ELECTRONICS and Beyond

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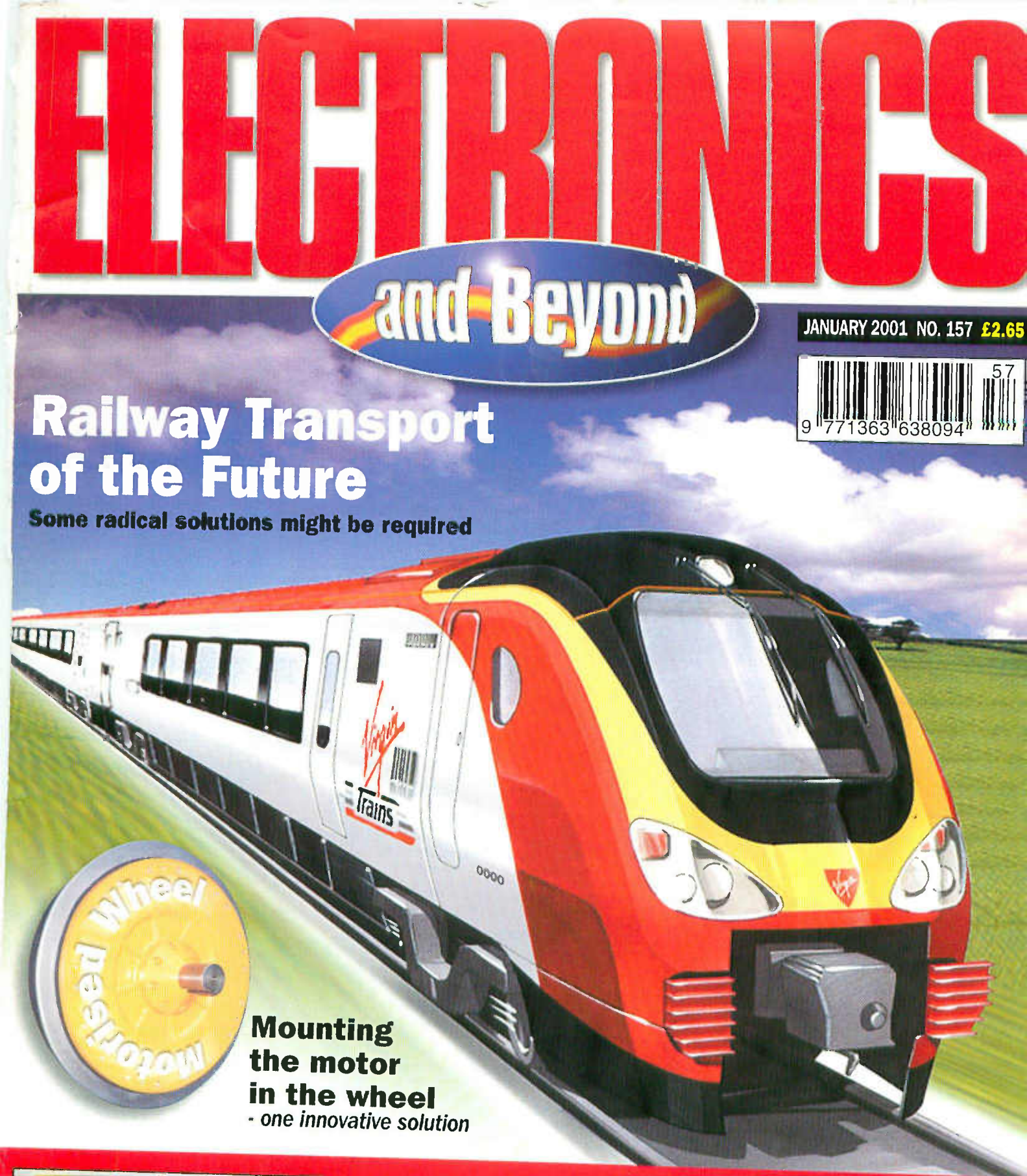
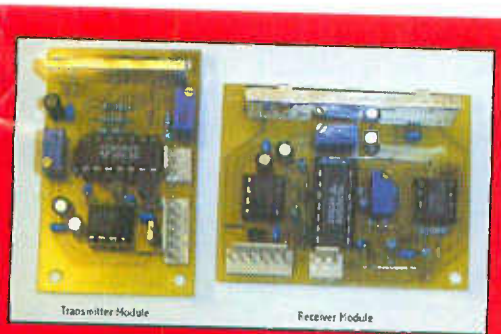
Railway Transport of the Future

Some radical solutions might be required



Mounting the motor in the wheel
- one innovative solution



Projects

PC Based Analogue Wireless Link

Disco Light Controller

Home Networking

Silicon Nanowires

Fuel Cell Developments

Three MP3 Players Reviewed

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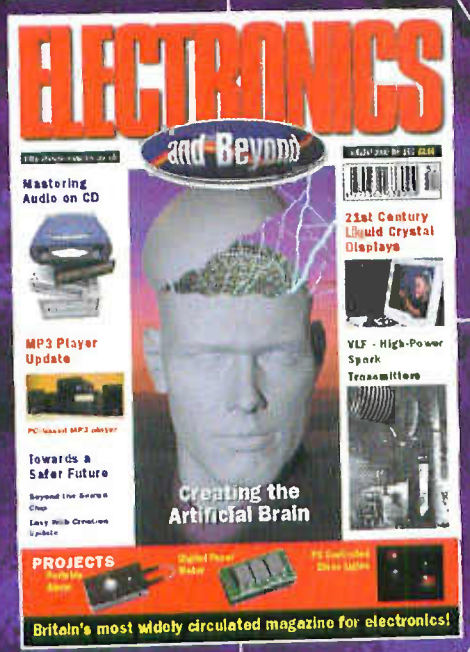

BACK ISSUES

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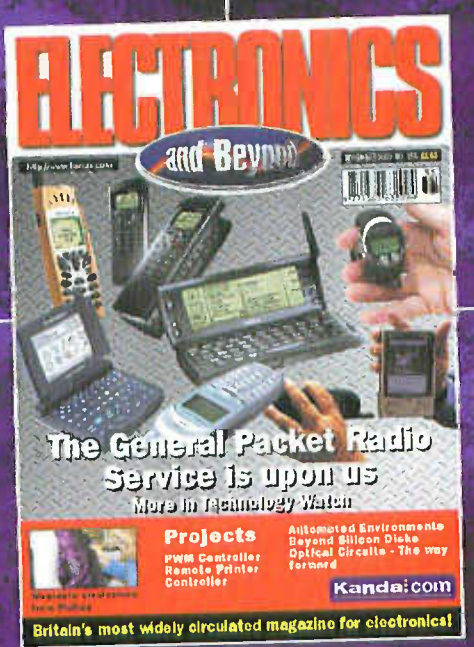

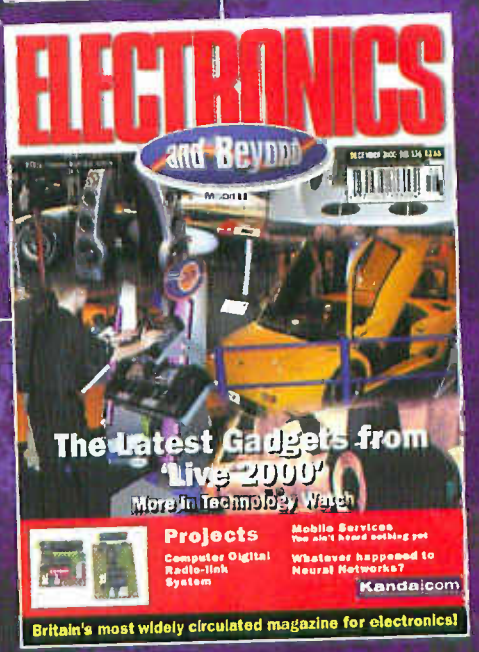

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ELECTRONICS and Beyond

With so much interest in the UK railway network at present, it is fitting to present a feature on Rail Transport of the Future. There is so much technology out there to provide adequate safety, lower maintenance costs and higher speeds. We hope Douglas Clarkson's article will show that there are plenty of alternative solutions to the variety of current railway problems.

Thank you for your replies to the questionnaire. As the old saying goes: You cannot please all the people all the time. In answer to some of your queries requesting practical projects. It is difficult to get people to provide simple practical projects. The reasons are many fold. Home electronics construction is now some 40 years old as opposed to home wireless construction that goes back many more years. Over those years, many thousands of ideas have been published and all those younger individuals of the 1960s have now aged and in many cases retired. As we have stressed in the recent past, very few young individuals have entered the marketplace, causing the educational establishments and the electronics industry, encouraged by the UK government to look overseas to fill our shortfall of electronic engineering skills. We will continue to publish practical projects when and where-ever possible but there are now fewer and fewer electronics enthusiasts around to read them. Also as we know, today's challenges that require electronic solutions are nearly always met by a complex mixture of software and hardware

Congratulations

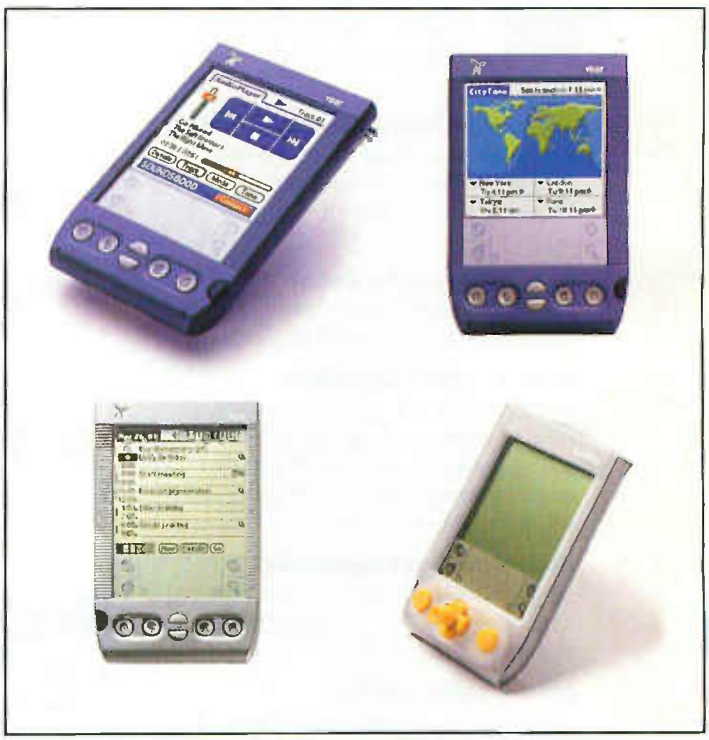
Winner of the Xicor Development kit

The lucky winner of the development kit is Mr V E Verity of Devizes, Wilts. Congratulations to you and all the runners up.

Paul Freeman-Sear

Britain's Best Magazine for the Electronics Enthusiast

NEWS REPORT



Colour All Round for Visor Handhelds

Handspring has introduced two new products in its Visor family of handheld computers: Visor Prism and Visor Platinum.

Visor Prism, Handspring's first colour-enabled product, has 16-bit colour and can display over 65,000 colours for viewing picture-quality graphics, as well as vivid games and maps.

Visor Platinum is the fastest Palm OS handheld computer on the market today – at least 50% faster than Visor Deluxe and as much as twice as fast as many other Palm OS products.

In addition, Visor Prism and Visor Platinum feature the Springboard expansion slot to harness the true benefits of a colour display and full expandability.

Visor Prism and Visor Platinum are available immediately at Handspring.com for around $270 and $200, respectively. Visor Prism comes in cobalt blue and Visor Platinum is metallic silver.

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

Airlines Pilot Satellite Internet

Airlines are testing a system from Globalstar, a global satellite phone company, which passengers have access to low-cost, high-speed Internet and e-mail services in-flight.

Data will be transmitted directly to the aircraft via Globalstar's network of satellites. The service is expected to be available to commercial airline fleets next year.

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

Philips Display Components Launches Cybertube

Philips has begun production of its latest addition to the Cybertube family, the 32VRF (34in.). The 32VRF Cybertube in 4:3 format joins the 27VRF and two widescreen Cybertube models, 30 wide (32in.) and 26 wide (28in.), already in volume production.

The Cybertube, the only television tube that projects a perfectly flat image, has been designed exclusively to meet the demands of Digital TV.

As in all Cybertubes, the 32VRF uses Philips' unique Gun Pitch Modulation system, which gives the TV picture the best possible purity and is perfectly flat.

Further, the flat exterior surface and slightly curved interior surface of the screen drastically reduces the tube's weight.

Production of the 32VRF underscores Philips Display Components' continued commitment to the development of innovative display technology and the future of HDTV world-class solutions.

Cybertube has been touted as a signature brand for Philips Display Components and is recognised as state-of-the-art picture tube technology, particularly because of its ability to step up to the needs of digital television and interactive viewing applications as they evolve over the coming decade.

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

Meet 3Com's Audrey

3Com has taken the wraps off its new Internet appliance, named Audrey.

Audrey, with one-touch access to email, Internet channels, a household calendar, address book and Palm HotSync technology, debuts as the first in 3Com's Ergo line of lifestyle-centered connected appliances.

Recognising true convenience as the key to a competitive leadership position, 3Com conducted in-home research on how families work and live and how they want technology to work for them.

The Ergo products, named for a Latin term meaning therefore, represent the best of the Internet in a convenient and intuitive way.

3Com's lifestyle research revealed that people want immediate access to specific information such as news, sports and weather.

By turning Audrey's channel selector knob, preferred Internet channels scroll across the bottom of the screen as if on a filmstrip.

People can customise some of the basic channels to meet personal information needs such as local weather information or stock quotes. In addition to these basic channels, consumers can also select six additional channels from a growing list of lifestyle-oriented Internet content and e-commerce providers.

The new device signals 3Com's intention to stake out a position in the non-PC device market and represents one of its first major initiatives since spinning off its high-profile Palm subsidiary earlier this year.

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

NEWS BYTES

Experimental Mobile Networks Sited in Cambridge

Vodafone and the University of Cambridge have announced the deployment of two test mobile networks in the Cambridge area.

The networks will be used by researchers and students to create and run new applications and services, aimed at encouraging continued innovation.

The first network facility to be made available to students will be based on General Packet Radio Service (GPRS), the high-speed packet data network associated with GSM.

Vodafone will be the first UK operator to incorporate the latest GPRS standards into its live GSM network and will begin full customer trials in November.

The GPRS network will be followed by a third generation (3G) test network in the spring.

Once the infrastructure is in place, Vodafone will work with the University and manufacturers to ensure that sufficient phones are available to carry out the trials, which will initially be within the University of Cambridge Computer Laboratory.

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

ARM Introduces Multimedia Extensions

ARM has announced Single Instruction Multiple Data (SIMD) extensions for the ARM architecture. The SIMD extensions are optimised for a broad range of software applications including video and audio coders, where the extensions increase performance by a factor of four.

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

Kaspersky AntiViral Toolkit Pro Updated

Anti-virus company Kaspersky Lab has launched version 3.5, of its virus hunter, AntiViral Toolkit Pro (AVP). The anti-virus application is powered by numerous unique anti-virus technologies and features a new design of the main user interface.

From a technical point of view, the key changes in the upgrade involve three program components: a redesigned user interface, implementation of new anti-virus defence methods and advanced features for centralised deployment and management of anti-virus protection across a network.

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

NEWS BYTES

Quantum Accelerates Expansion Programme

Virtual manufacturer Quantum Electronics has raised £750,000 from its chairman Bob Jones, the Welsh electronics entrepreneur, in the first phase of a funding exercise to finance an accelerated expansion programme.

The new funding will enable Newport-based Quantum Electronics to bring its additional 32,000 sq. ft. facility built earlier this year, up to full capacity within a two-year timeframe, rather than the five-year period originally planned.

Quantum Electronics acts as a virtual manufacturing facility for its 15 clients, which include Equiinet, Flexion Systems, Imigix and Virtual Access.

The company has a strategy of working with fast-growth electronics companies which means that it frequently has to ramp-up volume as clients make the transition from a start-up through to early stage and then established businesses.

The decision to secure additional funding was taken to enable Quantum Electronics to keep pace with its existing customer requirements, as forecasts for the coming year are showing considerable growth in demand.

For further details, check: **<www.quantum-electronics.co.uk>.**

Three Men and the Nobel Prize for Physics

Three scientists whose innovations have been fundamental to the development of the electronics industry are to share the 2000 Nobel Prize in Physics.

Retired Texas Instruments engineer Jack Kilby will receive half of the £500,000 prize money for his role in developing the integrated circuit.

The other half of the prize will be shared by Dr Zhores Alferov of the A.F. Ioffe Physico-Technical Institute in Russia and Dr Herbert Kroemer of the University of California at Santa Barbara.

Alferov and Kroemer separately created heterostructures, electronic components that allow small solid-state lasers to be used for practical applications such as compact-disc players and fibre optics.

For further information, check: **<nobel.sdsc.edu>.**

Pine Introduces Wearable MP3 Player

Pine has announced its first digital audio player designed for the fashion conscious listener, D'music Palmp-3.

The two and one-half inch disc-shaped Palmp-3 is a lightweight, wearable player. It offers users MP3 file playback, FM radio and voice recording capabilities, and features an electronic telephone directory for easy access up to 100 personal contacts.

The player comes in four colours and includes a neck string, armband and belt clip to give consumers several options to accessorise the player with.

The Palmp-3 has a LCD display allowing listeners to view song title, artist name and mode & function keys. It also includes a seven-band equaliser to give users the best quality sound for individual music tastes, ranging from jazz, super bass, disco, flat, rock and pop to classic.

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

Kanda crosses the Atlantic

Kanda Systems Ltd, a prominent third party tools supplier for the microelectronics industry has taken a move into the US market through the acquisition of Logical Devices Inc based in Denver. Kanda's chairman Kevin Kirk said that the deal fits in with the long term strategic goals of the company as Kanda is now on target to become the leading supplier of third party tools in the world.

Kanda works closely in partnership with many of the best silicon manufacturers in the world today to design, manufacture and market seriously easy development tools. Kevin also said that the aim of the organisation 'is to pass on the benefits of our innovations to enhance the whole field of microelectronics'. Acquiring the Logical Devices range enables Kanda to provide an easy to use and effective solution to production and development requirements.

Kanda is an independent, global organisation dedicated to being at the cutting edge of new technology. Crossing the Atlantic gives Kanda the opportunity to further develop and expand its product range through incorporating Logical Devices expertise in the device programming market.

Logical Devices has over 20 years experience of serving a broad spectrum of customers from high end industrial conglomerates, government bodies, end users consisting of medium and small manufacturing enterprises to individual engineers and hobbyists. Logical Devices pioneered the software driven universal programmer concept and today the universal modular programming systems provide all-round customer benefit keeping entry cost to a minimum without sacrificing excellence in quality.

Kanda employ a total quality management system and back up all products with full support mechanisms. Kanda provides a comprehensive technical support service through a helpline 01970 621041 and they are online at **<www.Kanda.com>**; specific help is always available on our range of forum sites.

MP2000 Digital Music Player Announced

e-Digital and Maycom has launched the MP2000 multi-codec, portable digital music player in time for the holiday shopping season.

The MicroOS-enabled MP2000 is small and ergonomically designed for ease of use. The unit has superb audio quality and louder output levels than most other portable music players on the market, without sacrificing battery life.

The internal, rechargeable NiMH battery provides nearly seven hours of continuous music playback, and its backlit LCD screen supports English and Japanese characters in a two line text and icon display. The player uses removable CompactFlash storage cards to store consumer's favourite music.

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

Explosions in Space

An MIT-built satellite roughly the size and shape of a dishwasher will be launched into near-Earth orbit to detect the largest known explosions in the universe.

These occurrences, called gamma-ray bursts (GRBs), signal the extragalactic release of as much power as a billion trillion suns, but no one is sure what causes them or exactly where they originate.

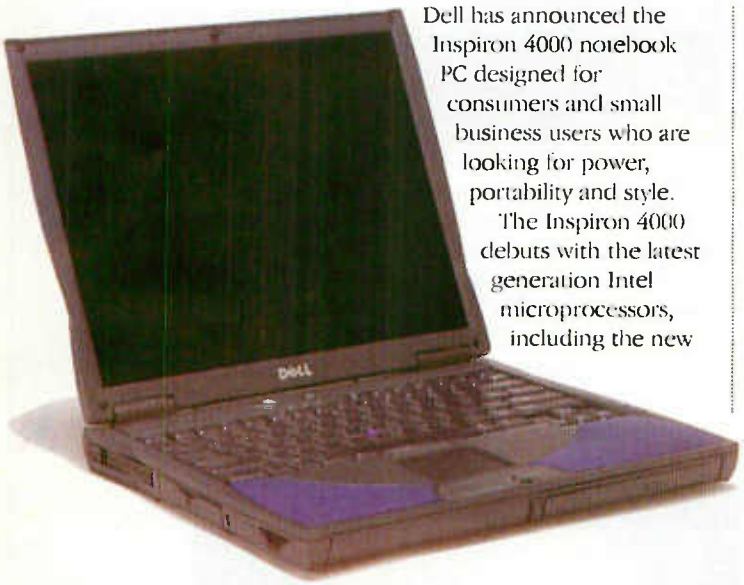
The High-Energy Transient Explorer (HETE-2) - the first satellite dedicated to the study of GRBs - will help scientists understand these perplexing explosions.

HETE-2 is the result of an international collaboration of scientists and engineers at MIT and other institutions in the US, France and Japan.

HETE-2 will serve the world's astronomers as the premiere burst spotter until the end of its extended mission in 2004.

For further details, check: **<www.mit.edu>.**

Dell Announces Inspiron



Dell has announced the Inspiron 4000 notebook PC designed for consumers and small business users who are looking for power, portability and style.

The Inspiron 4000 debuts with the latest generation Intel microprocessors, including the new 800MHz and 850MHz Pentium III processors with SpeedStep technology, the ATI Rage Mobility 128 video graphics solution with 8MB of SGRAM and 2X AGP and the latest optical storage technologies including a 8X/4X/24X CDRW drive.

The Inspiron 4000 weighs as little as 5.2lbs and offers a choice of five removable QuickSnap colour accent designs located on the LCD back and palm rest.

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

IBM Announces Microelectronics Push

IBM is spending $3 billion in a bid to expand its global microelectronics operations.

This is claimed to be the largest capital investment in its history. It includes plans to build the world's most technologically advanced chip-making facility in New York.

The new facility will combine - for the first time anywhere - IBM chip-making breakthroughs such as copper interconnects, silicon-on-insulator (SOI) and low-k dielectric insulation on 300mm (12in.) wafers.

IBM also expects to be the first chip-maker to mass produce semiconductors at line-widths below 0.10 microns, more than 1000 times thinner than a human hair.

IBM is also expanding organic and ceramic chip packaging operations worldwide.

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

iFeel Mice Adds Dimension to the Human Interface

Logitech has launched a new product category - optical wheel mice with the ability to feel events within all Windows applications and on the Web.

Now anyone who uses a mouse can experience tactile sensations via the mouse as the cursor travels over icons and menus, command bars, folders, tool bars, web buttons and hyperlinks.

What's more, because the iFeel mice are optical, they offer a high degree of precision while requiring no cleaning.

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

NEWS BYTES

Intel Targets Mobile Phones

Intel has developed a new flash-memory microchip that will allow next-generation Web-enabled cell phones to be used simultaneously for voice communication and Web access.

The flash memory makes it possible for data to be retained even when the device is turned off, and the energy-efficient chip will be able to access the Internet four times faster than current speeds.

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

Swedish Team Cracks Cambridge Codes

A team of Swedish computer enthusiasts has succeeded in deciphering increasingly difficult codes presented by author Simon Singh in his best seller, the Code Book.

Singh, who has a doctorate in physics from Cambridge University took two years to develop the brainteasers with Dr Paul Leyland, who works for Microsoft in Cambridge.

The codes, which took the Swedes the equivalent of 70 years of computer time to decrypt, ranged from ciphers dating back to ancient Greece through the famed Nazi Enigma code machine used in World War II.

For further details, check: **<www.cam.ac.uk>.**

Mobile Companies in Security Pact

Nokia, Motorola and Ericsson have been joined by Siemens in an alliance to develop secure mobile electronic transactions.

The alliance, dubbed Mobile E-Business Technologies (MeT), will offer consumers a simple and safe way to conduct e-commerce transactions over their mobile phones.

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

Microsoft Acquires Stake in Rival

Here's a turn-up for the books. Microsoft is paying approximately £80 million to obtain a 25% stake in Corel, the company that makes WordPerfect word processing software and other software applications for the Linux operating system.

The two companies have agreed to settle various legal disputes between them and to work jointly to develop applications based on Microsoft's Internet initiative, which it calls .NET.

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

NEWS BYTES

C&W to Move Traffic to Internet

UK telecom giant Cable & Wireless is planning to shift all of its voice traffic over to a new IP-based network within three years, in a move that highlights the speed with which the Internet is undermining traditional telecommunications systems.

Although all the major telecom operators including AT&T, British Telecom and Deutsche Telekom, are investing heavily in IP networks for data transmission, Cable & Wireless will be the first to migrate its entire voice service to the Internet-based system.

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

BBC Plans Five National Radio Services

BBC Radio has announced plans for five new national radio services that will operate alongside BBC Radios 1, 2, 3, 4 and 5 Live and the World Service, will comprise the BBC's national public service radio portfolio.

All of the new and existing services, which will be part of the licence fee package, will be available via digital satellite and cable, the Internet and digital radio sets.

By extending the range of BBC Radio and taking advantage of the different digital platforms, the new services will offer an attractive proposition to audience groups like young families and the ethnic minorities that are presently undeserved by BBC Network Radio.

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

Creative Delivers Dolby Sound on PC

Creative Technology has announced the Sound Blaster Live! line of sound cards, Dolby Digital audio solutions that give PCs user the best audio entertainment applications for music, movies, and games.

The Sound Blaster Live! series provides true multi-channel sound to consumers seeking an optimal sound experience from the PC.

As the PC transforms into an entertainment platform, Creative's audio solutions are at the heart of the sound evolution, providing entertainment enthusiasts with the ultimate in digital audio.

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

Electronic Toll Collection Debuts in Manila

TransCore has opened the first electronic toll collection (ETC) road in Manila, Philippines.

The road's ETC system will help reduce transit times and traffic congestion for Manila commuters, streamline toll transaction processing and enhance auditing capabilities.

The toll collection system was installed along sections of a new elevated toll road, the Metro Manila Skyway, as well as two existing toll roads, the South Luzon Expressway and the South Luzon Tollway.

The system covers about 30 miles (48 km) in a north/south direction, linking the central business area of Makati City in Metro Manila to Calamba and points south of Manila in Central Luzon.

The system incorporates automatic vehicle identification (AVI) transponders, called E-PASS, and magnetic-encoded cards for recording trips.

This provides a robust infrastructure for comprehensive audit capability, and E-PASS streamlines toll transaction processing. Payment for E-PASS transactions are made via pre-paid accounts registered with the E-PASS Customer Service Center.

As with ETC roads elsewhere, E-PASS uses windshield-mounted radio frequency identification (RFID) tags and lane-mounted tag readers to automatically register a car when it passes through a toll plaza.

Motorists using the wireless technology no longer have to stop, wait or fumble for cash, so traffic flows faster. The hardware is integrated with TransCore's proprietary traffic and business management software.

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

WebPad Appliance Launched by Honeywell

Honeywell has announced the availability of the Honeywell WebPAD Internet Appliance - the first-ever wireless, portable tool for high-speed connection to the Internet and centralised home control applications.

Weighing less than three pounds, measuring less than an inch thick and about the size of a standard sheet of paper, the Honeywell WebPAD Internet appliance allows a user to surf the Internet, send and receive e-mail, and enter information via a wireless touch screen display.

The device uses a wireless connection to a base station - similar to a PDA synchroniser - that's connected to broadband cable or DSL.

This enables users to enjoy all the benefits of a high-bandwidth Internet connection from anywhere inside or outside the home within 150 feet of its base station.

For further details, check: <www.honeywell.com/yourhome>.

New Restrictions on UK Amateur Licence

The Department of Trade and Industry has issued Notices of Variation to all classes of amateur radio licences, effective immediately.

The variations apply mostly to the unattended operations section in the BR68 booklet.

Five National Grid References are specified near Harrogate, Lincoln, Cheltenham, Bude in Cornwall and Scarborough, within 50km of which unattended operation is not permitted.

The restrictions also apply to 1,298 to 1,300MHz in the whole of Northern Ireland. These Notices of Variation are available on the Radiocommunications Agency.

For further details, check: <www.rsgb.org.uk>.

RAIL TRANSPORT *of the Future*

by Douglas Clarkson

Bombardier Transportation's Voyager and Super Voyager trains for Virgin Cross Country trains

The beginning of the 21st century is in many ways a good time to look back on the history of rail transport and look forward to anticipate how modern technology will be able to provide faster, more energy efficient and hopefully safer modes of passenger and freight transport. One aspect of this is to assimilate current technology developments with respect to train technology actually in place or soon to be delivered. It is also relevant to look further ahead and anticipate concepts in mass transportation, which may be in place in 10 to 20 years time.

The dominance of rail transport in the early part of the 20th century has been usurped by the rise of road and air transport. Within Europe, however, the birthplace of railway networks, there is a general awareness of the need to invest in a railway infrastructure both as a maintained track system and also in terms of basic train technology. Part of the impetus for this change in perspective was the oil crisis of the mid 1970's which forced national governments to develop transportation systems with higher energy efficiency.

While traditionally the disciplines of Mechanical Engineering and Electronics have pursued separate academic paths, in the seeking of solutions in advanced rail transportation, the two specialities are working very much together as Mechatronics - a fusion of mechanical engineering and electronics. This is seen, for example, in the Mechatronics Train Project which is a European based multi national initiative with the University of Loughborough acting as a focus for the various partners. Also the advent of the age of rapid data communications and computer technology it will make it possible to control systems within the railway networks and this has the potential to radically alter the nature of train transportation. Mechatronics is also being applied to other areas of 'moving technology' such as factory robot automation and motor car engineering.

Tipping the Balance

In an age of rising consumer expectation, rail transport has to compete with other transport modalities on the basis of speed, safety, comfort, and reliability and network capacity. The investment in railway infrastructure, which is at last beginning to take place in the UK, has a key focus in terms of speed, since this is a key factor for increasing passenger numbers. Increased speed is a function of the intrinsic track systems and the locomotives/carriages/wagons that will travel on it. Basically the speed of lines can be raised by increasing the radius of curves and increasing the tilt of the track to compensate for sideways forces on the bends. The routing of new tracks through built up areas can, however, be prohibitively expensive and be subject to prolonged planning enquiry delays.

Where the speed of locomotives and carriages is increased, this requires very careful development of these dynamical systems. To date national pride is very much a determining factor in mustering the necessary investment to carry such developments forward. The type of train developed, however, can very much be optimised for a given country's rail network. In France the TGV system is principally laid down using purpose built track with little in the way of bends. In other parts of Europe such dedicated tracks would be less practical because of more demanding topography and the presence of tunnels. Another approach is to use tilting trains, which can run faster over existing track compared with conventional non-tilting trains. Another aspect is the anticipated traffic density of such high-speed lines as an

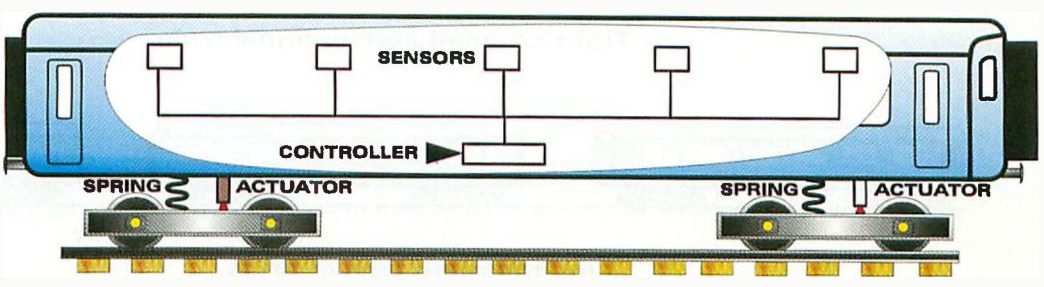


Figure 1. 'Comfort bogie' utilising active secondary suspension.

indicator of line profitability. During 1995 in Japan, for example, 276 million passengers were carried on the modern Shinkansen or Bullet train line while in France the comparable numbers on the TGV lines was 63 million.

A Historical Problem: Mechatronic Solutions

Train technology has progressed through many levels during the 20th century. This has largely been in relation to refinement of basic engineering design rather than introduction of radical new thinking. Train development has in many respects been surprisingly conservative - where an incremental approach is preferred as compared to one, which incorporates too many new concepts.

It is felt, however, that merely engineering out the faults of conventional train design is not the way forward. At a design stage, the Mechatronic Train Project, funded as a Brite-EURAM project within the European Community is looking to structure advanced technology, which will form the basis of the trains of the future.

It is useful at this stage, therefore, to anticipate designs which may be incorporated in train technology in the medium to long term future and which will be highlighted by projects such as the Mechatronic Train Project. One of the key design requirements for passenger rail systems is that they should present as little in the way of vibration so as to make the ride quality satisfactory.

The classic design of railway carriage with two wheel bogies, each of four wheels presents a problem in 'many body' dynamics that is complex to model and hence complex to design out aspects of unwanted vibration. Also, most of the vibrational components under 10Hz are all 'mixed' up from different independent sources. This leads to inherent problems of design where it is difficult to determine if improvement in one mechanical structure will significantly affect overall vibrational performance.

In terms of ride quality, one of the concepts already implemented in systems such as the Siemens 'comfort bogie' was that of active secondary suspension as indicated in Figure 1. Rather than incorporate additional passive mechanical energy absorption devices such as springs and shock absorbers, between the upper compartment and the bogie systems, a system of mechanical actuators seek to minimise vibration in the upper compartment based on accelerometer sensors distributed in the upper compartment. By such monitoring of vibrational modes of the upper compartment, the mechanical actuators can be controlled so as to remove energy from the observed modes of vibration. Using new technologies of sensor monitoring and active components to correct for vibrational modes, new opportunities are made possible for the radical design of such elements to simplify the degrees of freedom for vibrational resonance and hence control them.

Conventional designs of railway drive elements and carriages, lead also to intrinsic problems of track wear. Travelling along straight track may pose little in the way of complication, but in cornering, there is a basic conflict in terms of the speeds of the wheels - with the wheels on the larger radius of an axle requiring to travel further than those on the inner radius. This is likely to lead to increased mechanical instability of the rotating axle, which could cause

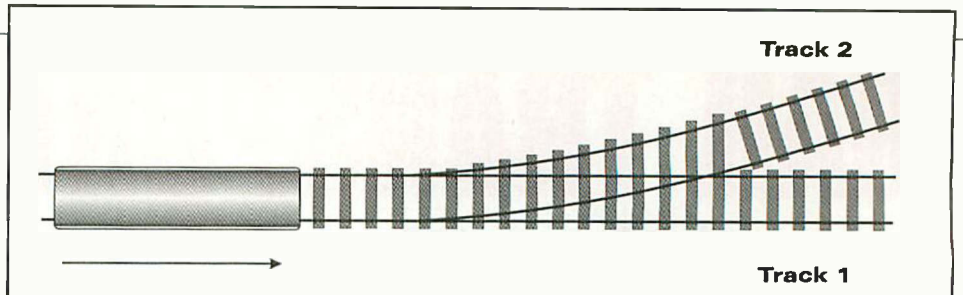


Figure 2. Concept of vehicle based track switching where control on board a train can decide whether to continue on line 2 or switch to track 1.

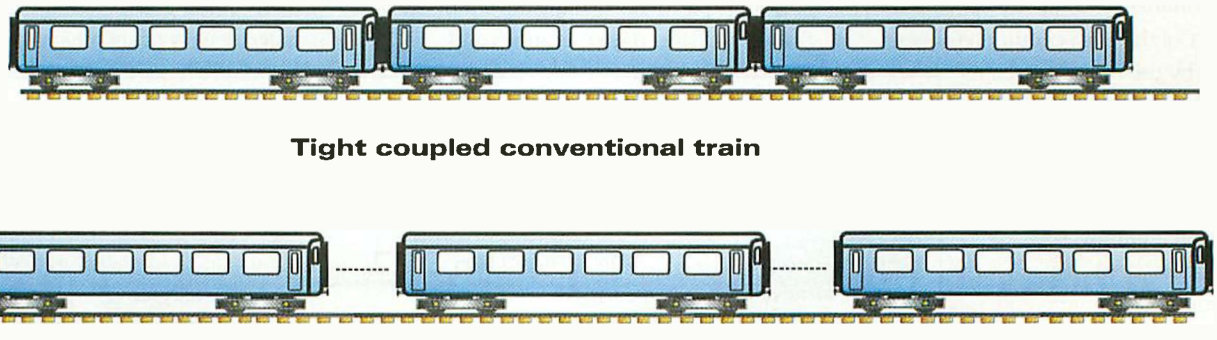


Figure 3a. Conventional configuration of train integration - a joined up train.
3b. Concept of semi independent train 'convoy'.

additional stressing on rail surfaces.

Differential velocity between wheels when negotiating corners will tend to initiate 'wheel hunting' and cause oscillatory sideways motion of the wheels. This tends to accelerate wear on both the wheels and on the track. One approach of 'mechatronics' is again to actively control the relative orientation of the wheel axle using actuators so that wheel orientation with respect to track direction is optimised and thus excessive wear is prevented.

As one starting point, the conventional twin bogie design of train carriages is perceived as introducing too much complexity into vibrational characteristics of such devices. Typically this also introduces considerable weight into rolling stock. Advanced two axle vehicles are considered entirely practical and aspects of simplified design would also introduce increased reliability. By making the vehicles of more lightweight materials incorporating magnesium and carbon fibre, sufficient strength would be introduced but with advantages of improved energy efficiency. The existing mass of some high speed trains can approach 1000 metric tonnes. Also, by incorporating motors directly within wheel elements, traction can be distributed across the train, rather than having a specific leading and trailing locomotive.

The advantage of direct wheel driving provides for wheels to be independently controlled at corners to prevent 'wheel hunting' and reduce wear on track. Already direct motor drive elements are available with rated power of 70kW per unit. Making carriages lighter, introduces the aspect of reduced wear and tear on railway track. The key to introduction of such technology, however, is to use advanced sensor/actuator systems within the field of control engineering.

Advanced Route Control

The Mechatronics Train project can also look ahead to 'doing things differently' with respect to control of traffic across a network. The concept of direct wheel control also makes possible the notion of 'vehicle based track switching' as indicated in Figure 2. Wheel control on board a train can decide whether to continue on track 2 or switch to track 1. This takes the element of 'actuation' away from conventional signaling of trains where rails are moved to control trains.

Much is made of the capacity of the rail network and how increased traffic would require significant expansion of the railway infrastructure. Expansion of rail networks is inherently very expensive. A basic cost often quoted is a figure of $33 million per mile though the UK route for the channel to London with a high speed link the cost is double this. Other approaches are therefore being considered as a means to increase inherent traffic capacity.

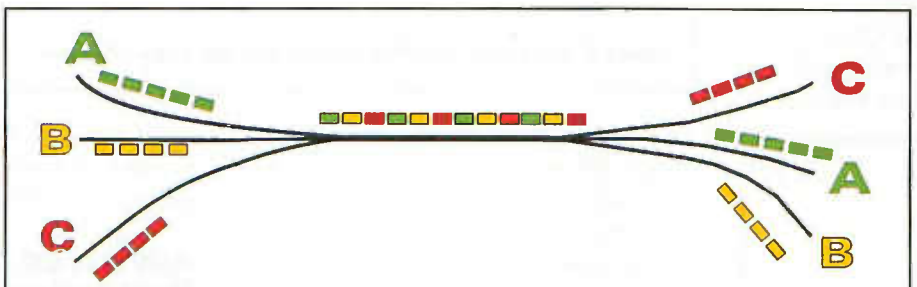


Figure 4. 'Fusion' trafficking of trains - trains can separate into individual units to negotiate a track segment and then reconstitute on remote side.

The conventional concept of train routing where physical linkages secure train elements is shown in Figure 3a. A more flexible concept of track utilisation is that as indicated in Figure 3b, where elements are independently powered but can travel as independent units and presumably with knowledge of the existence of other elements. The concept of the 'robot motor car' being propelled along a motorway is certainly many years away if it ever becomes adopted. On the railway, however, vehicle control is inherently more simple since the guiding of the vehicle is achieved by the track.

This concept of the inherent divisibility of a 'train' into its component elements as a means to increase network capacity is indicated in Figure 4. Trains A, B and C require to pass across a single line of track and continue on their way. The standard approach is to say halt trains B and C and let A proceed followed by say the transit of C and then allows finally B to pass. Where individual drive elements can act independently, it is quite possible for individual elements from the trains to separate and pass along the single track and then reform on the outgoing track as connected trains.

Taken to its nth degree, it is possible for much greater flexibility in the coverage of the rail network, though perhaps there are limits to how complex a rail system can be made for those who operate it and those who have to use it. At present it is generally a relief to know that all the carriages on a train will arrive together at the destination. As an example, we can consider a train with elements 1,2,3,4,5,6 leaving a station A in Figure 5. Elements 1,2,3 proceed on track ABCD and elements 4,5,6 branch at D, with element 4 joining the initial line after having reached station G and with elements 5 and 6 travelling independently to E. For this to become a reality, the elements would require to automatically driven. It would not be practical to have a driver in each element.

These are concepts of railway technology which developments in general technology has made possible. One of the problems of introducing new concepts into railway design is that the influence of the past remains very strong in setting the pattern of current thinking. One of the

Placing the electric motor in the wheel has many advantages.

- Direct Drive eliminates gears and transmissions. Tractive effort is produced where it is wanted.
- High overall efficiency of around 97% from rail output to electrical input. The motor uses regenerative braking thus reducing brake wear
- About half the weight of conventional systems
- The motor saves space allowing lower floor designs
- Independent wheel operation reduces most wheel and track wear

Information and picture supplied by Stored Energy Technology Ltd, Derby, UK

problems of the APT project was a degree of reluctance of some groups within BR to accept fairly straightforward elements of modern engineering practice into the APT system. Projects such as the Mechatronic Train Project are essential to 're-engineer' the issues at the core of rail transport.

Tilting Trains

The concept of tilting trains is an element affecting train speed, safety and passenger comfort. A train travelling at speed v on radius of circle r will experience a sideways acceleration of v^2/r. The standard compensation for travelling at speed on curves is to tilt the physical track as indicated in Figure 6. An exact correction, however, can only be achieved at a specific track velocity. Figure 7 indicates the variation of angle of tilt required as a function of track radius for a range of train velocities. Where railway networks have grown slowly such as in the UK, the lines of track will often involve relatively tight corners where maximum speeds of around 100 km/h were initially anticipated. Where new high speed lines are being implemented, these will tend to be designed to minimise radial acceleration by using bend radii in excess of around 3 miles.

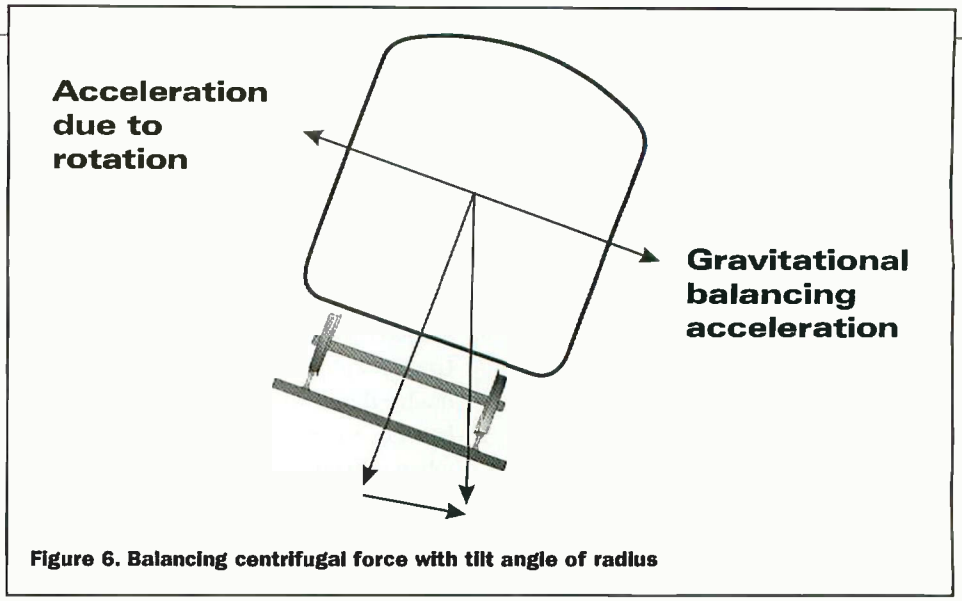


Figure 6. Balancing centrifugal force with tilt angle of radius

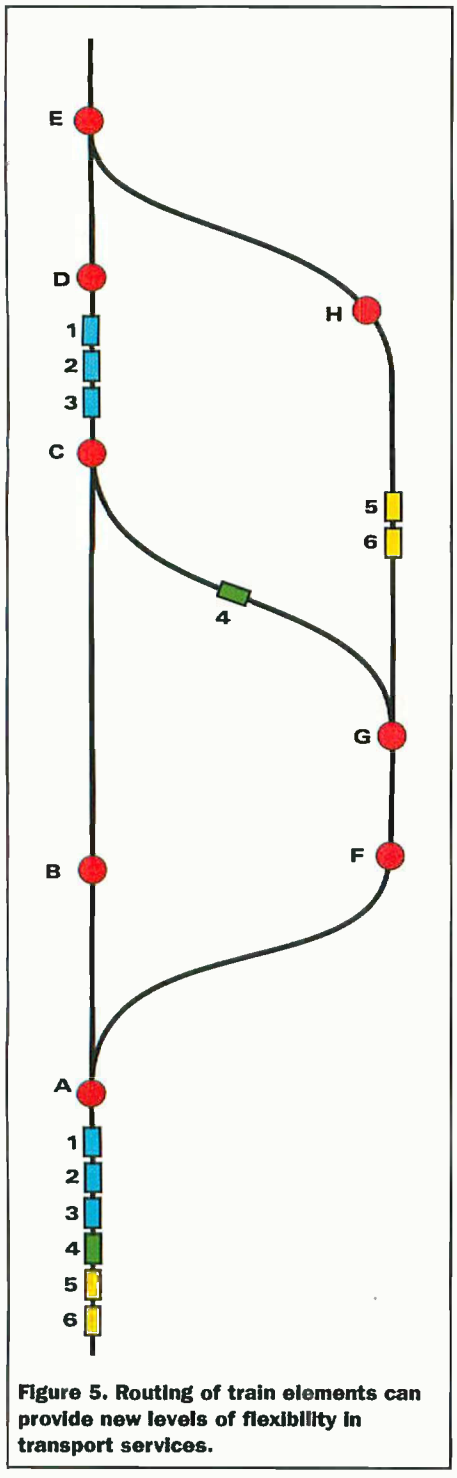


Figure 5. Routing of train elements can provide new levels of flexibility in transport services.

The element of tilting track/trains is principally for passenger comfort. Trains would not themselves be inclined to topple like lorries at roundabouts since the sideways forces would not be sufficiently great to achieve this. The tilt of the track is only usually felt when a high-speed train is forced to travel on a bend at much lower speed.

The solution of a tilting train provides for increased flexibility in the matching train speed, rail curvature and existing tilt of rails and can be achieved through use of rotational or sideways forces or through pneumatic/electronic actuation. The use has been towards that of electronic actuation.

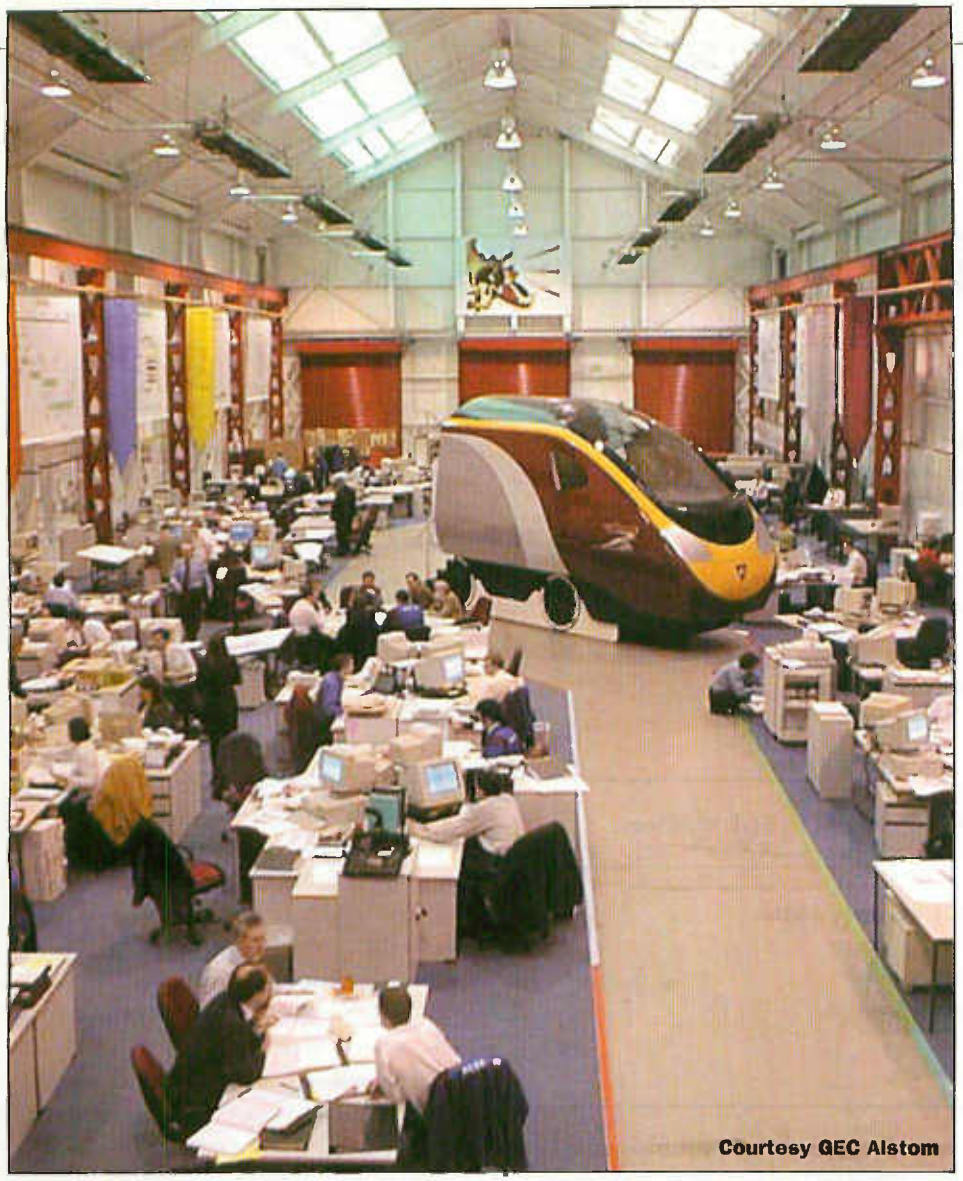
Tilting trains, however, are not a universal solution to high-speed rail travel. Tilting trains probably have a top speed of around 140mph on non-specialist or existing track. Various tilting train systems have been developed around the world. The APT in the UK was abandoned by British Rail but the technology sold to Italy where it was subsequently developed successfully. Key aspects in the demise of the APT included appalling project management, provision of insufficient resources and a general lack of quality control of construction of elements within the APT systems. In Sweden, ABB successfully developed the X15 system that allows the passenger carriages to tilt but provides no similar mechanism for the drive locomotives. The Swedish saga, however, reveals its own story of planning delay and limited development budgets.

Advanced Train Protection Systems

There is also the possibility of matching exact track information to a specific train so that details of exact track contours can be programmed in to optimise the train control. There is in this level of control the optimisation of dynamics between the train and the track it is traversing. This would necessitate increased flows of data to and from each train unit. Such data can improve speed performance, energy efficiency, passenger comfort and overall safety.

Systems with elements of such control have been implemented in Japanese railway systems. Elements of such control systems are indicated in Figure 8. Trains on the network are in communication with the status of other trains so that there is basic provision of safety in an Automatic Train Protection system. While this is a key feature of the system, it also allows for optimised loading on the network by moving trains 'in predictive mode'. Where for example a train is approaching a station and another train is just drawing out, the computer system can communicate the anticipated time/velocity profile of the departing train to tell the arriving train how to arrive as soon as possible at the selected platform. Passengers in individual stations can have access to train arrival information based on data originating from the actual transit data of trains.

Also, locomotive energy consumption can be optimised so that sections of track do not over tax sub station supplies - a feature that requires in this instance the power requirements of groups of trains to be shared collectively. It is also possible to request a train to use regenerative electric


Courtesy GEC Alstom

braking so that in slowing down it supplies power back into the supply system. Elements of control also allow individual trains to use energy in an optimised way - avoiding for example high accelerations followed by rapid braking.

Data packets of the Japanese Digital ATP contain 3050 bits of data. The transmission to/from trains to trackside units is implemented by means of radio links operating between 25kHz and 35kHz carrier frequency with a data rate of 4800 bps. In addition, train control, is also designed to minimise delay in arrival.

When trains travel much faster, reading and responding to visual trackside signals becomes more critical. Automatic response systems become more of a necessity at higher speeds. The concept of signals passed at red is more a concept of an anachronistic distant steam age.

The French Connection

It is interesting to observe the approach of the French to their train network. The 'top of the range' series of trains in France belong to the 'Train a Grand Vitesse (TGV)'. A key design change introduced was that of placement of wheel bogies so that they were shared by carriages. This tight coupling of bogies prevents carriages from pivoting away from each other on curves - a factor that further improves ride quality. In addition, in the event of a derailment, this tight coupling prevents cars jackknifing as with conventional twin bogie carriages. Trains, however, with this feature are less readily reconfigured with respect to adding or replacing carriages during the working day.

One TGV train has experienced a derailment at 182 mph - the fastest on record. This was due to an axle failure. Fortunately, due to the train design, there were only a few minor injuries.

In terms of achievable speed, in 1981 this was initially set at 270kph for commercial operation but tests showed that 380kph was achievable. By 1990 the TGV with improved suspension components set a new world speed record of 515kph in 1990 and with commercial operation to run at 300kph. The next stage in developments is to achieve speeds of 360kph. It should be borne in mind, however, that such speeds are only achieved on dedicated high-speed lines with optimised track configuration. Conventional train technology requires to be used on the remainder of the track system.

As trains go faster the dynamic stress on the track increases and this results in the requirement for additional maintenance. The reduction of train mass provides relatively little benefit from an energy efficiency perspective but it can provide a significant reduction in the loading on the track with speed. A key feature of the TGV programme has been to reduce the mass of the locomotive units and also of the carriages. By using lightweight materials, so called duplex (two level) carriages have been introduced which weigh no more than single level coaches but can accommodate 45% more passengers. The use of transformers made of cobalt alloy steel and aluminium sheet instead of copper wires has led to a weight reduction of transformers

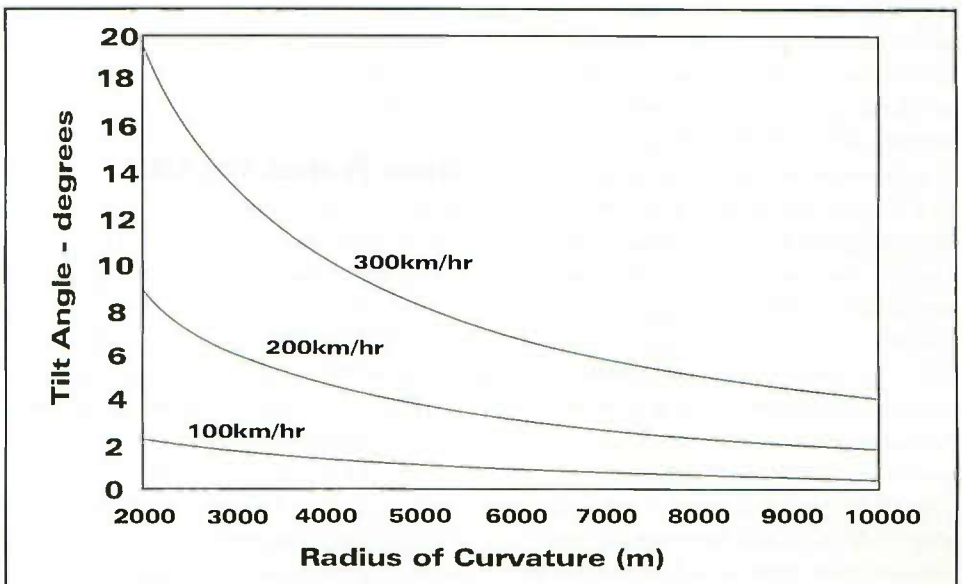


Figure 7. Variation of angle of tilt required as a function of track radius for a range of train velocities.

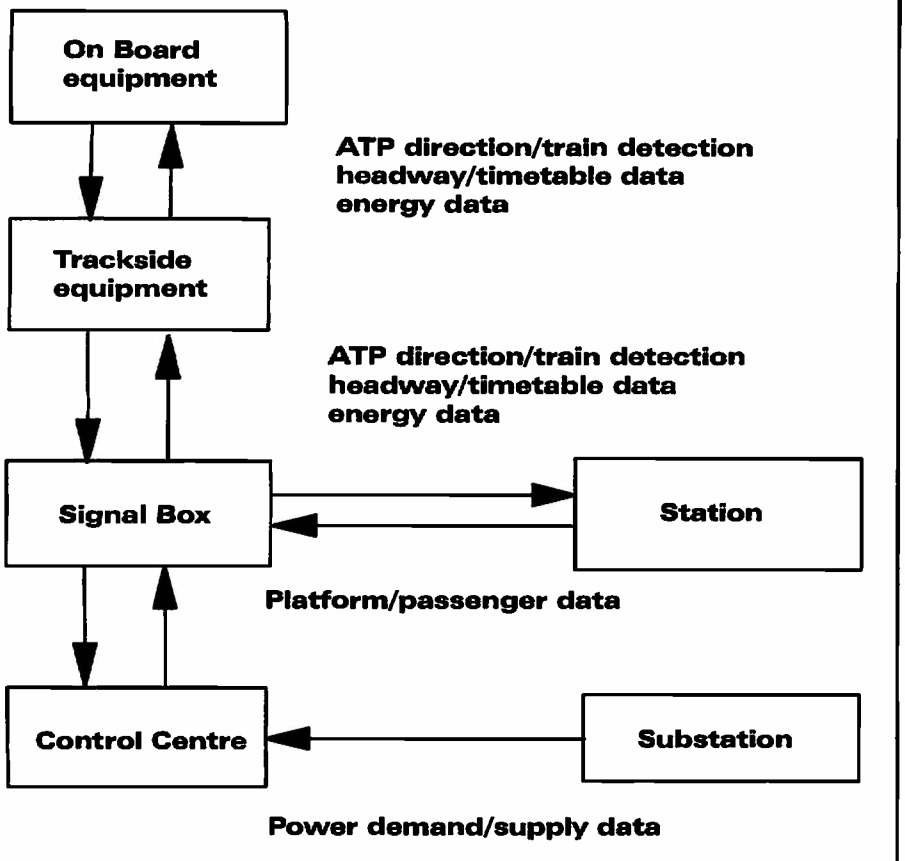


Figure 8. Elements of Japanese Digital Advanced Train Protection system.

from 11 tonnes to 7.5 tonnes. In the same phase of development, the power of locomotive units has been increased from 535 kW to 1100 kW.

Other Flags, Other Railways

In many ways it has been the example of the Japanese Shinkansen lines that has rekindled interest in high-speed train technology in Europe. One of the paradoxes of the 20th century has been the steady decline of passenger railway infrastructure in the USA, to such an extent that passenger services had to be taken over by a federal corporation, Amtrak, in 1971. Few high-speed lines are in place or are planned. Thus after 130 years of private companies providing passenger services, a government agency was required to intervene. The primary reason for this decline has been the unchecked rise of both rail and air travel and the huge investment that would be required to upgrade railway infrastructure - especially after World War II that wore out the entire railway system. With the lack of demand for 'home' railway technology developments, today the USA has to import foreign designed advanced railway technology. The neglect of the railway system leaves the USA therefore highly vulnerable in its economy to increases in cost of oil.

In Germany, there is some reserve in the implementation of their high-speed rail systems. There is a considerable 'green' lobby in Germany and so energy efficient systems of mass transportation find a broad base of approval. The very large cost, however, of establishing new fast lines has proved unpopular. The high cost has arisen principally due to the requirements of extensive tunnel sections.

New Trains for Old

In the UK, tilting trains are due to be a key feature of an upgraded West Coast line operated by Virgin Trains. GEC Astholm and Fiat Ferroviaria have been awarded a contract to provide and maintain a fleet of 55 electric tilting trains. Fiat Ferroviaria have experience of building the Italian pendolini tilting trains, with the new systems being capable of 140 mph (225 km/h). The rolling stock of the West Coast line is capable of a maximum of 110 mph but is very badly in need of upgrading and with rolling stock plagued with numerous technical faults. The initial operational life of the rolling stock was only 10 years but has been used for many more.

Also, Virgin has ordered 125 mph tilting diesel trains for its cross country high speed trains from Bombardier a Canadian based company. Some of these trains will be built in the UK at its Wakefield plant in West Yorkshire. New high-speed trains have also been ordered by Great Western Trains and North Western Trains.

Summary

Engineers can generally overcome the inherent problems of technology in designing modern railways, especially where new materials and computer technologies become available from other sectors of the economy. The delays in implementing modern railway systems inherently rest with economic factors and the general cycle of investment and revenue generation. As we develop an increasingly built up environment, future decisions on new train technology will potentially become increasingly expensive. Also, within Europe, there is a very *real* need to incorporate additional aspects of standardisation between national rail systems - otherwise the full potential of a widely connected fast European rail system will not be realised.

The poor state of the track maintenance in the UK as highlighted in the aftermath of the Hatfield crash is a very sobering discovery, since it identifies a culture of 'safety if we can afford it' rather than 'safety at all times'. The building of new fast lines, however, raises the stakes of safety even further and further focuses attention on the scope and performance of Automatic Train Protection systems that may or may not be fitted within new and existing networks.

Further Reading:

High Speed trains: fast tracks to the future, edited by John Whitelegg, Steffan Hulen and Torbjorn Flink, Leading Edge Press and Publishing, 1993

APT: A promise unfulfilled, Hugh Williams, published Ian Allan Ltd, 1985.

Points of Contact

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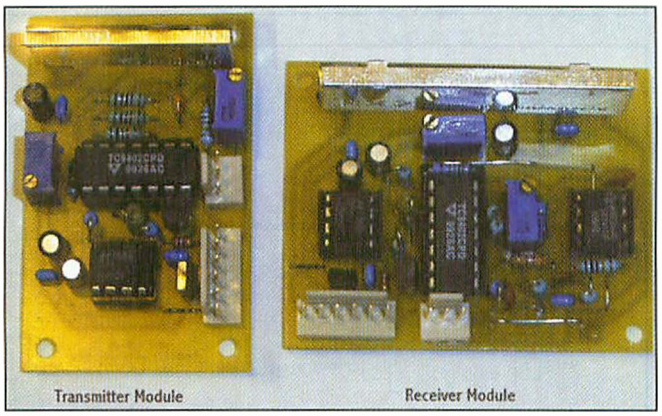
www.o-keating.com

Analogue RADIO LINKS

by Pei An

The article describes a radio link system that allows a slow varying analogue voltage to be transmitted from one location to other locations within 50 metres in a building and 300 metres in open fields.



The design uses TC94 series voltage-to-frequency and frequency-to-voltage converters. TX2 and RX2 UHF FM radio linker from Radiometrix are used for transmitting and receiving data.

Typical applications include remote monitoring environmental data, such as light intensity, temperature, humidity, moisture, and gas content in air, water pH and level in reservoirs.

How it works

The system consists of a voltage transmitter board and one or more receiver boards.

The transmitter board converts an analogue voltage into an equal space-to-marker ratio square wave signal whose frequency is linearly proportional to the input voltage. This is achieved using a dedicated IC, voltage-to-frequency converter. The square wave is then broadcast to surroundings through a digital radio transmitter (Figure 1a).

On the receiver side, a radio receiver intercepts the radio signal and demodulates it into a square wave. Two analogue data recovery methods can be used here to convert the frequency signal back into the analogue signal. One is the hardware solution and the other is the software solution. The first one involves a frequency-to-voltage converter IC (Figure 1b). The second method uses a computer or a micro-controller to count the frequency of the square wave signal and then calculates the voltage.

Radio transmitter and receiver (Ref 1)

The Radiometrix TX2/RX2 UHF transmitters and receivers can be used in the present system (See Figure 2). TX2 is a 2 stage SAW controlled FM UHF transmitter and RX2 is a double conversion FM superhet UHF receiver. TX2 and RX2 have two frequency versions: 418 MHz for UK use and 433.92 MHz for European use. Both are type-

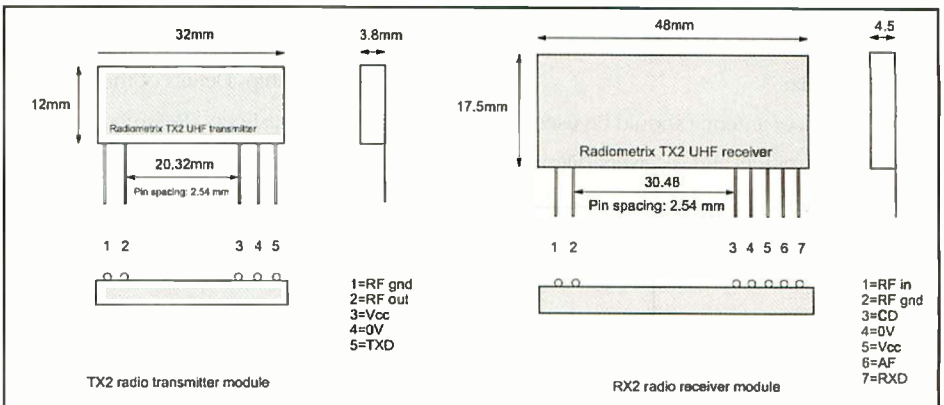


Figure 2 Pin-out of Radiometrix TX2 and RX2 modules

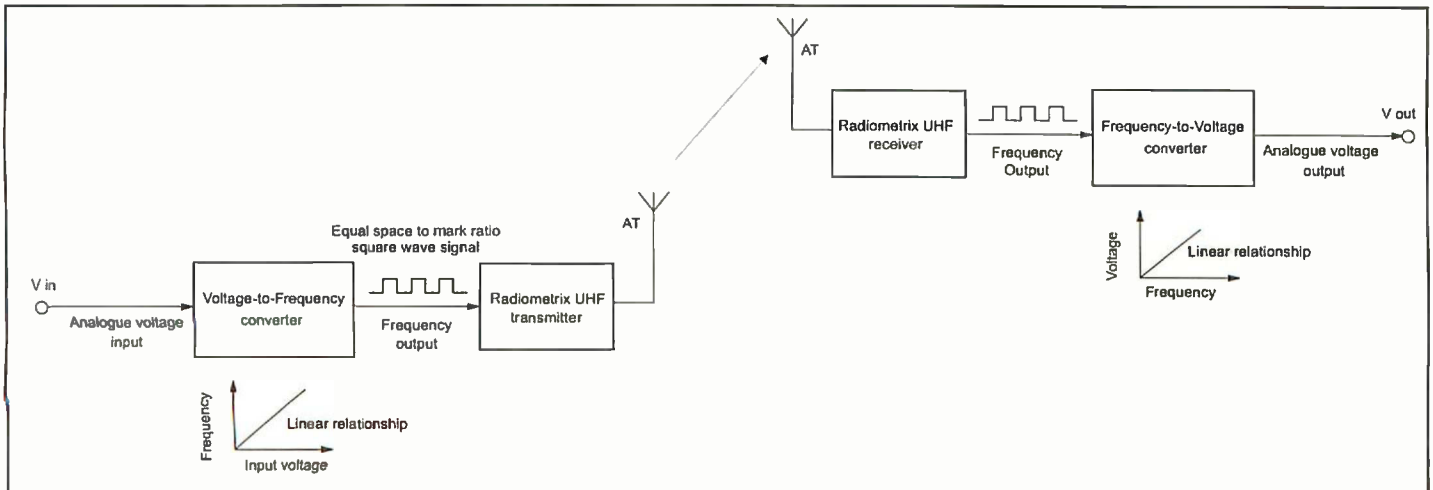


Figure 1a Radio-linked analogue voltage transmission system

Figure 1b Voltage receiver board

approved to ETS300-200 and EMC conformant to ETS300-683. Because they are type-approved, provided that they are used in the manufacturer's specified conditions with an appropriate antenna, the final products do not need further approval by Radio Authorities.

They are designed to transmit digital data at up to 40 Kbit/s (F version) or 14 Kbit/s (A version) over a distance of 300 metres in open field.

The digital signal that could be transmitted from transmitters to receivers should have a mark-to-space ratio ranging from 20% to 80% averaged over 3ms (F version) or 30ms (A version). The time between data transition is 0.025ms to 1.5ms (F version) and from 0.07ms to 15ms (A version). If an equal space and mark square wave is transmitted from the transmitter to the receiver, the frequency of the signal should be within 60Hz to 20kHz (F version) and 6Hz to 7kHz (A version).

A square wave is an ideal signal that can be transmitted from transmitters to receivers. For the A-version, the frequency of the square wave should be within 6Hz to 7kHz. For the F version, the frequency range is 60Hz to 20kHz.

Three types of antenna should be used with the transmitters and receivers (Figure 3). They can be easily constructed by users (Reference 1).

My prototype uses the 433MHz TX2/RX2 version. The receiver is an A-version receiver.

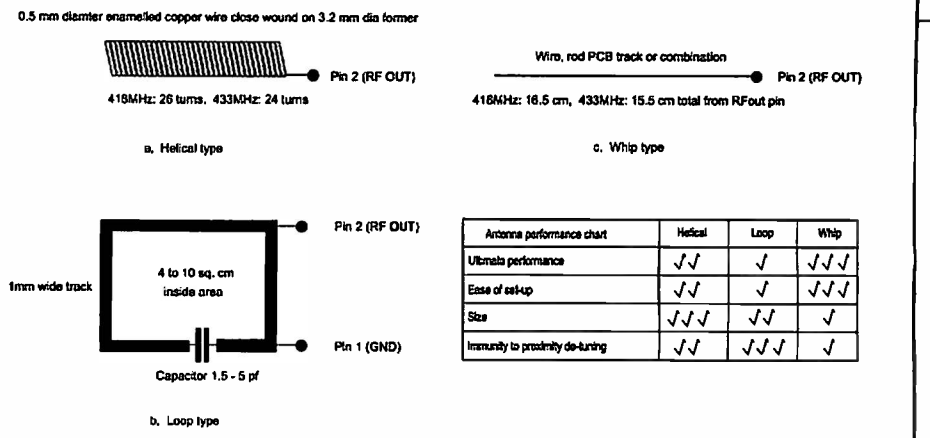


Figure 3 Various antenna to be used with the TX2/RX2 modules

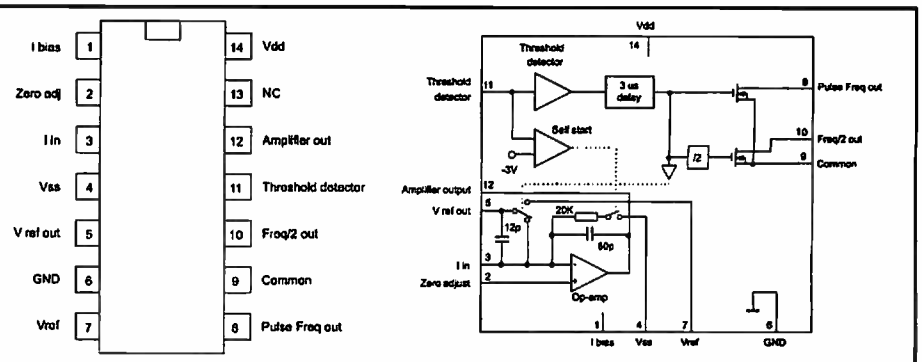
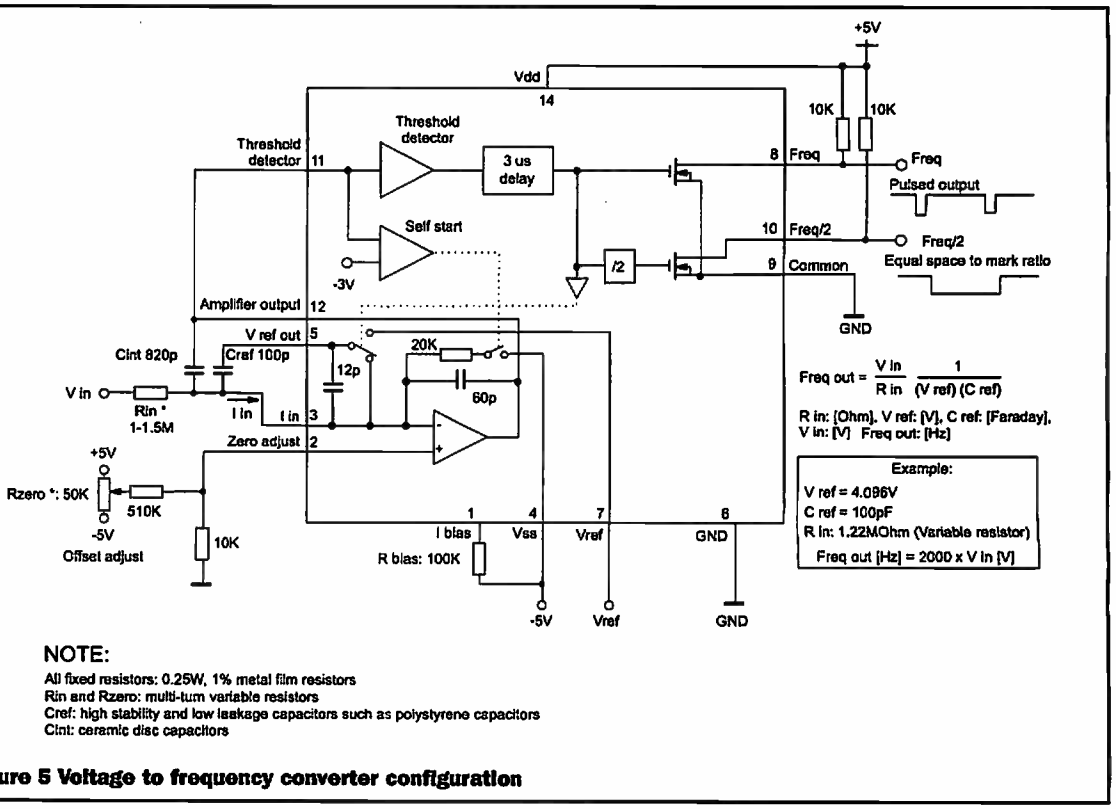


Figure 4 Pin out and internal block diagram of TC9400/9402

TC9400 F-V/V-F converter (Ref 2)

Telcom TC9400/9401/9402 is a family of low-cost voltage-to-frequency converters using low power CMOS technology. They accept an analogue input signal and generate an output pulse train whose frequency is linearly proportional to the input voltage level. They can be also configured as frequency-to-voltage converter, accepting an input frequency waveform and producing a linearly proportional voltage output. Figure 4 shows the pin-out function and the internal block diagram of the chip. Details of the ICs can be found in the datasheets (Reference 2).

Figure 5 shows a basic voltage-to-frequency circuit using the TC94 series. The input voltage (Vin) is converted to a current (Iin) by an input resistor (Rin). The current is then converted into a charge on the integrating capacitor, Cint, and shows up as a linearly decreasing voltage at the output of the op-amp. The lower limit of the output swing is set by the threshold detector, which causes the reference voltage to



NOTE:
All fixed resistors: 0.25W, 1% metal film resistors
Rin and Rzero: multi-turn variable resistors
Cref: high stability and low leakage capacitors such as polystyrene capacitors
Cint: ceramic disc capacitors

Figure 5 Voltage to frequency converter configuration

be applied to the reference capacitor. This action reduces the charge on the integrating capacitor by a fixed amount ($q = V_{ref} C_{ref}$), causing the op-amp output to step up a finite amount.

At the end of the charging period, Cref is shorted out. This dissipates the charge stored on the reference capacitor, so that when the output again crosses zero the system is ready to recycle. In this manner, the continued discharging of the integrating capacitor by the input is balanced out by fixed charges from the reference voltage. As the input voltage is increased, the number of reference pulses increases. This causes the output frequency to increase.

The output frequency (F_{out}) is related to the analogue input voltage (V_{in}) by the following transfer equation.

$$F_{out} = \frac{V_{in}}{R_{in}} \times \frac{1}{V_{ref} C_{ref}}$$

In which, F_{out} is in Hertz. V_{in} and V_{ref} are in Volt, R_{in} is in Ohm and C_{ref} is in Faraday.

Figure 6 shows a frequency to voltage circuit using the TC94 series. Each zero crossing at the threshold detector's input causes a precise amount of charge ($q=C_{ref} V_{ref}$) to be dispensed into the op amp's summing junction. This charge in turn flows through the feedback resistor, generating voltage pulses at the output of the op amp. A capacitor (Cint) across Rint averages these pulses into a DC voltage, which is linearly

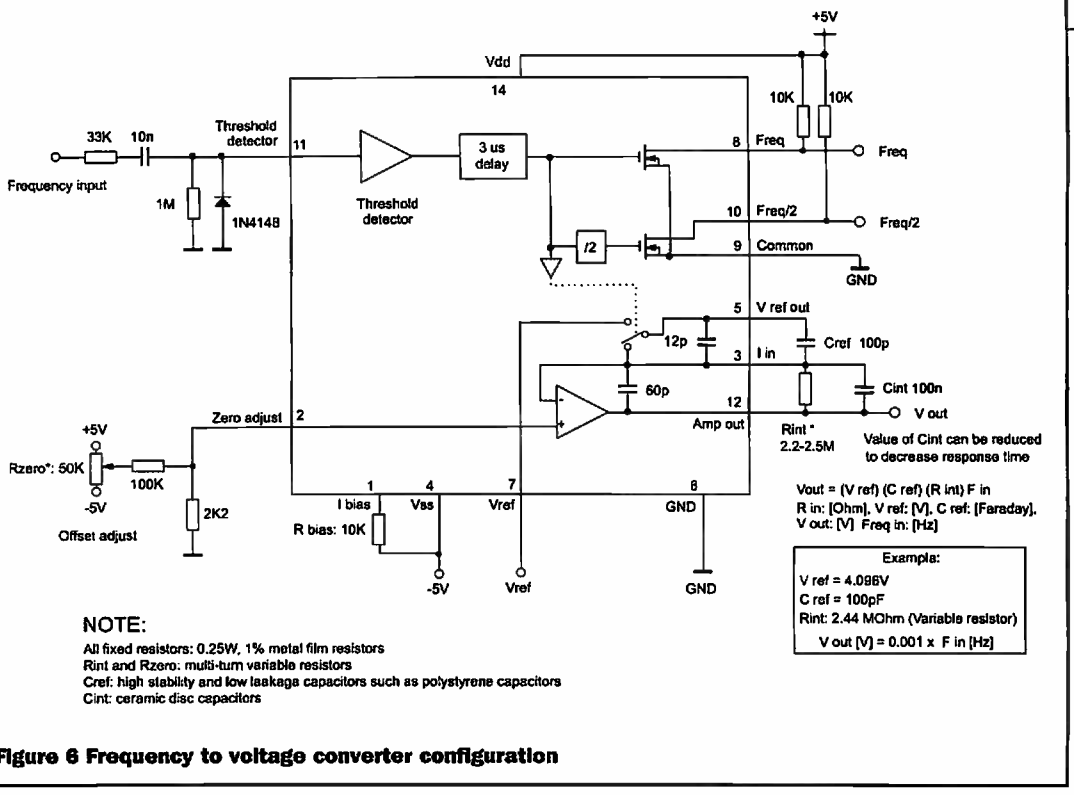


Figure 6 Frequency to voltage converter configuration

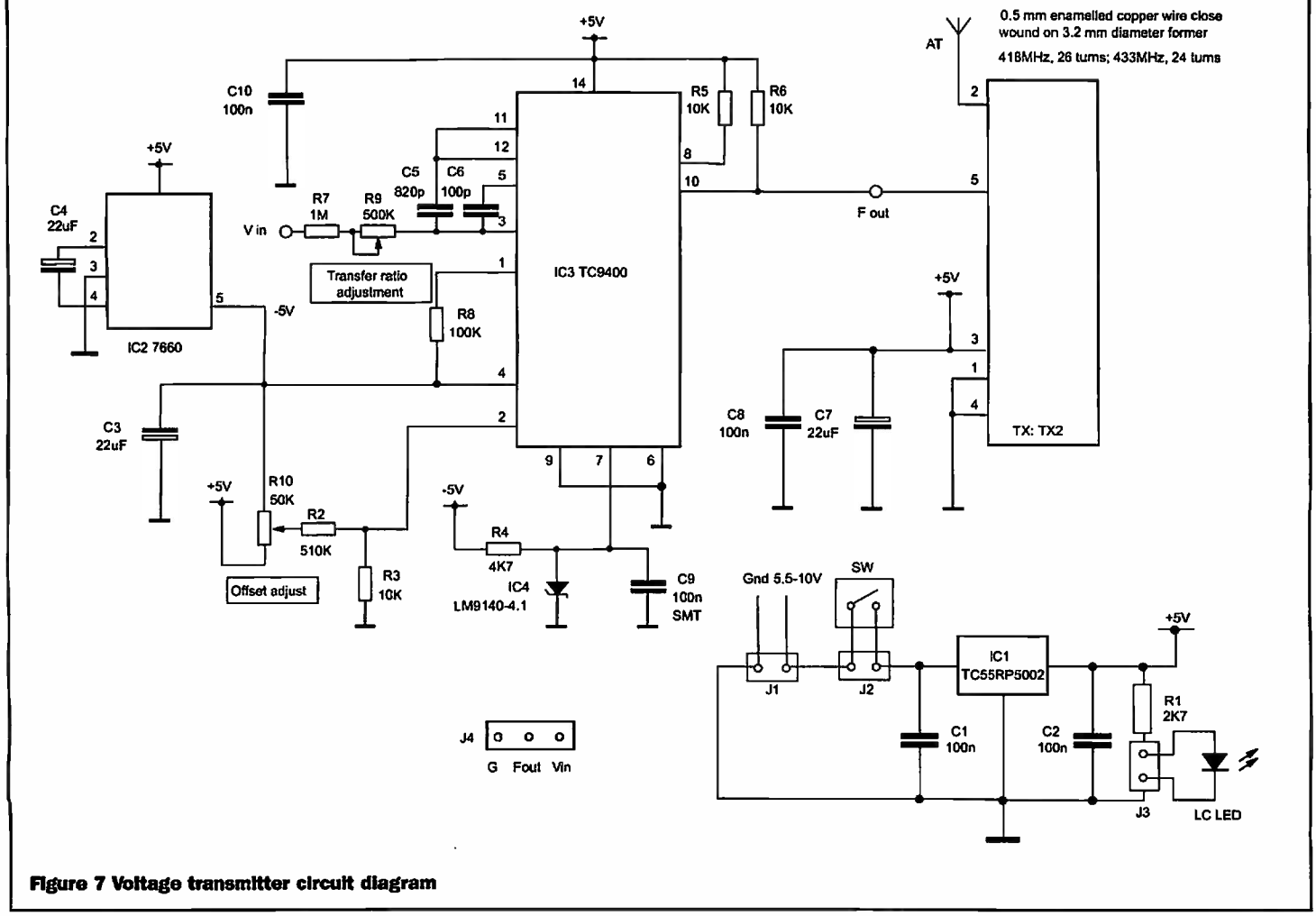


Figure 7 Voltage transmitter circuit diagram

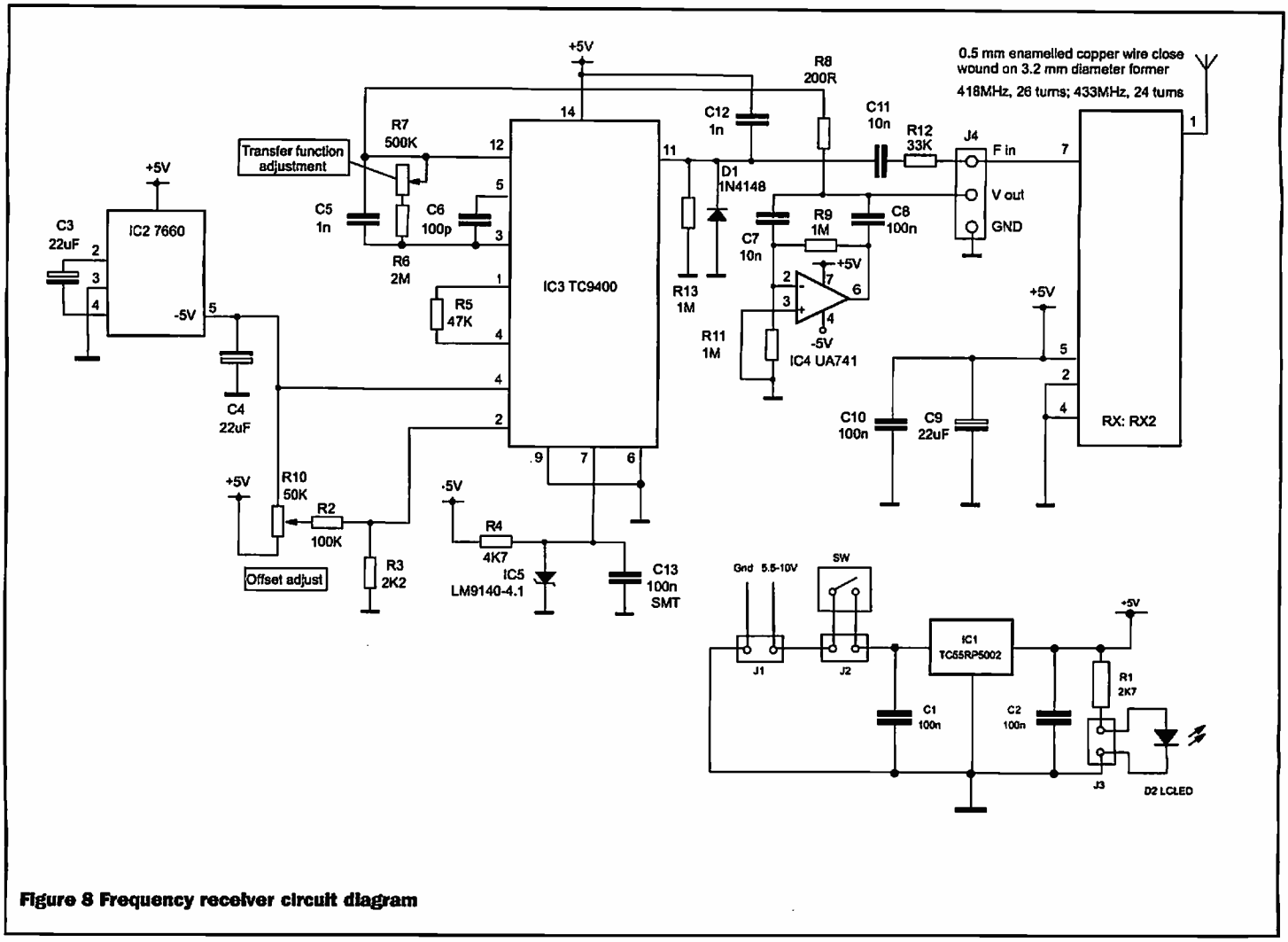


Figure 8 Frequency receiver circuit diagram

proportional to the input frequency.

The output voltage (V_{out}) is related to the analogue input frequency (F_{in}) by the following transfer equation.

$$V_{out} = V_{ref}\, C_{ref}\, R_{in}\, F_{in}$$

In which, F_{in} is in Hertz. V_{out} and V_{ref} are in Volt, R_{int} is in Ohm and C_{ref} is in Faraday.

Circuit of the analogue signal transmitter

Figure 7 gives the circuit diagram of the analogue signal transmitter and Figure 9 shows how the PCB board is constructed. TC94xx IC is configured as a V-F converter. V_{ref} is supplied by an LM9140 4.096V voltage reference. The square wave signal produced by the TC94xx IC is fed into a TX2 radio transmitter.

A 7660 supplies a negative voltage supply (-4.5 to -5V) from a positive supply rail. The positive supply rail is generated by a TC55RP5002 low dropout micro-power voltage regulator.

R10 is a 50K variable resistor for offset adjustment. When the input voltage is zero, the output frequency should not be zero. This is required by the radio linker. You need to trim this resistor to obtain the desired frequency offset. It is 40Hz in my design.

R9 is a 500K variable resistor that should also be trimmed to obtain the desired transfer function. In my prototype design, the frequency-to-voltage factor is 1000Hz per Volt. The transfer relation has the following form:

F out [Hz] = 1000 x Vin [V] + 40 [Hz]

The adjustment of R9 and R10 should follow this procedure:

set Vin = 0, adjust R10 to get F out = 40Hz

set Vin =2.000V, adjust R9 to get F out = 2040Hz.

Go back to (a) and (b) to recheck F_{out}. Two or three cycles are needed to achieve the above transfer equation.

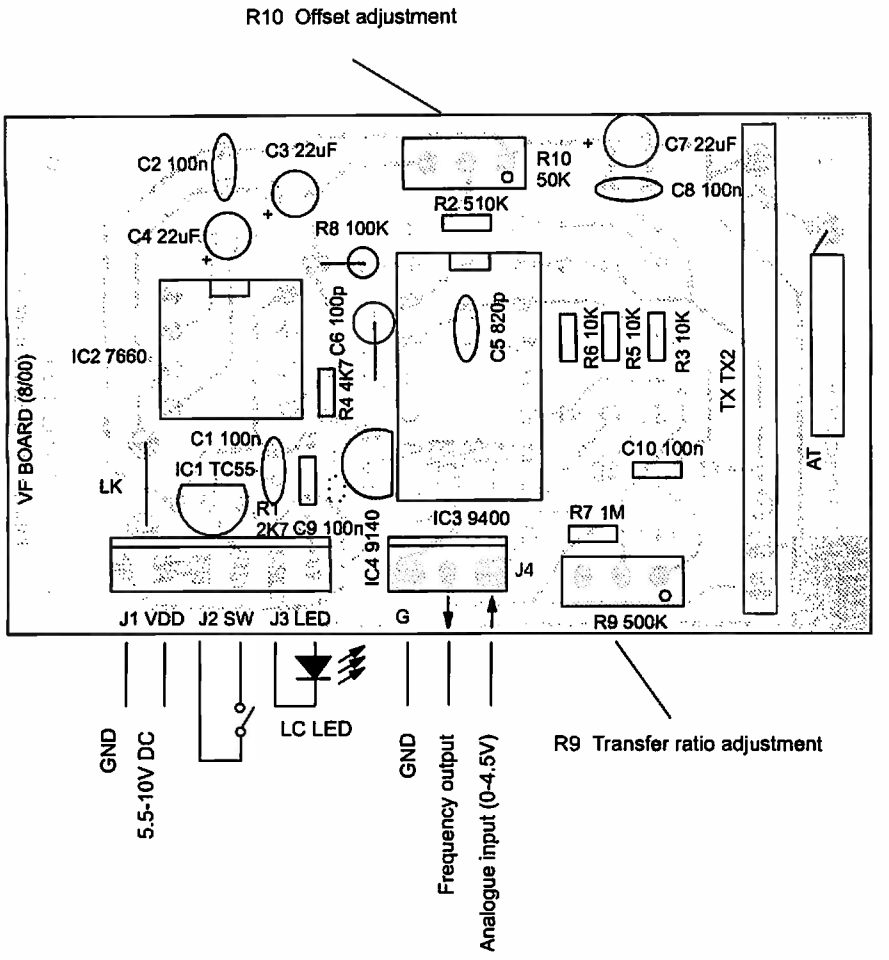
Circuit of analogue signal receiver using F-V converter

Figure 8 gives the circuit diagram of analogue signal receiver using a frequency to voltage (F-V) converter and Figure 9 shows how the PCB is constructed. The radio signal is fed into a RX2 radio transmitter through an antenna, from which a square wave signal is produced and is fed into a frequency-to-voltage converter. TC94xx IC is configured as F-V converter that converts a frequency signal into a voltage.

The reference voltage (V_{ref}) to the IC is generated by an LM9140 4.096V band-gap voltage reference. A 7660 supplies negative voltage (-4.5 to -5V) from a positive supply rail. The +5V positive supply rail is generated by a TC55RP5002 low dropout micro-power voltage regulator.

R10 is a 50K variable resistor for offset adjustment. When the input frequency is not zero, the output voltage can be trimmed to zero. In my prototype, the zero voltage frequency is 40Hz; therefore, R10 is adjusted to obtain zero voltage for this frequency input.

R7 is a 500K variable resistor that should also be trimmed to obtain the desired transfer function. In my prototype design, the frequency-to-voltage factor is 1 Volt per 1000Hz. The transfer relation has the



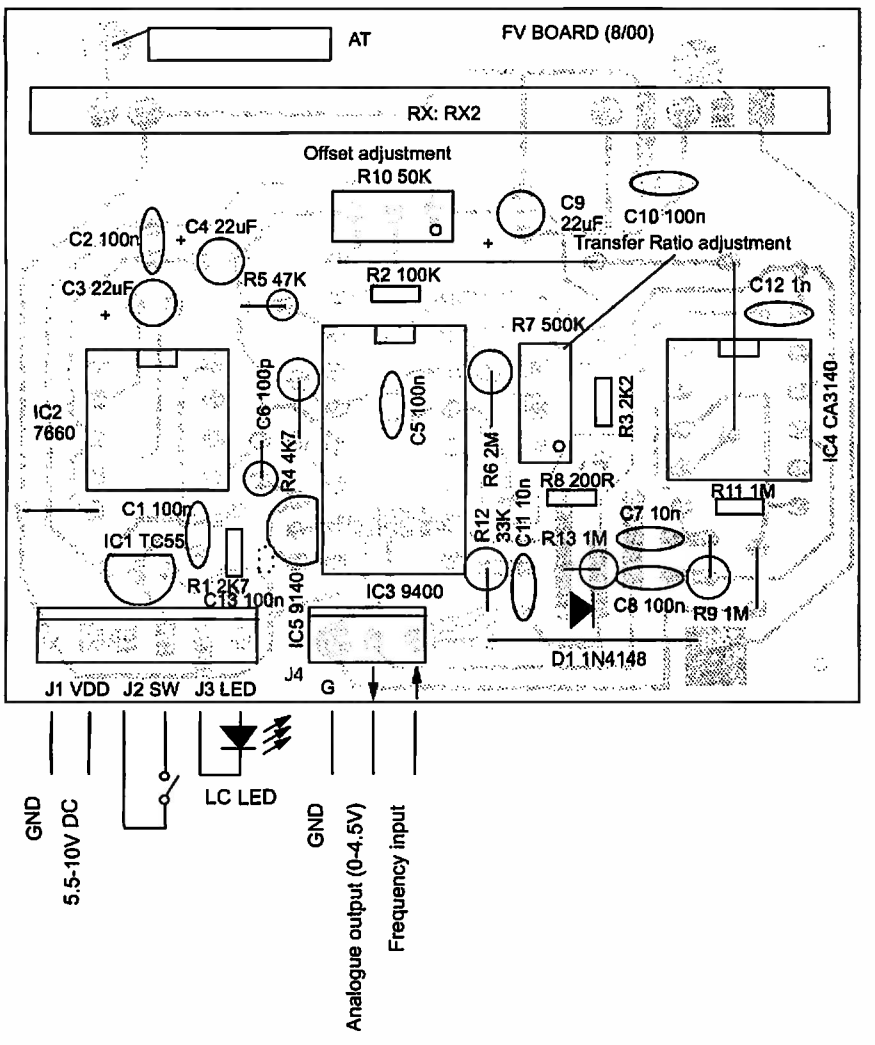


Figure 9 Component layout of the transmitter and receiver

following form:

Vout [V] = (fin [Hz] - 40 [Hz]) / 1000

Adjustment of R7 and R10 should follow this procedure:

Make sure that the transmitter board is in working order and a voltage generator is connected to the input of the board, that generates desired voltages.

set V_{in} = 0 on the transmitter board, adjust R7 to get V_{out} = 0V

set V_{in} =2.000V on the transmitter board, adjust R10 to get V_{out} = 2.000V

Go back to (b) and (c) to recheck V_{out}

Analogue signal receiver by counting frequency

Figure 10 illustrates how the frequency of a signal from the radio receiver is measured by a computer through a printer port (Figure 10a) or by a micro-controller (Figure 10b). In both cases, the F-V converter can be eliminated.

It is very easy to use a PC to measure frequency. The centronic port can be used for this purpose. The data output (RXD pin) from the RX2 is fed into an input line of a computer. DB3 of the Status port of the Centronic port (-ERROR) is used in the present case. The input line is Pin 15 on the Centronic port connector at the back of a computer (a 25-pin D-type female connector).

The following DOS based Turbo Pascal 6 program is used for counting the frequency. The program counts the number of pulses within a 2 second period, from which the frequency is found. The advantage of this sample program is that it is rather simple. The disadvantage is that a voltage signal is generated every 2 seconds (the integrating period is 2 seconds). So the analogue signal at the input of the transmitter board should be slow varying.

The program runs in the DOS environment. In a Windows 95/98 environment, some pulses will be missed out. So to run the program properly, the computer should start in a DOS environment.

Applications

The present analogue link is designed for voltage transmission and allows a slow varying signal to be transferred. The rate of

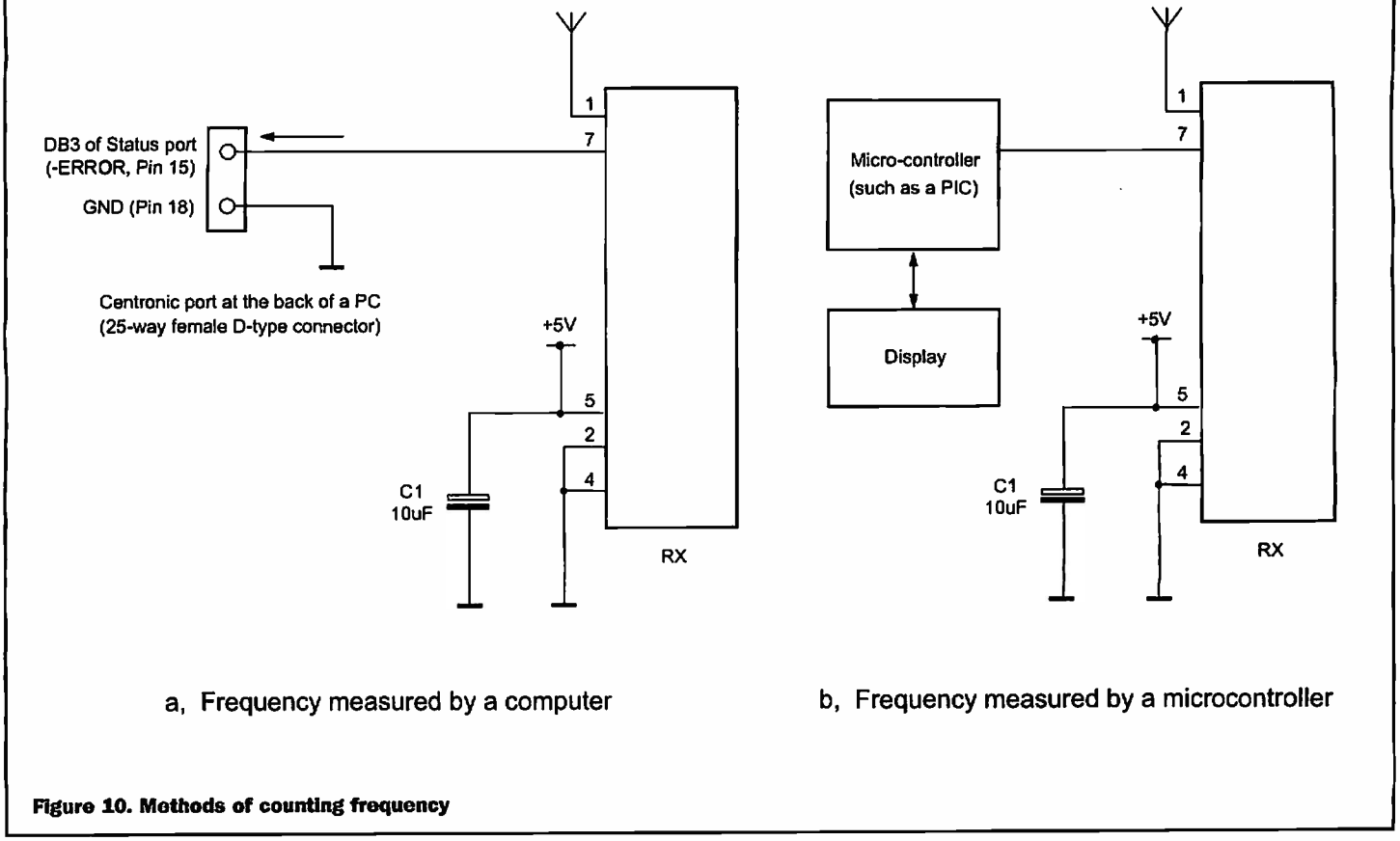


Figure 10. Methods of counting frequency

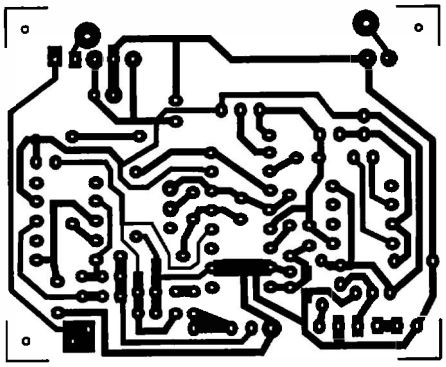
voltage change should be less than 100V/second (equivalent to 10Hz 5V amplitude triangular waveform). If the voltage varies faster than this, the output voltage on the receiver side will not follow the waveform of the input voltage.

In this circuit, there are small ripples present in the output voltage. So some averaging is required during the data logging. It is possible to decrease ripples in the output voltage by increasing the value of the integrating capacitor (C5) on the receiver board to 100nF (in the design, C5 is 1nF). This will increase the receiver's response time and only allows a slow varying signal (about 0.1V per second) to be transmitted.

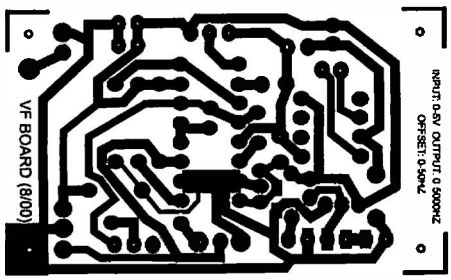
The accuracy of an analogue transmission signal is ± 5 mV or 1% of the output voltage (whichever is greater). The operation temperature range is 0-25°C.

The present design provides a basic building block for various remote data logging applications. The analogue input requires that the input voltage be within 0 to 4.5V. Any sensors having that voltage output level can be connected to the transmitter board. Sensors that have other types of outputs require a signal conditioning circuitry. The following is a list of sensors that can be used with the remote logger.

- Degree C Temperature sensors LM35
- Degree K Temperature sensors LM135
- AD590kH Infrared thermometer
- Calex T sensor Humidity sensors
- Mercator RHU217-AT AD/DC Current sensor
- LEM split core current sensor



Receiver Module



Transmitter Module

Acknowledgement

I would like to thank Mr. Kangyan from Radiometrix Ltd for his help and advice on this project.

Technical support

Designer's kits are available from the authors. The kit includes PCB boards, all components, and TP6 software. Please direct your enquiry to Dr. Pei An, 11 Sandpiper drive, Stockport, Manchester SK3 8UL,
Tel/Fax/Answer: 44-(0)161-477-9583.
E-mail: pan@intec-group.co.uk

References

1. Manufacturer's data sheets on Radio Packet Controller. Available from Radiometrix's website
<www.radiometrix.co.uk>
Telephone number: +44 (0)181 428 1220

2. Manufacturer's data sheet on TC9400 series. Available from Telcom's website:
<www.telcom-semi.com>

PARTS LIST

Radio transmitter module

Resistors

R1	2K7	R6	10K
R2	510K	R7	1M
R3	10K	R8	100K
R4	4K7	R9(VR)	500K
R5	10K	R10 (VR)	50K

Capacitors

C1	100n	C6	100p (axial)
C2	100n	C7	22µF
C3	22µF	C8	100n
C4	22µF	C9	100n (SMT)
C5	820p	C10	100n

Transistors

IC1 TC55RP5002
IC2 7660
IC3 TC9400
IC4 LM9140-4.1
D1 LC LED

Connectors

J1+J2+J3 6 Pin connector
J4 3 Pin connector

Others

PCB board (Figure 11b) SW AT

Radio Receiver module

Resistors

R1	2K7	R8	200R
R2	100K	R9	1M
R3	2K2	R10 (VR)	50K
R4	4K7	R11	1M
R5	47K	R12	33K
R6	2M	R13	1M
R7(VR)	500K		

Capacitors

C1	100n	C8	100n
C2	100n	C9	22µF
C3	22µF	C10	100n
C4	22µF	C11	10n
C5	100n	C12	1n
C6	100p (axial)	C13	100n (SMT)
C7	10n		

Transistors

IC1	TC55RP5002	IC5	LM9140-4.1
IC2	7660	D1	1N4148
IC3	TC9400	D2	LC LED
IC4	UA741		

Connectors

J1+J2+J3 6 Pin connector
J4 3 Pin connector

Others

PCB board (Figure 11a) SW AT

TP6 program list

```
Program TC9400;
(* Software driver for TC9400 Voltage to Frequency board *)
(* This program receives a frequency signal and reproduce the analogue voltage *)
(* Frequency signal input to DB3 of Status Port of the Centronic port *)
(* Copyright to Dr. Pei AN, 8/00 *)

uses
  graph,crt,dos;

var
  Freq:real;
  P_address,Count:integer;
  hour,minute,second,second100:word;

Procedure Centronic_address;
(* $000:$0408 holds the printer base address for LPT1
  $000:$040A holds the printer base address for LPT2
  $000:$040C holds the printer base address for LPT3
  $000:$040e holds the printer base address for LPT4
  $000:$0411 number of parallel interfaces in binary format *)
var
  lpt:array[1..4] of integer;
  number_of_lpt,LPT_number,code:integer;
  kbchar:char;
begin
   clrscr;
   LPT_number:=1;          (* to set defaut printer *)
   number_of_lpt:=mem[$0000:$0411]; (* to read number of installed Centronic ports *)
   number_of_lpt:=(number_of_lpt and (128+64)) shr 6; (* Bit manipulation *)
   lpt[1]:=memw[$0000:$0408];     (* Memory read procedure *)
   lpt[2]:=memw[$0000:$040A];
   lpt[3]:=memw[$0000:$040C];
   lpt[4]:=memw[$0000:$040E];
   textbackground(blue); clrscr;
   textcolor(yellow); textbackground(red); window(10,22,70,24); clrscr;
   writeln('Number of LPT installed  : ',number_of_lpt:2);
   writeln('Addresses for LPT1 to LPT 4: ',lpt[1]:3,'  ', lpt[2]:3,'  ', lpt[3]:3,'  ', lpt[4]:3);
   write('Select LPT to be used (1,2,3,4)  : ');
   delay(1000);
   if number_of_lpt>1 then begin  {select LPT1 through LPT4 if more than 1 LPT installed}
    repeat
      kbchar:=readkey;          (* read input key *)
      val(kbchar, LPT_number, code);  (* change character to value *)
    until (LPT_number>=1) and (LPT_number<=4) and (lpt[LPT_number]<>0);
              end;
   clrscr;
   P_address:=lpt[LPT_number];
   writeln('Your selected printer interface: LPT',LPT_number:1);
   write('LPT Address           : ',P_address:3);
   delay(1000);
   textbackground(black); window(1,1,80,25); clrscr;
end;

Function bit_weight(bit:byte):byte;
var
  i,dummy:integer;
begin
   if bit=1 then bit_weight:=1
    else begin
       dummy:=1;
       for i:=1 to bit-1 do dummy:=2*dummy;
       if dummy=0 then dummy:=1;
       bit_weight:=dummy;
       end;
end;

Function Frequency(Address:integer; Bit_weight:integer):real;
(* This function measures Frequency. Average period is 2 seconds *)
(* Address is the I/O address. For printer port, it is P_address+1 *)
(* Bit_weight is the bit weigth of the port used for measure the frequency *)

var
  time1,time2:real;
  counter:integer;
begin

   counter:=0;
   repeat until port[Address] and Bit_weight=0;     (* signal state low *)
   gettime(hour,minute,second,second100);
   time1:=minute*60+second+second100/100;         (* find time 1 *)
   repeat
   repeat until port[Address] and Bit_weight=Bit_weight; (* wait until signal high *)
   counter:=counter+1;
   gettime(hour,minute,second,second100);
   repeat until port[Address] and Bit_weight=0;     (* wait until signal low *)
   time2:=minute*60+second+second100/100;         (* find time2 *)
   until (time2>=time1+2) or (time2<time1);
   if time2>time1 then Frequency:=counter/(time2-time1)
end;

(* Main program *)
begin
   Centronic_address;
   count:=0;
   repeat
      count:=count+1;
      Freq:=Frequency(P_address+1, 8);   (* P_address+1 is the address of the status port,
                        8 is the bit weight of DB3 *)
      gotoxy(15,11);write('Frequency of the output signal [Hz]: ',Freq:8:1);
      gotoxy(15,12);write('Analogue voltage [V]          ',(Freq-40)/1000:8:5);
      gotoxy(25,1);write(' Current data logging cycle: ',count);
      gotoxy(25,25);write('Press any key to stop the program');
   until keypressed
end.
```

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RESEARCH NEWS

Personal Communications Systems and Intra home Networks.

Dr Chris Lavers examines these developments and the way machines and sensors in our homes will talk to each other in the future.

PART 1

Over the next two months I want to discuss some key changes that are currently taking place in intra-home personal communications.

E-M@iler the 'benchmark' of Future Personal Communications Systems

I believe that this current decade will provide users with the most exciting period of innovative change and design in electronic device manufacture than in any preceding generation. The advent of in-built Digital Signal Processing (DSP) and extensive use of 'horizontal design architecture' will be 'the shape of things to come'. What do I mean by horizontal design architecture? Well simply the design of software controlled devices able to communicate with as many other device platforms as possible, & offering the largest number of upgradable features to the user. E.g. for the sake of a little extra cost in design, users might prefer a 'ghetto blaster' that can display limited Short Message Service (SMS) to/from mobile phone users on a small LCD display screen and be able to play a voice-mail message out of the loud–speaker rather than a 'dumb' loud-speaker system. The key is to be non-application specific. There is no point in having a system that is the best at a specific application today because the needs of the consumer will change tomorrow. The future requires us to be diverse and to find new ways of doing and organising things. Future digital software radio must be robust against technology changes or 'future fade'.

Fig 1. E-Mailer Courtesy of Amstrad Plc.

The launch of the Amstrad e-mailer and a similar but more expensive system from Philips offers just this sort of horizontal design architecture and has taken the electronics market place by storm. The e-mailer satisfies a massive demand for a product, which offers simple access to e-mail services and beyond. Having 'played' with an e-mailer since June this year I can confirm for once that this really is a telecommunications device, which lives up to- and exceeds expectations. The Amstrad e-mailer Personal Communication Centre offers the very latest in digital telephone technology at an extremely attractive price of only £79.99 and represents the likely generic evolution of communications technology for the coming decade. It introduces advanced electronics that can fulfil a number of different applications, maximising the ability of a device to talk to as many other kinds of devices as possible.

The Amstrad e-mailer was launched in March by Sir Alan Sugar. According to Sir Alan, "the e-mailer brings e-mail to the mass market for the first time in an easy to use format at a very affordable price." Not everyone wants to have to shell out upwards of a £1K for a new PC, primarily if you are a small household/business, just for e-mail access. Currently only 1 family in 5 has access to e-mail at home in Britain. Projected Amstrad sales will see up to 1 million British homes installed with the e-m@iler phone within the next two years. There is no large outlay on a PC and there is no connection charge, contracts or monthly subscriptions. This is particularly relevant with a number of internet providers who have had to recently revise ambitious plans for free internet access.

Consumers instead are charged on a 'Pay as You Go' basis on their regular telephone bill, a successful method already applied in mobile phones as 'Pay as You Talk'. Revenue for Amstrad will come from e-mail usage as well as from specialist advertising routed through the e-mailer to the owner of the Personal Communications Centre (PCC). The PCC has an elegant telephone unit packed with features and with an adjustable backlit Liquid Crystal Display screen. The LCD display is a 0.7mm thick blue SuperTwist Nematic (STN). The display uses transparent Indium Tin Oxide (ITO) electrodes, with a 1/320 duty cycle, and uses 1/2 VGA 480 by 320 pixels. Dot pitch is 0.25 by 0.25, and dot size 0.235mm by 0.235mm.

It also comes with a Portable data bank (or Pocket Dock-It!) having a capacity to store 700 names and contact details (docked on the right in Figure 1). The software-controlled features include automatic e-mail notification and collection, answer phone and fax facilities. Amstrad has been working on their latest 'blockbuster' product for almost 2 years in collaboration with British Telecom. According to Sir Alan, "the e-mailer is also 'future proof', with the ability to receive software upgrades down the telephone line as they become available." This will maximise the ability of digital software systems to 'change with the times'. From time to time special offers will be shown on the LCD screen.

The user can respond simply by pressing a single SERVICES button so that the user is connected to the advertisers call centre.

Digital Communications Facilities

The heart of the device is its ability to combine the latest in digital telecommunications technology with the ability to send and receive e-mails, faxes etc. E-mails can be sent and received worldwide using Amserve™, the dedicated Amstrad server. Amserve was formed earlier this year to operate the company's business generated by the e-mailer. In early June Dixons Group Plc took a 20% stake in Amserve Limited as part of a £15M deal. Dixons provides advertising and service support as well as distribution and investment in support of the product. Amstrad regard Dixons as the pre-eminent retailer of mass consumer electronics goods, and will use this to aid penetration of the telephone market. The demand for the e-mailer is almost outstripping supply and compares with the demand created by the Amstrad word processor. The Dixons Group currently stock the e-m@iler in all 1000 Dixons, Currys, PC World and The Link stores in the UK. According to John Clare, CEO of the Dixons Group, "There is a definite pent up demand in the market for a product that will give non-technical people really easy access to e-mail services."

The e-mailer will help revolutionise communications in both home and office, giving the man in the street ready access to e-mail capabilities which is easy to operate and affordable. The e-mailer is designed to be 'plug and play' with easy to follow instructions. I managed to register the e-mailer and set up my e-mail address account with the Amstrad server in less than 10 minutes with no prior instruction.

Practically speaking all you need to do to send email is to push the E-MAIL SEND button. The LCD display will change to the relevant compose screen and after writing your e-mail pressing E-MAIL SEND again will send the e-mail! E-mail can even be accessed remotely from anywhere in the world whilst you are away via the Internet. The e-mailer also allows you to record voice/sound attachments, which can be sent with your e-mail. Selecting the polling facility will allow you to retrieve messages at set timed intervals from the Amserve server, but manual collection is also possible by holding down the E-MAIL SEND button. This informs you of any new messages by illuminating the red e-mail light and indicating the number of messages on the LCD screen. To discourage inadvertent e-mail checking and small children 'playing' with the device, 5 seconds is required to enact the manual request for e-mail to be downloaded.

Fig 2. E-Mailer Courtesy of Amstrad Plc.

The e-mailer allows you to register up to 8 different e-mail addresses each using a chosen PIN. A fax message from the e-mailer can be sent in the same way that you would compose and send e-mail. E-mail and fax messages can be sent to a compatible printer and attached e-mail pictures printed via a fax machine if required (.jpeg, .GIF and .bmp file format).

Personally one of the best features is the echo free Full-Duplex (FDX) hands free telephone operation. This avoids the risk of those irritating neck aches you can get from holding a phone for too long in the same position, freeing both hands up for other things, or a wander round a room to retrieve something whilst talking. The phone can also be operated in a mute function and is switchboard compatible, which is a key issue for companies whether small or large.

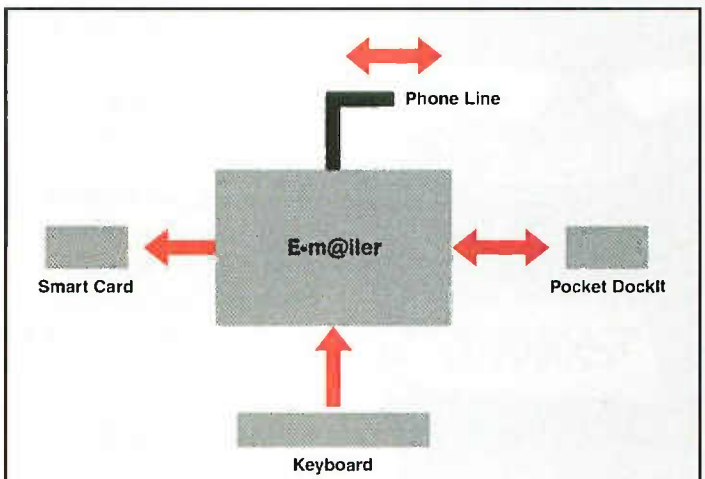

Fig 3. Information Transfer Input/Output

The Pocket Dock-It Databank (Figure 2) allows you to build up your Address book and then transfer it back to the e-mailer. Simply inserting your Pocket Dock-it into the docking station in the right side of the phone will automatically transfer your current Address Book details stored on the e-mailer to be automatically transferred to the Dock-It. Information transfer is illustrated in Figure 3. Caller Display Incoming calls are matched to the Address Book allowing stored details to be displayed on the LCD screen. Non stored details will display the number only.

The E-M@iler records all the messages digitally, so accessing them is quick and easy. Once voice messages have been received, the green 'VOICE' light illuminates and the screen displays how many messages you have. Press the VOICEplay button on the phone and your messages will appear on the screen, press again to listen to them. Once again this can be accessed remotely via the Web.

The E-M@iler is also compatible with Smart Media

and has a port for inserting a removable card. Smart Media is a digital solid state memory without any moving parts, so no 'whirring' hard disks. It is also used in digital cameras so a user may add to their existing memory and thus transfer data to PC. By using the removable SmartCard, the e-mailer can store more e-mail, fax and Voice-mail messages for later retrieval or archiving. There are no plans currently to incorporate any

	Basic Features	Advanced Features
Data Functions	Fax	
	E-Mail	Picture and Voice-Mail attachments Latest SMS Upgrade to Mobile-phone users Remote e-mail read Voice-Mail
Voice Functions	Real-time speech	Real time handsfree speech

Table 1 Current applications.

form of conventional PC hard-disk. The SmartCard allows data to be transferred anyway.

Back in July in discussion with Alan Hopkins at Amstrad, I pointed out that when requesting e-mails from the Amserve server, no matter how many there were it only incurred one fixed call cost, their first software generation e-mail composition required each e-mail to be sent and charged separately. Mr Hopkins explained that the next upgrade of downloaded software would allow multiple emails to be sent at a single fixed local call cost. Version 6 now installed permits a single billing on transmission of a group of e-mails. Current available features are listed in Table 1.

Future PCC Technology- Whatever you want that is commercially viable!

Probably the biggest potential of this device is that it is very simple to software configure a Next Generation e-mailer with the ability to offer weather, news and travel, etc. under what you might call E-Mail Application Protocol (EMAP), or Amserve INTERMAIL services. e.g. travel@amserve.net, weather@amserve.net, news@amserve.net, etc. which the user requests by sending an e-mail to one of the above addresses. This generates an auto-reply, which downloads an e-mail with several pages of text of useful information with e-mail links to other useful e-mail sites. This could be tested on a trial period to see whether there is any consumer demand for these 'teletext' style public information announcements. When I suggested this to Amstrad they were clearly interested and it is a fairly straightforward system to implement. However, Mr Hopkins voiced some caution at this early stage. "Investment is obviously required to set up the service. With the internet, third parties developed the Applications but with the e-mailer in its current form, we would have to do this. Someone (either us or the information provider) would need to perform a cost-benefit analysis on the investment." Clearly the key to getting this off the ground is to provide an initial limited range of services that people are prepared to pay for calls on more than just a one-off novelty look basis.

From here the implications are obvious, allowing the 'shadowing' of Amstrad web pages with 'mirror' e-mail downloadable text. Cost wise this may not be so unattractive to the customer given the lack of ready accessible cheap internet. Again this makes maximum use of the e-mailer's ability without requiring a £1000+ new internet ready machine with £20-30 a month in internet access/costs. Mass distribution of web information at relatively cheap cost? Other commercial Internet Service Providers (ISPs) could follow suit, again if they can see a commercial market in providing a lower level e-mail version of existing and future websites.

Alan felt that a better way would be to present pages as html using the browser. This would need server-side re-purposing of content and exposing the browser, both of which are under consideration.

Taking horizontal architecture further I suggested intermail request radio was possible through the hands free set. E.g. dial up amserveradio@amserve.net, a few seconds later the phone rings providing a radio station, with requests via email from Amserve clients. Specialist music stations: jazz, reggae, etc. already provide internet access to a wider global audience. There is no reason why a jazz enthusiast would not be prepared to pay for a BT local call to access internet/intermail radio of his/her favourite music genre. At which point Alan wasn't sure why someone would want to go to the bother of the email request. Why not just have an entry for say "Virgin Radio" under "SERVICES" which predialled 0800 301215 and output audio via the speaker. Again this is something the Amserve provider would have to enter into to discuss with a prospective radio station. Possible 'future applications' are summarised in Table 2.

The number of potential specialist 'vertical applications' is endless, even down to software control of the handsfree speaker to be triggered remotely to check if the dog at home is OK! Hotel phones can already be configured so that parent's with a small baby in another room can hear their baby breathing. However the question at the Amstrad end is, does the return warrant the investment if it's Amstrad paying? Particularly, as they are not at least at this stage, willing to open up the technology to 3rd party developers who might start to cut off Amstrad's main revenue supply –the Amserve clients. However it should be possible for e-mail attached software programs to configure the system to act in specific ways,

HTML web browser compatible
Software controlled radio operation
Data logging features
Remotely operable handsfree 'listening' & transmission
Secure data encryption
Slow low data-rate video to display/screen

Table 2 Possible future applications subject to feasibility studies.

e.g. a simple data logger linked to SMART sensors in remote locations. In terms of IT security, raised by E-mail systems in general, and given that the e-m@iler is software driven, I asked what was to protect the e-m@iler from malicious e-mail attachments sent to the Amstrad server or individual e-mail addresses? Could the e-mailer be forced, for example, into a send mode, which could route all e-mail addresses and textual information (+voice mail) contained on an individual

machine to a distant site for clandestine commercial purposes?

Cliff Lawson IT chief for the e-mailer explained that "the em@iler is far more secure than a PC. The way that such virus/security breach activity happens on a PC is by virtue of programs like Internet Explorer and Outlook having too many "bells and whistles" that will, for example allow an email attachment to be executed if it contains Microsoft Visual Basic scripting language. This is how the famous "ILOVEYOU" virus worked. Equally, there are all sorts of supposed "cleverness" in Explorer that allows it to run ActiveX controls, Java, Javascript, etc. and all of these provide "backdoors" for hackers to infiltrate machines via security breaches. The emailer has none of this. It is really VERY simple and only does the minimum necessary to send/receive email. When it connects to the (closed!) internet it only connects via PPP over TCP/IP and then performs an SMTP and up to eight POP3 sessions, none of which gives a Trojan entity the opportunity to execute on the ARM processor at the heart of the machine. Therefore it is very secure indeed. We have absolutely no concerns on that score".

However, it is interesting to branch off on a parallel theme that a determined team of software hackers can get into any system these days if they try with sufficient concentrated effort. This week Sandia National Labs in the US released details of their own software hacking team- the 'Red Team' which confidently announced to the world that they were capable of hacking all computer defences. Over the past 2 years- the time it has taken to develop the Amstrad e-m@iler the Sandia Red Team has, (at customer invitation I add), successfully invaded or devised successful mock attacks on 35 out of 35 information systems. The team is similar to the one in Sneakers starring Robert Redford!

Their work - challenged only by a new style of defence, also developed at Sandia, called an "intelligent agent" - demonstrates that competent outsiders can hack into almost all networked computers as presently conformed no matter how well guarded, according to the Information Design Assurance Red Team or IDART. "Networked computers might include e-commerce, transmitted or Net-stored financial, as well as medical data. Sites investigated by Sandia include information systems from 2 very large corporations and key government agencies", says team leader Ruth Duggan.

"We found specific weaknesses in every system." IDART was started in 1996 by Michael Skroch, now assigned to DARPA (Defence Advanced Research Projects Agency). DARPA was one of the team's principal sponsors before Skroch was asked to join as program manager. And of course DARPA were the original creators of what we now know as the Internet. The Red Team's mode is to "role-play the position of an adversary" - a point of view sometimes difficult for system designers to accept.

The mindset of an adversary

Whilst the Sandia group's actions are legal! its adoption of an "outlaw" mindset combined with a willingness to analyse how an information system can be penetrated (via the Internet or by an insider) has helped test and develop concepts in security technology. Some of these concepts are so advanced they are not yet available in the marketplace. The typical IDART group consists of 3 to 8 hackers, sometimes even explaining to clients in advance how and when they will attack. System defenders have time to prepare specific, automatic, and even redundant defences for their software, platforms, firewalls, and other system components. Yet hackers beat clients every time: their defences are breached.

"Right now, information system defenders have a very difficult job," says Duggan. "Our goal is to improve the security of information systems to make the attacker's job difficult instead." But the group has a long way to go. "Fortified positions do take us longer to break in," she says, "but on the order of minutes, not hours."

The extraordinarily broad abilities of cyber attackers - from professional hackers to terrorists to state- and corporate-sponsored aggressors – to penetrate any system they desire can result in pilfered information, corrupted data, a change in operational order, or a denial of services. Any of these, to an individual, is an annoyance. To major corporations this could result in billions of dollars misplaced or stolen, or a damaged reputation. In a medical or military emergency, an enemy could intercept messages, corrupt data, and deny access to services causing catastrophic damage.

To reduce such problems, the Red Team prefers to be called in at the design stage of a system, though it can attack a system already in place to ferret out weak points. "Our job is to understand how systems can be caused to fail, and then to help the customers improve the surety of their systems," says Sam Varnado, Energy and Critical Infrastructure Centre Director.

One key area of interest since the days of Homer's Illiad, is the Trojan Horse problem which is now a very big problem because today most software is written overseas because it is cheaper to get computer specialists in Bombay to write a program rather than a team in California. Trojan Horse time bombs that go off when the adversary chooses to trigger them could be placed in it. Asked why such events haven't already happened, members speculate it may be better for adversaries to keep US systems up, in order to extract data from them in a parasitic way without killing off the host.

The Red Team participates in attacks that range anywhere from 1 week to 5 months. The nature of the work still raises hackles among defenders, who sometimes fail to appreciate a friendly attacker. One group member tells clients to say to themselves, "The Red Team is my friend," and repeat it twice more when tempers grow short!

Anyone wishing to participate in an E-M@iler forum for future 'developments' in this and allied technologies are welcome to contact me at: c.lavers@brnc.ac.uk

If enough people put forward similar requests for future applications, a few of which I have outlined above, Amserve might consider developing the software. So let me know! This device really is a winner, in terms of cost and software upgradeable features. The E-M@iler PCC currently sets a very high benchmark for the global market in future Integrated Personal Communications Centres which are sure to follow.

For further information on the E-M@iler system contact:
Alan Hopkins:
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For E-m@iler images contact:
Designer Daniel Basgallop:
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Amstrad Plc, Brentwood House, 169 Kings Rd, Brentwood, Essex, CM14 4EF, England
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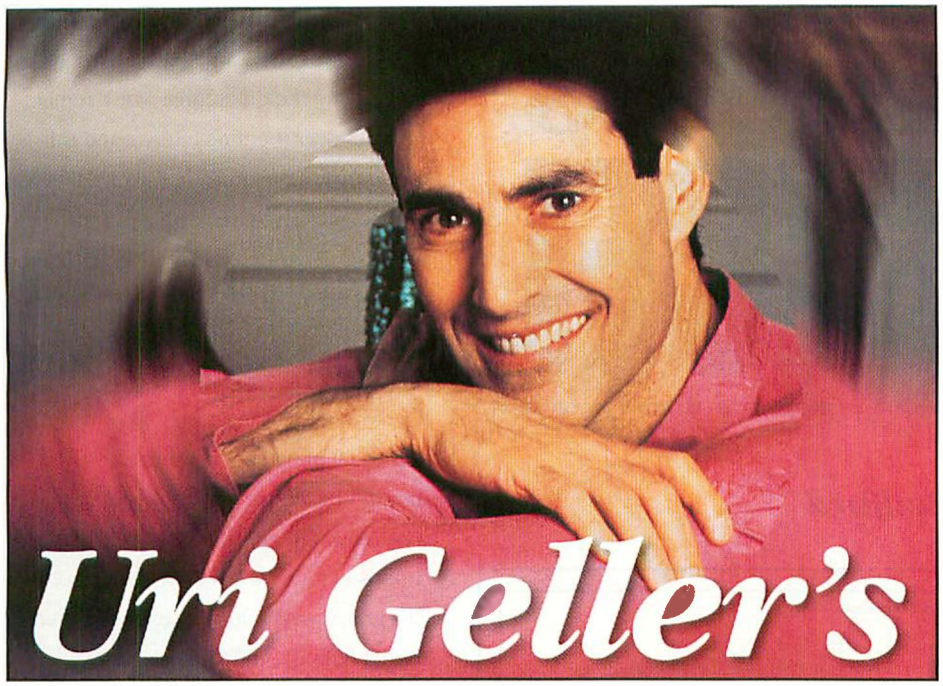
Ruth Duggan, 505- 844-9320, rduggan@sandia.gov
Web: **<www.sandia.gov>**
The IDART process is described at: **<www.sandia.gov/idart/>**



Uri Geller's EXTENDED REALITY

I got biorhythm?

About a century ago a Viennese psychologist named Hermann Swoboda announced his discovery that the state of his patients' minds seemed to go up and down in regular cycles of 23 and 28 days. The first was their physical 'biorhythm' and the second was their emotional one. When the lines of the two cycles crossed each other on the baseline of the chart, this was a 'critical day' when something unwelcome was likely to happen. So the science, or as many prefer, pseudoscience of biorhythm was born.

At about the same time a Berlin doctor named Wilhelm Fliess came to the same conclusions, while a few years later an Austrian engineer, Alfred Teitscher claimed to have found yet another natural and universal body cycle, this time of 33 days. This one was supposed to govern people's intellectual performance.

Swoboda designed a slide rule to help people work out their 'critical days', and today you can buy watches and other gadgets that help you find out where you are in your bio-cycles. You don't really need any of them, because all you have to do is work out how many days you have lived (not forgetting the leap years) and divide the total by 23, 28 and 33. The last day which was an exact multiple of each number was the first day of your current cycle.

Each cycle is now divided into halves, the first being the positive and the second the negative one. Now you draw all three cycles on a piece of chart paper so that each crosses the baseline in the middle (i.e. at 11½, 14 and 16½ days).

The idea of a universal biorhythm seems fairly plausible at first sight. Every form of life is affected by some kind of cycle, the most obvious one being the 24-hour period of day and night. This has a direct effect on most of our vital functions, as we know only too well when we take a long jet flight and become completely desynchronised, sometimes taking several days to recover from jet lag.

The month is also an important cycle, and a somewhat confusing one as there are several different months, the most important being the period between full moons (29.53 days) and the period between lunar perigees, when the moon comes closest to earth (27.55 days).

Considering what a dramatic effect the moon has on our oceans as it causes tides to ebb and flow, it wouldn't be surprising if it had some effect on our bodies, which after all are full of water. Are there tides in us?

Apparently there are. A Californian doctor named Laughton Miles did some fascinating research with a blind patient of his, and found that his body functions had become phase-locked with the lunar day - the time It takes for the moon to go once round the earth (24.84 hours). The man would even go to sleep exactly at the time of the local low tide. He had of course never even seen the moon and had no normal way of knowing where it was on his own.

It cannot be mere coincidence that the most important physical cycle of all, the female menstrual cycle, is close to that of a lunar month and could well have been locked on to it in the days before we lived in cities.

However - and this is where pop biorhythm theory begins to fall apart, there are no known natural cycles of exactly 28 days, or of 23 or 33 days. No supporter of the theory has yet suggested what might be causing any of these cycles, and you cannot have an effect without a cause, Another problem is that a good deal of research has gone to show that we certainly do have biorhythms, but not of universal and exact lengths. Sixty years ago, Dr Rexford Horsey made a detailed long-term study of a group of factory workers and found they did indeed have emotional cycles, at least, but they varied in length from 16 to 63 days, averaging around 33 days (which is supposed to be the intellectual cycle). Another researcher, Dr Leonard Ravitz, found another genuine biorhythm in the body's natural electricity, the most prominent cyclic fluctuations being from 14 to 17 days and 28 to 29 days in length. Again, it looks as if the moon was responsible for this.

The only way to be sure if you have any biorhythms is to measure them yourself. The easiest method is the one Hersey used - he got his subjects to keep a record of how they felt, ranging from +3 for feeling great to -3 for feeling terrible. He only looked for emotional cycles, but you can keep scores for your physical and intellectual cycles as well and wait to see if a pattern emerges.

My guess is that we all - men as well as women - have a cycle that is close to but not exactly 28 days, caused by the motions of the moon. The other two cycles, if they exist, are caused by circumstances beyond our control, and since there is nothing we can do about them, we may as well forget them.

Read Uri Geller's stunning online novel, Nobody's Child, at <www.uristory.com> Visit him at <www.urigeller.com> and e-mail him at <urigeller@compuserve.com>

Excursions INTO EXCEL

PART 3

by Mike Bedford

Simulating continuous systems is generally considered to be a rather specialised task for which dedicated, and sometimes quite expensive, packages tend to be used. If serious simulation is a regular requirement, you've probably already invested in this type of software. However, simulating continuous systems is one of the less obvious uses to which I've put Excel. And for those to whom this is only an occasional requirement, and for whom the purchase of proper simulation software can't, therefore, be justified, this could be an attractive solution. This is especially true in view of the fact that carrying out this type of simulation exercise in Excel really couldn't be much simpler.

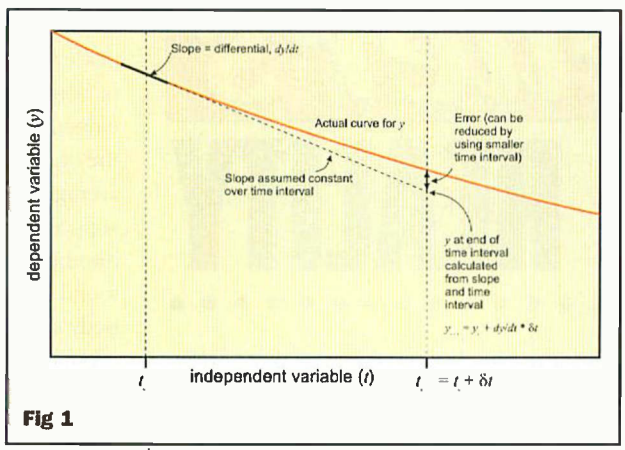


Fig 1

Simulation Basics

Simulating a continuous system involves solving one or more differential equations and plotting the result against the independent variable – usually time. Solving differential equations involves integration and, in a digital computer, this is done using one of the various methods of numerical integration. The integration method I've used, the Euler method, is the simplest method possible but it can still reap useful results. Nevertheless if, for reasons of increased accuracy, you need to use a different method of numerical integration, you could also use Excel to implement it. I'm not going to give instructions here, but if you search on the Web for references to the Simpson Method (or Simpson's Rule), and the Runge Kutta Method, you should be able to work out how to implement them, starting with my Euler example as a starting point. It would also be worthwhile reading up on the subject to learn something of the shortcomings of the Euler Method and how to spot cases in which you need a more sophisticated method.

Figure 1 shows the principle behind the Euler Method. As with all methods of numerical integration, we start with a known value of the dependant variable at the starting point, and then work out what it will be a short time later. This incremental process continues until the value of the dependant variable has been determined throughout the time range we're interested in. If we know the value of the dependant variable (y in Figure 1) at a particular time, and since the differential is the slope of the graph, the value of the dependent variable at the next time interval is greater by the differential multiplied by the time step. This is the principle of the Euler Method. Of course, unless the graph is a straight line the differential won't remain constant over the time interval and this is the source of the error. It also explains why the accuracy improves with a decreasing step size, a feature of all numerical methods of integration.

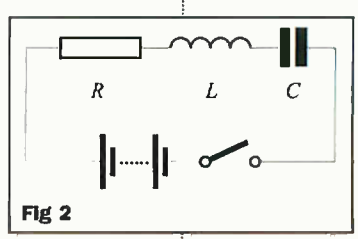


Fig 2

An RLC Circuit

If you're not particularly au fait with numerical integration, you may need to read through the above textual description a few times to get the idea. However, a picture is supposed to be worth a thousand words so let's jump straight into an example which should help to clarify things.

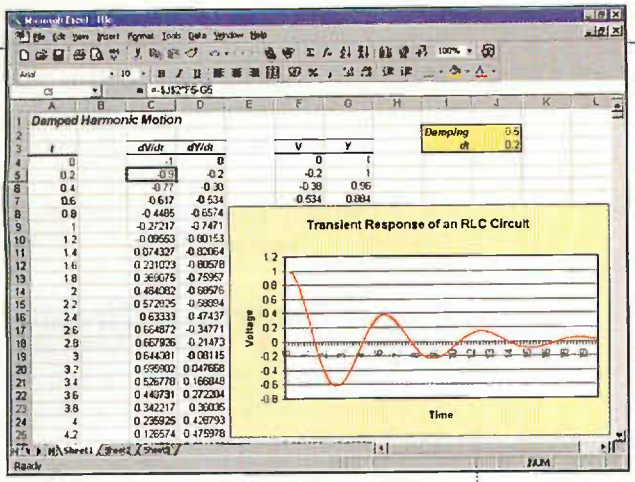
The example I've chosen is the transient response of an RLC circuit, that is, a circuit such as that shown in Figure 2. But rather than present the version of the equation which includes the values of the resistor, inductor and capacitor, I've simplified things by showing the general form of the equation for damped harmonic motion which describes this circuit's transient response. The same equation crops up in many areas of physics and also describes, for example, the displacement on a weight on a vertical spring. The following second order differential equation describes the operation of the circuit:

$$\frac{d_2Y}{dt^2} + D\frac{dY}{dt} + Y = 0$$

Where Y is the voltage across the capacitor, and D is something called the damping coefficient. Since this is a second order differential equation, the first job is to re-write it as a pair of first order differential equations. This is done by inventing a new variable name which represents the first differential, dY/dt. I used V. So, after making this substitution and doing a bit of rearrangement, we end up with the following two differential equations to solve:

$$\frac{dV}{dt} = -DV - Y \qquad \frac{dY}{dt} = V$$

Now to the spreadsheet, and a screen shot is included here. The basic technique



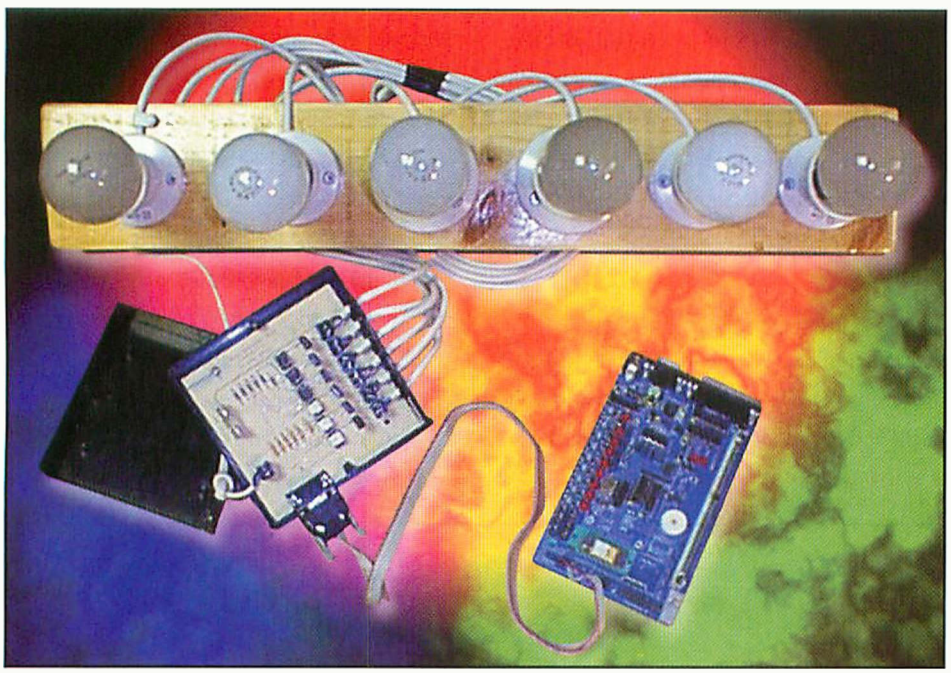
involves having a column for each of the differentials – in this case dV/dt and dY/dt – and a column for each of the dependent variables – V and Y in our example. We also have a column for the dependent variable, t, which starts at zero and is simply incremented by dt in each row. In the columns for the differentials, we put a formula which represents the differential equation. So, for example, the cell A4, the first in the column for dV/dt, contains **"= - J2*D4-E4"** (J2 contains the damping coefficient, D). In the columns for the dependent variables, except for the first row which contains the initial conditions, we have the formula for the Euler Method. So, for example, the cell D5, the first in the column for V excluding row 4 which contains the starting value, contains **"=D4+J3*A4"** (J3 contains the time step, dt). In this particular example, we have two columns, B and D, which contain identical values so the spreadsheet could be simplified. However, this has only happened here since dY/dt=V and, in the general case, you won't have duplicated columns. Actually I would advise against eliminating one of the redundant columns in this case since it's much easier to understand the workbook the way it's presented here.

Graph Plotting

A simulation exercise nearly always involves presenting the results as a graph, commonly of the independent variable(s) against the dependent variable, usually time. In our example, we only want to plot a single value – that of the voltage Y. To do this, the columns for t and Y are highlighted and the Chart Wizard used to create a line graph. By default this will cause a two-trace graph to be produced with traces for both t and Y plotted against the row number which isn't what we want. Of course, we could have just selected the column for Y which would give us a single trace of the shape required but the x-axis wouldn't reflect the true values for t. To change the graph from plots of Y and t against the row number to one of Y against t, remove the data range for t from the "Series" box in the "Series" tab of "Chart Wizard Step 2" and insert this same data range into the "Category (X) axis labels:" text box. With various other bits of fine tuning, the graph can be made to look like the one in the screen shot. If the graph is intended to be used in a report or an article for a periodical, though, it would be worthwhile exporting it to a drawing package for tidying up as described in this column a couple of months ago.

DISCO Light Controller

An ST7 based microcontroller 6 channel lighting sequencer by Tony Ashton



Introduction

This article is concerned with looking at a method of controlling 6 x 100 watt disco lights operating at 240Volts AC. The project will use minimal hardware and allow the user to update the sequence of the lights within the club environment. These disco lights are controlled by the Kanda ST7 Starter Kit, or flash circuit, which is shown in Appendix 2 later on in this article, together with the use of another circuit that will allow the operation of the mains supply voltage. The Kanda ST7 Starter Kit was designed to provide maximum flexibility to users of the ST7 family of high-performance microcontrollers. The Kanda Starter Kit offers many features such as using the 16-bit timers to produce Pulse Width Modulation (PWM) control. The project was designed around the ST72254G2 flash Integrated Circuit (IC) which is a 32-pin flash device and will allow the code to be updated easily when in operation. The Kanda ST7 Starter Kit, with a flash device, or an alternative circuit based around the ST72254G2 device will be connected to a power controller circuit in the way shown in this article, in order to provide control of the disco lights.

Figure 1 shows how the Kanda ST7 Starter Kit or an equivalent circuit that incorporates the ST72254G2 flash device is connected to the controller board. A lead made up of seven wires will be taken from the Kanda ST7 Starter Kit to the power controller board. Six of these wires will be connected from PB2-PB7 and the other to VDD, of the Kanda ST7 Starter Kit in order to provide 5 volts for the triac driver circuits . Each of these seven wires will be taken to a 9-way 'D' type connector on the power controller board, this is shown in Figure 2.

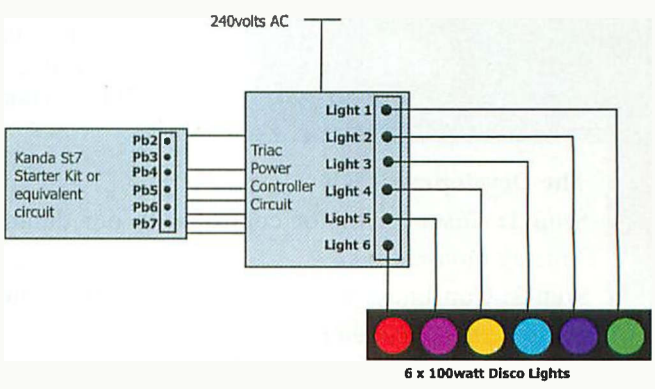


Figure 1. Block diagram of system

Power Controller Circuit

The power controller circuit uses triacs, and optocoupler triac drivers, the circuit diagram of the power controller board can be seen in Figure 2.

Figure 2 uses the Z0410DF triac, and the MOC3020 optocoupler triac driver which when combined together will provide smooth power control. A common problem within power switching circuits is that triacs switch from off state to the on state in a very fast time, and can produce extremely rapid increases in load current. Such a current step will produce harmonics within the circuit and can cause interference to AM radio reception. A simple way to prevent this would be to incorporate a capacitor and an inductor in the schematic to form a low pass filter and hence prevent the harmonic energy from reaching the load wiring and radiating everywhere. This filter will therefore reduce the interference to a nearby AM radio receiver. However the above circuit uses the MOC3020 optocoupler triac driver and can be used as a good noise barrier for digital signal isolation. The ground loop is also broken and any noise picked up by the cabling appears as a common mode noise at the terminals, and hence can be easily cancelled either solely by the optocoupler or using additional common mode chokes, thus eliminating the need for the low pass filter.

Protection Tips

The project has been designed to be used with 6 x 100 watt light bulbs, at a working voltage of 240 volts however, great care must be taken when working with this type of voltage. When the circuit has been produced and built it is recommended that it is inserted into a hard plastic case, and that all wires entering and leaving the box should be securely fixed, and that no bare wires can be seen. After the circuit has been built and checked for visual defects, the circuit was tested using a continuity tester in order to detect any

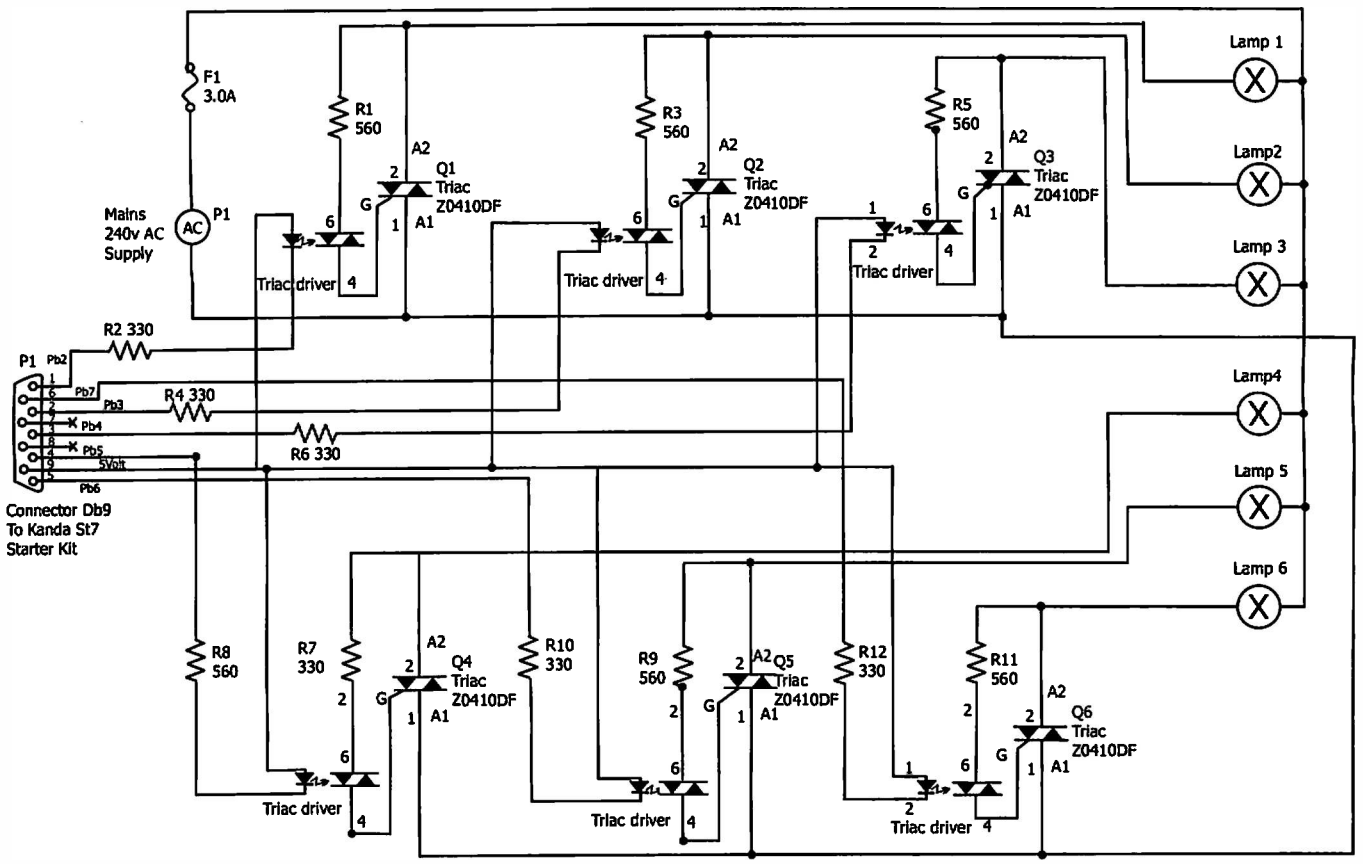


Figure 2. Schematic diagram of the power Controller Circuit

short circuits that might have arisen. When the circuit is running, the box must be kept in a closed position and nothing must be inserted in to the box. If any problems arise make sure that the power is disconnected from the mains supply before investigations start. A 3.0 Ampere fuse must be fitted to the circuit when working with 6 x 100 light bulbs operating a 240 volts AC.

User Instructions

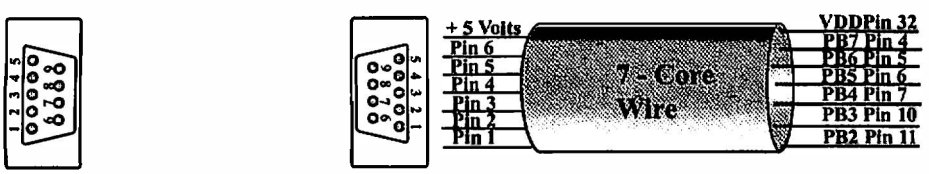
Before the power controller circuit is built make sure that the dimensions of the PCB will fit securely into the plastic case, and that fixing screws can be inserted into the board without short circuiting the PCB. The 9-way 'Male' 'D' type socket can be fitted to the PCB ensuring that it is placed close to the side of the box. The side of the plastic case can then be cut out in order for the 'Male' 'D' type socket to be accessed. It should also be ensured that the six 2-way terminal blocks for the connection of the lights are towards the front of the plastic case. The plastic case can then be drilled out in order for the cable of the disco lights to sit easily in the terminal blocks. The same procedure should be carried out for the mains cable which can be placed at the back of the circuit. If the cables are loose in the drilled holes then a grommet and cable clamps should be fitted for added protection. A seven way cable is then required with the 9-way 'Female' 'D' type socket connected to one end, and seven single in-line sockets connected to the other, these seven will then go to PB2-PB7 (pins 4-7, and 10-11), and VDD (pin 32) of the Kanda ST7 Starter Kit respectively. A diagram showing the connections can be seen in Figure 3.

Once the board has been tested and all the connections are secure, power can be supplied to the board. The initial start off will set the sequences to 15%, which will be the fastest sequence of the lights. However the Kanda ST7 Starter Kit can control the speed settings of the sequence of lights by simply

9-way 'Male' 'D' type socket connected to power controller board.

9-way 'Female' 'D' type socket.

Connections to Kanda ST7 Starter Kit Board.



9-Way 'Male'	9-Way 'Female'	Connection
Pin 1	Pin 1	PB2
Pin 2	Pin 2	PB3
Pin 3	Pin 3	PB4
Pin 4	Pin 4	PB5
Pin 5	Pin 5	PB6
Pin 6	Pin 6	PB7
Pin 7	Pin 7	NC
Pin 8	Pin 8	NC
Pin 9	Pin 9	+ 5 Volts

Connections from Kanda ST7 Starter Kit to Power Controller Board.

Figure 3.

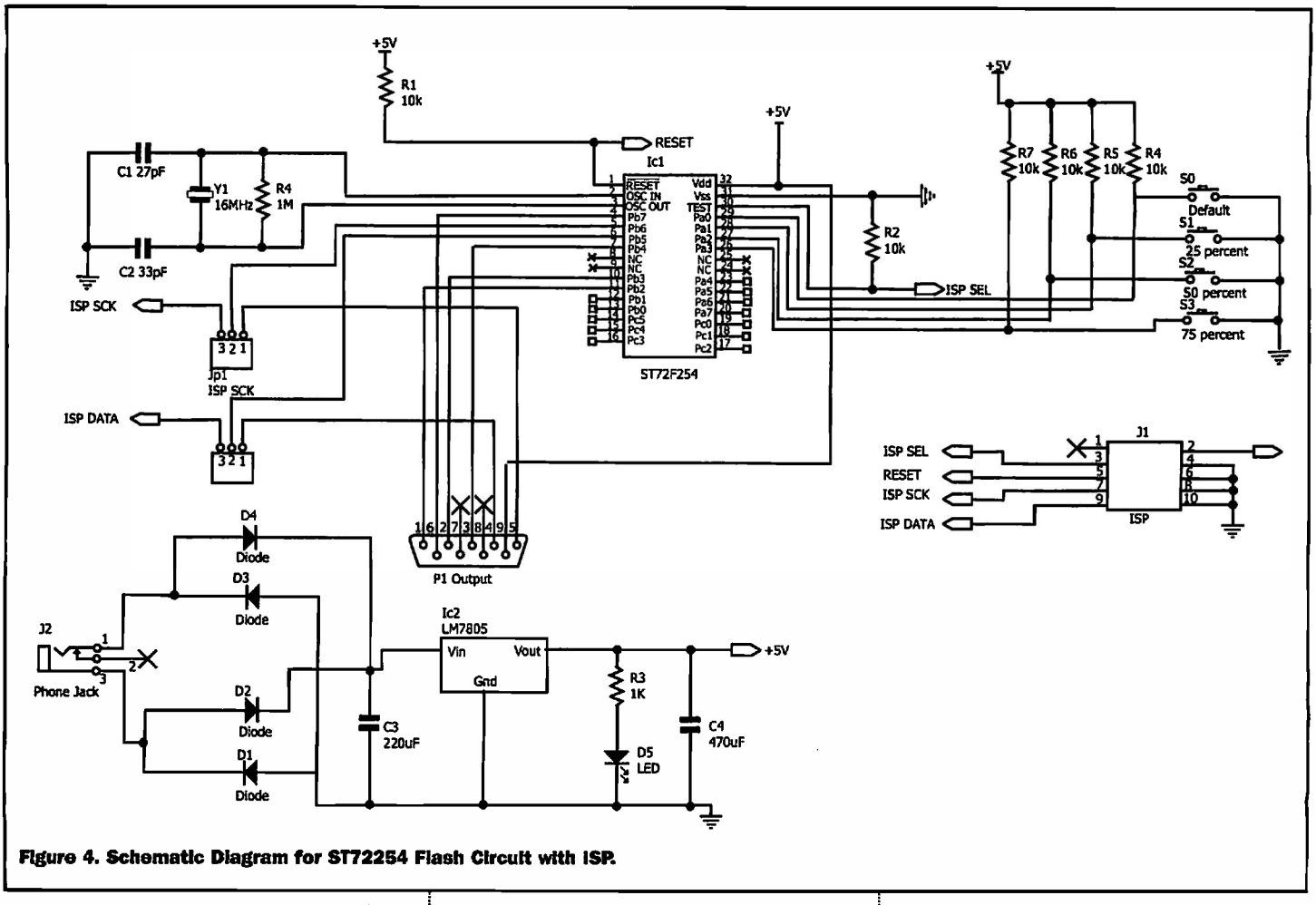


Figure 4. Schematic Diagram for ST72254 Flash Circuit with ISP.

pressing keys 0 - 3, the settings are shown below:

Button '0'	Sets Sequence to '15%'
Button '1'	Sets Sequence to '25%'
Button '2'	Sets Sequence to '50%'
Button '3'	Sets Sequence to '75%'

If button 3 on the Kanda ST7 Starter Kit is pressed the sequence of lights will operate at 75% which is the longest time interval between on/off of the lights. So this means that for the whole period the lamp is on for three-quarters of the time and off for the other quarter. At any time the user can select another speed such as button 2 and the sequence of the lights will increase to 50% and decrease the on/off time of the lights.

Software Design

The software was designed using the ST7 Starter Kit Assembler code. The software listings generated can be seen in Appendix 1 of this article. It will be noticed that there are three stages to the software:

The .sts which is the Set-up code
The .stv which is the Vector code
The .stm which is the Main code

The Set-up file will generate all the code necessary to set the ports of the ST7 microcontroller as inputs or outputs. The set-up code is also used to set the timers, and enable the interrupts. Once the interrupts have been enabled they can be manipulated within the vector file. The reset vector information can also be found in the vector file. The main file will then be left so as the user can input the main body of the code. Using the three different files in the way explained above keeps the code clear and easy to follow. If changes have to be made to the code at a later date it will be easy for the user to find the correct place to insert the new code.

In order to generate the necessary time delays between the flashing lights, the programmable timer was set-up to be a 16-bit free running increasing counter with its associated 16-bit registers. The two read-only 16-bit registers contain the same values but with the difference that reading the ACLR (Alternate Counter Low Register) does not clear the timer overflow flag. However writing in the CLR (Counter Low Register) or ACLR resets the free running counter to the FFFCh value. The timer clock depends on the clock control bits of the CR2 register. The value in the counter register repeats every 131.072, 262.144 or 524.288 internal processor clock cycles depending on the CC1 and CC0 bits. When the program is entered the counter is set to the default value of 15 percent; this is achieved by the following code.

```
Set:    ld a,#$26
        ld TAOC1HR,a
        ld a,#$66
        ld TAOC1LR,a
        clr TAACLR
```

The code shown above is used to set the default value for the counter in the Timer A Output Compare 1 Register (TAOC1R). When the code is running the value 2666h appears in the TAOC1R. The last line of the above code is used to set Timer A Alternate Counter Register (TAACR) to FFFCh. This is an increasing counter which will proceed to 0000h on the next clock cycle after FFFFh. When the value in TAACR matches the value in TAOC1R (in this case both set to 2666h) an interrupt is generated. This starts the sequence of lights at the default speed and will continue at this setting until buttons 0-3 on the Kanda ST7 Starter Kit are pressed which will change the speed of the sequence of lights. The code was designed to allow the user to update the sequence of lights within the vector file, which can then easily be transferred to the flash device by using a keyfob.

continued on page 32

Set-up Code

```
;ST7 Setup File - Created by Application Builder
; Setup File Created with Device Set to ST72C254G2
.Include $DeviceName        ; Include Device Definition File
(ST72C254G2.str)

        segment 'Rom'     ; Code segment - Address defined in
Definition file (.str)

Start:            ; Reset Label

                  ;**********Timer A Setup Code
                  ld a,#$10
                  ld TACR1,a
                  ;**********Timer A setup code
                  ld a,#$80
                  ld TACR2,a
                  ;*Timer A Output Compare Register 1
                  ld a,#$80
                  ld TAOC1HR,a
                  ld a,#$00
                  ld TAOC1LR,a

                  ; ********** Port A Setup Code
                  ld a, #$00        ; Bit On = Output, Bit Off
= Input
                  ld PADDR, a       ; Port A Direction
Register
                  ld a, #$FF        ; Option Selects Input or
Output Type
                  ld PAOR, a        ; Port A Option Register

                  ; ********** Port B Setup Code
                  ld a, #$FF        ; Bit On = Output, Bit Off
= Input
                  ld PBDDR, a       ; Port B Direction
Register
                  ld a, #$00        ; OCMP1A,
                  ld PBDR, a        ; Port B Option Register

                  ; ********* Control Registers
                  ld a, #$D9          ; Main Clock Out Off
                  ld MISCR1, a        ; Slow Mode : Fcpu =
4000000Hz
                   ; EIO Interrupt on falling and Rising Edge

                  ld a, #$00        ; Clock Filter Interrupt
Disabled
                  ld CKSR, a

                  ld a, #$7F        ; Stack Pointer Low Byte
                  ld s, a  ; Stack Pointer High Byte set by
hardware
                  ld a, #$7F        ; Watchdog Control
Register
                  ld WDGCR, a       ; Watchdog Disabled

                  rim       ; Global Interrupt Enable

Vector File Code
; ST7 Vector File - Created by Application Builder

        ; ********** Interrupt Service Routines
        ; File Created with Device Set to ST72C254G2
        segment 'Rom'     ; Code segment - Address defined in
Definition file (.str)
TimerA:  ; ******** TimerA Interrupt ISR Code Here
 ;*****************************************
 ;       CHANGING THE SEQUENCE BELOW WILL    *
 ;       ALTER THE SEQUENCE OF THE LIGHTS    *
 ;       IN ORDER TO UPDATE AT THE CLUB                *
 ;*****************************************
TADF:             ; Test TOF Flag (TASR.5)
        nop
        call seq_1
        jra TADF
        nop
        iret

seq_1:  call light_1
        call light_2
        call light_3
        call light_4
        call light_5
        call light_6
        call light_5
        call light_4
        call light_3
        call light_2
        ret
;*************************************

;       ADD LIGHT SEQUENCE HERE !!!!        *
;*************************************
light_1: nop
                  bres pbdr,#2
                        call tim
                  bset pbdr,#2
                  ret

light_2: nop
                  bres pbdr,#3
                        call tim
                  bset pbdr,#3
                        ret

light_3: nop
                  bres pbdr,#4
                  call tim
                  bset pbdr,#4
                  ret

light_4: nop
                  bres pbdr,#5
                  call tim
                  bset pbdr,#5
                        ret

light_5: nop
                  bres pbdr,#6
                  call tim
                  bset pbdr,#6
                  ret

light_6: nop
                  bres pbdr,#7
                  call tim
                  bset pbdr,#7
                        ret

tim:              nop
                  call timer
                  ld a,#$3F
                  ld stay,a
                  nop
                  ret

        ; ******** End Timer A Interrupt
                  segment 'Vectit'      ; Vector segment -
Address defined in Definition file (.str)

                  DC.W    0
                  DC.W    0
                  DC.W    0
                  DC.W    0
                  DC.W    0
                  DC.W    0
                  DC.W    0
                  DC.W    0
                  DC.W    0
TimA:             DC.W    TimerA
                  DC.W    0
                  DC.W    0
                  DC.W    0
EO:               DC.W    0
                  DC.W    0
reset:            DC.W    Start

                  end

 Main Source Code
;ST7 Main File - Created by Application Builder
 ; Author : Tony Ashton
 ; Company : Kanda Systems Ltd
 ; Comment : Code for Disco Lights/Easy to update in club
environment

; File Created with Device Set to ST72C254G2
.include $SetupFileName     ; Set up file (.sts) is included
here
segment 'Ram0'  ; RAM Page Zero segment - Always at ADDRESS
$80-$FF
;Define user variables here if required - Example Syntax is
;COUNTER DS.B 1
;COUNTER2 DS.W 1
;PIN_NUMBER EQU 6

comp dc.b $00
stay dc.b $3F
        segment 'Rom'  ; Code segment - Address defined in
device file (.str)
set:              nop               ;default setup code
                  ld a,#$26
                  ld TAOC1HR,a
                  ld a,#$66
                  ld TAOC1LR,a
                  clr TAACLR        ;timer A alternate counter
low register
                  jra main

main:             ld a,#$FF;stays here until interrupt on port
a is generated
                  ld pbdr,a
                  nop
                  nop
                  jra main ;returns to main until interrupt is
detected

timer:            nop
                  btjf padr,#0,default
                  btjf padr,#1,timer_25
                  btjf padr,#2,timer_50      ;sets speed of
lights from 25-75 percent
                  btjf padr,#3,timer_75
                  jra d1

d1:               clr TAACLR                 ;sets TACR to
FFFD
                  nop
                  nop
                  ld a,TAOC1LR      ;loads value into
accumulator
d2:               cp a,TAACLR
                  jrule high
                  nop
                  jra d2
high:             ld a,TAOC1HR
high_1:  cp a,TAACHR
                  jrule go ;jumps to go if TAACHR lessthan or
equals to zero
                  nop
                  jra high_1        ;returns to compare if
TAACHR is greaterthan zero
go:               nop
                  ld a,stay
                  cp a,#$00
                  jrule go_1        ;ends if stay is lessthan
or equal to zero
                  dec stay ;decrements value in order to reach
end of sequence
                  jra d1            ;jumps to d1 if stay is
greaterthan zero
go_1:             ret               ;jumps out of sequence and
turns on another light
;*************************************
;*                TIMING INTERVALS   *
;*************************************
default: ld a,#$26        ;timing interval for 15 percent
t3:               btjf padr,#0,t3             ;debounce
                  ld TAOC1HR,a
                  ld a,#$66
                  ld TAOC1LR,a
                  jra d1                      ;returns to d1

timer_25:ld a,#$3F        ;timing interval for 25 percent
t0:               btjf padr,#1,t0             ;debounce
                  ld TAOC1HR,a
                  ld a,#$FF
                  ld TAOC1LR,a
                  jra d1                      ;returns to d1

timer_50:ld a,#$7F        ;timing interval for 50 percent
t1:               btjf padr,#2,t1
                  ld TAOC1HR,a
                  ld a,#$FF
                  ld TAOC1LR,a
                  jra d1

timer_75:ld a,#$BF        ;timing interval for 75 percent
t2:               btjf padr,#3,t2
                  ld TAOC1HR,a
                  ld a,#$FF
                  ld TAOC1LR,a
                  jra d1

        ; Interrupts in use, so .STV File called here
        ; This file contains shell Interrupt Service Routines
(ISR)
        ; and Interrupt Vector Table.  Add Your ISR Code to
this file

          .include $VectorFileName  ; Interrupt and Vector
file (.stv) included here
                  end
```

PARTS LIST

Kanda ST7 Starter Kit or Equivalent
Circuit Using ST72254G2 Device
ST72254G2 Integrated Circuit

6 x 6 pin dual-in-line sockets
6 x MOC3020 Optocoupler, Triac Drivers
6 x Z0410DF 4 Amp 400 Volt Triacs
1 x 9-way 'Male' 'D' Connector
1 x 9-way 'Female' 'D' Connector
6 x 330R Resistors
6 x 560R Resistors
7 x 2-way terminal blocks
1 x Fuse Holder
1 x 2.6 Amp Fuse
6 x 100 Watt 240 volts Disco Lights
1 x Plastic Hard Case to Cover PCB.

Conclusion

This project is based around the ST72254G2 flash device, which can be used with the Kanda ST7 Starter Kit, or alternatively a circuit can be built dedicated to this project based around the ST72254G2 device. A circuit showing a simple design for the flash device is given in Appendix 2. The project uses the flash device to control the operation of disco lights, which operate at 240 volts ac. The only other circuit that was used within the project was the power controller board, which was used to supply the necessary voltage to the disco lights. This circuit was based around a triac, and triac driver that provide complete isolation from the Kanda ST7 Starter Kit. The circuit will operate up to six disco lights moving in what ever sequence the user requires. Using the flash device gives an added advantage of updating the software within the club environment using one of Kanda's keyfobs. This will allow the code to be changed to develop a new sequence for the disco lights, and update them simply by plugging the keyfob into the board and inserting the code into the flash device. When the full circuit was built the software worked well on the Kanda ST7 Starter Kit and with the Flash circuit shown in Appendix 2.

ST7 Starter Kits are available from Kanda Systems Ltd. They are available as a 32pin version – Order code ST7KND1-Kit 2 Price $160 or 42pin or 56pin versions – Order code ST7KND2 – Kit 2 Price $160

Phone Kanda Sales Hotline +44 1970 621030 or Fax +44 1970 621040 e-mail sales@kanda.com or view the website www.kanda.com

Other auxillary parts to create the disco lights project are available from component suppliers like Maplin Electronics

Appendix 1

The code shown on the next page are the three files generated from the ST assembler, as mentioned earlier in this article. They include the set-up file, vector file, and the main program file:

Appendix 2

The schematic diagram shown in Figure 4 will enable the user to run the ST72254 flash device directly from the circuit that will connect to the power controller board via the 9-way 'D' type socket. The circuit will also allow the user to update the software to the device by simply inserting a keyfob. The keyfob is a device available for in-situ programming within the club environment, so eliminating the use of a PC for programming.

PERFECT MIRROR

Used as a Light Guide

by Reg Miles

Building on the 'perfect mirror' they created in 1998, Massachusetts Institute of Technology researchers have proposed a new kind of coaxial cable that may be able to carry light over long distances and around sharp bends while retaining its polarisation.

The 'perfect mirror' is so-dubbed because it combines the best of both metallic and dielectric mirrors. A conventional metallic mirror reflects light omnidirectionally; it also absorbs a significant portion of the incident light. A dielectric mirror is composed of multiple layers of transparent dielectric materials, which can be made to be extremely low loss compared to metal; and it reflects a prescribed range of frequencies coming from within a limited set of angles. The 'perfect mirror' reflects light from all angles and polarisations like a metallic mirror, but can be as low loss as a dielectric mirror, thanks to the properties of its multi-layer coating.

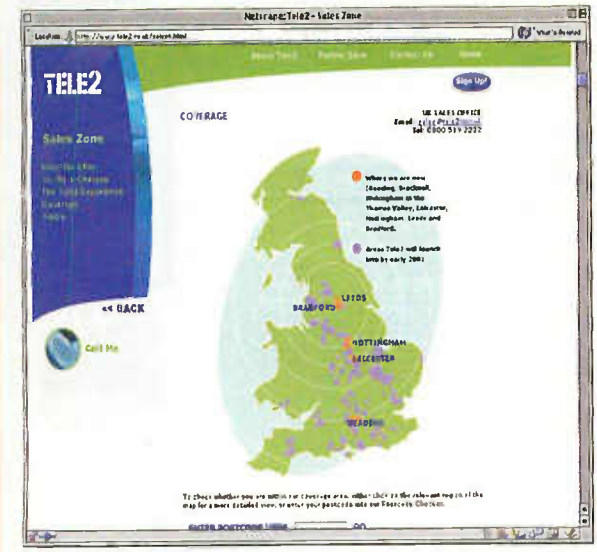
The researchers were Professors John D. Joannopoulos and Edwin L. Thomas, with Shanhui Fan and Yoel Fink, whose idea it was. Then, joined by Mihai Ibanescu, they put Fink's subsequent idea into practice and made a tube out of the 'perfect mirror' to create an omnidirectional waveguide. This has the significant advantage that it can bend the light in a shorter distance than an optical fibre; making it ideal for use in devices such as optical chips. It can also accomodate a greater bandwidth of light, with lower attenuation and less dispersion - thus getting more information to travel over longer distances.

Joannopoulos then proposed a coaxial version of it, with the inner and outer sheaths coated with the dielectric layers and the light propagated in the air-space between them. The researchers have launched a new company in Cambridge, Mass., called OmniGuide Communications, to explore the practicalities and possibilities of this and the multi-layer coatings.

According to the company: "The OmniGuide Fibre could substantially reduce or even eliminate the need for amplifiers in optical networks. Secondly it will offer a bandwidth capacity that could potentially be several orders of magnitude greater than conventional single-mode optical fibres. Elimination of the need for optical amplifiers will cut the cost of deploying and maintaining optical networks. Combined with the increased bandwidth, it will allow network operators to slash the cost-per-bit dramatically."

And according to Joannopoulos: 'What's important about this is that it has opened a new direction for experimental research that was not possible before. It's important to push along in this direction and see if we can find materials and fabrication approaches that will make this happen. We do know if we can do what the theory says, it will happen. This may be a breakthrough in bridging the very different requirements for transmitting infrared and radio frequencies at opposite ends of the energy spectrum. And the nice thing about it is that whatever you put in, you get out. This could make a big difference where polarisation is an issue.'

For additional information contact: **info@omni-guide.com**



Speed chills

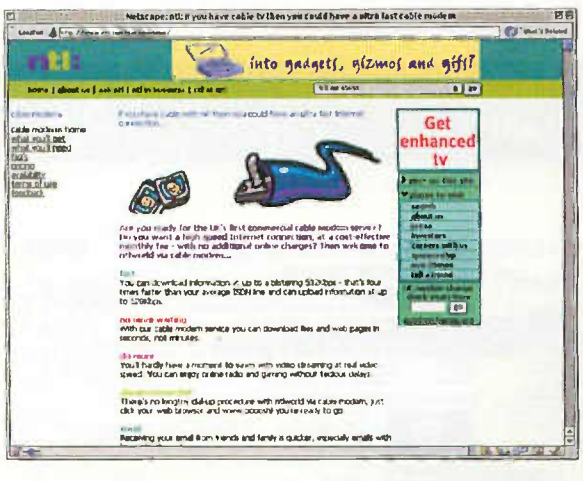
In the wake of BT's recent launch of its asynchronous digital subscriber line (ADSL) service, which gives always-on high-speed Internet connection for around £40 a month after you've paid an installation fee of £150, there have been several problems. Not the least of these problems is that many customers were provided with incorrect drivers for the hardware, which meant that they weren't able to use the service. Also, many teething problems occurred quickly after launch, and the service was unobtainable by many users for days afterwards. Not everyone in the UK yet has access to ADSL, mind you, and it may be several years before the whole country is fully covered.

Of course, things like this are relatively minor in the grand design of things, and we should all be thankful that there is now the option of broadband access to the Internet, albeit quite expensive for the home user. Funny thing is, high-speed Internet access has been around already for a while in at least a couple of different forms.

Residents in certain cities in the UK, for example, can access the Internet at high speed through Tele2's wireless service called DSL@home. Tele2 runs a business service for companies within the regions it operates over, and the residential service is intended to make full use of the system — business tends to use the service mostly over the day, whereas home user most often take access on evenings.

While download speed on Tele-2 residential wireless broadband Internet access service is not as high as ADSL (150Kbps, as compared with ADSL's 500Kbps), the beauty is its price — £10 a month. The downside is the relatively low number of areas covered, currently just a small handful, although further cities are to be covered over the coming months (around 40 areas are to be connected by the end of next year). You need to live within 15km of Tele2's central transmitter, and there must be line-of-sight between your home and the transmitter, to be able to gain access to the service. Following your agreement, Tele2 installs a small receiver/transmitter on your residence, for which there is a small installation cost of £50. Thereafter, for the monthly fee, you have high-speed Internet access. Check with Tele2 whether you are able to use the service, and further details of it and rollout over other cities can be found on the Tele2 Website, at: **<http://www.tele2.co.uk/>**.

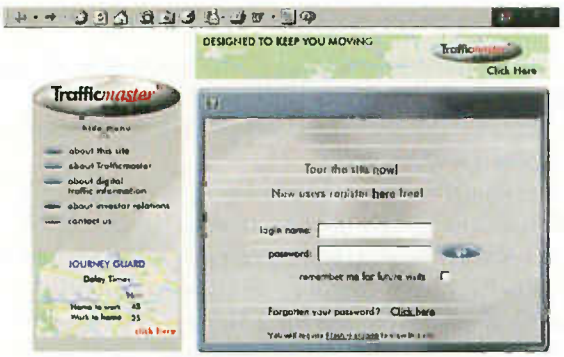
Another example of high-speed Internet access that steals BT's ADSL thunder is ntl's commercial cable modem service. Checkout **<http://www.ntlworld.com/cablemodems>** for further details. This has been rolling out over ntl's regions in the country for around a year, and currently most of the regions have access to it. The service compares almost exactly with ADSL, in that download speeds of 500Kbps are available, together with upload speeds of 128Kbps. It's priced the same too, at £40 a month, although you have to purchase the actual cable modem that connects your computer to ntl's digital cable, and currently only two cable modems are authorised to work with it, at around £150 each.



When all's said and done, the three services offer a great range of ways to get high-speed access to the Internet. While the two higher speed offerings are perhaps rather expensive for the ordinary home user, at £40 a month, you have to remember that all services are flat-rate — it doesn't matter how much you use the Internet (you could be connected for 24 hours a day, 7 days a week), you'll never pay any more. This is ideal for Internet-hungry families, say, who want to make sure their Internet costs are carefully controlled. Users within Tele2's areas may find that the much lower monthly rate is well worth it, despite the fact that download speed is lower than the other two services — you have to take into account that 115Kbps is still significantly better than a modem, and compares well with even the other main form of high-speed Internet access: ISDN. Both the ntl and the Tele2 services are better than ADSL however, when it comes to the range of computers that are supported. BT's ADSL offering currently supports only Windows-based machines, while the other two services allow any computer equipped with TCP/IP networking ability to connect.

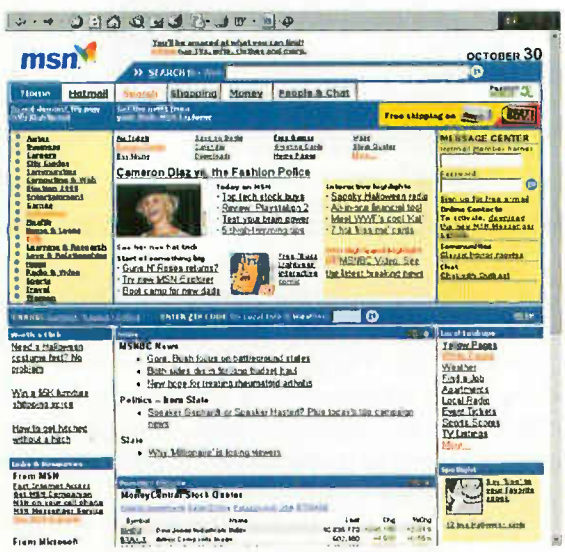
Whatever choice there is to make, at least we now have choice. Broadband Internet access is no longer a dream in the UK. It's here, in various forms, now. And, despite what BT tells us, we are not tied to using ADSL if we want it — there are other methods, and there are cheaper methods.

Live Traffic Information Available Online



Trafficmaster has made live traffic information available online at **<www.trafficmaster-online.com>**. The new Web site presents detailed UK maps overlaid with traffic congestion information updated every four minutes.

MSN Invests £600 million in Bid to Beat AOL



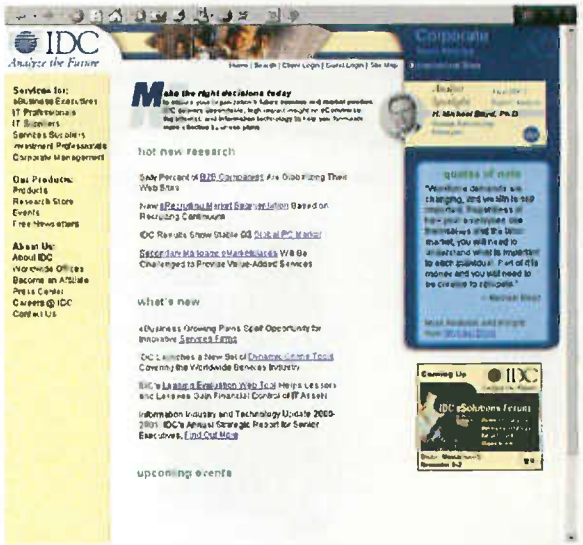
Microsoft is planning a $600 million effort to boost its MSN Internet service at **<www.msn.com>** by drawing subscribers away from market leader AOL.

Although MSN has only 3 million subscribers compared to AOL's 24 million, Microsoft claims many AOL users are dissatisfied and would switch Internet services if they were aware of a credible alternative.

Microsoft intends to position MSN as a viable alternative to AOL in a $100 million global advertising campaign that will compare the two services.

According to Internet analyst house Jupiter Research, only 55% of AOL users are satisfied with their Internet service, compared with 67% of subscribers to other services.

Ten Billion E-mails a Day



How does your in-box look today? The number of e-mails sent on an average day will reach 10 billion this year and rise to 35 billion by 2005, according to a report from International Data (IDC) at **<www.idc.com>**.

In Europe, the number of e-mails sent annually is expected to grow to 1.6 trillion in 2005, up from 511 billion in 2000 according to IDC.

The European market accounts for 20% of e-mail usage globally. While e-mail has always been the most popular application on the Internet, it continues to gain momentum as companies increasingly move business online.

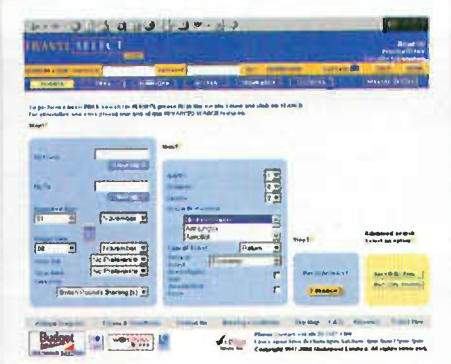
3Com to Poll the World

3Com is working with Harris Poll and technology leaders such as Sun, Microsystems and Oracle to carry out its Planet Project global survey next month.

The poll will include 20 questions in multiple languages on eight different topics, and will be administered on the Web at **<www.planetproject.com>**.

Topics include religion, beliefs and fears; health and well-being; sleep and dreams; self image; marriage; dating and sex; parenting and education; and law and order.

Nation Divides Over Technology



Medium-sized UK companies are enthusiastically using technology and implementing changes to improve their business while small companies and home workers are lagging behind and failing to capitalise on the technological revolution sweeping the UK. These are the key findings of a survey issued this month by Travelselect.com at **<www.travelselect.com>.**

Results from a survey of 350 UK small and medium-sized companies and home workers, which explored how businesses are trying to enhance their success, revealed that nearly 80% of workers in medium-sized enterprises use technology a lot.

Nearly 45% of these consider it gives them a great competitive advantage. Yet only 22% of self-employed workers questioned said they are heavy users of technology. As many as two in five self-employed people are not using technology at all.

Apple's QuickTime 4 Surpasses 100 Million Mark

Apple claims that more than 100 million copies of its QuickTime 4 software have been distributed via the Quickturn Web site at **<www.apple.com/quicktime>**.

The QuickTime TV (QTV) network now features more than 50 premium channels of video, music and news from leading international content providers.

Channels recently added to the QTV network include: the Apple Learning Interchange, British Web Broadcasting, CiaoItaliaTV, Eveo, Future Media Concepts, HealthscoutiTV, itsyourmovie.com, popwire and What's on the Web.

They join the QTV network's growing lineup of leading music, video and news providers, including: ABCNEWS.com, BBC World, Bloomberg, Disney.com and Virgin Radio.

30 Million Domains and Counting

The number of domain names registered on the Internet has passed the 30 million mark for the first time according to NetNames at **<www.netnames.com>**.

The most popular Internet suffix is .com, with over 18 million domains. .net has over 3 million domains and .org, 2 million.

The top country code top-level domain is .uk, which ends 2.2 million domain names. Germany's .de is second with 2 million, and the Netherlands, Argentina, and Italy are also popular.

NetNames, part of the NetBenefit group, is the UK's leading domain name registrar. It monitors domain name registrations around the world through its DomainStats service at **<www.domainstats.com>**.

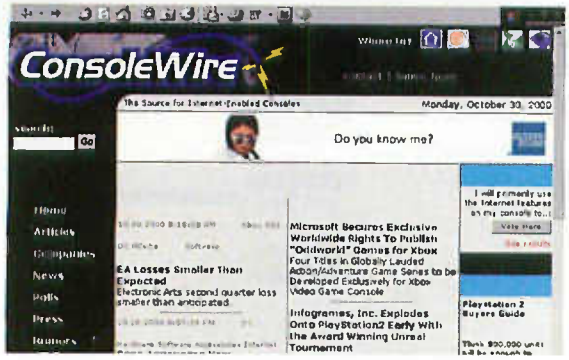
Lastminute Announces Voice Recognition Service

Lastminute.com at **<www.lastminute.com>** is to introduce an interactive voice recognition system, in partnership with Nortel, which will enable its customers to order goods at the last minute over the telephone.

Lastminute.com believes that this move will be a European first as no other European company currently has transactional voice capabilities in the e-business market.

The initiative is part of Lastminute.com's multiple-platform strategy, offering customers access to Lastminute.com via PC, telephone, mobile/WAP, interactive digital television and personal digital assistants.

Internet.com Launches ConsoleWire.com



Internet.com has launched ConsoleWire.com at <www.consolewire.com>, to provide real-time news and information on the Internet-enabled console industry.

ConsoleWire.com is intended to be the online resource for next-generation, Internet-enabled consoles and the technology that drives them. It provides users with new product launches and reviews, articles, company news, polls, press releases, the latest screen shots, product specifications and free e-mail newsletters.

ConsoleWire.com also provides online gaming professionals with valuable tools and resources such as breaking news and analysis, hardware and online capability overviews, specifications and accessories for popular systems including Sony Playstation 2, Sega Dreamcast and the upcoming Microsoft Xbox and Nintendo Gamecube.

Apps.com Powers Fast Company's 'Webify Yourself' Column

Apps.com at <www.apps.com> has been selected by Fast Company, a publicatio which follows fast growth companies, to power its new Webify Yourself column, featured on its Web site.

From its database of over 10,000 Web-based applications or Web apps, Apps.com provides Fast Company visitors with a selection of the most relevant business and career-related Web apps updated weekly.

Web apps are an increasingly popular tool for businesses and consumers. Web apps offer advantages over traditional software, including accessibility from any computer, extensive sharing and collaboration capabilities, and minimal need to download or install software.

Since users access Web apps via a browser, there are fewer worries about compatibility issues and viruses.

MacAddict.com Expands Coverage with Mac OS X Sub-Site

MacAddict.com, has added a Mac OS X section to its already extensive Macintosh online network at <www.macaddict.com/osx>. This sub-site is dedicated to the Mac OS X public beta. Features include news, weekly insights from top editors, frequently asked questions (FAQs), discussions, software recommendations and a Geek-to-English dictionary.

MacAddict.com delivers what is claimed to be the most sought after Mac home page on the Internet, complete with all the resources of a full-fledged online network, to the online Mac community. Its 17 affiliate sites are amongst the most respected Mac sites on the Internet.

Each site has been chosen for its high editorial standards and its performance in delivering up-to-the-minute, daily Mac information. Affiliate sites include: MacSurfer, The Mac Observer, MacFixIt and earBuzz.com.

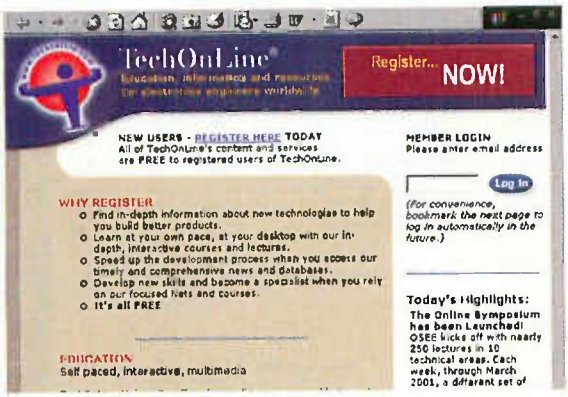
3Com to Poll the World

3Com is working with Harris Poll and technology leaders such as Sun, Microsystems and Oracle to carry out its Planet Project global survey next month.

The poll will include 20 questions in multiple languages on eight different topics, and will be administered on the Web at <www.planetproject.com>.

Topics include religion, beliefs and fears; health and well-being; sleep and dreams; self image; marriage; dating and sex; parenting and education; and law and order.

TechOnLine Launches Online Symposium for Electronics Engineers



TechOnLine at **<www.techonline.com>** the online resource for the design engineering community, has announced the launch of the inaugural Online Symposium for Electronics Engineers (OSEE) at **<www.osee.net>**.

With the creation of the OSEE, TechOnLine has pioneered a new e-Learning methodology to transfer technical knowledge by providing free access to live interactive lectures given by industry experts and working engineers over the Internet.

TechOnLine recognised the need for engineers to stay current with technology advances in electronics and created this unique forum for collaboration and intellectual exchange.

The OSEE supplies engineers with lectures from electronics experts in industry and academia, but in a unique alternative to traditional symposiums.

By remotely assembling an extensive global community of professional engineers, the symposium diminishes geographic and financial barriers and increases the pool of accessible experts. To date, the OSEE is the most cost-effective and convenient technical education and professional collaboration tool available for design and electronics engineers.

Jasc Paint Shop Pro Wins ConsumerREVIEW Award

Jasc Paint Shop Pro, has been selected by ConsumerREVIEW.com at **<www.consumereview.com>** as the recipient of a 2000 CHOICE Award.

The CHOICE Awards honour the favourite products of the more than two million consumers who frequent ConsumerREVIEW.com's network of 18 Web sites. ConsumerREVIEW.com is the leading, trusted source for consumer product information on the Web.

Jasc Paint Shop Pro is the complete graphics and photo editor for home and business. It combines easy-to-use photographic enhancement and graphic design tools with a simple, intuitive interface and an affordable price to meet the image editing demands of professionals and novices alike.

LoadVideo First to Market with DVD Streaming

LoadVideo.com at **<www.loadvideo.com>** has successfully achieved video streaming-full-screen DVD quality video streaming over high speed Internet connections.

"We have been working for the last 6 months to optimise the latest codec developments in order to achieve DVD quality video streaming over the Internet connections. We have taken movie distribution and movie watching to the next level. Broadband has made it possible, we make it accessible," said John Bransford, chief executive, Loadvideo.com.

Founded in 1999 by John Bransford and Eric Smith, LoadVideo is an online movie distribution company.

"LoadVideo is the newest distribution channel for licensed entertainment content. Consumers will be able to select their favourite motion picture titles – major features, documentaries, foreign releases and independents – and stream them in high quality to their computers," said Bransford.

Consumers will be able to view advertiser supported titles at no charge and pay to view others depending on the license agreement signed by the content providers," said Bransford.

LoadVideo is in the beta-testing phase of their product roll-out. They are now in negotiations with a number of major motion picture production and distribution outlets, as well as independent film companies to carry content on the site.

"Even in a broadband universe, the average consumer has access to very low quality video streaming. Providers have sacrificed quality in order to shrink video file sizes for the purposes of transmission over the Internet. The result has been fuzzy, jerky videos in 2in. by 2in. viewing areas," said Eric Smith, chief technology officer, LoadVideo.

"We have developed a video compression application that enables consumers to stream full size dvd quality video over standard broadband (DSL and cable). In less time than it would take you to pop a bag of popcorn, you can now come to LoadVideo and watch the movie you want. No lines, no late fees, no hassles," added Smith.

LoadVideo utilises a video compression algorhythm based on the MPEG-4 video coding structure. It achieves a 15 to 1 compression rate and will real time encode up to a 720 x 480 frame size at 29.97 frames per second.

Currently, this technology is optimised for the Microsoft windows platform, but LoadVideo is in the final stages of developing versions for Linux and Mac platforms.

Now all we need are low cost DSL and cable Internet services to be rolled out in the UK.

Lernout & Hauspie Launches Translation Portal

Lernout & Hauspie has launched L&H iTranslator Online at <www.itranslator.com>, an e-commerce portal, that enables professionals and businesses to submit documents via the Web for fast and accurate translations.

Users can choose machine translation for basic quality translations on the fly, at no cost. If a 'polished' translation of a document is required, the site provides fee-based access to L&H's worldwide network of human translation services.

L&H iTranslator Online offers 29 different language pairs for human translation and 16 different language pairs for machine translation.

The machine translation language pairs covered by L&H iTranslator Online include English to five languages and back – French, German, Italian, Spanish, Portuguese – and cross European languages including French to German, German to Italian and others.

L&H iTranslator Online provides users with expertise of more than 5,000 translators from 19 countries in more than 60 specialised subject areas and one of the world's largest multilingual terminology databases.

In addition, L&H iTranslator Online offers instant price quotes for human translation, job tracking capabilities and complete file encryption to ensure security.

TrendWatch Details Internet and Graphics Trends

TrendWatch at <www.trendwatch.com>, provider of reliable and timely market intelligence in the graphic arts, Internet, new media, publishing, printing, and packaging marketplaces, has unveiled its updated Web site where graphic professionals, industry suppliers, and market analysts can find the latest trend information.

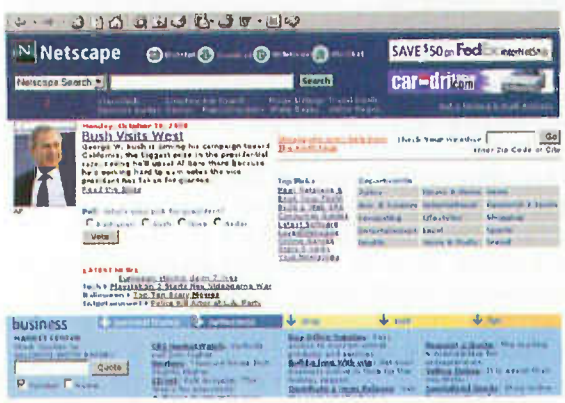
TrendWatch has been cited by both Web site visitors and major industry vendors as a powerful global information resource. These are major markets for firms such as Adobe, Agfa, Apple, Canon, Corel, Creo, Epson, Heidelberg, Hewlett Packard, Indigo, Macromedia, Presstek, Quark, Scitex, Xeikon, Xerox, and others.

Market applications addressed by TrendWatch include book, magazine, newspaper, and catalog publishing; advertising and graphic design; commercial photography, Website development; commercial printing; and more.

TrendWatch.com allows visitors to click through page after page of industry facts, market information, industry trends, forecasts, and graphs taken directly from TrendWatch reports.

Visitors can download free articles and reports written by the TrendWatch Partners. The site also charts the latest Business Conditions Indicators. TrendWatch market intelligence is based on original market research and proprietary forecasting methodologies.

Netscape Unveils Redesigned Netscape.com



Netscape has redesigned Netscape.com at <www.netscape.com>, with enhancements to the site that maximise the online experience, providing users easy access to a complete package of Web applications, content and features.

With a layout and interface that allows for quick access to information and services, the redesigned Netscape.com helps users better manage their work and personal lives making the online experience more productive.

The new layout of Netscape.com allows users to quickly manoeuvre throughout the site through the strategic placement of its six most heavily trafficked areas, including the recently launched Netscape Netbusiness area, which serves the needs of the fast-growing small business community.

Netscape has also announced the availability of the Netscape 6 Preview Release 3 (PR3), the third and final beta version of the new Netscape browser, via free download from <www.netscape.com/download>.

The browser offers new features, added functionality and greater stability, emphasising convenience, customisation, security and connectivity across multiple platforms.

PR3 offers users a new modern theme, streamlining the look and feel of the browser with enhanced usability and aesthetics to produce a sharper, crisper appearance.

A new address book synchronisation feature has been added that allows Netscape 6 users to view their address book contact information via Netscape.com.

Fast Search & Transfer Acquires ELEXIR

Fast Search & Transfer at **<www.fastsearch.com>** has acquired a majority interest in ELEXIR, a computational linguistics technology company specialising in the development of linguistic algorithms and resources for applications in information retrieval, information extraction and document analysis.

ELEXIR has constructed extensive computational dictionaries and programs for automatic document analysis that play a crucial role in improving the quality of indexing in online and offline retrieval systems. Among other applications, ELEXIR provided the language classification feature for FAST Web Search AlltheWeb at **<www.alltheweb.com>**.

Mars Images Chosen for 2001 Space Calendar

Images chronicling nearly a quarter century of Mars exploration have been chosen to appear in the 2001 edition of The Year In Space at **<www.yearinspace.com>**.

Among the 53 weekly images selected for The Year In Space are the Viking 2 lander's 1976 historic self-portrait backdropped against the rock-strewn Utopia Planitia region; Mars Pathfinder's 1997 photo of the intrepid Sojourner rover sniffing rocks in the Ares Valley; and Mars Global Surveyor's high-resolution image of gently sculpted sand dunes on the Red Planet from earlier this year.

Ens Entium: Internet Music Phenomenon Releases First CD

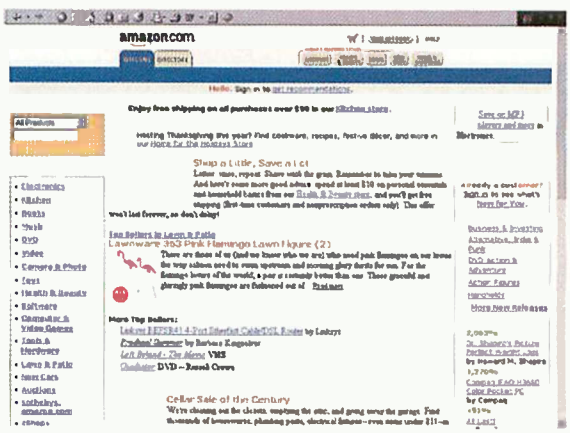
Ens Entium, has release two CDs after years of Internet success. People from all around the world have been eagerly awaiting a CD release from Ens and now it is finally here at **<www.mp3.com/ens>**.

Ens' music spans multiple genres including electronica, industrial, new age and alternative. It draws rave reviews from professional and amateur critics alike.

Ens is well known for some of the most engaging music available today on the Internet. The best part is all the music is available for free download at **<www.mp3.com/ens>** but CDs are for sale for those who wish to purchase them for just £4 each.

Ens is the creator of all the cutting edge loops featured on Mirata.com. These loops have become a big hit among Web designers and multimedia producers across the globe and are used on many multimedia Web sites. Mesmerise yourself by stepping into the aural landscape of Ens Entium.

Amazon.com Continues to Lead E-tail World



Nearly 25% of all online shoppers think of Amazon.com at **<www.amazon.com>** when they are asked to name a company that sells products or services online, and eBay.com follows with 15.9% of mindshare.

Amazon.com also captures the most online traffic with 41.5% of all online shoppers visiting their site; eBay.com follows with 31.4% of the online traffic. Amazon.com owns the majority of online purchasers as well, with 7.8% of all online buyers making a purchase at their site, while eBay.com captures 5.5%.

Finally, Amazon.com maintains a high level of satisfaction among its customers, with an overall satisfaction score of 8.53 (on a scale from 1 to 10) and is one of the leaders in satisfaction in terms of ease of use of their site, customer service and customer loyalty.

These statistics are based on results of a recent Harris Interactive e-commercePulse research report.

MSNBC.com Rated as Leading Online News Site

MSNBC.com at **<www.msnbc.com>** was the number one news site for the month of September according to the most recent data compiled by Nielsen/NetRatings and Media Metrix.

According to internal measurements, traffic to MSNBC Sports during the Olympics set new audience records. MSNBC.com maintained its standing as the primary source for news on the Internet with a significant lead over the competition in the combined home/work audience.

September Nielsen/Netratings show MSNBC.com had 10.4 million home/work users versus CNN.com's 7.6 million Home/Work users.

According to Media Metrix, MSNBC.com remains at the top of the general bews category with 8.9 million unique users in September, ahead of CNN.com.

Site Survey

Destinations of the month

We have all sorts of sea-life Websites this month. First off is a new interactive site that centres on the Race Rocks. These are positioned just over a mile from Rocky Point, the most southerly point on Vancouver Island, and are the scene of many shipwrecks as ships came through the Strait of Juan de Fuca bound for the ports of Victoria, Vancouver, Seattle and the inside passage. As such, this makes Race Rocks the most southerly part of Canada on the Pacific Coast. The Race Rocks Website, at: **<http://www.racerocks.com/>** has several Webcams in operation, and it provides a tremendous resource of information. It is maintained by the students of Pearson College, which also has the responsibility of protecting and preserving the Rocks' natural and unique biodiversity.

Project Delphis is a conservation effort to study dolphin behaviour and cognition, and to save wild dolphins from the current problems they face. The project has been in operation since 1985, and has recently set up the Project Delphis Website, at: **<http://www.earthtrust.org/delphis.html>**. You can see details of the project there, as well as several research projects currently being carried out.

Yeah well, we know it's not really about the sea, but it is called Surf and Sip, so is worth a look in this mini-roundup of sea-life Websites. Actually, it's a new form of Internet café, where networking stations provide wireless Internet access to users, through the users' own computers, instead of the more traditional method of renting wired computers in a café by the hour. The idea is that users can bring along their own laptop computers which have wireless networking ability, and simply sit at a table in the café to surf the Internet. It's based on the 802.11 wireless networking standard that allows 11Mbps networking over the wireless link. Several airports throughout the USA are already equipped with the same ability. Surf and Sip is currently available just in the USA, but is planned to become available in the UK next year. Details are available, at: **<http://www.surfandsip.com/>**.

FUEL CELL Developments

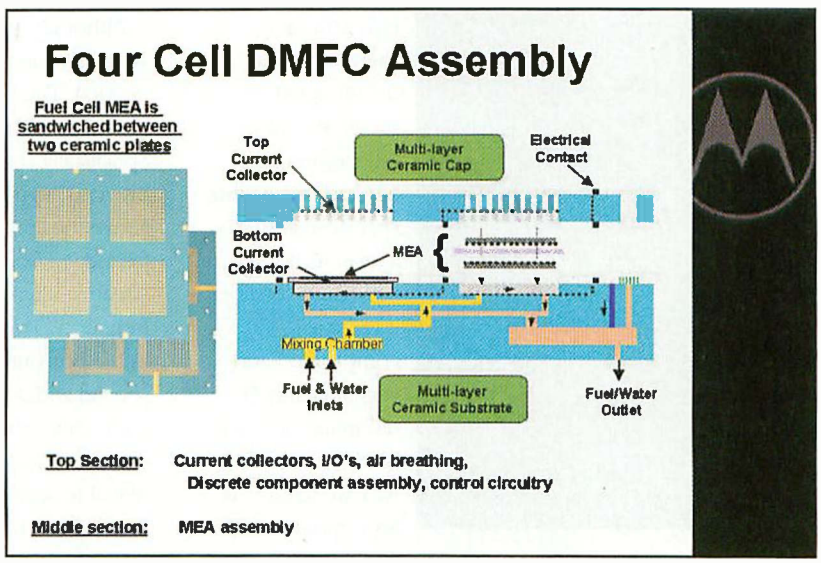
The latest news on the Motorola fuel cell by Reg Miles

Motorola researchers have reported further progress in miniaturising the fuel cell they are developing as a power source for consumer electronic devices like mobile phones, notebook computers and digital cameras. At the Motorola Labs they have demonstrated a prototype of a ceramic-based microfluidic fuel delivery system for the miniature direct methanol fuel cell (DMFC).

A direct methanol fuel cell converts the energy in methanol directly to electricity and operates at normal room temperatures. A catalyst (typically a mixture of platinum and ruthenium) is used to split a dilute mixture of methanol and water into protons and electrons, which provide the electrical current, and the by-product carbon dioxide. The electrons pass through an external circuit to power external loads, while the protons pass through a proton-conducting organic membrane to another platinum catalyst where they recombine with the returning electrons and with oxygen from the air to form water. The generation of electrons during the methanol-water reaction and their consumption during the proton-oxygen reaction complete the electrical power generation cycle of the fuel cell. Some of the water is recycled back to mix with the methanol, and the excess water evaporates as water vapour in the air.

The key technical challenges of fuel cells are to make them at a cost lower than rechargeable batteries. Also, the entire fuel cell system needs to be miniaturised to fit into today's small portable electronic equipment.

"Portable electronics are becoming more essential to daily life and increasingly we all want them to have new capabilities,' said Jerry Hallmark, manager of Motorola Labs' Energy Technology Lab. 'But adding features increases the demand on energy sources and systems. We need to develop new energy solutions - and fuel cells could be the breakthrough technology. Our challenge is to make these systems small, light and easy for consumers to use.



Eventually, these fuel cells could enable what people just dream of today - a lightweight energy source that would safely power a cellular phone for a month." However, Motorola's initial strategy is to develop a hybrid energy source, combining a miniature fuel cell with a rechargeable battery for peak power demands.

The key to successfully miniaturising a DMFC system is scaling down the system components surrounding the actual fuel cell device. Previous DMFC systems have used discrete tubes to mix the methanol fuel with water and deliver it to the fuel cell. Motorola has now successfully demonstrated the use of multi-layer ceramic technology for processing and delivering fuel and air to the fuel cell membrane electrode assembly (MEA). This fuel delivery system can be built into a miniature fuel cell.

The prototype, shown at the Power 2000 Conference in San Diego, California, combines fuel mixing and microchannels for delivery, substrate for MEA mounting, and electrical contact in just two ceramic pieces (see Figure). The lower ceramic piece handles the liquid fuel processing while the upper piece provides for passive air delivery (air breathing). The MEA is sandwiched between the two ceramic layers, making for simple assembly.

This ceramic technology also simplifies the interconnection of multiple fuel cells. In this implementation, they are arranged in a planar layout rather than a standard vertical stack. This simplifies the design of the fuel cell system and eliminates the need for an air fan or pump since all of the fuel cells are exposed to air. Several cells are connected together in series electrically to increase the output voltage of the system. This simplifies the interface to the actual electronic system.

While the research work is expected to continue for a few more years before being brought to market, the ceramic fluid-delivery technology will be used to build an integrated 100mW DMFC system, with the goal of five times the energy density of conventional Li-Ion rechargeable batteries.

In laboratory testing, the ceramic fuel cell assembly, measuring about 50mm across and 10mm in thickness, produces over 100mW continuously, when combined with an external fluid pumping system. It can output up to 180mW depending on the load. The fuel cell prototype has been operated for several weeks with very little degradation in performance.

The 'air breathing' fuel cell was developed in co-operation with Los Alamos National Laboratory. The highly simplified and miniaturised design eliminates the need for air pumps, heat exchangers and other complex devices that previous fuel cells required and which made them unsuitable for use in small portable electronic products.

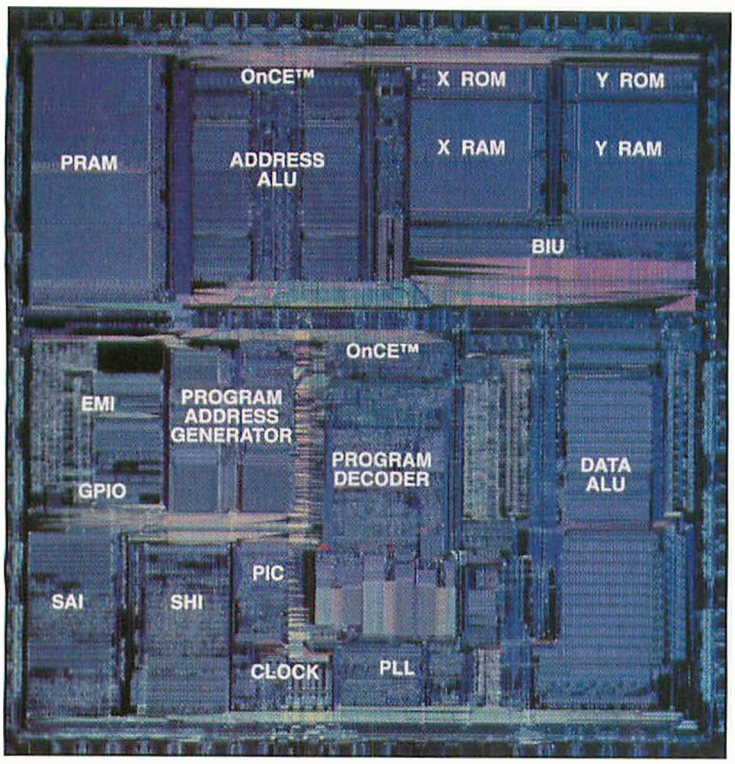
It is envisioned that the methanol required to run the fuel cells could be packaged in small inexpensive cartridges, similar in size to fountain pen cartridges. Thus, the technology could have the same consumer-friendliness as batteries.

For additional information contact: Motorola, Inc. Anne Stuessy, 847/538-6192 anne.stuessy@motorola.com

An Introduction to DSP

PART 1

by Mike Bedford



Motorola's DSP56004

The decline in the proportion of electronic engineers involved in analogue design is well documented and it's not at all hard to see why this revolution is taking place. A large proportion of today's electronic equipment is almost entirely digital – PCs, games consoles, electronic organisers and digital cameras are obvious examples. Furthermore, much of the remaining equipment – digital TV set-top boxes, mobile phones, and DVD players for example – contain a high proportion of digital circuitry. However, there's another important reason for the decline in analogue engineering. Even circuitry which has traditionally been thought of as the sole domain of analogue electronics is now turning digital due to the widespread adoption of DSP – digital signal processing. And it isn't just a matter of digital technology being fashionable or because it's becoming increasingly difficult to find good analogue engineers – major benefits are on offer to those who abandon op-amps, resistors and capacitors in favour of digital components. It's a little strange, therefore, that digital signal processing is so little appreciated beyond those who specialise in it. It's almost as if many engineers consider it to be a complicated and very specialised discipline or even a black art. This is why we felt it was appropriate to provide this, an introduction to digital signal processing for the non-specialist. Here we'll take a look at the basic principles of DSP, we'll investigate the digital signal processor (also abbreviated to DSP) which is used in this field, we'll consider the advantages it offers compared to analogue electronics, and we'll showcase a few real world applications.

The Basics

Conceptually, a typical digital signal processing application includes building blocks, which carry out the following functions.

1. Take an analogue signal – normally either audio or video – and sample it at regular intervals using a digital to analogue converter (ADC) to obtain a digital data stream.

2. Process the digital data in real time. Clearly the word "process" can mean just about anything and this depends on the required functionality. Nevertheless, functions such as filtering, analysis, pattern recognition, encryption, and encoding are typical. Normally this processing is done using a special type of processor, a digital signal processor, although it is possible to carry our digital signal processing using a standard microprocessor, a microcontroller, or even a PC with suitable interfaces. Nevertheless, throughout this article we'll concern ourselves exclusively with digital signal processing using a digital signal processor.

3. Convert the processed digital data back to the analogue domain using a digital to analogue converter (DAC).

Although these are the basic conceptual steps, a couple of further steps are generally needed. The first of these is low-pass filtering which comes before the ADC. Specifically, this is called anti-aliasing and prevents high frequency signal components, above the limit imposed by the sampling frequency, from appearing in the digital data stream as signal components at a lower frequency. This is covered in a bit more detail in the box out on the Nyquist Theorem. The second additional step, also low-pass filtering, comes after the DAC and smoothes out the stepped waveform which results from the digital to analogue conversion process. Figure 1 is a block diagram of a typical DSP system, which incorporates the five steps we've just looked at.

Note, however, that although this is a typical DSP block diagram, it's by no means universal. Some applications may require several signals to be sampled and fed into the processor, and conversely, some may have no input signal at all. At first sight this may seem unlikely but a musical synthesiser, for example, could well use DSP techniques to generate the notes but won't have any analogue inputs. Similarly, applications could have multiple analogue outputs or they could have none. Once again, you might consider this latter scenario to be unlikely but it's not hard to think of such an

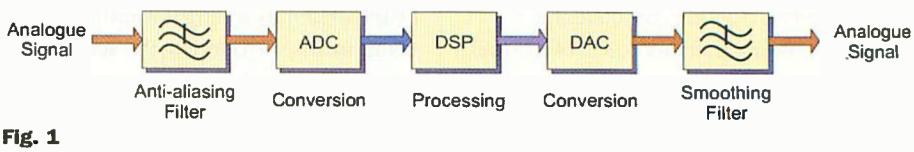


Fig. 1

application. For example, DSP could be used to analyse car engine noise to detect the onset of mechanical problems. In this case, although there would be an analogue input – the engine noise as detected by a microphone – the only output would be a digital one – a signal which would cause an error indicator on the dashboard to illuminate.

Advantages of Digital

Having looked at typical DSP systems, albeit only very simplistically, we're now in a position to ask a very obvious question, namely what advantages it offers over the conventional analogue techniques. After all, surely analogue circuitry is the most obvious way of processing real world analogue signals.

First of all, the component count will be much reduced from an analogue circuit containing op-amps, transistors and passive components. This normally results in a cost saving, it allows for the equipment to be more compact, and since there will be fewer interconnections, reliability gains are on offer too. In all probability, digital circuitry will also be less power-hungry than the analogue circuitry it's replacing.

The second important point is that digital signal processing chips are programmable and this provides flexibility. With traditional analogue circuitry, a change to the specification normally means a change to the hardware. And depending on how extensive the change, this could require a new PCB with the obvious implications to the manufacturing process. In many cases, changes to a system containing a DSP can be made by changing the software alone. In fact, very often, similar hardware can be used across the board for a variety of diverse applications. But programmability doesn't only reap benefits for the designer; it can also be good news for the customer. If the manufacturer chooses to do so, customers can be offered upgrades to existing equipment to provide additional features or to cope with changing requirements.

Thirdly, as the name suggests, digital signal processors are digital. As engineers and those with a serious interest in technology, you'll take with a pinch of salt, no doubt, the layman's perception of that word. But although we'd have to dismiss the assertion that the word "digital" is synonymous with high quality per se, this isn't to say that major advantages don't result from taking the digital route.

With analogue circuitry, precision is only available by using expensive high tolerance components. And even if these high precision components are used, temperature drift can still impact the precision achievable. With the DSP approach, any required degree of precision can be designed into the circuit, although designers do have to recognise that there will be a trade-off between precision and speed.

Another advantage of going digital is concerned with noise. Of course, noise cannot be eliminated entirely from a DSP system since the analogue input and output signals will both be subject to electrical noise. However, the digital circuitry certainly won't add to the overall noise on the signal. This is in marked contrast to an analogue system in which each stage of processing adds its own noise to the signal in a cumulative fashion. In contrast to digital processing, this can actually place a practical limit on the complexity of the circuitry.

Digital circuitry can also provide the user with a level of control that just isn't available in the analogue world. With analogue, unless associated digital circuitry is used specifically for control, the user will be limited to using simple controls such as switches and potentiometers. With digital circuitry, though, the user interface can include keypads and LCD panels, settings can be saved and recalled, and the equipment could be controlled remotely using a PC or perhaps even via the Web.

And finally, DSP chips are adaptable and they're powerful and this gives rise to much more sophisticated applications than could be achieved in the analogue domain. This is much the same argument as I gave earlier but turned the other way round. If digital techniques can be used to reduce the cost compared to that of analogue electronics, it could also be used, by maintaining the cost, to provide much greater functionality.

To summarise, therefore, the adoption of digital signal processing gives us more for less as well as providing size, weight and reliability gains. It probably wouldn't be over-stating the case to say that many of the technological advances which we've seen over the last decade and which now impact everyday life for many people just wouldn't have been possible without DSP.

What is a DSP?

OK, that's enough of the hype, let's now turn our attention to some rather more technical aspects. And the first area to look at is the heart of any DSP system, the DSP chip. In particular, let's look at how it differs from a standard microprocessor or microcontroller and what features it's been given to cope with its rather specialised task of processing digitised signals. Figure 2 is a block diagram of a typical DSP chip.

This appears to be not too dissimilar from a standard microcontroller such as a PIC processor but appearances are deceptive, as we'll see if we take a look at each of those blocks in turn.

Like an ordinary microcontroller, the heart of a DSP chip is the processor. This component executes instructions in sequence from the program memory and this will cause data to be read from or written to the I/O ports and/or changes to be made to the information stored in the data memory. As such, we've still not seen anything different from the way a microcontroller works. The major differences, though, all relate to performance. Simple microcontrollers are used to replace a handful of discrete logic chips to perform some simple task so speed often isn't an issue. It's common to see microcontrollers, therefore, with an 8-bit architecture and even those intended for higher performance tasks, such as the control of a car's ABS, only have 16-bit busses and registers. Carrying out complicated processing on a signal in real time, though, does require a high level of performance so 16-bits represents the bottom end with 24-bit and 32-bit architectures being typical in high performance chips.

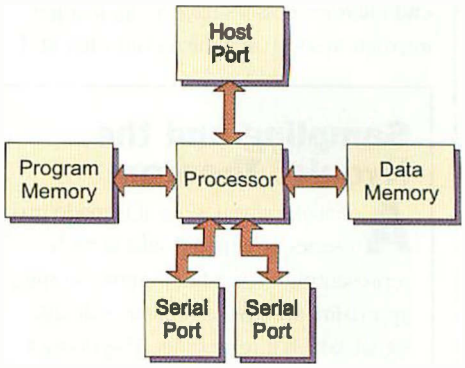


Fig. 2

Another differentiator is the clock speed. A cheap microcontroller may have a maximum clock speed of just 4MHz and higher up the range 20MHz would be typical. A high-end DSP, on the other hand, could feature a maximum clock speed of a few hundred megahertz. Of course, I only have to mention this sort of frequency and people will immediately draw unfavourable comparisons with the processors used in PCs which are now available with clock speeds of up to 1.13GHz. Of course, DSPs are far cheaper than Intel Pentium family processors and the latter would be totally uncompetitive if they were to be used in consumer electronics devices such as mobile

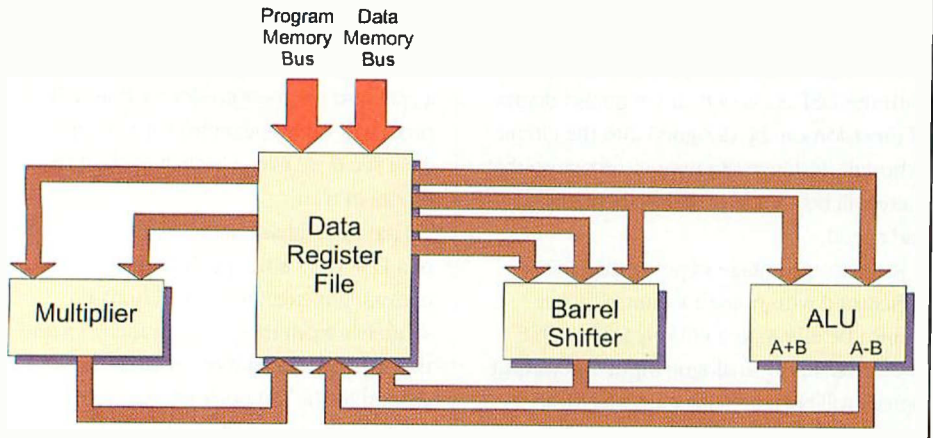


Fig. 3

phones. However, this is also an appropriate time to make another distinction between the processor in a DSP and that in a basic microcontroller (or an Intel chip for that matter). Typically microcontrollers have a simple instruction set and can execute most instructions in a single cycle. Ordinary microprocessors are general purpose devices – jacks of all trades but master of none. Top-end microprocessors have a much larger instruction set than a microcontroller and may average multiple instructions per clock cycle. However, this is an average speed and the actual number of cycles depends on the mix of instructions waiting to be executed at a particular time. It also varies considerable with the type of instruction and a multiply instruction may well take multiple cycles. Like a microcontroller, the DSP has a simple instruction set and will execute instructions in a single clock cycle. Unlike a microcontroller, though, instructions like multiply which are important for signal processing are included. And unlike the general-purpose microprocessor, even instructions like multiply and multiply-accumulate (a multiplication followed by an addition) are executed in a single clock cycle. The high speed of arithmetic instructions is achieved by dedicated hardware – often a multiplier or a multiplier-accumulator and a barrel shifter – in addition to the general-purpose arithmetic and logic unit (ALU). This results in very fast execution of the types of instructions which are important in signal processing and, arguably even more importantly, it provides a guaranteed level of performance rather than an average speed. Figure 3 is typical of the building blocks likely to be found in a DSP's processor.

Memory is another area in which a DSP differs from a general microprocessor or a microcontroller. The microprocessor in a PC uses a single pool of memory for storing both program and data. In a microcontroller, there may be two separate blocks of memory, EPROM for the program and RAM for working storage, but the two are,

Sampling and the Nyquist Theorem

A digitised signal, since it is made up of a series of sampled values, each representing a snapshot in time, is only an approximation to the original analogue signal, which it represents. This doesn't necessarily mean, of course, that it will be inferior to the analogue signal, even though there's potential for it to be worse – far worse. In order to use a digital signal processing system successfully, therefore, some knowledge of sampling theory is required. This way, the designer can ensure that the sampling frequency and resolution are adequate for the intended application without the system being over-specified and hence unnecessarily costly. Admittedly, sampling theory is by no means peculiar to the field of digital signalling processing. However, since an understanding of it is key to the proper use of digital signal processing, I though it would be appropriate to provide a bit of background information here.

First of all let's think briefly about resolution and by this I mean the number of bits used to represent each sample. The ADC and DAC chosen will dictate this figure and, obviously, there's a trade-off between resolution and price. A picture is worth a thousand words so the series of waveforms in Figure Box1 show how increasing the resolution of the sampling process gives a better approximation to the sine wave that the samples represent. Obviously, in order to illustrate the point as dramatically as possible, I've chosen artificially low resolutions of 2, 3 and 4 bits which allow 4, 8 and 16 different values to be represented. In practice the choice will normally be between 8, 12 and 16-bits although had I used these resolutions in the diagrams you would have struggled to see the differences visually. The ear is much more sensitive, though, and the difference between sampling speech at 8-bit and 16-bit resolution is very obvious. The differences in going from 16 to 24 bits, as in DVD for example, is also noticeable although less so than in going from 8 to 16 bits. To use the appropriate technical term, the number of bits dictates the dynamic range that is expressed in decibels. Dynamic range is given by the following formula:

$$DR\ (dB) = 20 \log_{10}\left(\frac{\text{largest discernable signal}}{\text{smallest discernable signal}}\right)$$

Which, in terms of digital sampling becomes:

$$DR\ (dB) = 20 \log_{10}\left(2^{B}\right)$$

where B is the number of bits. By rearranging this equation we get to a final result, namely that the dynamic range of a digital system is approximately 6dB per bit.

Dynamic range relates to the resolution of the waveform in the amplitude domain. Frequency response relates to the resolution of the waveform in the time domain and is controlled by the sampling frequency. Once again, the sampling frequency depends on the specification of the ADC and DAC or, more accurately, these components limit the maximum sampling frequency. Although it

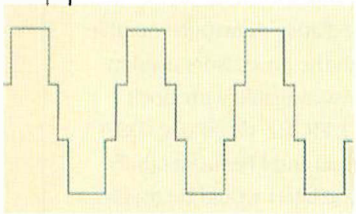


Fig box 1a

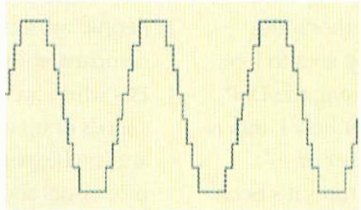


Fig box 1b

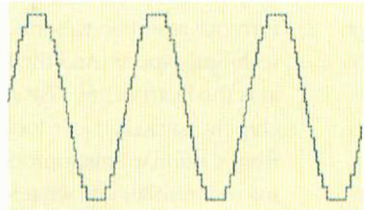


Fig box 1c

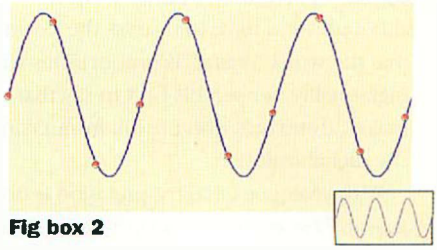


Fig box 2

nevertheless, interfaced to the processor via the same bus. Clearly this can result in a bottleneck. A DSP has separate areas of memory for program and data but, in many cases, different busses are used for the two so the bottleneck is eliminated. Furthermore, dedicated address generation hardware is used in the processor in order to speed up memory accesses. Multiple memory locations can, therefore, be accessed in a single memory cycle. Earlier, we looked at the multiply-accumulate instruction and I suggested that a DSP is normally able to execute this in a single cycle. You probably assumed that this single cycle excluded loading registers from memory and storing the result back to memory as these would all be separate instructions on a normal microprocessor. However, due to that address generator, all this is carried out in the same cycle. So, in a single cycle, a typical DSP can load two values from memory, multiply them together, add a third value from memory, and store the final result back to memory. Another difference from a simple microcontroller is that the program memory is often RAM rather than EPROM for its greater access speed. Instead of programming the DSP chip, therefore, a separate EPROM contains the program and this is loaded into the DSP at power-on.

Mention of program data being loaded into the DSP chip from external memory brings us to the subject of interfaces to the outside world. Typically, a DSP will have one or more serial ports that connect to ADCs and DACs to input and output the necessary analogue signals, respectively. Often, a DSP will also have a parallel port called a host port that is used for interfacing with a microcontroller or a microprocessor. In such a muli-processor system, the DSP will be used for the signal processing, as discussed and the microprocessor or microcontroller will handle the user interface. Many DSPs also bring the address, data and control busses outside the chip thereby allowing additional memory to be added.

To conclude this section, I should make it clear that what I've just described could be referred to as a microcontroller-type DSP. By this I mean that, like a general-purpose microcontroller, these devices have memory and I/O interfaces on-chip. However, although not as common, there's a different type of DSP chip that could be called a microprocessor-type DSP. Here, as with a general-purpose microprocessor, only the processor is on-chip and the memory and other peripherals that are required to build a working system have to be added as separate components. And finally, whereas this microprocessor-type DSP is one with a lesser degree of integration, there are also more highly integrated DSPs that have on-chip ADC and DACs. Since this limits the flexibility of the device, such chips tend to be tailored to specific examples such as speech processing, for example.

Applications

Elsewhere we present one particular application of DSP as a case study. However, decoding digital radio signals is just the tip of the iceberg so to conclude, let's take a look at the breadth of DSP applications. By necessity, this will be little more than a list

means that you'd be paying for performance you don't using, ADCs and DACs can be used at any sampling frequency up to the maximum specified. The sampling frequency you pick also depends on the DSP chip but the relationship here is far more convoluted and can't just be read of a data sheet. The rate at which the DSP can handle the input data stream does depend, of course, on the speed of the processor, but it also depends on the complexity of the processing which is being carried out on the signal. In practice, the design engineer will need to count the instructions (and hence the number of clock cycles) in the loop which processes the incoming data, and then pick a chip with a sufficiently high clock speed to achieve the required sampling rate.

The relationship between the frequency response and the sampling rate is expressed in the Nyquist Theorem. This theorem states that the sampling frequency must be more than double the frequency of the highest frequency, which is to be represented. So, for example, if an audio system needs to provide a frequency response up to 20kHz, the sampling frequency must be greater than 40kHz. Audio CDs sample at 44.1kHz to ensure a 20kHz frequency response. Figures Box2 and Box3 show a 20kHz sine wave sampled at over 40kHz and at exactly 40kHz respectively and (as in inset) the sine wave which could be reconstituted from these samples. In both cases the input sine wave is preserved. Note, however, that in Figure Box 3 we're absolutely on the limit with a sampling frequency equal to, but not greater than, the maximum signal frequency. And as such, as we can see in Figure Box4, if the sample points happen to lie at the zero-crossings, we loose the signal entirely. And Figure Box5 shows the effect of sampling the 20kHz signal at an even lower frequency. You'll notice now that the samples don't faithfully represent the input waveform at all and the insert shows that a very different waveform would end up being reconstituted. Of course we're only looking at sine waves here and, in the general case, signals will not be pure sine waves. However, since any waveform can be expressed as a sum of sine waves with differing frequencies and amplitudes, it's clear that sampling at too low a frequency will have the effect of filtering out the high frequency components and this will affect the shape of the reproduced waveform.

One other aspect we need to look at is aliasing since this was mentioned, briefly, when we looked at the building blocks of a typical DSP system. The Nyquist Theorem states that if a frequency higher than half the sampling frequency appears in the input analogue data stream, the digitised data stream will contain samples representing the sampling frequency minus the actual signal frequency. So, for example, if we sample at 20kHz and the input signal contains a 15kHz frequency component, this will appear in the digitised data stream as a 5kHz signal. This, of course, is far worse than signals above the Nyquist limit simply being lost since these so-called alisaed signals will interfere with the wanted signal. This explains why it's necessary to include a low-pass anti-aliasing filter before the ADC.

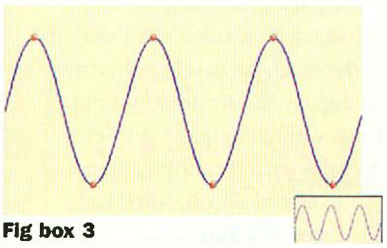


Fig box 3

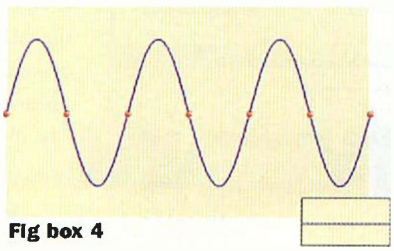


Fig box 4

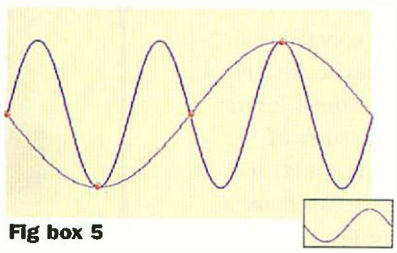


Fig box 5

but it should prove a useful application summary, nevertheless.

The first and, perhaps, the most important application area is consumer electronics, an area in which the selling price is paramount. And, as we've see, the adoption of digital techniques can often reduce the component cost significantly. So, for example, we now find DSPs turning up in mobile phones, digital cameras, TVs, digital set-top boxes, DVD players, answering machines, and audio systems. Communication, more generally, is another important application with standard and broadband (ADSL) modems, fax machines, video conferencing and wireless networking equipment all now using DSP. Image processing is another major growth area and here again, DSP lends a hand. Typical applications include pattern recognition, robot vision, image enhancement and animation. And so the list goes on … In the military we have secure communication, radar processing and missile guidance, in the medical field there's patient monitoring, patient scanning, EEG analysis, X-ray enhancement. DSP is even being used for seismic processing in the war against earthquakes.

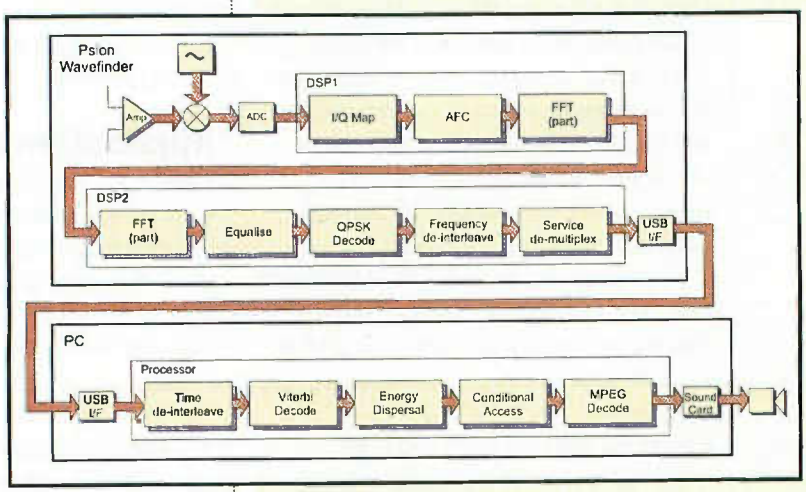
But what is perhaps even more amazing than the diversity of the applications is that, in many cases, the product is one which sells for just a few tens of pounds and yet has the processing power which, only a few years ago, would have been the domain of multi-million pound supercomputers. Perhaps we're now getting rather blaze about the falling price of technology but the advantages brought about by DSP are, perhaps, unprecedented.

Hands On

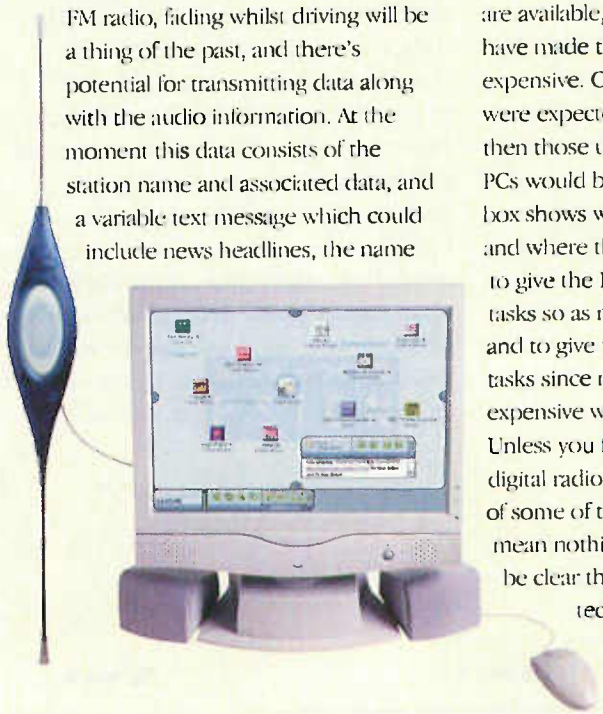
The best way to learn about DSP is to get your hands dirty writing some DSP code and trying it out yourself. To help you here, all the major DSP manufacturers produce so-called starter kits – boards containing an ADC, DSP and ADC which interface to a PC from which you can download the software. The kits are also supplied with software development tools, which run on a PC and a selection of sample programs. We'll take a look at a DSP starter kit from Texas Instruments next month.

Psion Wavefinder uses DSP

With the recent advertising campaigns by digital TV companies Sky Digital and OnDigital, most people are now aware that TV has gone digital and that a number of advantages are on offer compared to analogue television. Despite the fact that test transmissions of digital radio started much earlier than digital TV, in 1995 to be precise, far fewer people have heard of digital radio. Yet it, too, offers plenty of advantages compared to its analogue counterpart. First and foremost, since the signal is digital it can be compressed thereby allowing far more stations to broadcast in a given piece of the radio spectrum. Accordingly, there will be far more stations – initially five national stations from the BBC with a further five to come, ten national commercial stations from Digital One, and, in the fullness of time, lots more local and regional stations. Sound quality will also be better than with FM radio, fading whilst driving will be a thing of the past, and there's potential for transmitting data along with the audio information. At the moment this data consists of the station name and associated data, and a variable text message which could include news headlines, the name of a track being played, or contact details for the radio station. However, the scope is far more than this with talk of transmitting Web pages and photographic images to supplement the audio programme content. Although it's still early days for multi-media radio, it's clear that a PC would make an ideal digital radio receiver and with the Psion Wavefinder product (www.wavefinder.com), based on technology developed by RadioScape Ltd (www.radioscape.com) this is exactly what you can have. Wavefinder is a PC peripheral, which interfaces via a USB port and turns a PC into a digital radio receiver. In addition to playing the audio through a soundcard and speakers and displaying text messages on the screen, Wavefinder users will be able to receive multi-media content when it becomes available.



The RadioScape technology which is at the heart of Wavefinder is referred to as Software Defined Radio. Here, the absolute minimum of analogue circuitry is used. Instead, the radio signal is converted to baseband by a mixing process, and the baseband signal is then digitised and passed through to a DSP, or more accurately a pair of Texas Instruments TMS320C5402s. A balance had to be established between the work done on the DSP and that done on the host PC. Although DSPs with sufficient power to perform all the processing and generate audio from the baseband signal are available, using such a device would have made the digital radio adapter too expensive. On the other hand, if too much were expected of the processor in the PC then those users with modestly powered PCs would be excluded. The Figure in this box shows what is actually done in the DSPs and where the PC takes over. The aim was to give the DSPs the processor-intensive tasks so as not to burden the PC unduly, and to give the PC the memory-intensive tasks since memory on DSP systems is expensive whereas it's virtually free on a PC. Unless you fully understanding how a digital radio signal is encoded, the functions of some of the blocks in the diagram may mean nothing to you. However, it should be clear that without employing DSP technology, a significant amount of dedicated silicon would have been required.



EXPLODING *Information*

Two University of California professors have just finished analysing all new data produced worldwide last year, on the Internet, in scholarly journals, even in junk mail - and report not just staggering totals, but a 'revolution' in information production and accessibility.

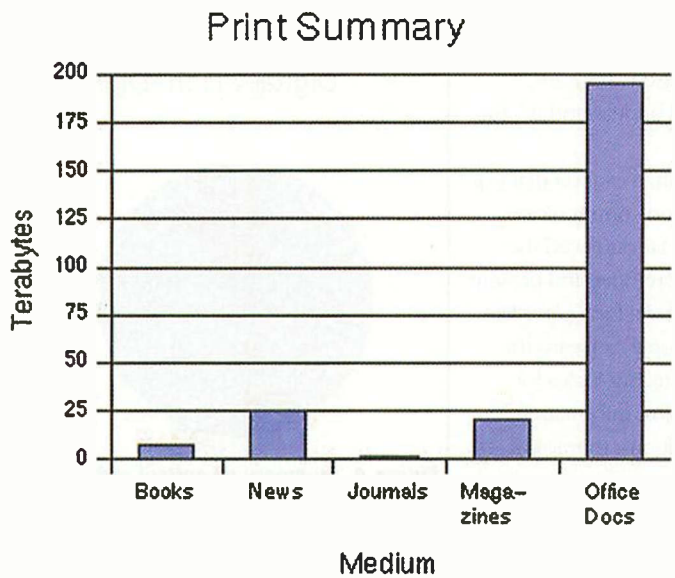


Figure 1. Over 93% of the information produced in 1999 was in digital format

In their report, 'How Much Information?' professors Hal Varian and Peter Lyman of the University of California Berkeley School of Information Management & Systems (SIMS) report new information production in terms of paper, film, optical and magnetic data.

The pair analysed industry and government reports for production of information that also includes e-mail, digital production, videos, DVDs, CDs, broadcast outlets, photographs, books and newspapers.

Information Overload

The study has, for the first time, used 'terabytes' as a common standard of measurement to compare the size of information in all media, linking and interpreting research reports from industry and academia. One terabyte equals a million megabytes or the text content of a million books. This standard makes it possible to compare growth trends for different media using one universal standard.

The numbers in the UC Berkeley report are mindboggling:

The directly accessible 'surface' Web consists of about 2.5 billion documents and is growing at a rate of 7.3 million pages per day.

Counting the 'surface' Web with the 'deep' Web of connected databases, intranet sites and dynamic pages, there are about 550 billion documents, and 95% is publicly accessible.

50% of all Internet users are native English speakers, while English language Web sites account for about 78% of all Web sites, and 96% of E-commerce Web sites.

A white-collar worker receives about 40 e-mail messages daily at the office.

90% of the world's e-mailboxes were found in the United States in 1984, but that dropped to 59% by the end of 1999. E-mail production accounts for about 500 times as much information as Web page production each year.

Worldwide production of books increased by 2% in the last year.

Production of newspapers in the last year decreased by 2%.

SIMS professor's Lyman and Varian and their research assistants James Dunn, Aleksey Strygin and Kirsten Swearingen translated original content volume into bytes, using the terabyte as the project's smallest practical measure. Then they calculated how much storage each type of media takes when subjected to different compression techniques, and factored in anticipated duplication.

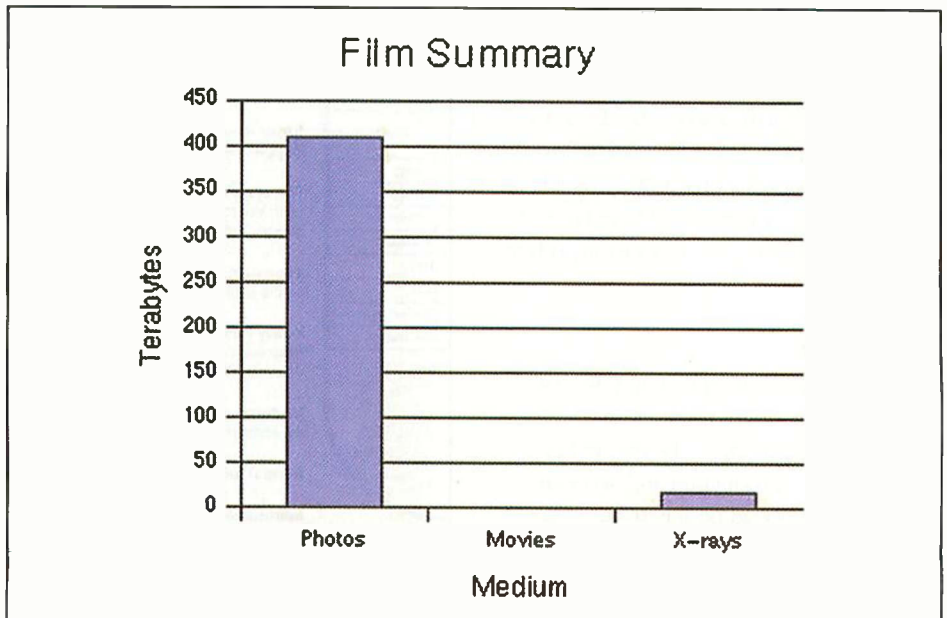


Figure 2. Summary of printed information published in 1999

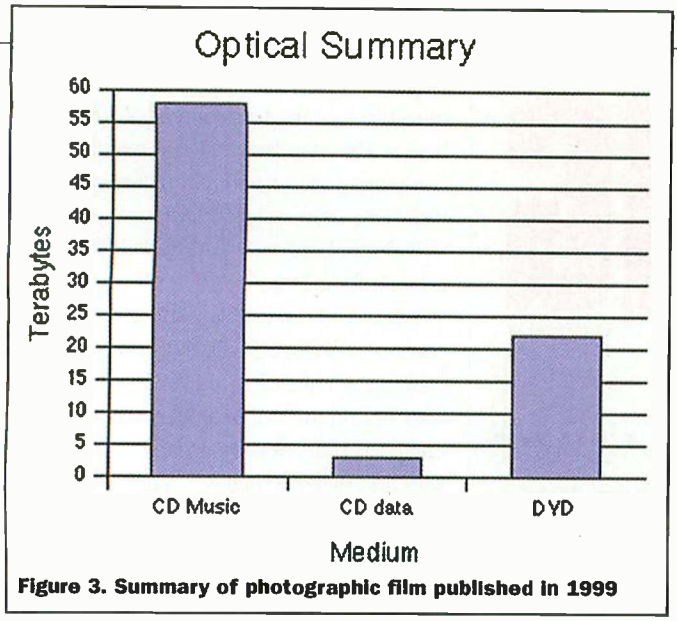


Figure 3. Summary of photographic film published in 1999

Emerging Trends

The professors said they were struck by three emerging trends.

One is the democratisation of data, the vast amount of unique information stored and also created by individuals. Original documents created by office workers represent nearly 90% of all original paper documents, while 56% of magnetic storage is in single-user desktop computers.

"A century ago, the average person could only create and access a small amount of information," wrote Varian and Lyman in their report. "Now, ordinary people not only have access to huge amounts of data, but are also able to create gigabytes of data themselves and, potentially, publish it to the world via the Internet."

The second surprise for the professors was the finding that print accounts for such a miniscule amount of the total information storage. But they said it doesn't mean print is dead, rather it is a very efficient and concentrated form for the communication of information.

The third striking finding for them was the dominance of digital information and its phenomenal growth. This further feeds the democratisation of data, they said, because digital information is potentially accessible anywhere on the Internet and is a universal medium because it can copy from any other format.

Storage

But just because storing vast amounts of information no longer requires an investment in real estate, the researchers said the ease of production and access to information may lead people to turn over personal data management to specialised businesses with giant data storage systems.

"After all," they wrote, "would you rather keep all your family photos on your PC hard drive, and risk losing everything if it crashes, or on a secure site managed by Kodak? On the other hand, individuals may prefer to keep information about themselves in smaller systems that only they control."

The researchers also forecast that businesses will be tremendously affected by this increase in individuals' instant access to real-time company data, something that a few years ago was restricted to the upper management.

"The difficulty will be in managing this information effectively: making sure that your suppliers, your employees, and your customers not only have access to the data they need to make informed decisions, but also can locate, manipulate and understand it," the report said.

Lyman and Varian caution that our ability to store and communicate information has far outpaced the ability to search, retrieve and present it. That's one reason for a place like SIMS, where people can learn the techniques and technologies for sorting the valuable information from the superfluous, they said.

"Information management - at the individual, organisational, and even societal level - may turn out to be one of the key challenges we face," the report said.

"It's the next stage of literacy," Lyman said.

The latest report is not in printed form, because its authors see it as a living document. It can be found at **<www.sims.berkeley.edu/how-much-info/index.html>** and will be updated periodically in response to comments from readers.

"It's a good way to kick off a discussion of what information is. We don't have a very good way of talking about information because it's changing so fast," said Varian, also co-author of Information Rules: A Strategic Guide to the Network Economy.

"In the past, we've talked about information in terms of the size of a physical inventory, such as counting books or films," Lyman said. "But in the future, the size and format of information will be dynamically reshaped to the needs of the reader."

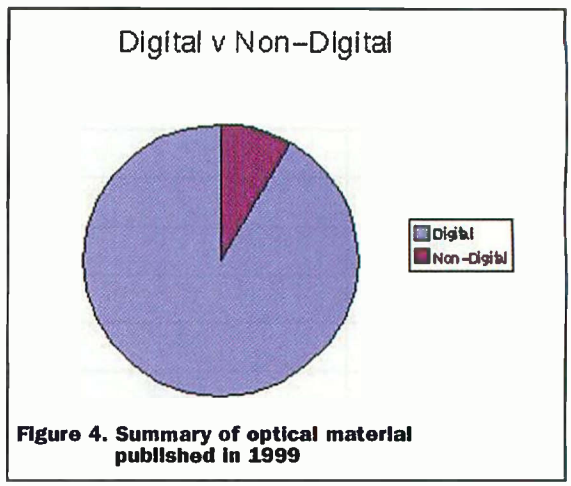


Figure 4. Summary of optical material published in 1999

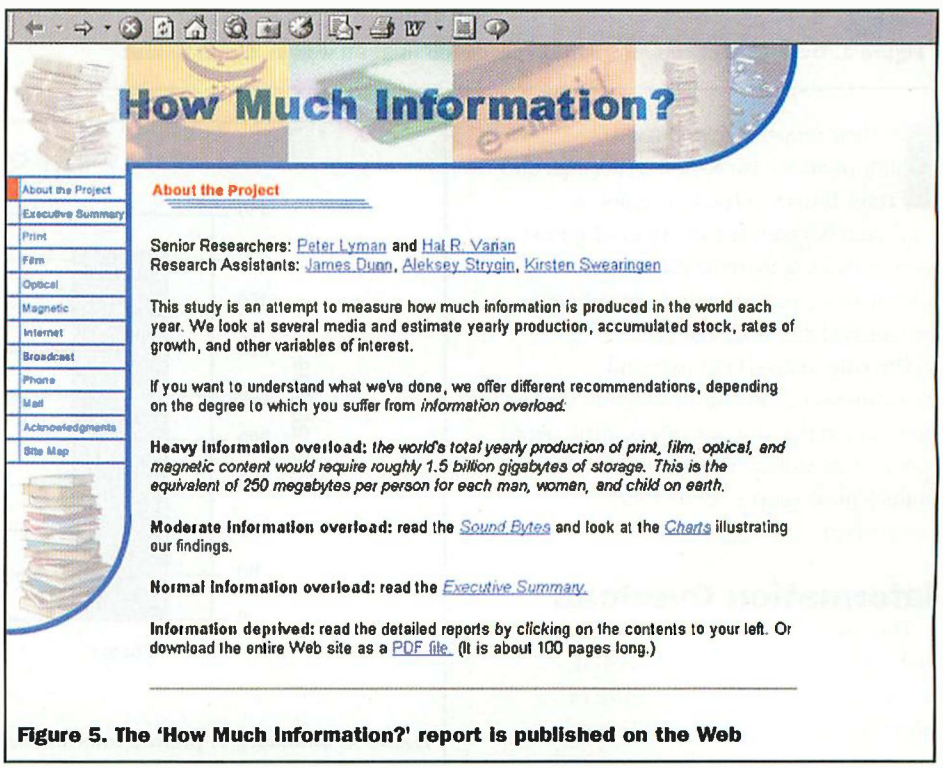


Figure 5. The 'How Much Information?' report is published on the Web

Extra Terrestrial UV RADIATION

PART 2

Dark light: The discovery of the ultra-violet wavelengths

by Gregg Grant

Introduction

The average temperature of the Earth at mean sea level is around 15°C. By the time an exploration vehicle has reached eight miles above the planet's surface this tolerable regime has deteriorated markedly, the temperature by now having dropped to -60°C.

For the next few miles the temperature remains steady until, at roughly 15 miles up, it begins to rise sharply, an increase '. . due to a layer of ozone, which strongly absorbs, and is heated by, ultra-violet light from the sun of wavelengths between 2 and 3 x 10 -5 cm.' [1]

The first man to record the solar ultra-violet spectra was a British pioneer of astrophysics, Sir William Huggins. The son of a silk mercer, he was educated privately before entering the family business. Shortly however he retired, to devote his life to scientific studies. An admirer of the work of the great German physicists Robert Bunsen and Gustav Kirchhoff, Huggins decided to concentrate his research efforts on the stars. In 1879, he obtained the U-V spectrum of white stars, his work being the first major, detailed investigation into these objects, work that he reluctantly gave up at the age of 84, because his eyesight was no longer as sharp as it had been. Another area in which William Huggins did pioneer work was in stellar photography, and he began using the new media to record spectra as early as 1863.

In 1906, the American physicist Theodore Lyman - having begun his research into U-V radiation at Harvard's Jefferson Physical Laboratory some years earlier - published the first accurate measurements for wavelengths below 2,000Å. A Bostonian by birth and a Harvard graduate also, Lyman concentrated his research on the problem of using diffraction gratings to measure wavelengths in the extreme U-V region. This work extended the then-known far U-V band significantly.

Four years later, at the age of 36, Lyman was appointed the Jefferson Laboratory's Director. He continued his analysis of the U-V spectra, as well as the optical properties of a number of materials. In 1914, he discovered the hydrogen spectral lines which bear his name, the Lyman Series. This is one of the hydrogen series occurring in the extreme U-V region of the spectrum, its limit being at a wavelength of 91.26 nanometres. The leading line - termed the Lyman- α- has a wavelength of 121.57nm and is important in upper atmosphere research, as it is strongly radiated by the sun.

One of the problems inherent in studying solar and stellar spectra is that almost all of the gas and dust that absorbs U-V radiation is located below 10,000 feet, or 3,000 metres. Yet locating measuring instruments above this height is equally as inhibiting since '. . . the amount of damaging ultraviolet (UV) radiation in sunlight increases. The sunburning power increases by 4% every 1,000 feet, or 300 metres in altitude.' [2] A solution to these limitations only came with satellites and space telescopes.

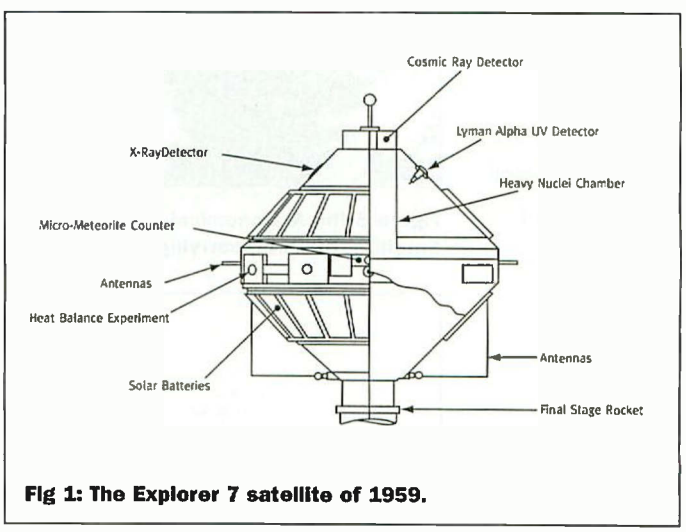


Fig 1: The Explorer 7 satellite of 1959.

Satellites and Small Telescopes

Among the early scientific satellites was the American Explorer series, perhaps the most successful of which was Explorer 7, blasted into orbit in October 1959 and illustrated in Figure 1, overleaf.

This vehicle was tiny compared with many that would follow it. With a diameter of 76.2cm, a length of 76.2cm also and weighing a mere 41.6 kilos, this small laboratory analysed U-V radiation, as well as measuring the heat received - and radiated by - the Earth. Its radio signals - on 19.9MHz - continued even after they were supposed to have automatically terminated in October, 1960.

The first satellite to continuously monitor the sun's U-V radiation was the Russian Greb 1, or Sunray 1, vehicle launched in June, 1960. For a number of months it recorded the strongest solar U-V radiation - the Lyman-_ radiation at 1216Å - and, from its launch until September, it showed that this type of radiation was constant.

Beginning in 1968, the Americans launched a series of what they termed Orbiting Solar Observatory or OSO satellites and Orbiting Astronomical Observatory or OAO satellites. The OSO series were the first such vehicles dedicated to astronomical U-V and X-ray observations and the first U-V observations of solar flares came from the OSO 4 satellite.

The OAO satellites provided the earliest U-V observations of stars and nebulae

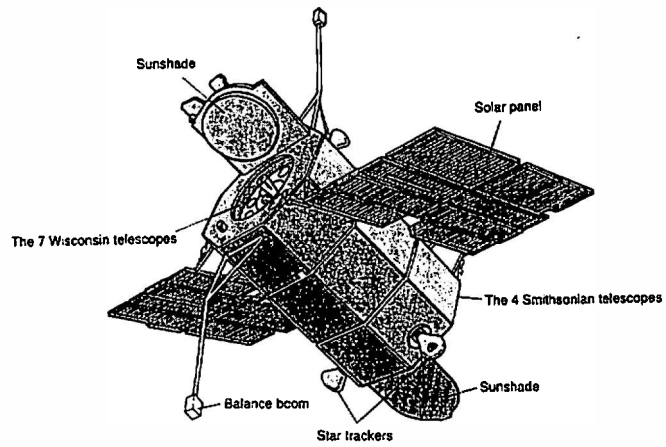


Figure 2 The OAO Satellite

outside our own solar system. OAO 2 - shown in Figure 2 - carried two major experiments.

The first one - designed by the Smithsonian Astrophysical Observatory - consisted of four 30-cm U-V telescopes, each of a different spectral sensitivity which created an image on a U-V sensitive television tube, having a 2_ field of view.

The vehicle remained in operation for some 16 months, the Smithsonian experiment succeeding in '. . . mapping 1/6th of the entire sky in four different U-V spectral intervals, obtaining 13,646 observations of 5068 stars!' [3] The end product was a catalogue of U-V bright stars which - subsequently - became the foundation on which the U-V research of the last three decades has been built.

The second on-board experiment was designed by the University of Wisconsin and aimed at gathering exact U-V luminosity and spectral information for a substantial number of sources from intergalactic nebulae, via other planets in our solar system, to the Earth's upper atmosphere. Consisting of a number of telescopes from 20 to 40cm aperture with scanning spectrometry and filter, the experiment carried out some dozen observations per day over the majority of the satellite's four-year life.

The result was new insights into starlight scattering in the U-V region as it passes through the interplanetary gas and dust, including the revelation that 0.01μm radius grains of graphite are present throughout the galaxy. Furthermore, the light emitted from other galaxies close to our own reveal an excess of U-V radiation, indicating that these galaxies too have a surfeit of similar particles.

Large Telescopes

One of the earliest large telescopes carried aloft was on board the OAO 3 vehicle, called Copernicus. Built at Princeton University Observatory, this 80-cm model, with an echelle-grating photoelectric spectrometer, whose resolution was 0.005 - 0.01nm, was precise enough to identify the faint absorption lines of the interstellar medium.

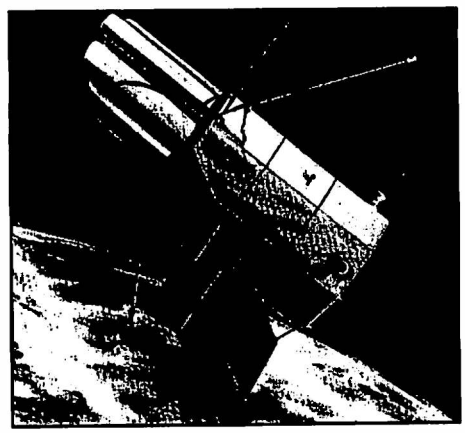


Figure 3 The Astronomical Netherlands Satellite, the ANS, carrying a UV telescope

Among its early results was that deuterium, an isotope of heavy hydrogen, was more abundant than previously thought. However, other heavy atoms such as phosphorus, nitrogen and carbon are less numerous in the interstellar gas and dust.

These satellites and telescopes were but the beginning. In 1974 another joint venture was launched. This was the Astronomical Netherlands Satellite, the ANS, shown in Figure 3, a co-operative effort between Holland and the US, which contained a 20cm UV telescope.

Undoubtedly one of the longest orbiting U-V telescopes however - and the most successful for that matter - is the International Ultraviolet Explorer, the IUE, shown in Figure 4. Placed in orbit in 1978, it was designed to observe the U-V sky for a period of five years. As late as 1995 however '. . the telescope was still functioning and had taken tens of thousands of spectra of stars, nebulae and galaxies.' [4]

The IUE is a joint US/European venture, controlled for 16 hours per day from NASA's Goddard facility and for the remaining eight hours by the European Space Agency's (ESA), Villafranca tracking station in Spain. To date, it's unquestionably the most productive mission in the brief history of spaceflight.

Nevertheless the IUE had limitations, among which was its small-diameter primary mirror - 45cm - and its instrumentation, which had been designed in the early 1970s. Consequently, it couldn't study very faint objects. So in June 1992, the United States, (US), launched the Extreme Ultraviolet Explorer or EUVE satellite, which was designed to broaden spectral coverage at the UV wavelengths.

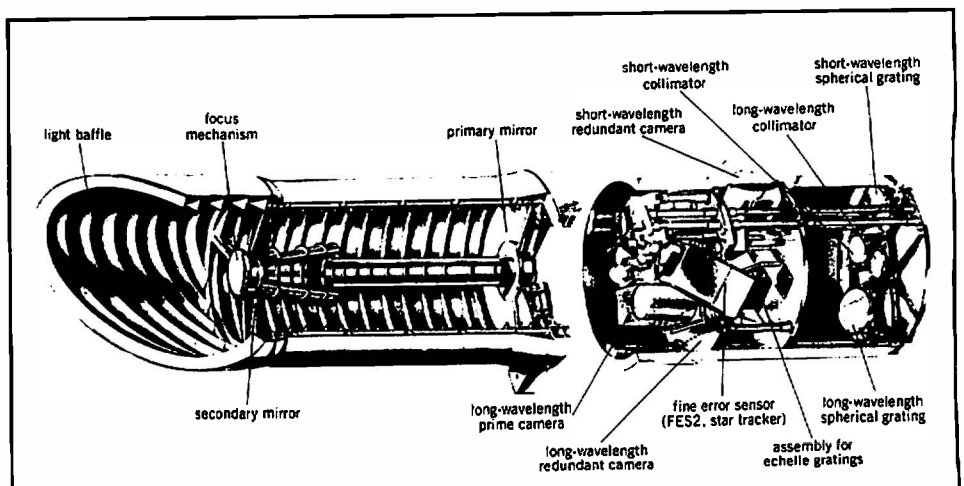


Figure 4: The International Ultraviolet Explorer telescope, controlled from NASA's Goddard Spaceflight Centre and ESA's Villafranca Tracking Station.

This vehicle's observations stopped down to 70Å.

Perhaps the most famous telescope currently in operation is the Hubble Space Telescope, if only because of its spectacular initial failure and later - in-situ - repair by space-walking astronauts. However, there's more to Hubble - illustrated in Figure 5 - than many people imagine.

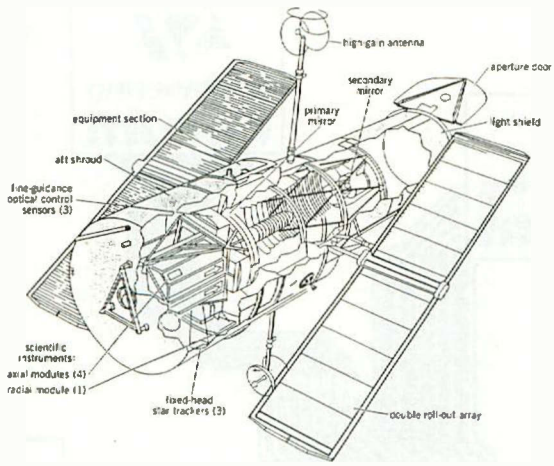


Fig 5. The Hubble Space telescope.

To begin with, this platform is another US/European joint venture and it carries a new UV observation device, the Goddard High Resolution Spectrograph, the GHRS. This piece of exploratory kit uses the Hubble's large, 2.6-metre mirror in its investigations. Launched in 1990, the Hubble telescope was - as noted above - corrected for earlier flaws in 1993.

Despite periodic complaints from a number of people - influential and otherwise - about the supposed waste of resources that, as they see it, space exploration entails, there is a great deal of work for these exploratory vehicles to do.

The Ozone Hole

Undoubtedly the most valuable work carried out by satellites and other orbiting probes and vehicles has been not so much gazing outwards, more scrutinising inwards, monitoring the threat to our planetary home through the 'hole' in the Earth's ozone layer.

Ozone is vulnerable to attack by chlorine oxides, themselves stemming from '. . a group of chemicals called chlorofluorocarbons, or CFCs, developed in the 1930s and widely used until recently in refrigerators, air conditioners, aerosol sprays, and various foam products.' [5] The problem with CFCs is that, no matter where they're used, they slowly rise from ground level - where they're perfectly stable - into the stratosphere where they break up under U-V radiation bombardment releasing chlorine, which is vigorously reactive.

In 1957, as part of the national contribution to the International Geophysical Year, (IGY), project the British installed spectrometers at two of their bases in Antarctica. They used the intensity of the U-V radiation reaching the equipment to work out just how much ozone was, in fact, protecting us.

What the meteorological scientist Joseph Farman discovered was that there was a decline in the ozone level during the southern spring, between August and November. This decline was recorded between 1978 and 1982 and was equally as evident in the following year. Early in 1984 Farman and his colleagues installed new instrumentation, whose readings confirmed their earlier measurements. The readings for the period between 1982 and 1994 are illustrated in Figure 6.

Further confirmation came from the Total Ozone Mapping Spectrometer, the TOMS, on board the Nimbus 7 satellite, which had been blasted into orbit in 1978. This instrument took no less than 190,000 ozone readings per day and when this data was analysed - after Farman and his colleagues had published a paper in the prestigious journal 'Nature' - it provided confirmation of their work.

The decline in ozone cover shook the meteorological and scientific communities, resulting in governments world-wide taking action in the shape of the Montreal Protocol of 1987, which was subsequently revised in 1990 and 1992. The aim was to remove some CFCs from industrial manufacture and consequently ' . . the global use of the most harmful CFCs fell by 40% within five years.' [6]

Nevertheless, the ozone depletion over Antarctica was very severe and so it will take decades for the CFCs already in the atmosphere to be eliminated. Nor is this all: it appears that the Arctic ozone blanket is also under threat.

Presently, the American National Aeronautics and Space Administration (NASA) and the European Commission (EC) have set up a joint study of the northern ozone shield, based in Sweden, some 200 kms north of the Arctic Circle. Involving scientists from 19 countries, a budget of $40 million and research aircraft and balloons complimenting the satellite images, there can be no doubt that the world is now taking U-V radiation VERY seriously indeed.

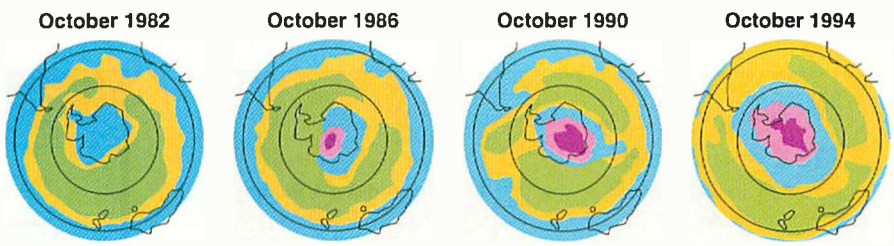


Fig 6. The Antarctic ozone layer, seen over the period 1982 to 1994. The 'hole' - illustrated in pink and deep red - has expanded considerable since the early 1980s.

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1: King-Hele, Desmond (1962): Satellites. Routledge & Kegan Paul, London. Ch 6, Page 103.

2: Burroughs et al (1996): The Ultimate Guide to the Elements. HarperCollins Ltd., London. Ch 6, Page 136.

3: Porter, Richard (1978): The Versatile Satellite. Oxford University Press, Oxford & London. Ch 9, Page 138.

4: Travers, Bridget (Editor) (1996): The Gale Encyclopaedia of Science. Gale Research, New York. Page 3790.

5: Monmonier, Mark (1999): Air Apparent: How Meteorologists Learned to Map, Predict and Dramatise Weather. University of Chicago Press, Chicago, USA. Ch 11, Page 210.

6: Ibid [2], Ch 5, Page 123.

Figures 1 & 2 adapted from Satellites. Courtesy Routledge and Keegan Paul.

Figure 3 Courtesy of The Versatile Satellite. OUP.

Figures 4 & 5 Courtesy of McGraw Hill, Encyclopaedia of Science and Technology.

Kanda.com

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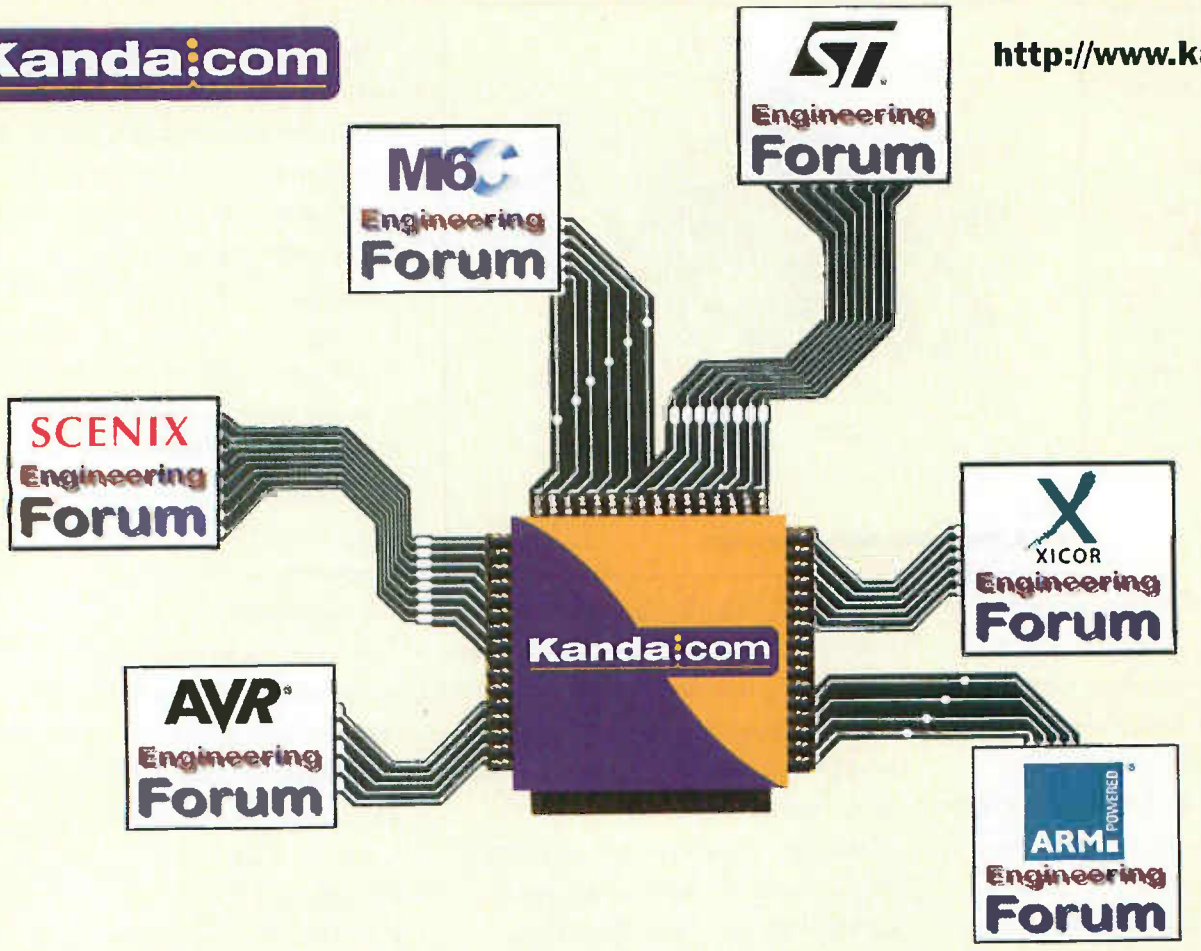


Did you know that Kanda.com has a range of diverse engineering forums providing you with interactive, up-to-date information. These sites offer you a free and reliable engineering service, backed by the worlds leading silicon companies. Our world-wide web arena provides the first point of reference with lists of frequently asked questions, hints and tips for engineer and hobbyist alike. Why not stop at our six Engineering Forum sites to get expert help, to see what the worlds leading silicon companies have to offer and learn about the latest cutting edge technologies. All our sites offer you the opportunity to interact through our discussion forums.
The Atmel AT91 Arm/Thumb series are a range of high performance, low power 32bit microcontrollers. These controllers are targeted for use in hand held performance computing. Some typical uses of the AT91 are MP3 players, GPS handsets, pagers and mobile phones.

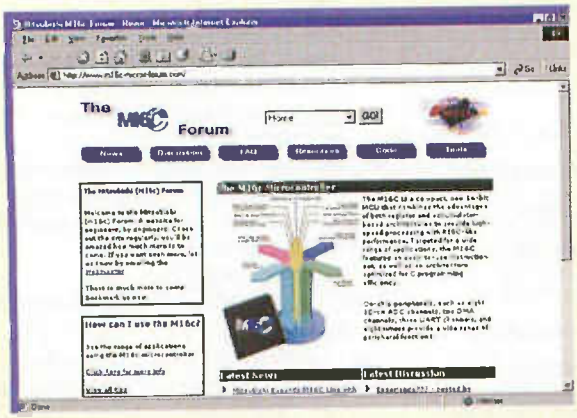
NEWS:

AT91 goes Flash

News on the AT91F40416, the first Flash based ARM/Thumb microcontroller.

Tutorials:

We have managed to obtain a range of tutorials for our visitors, these were previously only available to AT91 seminar attendants. These exclusive tutorials should help you get to grips with your first AT91 project in no time at all.

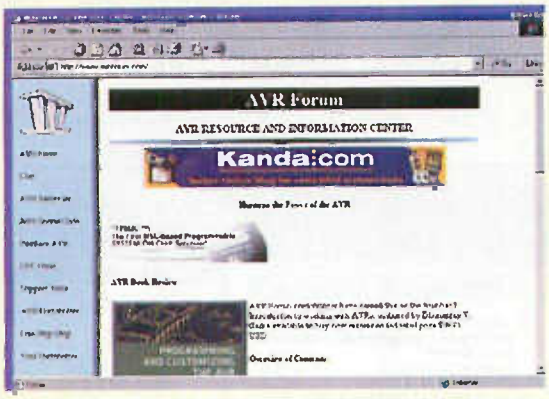


m16c Forum

<http://www.m16cmicros-forum.com>

The m16c series from Mitsubishi are an extremely versatile and secure range of 16-bit flash microcontrollers. Featuring large I/O (87-129), ADC/DAC, plentiful Flash and Ram(48KB-256KB) and a variety of additional peripherals available throughout the range such as: DRAM interface,CRC generation, SIM, USB, 12C, On-Screen Display, ISA, CCD and LCD.
These advanced features are well suited to any project which requires a user interface, such as Digital TV, Mobile Telephones, VCR, Pagers and Digital Cameras. Its low power, noise resistance and excellent analogue capabilities make it equally at home with safety critical automotive applications such as Airbags, ABS and engine management.
The newly launched m16c forum is aimed at making this excellent product more accessible to new users. As you would expect there are a range of tutorials, device datasheets and information on a range of development tools.

AVR Forum http://www.avr-forum.com



The Atmel AVR microcontroller is an extremely versatile and well-supported 8bit flash microcontroller. Available in 8 to 64 pin packages, flash memory sizes from 1kb to 128kb and features such as ADC, Infrared Generators, PWM , SPI, UARTS and Comparators coupled with its flash In-System programming make it an ideal projects controller.
The AVR Forum has a lively discussion forum, a good library of code samples, free tools, datasheets & schematics downloads, regular competitions and details of a range of development tools.

Tools: USB Programmer
Software: ISP Gold software update.
Content: Book Review

SX Forum http://www.sx-forum.com

The Scenix SX Microcontrollers are an amazingly fast (100MHz!) range of Flash Microcontrollers. Instruction sets and pin-outs are compatible with the popular PIC controllers.
With a range of software add-ons known as Virtual Peripherals the SX controller is able to perform many functions almost completely in software. Some examples are a V23 modem, 8-channel UART, DTMF detection and a complete PPP/TCP/IP stack enabling you to internet enable your projects.
The SX Forum contains a great deal of information on using these virtual peripherals, including application notes, tools & demo kits as well as a discussion forum to discuss your designs and ideas with other experienced users.
Tools: SX TCP/IP Stack and 10-Base T Ethernet.
Tutorials & App Notes: Including interfacing SX to ISA Bus, Caller ID, 3 Phase AC motor control.
Notes: We welcome contributions and ideas from visitors.

Xicor Forum http://www.xicor-forum.com

Xicor produce a wide range of IC's which allow you to easily add additional features to your circuit including: Battery Management, EEPROM, Real Time Clock/Calendar/Alarms, Digital Potentiometers, Smart Op Amps. There are also products suited at protecting other digital electronics on your circuit by providing CPU supervisor features including: watchdog, voltage detection, low voltage reset and voltage monitoring.
The real benefit of using these products is that various combinations of the features listed above are available in a single package. For example: Real Time Clock plus 2 Alarms, 2 Kbytes EEPROM, Low Voltage reset and watchdog available in a single 8-pin SOIC package.
The Xicor forum contains everything you need to start using these devices including: tutorials, application notes, FAQs and full details of obtaining development kits for PC based configuration of these devices. There is also a discussion area which is frequented by new and experienced users as well as Xicor & Kanda staff.

ST7 Forum http://www.st7-forum.com

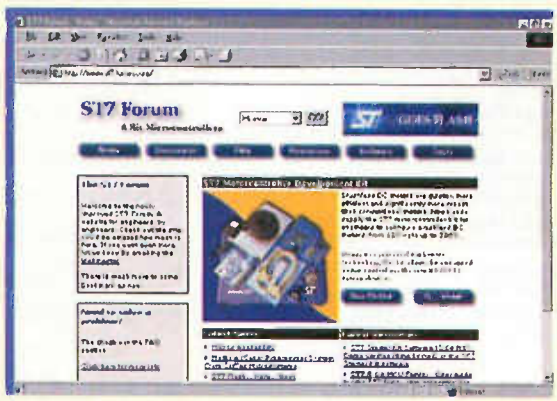
STMicroelectronics (formerly SGS Thomson) micro controllers are renowned for their Quality, Ruggedness and Reliability, but were previously only available in mask ROM, OTP and expensive EPROM.
STMicroelectronics have now added Flash programming capability to the ST7 range of 8 bit general purpose micro controllers and with very competitive pricing and availability these are now very desirable devices.
ST7 has a full range of packages with a wide variety of onboard general purpose peripherals such as ADC, PWM, SPI, UART, Timers, Watchdogs and low level detection as well as specialist peripherals including Motor Control, CAN and USB meaning that there is an ST7 device to suit all needs.
Easily programmable using 'C' or Assembler and with widely available development tools including Evaluation Kits, Emulators and Production Programmers make the ST7 micro controller the choice of the discerning engineer.
The ST7 Forum is designed to give the engineer all the resources required to use and implement an ST7 solution including datasheets, application notes, tools, sample programs and demonstration kits as well as a discussion forum where you can discuss your designs and ideas with other ST7 users.

Kanda ST7 Tools

ST7 Starter Kit for OTP, EPROM and Flash devices
ST7 ISP for Flash devices
ST7 Evaluation boards for Flash devices
ST7 Keyfob Kits for Flash devices
ST7 Keyfobs for Flash devices
ST7 Motor controller Development Kit for OTP and EPROM

Other Tools

STMicroelectronics ST7 Toolchain
Softtec Emulators
Cosmic 'C' COMPILER
Hiware 'C' Compiler



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 2000

5 to 7 Dec. OSPMA, FieldComms, Industrial Networking Show, ExCel. Tel: (0207) 417 7400.

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

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

January 2001

10 to 11 Jan. Communications for Business 2001, NEC, Birmingham. Tel: (0208) 541 5040.

29 Jan to 1 Feb. Digital Solutions - Imaging & Output Olympia, London. Tel: (0207) 357 6161.

February 2001

7 to 8 Feb. Softworld HR & Payroll ExCel, London. Tel: (0208) 541 5040.

7 to 8 Feb. Legal IT Business Design Centre, London. Tel: (01491) 575 522.

13 to 14 Feb. Technology for Marketing Olympia, London. Tel: (020) 8987 7905.

20 to 22 Feb. Smartcard ExCel, London. Tel: (01895) 454 545.

21 to 22 Feb. Computer Trade Show, NEC, Birmingham. Tel: (0208) 541 5040.

23 to 24 Feb. Digital Mapping Show, Barbican Centre, London. Tel: (01883) 652 661.

March 2001

7 to 8 March. Softworld Accounting & Finance Olympia. London. Tel: (0208) 541 5040.

13 to 15 March. Telecommercexpo ExCel, London. Tel: (020) 8910 7910.

22 to 23 March. Linux Expo 2001 Olympia, London. Tel: (01256) 384 000.

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

April 2001

3 to 5 April. Electronic Design Solutions, NEC, Birmingham. Tel: (020) 8910 7910.

3 to 5 April. NEPCON - Electronics Exhibition, NEC, Birmingham. Tel: (020) 8910 7910.

9 to 11 April. Convergence, Olympia, London. Tel: (01244) 881 777.

24 to 26 April. Webcom ExCel, London. Tel: (01732) 377 646.

May 2001

16 to 17 May. The Embedded Systems Show, ExCel, London. Tel: (0207) 681 1000.

16 to 17 May. European Cable Communications, ExCel, London. Tel: (020) 8910 7910.

21 to 23 May. Mediacast Communications & IT, ExCel, London. Tel: (020) 8910 7910.

21 to 23 May. Cable & Satellite Mediacast, ExCel, London. Tel: (020) 8910 7910.

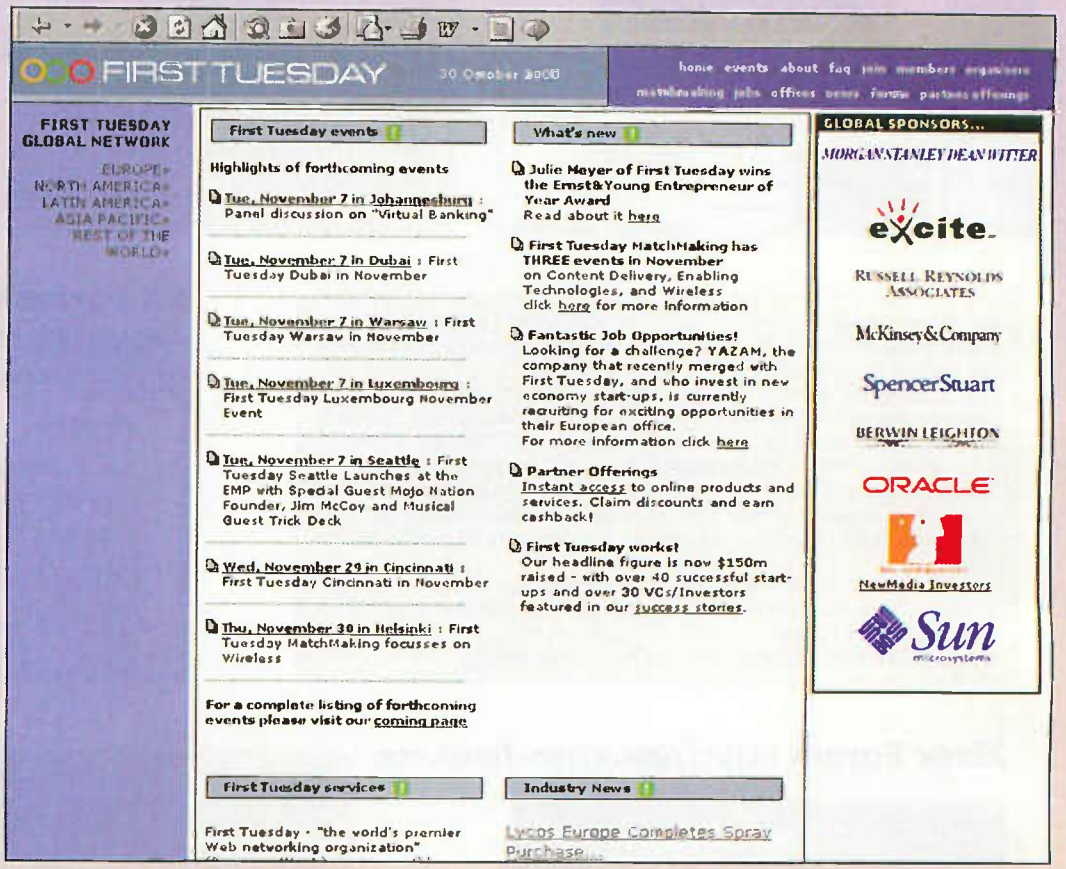
22 to 24 May. Mobilexpo, NEC, Birmingham. Tel: (020) 8910 7910.

June 2001

26 to 28 June. Networks Telecom, NEC, Birmingham. Tel: (020) 8987 7905.

Please send details of events for inclusion in 'Diary Dates' by e-mail to: swaddington@cix.compulink.co.uk.

What's On?



It Might Not be Right, But it's Free

What's next for the music industry? First Tuesday's panel of new music entrepreneurs gave their views at a meeting on the first Tuesday in October.

If nothing else, the energetic discussion proved that the genie is out of the bottle. Whether the music industry knows where it's going or not, the pressure for change is growing.

Or, as various members of the First Tuesday audience put it: "Your major labels don't seem to understand that we don't give a **** if you go bust... You can't incentivise me to pay £3.50 for a track I can download from Napster for free...your business is already dead... I'm not saying it's right, I'm just saying it's free!

"... You are the upper class and I don't care about you. The merchant class, of DJs for example, will always be able to make money touring... I'm a regular Napster user so slap the cuffs on if you want."

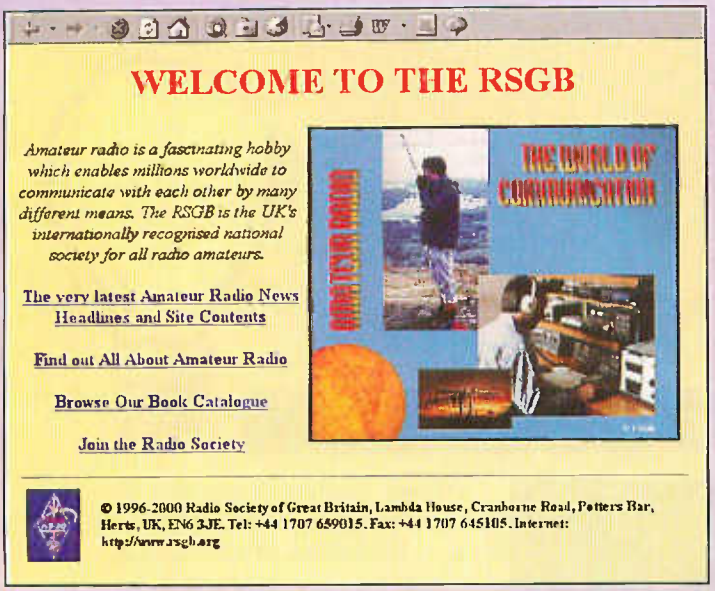
And from another, "50% of Napster users would pay if you gave them a way so don't prosecute them and call them thieves."

Becky Lancashire, founder of Clickmusic at <www.clickmusic.com> pointed out that the UK music market is incredibly fast moving - there are 200 new releases a week, involving just a three-to-four-week marketing cycle.

Listeners expect information on bands and their products to be up to date, so they need an effective directory to navigate them to it. For example, at the moment, Boyzone.com is a gay porn site and Oasis.com stands for Optimised Architectures for Systems in Silicon.

EMI executive Fionnuala Duggan said her company will use the technology as part of a marketing plan for acts deemed less 'radio friendly' - to attract attention and test whether consumers liked them before elevating them to a more traditional marketing approach.

First Tuesday at <www.firsttuesday.com> is the global meeting and market place for start-ups, connecting people, ideas, money and services.



RSGB Annual Meeting Set for December

The RGSB Annual Meeting, which is open to members and non-members, will take place at Harrogate Ladies' College, Harrogate in Yorkshire on December 2.

The event will consist of the 54th annual general meeting; and extraordinary general meeting; and an open form.

The annual general meeting and extraordinary general meeting will take place at 11:00hrs and is followed by lunch and an open forum meeting at 14:30hrs.

In the evening, an RSGB Dinner is being organised. If you wish to purchase a ticket for the Dinner please contact the RSGB.

For further details, check: <www.rsgb.org.uk>.

FastParts.com's CEO Addresses IDC's Internet Forum

FastParts.com CEO, George Gordon, addressed the IDC's third annual Internet Executive Forum at the end of October on the Internet and the Electronics Supply Chain.

"By providing a web interface for buyers and sellers, e-marketplaces can provide tremendous improvements in supply chain efficiencies," said George Gordon, CEO of FastParts.com.

"Neutral models like FastParts.com, that encourage collaboration throughout the entire supply chain, will be the real winners. Our goal is to help purchasing and material management professionals reduce costs and increase productivity by enabling them to quickly and easily locate electronic inventory and negotiate a fair market price directly online."

The FastParts.com at <www.fastparts.com> e-marketplace is a neutral and anonymous trading environment that guarantees payment to the seller and provides a one-year warranty on electronic components to the buyer.

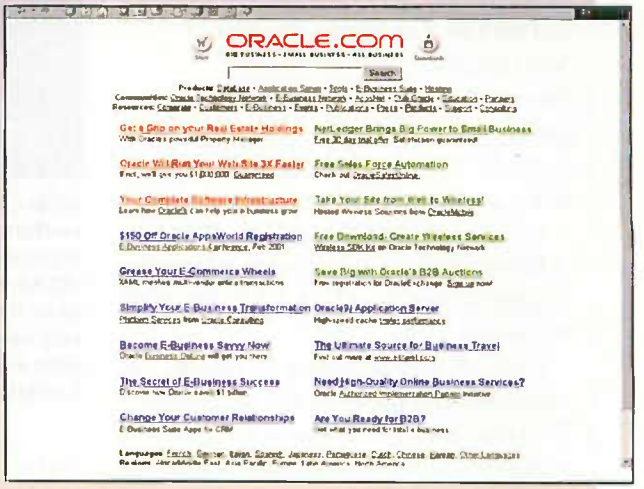
Ellison Demonstrates Features of New Initiative

Larry Ellison, CEO of Oracle, used his keynote address at Internet World Fall 2000 in the US to outline the major features of Oracle9i, the company's database and application infrastructure initiative.

Ellison derided competitors' products in what was an occasionally self-mocking infomercial, at several points observing that Microsoft's Application Centre works very fast for a very short time.

Ellison laid out Oracle9i's ambitious design goals, which include supporting a million simultaneous users, delivering a million pages per second, performing a million transactions per minute, and providing complete fault tolerance.

Oracle9i is an all-encompassing software infrastructure vision, in which 75 of the company's major products have been combined in the 2 main pieces, Oracle9i Database and Oracle9i Internet Application Server.



Ellison demonstrated several important advances in the package, including vastly improved transaction-processing speed and real-time page updates.

But the most impressive aspect of the package is the combined scalability and fault tolerance of the new 9i Application Server. Performance increases in proportion to the size of its server clusters, and as Ellison demonstrated graphically, when one component of the cluster crashes, performance decreases but applications continue to be served.

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

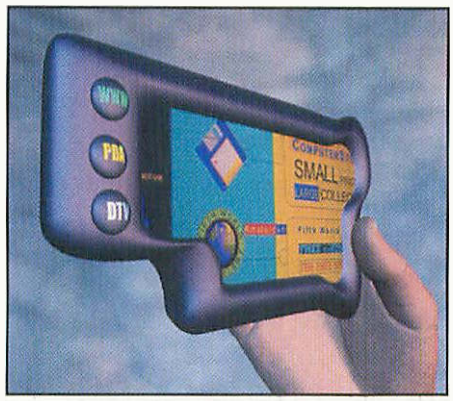
COMMENT

by Keith Brindley

There's little doubt that, at some stage, the use of flat-screen display technologies will surpass the use of good old-fashioned cathode ray tube displays. Already, in certain applications such as laptop computers, pocket televisions, mobile phones, personal digital assistants and the likes, flat-screens in the form of liquid crystal displays have become extremely popular. But for larger displays such as full-sized televisions and desktop computer monitors, CRTs remain the most widely used. It's economics of manufacture at the moment that holds back the wider use of flat-screen display technologies in the vast majority of cases, but all that will change over the coming years.

It's worth bearing in mind the current trends, which suggest that, the use of flat-screen displays will surpass that of CRTs sometime within the next couple of years, at least in terms of monetary value in the marketplace. Within 6 years estimates are that flat-screen technologies will earn twice as much as CRTs. In effect, CRT usage remains at a fairly constant level, while flat-screen display usage is increasing at a rate that doubles its market worth every 5 years.

The current problem with flat-screen displays at the moment is price. As small displays they are highly economical as they don't need the high-voltage requirements that dog the use of cathode ray tubes in small size environments, but in anything greater than the 14 inch size of laptop computers flat-screen displays currently become highly uneconomical. For example, a typical 15 inch display for use with a desktop computer is around three or four times the price of its typical CRT counterpart. The reason for this is purely a manufacturing issue — it costs a lot of money to create large flat-screen displays. Flat-screen displays represent a relatively new technology that requires significant investment and development. But over the next few years flat-screen technology, and several new



Within a relatively short time, light emitting polymer displays capable of high-resolution multimedia performance will be available. This example of a design used for a personal digital assistant is only one of many applications planned for light emitting polymers. Courtesy of Cambridge Display Technology.

display technologies will make them easier to manufacture, hence cheaper to buy.

One of the inventions that looks set to revolutionise flat-screen display technology is the light emitting polymer (LEP). Light emitting polymers are being spearheaded by the Nobel prize winning UK team that discovered the polymers, in the shape of their commercial arm — Cambridge Display Technology (CDT). Unlike flat-screen displays based on liquid crystals, light emitting polymers have one very important manufacturing advantage — the display is built on a single sheet of substrate such as glass or plastic. Liquid crystal displays, on the other hand, require a two-sheet substrate. This makes light emitting polymers comparatively easy to construct. The substrate doesn't need to be rigid, so displays can be made to fit non-flat surfaces, they can be flexible, and even built to fit specific shapes.

Construction requires the application of a thin film of polymer onto a substrate coated with a transparent oxide electrode. Consequently, an aluminium electrode is sputtered or evaporated on top of the polymer. An electric field applied to the two electrodes results in light emission from the polymer. Response times of LEP elements created this way are below the microsecond level, and intensity of light emitted is proportional to current, with low current requirements. Different polymers emit different wavelengths of light, hence by combining a patterned grid of three types of light emitting polymers, with their consequential patterned grid of electrodes, it's possible to create a coloured display that is comparatively cheap to build, yet simple to control and use.

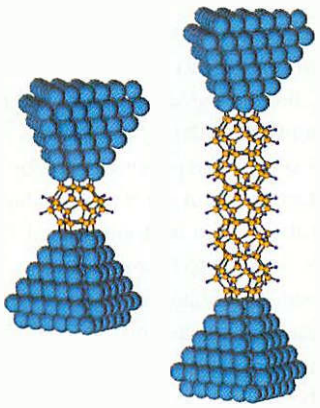
But even a smart new technology like light emitting polymers goes nowhere without the support of the big boys in the electronics world. While Cambridge Display Technology has undertaken the research and development of light emitting polymers, it is now looking to major players to cooperate with. Already Cambridge Display Technology has commercial agreements with the likes of Philips and Seiko Epson, and many more are likely to come to this UK firm with a view to licensing the technology and manufacturing their own light emitting polymer display products. Cambridge Display Technology wants to maintain the intellectual property to do with light emitting polymers, and believes that it stands a good chance of succeeding because of the work it has already done in this field.

While the technology is still in its early days, LEP displays for mobile phones are expected to reach the market next year. Within a very few years after this, laptop-sized displays are envisaged, with even larger ones than that being the eventual result. While light emitting polymers obviously have a few years to go before they catch up with other flat-screen display technologies such as liquid crystal, because of their easier manufacturing processes, catch up they undoubtedly will, and eventually it's most likely they will overtake liquid crystal and other flat-screen displays.

The opinions expressed by the author are not necessarily those of the publisher or the editor.

SILICON NANOWIRES

by Reg Miles



1. Left nanowire is 0.6nm long, and is composed of 24 silicon atoms, the right is 3nm long. Blue balls -aluminium atoms; yellow balls - silicon;. small blue - hydrogen.

At the Georgia Institute of Technology, researchers have been using an IBM SP-2 computer to simulate the assembly of silicon nanowires from clusters containing 24 atoms or etched from the bulk, to provide device designers with the theoretical information they will need to produce these nanowires just a few atoms in diameter in the not-too-distant future.

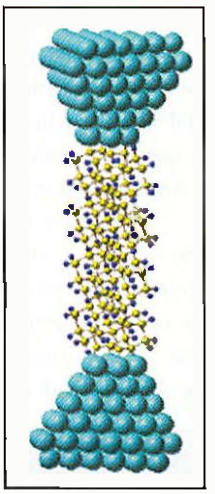
The researchers, Uzi Landman, Robert Barnett and Andrew Scherbakov, with Phaedon Avouris from the IBM T.J. Watson Research Center, cover a number of issues relating to the atomic structure, electronic properties and electrical transport in silicon nanowires that will have to be considered by designers using devices this small. According to Landman: 'It's a much-discussed expectation that devices of this size will be different, but in what ways and hy how much, remains unknown. In this study, we have explored certain unique properties of systems this small through first-principles quantum mechanical simulations. Such simulations, which are to the hest of our knowledge the largest ones to date, are essential for gaining reliable and predictive information about these systems. They were carried out by a combination of improved methods and high-powered computers.'

The impetus to increase speed while at the same time reducing energy use is pushing designers to make devices smaller with more packed onto a chip; a pressure that will eventually drive them to using features as small as one nanometre. 'When that happens, Landman noted, 'quantum mechanical effects will dominate device operation - and the expectations that have long governed device design will no longer apply.

'Avouris added: 'This work attempts to fill in some of the gaps in our knowledge in this area. While the wires, on which we report, are significantly smaller than those likely to be used in the near future, they are particularly useful because they tell us what to expect in the fully quantum mechanical limit – the ultimate miniaturization limit. The calculations have revealed a number of significant changes in important properties.

'Whether self-assembled from clusters or etched from the bulk, the silicon was passivated by attaching hydrogen atoms to unused bonds, and the wires were connected to aluminium leads.

The theoretical simulations produced data on the nanowires 'electrical conductance, the influence of the silicon-metal interface and the role that doping with aluminum atoms may play in changing materials properties. The work also suggested new ways of doping ultra-small transistor channels that could circumvent some current technological issues.



2. Silicon wire created through etching. The wire is 3 nm long and 1nm wide, attached to aluminium electrodes.

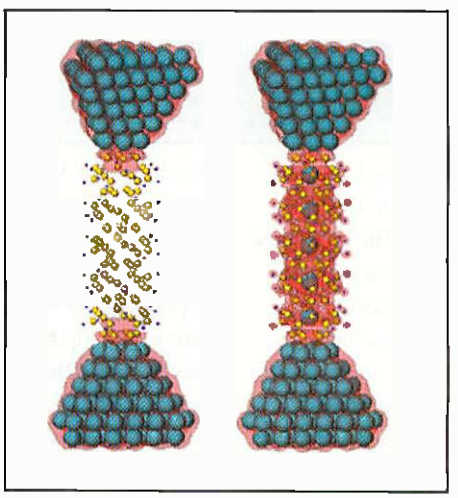
The simulations revealed that electronic states formed from a combination of orbitals from the aluminium leads and the silicon wire atoms penetrate all the way through short nanowires of 0.6nm in length, giving such silicon bridges a finite conductance. But in longer 3nm structures, these electronic states penetrate only partially into the nanowire, with the silicon retaining its semiconducting properties.

The transfer of electrons from the aluminium to the silicon at the junction between the two materials creates a localized dipole which forms a barrier to the flow of electrons. The simulations show that the height of such Schottky barriers at nanoscale metal-to-semiconductor contacts may not be too different from those found at more familiar size scales. According to Landman: 'The height of the barrier depends on the nature of bonding and atomic arrangement at the contact itself and varies for the various configurations of nanowires that we studied between being40 to 90 percent larger than the value found at the corresponding macroscale contact. This is good news because it means that device engineers won't have to apply dangerously large voltages across the barrier formed at nanoscale metal-to-silicon contacts, as some researchers had suspected.

'The simulations also suggested a way that could overcome some of the anticipated problems involved in doping the silicon used in devices this small, where the dopant concentrations could be expected to vary considerably between devices. Building nanowires from silicon clusters would achieve device consistency: the clusters form hollow cages that could be fabricated around a dopant atom.

Another problem that was revealed was that the wave-like nature of the electrons could cause interference effects in the electric conductance through the silicon nanowires when they are used as current channels. When voltage is applied to open the channel, electrons penetrating the silicon nanowire from one of the aluminium leads may bounce off the contact to the other lead and flow back toward the source contact. Upon reaching that contact, they may bounce off again, and the process may repeat itself. This behavior would result, at certain electron wavelengths and wire configurations, in interference resonances that would cause the channel to appear transparent, leading to the occurrence of spikes in the current flowing through the nanoscale channel. Landman pointed out: 'In macroscopic devices, this phenomenon is of no particular consequence, showing again that small devices are different in ways that go beyond simple scaling with size. When building a device, engineers would have to take this into account and either find ways to use it or avoid it.

'The next step is to actually fabricate and test devices this small.



3. Electronic density near the Fermi level for undoped (left) and doped (right) silicon nanowires. In both cases, the density of states iso-surfaces (depicted in red) is superimposed on the atomic structure of the nanowire. Aluminium doping atoms inside each of the silicon clusters on right. The electronic density extends through the entire doped nanowire, bridging the two connected aluminium electrodes, resulting in a low threshold bias voltage for the current flow through the doped nanowire. For the undoped nanowire (left), the density of states penetrates only a short distance into the silicon, and a relatively large bias voltage is required for current flow.

HOME NETWORKS

Consumer electronics goods will soon be sold with built-in networking systems. Reg Miles investigates the different methods of sending Audio, Video and Data around the home.

The time of buying consumer electronics product and just plugging it into the mains, with possibly a connection to a central device - such as a TV or amplifier, is coming to an end. Digital products in the near future will be designed to operate as part of a home network. And will not give of their best, nor be cost-effective, when used independently.

Of course, networks are not an entirely new thing in consumer electronics products; there are a number of basic systems that have been available for some time. The Philips originated Easy Link system is one such embryonic network that has also been adopted by other companies under a variety of names. With it a VCR can communicate with a TV so that channel settings can be shared; and functions can be initiated by pressing a single button.

There are also some basic networks to facilitate the editing of camcorder footage. However these synchro-edit systems have tended to be proprietary ones, with little compatibility between makes. The basic idea is that the camcorder is linked via a special lead to a VCR (or two camcorders or two VCRs are linked). The source machine containing the original tape is controlled by the edit recorder to which the original material is dubbed - with the results viewed on a monitor (or, more likely, a TV). This allows greater accuracy. It has also brought a degree of automation to the editing process, through the additional facility of programmable edit in and out points. Digital camcorders, such as JVC's GR-DVX8 (see Figure 1), can now be connected to a computer for editing.

A lot of proprietary systems exist in the more ambitious home networks, too. These having been developed by companies that specialise in home automation. But comprehensive networks have tended to be expensive. While affordable ones have concentrated on applications such as remotely controlling lights and curtains, which most people think of as trivial or, if used in conjunction with some form of home security system, unnecessary - most do not even have a basic alarm system.

More generally appealing are those systems that extend the application of AV components beyond the living room, without sacrificing remote control. Thus a videotape playing on a VCR in the living room can be watched in the bedroom and the supplied remote control will still operate it. Its signals are picked up by a receiver and there converted to a form of signal that is appropriate for the network - wired or wireless, sent to a transmitter that reverses the process and passed on to the AV components.

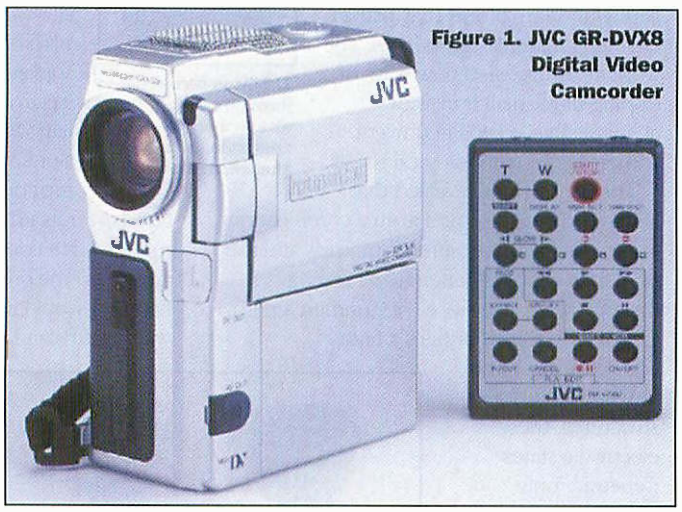


Figure 1. JVC GR-DVX8 Digital Video Camcorder

Figure 2. Sharp and Sony OP i.Link mini connectors

However, TVs, VCRs, CD players, etc are designed to be individual products, or at best part of a self-contained component system, not part of a network. The more expensive systems may use customised components to provide a degree of interaction with each other so that each at least knows that the other components exist and whether they are active or not. But this is still primitive beside the ambitions of those who are providing the impetus: their goal is to make each component an extension of all the other components. Thus, when you buy a product and plug it in it will communicate with the existing network and set itself up accordingly, taking into account the existing user preferences and configuring itself to share the resources depending on the size and scope of the local area network (LAN).

This is what the present efforts by manufacturers and standards organisations are all about. If an In-Home Digital Network (IHDN) is going to be a practical proposition, enabling more products to be sold, those products must be capable of communicating straight out of the box, and must be available at prices that enable mass production to be feasible. The use of embedded electronics is the key to providing the necessary complexity at an acceptable price. And to hiding that complexity behind a simple interface. For the network will have to be operated by people who cannot program the timer of a VCR as well as by those who can. Despite a limited memory it must react quickly and reliably to their commands. Then, when something does go wrong, it should be capable of sufficient self-diagnosis to at least indicate the probable cause and either provide the information necessary to overcome it or inform the user to call for expert help. And, of course, it must be capable of managing itself at all times.

An IHDN will basically consist of three layers: a networking layer that provides the interconnections; a middleware layer that enables the interoperation; and an applications layer which is the features that will sell the concept to the consumers. The interconnections can be either wired or wireless, or a combination thereof. The middleware layer is mostly a software one, equivalent to an operating system, but distributed over the whole of the network. Its role is to control the functioning of individual components in relation to the requirements of the network, to allocate bandwidth according to the application, to configure the network for its optimum performance with the range and type of

components that constitute it, and to set up communication protocols. It should also be capable of handling factors that are independent of the components, such as user preferences, and distributing them to the relevant components - all the TV sets in the home being provided with the same channel preferences, for example. Which leads neatly to the applications layer, where such user conveniences are incorporated to initially tempt the consumer to buy the products and then to keep them happy while they are using them.

Wired for Sound and Vision

A dedicated wired network is probably the most efficient one in terms of the bandwidth that can be handled - depending on the original design criteria, of course. Particularly when compared to wireless networks, where achieving bandwidth is difficult in the much-used radio frequency spectrum. The dedicated wired network is also the less likely to suffer from interference - depending on the type of cable being used. With optical fibres the possibility of interference is negligible. However, anyone who has connected up a home cinema or hi-fi system will be aware of the disadvantages: it takes time and, unless measures are taken to hide the cables, looks unsightly when it is finished. Translate that to every room in the home and between all the rooms and the attraction of dedicated wiring begins to wear off. The alternative to installing dedicated wiring is to make use of existing wiring - for the phone or AC mains. One obvious disadvantage of using the phone wiring as a basis for a network is that in most homes it would not provide a complete network because it is limited to just a couple of rooms. Also a growing number of people prefer the conventional phone network in favour of a single point with a cordless phone or a mobile solution). Another disadvantage is that it is not particularly resistant to interference - particularly when it is a party line. It also has a limited bandwidth. And any system must take into account changes to the network that result from a phone being answered, a fax being received or an answering machine recording a message. The alternative of using the AC mains wiring does have the advantage of providing a comprehensive network in most homes. However, it too can suffer interference, in this case from household appliances drawing from the mains supply.

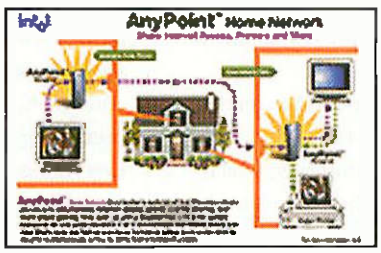


Figure 3. Intel AnyPoint home network

The Wireless Approach

Wireless networks have the obvious advantage of being simple to set up. And of allowing items of equipment to be put exactly where they are wanted without the worry of how to get signals to and from them. There are two possible wireless approaches: infrared and radio frequency.

A lot of equipment does already rely on infrared transmission for carrying signals - rear speakers in a home cinema set up, for example. However, infrared does have the very obvious limitation in what is meant to be a home-wide network of being restricted to individual rooms. Although, as already mentioned, its signals can be passed on via another medium. Its bandwidth is comparatively limited for a practical home system at present. It is also susceptible to interference from ambient light and lighting flicker. However, that and the bandwidth are constantly being improved.


Figure 4. COMPAQ iPaq connection point

RF also suffers from interference from other radio sources that are growing in number - particularly the unlicensed LANs. Microwave ovens are another potential source of interference, although systems should be designed to account for their use in the home. The home environment itself will also affect the signals, with walls, metal, and the people themselves interacting with the transmissions. However, the performance of the low power signals is usually improved by the use of spread spectrum technology. This is a wideband technique, originally developed for military use, that spreads the signal over a range of frequencies in a psuedo-random manner to minimise interference and noise - the receiver being adapted to correlate the deviations to reconstruct the original signal. The two most commonly used variations on this are frequency hopping spread spectrum (FHSS) and direct sequence spread spectrum (DSSS). The former uses a narrowband carrier that, as the name implies, rapidly and psuedo-randomly changes frequency; the receiver keeping up with those changes by itself hopping in synchronisation through the use of a matching psuedo-random number generator which makes it appear to be a single channel. The latter generates a redundant bit pattern for each bit to be transmitted; this is called a chip code, and the longer it is the greater the likelihood of the original bit being recovered. The use of these techniques is also an aid to security, making the signal appear as noise to an unauthorised receiver.

Safety is an additional concern for a wireless network, given the publicity that has recently been attracted by the possible danger from electromagnetic radiation when using mobile phones. However, wireless networks operate at a lower power than mobile phones because of their limited range: and the transmitter is unlikely to be in close proximity to the head. Additionally, wireless LAN products tend to operate in bursts rather than transmitting and receiving constantly.

An RF network is composed of products that each incorporates a transceiver. However, as this obviously adds to the cost of the product, which would have to be reluctantly shared by those consumers who did not want a network, at least in the early days the transceiver would presumably be offered as an optional slot-in module. Two arrangements are possible: an independent WLAN with all the products communicating one with another solely through RF; and an infrastructure WLAN in which an RF access point in each room is linked to a wired network (most existing wireless networks use this hybrid system).

However, its greater cost will probably make the wired approach more popular in the early days of home networks. And the standard that seems to be the most likely contender for the role is IEEE1394 (pronounced I-triple-E). This was originally developed by Apple under the name of FireWire, and made into a standard by the Institute of Electrical and Electronics Engineers in the USA. This has subsequently been given the alternative name of i.Link by Sony (which seems to have become the accepted name for it when used with

consumer electronics products). It is both a PC interconnect and a consumer electronics digital interconnect for home entertainment.

The basic version, 1394a (improving on, but retaining compatibility with the original 1394-1995 specifications), provides for a maximum cable length of 4.5m, 64 nodes per bus (on 15 links), and transmission speeds of 100, 200 and 400Mb/s, with full plug and play capability. A further upgraded version, 1394b, offers an extended distance of 100 metres and transmission speeds of 400, 800, 1600 and 3200Mbs (the last two requiring glass fibre interconnects). NEC has developed the world's first prototype switch LSI for these home networks. This provides hardware routing of data traffic, and comes with a firmware library enabling automatic network configuration, and enhanced data transfer rates for early IEEE1394 devices. The firmware also provides for the use of wireless media for IEEE1394 in the 2.4 and 5GHz bands, and use of the LSI as a relay for IEEE1394 optical fibres of around 1km. Sharp and Sony have coincidentally announced the basic specifications for the use of plastic optical fibres based on the 1394a-2000 communications protocol. They have named it OP i.Link, and hope to have it accepted as a standard. The optical fibre is a step index type, employing a 650nm semiconductor laser, with a transmission distance of up to 10m, and having miniature connectors (see Figure 2).

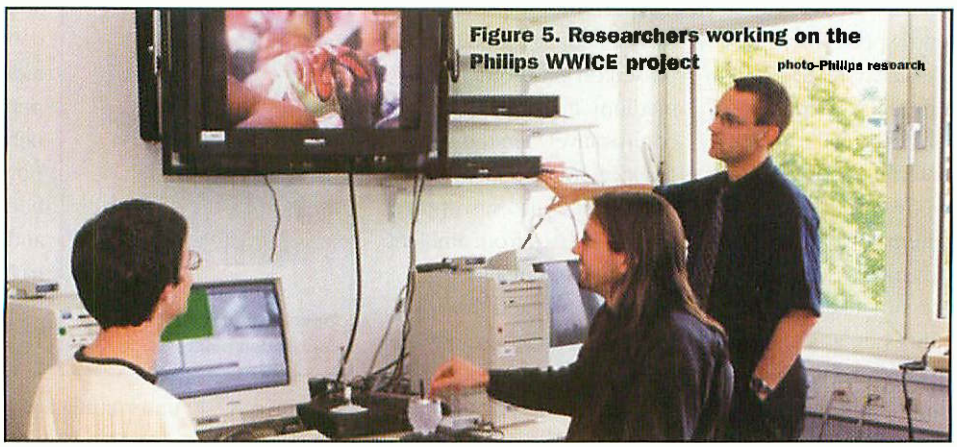


Figure 5. Researchers working on the Philips WWICE project photo-Philips research

Network through the phone line

When it comes to using existing wiring in the home, the phone network is leading the way: at least in the USA where homes tend to have more phone sockets than in Europe. The Leapfrog Home Network allows stereo audio and colour video to be viewed up to 500 feet away from the source. It achieves this without interfering with voice and data signals by transmitting at the comparatively low frequency of 30MHz through the phone line. It also integrates a remote control extender to enable existing remote controls to operate AV equipment from other rooms. In operation the source is connected to a transmitter by normal cables and the transmitter is connected to the phone socket; at the other end a lead from the phone socket goes to a receiver and normal cables run from that to the TV and/or speakers. However, it is an analogue system, so the bandwidth is of more manageable proportions than a digital system.

Such a system is that devised by the Home Phoneline Networking Alliance (HomePNA). Their recently proposed second generation technology increases the available bandwidth from the first generation 1Mb/s to 10Mb/s; but this is still only sufficient for computer, including Internet, uses, not broadband. The slow version has been certified for use in 19 European countries, including the UK. The system is based on Ethernet, but with a special header designed for the more rigorous phone line environment. The use of frequency division multiplexing (FDM) enables the HomePNA signals to coexist with both voice and data signals - and its power is lower. A time modulation line coding method, developed by Tut Systems (a member of HomePNA), provides dynamic correction for variations in the conditions of the phone line.

Another member of HomePNA is Intel, who has introduced the 21145 Phoneline/Ethernet LAN Controller, which uses Ethernet to connect the devices to the phone network. The company has also introduced the AnyPoint Home Network, which is simple to set up and enables people with multiple PCs to share peripherals and Internet access over phone lines (see Figure 3).

Mains Wiring

Regarding the use of AC mains wiring, and the various standards - CEBus, Lonworks, Powerline and X10, its low bandwidth of under 2Mb/s restricts it largely to an automation network, controlling lighting, appliances and security. Although work is in progress to upgrade its potential and broaden its range. The standards each provide a communications protocol between transmitters and receivers over the AC mains. Transmitters and receivers can generally be plugged into standard sockets, although some must be hardwired. In operation the user, or a timer, or some event, depending on the application causes the transmitter to send a command to a receiver to perform a function - such as dimming a light. In order to ensure that it is the correct light the receiver's ID is sent before the command.

Infrared Systems

Moving on to wireless, more particularly, infrared. This spans the automation and data/audio networks in its transmission speeds. In the specifications of the Infrared Data Association (IrDA), which have become familiar through incorporation into computers and peripherals, these range from 9600-115200b/s for Serial IR (SIR), and from 1-4Mb/s for Fast IR (FIR) compatible high speed extensions. 16Mb/s is in the offing, and 50Mb/s is theoretically possible. There are two types of infrared systems - directed (line of sight) and diffuse. IrDA is of the former type, and is thus a one-to-one link. That and its generally limited range of about 1 metre makes it more of a personal area network (PAN) than a LAN. Devices with a greater range are available, and development continues to push it up to 10 metres and more; however, there is still only limited scope for achieving a LAN. Diffuse infrared, conversely, makes an ideal LAN, with everything bathed in infrared from everything else - at least within a room. RF networks are generally not directional (although the use of antenna arrays to create a directional beam does allow a greater transmission speed with less power). But their range does place them into either the PAN or LAN categories, albeit with some overlap. And their transmission speeds place them into either the data/audio or home entertainment networks.

Bluetooth Networks

Bluetooth, named after a 10th Century Viking king by Ericsson who began its development, was conceived as a short range, low power PAN for roles like communicating between headsets and mobile phones. However, it can manage up to 10 metres, and ten times that if the antenna power is increased from 0dBm to 20dBm. Its maximum transmission rate is 1Mb/s. As with a number of these low power systems it uses the unlicensed 2.4GHz band -

Figure 6. Philips 'HyperTel' concept
photo-Philips research

one of the bands originally reserved for industrial, scientific and medical uses (ISM). The Institute of Electrical and Electronics Engineers intends to convert Bluetooth into an IEEE standard. This IEEE802.15 will include a low rate version (2-200kb/s) and a high rate version (20Mb/s) to extend its range of applications. Their IEEE802.11 standard has a transmission speed of 2Mb/s, and up to 20Mb/s for IEEE802b - both in the 2.4GHz band. This has more power and a greater range than Bluetooth, and is thus a true LAN. Interestingly, another standard, HomeRF, was developed from this and the Digital Enhanced Cordless Telephone (DECT). It too uses the 2.4GHz band; and has a range of 50 metres. Until late summer 2000 it operated with transmission speeds of 1 and 2Mb/s; but then the Federal Communications Commission allowed an increase to 10Mb/s. Compaq's access point, iPAQ Connection Point, makes use of HomeRF (see Figure 4). It also accepts HomePNA and Ethernet; and will act as a bridge to provide any combination of the three. Incidentally, the Intel AnyPoint Home Network is also available as a wireless version using HomeRF (both they and Compaq are members).

Higher Band Networks

Higher up the frequency band, at 5GHz, which has been allocated to wireless LANs worldwide, two systems are preparing to compete head to head: the high band IEEE802.11a and the European High Performance Radio LAN (HiperLAN/2), both operating in the 5GHz band. Incidentally, HiperLAN/1 also operates in the 5GHz band, but it has a transmission speed of about 20Mb/s, whereas HiperLAN/2 (and IEEE802.11) can operate at up to 54Mb/s and so are suitable for home entertainment. HiperLAN is being developed by the European Telecommunications Standards Institute (ETSI) under the name of Broadband Radio Access Networks (BRAN), and it has become known as ETSI/BRAN HiperLAN/2. Both have a range of over 30 metres indoors and five times that distance when unobstructed. The HiperLAN/2 standard is the more advanced, as it is still being developed; but the performance of the two is very similar.

Of the middleware layer in the network there are four contenders: Jini from Sun Microsystems, Universal Plug 'n' Play (UPnP) from Microsoft, the computer industry's initiative Home API (HAPI), and Home Audio Video interoperability (HAVi). This is a consortium of originally eight consumer electronics companies: Grundig, Hitachi, Matsushita (Panasonic), Philips, Sharp, Sony, Thomson and Toshiba. This last is the only one of the four that has been designed for the specific requirements of a home AV network. After a slow start, when only the original members seemed to have any interest in it, the ranks are now swelling.

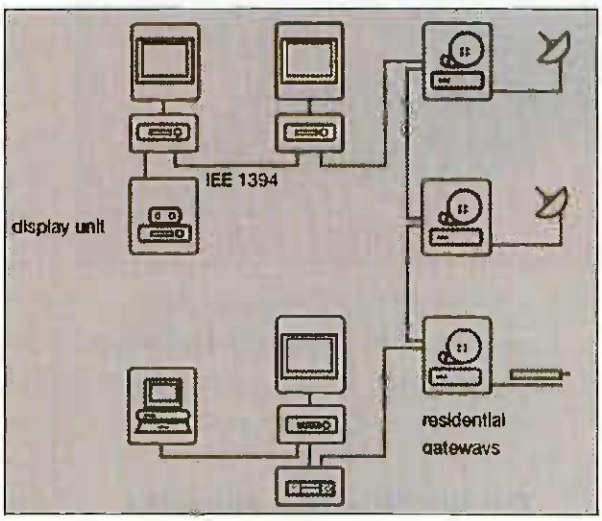


Figure 7. COMMEND project demonstrator

Although the emphasis is on audio and video entertainment products, HAVi can be implemented on any platform from embedded environments to PC systems. Unlike the others it has no central control through which all the devices communicate, because there is no logical centre - the components are used as and when required. The components themselves can play the role of a central control. This is also a feature of HiperLAN/2. Jini puts greater emphasis on computers and peripherals; and is based on IP protocols. However, a HAVi-Jini bridge now exists to allow their cooperation. UPnP is intended to simplify the interconnection of PCs, appliances, networks and services by extending Plug and Play. And relies on Windows APIs. HAPI is a development of that which has the aim of controlling all aspects of the home, covering AV, computers, home appliances, security, etc. In both cases, bridges are anticipated.

As you would expect there are a number of projects related to home networking: either company or European initiatives. In the former case there is the Philips Window on the World of Information, Communication and Entertainment (WWICE) - see Figure 5, that I covered in issue 156. While Figure 6 shows the Philips 'Hyper Tel' concept, that allows the flexible introduction of a number of interactive narrowband and broadband services into networks of different origins, such as cable, telephony or wireless networks. The bandwidth is shared dynamically and quality of service can be managed. The system consists of a reprogrammable hardware and software architecture, and allows operation under all evolving standards.

The Configurable Multimedia Terminal Device Technology (KoMEt) is a Grundig project funded by the German Ministry of Economic Affairs. The focus here is on the architecture and characteristics of in-house wireless AV networks. Besides the standardisation issue between IEEE802.11a and HiperLAN/2, Grundig is interested in the channel characteristics and therefore the RF part of the networks. The project will investigate and implement an RF-modem working in the 5-6GHz range, base band processing that enables transmission of MPEG-2 in those bands, and a service access to a broadband AV-service.

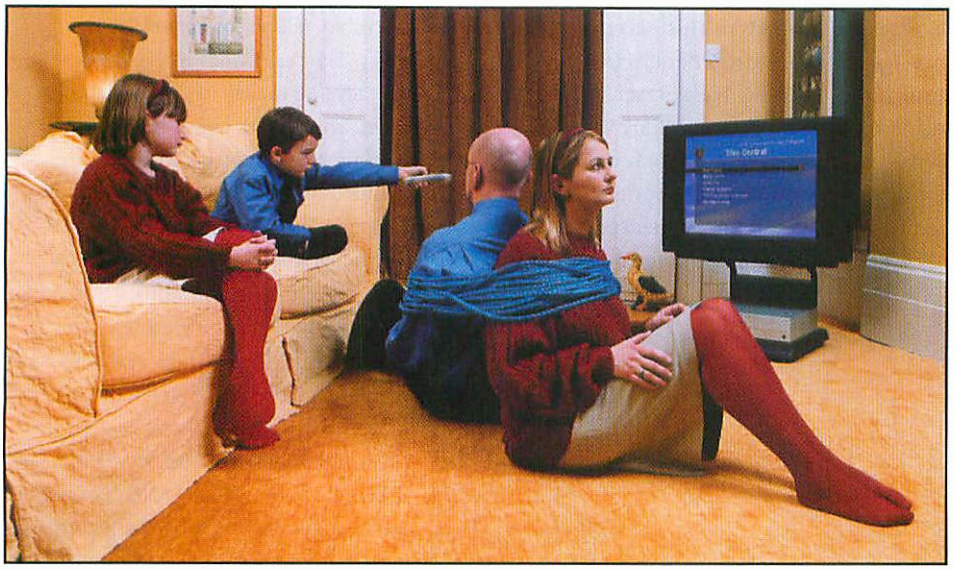
Lastly, Consumer Multimedia Networks in Digital (COMMEND). This has just finished; but had the aim of simplifying the exchange of information between devices, anywhere in the home, and of creating European proposals for standards, including contributing to the HAVi and HiperLAN/2 specifications. There were four companies involved: Grundig, Philips, Sony and Thomson. And they investigated both wired and wireless options from low to high bit rates. Showing the results as demonstrators at exhibitions (see Figure 7 for one example).

Having AV products networked seems quite natural; but I imagine that the ultimate goal of having everything in the home networked will take some getting used to.

PERSONAL VIDEO RECORDERS

A New Way to Watch TV

New digital interactive systems are about to enter our homes via what we call TV. Will the technology change the way we watch television and what we watch or will the TV companies change it for us?



This Autumn, TiVo Inc., a NASDAQ listed company, in association with British Sky Broadcasting, are launching a new way of watching TV and it could change the way British viewers initially watch television. This service amounts to giving you your own Personal Television Recorder or PTR with effectively your own TV schedules.

Available in the UK from October 2000, this new service gives viewers control over what they watch and when they watch it, regardless of when programmes are scheduled.

For the first time, British viewers will be able to pause, rewind and playback in slow-motion live television. Recording programmes will still be at the usual touch of a button but with no more setting clocks or searching for that videotape.

The set top box will have a hard disk recording system similar to the hard drive in your computer and this will be able to store up to 40 hours of programming.

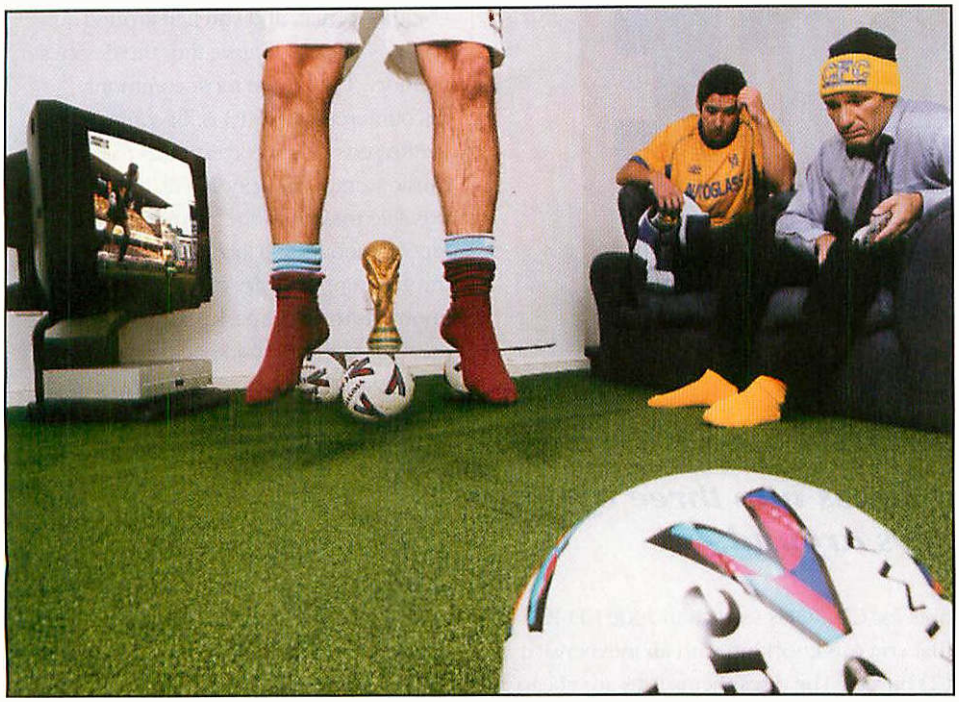
Do we like the adverts as much as the programmes?

Market research has been carried out in the US with users of PTR's or Personal Television Recorders and the majority of viewers reported 'fast forwarding the ads'. This is not good news for the advertiser nor the TV company whose revenue as we know comes from selling ad space. More controversially there will be a manual override to cut out the advertising. This may be convenient for the viewer but could be disastrous for the TV companies who might otherwise rely on advertising revenue.

Isn't data a wondrous and valuable thing?

Marketing Gurus are keen to get their hands on personalised data. They would love to know more about you and your lifestyle and hence target you with advertising that is sympathetic to your lifestyle. Up until now, national commercial television advertising has been very much of a hit and miss approach. The advertisers only know general trends about the sort of people that might be watching at certain times. Now, because of the launch by TIVO inc. this box will actually monitor the types of programme you watch and when you watch them. It can then relay the information back to base. This is called information backhaul. This information can then be sold to broadcasters. It is understood that at present all detailed information on programme viewing would only go to the broadcaster originating the programme. More general information should be available to anyone who wants to pay for it. This individual data for the advertiser could open up several routes to targeting the punter. However the viewer that receives personal adverts is just too organisationally remote as yet.

There is a facility in the new box to programme viewing preferences and recording habits. The system will then automatically



suggest or record programmes it thinks the viewer would like to watch.

There is a Season Pass, so called by TiVo, that automatically records every episode of a series. This useful feature should stop frantic tape searching at the last minute and possibly losing the front end of programmes due to that 'dodgy' internal clock.

Manufactured by consumer electronics manufacturer Thomson, under the Thomson SCENIUM brand, the TiVo Recorder should work in almost all UK homes, no matter how they receive their television. TiVo is compatible with analogue and digital terrestrial, digital satellite and analogue cable services. Digital cable compatibility will be available soon.

Pause Live TV

Here's an interesting bonus for the serious TV viewer or addict who gets agitated by potential visitors at the front door or having to answer the phone during an important programme, the TiVo system can pause live television for up to 30 minutes in order to answer the phone or the door. When they return they can pick up the programme exactly where they left off. There is full VCR functionality on all recorded programmes. You can fast forward and rewind up to sixty times the speed of the normal broadcast.

Another aspect is that you can 'rewind' live programmes. Football fans will not have to rely on the traditional TV station to provide action replays to get a second look at that suspect goal.

Recording without Videotapes

The days of hunting around for blank videotapes to record programmes at the last minute should be consigned to the history books as TiVo digitally records up to 40 hours of programmes on to a built in hard drive.

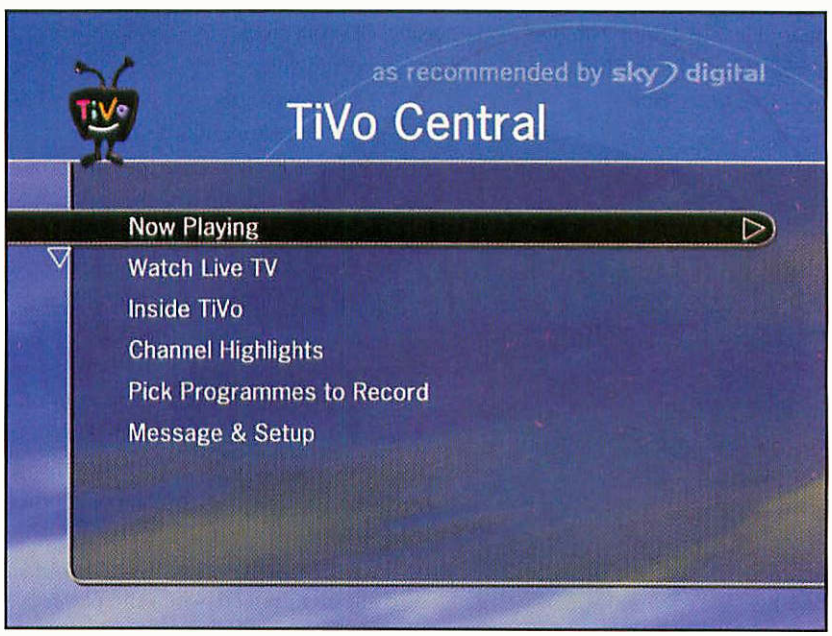
The 'likes and dislikes' button

Your own viewing preferences can be programmed in to the system. Your likes and dislikes are entered via the 'thumbs up or down' buttons. Knowing this the system then makes suggestions to you as to what you might like to watch. This element could become a more contentious issue in the future as so called paternalistic guidance from the TV companies could be driven in all sorts of directions! Thus, there is always a great tendency to drive programming along the populist route and so reducing minority programmes. Useful feedback could be obtained from the viewer by asking them to suggest what they would like to view. Do bear in mind though, the more buttons you press, the more the TV company knows about you.

On Screen Programme Guide

The 'On Screen' Programme Guide allows viewers to locate programmes by name, channel, date and time. This feature will give analogue terrestrial and analogue cable viewers their first experience of a true interactive programme guide.

Those who subscribe will receive a daily listings update via their phone line. The company supplies an adapter for use on a normal phone line.



And the Cost?

The TiVo Recorder will cost around £399 from BSkyB from the launch and Subscription will he available in two forms: Lifetime Subscription for the TiVo Recorder for a one-off payment of £199, or alternatively Ongoing Subscription for £10 per month

For further information and pictures please contact <www.tivo.com>

THREE of a Kind

Martin Pipe plugs his headphones into three of the newest MP3 players around.

In this article, we'll examine - inside and out - three of the latest personal MP3 players on the market. The first is the inexpensive Smart MP3 CD-ROM/CD player that I raved about in last month's (Live 2000) Technology Watch. The second is the latest Rio600 personal player from one of the most established manufacturers in this rather new business - SonicBlue (neé Diamond Multimedia). Our final player is the HipZip from Iomega, a company that's better known for its removable media products. Things have moved considerably since we reviewed Diamond's original Rio PMP300 last year, and compared it with a Sony Minidisc Walkman. The PMP300, and the other players around at that time (Pine, Saehan, MPress, etc) employed expensive flash memory to store music. Since last year, the prices of the various designs of flash memory card (Smartmedia, MMC, CompactFlash) have not dropped significantly. A 32MB CompactFlash card, for instance, will set you back around £80 even now! Fine if you happen to also have a digital camera and can justify the money some other way. If you don't, you had better enjoy your music a helluva lot to justify that kind of money - which alone will buy you a decent personal CD player!

Smart MP3 Player

Hence this article; the three players reviewed here make provision for some kind of cost-effective media alternative. Smart opts for CD-ROMs - which include CD-Rs that you can knock up with an inexpensive CD burner. The discs themselves are cheap these days, even branded CD-R media (TDK, for instance) selling for 50p each when bought in lots of 10. The 650MB capacity of a CD-ROM can comfortably accommodate over 100 typical MP3 files. And - unlike other MP3 players - the Smart is also compatible with your 'legacy' CD collection! Iomega, meanwhile, plumps for its miniature 40MB Clik! (or PocketZip as they are now) discs, which sell for around £10 each. The HipZip is also capable of being used as a backup device, insofar as files (whether music or data of another type) can be transferred to or from your computer. Indeed, when the player is connected to your PC, the HipZip is given a drive letter. 40MB is not a huge capacity for back-up purposes, but the feature will still be useful if you have some other product that uses the same PocketZip media (digital camera, for instance).

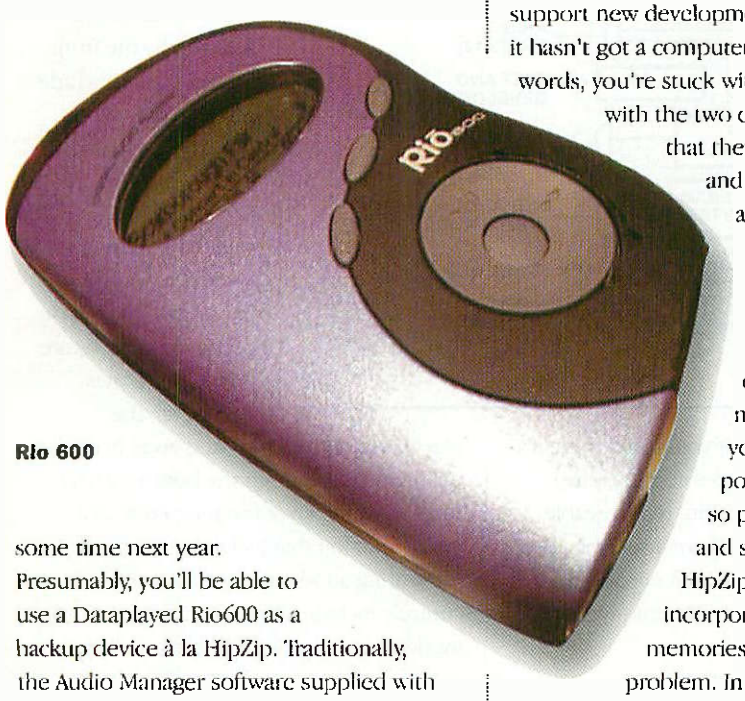
Sonic Blue's approach is a hybrid one. The Rio600 has 32MB of memory built-in, but this can go quite far because the player supports the super-efficient WMA (Windows Media Architecture) codec - which is capable of achieving passable results at 64Kb/sec. Use this format, and you'll fit around 70 minutes of stereo music into the device's memory. The bitrate most commonly encountered with MP3 is, of course 128Kb/sec - which corresponds to half the music storage capacity. It will, however, be possible to expand the memory of the Rio600 (and its 800 'bigger brother') through a proprietary expansion architecture known as the 'backpack'. SonicBlue has great plans for the backpack, which is essentially a replacement rear cover (it also accommodates the battery compartment). The first backpacks will include 32MB (£90) or 64MB (approx. £130) of flash memory, giving aggregate capacities of 64MB and 96MB respectively. Next year, Sonic Blue will be launching a backpack based around IBM's innovative Microdrive - which is essentially a microminiature hard disk drive. 170MB, 340MB and 512MB versions of the drive are currently available from IBM, and a 1GB model has just been announced. The drives that IBM sells through its normal channels

IOMEGA HipZip

take the form of pluggable Type II CompactFlash cards. Unfortunately, Sonic Blue will be sealing the Microdrive into the backpack. As a result, you won't easily be able to upgrade the drive to a newer one of higher capacity, or plug in any CompactFlash memory cards (which are electrically-compatible and have the same form factor). Sonic Blue is aware of this limitation, and told us that it would be prepared to react to customer demand.

Of greater interest than even the Microdrive is the DataPlay - a tiny (it's the same size as an American quarter-dollar) removable disk with a claimed capacity of 500MB. Best of all, the disks - which resemble ultra-Minidiscs - will sell for between $5 and $10 each, according to its inventor's website (www.dataplay.com). Sonic Blue is working with Dataplay to produce a compatible backpack. This version, like the others, will incorporate a

rechargeable battery pack - a mains unit/charger is supplied. Although DataPlay peripherals - of one kind or another - should start appearing by the spring, Sonic Blue couldn't give a release date for its Rio backpack. The company does say, however, that a 340MB Microdrive version will, however, start shipping some time next year. Presumably, you'll be able to use a Dataplayed Rio600 as a backup device à la HipZip. Traditionally, the Audio Manager software supplied with Rio products will let you upload to the player, but not transfer files back into the PC (presumably for copyright reasons).



Rio 600

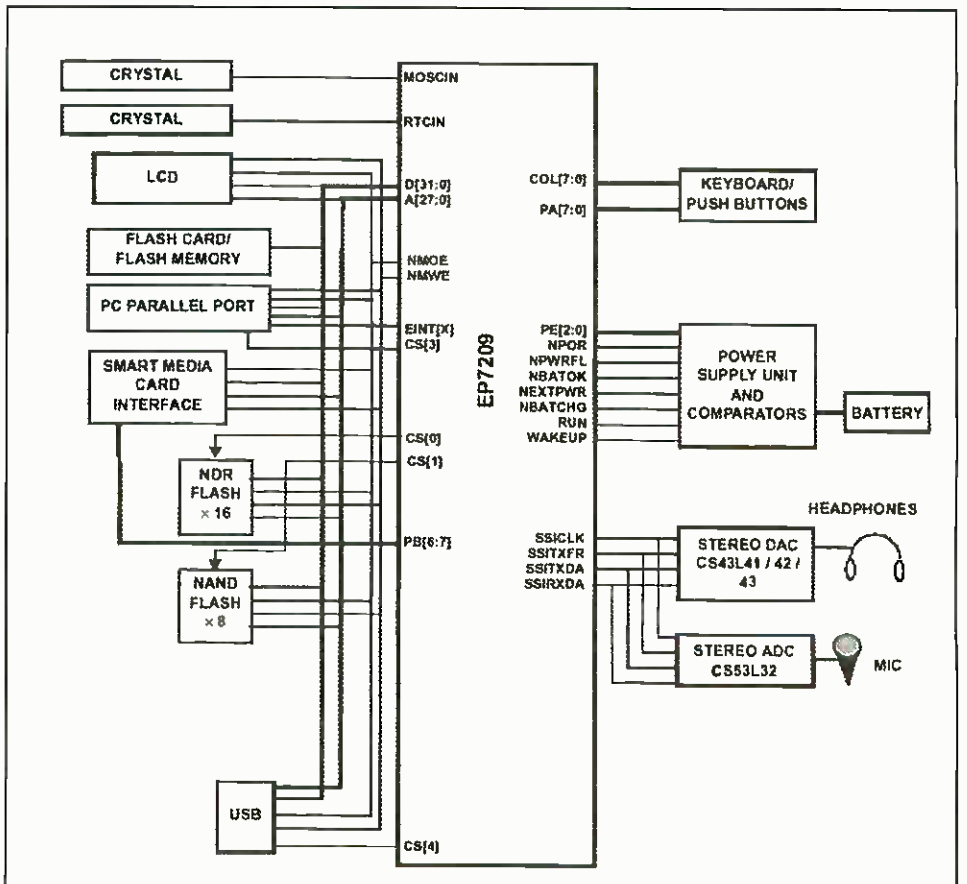
However, third parties have written applications to get around this restriction. Software for legacy Rio products (the PMP300 and 500) can be downloaded from Riosource (`www.riosource.com`). We reckon that the Rio600 will be supported soon. Just as well, because 500MB is a rather more practical amount of capacity than the HipZip's 40. Sonic Blue realises this, and plan to introduce full digital rights management (DRM) in a future Rio600 firmware upgrade. Accompanying this would be a modified version of the Audio Manager software. The player would look at a file's embedded 'certificate', which describes - amongst other parameters - its copyright status. Although you wouldn't be able to transfer copyrighted music files back to a PC from the player, the same wouldn't apply to non-music data files of your own creation. Sonic Blue has a provisional version of DRM waiting in the wings, but hasn't enabled it because file transfer over USB is made considerably slower (25 seconds against 5 seconds for the average track) because of all the validity-checking that's going on. DRM is very much in its infancy at the moment.

Note that the Iomega HipZip employs the same Cirrus Maverick chipset as the Rio600. This chip relies on external flash memory to store the application code (which includes the MPEG codecs). Players based around the Maverick can thus be upgraded to support DRM and new codec technologies - for as long, of course, as the manufacturers continue to support the product! The codec built into the Smart player is mask-programmed, and cannot be upgraded to support new developments (but then again, it hasn't got a computer interface!). In other words, you're stuck with MP3! The problem with the two disk-based players is that they're prone to shocks and the like, causing audible skipping and drop-outs. In this respect, they can't hope to compare with the more expensive solid-state memories. Why do you think MP3 portables have proved so popular with joggers and skiers? That said, the HipZip and Smart players incorporate anti-shock buffer memories to reduce the problem. In use, we found that the HipZip's was the more effective of the two. The Rio600 suffers from no skipping whatsoever, regardless of how vigorously it is shaken, thanks to its reliance on memory.

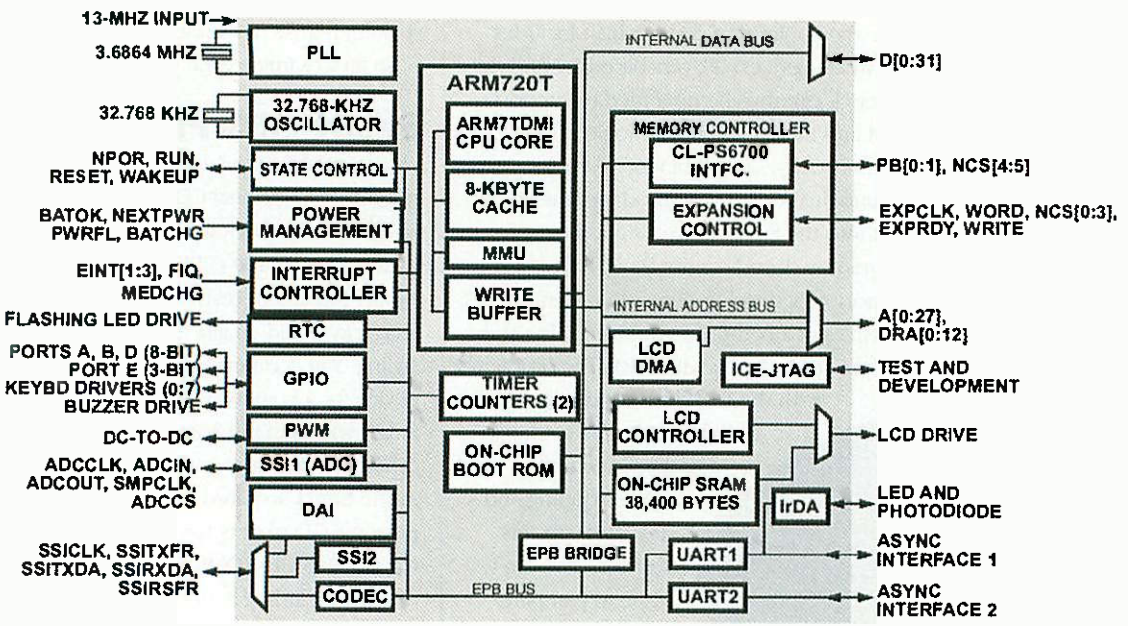
So let's examine each player in turn:

Smart MP3 Player, £130

I bought this personal device, which resembles a personal CD player, at the Live2000 event back in September. Its special show price of £100 (£130 normally) was simply too low to resist - despite the 'plasticky' build quality and extremely tacky styling. You certainly won't mistake this device for a Sony Discman, although the Smart will - like the Sony, and unlike the other two MP3 players - also play audio CDs. At the time I acquired the device, no other personal CD players have the Smart's ability to play MP3 CD-ROMs. As I write this article, others - including a model from Pine - are on the way. It's certainly a neat concept, particularly for business travellers and holidaymakers. After all, ten average-sized albums, converted into MP3 format, will easily fit onto a single CD-R. As a result, you can be accompanied by your favourite music, yet still travel light. But then again, the device is - on account of its reliance on CD media - considerably larger than the average MP3 personal, and is perhaps not the best choice for sports enthusiasts and joggers. The Smart is also compatible with CD-RW media, although the manual doesn't mention the fact. Note that the laser has to



Maverick implementation block diagram



Maverick functional block diagram

work harder, on account of the lower reflectivity of CD-RW media, and so there is a very slight premium in terms of battery life. Very few personal audio CD-only players, let alone hi-fi ones, can claim such prowess! The device could also be hooked up to a car audio system with line inputs, or a standard cassette player via an adaptor. For such eventualities, the Smart player is equipped with a line-out jack in addition to a regular headphone socket.

Also built in is a low-quality voice recorder/player, which takes advantage of additional functionality provided by the Samsung TL7231 MPEG decoder chip. Flick a side-mounted switch to the side, and up to 500 seconds of speech can be recorded. Your speech is written to a (volatile) 8-megabit RAM, which is normally used as a buffer during MP3 playback (8Mb is enough to buffer a 128Kb/sec stream for the specified 50 seconds). To this end, there's a mike input on the side of the unit (at a pinch, you could use the earphones), which feeds the TL7231 via an AGC preamp based around a Samsung KA2220ST IC. Unfortunately, your recording is lost if you remove power from the unit, or change to the playback mode (the RAM is reused as a buffer). But then again, I wouldn't worry about it. The sound quality is so atrocious that's it's difficult to make out what was originally said! Another somewhat lacklustre part of the design involves the power arrangement - in fact it's far from Smart. The unit is supplied with a power supply that also acts as a charger if appropriate batteries are installed. As a result, you must remember to remove any cells from the battery compartment (two AA cells power the unit, incidentally) before running the player from the mains. If you don't, there's a chance that those batteries could expire dramatically! But then again, rechargeable batteries (NiMH or NiCd) are a sensible idea. Note that no CD ripping/MP3 encoding software is supplied with the unit - you'll have to acquire your own.

The Smart's user interface is rather odd, all information being relayed to the user by means of a numeric LCD screen. Fine for time-related functions, but close to useless as far as text is concerned - hardly surprisingly, the player won't display ID3 song-information tags! Yet the Smart does attempt to display some 'text' during certain modes - and it's rather difficult to understand if (i) you're a new user and (ii) the less-than-well-written manual isn't to hand. Compare this state of affairs with the wonderful alphanumeric displays fitted to the Rio600 and HipZip! The display, in conjunction with the various keys, will allow you to select different directories, each of which could contain the MP3 files from a given album. We found that the tracks are played in the right order if the filenames are numbered. In its default playback mode, the Smart will scan through the disk and play the tracks sequentially according to their location on the CD-ROM. This is a deliberate move to minimise movement of the laser pick-up - so that the sled motor is operated less and power consumption kept as low as possible.

HipZip showing drive

Other playback modes that can be selected by the front panel buttons include random, intro and repeat. Note that the Smart's buttons aren't particularly designed or well-organised. For some reason, the most-important 'play/pause' and 'stop' buttons are the smallest ones. Worse still, the play/pause button is located away from the main group. Although the buttons aren't recessed, the player is equipped with a 'hold' function that locks out the controls, preventing accidental operation. Other controls include a button that calls up a 5-mode preset equaliser (a feature of the Samsung decoder), track forward/back buttons and a thumbwheel volume control. Note that when CDs are being played, the button is only capable of engaging a simple 'bass-boost' function. As regards MP3 playback, the manual warns you to avoid any files that exceed a data rate of '196kb/sec'.

Interestingly, the TL7231 datasheet states that data rates up to 320Kb/sec are supported. The limitations described in the manual cannot be attributed to the mechanism either - even a single-speed mechanism is capable of delivering a transfer rate of 150 kilobytes per second, which is far in excess of the rates associated with even the highest-quality MP3s. In our tests, we had no problems with variable bit-rate (VBR) files, the peak data rates of which significantly exceeded 196Kb/sec. Some of the files on our test discs were encoded at 256Kb/sec, and posed no problem to our particular sample of the Smart. However, our Live 2000 photographer, who also bought a unit, did have problems with his unit. Maybe I was just lucky - but such variations between

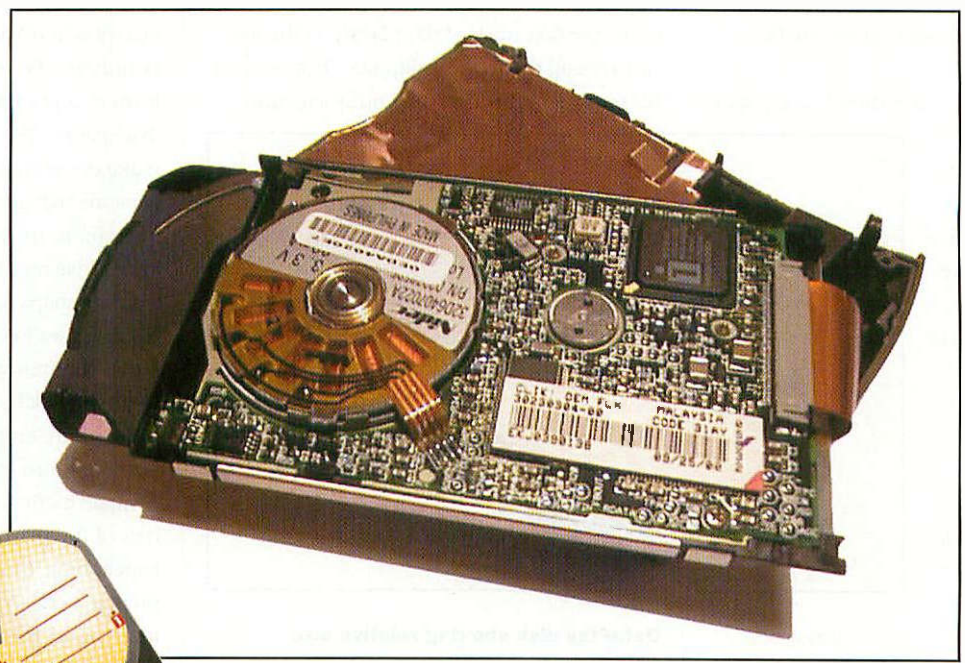
samples are very unusual! The Smart will not work with sample rates of less than 32KHz (something confirmed by the TL7231 datasheet) or decode MP2. Bear the latter restriction in mind if you hope to play files created with Iomega's excellent (and free!) RecordIt program!

Sound quality is, on the whole, fair bearing in mind the low price. The headphone output, auditioned with a decent pair of Sennheiser 'cans' is acceptable although lacklustre in hi-fi terms (on which subject, don't bother with the supplied 'in-the-ear' jobs - they're crap). With both MP3 files and CDs, there's a lack of depth and bass. Noise levels are commendably low, though. The line-level output, fed to a hi-fi system, yielded much better results. Bass delivery improves (but only slightly), while previously-unheard finer details spring out of the mix. The strange thing is that much of the CD-specific circuitry is made by Technics/Matsushita - as a look inside the unit reveals. The other components include an Oak Technology OTI9150 IDE CD-ROM controller (which is presumably used to generate some of the control and timing signals for the TL7231) and a Samsung microcontroller/LCD controller. The TL7231 has its own DAC, which is employed by the Smart. Interestingly, the chip has serial data and clock outputs for an external DAC. These could form the basis of future experimentation, including a S/PDIF output built around the Cirrus CS8402. But, then again, why bother? An increasing number of DVD players, all of which feature digital audio outputs, are capable of decoding MP3s. It's strictly a case of horses for courses, and in this respect the Smart will fit the bills of many music fans. It's refreshingly unpretentious, and - if my experience is anything to go by - does more than it claims.

Contact: Euro Asia Technologies, 020 8890 3900.
www.smartproducts.co.uk
(original Live2000 supplier) or
Jedan: 020 8668 0016.
www.jedan.co.uk
(these guys do it for £119, plus £5 postage)

Iomega DAP-40 HipZip, £290

The America-made HipZip represents Iomega's first foray into the competitive world of personal MP3 player hardware. By the standards of most portable players, it's quite heavy - but then again the unit does incorporate a (lithium-ion) battery pack and the PocketZip drive. The HipZip is supplied with a charger/mains unit, carrying case, two 40MB PocketZip disks, cables and software.



Left: ClikDisks and above: Inside the IOMEGA HipZip

According to the specs, you should also get headphones - but they were missing from the pre-release review package, and so we couldn't assess their performance. Interfacing with the PC (or Mac, for both platforms are supported) is via USB. Transferring music between computer and player is thus very quick, each track taking a few seconds. Unlike the Rio600, you can transfer files both to and from the player (I can't imagine that the RIAA is going to be impressed by this!). This freedom is probably intentional, so that one can use the 40MB PocketZip disks for back-up and archiving. Indeed the driver supplied as part of the software adds the device to your desktop, giving it a drive letter so that it can be treated like a small-capacity (by modern standards) removable hard disk. This can be quite useful if you've got another PocketZip peripheral, such as Agfa's CL30 digital camera. It also makes transferring music files into the player a doddle - simply drag them from the relevant folder to the HipZip one. As far as creating MP3 files in the first place is concerned, the HipZip is supplied with the well-known MusicMatch Jukebox.

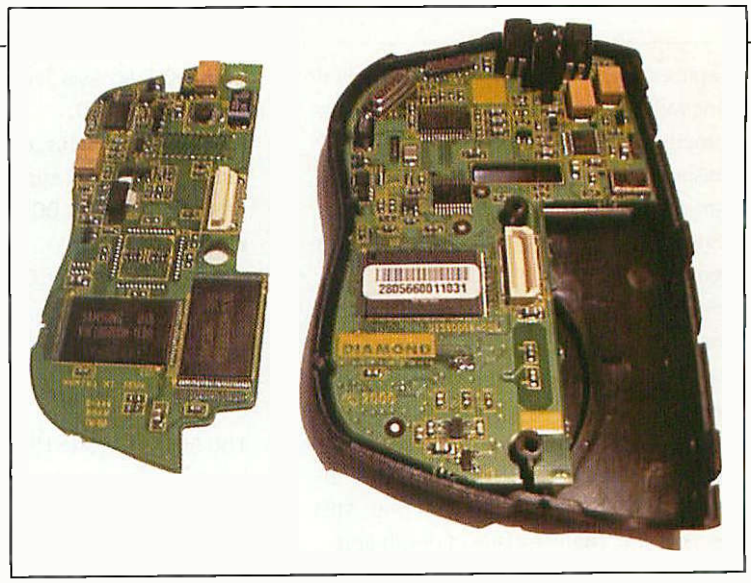
Iomega doesn't supply its excellent RecordIt real-time MP2 recording software with the player. But then again, the device won't handle MP2 files created by RecordIt. Copy MP2 files across, and - as with other unrecognised forms of data - they won't appear on the playlist (the HipZip thus represents a novel method of smuggling secret information across sensitive borders - somebody tell James Bond!). Bearing in mind the 40MB capacity of those PocketZip disks, you're better off working with MP3 or WMA anyway. Both of these are supported by the HipZip, which is based around the Cirrus Maverick (EP7209) ultra-low power audio 'system on a chip'. The device incorporates a 32-bit ARM720T RISC core that, amongst other things, runs the audio decompression algorithms. According to Cirrus Logic, the performance of the EP7209 is roughly equivalent to that of a 100MHz Pentium-based PC. Even after MP3 audio decoding, 25MHz of processing power is available for other functions - such as tone control, user interface and so on. Iomega's firmware is stored in flash memory, and can be updated with new versions as other codecs arrive. In this way the player will, no doubt, be able to support DRM once the standards have been finalised to everybody's satisfaction. Out of interest, the installation software checks the firmware that's already in the player, and updates it where necessary.

The player itself has curved sides with rubberised hand grips. Note that the latter are held in place by nothing more than double-sided sticky tape, and they could end up peeling away in time! One side of the HipZip sports the DC power jack, USB port, headphone and 'control-lockout' switch. You

don't, as with the Smart unit, get a separate line output jack. On the opposite side of the case are three menu buttons (select/up/down), which are used primarily to configure the player. Those up/down keys double up as volume adjusters. On top of the player is a hinged clear blue plastic, which covers the PocketZip disk compartment. The disk is inserted into a slot until a 'click' is heard (an explanation for the Iomega medium's original name, perhaps?). Releasing a disk involves pressing its top section (which still protrudes slightly from the slot) causing it to spring out. Disassembling the HipZip reveals that the device essentially consists of two internal components, which are joined via a ribbon cable. The first is the player itself, while the second is the long and thin drive mechanism. Its dimensions lead us to believe that the drive is probably the same one that Iomega builds into its PCMCIA PocketZip drive card.

The front panel contains the play/on, track select and stop/off buttons. Above these is a large graphical LCD screen, which is packed with information. The track name and artist - which can be read from the file's ID3 tag - are displayed, along with volume/equaliser settings and track number/time. The screen is very readable, although is spoilt by a series of faint vertical background lines. Its contrast cannot be adjusted, although you can invoke a backlight that operates when a key is pressed. The user-friendly menu system provides access to a wide variety of functions, including playlist management, playback mode (random/repeat), backlight and track/disk/player information. Amongst other things, you're told the version of firmware that currently resides within the player. You might want to upgrade the firmware if a later version is available on the relevant pages of Iomega's web site **(www.iomega.com/software/completed/hipzip.html at the time of writing).**

Because the headphones were missing from our review sample of the HipZip, we relied on our Sennheiser references for the listening tests. Overall, the sound quality is more than acceptable. For a start, bass performance is audibly superior to that of the Smart player. There's a fair amount of punch and clarity - although a good personal CD player is capable of resolving more sonic detail. We did find that the equaliser could introduce a noticeable degree of mid-range colouration - it's best switched off in our opinion. A vigorous shake of the player resulted in no interruption, and so Iomega has presumably included a sizeable amount of memory to buffer the datastream from the PocketZip drive. Random track access times are slightly faster than the Smart, but no match for the Rio600. Irritatingly, you can't go to the first track of the playlist to the last by pressing the reverse-skip key. Instead, you have to wade through the entire selection.



Inside the Rio 600

DataPlay disk showing relative size

We achieved several hours of playback from a single charge of the battery. Indeed, Iomega claims that up to 12 hours of continuous playback are possible. In all, the HipZip is a unique product. In its defence, the player has a good sound quality, excellent user interface and (restricted) back-up potential. Against it, however, is the product's significant price - £300 ain't cheap. And although PocketZip discs are more capacious and considerably cheaper than flash memory (£10 for a 40MB disk, against £80 for a 32MB memory card), their capacity and price dwindle into insignificance when compared with 50p 650MB CD-Rs that the Smart works with. Shop around, and you could buy the Smart player and an end-of-line CD-R(W) drive for your PC for much the same money that Iomega is asking for its HipZip.

Contact: Iomega, (0207) 365 9527.
www.iomega-europe.com

Sonic Blue Rio600, £170

As we discussed earlier on, the real potential of the Rio600 lies in the future, when Dataplay and Microdrive storage media peripherals become available for it in the form of replacement rear panels known as 'backpacks'. For now, though, you'll have to make do with the (expensive) flash-memory versions that are currently available if you need more than the integral 32MB. Both the Microdrive and Dataplay are tiny media, and that's perhaps just as well if the Rio600 has plans to swallow them - for the player is itself rather diminutive in stature, and so too must the backpack by default. Supplied with the player is an 'empty' backpack that contains nothing more than a single AA battery compartment. The backpack slides onto the rear of the player, and latches into position (unclipping it involves pressing a button and pulling it off). A 32-pin mini-header interconnects the electronics of the two. In the supplied backpack, only two of these pins (battery positive and ground) are employed. The standard Rio600's 32MB of flash memory is built into the player itself - an upgraded backpack adds to this capacity.

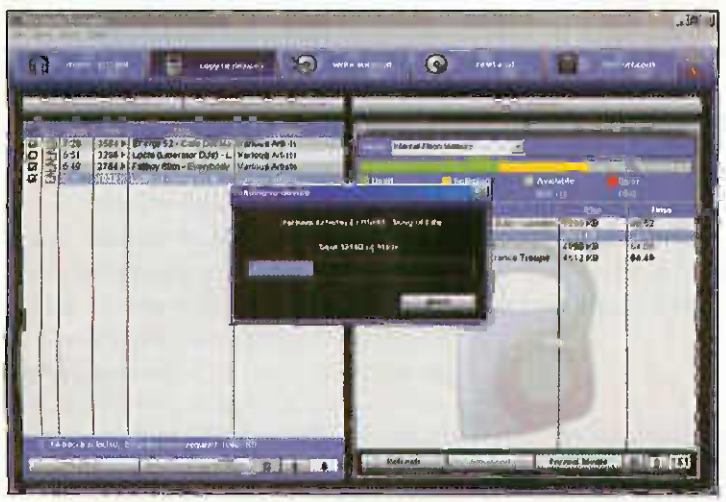
Player and empty backpack apart, you get the computer interface lead, software and a pair of earphones. The Rio600 interfaces to your computer via USB, and we're pleased to report that both Mac and PC platforms are catered for - software for both can be found on the accompanying CD-ROM. The primary function of Rio Audio Manager is to download tracks to the player. It also includes a CD-ripper, and MP3/WMA encoder. As with the MusicMatch Jukebox software supplied with the HipZip, the ripper will talk to an on-line database known as Gracenote/CDDB (www.cddb/com), and retrieve the CD artist/tracknames. This worked with very commercial CDs we tried! Rio Audio Manager also includes a playlist

manager, so that you can determine the order in which ripped (and downloaded) tracks are transferred to the player. The transfer speed is exceptionally fast, thanks to USB. Tracks whizzed across in a matter of seconds. As discussed previously, the software won't let you transfer tracks from the player to your hard disk. This was done to appease the RIAA, which instigated an unsuccessful legal action against Diamond Multimedia (as SonicBlue was originally known) at the time it launched its original Rio PMP300 player. Another feature of the software is basic audio CD mastering, although we couldn't get it to work with our new-ish Memorex burner - even after running a program patch. These software updates are available from the www.rioport.com website (which is linked from the program).

Upgrade IOMEGA firmware

The player is of a very pleasant appearance and design. Although the oval front panel display is smaller than the HipZip's, it is very readable. The artist and name of the track, which can be derived from ID3 tags, scroll from right to left. The display also tells you the bitrate and encoding standard, track time/number and volume level. Under the display are oval buttons for configuration menu access and track selection/volume adjustment. Beneath these are yet more controls, arranged in a disc. At the top and bottom are 'play/pause' and 'stop' respectively. The left and right buttons, meanwhile, allow you to seek through the currently playing track in either direction. They also scroll through menu options, which are selected by another button that's located in the middle of the list. There are four main menus, which are presented as a tabbed list at the bottom of display when the oval menu button is pressed. The first tab provides access to no less than seven preset equalisation curves, in addition to a user-defined (bass/treble) one.

The second ('player') allows you to select repeat and random playback modes, edit the playlist or - for some reason - delete tracks. Next up is 'pref(erence)s'. From here you can invoke power-saving (the idle time, after which the player goes into a sleep mode), turn the display backlight on or off, check battery condition (there's also a 'calibrate' function, which requires you to insert an unused 'reference' battery), or enter the correct time and date. The final menu option displays the amount of memory available/remaining and the firmware version. As with the HipZip, the Rio600 - which is also based around the Cirrus Maverick (EP7209) chip - can be upgraded to support DRM and future audio compression technologies. MP2 files aren't supported - the extension is not recognised by Rio Audio Manager. When they're renamed to .MP3, they can be auditioned via the software's internal player without problem. Transferring them to the Rio600 through Audio Manager invokes a 'conversion stage', and the result - as experienced via the player - is very horrible indeed.



Rio Audio Manager transfer tracks

Like many modern mobile phones, the Rio's faceplate can be detached and replaced with one of a different colour. The supplied faceplate is bluish-purple in colour, but you'll be able to buy - for £10 - a pack of three (green, white and red) replacements. On top of the player is a switch that doubles up for power and control panel lock-out. There's also a non-standard jack socket that combines the USB interface and headphone socket (note that, as with the HipZip, no line output has been provided). A standard 3.5mm stereo jack for the headphones is flanked on either side by two four-way contacts. In all, the weird plug at the player end of the USB cable supplied with the player has a total of 12 contacts available, which seems rather excessive seeing that the USB interface only requires four! Perhaps Sonic Blue has plans for the unused pins. This departure from standards means that (i) if the cable goes wrong, you'll need to buy a replacement from SonicBlue and (ii) you can't have headphones and USB connected simultaneously. On the subject of headphones, the ones supplied are basically 'in-the-ear' types, but with rather uncomfortable clamps to hold them in place. The sound produced by them is extremely poor - indeed, they're worse than the ones supplied with the Smart player. Their sonic presentation is hollow, bass-shy and lacking in detail.

Amazingly, all of the Rio600 reviews I have seen to date praise the sound quality of the unit. One can only hope - for their sake - that the reviewers in question were using their own headphones. If they weren't, they must be equipped with cloth ears - it's as simple as that! The supplied headphones certainly don't do justice to the player. Our reference Sennheisers showed the Rio600 in a much better light. Aurally, it's vibrant and pacy - but, as with the Iomega, keep the equaliser off because it does introduce colouration. Thankfully, there's a 'flat' position. In all, the Rio600 is an excellent and well-featured little player. Unfortunately, the 32MB of memory is restrictive - despite the support for WMA - and expensive to upgrade. Individuals with varied musical tastes or large record collections are still directed to the Smart, which is - sadly - bulkier and uglier. Come the arrival of the Dataplay (and to a lesser extent the Microdrive) backpacks, and our recommendation to such users will change in Sonic Blue's favour. A more expensive 'executive' version of the Rio600 with 64MB of memory is on its way, incidentally. The Rio800 also features voice recording (a feature of the Mirrus Maverick, as the chip's functional diagram shows), a polished-steel case and (apparently) a remote control with in-built FM radio.

Contact: Sonic Blue, (01189) 444400.
<www.riohome.com>

QUANTUM DOTS

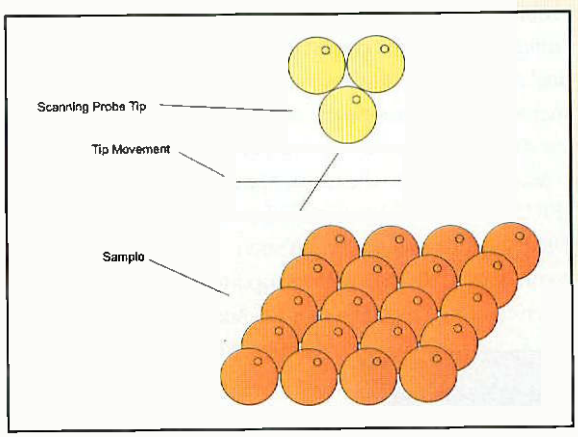
The Future of Electronics

High-speed electronic devices of the future will probably be built from devices called quantum dots. David Clark takes a look at these extraordinary "components".

At the cutting edge of telecommunications and computing technologies ultra-fast operating speeds and high component densities are of paramount importance. In the quest to achieve these twin ideals electronic devices have become ever smaller; but there is a limit to how small these devices can be made to be using conventional mass-production photolithography techniques. The limiting factor is the wavelength of the light employed for the process, the best resolution achievable being around 100 nanometres using ultra-violet light. Individual components are in the micrometre size range.

To achieve faster speeds and higher component densities than this we need to enter a world where individual atoms can be accurately manipulated into position, a world a thousand or more times smaller and measured in single-figure nanometres and Ångstroms, the unit of measurement of atoms and molecules. Theoretically at this level many thousands of components could be fitted into the area only one would occupy in the "micro" world.

For several years it has been possible to build devices consisting of only a few atoms using specialised laboratory instruments such as the Scanning Tunnelling Microscope (STM) and the Atomic Force Microscope (AFM).



The Scanning Tunnelling Microscope

The scanning tunnelling microscope (STM) takes advantage of the phenomenon of quantum tunnelling to enable images of the atoms at the surface of a material to be made. Quantum tunnelling occurs when an electron crosses an energy barrier that would normally confine it. This doesn't break any laws of physics at the level of individual atoms and electrons because the position of an electron is defined by its likelihood of being there, and there is a small possibility of it being beyond its "normal" boundary. These electrons are gathered by a charged probe passed at a fixed (average) distance above the surface of the material and form a small current that varies according to the number of electrons that tunnel out of the surface. This current corresponds to an atomic profile of the surface, and can be used to generate an image of the individual atoms.

The Atomic Force Microscope

The Atomic Force Microscope (AFM) is an instrument similar to the STM. Here however the probe can also move perpendicularly to the material surface and it follows the surface atomic profile as it scans. The force needed to maintain the probe at a fixed height over the "surface" of each atom as it moves across the material is monitored and this measurement provides the information from which an image can be generated. An advantage of the AFM is that it can be used to scan the profiles of non-conducting materials.

Manufacturing With Microscopes

By injecting bursts of current via the probe tip of an STM or an AFM atoms can be etched out of, or placed onto, substrate materials. Smaller currents can be used to "push" atoms around and into the required position. In this way patterns of single atoms can be designed onto the surface of a material to make devices as required.

These instruments have opened the door to a new level of technology, but they are not suited to mass production of course and are therefore of limited use in the commercial world. However it has recently been established that extremely thin layers of semiconductors (a few atoms deep) on a suitable substrate possess the very useful property of self-assembling into three-dimensional structures - small islands of one type of atom sticking out of a crystal "sea" of other atoms. This brings the possibility of the commercial production of real world components of this size a great deal closer. These devices rely for their action on the quantum effects that are only evident in structures having dimensions measured in atomic units, and this has given rise to these atomic islands gaining the title of "quantum dots" [1].

The Quantum Dot

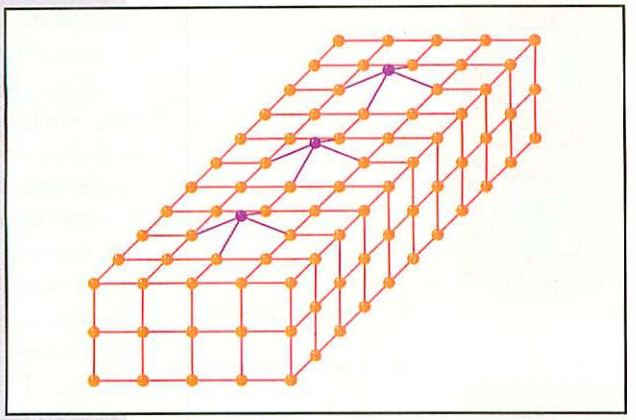
So how do quantum dots work? Each dot is a region of semiconductor material that

The Ångstrom

The diameter of an individual atom is around one Ångstrom, the unit named for Anders Jonas Ångstrom, the Swedish physicist influential in the middle of the nineteenth century. A large part of his work was in spectroscopy and the measurement of the wavelengths of the lines in the spectra of incandescent gases. These lines (though it was not realised at the time) are a consequence of the quantum nature of the energy levels of the electrons of atoms. One Ångstrom is defined as one tenth of a nanometre; thus individual components on integrated circuit substrates which have sizes measured on the micrometre scale each consist of several tens of thousands of atoms, an indication of the difference of scale of quantum dot technology and "conventional" microelectronics.

Forming Quantum Dots

Quantum dots can be made by layering onto a substrate extremely thin slices of semiconductor crystal having a slightly different lattice structure to the underlying material. The tension between individual atoms is great enough to cause the films to buckle and form structures that "stick out" of the film. Remarkably, and usefully, individual dots appear to repel each other in a way that makes the most stable structure the one where the dots are spaced in a regular array of uniform dots.



contains a small number of electrons (sometimes just one electron) that are trapped in their immediate locality because they don't possess sufficient energy to jump to an adjacent dot. The electron is trapped in an energy 'well' (see Figure 1).

However by applying an appropriate voltage in the vicinity of the dot the electron can be encouraged to "jump" make the jump to an adjacent dot. In the quantum world the electron can jump through the energy barrier rather than having to jump over it - it "tunnels" through the barrier. This could be thought of as being like trying to throw a ball over a wall that's extremely high but has a gap in it just large enough to let the ball through (see Figure 2).

If the ball cannot be given enough energy it will never go over the wall but there is a small chance it will go through the gap. This very process that makes quantum dots useful for nanometre size components is the same as the one that is undesirable in "normal" semi-conductor action, causing the reverse leakage current in diodes and transistors for example. (This is also the process that prevents the use of "normal" semiconductors at this level of size and packing density, as the tunnelling becomes more significant than normal semiconductor action.) Encouraging the electron to jump the barrier by applying a voltage nearby causes a "nanocurrent" to flow, just as applying a voltage to a "normal" material causes a current to flow. An electron already in the dot to which the first electron has tunnelled will be repelled by this electron and so will itself jump to the next quantum dot, and so on. Using this principle devices have now been made in the laboratory that can perform logic functions, and act as memory storage devices [2]. Lasers have also been produced using this remarkable new technology.

Real Devices

Each quantum dot can be designed to be a "box" that can hold only either one electron for example, or no electrons So a device can be built consisting of a group of four quantum dots holding two electrons. Being negatively charged the two electrons move as far apart as possible - this means to the opposite corners of the box. Thus there are only two possible states [3] - the device is a bistable multivibrator and can act as a memory cell. See Figure 3.

Other logic gates have been constructed on the same principle. These are so close together on the underlying substrate that they are extremely fast in operation and of course extremely large numbers of gates can be held on one crystal substrate.

Perhaps the most basic component however made using this technology is the resonance tunnelling device (RTD). This acts as a switch, controlling the passage of a single electron. See Figure 4.

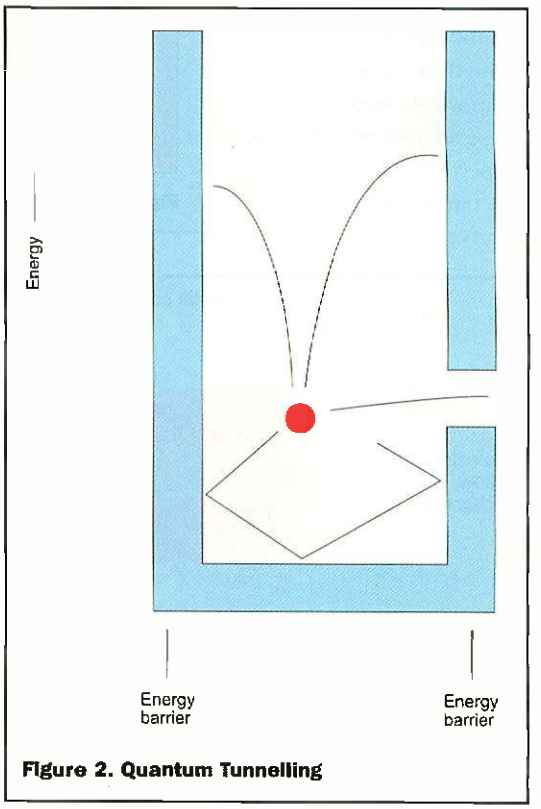


Figure 2. Quantum Tunnelling

By altering the charge on the metal electrode the "height" of the walls of the barriers in the electron conducting channel is decreased or increased hence allowing or blocking the tunnelling of the electrodes in the conducting layer through the barriers, in other words acting as a switch [4].

A third class of device is the single-electron transistor. (See Figure 5.)

Here the device acts like an ultra-small Field Effect Transistor (FET). The tunnelling of electrons from the "source" to the "drain" (driven by an external voltage) is controlled by the voltage on the "gate". Each so-called "tunnel junction" is a narrow (a few atoms thick) layer of insulator, and the junctions are isolated from the "gate" by a (relatively) thick layer of insulating material. Its thickness means that electrons cannot tunnel through it and so it acts as a capacitor dielectric.

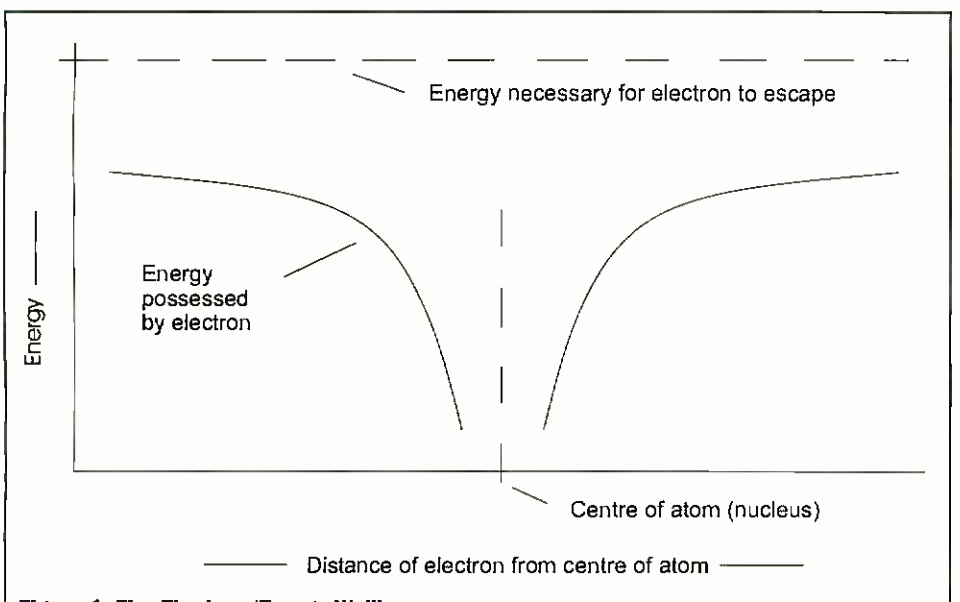


Figure 1. The Electron 'Energy Well'

In theory then the components necessary to build an ultra-fast, ultra-small computer are available. But perhaps even more remarkable is another device being researched, a nanometre scale semiconductor laser. The extreme regularity of the self-assembled quantum dots' crystal structure means that the spread of frequencies within the beam is narrow, the proximity of the dots means the frequency is high, and the high packing density of the dots means that the beam will be intense [5]. These are all highly desirable properties for fast rates of data transmission by optical means.

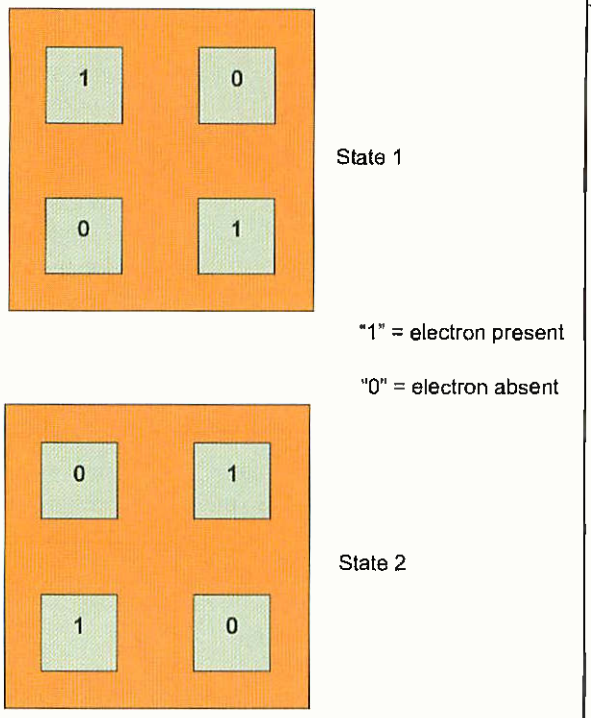


Figure 3. The Quantum Dot Bistable

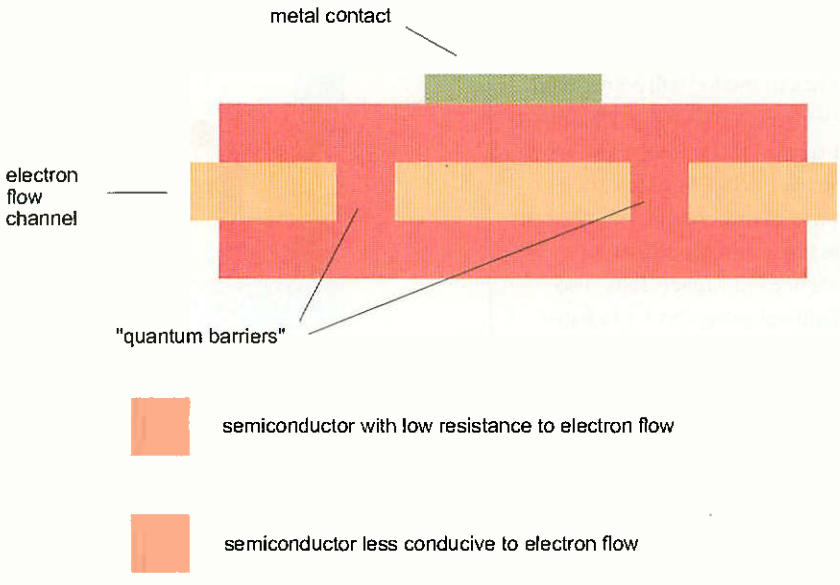


Figure 4. The Resonance Tunnelling Device

Conclusion

One major practical problem that hasn't been mentioned is that these devices currently only operate at extremely low temperatures, needing cooling with liquid helium or liquid nitrogen [6]. Higher temperatures mean that the electrons have sufficient energy to tunnel in an uncontrollable manner. Nevertheless, as has been the case with superconducting materials, further development should mean that the temperature at which the devices operate would rise and eventually it is believed devices will be possible that can operate at room temperature.

A further problem is getting the information out of such highly packed devices. These quantum devices can only be connected to others in their immediate vicinity. Connections to the outside world are a difficulty, not only in terms of measuring the tiny charges involved but also in the physical size limitations. Metal wires would be enormous compared to the devices that they were linked to and this would defeat the object of the technology to a significant degree. A line of the bistable-type devices already mentioned connected in series could act like a wire however, effectively passing "1"s along a line; this might be one solution. Hybrids of quantum devices and "normal" micro-electronic devices may be another, as might another concept under development, molecular wires. These are organic molecules that conduct electrons and can be linked to a gold lead.

Finally there is another perhaps more serious problem. The fact that the devices don't produce heat might be thought to be a great advantage. However because of this, according to the laws of thermodynamics involved, the actions of the devices could reverse as easily as they occur - a computer might never get to complete its task. Not so useful! Nevertheless these problems should be overcome eventually - there could be enormous profits for the organisations that can surmount these limitations. The future looks, well, small!

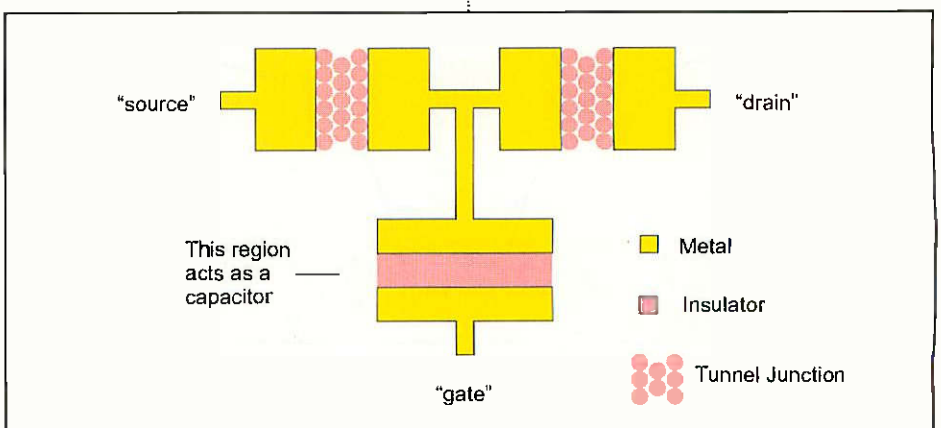


Figure 5. The Single Electron transistor

Acknowledgements

[1] www.sandia.gov/media/NewsRel/NR1999/quantum.htm

[2] www.mitre.org/research/nanotech/goldhaber_on_qdot_cells.html

[3] www.eetimes.com/story/OEG19990428S0015

[4] www.mitre.org/research/nanotech/resonance_tunneling_device.html

[5] also from [1] above

[6] www.mitre.org/research/nanotech/molecular_quantum_dot.html

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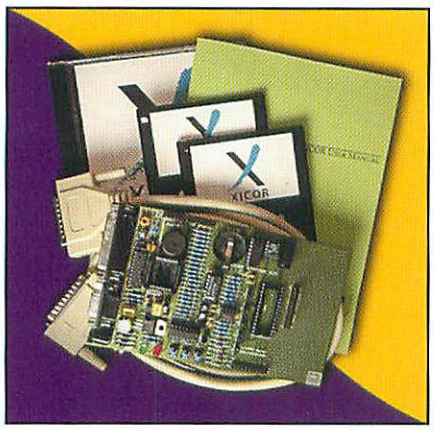

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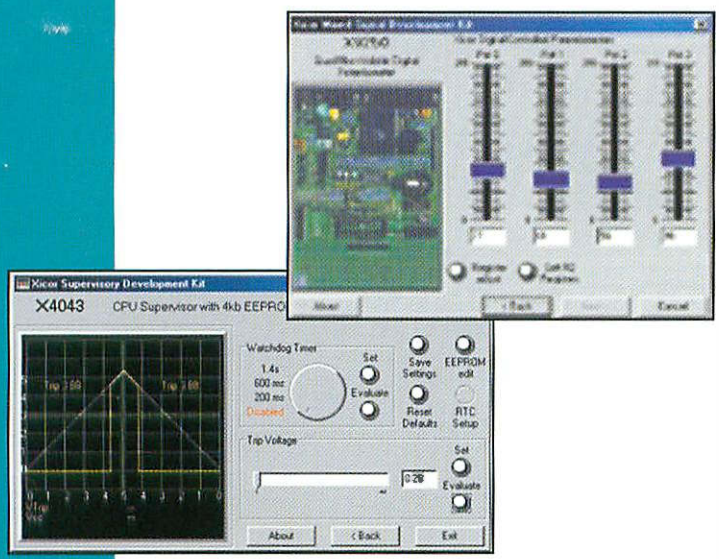

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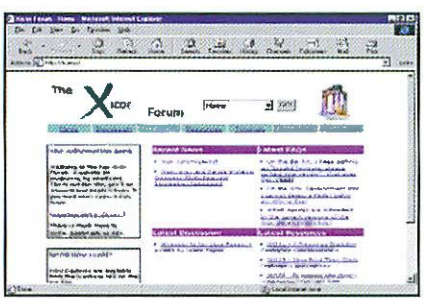

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