VSS); the LED pin pulses on and off during the sequence, and the IC automatically goes into the 'standby' mode at the end of the sequence.

Figure 11 shows basic ways of using 8-pin versions of the

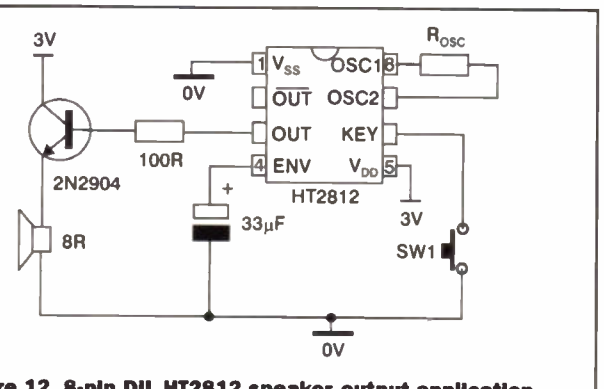


Figure 12. 8-pin DIL HT2812 speaker-output application circuit with envelope control.

IC Part No.	Sound Effect	R_{OSC} Value (nominal)
HT2812A	Aeroplane	390k
HT2812B	Rocket	220k
HT2812C	Siren II	390k
HT2812D	Police Car	150k
HT2812E	Fire Brigade	150k
HT2812F	Siren I	390k
HT2812H	Dialing Tone	390k
HT2812J	Chicken Sound	62k
HT2812K	Ambulance Sound	390k

Figure 9. Sound-play and R_{OSC} details of nine popular sub-variants of the HT2812 sound effects generator ICs

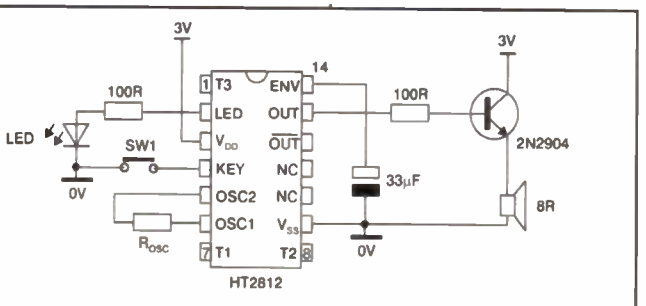


Figure 13. 14-pin DIL HT2812 speaker-output application circuit with LED output and envelope control.

IC Part No.	Sound Effect	R_{OSC} Value (nominal)
HT2813D	Ghost	120k
HT2813E	Bird Song 1	56k
HT2813F	Bird Song 2	56k
HT2813G	Cow	62k
HT2813H	Little Dog	300k

Figure 14. Sound-play and R_{OSC} details of five popular sub-variants of the HT2813 sound effects generator ICs.

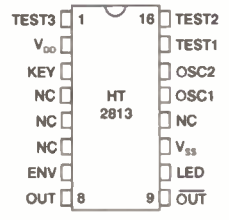


Figure 15. Outline and pin notations of the HT2813 range of ICs.

HT2812 to drive a piezo sounder output, connected between the IC's two 'OUT' pins, and Figure 12 shows the Figure 11(b) version of the circuit modified to drive an 8R0 speaker output via a emitter follower stage. Finally, Figure 13 shows a 14-pin DIL version of the IC configured to give envelope control, with both LED and speaker outputs.

The HT2813 Series (Holtek)

The HT2813-series ICs are similar to the HT2812 type but generate a different range of sound effects and are each encapsulated in a 16-pin DIL package. Figure 14 shows basic sound-play and 'R_{OSC}' resistor value details of the five most popular ICs in the range, and Figure 15 shows the IC's outline and pin notations. Figure 16 shows the basic connections for using an HT2813 IC with a speaker or (shown dotted) a piezo sounder output.

The HT2821 Series (Holtek)

The HT2821-series ICs are similar to the HT2812 type but each generate two different sound effects (each controlled by its own key switch) and are encapsulated in a 14-pin DIL package; they operate from a 2.4V to 3.3V DC supply, consume a typical standby current of 1μA, and have their main oscillator frequency controlled by a single external 'R_{OSC}' resistor. The two most popular ICs in the range are the HT2821A, which generates machine gun and bombing sounds and needs a 180k 'R_{OSC}' value, and the HT2821E, which generates brake and explosion sounds and needs a 560k 'R_{OSC}' value. Figure 17 shows the outline and pin notations of the HT2821 IC, together with the basic connections for using it with a speaker or (shown dotted) a piezo sounder output, but with the ENV facility unused.

The HT2830 Series (Holtek)

The HT2830-series ICs use an 18-pin DIL package and each generate a push-button controlled variable-rate 'base' sound (such as that of a jet engine, a helicopter rotor, or a train), plus two push-button controlled 'fighting' sounds (such as a machine gun and a missile, or a bell and a horn). The ICs operate from a 2.4V to 3.3V DC supply, consume a typical standby current of 1μA, have their main oscillator frequency controlled by a single external 'R_{OSC}' resistor, and have provision for driving two external LEDs, which flash at a rate proportional to the base sound rate.

Figure 18 shows the outline and pin notations of the HT2830 IC, together with the basic connections for using it with a speaker or (shown dotted) a piezo sounder output. The IC's base-sound rate can by increased via SWUP or decreased via SWDN, and the two fighting sounds can be selected via SWA or SWB. The R_{OSC} value is typically in the range 51k (for the HT2830B 'helicopter sound' IC) to 82k (for the HT2830C 'train sound' IC).

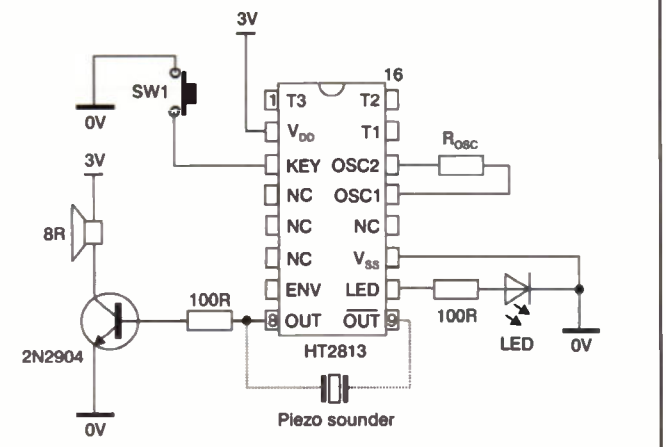


Figure 16. Basic connections for using an HT2813 IC with a speaker or (shown dotted) piezo sounder output.

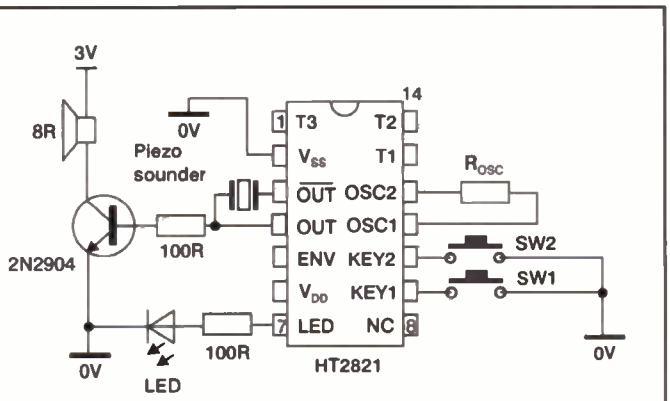


Figure 17. Outline, pin notations and basic usage circuit of the HT2821 IC, with ENV facility unused.

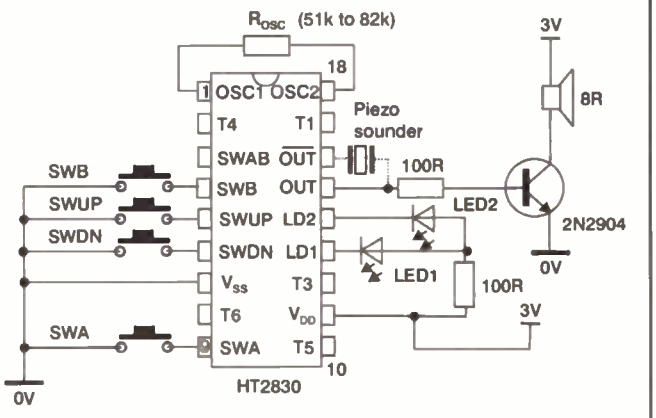


Figure 18. Outline, pin notations and basic usage circuit of the HT2830 IC.

IC Part no. & sound type	Sound 1	Sound 2	Sound 3	Sound 4	R_{OSC} Value (nominal)
HT2844 (toy guns)	Rifle	TV Game	Bombing	M.G.	220k
HT2844C (animals)	Chick	Cricket	Frog	Bird	220k
HT2844M (helicopter)	Rotor (fast)	Rotor (slow)	Explosion	M.G.	270k
HT2844N (racing cars)	Engine (slow)	Engine (fast)	Horn	Brake	270k
HT2844P (jet aircraft)	Jet (slow)	Jet (fast)	Missile	M.G.	430k
HT2844S (morning call)	Phone	Siren	Ambulance	Melody*	560k
HT2844T (alarms)	← 4 different 'alarm' sounds →				220k

Note::- Melody* = London Bridge is Falling Down

Figure 19. Sound play and R_{OSC} details of seven popular variants of the HT2844 sound effects generator ICs.

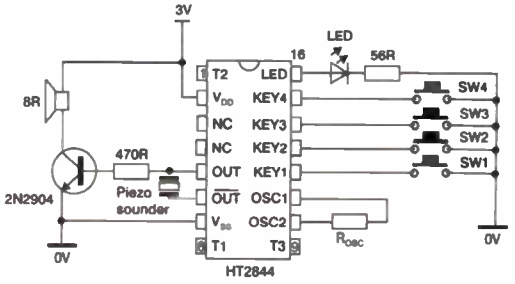


Figure 20. Outline, pin notations and basic usage circuit of the HT2844 IC.

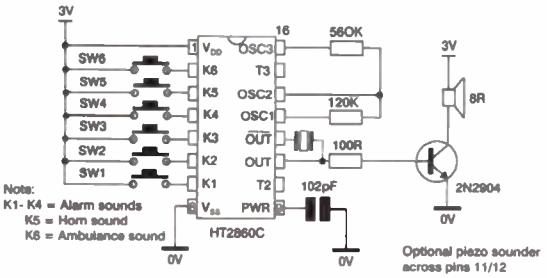


Figure 22. Outline, pin notations and basic usage circuit of the HT2860C IC.

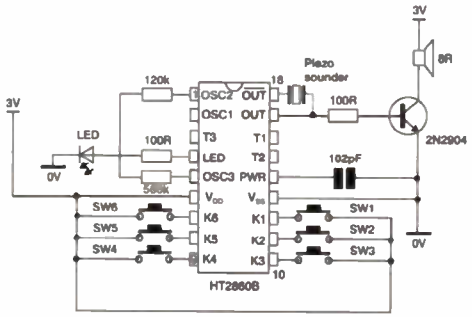


Figure 21. Outline, pin notations and basic usage circuit of the HT2860B IC.

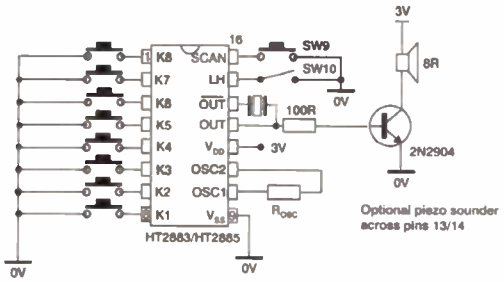


Figure 23. Outline, pin notations and basic usage circuit of the 16-pin version of the HT2883/HT2885 IC.

The HT2844 Series (Holtek)

The HT2844-series ICs use a 16-pin DIL package and each generate four independent push-button activated sound effects. The ICs operate from a 2.4V to 3.3V DC supply, consume a typical standby current of 1μA, have their main oscillator frequency controlled by a single external 'R_{OSC}' resistor, and have provision for driving one external LED. The series contains seven general-purpose ICs, which each generate four sounds of a particular type; Figure 19 shows the sound-play and R_{OSC} details of these seven ICs, and Figure 20 shows the outline, pin notations and basic usage circuit of the HT2844 IC, using either a speaker or a piezo sounder output.

The HT2860 Series (Holtek)

The HT2860-series ICs each generate six different sound effects, which can each be triggered via an external key (K) switch. The six sound effects are priority rated from K1 (highest priority) to K6 (lowest priority); thus, if a single K switch is closed, the associated sound effect plays for the duration of the switch closure, but if a number of K switches are closed simultaneously (say K1, K3 and K5) the IC repeatedly plays through the selected sound effects in their priority sequence (K1-K3-K5-K1, etc.) for the duration of the multiple-switch closure.

The HT2860-series ICs operate from 2.4V to 4.5V DC supplies, consume a typical standby current of 1μA at 3V, have their main timing controlled by two external resistors, have a power-on reset (PWR) feature that is controlled by asigle external 102pF capacitor, and use either a 16-pin or 18-pin DIL package. The two most popular ICs in the range are the HT2860B, which uses an 18-pin DIL package and generates six different alarm sounds, and the HT2860C, which uses a 16-pin DIL package and generates four different alarm sounds plus a horn sound (K5) and an ambulance sound (K6); Figures 21 and 22 show the IC outlines, pin notations and basic usage circuits of these two ICs.

The HT2883/HT2885 Series (Holtek)

The HT2883 and HT2885 series ICs operate from 2.4V to 3.3V DC supplies, consume a typical standby current of 1μA, have their main timing controlled by a single external 'R_{OSC}' resistor, and are each capable of generating eight different sound effects, which are priority rated from K1 (highest priority) to K8 (lowest priority); ICs in the series are produced in 16-pin DIL and/or 8-pin DIL forms.

Figure 23 shows the outline, pin notations and basic usage circuit of the 16-pin DIL version of the HT2883/HT2885, using either a speaker or a piezo sounder output. The basic action of this IC is such that any one of the eight available sound effects can be individually activated by closing its own key (K) switch, or the effects can be activated sequentially - in their priority order - by activating SCAN switch SW9. When the sounds are keyed independently, they are keyed in the 'one-shot' (fixed duration) mode when the LH (level hold) pin is open (SW10 open), or are keyed for the duration of the 'K' switch closure when the LH pin is grounded (SW10 closed). When the IC is keyed in the sequential mode, the sounds scan sequentially throughout the duration of the SCAN key (SW9) closure in the HT2883, or scan one step and then repeat for the duration of the SW9 closure in the HT2885 (this SCAN function is independent of the LH key and is the only difference between the HT2883 and HT2885 versions of the IC).

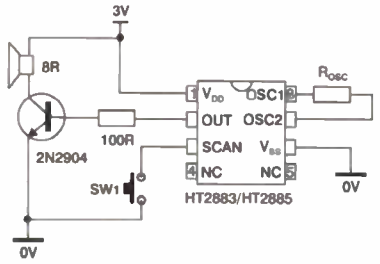


Figure 24. Outline, pin notations and basic usage circuit of the 8-pin version of the HT2883/HT2885 IC.

Figure 24 shows the outline, pin notations and basic usage circuit of the 8-pin DIL version of the HT2883/HT2885, which is designed to drive a speaker output and operates in the sequential scanning mode only.

The HT2883/HT2885 series of ICs are produces in a variety of sub-variants; Figure 25 lists basic details of the six most important and generally-available ICs is the series.

IC Part No.	Manufacturer's Classification of the 8 Available Sound Effect	Available DIL IC Types	R_{OSC} Value (nominal)
HT2883	Toy Gun Sounds	8-pin/16-pin	150k
HT2883E	Submarine War Sounds	16-pin	330k
HT2883F	Helicopter War Sounds	16-pin	330k
HT2883I	Racing Car Sounds	16-pin	330k
HT2885	Toy Gun Sounds	8-pin/16-pin	150k
HT2885D	Toy Phone Sounds	16-pin	270k

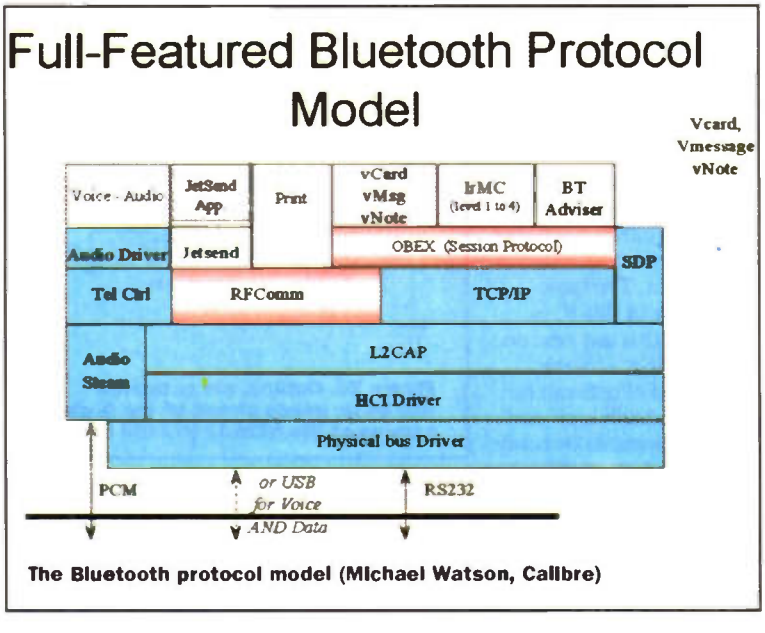
Figure 25. Sound play, IC packaging and R_{OSC} details of the main variants of the HT2883/HT2885 sound effects generator ICs.

TECHNOLOGY WATCH

with Martin Pipe

Here's an interesting peripheral. The C-Pen, from Swedish startup C Technologies, is a new handheld assistant in a pen. It's used rather like an luminous-ink highlighter to scan printed text ranging in size from 7 to 20 point, courtesy of an in-built digital camera with a lens at its tip. The text is converted by OCR (optical character recognition) into machine-readable form, which can be saved and viewed on its 4-row LCD screen. The ASCII text can then be transferred via an IrDA infrared link to the user's PC. Target users, according to C-Pen marketing chief Magnus Manhem, include lawyers, doctors, journalists and anybody else who has to work extensively with the printed word. The device, which will be distributed in the UK by PPCP, weighs just 100g and will yield up to three hours of operation from a single charge of its internal rechargeable battery. Making all this possible is a great British development - a StrongARM processor running at 100MHz - and 8MB of flash memory, 6Mb of which is available to store up to 3,000 pages of printed text. Entries can be located and changed on the pen, using its search and edit functions.

C-Pen's scanning speed is said to be 15 centimetres of text per second. Scanned text can be transferred to a PC, and popular word-processing applications, via IrDA. Text can also be uploaded from the PC to the C-Pen, which runs an operating system known as ARIPOS. C-Pen's built-in software includes a Microsoft Outlook-compatible address book that can store 250 addresses, telephone numbers and email addresses. A dictionary program, meanwhile, allows users to translate individual words into and out of English. According to its developer, the C-Pen will soon also be able to communicate with GSM mobile phones via its IrDA port to send faxes, Short Message Service (SMS) messages and e-mails. All of this is of course great from a technology perspective, and I can't wait to get hold of a C-Pen myself. But then again, it's rather expensive at £350 or so...



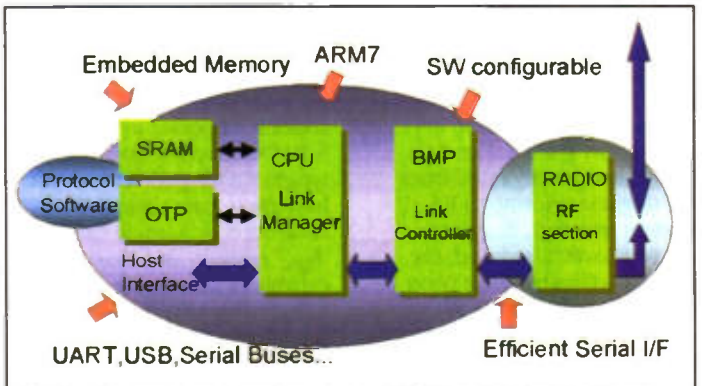
The Bluetooth protocol model (Michael Watson, Calibre)

The C-Pen story goes further, though. Ericsson, the famous telecoms giant that also happens to be Swedish, was obviously so impressed with the C-Pen's potential that it acquired a stake in C-Technologies. If Ericsson starts building the devices in volume, as is predicted, then prices should drop to an affordable level. Ericsson is also developing a new - and even more interesting - version of the pen. This one, which has already been demonstrated at the CeBIT trade show in prototype form, eschews IrDA in favour of a new RF communications protocol known as Bluetooth. If all goes well, the C-Pen could take the honours as the world's first Bluetooth peripheral. That said, the commercial version is more likely to be a 'dual-mode' IrDA/Bluetooth model.

So what exactly is Bluetooth? It is, in actual fact, the name of a cross-industry 'special interest group' that was founded in 1998. The founder members of Bluetooth, which has a web site at http://www.bluetooth.com, include the aforementioned Ericsson, Nokia, Intel, IBM and Toshiba. Since its 1998 beginnings, all manner of telecomm-unications and IT companies have jumped on board, the last count, there were more than 1000 organisations with some kind of involvement. Bluetooth is working towards an industry networking standard that allows digital devices to talk to each other via radio. This opens up all kinds of exciting possibilities, the most obvious being the transfer of data between mobile computers, hand-held peripherals and mobile phones.

Interestingly, the first version of this standard (1.0) is already with us - although the C-Pen prototype demonstrated at CeBIT employed an earlier (0.85) 'beta' protocol. The eventual aim of the group is a OEM (original equipment manufacturer) VLSI chip that contains all of the required digital RF circuitry, an aerial, and software development kits for product developers. Initially, the Bluetooth chipsets will be quite expensive - they could add as much as $30 to the manufacturing cost of a mobile phone. We can thus expect the first Bluetooth-ready phones (and other devices) to be quite pricey. In time, though, the cost could fall to under $5.

Data transfer without wires is hardly a new idea. On many items of modern equipment, including upmarket mobile handsets, notebooks, PDAs and even some printers, you'll find an IrDA port. Current applications of IrDA include wireless printing, and the synchronisation of documents between PDAs and PCs. Some of the latest mobile phones are supplied with SMS e-mail editing software for your PC - the idea being that you type out your text on a full-size keyboard before zapping it over IrDA to the handset. Of course, you can also archive received messages on your PC's hard disk. There are two standards of IrDA. The first, 1.0, could only muster 115.2kbps - although it was eventually followed by 2.0, which supports transfer



This is the hardware architecture of Philips Semiconductors' planned Bluetooth solution

rates of up to 4Mbps.

All of the currently-available OEM IrDA modules, from manufacturers like Sharp, simultaneously support the 1.0 and 2.0 protocols. In a future article, we'll look at how these devices can be used to add IrDA functionality to a desktop PC - few examples of the latter support it as standard. Out of interest, the very latest incarnation of IrDA is said to support speeds of up to 16Mbps - which seems almost impossible (but then again, who would have thought that speeds approaching 56kbps over unmodified phone lines would have been possible five years ago?) This is faster than the 10Mbps Ethernet that forms the basis of most office networks.Bluetooth 1.0, as it stands, cannot manage a gross (the aggregate of transmit and receive paths) rate of more than 1Mbps. It can't, for the present, compete with IrDA in terms of speed. So why bother? After all, speed is everything in the datacomms world! For a start, it's easier to use. You don't need to bother with lining up the infra-red windows of both devices as you do with IrDA. What's more IrDA devices cannot be physically separated by more than a metre, or transfer won't work properly. Because Bluetooth employs low-power radio rather than optical paths, there's no need for line-of-sight. As long as the two Bluetooth devices are within ten metres or so of each other, then they should able to communicate.

Walls won't prove obstructive either, unless they're lined with metal. That 1Mbps will be fast enough for most of the applications that Bluetooth proponents currently have in mind - we'll discuss some of these shortly. Remember that most

As this slide suggests, the ultimate goal of Bluetooth is to enable a whole range of digital devices to talk to eachother (Stephen Nachtsheim, Intel)

people are quite happy surfing the Internet at speeds of 56kbps or - as they are in reality - less. Bluetooth is twenty times faster than the fastest common connect speed of such modems. That's not to say that future applications, as yet unenvisaged, won't demand bandwidths greater than 1Mbps. Future revisions of the spec will probably step up data rates. Look at how IrDA has progressed since its 115.2kbps beginnings - and remember that there's now a 100Mbps Ethernet standard that's fast becoming popular now that prices have fallen...

The short 10m radius of possible Bluetooth communication is a by-product of the low RF powers involved. GSM handsets have a fair range, but they're capable of reaching two watts, when poor conditions call for it. Bluetooth, however, won't go above a milliwatt or so. The reason is simple - power consumption. The lower the power needed, the smaller the battery requirement. Your PDA will operate for longer, and we can expect to see unusual Bluetooth devices, such as personal organiser watches, that simply don't have the space for cumbersome batteries. The prototype Bluetooth chips also offer a 'low power' standby mode, which reduces consumption to a barely perceptible level when the radio functionality isn't actually being used. Interestingly, there are plans to offer versions with increased transmitter power - these could offer ranges as high as 100m. These would be ideal for digital security cameras, and other applications where range is more important than power consumption.

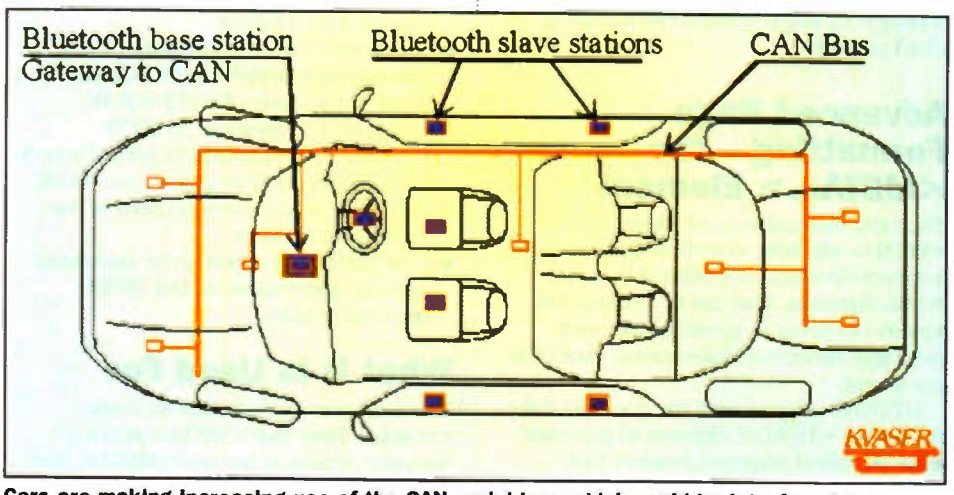
Frequencies? Bluetooth will operate on the licence-free 2.45GHz industrial, scientific and medical (ISM) band. In UK homes, these frequencies are used for the latest breed of video senders and - more importantly - microwave ovens. One could imagine all sorts of problems if you have a leaky microwave oven, or there happens to be one in the immediate neighbourhood. Hopefully, the impressive technology that underpins Bluetooth should provide some guarantee of dependability. Spread-spectrum and frequency-hopping technology were, until recently, unheard of outside the field of military communication. Bluetooth will use these techniques to automatically find available radio channels, and retune if interference is experienced.

Indeed, each 'packet' of data is transmitted on a different frequency 'hop' - which helps to reduce the possibility of unauthorised interception by hackers. The design also addresses the issue of congestion - in some areas (central business districts, for example), there could be a lot of Bluetooth activity going on, even within that ten-metre radius. Authentication and encrytion is also supported, as another deterrent to hackers. Bluetooth will also support up to three simultaneous voice channels, or mixed data/voice. This opens up the worlds of multi-player gaming, technical support and simultaneous talk and fax/e-mailDAB was on demonstration, courtesy of the BBC and commercial competitor Digital One.

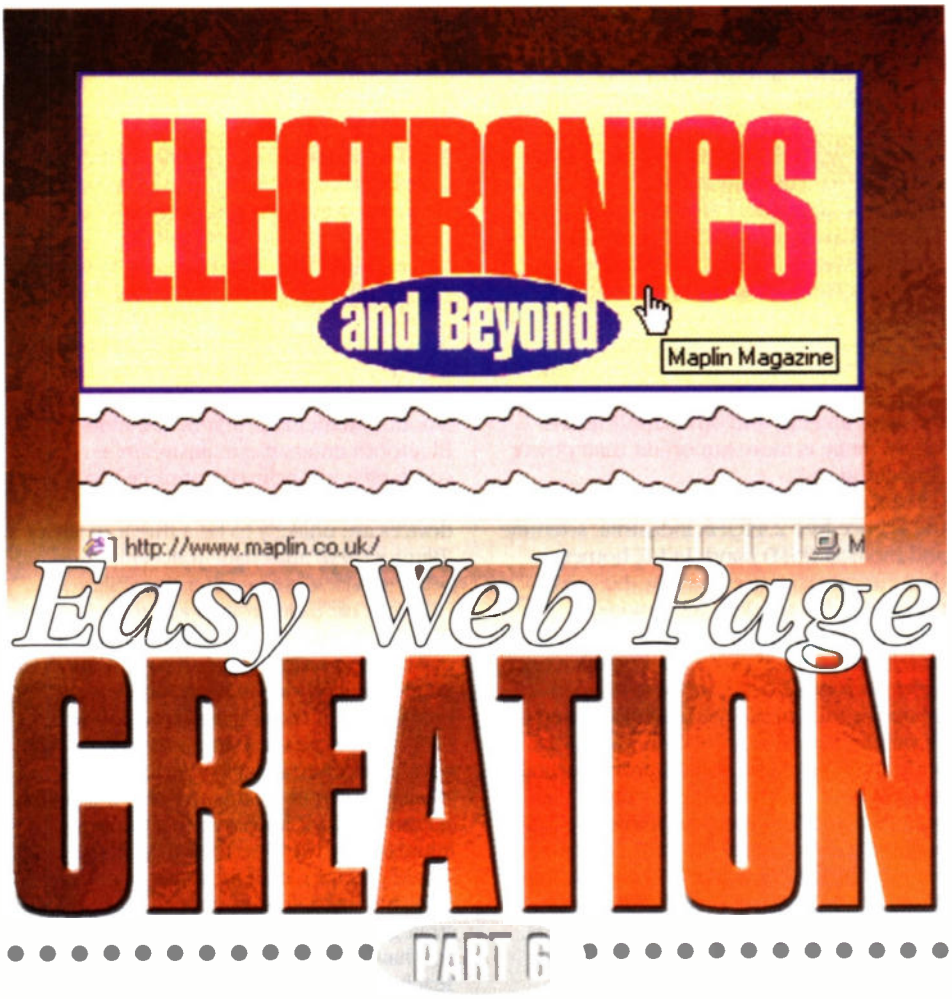
Ericsson reckons that by 2002, Bluetooth will be a built-in feature in more than 100 million mobile phones. We could also see it as a standard fixture in several million other communication devices, ranging from headsets and portable PCs to desktop computers and notebooks. The touted applications are quite exciting, and perhaps explain Ericsson's seemingly-optimistic figures. Imagine being able to pay for your petrol automatically, for example. The pump would handshake with your next-generation mobile phone/PDA - which would contain encrypted credit details - before filling up. As soon as you've poured the petrol in your tank, the pump would arrange for your account to be debited by the appropriate amount. Remember that by the time Bluetooth enters the mainstream, e-commerce will be commonplace too. The low RF power emissions of Bluetooth devices are unlikely to be a threat to safety. 'Bluetoothed' automatic tollbooths, and other services, are another possibility.

If your car's electronics was to be Bluetooth-enabled, it could automatically dial out to a roadside repair organisation via your mobile phone in the event of a breakdown. If the car was equipped with a GPS receiver or some other form of navigation, then details of its location could also be transmitted. Imagine also a wireless school network, where each student is equipped with a Bluetooth PDA. They would receive e-mail messages from teachers and fellow students via strategically-placed Bluetooth access points, and have access to on-line databases. Teachers would also be able to keep track of attendance. Bluetooth could also considerably enhance consumer electronics. A digital camera capable of quickly transferring stored pictures to a PC without wires is an obvious one. So too are information services in museums and other public locations. But what if the technology was to be introduced to personal MP3 players? One can imagine MP3 kiosks cropping up in supermarkets and record stores. Pay your money (or e-cash), and the songs of your choice would be quickly transferred to the player's memory. No wires, and no messing around with memory cards. Clearly, Bluetooth has a bright future ahead of it.

Martin Pipe welcomes comments and ideas. E-mail him as: *whatnet@clx.compulink.co.uk* Or look out for him online! His ICQ ID is: 15482544



Cars are making increasing use of the CAN seriel bus, which could be interfaced to a Bluetooth transciver - thus enabling all kinds of exciting new applications (Kvaser)



Easy Web Page CREATION

PART 6

In part 6, the final part, Mike Holmes discusses enhanced layout design -

METAs, STYLEs and Forms

In the last part of this series we will try to tidy up all the loose ends, things that can be done with an HTML page not discussed so far. Not yet mentioned, for example, is the use of form elements, also, having created and uploaded a working Web site, with all your information on it that you really have a burning need to tell the world about, how does anyone know that it actually exists? There are so many millions of sites on the Web already, you need a means to inform others that your site is now available, and this is usually achieved by adding your site to a Web search engine. Don't go away!

Advanced Page Formatting – The <META...> Element

The Meta element is used within the <HEAD> element to embed document information that is not defined by other HTML elements. This can be extracted by servers or clients to identify, index and catalogue specialised information about the document.

HTTP servers can read the content of the document <HEAD> element to generate what are called response headers that correspond to any Meta elements defining a value for the attribute HTTP-EQUIV. As the author of the document, this provides you with a mechanism (though not necessarily the preferred one) for defining specialised information that will be included in the response headers for an HTTP request. <META> statements must be contained within the <HEAD> element, commonly, in front of the <TITLE> element.

The attributes of the <META> element are:

- HTTP-EQUIV binds the element to an HTTP response header. If not present, the NAME attribute must be used to identify this meta-information.
- NAME meta-information name. If not present, then NAME can be assumed equal to the value of HTTP-EQUIV.
- If you want to generate an HTTP response use HTTP-EQUIV only. If you do not want an HTTP response, use NAME only. You should not need both in the same Meta element.
- CONTENT the content to be associated with the given name and/or HTTP response header.

What It Is Used For

This is all very unclear without some examples. Note that <META> is not a 'wrapper', that is, it has no </META> part. Its sole contents are its attributes. So, if the document contains:

```
<META HTTP-EQUIV="Expires" CONTENT="Mon, 25
Oct 1999 14:34:02 GMT">
<META HTTP-EQUIV="Reply-to"
CONTENT="me@my.domain.uk <Joe Smith">
<META HTTP-EQUIV="Content-Type"
CONTENT="text/html; charset=iso-8859-1">
```

Then the HTTP response header would be:

```
Expires: Mon, 25 Oct 1999 14:34:02 GMT
Reply-to: me@my.domain.uk (Joe Smith)
Content-Type: text/html
Charset: iso-8859-1
```

The 'Expires' option is supposed to alert the server or client that the page has expired and so a new version should be sought from the domain, but it only works if the browser or the server software can respond to it. Because you have no control over what software is available on the server of free Web space, it is fairly safe to assume that 'Expires' is unlikely to work as you anticipated, so it can be ignored.

If the NAME attribute is used in place of HTTP-EQUIV, then the server should not generate an HTTP response header for this meta-information – instead, you effectively get a new 'custom' element. Hence, arbitrary data not catered for by any conventional element can be included – a common example is:

```
<META NAME="Originator" CONTENT="My Word
Processor program">
```

meaning (usually) the software that was used to create the page. Other well-used variations include the likes of:

```
<META NAME="Description" CONTENT="My
Homepage. Start here for main links to other
pages">
<META NAME="Locale" CONTENT="EN-UK">
<META NAME="Catagory" CONTENT="home page">
```

You must not use the Meta element to define information that should be associated with an existing HTML element. An example of an inappropriate use of the Meta element is:

```
<META NAME="Title" CONTENT="My Hobbies">
```

because there is already a <TITLE> element for this purpose.

You should avoid naming an HTTP-EQUIV equal to a responsive header that is typically only generated by the HTTP server. Some inappropriate names are 'Server', 'Date' and 'Last-modified'. Whether a name is inappropriate depends on the particular server implementation.

Server Push And Client Pull

The <META> element is particularly useful for constructing what are called 'dynamic documents':

Server Push - In server push, the server sends down a page. The browser displays it but leaves the connection open. Whenever the server wants to send more it does so and the browser displays that. However, this requires special server-side software that, again, you would not be allowed to put onto

free Web space, so the Server Push method can be ignored.

Client Pull - Here the client browser requests a page as normal, but which includes a directive, written as a HTTP response meta statement in the document header, that says effectively "reload this page in 5 seconds", or "load this other URL in 10 seconds". After the specified amount of time has elapsed, the client does what it was told, and either reloads the current page or gets the new page.

One simple application of client pull is to cause a document to be automatically reloaded on a regular basis. For example, consider the following document:

```
<HTML>
<HEAD>
<META HTTP-EQUIV="Refresh" CONTENT=10>
<TITLE>Document ONE</TITLE>
</HEAD>

<H1>This is Document ONE!</H1>

<P>Here's some text. </P>
</HTML>
```

Where loaded into a browser supporting dynamic documents through client pull, it would re-load itself every ten seconds.

In this example it means that an "infinite loop" situation is set up, in that the same page keeps reloading itself from the domain. The only way it can be interrupted is by pressing the browser's 'Back' button or by some other means that goes to a different URL, or by closing the current window, and it is quite frankly a bit pointless aside from being an interesting experiment.

Crude Animations

Client pull is much more useful if used to cause another document to be loaded in place of the current one. This makes a form of simple 'animation' possible, where for example you could have some sort of title displayed in an upper frame (see Part 5 about frames), the contents of which changes periodically without user intervention. The kind of HTTP response header to do this will look like:

```
<META HTTP-EQUIV="Refresh" CONTENT="10;
URL=http://my.domain/document2.html">
```

Important: the URL needs to be fully qualified as 'http://whatever/whatever'; it cannot be a relative URL.

Take the case then that "document2.html" comprises:

```
<HTML><HEAD>
<META HTTP-EQUIV=REFRESH CONTENT="10;
URL=http://my.domain/document1.html">
<TITLE>Document TWO</TITLE></HEAD>

<H1>This is Document TWO!</H1>

<P>Here's some other text. </P>
</HTML>
```

On loading either one of the documents, the browser will load the other in ten seconds, then the original one, then the second again and so on forever. The technique can be used to create endlessly repeating 'banner' like messages; the disadvantage is that the browser must be on-line for the duration else a failed connection error occurs.

How do you make it stop? The easiest way is to either close the window, or put a hyperlink in one or all of the documents that points to another URL, and that page does not have a 'Refresh' meta statement.

The interval can be 0 seconds! This will cause the browser to load the new page as soon as it possibly can (after the current page is fully displayed).

The page can have anything on it that a page can normally carry, including pictures. You could have a series of pages chained together, that display in sequence automatically, rather like a 'tutorial'. Furthermore, the last page may also reload the first page, setting up a loop.

Getting Your New Web Site Registered With A Search Engine

Of much more interest to us at the moment, however, is this type of meta statement:

```
<META HTTP-EQUIV="Keywords"
CONTENT="Electronics, Audio, Video, Radio,
Kits, Maplin">
```

This is of particular relevance when it comes to registering your Web site with any of the popular Web Search Engine sites. It is highly likely you have used one of these already, such as "Alta-Vista", "Lycos", "InfoSeek", etc. Using one of these search engines is still the only way of locating Web pages by the subject you are interested in. The process that the search engine uses to generate a listing of sites according to what is typed in its 'Find' input field is performed by – you guessed it – matching keywords!

So, now that you have got a running Web site with one or more pages with keywords type meta statements, how do you add it to one of these search sites? If you load any of the Web search sites you should find on it somewhere a button or a hyperlink labelled something like "Add a site" or "Add my site", etc.

A fair number of the most well known (and well used!) search engine sites can be found on the page: http://www.demon.net/inews/search.html.

In every case your Web site can be 'registered' with one of these free of charge. Read the instructions where applicable, and follow them. You should only register your site with any one search site once, and not repeatedly every time you have changed something, in case you think it won't know about the changes! The reason is that, once registered, your site is (or should be) re-examined periodically for any updates.

'Crawlers' And 'Spiders'

The typical sequence of events is that, at some point after you have entered the details in the 'Add a site' form page and submitted it, the search site actually visits and explores your Web site using a piece of software commonly known as a 'Web Robot', or, more colloquially, a 'Web Crawler' or 'Spider'.

Typically, the 'Web Robot' is particularly interested in pages having "HTTP-EQUIV=Keywords" meta statements, because it will be these keywords that will finally be added to the search engine's main index. Thus, ultimately, when someone types a word or phrase that matches one or more of your keywords in the 'Find' field of the search engine then (hopefully!) it includes your page in its list.

Figure 1 illustrates the sort of style these lists take (styles vary). The significant points are as follows:

- The title of the entry (shown in blue in Figure 1) is taken directly from the <TITLE> element of the page.
- The descriptive paragraph of words that follows it is taken directly from the CONTENT attribute of: <META NAME="Description" CONTENT= (etc.) in the <HEAD> element. Failing this, or alternatively, it is taken from the first few lines of the visible text on the page (in the <BODY> element).

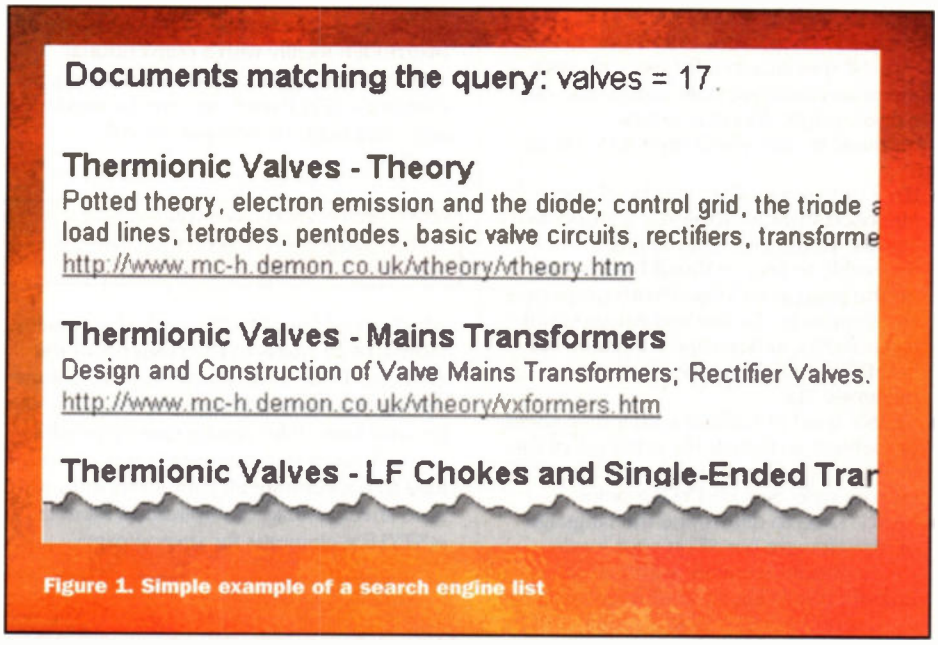


Figure 1. Simple example of a search engine list

- Not least, the search engine found the entry in the first place because the 'Find' field contents matches one or more of the keywords supplied in the page's <META HTTP-EQUIV="Keywords" CONTENT= (etc.) element!

You should not try to create a block of text in the <BODY> element as the list of keywords – this seems to have been a common misconception amongst amateur Web authors – indeed some search site instructions specifically ask that you don't do it. This is because the first lines of the text are quite likely what will be used as the description of the entry, and an obscure list of keywords would not make much sense.

It should be pointed out that registration may not take place immediately. It may be several days before the 'Web Robot' can get around to visiting your site – there has so many other places to look at after all – so trying to find your site with the same search engine is unlikely to succeed within five minutes (or even five days, perhaps) of adding it.

Similarly, you should consider carefully what keywords you want to include. The more the merrier is not necessarily true; what you need are ones that are specific to your page's contents but without being too obscure, yet at the same time must not be too generalised or vague. A good balance can be struck between the fairly obvious and the more specific so that as the user recomposes the search phrase to narrow the search, you page still has a chance. For instance, in the HTTP response header:

Keywords: Radio, Communications, HF, Amateur Radio, Radio Ham

the phrase 'Amateur Radio' is a narrower search than just 'Radio' but the page is still listed. Don't forget, your page is competing with possibly millions of others in the same subject range!

Advanced Page Formatting – The <STYLE> Element

Most HTML elements have several common attributes, such as ID, LANG, STYLE, DIR and CLASS. These were extensions to the HTML 2.0 specification, for use with such features as 'cascading style sheets' and on-the-page scripts, and may not be recognised by older Web browsers. These are:

- ID: a unique identifier for the element. In Microsoft Internet Explorer, it works as a 'handle' to the element making it accessible to Java or Visual Basic script on the page as an 'object' with properties' and 'methods'. To also make it accessible to JavaScript in Netscape Navigator, set 'NAME' as well; Netscape does not recognise 'ID'.
- CLASS: used in tandem with a style sheet or element to format the contents of the element, specifies the unique name of a custom style. See <STYLE> below.
- LANG: used to determine the language of the element based on your locale. 'en.uk' should compare with British English, but trying to set this element has caused problems, so don't bother with it.
- DIR: used with the LANG attribute, defines the direction of text, right-to-left or left-to-right. Again, ignore it (unless you live in China).
- STYLE: sets a formatting style for the contents, syntax as per the <STYLE> element and style sheets.

The <STYLE> Element

Inserted into the <HEAD> element, it offers an alternative (and in many cases, a more sophisticated) way of controlling the appearance of the document as compared to using <FONT>. <STYLE> is a wrapper containing one or more definitions that control typesetting and layout. A typical syntax is:

```
<STYLE TYPE="text/css">p {font-family:Times
New Roman, TimesRoman; font-size:11pt;
color:#000000;}</STYLE>
```

Because 'p' corresponds to 'P' in '<P>', it means that the contents of all <P> elements on the page adopt this style. This is very much more efficient than using umpteen instances of <FONT>, because if you want to change the overall appearance, you only need to actually change this one thing to alter the complete document.

It is especially useful in large tables. Because text in every table cell must be defined individually with <FONT> if something other than the browser's default display is required (the <FONT> element cannot be used to enclose an entire table), it becomes extremely complicated to organise if there are many cells.

Instead, if 'p' in the above style is 'td' (matching <TD>), then every cell adopts the style and the document is considerably less 'verbose' in terms of coding.

Or, you can make up a name of your own to create a custom style. In this case, each element that you want to apply the style to must have this name assigned to its CLASS attribute. The advantage of this method is that you can choose exactly which elements use the style, instead of the 'blanket' method where every matching element is changed.

Usually, a style setting of this sort may be overridden locally with a conventional <FONT> setting method. Alternatively, an element's STYLE attribute may be used to add extra features to conventional methods:

```
<FONT [conventional settings]
STYLE="{margin-left:14px; text-indent:-
14px;}">
```

which should apply what's called a 'hanging indent' of 14 pixels to the contents of the element. There is no conventional attribute setting that does anything like this, so it can be seen how styles can be quite powerful.

If you use styles extensively, it is a good idea to concentrate all your styles into one style sheet instead of duplicating identical <STYLE> elements for several pages:

```
<LINK HREF="styles/common.css"
REL="STYLESHEET">
```

The above is again inserted into the <HEAD> element. The style sheet merely comprises a series of text lines, each of which is in the format 'element name { settings }'. It is beyond the scope of this article to go into all the different element names and possible settings; for more information refer to the examples in: http://www.mch.demon.co.uk/maplin/styles.htm.

All that can be said in summary is that styles allow HTML documents to be formatted by more professional typesetting techniques, such as you might use in a DTP program. Specifying '12pt' is somewhat less ambiguous than '<FONT SIZE=3>' – the only snag being that the client browser must be able to recognise and use styles.

Forms

The major difference between the HTML specification 2.0 and its predecessors is the inclusion of the Form elements. These allow user input in HTML documents – typical uses are for returning comments to the Web site author, questionaires, order forms, 'guestbook' entries, etc.

The following elements are used to create a form:

```
<FORM> ... </FORM> - A form within a
document.
<INPUT ...> ... </INPUT> - One input field.
<SELECT> ... <SELECT> - A selection list.
<OPTION> - One option within a Select
element.
<TEXTAREA ...> ... </TEXTAREA> - A multi-
line input field.
```

Each variable field is defined by an INPUT, TEXTAREA, or OPTION element and must have the NAME attribute set to identify its value in the data that is returned when the form is submitted.

The <FORM> Element

The Form element wrapper defines its contents as a data input form. There can be several in a single document, but Forms cannot be nested.

The ACTION attribute is a URL specifying the location to which the contents of the form is submitted to elicit a response. If the ACTION attribute is missing, the URL of the document itself is assumed. The way data is submitted varies with the access protocol of the URL, and with the values of the METHOD and ENCTYPE attributes. In general, the METHOD attribute selects variations in the protocol. The ENCTYPE attribute specifies the format of the submitted data in case the protocol does not impose a format by itself.

For most practical purposes, a form is best handled by a CGI (Common Gateway Interface) script on the server. This implies that your ISP makes such a script available, as in:

```
<FORM ACTION="/cgi-bin/mailform"
NAME="MailForm">
```

This is a compiled script called 'mailform' in

sub-folder 'cgi-bin' off the Web space root domain, '/'.

The default METHOD is GET, although alternatively the POST method may be used if the form can be sent as e-mail. With the post method, the ENCTYPE attribute, if used, is a MIME type specifying the format of the posted data. By default this is 'application/x-www-form-urlencoded'.

```
<FORM ACTION="mailto:your-
email@your.domain.com" METHOD="POST"
NAME="MailForm">
```

The giant fly-in-the-ointment with this is that it requires that the user possesses e-mailing software able to accept the form data as given, following that the browser invokes it in response to the 'mailto:' protocol. It may be compiled into a single line that looks like:

```
mailto:your-
email@your.domain.com?subject=MailForm&Item
1=yyyy&Item2=zzzz etc.
```

If the e-mailing software can't make head or tail of this, it won't work.

Under any protocol, the submitted contents of the form logically consist of name/value pairs. The names equal the NAME attributes of the various elements in the form. In the above, 'Item1' has the value 'yyyy', 'Item2', 'zzzz'. This is why every form element must have a NAME.

There are two example pages demonstrating each type of action protocol at: http://www.mc-h.demon.co.uk/maplin/ as testfrm1.htm and testfrm2.htm. Figure 2 shows how the input elements appear on these pages.

Version 1 uses the e-mail method and generates the string:

```
mailto:your-
email@your.domain.com?Subject=TestForm&Form
Type=Demo&Name=me&Email=your-
email@your.domain&Locale=United+Kingdom&
Comment=Some+text+here.
```

whereas version 2 has a quite different result. In this particular case, the CGI script formats the data into an e-mail message that is then posted to the webmaster of the site. The essential parts of this received e-mail appear as follows:

```
From: webmaster@this.domain
Subject:
http://www.this.domain/testfrm2.htm
To: webmaster@this.domain
```

```
----- BEGIN FORM -----
Subject         TestForm
FormType        Demo
Name            me
Email           your-email@your.domain
Locale          United Kingdom
Comment         Some text here.
btn_submit      Send...
----- END FORM -----
```

'Subject' and 'FormType' are names of INPUT elements of type HIDDEN, that is, invisible, which do no more than describe what this form is (with the exception that 'Subject' defines the subject header of the e-mail in the POST e-mail method). 'Name' is the text input field on the page beside 'Name' in Figure 2, 'Email' is the second text field, 'Locale' is the dropdown list below that, and so on.

The SUBMIT button, called here 'btn_submit', is a special type of INPUT used to e-mail the form or send its contents to the server as specified by the ACTION attribute. In Figure 2, the 'Clear' button is of type RESET which resets the fields to their initial values. To see how these elements are written, see: http://www.mch.demon.co.uk/maplin/testfrm2.htm.

Other Types Of <INPUT>

Although there is only one INPUT element, its use and function is set by its TYPE attribute:

- BUTTON: a button for any purpose other than SUBMIT or RESET. Normally the required action has to be performed by on-the-page script.
- CHECKBOX: a square that can be 'checked' or 'unchecked'.
- HIDDEN: an invisible field, but which is sent with the submitted form. Its value may be any other arbitrary information.
- IMAGE: An image as specified by the SRC attribute, exactly as for the <IMG> element.
- PASSWORD: same as the TEXT attribute, except that text is not displayed as it is entered.
- RADIO: a roundel used to set a single value from a set of alternatives. Each radio button field in the group should be given the same name. Only one in each group can be selected at a time, and only the selected button in the group generates a name/value pair in the submitted data, hence radio buttons require an explicit VALUE attribute to identify which one it is.
- TEXT: a single line text entry field.
- TEXTAREA: a multi-line text entry field with vertical scroll bar.

The dropdown list in Figure 2 is a SELECT element. It allows the user to choose one of a set of alternatives described by textual labels. Every alternative is represented by the OPTION element:

```
<SELECT NAME="flavour">
<OPTION VALUE="Vanilla">Vanilla
<OPTION VALUE="Strawberry">Strawberry
<OPTION VALUE="Rum and Raisin">Rum and
Raisin
<OPTION VALUE="Peach and Orange">Peach and
Orange
</SELECT>
```

The Option element can only occur within a Select element, and represents one choice. If VALUE is omitted, the displayed text is assumed. If no option is initially marked as selected, then the first item listed is selected.

Designing forms is a complex subject, so before experimenting you are recommended to read the descriptions for the various form elements on the page:

```
http://www.mch.demon.co.uk/maplin/glossary.
htm.
```

Form elements are not very useful if you are unable to use them for what they were initially included in the HTML specification for, namely, enabling clients to post information entered on pages back to yourself as the originator of those pages. Except, that they are also useful for providing input for scripts, thereby turning your pages into mini-programs – as though all of this wasn't complicated enough already!

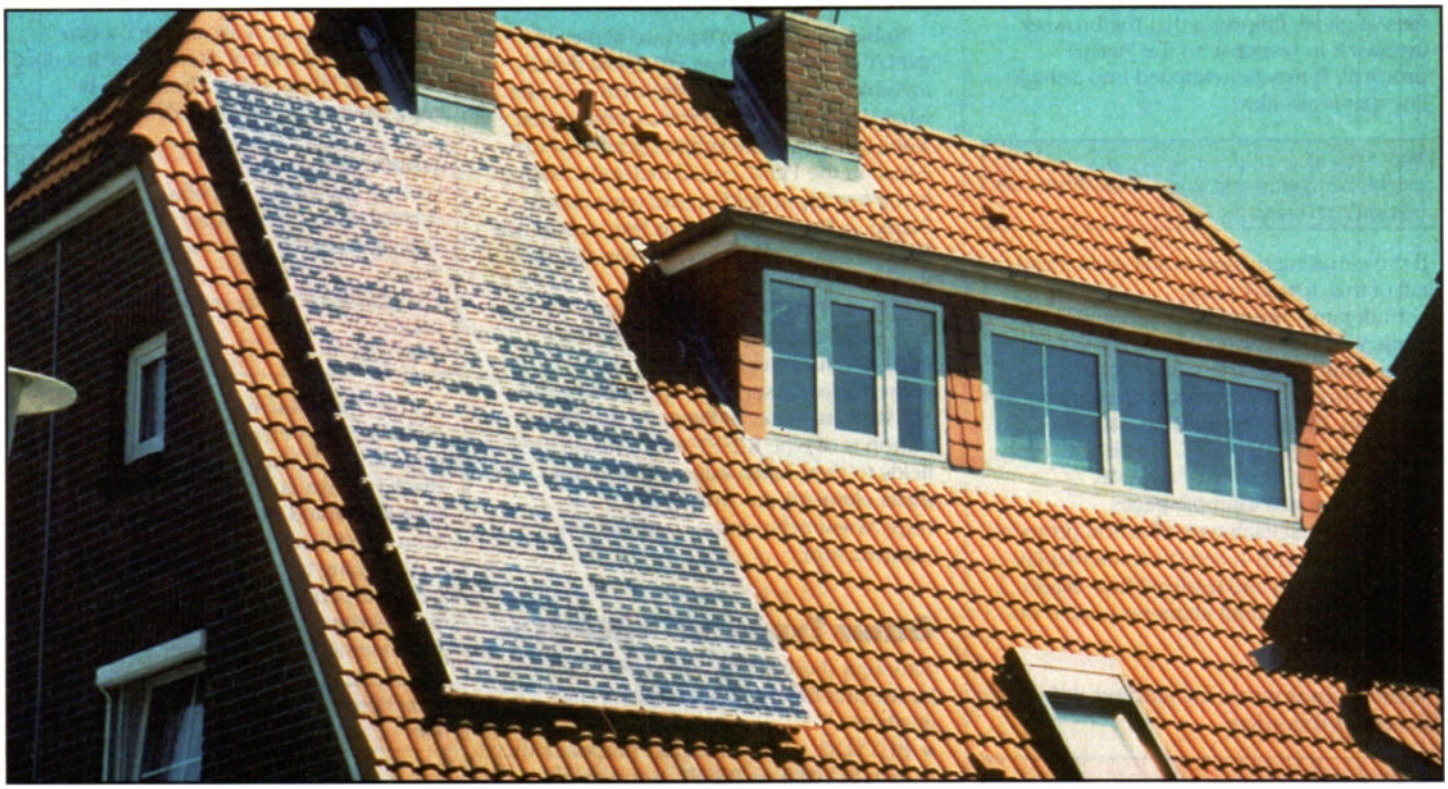
Figure 2. Example of a user input form

Solar Electricity

THE DOMESTIC SITUATION

PART 2

Paul Freeman-Sear reports on the future potential of Photo-voltaics for the home.



Solar power is now being installed increasingly in commercial installations around the world - a fact highlighted in last months article. However, little emphasis has been placed on domestic installations. The typical solar panel home installation has not been popular particularly in the UK. The reasons for domestic installations not taking place in the UK are many fold from the purchase and installation cost being too high to the ill conceived perception that that the amount of sunlight we receive on any one day is just not worth harnessing.

This latter notion couldn't be more from the truth. Just witness the fact that thousands of solar electric homes are being built around the world. Norway has in excess of 50,000, Germany 3000 and Japan aims to have 62000 new homes equipped with solar electric panels by the year 2000.

It is estimated that the total amount of solar energy falling on Britain's buildings could meet almost two thirds of our electricity demand.

Any Incentive?

With most people wishing to wear a 'Greener hat' these days, in the knowledge that solar electricity can save thousands of tons of greenhouse gas (CO_2)emissions, it is surprising that the subject of solar electricity in the UK should not have become a political issue. As yet there are no government subsidies towards installations in the UK.

Over in mainland Europe, subsidies are available in Germany where typically 70% of the capital cost can be reclaimed. There is also the issue of the big differential in cost of electricity when it comes to importing and exporting electrical energy.

In Britain, electricity consumers typically would pay about 7p a unit (kWh) for its usage from their supplier. In comparison, surplus electricity generated from on-house PV panels will only provide a return at around 2.8p/unit. In Germany the electricity companies are legally obliged to pay the solar electric generators some 90% of the price they charge for domestic electricty. Maybe one day we will see an EU directive for more favourable import and export electricity tariffs.

Some Useful Large Numbers

Total solar energy falling on UK per annum	222,180TWh
Solar energy falling on UK buildings each year	1614TWh
UK Annual Electricity consumption	300TWh
Annual generating potential of solar electric in UK	200TWh

Household requirements

So what is typically required for a household to become solar powered? First you need the space or an area to devote to the panels themselves. If one goes for the more efficient monocrystalline or polycrystalline panels of between 12-15% efficiency and 11-14% respectively then about an area of 20m² is required. This area is typically available on a roof or might be available in a garden. The roof should ideally be south facing for maximum return. If not then the panels could be maximally orientated due south on the ground at about 35 degrees to the horizontal.

Power generated

Such an area would achieve 2kW$_p$ output in good conditions and provide around 1500kWh per year. This might typically contribute about 43% of the household annual electricity needs - any surplus electricity being exported to the grid. These crystalline panels are normally guaranteed

for at least ten years and will produce generally 90% of their rated power output after that. The raw variable DC output is fed via protection equipment to power inverters. The job of the inverter is to convert the DC output to AC mains and can either be one high power unit or several smaller low power units running in tandem.

If there is a requirement to export electricity into the grid the inverters must produce a synchronous 50Hz AC output. Power output will also vary throughout the year, the peak occurring in June where in excess of 7kWh/day can be achieved to just above 1kWh/day in mid winter. From this, a mean power of 4.1kWh can be typically achieved and thus a total of 1500 units a year.

Costs

A complete installation one off purchase cost, is currently around £5-6 per peak watt. So for a 2kW installation this would vary between £10,000 - £13000.

If bulk purchasing is operating say through a developer installing in a series of houses, the cost comes down to around £8000 - £9000. It should be emphasised that this cost includes complete installation and maintenance costs. These sorts of figures result in actual cash payback periods of hundreds of years and on the normal scale of things would be considered totally uneconomic at the moment. Table 1 shows a typical breakdown of figures for a 'one-off' purchase.

Table 1

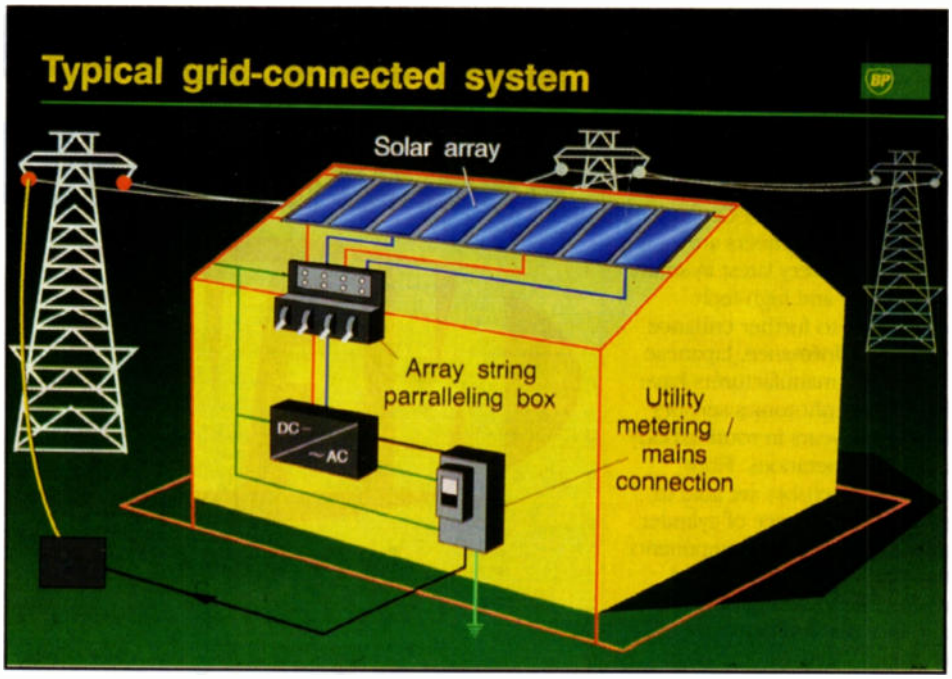
For a 2kW$_p$ System	Average estimated cost
PV Modules	£8180
Inverter	£2120
Balance of system costs	£1080
Installation	£1860
Total	£13240

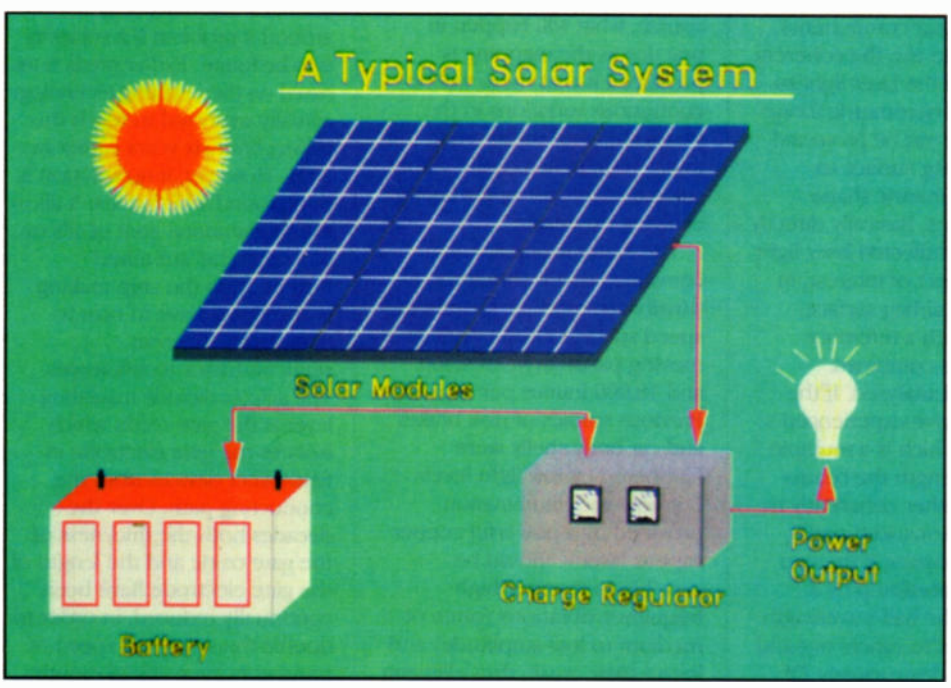
Figures supplied by Greenpeace

Two main areas have to be considered here for the future. The first is that the cost of installed systems has to drop significantly for it to become attractive. As can be seen from the price breakdown, greater mass production of the Photo Voltaic panels could bring significant reductions along with many more competitor companies selling panels. Again the same applies to the cost of the inverters.

Secondly, the price paid per unit to the solar electric generator (in this case the consumer) to the price per unit imported has to achieve parity ie import and export electricity are the same price to provide a suitable incentive. This second point would make a great deal of difference because experiments have shown that if a system is installed between 2-4kW$_p$ on a house, the house could become a net exporter of electricity depending on household consumption. This knowledge alone, one of having zero electricity bills would drive the whole domestic solar industry forward very quickly in the new-build sector.

For now though it makes better sense to use as much of the solar generated electricity on site as possible. Current average consumption is based on solar electric trials in Germany where typically 45% of the solar electricity is used and 55% exported. Much of this export occurs because of non use in the daytime. As we know, greatest domestic electrical demand comes in the evening time, at a time when Photovoltaics cannot produce electricity. Turning the surplus of daytime electricity into storage means that some of the electricity or other forms of energy can be reclaimed when dark. Common sense applications would be to heat your domestic hot water by the surplus electricity throughout the day, charge batteries (including electric vehicles for urban cycles) and generally store the electricity in other forms of potential energy.





In conclusion

As was highlighted from last months article, there are many different areas of research into converting light to electricity.

The results of that research could mean that efficiencies greater than the current 17-18% will be achieved. Also a much cheaper manufacturing technique might prevail. The outweighing benefits of solar electricity could then provide an extra feature in the battle to sell new homes in the future particularly as the general cost of maintaining a home could take a greater proportion of the household income.

Points of contact

Thanks go to Greenpeace for supply of information and to Mark Hammonds of BP Solarex.

BP Solarex has 4 distributors in the UK. They are:

BECO Solar,
Devon Tel:01803 833636
URL: **www.becosolar.com**

Dabbrook Power Systems,
Great Yarmouth Tel: 01493 441711
URL: **www.ncsl.co.uk**/onsite.html

Marlec Engineering Co Ltd.,
Corby Tel:01536 201588
URL: **www.marlec.co.uk**

Wind and Sun,
Leominster Tel: 01568 760671
URL: **www.windandsun.co.uk**

RESEARCH NEWS

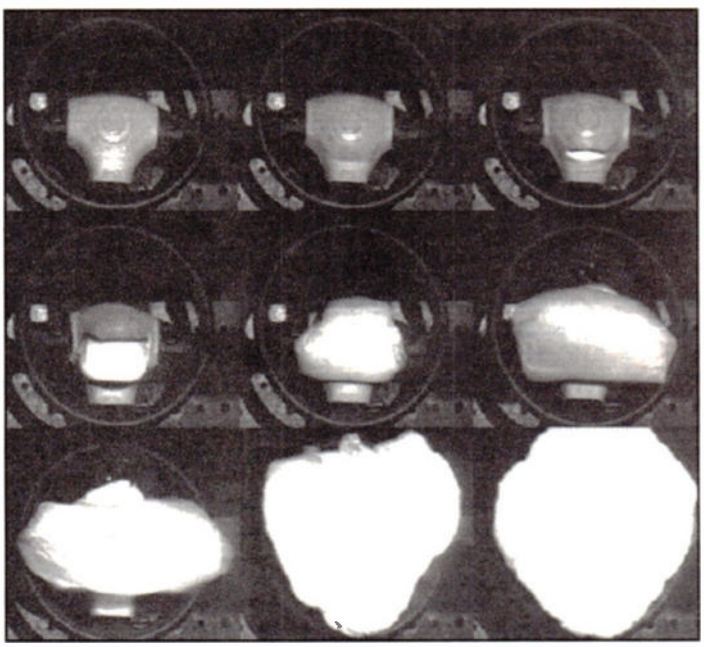
by Dr Chris Lavers

A New Laser at Rover for Improvements in Airbag Safety Deployment

Ever since the first production of the automobile began, car engineers have worked diligently to improve vehicle safety, reliability and engine efficiency. It is hardly surprising that at the end of the Twentieth Century modern-day engineers are enlisting the very latest in smart technology and high-tech computers to further enhance vehicle performance. Japanese and US car manufacturers have been using photonics sensors for several years in routine body assembly operations. Fibre optic laser sensors are able to detect the presence of cylinder grease or check that components have been given the correct rustproofing coating (it is the author's opinion that it is never enough!) However, the most exciting developments are taking place in the use of lasers in automobile safety. When engineers at Rover's Applied Optics Group recently brought an Oxford Lasers 'VisiLase' system they didn't imagine how valuable it was going to prove to be. Originally the group purchased the laser to map airflow in the combustion chamber of a running engine on a very fast timescale. However, the Rover Research and Development Laboratory group leader, Dr Clive Buckberry found that the system could also take previously unrecordable high-speed images of airbag deployment which have now led to important design improvements for increased safety.

The group decided to look at high speed images of what happens when a steering wheel mounted airbag is deployed during a simulated crash. An expanded laser beam was aimed directly at the whole area in front of the driver where the airbag was intended to appear when firing was activated. The images produced (Figure 1) allowed Rover engineers to clearly see the front panel tearing off as it opened and the precise manner in which the airbag unfolded during its rapid expansion phase.

Dr Buckberry's group then took an original approach to paint a set of grid lines onto an airbag surface to allow laser geometric mapping of the bag surface during its expansion phase. Using the group's world renown expertise in the application of speckle interferometry for mapping



vibrations of car components Clive hopes to use the coherent properties of the laser light to generate interferometric fringe patterns that can be projected onto the airbag surface to produce volumetric shape measurements. Basically directly or indirectly reflected laser light from any object of interest, in this case the airbag surface, compared with a reference beam may be combined together and analysed. If the two beams have experienced a phase shift which is a multiple of the wavelength the beams will add together coherently to produce an enhanced signal strength. However, if the two beams are out-of-step by a multiple of the half-wavelength they will tend to cancel out and interference destructively. Of course, what will happen in practice as the mapping is produced is that there will be continuous variations in the phase shift and therefore in the interferogram across the whole surface of the airbag during the evolving expansion.

The Rover group are also convinced that it should be possible to produce crisp high speed speckle interferograms of moving parts between 4,500 and 18,000 frames per second. Previous studies of disk brakes and car body shells were hampered by low light levels but now with illumination provided by a powerful copper vapour laser it should be possible to monitor high frequency vibrations (often of medium to low amplitude) and locate their cause, thus allowing their isolation and removal.

Dr David Towers of Rover's Applied Optics Groups says "I have been very satisfied with the results already achieved with out 'VisiLase'. What I didn't expect was that the team would keep coming up with new ways of using it."

Hopefully the application of this new laser monitoring system will not only increase safety for driver's during a collision, a worthwhile alm on its own, but will help to provide a quieter and smoother ride for all.

For further information contact:

Ms Margaret Webb at Oxford Lasers Ltd on 01235 554211, or, Oxford Lasers Ltd, Abingdon Science Park, Barton Lane, Abingdon, Oxford OX14 3YR.
E-Mail oxford.ltd@oxfordlasers.com

Hitting the Limit

According to Researchers at Bell Labs conventional silicon electronics will reach a fundamental physical limit some time early in the second decade of the next century. They have discovered that the critical insulator layer of silicon dioxide cannot be any thinner than 0.7nm for devices to work properly, a limit that is predicted to be reached in 2011. Researchers also claim that current oxide growth techniques raise the minimum required thickness to 1.2nm. This is at the limits of what is possible today (on conventional 200mm wafer chips and future 300mm wafer chips), although devices with these dimensions are not due to reach mainstream manufacturing until 2008. However, this takes no account of man's ingenuity to get around a problem if a solution is to be found. Earlier predictions based on then existing technology actually expected to reach this ceiling limit six years earlier in 2005. However, if no solution is to be found which doesn't allow the fundamental limit of silicon dioxide to be 'stretched' further, then the chip-making industry will have to turn to completely different semiconductor technologies. The silicon dioxide insulating layer is the gate oxide which isolates the gate electrode in field-effect devices from the conducting path. Over the decades both the thickness of the gate oxide and the length of the gate electrode have been continually reduced, in order to double the switching speed of transistors every 18-24 months

in the now famous Moore's Law. If you plot the log number of transistors on a chip versus the year from about 1970 to 2000 you get a straight line graph from a humble 4004, 100kHz machine right up to a modern 800MHz system possessing in excess of 10 million transistors. The gate oxide thickness in current devices is about 4nm. A silicon sample was exposed to temperatures exceeding 1000°C for only 10 seconds, producing a silicon dioxide layer 5 atomic layers thick. This fabrication technique is known as rapid thermal oxidation, and then more silicon is grown on top using chemical vapour deposition. Layers are produced which have exceptional uniformity and smoothness, crucial to maintain the integrity of the oxide barrier. The outer two layers form surface bonds with the surrounding silicon, leaving the three innermost atomic layers to provide the insulating barrier. The barrier's insulating properties are destroyed for anything less than 0.7nm - equivalent to 4 atomic layers. In practice however the gate oxide must be slightly thicker, about 5 atomic layers because the interfaces are rough on an atomic level.

Forthcoming Electronics and Electronics Related Meetings

Sensors for Water Interest Group- Monitoring Industrial Water Emissions held at ICI Runcorn 9th November Chairman Dr Terry Wilkins ICI, Contact: Michael J Scott SWIG, 27 West Green, Barrington Cambridge, CB2 5RZ Tel/Fax 01223 870967 E-Mail michaeljscott@compuserve.com

Remote sensing/Non-invasive measurements 22nd February 2000, held at Yorkshire Water Esholt Works. Chairman Dr Issey Caffour.

Condensed Matter and Material Physics Conference (CMMP'99) will be held at Leicester University and will cover interesting aspects of materials and applications into science and technology between the 19th and 22nd December 1999. Areas covered will include: semiconductors- transports and devices, optical properties and characterisation, and will also include the dynamic crush testing of composite materials.

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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