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ELECTRONICS

and Beyond

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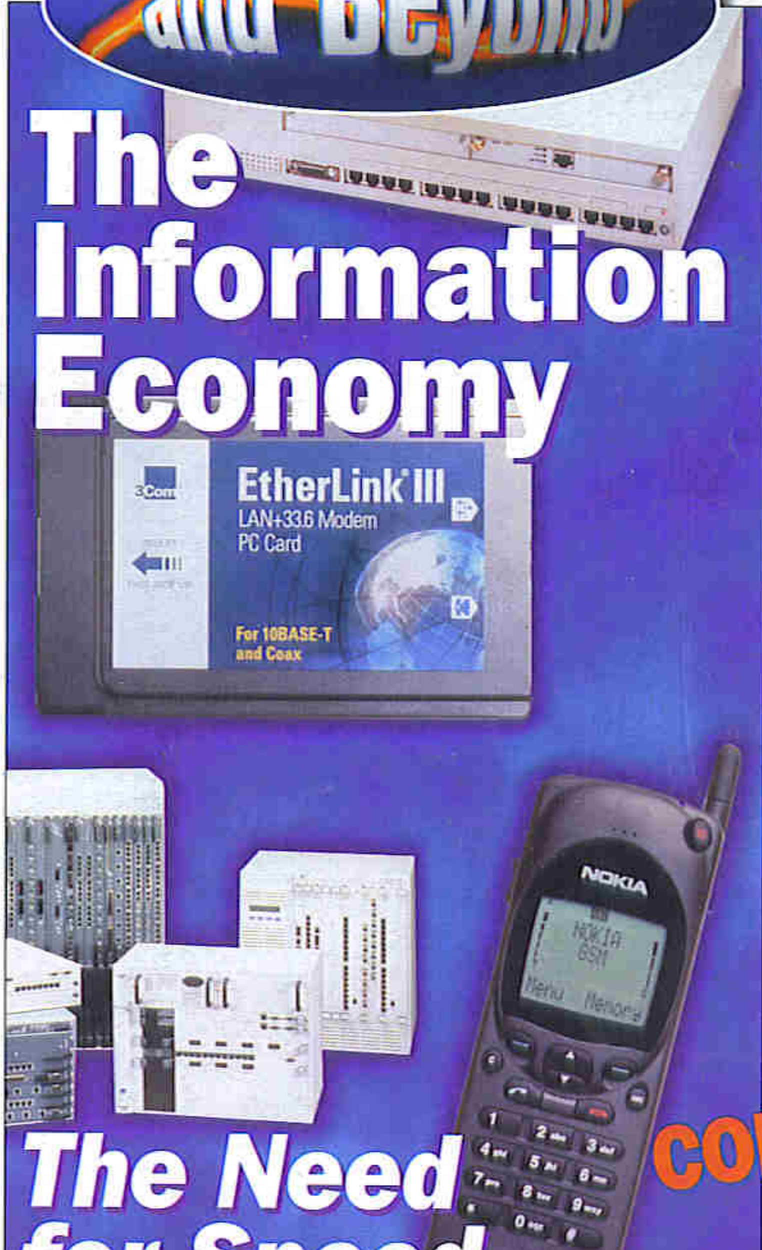
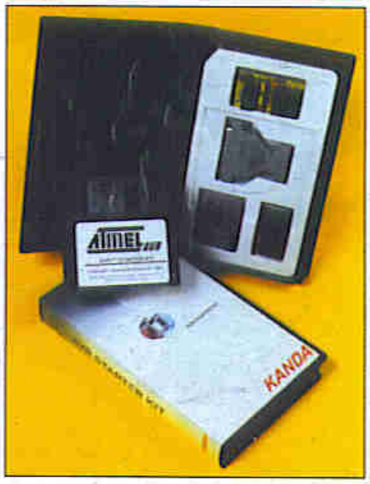
Image Sensor Technology

The Information Economy



The Need for Speed

AVR – An Introduction



A Microprocessor System with a difference

In the Interest of Security

Surveillance plunges to greater depths

COMPETITION!

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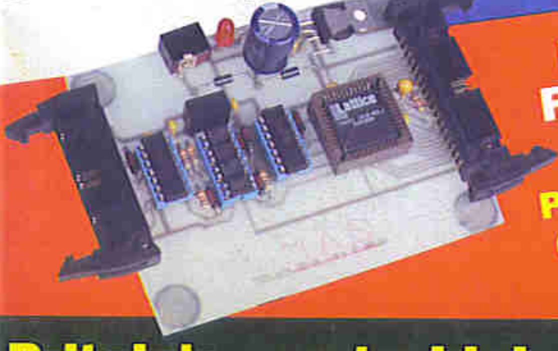

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Game Port Data Logger

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THE MAPLIN MAGAZINE
ELECTRONICS and Beyond
November 1997 Vol. 17 No. 119

Projects

Features

Regulars

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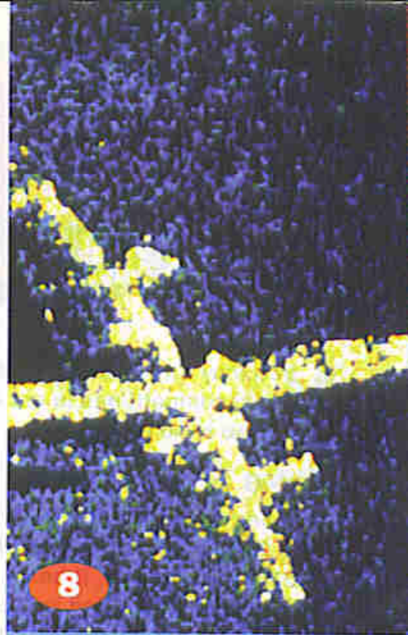
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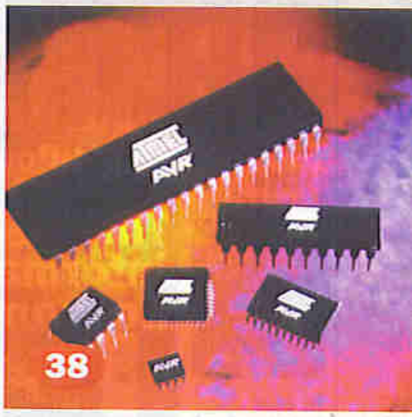
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ELECTRONICS and Beyond

You may have noticed that we at Maplin regularly hold competitions in our magazine and this issue is no exception.

Fluke Scopemeter Competition

You'll see this month that we have a review of the Fluke 123 Industrial Scopemeter. This is an extremely versatile service tool, it being a 'scope, a multimeter and a recorder all rolled into one. At the end of the review there is a competition to give away one of these. The Scopemeter is valued at over £800 and so this has to be a competition worth entering. Good luck to all applicants.

Congratulations

Mr D A Bayliss of Rickmansworth, Herts wins a Tektronix Multimeter for being the first person picked out of the hat from our reader survey. We should be reporting the results of the survey next month.The ten runners up are:Martin Glavin Ireland, Michael Dowling, Ireland, J W Simon, Fife, Philip Stevenson, Belfast, P Goodhart, Herne Bay Kent, E M Jolliffe, Cromer Norfolk, I C Stedman, Sidcup Kent, Anthony Sandys, London, D R Pellegrini, Cardiff, John Rabone of Plymouth. Each of our runners up will receive 12 further issues of Electronics and Beyond absolutely free.

Paul Freeman-Sear, Publishing Manager

Britain's Best Magazine for the Electronics Enthusiast

NEWS REPORT

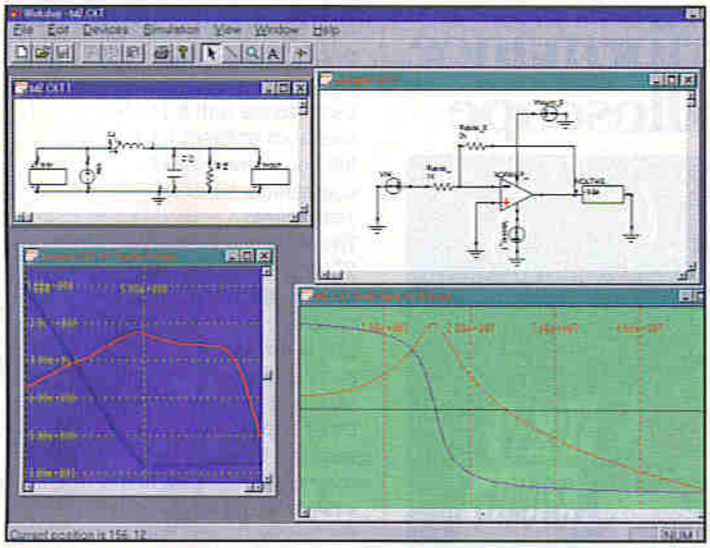
Game Developer Signs Leading Basketball Team

Video game developer, Acclaim Entertainment, has signed a leading US basketball team to develop motion capture video for the next instalment of its top-selling NBA Jam basketball video game series.

During a two-day period, the Minnesota Timberwolves first team donned a full-body, form-fitting lycra suit with strategically-located light sensors. Players then performed hundreds of basketball manoeuvres to video. Acclaim's proprietary tetherless system captures more than 50 bone rotations simultaneously at 60 frames per second – 50% more accurate than any other motion capture system on the market.

NBA Jam '98 will be available in spring 1998 for the Sony PlayStation and Nintendo 64.

For further details, check: `www.acclaimnation.com`.
Contact: Acclaim Entertainment, Tel: +1 516 656 5000.



Low Cost Industry Standard Spice Software

B2 Spice Lite, from RD Research, brings computer-based electronic circuit design within the reach of engineers and enthusiasts. Priced at under £50, the software application based on the widely used professional B2 Spice, enables electronics designers to build and test a circuit on their computer using industry-standard Spice software.
Available in PC or MAC formats, B2 Spice Lite will allow electronics designers to build a virtual circuit on the computer screen and enable them to test, measure or analyse any element of their design. A comprehensive range of tests can be performed on the design, removing the time and building a test circuit with physical components.
For further details, check: **www.paston.co.uk/spice.**
Contact: RD Research, Tel: (01603) 872331.

Optical Disk Offers Low Cost Rewritable Storage Solution

By combining an IDE interface with bundled Seagate backup software, the latest multi-function, rewritable optical disk and CD ROM drive from Panasonic provides users with one of the industry's lowest cost removable storage solutions.

Pansonic's LF-1196 is a 650M-byte, rewritable optical disk drive that offers high-speed storage on optical media and allows users to read their existing CD ROMs at speeds of up to 8×. The low cost enhanced IDE ATAPI interface eliminates the need to purchase and install an additional SCSI board.

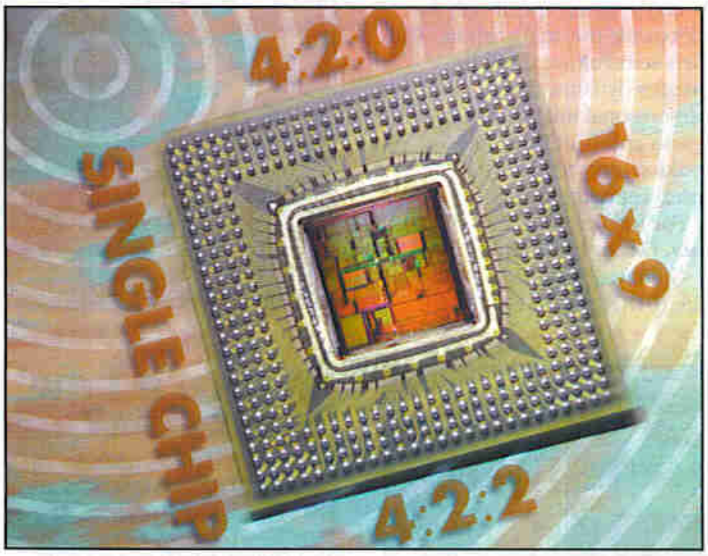
For further details, check: **www.panasonic.co.uk.**
Contact: Panasonic, Tel: (0500) 404041.

GPT Wins Boots Loyalty Card Order

GPT Card Technology has won a £4 million contract to supply smart memory cards for the Boots loyalty scheme. GPT partnered with Thames Card Technology to develop the card, which allows Boots customers to collect points as a reward for buying everyday items in store. The Boots smart card is based on Siemens' 4442 embedded microprocessor technology.

For further details, check: **www.gpt.co.uk.**

Contact: GPT Card Technology, Tel: (0115) 9433687.



Digital Video Codec Drives New Video Applications

Digital video technology developer, C-Cube Microsystems, has unveiled the world's first single-chip MPEG-2 codec, achieving the level of feature integration and performance necessary to address volume recordable video applications in the consumer electronics, PC and professional video markets.
By providing digital recording and playback capabilities in a single, cost-effective solution, C-Cube's DVx architecture will enable MPEG-2 to drive a new genre of volume digital video applications, including recordable DVD, MPEG-based non-linear editing, HDTV, two-way set-tops and MPEG-2 based camcorders.
For further details check: **www.c-cube.com.**
Contact: C-Cube, Tel: +1 408 490 6300.

NEWS BYTES

IBM Sources Processor from AMD

Some models of IBM's future line of Aptiva PCs will make use of the K6 MMX chips designed by AMD, in an agreement that industry analysts reckon gives AMD fresh credibility as a rival to Intel.

For further details, check: www.amd.com.

Contact: AMD, Tel: +1 800 222 9323.

Java Still Brewing

After all the hype last year about Sun Microsystems' Java programming language, it has yet to really hit the mainstream of computer programming languages. A Forrester Research survey earlier this year found that only 16% of companies that said they would use Java, had actually installed any Java applications.

A similar study by Zona Research study last month indicated that 50% of respondents were worried about the software's ability to run on all platforms. Meanwhile, 43% of the 280 companies involved questioned whether Java was fast enough for their needs.

For further details, check: **www.sun.com.**

Contact: Sun, Tel: (01276) 20444.

HP Introduces Cost of Fax Model

A unique mathematical model devised by Hewlett-Packard enables fax users to quantify that conventional fax can be time intensive and costly, compared with alternative technologies.

For further details, check: www.hp.com/info/cof.

Contact: Hewlett-Packard, Tel: (0990) 474747.

Softbank to Acquire Kingston Technology

Japan-based Softbank, which has built an empire based on software distribution, trade shows, publishing and Internet media ventures, has announced its intention to buy 80% of Kingston Technology, the world's largest maker of plug-in PC memory boards.

It remains a mystery why Softbank would expand into a business area that's currently flat in growth and notorious for cyclical price swings, but Softbank president and founder, Masayoshi Son, has defended the $1·5 billion deal as a good business strategy.

For further details, check: **www.kingston.com.**

Contact: Kingston Technology, Tel: (01932) 738888.

Web Update

You can now check out any of the companies featured in the News Report by visiting our Web site at: www.maplin.co.uk/magindex.htm#top.

Here you will find the full text of each news item together with a hot link to relevant Web sites. The *Electronics and Beyond* News Report is published online the day after the magazine appears in the high street shops.

NEWS BYTES

Nokia Supports Cellular Standards

Nokia, Europe's largest manufacturer of mobile phones, is joining rivals Alcatel, Ericsson and Siemens in developing standardised GSM-based wireless technology capable of handling full-motion video.

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

Contact: Nokia, Tel: +35 89 180 71.

NEC Drops DVD Standard

Japanese manufacturer, NEC, is going ahead with the development of its own high-capacity rewritable DVD disks for digital video, audio and computer data. With the announcement, NEC becomes the fourth major company after Sony, Philips and Hewlett-Packard, to abandon the so-called 'industry standard' for such disks.

For further details, check: www.nec.com.

Contact: NEC, Tel: (0181) 993 8111.

Next Generation PowerPC

IBM and Motorola are set to deliver new levels of performance to its PowerPC microprocessors using next-generation design and manufacturing process technology.

The PowerPC 750 and PowerPC 740 microprocessors employ a new and advanced design, provide high performance while using a mere fraction of the power of most processors available today.

Meanwhile, the PowerPC 604e microprocessor, at speeds up to 350MHz, is the fastest PowerPC processor available, and is manufactured using next-generation, 0·25μm process technology.

These processors deliver 30 to 60% better performance than previous PowerPC microprocessors for Macintosh, Mac-compatible and UNIX systems.

For further details, check: www.chips.ibm.com and www.mot.com/PowerPC/.

Contact: IBM, Tel: (0990) 426426 and Motorola, Tel: (01293) 404343.

Intel Countersues Digital

Intel has responded to the patent-infringement charge made against it in May by Digital, by filing a countersuit alleging that Digital's Alpha processors infringe on Intel patents dating back to 1984. Industry and legal analysts are speculating that the countersuit may set the stage for bringing the two parties to an out-of-court settlement.

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

Contact: Intel, Tel: (01734) 403000.

Analogue Performance from PC Oscilloscope

Pico Technology's new ADC 200-100 virtual instrument combines 10MS/s dual-channel oscilloscope with a 50MHz spectrum analyser for £549, a fraction of the cost of comparable benchtop instruments.

The latest model in the ADC 200 range offers all the functionality of a normal benchtop scope together with all the advantages of a PC, such as the ability to annotate, save and print waveforms. Other benefits are context sensitive help and the ability to copy and paste waveforms straight into a wordprocessor.

For further details, check: www.picotech.com.

Contact: Pico Technology, Tel: (01954) 211716.

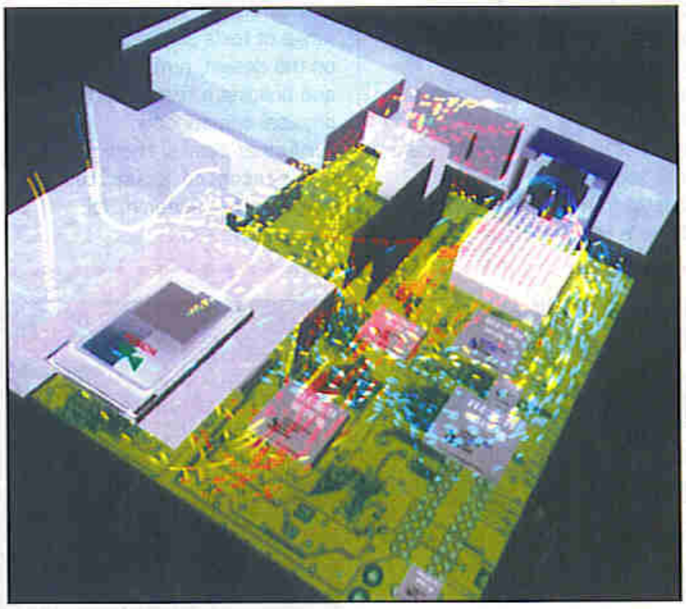
Virtual Reality Measures Thermal Analysis

Understanding and analysing the complex thermal behaviour of electronic components and systems has now been enhanced with the introduction of Flomotion, a dynamic new processing module designed to animate the results of static thermal analysis from Flomerics.

Unlike generic animation software tool, Flomotion has been designed specifically for electronic thermal analysis. The new stand-alone module creates dynamic three-dimensional images of particle tracks and heat flux lines, making it particularly easy to interpret results.

For further details, check: www.flomerics.com.

Contact: Flomerics, Tel: (0181) 941 8810.



'Moore's Law' Extension?

The Texas-based Sematech consortium has developed a technique for replacing a chip's microscopic aluminium wiring with copper, which is a superior conductor of electricity and therefore able to allow data to travel much faster through the chip circuitry.

The feasibility of depositing copper on silicon wafers has long been a goal of the semiconductor industry. The advance may extend the life of 'Moore's Law', declared by Intel co-founder, Gordon Moore, which asserts that chip performance will double every 18 months.

For further details, check: www.sematech.org.

Contact: Sematech, Tel: +1 512 356 3400.

Compaq Announces Monitor Promotion

Compaq is offering a free monitor with every Compaq Deskpro 2000, 4000 and 6000 PC sold. The offer is to apply for a limited period and offers Compaq's latest range high performance 15 and 17in. monitors.

Deskpro PCs featuring Pentium Pro or Pentium II processors come with a free Compaq V70 17in. monitor that normally costs £510. Deskpros with Pentium or Pentium MMX processors will include a free 15in. Compaq V50 or P50 monitor, depending on customer preference, worth over £300.

For further details, check: **www.compaq.com**.

Contact: Compaq, Tel: (0990) 134456.

In the Interest of SECURITY

by Douglas Clarkson

Security has been defined in one reference as 'the safety of a country or organisation against espionage, theft or danger'. Security invariably implies a protection from or consideration of risk. The implementation of security is, therefore, a response to a perceived danger or threat. As increasing levels of security are implemented, it implies that levels of risk and threat are themselves increasing.

The traditional focus on security tends to be that of meeting threats and dangers by using increasingly complex technology. There are observers, however, who look at such developments with considerably more perspective. As the millennium approaches, there appears to be a wave of self analysis breaking upon us to explain why the risks around us are increasing. Our conventional approach to security is typically, however, one of response to risks and threats rather than response to the underlying reasons for a more dangerous world.

As might be expected, there are few obvious leads to follow in the search for means of implementing or subverting security in our highly technical society. This is to both suppress knowledge of the technology and methods used and also to prevent awareness of potential targets being raised. If, however, you ask the new kid on the block and search under 'security' using a search engine on the Internet, you can get almost a million 'replies'.


Figure 1. CCTV system in industrial application. (Courtesy, Dedicated Microcomputers).


Figure 2. ISIT Ultra low-light television camera system with light sensitivity of 0·000005 lux (at faceplate). (Courtesy, Simrad Ltd.)

The technology of the security industry is also vast and tends to be concentrated in specific divisions such as access control, manned security, security systems, CCTV, physical security equipment, safes and security transport. The field of computer security is itself a vast and rapidly developing field.

Trade Wars

National security used to be primarily about stealing or preserving defence secrets. While this is still very much a sensitive area, the focus has shifted to that of economic security achieved by possessing superior technology and also access to the natural resources to maintain the means of industrial production – such as oil.

In confirmation of this, there is continuing evidence that intelligence agencies of national countries allocate significant resources to winkle out industrial and commercial secrets. It was reported in 1995 that France expelled a team of five CIA agents who had been accused of obtaining secrets from French telecommunications and electronics industries. Not to be outdone, the US government claimed that French agencies had targeted over 70 major US corporations and finance houses, including Boeing, IBM, Texas Instruments and Corning Glass.

Various sources conclude that around 80% of Japan's espionage effort is in the commercial sector – with the majority being directed against the US. The true picture of such espionage must assume a highly classified status.

There is indication also of transnational espionage within the confines of Europe. In a period when political and economic links are being reinforced, national governments within Europe are not keen to risk relationships by accusing fellow Europeans of espionage. It is more than a curious reflection, however, that the very great lengths which are undertaken to disseminate scientific and technical information within Europe (such as ESPRIT) provide a very convenient directory for external agencies to access. Are the technical development programmes of the USA and Japan as easy to access?

It is quite likely, however, that the Japanese are remarkably good at collecting and collating entirely legitimate sets of information which are not especially valued in the West. As an example of this, when the contents of a 'superfluous' patent library was being disposed of in Glasgow, it was duly purchased in its entirety by Japan.

If such a massive industrial espionage effort is being mounted around the world, it is a great mystery that hardly any cases pass through the criminal courts.

Cyber Spies

There are hints, however, that increasingly groups such as the CIA and MI6 are navigating the world's wired highways – following and intercepting interesting trails and sources of digital data. It is all very much, however, a closed book to outsiders.

Perhaps it does not take much imagination to think of what techniques major intelligence agencies could now be utilising. Faced with the awesome task of monitoring traffic and sites for possible 'interesting' or 'embarrassing' data, the emphasis will be to automate Net surfing and analysis of data over general networks as much as possible. It is likely, however, that this will be more of a development from previous systems to analyse computer data than an entirely new departure. Systems could conceivably be based on word and phrase searching or advanced neural network technology could be used to 'detect' material of interest – presumably for scrutiny by a security operative.

The Tale of the Clever Copier

Within the intelligence community of the Cold War era, one of the favourite tales told by the CIA was the bugging of a photocopier of American design in a sensitive Soviet ministry department. A highly specialised film camera was developed that would capture on film each sheet copied. It was initially installed by a photocopier service technician and subsequently replaced with new units during its active service life. It proved to be an invaluable source of intelligence.

In modern office life, nothing is as ubiquitous as the photocopier. Political scandals and journalistic coups have been precipitated by the occasional sheet absent-mindedly or otherwise left behind in the photocopy room. To capture a whole stream of potentially sensitive data could be even more devastating for an organisation that is specifically targeted.

While, as far as I am aware, there have been no cases reported of the use of surveillance cameras inside photocopiers, it must remain a source of temptation to would-be snoopers. A photocopier, also, could be easily tapped for power supply lines. Just how the data would be extracted would take a little more planning, though various methods could be used.

Consider also in this regard, fax machines, computer printers and scanners. It could, for example, be possible to store incoming/outgoing messages in solid-state devices and then at an appropriate time, download them to a controlling host. Then again, it could be easier just bugging the phone line. In general, however, the more complex the technology we use, the more opportunities there are to subvert the sets of data it manipulates.

Intellectual Property

Also, increasingly, the aspect of security is not about physical security. It is about control of access to sensitive information of a large array of types and formats. The problem of sensitive material 'walking' to other companies is also one which is focused around employees moving to different companies. Key personnel with access to sensitive product development information are now identified as a potential future security breach. The secrets may be in the head of the member of staff or in printouts or copies of data secured during the individuals's period of employment. Increasing restrictions are being applied to such individuals when they leave the employment of a given company.

The Security of Everything

In terms of security, most people have the impression of the security of their personal property, of their finances or the location where they live. In an age of apparent political security – the Cold War is over – some world watchers still point to worrying trends that affect the security of everything.

As the level of production in the world economy increases, the increasing efficiency of production is tending on the whole to require less people as a proportion of the population to produce these goods. Of the 820 million of the world's working population, one third is already either jobless or struggling to make ends meet. As the polarisation of wealth continues with the rich getting richer and the poorer getting poorer – based on market forces – this places increasing strain on social cohesiveness. Even in China, with an economic growth rate around 10% per year, many millions of unemployed individuals move from city to city looking for work that does not exist.

The last time such chaotic forces of unemployment reared themselves was during the depression of the 1930s. It is not often recalled how close things almost came to social breakdown in the USA around this period. The economies of the West were subsequently tipped out of decline by re-arming for an even more disastrous World War. The stability of many developing countries is increasingly in question as social deprivation arising from miserable living conditions takes their toll.

It is only now, however, that various commentators are looking at security not in a narrow sense, but in a more expansive one. It is being recognised that security is not so much something you have installed by a security contractor, it is instead a factor that needs to be encouraged in all layers of society and both nationally and internationally and especially in the trade of the developed world with the developing world.

While there are indeed now these commentators who can provide some revealing reasons for the various strains being felt by society generally, there are very few, if any, politicians who want to halt the march of the world's increasingly assertive market economy. They would not be seen as the bearer of glad tidings.

Turning Up the Volume

It is difficult to put a measure on the volume of data that is communicated around the world. The Swift interbank messenger system has shown a growth from 157 million messages in 1985 to 457 million in 1993. The SITA airline traffic network showed an increase from 2,350 billion bits in 1988 to 6,620 billion bits in 1992. This is evidence of both increased commerce and the need to keep expanding telecommunications infrastructure.

Under the surface, therefore, out of knowledge of the public, the world is literally alive with data transactions which underpin all corners of our commercial world. The smooth operation and social stability of the world depends vitally on this traffic.

Security of the Internet will be increasingly important as more and more applications take up its functionality. There are many web watchers, however, who have significant doubts about the security of existing transaction systems, though by all accounts, the security of the Internet is itself fantastically complex.

Financial Cyberspace

Security in the broader sense may also be considered to be vitally influenced by the way in which the world financial markets operate. The turnover on the world currency markets (not including stocks, bonds, shares or derivatives) is a staggering $1,230 billion per day. This is perhaps why individual currencies are so vulnerable when identified as a target for speculation.

The deregulation of telecommunications companies, such as BT, and the removal of exchange controls in movement of foreign currency has separated the making of money by the process of selling goods or 'tangible' services and the making of money through dealing on the financial markets. For every single dollar spent or invested in the 'visible' economy in manufacturing goods or providing raw materials or 'real services', it is estimated that there are in the region of $40 existing as virtual 1s and 0s in financial cyberspace.

It must be recognised, however, that the world financial markets have now been so configured that they are largely outside the control of individual national governments. The UK's annual gross domestic product of around £700 billion is only a fraction of the total funds traded in all the world's money markets each day.

Commentators note that the world has effectively two economies – one real and one virtual. The advent of technology has made possible the rapid communication and massive volume of information to cope with the emerging financial cyberspace. Is it the case that the financial sector is effectively operating above and beyond the confines of national government – and that by making its virtual money grow, it has achieved precisely what it all along intended? With national economies linked to the profit and loss on these money markets, however, some commentators are worried about the dangerous instabilities they could unleash.

Erosion of National Boundaries

High speed networks and the information superhighway are also a means of communicating intellectual property across the world – circumventing national customs boundaries. Thus, a corporation in the USA with subsidiary companies around the world can exchange information on technology developments and research without recourse to national security or economic interests.

The Internet has added considerable complication to the process of financial dealing. Already, share selling web pages have opened up, whose activity clearly threatens the highly regulated 'nationally based' financial dealing centres at present in existence.

Data Encryption

Security in sending messages can also be a double-edged sword. It can provide a means of companies preserving their secrets. It allows government security services to encrypt sensitive data. It also provides a means of allowing criminals and terrorists and other undesirable groups to subvert public and national safety. The trail of investment fraud and money laundering of a vast range of criminal enterprises could end up being a closed book.

Security and Reliability

Security also encompasses aspects relating to reliability. To date, there have been two major hiccups with telecommunications structures – both, as it happens, due to apparently insignificant glitches. In one incident, AT&T's entire long distance switching network crashed in late January 1990 and was out for 9 hours. This fault was caused by the failure of a single logic circuit in a single switching node – a true embodiment of chaos theory.

On 7th August 1996, the America Online system went down for 19 hours and affected 16 million subscribers. The cause of this incident was installation of new software following a scheduled maintenance upgrade. This system had only shortly before been declared 'virtually immune' to such troubles. Also, in an environment of rapid expansion of new systems to cope with increasing traffic volume, these problems may reappear. Also, such technologies have also been likened to a 'house of cards', where severe failure in one layer can cause the collapse of the entire system.

The reality of these risks has largely been highlighted by computer risks specialist, Peter G. Neumann, in his book Computer Related Risks. The venerability of computer and related networks is, however, widely recognised and in 1996, the Clinton Administration called on US Industry to engage upon an equivalent 'Manhattan Project' to create defensive safeguards in products and services. Is there a comparable European initiative? Is this an attempt by the US to dictate a whole new level of standards for domination of world markets?

Although the Year 2000 problem with software is not the focus of attention here, it identifies the problem of misplaced focus. As numerous computer systems were developed and sold with the knowledge that customers would seek to operate them in the year 2000 and beyond, at the same time, there was no great consideration in many cases given to the fact that the software might fail at this changeover time.

This is a symptom of an industry under increasing pressure to turn round products as fast as possible and not verify completely all software scenarios. The unfortunate failure of the first Ariane 5 rocket in June 1996 was attributed to such a lack of software verification. It is commented that while the individual bug that caused the problem took only about 2 weeks to rectify, the entire software system has had to be re-evaluated to exclude future mishap in other modules. This is taking many months to undertake and is significantly delaying the Ariane 5 project.

Securing Resources

The message of 'security' and 'stability' of our economy is increasingly seen by various commentators as being tied up with managing a sustainable world economy. If, for example, the population of China lived as well as those in Japan, France or the USA, the result would be untold ecological devastation. According to Lester R. Brown of the Washington DC-based Worldwatch Institute, "The deteriorating relationship between us and our natural support systems, and the economic effects of that changing relationship, will become a consuming concern of governments in the decades ahead".

The argument which the market economy has always proposed is that the well-being of the world depends on the growth of the world economy. Money will trickle down to those who have none. Similarly, as economies become richer, then this will in turn introduce increased security and stability both locally and hence, globally. There are now doubts that this approach to development is sound and indeed, suspicion that it has in fact had the exact opposite effect in the developing world.

Increasingly, therefore, security in this context is being viewed in a new light. The fruits of economic development are increasingly seen as destroying the ability of the Earth to provide many of its key products and resources. The seas are overfished. Cultivated land is eroded and rendered infertile due to over use and pesticides. Forests are felled in an unsustainable way. Water is in many areas becoming a highly contentious commodity. Key natural resources and minerals and in particular, energy sources, are not managed in a sustainable way. Population growth continues at an alarming rate.

This gives rise to the very real prospect that 'resource' wars could lead to foreign conflicts and a general destabilisation of the world scene, with all the threats/perils and dangers that this could introduce into our everyday lives.

It is perhaps time for the information age to pause amid the hasty onrush of impatient change. As David Brown, author of Cybertrends notes, "it is time to consider what progress and communication really means". The patterns of data are there – but is anyone reading the signs?

CCTV Surveillance

A major sector with the more 'visible' security industry is that of CCTV technology. It is also an area which intimately involves the general public through the widespread use of such cameras. As increasing use is made of covert cameras, greater vigilance will be required to ensure that these are used appropriately.

The approach of the CCTV is that of a deterrent through likelihood of detection. Cameras themselves have no direct power to stop acts of violence or theft in their tracks. With many town centres wired for such detection, this has spawned a large CCTV surveillance industry of 'visible' camera systems.

Surveillance cameras are being installed in public transport vehicles in moves to control violent incidents. They are used to monitor and control crowd movements at sporting venues. Already, some cash dispensers incorporate CCTV cameras to provide a video log of transactions. In this way, the issue of identity of card users can be verified in cases of disputed withdrawals. This would, in many ways, act to the benefit of banks and their legitimate customers. It is not clear, however, what percentage of cash dispensers have such cameras installed.

Covert cameras are now widely available in a variety of shapes and sizes. In retail outlets, conventional CCTV cameras indicate the intention to detect theft, and shoplifters seek consequently to target blind spots. Such areas are now being covered by miniature covert cameras. One of the new small pinhole cameras is only 25×25mm in size, with a pinhole of 1·5mm used to obtain the image. This is sufficient to give the required field of view over the area being monitored.

Also, if access to PCs is a security issue, how long will it be before they are installed with a covert camera system that can broadcast via network or modem links the identity of a user. Alternatively, at power up, the user could see the image of the last person to access the system – or page through images of previous sessions?

There must always be some anxiety regarding the ethics of use of covert cameras. While the use, for example, of such units in clothing shop changing areas could be considered one way to detect shoplifting, this would be clearly compromising privacy. Covert cameras are beginning to be used in museum and art galleries to switch from the use of attendants. This comes also at a time of static or falling revenues for the arts. There must, however, be vigilance for the more undesirable and unsavoury uses of such covert equipment.

Covert cameras are now so small that they can be incorporated readily into a wide range of objects. It is really a very demanding skill to be able to detect such devices. Such cameras are either supplied 'ready to go' in a range of disguises or as discrete electronic units for incorporation into systems. Everyday items used include alarm clocks, office wall clocks, loudspeakers, box files and wall thermostats. In busy working environments, it is very easy to disguise a single 1·5mm diameter pinhole. Cameras can also be concealed in smoke detectors – hidden behind the side mesh. Also, cameras can be concealed in either dummy or operational PIRs. Cameras can also be hidden in recessed ceiling light housings.

Pinhole cameras, however, tend to have least light sensitivity and so under low light conditions, it may be better to use a discrete PIR or smoke detector camera than a totally covert one.

Developing CCTV Technology

While the use of CCTV cameras has increased, the technology they use now has advanced significantly. The sophistication of such CCTV systems, however, has increased

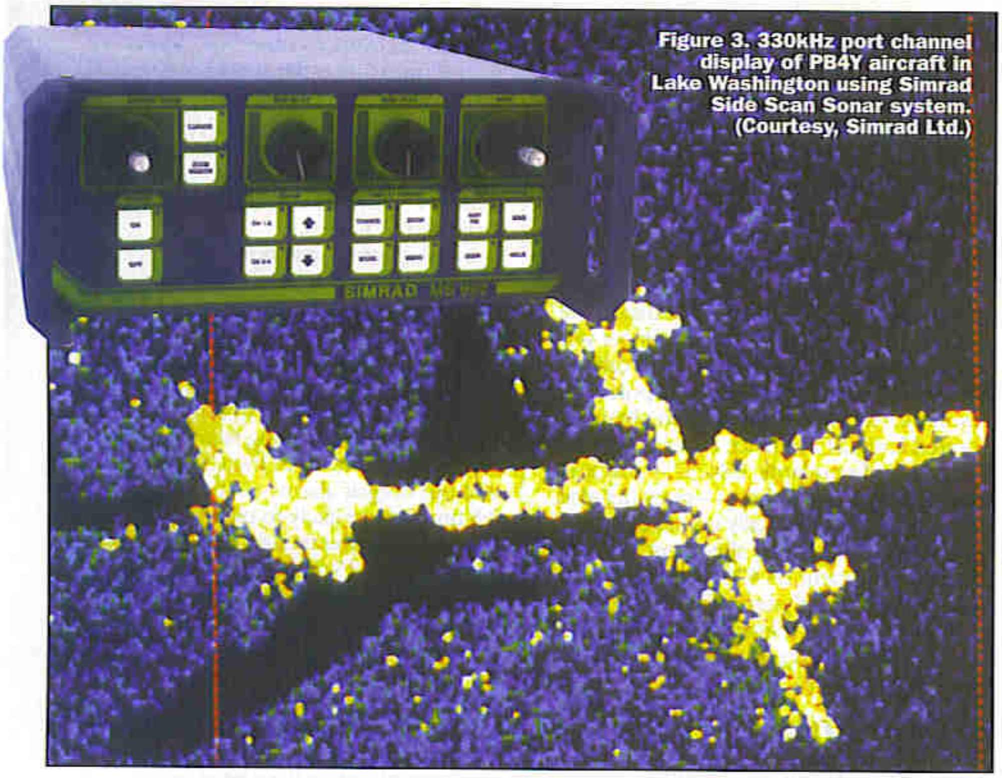


Figure 3. 330kHz port channel display of PB4Y aircraft in Lake Washington using Simrad Side Scan Sonar system. (Courtesy, Simrad Ltd.)

to allow use of colour and audio. Black and white sensitivity can begin as low as 0·08 lux and with colour from 1·5 lux. Equivalent electronic shutter speeds as high as $^1/_{1200}$sec can be used to 'freeze' speeding vehicles for licence number identification. Backlit compensation can also ensure improved visibility of poorly or unevenly lit subjects. Variable focus systems allow better identification of selected features/ individuals. Signal-to-noise ratios have improved – giving clearer pictures even in low light conditions.

The use of duplex video multiplexing allows signals from as many as 16 separate cameras to be displayed on a central monitoring system. Video processing techniques for compression to JPEG standard allows such images to be transmitted over telecommunications links such as ISDN to remote locations. The DVST system of Dedicated Micros, for example, allows such remote monitoring of secured premises – with voice links to warn intruders they have been detected.

Also, the UNIPLEX system from the same company grabs a continuous sequence of full pictures from individual cameras on the system and logs each with details of location, date and time, and stores the data onto a single frame of videotape. Up to 16 cameras can be configured in a single multiscreen display.

Thus, the very real prospects emerge for security services to be provided over very long distances – potentially across national boundaries in the longer term. Can we imagine, therefore, the scenario where a security operative has to know the equivalent of 'Hoi, we're watching you' in a wide range of languages?

An extensive range of video recorders are available for security applications. These include VHS and super VHS standard with conventional realtime recording and also time lapse recording of up to 960 hours (40 days). For covert or mobile use, the Sony GVS50 is powered by a 12V supply, uses NTSC Hi8 playback and up to 5 hours recording on long play mode. Its total weight is 1kg. A recently introduced unit is the JVC SR-L901E, which allows up to 24 hours of continuous high density video and audio recording at a frame rate of 8·3 frames per second.

Appearing now in do-it-yourself stores are CCTV systems which can be monitored an the AV channel of a domestic TV. With the option of transmitting CCTV images over the Internet, surveillance can indeed now be carried out on a global basis – in theory, at least.

Marine Surveillance

With the increasing awareness of the value of resources of the sea, in particular, with oil exploration and production, a whole new industry has developed to meet the requirements of commercial marine inspection and surveillance – possibly including fish farms. With the very high cost of operating in such conditions, the development of rugged, effective CCTV cameras has been a key requirement of the offshore oil industry.

A range of systems are manufactured and distributed by Simrad Ltd. While a broad range of camera types are available, these are typically of two types – a low light, long range viewing system and a high resolution colour type for inspection work.

The long range type will be appropriate for locating of key features such as pipelines and anchor chains, while the inspection cameras are used to observe the status of discrete systems by way of maintenance inspection. Such cameras are primarily intended to be used by manned or unmanned submersibles.

A typical specification of a low light level, long range viewing unit is summarised in Table 1.

In addition, some cameras of this type include remote control focusing, though typically with reduced resolution and light sensitivity.

To give some idea of its superb light sensitivity, its limiting sensitivity is approximately of the order of 0·01% of bright moonlight. The use of specialised Silicon Intensified Target (SIT) technology provides an increased sensitivity of around 1,000 compared with conventional CCD technology.

While typically such cameras have a rated

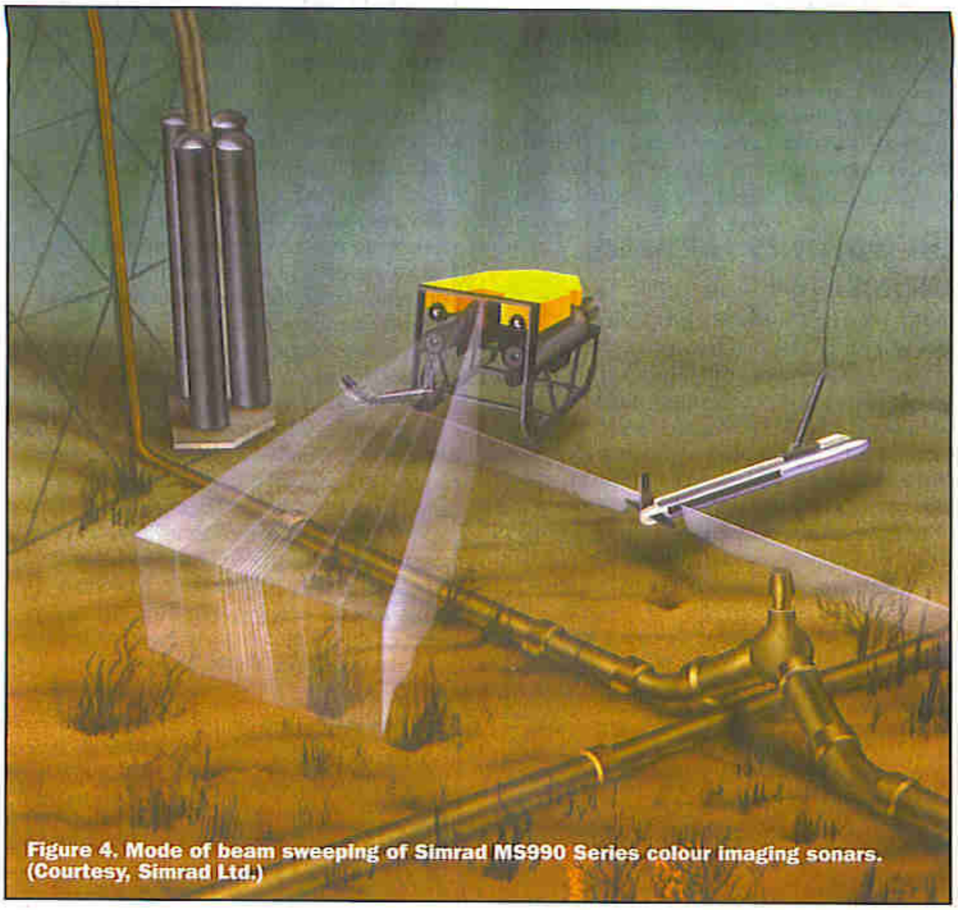


Figure 4. Mode of beam sweeping of Simrad MS990 Series colour imaging sonars. (Courtesy, Simrad Ltd.)

Parameter	Value
Resolution	700 TV lines (typical)
Sensitivity (limits)	0·0002 lux (at faceplate)
Sensor type	1in. Silicon Intensified Target (SIT)
Water depth	3,000m
lens	6·5mm f1·8
Iris	Automatic light control
Focus	Fixed (150mm to infinity)
Angle of view	88° diagonal

Table 1. Specification Simrad GE1324 low light, long range camera.

depth of 3,000m, special systems can be constructed to withstand depths of 6,000m.

One of the less well known dangers of oil activity in the North Sea is that of unexploded bombs dropped by the German Luftwaffe during the last war. These bombs may be encountered where they initially came to rest or they may be disturbed by fishing trawlers. Recently, such a 250kg bomb was discovered during routine annual inspection a mere 9 feet from one of the main oil pipelines in the Nelson field in the heart of the North Sea and which usually produces 160,000 barrels of oil a day. During the process of moving the bomb and its detonation by private contractors, the pipeline will be filled with water to minimise the chance of a severe oil spillage and the whole process is scheduled to take about five days to complete. Oil exploration and extraction has always the possibility of ecological hazard. The technology of routine underwater CCTV monitoring, however, can significantly act to lessen such risks.

Using a totally different technology, side scan sonar technology offers unique facilities for mine counter measures, search facilities, hydrophonic/geological survey and commercial engineering survey operations. It would have been systems of this type that would have been used at the height of the Cold War to hunt for mines on the sea bed. Are they still there?

Table 2 summarises the specification of a typical side scan sonar system.

As a side scan sonar unit is towed above the sea bed, features such as sunken ships or ditched aircraft can be clearly visualised on the colour monitor screen. They do not, therefore, require a source of light to function.

UK Security Industry Structures

In the UK, the British Security Industry Association (BSIA) represents the interests of over 260 member companies which operate in the UK. Companies must be ISO 9000 registered to belong to the association. Groups such as the BSIA are increasingly seeking to introduce increased regulation into the security industry which is rapidly expanding and with presently a turnover of around £3 billion per year. The BSIA has also helped to establish the National Approval Council of Security Systems (NACOSS).

At a local level, the relevant police constabulary are usually able to provide a list of security alarm installers which have been vetted from a 'security' point of view – presumably through verifying personnel of the companies and general checking on their performance. It tends only to be commercial premises that can opt to pay for police response to their alarms.

The Association of the Chief Police Officers (ACPO) has issued draft guidance that in the event of more than four false alarms per year, officers should no longer respond to calls. The lack of a guaranteed police response may in turn involve problems with obtaining required levels of insurance cover.

In terms of standards, BS4737 – 'Intruder Alarm Systems in Buildings' – gives detailed guidance on professionally installed alarm systems and has general alignment with IEC 328. The document BS 6707 – 'Specification for Intruder Alarm Systems for Consumer Installation' defines a level of specification for systems installed primarily by the do-it-yourself enthusiast.

Security USA

Security in the USA is largely about preserving wealth. To those who have, so will they continue to have and those who have not, then this will continue to be their lot. There are useful generalities, however, in studying experience in security from the USA perspective. Also, extensive research into the criminal mind, even to the extent of accompanying burglars as they ply their trade, has furnished an extensive if not exotic literature. The earlier appearance of the US security industry – worth currently around $14 billion per year, has given it more time to rationalise its statistics.

There is, for example, a trend that households of lower income are actually burgled more often. This is primarily on account that a 'low income neighbourhood' is probably intimately known by a burglar and presents an easy target. While more affluent households present more of a temptation, these houses are probably better protected.

There is also a 'time in residence' effect. Houses are most likely to be burgled in the first 6 months after occupation. This is perhaps because the occupant tends to put off fitting an alarm as more pressing items are first resolved. Another consideration is that 'strange' vehicles in drives would not attract undue attention in a newly occupied home.

In these days of getting inside the criminal mind, the currently favoured theory of the process of burglary is explained by the so-called 'Rational Choice Theory', as expounded by Gary Becker around 1988. According to this theory, each burglary tends to be a judgment between the benefits – something for nothing – and the risk of being caught. Key factors will determine the perceived balance of risk. The possible spoils of burglary are offset by the number of security precautions observed. A key countermeasure is the presence or otherwise of a security alarm system.

It is not surprising that the US home security industry favours the deployment of alarms to combat burglary. A typical set of data to confirm this view of things is indicated in Table 3.

In this context, additional security precautions can include a car in the driveway, exterior lights, adequate locks on doors or a dog. Managerial measures can include having mail collected and stopping newspaper and milk deliveries. The ratio of incidence of burglary between extremes of protection is a surprising factor of 10·9. On the law or averages, in the USA, houses without burglar alarms are typically around 2·5 times more likely to be burgled.

In the USA, the time to respond to an alarm may be 15 minutes for a private security company or 30 minutes for the police on a good day when they have less serious matters to attend to. Today's burglars do not hang about – in and out in under 5 minutes. It is quite rare, therefore, for burglars to be intercepted on the premises.

In the USA, most domestic and commercial alarms have been monitored traditionally by the local police. The relatively large number of false alarms, however, has been a serious problem. When alarms are still monitored by local police, various escalating codes of practice have been implemented – state by state, city by city, to try to reduce such a waste of police time. Such measures include on the spot fines for each false alarm – leading to suspension of cover in the event of say, more than 4 false alarms in a year.

This has led to the growth of the private sector to monitor alarms. Where private patrols are dispatched and find evidence of a break in, the police are notified, who in turn, respond more rapidly. Apparently, such private guard companies employ off-duty policemen and those with 'military experience'. They are issued with and wear bullet proof vests and carry arms – for self defence.

The difference between the USA and the UK in terms of alarm monitoring is quite interesting. In the USA, the last thing anyone would do when a neighbour's alarm goes off in the middle of the night is to call round and investigate. In the UK, neighbourhood watch schemes would encourage neighbours to watch properties during holidays and to reset any false alarms. This is also helped by the typical marvellous closeness with which modern houses in the UK are constructed. Thus, alarms in the UK are not perceived as resulting in a slow response.

Average rates of false alarms in the USA have been declining, as a result of pressure from various agencies – in particular, the security industry itself, which perceives that every false alarm is a small dent in its reputation. In the UK, however, there is not

Parameter	Value
Display resolution	640×480×128 colours
Frequency of transducer	120/330kHz 120/675kHz
Depth rating	1,000m
Telemetry	2 wire (twisted pair/coax)
Power requirement (system)	200 VA
Weight (towfish)	27·2kg

Table 2. Specification of typical Side Scan Sonar unit.

Alarm Status	Precautions	Probability of Burglaries %
NONE	Less than 3	2·29
YES	Less than 3	1·35
NONE	Greater than 3	1·1
YES	Greater than 3	0·21

Table 3. Relative effects of having combinations of alarm systems and levels of precautions.

the same incentive to reduce false alarms. Most alarms are not connected to the police or central private monitoring agency and neither are all alarms registered like televisions or cars.

Technological Development

The development of battery technology has helped the development of wireless systems. This confirms the trend for wired systems to lose market share to wireless systems. There is also the prospect of greater integration of security-based applications into emerging telecommunications functions. Thus, using cellular network technology, an advanced mobile phone could be capable of alerting its owner to the status of his or her alarm system. Also, the range of functions able to be handled by devices of the current footprint of today's mobile phone is likely to expand significantly. Many of these functions will have significance for the security industry. Remote video monitoring of sites using video phones of the future may even be possible.

With the process of global deregulation of telecommunications, phone companies are acutely aware of the range of services they could potentially offer. Their entrance into the security industry is awaited with some trepidation. Also, in city areas, independent radio networks are being established to provide increased resilience to alarm monitoring. This is to safeguard against loss of conventional telephone links.

Summary

The sobering effect of the approach of a new millennium is certainly initiating much by way of reflection in the security of the world. Security can, in fact, be viewed with two perspectives. One is the influence of things external that prompt the need for security measures and the other is the means and methods to provide that level of security. To have a balanced view of security requires both to be appreciated. With the world increasingly interconnected in so many ways – socially, economically, ecologically and politically, problems in these areas tend to ripple round the world.

While it is appropriate to assimilate and develop security technology to make our lives and living spaces safer, in the bigger picture, the outworking of the 20th century's interpretation of market forces is creating the very conditions through social and ecological havoc to undermine the very security that we currently enjoy.

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Dedicated Micros,
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Manchester,
M27 4FL.
Tel: (0161) 794 0424.

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RESEARCH NEWS

by Dr. Chris Lavers

Unpowered 'Smart' Electrochromic Windows

Recent work by Dr Clemens Bechinger, previously at the National Renewable Energy Laboratory in Colorado, but now at the University of Konstanz in Germany, has been the development of a revolutionary self-powered electrochromic window requiring no external power supply, which has recently been publicised in Nature (*Nature* Volume 383, 17 October 1996). Both electrochromic materials (materials that change colour in response to a voltage driven change in oxidation state) and photochromic materials (materials that change colour after light absorption) are currently being investigated for several potential applications in 'smart' windows, imaging devices and display devices. In Bechinger's device, an electrochromic film and a photovoltaic film form the two electrodes of an electrochromic cell. The separation of the two electrodes allows both electrochromic and photochromic properties to be optimised individually.

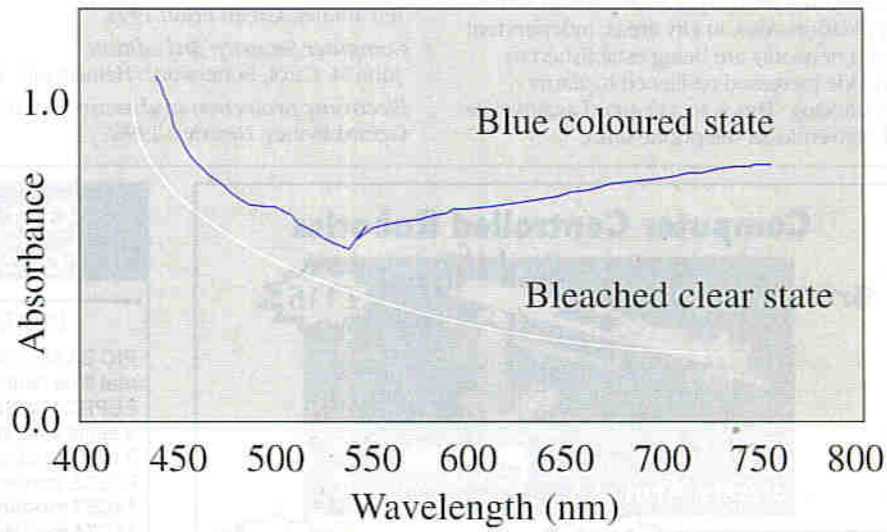
The light absorbing function of the photoelectrochromic (PEC) cell is performed by a dye-covered electrode that produces a voltage sufficient to colour a 500nm thick thermally evaporated WO3 electrochromic film on an Indium tin oxide (ITO) coated glass substrate. The dye is Ruthenium(II)L'L'' (where L' is 2,2'-bipyridine-4,4' dicarboxylate and L'' is 4,4'-dimethyl-2,2'-bipyridine), is deposited from a dilute solution in ethanol to leave a TiO^2 (sapphire) electrode almost completely transparent to visible light. The cell is filled with Lithium Iodide and 4-t-butylpyridine. Light absorption by the sensitised dye leads to electron injection in the TiO^2 film. An open-circuit photovoltage of 0·6-0·9V is generated but is insufficient to colour the cell. However, when the cell is short-circuited, a Lithium Tunsgsten oxide is formed which has a distinct blue colour.

WO^3 (transparent) + Li+ $LiWO^3$ (coloured)

The electrochromic process is highly reversible and lifetimes of over 107 cycles have been demonstrated in displays. When the incident light is blocked, the cell spontaneously discharges and returns back to its bleached transparent state. Photo 3 shows the typical PEC cell's absorbance in both the bleached and coloured states.

The PEC device (shown in Photo 4 under illumination) has advantages over earlier 'smart' windows as existing 'smart' windows require an external power supply. A self-powered 'smart' window which uses the energy of incident sunlight to modulate its own transmissivity could be easily installed in existing buildings without significant expense and reduces the necessity for air-conditioning. In addition, even infra-red absorbing dyes may be employed in these electrode systems, in which case, the

Figure 1. Typical PEC device absorbance in both a bleached and coloured state.



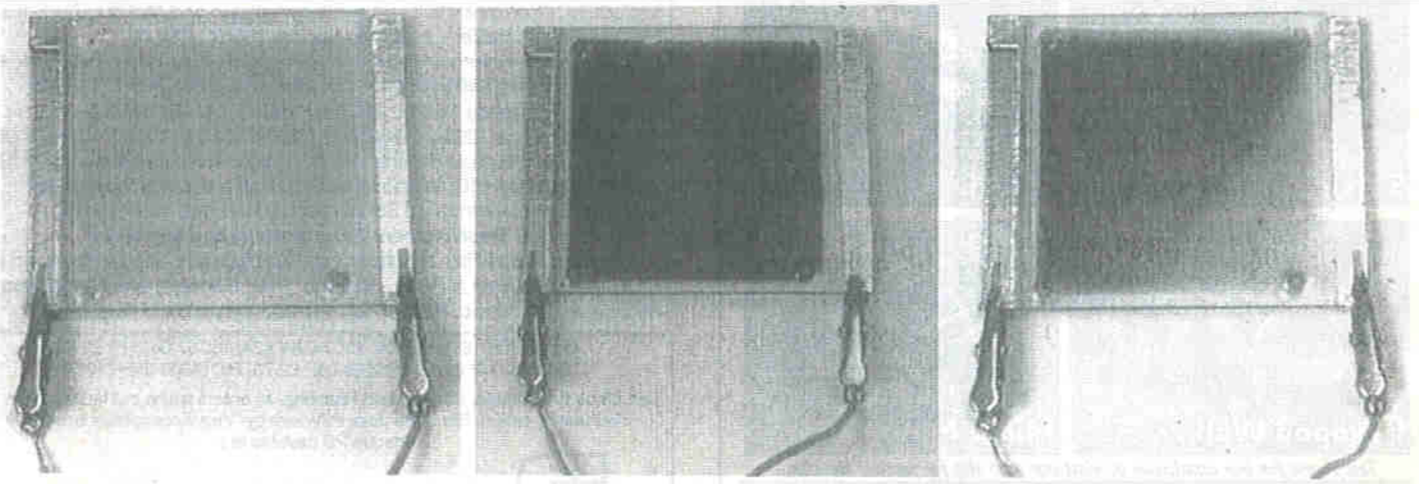


Photo 4. Photograph of a PEC cell with a 25cm² area: Left). The bleached state of the cell is weakly yellow due to the photochromic dye and some scattering from the TiO2 electrode. Middle). The dark blue coloured state is achieved by illuminating the cell at an intensity of about 75mW cm⁻² for 60 seconds. Right). The cell with both regions coloured and bleached is achieved by selective illumination of the substrate. Here, one corner has been kept masked. The states shown in Middle and Right will remain virtually unchanged for up to 24 hours if the cell is kept at open-circuit.

device would be transparent to visible light but darkened by sunlight or when addressed by an infra-red semiconductor laser diode. Current dye-sensitised electrodes are quite inexpensive, robust and easily scaled up to give large-area substrates, certainly a problem in large scale liquid crystal device technology. Dr Clemens Bechinger also says that it is possible to significantly lower the voltage threshold required for switching. The use of magnesium fluoride layers has allowed him to achieve their smallest switching voltage of 0·87V to date.

Formation of the British Entertainment Laser Association

Several of the UK's leading optical suppliers, including Spectra Physics and the laser giant, Coherent (actually an American company), have decided to form their own industrial watchdog to protect against untrained and unsafe use of laser equipment for venues such as laser light shows, in line with current UK legislature and guidelines from the Health and Safety Executive. The new organisation is to be called BELA, an acronym of the British Entertainment Laser Association. Future aims will be to extend this organisation to cover European suppliers and to try to readdress the downward trend of an industry in which until recently, the UK was the major supplier of lasers and laser display systems. Unfortunately, poor inward investment and resulting inferior quality products has knocked the UK off its top position. Britain is unlikely to act independently of its European partners as the French laser association, Club Laser de Puissance, has strongly advocated the development of a European laser strategy to cover the existing eleven national laser associations for some time, to form a pan-European laser federation. Further information may be obtained by contacting:

Ms Helen Goldsmith,
Laser 2000,
Britannia House,
Denford Road,
Ringstead,
Northamptonshire,
NN14 4DF.
Tel: (0193) 461 666
Fax: (0193) 461 699

UK Laser Forum

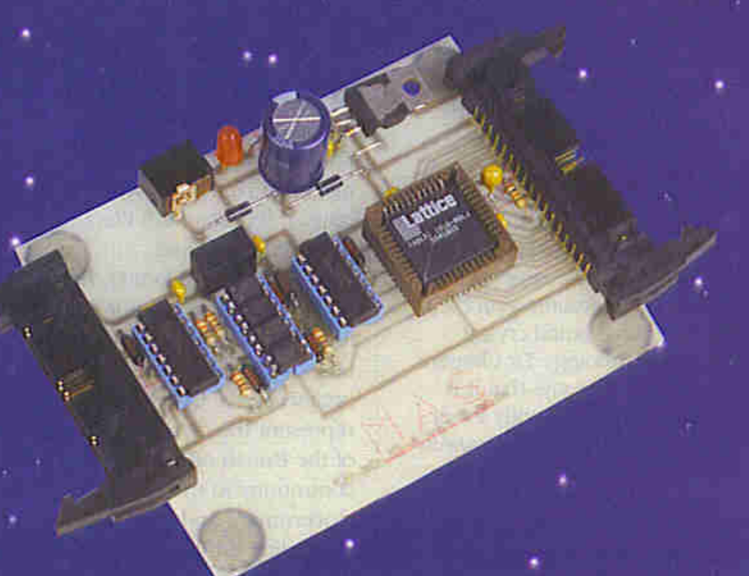
A new UK forum for optical technologies and devices has just been launched. The council for Laser and Electro-Optic Research and Development (CLEORD) has been formed from a number of academic departments, end users and regional and local organisations. CLEORD will represent the diverse interests of the British optoelectronics community to the British Government and also to the expanding European Union for European funds. Its main objectives are to promote technology transfer within the UK and the dissemination of scientific information on laser applications and optoelectronics technologies.
Fax: (01923) 859 393.

The Future is Bright, the Future is ITEC

The Government's Office of Science and Technology has produced a series of Action Plans for all of the key technological areas in the UK. According to the Government's latest Department of Trade and Industry report, information technology, electronics and communications (ITEC) "will be the industry that determines our future success and competitiveness in all industry sectors in the next one or two decades", says the ITEC panel. Following consultation with 10,000 people, each of 16 dedicated panels, including IT, electronics and communications, defence and aerospace, energy and transport identified the likely trends and the hurdles in the next 10-20 years and the developments in science, engineering and technology needed to overcome them.

ITEC stresses the need to involve both business and research, the necessity to evolve a national strategy for technology transfer and to cement the existing relationship between academic departments and industry. Copies of The Foresight panel Action Plans may be obtained free from the Office of Science and Technology by sending a fax to (0171) 271 2015.

PC Interface Bus 'IBUS'



Printer Port Adaptor

by Neil Johnson

The ordinary PC-compatible computer can form the heart of a powerful measurement and control system, offering data processing, storage, graphical display, user interface and communications facilities in one unit. However, for interfacing to user-designed custom hardware, the PC is somewhat lacking.

This project presents a solution to this deficiency – the PC Interface Bus, or IBUS, for short. The IBUS is a simple 8-bit bidirectional bus operating at a fairly modest speed, and can handle a large number of interface modules.

The IBUS

The IBUS has been designed to satisfy the needs of the PC expansion enthusiast, with the aims of minimum interface component cost and large expansion capability. All previous PC expansion projects have either used one of the PC's standard ports or a special purpose card. On a typical PC, you are limited to one free printer port, one free serial port and three or four spare slots. In contrast, the IBUS can, in theory, interface 256 separate modules to one printer port. This should provide plenty of room for even the most enthusiastic constructor!

The IBUS has been designed to provide full electrical isolation between the PC and the interface bus and any connected modules. This is achieved with opto-isolators and a DC-DC converter.

Finally, simplicity of design has been a key design requirement. There is a certain natural beauty in simple designs. Problems tend to breed like rabbits in complex systems, causing frustration for the designer, constructor and user (sometimes one and the same). This project uses a programmable logic device to keep the component count low and the PCB layout as small and simple as possible.

The full specification of the IBUS is shown in Table 1.

Printer Port Adaptor

The first module in the IBUS chain is the Printer Port Adaptor. As its name suggests, it provides an interface between the PC's printer port and the IBUS. A block diagram for the Printer Port Adaptor is shown in Figure 1.

Starting at the left, the Printer Port is buffered to drive the opto-isolator array. Together with the DC-DC converter, this provides total electrical isolation between the PC and the IBUS.

A second set of buffers follows the opto-isolators before feeding the signals into the core of the adaptor, the Logic Module. This consists of a serial-to-parallel shift register providing data to three registers: an 8-bit address register, a 4-bit control register, and an 8-bit bidirectional data register. The IBUS Port connects directly to the Logic Module on the right hand side.

The power supply consists of two parts. The first part regulates the DC supply down to +5V and is able to supply up to 500mA. This provides power for the IBUS-side circuitry and the IBUS interface itself. The second part of the power supply, the DC-DC converter, provides an electrically isolated supply for the PC-side of the adaptor.

Bus Connections:

Pin	Function	Pin	Function
1	GND	2	GND
3	A0	4	A1
5	A2	6	A3
7	A4	8	A5
9	A6	10	A7
11	GND	12	GND
13	+5V	14	+5V
15	+5V	16	+5V
17	GND	18	GND
19	RD	20	GND
21	WR	22	GND
23	GND	24	GND
25	D7	26	D6
27	D5	28	D4
29	D3	30	D2
31	D1	32	D0
33	GND	34	GND

Interface:	8-bit data, 8-bit address, bidirectional expansion bus
Address:	8-bit (0-255)
Data:	8-bit (0-255), bidirectional
Control:	Read, Write strobes, active low, data latched on rising edge
Supply:	+5V @ 200mA is available for powering bus interface circuit only
Cable:	Standard 34-way IDC ribbon cable, unterminated
Connectors:	Standard 34-way IDC connectors, bump polarized
Timing:	Bus cycle time approximately 1ms, depending on speed of host PC. Read, Write need 4 cycles, approximately 4ms total.
Signal Levels standard TTL:	low: < 0·8V high: > 2·0V

Table 1. IBUS Specification.

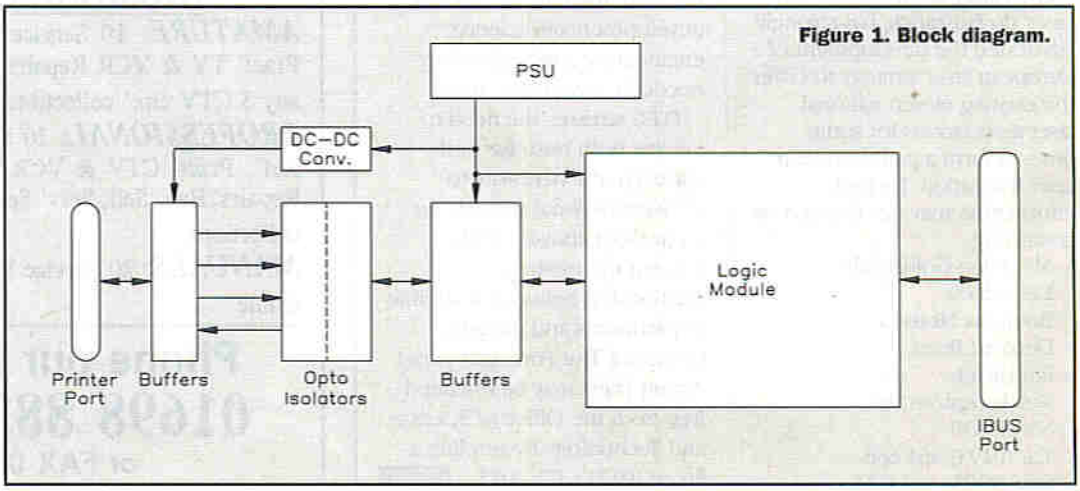


Figure 1. Block diagram.

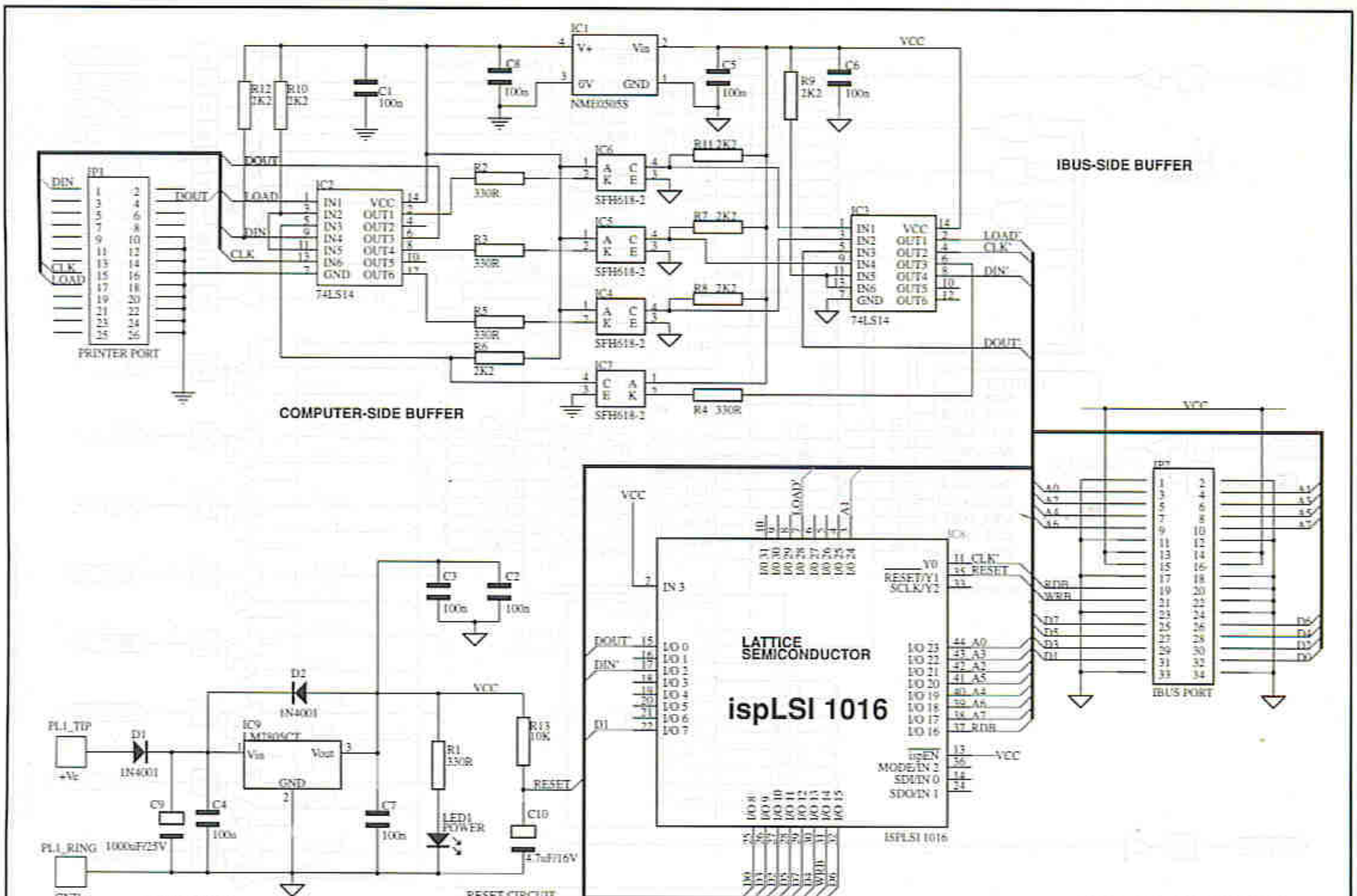


Figure 2. Circuit diagram.

How it Works

The full circuit diagram of the IBUS printer port adaptor is shown in Figure 2. The printer port is a simple TTL-level interface. It provides a number of input and output pins suitable for direct connection to logic gates. To minimize the number of expensive opto-isolators, a serial interface is used between the PC and the IBUS adaptor. In this design, only four lines are required to provide all the control and data signals: Data In, Data Out, Clock, and Load.

Starting with the PC side of the electrical barrier, the PC is attached to the printer port, JP1, from which the four signals are connected. IC2, a hex Schmitt buffer, provides extra drive signal for the opto-LEDs (IC4-6) and signal buffering for the opto-transistor, IC7. Resistor R12 provides a pull-up for the open-collector signal from the printer port, while R10 ties the unused inputs high.

To drive the LEDs in the opto-isolators, the high current sinking capability of the TTL outputs is used, with resistors R2, R3 and R5 limiting the LED current to about 10mA. Resistor R6 provides a collector load for the opto-transistor of IC7, whose output is buffered by IC2.

IC1 is the DC-DC converter. It consists of an oscillator, a small transformer and a rectifier/smoothing circuit, with the transformer providing the isolation between the input and the output. The converter provides a regulated +5V output, up to 200mA, to drive the buffer and LED circuits. Together with the opto-isolators, it provides complete electrical isolation between the PC and the IBUS.

The other side of the barrier is similar, with roles reversed for the buffers. Resistors R7, R8 and R12 provide collector loads for the opto-transistors of IC4-6, and resistor R4 limits the LED current in IC7. As before, R9 ties the unused inputs high.

It is worth noting the reason for tying the unused inputs to a high state. Although not strictly necessary for ordinary TTL gates, as they will naturally float to a high state, it makes good practice to externally tie them high. They could be pulled low through a suitable resistor. However, TTL inputs sink far less current than they source – typically a few tens of microamps, while sourcing several hundred microamps. For any circuit with more than a few unused inputs, this difference can be considerable.

The isolated and buffered signals from the printer port are then fed into the main circuit block, IC8. This is a Complex Programmable Logic Device (CPLD), containing approximately 2,000 logic gates – imagine this as 500 typical quad logic ICs, and one can see the benefits of using this device. A full diagram of the main logic is shown in Figure 3, and will be discussed below.

All connections to the IBUS are made directly to IC8. The remaining connector pins are connected to either ground or +5V. These supplies are only for powering a small number of interface components, not for entire interface modules. If too much current is drawn from the IBUS, IC9 will not be able to provide sufficient current to power both the onboard circuits and the extra load, causing it to overheat and, eventually, shut down. You have been warned!

The final part of the circuit provides the Power Supply Unit (PSU) and a reset pulse. The PSU is based around IC9, a standard 78xx series linear regulator – in this case, a 7805 variant capable of supplying up to 500mA. Power enters the board via DC connector, PL1. Diode D1 protects the board from incorrect supply polarity, while diode D2 protects IC9 against reverse voltages, most likely after the power is switched off. Supply status is provided by LED1 – the ubiquitous 'Power On' indicator.

Embedded Logic

The heart of the IBUS printer port adaptor is IC8, a CPLD programmed with the complex logic of this design. A block diagram of the logic system is shown in Figure 3.

Data from the PC enters via the DataIn signal, clocked into the 10-bit Master Shift Register (MSR) by the Clock signal. Once all 10 bits have been loaded, the Load strobe line is pulsed high. The top two bits of the shift register provide a set of enable signals via an internal address decoder. These lines select which of the internal registers is activated by the Load strobe. The register address allocations are:

Address	Register
00	Data Input Register
01	Data Output Register
10	Control Register
11	Address Register

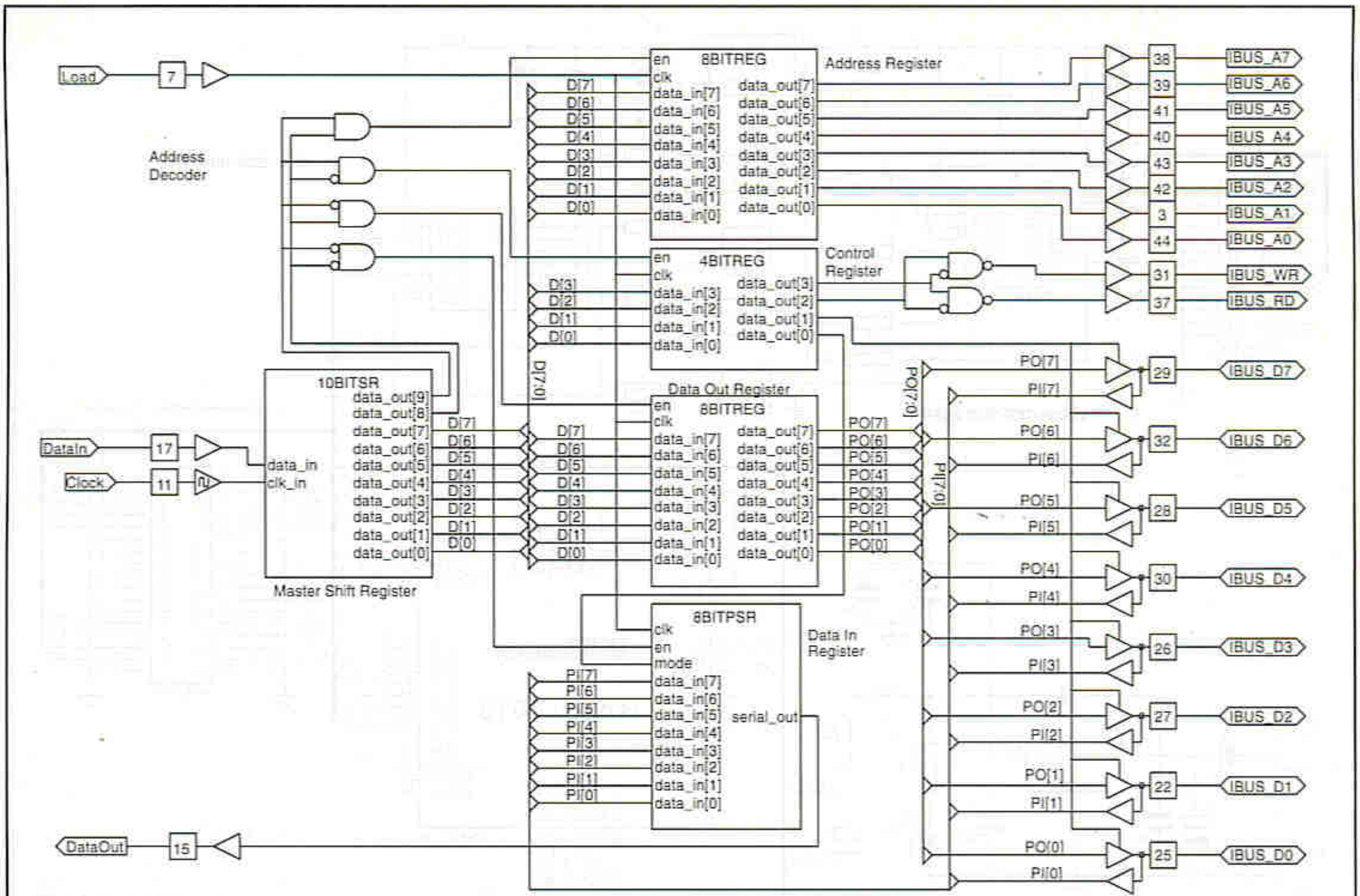


Figure 3. CPLD Logic.

The MSR provides a write-only interface to the internal logic. A full 10-bit word is made up from the two address bits and the eight data bits. The address bits occupy the top two bits of the word, as the example below illustrates:

Address:	11
Data:	00110010
Data to write:	1100110010

The Address Register (AR), top, is a write-only 8-bit register. Its contents define the current IBUS address, and all eight bits are visible from the IBUS connector. Before either a read or a write operation, the desired address is written into the Address Register.

The Control Register (CR) provides both internal and external control signals. The two external signals are Read and Write. The two AND gates between the CR and the IBUS connector ensure that one, and only one, of these lines can be set low at any one time. This ensures correct operation of the IBUS even after a reset or if corrupt data is written to the CR. The other two control signals are used to determine the mode of operation of the two data registers. The bits are assigned as follows:

Bit	Function
0	DIR Mode
1	Output Enable
2	Write
3	Read

The Data Register consists of two 8-bit registers to provide a full, bidirectional 8-bit interface to the IBUS – one as a parallel output register, and the other as a parallel input, serial output shift register to send the received data to the PC. Control of the DR is from two bits of the CR and two enable signals.

To write a byte to the IBUS, the 8-bit parallel output register is used. Firstly, a byte is written to register address 01. This loads the Data Output Register (DOR) with the desired byte. Secondly, bit 1 of the CR is turned on, enabling the output buffers. Thirdly, the Write bit of the CR is pulsed, and finally, the IBUS data output buffers are put back into a high-impedance state. Figure 4(a) shows the states of the relevant signals.

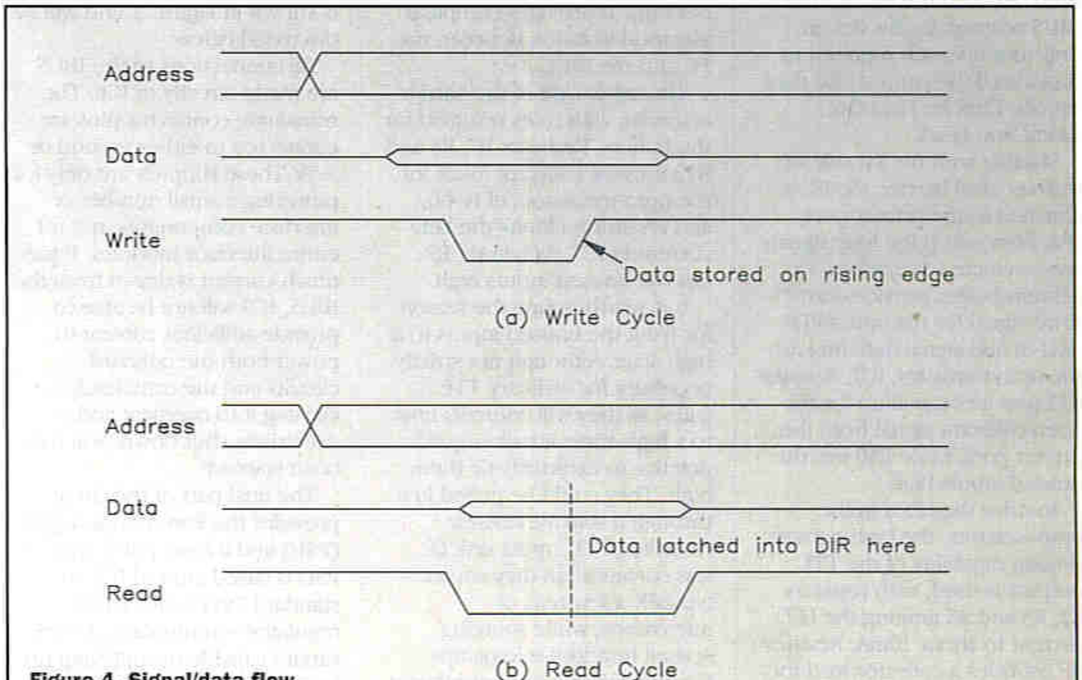


Figure 4. Signal/data flow.

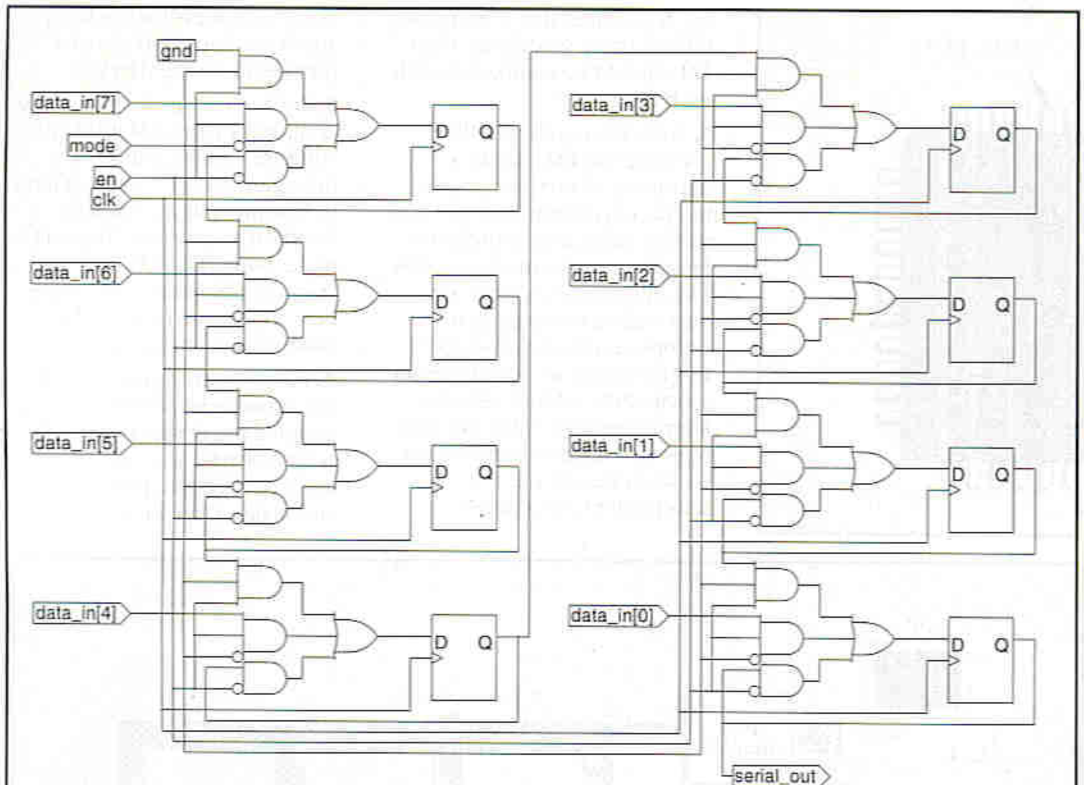


Figure 5. Internal structure of the DIR.

To read a byte from the IBUS, the Read line must be set low, data must be latched into the Data Input Register, the Read line set high again, and the data clocked out of the 8-bit shift register and into the PC (see Figure 4(b)). Figure 5 shows the internal structure of the DIR. The first step is to set the Read bit of the CR high. The inverters automatically convert this to a low level for the IBUS. Then, the Mode bit of the CR is set to a 0, preparing the Data Input Register (DIR) to receive a parallel byte. To latch the current IBUS value into the DIR, a dummy write is performed to the DIR, at address 00. The Read line is then reset and the Mode bit set to a 1 (these two operations can be combined into one write to the CR). Lastly, the eight data bits are shifted out of the DIR on successive dummy writes to the DIR.

At first glance, it all looks horribly complicated, but with the aid of some relatively simple software, virtually all of this complexity is hidden (or, in technical parlance, 'encapsulated').

Do It Yourself

Construction of the IBUS Printer Port Adaptor is very straightforward. All components are mounted on the single-sided board, using sockets where indicated in the text. The PCB overlay is shown in Figure 6.

Begin with the smallest components, the wire link, resistors, diodes, capacitor C10 and the decoupling capacitors. Make sure the diodes are inserted with the correct polarity. Continue with the ICs, voltage regulator and power connector. A socket is needed for IC8 as the CPLD is provided in a PLCC (Plastic Leadless Chip Carrier) surface mount package. The two buffer chips and the opto-isolators can be mounted directly onto the board.

The DC-DC converter and the two data connectors should next be soldered to the board. Ensure that the converter is inserted the correct way around – pin 1 is indicated by a dot on the body. As a very expensive item, you only get one chance of being right. Connect it the wrong way around and . . . puff! In situations like this, the author applies a variation of a maxim learnt at school: check a thousand times, but only solder once. Experience has provided ample evidence to support this practice.

Finally, fit the remaining capacitor, C9, to the board, again following the polarity indications shown in Figure 6.

Testing, Testing

Before fitting the CPLD, and the other ICs if sockets are used, power up the board and check the supply voltages with a multimeter. A DC supply capable of 9V at 300mA should be sufficient. There should be a regulated +5V across all of the supply pins. For IC2 and IC3, pin 7 is GND and pin 14 is +5V. For IC8, pins 1 and 23 are GND and pins 12 and 34 are +5V. Figure 7 shows where pins 1 and 44 are for IC8, the pin numbers following a counter-clockwise path around the periphery of the device. If any voltage levels are missing or wrong, switch off immediately and investigate.

Assuming the supply voltages are correct, insert IC2 and the four opto-isolators, IC4-7. Please note that IC7 is inserted upside down with respect to the others, with its notch pointing downwards. Apply the power again and check that +5V is across IC2, pins 14 and 7. If all is well, continue with IC3 and IC8. Repeat the supply check once more, just to be sure.

The next stage of testing involves connecting the adaptor to your PC. For this, a cable is required. At one end should be a 25-way D-connector, and at the other, a 26-way IDC connector to mate with JP1. By

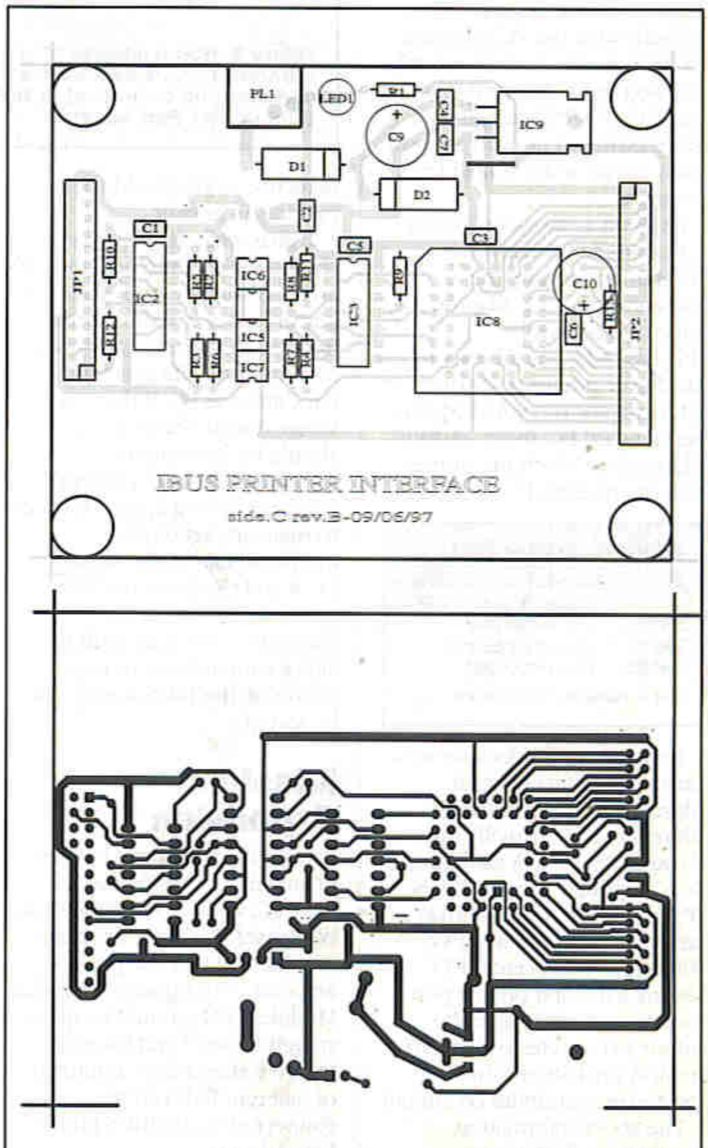


Figure 6. PCB component positions and PCB track layout.

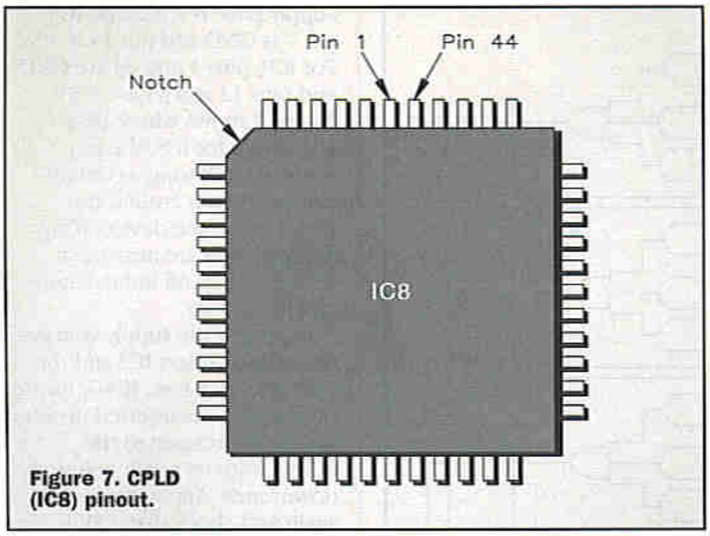


Figure 7. CPLD (IC8) pinout.

far the easiest way of making this cable is to use an IDC-terminated D-connector – no soldering is required to complete the termination. This is much faster, and less error-prone, than hand-soldering 25 little wires. A vice can be used to carefully squeeze the two connector halves together.

Before connecting the adaptor to your PC, it is advisable that the PC is turned off. With the D-connector firmly attached to the PC, turn it back on. With the IBUS adaptor board powered up, you are now ready to run some simple test programs.

Program 1, shown in Listing 1, is a simple GWBASIC program to exercise the functionality of the adaptor. The value of the variable LPT_BaseAddr must be set to whichever printer port your IBUS adaptor is connected. On the standard PC, there are four addresses at which the printer port can be found:

Address	Printer Port
&H3BC	Found on Monochrome Display Adaptor (MDA)
&H378	First printer port
&H278	Second printer port
&H2BC	Third printer port

(&H = hexadecimal notation)

Because the PC does some rearranging of its internal addresses at bootup, the address of LPT1 actually varies. If you have an MDA card fitted, then its printer port becomes LPT1, with the first non-MDA printer port becoming LPT2. Without an MDA card, LPT1 becomes the first printer port on your system. One of the author's computer systems has an MDA card fitted, which resulted in some initial confusion!

The above information should be sufficient to determine which address you should use. If not, a little bit of detective work should soon provide an answer.

If all is well, the program should indicate the presence of an IBUS adaptor card. The test performed is to write a byte into the DOR then read this back into the DIR and then back into the PC. If the two values match, the adaptor should be functioning.

As a further test, a second program, Listing 2, can be used to manually set or clear individual bits in the AR and DOR and the Read and Write signals, and to read the contents of the DIR. With the aid of a multimeter or logic probe, all the IBUS signals can be tested.

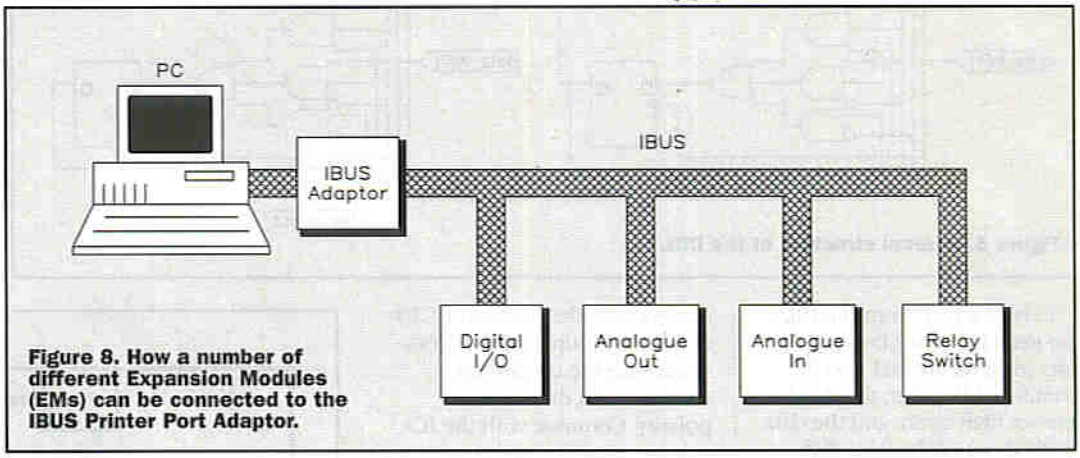


Figure 8. How a number of different Expansion Modules (EMs) can be connected to the IBUS Printer Port Adaptor.

Mission: Expansion

You are now the proud owner of an 8-bit expansion bus for your PC. What next? Expansion, of course! The IBUS has been designed so that the process and cost of designing Expansion Modules (EM) should be quite straightforward and low cost. Figure 8 shows how a number of different EMs can be connected to the IBUS Printer Port Adaptor.

To aid the constructor, a set of guidelines has been drawn up. It is hoped that if everybody follows these guidelines, then EMs should be compatible with each other.

1. Limit the number of IBUS addresses an EM uses to a maximum of two. For simple interfaces requiring a single 8-bit read or write, one address will be sufficient. For more complex EMs, a system of control and data registers is suggested, occupying two address spaces. In this system, a control register specifies the address of some internal register, while the data register is used to transfer data between the PC and the selected internal register.

2. Only use the IBUS supply lines to power the IBUS interface components. For example, a suggested circuit that uses four ICs, with a current consumption of about 5mA. Alternatively, just provide power to a set of buffers between the IBUS and the EM: one octal buffer for the address bus, two buffers for the Read and Write lines, and an octal transceiver for the data bus.

3. Try and encapsulate all of the complexity of an EM inside the software – a function, procedure or subroutine. Think of it as providing a software interface to your EM. This will make using your EM considerably easier, since each new application can use the same, simple interface.

4. Put as much complexity into the software as possible. Keeping the design of the EMs simple keeps the costs low, reduces hardware problems, and makes it much more fun. With today's modern high-speed computers, there is plenty of processing power going to waste – use it!

To provide a starting block for your designs, a simple 8-bit IO port is illustrated in Figure 9. It contains all of the basic functionality needed for an EM – address decoding, data

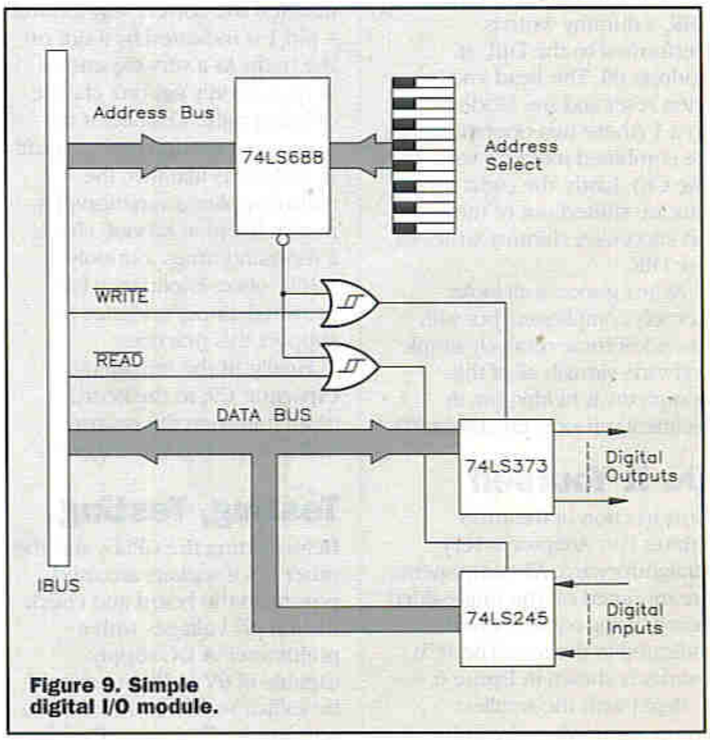


Figure 9. Simple digital I/O module.

writing and data reading. Add a power supply, a chunk of stripboard and a couple of connectors, and we have our first EM. Now, that's progress!

Support Software

To accompany this project, a disk is available with a library of software routines for a number of different languages. As well as the programs in Listings 1 and 2, there are source code libraries for QBasic and C for DOS, and a DLL for Windows with example programs in Visual Basic and Visual C.

Also on the disk is the design data for the CPLD, including full schematic files and the JEDEC programming file for downloading to a programmer. The Synario software used to design the logic is freely available from Maplin on the Lattice data CD.

Acknowledgements

The author would like to express his thanks to Cambridge Consultants Ltd., Cambridge, for help in providing development facilities for this project.

Further Reading

For readers who would like further information about PC expansion techniques and programming, the following books were used during the development of this project.

For PC hardware:

PC Intern, by Michael Tischer, published by Abacus.

The Indispensable PC Hardware Book, by Hans-Peter Messmer, published by Addison-Wesley.

Both books cover PC hardware to a considerable depth, in particular, the operation and programming requirements of the various ports.

For Windows programming:

Programming Windows 3.1 and 95, both by Charles Petzold, published by Microsoft Press.

These are very well-written reference books on writing programs for Windows 3.1 and Windows 95. Aimed specifically at the intermediate to advanced C programmer.

For general electronics:

The Art of Electronics, by Horowitz and Hill, published by Cambridge University Press.

This is probably the best book in its field, and also easy to read for all levels of interest. If you have even the slightest interest in electronics, this book is definitely recommended.

```
10 REM
==================================================
20 REM IBUS Printer Port Adaptor
30 REM Test Program #1
40 REM ------------------------------------------
50 REM This program tests the specified printer port to detect the
60 REM presence of a Printer Port Adaptor. It uses the port adaptor
70 REM loopback test feature to read the contents of the Data Output
80 REM Register back into the Data Input Register. The two test bytes
90 REM are AA and 55, which exercise all bit combinations between
them.
100 REM
110 REM The program displays the operation status while running, and
120 REM displays a summary PASS/FAIL at the end.
130 REM ------------------------------------------
140 REM Written by: Neil Johnson
150 REM Language: Microsoft GW-Basic
160 REM Date: 7th July 1997
170 REM Version: 1.0
180 REM ==============================================
================
190 :
200 REM **** Change the address below to match your printer port ****
210 :
220 LET GLB.BASEADDR = &H3BC
230 :
240 CLS
250 PRINT: PRINT
260 PRINT " IBUS Printer Port Adaptor Test Program"
270 PRINT "--------------------------------"
280 PRINT
290 :
300 REM Test for presence of IBUS Printer Adaptor board
310 REM at the specified port.
320 :
330 PRINT "Scanning printer port at address &H";HEX$(GLB.BASEADDR)
340 PRINT
350 :
360 LET GLB.TEST = 0
370 :
380 REM Execute test with test word &HAA
390 :
400 LET GLB.TESTBYTE = &HAA
410 GOSUB 570
420 :
430 REM Execute test with test word &H55
440 :
450 LET GLB.TESTBYTE = &H55
460 GOSUB 570
470 :
480 PRINT "Test result:"
490 PRINT "IBUS Printer Port Adaptor ";
500 :
510 REM If Test = 0 then the test failed.
520 :
530 IF GLB.TEST = 0 THEN PRINT "not found." ELSE PRINT "found at
&H";HEX$(GLB.BASEADDR)
540 END
550 :
560 :
570 REM ==============================================
================
580 REM Test IBUS adaptor with
590 REM byte in glb.testbyte
600 REM ------------------------------------------
610 :
620 REM Start by assuming adaptor present
630 :
640 LET GLB.TEST = 1
650 :
660 REM Write testbyte into Data Output Register
670 :
680 LET GLB.BYTE = GLB.TESTBYTE
690 LET GLB.REG = 1
700 GOSUB 1030
710 :
720 REM Enable output buffers
730 :
740 LET GLB.BYTE = 2
750 LET GLB.REG = 2
760 GOSUB 1030
770 :
780 REM Do a dummy write to the Data Input Register
790 :
800 LET GLB.BYTE = 0
810 LET GLB.REG = 0
820 GOSUB 1030
830 :
840 REM Change DIR to read mode
850 :
860 LET GLB.BYTE = 1
870 LET GLB.REG = 2
880 GOSUB 1030
890 :
900 REM Read byte from DIR
910 :
920 GOSUB 1560
930 :
940 REM Compare glb.invar with glb.testbyte. If different
950 REM set GLB.TEST to 0.
960 :
970 IF GLB.INVAR <> GLB.TESTBYTE THEN GLB.TEST = 0: PRINT " -
FAIL":GOTO 1000
980 PRINT " - PASS"
990 :
1000 PRINT
1010 RETURN
1020 :
1030 REM ==============================================
================
1040 REM Write byte in glb.byte to
1050 REM adaptor register glb.reg
1060 REM ------------------------------------------
1070 :
1080 REM Print status message
1090 :
1100 PRINT "Writing &H";HEX$(GLB.BYTE);" to h/w register ";GLB.REG;
1110 :
1120 REM Write data bits
1130 :
1140 FOR COUNT=0 TO 7
1150 :
1160 : REM Put out the next bit
1170 :
1180 : OUT (GLB.BASEADDR+2), 1-((GLB.BYTE AND 2^COUNT)/2^COUNT)
1190 : GOSUB 2030
1200 :
1210 : REM Toggle the Clock line up and down
1220 : OUT GLB.BASEADDR, 64
1230 : GOSUB 2030
1240 : OUT GLB.BASEADDR, 0
1250 : GOSUB 2030
1260 NEXT COUNT
1270 :
1280 REM Write address bits
1290 :
1300 FOR COUNT=0 TO 1
1310 :
1320 : REM Put out the next address bit
1330 :
1340 : OUT (GLB.BASEADDR+2),1-((GLB.REG AND 2^COUNT)/2^COUNT)
1350 : GOSUB 2030
1360 :
1370 : REM Toggle the Clock line
1380 :
1390 : OUT GLB.BASEADDR, 64
1400 : GOSUB 2030
1410 : OUT GLB.BASEADDR, 0
1420 : GOSUB 2030
1430 NEXT COUNT
1440 :
1450 REM Toggle Load line high-low
1460 :
1470 OUT GLB.BASEADDR, 128
1480 GOSUB 2030
1490 OUT GLB.BASEADDR, 0
1500 GOSUB 2030
1510 :
1520 PRINT " _"
1530 :
1540 RETURN
1550 :
1560 REM ==============================================
================
1570 REM Read a byte from
1580 REM DIR. Put byte
1590 REM into glb.invar
1600 REM ------------------------------------------
1610 :
1620 LET GLB.INVAR = 0
1630 :
1640 REM Set Address bits to 00
1650 :
1660 OUT (GLB.BASEADDR+2),1
1670 :
1680 FOR COUNT=0 TO 1
1690 :
1700 : REM Toggle the Clock line
1710 :
1720 : GOSUB 2030
1730 : OUT GLB.BASEADDR,64
1740 : GOSUB 2030
1750 : OUT GLB.BASEADDR, 0
1760 NEXT COUNT
1770 :
1780 REM Read first bit
1790 :
1800 GLB.INVAR = ((INP(GLB.BASEADDR+1) AND 8)/8)
1810 :
1820 REM Read remaining bits
1830 :
1840 FOR COUNT = 1 TO 7
1850 :
1860 : REM Toggle Load Line up and down
1870 :
1880 : OUT GLB.BASEADDR,128
1890 : GOSUB 2030
1900 : OUT GLB.BASEADDR,0
1910 : GOSUB 2030
1920 :
1930 : REM Read next bit from port and add to GLB.INVAR
1940 :
1950 : IF ((INP(GLB.BASEADDR+1) AND 8)/8) = 0 THEN GOTO 1970
1960 : GLB.INVAR = GLB.INVAR OR 2^COUNT
1970 NEXT COUNT
1980 :
1990 PRINT "Read &H";HEX$(GLB.INVAR);
2000 :
2010 RETURN
2020 :
2030 REM ==============================================
================
2040 REM Short Delay
2050 REM ------------------------------------------
2060 :
2070 FOR DELAY=1 TO 100
2080 NEXT DELAY
2090 RETURN
```

Listing 1. Test Program 1.

```
10 REM ==========================================================================
20 REM IBUS Printer Port Adaptor
30 REM Test Program #2
40 REM ------------------------------------
50 REM This program exercises the port adaptor, allowing the user to
60 REM change the Address, Read, Write, and Data Out bits directly.
70 REM The user can also read the status of the eight Data bits.
80 REM ------------------------------------
90 REM Written by: Neil Johnson
100 REM Language: Microsoft GW-Basic
110 REM Date: 7th July 1997
120 REM Version: 1.0
130 REM ==========================================================================
140 :
150 REM **** Change the address below to match your printer port ****
160 :
170 LET GLB.BASEADDR = &H3BC
180 :
190 CLS
200 PRINT " IBUS Printer Port Adaptor Control Program"
210 PRINT " ----------------------------------------"
220 :
230 REM Define global variables
240 :
250 LET GLB.ADDR = 0
260 LET GLB.DATA.IN = 0
270 LET GLB.DATA.OUT = 0
280 LET GLB.CNTL = 0
290 :
300 PRINT " ADDRESS BUS"
310 PRINT " bit bit"
320 PRINT " 7 6 5 4 3 2 1 0"
330 PRINT "key: Q W E R T Y U I"
340 PRINT "state:"
350 PRINT
360 PRINT " DATA BUS OUTPUT"
370 PRINT " bit bit"
380 PRINT " 7 6 5 4 3 2 1 0"
390 PRINT "key: Z X C V B N M ,"
400 PRINT "state:"
410 PRINT
420 PRINT
430 PRINT " CONTROL"
440 PRINT " Read Write"
450 PRINT "key: [ ]"
460 PRINT "state:"
470 PRINT
480 PRINT "To read the Data Bus, press ENTER"
490 PRINT
500 PRINT "To Quit, press #"
510 :
520 REM Enter key processing loop
530 GOTO 1140
540 :
550 LET A$=INKEY$
560 IF A$="" THEN GOTO 550
570 :
580 REM Process keystroke
590 :
600 REM Is it Quit ?
610 IF A$="#" THEN CLS:END
620 :
630 REM Is it toggle read or write ?
640 IF A$="[" THEN GLB.CNTL = GLB.CNTL XOR &H8: GOTO 1100
650 IF A$="]" THEN GLB.CNTL = GLB.CNTL XOR &H4: GOTO 1100
660 :
670 REM Is it a read ?
680 IF A$=CHR$(13) THEN GOSUB 1880: GOTO 1140
690 :
700 REM Is it one of the address bit changes ?
710 IF A$="Q" THEN GLB.ADDR = GLB.ADDR XOR &H80: GOTO 1040
720 IF A$="W" THEN GLB.ADDR = GLB.ADDR XOR &H40: GOTO 1040
730 IF A$="E" THEN GLB.ADDR = GLB.ADDR XOR &H20: GOTO 1040
740 IF A$="R" THEN GLB.ADDR = GLB.ADDR XOR &H10: GOTO 1040
750 IF A$="T" THEN GLB.ADDR = GLB.ADDR XOR &H8: GOTO 1040
760 IF A$="Y" THEN GLB.ADDR = GLB.ADDR XOR &H4: GOTO 1040
770 IF A$="U" THEN GLB.ADDR = GLB.ADDR XOR &H2: GOTO 1040
780 IF A$="I" THEN GLB.ADDR = GLB.ADDR XOR &H1: GOTO 1040
790 :
800 REM Is it one of the data bit changes ?
810 IF A$="Z" THEN GLB.DATA.OUT = GLB.DATA.OUT XOR &H80: GOTO 940
820 IF A$="X" THEN GLB.DATA.OUT = GLB.DATA.OUT XOR &H40: GOTO 940
830 IF A$="C" THEN GLB.DATA.OUT = GLB.DATA.OUT XOR &H20: GOTO 940
840 IF A$="V" THEN GLB.DATA.OUT = GLB.DATA.OUT XOR &H10: GOTO 940
850 IF A$="B" THEN GLB.DATA.OUT = GLB.DATA.OUT XOR &H8: GOTO 940
860 IF A$="N" THEN GLB.DATA.OUT = GLB.DATA.OUT XOR &H4: GOTO 940
870 IF A$="M" THEN GLB.DATA.OUT = GLB.DATA.OUT XOR &H2: GOTO 940
880 IF A$="," THEN GLB.DATA.OUT = GLB.DATA.OUT XOR &H1: GOTO 940
890 :
900 REM Unknown command, so ignore it
910 BEEP
920 GOTO 550
930 :
940 REM Update data output register
950 LET GLB.BYTE = GLB.DATA.OUT
960 LET GLB.REG = 1
970 GOSUB 1400
980 GLB.CNTL = GLB.CNTL OR 2
990 LET GLB.BYTE = GLB.CNTL
1000 LET GLB.REG = 2
1010 GOSUB 1400
1020 GOTO 1140
1030 :
1040 REM Update address register
1050 LET GLB.BYTE = GLB.ADDR
1060 LET GLB.REG = 3
1070 GOSUB 1400
1080 GOTO 1140
1090 :
1100 REM Update control reg
1110 LET GLB.BYTE = GLB.CNTL
1120 LET GLB.REG = 2
1130 GOSUB 1400
1140 :
1150 REM Display data on screen
1160 :
1170 LOCATE 7,1: PRINT "state:";
1180 FOR COUNT=7 TO 0 STEP -1
1190 : IF (GLB.ADDR AND 2^COUNT) = 0 THEN PRINT " 0"; ELSE PRINT " 1";
1200 NEXT COUNT
1210 :
1220 LOCATE 13,1: PRINT "state:";
1230 FOR COUNT=7 TO 0 STEP -1
1240 : IF (GLB.DATA.OUT AND 2^COUNT) = 0 THEN PRINT " 0"; ELSE PRINT " 1";
1250 NEXT COUNT
1260 :
1270 LOCATE 14,1: PRINT "read: ";
1280 FOR COUNT=7 TO 0 STEP -1
1290 : IF (GLB.DATA.IN AND 2^COUNT) = 0 THEN PRINT " 0"; ELSE PRINT " 1";
1300 NEXT COUNT
1310 :
1320 LOCATE 19,1: PRINT "state:";
1330 IF (GLB.CNTL AND &H8) = 0 THEN PRINT " 0"; ELSE PRINT " 1";
1340 IF (GLB.CNTL AND &H4) = 0 THEN PRINT " 0"; ELSE PRINT " 1";
1350 :
1360 GOTO 550
1370 :
1380 END
1390 :
1400 REM ==========================================================================
1410 REM Write byte in glb.byte to
1420 REM adaptor register glb.reg
1430 REM ------------------------------------
1440 :
1450 REM Write data bits
1460 :
1470 FOR COUNT=0 TO 7
1480 :
1490 : REM Put out the next bit
1500 :
1510 : OUT (GLB.BASEADDR+2), 1-((GLB.BYTE AND 2^COUNT)/2^COUNT)
1520 : GOSUB 2330
1530 :
1540 : REM Toggle the Clock line up and down
1550 : OUT GLB.BASEADDR, 64
1560 : GOSUB 2330
1570 : OUT GLB.BASEADDR, 0
1580 : GOSUB 2330
1590 NEXT COUNT
1600 :
1610 REM Write address bits
1620 :
1630 FOR COUNT=0 TO 1
1640 :
1650 : REM Put out the next address bit
1660 :
1670 : OUT (GLB.BASEADDR+2),1-((GLB.REG AND 2^COUNT)/2^COUNT)
1680 : GOSUB 2330
1690 :
1700 : REM Toggle the Clock line
1710 :
1720 : OUT GLB.BASEADDR, 64
1730 : GOSUB 2330
1740 : OUT GLB.BASEADDR, 0
1750 : GOSUB 2330
1760 NEXT COUNT
1770 :
1780 REM Toggle Load line high-low
1790 :
1800 OUT GLB.BASEADDR, 128
1810 GOSUB 2330
1820 OUT GLB.BASEADDR, 0
1830 GOSUB 2330
1840 :
1850 :
1860 RETURN
1870 :
1880 REM ==========================================================================
1890 REM Read a byte from
1900 REM DIR. Put byte
1910 REM into glb.invar
1920 REM ------------------------------------
1930 :
1940 LET GLB.INVAR = 0
1950 :
1960 REM Set address bits to 00
1970 :
1980 OUT (GLB.BASEADDR+2),1
1990 :
2000 FOR COUNT=0 TO 1
2010 :
2020 : REM Toggle the Clock line
2030 :
2040 : GOSUB 2330
2050 : OUT GLB.BASEADDR,64
2060 : GOSUB 2330
2070 : OUT GLB.BASEADDR, 0
2080 NEXT COUNT
2090 :
2100 REM Read first bit
2110 :
2120 GLB.INVAR = ((INP(GLB.BASEADDR+1) AND 8)/8)
2130 :
2140 REM Read remaining bits
2150 :
2160 FOR COUNT = 1 TO 7
2170 :
2180 : REM Toggle Load Line up and down
2190 :
2200 : OUT GLB.BASEADDR,128
2210 : GOSUB 2330
2220 : OUT GLB.BASEADDR,0
2230 : GOSUB 2330
2240 :
2250 : REM Read next bit from port and add to GLB.INVAR
2260 :
2270 : IF ((INP(GLB.BASEADDR+1) AND 8)/8) = 0 THEN GOTO 2290
2280 : GLB.INVAR = GLB.INVAR OR 2^COUNT
2290 NEXT COUNT
2300 :
2310 RETURN
2320 :
2330 REM ==========================================================================
2340 REM Short Delay
2350 REM ------------------------------------
2360 :
2370 FOR DELAY=1 TO 100
2380 NEXT DELAY
2390 RETURN
```

Listing 2. Test Program 2.

PC INTERFACE PARTS LIST

RESISTORS: All ±5% ¼W

R1-5	330Ω	5	(G330R)
R6-12	2K2	7	(G2K2)
R13	10K	1	(G10K)

CAPACITORS

C10	4·7μF 16V Tantalum Bead	1	(WW64U)
C1-8	33nF Resin-dipped Ceramic	8	(RA46A)
C9	1,000μF 25V Radial Electrolytic	1	(AT52G)

SEMICONDUCTORS

D1,2	1N4001	2	(QL73W)
IC1	NME0505S	1	(AH18U)
IC2,3	74LS14	2	(YF12N)
IC4-7	SFH618-2	4	(CY94C)
IC8	ispLSI1016	1	(VR43W)
IC9	LM7805CT	1	(AV16S)
LED1	5mm Red LED	1	(WL27E)

MISCELLANEOUS

JP1	26-way PCB IDC Plug	1	(FA43W)
JP2	34-way PCB IDC Plug	1	(FA44X)
PL1	2·1mm PCB Power Socket	1	(RK37S)
	PCB	1	* See Text *

FOR PC TO IBUS ADAPTOR CABLE:

26-way IDC Socket	1	(FG85G)
25-way IDC D-plug	1	(JW79L)
26-way IDC Ribbon Cable	1m	(XR75S)

The software accompanying this project, supplied on a 3½in. disk, and a ready-programmed ispLSI1016, are available from the author at the address below. The disk costs £10 and the CPLD costs £15. Postage is £2.50 for the UK, £5 for everywhere else. Please send your order, with cheque or postal order payable to "Neil Johnson", to: Neil Johnson, IBUS Adaptor, 2 Chapel Field, Dixter Road, Northiam, East Sussex, UK. TN31 6PQ.

COMMENT

by Keith Brindley

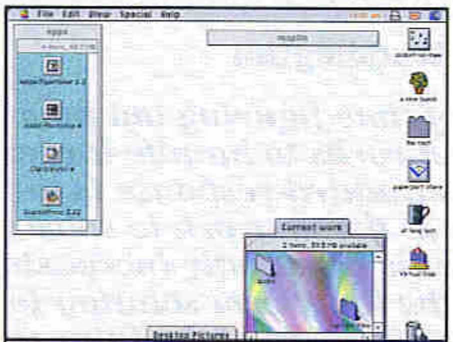
New versions of certain computer operating systems are often launched with significant hype. Windows 95, on its launch two years ago, was the prime example. Millions of dollars were spent by Microsoft worldwide to launch the then latest version of its PC operating system, advertising its virtues in press and broadcast media so that hardly a person on the planet didn't know what Windows 95 actually was. No-one is yet sure of Microsoft's marketing policy for its next foray into operating systems (Windows 98 is due next year sometime), but it's a pretty safe bet that the hype will be even bigger than before. After all, what happens on the PC desktop is largely driven by the products Microsoft develops. Some 90% of the world's computer systems run some version of Microsoft's operating systems – either DOS, Windows 3.1, Windows 95, or Windows NT (that's if you take seriously Microsoft's cut-down operating system for palmtop and pen-based portable computers, Windows CE). As a result, the effects of a new version of Windows are bound to have a widescale impact on the world's computers.

Other operating systems are launched with a little less of a blaze of publicity, yet have a similar impact on the world's computers. The operating system on which Windows itself is generally considered to have been based, runs on most of the world's remaining computers – Apple Macintoshes. Nobody can deny that the operating system used by Apple Macintosh computer is advanced. Indeed, it's so advanced that Windows itself – even in its Windows 95 incarnation – only barely manages to match the Mac OS eleven years after its inception.

The Mac OS has evolved through several releases since the Mac first took the computer world by storm back in 1984. At the end of July, the latest version of it – Mac OS 8 – was released in the United States. Interestingly, while Apple doesn't go in for the massive advertising spends associated with Microsoft's Windows releases, sales of Mac OS 8 were more than four times what even Apple itself expected, with over 1·2 million copies sold in less than two weeks, which proves that hype isn't everything. Indeed, hype is nothing without a decent product to back it up.

As a rule, Apple localises its software for releases in other countries in a process that takes two to three months, with the outcome that the UK version should be available at just about the time this column goes to press, so it's fitting that I look at Mac OS 8 now.

At first glance, Mac OS 8 has few visible changes over earlier versions – slightly changed window appearance, a new fold-up window button, a new screen font and so on – which is tantamount to proving that the Mac visual interface is about right as it stands and where it stood back in 1984 (it must be – 'cos Windows 95 emulates it, right?). But it's not the visual interface where the majority of the new features have been incorporated.



Various window types shown in Mac OS 8 running on my Mac. On the left is a window showing aliases of applications as small buttons. Top is a folded up window. At the screen bottom are two pop-up windows; one opened, one closed. At the right side of the desktop are the hard drives connected to my computer. One: 'the rest' has its window opened on another monitor.

Underlying the interface are several new tools and functions that make Mac OS 8 the coolest operating system in town. For a start, the new Finder (the desktop that controls the computer interface – equivalent to Windows' Program Manager, File Manager, and Explorer in one) is the first version that is totally PowerPC native. Prior to Mac OS 8, parts of the Finder were written in code that earlier Macintosh microprocessors could understand and use. While newer PowerPC microprocessors (available in all current models of Macintosh computers) can use such non-native code, they do so at a speed hit. Now that the Finder is PowerPC native, the Finder is, as a result, naturally faster, more responsive, and multi-threaded, all of which means that new features can be (and have been) added without sacrificing speed.

To this end, several new and unique features are incorporated into Mac OS 8. One of the nicest is the use of spring-loaded folders. This is a means whereby you can locate folders nested within other folders right throughout your hard drive. Merely by double-clicking a folder or hard drive icon without letting go the mouse button after the second click (this is a process called, by Apple, a click and a half), the folder or hard drive opens up to view the window it contains. Following that, you can continue – dragging to a folder within that window causes the next folder to open and the first one to close, and so on, throughout the hierarchy. You can launch applications or open files this way, too. The process is even extended as you drag files or folders on your desktop, allowing those files or folders to be moved to spring-loaded folders anywhere on your system. So, in a single step, there's no need to actually have open windows on your desktop at all; keeping your screen clear and uncluttered. There's nothing else (in any other operating system) quite like it.

Having said that, Mac OS 8 brings two new sorts of windows to the desktop for those who still like to have window access. First of these is pop-up windows. Here, you simply drag a window to the bottom of the screen in whatever position you want, at which point, the window automatically converts to a tab. Clicking the tab thereafter opens the pop-up window again. The point is, you're not restricted to having the tab placed automatically on a taskbar where the operating system puts it, you can drag it to the position of your choice, and even to second or subsequent monitors you might have on your system.

Second new window type is button view, in which files, folders or applications within any window can be changed into buttons which open with a single click. By placing aliases of selected files (the feature Windows 95 emulates with shortcuts) in a window, say, the window effectively becomes a dock which can be moved around the screen to suit, giving easy and instant access to chosen areas.

Mac OS 8 extends the Mac's traditional ease of use on the Internet, too. Incorporated are new push technologies which allow users to specify the types of information coming to their desktops from the Internet, and all the usual array of Internet access tools such as Internet Explorer, Navigator, Emailer, and AOL.

To round off the Internet tools, Personal Web Sharing and Personal Net Finder are two new features that allow any Macintosh running Mac OS 8 to be turned into a Web server, by enabling HTML and other Web-formatted content to be accessed by Web browsers on any computer platform.

Byte magazine, in its December 1994 issue, summed up the operating system situation when it said:

'…it would not be an exaggeration to describe the history of the computer industry for the past decade as a massive effort to keep up with Apple…".

Also, when referring directly to the Mac itself in the same article:

'…(the Mac) went on to pioneer or popularise almost every innovation in personal computing."

There's little doubt, Mac OS 8 re-affirms all this, stressing the advantages in ease-of-use and user-friendliness the Mac's always had over Windows and pushing it way out ahead again in terms of powerful features. It will be interesting to see which of the features Windows 98 manages to include on its launch next year, in its continued effort to keep up with the Mac OS.

The Information ECONOMY

PART 3

The Need for Speed

by Stephen Waddington

Technologists spend a lot of time figuring out how to enable voice and data networks to handle larger volumes of traffic. The standard response is to throw more bandwidth at the network to solve performance problems. But is constantly increasing bandwidth realistically the long term solution to building and managing networks of the future? Here, Stephen Waddington examines the options.

There are two driving forces fuelling the explosive growth in the technology sector, namely, the continual improvement in microprocessor processing power, and networking in the form of the Internet, remote dial-up connectivity and bandwidth hungry applications. In the microprocessor business, even after almost two decades, Gordon Moore's law still holds true. In 1979, the Intel founder prophesied that processing power would double every 18 months. There is certainly no sign that the industry is about to run out of steam in the next five years.

The networking sector is slightly less predictable. Networks face unprecedented challenges today. More and more users are coming online, requiring access from more locations. Desktop computing power continues to increase rapidly, driving the development of bandwidth-intensive, mission-critical desktop applications. Other new applications, particularly multimedia applications, challenge the network infrastructure with new bandwidth requirements that were never considered during the initial network design. Additionally, intranets and Web-based computing are resulting in more widely distributed and unpredictable traffic flows.

In terms of user demand, the use of more multimedia information on the Internet by business and consumers is a major growth factor. The networking industry is experiencing a fundamental shift from user-owned and private networks to a proliferation of public access services and private virtual networks. Another driver is the availability of affordable networking equipment that enables larger numbers of users to access corporate information from remote sites.

Text Book Networking

Before we go any further, let's make a quick trip to a text book and review what a network looks like. Figure 1 shows each of the elements of a simplified network from a company's perspective at one edge, to a private individual's perspective at the other edge. In the commercial world, users connect to a network via a local area office based network (LAN). Beyond this, companies with multiple sites are interconnected via a wide area network

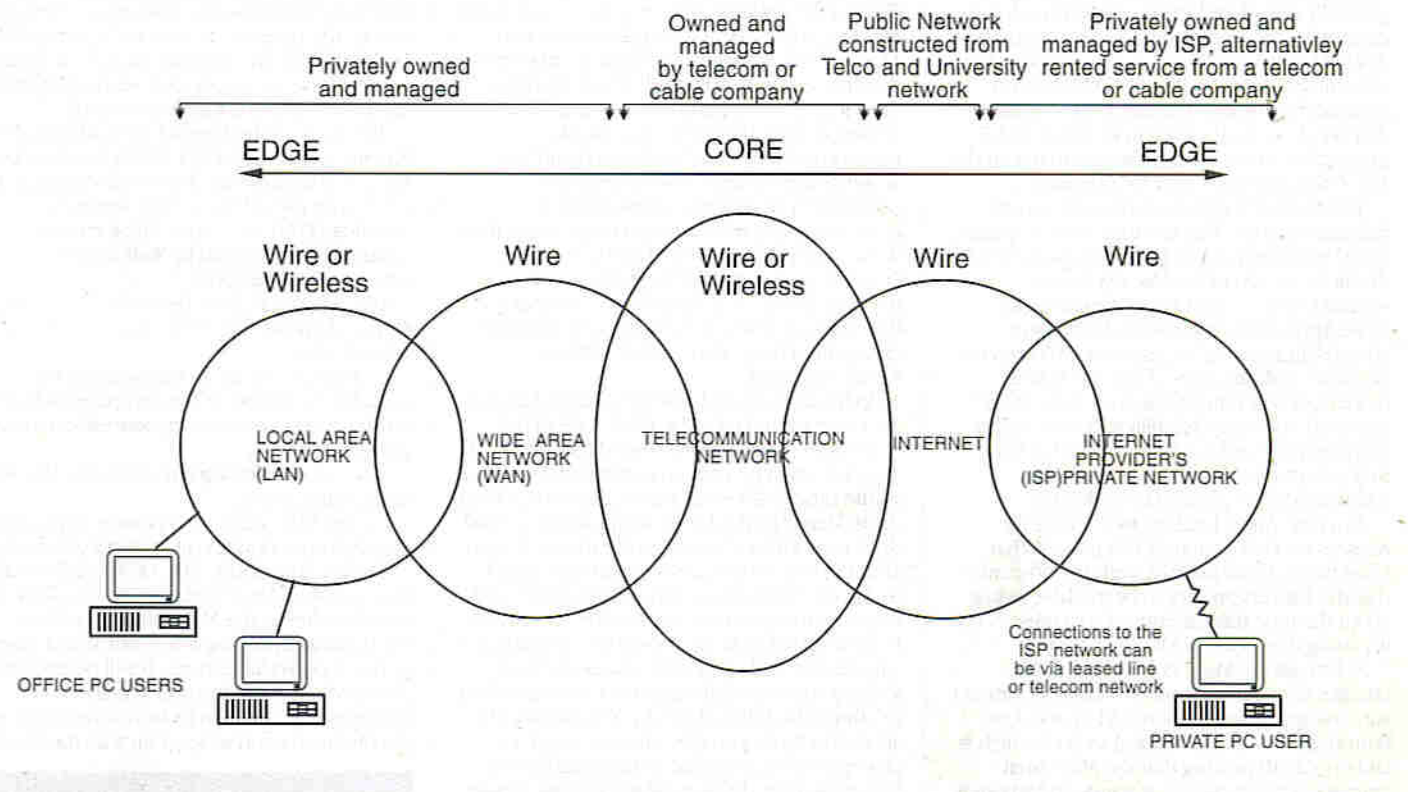
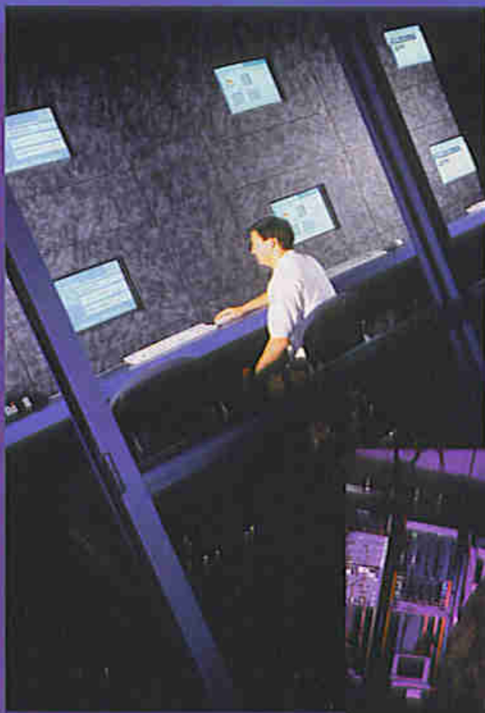


Figure 1. Networking infrastructure.



Interactive engineering design networked multimedia demonstrations.

Networking interoperability test laboratory.

(WAN). The telecommunications network is the very high-speed backbone of a country's network infrastructure and Internet. At a national level, telecommunications operators such as British Telecom provide services over a public network, with a core network capable of controlling and managing the flow of every traffic type at extremely high speeds.

At the other edge of the network, an individual can connect to the Internet from home directly over a public telecommunications network or via an Internet Service Provider (ISP). Regard Figure 1 as a blueprint, but do not accept it as a rigid model. For example, a LAN can be completely self-contained with a few users in a single office accessing a single server and maybe a printer, without any external connections. Similarly, the boundaries at the edge of each segment of the network such as the LAN/WAN or enterprise/telecommunication network interface vary a great deal and in some cases, can be non-existent. For example, a remote user is able to dial-up to a company WAN via a telecommunications network and a user on an office LAN could access the Internet via a dial-up Internet account.

Chaotic Demand

Within the UK, British Telecom's central trunking cables and long-distance cables are now fibre optic, capable of handling a huge capacity of up to 2·2G-bps. The newest digital switches, which point information into the direction of its intended recipient, are much slower, but still fast enough – 655M-bps for the new ATM switches – to shift data around the country pretty quickly.

The problems begin when data gets past the nearest telecommunication operator's switching centre and heads toward residential and business subscribers, since it is usually carried over conventional copper twisted pair wiring. Since it is too costly to convert all of this wiring to connect directly to the fast network, the existing twisted pair copper network must be worked over to accommodate fast data transmission.

Meanwhile, networks keep adding users, and those users want access from more locations than ever before, including a variety of remote sites. A proliferation of bandwidth-intensive, mission-critical applications, particularly multimedia traffic, is pushing up traffic levels. Intranets and Web-based computing have resulted in chaotic and unpredictable traffic flow.

Higher traffic flows are exacerbated by the fact that, with Web-based computing, a PC can be both a subscriber and a publisher of information. The Web site paradigm means that information can now come from literally anywhere on the network, creating massive amounts of traffic to and from widely distributed locations.

Adding to all the other difficulties arising from Web-based computing is the growing loss of locality in traffic flow. Hierarchical SNA terminal/host systems based on mainframe technologies are extremely predictable when it comes to locating traffic. By comparison, client/server systems, though more busy than host-based systems, still let managers predict with relative certainty where most of the traffic will be coming from and where it will be going. The traditional 80 to 20 rule generally applies: 80% of the traffic tends to be local, 20% remote.

But Web-based networks do not play by this rule. Traffic is much more unpredictable because of the disparate Web site paradigm. And one of the biggest problems the industry faces is having client/server applications and Web-based networking to coexist in the same network environment.

Future Proof Networking

As a result of all the factors mentioned here, we need to do a number of things in order to build successful networks in the future, including:

- Establish dynamic anywhere-to-everywhere connections
- Make performance predictable
- Deal with highly variable traffic flows
- Lower latency and lag to accommodate time-sensitive applications
- Set up levels of security for information access

If networks do not satisfy criteria like these, performance will suffer and the newer voice and video applications will simply not be able to run. However, the industry is already moving to meet these challenges. Specifically, technologies are evolving to high-speed LAN technologies, among them 100BASE-T Fast Ethernet, Gigabit Ethernet, OC-12 for Asynchronous Transfer Mode (ATM), and broadband switching targeted at diverse network environments. Table 1 summarises current network technologies at each level within the network environment.

Let's refer back to the network shown in Figure 1 and review the emerging standards and technologies in each area. Figure 2 plots the emerging technologies in each area of the network.

LAN Technology

Let start at the edge of the network with the LAN. Gigabit Ethernet is an emerging LAN transmission standard, defined earlier this year, that provides a data rate of 1 G-bps – a billion bits per second. By comparison, 10Base-T runs at 10M-bps. Gigabit Ethernet is defined in the IEEE 802.3 standard and the

Technology	Speed	Medium	Users
ADSL	1·544-8M-bps	Twisted-pair (used as a digital, broadband medium)	Home, small business, and enterprise access using existing copper lines
Cable modem	512k-bps to 52M-bps	Coaxial cable (usually uses Ethernet); in some systems, telephone used for upstream requests	Home, business and school access
Dedicated	56k-bps	Various	Business e-mail with fairly large file 56k-bps on attachments
Frame Relay Digital (DirecPC)	400k-bps	Airwaves satellite	Faster home and small enterprise access
Ethernet	10M-bps	10BASE-T (twisted-pair); 10BASE-2 or -5 (coaxial cable); and 10BASE-F (optical fibre)	Most popular business local area network (LAN)
Fast Ethernet	100M-bps	100BASE-T4 (twisted pair); 100BASE-TX (coaxial cable); and 100BASE-FX (optical fibre)	Workstations with 10M-bps and Ethernet cards can plug into a Fast Ethernet LAN
FDDI	100M-bps	Optical fibre	Large, wide-range LAN usually in a large company or a larger ISP
Frame relay	56k-bps to 1·544 M-bps	Twisted-pair or coaxial cable	Large company backbone for LANs to ISP and ISP to Internet Infrastructure
Gigabit Ethernet	1G-bps	Optical fibre (and 'copper' up to 25 metre)	Workstations, networks with 10/100M-bps. Ethernet will plug into Gigabit Ethernet switches
IDSL	128k-bps	Twisted-pair	Faster home and small business access
ISDN	BRI: 64 to 128k-bps PRI: 23 assignable 64k-bps channels plus control channel; up to 1·544M-bps	BRI: Twisted-pair PRI: T-1 line	BRI: Faster home and small business access. PRI: Medium and large enterprise access
OC-1	51·84M-bps	Optical fibre	ISP to Internet infrastructure and smaller links within Internet infrastructure
OC-12/STM-4	622·08M-bps	Optical fibre	Internet backbone
OC-24	1·244G-bps	Optical fibre	Internet backbone
OC-256	13·271G-bps	Optical fibre	To be determined
OC-3/STM-1	155·52M-bps	Optical fibre	Large company backbone and Internet backbone
OC-48/STM-16	2·488G-bps	Optical fibre	Internet backbone
Regular	14·4 to 56k-bps	Twisted-pair copper wire	Home and small business access telephone service (POTS)
SciNet	2·325G-bps	Optical fibre	Part of the vBNS backbone (15 OC-3 lines)
STM-64	10G-bps	Optical fibre	To be determined
T-1 (DS1)	1·544M-bps	Twisted-pair or optical fibre	Large company to ISP and ISP to nternet infrastructure
T-1C (DS1C)	3·152M-bps	Twisted-pair or optical fibre	Large company to ISP and ISP to Internet infrastructure
T-2 (DS2)	6·312M-bps	Twisted-pair or optical fibre	Large company to ISP and ISP to Internet infrastructure
T-3 (DS3)	45M-bps	Coaxial cable	ISP to Internet infrastructure and smaller links within Internet infrastructure
T-3D (DS3D)	135M-bps	Optical fibre	ISP to Internet infrastructure and smaller links within Internet nfrastructure

Table 1. Networking technologies.

Combined Ethernet network interface card (NIC) and modem.

High speed backbone switch from Lucent.

Family of hubs, the key device that interfaces local area networks (LAN) to form a wide area network (WAN).

Telecommunications network does not necessarily have to be wire based; increasingly, operators are opting to employ a wireless infrastructure.

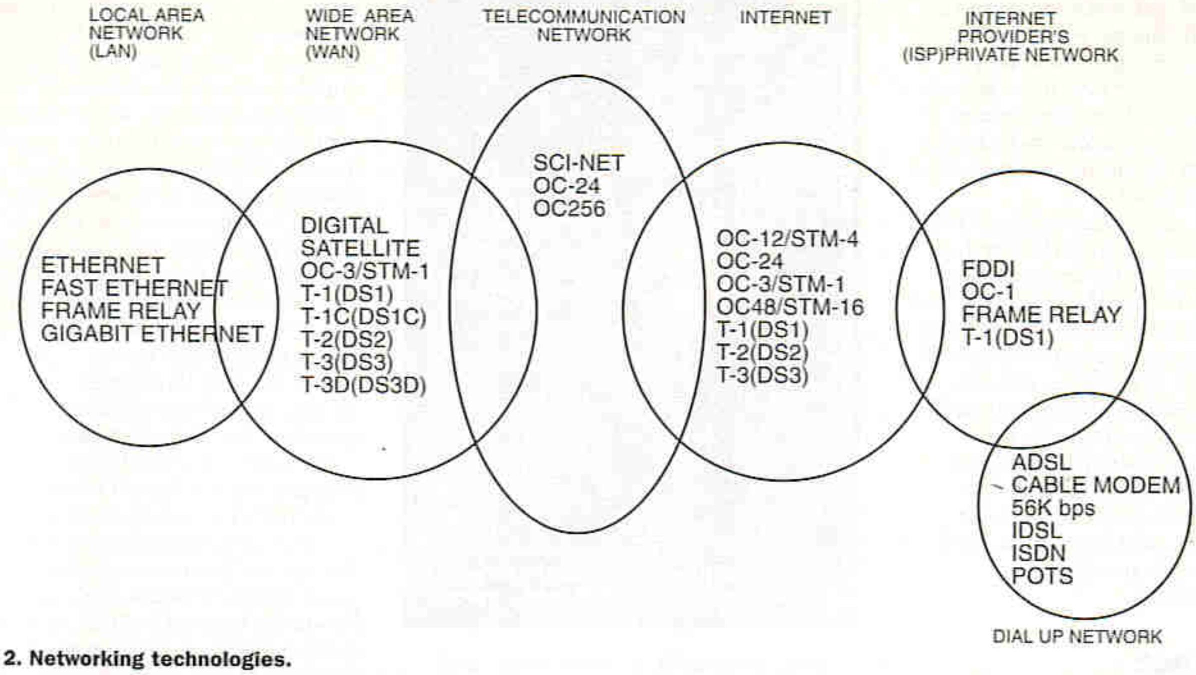


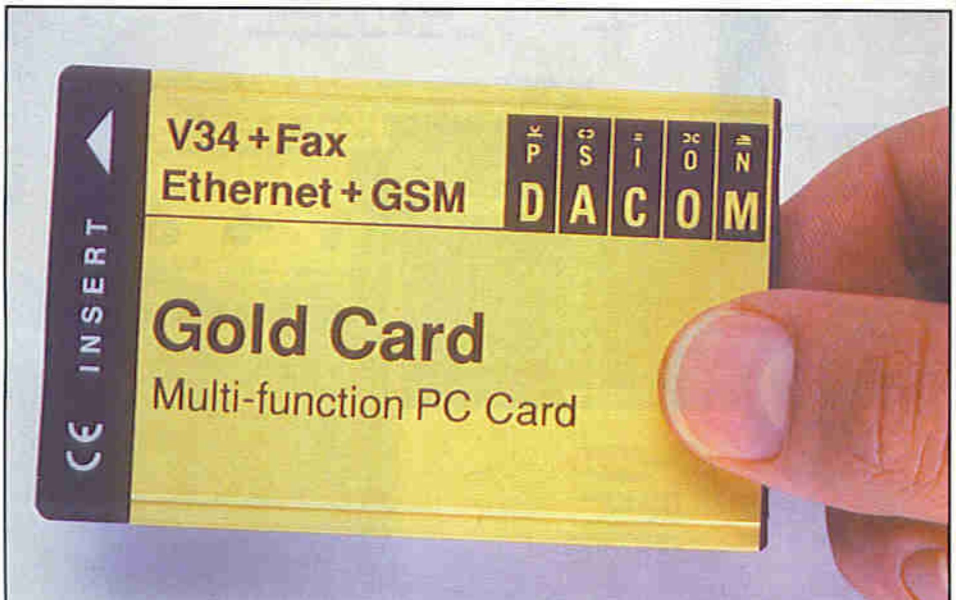
Figure 2. Networking technologies.

first product versions are beginning to emerge. Gigabit Ethernet will be used primarily on optical fibre, with short distances possible on copper media. Existing Ethernet LANs with 10 and 100M-bps cards can feed into a Gigabit Ethernet backbone.

WAN Technology

An alternative technology that competes with Gigabit Ethernet is ATM, although ATM is primarily a WAN and Enterprise-based technology. Cost, not in terms of product, but in terms of wiring infrastructure, is the issue which limits ATM in the LAN. ATM is a switching technology that organises digital data into byte-size cells and transmits 53 cells at a time over a digital medium. Individually, a cell is processed asynchronously relative to its related cells and is queued before being multiplexed over the line. ATM switching handles connection-oriented packets.

British Telecom video wall which is used to assess the performance of video streams for interactive television in the local loop.



Psion Datacom combined wireless and Ethernet network interface card (NIC).

Because ATM is designed to be easily implemented by hardware rather than software, faster processing speeds are possible. The prespecified bit rates are either 155·520M-bps or 622·080M-bps. US publication IEEE Spectrum reports that speeds on ATM networks are expected to reach 10G-bps.

Telecommunication Technologies

One of the major challenges facing telecommunications operators is their investment in a mature copper network infrastructure. Twisted pair networks were designed and built for crude analogue voice-based communications. This is not a good fit with users seeking to run high-speed data connections to online service providers or the Internet.

This does not mean that cable operators will clean up the market for digital telecommunications services. Clearly, this is not happening. Instead, a new breed of technologies called xDSL is enabling multiple forms of data, voice, and video to be carried over traditional twisted-pair copper wire. xDSL is expected to have a significant impact in the next three years by supporting high-speed Internet/intranet access, online services, video-on-demand, TV signal delivery, interactive entertainment, and voice transmissions.

The first xDSL technology was specified in 1987 by Bell Communications Research, a consortium formed by the regional Bell operating companies. At the time, xDSL was designed to provide video-on-demand and interactive TV applications over twisted-pair wires. However, it stalled when alliances soured between Bell companies and cable companies. Interest in xDSL regained momentum after fibre-based broadband loops proved to be too costly and time-consuming for widespread deployment. However, xDSL technology is still at least two to three years from widespread commercial availability.

The Internet

Established in 1969 as a scientific-academic network of four computers and financed by the US defence establishment, the Internet is now a public, self-sustaining facility accessible to tens of millions of people world-wide. Physically, the Internet uses a subset of the total resources of all the currently existing public telecommunication networks. Technically, what distinguishes the Internet as a co-operative public network is its use of a set of protocols called Transmission Control Protocol/Internet Protocol (TCP/IP).

Modem from Portable Add-ons based on Rockwell/Lucent K56Flex technology.

Although e-mail is the most widely used application on the Internet, the Web is the most exciting with its great range of content. Latest estimates put the number of Web sites connected to the Internet at over 150 million, with approximately 9 million people reported to be using the Web every day.

However, for many businesses and users, the Internet has not lived up to its promise of fast access to a wealth of information, increased sales from a channel to millions of customers, reduced costs and improved communications. This is why US universities are creating a next generation Internet, known as Internet2. At each of the member universities, a team of developers and engineers is working to develop and enable Internet2 applications. At the same time, each team co-ordinates its efforts with similar teams at other Internet2 universities.

Leading universities see advanced networking as critical to their teaching and research missions. Internet2 provides the framework for them to work together. The project will simultaneously push the leading edge of multimedia broadband networking, and help meet the growing production requirements of member universities. I2 is also working with computer networking corporations and non-profit organisations to ensure that the developments of Internet2 are used to improve all computer networks, including the existing Internet.

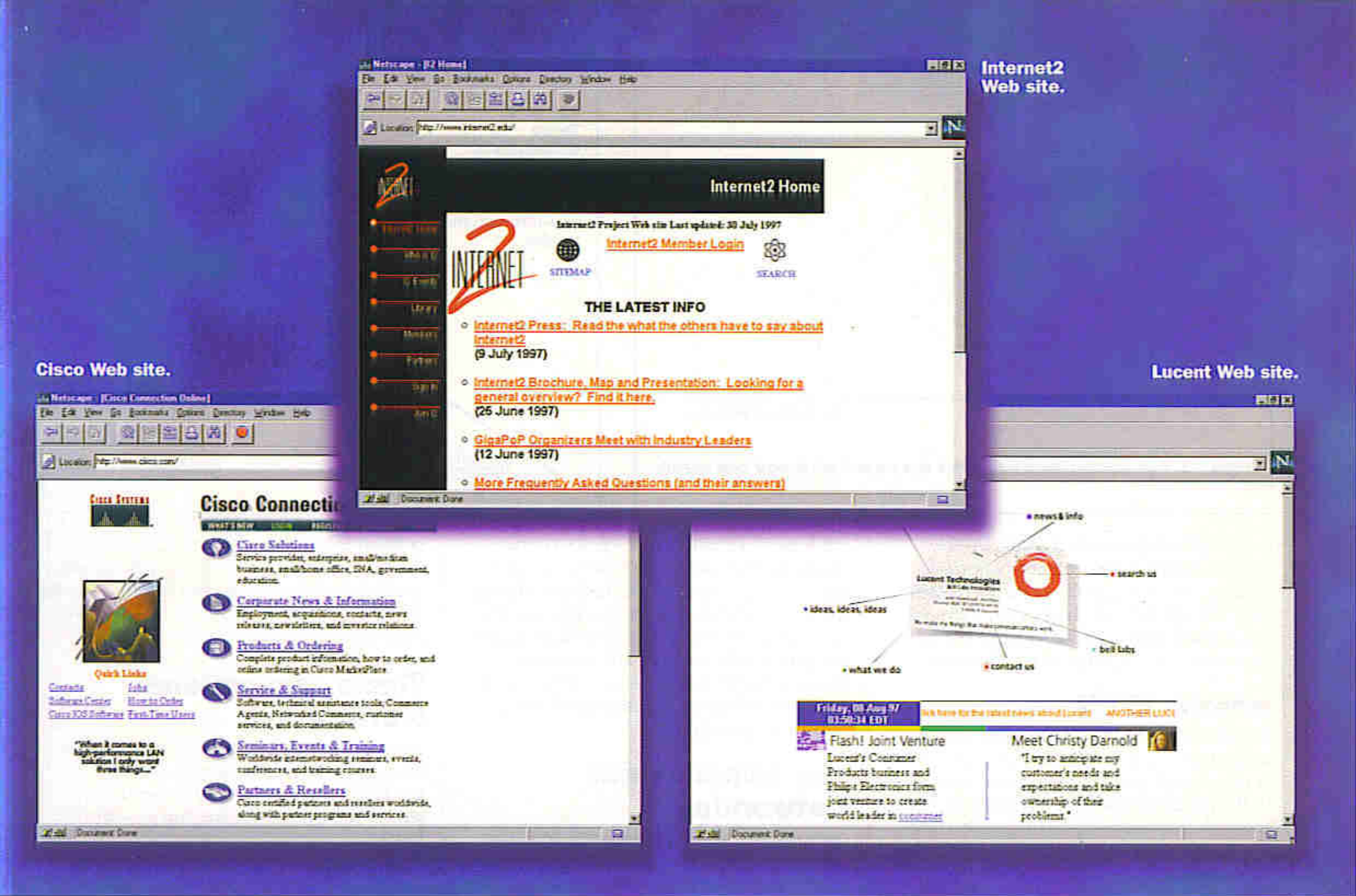
But Internet2 will not replace the current Internet, nor is it a goal of Internet2 to build a new network. Initially, Internet2 will make use of existing national networks, such as the National Science Foundation's very high speed Backbone Network Service. Eventually, Internet2 will use other high speed networks to connect all of its members to each other and to other research organisations. Part of the Internet2 mission is to assure that the technology – both software and hardware – is based on open standards and is available to be adopted by others, including commercial network and Internet service providers.

Similarly, Internet2 will not replace current Internet services for members, other organisations, or individuals. Member institutions have pledged to use existing Internet services for all network traffic that is not related to Internet2. Other organisations and individuals will continue

3Com Web site.

British Telecom Web site.

Bay Networks Web site.



Internet2 Web site.

Cisco Web site.

Lucent Web site.

to use the existing Internet services from commercial providers for applications like e-mail, the Web, and newsgroups. Internet2 will provide the means to demonstrate the next generation of computer network applications and engineering that can be used to advance existing networks.

Aside from the much faster networks that will be used by Internet2, the applications developed will utilise a whole set of network tools that do not currently exist. For example, one of these tools is commonly known as a Quality-of-Service guarantee. Currently, all information on the Internet is given equal priority as it is passed along the network from one computer to another. Quality-of-Service would allow applications to request a specific amount of bandwidth or priority for themselves. This would allow two computers running a medical application to communicate at the high speeds required for real-time interaction. At the same time, a less bandwidth-intensive application like the Web would need only use the connection speed necessary for it to operate smoothly. We'll examine this in more detail.

Dial-up Technologies

At the opposite edge of the network, an emerging technology, 56k-bps analogue modems, will provide a range of midband – 28·8 to 56k-bps access to the Internet, intranets, and remote LANs. Although final standards for this technology are expected to take about two years to develop, some pre-standard technology is already available.

There are currently two separate and incompatible proprietary 56k-bps modem technologies – X2 from US Robotics and K56flex from Lucent Technologies and Rockwell International. Potential users need to be aware that in order to get 56k-bps throughput, there must be a 56k-bps modem using compatible modulation techniques at each end of the connection. X2 and K56flex are currently totally incompatible.

Both 56k-bps technologies exploit the fact that most telecommunication companies are interconnected with digital lines. Assuming your Internet connection provider has a digital connection to its telephone company office, the downstream traffic from your local Internet access provider can use a new transmission technique on your regular twisted-pair phone line that bypasses the usual digital-to-analogue conversion. The modem, new or upgraded for X2, does not need to demodulate the downstream data. Instead, it decodes a stream of multi-bit voltage pulses generated as though the line was equipped for digital information. Upstream data still requires digital-to-analogue modulation.

The International Telecommunications Union (ITU) is currently developing into a standard, but international standards typically take years to evolve, and the market is moving too fast to wait. Internet use is increasing rapidly, and 56k-bps modems are coming onto the market now, so it is in customers' best interests to have at least an

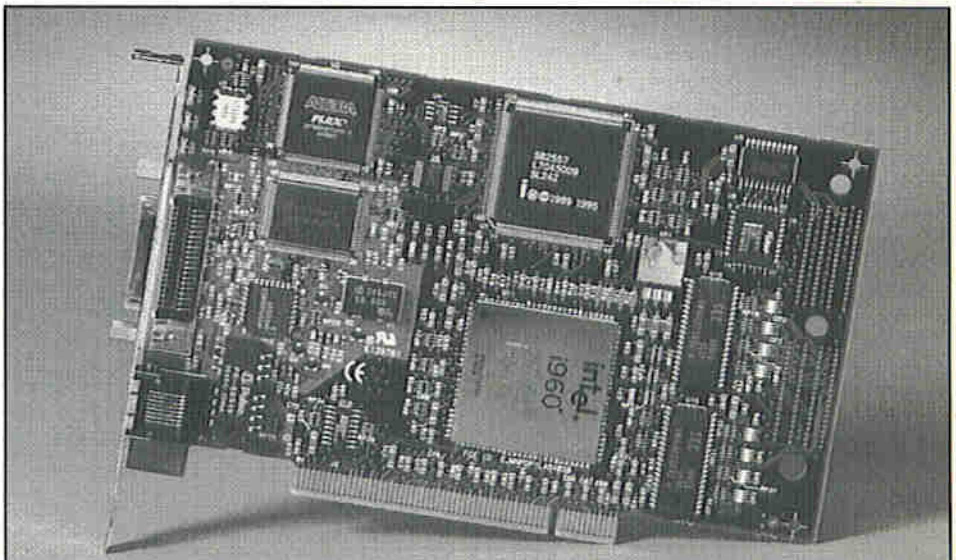


Photo 16. Internet network interface card. (nic.bmp)

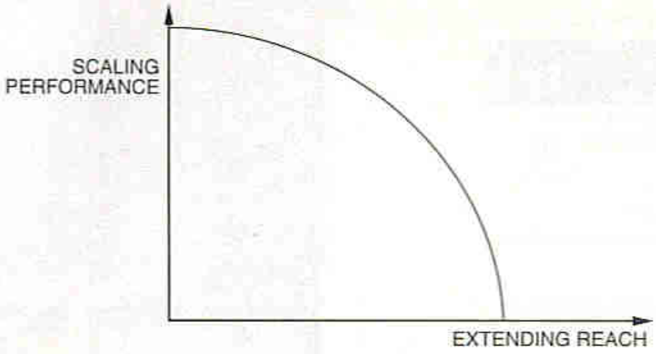
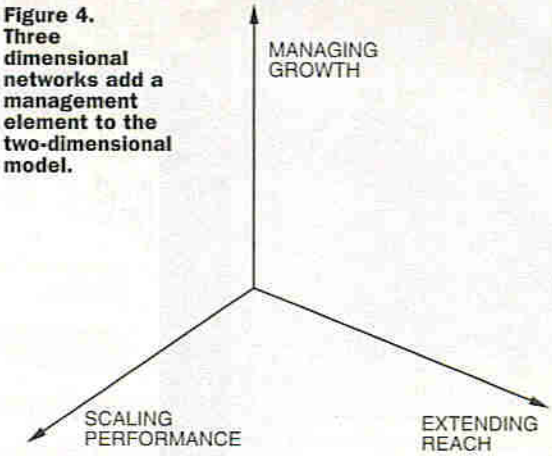


Figure 3. Two dimensional networks are based on speed and reach.

Figure 4. Three dimensional networks add a management element to the two-dimensional model.



interim standard as soon as possible. To protect customers' investments as formal standards evolve, manufacturers are designing their 56k-bps modem chips to be easily upgradeable with a simple software change that can be accomplished via the Internet.

Interim ISDN

If the 56k-bps standard is going to take off, all the bad or corroded splice connections in the twisted pair wiring must be replaced or the connection will be too noisy for high speed data transmission. This is very costly for the telecommunication companies, which is why ISDN lines (128k-bps) have a high price; the consumer is also paying for the upgrade of the pairs to make the connection between his home or office and the closest switching station clean enough for data transfer.

Integrated Services Digital Network (ISDN) is a set of Consultative Committee on International Telephone and Telegraphy (CCITT)/International Telecommunications Union (ITU) standards for digital transmission over ordinary telephone copper wire as well as over other media. Home and business users who install ISDN adapters can see highly-graphic Web pages arriving at rapid speeds of up to 128k-bps. ISDN requires adapters at both ends of the transmission so your access provider also needs an ISDN adapter. ISDN is generally available as a standard service from telecommunications companies in most urban areas in the US and Europe.

There are two levels of service: the Basic Rate Interface (BRI), intended for the home and small enterprise, and the Primary Rate Interface (PRI), for larger users. Both rates include a number of B (bearer) channels and a D (delta) channel. The B channels carry data, voice, and other services. The D channel carries control and signalling information.

The Basic Rate Interface consists of two 64k-bps B channels and one 16k-bps D channel. Thus, a Basic Rate user can have up to 128k-bps service. The Primary Rate consists of 23 B channels and one 64k-bps D channel in the United States or 30 B channels and 1 D channel in Europe.

More Than Speed

But speed can be only part of any network solution. Data is like a gas. It will expand to fill any space, irrespective of the size or volume. Managers will also need to implement a strategy that leads to pervasive deployment of network services. Not just the traditional services like resource sharing, e-mail, and transaction processing, but also new classes of services such as Web-based navigation, full searches, and real-time multimedia. To attain this goal of pervasive availability of services, a new networking dimension is required.

Two Dimensional Networking

Over the past several years, networks have been augmented in two major dimensions: scaling performance from the enterprise through the WAN and LAN, and extending the reach of the network from central sites out to remote sites and mobile users, as shown in Figure 3.

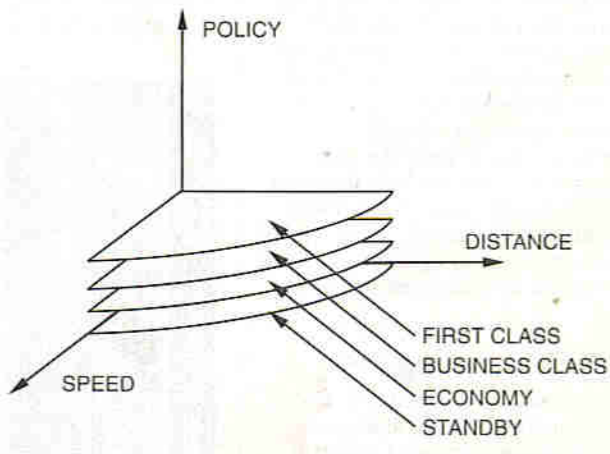
However, a two-dimensional networking approach ends up using bandwidth as a cure-all for congestion and complexity. This works to some extent, but it cannot work forever. When locality of traffic is tossed to the networking winds, how do you know where to implement a bigger cable or your next switch? And when you cannot predict the routes traffic will take, what good is sophisticated route caching in your routers? A related problem is the Java effect: When every user has a unique, customised home page on the Internet, where is the commonality that makes data caching effective?

Three Dimensional Networking

Networking giant, 3Com, believes that the strategy that will best benefit networking in the future is to add a third dimension as shown in Figure 4 – managing growth. This involves converting networks from single-service infrastructures into multi-policy service infrastructures. To help illustrate the notion of multi-policy service, think of a network as if it were an airline ticketing system where passengers are divided into various classes.

Most networks now resemble an airline with a very efficient standby shuttle service. Once you buy a ticket, you can almost always find a seat on the next flight. But you are not guaranteed a seat. On a network, basic services such as e-mail and elementary information publishing get along fine going Standby Class – that is, utilising the network on an as-available basis.

Figure 5. Four classes of network performance, allied to the airline analogy.



Policy	Service Examples
Standby	E-mail, information publishing, navigation, text indexing and searching.
Economy	Order entry, procurement, electronic commerce, customer interactions.
Business Class	One-way/video, collaboration computing, or higher level of security.
First Class	Two-way audio/video, real-time monitoring, or highest level of security.

Table 2. Example service levels for each class of performance in the three dimensional networking model.

Photo 17.
Rockwell Web site.

Photo 18.
US Robotics Web site.

Service Level Guarantees

But to meet the demands of tomorrow's networks, a multi-policy performance approach is required. In terms of the airline analogy, we have to create more seating classes. The exact number and definition of these classes, or policies, would be up to the group running the network, but here is basically how it would work. Suppose we add Economy Class, where a seat on the network is guaranteed for a particular mission-critical application. That way we would have a policy to take care of an enterprise order entry system that must be up and running all the time, without fail.

For certain privileged applications or user communities, we could institute a Business Class with even more passenger amenities than Economy Class. These amenities might include more room, higher bandwidth, a separate passenger compartment, tighter network security, faster boarding, lower latency, and travel club privileges.

A First Class policy level could be reserved for the most sophisticated and demanding network applications, such as two-way audio and video, or real-time monitoring. First Class would bestow the highest bandwidth and the most privileges with respect to elements like latency, transmission quality, and virtual LAN membership. Together, Figure 5 and Table 2 show example service levels for each class of performance.

Bear in mind that you cannot create and run this sort of policy-based network without the equivalent of an effective travel agent. This is a management function that understands all the schedules, policies, and tariffs, and can ensure that users have access to the network according to the policy level assigned.

Stretching the airline analogy even further, future networks will also require an air traffic control function. Regardless of how efficient and knowledgeable your travel agent is, there still exists the risk of mid-air collisions due to excessive congestion. In other words, managers will need to place intelligence around the network, not just at the centre. It is only with a good air traffic control radar umbrella that managers will be able to handle the additional complexity introduced by multi-policy network infrastructures.

Networking companies are defining network management systems to create classes of network service allied to the delivery of different tiers of quality of service. The two leading networking companies, Cisco and 3Com, have both defined their own approaches in the form of the Internetworking Operating System (IOS) and Transcend, respectively.

Network Management

The 3Com Transcend Networking framework for building networks can accommodate the new generation of business applications while also integrating legacy systems and applications. This overarching framework provides solutions along three critical networking vectors: scaling performance within the local area network (LAN), extending the reach across the wide area network (WAN) to remote sites and users, and managing the growth of the network as a whole.

Transcend Networking solutions are designed to address specific needs. In many situations, this takes the form of a bandwidth hierarchy, in which bandwidth requirements at the network's core, backbone and edge, wiring closets and remote sites, are satisfied with the appropriate combination of hub, switching, and routing solutions.

3Com's TranscendWare software powers all aspects of the Transcend Networking framework by integrating intelligence into the full range of 3Com solutions – from the end systems to the network core. With the pervasively distributed intelligence that TranscendWare software provides, IT management can more easily deliver the high performance, economical LAN/WAN connectivity, and administrative control necessary to implement demanding new network applications and handle unpredictable intranet traffic flows.

More important still, TranscendWare software enables the deployment of policy-based networking under the central control of IT management. When fully realised, a policy-based infrastructure lets managers more easily bring the network into alignment with key business objectives, such as better application response time and greater security.

This approach gives businesses a new dimension in networking: the ability to specify desired network behaviour according to predefined policies, optimising the delivery of services to network users. Software-enabled, policy-based networking will deliver capabilities such as user and application prioritisation to ensure that business-critical applications maintain desired levels of service, even when the network experiences transient traffic peaks and bottlenecks. ELECTRONICS

Further Reading

3Com	www.3com.com
Internet2	www.internet2.edu
Cisco	www.cisco.com
British Telecom	www.bt.com
Bay Networks	www.baynetworks.com
US Robotics	www.usr.com
Rockwell	www.rockwell.com
Lucent	www.lucent.com

PROJECT

Catching Data VIA THE GAME PORT

PART 2

Software Driver and Application

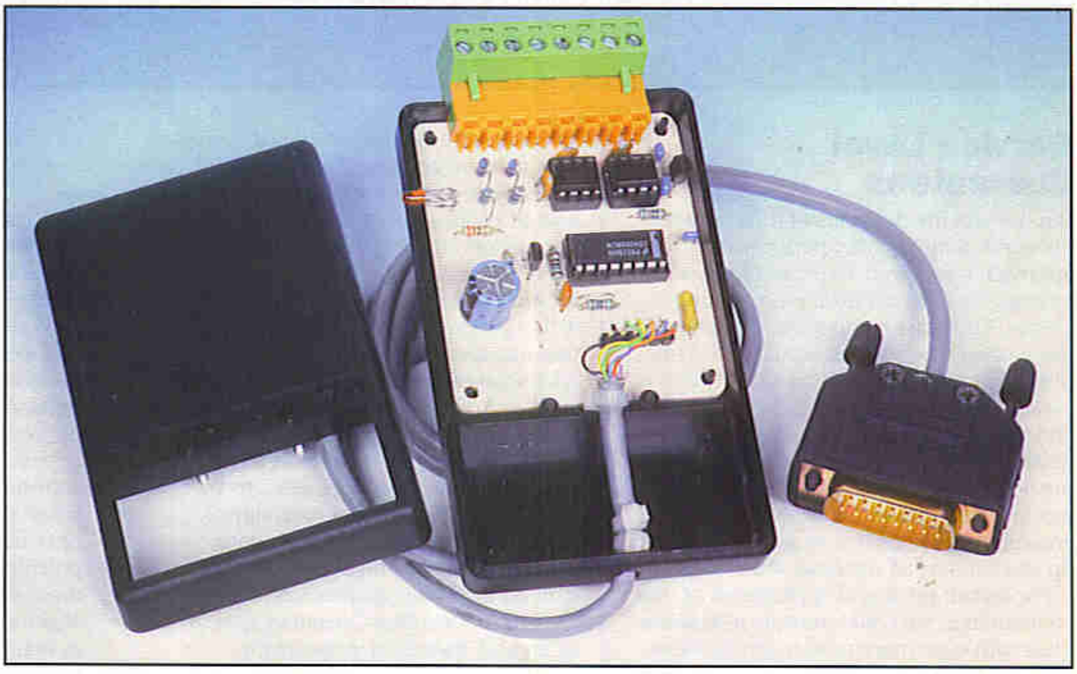
by Dr Pei An

Last month, I gave the hardware details of the game port data logger. In this article, I will describe the software driver for the data logger and give some application ideas. The software driver is written in Turbo Pascal 6 for DOS.

Software Driver for the A/D Converter

From the circuit diagram of the system, we can see that -CS1 and Dout of IC2 (the first TLC548) are connected to DB4 (bit weight=16) and DB5 (bit weight=32) of the game port (port address=201h). The software driver first detects the low-going edge of -CS1. Then, it continuously reads data from the game port until -CS1 goes from low to high. The program also calculates the total number or amounts of data read during this period of time.

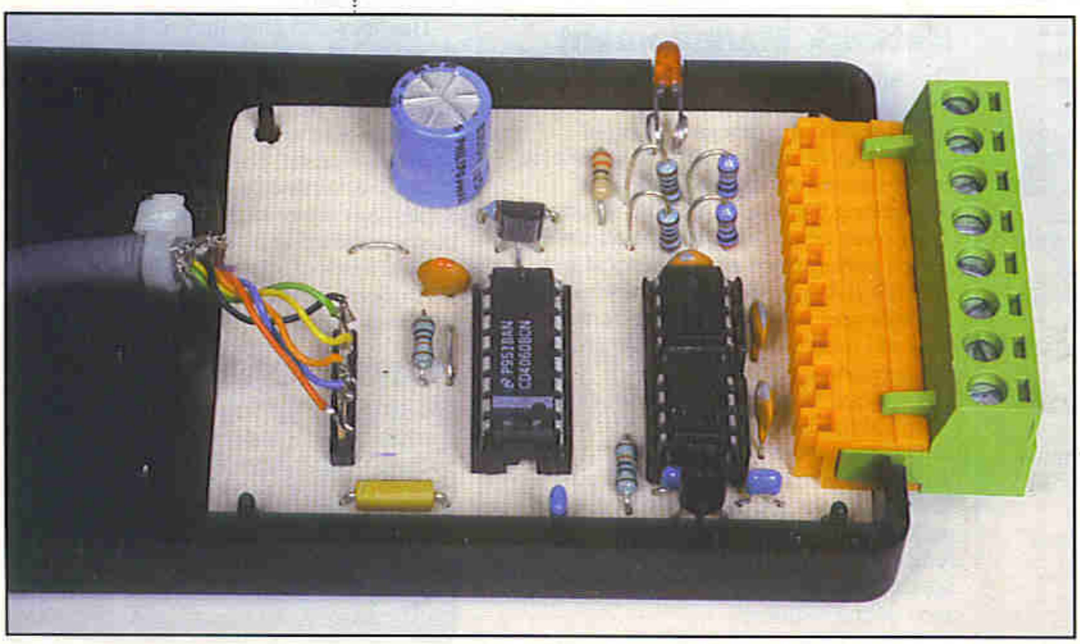
During this period of time, IC2 outputs 8 bits of A/D conversion data serially from the Dout pin. The total number or amount of data read from the game port is much bigger than 8. This means that for each serial data bit output from IC2, there are several readings from the game port. The serial data (either 0 or 1) is obtained by masking out DB5 of the data read from the port. Knowing the total number or amount of data and the data itself, we can find the 8 serial data bits. The procedure to achieve this is listed in Listing 1.



Software Driver for the Resistance Channel

The most important feature of the driver is to measure the time period of the one-shot multivibrator. The driver first issues a port write operation to the game port using port [$201]:=0 to start the monostables. Immediately following this, the counter value in the 3rd 8254 counter is read and is assigned to a variable, Time1. Next, a loop continuously checks if the associated game port bit goes low. As soon as it does, the 8254 counter is read again and the value is assigned to the other variable, Time 2. The time interval is then calculated.

As a computer is caused to execute an interrupt handler every 54·5ms to update its internal time-keeping register, it may introduce an error in the above time measurement procedure. Therefore, the driver checks if there is a DOS interrupt during the measurement of the one-shot period. This is done by checking that the contents in the time-keeping memory



```
Function AD(channel:byte):real;
(* read serial data bits from A/D channel 0 (channel=0) and channel 1
(channel=1)*)
var
    data_bit:array[1..8] of byte;
    i,bytex,skipnumber:byte;
begin
    repeat
    scannumber:=0; (* read the first time *)
    repeat until port[$201] and 16 = 16*(1-channel);
    repeat until port[$201] and 16 = 16*channel;
    repeat
    scannumber:=scannumber+1;
    bitx[scannumber]:=port[$201];
    until port[$201] and 16=16*(1-channel);
    scannumber_old:=scannumber;
    scannumber:=0; (* read the second time *)
    repeat until port[$201] and 16 = 16*(1-channel);
    repeat until port[$201] and 16 = 16*channel;
    repeat
    scannumber:=scannumber+1;
    bitx[scannumber]:=port[$201];
    until port[$201] and 16=16*(1-channel);
    until abs(scannumber-scannumber_old)<=3;
    for i:=1 to scannumber do bitx[i]:=round((bitx[i] and 32)/32);
    skipnumber:=round((scannumber)/8);
    bytex:=0;
    data_bit[1]:=bitx[4];
    for i:=2 to 8 do data_bit[i]:=bitx[5+(i-1)*skipnumber];
    for i:=1 to 8 do bytex:=bytex + data_bit[i]*bit_weight(9-i);
    AD:=bytex*2.50/255; {voltage reference: 2.50V}
end;
```

Listing 1.

```
Procedure find_R_t(x:byte);
(* find the period of the single-shot multivibrator *)
(* x selects AX (x=1), AY (x=2), BX (x=3), BY (x=4) *)
var i:integer;
    Rx1,Rx2,tstart,Tend:integer;
begin
    sum:=0;
    for i:=1 to 10 do (* read the period for 10 times *)
    begin
    dummy:=bit_weight(x);
    repeat
    init_8254; (* initialize 8254 *)
    Tstart:=memw[$0000:$046c]; (* check DOS clock refresh *)
    port[$201]:=0; (* output 0 to the game port *)
    Time1:=read_8254; (* read 8254 timer first *)
    repeat until (port[$201] and dummy) = 0; (* check monostable output *)
    Time2:=read_8254; (* read 8254 the 2nd time *)
    delay(5);
    Tend:=memw[$0000:$046c]; (* check DOS clock refresh *)
    until Tstart=Tend; (* in the above operation, DOS clock should not be
    refreshed. Otherwise the counter value will be invalid *)
    Rx1:=time1-time2; (* find the time period *)
    sum:=sum+Rx1/10; (* find the average *)
    end;
end;
```

Listing 2.

```
Function R_t(x:integer):integer;
(* read the single-shot period for three times and analyze the data *)
(* this is used to reduce data reading error *)
(* x selects AX (x=1), AY (x=2), BX (x=3), BY (x=4) *)
var
    rt1, rt2, rt3, average, error:real;
begin
    repeat
    find_R_t(x); rt1:=sum; {read the 1st time}
    find_R_t(x); rt2:=sum; {read the 2nd time}
    find_R_t(x); rt3:=sum; {read the 3rd time}
    average:=(rt1+rt2+rt3)/3; {find average}
    error:=sqrt((sqr(rt1-average) +sqr(rt2-average) +sqr(rt3-average))/3)
    {find square root error}
    until error/average<=0.05; {if error/average<=5%, data accepted}
    R_t:=round(average); {average assigned to R_t}
end;
```

Listing 3.

```
Procedure R_calibrate;
begin
    clrscr;
    writeln('Calibration of resistance channels 1');
    write('do not connect anything to terminals, press RETURN');readln;
    T1_rhigh:=R_t(1);
    writeln('External resistance=200,000 Ohm, time period count=', T1_rhigh);
    write('Short terminals then press RETURN'); readln;
    T1_rlow:=R_t(1);
    writeln('External resistance=1000 Ohm, time period count=', T1_rlow);
    writeln;
    writeln('Calibration of resistance channels 2');
    write('do not connect anything to terminals, press RETURN'); readln;
    T2_rhigh:=R_t(2);
    writeln('External resistance=200,000 Ohm, time period count=', T2_rhigh);
    write('Short terminals then press RETURN'); readln;
    T2_rlow:=R_t(2);
    writeln('External resistance=1000 Ohm, time period count=', T2_rlow);
end;
```

Listing 4.

locations do not change during the measurement. The one-shot period is measured 10 times and the average value is calculated. The program list is Listing 2.

Init_8254 and read_8254 are associated with 8254 operations. They will be explained later. As further error checking, the above measurement procedure is repeated three times. The average of the measurements and the square root error are calculated. The error should be less than a preset value, then the average is accepted as a valid data. If the measurements do not satisfy this, the procedure will measure the one-shot period three times again and do the error checking. This is achieved using the function R_t (x:integer):integer, which is listed in Listing 3.

The relation between the one-shot period and the external resistance value is obtained from a calibration. In the calibration, two one-shot periods are measured for two external resistors of known resistances. The calibration is facilitated by the hardware design. Referring to the circuit diagram, when the two resistance input terminals are left open, the external resistance is 201kΩ. When the terminals are shorted using a copper wire, the external resistance becomes 1·00kΩ. The program list for calibration is given in Listing 4.

Any resistance value (Resistance) can be calculated using the following equation after the one-shot period (Period) for that resistance is measured;

$$\text{Resistance} = R_{low} + \frac{\text{Period} - T_{rlow}}{T_{rhigh} - T_{rlow}}(R_{high} - R_{low})$$

R_{high} and R_{low} are the resistance values for the calibration. R_{high} = 201kΩ and R_{low} = 1kΩ. T_{rhigh} and T_{rlow} are the one-shot periods measured for R_{high} and R_{low} during calibration.

The external resistance (Resistance) and the resistor connected to the terminals (R_x is the resistance value) have the following relationship:

$$\text{Resistance} = R_{low} + \frac{(R_{high} - R_{low})\, R_x}{R_{high} + R_x}$$

Using the 8254 PIT Inside a PC

The onboard 8254 programmable timer/counter IC (it is also called the Programmable Interval Timer, PIT) is used for precise measurement of time and for precise delay for a time period. A computer has at least one 8254 PIT onboard. Some computers may have two 8254s installed. Each 8254 provides three programmable timers/counters.

The details of the 8254 and its operation are not to be presented in this article. Readers could read other PC hardware books. In brief, the 8254 comprises three programmable counters, counter 0 to counter 2. Every counter is supplied

```
begin
(* Control word= b6H = 10110111b
   10 = select counter 2
   11 = read/write low count byte first then high byte
   011 = mode 3
   0 = binary counting with 16-bit *)
(* $42 is the I/O address of 2nd timer of 8254, $43 is the I/O address of control register *)
   Port[$43]:=$b6; (* load control word to the control register of 8254 *)
   Port[$42]:=255; (* load low count byte *)
   port[$42]:=255; (* load high count byte *)
   port[$61]:=port[$61] or 1; (* disable speaker *)
   port[$43]:=$80; (* 80H is the counter latch command for counter 3 *)
end;
```

Listing 5.

with its own clock signal (CLK0 to CLK2). Inside a computer, the frequency of the clocks are 1·193180MHz precisely (period = 0·838μs). This frequency does not change no matter what kind of computer it is. Each timer/counter also has a clock enable input and a programmable output. The output waveform can be programmed in one of 6 modes.

The first output of the 1st PIT generates a system interrupt at a frequency 18·206 times per second. During the interrupt, the interrupt handler increments the system clock by 1. The system clock is stored in three memory locations and the contents indicate the number of timer pulses (18·206 pulses per second) since 0:00am.

0000:046ch: a word location containing the lower timer count (16 bits)

0000:046eh: a word location containing the upper timer count (16 bits)

0000:0470h: a byte showing the timer overflow, 1=24 hour passed.

The second output of this PIT is used for memory refresh. The third output is used for generating audio signals for the onboard speaker.

Amongst these three timers/counters, only the last one can be used for other timing applications. In this program, this timer/counter is used for measuring the length of the one-shot period. The timer/counter is programmed as a free-running counter with the counter constant being 65,536. This is achieved using the following procedure, init_8254, shown in Listing 5.

Procedure init_8254;

Read_8254, Listing 6, is a function to read the high-order and low-order bytes of the counter and to combine the two bytes into a single value.

These two procedures are used throughout the one-shot period measurement procedures.

Application Ideas

The game data logger can be used for various data acquisition applications.

The two analogue voltage input channels can measure voltages from 0 up to 2·5V. By using a proper sensor and an amplification circuit, temperature, pressure, light intensity, magnetic field intensity, etc., can be measured by a computer.

The two resistance input channels can measure resistance. I will introduce two sensors which measure light intensity and temperature.

Light Dependent Resistor (LDR)

When light falls on the surface of some materials, their electrical resistance changes. A light dependent resistor (or a photo conductive cell) consists of a disc made of such material. The resistance varies according to the level of illumination. The spectral response covers most of the visible light region and is close to that of the human eye. LDRs are inexpensive devices and easy to use. A typical LDR is the ORP12 (MPS Stock Code HB10L), which has a dark resistance of 10MΩ. The resistance reduces to several hundred Ohms if it is illuminated by a strong light. It has a very slow response to the change in light intensity, which is in the magnitude of several hundred milliseconds.

In use, the LDR is connected across the two resistance input terminals. This can form a computer-based sunshine duration measurement system.

Thermistor

A thermistor is a thermally-sensitive resistor which consists of a sintered mixture of certain materials in the form of a stripe. The property of the mixture is that its resistivity decreases as temperature increases. The relationship between temperature and resistance is:

$$R_T = R_{ref}\, e^{-\beta\left(\frac{1}{T}-\frac{1}{T_{ref}}\right)}$$

R_T is the resistance in Ohms at a given temperature T (in Kelvin). R_{ref} is the resistance at given reference temperature T_{ref}, usually 298K (25°C). The constant depends on the material used in the thermistor.

Thermistors are inexpensive devices and operate over the temperature range -50°C to +300°C. They can be made very small so as to achieve a very high thermal response. Let us look at one example of thermistor. A bead thermistor (MPS Stock Code CR05F) has a resistance 352·4kΩ at 0°C. The resistance decreases to 100kΩ at 25°C and decreases to 4·77kΩ at 100°C.

In use, the thermistor is connected across the two resistance input terminals. This can be used for temperature monitoring applications.

Technical Support

The designer's kit is available from the author. The kit consists of all the components for readers to construct a complete unit. Source code in Turbo Pascal 6 and EXE file are provided on a 3½in. floppy diskette. The price of kits is £39 including postage and packing. The assembled and tested units are £48 each. Please direct your enquiry to Dr. Pei An,

11 Sandpiper Drive, Stockport, Manchester SK3 8UL. U.K.
Tel/Fax/Answer: +44-(0)161-477-9583.
E-mail: pan@fsl.eng.man.ac.uk.

```
Function read_8254:integer;
(* Read two byte from the counter of 8254*)
(* $42h is the I/O address of the 2nd timer/counter of the 1st on-board 8254 *)
var
   low_byte, high_byte:byte;
begin
   low_byte:=port[$42]; high_byte:=port[$42]; (* read lower 8-bit and upper 8-bit *)
   read_8254:=low_byte + 256* high_byte; (* combine lower and upper bytes *)
end;
```

Listing 6.

Diary Dates

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

October 1996

5 October. FUSE Annual Conference 97, The Belfry, Birmingham. Tel: (0181) 982 4780.

7 October. Document 97, NEC, Birmingham. Tel: (0181) 742 2828.

7 October. GIS 97, NEC, Birmingham. Tel: (0181) 742 2828.

7 to 9 October. World Power and Energy, NEC, Birmingham. Tel: (01322) 660070.

7 to 9 October. Voice Europe – Computer Telephony and Voice Processing, Olympia, London. Tel: (01244) 378888.

7 to 9 October. GIS '97 – Geographical Information Systems, NEC Birmingham. Tel: (0181) 742 2828.

7 October. Electronic Commerce 97, Wembley Conference and Exhibition Centre, London. Tel: (0181) 332 0044.

27 October. NetWorld+Interop UK, Olympia, London, Tel: (0181) 261 4415.

28 October. Instrumentation Harrogate, Harrogate International Centre, Harrogate: Tel: (01822) 614671.

21 to 22 October. Property Computer Show, New Connaught Rooms, London. Tel: (01273) 857800.

12 to 23 October. Electronic Commerce 97, Olympia 2, London. Tel: (0181) 332 0044.

November 1996

1 to 2 November. Radio Rally, Llandudno, North Wales. Tel: (01707) 659015.

3 November to 19 December. Amateur Radio Morse Workshop, Highbury College, Newbury. Tel: (01705) 383131.

4 November. Interconnect Technology, Institute of Physics, London. Tel: (0171) 287 4898.

4 November. Euromilcomp 97, Wembley Conference and Exhibition Centre, Tel: (01322) 660070.

4 November. Records Management Society of Great Britain, Central London, Tel: (01494) 488599.

4 to 5 November. Software in Sales and Marketing, Wembley Centre, London. Tel: (0181) 541 5040.

18 November. Electronic Information Displays, Sandown Exhibitions Centre, Esher. Tel: (01822) 614671.

18 to 19 November. Workplace '97, Olympia, London. Tel: (0181) 910 7910.

19 November. System Builder, Sandown Exhibition Centre, Esher, Tel: (01822) 614671.

24 November. TMA30, TMA Ventures, Brighton. Tel: (01372) 361000.

26 November. Groupware and Workflow, Bloor Research, The Commonwealth Institute. Tel: (01908) 373311.

26 November. The BackOffice Magazine Conference, The Conference Forum, Aldgate, London. Tel: (0171) 600 9400.

December 1997

3 December. Modelling The Real World – Improving The Performance of IT Processes, Royal Horticultural Hall, London. Tel: (01635) 32338.

6 December. RSGB Annual Meeting, London. Tel: (01707) 659015.

6 December. Computer Sale and Exhibition, NEC, Birmingham. Tel: (01691) 682432.

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

What's On?

Electronic Commerce 97 Launch Pad for Europe

At least two dozen new products and services aimed at improving the way organisations conduct business electronically, will be unveiled at Electronic Commerce 97 at Olympia 2, from 21 to 23 October. This showcase event, now in its third year, also welcomes several new exhibitors, including UUNET, Unisys, The Web School, Omnes and Inter.net.uk.

Among the companies announcing new products at the event are Albany Software, Elcom, Foresight, Harbinger, Inter.net.uk, Modcomp, nCipher, NEXOR, Prospera, SAA, Unisys and Wick Hill.

Another exhibition highlight will be an 'Electronic Commerce In Action' demonstration, focusing on Tesco's highly acclaimed Web site. It will show the importance of electronic commerce for small companies wishing to compete alongside the large multi-nationals in supplying goods to an organisation like Tesco. At the same time, large suppliers are reminded that they cannot be complacent about service and business relationships when electronic commerce is making it so easy for smaller companies to compete equally for the business.

Electronic Commerce 97 focuses on the key issues surrounding electronic commerce, with seminar sessions, show features, leading edge products and services all aimed at answering any enquiries on what, why, when and how to conduct business electronically. Some of the key issues to be covered are security, payments and online banking, sales and marketing on the Internet, logistics and the impact of the new millennium.

For further details, check: www.t-stone.co.uk. Contact: Electronic Commerce, Tel: (0181) 332 0044.

£10 Million Awards to Link Science and Business

New awards worth £10 million will help science and business work together to explore new markets and technologies to secure long term competitive success, Margaret Beckett, president of the board of trade, announced this month.

The Foresight Link Awards will bring together new areas of industry of science and government to identify future business needs and how developments in science, engineering and technology can help meet these needs.

Speaking at the Competitiveness UK Business Summit in London, Beckett said, "We want to ensure that British excellence in basic science – and its access to world science – is translated into British business success".

"This is what the Foresight programme is about. Foresight brings together business, the science base and government to explore emerging opportunities in markets and technologies. But Foresight is not just about setting an agenda for the future. It is also about acting on it", said Beckett.

Projects addressing any of the Foresight priorities can apply for support. Preference will be given to sectors that do not have an established track record of collaboration with the science base. The priority areas are:

- A cleaner, more sustainable world – embracing pollution monitoring and control technologies as well as technologies for conserving energy and natural resources.
- Social trends – how populations changes are creating new markets and how people are adapting to new technology at home and at work.
- The use of innovative technologies in improving production processes and services in manufacturing.

Contact: Foresight Link Awards, Tel: (0171) 215 0369.

Be Demonstrates BeOS for Intel PCs

Before an audience of software developers at the Be Developer Conference in Boston last month, Be demonstrated its Be Operating System (BeOS) running on Intel-based personal computer hardware for the first time.

The French company went on to announce that it will simultaneously release Intel and PowerPC versions of Operating System within its next release in January.

During the conference's general session, Be engineers demonstrated identical functionality on both Intel and PowerPC processor platforms – from performance characteristics through user interface and experience. Company officials explained that the main differences the user will see will have to do with the relative performance characteristics of the individual processors, and the cost of the underlying hardware.

To further make the point, Be engineers demonstrated the ability to take source code for an application and recompile it for both the Intel and PowerPC platforms. Once compiled, the application operated identically on both types of PCs. In addition, Be demonstrated the BeOS running on multiprocessing hardware for both Intel and PowerPC platforms.

For further details, check: **www.be.com**.
Contact: Be, Tel: +33 1 49 06 73 75.

Introducing THE AVR

by Kevin Kirk

Wherever your interest in the electronics industry lies, you can't help but noticing that microcontrollers are popping up everywhere. Indeed, they represent a mini (in overall worldwide electronic industry terms) industry on their own.

The turnover in the 8-bit device market is around about the $14 billion mark this year, and is set to grow to at least $20 billion by the year 2000. It is becoming hard to conceive of a mainstream electronics product that doesn't have one of these devices lurking in it somewhere. The attractions are obvious; in addition to adding a modicum of intelligent control to a design, they are cheap, small, flexible and, on the whole, easy to use.

Microcontrollers grew up out of the mainstream microprocessor market. In essence, what happened was that as soon as the latest version of a processor family came out, then the oldest member of the family had some memory and I/O capabilities added and it became a microcontroller. Probably the best manifestation of this is the widely recognised (and much loved) 51 series. This device was originally designed by Intel and was based on their early 8-bit processors. By modern standards, it is fairly slow (although some high speed versions are being produced by specialist second source manufacturers) as it performs a divide-by-12 on the clock, giving the user a fairly modest instruction cycle time. It does have two main advantages though, in that it has an enormous amount of software written for it (much of which is available on the web) and it has one of the best bit manipulation structures around. However, this is at the expense of a high equivalent gate count of about 8,000 gates. It is also has the most widely licensed architecture around and is produced in various guises by a variety of manufacturers such as Siemens, Philips, MHS, Atmel and Dallas.

Microcontrollers have progressed a long way since those early days and the devices that you buy now are usually specifically designed as microcontrollers, rather than an obsolete processor with some I/O glued on. The architecture is now designed for stand-alone use, so the devices usually contain a watchdog, at least one timer, a counter, special function registers and, of course, I/O.

The most widely known device is probably the PIC from Microchip. Through a combination of low cost, flexible hardware and excellent marketing, this device has made massive inroads into the hobbyist/small business electronics sector. Most of the PIC devices were, and still are, EPROM-based. This meant that they would either be in the expensively packaged ceramic versions that can be erased using UV or in the plastic packaged one time programmable (OTP) versions. This made development either expensive or long-winded. The release of the 16C84, with its onboard EEPROM and 100 reprogramming cycles, was therefore very popular for experimenters. It uses a superset of the basic Reduced Instruction Set and it has a serial programming interface (albeit with a requirement for a 12V programming supply). For development, it is the cheapest way of going down the PIC route.

Other microcontrollers, that are well known in the wider electronics industry, are still relatively unknown in the small user market. These range from the SGS Thomson ST6 (a funny little device with an odd internal pipeline system but with some excellent development tools) through to 'Coldfire', which is the industry's current darling. In all, there are probably over twenty different architectures competing for sockets out there.

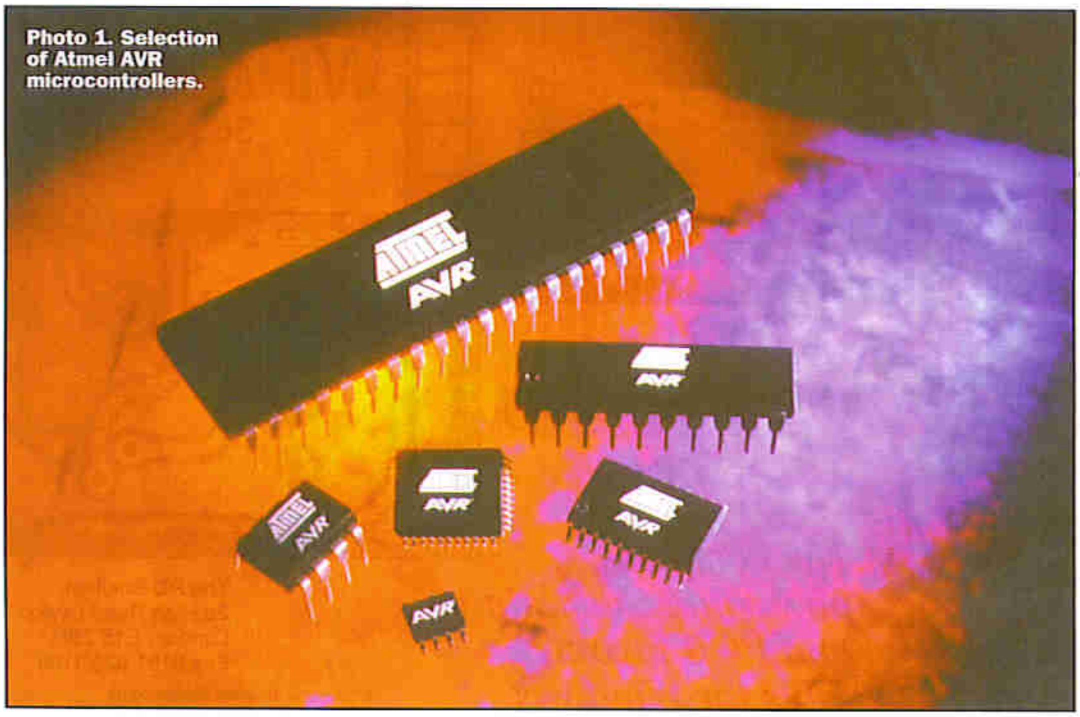


Photo 1. Selection of Atmel AVR microcontrollers.

The AVR

In order for a new device to succeed in the face of this sort of competition, it needs to be a little bit special. The new AVR from Atmel is! Atmel, who are the second largest producer of Flash Memory in the world, moved into the microcontroller market a little over 3 years ago. They followed a fairly safe route at first, by obtaining a license from Intel to produce their own version of the 51 series. What they did differently was to put flash memory into the device instead of EPROM, which allowed the device to be reprogrammed up to 1,000 times. This was excellent news for developers who could 'tweak' their code without expending devices or waiting for UV 'cleaners'. Other than that, they were fairly conventional, if a little more expensive than their OTP counterparts. However, they could use readily available 51 series development tools and were pin compatible with other 51 series devices. Atmel later brought out a 20-pin package, based on the same architecture, called the 2051. It has the same UART and Interrupt structure as the bigger devices and could use the same code. This device is popular in the States but has yet to find wide acceptance in the UK.

Meanwhile, in Norway, a new device was taking shape. This device has laid claim to a number of innovations. First of all, it is the first device that was actually designed around an IAR 'C' compiler. This means that code written in C is very nearly as compact as that written in assembler. Secondly, it doesn't have the conventional 'working' register bottleneck. Most microcontrollers require the

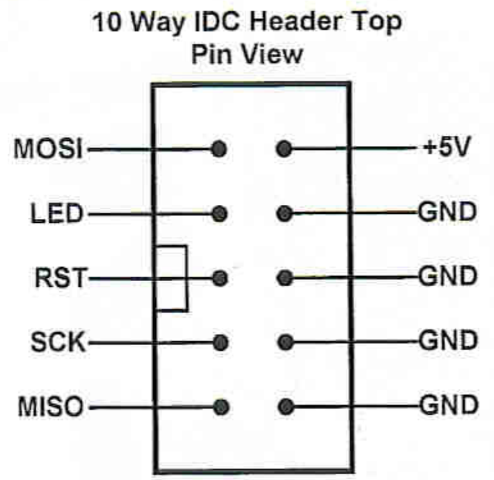


Figure 1. In System Programming interface.

programmer to perform mathematical, logical and (in the case of the PIC) literal instructions through a central register. This new device uses a series of 32 registers, most of which can perform this task, so dealing with interrupts or sub-routines becomes a lot easier as you don't have to store the working register value before you can perform your service routine.

Probably the biggest innovation was the speed of the device. Other microcontrollers divide the number of pulses from the system clock into a number of sub-divisions. The 51 series divides by 12 for instance, and the PIC divides by 4. The processors use these timing 'states' to perform certain tasks, for instance, instruction fetch, instruction decode and instruction execution. Some of the impact of this can be minimized by performing 'pre-fetches'. This is where the next instruction is fetched at the same time as the last instruction is executed. This is what is done in the PIC, which results in an effective clock division of 2 instead of 4. The AVR has a more static structure and does not require any clock division at all. Therefore, at 16MHz, the device is capable of executing an instruction in 62·5ns, which must make it one of the fastest 8-bit microcontroller on the market (the fastest appears to be the Scenix SX which clocks in at 50MIPs at full speed, but more on that at another time).

In System Programming

The microcontroller market is moving over to In System Programming as the preferred methodology for programming the device. The idea is that you don't have to actually program the device before you put it in circuit but could, instead, solder it into your circuit blank and then program it at build time. There are a number of advantages to this in a production environment, such as the ability to integrate the latest software upgrades, installation of diagnostic routines, etc. To the developer, this system creates a wonderful flexibility, especially if it coupled with the reprogramming capabilities that flashram offers. So, you could design your circuit, build in the programming interface (see Figure 1) on the board, then undertake a number of write and test cycles until your code is perfect. One point to note is that the device itself does not need any special programming voltage to be applied, so you do not have the extra hassle of designing in a supply purely for programming. We shall be using this flexibility when we start looking at practical projects next month.

The Instruction Set

The AVR is touted as a Reduced Instruction Set Computer (RISC) but if you look at the instruction set (see table), you will see that it has 180 instructions, which is hardly what most people would consider to be RISC. So, Atmel are calling the device a RISC processor with a CISC (Complex) Instruction set. In order to square this particular circle, you need to look at the reasoning behind the RISC technology and how Atmel are applying it. A processor spends most of its time decoding instructions, in essence, it goes to a lookup table to see how to execute a command. The larger the instruction set, the longer it takes to decode, because it spends longer going through

Mnemonics	Operands	Description	Flags
ADD	Rd, Rr	Add without Carry	Z,C,N,V,H
ADC	Rd, Rr	Add with Carry	Z,C,N,V,H
SUB	Rd, Rr	Subtract without Carry	Z,C,N,V,H
SUBI	Rd, K	Subtract Immediate	Z,C,N,V,H
SBC	Rd, Rr	Subtract with Carry	Z,C,N,V,H
SBCI	Rd, K	Subtract Immediate with Carry	Z,C,N,V,H
AND	Rd, Rr	Logical AND	Z,N,V
ANDI	Rd, K	Logical AND with Immediate	Z,N,V
OR	Rd, Rr	Logical OR	Z,N,V
ORI	Rd, K	Logical OR with Immediate	Z,N,V
EOR	Rd, Rr	Exclusive OR	Z,N,V
COM	Rd	One's Complement	Z,C,N,V
NEG	Rd	Two's Complement	Z,C,N,V,H
SBR	Rd, K	Set Bit(s) in Register	Z,N,V
CBR	Rd, K	Clear Bit(s) in Register	Z,N,V
INC	Rd	Increment	Z,N,V
DEC	Rd	Decrement	Z,N,V
TST	Rd	Test for Zero or Minus	Z,N,V
CLR	Rd	Clear Register	Z,N,V
SER	Rd	Set Register	None
CP	Rd, Rr	Compare	Z,C,N,V,H
CPC	Rd, Rr	Compare with Carry	Z,C,N,V,H
CPI	Rd, K	Compare with Immediate	Z,C,N,V,H
RJMP	k	Relative Jump	None
RCALL	k	Relative Call Subroutine	None
RET		Subroutine Return	None
RETI		Interrupt Return	I
CPSE	Rd, Rr	Compare, Skip if Equal	None
SBRC	Rd, b	Skip if Bit in Register Cleared	None
SBRS	Rd, b	Skip if Bit in Register Set	None
SBIC	P, b	Skip if Bit in I/O Register Cleared	None
SBIS	P, b	Skip if Bit in I/O Register Set	None
BRBS	s, k	Branch if Status Flag Set	None
BRBC	s, k	Branch if Status Flag Cleared	None
BREQ	k	Branch if Equal	None
BRNE	k	Branch if Not Equal	None
BRCS	k	Branch if Carry Set	None
BRCC	k	Branch if Carry Cleared	None
BRSH	k	Branch if Same or Higher	None
BRLO	k	Branch if Lower	None
BRMI	k	Branch if Minus	None
BRPL	k	Branch if Plus	None
BRGE	k	Branch if Greater or Equal, Signed	None
BRLT	k	Branch if Less Than, Signed	None
BRHS	k	Branch if Half Carry Flag Set	None
BRHC	k	Branch if Half Carry Flag Cleared	None
BRTS	k	Branch if T Flag Set	None
BRTC	k	Branch if T Flag Cleared	None
BRVS	k	Branch if Overflow Flag Set	None
BRVC	k	Branch if Overflow Flag Cleared	None
BRIE	k	Branch if Interrupt Enabled	None
BRID	k	Branch if Interrupt Disabled	None
MOV	Rd, Rr	Copy Register	None
LDI	Rd, K	Load Immediate	None
LD	Rd, Z	Load Indirect	None
ST	Z, Rd	Store Indiredt	None
IN	Rd, P	In Port	None
OUT	P, Rd	Out Port	None
LSL	Rd	Logical Shift Left	Z,C,N,V,H
LSR	Rd	Logical Shift Right	Z,C,N,V
ROL	Rd	Rotate Left Through Carry	Z,C,N,V,H
ROR	Rd	Rotate Right Through Carry	Z,C,N,V
ASR	Rd	Arithmetic Shift Right	Z,C,N,V
SWAP	Rd	Swap Nibbles	None
BSET	s	Flag Set	SREG(s)
BCLR	s	Flag Clear	SREG(s)
SBI	P, b	Set Bit in I/O Register	None
CBI	P, b	Clear Bit in I/O Register	None
BST	Rr, b	Bit Store from Register to T	T
BLD	Rd, b	Bit Load from T to Register	None
SEC		Set Carry	C
CLC		Clear Carry	C
SEN		Set Negative Flag	N
CLN		Clear Negative Flag	N
SEZ		Set Zero Flag	Z
CLZ		Clear Zero Flag	Z
SEI		Global Interrupt Enable	I
CLI		Global Interrupt Disable	I
SES		Set Signed Test Flag	S
CLS		Clear Signed Test Flag	S
SEV		Set Two's Complement Overflow Flag	V
CLV		Clear Two's Complement Overflow Flag	V
SET		Set T in SREG	T
CLT		Clear T in SREG	T
SEH		Set Half Carry Flag in SREG	H
CLH		Clear Half Carry Flag in SREG	H
NOP		No Operation	None
SLEEP		Sleep	None
WDR		Watchdog Reset	None

Table 1. Instruction set.

the lookup table. So, if you reduce the number of instructions, then it won't spend so long looking them up. The AVR neatly sidesteps this issue in two ways. First of all, the instruction set, whilst looking comprehensive (see Table 1), is in reality, a series of repeated instructions each with a slightly different emphasis. So, for example, Branch if carry clear (BRCC) is actually the same instruction as Branch if bit in SREG is clear (BRBC). Secondly, because of the architecture, it is able to decode CISC instructions at RISC speeds.

The instruction set is comprehensive and has a very rich set of branch instructions, with both jumps and skips. The arithmetic instructions are straightforward with some nice little features like a 2s compliment instruction. This is nice when you want to subtract one number from another (you just add the 2s compliment of the number you want to subtract to the number you want to subtract it from then discard the carry). Arguably, you just need to invert the number and add 1 but this is neater. It lends itself very well to serial port work as many protocols transmit the 2s compliment of a checksum, for instance, as a form of error checking on packets. Bit manipulation is adequate, though not as good as the 51 series.

The main niggle is the way that ports are accessed. To get at a port, you must use an IN or OUT instruction for bytewide data transfer. This is a little clumsy in comparison with the PIC, which treats the port as a register. It does have bitwide instructions for directly setting and clearing port register bits and for testing port bits. The port structure is true tri-state (like the PIC but unlike the 51) and has the capability of reading either the associated port register or the port pin itself. The beauty of that is that you can read what you actually wrote to the port and not what the processor thinks that it has on it. So, if you are directly driving the base of a transistor from the port, it would normally read a high as a low on the port. If you read the register, you don't have this problem. The ports are capable of directly driving LEDs (they can sink 28mA) and do pull to the rails. There is also a program option of having input pull ups on the ports so you can wire OR ports or drive them with either tri-state or fixed logic, which is a nice touch.

Photo 2. Atmel AVR starter kit.

The first device in the series, the 1200, is a little light on scratchpad memory (basically, it just has the 32 registers), but there is a 64-byte EEPROM onboard, which is very useful for local non-volatile storage. Program memory is 1k-byte, which is a little disingenuous as it requires 2 bytes per instruction, but given the flexibility of the instruction set, it is surprising what you can achieve in such a small amount of memory. Later versions in the range have a much more generous memory allocation in terms of Flash, EEPROM and RAM.

Finally, on the support side, Maplin have both an AVR starter kit, which contains an assembler, simulator, In system programmer and Stand-alone programming module (Order Code NR20W) and a training system (NR41U) available. The device itself is the AT90S1200 (NR25C), the pinout of which is shown in Figure 2, and it weighs in at a very affordable £5.19.

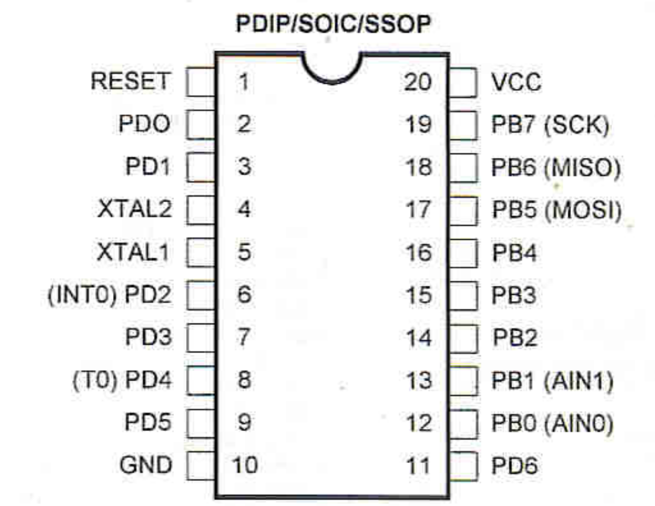


Figure 2. AVR 90S1200 pinout diagram.

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Club Corner

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The British Amateur Electronics Club (founded in 1966), for all interested in electronics. Four newsletters a year, help for members and more! UK subscription £8 a year (Junior members £4, overseas members £13.50). For further details send S.A.E. to: The Secretary, Mr. J. F. Davies, 70 Ash Road, Cuddington, Northwich, Cheshire CW8 2PB.

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

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

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

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

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

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

Sudbury and District Radio Amateurs (SanDRA) meet in Gt. Cornard, Sudbury, Suffolk at 8.00pm. New members are very welcome. Refreshments are available. For details please contact Tony, (G8LTY), Tel: (01787) 313212 before 10.00pm.

TESUG (The European Satellite User Group) for all satellite TV enthusiasts! Totally independent. TESUG provides the most up-to-date news available (through its monthly 'Footprint' newsletter, and a teletext service on the pan-European 'Super Channel'). It also provides a wide variety of help and information. Contact: Eric N. Wiltsher, TESUG, P.O. Box 576 Orpington, Kent BR6 9WY.

Thanet Electronics Club. For school age Ham Radio and Electronics enthusiasts, enters its 16th Year. Meetings held every Monday evening from 7.30pm at The Quarterdeck, Zion Place, Margate, Kent. For further details contact: Dr. Ken L. Smith, (G3JIX), Tel: (01304) 812723

Wakefield and District Radio Society meet at 8.00pm on Tuesdays at the Community Centre, Prospect Road, Ossett, West Yorkshire. Contact Bob Firth, (G3WWF), (QTHR), Tel: (0113) 282 5519.

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

Winchester Amateur Radio Club meets on the third Friday of each month. For full programme contact: G4AXO, Tel: (01962) 860807.

Wirral Amateur Radio Society meets at the Ivy Farm, Arrowe Park Road, Birkenhead every Tuesday evening, and formally on the the first and third Wednesday of every month. Details: A. Seed, (G3FOO), 31 Withert Avenue, Bebington, Wirral L63 5NE.

Wirral and District Amateur Radio Society meets at the Irby Cricket Club, Irby, Wirral. Organises visits, DF hunts, demonstrations and junk sales. For further details, please contact: Paul Robinson, (G0JZP) on (0151) 648 5892.

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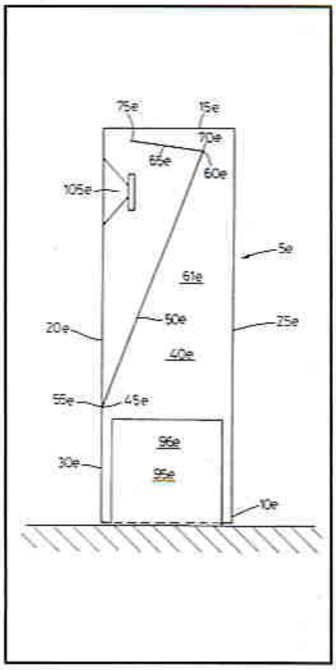
G. Johnston,
Kilmarnock, Ayrshire.



Thank you for sending in these details and suggestions.

Dimmer Cheaper?

Regarding the Star letter from M. Perry (Issue 118), whilst agreeing with the suggestion of separating fixed voltage and variable voltage loads, a somewhat less expensive alternative to a variac would be to use a dimmer designed to be used with low voltage lighting transformers. Home Automation offer a 250W version, ref. P250W1DLV and a 500W unit, ref. P5001DLVRS. Alternatively, it might be possible to use Maplin's Stock code VF37S – K5002 Halogen light dimmer. Although setting this could be less easy and I suspect is more expensive than the ready-made items! One or other of the above would be used to control the mains input to a suitable low voltage transformer.

I. M. Tasker,
Skillington, Grantham.

Some useful suggestions. At £17.99 including VAT, the VF37S kit is comparably, even favourably priced, in relation to many ready-made halogen light dimmer units. It's designed to work with inductive loads such as transformers and motors, so could, in theory, be used to control an AC-motor powered model train or other appliance.

In this issue, Gareth Connor, formerly of GJC Designs, London, wins the Star Letter Award of a Maplin £5 Gift Token for writing in to report the existence of surface mount electrolytic capacitors and an effective magazine delivery service!

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Star Letter

Dear Sirs,

I would like to correct an error that was first perpetrated by Ian Davidson in the July 1997 edition in his article on SMT. Subsequently, the error appeared again in *Air Your Views,* October 1997. SURFACE MOUNT ELECTROLYTIC CAPACITORS EXIST! Take a look at the Farnell Catalogue for SM electrolytics. Order code 556-130 is 100μF 6·3V, 556-269 is 22μF 35V. These caps have an aluminium can and on first appearance, look like very low-profile standard electrolytics with altered lead-outs. Prices are under 20 pence each. The manufacturer is Panasonic. RS Components do a range of similar capacitors; Stock code 108-160 is 100μF 6·3V. The above type of capacitor is designed to be put through the normal SM infra-red solder reflow process. Whilst some people may baulk at the idea of subjecting an electrolytic cap to IR reflow temperatures, they are designed to cope. Consider that many conventional wire-leaded electrolytics pass over flow-solder baths with pre-heat and cool-down tunnels for correct temperature cycling. Conventional electrolytics are subjected to, and designed for, high temperatures. SM electrolytics have been in regular commercial and industrial use since at least 1993. At that time, I was on contract with a West Yorkshire audio company that was putting in an SMT facility for its mixing console manufacturing operation. PCBs designed from that date onwards had SM electrolytics throughout. Soldering was by IR reflow, and if component degradation leading to reduced audio quality had been an issue, the company would not have used SM electrolytics. They still use SM electrolytics today. The move from conventional leaded to SM components and assembly methods has improved the quality and reliability of the Company's products. RS also do a more typical surface-mount looking component which is described as being "Aluminium electrolytic, speciality polymer". Stock code 385-339 is a 6·8μF 16V device. At well over £1 each, this type is not cheap, but they do exist. Having not used this particular type of capacitor, I cannot comment on its characteristics. I hope that this clears up the error and enlightens a few readers. Having got the moan out of the way, a compliment: Thanks for the good mag – keep up the good work. Having moved from London to Zimbabwe earlier this year, the mag now has to travel halfway round the planet to get to me. So far, it has done so without hitch, and always very quickly. The October edition arrived on September 3rd . . . A Quantum Leap perhaps?

Thank you for pointing out this apparent gap in our knowledge/product lines. Good to hear you like the magazine otherwise and that the delivery service is up to scratch; you received your well-travelled copy 2 days before it was due to appear in the shops in the UK!

Network Computers – Plug Included!

Dear Sir,

After reading Keith Brindley's article *Comment* in Issue 118, I was somewhat bemused by the misconceptions often shown regarding Network Computers (NC's). It's funny how people have the idea that somebody would bother, in this day and age, to develop a dumb terminal for networks and try to sell it as a new idea. The Network Computer is far from being dumb. Here is a précis of the specification:

- 40MHz 32-bit RISC processor with hardware floating point co-processor (IEEE 754 – 1985).
- 8M-bytes of EDO DRAM (upgradeable to 32M-bytes).
- MPEG2 (and MPEG1) compatibility with 2M-bytes of decoder RAM.
- SVGA (800 × 600) display @ 16bpp.
- State-of-the-art font and graphics software producing a crisp, high legibility display, even on a TV screen.
- Smartcard socket for ISP setup and user configuration.
- Operating System in ROM (externally upgradeable by exchange of ROM card).
- Built in HTML 3.2 Web browser supporting frames, tables, forms.
- 28·8k-bps internal modem OR networking interface card.
- 16-bit CD quality stereo audio.

Sockets for SVGA monitor, AT keyboard, PS2 mouse, stereo audio out, bi-directional parallel port, SCART socket for connection to TV, and composite video outlet. The operating system (NCOS) is a very close relation to Acorn RiscOS which has a proven track record of over eight years and is a very stable, comprehensive, and intuitive GUI. Don't be fooled by the 40MHz clock speed, the ARM 7500FE processor is no slouch and has roughly the same throughput as a 100MHz 486 DX4. This, in itself, will not sound very impressive to the average PC user but, when the efficiency and responsiveness of the Operating System is taken into account, you'll find that any version of MS Windows on even the fastest Intel processors would have trouble being as slick. In addition to this, there is a version of the machine already in existence which has the 200+ MHz StrongARM processor (co-developed by ARM and Digital Semiconductor) at its heart. The Digital StrongARM SA-110 processor has the highest published scores for the CaffeineMark 2.01 interpreted Java applet performance benchmark in comparison to other desktop systems, i.e., it is the fastest in the world at executing JAVA code! The Smartcard is a neat idea, as it allows the user to set up all their preferences such as screen display, Internet service provider, printer, etc., with this configuration being stored on the Smartcard. If another user wants to use the machine, they simply insert their own Smartcard which sets up the NC to the configuration on their card complete with Internet account details, software, and display preferences. Without the card, the machine returns to the default setup, as supplied, with no user files stored in it. This means that any NC can be used and will be set up to the user's preferences – great for intranets. The card system is one of the reasons why the NC can show great savings in intranet maintenance costs, as it is much simpler to replace a basic unconfigured machine than to spend hours trying to retrieve files and re-installing and configuring software on a PC with setups stored on the hard disc. Not that I would expect many breakdowns as ARM processors consume very little power and generate hardly any heat, and the fact that access to the hard disc is not required for the Operating System to work; both contribute to the renowned ruggedness of Acorn's computers. The basic device used to communicate with the NC, as supplied, is an I/R remote control which has all the buttons necessary for navigation through the browser interface, and an alphanumeric keypad for text and URL entry. A full-sized I/R keyboard is available as an option. A common criticism of the NC concept is lack of local storage. The reasons for not having this included in the basic machine are two-fold: Firstly, the specification was for an inexpensive unit (less than $500 US) which would be seen primarily as a domestic device comparable to a video recorder or satellite system. The intention was for all storage to be done over the network (ostensibly provided by Oracle Corporation – the second biggest software company in the world). Who's the biggest? Secondly, the Operating System does not require a hard drive to function as it is contained in ROM (additional facilities can be loaded temporarily into a module area of RAM). If local storage is required, this can be provided by a ZIP drive connected to the parallel port, effectively turning the NC into a more-or-less conventional desktop computer. ZIP drives are already supported by the operating system. So, make no mistake, the NC is a real computer with enough power to use as an Internet access device and more! It is supplied with a word processor which can save in MS Word 7 format and is capable of running very sophisticated software. By the way, software on Acorn machines tends to be very compact and efficient, often being written in assembly language as ARM code is quite simple. 'Bloatware' doesn't exist on the Acorn platform, which means that resources are much better used, with 8M-byte of RAM being sufficient to multi-task several useful programs. For the majority of computer users, the machine could become much more than an adequate replacement for a PC, and at a very affordable price. For more details, try looking on the 'Web' at:
http://www.acorn.com/acorn/products/nc/,
http://www.acorn.com/acorn/technology/nc/ncdesign.html,
http://www.cybervillage.co.uk/acorn/hotnet/index.stm,
http://www.arm.com/.
Have a good look round. If you thought that Intel processors were the only ones worth looking at, it should be an eye-opener! I make no apologies for wholeheartedly supporting these excellent British products, even though the mere mention of Acorn computers or ARM processors seems to instantly destroy one's 'street cred' these days.

Rennie Hill
rennie@reji.demon.co.uk.

Ssh! Everyone will be wanting one if you carry on like that. . .

Sounding Off!

Dear Sir,

This letter is concerning the Velleman LED VU Meters article in the October issue. My attention was drawn to the calibrating methods used. My understanding of audio equipment has lead me to believe that currently, there are at least two signal levels common to equipment: -10dBu for domestic equipment (Hi-Fi, etc.) and +4dBu for professional equipment (public address and studio quality). These levels correspond to the voltage levels that any internal VU meter would read 0dB: 0·24V for domestic equipment and 1·23V for professional equipment. I think that readers should be aware of this, and should calibrate the VU meter to the relevant signal level and corresponding voltage, preferably using an existing calibrated VU meter as a guide. Finally, the formula for calculating the dB ratio is: dB = 20Log10(V1/V2) – adding the "u" after dB means that the ratio is relative to 0·775V rms (which apparently dates to the early telephone industry).

L. G. Jones,
Abergavenny, Gwent.

Or relative to 0·7746V rms, and with an upper case 'U', if you want to be even more exact!

Hi-Tech HITS THE BETTING JACKPOT

by Alan Simpson

That horse racing is the 'Sport of Kings', few would deny. Just scan through any recent copy of Tatler – or come to that, the most recent Horserace Totalisator Board Annual report, and there will be pictures of horses, royalty and Lords in abundance.

The high and mighty also score in the horse stakes. Between the regal photos is pictures of the elfin look-alike Robin Cook and the recently vanquished Michael Howard. Very much a case of the Tote Board – a government established quango – hedging their bets.

It was 1929 when the Tote first opened for business at Newmarket and Carlisle. Its birth had been a long and painful process and its early years were marked by financial ill health. Britain, with a long history of racing and breeding, was unusual among racing countries in the way that bookmakers had been allowed to dominate the betting scene. Irritated by the huge sums which totalisator betting was providing to help the sport in other countries, The Jockey Club – the supreme being in the racing fraternity – took the view that betting should be encouraged to contribute towards the sport.

Sir Winston Churchill, then Chancellor of the Exchequer, promised to make time for a Private Members Bill to be introduced and in August 1928, the Racecourse Betting Act became law. In turn, the Bill provided for the creation of a statutory body, the Racecourse Betting Control Board, whose objectives were to provide backers with an alternative to betting with the bookmakers and to generate money to support the sport of horse racing. The fledgling Tote had no money and financed itself by borrowing from the banks. It ran into considerable financial difficulties in the early years. (Sounds rather like the typical heavy punter).

The scene of the 150th year of the Tote Ebor held in 1993 at York racecourse.

The Tote operated against fierce competition from the bookmakers on-course and was not allowed to take part in the lucrative off-course credit market until a group of shrewd racehorse owners formed a private company. The role of Tote Investors Limited was to channel off-course bets to the Tote's racecourse pools on a commission basis. This structure continued from 1929 until 1960 and the Tote was able to make contributions to racing in this period of nearly £9 million. Cash betting away from the racecourse was still against the law which, not surprisingly, was broken with monotonous regularity by bookmakers who operated a system of street corner and factory runners to collect bets and were prepared to pay the penalty when the law caught up with them. Plainly, the law was being held in disrepute and in 1960, following police pressures, the Government introduced the Betting and Gaming Act which legalised off-course betting.

It was at this juncture that the Tote could have been given an off-course monopoly, although the task of weaning the betting public off starting price betting nurtured by the illegal bookmakers would not have been easy. The public were not familiar with pool betting, but the opportunity was there and was missed. The illegal bookmakers were allowed to come out of the woodwork and were legalised by local magistrates and given licences to bet in their new-fangled betting shops. They spread rapidly throughout the country and reached a peak of 15,578 in 1968. Today, there are some 8,500 betting shops.

Betting Wars

The Tote was unable to take part in this off-course betting boom. Although allowed to run betting shops like the bookmakers, they were not allowed to offer starting price betting. And this is what the public were used to, for they had traded illegally at starting price for years. This development of starting price betting shops had an adverse effect on the tote's finances and in 1972, in order to restore their competitive position the tote was empowered by another act of parliament to accept bets at starting prices as well as tote odds. Very much a case of 'if you can't beat 'em, join them'.

Today, the Tote in Britain is organised into three sections:

- The Racecourse Cash Division continues to have an exclusive licence to run pool betting on Britain's 59 racecourses.
- Tote Credit offers its 50,000 members credit facilities to bet at Tote odds and starting price. The group has been relocated and instead of operating from a London headquarters with numerous provincial offices, now operates from Wigan, Lancs., in a centre fully equipped with the latest in computer and telecommunications technology.
- The third division is Tote Bookmakers which now is responsible for running 201 betting shops off-course and 69 shops on-course. Like Tote Credit, they accept bets at Tote odds and starting price.

To end this brief saga of The Tote, the organisation has joined forces with a major leisure chain to form Tote Direct which offers bookmakers the opportunity to take Jackpot, Placepot, Trio and Dual Forecast bets without risk using a new computer terminal developed specifically for this task.

The Tote Cheltenham Gold Cup.

A Safe Bet

Hi-tech Spreads the Betting – Fast

Despite falling revenues – thanks to the competitive pressures of the National Lottery – turnover still exceeds £300 million. But fortunately for all concerned – the Tote authorities, the betting shops and the punter – high-tech support is available in the shape of powerful computers and communications. Tote Direct are making extensive use of Paknet Radio-Pads which are installed next to Tote Direct terminals in betting shops in the UK. These terminals will enable customers to place bets at Tote odds, off-course. Radio-Pads send the bet transaction data via radio to a network of base stations located all around the country. Paknet, the Vodafone Public Data Network, supplies these high-speed radio and fixed communications links from the Tote Direct terminals installed in betting shops right through to the Central Tote host computer in Wigan.

The Paknet communications solution is near instantaneous and error-free. Bets are entered on the standard Tote machine readable card which is then fed into the Tote Direct terminal. A visual check of the selection appears on screen for verification; the data is communicated over the Paknet network to the Tote Centre in Wigan and the customer's receipt is then printed with details of the bet and identification number. The entire transmission takes just three seconds, allowing customers to place bets even as the horses are entering the stalls. The on-line system confirms that the bet has been duly registered and all is set for the 'off'. To collect any winnings, the fortunate punter simply produces the receipt which is then fed into the terminal. This then receives the electronically calculated winnings from the Tote centre, again, via Paknet.

Sure-thing Bet

Paknet, supplies a sure-thing bet for all involved. With over 45,000 Radio-Pads sending two-way data over the Paknet network, it's not surprising that a common belief is that all this traffic goes from Radio-Pad to Radio-Pad. In fact, for many applications, large numbers of Radio-Pads are either calling into, or being called by, a single host computer. Not unexpectedly, many of these calls occur simultaneously. If a Radio-Pad is used at the host end, it would only be able to sustain a single call at a time (the port) and as a result, would be unable to provide sufficient call handling capacity during busy periods.

The simplest way to provide sufficient call capacity at the host end is to connect a 64k-bps digital leased circuit from the host into the nearest Paknet exchange. These circuits carry X25 data packets directly to and from the network and are capable of supporting hundreds of simultaneous calls.

Around 85 base stations hosts up and down the country and linked by landline to each other in a honeycomb network, are connected to the Paknet network using 64k-bps circuits. These provide card authorisation, polling and transaction services and are operated by major clearing banks, regional electricity companies and the national lottery, to name but a few users. Among these users, Tote Direct claims that at a single race meeting, their leased circuits can be called upon to handle around 32,000 calls, the majority of which occur within just a few minutes of each race. The network is particularly active in March, April and June when the national racing events – Cheltenham Festival, Grand National and Epsom take place.

Signals from each bookmaker's shop goes to a local base by means of an aerial array on the roof. Reception is up to ten miles from each array to the local base station which routes the message to a main switch, from where it travels by landline to Wigan and as a back-up to Warrington – all within two seconds. The same backbone network relays the return messages. Overall, the network achieves some 40bps UK transmission time.

One further major advantage of leased circuits is that they offer a seamless gateway into Vodafone's messaging services, such as GSM data, direct input paging and Short Message Services, thereby ensuring that the number of direct host connections is destined to expand. Already, there are over 2,300 Paknet Radio-Pads providing communications for Tote Direct terminals in branches of Corals, the Tote Bookmakers and in leading independent bookmakers. With Ladbroke recently joining the Paknet club, the number of installed terminals will double.

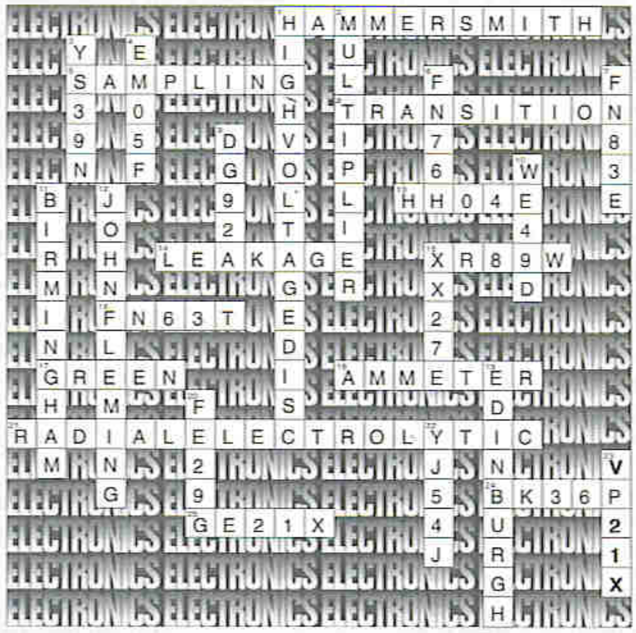
Place Your Bets

As John Smith, director and general manager of Paknet comments, "It is great to be at the heart of the revolution in off-course Tote betting. This is one application in which speed, accuracy and economy are critical. There is now a momentum for other betting chains to install terminals on their premises, thereby offering their customers better odds and a greater spread of bets."

However, it is not just betting which is receiving the attention of Vodafone Paknet. Already handling roadside traffic data on the M40 motorway, Paknet operations include TrafficMaster, London's variable message signs, traffic counting in Essex and Kent, traffic light monitoring, parking machine telemetry and RAC messaging. Away from UK roads, Paknet is being used for automated lighthouse telemetry radio navigation, security alarm signalling, electricity meter reading (overnight) and credit card authorisation from over 10,000 points of sale. Already, there is talk that the Rugby Union authorities are looking at match betting. It is time to place your bet.

ELECTRONICS and Beyond
CROSSWORD SOLUTION

CROSSWORD No. 6 *Solution* September 1997



Congratulations to Ben Blundell of Whaleybridge for the first correct reply. £25 will be on its way to you.

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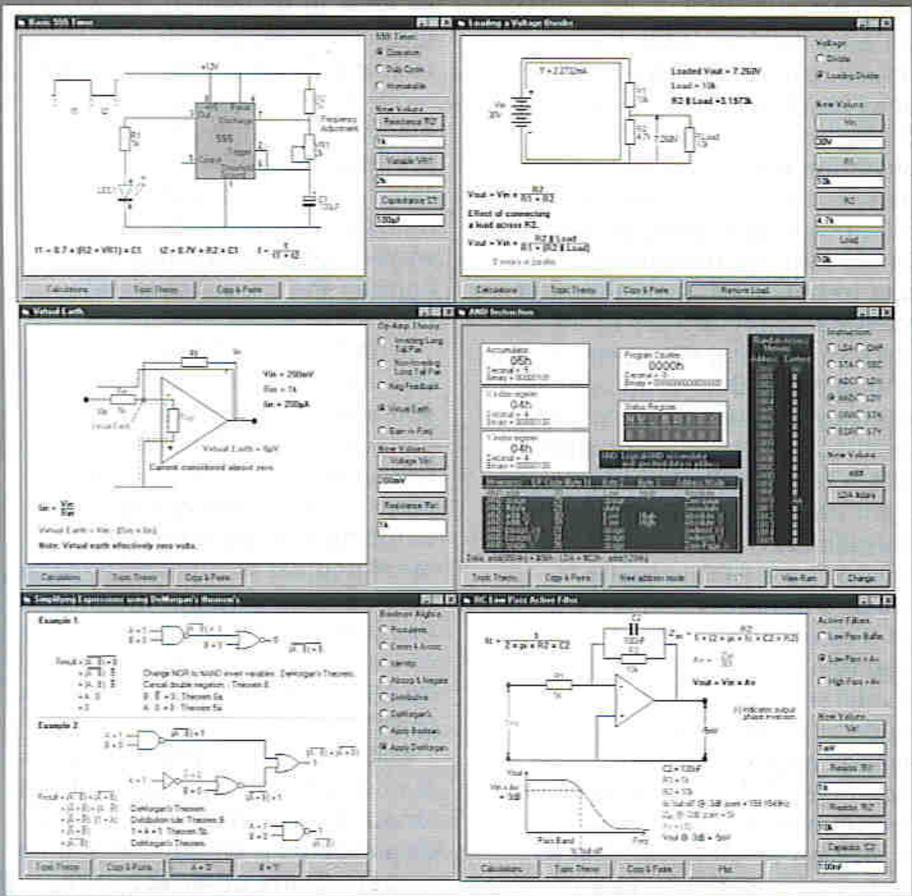

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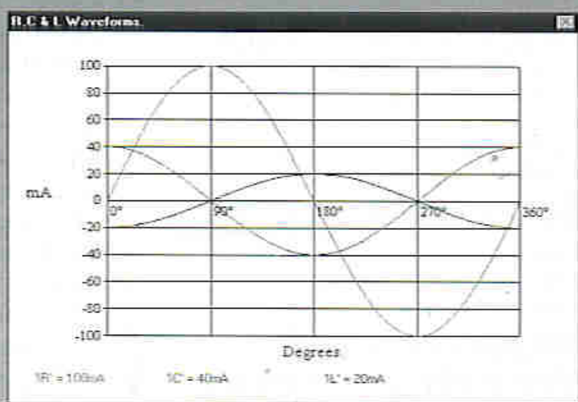

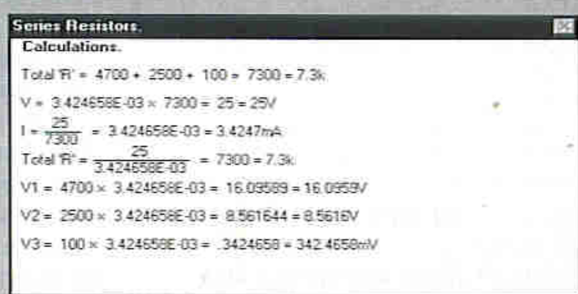

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MPS
MAPLIN PROFESSIONAL

CATALOGUE PREVIEW

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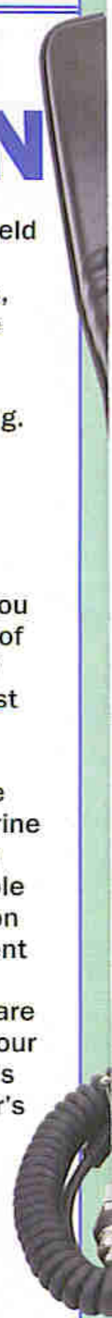
Welcome to another mini preview of the new Maplin MPS catalogue, bringing you a selection of the newest and most popular products from Maplin MPS. You'll find some useful information on Navigation and Night Vision, Aerials and Aerial Amplifiers and Audio Connectors in this supplement. See our new catalogue for many thousands of electronics and associated products.

NAVIGATION AND NIGHT VISION



GPS

GPS (Global Positioning System) was originally developed for military use by the US Air Force some years ago, at a cost of over $12 billion. It is a location and navigation utility that determines a user's precise latitude, longitude and altitude by means of tracking signals that are transmitted, on L band frequencies, by a series of satellites. There are 24 of these satellites orbiting the earth, at an altitude of 10,800 nautical miles. Receiving the signals from three satellites will give a positional fix, while a fourth will also allow height above sea level to be determined. This information is provided by a GPS receiver in around a minute, provided that it has a clear view of the sky.

You don't have to work for the US military to use GPS. Indeed, you don't even need to pay anybody a subscription to take advantage of this valuable service. There is one caveat, however – the version of GPS available to non-military users has been treated with a random factor, known as selective availability, that reduces accuracy. The civilian variant of GPS – known as SPS (standard positioning service) – is limited in accuracy to anywhere between 25 and 100 metres.

The extremely-accurate military-specification receivers use another signal, known as precise positioning service, or PPS. If more accuracy is required from SPS equipment, a system known as differential GPS (DGPS) can be used to overcome the effects of selective availability, and make positioning consistently accurate to within 25 metres. DGPS makes use of an additional receiver that picks up signals from radio beacons' installed in various countries. Many high-end GPS receivers offer interfaces for DGPS receivers.

The first GPS receivers for civilian use started appearing five or so years ago, and were intended primarily for fixed installation in boats. Miniaturisation of electronics has allowed more compact hand-held devices to be manufactured – ideal for campers, mapmakers, explorers and travellers. Some models, which include built-in electronic compasses, are particular suited to orienteering. Most include route-planning facilities – you can define waypoints or landmarks that contain the co-ordinates of desired destinations.

With GPS, you know where you are, and can radio the details of you location to the emergency services if help is needed. Most GPS receivers have a serial interface that allows external equipment to be attached. The most popular is the NMEA marine electronics standard, although many GPS receivers are capable of working to the more common RS232 standard, for attachment to PCs and the like.

Microsoft's AutoRoute software is now GPS-enabled, so that your location relevant to the route is displayed on a laptop computer's screen. Some other software, such as GPSS, will provide spoken directions to a location – again, GPS is used to feed the system with the vehicle's current location. In-car navigation systems, such as Philips' Carin, take a similar GPS-based approach. Future in-car developments will be linked to GPS systems – imagine a security system that pinpoints a stolen vehicle via a cellular phone, or even an engine management and diagnostics system that automatically calls a breakdown operator with details of the car's location, as well as the fault.

TRAFFICMASTER

Trafficmaster, which is now being offered as an option on certain makes of cars, relays up-to-the-minute traffic information to drivers. The information offered is much more up-to-date than that offered by radio traffic bulletins – this is because Trafficmaster works by directly monitoring traffic flow at strategic points, with devices that resemble speed

This is just a small selection of products in this range. See the latest catalogue for more details. All prices include VAT.

cameras. Information from these traffic sensors is passed to Trafficmaster's headquarters in Milton Keynes, and then disseminated via a series of paging transmitters located at cellphone towers. Currently, Trafficmaster covers the entire network of national motorways, plus an ever-increasing number of trunk roads.

The Trafficmaster in-car terminal is fixed to a convenient point on the dashboard, and derives its power from the car's electrical system. The unit receives signals from the Trafficmaster paging transmitters via a tiny built-in aerial, and decodes the information. This is either displayed on a LCD map display, or spoken' to you by means of a voice synthesiser. The latter approach is preferable, since it means that your eyes are focused on the road at all times. In addition to Trafficmaster's purchase price, a low-cost six-monthly or annual subscription is required. The time and petrol saved by Trafficmaster in just one journey could pay for not only the receiver, but the year's subscription as well.

NIGHT VISION

Have your ever wanted to see in pitch blackness? With night vision apparatus – which, like GPS, has its roots in the military – you can. Night vision is ideal for applications as diverse as wildlife watching and surveillance. It works by collecting the photons of whatever little light there is, and focusing them with a lens onto a device known as an image intensifier. The image intensifier contains a photocathode, charged by a high voltage derived from the batteries via an inverter. The photocathode converts the light photons into electrons, which are accelerated across an electrostatic field inside the intensifier. The accelerated electrons strike a green phosphor screen – similar to that found on monochrome CRT screens – generating the visible intensified' image. Night vision products are available as in monocular (one eye) and binocular (both eyes) form. Binoculars contain two scopes, thereby offering stereoscopic vision.

AERIALS AND AERIAL AMPLIFIERS

Put simply, if you want to get the best from your TV or FM radio, invest in a suitable outdoor aerial and install it properly. Modern AV equipment is capable of excellent results, which are seldom realised because the first stage of reception is ignored. The aerials used to feed TVs have, in many cases, been up on roofs for many years and have suffered under the weather. In some cases, essential components have simply corroded away; in others, the aerial has been blown off-direction. The results speak for themselves – pictures that exhibit ghosting and grain, garbled teletext or crackly Nicam stereo sound. Similarly poor results tend to be associated with indoor aerials, the performance of which will vary with passing traffic and even the movement of people in the room. Note that Channel 5 reception requires a high-quality aerial in most cases. This is because it transmits at a fraction of the power levels available to the more established broadcasters. Special 'temporary' caravan aerials, which mount on a window with 'suckers', are available for travellers. These will provide much better performance than an indoor aerial, or the loop built into portable TVs.

With respect to VHF/FM radio reception, many of us rely on the simple wire aerial supplied with the tuner or stereo system. The results speak for themselves – hissy stereo reception, even from the powerful BBC transmitters, and a lack of choice simply because other stations are simply too weak for the tuner to resolve.

SPOILT FOR CHOICE

The Maplin MPS catalogue lists a wide variety of TV and radio aerials for home installation, and the choice is bewildering. However, armed with some basic information, selecting one appropriate to your individual needs is relatively straightforward. So too is installlation, which is within the capabilities of any competent DIY enthusiast equipped with the required tools. For best results, the aerial needs to be installed in the highest possible position – which inevitably means the roof of a building. Indeed, raising the height of an aerial by as little as a metre can double the available signal strength. Although Maplin does sell chimney mounting kits, we would only recommend that roof installation is undertaken by those with the correct roof ladders and experience. However, Maplin also sells brackets for mounting on the side of the house, and with an aluminium pole of the appropriate size, aerials can be elevated to an adequate height. Outdoor installations should be carried out with safety in mind, and all mounting components and surfaces should be up to the job. As an alternative, an aerial could be fitted inside the roof, but the best performance will not be obtained. Reflections from water tanks could cause ghosting, and the roof structure will attenuate the signal. In strong signal areas, however, acceptable results can be achieved.

TV aerials are 'directional', meaning that the greatest signal pick-up is from one direction. As a general rule, the greater the number of elements, the greater the directionality and the greater the signal pick-up. Ten-element aerials are designed for areas of high signal strength – in other words, those relatively close to the transmitter. Fourteen-element aerials are intended for medium-signal areas, while eighteen-element aerials are designed for 'fringe' locations where the wanted signal is quite weak. Weak reception is characterised by grainy pictures. There are also specialised types designed to squeeze every last microvolt out of the air – such models are ideal for 'extreme fringe' locations that are a long distance away from the transmitter. A look at neighbours' TV aerials will provide some indication as to the type that will be required but do consider that another more suitable transmitter may since have been conmmissioned. Before purchasing and installing a TV aerial, it may be worth contacting the BBC's engineering department to find out details of the transmitter that serves your region.

Regardless of the aerial you choose, it should be aimed directly at the transmitter, following the 'line of sight'. Professional installers use a signal strength meter, aligning the aerial for maximum signal. DIY installers could use the positioning of neighbours TV aerials as a rough guide, and monitor the picture on a TV set across all five channels for final adjustment. Look to minimise ghosting, which is caused by 'multipath distortion' – the aerial picking up delayed (reflected) versions of the wanted signal – as

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XQ44X Group B **£79.99**
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This is just a small selection of products in this range. See the latest catalogue for more details. All prices include VAT.

well as patterning and grain. In some instances, notably installations in built-up areas, a compromise may have to be reached.

CORRECT POLARISATION

Another issue is that of 'polarisation' – in other words, whether the elements are orientated vertically or horizontally. Vertical polarisation is often used by small 'relay' transmitters that provide TV channels to small communities. Polarisation, a principle which is also used in satellite TV broadcasting, is used to maximise the number of channels that can be squeezed into the available frequency spectrum without mutual interference. A vertically-polarised aerial will pick up very little signal from a horizontally-polarised transmission – for this reason, it is important to ensure that the aerial is polarised correctly. Again, a glance at nearby TV aerials will provide an answer. Polarisation is one important factor. Another is that of aerial 'grouping'. Aerials are designed to deliver maximum gain over a relatively small band of frequencies, known as a group, that lie within the overall TV broadcast band. There are six groups, which overlap to a ceratin extent, and it is important to select the correct type. Maplin sells a list of transmitter sites, and the most suitable aerial group is listed. The six groups are:

Group A:	Channels 21 to 34
Group B:	Channels 39 to 53
Group C/D:	Channels 48 to 68
Group K:	Channels 21 to 48
Group E:	Channels 39 to 68
Group W:	Channels 21 to 68

Each group will encompass all of the terrestrial channels for a given area, although the introduction of Channel 5 may well create some exceptions. In some cases, the Channel 5 transmitter may broadcast on a different group. In some cases, you might be able to use a Group K or Group E aerial. These offer extended coverage from the bottom and top of the bands respectively, at the expense of a slight reduction in gain. Where the difference is too great, a wideband (Group W) aerial of greater size (i.e. more elements) should be used. The extra size is needed to provide additional gain; the wideband aerial is effectively a compromise design, and will deliver reduced gain across the entire TV band, when compared to a grouped aerial of equivalent size.

The better high-gain wideband aerials are highly directional, and will give excellent results across the band. These types are ideal for partnering with an aerial rotator, so that different ITV regions can be selected without the need for multiple aerials. Note that if Channel 5 terrestrial reception is poor or non-existent, there is an alternative. The service can also be received via satellite (Astra, 10.921GHz, horizontal polarisation, soft-scrambled, Panda-1 stereo) and so this route should be considered if a satellite system is already installed.

Although it is possible to purchase directional VHF aerials for radio reception, the most popular models tend to be omnidirectional models that will pick up radio stations equally from all directions. VHF radio aerials are designed to receive the entire band, although best results tend to occur in the middle of the band (i.e. around 98MHz). Polarisation is also used in VHF/FM radio broadcasting – but the only practical way of installing a large VHF beam aerial is to install it horizontally. These days, however, radio transmitters employ mixed (both vertical and horizontal) polarisation to ensure good results with both horizontally-polarised aerials (homes) and vertically-polarised aerials (cars and portable sets). If a directional (beam) FM aerial is chosen, correct alignment is necessary to prevent distortion caused by multipath reception.

AERIAL AMPLIFIERS

In addition to aerials and fixing kits, Maplin also sells a range of accessories, such as cable, plugs, lightning protectors, radio interference filters (for CB, etc.) and attenuators (the latter is designed to help in situations where the received signal strength is too high – this can cause patterning on TV pictures, and whistles on FM stereo radio). There are also distribution amplifiers, which allow a single aerial input to feed a number of TVs located around a house. Aerial amplifiers, which 'boost' the signal, are also available. These should only be considered if a picture is poor due to weak signal strength, and not interference. They will not eliminate ghosting either – only correct aerial alignment can help here. If interference is the cause of poor TV reception, an aerial amplifier can sometimes make matters worse. Contacts:

BBC Engineering Information Villiers House, The Broadway, Ealing, London W5 2PA Tel: (0345) 010313
Web: http://www.bbc.co.uk/enginfo

BBC engineering information is also available on page 698 of the BBC Teletext service. Channel 5's transmitter details can be found on page 597 of its teletext service.

AUDIO CONNECTOR SELECTION GUIDE

There is a variety of different connectors used to interface audio equipment. The choice may relatively straightforward when making leads to interconnect audio equipment that you already have. However, connector issues are important if you are constructing a piece of equipment. The connector must be compatible with the equipment that is likely to be used with, and must reflect the nature of the signals being passed through them. Note that isolated sockets should be used with metal-cased equipment, particularly if the ground on the connector is 'floating'.

XLR 'barrel' plugs and sockets are normally used where microphones or balanced audio signals are encountered. Balanced audio – in which antiphase (differential) signals and ground are employed to reject hum over long cable lengths – tend to be found in professional and semi-professional audio equipment, such as mixers and amplifiers. The 3-pin connectors are robust, having been designed to withstand the rigours of 'on the road' use. A mechanical interlock prevents the plug from accidentally disengaging from the socket.

Pinout:
Pin 1: Ground/shield
Pin 2: In-phase
Pin 3: Out-of-phase

PHONO

For many, the phono connector is the 'de facto' audio connector, since it was originally designed for interfacing domestic audio equipment. Phono connectors have two conductors, and are intended for 'single-ended' (unbalanced) signals. In the world of high-fidelity, they are specified for both line-level (tape, tuner and CD), and low-level (turntable) connections. Nowadays, phono connectors are also used for composite video, the coaxial digital outputs of CD players, and the AC-3 RF outputs of laserdisc players. When wiring leads, note that the barrel for signal ground, and an inner pin for the signal. We recommend that gold-plated phono connectors should be used for high-quality applications, and that metal-shielded plugs be used wherever low-level signals (such as those from turntable cartridges) are present.

DIN (DEUTSCHE INDUSTRIE NORMEN)

DIN connectors, which were highly popular in 1970s audio equipment, are now rarely seen in such applications. They were designed to simplify the installation of hi-fi, and were used for both speaker and low-level connections. Despite their near-disappearance, knowing about DIN wiring conventions is important if equipment of this vintage is still in use; some early VCRs also used them for audio inputs and outputs, and they were also a fixture on some home computers (such as the venerable BBC machine).

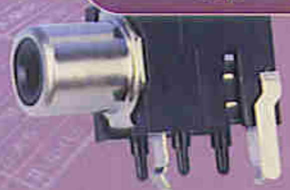
The most commonly-encountered 5-pin 'A' type lives on as a common PC keyboard connector, and a standard way of interconnecting electronic musical instruments, thanks to the MIDI (Musical Instrument Digital Interface) standard. The 5-pin 'A' connector is one of an extensive range that ranges from 2 to 14 pins, and there are also 'mini' variants that are common in the world of computer interconnections. Most plugs are plastic, although some pin configurations are available with metal casing. These shielded variants are ideal for low-signal applications. Some 'latching' plugs and sockets are also available from Maplin.

Although there are equipment-specific exceptions, most DIN audio applications follow a standard pin-out, which is listed below. DIN is worth considering by home constructors, largely because the connectors are economical and offer multiple pins in a limited space. Note, however, that cross-talk can be a problem. With 3-head tape decks, for example – it was not uncommon for the monitored replay signal to 'leak' to the wires carrying the record signal, creating an eerie 'echo'. Most of this can be attributed to the fact that most of the ready-made DIN leads have conductors with an overall screen. Maplin does, however, sell multi-core cables with individually-screened wires. We recommend that such cable should be used to make custom cables for hi-fi applications.

2-pin: Flat pin - ground
round pin - signal

5-pin A (tape):	Pin 2 - ground
Pin 3 - input L	Pin 5 - input R
Pin 1 - output L	Pin 4 - output R
5-pin A (turntable):	Pin 2 - ground
Pin 3 - input L	Pin 5 - input R

5-pin A (line input, e.g., tuner):
Pin 2 - ground



PCB Mounting Socket
ORDER CODE: HF99H
50p

Scart Extension Leads
ORDER CODES:
BM81C 2 Way £8.49
AQ17T 3 Way £10.49
BM82D 5 Way £9.99

BNC Plug to UHF Socket Adaptor
ORDER CODE: DV35Q
£3.22

High Density 15-way D-type Connector
ORDER CODE: JW77J
£1.52

Feed Through DIN Rail Terminal
ORDER CODE: MB24B
60p

Phono Plugs
ORDER CODE: VM46A
£9.99

This is just a small selection of products in this range. See the latest catalogue for more details. All prices include VAT.

Pin 1 - input L — Pin 4 - input R

5-pin A (mic, low impedance);
Pin 2 - ground
Pin 3 - input R/mono — Pin 5 - input L

5-pin A (mic, high impedance);
Pin 2 - ground
Pin 1 - input R/mono — Pin 4 - input L

5-pin A (MIDI data); — Pin 2 - ground
Pin 3 - Thru loop — Pin 5 - loop return
Pin 1 TxD Thru return — Pin 4 - TxD

5-pin A (PC keyboard) — Pin 2 - data
Pin 3 - reset (active low) — Pin 5 - +5V
Pin 1 - clock — Pin 4 - ground

3.5MM/2.5MM/6.3MM 'JACKS'

3.5mm 'stereo' jack plugs and sockets are commonly used as headphone and line-outputs on portable audio equipment, such as personal stereos and 'ghetto blasters'. They are also used for audio inputs and outputs on PC soundcards and Apple Macintoshes. The mono variant is often specified as a microphone connector with such equipment. The more established 6.3mm connector has a wider range of applications. It is a common microphone connector for domestic, and even some semi-professional audio equipment. 6.3mm connectors are also used for musical instruments, such as guitars (low-level) and keyboards (line-level). In domestic hi-fi and professional audio equipment (such as mixers), the stereo 6.3mm connector is often used as a headphone socket. A smaller 'subminiature' connector, which has a pin diameter of 2.5mm, is less common. Standardised connections across all three types are identical. Screened plugs and sockets should be employed wherever low-level signals, such as those from microphones, are involved. Some sockets have a break-action contact to (an) extra pin(s); this allows constructors to facilitate automatic source selection. It is also possible to implement a system whereby the connection of only one of a pair of microphones automatically switches the microphone channel to mono.

Mono: barrel - ground
tip - signal

Stereo: barrel - ground
ring - right channel
tip - left channel

SCART

Although the 21-pin SCART (also known as the Euroconnector or Peritel) is primarily designed as an AV connector, knowing which pins carry the audio signal is very useful. Not all AV equipment has phono audio outputs, although it is beneficial to route the sound from a satellite receiver, VCR or TV set to a stereo system or AV amplifier. In particular, NICAM TVs are capable of excellent stereo sound, which is seldom realised through the poor-quality and inadequately-spaced speakers that such sets tend to incorporate. Although 'standard' Scart-to-phono leads are available, they tend to be relatively short. A custom cable of the appropriate length will allow the TV and hi-fi – which tend to be separated in the average living room – to be bridged.

Pin 1: Output R
Pin 2: Input R
Pin 3: Output L
Pin 4: Ground
Pin 6: Input L

BINDING POSTS

Ideal for speaker connections – particularly those on high-powered amplifiers since heavy gauge wires can be accommodated. Most will also accept 4mm 'banana' plugs for easy connection and disconnection of speakers. The standard colour code convention is black for ground/negative, and red for signal/positive.

'PUSH-FIT' AND LEVER-TYPE 'QUICK' CONNECTORS

Ideal for speaker connections on relatively low-powered amplifiers. Designed for ease of use, but the bigger speaker cables cannot be inserted. The standard colour code convention is black for ground/negative, and red for signal/positive.

POWER CONNECTIONS

In many cases, the mains power cable is fitted directly to the equipment. In some cases, however, Telefunken-style mains connectors are specified; leads are available from Maplin. Some professional equipment uses male IEC 'kettle' type or Bulgin connectors, for which suitable female plugs and/or mains leads are available. Older Japanese amplifiers have American-style mains sockets for power distribution, so that other equipment can be controlled from a single power switch. These connectors do not conform to European safety standards, and we recommend that a separate mains distribution system is used.

Low-voltage battery-powered audio equipment normally also makes provision for an external DC power source. Smaller devices, such as the all-pervading personal stereo, often specify a 1.3mm plug. One conductor is the barrel; the other is a receptacle 'core' that mates with a pin located within the socket itself. Larger (2.1 and 2.5mm) connectors are specified for larger portable equipment, such as LCD 'personal' TV sets and portable CD players. Regardless of connector type, it is critically important to observe polarity – or damage to the equipment may result. Note that there is no convention as to whether the core or the barrel is positive or negative.

Image SENSORS

by Reg Miles

The change from pickup tubes to solid-state image sensors has given a considerable boost to video cameras, and been essential for the development of still digital cameras. For, although the size of tubes was in the process of being reduced, largely to cater for the amateur camera market, they were still very large in comparison with a chip.

The old imaging tubes were also made of fragile glass. Image forming light passed through a glass faceplate (see Figure 1) which had a transparent conductive coating on the inside acting as the signal electrode, this in turn was coated with a layer of photo-conductive material to form the target. An electron gun produced a scanning beam which was focused and deflected electrostatically or electromagnetically, or a combination of both. A fine mesh was mounted on the last gun electrode (or wall anode) immediately before the target, this served to trap ions, decelerate the electrons and straighten the beam. The low velocity electrons stabilised the surface of the target at the potential of the gun cathode and a positive voltage was applied to the signal electrode to create a potential difference across the target. When this was exposed to light, a more conductive path was established and a positive charge pattern corresponding to the variations in image intensity was produced. The scanning electron beam then sequentially restored the charge pattern to cathode potential, producing a series of current pulses that became the video signal.

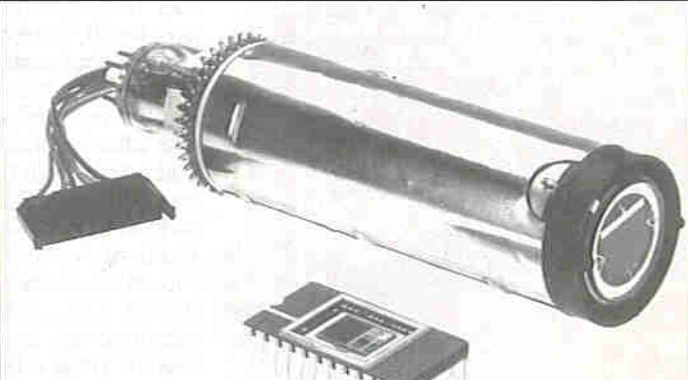
Colour was simple enough to achieve with three tubes: the light was split into its primary components by dichroic mirrors or prisms and directed to each tube (although the result was bulky). A single tube had a filter of fine pitch colour stripes immediately behind the faceplate, with several methods used to differentiate the colours and identify their spatial positions.

There were a number of different types of tube – Newvicon, Plumbicon, Saticon, Vidicon (the first small tube developed in the early Fifties), etc., which differed mainly in the materials used for their target and signal electrode.

There were also different sizes – 1, 2/3, 1/2 and 1/3in.; although these were the diameter of the tubes, the sizes of the sensitive areas were 12·7×9·5mm, 8·8×6·6mm, 6·4×4·8mm and 4·8×3·6mm, respectively. This sizing convention has been retained for solid-state image sensors – even though they don't have a diameter.

Solid-state Image Sensing

The first solid-state image sensor was a Charge Coupled Device (CCD) developed by Bell Systems in 1972 (although the principle had been known since the mid-Thirties). It was a large p-type silicon IC chip. One surface was oxidised, and onto this was deposited a pattern of parallel tungsten electrodes covering most of the chip (refer to Figure 2). Each electrode was 9µm wide, separated by a 2µm wide etched-out space. Every third electrode was connected to a common conductor, and the region under each three electrode group constituted one line of 106 pixels, which were insulated from one another by diffused impurities near the surface of the silicon (channel stop diffusion) running from top to bottom to create 106 columns. The CCD was of the Frame Transfer (FT) type with a light sensitive imaging area in the upper part and a storage area in the lower part, each consisting of 106×64 elements.



CCD and tube with same imaging area.

When an image was focused onto the light sensitive area, free electrons were generated locally within the silicon in numbers directly proportional to the numbers of photons received. Within each pixel, the centre electrode was connected to a more positive voltage with respect to the silicon by comparison with the other two, and thus, the electrons gathered in the well immediately under it at the silicon surface.

The charges were accumulated for a period of 1/60s (the US field rate), and then shifted down to cells in the storage area (shown in Figure 3). This was achieved by a 3-phase driving method in which different driving pulses were applied independently to the three successive transfer electrodes, giving a more positive potential to the electrode next to the one holding the charge, accompanied by a decrease in the potential of the electrode over the charge packet. These changes in the electrical potential of adjacent electrodes created an electric field within the silicon crystal that caused the charge to move from under one electrode to under the next, and so on, giving the process of 'charge coupling'.

This vertical transfer of the frame from imaging to storage area took about 1ms and occurred during the field blanking (or vertical retrace) period. Then, while a new frame was being integrated in the imaging area, the stored frame was shifted down line by line into a horizontal shift register to the output gate. When all the lines had been

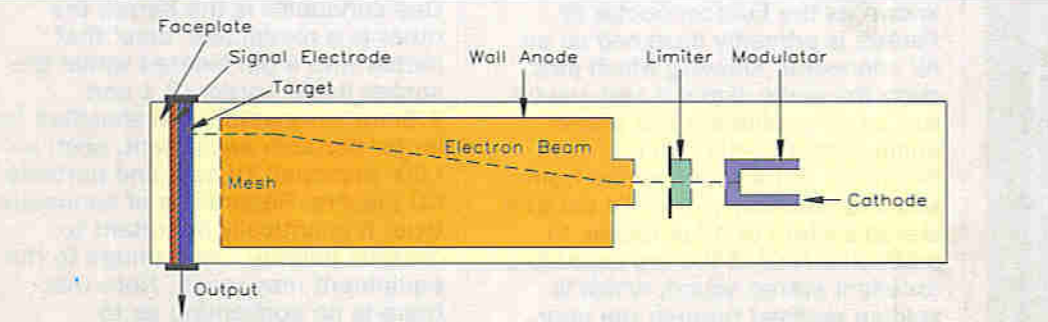
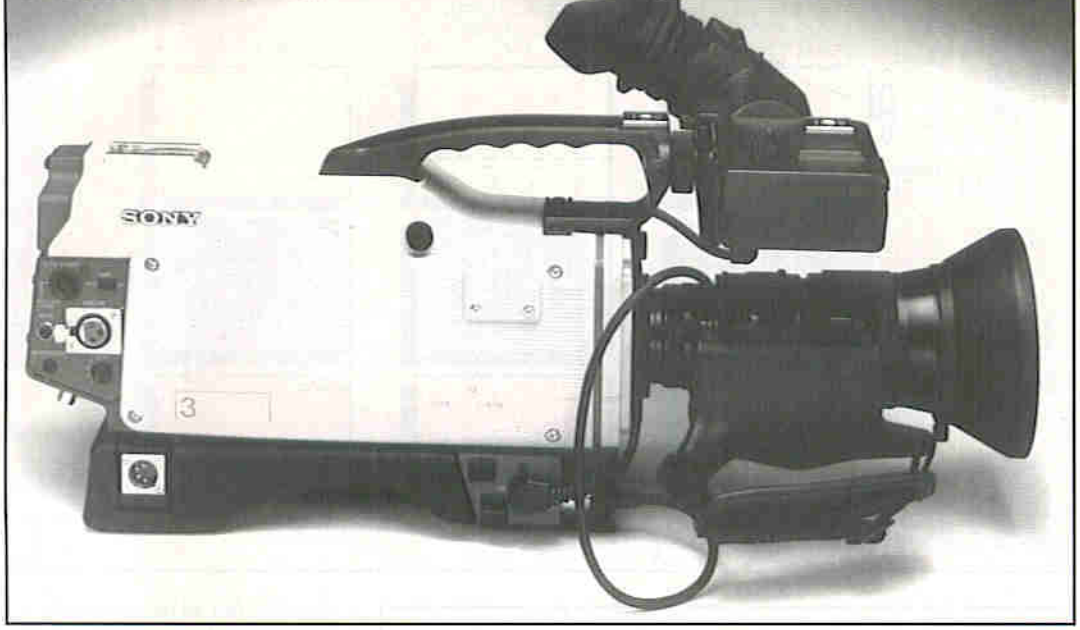


Figure 1. Tube operations.

First professional 3-CCD camera.



types: it uses the interline transfer method of vertical shift registers but, like FT, the charges are transferred at high speed during field blanking into an opaque storage area for readout (shown in Figure 5). Note the sweep out drains for the electronic shutter: these dump the early build-up of charge to leave just a brief effective charge giving a reduced exposure time (refer to Figure 6). Their position between the imaging and storage areas allows the charge to be dumped without passing through the storage area.

Incidentally, a storage area can be smaller than an imaging area because it does not gather light. Silicon devices are inherently sensitive but, to minimise subsequent amplification, the larger the

read out, the whole process was repeated.

The disadvantage of the FT process is that transferring the frame through the imaging area allows it to briefly affect and to be affected by the new frame, causing vertical smearing – a phenomenon that is most noticeable when there are bright lights in the image which smear and give a vertical white streak. Some cameras employed a mechanical shutter to block out the light during charge transfer and thus prevent a new charge building up until the process was completed.

IT and FIT

But there are now two other types that do not rely on this method of charge transfer: Interline Transfer (IT) and Frame Interline Transfer (FIT). The former does not have a storage area, instead, the charges are shifted sideways during field blanking into cells adjacent to each pixel which form opaque vertical shift registers through which the charges are transferred by charge coupling to the horizontal shift register (see Figure 4).

Because there is no storage area, the charges move down the vertical shift registers and out through the horizontal shift register at the same time as the new charge is being integrated, so, apart from field blanking, the readout is continuous. The disadvantage is that the vertical shift registers further separate the pixels and thus reduce the chip's resolving power. This also applies to the FIT, which is a combination of FT and IT

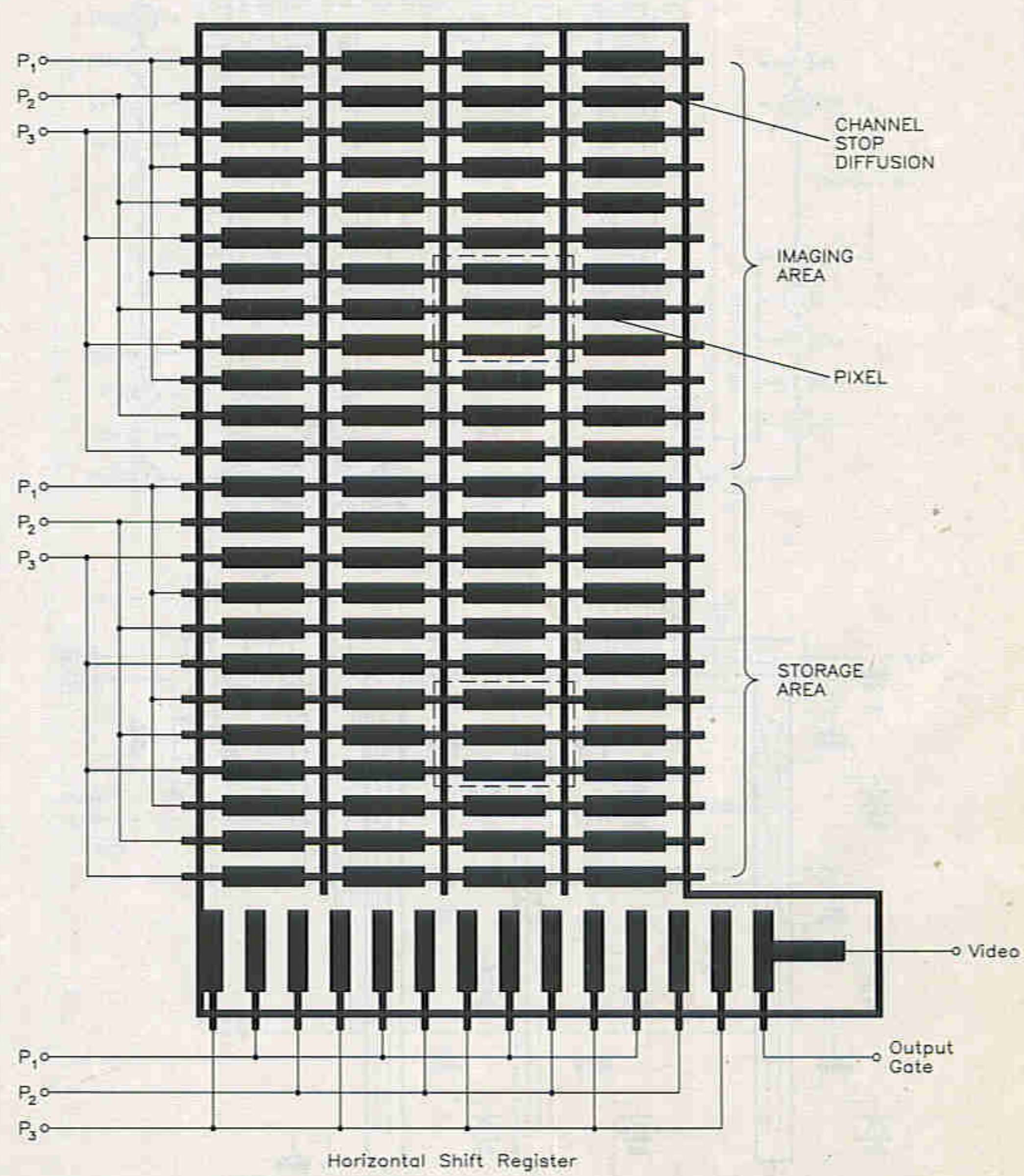


Figure 2. First Charge-Coupled device (CCD).

pixels, the better.

An alternative way of maximising light collection is to use a sheet of microlenses bonded to the imaging area, as shown in Figure 7. Because each lens collects and refracts light into the pixel (see Figure 8), the light shield can be larger to minimise unwanted light entering the vertical shift register and causing vertical smearing (particularly with the comparatively slow-moving charges in the IT type) – but still sensitivity is approximately doubled. The Hyper HAD (Hole Accumulated Diode) FIT CCD also employs microlenses to increase its sensitivity, but in addition, has transparent and buried electrodes to increase the area available for pixels.

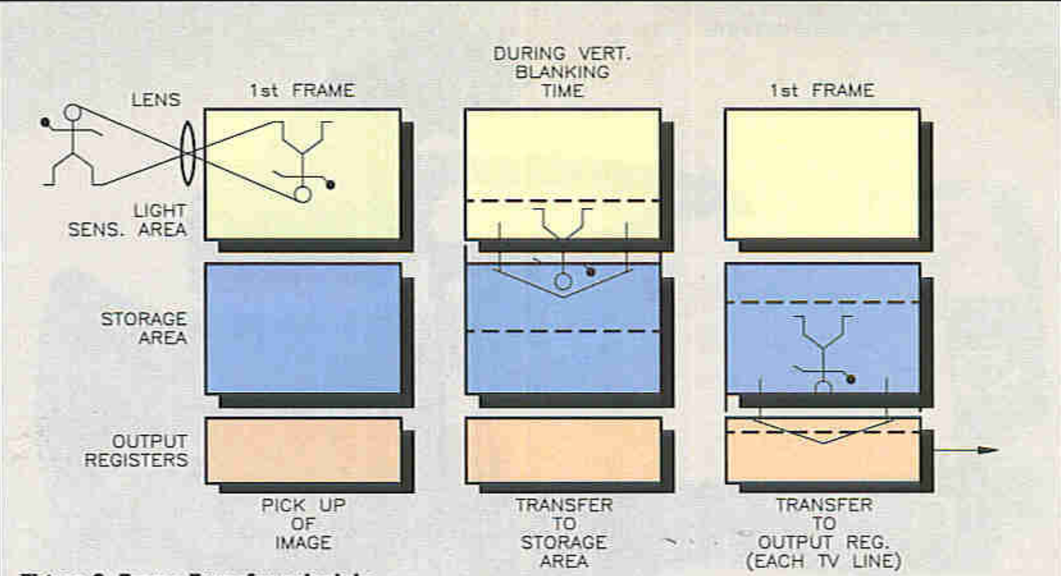


Figure 3. Frame Transfer principle.

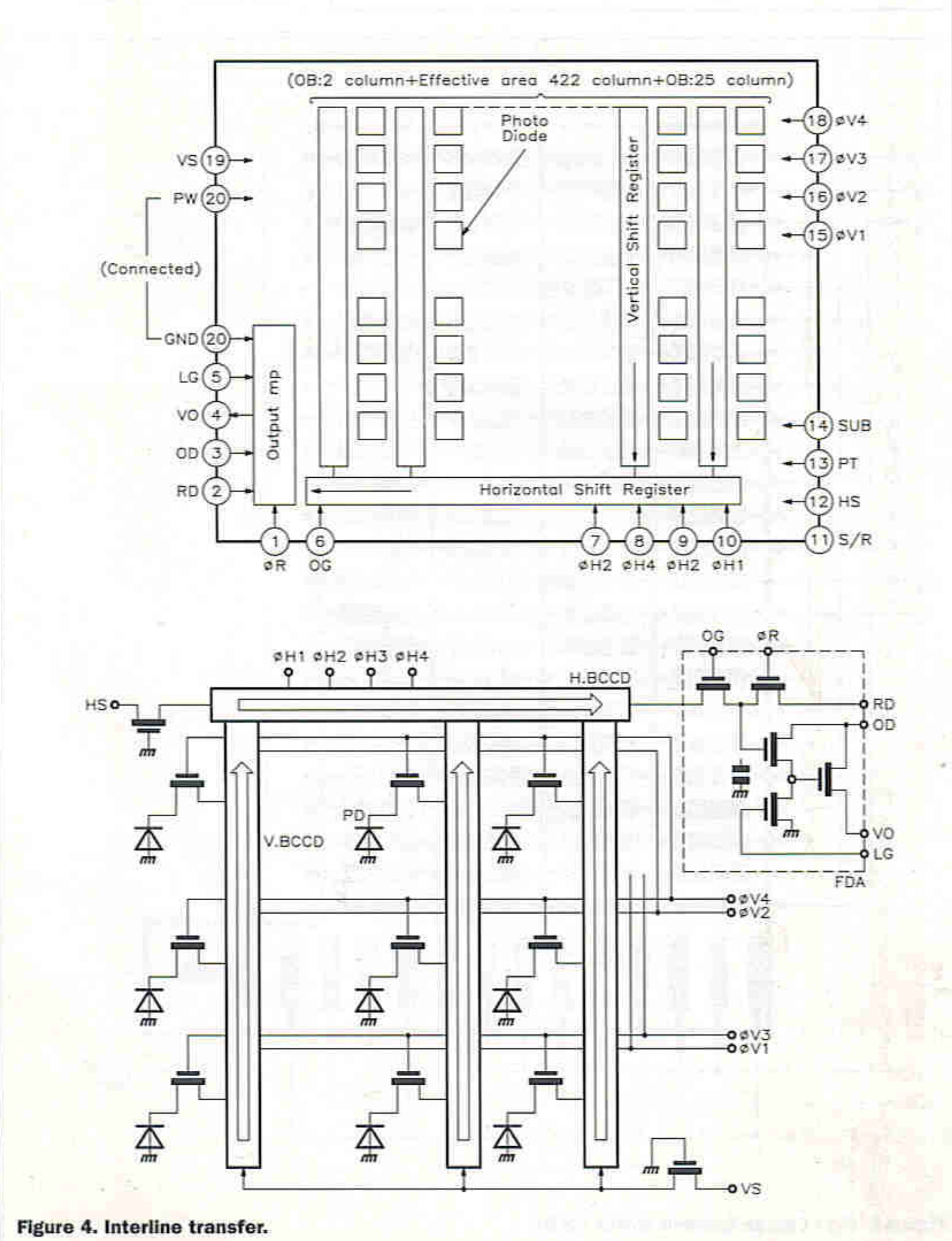


Figure 4. Interline transfer.

Actually, not all the pixels are sensitive to image-forming light; there is always a discrepancy between the total and effective number of pixels of around 6%, mainly due to the need for optical black (see Figure 9). Tubes needed this, too. When optical black is read out, dark (residual) current is produced and the resulting signal is clamped to a fixed DC potential, thus, any variations in video black level caused by temperature-induced changes in dark current are sensed and corrected.

The MOS Sensor

There is another type of image sensor – the Metal Oxide Semiconductor (MOS). This relies on switches to shift the charges rather than charge coupling. Each pixel has a MOS transistor switch under it and these are individually addressed to move the charges down and then out. However, it does seem to have lost favour recently.

Whatever the type of chip, the number of vertical pixels must be equal to the total number of active lines in a TV frame – 576 in the case of a 625-line system. However, in order to cope with interlacing, each frame must be turned into a field so the number of lines must be halved. Field integration achieves this by combining the charges from adjacent lines: the first frame is turned into the odd field with lines 1 and 2 added to become line 1, lines 3 and 4 becoming line 3, and so on; then the next frame is turned into the even field with lines 2 and 3 becoming line 2, lines 4 and 5 becoming line 4, and so on; then the process repeats.

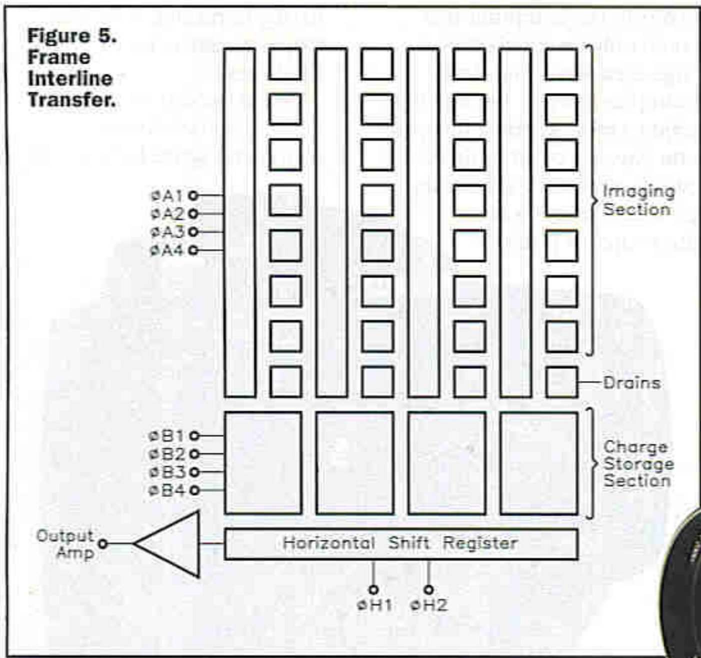


Figure 5. Frame Interline Transfer.

Mixing is done in the IT vertical shift registers and in the FT/FIT storage area. The result of this double integration is a reduction in vertical resolution, but an increase in sensitivity. Some professional cameras allow the option of adding only small amounts of charge from adjacent lines to smooth the transitions and thus increase resolution. Specialist imaging cameras with IT chips are capable of reading out single lines – 1, 3, 5..., then 2, 4, 6..., from the same frame. Although the 1/50s field rate is maintained, integration lasts for 1/25s (frame rate) – additional vertical resolution is gained at the expense of motion blurring, unless the electronic shutter is used; this sweeps out the whole charge and thus reinstates 1/50s integration and also freezes motion – but at the expense of reduced sensitivity. Some cameras have a slow shutter mode to increase sensitivity: integration lasts for a pre-set period and the signal goes to a digital memory in the camera, from where the video signals are repeatedly read out at normal field rate – but it is only practical for static subjects.

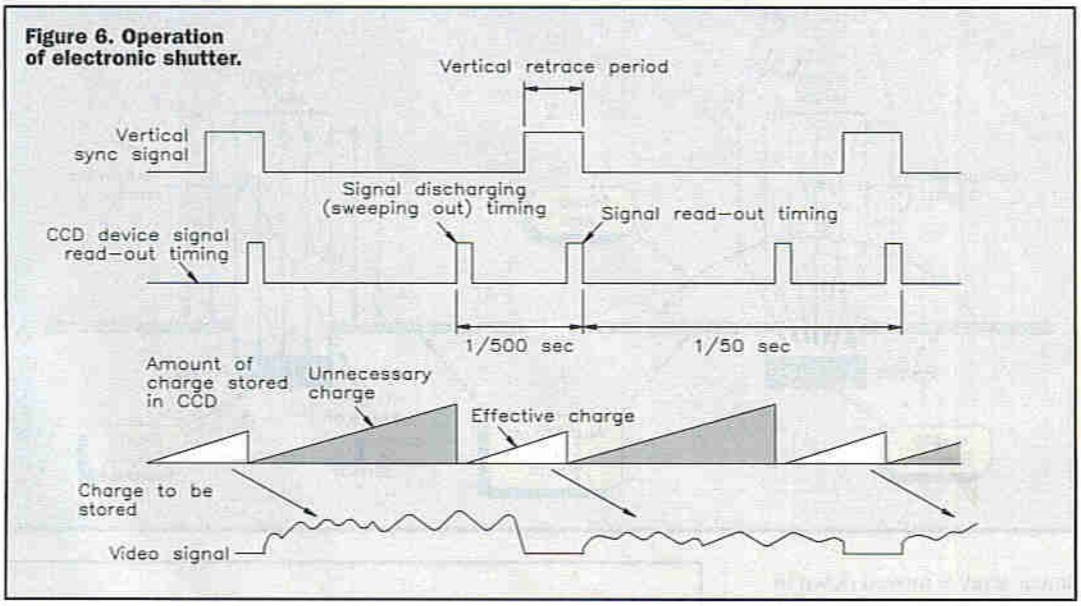


Figure 6. Operation of electronic shutter.

Colour Copy

Colour is added in the same way as with tubes: three chips use dichroic prisms, while a single chip has either a filter mosaic with one colour per pixel or vertical pixel-wide filter stripes. The latter reads out the colour signals via a double or, more usually, triple horizontal shift register, depending on the filter colours. Of course, having colour filters on a single chip reduces resolution because it takes three pixels to make one of full colour. When three chips are used, they are normally spatially offset to effectively fill in the spaces between each other's pixels and increase the resolution. This also reduces aliasing – artifacts in the image arising from 'beats' between the fine image details and the spatial sampling of discrete pixels. At least two samples must be obtained from any detail if it is to be resolved, so three adjacent pixels must be covered by that detail. Aliasing is also tackled by the use of a low-pass optical quartz filter that diffuses the finest details while passing all those that can be adequately resolved.

The early image sensors produced in the early to late Eighties also manifested other problems and were generally inferior to tubes in their performance. Besides aliasing and vertical smearing, there was blooming – where bright light would produce excessive charge that spilled over into adjacent pixels, and fixed pattern noise – caused by the inability to manufacture pixels of equal sensitivity. The sensors were also less sensitive and had a more restricted dynamic range than tubes, so they could not operate effectively in low light and the images lacked both highlight and shadow details. Lastly, the resolution was inferior to tubes with the same imaging area. However, they also had perceptible advantages, and the development potential of both the sensors and the cameras using them was considerable.

Panasonic NV-RX49 camcorder.

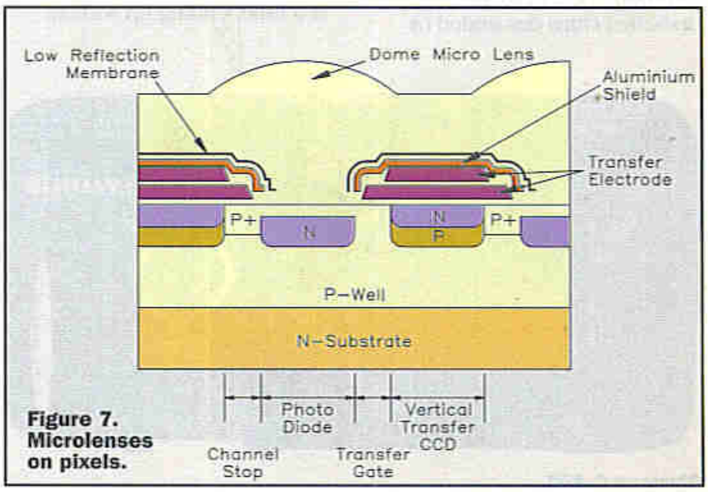


Figure 7. Microlenses on pixels.

All the problems have now been largely or completely overcome by design and manufacturing improvements.

However, one advantage, that of a fixed geometry resulting from the array of pixels, does also have the disadvantage of requiring chips to be made specifically for 525- or 625-line systems, whereas tubes could be used for either by just changing the camera electronics. The number of horizontal pixels will depend on their size relative to the chip, and how much of the surface is available for them, and whether the aspect ratio is 4:3 or 16:9.

Hold Still!

Digital still cameras are different; they can have any number of horizontal and vertical pixels because they do not have to conform to a TV standard. However, many of the lower cost consumer/business models do conform to the 640×480 VGA standard, which was devised to simplify conversion to video in the USA with its 525-line TV system. Another difference is that integration is determined by the shutter duration, as with a photographic camera, rather than the necessity to conform to the interlaced scanning of a TV system. The shutter can be electronic – with speeds up to 1/16,000s, or a conventional electromechanical type – with speeds up to 1/8,000s (the latter has the advantage at the slow end with a duration of up to 30s by comparison with about 1/8s). In either case, integration begins when the shutter button is pressed (an electronic shutter dumps the charge up to that point) and continues for the pre-set time.

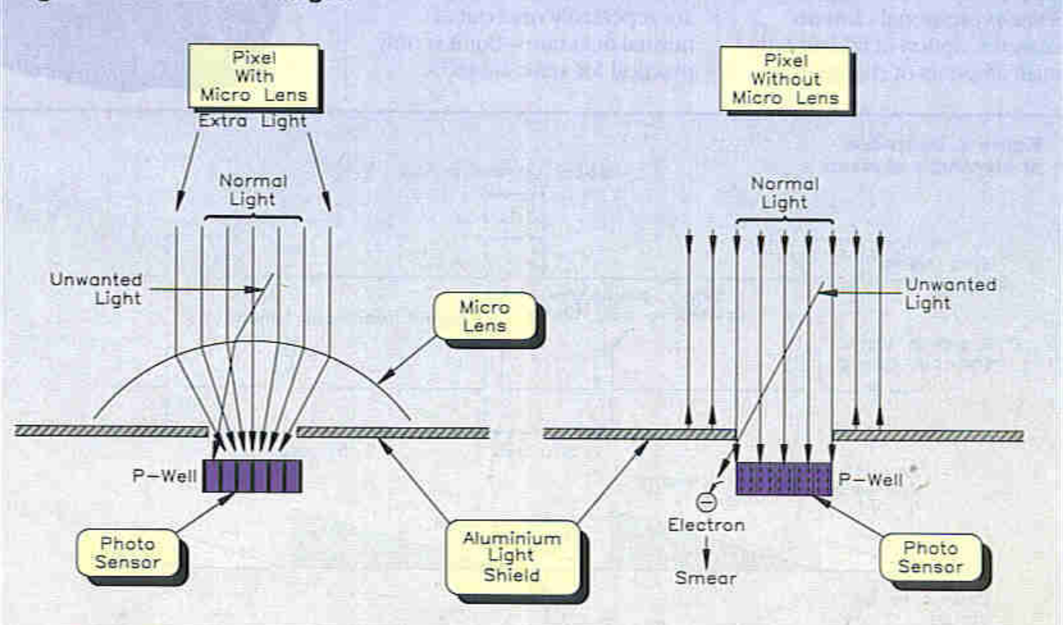
The sudden spate of still cameras has meant that chip manufacturers have been unable to produce the range of dedicated chips demanded by the camera manufacturers, so many are using video chips. In this role, they read out the odd and then even lines from the one integrated frame. The electronic shutter cannot then be used because it is set to operate at video field rate. The dedicated chips use progressive scan, with the lines read out serially.

Colour is achieved by the same methods used for video cameras, with the exception of some single-chip studio cameras that make successive individual exposures through red, green and blue filters. This triple shot approach allows all the pixels to be used for each colour, giving a good resolution image – and keeps down the cost. The disadvantage is that it is obviously confined to static subjects – such as catalogue shots. This restriction also applies to linear array devices, with the pixels in a line. The linear array is moved down in tiny increments exposing a line at a time, ending up with an image in the computer that could only be equalled by a large area array chip. Early examples had just the one line, giving a monochrome image in one pass or colour in three passes; now, they are usually tri-linear devices with three lines of pixels having horizontal RGB filter stripes to give colour in a single pass.

Going back to area array types, their development is continuing apace for both still

Minolta RD-175.

Figure 8. Microlens advantages.



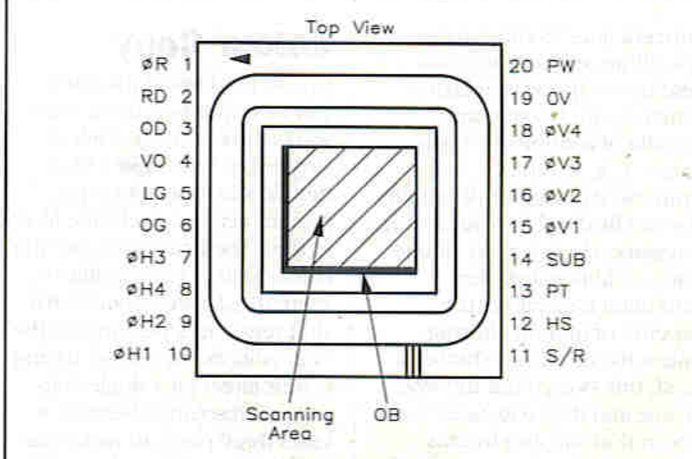


Figure 9. Optical black areas on a CCD.

Olympus C-400.

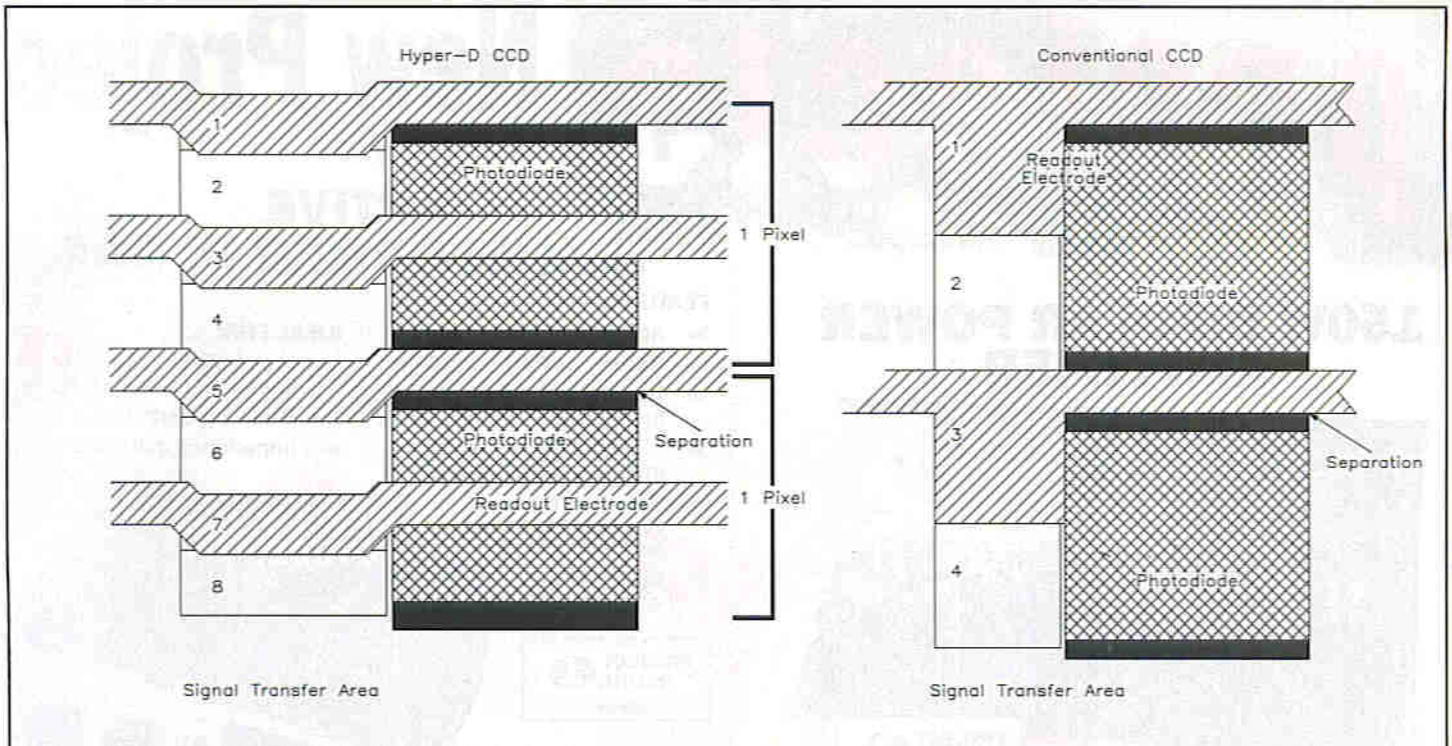


Figure 10. Hyper-Dynamic Range CCD readout structure.

and video cameras.

There are types designed to improve the S/N ratio by having an amplifier attached to each pixel so that when the signal reaches the output amplifier, it is 10-20 times stronger. This will allow smaller pixels so that more can be squeezed onto a chip, or the size of the chip can be reduced; it will also mean greater sensitivity, and the use of still higher shutter speeds. Canon's Base Stored Image Sensor (BASIS) is of this type, using MOS switching; but apart from an appearance in a prototype still camera, it has so far been confined to autofocus systems in their SLR cameras.

Hyper-Dynamic

Panasonic's Hyper-Dynamic Range CCD is being developed to improve the dynamic range and thus record more detail in darker shadow and, particularly, brighter highlight areas. It is claimed to have achieved a dynamic range twenty times greater than that of a conventional CCD. It does this by using an 8-phase driving method instead of the normal 4-phase (see Figure 10), with a readout electrode also transecting the centre of each pixel. This allows a standard illumination charge to be transferred to the vertical shift register and moved along followed by the transfer of a second charge of shorter duration for high illumination – the durations cover the ranges of $^1/_{60}$-$^1/_{15000}$s and $^1/_{60}$-$^1/_{20000}$s, respectively (refer to Figure 11.1). The device can also be adjusted to give high resolution driving, in which the standard signals are read out by combining two sets of the eight transfer electrodes, then driving the electrode independently when transferring the charge (Figure 11.2), or a combination of both (Figure 11.3).

High definition 16:9 chips with over one thousand lines have been used in top range video cameras for some years, and their numbers will increase with the American digital HDTV system. Digital still cameras have also had chips with a million or more pixels for quite a while, and multi-million types dominate the professional arena. However, the record to date is held by a Philips development which has 42 million pixels.

Summary

The physical and operational characteristics of solid-state image sensors is enabling them to be used in roles and places that would have been impossible for tubes. The next stage of development, with image sensor and camera components combined on a single chip, has already begun – and their widespread availability seems just a matter of time.

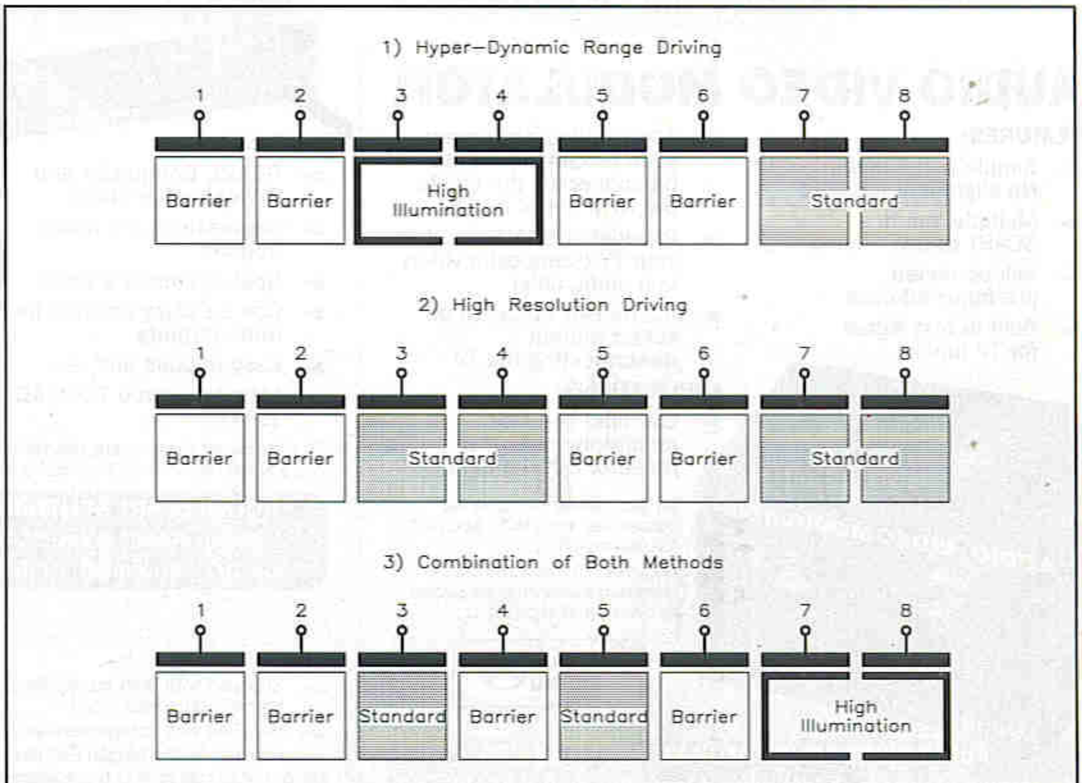


Figure 11. Driving methods of Hyper-Dynamic Range CCD.

projects

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*Quoted values measured using recommended PSU

Kit includes all components, PCB, heatsink, greaseless insulators, fixing hardware and full instructions. Pre-amp components and PSU not supplied.

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FEATURES:

- Simple construction. No alignment required
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APPLICATIONS:

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PROJECT RATING 2

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Construction details: Audio Video Modulator leaflet XZ10L 80p
Issue 108 / December 1996 Electronics & beyond XD08J £2.25

ACTIVE TRANSFORMER DI BOX

FEATURES:

- Active design
- Battery or PSU operation
- Low battery and power on indicators
- 6.35mm (1/4in) jack inputs and XLR output
- Pre-punched silk-screened front and rear panels
- Sturdy and compact

IDEAL FOR:

- Matching unbalanced lines into balanced inputs
- Breaking earth loops
- Impedance matching

NEW LOW PRICE!

PROJECT RATING 1 Simple

Kit includes all components, connectors, wire, PCB, box, panel labels and full instructions. Requires PP3 battery or 9V mains adaptor (not supplied)

ACTIVE TRANSFORMER DI BOX KIT LU32K £29.99
Construction details: Active Transformer DI Box leaflet XV98G 50p
Issue 106 / October 1996 Electronics & beyond XD06G £2.25

ACTIVE SCART SPLITTER/SELECTOR

NEW LOW PRICE!

PROJECT RATING 2

FEATURES:

- SCART, Composite and S-Video compatible
- Separate phono audio outputs
- Split or source 2 ways
- Can be daisy chained for more outputs
- Easy to build and use
- Mains powered 230V AC 1.84W

IDEAL FOR:

- Connecting a single TV, VCR or cable/satellite unit to two other units
- Buffering of signals to reduce degradation
- Simple input selection of audio and video source

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ACTIVE SCART SPLITTER/SELECTOR KIT LU21X £34.99
Construction details: Active SCART Splitter/Selector leaflet XZ36P 80p
Issue 107 / November 1996 Electronics & beyond XD07H £2.25

These kits are:

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Kits from Maplin

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– No home or professional studio should be without one!

FEATURES:

- Easily and clearly identifies interconnections on most types of audio cable
- Battery powered and portable
- Easy to build
- No setting up required
- EMC / CE Compliant

IDEAL FOR:

- PA/sound engineers
- Gigging Bands
- Home & professional studios
- Audio/Hi-Fi

PROJECT RATING 3 Average

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Issue 114 / June 1997 Electronics & Beyond XD14Q £2.25

1.5A VARIABLE VOLTAGE POSITIVE AND NEGATIVE REGULATED PSU KITS

NEW LOW PRICE!

PROJECT RATING 3 Average

FEATURES:

- Output reverse polarity and back-voltage protection
- Output voltage range: 1.25V to 37V (depending on input)
- LED power-on indication
- Variable output voltage
- Low noise
- Compact dimensions
- Easy to build
- Can be used with single, split and twin secondary transformers
- EMC / CE compliant

Kit includes all components, PCB, heatsink and full instructions. Mains transformer, other mains-side components and enclosure are dependant on users intended application and therefore not included in the kit.

VARIABLE POSITIVE PSU KIT LU86T £7.99
VARIABLE NEGATIVE PSU KIT LU87U £7.99
Construction details: Positive and Negative Variable PSU Leaflet XZ40T 50p
Issue 113 / May 1997 Electronics & Beyond XD13P £2.25

SIREN SOUND GENERATOR KITS

NEW LOW PRICE!

FEATURES:

- Easy to build – ideal beginners' project
- Three versions available
- Auto power-off for long battery life
- Low quiescent current (typically $1\mu A$ @ 3V)
- Wide supply voltage range: 2.4V to 24V
- Speaker or buzzer output drive
- Touch, switch contact or digital input to trigger siren
- Pulsed LED output
- Compact PCB
- EMC / CE Compliant

IDEAL FOR:

- Audible warning devices
- Sirens and alarms
- Children's toys

PROJECT RATING 1 Simple

Kit includes all components, PCB, LED, piezo sounder and full instructions. Enclosure, loudspeaker, switch/touch pads, battery, etc., are dependant on user's intended application and therefore not included in the kit.

CAR ALARM SIREN KIT LU85G £6.99 USA POLICE SIREN KIT LU88V £6.99
WAILING POLICE SIREN KIT LU89W £6.99
Construction details: Siren Sound Generator Leaflet XZ42V 50p
Issue 112 / April 1997 Electronics & Beyond XD12N £2.25

ELECTRONIC DICE KIT

NEW LOW PRICE!

FEATURES:

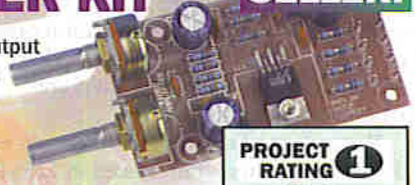
- Easy to build – ideal beginners' project
- Auto power-off for long battery life
- Low quiescent current (typically $1\mu A$)
- 3V supply voltage (2 x 1.5V cells ideal)
- Touch, switch contact or digital input to 'roll' dice
- 'Rolling dice' sound effect
- Dice can be interlinked for games requiring more than one dice
- EMC / CE Compliant

Kit includes all components, PCB, LEDs, piezo sounder and full instructions. Enclosure, fixing hardware, switch/touch pads, battery, etc., are dependant on user's intended application and therefore not included in the kit.

ELECTRONIC DICE KIT LU78K £6.99
Construction details: Electronic Dice Leaflet XZ43W 50p
Issue 112 / April 1997 Electronics & Beyond XD12N £2.25

VIDEO DISTRIBUTION AMPLIFIER KIT

TOP SELLER!



PROJECT RATING 1 Simple

FEATURES:

- Composite video input/output
- Four outputs as standard
- Units can be cascaded for multiple outputs
- Easy to build and use
- Compact dimensions
- Video gain (0dB to 8dB) control
- HF boost (0dB to 8dB) controls
- Wide bandwidth: 20Hz to 50MHz
- 75Ω or high impedance input
- 75Ω outputs
- Single +12V DC @ 50mA Supply
- EMC / CE Compliant

IDEAL FOR:

- Video signal distribution
- Video dubbing/duplication
- CCTV/Security

Kit includes all components, PCB, potentiometers and full instructions. Enclosure, knobs, coaxial cable, connectors, etc., are dependant on user's intended application and therefore not included in the kit.

VIDEO DISTRIBUTION AMPLIFIER KIT LU79L £14.99
Construction details: Video Distribution Amplifier Leaflet XZ38R 50p
Issue 111 / March 1997 Electronics & Beyond XD11M £2.25

CONTINUITY TESTER KIT

PROJECT RATING 1 Simple

FEATURES:

- Easy to build – ideal beginners' project
- Audible continuity indication
- Can discriminate between semiconductor junctions and 'true short-circuits'
- Compact, lightweight and portable
- Battery powered
- No setting up required
- EMC / CE Compliant

NEW LOW PRICE!

IDEAL FOR:

- Tracing faults on PCBs
- Checking components
- Tracing wiring

Kit includes all components, PCB, box, box label, sockets, wire, speaker, test leads, etc., and full instructions. Requires Alkaline PP3 battery (not included in kit).

CONTINUITY TESTER KIT JA13P £14.99
Construction details: Continuity Tester Leaflet XZ39N 50p
Issue 111 / March 1997 Electronics & Beyond XD11M £2.25

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WHAT'S IN A NAME

PART 9

Sign Language

by Greg Grant

Few things are more eloquently expressive, it seems to me, than a Sign Language Communicator. Whilst the announcer, host, lecturer or whoever talks his or her head off, the Sign Language interpreter translates what's being said with a rapidity racecourse tic-tac men would be pushed to equal. Yet, such a world is closed to those who don't understand the signs.

A great deal of science and technology is also closed to many people for the same reason, communications engineering being one such discipline. It is, majoratively, based on mathematics communicated by sign language. And it doesn't end there: even the accompanying drawings and illustrations are frequently in an equally peculiar shorthand. How did we allow this to happen? In fact, we didn't. It happened anyway for the simple reason that stored information is useful only if it can be readily retrieved and accessed. How do you do that?

Use a set of symbols, agreed on beforehand as being meaningfully communicable, attached to a base of some kind. This base has, in the past, been parchment, pieces of bone, a cave wall, paper or more recently, a video disc or cassette.

Undoubtedly, the most common symbols used by communications engineers in their work are the standard mathematical ones, plus some others. Signs like '+', '–', '=', '×' and, of course, the decimal point. Where did they come from?

The earliest of these to reach Britain was the decimal system, introduced in 1253 by John of Halifax, better known subsequently as Sacrobosco. In the case of the '–' and '+' signs, the origin was trade.

By the middle of the 15th century, the Hanseatic League – a commercial conglomerate composed of the German port towns such as Hamburg – had developed seaborne commerce to the extent of accurately assessing cargo quantities. In 1489, Johann Widmann's book, *Mercantile Arithmetic,* was published in Leipzig, becoming the first work to use the surplus and deficit indicators common in the warehouses and on the quays of the League: the '+' and '–' signs. The first man to use the symbols with their present meanings in an algebraic expression for example, was the Dutch mathematician, Vander Hoecke, in 1514.

Another 25 years would pass before the indicators were used in Britain, they being explained in Robert Recorde's *Grounde of Artes.* Immensely popular, this tome ran to no less than 29 editions!

A Welshman, born at Tenby in Dyfed, Recorde was undoubtedly the finest mathematical brain in 16th century Britain. A Fellow of All Souls at 21, as well as a trained physician, he was the first scholar to introduce algebra into Britain. He was also the first man to write both astronomical and mathematical textbooks in English. Indeed, his mathematical textbooks would be used in schools and universities for more than a century.

The '=' sign also first appeared in one of Recorde's textbooks, *The Whetstone of Witte,* which appeared in 1557. He chose the symbol, he claimed, because he felt that no two things could be more equal than two parallel straight lines. Sadly, he died in prison, having lost a legal argument with the Duke of Pembroke.

Another area of mathematics which plays a large part in communications engineering is trigonometrical ratios. They were first developed by the Austrian astronomer and mathematician, Georg von Lauchen, known to history as Rheticus. Born in Feldkirch, in the Tyrol, he studied at Zurich and Nuremberg, Tubingen and Wittenberg, eventually becoming a Professor of Mathematics at the latter in 1536.

Having worked for Nikolaus Kopernikus, who would shortly turn astronomy on its head, Rheticus went on to develop the formula for Sin a/2 and Sin a/3 in terms of Sin a. The author of *Opus Palatinum de Triangulis,* published in 1596, Rheticus was also noted for his trigonometrical tables and giving the world the term 'Hypotenuse'. The other expressions common in trigonometry – Tangent and Secant – were coined by Thomas Fincke in 1583, and the subject was first explained in Britain in the following year by Thomas Blunderville in his work Exercises.

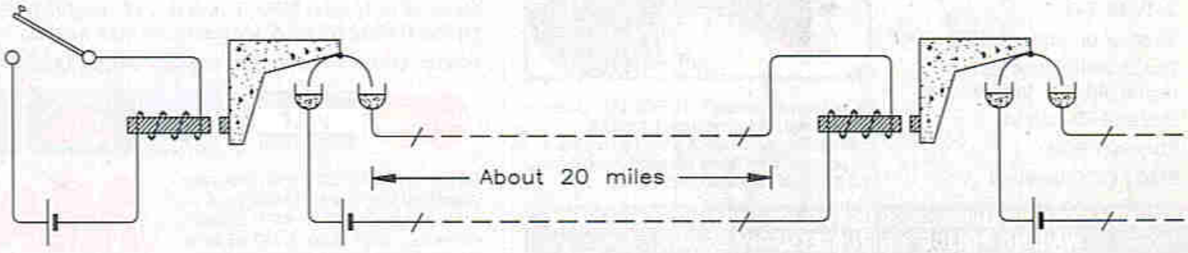
Another brilliant British mathematician, physicist and astronomer was Thomas Harriot. Born in 1560, his major work – *Practice of the Analytic Art* – only saw the light of day in 1631, eleven years after his death. In it, he introduced the indicators '<' and '>' for 'is less than' and 'is greater than', respectively, and a central dot as a multiplication symbol. In fact, a great deal of Harriot's work, including a set of rules for calculating the date of Easter, has only come to the world's attention in the present century.

It was at this time too that William Oughtred, the inventor of the Slide Rule – long regarded as the Badge of Office of the Engineering profession – published his *Clavis Mathematicae,* or 'Key to Mathematics.' Among a number of new notations introduced in it was another way of indicating multiplication, the one that remains in use to this day: '×'.

Twenty years later, the German mathematician, Johann Heinrich Rahn's *Teutsche Algebra* appeared, 71 years after his death. In it, he used the symbol '÷' for division which, despite its late appearance, has endured unchallenged to this day.

The great importance of widely acceptable symbols was illustrated for all to see with the discovery of the Calculus, arrived at more or less simultaneously by Leibnitz and Newton. Both men also developed techniques and symbols for manipulating their discovery and recording

Figure 1. Morse's relay system, from an illustration of 1867. The electromagnet closed a mercury switch, activating the next battery and some 20 miles of wire.



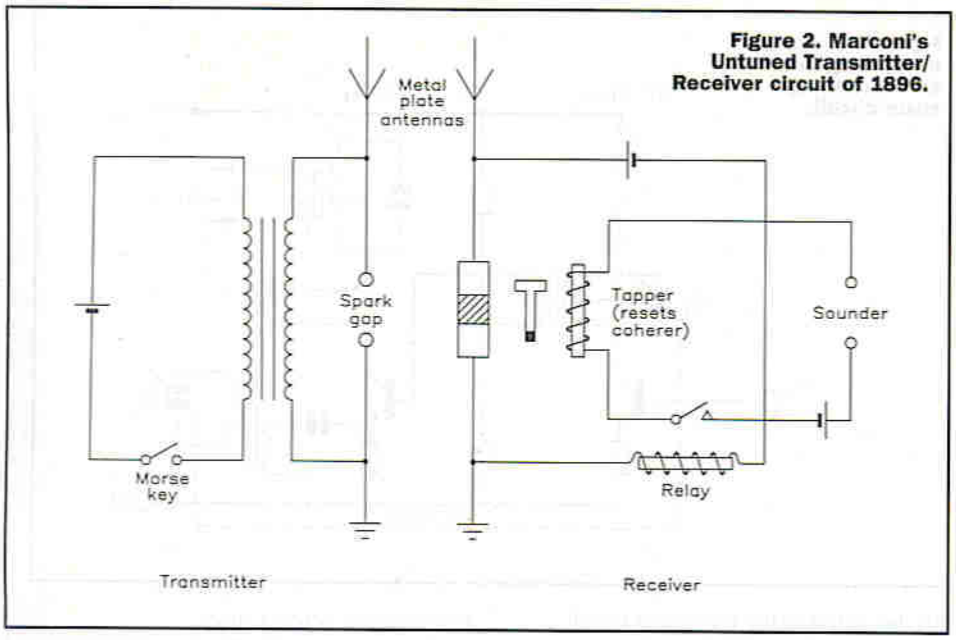


Figure 2. Marconi's Untuned Transmitter/ Receiver circuit of 1896.

their calculations and results. Newton's technique was to place both dots and primes above the variables, and use '∞' for an Infinitesimal. Leibnitz, on the other hand, had created an entirely different method, the one in common use today: the dy/dx notation and the integral sign '∫'.

In Britain, however, mathematicians and physicists stuck with Newton's system whilst their continental colleagues followed Leibnitz. Consequently, for almost a century after Newton, mathematics in Britain hardly progressed at all.

In fact, it would be 1815 before British mathematics began to pick up again, thanks to the creation of the Analytical Society. In its opening meeting at Cambridge, the Society declared its express purpose: replacing Newton's clumsy notation with the one we have long been familiar with.

In 1706, William Jones's *New Introduction To Mathematics* became the first such tract to use the Greek letter 'π' to represent the ratio of a circle's circumference to its diameter. Twenty-one years later, the Swiss mathematician, Leonard Euler, introduced the letter 'e' as the symbol for the base of Natural, or Hyperbolic, logarithms. He also introduced the 'f(x)' symbol for functions.

By the first decade of the 19th century, electricity came under increasing scientific scrutiny and mathematics formed a natural part of this investigation, as indeed did illustrations.

In 1854, George Boole introduced two important symbols, namely '.' and '+', for use with the algebra he'd developed to bridge the gap between mathematics and logic. By 1889, the Italian mathematician and linguist, Giuseppe Peano, had published his *Principles of Arithmetic: An Exposition of New Methods* in which he introduced the common signs used in Set Theory and Logic, including those for Union 'U', Intersection '∩' and Contains '⊇'.

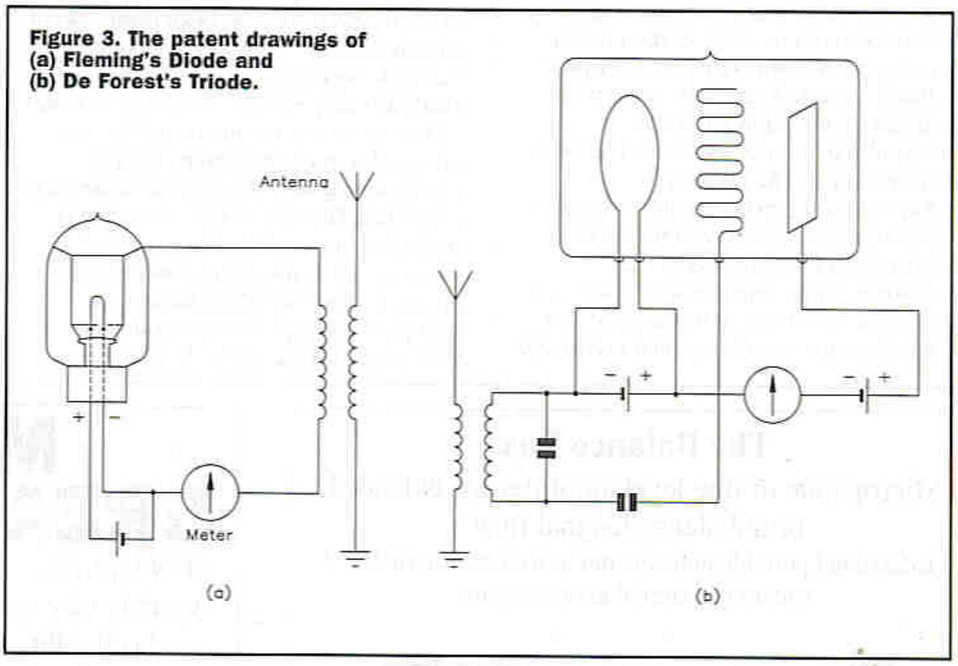


Figure 3. The patent drawings of (a) Fleming's Diode and (b) De Forest's Triode.

The electrical profession, of course, was well-established by this time and had long been using drawings and illustrations. One example was that of Alessandro Volta's battery of 1800, used in the Royal Society's *Transactions* report on the discovery. Another was that of Figure 1, detailing the workings of Samuel Morse's telegraph. Whilst both manifestly illustrated what the devices looked like, leanings towards the more symbolic were already evident.

From Marconi's Untuned Transmitter/Receiver circuit of 1896 – shown in Figure 2 – to Sir Ambrose Fleming's Diode patent application of 1905 (see Figure 3a), to Lee de Forest's Audion patent of 1907 (see Figure 3b), the circuit diagram too was still attempting to diagrammatically represent the real thing. Yet here also, a lurch towards symbolism could be seen and, from De Forest's patent, it's easy to understand how the Americans came to call the Anode a Plate!

As circuit design advanced, the individual component symbols tended to become

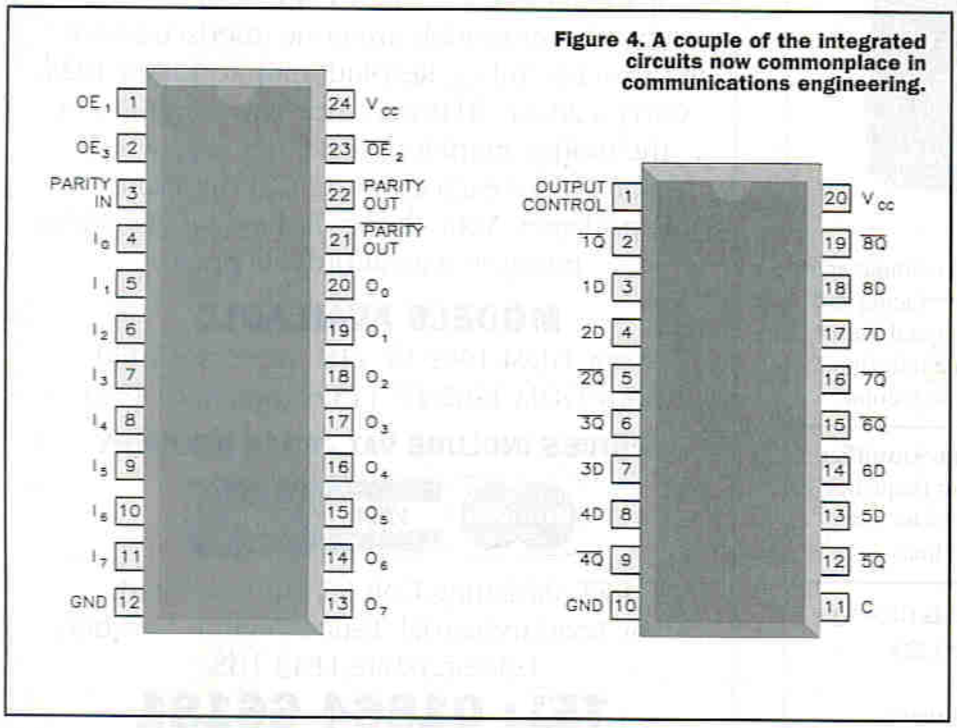


Figure 4. A couple of the integrated circuits now commonplace in communications engineering.

standardised generally, just a few national variations appearing from time to time, such as the American symbol for a capacitor, which showed the top plate of the symbol curved.

Another example of change was the phasing out of De Forest's grid symbol. It became a straight, dashed line, first shown in 1919 in the *Electrician* magazine's circuit diagram explaining Eccles-Jordan's method of using two, parallel-connected triodes to generate oscillations, in other words, their bistable flip-flop design. The changed symbol was also used in the circuit diagram of Cady's oscillator of 1921. However, circuit diagrams did retain a mixture of realism and symbolism for some years, the symbol for resistance being but one example.

At once symbolic and realistic, the triangular symbol seemed an excellent choice, given that current had to overcome electrical opposition. Another example of the genre was the coil, which actually LOOKED like what it represented and where the transformer was concerned – be it iron-cored or not – the representation was also at once symbolic and descriptive.

Valves – and to begin with transistors – were almost invariably shown as encapsulated, thereby indicating their self-containment and functionality.

Anyone taking up electronics either as a hobby or a profession could therefore relate many of the symbols to the components they represented, as well as to the component's role in the scheme – or even schematic – of things. All this changed with the arrival of the integrated circuit.

The 20- and 24-pin blocks of ubiquitous, yet seemingly mysterious, black plastic shown in Figure 4 are the ultimate in symbolism. They look even more so when you're confronted with an entire circuit card of them!

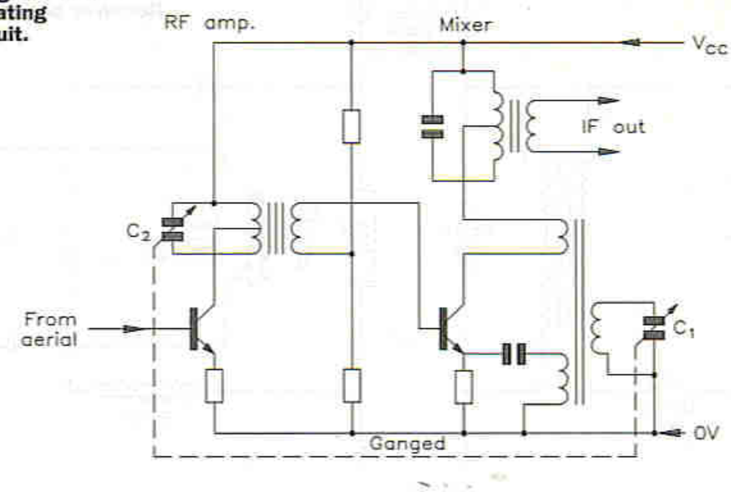
There is no way the interested layman can possibly attempt to even consider understanding what is going on inside such a structure. This sort of representation is strictly for the initiated. The integrated circuit, in fact, is the ultimate in paradoxes: reduced to such simplicity because to attempt to consider illustrating all that's going on in one would be the ultimate nightmare in complication!

Unsurprisingly, this ultimate symbolism has affected circuit diagram representation generally, as illustrated by the circuit in Figure 5.

Resistors are now thin tubes, transistors are no longer encapsulated and the transformers can JUST be identified as devices composed, primarily it would seem, of coils.

And it won't end there. For example, what began as the symbol for an Operational Amplifier is now used to denote virtually any such device. Unless we're careful, the medium – all too shortly – will no longer be the message. ELECTRONICS

Figure 5. A modern circuit diagram of a self-oscillating mixer circuit.



Security Electronics
SYSTEMS AND CIRCUITS
PART 2

Ray Marston continues his explanation of electronic security system basics in the second episode of this new series.

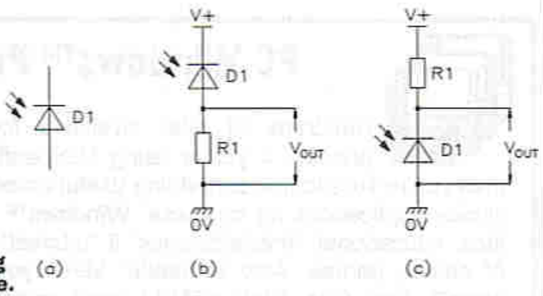


Figure 1. Photodiode symbol (a) and alternative ways – (b) and (c) – of using a photodiode.

Last month's opening episode of this new series started off by looking at electronic security system basic principles and went on to explain that all such systems contain a number of major elements, including a sensing unit, one or more data links, and some kind of alarm response unit. The episode then went on to look at various types of electromechanical and electrical sensor devices. This month's episode continues this theme by looking at various types of electronic sensor device, and at various types of data link and alarm response units. Next month's episode will look at practical contact-activated security systems and alarm circuits.

Electronic Sensor Devices

An 'electronic' sensor may take the form of a single semiconductor component such as a photodiode or phototransistor, or may be a combination of electrical and/or electronic components that together perform a particular sensing function; examples of the latter type are electronic keypad locks and light-beam alarms. The most important of such devices are described in this section.

Photodiodes

When p-n silicon junctions are reverse-biased, their leakage currents and impedances are inherently photosensitive; they act as very high impedances under dark conditions and as low impedances under bright ones. Normal diodes have their junctions shrouded in opaque material to inhibit this effect, but photodiodes are made to exploit it and use a translucent casing material; some photodiodes are made to respond to visible light, and some to infrared (IR) light. Figure 1(a) shows the standard symbol of a photodiode. In use, the photodiode is simply reverse-biased and the output voltage is taken from across a series resistor, which may be connected between the diode and ground as shown in Figure 1(b), or between the diode and the positive supply line, as in Figure 1(c).

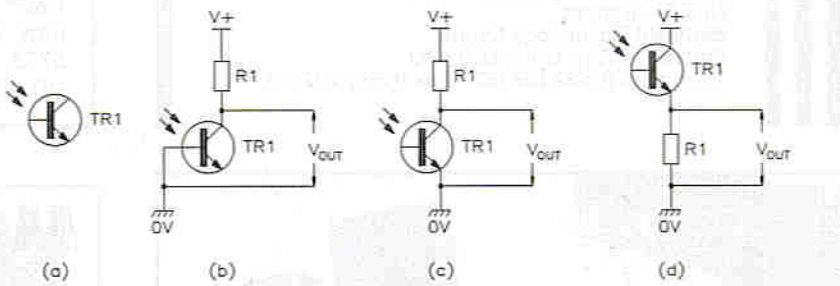


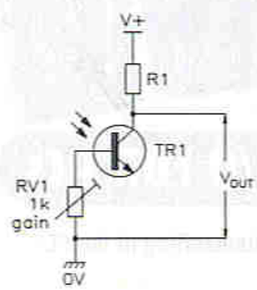
Figure 2. Phototransistor symbol (a) and alternative ways – (b) to (d) – of using a phototransistor.

Phototransistors

Ordinary silicon transistors are made from an npn or pnp sandwich, and thus inherently contain a pair of photosensitive junctions. Some types are available in phototransistor form, and use the standard symbol shown in Figure 2(a). Figures 2(b) to 2(d) show three basic ways of using a phototransistor; in each case, the base-collector junction is effectively reverse-biased and thus acts as a photodiode. In (b), the base is grounded, and the transistor acts as a simple photodiode. In (c) and (d), the base terminal is open-circuit and the photo-generated currents effectively feed directly into the base and, by normal transistor action, generate a greatly amplified collector-to-emitter current that produces an output voltage across series resistor R1.

The sensitivity of a phototransistor is typically one hundred times greater than that of a photodiode, but its useful maximum operating frequency (a few hundred kHz) is proportionally lower than that of a photodiode (tens of MHz). Some phototransistors are made in very-high-gain Darlington form. A phototransistor's sensitivity (and operating speed) can be made variable by wiring a variable resistor between its base and emitter, as shown in Figure 3; with RV1 open circuit, phototransistor operation is obtained; with RV1 short circuit, photodiode operation occurs.

Figure 3. Variable-sensitivity phototransistor circuit.



Optocouplers

An optocoupler is a device housing a LED (usually an IR type) and a matching phototransistor; the two devices are optocoupled but are electrically isolated from each other and – in a normal type of optocoupler – are mounted in a light-excluding housing. Figure 4 shows a basic optocoupler 'usage' circuit. The LED is used as the input side of the circuit, and the phototransistor as the output. Normally, SW1 is open and the LED and Q1 are thus off. When S1 is closed, a current flows through the LED via R1, and Q1 is turned on optically and generates an output voltage across R2. The output circuit is thus controlled by the input one, but the two circuits are fully isolated electrically ('isolation' is the major feature of this type of optocoupler, which can be used to couple either digital or analogue signals).

The Figure 4 device is a standard type of optocoupler.

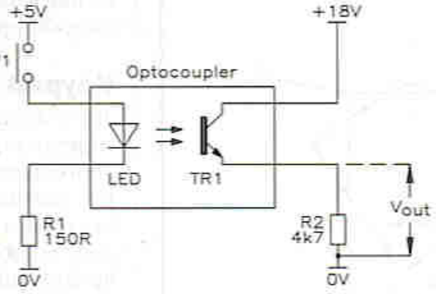


Figure 4. Basic optocoupler circuit.

There are, however, two special types of optocoupler that are of particular value in security electronics applications, and these are shown in Figures 5 & 6. The Figure 5 'slotted' device has a slot moulded into the package between the LED light source and the Q1 light sensor. Light can normally pass from the LED to Q1 via a pair of windows in the slot walls, but can be blocked by placing an opaque object in the slot. The slotted optocoupler can thus be used in a variety of 'presence detecting' applications, such as limit switching and dark-liquid level detection.

The Figure 6 'reflective' optocoupler has the LED and the Q1-Q2 Darlington light sensor optically screened from each other within the package but arranged so that they both point outwards – via windows – towards an external point. The construction is such that an optocoupled link can be set up by a reflective object (such as metallic paint or tape) placed a short distance outside the package, in line with the LED and Q1. The reflective optocoupler can thus be used in applications such as tape-position detection, engine- or motor-shaft RPM measurement, or marked-object theft (illegal movement) detection, etc.

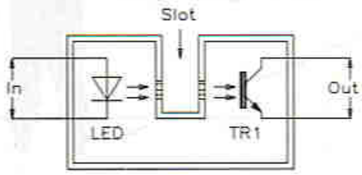


Figure 5. Slotted optocoupler device.

Light-beam Units

Most modern 'light-beam' units work on the basic principle illustrated in Figure 7, in which a focused invisible beam of pulsed infrared light is generated by a transmitter unit, and is detected at a remote point by a matching lens and receiver/detector unit. Normally, the unit is configured so that the receiver generates an alarm output if the IR beam is interrupted. Such units have useful operating ranges of up to 30m and are often used in industry in automatic batch counting and safety-switch operating applications, and in commercial and domestic applications as intruder-detecting security alarms. Simple single-beam alarms of the basic Figure 7 type have fairly low values of reliability, since they can easily be triggered by insects settling on one or other of the unit's lenses, but dual-beam types of alarm – in which both the transmitter and the receiver use two lenses placed a few inches apart – have high values of reliability.

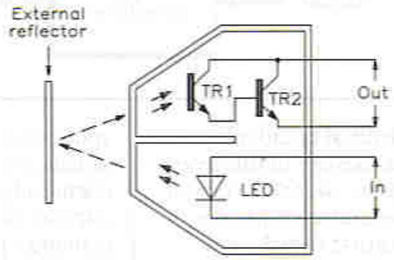


Figure 6. Reflective optocoupler.

Pyroelectric IR Detectors

Some special crystals and ceramics generate electric charges when subjected to thermal variations or uneven heating; this is known as a pyroelectric effect. Pyroelectric infra-red detectors incorporate one or two elements of this type, plus a simple filtering lens and a field-effect transistor (FET), configured in the basic way shown in Figure 8(a). The basic action of the device is such that if a human body moves within the visual field of its pyro-electric elements, part of the radiated infra-red energy of that body falls on the surface of the elements and is converted into a minute variation in surface temperate and a corresponding variation in the element's output voltage. When the unit is wired as shown in the Figure 8(b) basic usage circuit, this movement-inspired voltage variation is made externally available via the buffering JFET and capacitor C1 and can, when suitably amplified and filtered, be used to activate an alarm when a human body movement is detected.

Note that pyroelectric IR detector circuits of the basic type described above have, because of the small size of the detector's light-gathering lens, maximum useful detection ranges of just over 1m, but that this range can be extended to more than 10m with the aid of a relatively large external light-gathering/focusing lens of the type used in modern passive infra-red (PIR) movement detector systems (see last month's Figure 4 and its associated text).

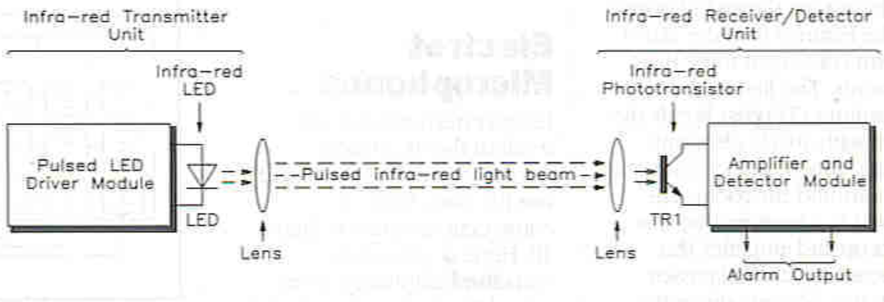


Figure 7. Basic infra-red light-beam alarm system.

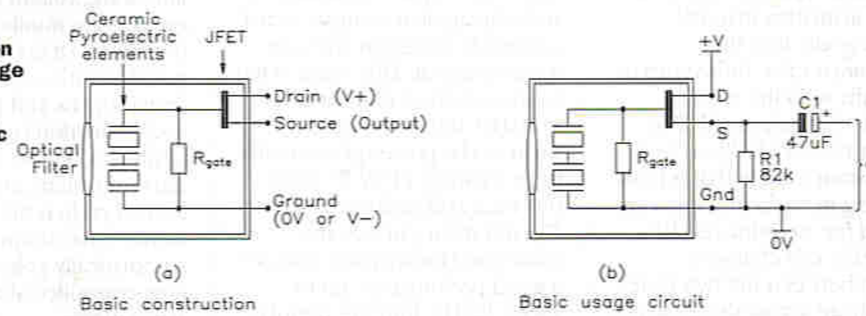


Figure 8. Basic construction (a) and usage circuit (b) of a pyroelectric infra-red detector.

Piezoelectric Transducers

A piezoelectric transducer is an electro-constrictive device that converts a varying electrical signal into a sympathetic set of

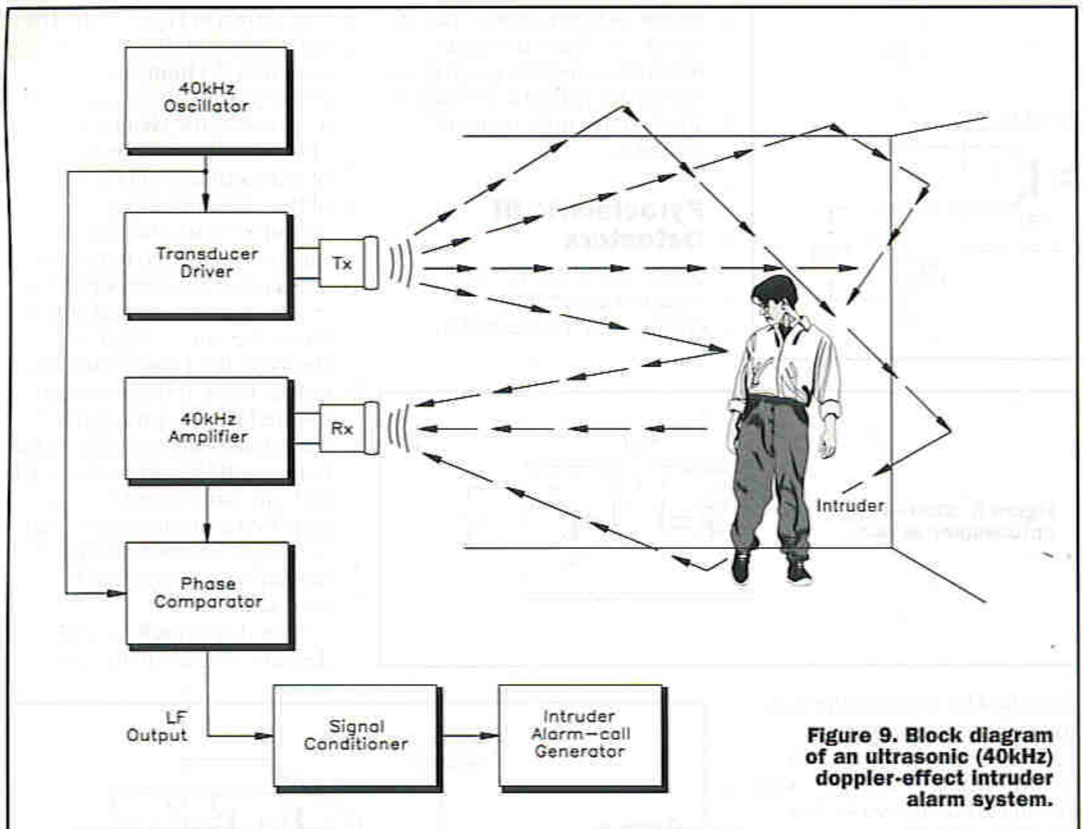


Figure 9. Block diagram of an ultrasonic (40kHz) doppler-effect intruder alarm system.

fine mechanical variations, or vice-versa. Devices of this type include piezo sounders, 'crystal' earphones and microphones, ordinary quartz crystals, and ultrasonic transducers. Most devices of the latter type are sharply tuned low-power units designed to peak at about 40kHz, and are supplied in matching pairs, with one optimised for use as a signal transmitter and the other as a signal receiver. They are useful in many remote control and distance-measurement applications, and in 'doppler effect' intruder alarm systems of the basic type shown in Figure 9.

The Figure 9 intruder alarm system consists of three main elements. The first is a transmitter (Tx) that floods the room with 40kHz ultrasonic signals, which bounce back and forth around the room. The second is a receiver (Rx) that picks up and amplifies the reflected signals and passes them to a phase comparator, where they are compared with the original 40kHz signal. If nothing is moving in the room, the Tx and Rx signal frequencies will be the same, but if an object (an intruder) is moving in the room, the Rx signal is doppler-shifted by an amount proportional to the rate of object movement (by about 66Hz at 10in./s). The l.f. output of the comparator is passed on to the third system element, the alarm activator, which is a signal conditioner that rejects spurious and out-of-limits signals, etc., and activates the alarm-call generator only if an intruder is reckoned to be genuinely present. In practice, many systems of this basic type have poor reliability when set to high-sensitivity levels, since they can easily be false-triggered by draughts, central-heating air currents, and curtain movements, etc. Low-sensitivity versions of the system are often used to protect small areas, such as the interiors of automobiles, however, and usually have high values of reliability.

Electret Microphones

Electret microphones are modern highly efficient 'capacitor' microphones, and use the basic form of construction shown in Figure 10. Here, a lightweight metallised diaphragm forms one plate of a capacitor, and the other plate is fixed and is metallised onto the back of a slab of insulating material known as electret; the capacitance value thus varies in sympathy with the applied acoustic (sound) signal. The electret material holds a fixed electrostatic charge that is built in during manufacture and can be held for an estimated 100-plus years; this charge is applied between the two plates. The voltage across the capacitor equals this charge divided by

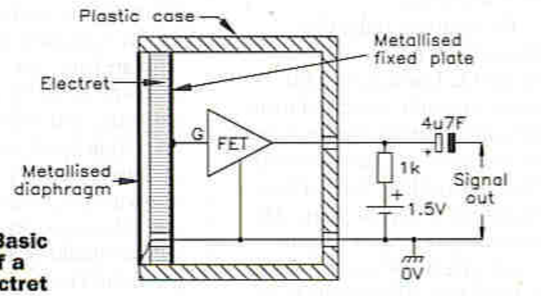


Figure 10. Basic elements of a modern electret microphone.

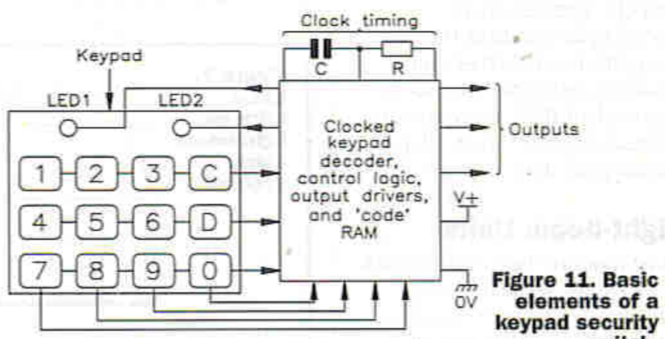


Figure 11. Basic elements of a keypad security switch.

the capacitance value and – since this varies in sympathy with the applied acoustic signal – varies in sympathy with the acoustic signal. This signal is fed to the outside world via a built-in IGFET transistor, which needs to be powered externally from a battery (1·5V to about 9V) via a 1kΩ resistor, as shown. Electret microphones are robust and inexpensive and give a good performance up to about 10kHz; they are useful in many audio sound pickup applications, particularly in sound-activated alarms and eavesdropping units.

Keypad Switches

These are modern and greatly superior replacements for conventional electromechanical key switches, and are opened by typing a secret multi-digit code number into a simple keypad, rather than by the use of an easily lost or stolen mechanical key. Typically, units of this type take the basic form shown in Figure 11, in which the keypad houses twelve push-button switches, notated with the numerals 0 to 9 and the letters C (change code) and D (disable/enable), plus two state-indicating LEDs. The switches are (in this example) arranged in four vertical and three horizontal columns, which are wired to a clocked decoder and control logic network that converts each digit keystroke into a 4-bit binary code and compares it with the 4-bit code that is stored in the matching line of the system's RAM; if the entire code number (which is usually 4 to 8 digits long) is typed in without error, the switch opens and performs a useful function (opens a door or gives access to an engine's start-up system, etc.), but if the correct code is not entered within three attempts, the lock automatically goes into a time-controlled shut-down or alarm mode.

In the above system, the

secret code number can be changed at any time by simply typing in the existing code, pressing the 'C' switch once (to gain direct access to the RAM), typing in the new code number, and then pressing the 'C' switch again (to return to normal operation). The entire keyswitch can be disabled (for a time-controlled period) or re-enabled at any time by operating the 'D' switch, which give a toggling disable/enable type of action; the keypad switch's operating mode is displayed at all times via the two state-indicating LEDs.

Digital Time Switches

Figure 12 shows a symbolic representation of a digital time-operated SPST electric switch, in which the switch arm is controlled via accurately timed digital circuitry and can be programmed to turn on and off at any desired times of the day or week. Digital time switches offer far greater precision than normal analogue types, and are used in many light-switching and solenoid-operating security applications.

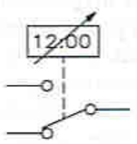


Figure 12. Symbolic representation of a digital time-operated SPST electric switch.

Miscellaneous Electronic Sensors

A variety of special-purpose electronic sensors of value in security applications but not so-far mentioned in this section are also available from some specialist dealers. Amongst the most useful of these are radioactive 'smoke detector' elements that respond to various ionised particles, humidity sensors, strain gauges, Hall-effect devices that respond to magnetic field strength (flux density), and 'gas' sensors that react to gases such as propane, butane, methane, isobutane, petroleum gas, natural gas, and 'town' gas. A few of these devices are described in some detail in later episodes of this series.

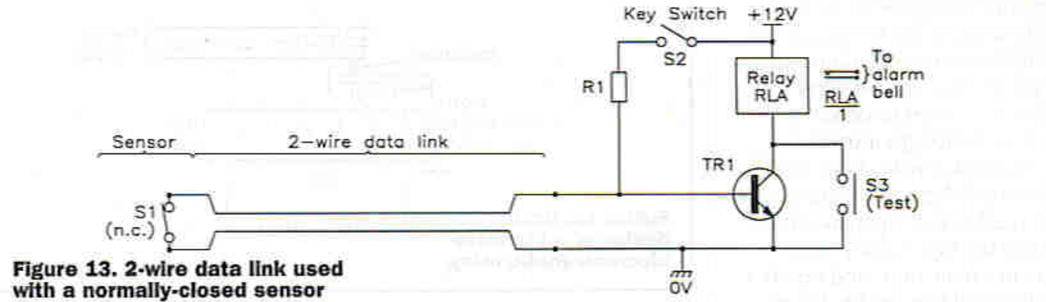


Figure 13. 2-wire data link used with a normally-closed sensor switch offers good security.

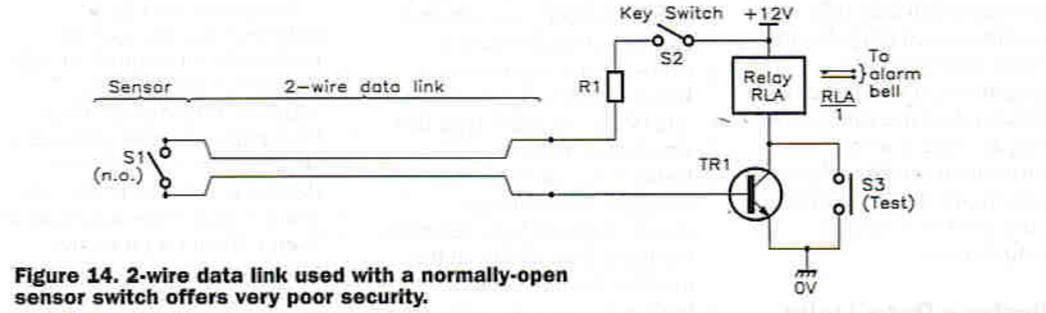


Figure 14. 2-wire data link used with a normally-open sensor switch offers very poor security.

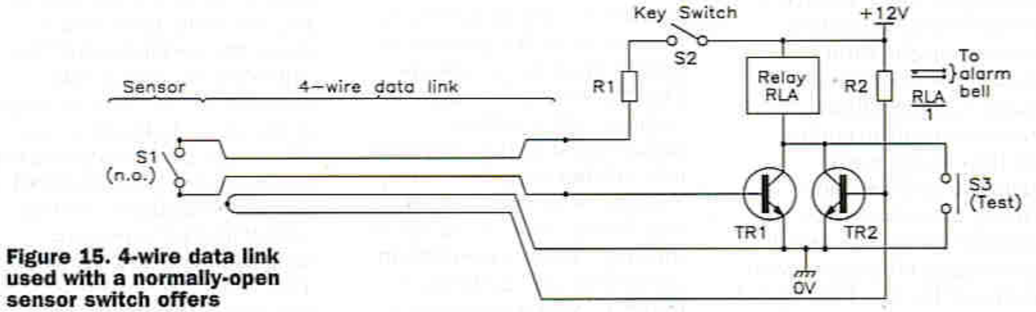


Figure 15. 4-wire data link used with a normally-open sensor switch offers excellent security.

Data Links

Data links are (apart from the actual signal processing unit) one of the three major elements of any electronic security system, the other two elements being the sensing unit(s) and the response unit. All practical security systems use at least two data links (see last month's Figure 1), which may have individual lengths ranging from less than 1mm to many thousands of km, depending on the specific application. Most data links fit into one or other of three basic types, being either hard-wired types, opto-coupled types, or wireless types, as described in the rest of this section.

Hard-wired Data Links

Most hard-wired data links take the form of a length of multi-cored cable, used to link a sensor or response unit to the alarm system's main control unit. Figures 13 to 15 show examples of such cables used to link a sensor switch to the input of a simple burglar alarm unit. In Figure 13, the sensor switch is a normally-closed one of the type used to protect doors or windows and is connected to the unit via a 2-wire (or 2-core) data link; this circuit's basic action is such that when key switch S2 is closed, Q1 and the alarm both turn on if sensor switch S1 is opened or the data link is accidentally or deliberately cut; this circuit thus has an inherently good anti-tamper performance.

In the Figure 14 circuit, the sensor switch is a normally-open type such as a pressure-mat switch, and is connected to the unit via a 2-wire data link; this circuit's basic action is such that when key switch S2 is closed, Q1 and the alarm normally both turn on if sensor switch S1 is closed, but will fail to operate if the data link is accidentally or deliberately cut; this circuit thus has a poor anti-tamper performance.

Finally, Figure 15 shows a high-security version of the above circuit. In this case, the sensor switch is again a normally-open type such as a pressure-mat switch, but is connected to the unit via a data link that uses four wires, two of which serve an anti-tamper function; this circuit's basic action is such that the alarm normally turns on via R1-Q1 if sensor switch S1 and key switch S2 are both closed, but operates instantly (even if key switch S2 is open) if the 4-wire data link is accidentally or deliberately severed; this circuit thus has an excellent anti-tamper performance and is often used in department stores and other places in which the public have easy access to parts of the alarm system.

Opto-coupled Data Links

Opto-coupled data links are often used in applications where it is not possible or convenient to use a hard-wired data link, and come in three basic types, being either infra-red 'light-beam' types, fibre optic 'light guide' types, or laser beam types. Light-beam types are used mainly in short-range (less than 6m) remote control applications, but can – if used with a good lens system – be effective at ranges up to about 20m; units of the latter type are sometimes used (in domestic applications) as a data link between a shed or other remote building's intrusion sensor and a main alarm unit. Fibre optic light guide data links are used mainly in applications where the link is fairly long (greater than 10m) and needs a wide signal bandwidth. Laser beam data links are used mainly in medium-range applications in which it is not possible to use a hard-wired data link; they are sometimes used (illegally) in remote eavesdropping applications, in which the beam is bounced off the window of a room in which a secret conversation is taking place, the return beam being modulated by the window's acoustic pickup signals.

Wireless Data Links

Wireless data links – usually operating at 418 or 458MHz – are widely used in modern domestic burglar alarm systems (see last month's Figure 5) to link the system's various sensors to the main control unit, thus greatly easing installation problems and enabling the system to be remote-controlled via a small key-fob signal transmitter. Most systems of this type have typical control ranges of up to 30m, but some sophisticated systems can be interfaced with both the domestic heating control unit and with the normal telephone system, enabling alarm and heating systems to be remotely monitored or controlled over a range of thousands of miles. The owner of such a system can, while holidaying or working abroad, use a fixed or mobile 'phone to check the home's security at any time, or can use it to remotely turn on the building's central heating system prior to eventually returning home.

Alarm Response Units

Alarm response units are the final major elements in any electronic security system, and usually take the form of a simple relay, some type of electromagnet, a solenoid- or motor-operated mechanism, or (in burglar alarm and other high-level security systems) a sound-generator and/or a light strobe unit; brief details of units of these types are given in the rest of this section.

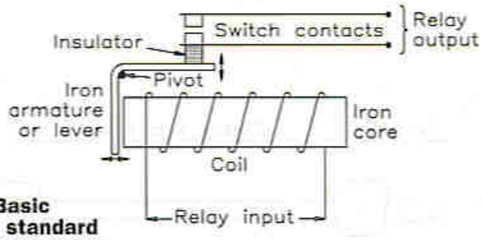


Figure 16. Basic design of a standard elecromagnetic relay.

Relay Response Units

Relays are electrically operated switches that can be used to activate virtually any external electrical devices (such as lamps, sirens, motors, etc.). Relays come in two basic types, one being the 'reed' type that was shown in last month's Figure 12(a) and the other being the conventional electromagnetic type that takes the basic form shown in this month's Figure 16. Here, a multi-turn coil is wound on an iron core to form an electromagnet that can move an iron lever or armature which in turn can close or open one or more sets of switch contacts. The operating coil (which requires only a modest operating current) is electrically fully isolated from the switch contacts (which can control fairly high currents), and can be shown as separate elements in circuit diagrams, as shown in Figure 17, which represents a relay with a 12V, 120Ω coil and a single set of normally-open (n.o.) switch contacts.

Relays with a single set of n.o. contacts are usually used in the basic non-latching mode shown in Figure 18(a), in which the relay closes when S1 is closed and opens when S1 is opened. Relays with two (or more) sets of n.o. contacts can also be used in the self-latching mode shown in Figure 18(b), in which n.o. contacts RLA/2 are wired in parallel with S1 so that they close and lock (latch) the relay on as soon as S1 is closed; once the relay has locked on, it can be turned off again by briefly breaking the supply connections to the relay coil.

Relay coils are highly inductive and may generate back-emfs of hundreds of volts if their coil currents are suddenly interrupted. These back-emfs can easily damage switch contact or solid-state devices connected to the coil, and it is thus often necessary to 'damp' them via protective diodes, as shown in Figures 19. In Figure 19(a) the coil damping is provided via D1, which prevents switch-off back-emfs from driving the RLA-SW1 junction more than 600mA above the positive supply line. This form of protection is adequate for normal switching applications. In Figure 19(b), the damping is provided via two diodes that stop the RLA-SW1 junction swinging more than 600mV above the positive supply rail or below the 0V rail. This form of protection is recommended for all applications in which SW1 is replaced by a transistor or other solid-state switching device.

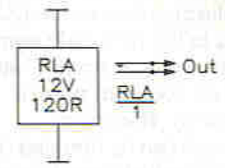


Figure 17. Representation of a 12V, 120Ω relay with one set of n.o. contacts.

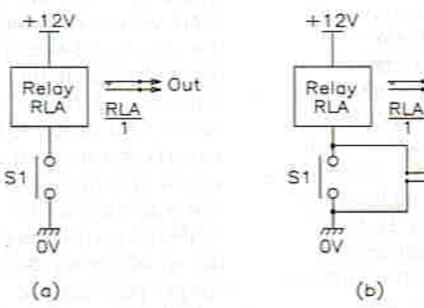


Figure 18. Relay switch used in (a) non-latching or (b) self-latching modes.

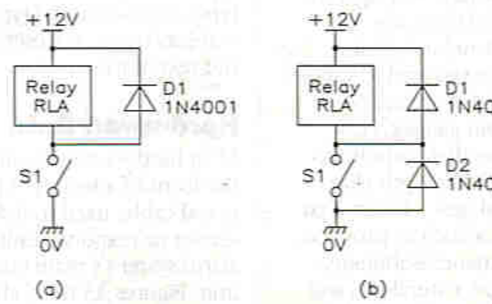


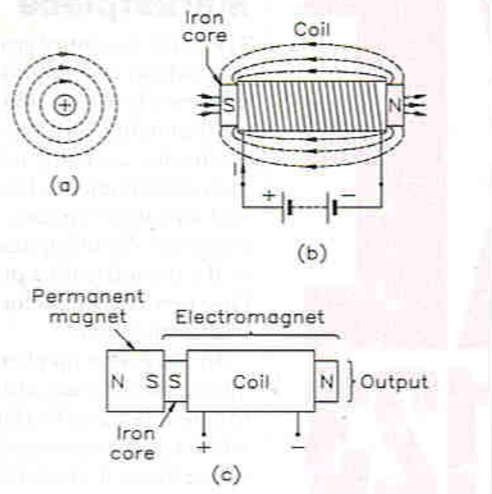
Figure 19. Relay coil using (a) single-diode or (b) two-diode coil damper.

Electromagnet Units

Electromagnet units are widely used in industrial and commercial applications to control the hold or release actions of security doors and safety guards and gates, etc. Figure 20 illustrates basic electromagnet operating principles. When a current is passed through a wire, a magnetic field is generated about the axis of the wire, as shown in the cross-sectional view in Figure 20(a). When such a wire is wound as a coil on an iron-cored former, the fields of the individual turns interact in the way shown in Figure 20(b), causing the core to act like a normal bar magnet (with north and south poles) when the coil is energised, but to act like a piece of non-magnetic iron when the coil is not energised. This basic type of electromagnet is thus used in energise-to-hold applications.

Figure 20(c) shows a useful variant of the normal electromagnet. Here, a permanent magnet is fixed to one end of the electromagnet's iron core, in the polarity shown in the diagram, and the other end of the core forms the output of the unit. When the electromagnet is not energised, its iron core acts as a simple extension of the permanent magnet, with its output acting as the southern pole of the magnet, but when the

Figure 20. Diagrams showing the magnetic fields generated by (a) a current-carrying wire and (b) an electromagnet, and the basic construction of (c) an energise-to-release type of holding magnet.



electromagnet is energised, its magnetic field opposes that of the permanent magnet, and (if the two opposing fields are of equal strength) the unit's output is thus demagnetised. This type of unit thus acts as an energise-to-release type of holding magnet.

Solenoid-operated Units

Solenoids are electromagnetic devices that are designed to move an iron ram or an armature and thereby activate a device such as a power switch, a safety latch, or a control valve or tap, etc. They consist – in essence – of a multi-turn coil that is wound about the axis of a fixed or moving iron core. Fixed-core types act as simple electromagnets that move an external iron armature when the coil is energised; the best known example of this type of unit is the standard electromagnetic relay shown in Figure 16. In moving-core types of solenoid, the coil is wound on a plastic or waxed-paper tube in which the iron core (which usually takes the form of a ram) is free to move; the basic action of this type of unit is such that centre-of-mass of the iron core (ram) is forced into a central position within the coil when the coil is energised, but may be forced into a different position (via a spring, etc.) when the coil is not energised.

Moving-core solenoids come in several basic variants, and the three most widely used of these are shown in Figure 21. The most widely used type gives a simple linear movement of the ram, as shown in Figure 21(a). Here, the ram is normally biased to the left-of-centre of the coil by two collars and a spring, but is forced to the right (to the coil's central position) when the coil is energised, thus giving a thrust action at the right-hand end of the ram and a pull action at the left-hand end; many practical solenoids of this basic type are designed to give only a thrust action or only a pull action.

A useful variant of the moving-core linear solenoid is the magnetically latching split-coil type shown in Figure 21(b). Here, when a pulse of energizing current is fed to the right-hand (RH) side of the split coil, the ram is forced to the right until a machined collar makes contact with a fixed ring magnet, which latches the ram in that position when the coil is de-energised. Once the ram has latched into this position, it can only by unlatched by feeding a pulse of energizing current to the left-hand (LH) side of the coil, thus forcing the ram to the left until its left face makes contact with a fixed disc magnet, which latches the ram into this alternative position, and so on. Magnetically latching solenoids are useful where low mean power consumption is required. Note that simple split-coil solenoids are widely used as points-controllers in model railway systems, but do not incorporate magnetic latching.

Finally, the third type of moving-core solenoid is the rotary movement type shown in Figure 21(c), in which the solenoid's linear action is converted into rotary form via a simple crank or link mechanism. These units typically give maximum shaft rotation angles in the range 45° to 95°.

Motor-operated Units

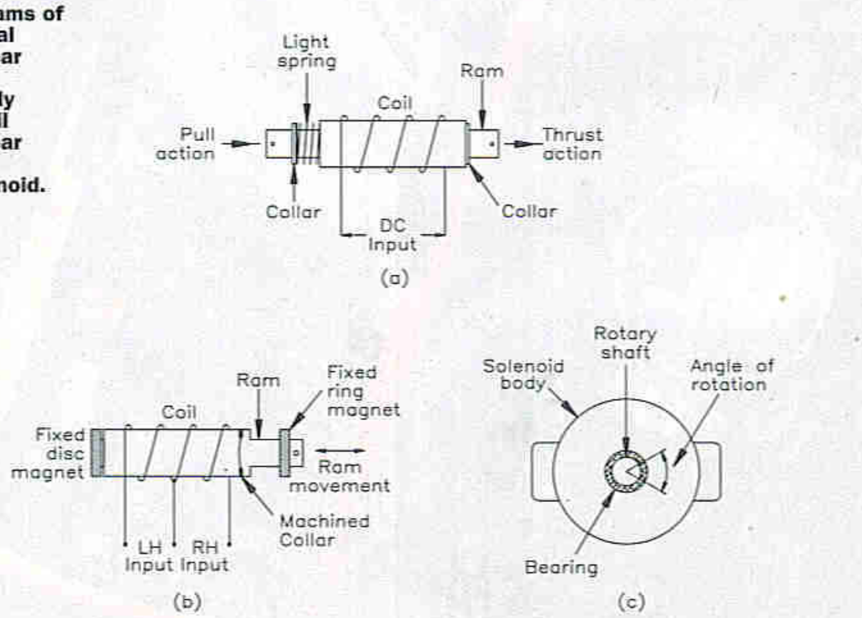
Electric motors are widely used in industry and commerce to give automatic operation of safety and security doors, and to automatically operate customer-access doors and gates under approved safety/security conditions.

Sound-generator/ Light-strobe Units

All emergency-warning security and safety systems should (ideally) by fitted with an efficient attention-grabbing sound-generator system, to warn all and sundry of the existence of the emergency state, and with some form of light-strobe unit, to visually indicate the precise source of the emergency signals. In buildings, the sound-generator may take the form of an electromechanical alarm bell or a piezoelectric-based electronic siren, and the visual warning may come from a special light-strobe; in automobiles, the sound-generator may take the form of a siren or a unit that pulses the vehicles horn, and the visual warning should be obtained by flashing the vehicle's lights. In all cases, the alarm-condition indicator unit must be fitted with an automatic timing mechanism that shuts it down after a pre-set period (typically less than 15 minutes) of operation.

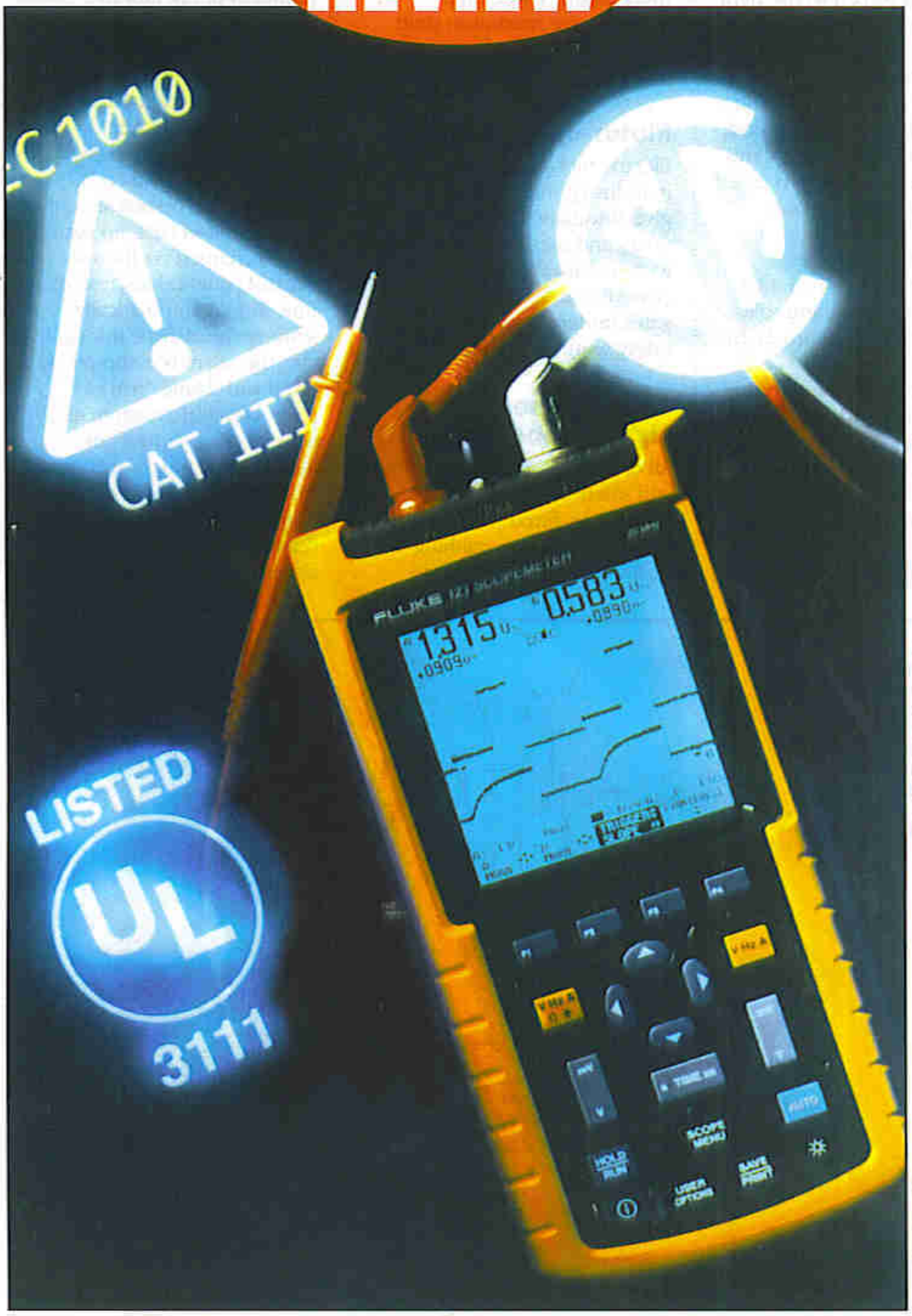
In burglar alarm systems, the sound-generator and light-strobe units should be fitted together in a special alarm box and mounted high up on an external wall that (ideally) faces onto a well-used street or passageway. The box should have a built-in back-up battery that is charged via the system's control panel cables, and the unit should automatically activate the alarm if this cable is cut; the alarm box should be fitted with some form of microswitch that automatically activates the alarm if any attempt is made to open its front cover or pull it from the wall. Units of this type are readily available from electronic alarm system suppliers.

Figure 21. Simplified diagrams of (a) a conventional moving-core linear solenoid, (b) a magnetically latching split-coil moving-core linear solenoid, and (c) a rotary solenoid.



FLUKE SCOPEMETER® 123

REVIEW



Trends in the Industrial Marketplace

The drive to control costs by increasing productivity and improving energy efficiency is common in all manufacturing environments. To achieve these goals, electronics are being integrated into an increasing number of mechanical, hydraulic and pneumatic systems. Whilst these electronic control systems provide benefits to the manufacturing process, they also raise new challenges for the staff maintaining them.

An increasing number of mechanically inclined technicians are expected to troubleshoot and fix electronic problems, often with few tools or the training in how to use them. In most cases, when starting a service job, the technician does not know what has caused the problem. It could be a glitch lasting a few microseconds or an intermittent problem which only happens occasionally and yet he is expected to find the cause of the problem quickly to keep the production process up and running.

In the past, a digital multimeter provided the basic capabilities necessary to troubleshoot the voltage, current, frequency and other aspects of an electrical signal. However, motor drives, inverters and complex control systems require the use of more capable tools if they are to provide fast answers.

The Right Tool for the Job

The people at Fluke recognised these trends, and have developed an exciting new test tool for the industrial service technician, called ScopeMeter® 123. This innovative tool is an easy to use, integrated oscilloscope, multimeter and paperless chart recorder, in a rugged handheld package. The full integration of the capabilities of a DMM and a scope means that scope waveforms and DMM readouts are displayed simultaneously, on both channels.

'Eddie'

During its development, the instrument was codenamed 'Eddie' (the name of the nine year old son of Peter Deverson, senior planning manager for the project.) One of the development goals was that the operation of the instrument should be childs' play, and that the real Eddie should be capable of operating the Scopemeter® 123 on his tenth birthday. This goal was achieved during a pre-launch test earlier this year!

"What we learned during all of our customer visits was that getting a stable picture is a big challenge for those who use an oscilloscope infrequently and often they don't trust what they end up seeing on the display", said Peter Deverson. "That's why we decided to develop the 'connect and view' hands-off operation".

Connect & View – Whatever the Signal

Connect and View is just that – simply connect the signal and view the screen. ScopeMeter® 123 gives an instant, perfectly stable display without touching a button, even when a new test point is probed. To verify that the signal under test is correct, the user can choose from 26 automatic scope and meter measurements. Typical measurements include Vdc, Vrms, Vpeak, Amps, time, frequency, duty cycle, phase, temperature and even resistance, continuity and capacitance.

The scope has a 20MHz bandwidth and its trigger modes include video, single capture and roll. The meter is a true-rms dual-channel 5,000-count DMM with 0·5% accuracy.

It's a Chart Recorder Tool

Fluke's unique dual-channel TrendPlot™ recording function makes it easier for technicians to see trends and to isolate intermittent problems or those that occur during 'off' hours. It works like a chart recorder to help identify these faults by recording readings – such as volts, amps, temperature, frequency, and phase, and even resistance or capacitance – over time.

Advanced ASIC Technology

In order to affordably achieve the design requirements for the ScopeMeter® 123 test tool, a high degree of integration was needed to incorporate all components on a 16 × 10cm circuit board. The family of ASICs consists of analogue acquisition and trigger chips, developed in conjunction with Philips, and a digital FlexCore chip developed in conjunction with Motorola.

In addition to saving space, these highly integrated chips dramatically reduce the need for interconnections during assembly. This makes the product easier to test, increases reliability and significantly reduces power dissipation, an essential requirement for handheld instrumentation.

To handle complex analogue and high-speed digital functions, two analogue ASICs were developed by Fluke using a sophisticated BiCMOS process from Philips Semiconductor. These ASICs perform the input conditioning and analogue trigger control. By locating these functions in separate chips, crosstalk is minimised. The result is a high-accuracy 5,000-count multimeter, directly from the oscilloscope input signal.

The design demands for the digital ASIC were just as stringent. A single chip was required to cover the following functions: acquisition, peak detection, constant signal analysis, trigger control, display control, communication, real time clock and processing. These demands led to the choice of Motorola's FlexCore technology. FlexCore combines off-the-shelf convenience with the flexibility of custom designs, using basic microprocessor cores with customer-specific combinations of on-chip peripherals and proprietary logic. The required chip differed from almost all other digital ASIC designs in the number of asynchronous elements which were needed, and the extensive simulation and testing required to ensure a first time right project.

Test Lead Design

To further improve ease of use, a new shielded test lead was developed. The new test lead not only takes multiple meter readings, capacitance and resistance measurements and continuity checks, but also shields the incoming signal from noise pickup. In addition, the same test lead functions as a scope probe for wide bandwidth displays. This speeds up the troubleshooting process, as the user no longer has to swap leads to make different measurements.

The Fluke 123 Industrial ScopeMeter® test tool has a very bright backlight LCD and runs on a rechargeable Ni-Cd battery for up to five hours of untethered operation. Its ruggedized, drip-water and dust-proof design allows it to survive in harsh industrial environments. The Fluke 123 can store two screen images and up to 10 user set-ups in non-volatile memory, and includes an RS-232 interface for printing or downloading measurements to a PC for further analysis. Full compatibility with FlukeView for Windows software makes it easy to document, analyse, and archive ScopeMeter® 123 measurements.

Designed for Safety

Like the higher-end Fluke ScopeMeter® test tools, the ScopeMeter® 123 is designed to handle measurements on 600V rms industrial power distribution systems. It meets IEC 1010-1, EN6 1010-1 and ANSI/ISA S82.01-1994 safety standards at the overvoltage category III levels. It is also listed with UL under UL 3111-1 and has been approved to CSA C22.2 No. 1010.1, where it conforms to 10V/m EMI requirements. Because of its battery power and safety design, the ScopeMeter® 123 requires no safety ground and does not suffer from ground loop problems, noise, or interference.

Complete and Ready-to-go Out of the Box

The Fluke ScopeMeter® 123 is now available from Maplin (Stock Code NR18U) at just £695.00 + VAT. It comes complete with a line adapter/charger, shielded test lead set, alligator clips, hook clips, rechargeable battery pack and user's manual. The instrument is covered by a three-year warranty.

The meter with additional software (Stock Code NR83E) for the ScopeMeter® 123 is available, please ring Customer Services on (01702) 554002 for details.

Fluke 123 Industrial ScopeMeter®.

WORTH OVER £800

COMPETITION

WIN A FLUKE SCOPEMETER® 123

Here's your chance to win a fabulous new Fluke ScopeMeter® 123 with our competition. All you have to do is answer the following question correctly to be included in our prize draw to be drawn on 7th November 1997.

Q.) What makes ScopeMeter® 123 easy to use?

(a) Glitch detection ☐

(b) Flex core technology ☐

(c) Connect & View ☐

NAME ....

ADDRESS ....

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POSTCODE ....

TECHNOLOGY WATCH

with Martin Pipe

There's a small but real chance that cash will become obsolete in the next century. Many of us are familiar with the first form of electronic purchasing power – the magnetic stripe-based credit card – which first saw the light of day in the 1960s. Electronic cash, which is being spurred on by new media like the Internet and home shopping, will typically be used for smaller transactions, and could replace the coins and notes that we still tend to use.

The majority of systems are based around the use of a smart card – a piece of plastic with the same dimensions as a credit card, but with a microprocessor and non-volatile memory embedded within. In modern smart cards, the microprocessor is an 8-bit type. This microprocessor is combined with the memory – a mixture of RAM, ROM, and EEPROM – on a single piece of silicon. Modern smart cards typically specify between 124 and 512 bytes of RAM, 4 and 20k-bytes of ROM, and 1 to 8k-bytes of EEPROM.

The ROM contains the security algorithm, and is isolated from the external contacts for security reasons. It contains security bits to help protect the private key (which in most cases, is a 512-bit type). Most vendors are moving toward an even more secure 1,024-bit key. This requires both larger ROM for storage, and more RAM in which to perform the necessary calculations.

Gold-plated contacts allow the smart card to communicate with a retailer's reader terminal via a serial datastream. It reads the amount of electronic cash in the card (to check that sufficient funds are available), deducts the appropriate amount and updates the remaining balance. The terminal also powers the card for the duration of the transaction, and provides a clock signal.

Contactless smart cards are also being considered. These have a wire coil that acts as an antenna. The card is placed in a high-frequency AC field, which is induced in the coil. The field is then rectified, regulated and used to power the smart card. The same coil acts as an aerial, and it's over this radio link that communication is established between card and reader.

There are some other interesting technical issues associated with smart cards. The silicon is most often manufactured on a 0·8 to 1·2μm process. Although these fabrication processes hardly represent the current state-of-the-art, they are well-known and cheap to implement – unit cost is an important consideration in mass-market applications. The size and shape of the chip die is also important. The smaller the die, the smaller the surface area – and the less likely the chip is to crack and be rendered useless.

Early smart cards, with a 25mm² or larger die, wouldn't survive common forms of abuse, such as scraping ice off a car's

windscreen. Note that the newer smart cards still require more care than credit cards – and shouldn't be treated as another 'flexible friend', even with the smaller 18mm² dies involved. If the chip does crack, then the amount of cash stored in the card will be unreadable. One can almost imagine the arguments taking place between bank and customer. . . . Banks must, presumably, be taking steps to avoid the type of fraud that could be perpetrated.

The first smart cards were conceived by a Roland Moreno in 1974. Indeed, it's true to say that electronic cash isn't new either – particularly in Moreno's native France. Across the Channel, financial smart cards have been widely used for more than a decade. Dataquest estimates that over 30 million are now in circulation in France. The rest of the world, including – surprisingly – the US, has been relatively slow to respond.

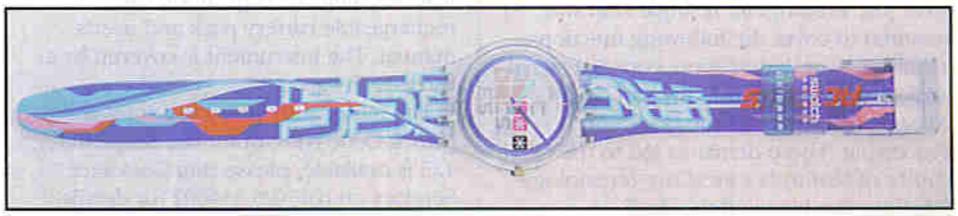
That said, a system known as Mondex has been gaining prominence recently. Mondex, originally developed by our very own NatWest, is a smart card that stores up to £500 electronically. Secure (encryption-compatible) Web sites, or the next generation of cashpoint machines, will allow you to transfer cash from your bank account to the smart card. Mondex is seen as an alternative to cash for low-value transactions – the average in Swindon, where a trial was conducted recently, is £3.50 – at real and 'virtual' retailers alike. Seventeen major banks worldwide hold equity in Mondex, but more are expected to acquire licenses when the first commercial systems go on-line in 1998.

Another standard is EMV, developed by Europay, Mastercard, and Visa. An electronic cash system known as VisaCash was trialled in Atlanta during last summer's Olympic Games. There are similar projects being conducted by Mondex and US West in other US cities. In the UK, smart cards have been used here for some time, however – as subscribers to Sky Television will know. The Sky subscriber's card also contains a secure microprocessor and memory. They are similar to the electronic cash cards that will begin to appear soon.

In western Sydney, Australia, another electronic cash trial is taking place. The progressive Swiss watch maker, Swatch (also involved in cars and pagers), has developed a 'smart watch', in conjunction with Card Technologies Australia. Since nearly everybody wears a watch, this system has distinct lifestyle advantages. In terms of technology, the part of the watch involved in transactions is effectively a contactless smart card. The watch – which is also a timepiece – has to be brought within 20cm of the reader terminal.

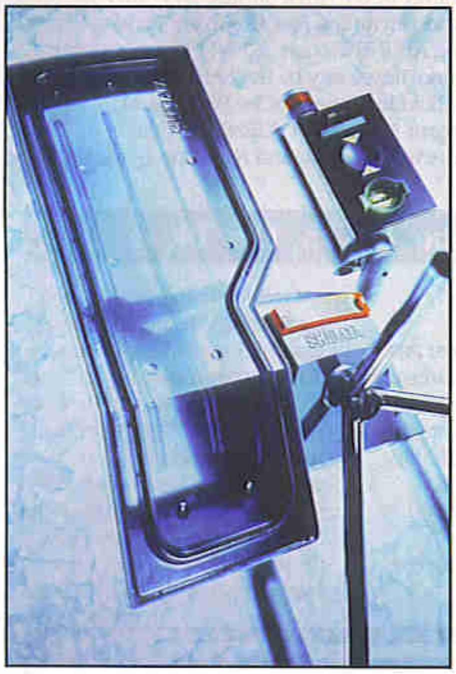
Applications of the 'cash Swatch' include the purchase of bus tickets and newspapers, and the opening of security doors. Swatch Access, which is already commercially available, integrates a contactless smart card which is used to emulate a ski-pass. Some resorts are already installing the required contactless turnstiles in their ski-lift queues.

As with credit cards, the real advantage of electronic cash to the consumer is convenience, tied in with the reduced risk of theft – the identity of an electronic money card would be tied to that of its



owner. The latter advantage does have some libertarian disadvantages, though. Theoretically, a 'Big Brother' type agency could use it to track not only the individual's purchasing preferences (something that could be used for sales purposes), but also their whereabouts.

Some retailers don't have, or want, the means to take credit cards. It might have something to do with the fees charged by the credit card companies. Perhaps it's because a piece of plastic is less tangible than real money that you can touch, and instantly recognise its value. We tend to fear things that we don't understand, and such retailers believe that these electronic systems are open to fraud. But then again, so is real money (in the form of counterfeiting).



In reality, a properly designed retail or sales system based around credit card transactions is very secure indeed. Most credit card frauds involve the actual theft of a card from an individual, or the interception of a transaction slip. However, the seemingly virtual nature of electronic cash (mind you, all monetary systems are virtual when you think about it) may well limit its initial take-up. Although some of the bigger retail chains and services will get involved, take-up of the electronic terminals will probably be slower elsewhere.

The Internet is a potential target application for electronic transactions. At the moment, you have to give a credit card number by typing it into a secure e-mail. We could begin to see consumer terminals that combine electronic cash and credit card readers. These would plug into a spare serial port on the PC (or set-top box for that matter). As far as the PC is concerned, Microsoft has written a Windows API (Application Programming Interface) for this purpose. Mastercard and Visa have developed a series of Internet-based protocols, known as SET (Secure Electronic Transactions), that will allow smart cards to be used for online transactions.

Interestingly, a consumer terminal was demonstrated to me in 1996. The Transphone, from UK company, Netex, combined a magnetic card reader (for credit cards), smart card reader and Internet telephone. It included a range of software, including Internet Phone and browser plug-ins – and was going to sell for £130 originally. Its inventors believed that the cost would fall to £20 with time. Unfortunately, Netex's parent company, Firecrest PLC, apparently went into difficulties at the end of 1996. Transphone hasn't been seen since, and its web site (http://www.transphone.co.uk) is now dead.

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Online Services

As expected, although much bigger than had been thought, CompuServe posted a loss at the end of June of $18 million (£11 million) for the quarter ending 30th April. Over the full year, losses totalled almost $120 million, so it looks as though the management of CompuServe is slowly bringing things around. In the recent past, it's been speculated that CompuServe's main problem has been due to the service being perceived as a proprietary one – you need proprietary software to be able to access the specifically proprietary content available on its proprietary network.

Of course, all online service providers (America Online, the Microsoft Network, and CompuServe included) have this apparent problem. In the longer past, this hasn't been an issue, and has even been the very reason why online services were so popular – by their very nature, they are uncomplicated and easy to get to grips with. However, with the ever-increasing popularity of the Internet and the burgeoning number of Internet service providers getting on the Internet bandwagon, online services have been pushed into the background – at least as far as the potential user is concerned.

All the online service providers have had to reinvent themselves in this light. Instead of just being online services, they have had to choose between turning into a purely Internet service provider with added content (the Microsoft Network's method), or turning into an online service provider with Internet service provider access (America Online's and CompuServe's method). Which is the more popular choice is yet to be seen.

Meanwhile, CompuServe is still seen to be struggling (if the year's results are anything to go by), although the reduced losses of the final quarter of its financial year do show that things might be about to come around for the company. After all, CompuServe boasts the greatest number of users of any service (online or Internet) in the UK, so is effectively the largest online and Internet service available. So the argument goes, 450,000 UK users can't be wrong. CompuServe's recent release of its new client (version 3) brings the online service slap bang up to date too, although the lack of mime-compliant e-mail has been criticised.

Interestingly, CompuServe's results coincided with the announcement from America Online that its pricing structure will change to a flat-rate scheme (the Microsoft Network's scheme is already flat-rate), more like conventional Internet service providers' schemes. The pressure is now on CompuServe to follow suit, rather than continue to charge on its standard pay-by-the-hour scheme.

Netscape Pushes Out Netcaster

Less than three months after the launch of Communicator, Netscape's fourth generation Web browser, the company reckons the 'push' component is ready. This month, Netscape began distributing Netcaster, a Java-based tool that delivers information to the desktop.

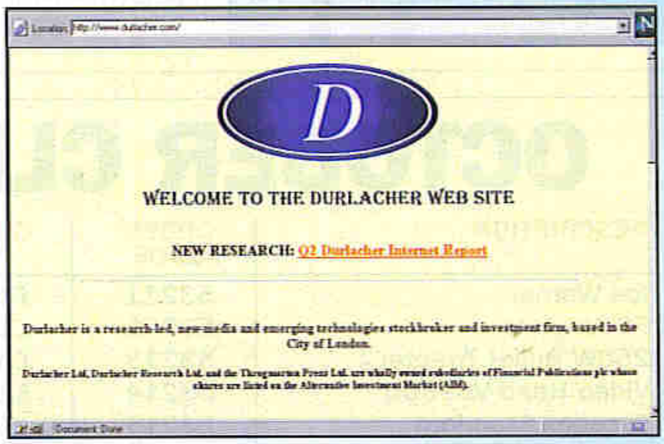
Netcaster is the first push software based on open Internet standards, such as HTML, Java and JavaScript, allowing virtually any Web site to become a channel that delivers up-to-date information directly to the desktop. Users of Netscape Netcaster can subscribe to rich, dynamic channels, view channels and other Web sites offline, and create a Webtop or a favourite channel anchored to the desktop.

Netscape at `www.netscape.com` reckons more than 700 content providers are ready to deliver news, stock quotes, and other Web-based information using Netcaster, including Fast Company, Federal Express and IndustryWeek, joining ABCNEWS.com, CNNfn, Gartner Group Advisor, Industry Watch and Travelocity by the SABRE group. New premier home channels include Disney, Excite Personal, MTV Online, and TV Guide Entertainment Network (TVGEN), in addition to CBS SportsLine, Hearst's HomeArts Network and Netscape Guide by Yahoo.

Internet Usage Up in the UK

The Durlacher Quarterly Internet Report at `www.durlacher.com/btq2/index.html` found that the home Internet market had grown to more than 1.1 million accounts in the UK. Excluding academic usage, the report found, based on a survey of 2,000 households, that some 4 million people are using the Internet in the UK.

Online service providers – such as America Online and CompuServe – account for 70% of the home market share, though the number of Internet service providers has more than doubled from around 80 in September 1995 to just under 200 in June. The report predicts that by 1999, there will be 2·6 million home Internet accounts in the UK.



CompuServe Segregates Adult Content, Launches Adult Controls

CompuServe has separated its online adult content areas from the rest of its content, creating an Adult Community. The Adult Community aggregates adult-oriented Forum areas, file libraries and games, as well as chat areas where adults can communicate with one another in real time.

Access to the Adult Community is controlled by new CSi Adult Controls which require a user to create a password and confirm that they are at least 18 years of age to become a member of the Community. These new Adult Controls are in addition to CSi's Parental Controls. Parental Controls allow parents to restrict Internet access via CSi or to selectively control access to various Internet content with Cyber Patrol.

The Adult Community is one of more than 40 CSi communities – online areas, which bring all of CSi's content and functionality pertaining to a particular topic together under a single, easy-to-navigate, enhanced menu.

For further details, check: `www.compuserve.co.uk`.

Contact: CompuServe, Tel: (0118) 9525555.

Netstore Launches First Internet Off-site Disaster Service

UK-based start-up Netstore, has announced a portfolio of secure automated off-site disaster recovery services that operates over the Internet. Netstore data recovery service is designed securely to safeguard data on a Portable, desktop PC, workstation or server. Once configured with Netstore's client application, the PC automatically connects to the Netstore secure Data Centre at scheduled intervals or on demand and backs up files and applications that have been modified since the last backup session.

Using the Netstore disaster recovery system, a user is able to restore a backed-up file at any time. And because Netstore utilises the Internet to transfer files, users can access files from anywhere in the world. All versions of files are maintained for as long as an account is maintained with Netstore, so that it is even possible for users to restore files that have later been modified.

Netstore uses two data repositories – one at its head office in Bracknell, Berkshire, and a second mirror site in Leeds to store user data. This duplication of the user's data provides an additional level of security in case of routine maintenance or the unlikely failure of one of the Data Centres. Storing data off-site rather than on a duplicate hard drive, ZIP drive or floppy disk provides users with an additional level of security.

Netstore disaster recovery services are available immediately directly from Netstore. A single user license is priced typically at £10 per month.

For further details, check: **www.netstore.co.uk.**

Contact: Netstore, Tel: (01344) 395762.

Pavilion SchoolNet Opens for New Term

SchoolNet is an Internet-based education initiative launched this month by Pavilion Internet. The scheme will provide schools with an Internet connection, which can be used simultaneously by a whole classroom of pupils.

SchoolNet at **www.pavilion.net** has been set up to allow schools to offer pupils hands-on experience of Internet technology in a group learning environment. Schools will have unlimited space to publish their own publicity and information on the World Wide Web.

Pupils will be able to use information sources from around the world to gather research for projects. They will also be able to communicate with other schools locally, nationally, and internationally, both through e-mail and their own web sites.

Pavilion, together with Cable and Wireless Communications, will provide schools within a Nynex region, a Network ISDN connection. This starting connection is capable of being used by up to 29 users at one time.

The Pavilion package includes an ISDN line and all call charges, the required router, domain name and SMTP mail delivery, which will allow every student and member of staff their own e-mail address. The all-inclusive price for SchoolNet is just £2,500 per year for a minimum two-year contract.

Contact: Pavilion, Tel: (01273) 607072.

Web Paint Pot

Picture Man Collection Painter, released this month by The Thompson Partnership, is a drawing application designed for the creation of Web content such as banners and buttons. The package allows users to experiment with chaotic colours, fractal fillings, or different paint applications.

Picture Man Collection Painter is available from The Thompson Partnership, priced £24.95, or download a trial version from the company's Web site at **www.ttp.co.uk.**

Web Consortium Publishes HTML 4.0 Draft

The World Wide Web Consortium (W3C) has announced the first public working draft of HyperText Markup Language (HTML) 4.0 at **www.w3.org/MarkUp/**, the latest version of the Web's basic publishing language.

The HTML 4.0 working draft builds on the multimedia and hypertext features, which debuted in the HTML 3.2 Recommendation published in January 1997. HTML 4.0 adds enhancements in several areas to make the Web more appealing for both content providers and users. Additions include: Advanced Forms, Frame Improvements, Table Enhancements, Object Support, Script and Style Elements.

Speaking to *Electronics and Beyond*, Tim Berners-Lee, W3C director and inventor of the Web, said "HTML 4.0 demonstrates the power of the W3C process. The W3C HTML Working Group is making the Web more appealing, more accessible, and more international".

The W3C HTML Working Group includes key industry players such as Adobe Systems, Hewlett Packard, IBM, Microsoft, Netscape Communications, Novell, SoftQuad, Spyglass and Sun Microsystems; content specialists at HotWired, PathFinder and Verso.

Oracle's Plans for Integrating Web with TV

Oracle is planning to use a broadcasting technology known as 'the vertical blanking interval' – a space between TV signals that can be adapted for sending data – to automatically integrate data from the Web into TV programs in progress. One example of use for the system is that a person viewing, say, a football game could interact with other viewers through a Web-based chat session appearing in one window on the screen. For further details, check: **www.oracle.com.**

Contact: Oracle, Tel: (0118) 924 0000.

@Internet

UK Internet Infrastructure Gets Upgrade

Experiencing accelerating business-led demand for Internet services, UUNET UK is embarking on an unprecedented Internet backbone upgrade. The company has already begun substantially increasing capacity on its UK Internet backbone infrastructure, introducing line speeds up to 155M-bps.

The UK backbone upgrade is part of a world-wide infrastructure investment programme by WorldCom. The current phase of the programme includes a $500 million, 20G-bps transatlantic link, as well as the first stage of construction of a pan-European broadband network programme costing more than $200 million.

UUNET UK's Internet backbone has been designed to be fully scaleable, running from the currently widespread 2 and 4M-bps connections, through 155M-bps and up to 625M-bps.

For further details, check: **www.uunet.com.**

Contact: UUNET, Tel: (0500) 474739.

Thin Revenue from Thin Clients

After surveying tens of thousands of employees in France, Germany and the UK, Inteco has developed scenarios which forecast a total business expenditure on intranets and the Internet in Europe, in the year 2000, of $18 billion, of which only $1 billion will be for Network Computers.

"The majority of client devices on European corporate intranets will continue to be PCs, and Network Computers aren't going to be bought for anything else", said Tom Bachman, President of Inteco.

Inteco's European findings also corroborate results of similar studies conducted in the US, which show that spending on intranets will far outstrip that on the Internet by businesses. During 1997, companies will pay nearly $1.4 billion for each. However, by 2001, the annual corporate expenditure on intranets will reach nearly $19 billion in Europe, while Internet spending will trail at around $6 billion.

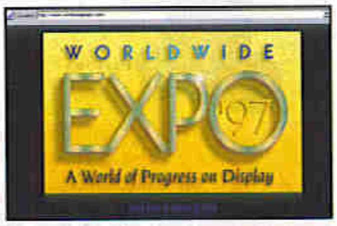
For further details, check: **www.inteco.com.**

Inventors Exhibit at Trade Show without Leaving Home

Inventors & Entrepreneurs Worldwide Expo '97 is not a conventional exhibition. The global event, which attempts to match inventors with investors and entrepreneurs, is currently taking placing on the Web at **www.worldwideexpo.com.** Unlike a real-world event, millions can attend this online Expo without leaving home, booking hotels or eating bad food.

For exhibitors, it represents not three days but three months of exposure for not tens of thousands but merely a few hundred pounds. And for attendees, it's absolutely free. The Inventors & Entrepreneurs Worldwide Expo '97, featuring 'A World of Progress on Display', opened its virtual doors in mid-August with virtual aisle after aisle of small businesses, new products and new opportunities.

A global paging system lets exhibitors send messages and files to business associates in real time, or visitors can page an exhibitor for a private business discussion. There's a multimedia presentation 'hall', plus scheduled seminars and conferences, not to mention a Java-based public chat room that never closes.



Site Survey

The month's destinations

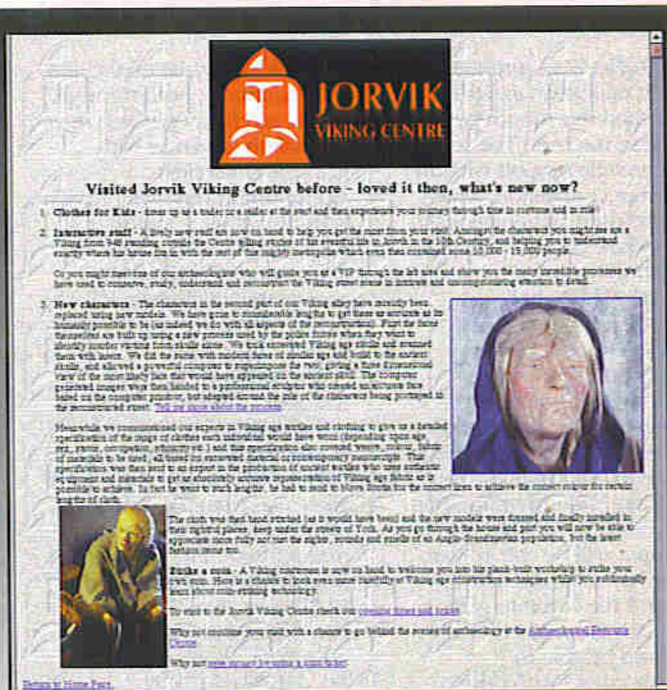
On yer Vikings . . .

Any visitor to York over the last few years must surely have been to the Yorvik Viking Centre, the fascinating (if smelly on occasion) museum in which visitors can walk along streets recreated to be as close to authentic Viking life as possible. But that, as they say, is history, and this is now! In true multimedia fashion, now you can even sample Viking life on the World Wide Web, and even on CD-ROM.

The York Archaeological Trust, which created the Yorvik centre, has combined forces with the National Museum of Denmark to create a Web site that captures the essence of the vikings. Surf to: **http://www.pastforward.co.uk/vikings/index.html**,

where you'll find the main entry point. From here, there are a host of links to other sites, museums, exhibitions, schools and so on. You can access the Jorvik Viking Centre's own Web site too, on **http://www.demon.co.uk/tourism/jvc/**.

Accompanying the main Web site are details of a new CD-ROM entitled The World of the Vikings. It's well worth a look for anyone studying



Viking history, as it has over 3,600 photographs of artifacts and places, together with spoken commentary. The project is put together in a way which no amount of foot-slogging around museums or poring over books could ever hope to achieve. The multimedia coordinators for the CD-ROM project bill it as the most complete reference resource on Viking history and culture.

ELECTRONICS and Beyond

in the pipeline

Don't miss another great assortment of entertaining and easy-to-make projects and essential electronics information aimed at the novice constructor.

Issue 120 on sale Friday 7th November

AVR – The Project

An application for Atmel's new AVR 8-bit microcontroller.

National Lottery Predictor

An electronic version of Mystic Meg – arguably prettier, undoubtedly cheaper and possibly more accurate in its predictions!

Melody Generator

Ring the tunes and hum along to the notes with this harmonious project.

PLUS Part 4 of Stephen Waddington's series on the Digital Economy examines the silicon chip industry.

Alan Simpson reports on Internet Security – are your electronic transactions safe from all those hackers?

Part 3 of Security Electronics Systems from Ray Marston covers practical contact-activated security systems and alarm circuits.

The Hills are Alive! Rob Sperring guides us to Technology in the Mountains.

Stephen Waddington reviews PCB CAD Packages and the Avro Pacific 'Fax Friend', an automatic fax switching unit that allows a facsimile machine and phone to co-exist happily connected to the same telephone line.

Project Ratings

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

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

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

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

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

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

Ordering Information

Kits, components and products stocked at Maplin can be easily obtained in a number of ways: ❶ Visit your local Maplin store, where you will find a wide range of electronic products. If you do not know where your nearest store is, telephone (01702) 554002. To avoid disappointment when intending to purchase products from a Maplin store, customers are advised to check availability before travelling any distance; ❷ Write your order on the form printed in this issue and send it to Maplin Electronics PLC, P.O. Box 777, Rayleigh, Essex, SS6 8LU. Payment can be made using Cheque, Postal Order, or Credit Card; ❸ Telephone your order, call the Maplin Electronics Credit Card Hotline on (01702) 554000; ❹ If you have a personal computer equipped with a MODEM, dial up Maplin's 24-hour on-line database and ordering service, CashTel. CashTel supports 300-, 1200- and 2400-baud MODEMs using CCITT tones. The format is 8 data bits, 1 stop bit, no parity, full duplex with Xon/Xoff handshaking. All existing customers with a Maplin customer number can access the system by simply dialling (01702) 552941. If you do not have a customer number, telephone (01702) 554002 and we will happily issue you with one. Payment can be made by credit card; ❺ If you have a tone dial (DTMF) telephone or a pocket tone dialler, you can access our computer system and place your orders directly onto the Maplin computer 24 hours a day by simply dialling (01702) 556751. You will need a Maplin customer number and a personal identification number (PIN) to access the system; ❻ Overseas customers can place orders through Maplin Export, P.O. Box 777, Rayleigh, Essex SS6 8LU, England; telephone +44 1702 554000 Ext. 376, 327 or 351; Fax +44 1702 554001. Full details of all the methods of ordering from Maplin can be found in the current Maplin Catalogue.

Internet

You can contact Maplin Electronics via e-mail at **<recipient>@maplin.co.uk** or visit the Maplin web site at **http://www.maplin.co.uk**.

Prices

Prices of products and services available from Maplin shown in this issue, include VAT at 17·5% (except items marked NV which are rated at 0%). Prices are valid until 3rd November 1997 (errors and omissions excluded). Prices shown do not include mail order postage and handling charges. Please add £2.95 to all UK orders under £30.00. Orders over £30.00 and MPS Account Holding customers are exempt from carriage charges.

Technical Enquires

If you have a technical enquiry relating to Maplin projects, components and products featured in *Electronics and Beyond*, the Technical Sales Dept. may be able to help. You can obtain help in several ways: ❶ Over the phone, telephone (01702) 556001 between 9.00am and 5.30pm Monday to Friday, except public holidays; ❷ By sending a facsimile, Fax (01702) 554001; ❸ Or by writing to Technical Sales, Maplin Electronics PLC., P.O. Box 777, Rayleigh, Essex, SS6 8LU. Don't forget to include a stamped self-addressed envelope if you want a written reply! Technical Sales are unable to answer enquires relating to third-party products or components which are not stocked by Maplin.

Maplin 'Get You Working' Service

If you get completely stuck with your project and you are unable to get it working, take advantage of the Maplin 'Get You Working' Service. This service is available for all Maplin kits and projects with the exception of: 'Data Files'; projects not built on Maplin ready etched PCBs; projects built with the majority of components not supplied by Maplin; Circuit Maker ideas; Mini-Circuits or other similar 'building block' and 'application' circuits. To take advantage of the service return the complete kit to: Returns Department, Maplin Electronics PLC., P.O. Box 777, Rayleigh, Essex, SS6 8LU. Enclose a cheque or Postal Order for the servicing cost (minimum £17) as indicated in the current Maplin Catalogue. If the fault is due to any error on our part, the project will be repaired free of charge. If the fault is due to any error on your part, you will be charged the standard servicing cost, plus parts.

MAPLIN NEWS

MANAGEMENT RECRUITMENT DRIVE AT MAPLIN

Maplin is recruiting to fill up to 20 management positions in new stores set to open all over the UK this year. Maplin is interested in candidates with solid retail experience, and preferably some technical knowledge covering at least one of the company's core product areas – sound and vision, computing, electro-mechanical and components, security, and projects and modules.

The company is growing fast, having opened six new Maplin high street stores and two Mondo superstores over the last nine months.

Progress for Maplin staff can be equally rapid. Ann Belwood (37), manager of the company's Bradford store, joined Maplin in 1993 as a part time administrative assistant. Just two years after going full time, she took over the Bradford store as manager. "I like working in a small team, and I enjoy the customer contact," she explains. "I don't have a technical background, so I'm learning from my colleagues on the shopfloor all the time."

Nick Butcher (24) graduated in media studies, joining Maplin just 12 months ago. Currently assistant manager in the Milton Keynes store, he has gained sales and management experience in several Maplin stores, and now hopes to make it to store manager before perhaps moving over to buying.

"I've picked up the technical side of things fairly quickly," says Nick. "Many of our customers are very specific in their requirements, and for those who need access to specific technical knowledge, I draw on the experience of my colleagues, or the technical helpline we run."

Jackie Featherstone (41) manages the Mondo superstore in Leeds, and moved across to electronics retail after 15 years in fashion.

"Fashion is quite an ageist environment, so I moved over to superstore management with Staples. Then, I visited a Maplin store quite by chance with my partner, who is an electrical contractor, and came out having bought some aromatherapy kit. I was mesmerised by the sheer range and appeal of the products the store carried. And by complete coincidence, I was headhunted for the job at the Mondo superstore later that week," says Jackie.

Jackie says she finds the job enjoyable because it continues to offer a challenge both technically and commercially. "It's put the adrenaline rush back into retailing for me," she explains.

"We're looking to recruit some 15 store managers and an additional 35 trainees with management potential," confirms retail operations director Colin McMahon.

afdec MEMBER

Maplin has become the first mail order and retail based electronics company to be accepted as a member of the Association of Franchised Distributors of Electronics Components (AFDEC).

As the industry's trade organisation, AFDEC represents the business interests of franchised component distribution companies in the UK. The association aims to promote the benefits of quality products, high standards of service and best business practices to customers through a franchised distribution network.Acceptance to the electronics industry's organisation means professional recognition in the component distribution sector. Customers can continue to be assured of receiving the high level of service together with competitively priced, good quality product ranges that they have come to expect from Maplin.Membership of AFDEC follows Maplin's IS09002 and BSI registration and comes after the recent signing of successful distribution agreements with several manufacturers of components products and of high quality test and measurement equipment such as Tektronix and Fluke.

MAPLIN STRENGTHENS MARKETING DEPARTMENT

Specialist electronics retailer Maplin has recruited David O'Reilly to the newly appointed post of marketing manager following the recent appointment of Neal Turner as sales and marketing director.O'Rellly's appointment coincides with company's 25 year anniversary. His role will involve developing Maplin's marketing program for retail and trade customers. He will also be responsible for the mail order business across Maplin's core product areas including computer peripherals and networking,electromechanical and components, project and modules, audio-visual and security. Having previously worked for Cornwell Parker and Office 1 Superstores Ltd. O'reilly has gained experience in similar roles with particular responsibility for new product development, customer loyalty programs and data marketing initiatives.

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