ELECTRONICS and Beyond

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OCTOBER 1999 NO. 142 £2.65

Space Tourism

A Holiday out of this World

Music on the Move

We review an MP3 and MiniDisk player

Zero Emission Transport

Powered by air

In-car Entertainment

A practical guide to sound improvement

PROJECTS FOR YOU TO MAKE

- Measuring Small Temperature Changes
- GZ34 Valve Rectifier PSU
- Desktop Robot
- Millennium Clock
- Solar-powered Switched Mode Power Supply

MAPLIN ELECTRONICS

Britain's most widely circulated magazine for electronics!

THE MAPLIN MAGAZINE

ELECTRONICS and Beyond

October 1999 Vol. 18 No. 142

Projects

Features

Regulars

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

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Fax: (01702) 554001.

UK Newstrade Distribution
Maplin Electronics PLC.

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

ELECTRONICS and Beyond

Last month we featured a valve amplifier from Mike Holmes using two KT66s. To compliment this design, this month we feature another valve project from Mike - a power supply featuring a GZ34. For those of you using the Millennium amplifier this will be a very useful and practical modification that will increase the life of the valves and make it a more 'purist' design.

Richard Grodzik describes a simple programmable robot that we are sure can be readily adapted or used within a more elaborate outer body. As we start the run up to Christmas, some of you may well be tempted to turn this project in to a party piece. It should provide endless fun!

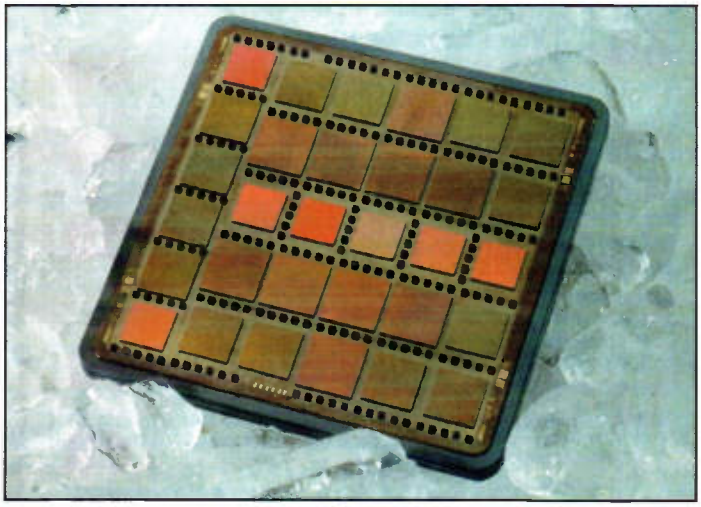
Albert Einstein was one of the most creative intellects in human history. In 1905, his 'annus mirabilis,' he published four research papers, each containing a great discovery in physics. This was destined to change forever our view of the universe. Graham Marett starts a two part series about this great man on page 66.

New Aberdeen Store

Maplin will be opening its 53rd store in the UK at Aberdeen on the 11th September. All our readers in Northern Scotland will be able to see a wide range of products on display at our new store, which is situated at Unit 4 Haudagain Retail Park, great Northern Road, Woodside, Aberdeen.

Britain's Best Magazine for the Electronics Enthusiast

NEWS REPORT



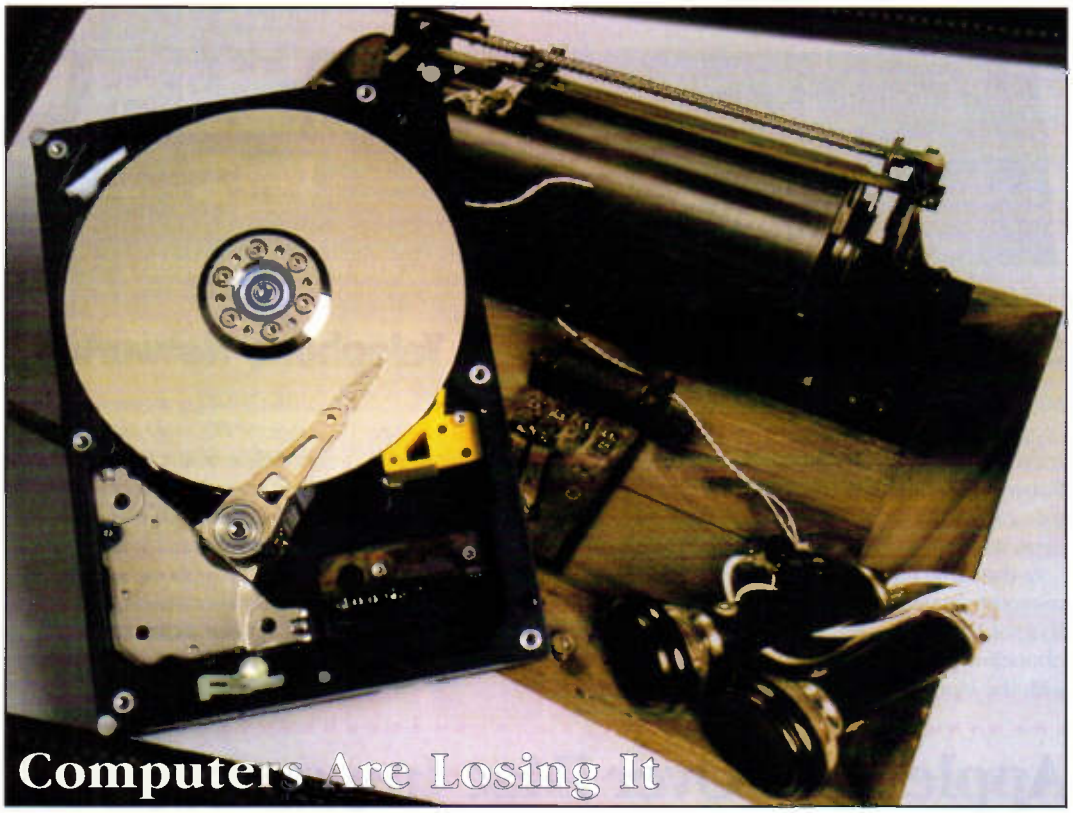
IBM Acquires Sequent for High-End Server Technology

IBM has acquired Sequent Computer Systems for £485 million. Sequent makes computer systems created by combining hundreds of off-the-shelf microprocessors into a single parallel processor.

Sequent is set to become an IBM subsidiary, and its technology will be incorporated into IBM's RS6000, Netfinity, and other server computers.

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

Contact: IBM, Tel: (0990) 431611.



Computers Are Losing It

The promise that modern information storage devices, from magnetic tape to compact disks, would make data inviolate, is not becoming a reality, according to archivists.

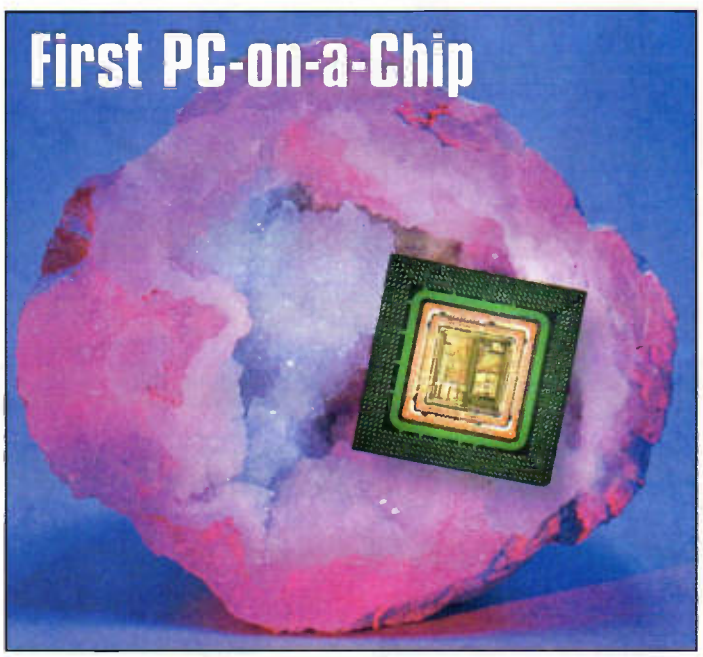
Not only are storage device materials subject to ageing or accidental corruption, some of the technologies used to record data are becoming obsolete, which threatens to make it nearly impossible to retrieve even the data that does survive.

The US National Media Lab reports that magnetic tape, floppy disks, hard disks, and video tape can only survive for about 10 years and that CD-ROM is more vulnerable to damage and information loss than originally thought.

For further details, check: <www.nml.org>.

Contact: National Media Lab, Tel: +1 (651) 736 7918.

First PC-on-a-Chip



National Semiconductor has developed the first of the PC-on-a-chip family of processors that integrate into a single chip digital video functions and PC functions such as processor, system logic, graphics, MPEG video decompression, audio, TV input/output and peripheral input/output.

The new chip, called the Geode SC1400, will be used in information appliances now being developed by such companies as Acer, AOL, Philips, WYSE, and others.

Designed around National's x86-based MediaGX processor core, the Geode SC1400 integrates digital video and major PC functions, with the exception of DRAM and high-voltage components, into a single chip of silicon. These functions, as already listed, normally require at least half a dozen separate chips in a conventional PC or set-top box.

The Geode x86 processor core is a critical feature, needed to deliver a full, rich Internet experience based on complete compatibility with standard applications and plug-ins. High-end hardware MPEG-2 decoding technology supports streaming video, DVD playback and video-on-demand.

This level of integration offers information appliance manufacturers several significant advantages, such as high performance, low power consumption for longer battery life, and small form factor which is especially important in consumer devices. In addition, customers' overall design and manufacturing costs are lower because National provides validated system solutions with fewer components.

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

Contact: National Semiconductor, Tel: (01475) 633733.

NEWS BYTES

Xerox and 3M Makes Paper Electronic

Xerox has partnered with 3M to commercially produce electronic paper. Electronic paper, which has until now been a Xerox research project, is a reusable electronic display. The product uses a display technology called gyricon created by Xerox a decade ago. Small beads, similar to toner particles, are embedded in a uniform pattern in a flexible binder sheet. The beads rotate to display one side to the viewer when a pattern of electrical voltage is applied to the surface and the image stays until a new pattern is applied.

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

Contact: Xerox, Tel: (0800) 454197.

HP Step Closer Towards Molecular Computing

Researchers from Hewlett-Packard have developed a way to create molecular-sized computing components using chemical processes to make integrated circuits. Although their accomplishment is just a first step for the new field of molecular electronics known as moletronics, it leads in the direction of a new world in which computers will be 100 billion times as fast as a Pentium processor.

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

Contact: HP, Tel: (0990) 474747.

Microsoft Broadens Beyond PCs

Microsoft is preparing for a future dominated by non-PC technologies such as Internet services and handheld computing. To reflect its change in attitude, the company has adjusted its vision statement to 'Empower people through great software anytime, anyplace, and on any device'.

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

Contact: Microsoft, Tel: (0345) 002000.

Corel Announces Upcoming Products for the Mac

Corel has renewed its commitment to the Macintosh platform with the announcement of three new products: Corel Print Office 2000 for Macintosh, Corel Print House 2000 for Macintosh and Corel Custom Photo for the Macintosh.

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

Contact: Corel, Tel: (0800) 973189.

NEWS BYTES

Avery Media Software is New Way to Label

Avery has introduced a new computer program, Avery Media Software, to format and print onto CD-ROM, DVD, audiotape, videotape, Zip disk and computer disk labels.

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

Contact: Avery, Tel: (01628) 764 000.

Share Devices Without Wiring

Proxim has announced the UK launch of its Symphony product family, a low-cost, easy-to-use wireless networking solution for the small office and home markets.

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

Contact: Proxim, Tel: (01235) 86 50 01.

Place Your Bets on a Blue-Blooded Boy

The new royal couple should be looking to paint their nursery blue, according to research from the UK's largest data mining specialist.

From detailed predictive analysis, SPSS is confident that a new royal prince is on the way, despite Sophie's recent baby denials.

The process was carried out using a data modeling system, built by SPSS. This was based on historical evidence from previous royal marriages, as well as outside factors, such as Sophie's non-aristocratic stock.

Results show that the baby is likely to be born within the next two years, and 67% more likely to be a boy than a girl.

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

Contact: SPSS, Tel: (01483) 719200.

Nokia Announces Mobile Phone Browser

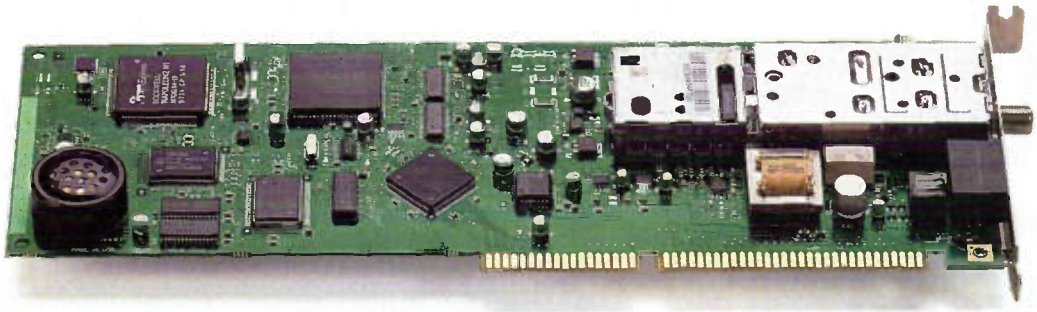
Nokia announced a WAP browser to provide mobile terminal manufacturers with a standard based WAP browser applications and services.

The Nokia WAP Browser is a software product that can be ported and integrated to wireless devices, like mobile phones and personal digital assistants (PDAs).

By licensing the browser Nokia wants to further encourage the broad adoption of the WAP standard in the mobile device industries.

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

Contact: Nokia, Tel: (01480) 434444.



3Com to Deliver 10Mbps Home Telephone Networking

3Com said this month that it supports the announcement from the Home Phoneline Networking Alliance (HomePNA) that it has selected a second-generation technology.

At the same time, 3Com also reiterates its intention to ship a suite of 10Mbps home phoneline products, compliant with the HomePNA 2.0 standard by the end of the year.

The HomePNA 2.0 technology standard - ten times faster than products available today - was submitted by Epigram (the home networking division of Broadcom) and Lucent Technologies Microelectronics Group. Final approval of the HomePNA 2.0 proposal is expected during the second half of 1999.

This 10Mbps technology connects PCs over existing home phoneline wiring infrastructures. Consumers will be able to set up and use home phoneline networks without interrupting standard telephone service.

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

Contact: 3Com, Tel: (0118) 927 8200.

Apple Sues Over iMac Imposter

Apple has filed a lawsuit against PC-maker Future Power, accusing Future Power of copying Apple's iMac design with its E-Power range of PCs. Like the iMac, E-Power sports an all-in-one design and comes in a rainbow of bright colours. Unlike the iMac, however, E-Power contains a floppy drive, uses an Intel Celeron processor, and runs Windows 98.

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

Contact: Apple, Tel: (0870) 600 6010.

Intel and Cisco Team Up On DSL Modems

Intel and Cisco Systems have formed a partnership to develop, manufacture and market Asymmetrical Digital Subscriber Line (ADSL) modems that will be used for high-speed Internet access via existing copper telephone wires.

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

Contact: Intel, Tel: (01793) 403000.

Transport Chaos Sends City Workers to Superhighway

London companies are beating the summer's transport problems by setting up employees with home offices, according to digital connectivity specialist, Hermstedt.

Managers are equipping their staff with PCs and ISDN cards, allowing them to instantly connect up to office networks, email systems and Intranets, from the comfort of their studies.

The 'strain drain' away from London's streets and offices follows a series of transport problems, notably the disruption caused by this summer's Northern and Circle Line engineering works.

Many thousands of workers have been unable get to their offices on time due to road and Tube congestion, causing millions of pounds of lost productivity. Hermstedt has witnessed an 100% increase in teleworking sales to City-based companies.

The number of teleworkers in Britain currently is expected to rise by 400% in the next 10 years according to Hermstedt.

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

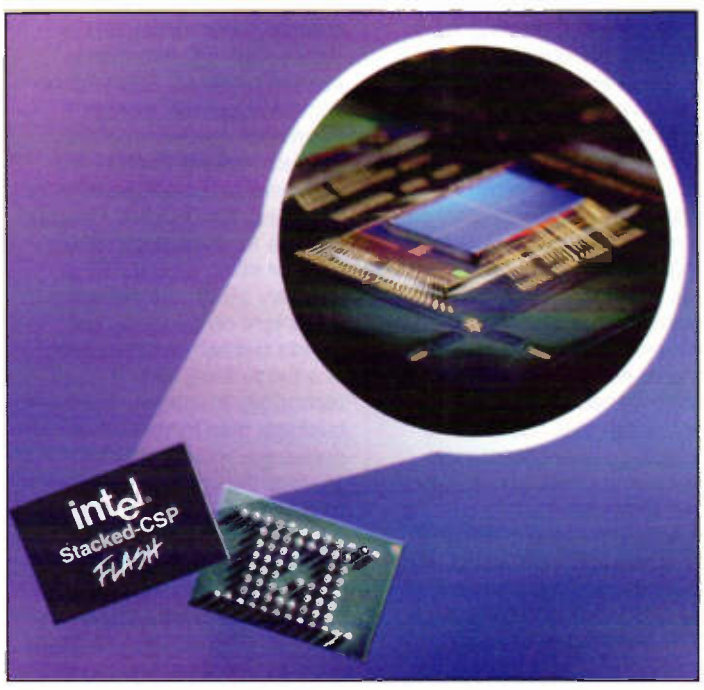
Contact: Hermstedt, Tel: (0171) 421 1500.

Companies Devise Standard for Stacked Chips

Hitachi, Intel, Mitsubishi and Sharp have announced an agreement to standardise specifications for stacked chip scale packages (S-CSP), a multiple memory module for mobile communications and hand-held computing applications.

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

Contact: Intel, Tel: (01793) 403000.



NEWS BYTES

Linux Set to Account for a Quarter of Server Sales

Linux will generate 24% of worldwide server appliance revenues by 2003, according to Dataquest. The analyst found that Linux servers will account for £2.3 billion of total market earnings, or 1.1 million units.

These forecasts demonstrate the growing popularity of the Linux operating system, which currently has more than 10 million users and accounted for almost 20% of all server operating system shipments last year.

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

Contact: Dataquest, Tel: (01784) 431611.

Worker Deficit Seen Lasting Years Longer In Information Tech

The shortage of qualified information technology workers is expected to continue at least through 2003, according to a report from Meta Group.

Meta's 1999 IT Staffing and Compensation Guide predicts that about 400,000 information technology jobs will be left open this year, while companies are being forced to offer higher salaries and provide signing and project bonuses to gain and retain employees.

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

Contact: Meta Group, Tel: (01252) 819494.

PC Shipments Surge More Than 25%

Worldwide personal computer purchases rose more than 25% from the same period a year earlier, due to lowered prices and raised interest in the Internet. International Data found that PC shipments rose 27% to almost 26 million units.

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

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

Bluetooth Enables Wireless Connectivity for Mobile Devices

The five founding companies of the Bluetooth Special Interest Group (SIG), Ericsson, IBM, Intel, Nokia and Toshiba, have announced the release of the Bluetooth 1.0 specification.

Bluetooth technology will provide an easier way for mobile computing and communications devices to communicate with one another and connect to the Internet at high speeds without the need for wires or cables.

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

Contact: Intel, Tel: (01793) 403000.

NEWS BYTES

Mitsubishi Enables Embedded Web-Control

Mitsubishi ChipConnect Software Developers' Kit (SDK) offers the first Internet-based flash reprogrammability, plus monitoring and control of 8- and 16-bit microcontroller-based embedded systems.

The key software component of the kit is the Embedded Micro Internetworking Technology (EMIT) evaluation tool from emWare, the leading provider of device-networking software for products using 8- and 16-bit microcontrollers (MCUs).

For further details, check: <www.mitsubishichips.com/chipconnect>

Contact: Mitsubishi, Tel: (01707) 278900.

3Com Delivers Palm IIIe Organiser

3Com has launched the Palm IIIe connected organiser, a low-priced, entry-level addition to its industry-leading family of handheld products. The company has also announced new accessories including a Universal Serial Bus connection kit and a variety of carrying cases.

As the entry-level model in the Palm III family of products, the Palm IIIe organiser is ideal for users new to Palm Computing products - including students, parents and business professionals.

The Palm IIIe features the same convenient form factor as the award-winning Palm III organiser plus the advanced liquid crystal display screen for improved contrast and clarity that was first seen in the Palm IIIx organiser.

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

Contact: 3Com, Tel: (0118) 927 8200.

PhonePad99 Delivers Telephone Messages

Russell Information Sciences has applied computer technology to the mundane task of telephone messages with the release of a product PhonePad99.

PhonePad99 eliminates the problem of illegible messages and wrong phone numbers as well as the typical time delay in delivering the phone messages.

Auto-Lookup identifies the recipient with a couple of keystrokes and the Caller Recognition feature fills in the caller's name, company and phone number. Each phone message is automatically stamped with the date, time and operator who took the message.

For further details, check: <www.phonepad99.com>.

Contact: Russell Information Sciences, Tel: +1 949 362 4000.

Traditional IP Business Model is Flawed Says Start-up Venture Chief

Intellectual Property (IP) is all the rage amongst the venture capital and investment community following the relative success of companies such as ARM and ARC. But the approach of these companies is flawed, according to Ken Will, chief executive officer of UK-based start-up Siroyan Technology Limited.

Siroyan is looking to change the rules of the IP business. It has just appointed Adrian Wise, one of the world's most senior and respected multimedia electronics gurus, having edited the MPEG-2 digital video compression standard.

According to Will, traditional IP vendors are failing to offer a complete solution, which means that designers have to spend large amounts of time retrofitting their designs to incorporate third party IP.

Beyond this Will claims that IP companies have built their business models for short-term gain and will struggle to sustain business and profit over the long term.

Siroyan is developing a series of innovative and complete electronics design solutions combining application modules and a core platform with an integrated development environment. The technology will be targeted at emerging applications such as Internet and multimedia appliances.

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

Contact: Siroyan, Tel: (0181) 956 2233.

Technology Worship Is Bad For Britain, Says CDT's Danny Chapchal

A British technology entrepreneur has issued a blistering attack on the UK's technology community, claiming that its lack of commercial awareness would ultimately stall the growth of the nation's knowledge-based economy and scupper any form of entrepreneurial activity in the UK.

"Time and time again scientists and inventors create what they believe to be a world beating product and believe that the world will in turn beat a path to their door. There are now plenty of cases in the UK which show this is absolutely wrong," said Danny Chapchal, CEO of polymer display inventor CDT.

"All too often the original inventors are not prepared to exit their existing jobs and take on the risk of a start-up. They don't have the stomach for it, yet they are reluctant to hand over control and equity to commercial individuals who are prepared to take risk," said Chapchal.

Chapchal firmly believes that it is marketing that makes a technology, not technology that makes a market. "History is littered with examples of very neat, yet badly marketed British technology that has failed to achieve market acceptance, Ionica being the latest example," said Chapchal.

Speaking at the Strategies for Innovation Conference held in London in July, Chapchal pointed to his own company CDT, a developer of light emitting polymers (LEP) or plastic that glows, which was spun out of the Cavendish Laboratories at the University of Cambridge in 1992.

Instead of an all or nothing manufacturing approach, Chapchal set the company upon a course of licensing and joint development. This has enabled the company to exploit LEP as a platform technology, in application ranging from micro-displays through to television, computer and large area displays.

To date, the company has secured relationships with DuPont (joint development of flexible substrates for large area displays), Philips (license for low-information content applications), DELTA (license for high information content displays), Seiko-Epson (joint development for high information content displays), Hewlett-Packard (license and joint development programme for small area displays) and Hoechst (license for materials supply).

"Prior to my joining CDT in February 1996, the company was intent on taking on the world's display manufacturers in a bid to bring its LEP technology to market. The business plan forecast that pursuing a manufacturing strategy the company would today own 10% of the television market - with funding of less than £10 million," said Chapchal.

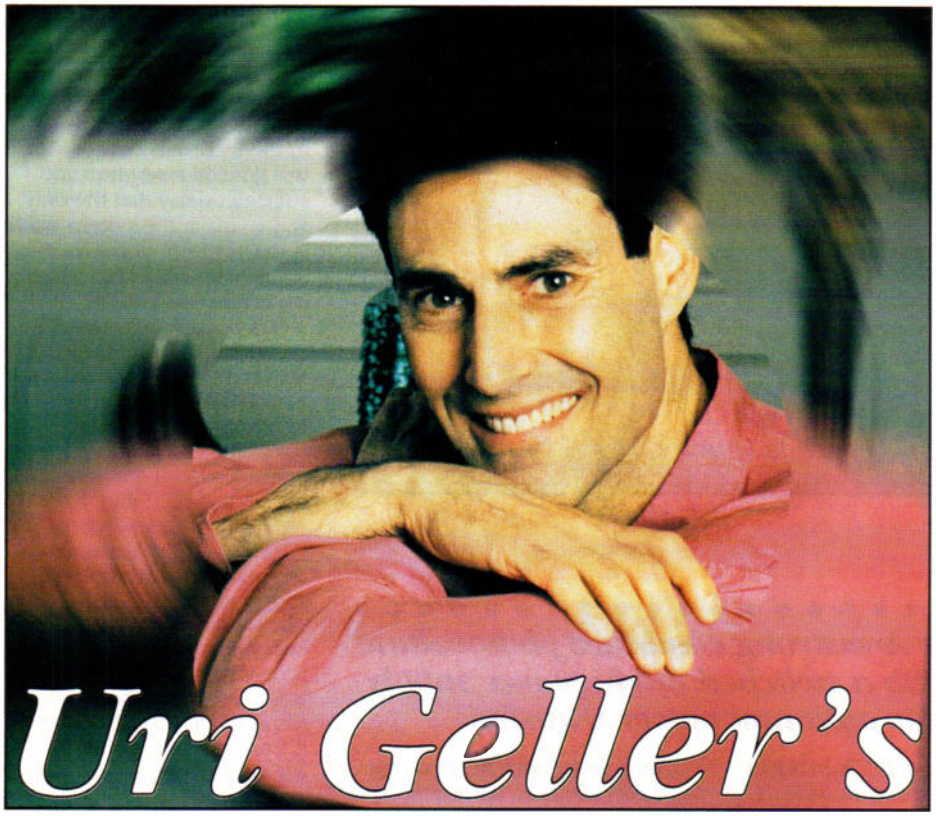
The old strategy was flawed for two key reasons, namely funding and risk. "Display manufacturers such as Samsung and Seiko Epson typically invest £300 million in a display manufacturing plant. CDT simply did not have access to this level of funding," said Chapchal.

"Secondly it is not possible to bring a new technology to market without a huge investment in research and development and complementary manufacturing skills. Had CDT pursued a technology led strategy, it would have exhausted its funding within six months," said Chapchal.

"By focussing on markets and working with market makers we have speeded up the basis of this technology and started to establish a platform for the next generation of displays," he added.

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

Contact: CDT, Tel: (01223) 276351.



Uri Geller's EXTENDED REALITY

Tribute to a Maverick

A regular reader of this column asked me the other day why I don't write more about myself in it. Well, there are two reasons. One is that there is plenty about me in print already including Andrija Puharich's biography of me (now on my website) and Jonathan Margolis' more recent one, which brings the story right up to date. The other is that since this is a technical magazine, I try to concentrate on matters that are more to do with the frontiers of science than what some people see as the fringes of mysticism.

However, I am going to break my rule here. A book popped through my letterbox recently entitled Memories of a Maverick by H.G.M. Hermans (Pi Publications, P.O. Box 11, 3140 AA Maassluis, Netherlands). The maverick in question was Andrija Puharich (1918-1995) and the author, 'Bep' Hermans was his second wife. Her book has prompted this tribute to a great and much misunderstood scientist of great vision, versatility and courage and a wonderful human being. But for him, nobody outside Israel would probably ever have heard of me, and it is no exaggeration to say that I owe my career and my success to him.

We first met on August 17th, 1971 when he came along to the night-club in Tel Aviv where I was doing my show. I trust my first impressions of people, and the very first words I remember saying to him were "I think we can work together", and so we did starting right away and continuing for several years in and out of dozens of laboratories (as you can read in Charles Panati's The Geller Papers). One of those lab reports, "Information transmission under conditions of sensory shielding" was published in the world's leading scientific journal Nature (October 18th, 1974). None of this would have happened if Andrija had not set the ball rolling.

When we met, Andrija already had quite a track record in 'straight' science. He had dozens of patents for his miniaturised hearing aids. He had two university degrees (in medicine and philosophy). He did pioneering work in blood coagulation and the extraction of energy from water by hydrolysis. He was Senior Research Scientist at New York University Medical School. He was no amateur scientist.

He was an unusual one, though. Fascinated since his college days by the powers of the mind, he tramped the world in search of people who could show him what it can do. First came experiments in telepathy with Eileen Garrett, Peter Hurkos and others in his own lab. Then he was off to Mexico in search of 'sacred' mushrooms used by shamans to obtain information. Next stop was Brazil, where he made a detailed study of the psychic surgeon known as Arigó. Typically, Andrija wanted to get close to the action and he offered himself as guineapig. A lipoma was duly hacked out of his arm in a few seconds, with a very rusty-looking knife and no kind of anaesthetics or antiseptic precautions.

He was devastated when Arigó died in a road accident in 1971, a few months before we met, though he later managed to study an equally unconventional healer, Pachita, in Mexico.

He still found time for more conventional research, notably into the effects of ultra low frequency waves on the human brain. He was the first to investigate the mysterious signal known as the Woodpecker (which is what it sounded like) coming from two huge transmitters in the Soviet Union that was disrupting radio broadcasts all over the world. Their purpose has never been revealed, and he was convinced that the Soviets were testing a new type of psychological weapon based on technology developed by Nikola Tesla.

In 1983 he announced the successful treatment of tumours in mice with gaseous superoxide anion and ozone, a discovery that seems to have been swept under the rug. Towards the end of his life he was working on a theory of a common scientific basis for all kinds of healing, both conventional and unconventional. His last public presentation, in 1990, had the typically forwardlooking title "Unification of the four forces of nature with the human mind: theory and experiment"

I have to admit that there was a strange side to Andrija. Back in the early fifties, after a meeting with an Indian mystic, he became convinced that human affairs were being directed by a bunch of extraterrestrials called The Nine. He really believed this, and seems to have unwittingly founded a kind of Nine cult (of which I am not a member). Many of these utterances came through hypnotised people, including me, and he included several pages of them in his book about me, well aware that this wouldn't do his scientific reputation much good, as indeed it didn't. Yet he was like that a true maverick who refused to run with the herd.

In his letters to Bep and in his personal papers, Andrija gave fascinating accounts of his mushroomhunts in remote parts of Mexico, and of the bizarre events that followed the delivery of his 1,200page biography of Tesla to his publisher, Dell. They never published it, following alleged intervention by the CIA which, to add to the confusion, then invited him to become a research director. He flatly refused to have anything to do with them.

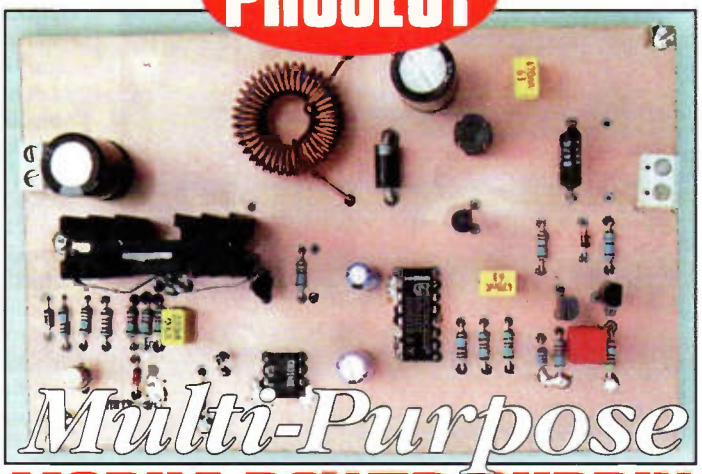
The most poignant item that Bep unearthed was the prize-winning essay on George Washington that Andrija wrote when he was 19. In its opening sentence, he seems to have written his own epitaph:

"When a man belongs to posterity, he is an alien to his contemporaries, since the effects of his work are too far-reaching to be appreciated by his own generation... There is too much of the visionary about such a man to convince the practical minded."

Uri Geller's novel Dead Cold is published by Headline Feature at £9.99, Ella at £5.99, and Jonathon Margolis' Uri Geller Magician or Mystic? by Orion Books at £6,99.

Visit him at **www.tcom.co.uk/hpnet/** and e-mail him at **urigeller@compuserve.com**

PROJECT



Multi-Purpose MOBILE POWER SUPPLY

Andrew Armstrong combines photovoltaic cells with a switched mode power supply for optimum power transfer.

This project is a multi-purpose power supply which was first thought of as a means to extend the battery life of my portable computer. In order to sit in the garden while doing a day's work on the laptop, either a mains lead or more than one battery would be required.

Experiments using an amorphous solar panel not only gave too low a voltage off load, but also failed to transfer the power which the panel was capable of generating. It was a 12V panel, but when connected to a dummy load drawing the same power as the computer, the voltage fell to around 3V, instead of the 19V needed to fully power the machine and charge the battery.

Maximum power transfer theorem

Figure 1 shows a representation of a power source connected to a load. This approximately simulates any normal power source and load.

In order to transfer the maximum power from the source to the load, the load resistance must be equal to the internal resistance of the power source. Note that this does not correspond to maximum efficiency. If all else is equal, the efficiency of energy transfer increases as the ratio of load resistance to internal resistance increases. If the energy is drained from a battery very slowly, then most will be transferred to the load; if the energy is drained in such a way as to maximise the power output, then half the energy is dissipated in the source resistance.

All of this is important to solar panels, because the amount of power available is limited and, in order to make the best use of expensive solar panels and scarce sunlight, the load should ideally be altered to match the instantaneous performance of the panels.

The effective source resistance of a solar panel depends on the amount of light it receives, as well as on the load current drawn. Therefore, a given load will only draw the maximum power that the panel can give at one particular light level. In cases where the solar panel is, for example, charging a lead acid battery, the panel will typically be rated to give maximum power at around 17V in bright sunlight, so that it provides a useful rate of charge in moderate light levels. This does mean that a lot of available power is wasted when the sun is bright, in order to obtain useful charge rates even at low light levels when the battery is near full charge.

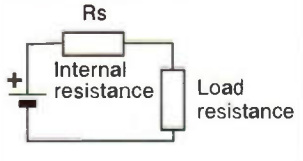


Figure 1. Power source connected to load.

Figure 2 shows typical voltage and power curves for a solar panel in bright sunlight. The operating point of this sort of panel when charging a battery would be around the place at which the two curves intersect, significantly below the maximum power that is available. Interestingly, wind powered generators also give a variable effective source resistance according to wind velocity and, although the response curve is entirely different, the principle that the load should ideally be altered to match the available power remains true.

In either type of renewable energy source, the typical operating conditions are unlikely to correspond with maximum efficiency unless some means of optimisation is used.

What it does

This project provides the optimum power required. It uses a switched mode power supply in an inverting step-up mode to convert whatever voltage the solar panel supplies to run whatever voltage the load requires. The important point is that the output voltage is drawn relative to the positive input supply, rather than the negative as is more usual.

If there is more power available than the load requires, then it works as a conventional switched mode power supply, limiting its output voltage to match whatever is the maximum safe for the load. For example, it might be set to 14V to charge a 12V lead acid battery.

The means of setting the voltage deserves a mention. Because the switched mode control IC is designed to control output voltage relative to its input 0V, the use of a standard potential divider feedback would result in the output voltage being controlled relative to the input voltage - not what is needed! Transistor Q3 is added to the potential divider circuit so that the upper resistor has the output voltage minus the Vbe of around 0.6V across it. The collector of Q3 then provides a current dependent on the output voltage to the lower potential divider resistor, so that the input voltage no longer directly affects the output voltage.

This method of voltage setting adds little delay, and no gain, in the feedback loop, which means that it is most unlikely to make the control unstable. Schemes which add op-amps in the feedback loop of ICs of this general type often add sufficient delay that the only way to make the system stable is to slow its response to transient load changes - which is a problem best avoided.

It is possible to use the power supply in conjunction with the cigar lighter output in a car to deliver the 19V needed to power most portable computers. If plenty of power is available, and if the output load does not exceed the power capability of the switched mode IC, then this project will work as a straightforward power supply to run the computer. The topology chosen gives the bonus that because the output is only present when the circuit is functioning correctly, most forms of failure will simply stop it from working, rather than allowing the car power with all its high voltage transients to be connected directly to the load.

When used in a situation where the input power is insufficient to supply the maximum demand of the load, it automatically adjusts itself to make the best use of whatever power there is. A "dither signal" repeatedly turns down the output by a fraction of a percent, and samples the change in load current. If the load current rises when the duty cycle of the converter is reduced, that means that the power source is being loaded too heavily, and the load should be reduced in order to improve efficiency. In this case, the sampling of the change in output current achieves exactly this. The demand adjusts itself to match what is available from the power source.

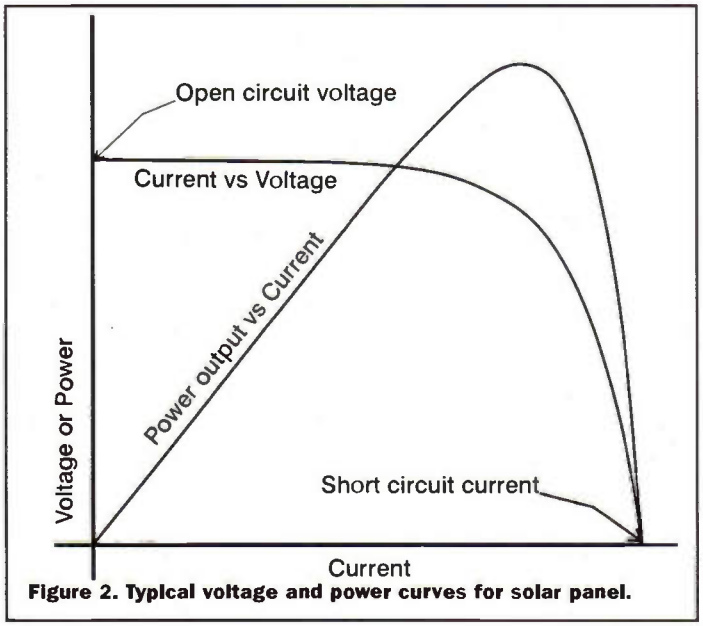


Figure 2. Typical voltage and power curves for solar panel.

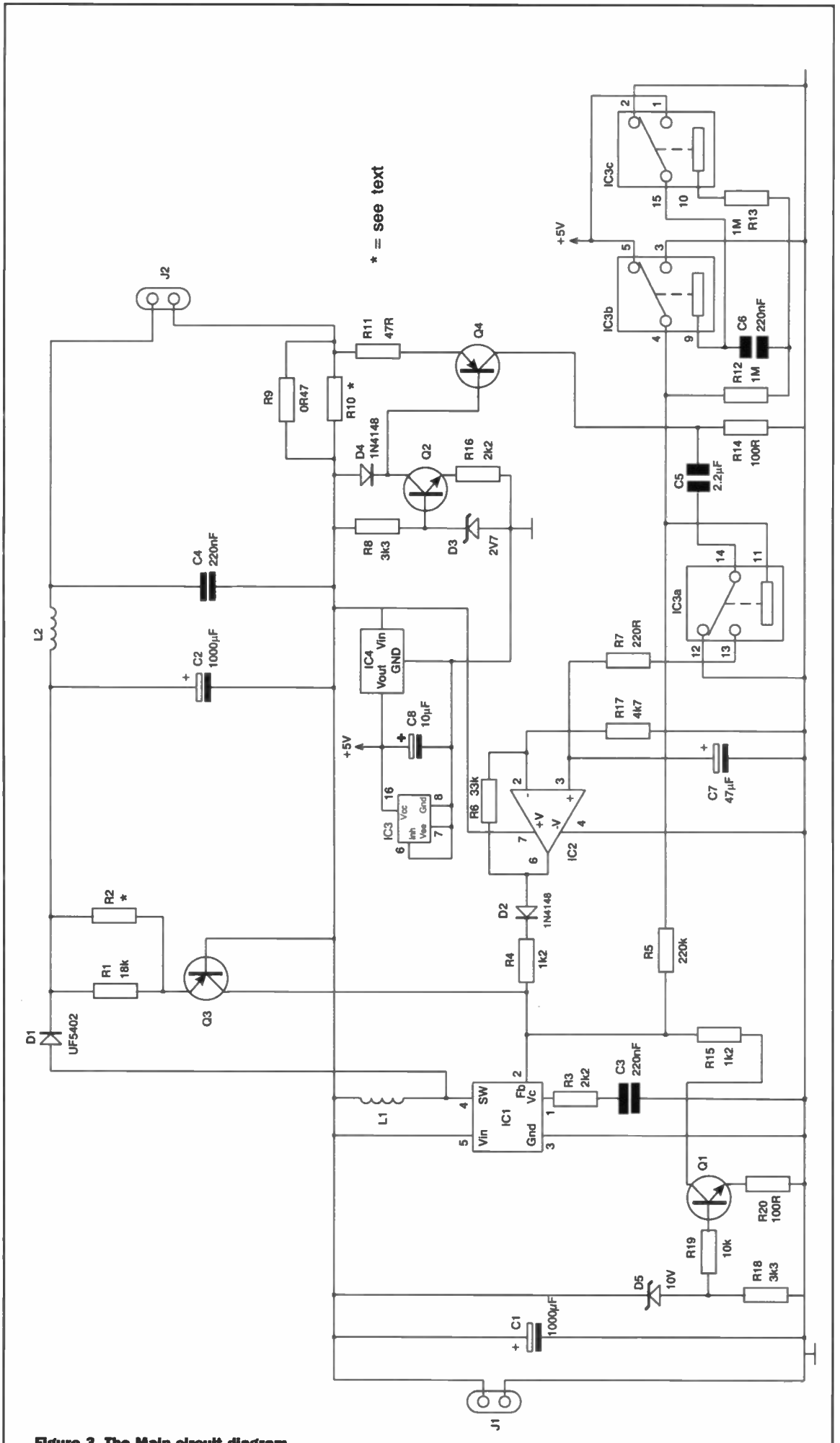


Figure 3. The Main circuit diagram of switched mode power supply.

Startup

One snag in the otherwise valid theory showed itself at the prototype stage. The circuit could not start up properly if the source power was insufficient for the load. It never got close enough to a properly controlled state for the power adjustment control loop to have any effect. This loop only works when the switched mode controller chip is running in its regulating mode, so that the dither signal can actually affect the mark:space ratio of the switched mode IC.

What happened was that the power supply tried to draw so much power from the source that the voltage fell too low for the system to function. What is worse is that the resistance seen at the input terminals of a switched mode power supply is negative incremental. Because the normal power supply control loop tries to deliver the same load power regardless of the input voltage, then the current increases as the input voltage falls. This means that a small drop in the input voltage causes the input current to rise, further lowering the input voltage, in a vicious circle. In that case, even if the unit could power up correctly, a brief cloud across the sun could stop it dead.

The solution was to limit the output power according to the input voltage – thus preventing the input voltage from being reduced too far. The system which controlled the input voltage had to work via the feedback pin of the switched mode controller, so that the system would then run in regulation, and thus permit the dither signal to adjust the system for optimum efficiency.

The components for this were added at a late stage in the design, and are not in exactly the same position on the model shown in the photograph as they are on the final design.

The circuit

The circuit of this project is shown in Figure 3. The unit is designed around a standard 5-pin TO220 switched mode chip. This incorporates all the control and power switching elements, and it is possible to make a straightforward

power supply by adding a power inductor, high speed power diode, three resistors, a film capacitor and two electrolytic capacitors.

The IC can be either the National LM2577ADJ (available from Maplin) or the Linear Technology LT1170. The National IC switches at approximately 50kHz, while the Linear Technology one runs at around 100kHz, and the resistor in the feedback loop compensation network, R3, needs to be lower for the National IC than for the Linear Technology one.

In either case, a 150H inductor can be used as the energy storage component, and the other components are also unchanged.

If there is plenty of input power available, at 12V or more, then Q1 is switched on, and R15 in series with R20 forms the lower part of the feedback potential divider which sets the voltage. The values shown here, with R1 at 18k and R2 not fitted, give an output voltage of just under 19V, suitable for many laptop computers. Other voltages can be chosen by fitting different values of resistor for R1, and adding a much higher value in parallel (R2) to set the voltage in finer increments than can be achieved by the steps of value in normal resistor ranges.

The output voltage will alter slightly in time with the dither signal, but this will not affect the types of load for which this circuit is mainly intended. Because the output will not increase when the aiming voltage is reduced slightly, the efficiency optimising circuit will not reduce the output. It cannot increase it above its normal set point, so the unit will simply work as a normal switched mode supply.

If there is not quite enough input power for the output to reach its voltage limit with whatever load is connected, the first thing that will happen when the unit is switched on is that it will draw sufficient current to reduce the source to about 12V. At this point the demand from the unit will be reduced to prevent the input voltage sagging further.

At below approximately 12V input Q1 starts to switch off, reducing the voltage to which the unit is trying to regulate. This keeps it working at a fair efficiency while the dither alternately raises and lowers the output voltage slightly, samples the change, and adjusts the demand accordingly.

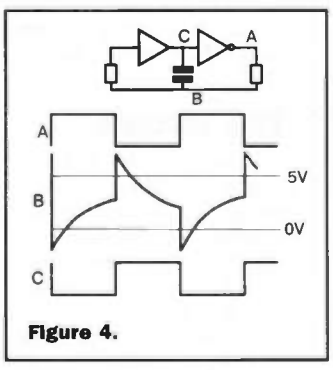


Figure 4.

The optimising loop

This part of the control system works as follows. First of all, a dither signal must be generated, and this must be synchronised with the sampling of the load current. It is convenient to use a CMOS analogue changeover switch as the sampling gate, so the oscillator generating the dither signal is made from the other two changeover switches in the 4053 triple analogue switch. At first sight the oscillator circuit may look confusing, but the principle is straightforward. The two inputs of the changeover switches are connected to the supply lines – one to give logic 1 when the control signal is at logic 1, the other to give logic 0 under the same condition. These switches effectively form one inverter and one non-inverting buffer, with the control pin as the input and the common switch pin as the output. To make this clearer, the circuit is re-drawn in Figure 4 using conventional gates.

As the waveform diagram shows, the capacitor is charged to a voltage outside the power supply range of 0 and 5V at the beginning of each cycle. The capacitor immediately starts to charge towards the opposite supply rail, and just after it passes the midpoint of the power supply the circuit switches and it then starts to charge in the opposite direction. During the switching, the capacitor–resistor feedback around the non-inverting buffer provides positive feedback to speed the switching, so that the circuit switches cleanly and reasonably predictably.

The square wave output of this oscillator is added to the voltage at the feedback pin of the switched mode IC, causing the IC to alternately increase and decrease the output aiming voltage. The magnitude of the dither is controlled by the value of R5. The value of this component should be in the range 47k to 470k depending on the precise application.

As the output is perturbed, it is necessary to sample a signal which indicates whether the current increased or decreased. To do this, the load current flows through a low value resistor, across which there is a voltage drop representing the current. To avoid wasting too much power, a low value is chosen to give a low voltage drop. The value of the resistance here must be chosen according to the load current in use.

To provide a useful feedback signal, the voltage representing the load current needs to be relative to the negative supply, instead of the common rail. To provide this, a crude current mirror (consisting of Q2, D4, and Q4) is used. Q2 provides a constant current (regardless of input voltage) to D4, whose forward voltage compensates for the Vbe of Q4. (If D4 were not present, Q4 would not conduct until the voltage across R9//R10 (where // means "in parallel with") exceeded around 0.6V, giving rise to unnecessarily large losses in the resistor.)

This mirror circuit provides a current into R14. With no load current, the current in R14 is low, but it increases in proportion with the load current. This does not give an accurate measurement of current, but none is needed. It is sufficient to know whether the current increased or decreased when the output aiming point was increased.

Sampling

In order to register only the change in current, the mirrored signal is transferred to a storage capacitor by means of AC coupling with a reset during the non-sampling period. What this means is that during the time for which the power is reduced, the output side of C5 is connected to 0V, then for the "normal" power time it is connected to the storage capacitor. If the voltage across R14 rises when C5 is connected to C7, then charge will be transferred to C7, thus increasing its voltage. This voltage is amplified and fed to the feedback pin of IC1 to control the power output at close to optimum.

The sample rate has to be very low for the circuit to work properly. This is because the large value electrolytic capacitors on input and output take a significant time to charge and discharge, so that the output current takes significant time to settle to its new value when the dither signal is applied. Large value electrolytic capacitors are necessary in order to keep the switched mode power supply working correctly. Their most important characteristic is the low impedance at high frequencies, and a sufficiently low esr (effective series resistance) is not available from normal low value electrolytic capacitors. User choices

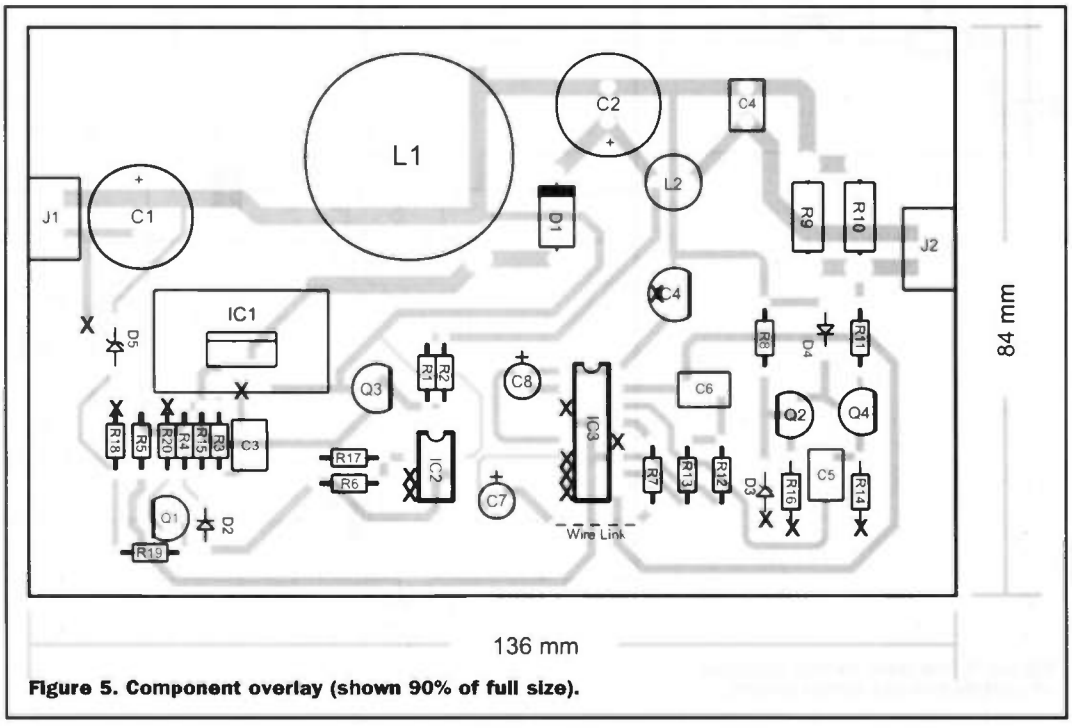


Figure 5. Component overlay (shown 90% of full size).

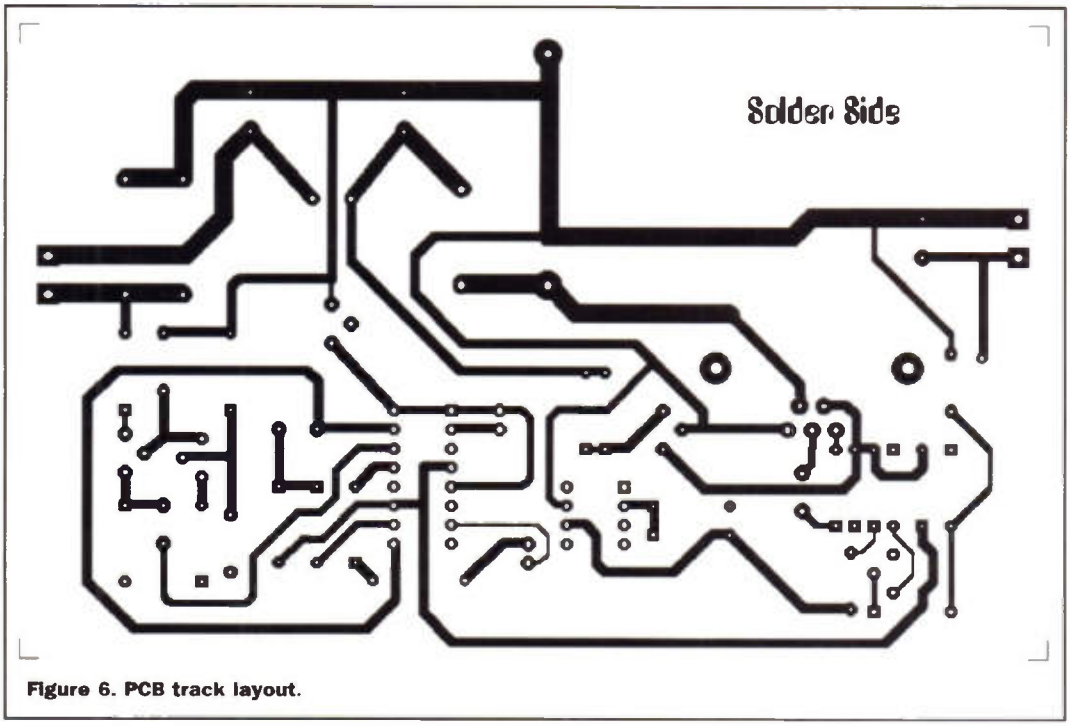


Figure 6. PCB track layout.

Several component values may be chosen to match the specific use to which the circuit will be put. R1 and R2 are used to set the output voltage, and the value of 18k for R1, with R2 omitted, is suitable for the type of portable computer which needs approximately 19V to charge its batteries.

The voltage for D5 should match the solar panels in use. For example, if a nominally 6V solar panel is to be used, a 4.7V zener diode is likely to be suitable.

The value of R5 should be chosen to give an output change adequate to adjust the system to close to maximum efficiency without disturbing the output by too large a percentage. The value of R5 will typically need to be higher if the output voltage is lower.

The value of the current sense resistance, R9//R10, needs to be chosen to give an adequate current signal without wasting more power than necessary.

Solar cells

The final prototype was tested using 15 Maplin solar cells type BZ46A.

These are supplied with a metal contact bar which can be used to connect them electrically as well as provide a modicum of mechanical support. 3 rows of 5 cells were used, and as each "cell" is actually two cells in series inside a plastic case with a lensed front, the approximate output voltage from this array is 13.5V. In practice, extra mechanical support was provided, in the form of hardboard strips fixed in between each row of cells by double sided adhesive tape.

Almost any solar cells in the range 6V to 24V can be used, with a wide range of powers. The ones chosen represent good value in terms of watts per £, and are crystalline rather than the slightly lower efficiency amorphous cells.

Assembly

This project has few assembly problems. In order to make the switched mode power supply work well without difficulty, a ground plane has been used.

The suggested approach is to etch the tracks on the solder side of the pcb, and leave an unbroken ground plane on the other side. The prototype was made using Press-N Peel material, with the ground plane side coated with pcb lacquer before etching.

The suggested method of assembling the pcb is to clear the copper away from around all the holes except those where top soldering is needed. These holes are marked X on the placement diagram. Take care to remove all traces of copper swarf, or a short circuit is almost inevitable.

When the component pins have been soldered on the underside of the pcb, top solder those which require top soldering.

The only other point to note is that the pins of IC1 should be bent very carefully to fit the hole pattern on the pcb. On the prototype it was found easiest to fit the heatsink, then clip the IC to the heatsink, in order to make sure that the IC was at the correct angle before soldering.

In use

This project incorporates a switched mode power supply, which can cause interference. The extra filter on the output, and the groundplane construction, will tend to minimise this, but it would be unrealistic to expect good radio reception within a metre or so of the unit while it is running, unless it has been fitted into a metal case, perhaps with extra filtering.

Please note also that the input does not incorporate polarity protection, or a fuse. If the unit is to be used in a car to run a laptop, then an inline fuse should be fitted in the power input cable. ELECTRONICS

PROJECT PARTS LIST

RESISTORS

R1	18k *	
R2	*	
R3, 16	2.2k	
R4, 15	1.2k	
R5	220k	
R6	33k	
R7	220R	
R8, 18	3.3k	
R9	0R47 *	
R10	*	
R11	47R	
R12, 13	1M	
R14, 20	100R	
R17	4k7	
R19	10k	

CAPACITORS

C1, 2	1000µF 25V electrolytic	JL56L
C3, 4, 6	220n 0.2" pitch	
C5	2.2µF film 0.2" pitch	
C7	47µF electrolytic	
C8	10µF electrolytic	

SEMICONDUCTORS

D1	UF5402	
D2	1N4148	BCN60
D3	2V7 zener	
D4	1N4148	BCN60
D5	10V zener *	
Q1, 2	ZTX107	QL43W
Q3, 4	BC557	QQ16S
IC1	LM2577ADJ	AD90X
IC2	CA3140	QH29G
IC3	4053	QW36P or AB53H
IC4	78L05	ARF65

MISCELLANEOUS

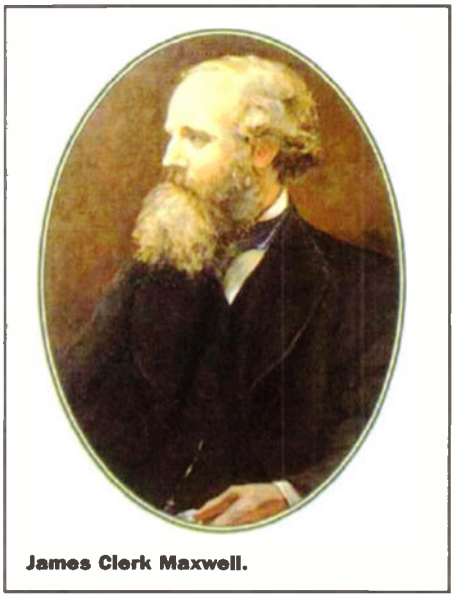
SP1	Solar panel 400mA 0.9V 15	BZ46A
J1, J2	2 pin 0.2" screw terminals	NE93B
L1	150µH power inductor	JL72P
L2	10µH	AH26D
Heatsink for IC1		AX96E
Hedatsink Clip		AX97F

* = see text

This project is not available as a kit from Maplin Electronics

The Discovery OF THE ELECTRON

Gregg Grant believes that sometime in the new millennium, the electron will no longer be a fundamental particle. It could be replaced by the fundamental particle of light - the photon. In this, the centenary year of its discovery, both the particle and its discoverer deserve to have their achievements recorded.



James Clerk Maxwell.

Introduction

The perception that invisible radiation was a feature of the natural world is relatively recent. It was only in 1800 for example that the astronomer William Herschel realised that invisible rays were heating one of his thermometer's more effectively than visible sunlight could. This radiation - located beyond the red area of the spectrum - Herschel termed *Infra-red* radiation.

There was also, it was later discovered, another type of invisible radiation, first noted by physicists who were attempting to pass electricity through gases. They realised that this type of ray could be detected by the fluorescence it produced, which was particularly noticeable in the vacuum tubes made by the British physicist William Crookes.

Crookes and His Tubes

At once ' . . scientist extraordinary, speculative genius, and brilliant public lecturer' [1] Crookes created a type of low-pressure discharge tube whose cathode was a flat aluminium disk and whose anode was a single wire, located off to one side, outside the particle stream.

This tube, the Crookes Tube as it came to be called, was the most efficient such enclosure yet devised and a considerable improvement on those of the German inventor Johann Geissler, which had been used extensively in scientific work for the previous 20 years. The reason for the improvement was a modified mercury vacuum pump.

In 1880, Crookes began to investigate the phenomenon known as cathode rays, using his newly developed tube.

First termed such by the German physicist Eugen Goldstein in 1876, these rays posed a number of questions for the physicists of the day.

Up to this time, almost all observations concerning cathode rays could be explained by regarding them as either a variant of electro-magnetic radiation - like the waves recently postulated by the Scottish physicist James Clerk Maxwell - or as a stream of particles.

Crookes demonstrated that cathode rays travelled in a straight line and also cast a well-defined shadow, termed the Crookes Dark Space. This was a relatively non-luminous region between the cathode glow and the negative flow in the tube itself.

In fact, this particular radiation could even move a small wheel, when it struck the wheel on one side! Crookes also proved that the rays could be bent by a magnet, the nature of the curve indicating that cathode rays were negatively charged.

Obviously, electro-magnetic waves could not carry such a charge and so Crookes put forward the view that cathode rays were - in effect - a stream of particles that held some form of electrical charge. Despite this though, the *nature* of this phenomenon remained uncertain.

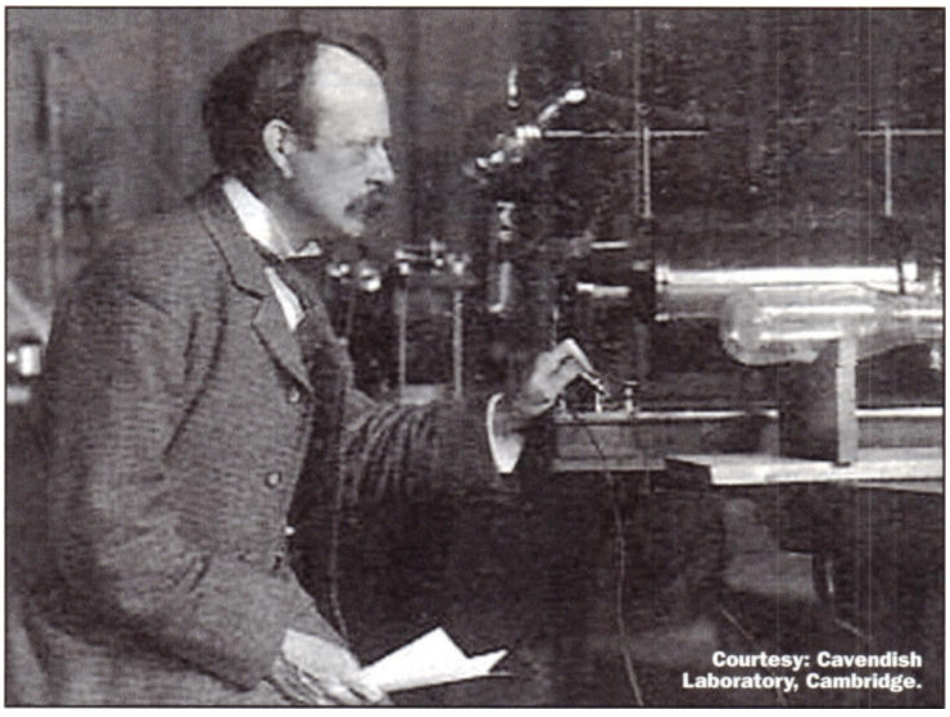
By 1895 the German physicist Philipp Lenard had created an evacuated tube with a thin aluminium 'window,' the *Lenard Window*; which enabled cathode rays to emerge into the open air. Using this tube Lenard ' . . established that cathode rays consisted of negatively charged particles, a discovery for which he claimed priority.' [2] He nevertheless still considered that cathode rays were indeed rays, as opposed to particles.

At the same time, the French physicist Jean-Baptiste Perrin also demonstrated that cathode rays did indeed carry a negative charge. However, a year earlier a British physicist had also began an investigation into cathode rays. His work would finally settle the nature of cathode rays once and for all.

Thomson Takes a Hand

Joseph John Thomson was born in the Manchester suburb of Cheetham in 1856, the son of a bookseller and publisher. In 1870 he entered Owens College, spending the next three years studying engineering, before going on to Trinity College, Cambridge, from where he graduated with a BA degree. He was a prizeman of the college.

In 1881, Thomson published a paper on energy transformation, in which he introduced the concept of electro-magnetic mass, he put forward the idea that an object's mass changed when it was electrically charged. A decade later, the Irish physicist George Johnstone Stoney suggested that - electricity existed - like matter itself - as fundamental particles. Furthermore, these



Courtesy: Cavendish Laboratory, Cambridge.

particles all carried the same electric charge. He even put forward a name for this fundamental unit: the electron.

In 1894 Joseph Thomson, who was known - for obvious reasons - as 'JJ' was appointed the Cavendish Professor of Experimental Physics at Cambridge. He soon announced that, in the course of experiments he had discovered that the velocity of cathode rays was considerably lower than that of light.

Three years later, the significance of Stoney's suggestion - although it had made little impression at the time - came into its own. Thomson, in a now-classic experiment, demonstrated that cathode rays could also be deflected by an electric field .

From the amount of this deflection, he calculated the ratio of the electric charge of a cathode ray to its mass, which proved to be quite high.

This meant that either the particle's mass was low or the charge was high, or both. 'JJ' took the view that the charge would in fact, be the unit charge calculated from Faraday's Laws of Electrolysis, of 1832.

If he was correct, then the mass of a cathode ray particle would be but a tiny fraction of that of the hydrogen atom, the smallest such particle known to science at this time. In fact, the electron proved to be first particle to be discovered that was smaller than an atom. It would subsequently prove to have a mass only 1/1837th that of a hydrogen atom. 'JJ' had therefore discovered the first *sub-atomic* particle.

The Electron

Since he suspected that the cathode ray particle did indeed carry the fundamental unit of electric charge, Thomson took up Storey's suggestion and called the particle the Electron. Two years later, he completed his examination of cathode rays with two more experiments.

Using the Cloud Chamber recently developed by another Cambridge physicist, C.T.R. Wilson, 'JJ' proved that cathode particles carried the same amount of charge as hydrogen ions in electrolysis.

Secondly, he measured the charge of the electron, in the process of which he recognised ionisation to be a splitting of atoms. He also thought that the particles emitted by the Photo-electric Effect would have the same mass-to-charge ratio as cathode rays. That he was correct in this, would later be proved by no less a scientist than Albert Einstein.

Thomson ' . . valued and inspired enthusiasm in his students,' ' and his own blend of prodigious memory, enthusiasm, kindness and inspiration created an experimental physics environment whose graduates left Cambridge to become - in time - professors themselves, in no less than 55 of the world's universities!

In 1906, 'JJ' received the Nobel Prize in Physics for his discovery of the electron. Later in their careers, no less than seven of his former students would - like their professor - become Nobel Prizewinners in their turn!

References

1: Aitkin, H.G.J. (1976): *Syntony & Spark: The Origins of Radio.* John Wiley & Sons, London. Page 110.

2: Weber, Robert L. (1988): *Pioneers of Science.* Adam Hilger, Bristol & Philadelphia. Page 27.

3: Ibid. [2], Page 30.

ELECTRONICS

PROJECT

Measuring Small TEMPERATURE CHANGES

PART 2

Dr. Pei An continues his computer-based temparature measuring system.

ICL7135 A/D Converter

The ICL7135CPI is a precision A/D converter that combines dual-slope conversion reliability with ±1 count in 20,000 counts accuracy. It also features auto-zero and auto-polarity. It has multiplexed BCD outputs and requires LED display drivers to form a complete digital volt meter (DVM). The outputs can be interfaced to a computer. The pin-out is shown in Figure 7. The device requires ±5V power supplies, and the supply currents to the positive and the negative power rail are 1.1mA and 0.8mA, respectively.

The analogue section of the ICL7135 requires only four external components. They are the reference capacitor, C_{REF}, the auto-zero capacitor, C_{AZ}, the integrating capacitor C_{INT} and the integrating resistance R_{INT}. They have to be chosen to suit a particular application. The details are given in the manufacturer's data sheet.

The data output sequence is given in Figure 8. There are five digit drivers D5 to D1. They produce positive going signals and the scanning sequence is from D5, D4, D3, D2 and D1. The binary coded decimal (BCD) value appears at B8, B4, B2 and B1 pins in phase with the digit drive signals. -STROBE (pin 26) is a negative going output signal that is used for transferring data to external circuits. It produces five negative-going pulses after a new A/D conversion is completed.

When RUN/-HOLD is high (or left open) the A/D converter will continuously run with equally spaced measurement cycles for every 40002 clock pulses. If it is low, the converter carries out the present measurement cycle and then holds the reading for as long as the pin is held low. A short positive-going pulse on the pin (greater than 300ns) will initiate a new measurement cycle. BUSY (pin 21) goes high at the beginning of the signal integrate and stays high until the first clock pulse after the zero crossing.

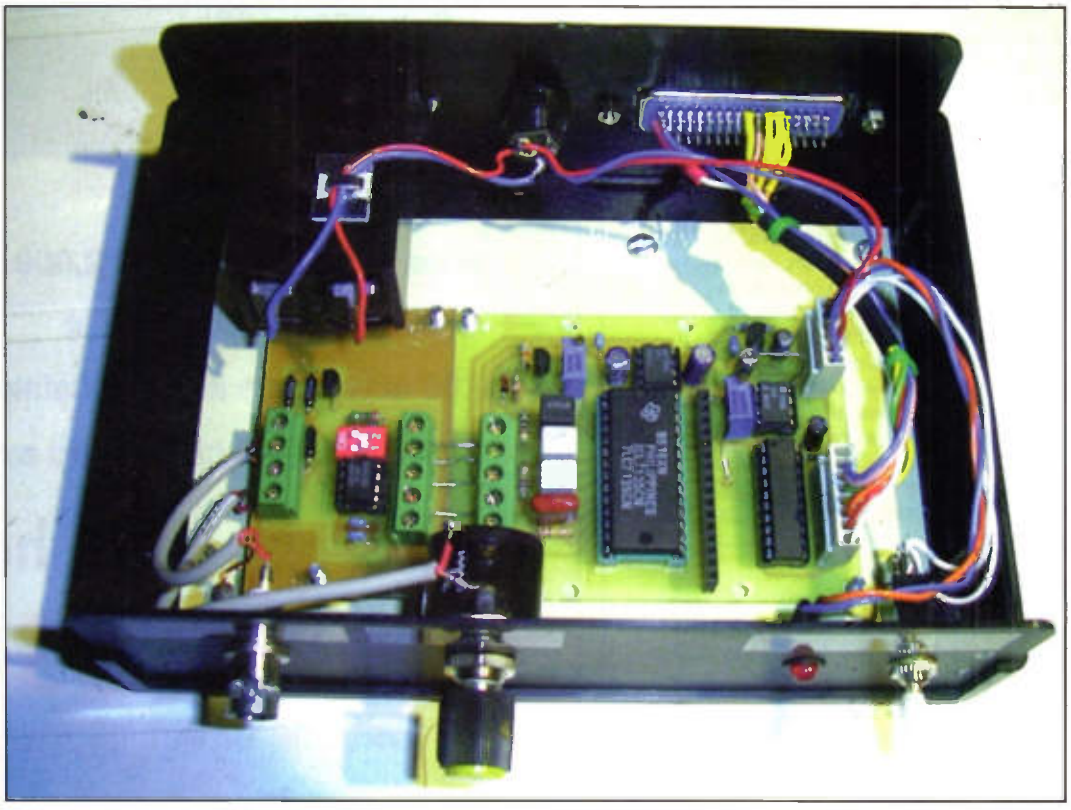
The Centronic Port

The Centronic port on computers consists of three independent ports, namely, the Data port (8 outputs), the Control port (4 outputs) and the Status port (5 inputs). The Data port and the Control port are output ports. The Status port is an input port. Figure 9 shows the pin-out of the Centronic port.

In the present project, the DB0 of the Control port is used to select digital data inputs to computers. The Status port reads 5 data bits from the A/D converter.

Interfacing the ICL7135 to the Centronic Port

B1, B2, B4 and B8 from the ICL7135 are connected to pins 11,13,15 and 17 of the 74LS241.



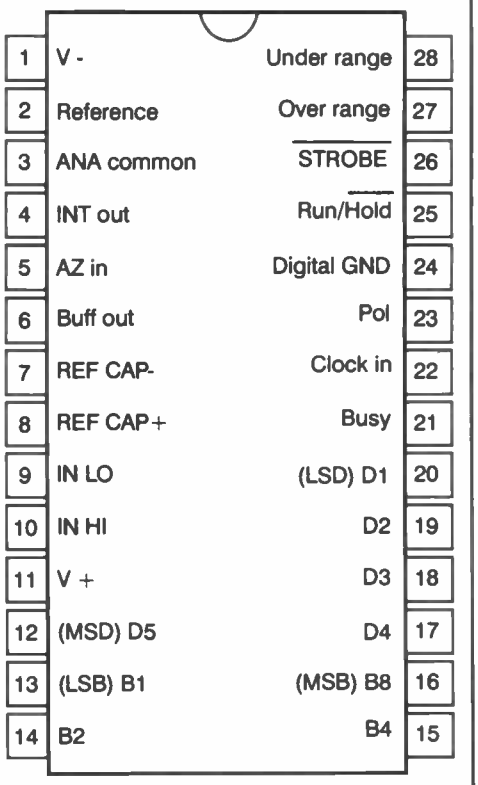


Figure 7. Pin-out of the ICL7135.

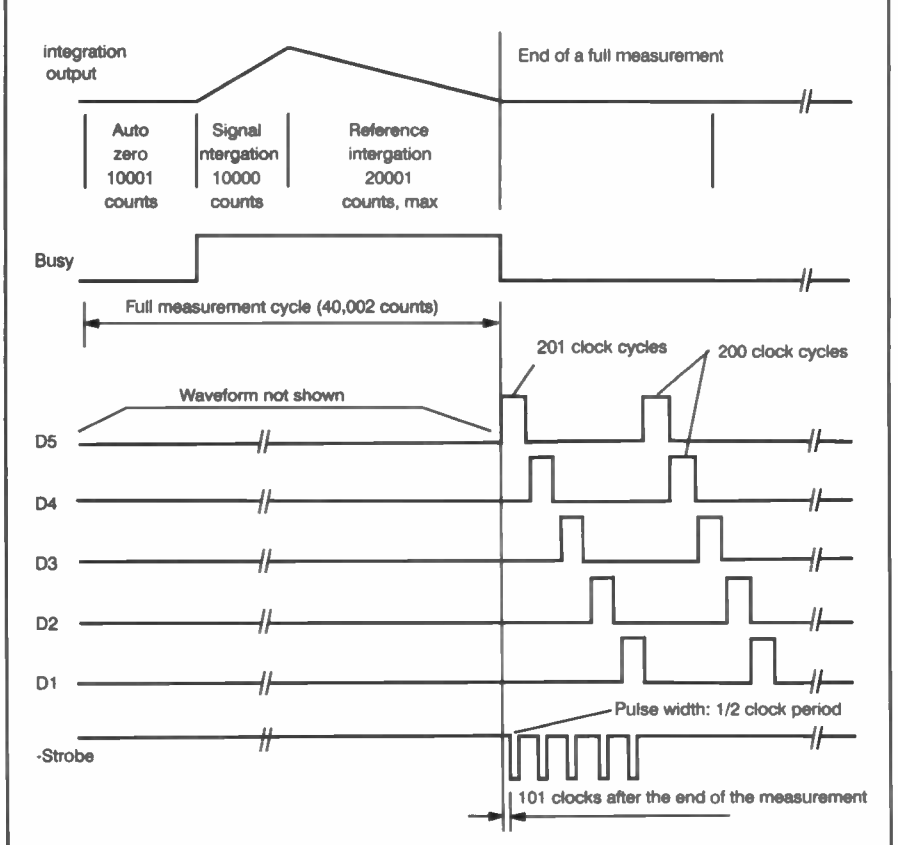
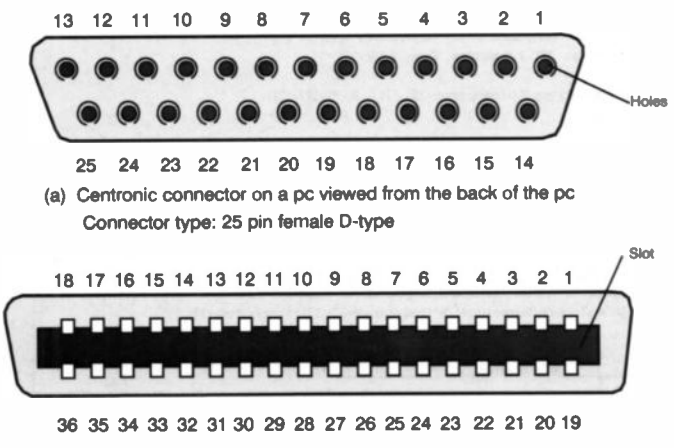


Figure 8. Timing sequence of the ICL7135 A/D converter.

74LS241 is a tri-state octal buffer IC. When pin 1 (the 1st enable) is low, the outputs 18, 16, 14 and 12 follow the inputs at pins 2, 4, 6 and 8. When pin 19 (the 2nd enable) goes high, the outputs 3, 5, 7 and 9 follow the inputs at pins 17, 15, 13 and 11. If Pin 1 and Pin 19 are connected together to form a Data Selection Line (DSL), by putting the line low and then high, the Status port can read 8 bits connected to buffers through four lines (see Figure 3). Pins 3 and 18, pins 5 and 16, pins 7 and 14 and pins 9 and 12 are connected together.

Referring to Figure 3, the DSL line is controlled by DB0 of the Control port of the Centronic port. Data transfer into the computer is described below.

Firstly, the DSL is held low. The computer checks D1. After D1 goes from low to high and then low, the DSL line is brought high and the computer checks the –STROBE line. There will be five high-to-low-then-high pulses once a new conversion result is ready inside the ICL7135. When the DSL line is high, B1 to B8 are connected to the Status port. Every time when the -STROBE line goes low, the data bits B1, B2, B4 and B8 are read into the computer. There will be five data that correspond to digits D5 to D1. Finally the five data are combined into a single value. The polarity of the result is obtained by reading the Polarity bit.



Pin functions of the Centronic port connectors

CONNECTORS ON pcs	CONNECTORS ON printers	DIRECTION OR C	Name	E NTONS
1	1	OUTPUT	STROBE	LOT TO STROBE DATA INTO PRINTER
2	2	OUTPUT	DB0	data bit 0
3	3	OUTPUT	DB1	data bit 1
4	4	OUTPUT	DB2	data bit 2
5	5	OUTPUT	DB3	data bit 3
6	6	OUTPUT	DB4	data bit 4
7	7	OUTPUT	DB5	data bit 5
8	8	OUTPUT	DB6	data bit 6
9	9	OUTPUT	DB7	data bit 7
10	10	INPUT	ACK	low to indicate data received, printer ready
11	11	INPUT	BUSY	high to indicate printer busy
12	12	INPUT	PE	high to indicate printer paper empty
13	13	INPUT	SLCT	high to indicate printer on line
14	14	OUTPUT	LF/CR	auto linefeed after carriage return
15	32	INPUT	ERROR	low to indicating printer error
16	31	OUTPUT	INITIALIZE	low to initialize printer
17	36	OUTPUT	SLIN	low to select printer
18-25	19-30 and 33		GND	twisted-pair return Ground
	18,34		Unused	
	16		Logic GND	logic ground
	17		Chasis GND	chasis ground

Figure 9. Pin-out and functions of the Centronic port.

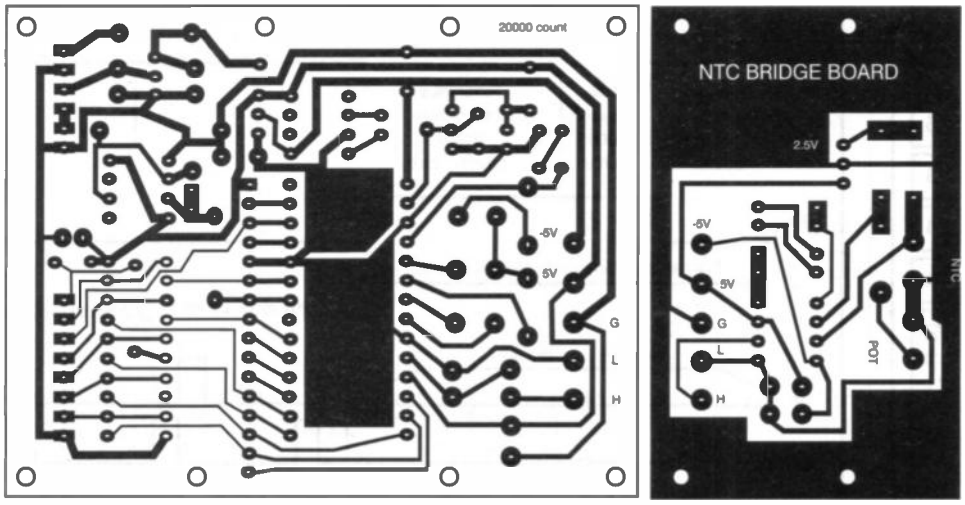


Figure 10. PCB boards.

Hardware Assembly

The circuits are constructed on two single-sided PCB boards. Figure 10 shows the artwork of the PCB boards and Figure 11 gives the component layout for the two PCB boards.

After assembly, RV1 and RV2 variable resistors have to be adjusted. The reference voltage to the A/D converter is set to 1.000V by adjusting RV1. The frequency of the clock is set to 100kHz by adjusting RV2. Such a frequency enables the A/D converter to reject both 50Hz and 60Hz mains interference.

The two PCB boards are then mounted inside a box. Screened box is preferred to reject electro-magnetic interference.

The NTC sensor is inserted inside a thermal insulation material (could be a piece of sponge). Then they are mounted inside the sensor box.

```
Program ICL7135_AD_Converter;
(* This program should run in DOS environment *)
(* In Windows 95 98, start the computer in DOS environment *)

(* Connection details.
   Strobe = DB7 of status port
   Selection Line = 1, B1,B2,B4 and B8 are connected to Status port (DB3,DB4,DB5 and DB6)
   Selection line = 0, DB0=NC, DB1= digital input, DB2=Digit 1, DB3=Polarity *)
(* Software description:
   Check digit 1 until it drops from 1 to 0, then
   Check -Strobe until it goes low from high, read 5th digit
   Check -Strobe until it goes low from high again, read 4th digit
   Check -Strobe until it goes low from high again, read 3rd digit
   Check -Strobe until it goes low from high again, read 2nd digit
   Check -Strobe until it goes low from high again, read 1st digit *)

uses
    crt,dos;

const
     B=4143      (beta value of the NTC);
     T0=25       (reference temperature);
     R0=100000   (reference resistance);

Var
   P_address:integer;
   dummy,lpt_number:byte;
   hour1,minute1,second1,second1001:word;
   hour2,minute2,second2,second1002:word;
   time1,time2,AMP,temperature:real;


Function Centronic(x:integer):integer;
(* detect number of LPT ports installed on a PC and report base addresses *)
(* $000:$0408 holds the printer base address for LPT1
   $000:$040A holds the printer base address for LPT2
   $000:$040C holds the printer base address for LPT3
   $000:$040e holds the printer base address for LPT4
   $000:$0411 number of parallel interfaces in binary format *)
var
        number_of_LPT, LPT1, LPT2, LPT3, LPT4 :integer;
begin
     number_of_LPT:=mem[$40:$11];                    (* read number of parallel ports *)
     number_of_LPT:=(number_of_lpt and (128+64)) shr 6;
     lpt1:=0; lpt2:=0; lpt3:=0; lpt4:=0;
     LPT1:=memw[$40:$08];                            (* Memory read procedure *)
     LPT2:=memw[$40:$0A];
     LPT3:=memw[$40:$0C];
     LPT4:=memw[$40:$0E];
     case x of
        0:       centronic:=number_of_LPT;
       1:        centronic:=lpt1;
       2:        centronic:=lpt2;
       3:        centronic:=lpt3;
       4:        centronic:=lpt4
      end;
end;


Function Read_status_port(P_address:integer):integer;
(* read data from the Status port and perform bit manipulation *)
var
   bytel:byte;
begin
     bytel:=port[P_address+1];          (* read a byte from the status port *)
     bytel:=bytel and 120;              (* 01111000 (MSB to LSB) and 0dddd... = 0ddddd000 *)
     Read_status_port:=bytel shr 3;     (* shift 3 bit right, Read_status_port = 0000hhhh *)
end;

Function Voltage:real;
(* read voltage conversion result from the A/D converter *)
var
   Digit: array [1..5] of byte;
   i:byte;
   V,polarity:real;
begin
     gettime(hour1,minute1,second1,second1001);
     time1:=hour1*3600+minute1*60+second1+second1001/100;
     port[P_address+2]:=1 {SEL=0};
     repeat until read_status_port(P_address) and 4 = 4;  { D1 goes high }
     repeat until read_status_port(P_address) and 4 = 0;  { D1 goes low }
     port[P_address+2]:=0 {SEL=1};
     for i:=1 to 5 do
         begin
              repeat until port[P_address+1] and 128 = 128;
              repeat until port[P_address+1] and 128 =0;
              digit[i]:=read_status_port(P_address);
         end;
     port[P_address+2]:=1 {SEL=0};
     polarity:=read_status_port(P_address) and 8/8;
     gettime(hour2,minute2,second2,second1002);
     time2:=hour2*3600+minute2*60+second2+second1002/100;
     Voltage:=(digit[1]*10000+digit[2]*1000+digit[3]*100+digit[4]*10+digit[5])/10000*(2*polarity-1);
end;


Function Resistance(temperature:real):real;
(* Calculation for resistance at any temperatures (unit in deg C) *)
(* NTC properties:  NTC R-T matched, Farnell 732-242 *)
begin
     Resistance:=R0*exp(B/(temperature+273.17) - B/(T0+273.17));
end;


Function DT(temperature:real):real;
(* calculate temperature drift from the last zero adjustment *)
var
   Vout,DR:real;
begin
     Vout:=voltage AMP; {output voltage from the bridge. Voltage is measured by A/D converter}
     DR:=Vout/2.50*(100000+Resistance(temperature)); {find out resistance change since zero adjustment}
     DT:=DR/Resistance(temperature)/B*(temperature+273.17)*(temperature+273.17);
end;

(* _____Main program _____ *)
Begin
     clrscr;
     write('Input 1,2,3 or 4 to select LPT1,LPT2,LPT3 or LPT4 :'); readln(lpt_number);
     write('Input amplification                               :'); readln(AMP);
     write('Input current temperature                         :'); readln(temperature);
     P_address:=Centronic(lpt_number);
     repeat
     writeln(DT(temperature):9:7,' deg C   ');
     delay(50000);
     until keypressed;
end.
```

Program List - 1.

Software Driver

The control software is listed in Program List-1. The program asks for the number of the LPT port to which the logger is connected. It then asks the amplification (10 or 100 depending on the switch position on the PCB board). Finally, the ambient temperature is keyed in. After this, the program shows the temperature drift on the screen. The software has been tested on a Pentium 300MHz computer.

`Function Centronic(x:integer):integer` is a useful function. When x is 0, the function returns the number of LPT ports installed on the computer. When x=1,2,3 or 4, the function returns the I/O address for LPT1, LPT2, LPT3 and LPT4.

`Function Voltage:real` returns the voltage measured by the A/D converter.

`Function DT(temperature):real` returns the temperature drift from zero for an ambient temperature.

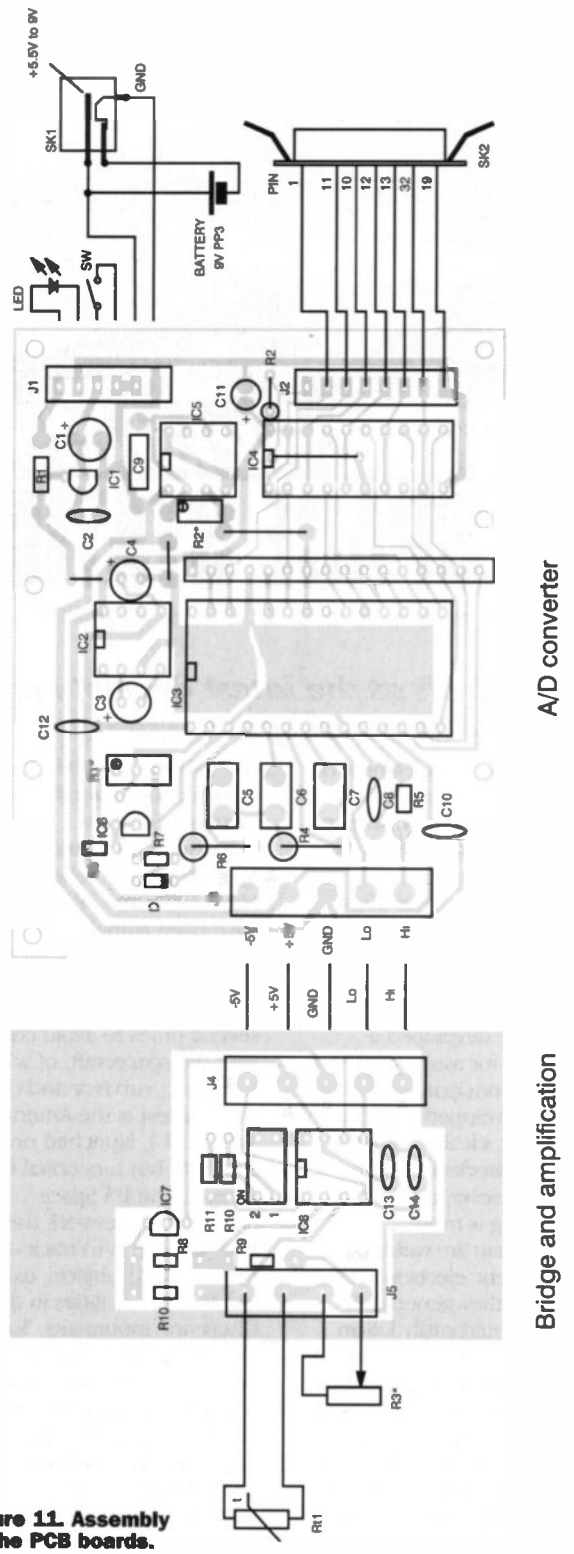


Figure 11. Assembly of the PCB boards.

Using the Device

After the power is switched on, the device takes about an hour or so to reach a stable operating condition. During this period, the NTC and resistors in the Wheatstone bridge are heated up slightly and reach a steady state condition.

Temperature drift is shown on the screen. The drift is a temperature change from the temperature at which the bridge is zeroed using the 'Adjust' control knob. The maximum temperature drift shown on the screen is ± 0.35°C. Temperature drift can be zeroed anytime by adjusting the 'Adjust' knob.

Technical Support

Designer's kits are available from the author, Dr. Pei An. Telephone/Fax/Answer: 44(0)1614779583.
E-mail: pan@intec-group.co.uk

PROJECT PARTS LIST

FIXED RESISTORS
(0.25W 1% metal film resistors for all resistors, if otherwise stated)

R1	2k7	R2 10k
R3	6k8	
R4,5,7	100k	
R6	27R	
R8	100k, 0.1% precision resistor, and temperature coefficient: 15 PPM	
R9	80k24, 0.1% precision resistor, and temperature coefficient: 15 PPM	
R10	100k, 0.1% precision resistor, and temperature coefficient: 15 PPM	

THERMISTOR

Rt1	100kΩ NTC thermistor

VARIABLE RESISTORS

RV1	100k 10 turn
RV2	5k 10 turn
RV3	50k 10 turn wirewound variable resistor (which is fixed on the panel)

CAPACITORS

C1,11	22µF/16V electrolytic capacitor
C2,10,12, 13,14	100nF ceramic
C3,4	10µF/16V electrolytic capacitor
C5	0.47µF PPS capacitor
C6,7	1µF polyester capacitor
C8	100nF polyester capacitor
C9	10nF polypropylene capacitor

SEMICONDUCTORS

IC1	TC55RP5002EZB +5V low power LDO voltage regulator
IC2	TC7660 voltage inverter
IC3	ICL7135CPL
IC4	74LS241
IC5	CMOS 7555 timer
IC6	ICL8069 temperature compensated 1.2V voltage reference
IC7	TLE2425 +2.5V voltage reference
IC8	INA118 instrumentation amplifier
D1	1N4148

CONNECTORS

J1	6-way PCB connector pairs
J2	8-way PCB connector pairs
J3	6-way screwed terminals
J4	6-way screwed terminals
J5	4-way screwed terminals
SK1	2.5mm power socket
SK2	36-way Centronix-type female connector
SK3	BNC connector pairs

MISCELLANEOUS

SW	2-way DIP switch
SWITCH	Toggle switch
Battery	9V PP3 battery
LED	3.0 mm low current LED, red, with panel mounting LED holder
	PCB board for the A/D converter and PC interface
	PCB board for the bridge and amplifier
	Box for the logger unit
	Box for the NTC sensor
	Screened cable for the NTC sensor
	Panel mounting battery holder for the PP3 battery

RESEARCH NEWS

Future Reusable Space Vehicles AND THE INTERNATIONAL SPACE STATION

PART 2

In this second part, Dr. Chris Lavers continues his look at the latest developments in space launchers, the International Space Station and space tourism.

Radiation Effects

By comparing damage done during MIR flights with damage to tissue by gamma rays in the lab, scientists have concluded that astronauts have been exposed to about 0.15 sieverts-equivalent to a few thousand chest X-rays. US civilians are allowed only 0.05 sieverts per year. Living in a radiation field especially during intense solar activity, with increased levels of ionospheric radiation (through which the station will fly), and highly energetic charged particles, is not an attractive proposal to crew. Due to a quirk of bad timing, most assembly work will be carried out at the peak of the solar cycle where solar flares can boost radiation levels by an order of magnitude compared with quiet periods.

However, the biggest on-orbit risk to the station is space debris. 45 years of human activity has left the Earth surrounded by a vast and deadly cloud of orbiting junk from spent rocket stages and failed satellite to flecks of paint and even a space glove left over from Ed White II's space walk (see Figure 10). In fact a fleck of blue paint frosted over a Shuttle window when Bruce Melnick, now responsible for delivering the ISS into orbit (and recently Mars Pathfinder and Mr John Glenn) and woke him in the 'night' with a bang. Fortunately damage was not severe and no loss of life resulted. Over 1,000,000 paint flakes between 1-100μm in size are estimated to exist and are untracked! Impacts with meteoroids and small debris have meant that over 60 outer windows have been replaced, costing $40K each. Eric Christiansen, Chief Analyst at the Hypervelocity Impact Test Facility at Johnson Space Centre has developed a shield to protect the ISS against marble-sized aluminium debris (1cm across) moving at up to 7km/s. The layer has an aluminium bumper, followed by layers of ceramic and Kevlar cloth. The important Habitation module has a 1.8% chance of being punctured in the 10 year period. This doesn't sound too bad, but there are about 30 modules in all, and over 20 years the probability rises to 42%.

Taking the inevitable to be something worth dealing with NASA and scientists from the Ukraine have developed a welding tool for assembling the station and anticipated repairs. NASA has developed an electron beam welder, ideal for space since it only works in a high vacuum. However, electron beam welding is more dangerous than arc welding. When energetic electrons smash into a target they generate X-rays which could easily kill an astronaut. However, only thin sheets of metal need to be joined and so a low power beam may be used. The so called Universal Hand Tool (UHT) is an electron beam welder that does not produce dangerous X-rays, operates at only 8kV and has been tested during spacewalks during 1984 and 1986. During construction astronauts will carry out 59 welds.

Between the launch of Sputnik on 4 October 1957 and May 1997 some 3800 rockets have been launched into space, adding 4,500 tons of material and 2000 discarded satellites in orbit. The Shuttle has swerved several times to avoid colliding with old spacecraft, of which the oldest survivor and one of the smallest is the American Vanguard 1, launched on March 17, 1958, but functional for only 6 years. The US Space Surveillance Network uses radar and telescopes to track over 8500 orbiting objects, using the old NORAD facilities in the Cheyenne mountains. To be detected, objects must be between 10-30cm big and in Low-Earth Orbit between 200-2000km, and larger than 1m if in Geostationary Earth Orbit, some 36,000km up. Approximately one of these objects reenters Earth's atmosphere every week.

Figure 10. Distribution of known space debris: Courtesy: NASA.

Collisions!

The first confirmed collision took place on 24 July 1996 when a French satellite CERISE, was damaged by a fragment of an Ariane rocket launched in 1986. The relative speed at the time of collision was 50,000km/hour! Since 1961 over 150 satellites have blown up or fallen apart, scattering more than 10,000 fragments large enough to track. Experts are worried that the amount of debris will increase and reach a situation that as a result of a normal launch debris fragments and impacts with satellites will create new debris. This 'avalanche' effect must be avoided if the most useful regions of space, already crowded, are to be prevented. The risk of an operational satellite being hit by an object is still small but steadily increasing. There is no feasible way of cleaning up space, apart from possible advances in ground-based lasers for vaporising some satellite material, nudging it off course and eventually into the atmosphere. Fortuitously, as solar radiation increases the number of satellites that re-enter the expanded outer atmosphere increases which helps clear debris. The best that can be achieved is reducing future debris. However, the volume of launches may outstrip individual improvements. Iridium will now comprise 66 satellites with a number of spares at an altitude of 770km and Teledesic's revised system is still likely to have over 280 satellites at an altitude of 700km.

Facts and Figures

It is estimated that the Space Station will need about 120,000kg of propellant to maintain its 300×365km orbit during the first decade of operations. Russia will supply Soyuz Transfer Modules (TMs) for crew ferrying and return. Two TMs will be docked permanently to provide quick escape for six crew. Although Russian participation saved the ISS at the hands of the US Congress, financial and political difficulties in Russia cast doubt on many of its commitments to the revised assembly schedule. Russia, originally a participator in core "ownership" of the ISS has now been given a one-off payment of $200 million for the Functional Energy Block (FGB) and relegated to the role of contractor to Boeing Corporation. The station has been scaled down several times to ensure its financial survival. With Daniel Goldin, President Clinton has established a $2.1 billion a year package for the station until 2002. The ISS will include 46,200 cubic feet of work and living space for six crew and will generate 11kW of electricity from two 112×39ft solar arrays and a 115m long boom, and will consist of seven laboratories, a habitation area, plus solar arrays, robot arms and other equipment. As a consequence of delays, the European COF and the JEM will be delayed further, current schedules have the JEM in place after 2001 and the COF after 2002. Nodes 2 and 3 of the ISS will be managed and executed by the Italian Space Agency using European technology. The launch of Node 2, the first European-built Node of the Station, is currently planned for April 2001. However, the original schedule for the space station Freedom was for completion in 1994, 10 years after President Reagan gave the go ahead! The latest schedule expects completion in 2003.

By 2012 taking into account all the launches required to build it the ISS could cost in excess of $100 billion. The vast cost of the Station gives an indication of the cost of manned flights to Mars using existing technologies. The danger of launching vehicles, hardware, supplies, full life support etc. even in a relatively low earth orbit is exceedingly expensive. Of the five main groups funding the ISS, Canada, Europe, Japan, Russia and the USA, Canada probably has the smallest overall program, with the USA and Russia the widest, spanning space sciences, life and microgravity sciences, engineering and technology development and earth sciences. Langley Research Centre has begun evaluating potential designs for a special technology development facility for the ISS or Materials Exposure Facility this centre would provide several benefits to the space research and space business communities. Some anticipated benefits include space validated components for HF radio and optical communications. It has only recently been proved what a significant effect gravity has in a range of processes involved in materials production. Processes involving crystallisation typically involve 'dendritic' crystal growth. In space, dendritic development is more pronounced and alters characteristics such as strength.

There is a strong move towards securing commercial interest in a range of scientific experiments. This will reduce the need for public support for the ISS. The inherent commercial value of information from space based processing is questionable, but will become clearer with time. The first customer has been signed up for the Spacehab commercial space research facility aboard the ISS. The Colorado School of Mines' Centre for Commercial Applications of Combustion in Space will use the Spacehab- furnace to process exotic glasses and ceramic materials in microgravity. Boeing meanwhile has signed a contract with Spacehab for the use of an Integrated Cargo Carrier to support the ISS assembly mission in March 2000.

The role of plant biotechnology to enhance plant products that improve our quality of life and

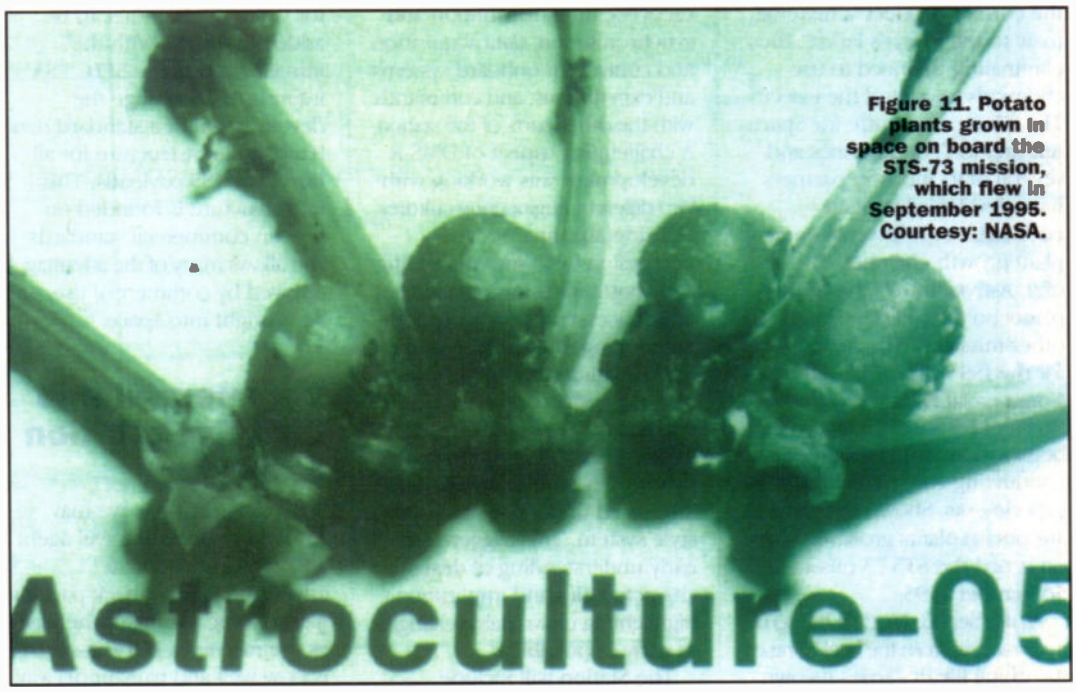


Figure 11. Potato plants grown in space on board the STS-73 mission, which flew in September 1995. Courtesy: NASA.

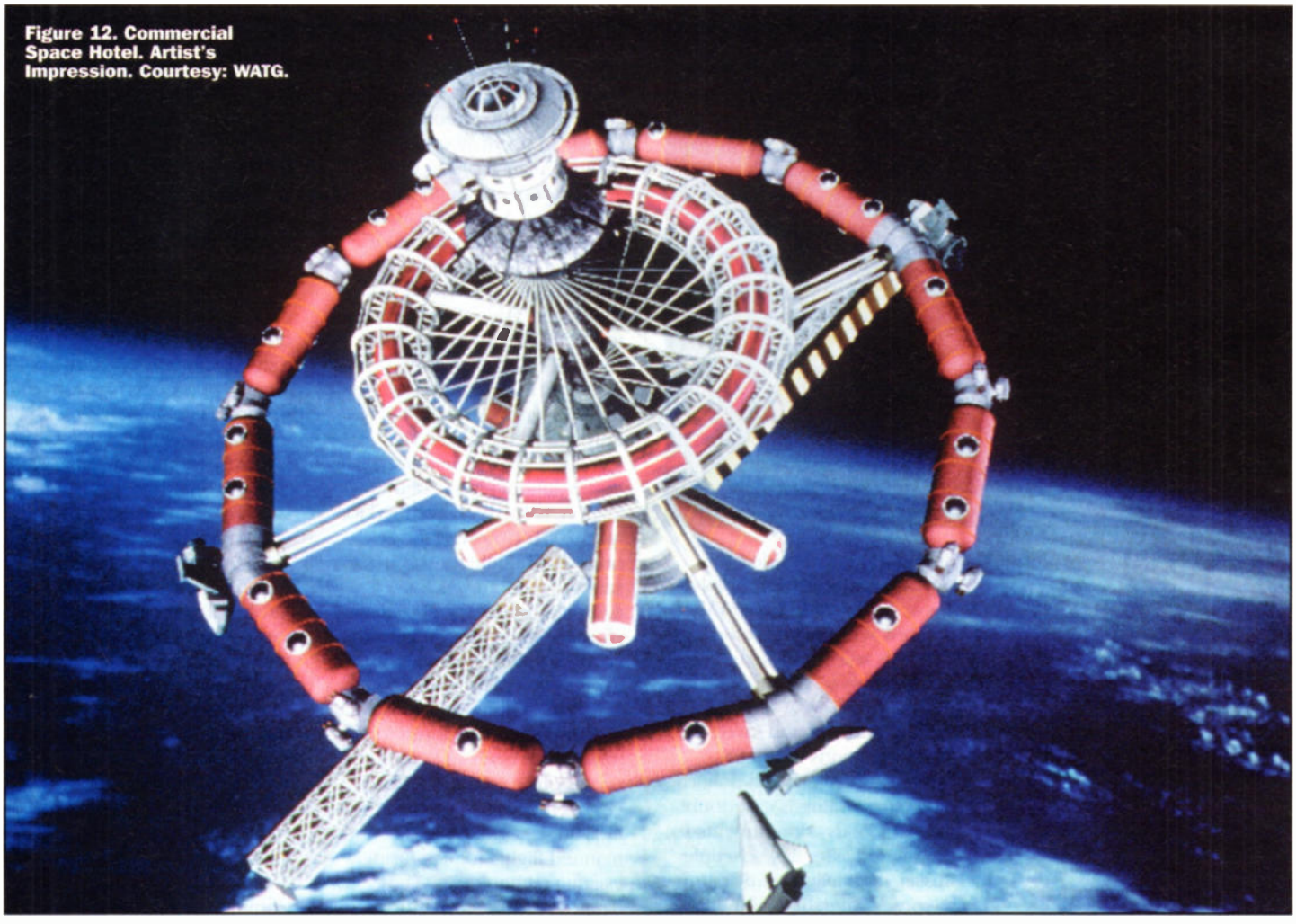


Figure 12. Commercial Space Hotel. Artist's Impression. Courtesy: WATG.

contribute to the environment will be examined. One of the most active areas of plant biotechology, is in transferring desirable genes into plants that have no commercial value into an important crop variety. A recent example is a corn hybrid that now has a gene resisting the corn borer insect, responsible for bad losses to seed and field corn producers. The gene allows the corn to produce a material toxic to the insect's larvae, thus eliminating the need to use chemicals to control the insect. The Wisconsin Centre for Space Automation and Robotics and several of its industry partners have developed a totally enclosed, controlled environment plant growth chamber. The unit, Astroculture™, has grown plants on SPACEHAB-03 and other missions. The new unit for the ISS will be called the Commercial Plant Biotechnology Facility and once in place will become a unique tool for conducting commercial plant experiments. Shown in Figure 11 are potato plants grown in space on board the STS-73 mission of September 1995.

As the Service Module has to be autonomous from the beginning of its orbital life, it carries its own Data Management System (DMS-R). Ultimately, the DMS will control the module and perform overall control, mission and failure management of the entire Russian Segment, such as system and subsystem control, especially guidance, navigation, mission management and supervisory control by ground and crew, management of onboard tasks and failure recovery, time distribution and synchronisation, data acquisition and control for onboard systems and experiments, and commands with the other parts of the station. A challenging aspect of DMS-R development was working with two different engineering cultures. Considerable analysis and persuasion went into discussing and constraining Russian changes to items essential for a properly functioning integrated system, while limiting schedule and costs. The most effect approach was to encourage Russian involvement in matters of common concern before they would have become interested under the old Soviet style system. This triggered an early understanding of design characteristics and implications, highlighting unavoidable changes as early as possible.

The Station will include standard payload computers SPLC, see Table 2, which must be compatible with the ISS data management system and interfaces with the MIL 1553 data bus, for command and monitoring of traffic. The medium rate data link is an ethernet link typically used for science data with transmission requirements higher than the MIL 1553, and a high rate data link typically used for video applications, to be added in future. With the introduction of the SPLC ESA intends to encourage the development of a standard data handling infrastructure for all European ISS payloads. This infrastructure is founded on proven commercial standards and allows many of the advantages enjoyed by commercial users to be brought into space.

Commercial and Civil Exploitation of Space

According to some, we may soon visit our local travel agent and book the 'ultimate' adventure holiday, back packing will soon be a thing of the past as the race for a place in space is now well and truly underway. The space travel industry means big business and is no longer the monopoly of NASA and government agencies, associated with expensive launch costings. Fed up with government cutbacks, former NASA engineers and astronauts have spearheaded private companies in a bid to privatise space with projects ranging from space launch vehicles to orbiting hotels.

Momentum has been boosted with the launch of the X-Prize in 1996, a US-based not-profit organisation offering $10M to the first company to launch a reusable vehicle that makes two consecutive trips with at least three civilians to 100km above the Earth. The X-Prize was set up to drive and develop the space tourism industry. Competitors will demonstrate the technical and operational capabilities needed by vehicles that will carry customers into space.

Britain's leading amateur rocket scientist Steve Bennett, 35, (a former toothpaste technician from Dukinfield near Manchester and now Managing Director of Starchaser Industries, operating from Salford University) is hoping to win the £6.5M prize and build a spacecraft reaching orbit

62 miles above the Earth. However, his credentials for becoming the first amateur astronaut in space also take in his 1998 attempt to launch a £70K 3-stage rocket, Starchaser 3, which ended in spectacular failure when it crashed into a Dartmoor hill near Okehampton, causing a huge area of blackened moorland, visible more than 15 miles away. The other two seats are currently vacant, one for sale at £65K, the third is being raffled in a competition on the Internet. Two Russian cosmonauts, Alexander Martynov and Alexander Volkov, recently joined in a UK ceremony to support Mr Bennett's ambition to get into space. Inspired as a child by Thunderbirds, his capsule is inevitably called Thunderbird and will be launched by Starchaser 4. The crew will be strapped back into a 3-ton pressurised capsule. Thunderbird has been seeded joint-first of 14 would-be X-prize entrants. His nearest serious contender is most likely Burt Rutan, famous as the American who built the Voyager round the world aircraft. Bennett's module will follow a ballistic trajectory, with air-breathing jet engines powering it for 30km and a rocket motor taking it the rest of the way.

Travel agents are lining up to endorse the successful entrants. Japanese construction company Shimizu and international hotel architects, Wimberly Allison Tong and Goo (WATG) of London UK are working on the concept for an orbital space hotel. WATG was founded in 1945 and has completed work in over 112 countries and territories from offices in London, Honolulu, Newport Beach and Singapore, and has been ranked the number one architectural firm in the world specialising in hospitality and leisure projects. WATG's design is a wheel shaped resort, created from used shuttle tanks spinning in orbit to create 20% of normal earth gravity in bedrooms around the outside of the wheel, but allowing for weightless sport in the centre. In a 320km orbit the hotel may accommodate 200 people, see Figure 12. According to Debra Joyce of WATG "It is fantastic how this project has captured everyone's imagination."

WATG have designed a space resort in LEO utilising recycled external shuttle fuel tanks salvaged from future shuttle launches. Fuel tanks are about 31m long and 8m wide, so each could make up a couple of floors and accommodate quite a few people. Expected to be operating in 2017, the hotel will start with 10 people in orbit. Passengers will be ferried from the resort by the next generation of space shuttles, (Venture Star?), or reusable vehicles under design. The resort will be between a theme park and a cruise ship, taking into account the needs of paying guests rather than well-trained astronauts. The development of the orbiting resort will be privately financed; NASA though interested in promoting public space travel in the future, is not involved in any direct way.

Dr Buzz Aldrin, former astronaut and second man to walk on the moon, believes the opportunity to book a long weekend in a LEO would be extremely popular. "The view from space is like having a globe on your desk," he said. "It's a broadening experience after looking at parts of the Earth only on maps to then see them for real." A viewing deck on-board the WATG resort will have panels providing computer-aided images to help guests identify which part of the Earth they are looking at. Guests will be able to play ball games in zero gravity to prevent muscles from atrophying. Visitors may have a chance to dock alongside and pay a visit to the ISS and possible space walks. The designers conceive the hotel being divided between areas of zero and artificial gravity. This allow guests to experience floating in space, and to partake in earthly activities such as taking a shower or sitting down for a meal. Howard Wolff, Vice-President at WATG said the project presented the design team with a completely different set of challenges in comparison to their normal work designing destination resorts. "It's like developing a new, vast and wonderful frontier," he said. "But the point will be to strike a balance between creating an out-of-this-world experience and providing some creature comforts that travellers have come to expect in other destination resorts." But don't book yet! Current price tags put the cost of such a holiday at $10M, moving space tourism into the private sector should bring this down to an expensive but feasible $100K, comparable with ambitious Polar and Himalayan climbing expeditions.

Finally, the last word should go to 51 year old Welsh born businessman Peter Llewellyn, who has agreed to pay $100M for a week's ride on Russia's ageing, accident prone MIR space station. He aims to travel to the MIR in August in a Soyuz rocket with two Russian cosmonauts as the world's first commercial paying passenger. After a week in space he will return. The deal requires him to hold a pilot's licence, invest the $100M, upgrade equipment at the state run RKK Energia company and in return he gets the flight! This funding could help to prolong the life of MIR by several months after August when current funding is likely to have its plug pulled - but Russian expectations on Llewellyn fulfilling these prerequisites may be premature!

VME CPU MODULE

Power interface	5V/10W, without mezzanine boards
Data interfaces	Master VME bus, a 32/D32 mode, 6 senal interfaces, 2 local mezzanine I/F
CPU	ERC32
Memory	8MB SRAM, 4MB EEPROM
Software	Basic software package and V Works Kernel in ROM

VME Mass Memory Module

Power interface	5V/ <5W
Host CPU data interfaces	slave VME bus
Memory	disk or DRAM
Storage capacity	50MB

VME Extension Module

Power interface	5V/200mA (without mezzanine boards)
Host CPU data interfaces	slave VME bus and mezzanine I/O local bus (4x)

MIL 1553B Mezzanine Board

Power interface	5V/250mA 12V/300mA
Host CPU data interfaces	mezzanine I/O local bus
MIL bus	MIL STD 1553B

Ethernet I/F Mezzanine Board

Power interface	5V/1W
Host CPU data interfaces	mezzanine I/O local bus
LAN data interface	AUI

Serial I/F Mezzanine Board

Power interface	5V/200mA
Host CPU data interfaces	mezzanine I/O local bus
Data interfaces	2 asynchronous RS 422/RS 485

Analogue input I/F Mezzanine Board

Power interface	5V/<1W, ±12V <1.2W
Host CPU data interfaces	mezzanine I/O local bus
Performance	12-bit resolution, max. 100 samples/s 8 differential input channels

Digital I/F Mezzanine Board

Power interface	5V/<1W
Host CPU data interfaces	mezzanine I/O local bus
Performance	12 opto-isolated input/output lines, max 100 samples/s

SPLC Housing and Power Supply 5-slot Version

Mass	3.4kg (include. power supply, backplane, and harness)
Housing size	160mm by 295mm by 260mm
Number of VME slots	5
Construction	coated aluminium
Power supply	120 or 28V DC input

VME Interface Chips

FPGA	Master mode
FPGA	Slave mode only

SPLC EGSE

Development environment	Unix and V×Works
Test system	PACTS
Hardware platform	VME

Table 2. SPLC Standard Items List.

For more information

on the ISS you can visit **www.estec.esa.int/spaceflight**

or On space hotels:
Miss Debra Joyce,
Wimberly Allison Tong & Goo,
Alexandra House, 6 Little Portland Street London W1N 5AG.
E-Mail:london@watg.com

or Space Tourism Society,
Design Science International,
326 South Bundy Drive,
Los Angeles, CA 90049, USA.

or Mr Steve Bennett,
Starchaser Foundation,
PO BOX 21, Dukinfield,
Cheshire SK16 5FD.
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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 1999

1 to 2 Oct. TheatreWorld - Theatre Productions & Management, Wembley Exhibition Centre, London. Tel: (01895) 811 986.

5 to 6 Oct. FieldComms - Industrial Networking Show, Telford Exhibition Centre, Telford. Tel: (0171) 417 7400.

6 to 7 Oct. Softworld in Accounting & Finance, National Exhibition Centre, Birmingham. Tel: (0181) 541 5040.

6 to 7 Oct. TEST - Electronic Testing Exhibition, National Exhibition Centre, Birmingham. Tel: (01203) 230 333.

12 to 14 Oct. Cards UK - Plastic Card Technology, National Exhibition Centre, Birmingham. Tel: (0121) 767 2665.

19 to 20 Oct. Property Computer Show 99, Barbican Centre, London. Tel: (01273) 836 800.

20 to 21 Oct. Accounting IT, Business Design Centre, London. Tel: (0171) 221 1155.

26 to 28 Oct. City Information Show, Barbican Centre, London. Tel: (01865) 204 947.

26 to 28 Oct. Computers & Networks in Manufacturing, National Exhibition Centre, Birmingham. Tel: (0181) 232 1600.

26 to 28 Oct. Mobile Data Communications Trade Exhibition, Olympia, London. Tel: (0181) 910 7910.

26 to 28 Oct. Windows NT - Computer Trade Exhibition, Olympia, London. Tel: (01256) 384 000.

November 1999

2 to 4 Nov. e-business expo 2, Olympia, London. Tel: (0181) 910 7910.

8 Nov. PC@Home+Internet4All, G-MEX Centre, Manchester. Tel: (01895) 630 288.

10 to 11 Nov. Data Warehousing, Olympia, London. Tel: (0181) 879 3366.

16 to 18 Nov. Digital Media World, Wembley Exhibition Centre, London. Tel: (01244) 378888.

16 to 18 Nov. Electronic Information Display, Sandown Exhibition Centre, Sandown. Tel: (01822) 614 671.

17 to 18 Nov. JAVA - Computer Software Trade Exhibition & Conference, Olympia, London. Tel: (01256) 384 000.

17 to 18 Nov. Softworld in Sales & Marketing, National Exhibition Centre, Birmingham. Tel: (0181) 541 5040.

December 1999

7 to 8 Dec. Digital Signal Processing & Data Acquisition, Sandown Exhibition Centre, Sandown. Tel: (0181) 547 3947.

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

February 2000

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

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

March 2000

6 to 9 March. Electrex 2000, National Exhibition Centre, Birmingham. Tel: (01483) 222 888.

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

April 2000

10 to 13 April. Automation & Robotics, National Exhibition Centre, Birminham. Tel: (01737) 768 611.

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

28 to 30 April. PC@Home & Internet 4, Earls Court, London. Tel: (01895) 630 288.

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?

Apple is Talk of the Town

Apple was the talk of New York throughout July, quite literally as visitors flocked to Macworld Expo. Chief executive officer Steve Jobs was on top form. During his keynote speech the Apple boss introduced iBook, the first consumer portable to provide cable-free Internet access via AirPort, Apple's new wireless local area network (LAN) solution. Apple also unveiled QuickTime TV (QTV) which it claims is the Internet's highest-quality network for Web-based video and audio, seamlessly integrating four key elements: Apple's QuickTime 4 Player software; Apple's open-source QuickTime Streaming Server software; the Apple/Akamai technologies streamed content delivery service; and content from leading providers. Building upon its success of the iMac, Apple's iBook, or the 'iMac to Go' features battery life of up to six hours, a PowerPC G3 processor which Apple claims outperforms the fastest Intel processor found in any notebook PC and AirPort networking for wireless Internet access. And like the iMac, the iBook is available in two colours, Blueberry and Tangerine. Additional iBook features include a 12.1in, TFT, a built-in 56k modem and 10/100BASE-T Ethernet network adapter, built-in CD-ROM drive, and two built-in antennas and an internal slot to accept Apple's new AirPort wireless networking card. QTV, the Internet's highest performance network for Web-based video

and audio, seamlessly integrates Apple's QuickTime Streaming Server with Akamai Technologies' global Internet content delivery service to give Macintosh and Windows users one-click access to high-quality, popular content, free of charge to viewers at <www.apple.com>. QTV provides leading content providers with the fastest, most reliable distribution network available. New 'intercasters' on the QTV network include ABC News, Disney, ESPN, The Knitting Factory, RollingStone.com, VH1 and Virgin Radio. See @Internet for further details. Demonstrating continued enthusiasm for the Macintosh platform, Apple also announced that third-party developers have introduced nearly 5,000 new Macintosh software and hardware products in the past 12 months. In one year, third-party software developers have announced 3,935 new software titles for the Macintosh platform. Hardware manufacturers, fuelled in part by iMac's support for the Universal Serial Bus (USB) and the Power Macintosh G3 computer's support for USB and FireWire have developed more than 1,053 new products, ranging from storage devices, printers, scanners and cameras to game controllers.

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

Contact: Apple, Tel: (0870) 600 6010.

Computers Look to the Future

It may be some time before you can serve a ball and play virtual tennis over the Internet. But during a recent three-day workshop held at US-based Stanford University, participants were treated to demonstrations of devices and software that promise to transform the way that individuals experience the Internet and dramatically expand the ways in which both consumers and companies use computer-based communications. An international audience toyed with displays that allow a person to not only see but feel and manipulate three-dimensional objects displayed on a computer screen; watched realistically rendered animated characters adapting instantly to sudden and unpredictable changes in their environment; and viewed videos of robots ironing shirts, erasing blackboards and dancing with graduate students. In the past, computer simulations used for product design have been largely static in nature. But the explosion in computing power in recent years is making it possible to animate such prototypes, adding a whole new dimension of utility to the practice of virtual prototyping that is affecting a large number of industries. The current state of the art in providing motion support for virtual prototyping was the focus of the meeting. From a commercial standpoint, the assembled experts agreed, some of the laboratory developments that were presented aren't quite ready for prime time. Along with the need for further technical refinements, many face the classic chicken-and-egg problem: If they can be manufactured in large quantities, then the cost of production can be reduced dramatically; but the only way to sell them in large quantities is to cut the price substantially. The May workshop, titled 'Motion Support in Virtual Prototyping', took place at Stanford's Centre for Integrated Systems and was organised by Jean-Claude Latombe, chairman of Stanford's Department of Computer Science. The workshop was co-sponsored by the Alliance for Innovative Manufacturing (AIM) and the Stanford Computer Forum.

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

Contact: Stanford University, Tel: +1 650 723 2300.

Minister Acknowledges Wireless Revolution

Video telephone calls, virtual offices for homeworkers and the remote diagnoses of patient illnesses are just some of the possibilities set to become reality under plans for broadband services unveiled by Telecoms Minister Michael Wills. Wills announced that he intends to consult on auctioning large amounts of radio spectrum that will enable new suppliers to offer low-cost access to the information superhighway. The new frequencies will give access over radio links without the need to lay cables to subscribers' homes. Will's launched the consultation document, Wireless in the Information Age, at an event hosted by the Government's independent advisors, the Spectrum Management Advisory Group. The announcement of spectrum for broadband wireless access forms part of the governments' overall 'Information Age' strategy for encouraging a competitive communications market and for ensuring that the opportunities are grasped by industry. Other elements include: the encouragement of competition in the last connection to the home and workplace through, the provision of spectrum, enabling the UK to pioneer digital television, lifting the broadcast entertainment restriction on BT and putting the UK in the vanguard of the next generation of mobile communications, through the proposed licences for 3rd Generation networks.

For further details, check: <www.open.gov.uk/radiocom>.

Contact: DTI, Tel: (0870) 1502 500.

Bio-Feedback WITH ELECTRONIC ENHANCEMENT

PART 4

In the final part of this series David Clark looks at some other issues related to bio-feedback with electronic enhancement.

In this last part I'm going to have a brief look at one or two of the less common forms of bio-feedback with electronic enhancement, and also have a look at one or two other pieces of equipment which are closely related to bio-feedback. Plus I'll also be discussing some of the safety aspects of the use of this type of equipment, particularly in regard to connecting people to electrical equipment and especially mains powered equipment.

History

The type of electrical equipment used in bio-feedback with electronic enhancement has evolved from equipment used often in more specialised ways in a hospital environment, and in particular the Medical Physics, Clinical Instrumentation and Physiological Measurement, and Bio-engineering Departments. This area of engineering was effectively unknown until after the Second World War, when it flourished with the growth of the electronics industry fuelled by the increasing miniaturisation and complexity of semiconductor based devices. Relatively early work involved measurement of the acidity of gastric fluids with miniature transmitters which gave outputs related to pH (acidity). This is an area which is now part of more specialised bio-feedback work using electrogastrography (EGG), where digestive secretions which increase as a result of nervous system activity are monitored. Other techniques mentioned in earlier parts of this series which stem from medical work include electrocardiograms (ECG), electroencephalograms (EEG) and electromyograms (EMG) which monitor heart, brain and muscle function respectively.

Physiological Measurements

Several other types of medical technology are connected both to bio-feedback and to the other types of equipment (which will be looked at briefly in a later section of this part of the series), all linked to measurements of the electrical activity of the nervous system and its associated biological sensors. For example measurements are routinely made of the effectiveness of the nerve conduction system both in the limbs and in the spine, and studies are made of the electrical activity of sight and hearing mechanisms (electroretinograms - ERG and electro-oculograms - EOG) to help investigations into problems in these areas. As well as this there is the use of measurements of muscle activity (electromyograms - EMG) for diagnostic purposes rather than bio-feedback therapies.

Related Work

In view of the close connection between magnetic fields and electric fields, perhaps not surprisingly much work has been done on nerve stimulation by magnetic field rather than by electrical connection which of course has the advantage of avoiding the risks associated with connecting electrodes directly to people. Additionally magnetic fields have been used in an attempt to encourage broken bones to heal in the occasional cases where these don't self-heal normally.

Finally, in this far from complete summary of the types of work done, I want to mention a technique known as Applied Potential Tomography (tomography meaning a picture of a slice). Using equipment developed for this work images of a cross-section of various parts of the body can be made by connecting a 'ring' of electrodes around the part of interest, and then using computer analysis techniques to generate an image based on measurements of voltages appearing on those electrodes when a potential is applied between two of those electrodes. Measurements have even been made using this equipment in the effectively weightless conditions experienced by an aircraft in 'free-fall' flight.

However with feet more firmly on the ground, the next section examines another important aspect of using this type of equipment, and that is electrical safety.

Electrical Safety

Including safety in the design of any piece of electrical equipment is obviously of great importance, and anyone using such equipment has a right to expect that they will not be harmed by that equipment, not only when it is operating normally but also if it develops a fault. In most cases the worst that should happen is that the equipment simply doesn't work. Taking account of this in the design of the types of equipment encountered by most of us in our daily lives is relatively straightforward - the metal parts of TV's, fridges, hi-fi equipment, etc. are sturdily connected to a protective earth via the mains lead, or all parts are doubly insulated from anything at mains voltage, as indicated by the 'box within a box' symbol (see Figure 4 in the side text on equipment safety testing) found on most electric drills and the AC adaptors often used to power electronic keyboards etc. Things get more complex outside of the front door of the home or office - if you get into a lift on the fifteenth floor and are heading for ground level it would be nice to think that the design engineer had given a lot of thought to what might happen in the event of a fault occurring beyond simple electric shock protection! - and in some situations the option of the equipment simply not working is in fact not an option. This is the case for much medical equipment, which is often found in critical care and emergency situations.

The potential safety consequences of using poorly designed medical equipment are far worse than those of using almost any other badly designed piece of equipment, and can be as bad as or worse than those of using a badly designed lift (as just one example). In this section I shall be looking at how safety is designed into the medical electrical equipment.

Electrical isolation

As has been hinted at biological effects can occur where only very small voltages and current flows are involved. Most people are aware of the risk of electric shock which can cause the heart to stop beating, and this can occur at low currents because the mains supply frequency of 50Hz is at the centre of

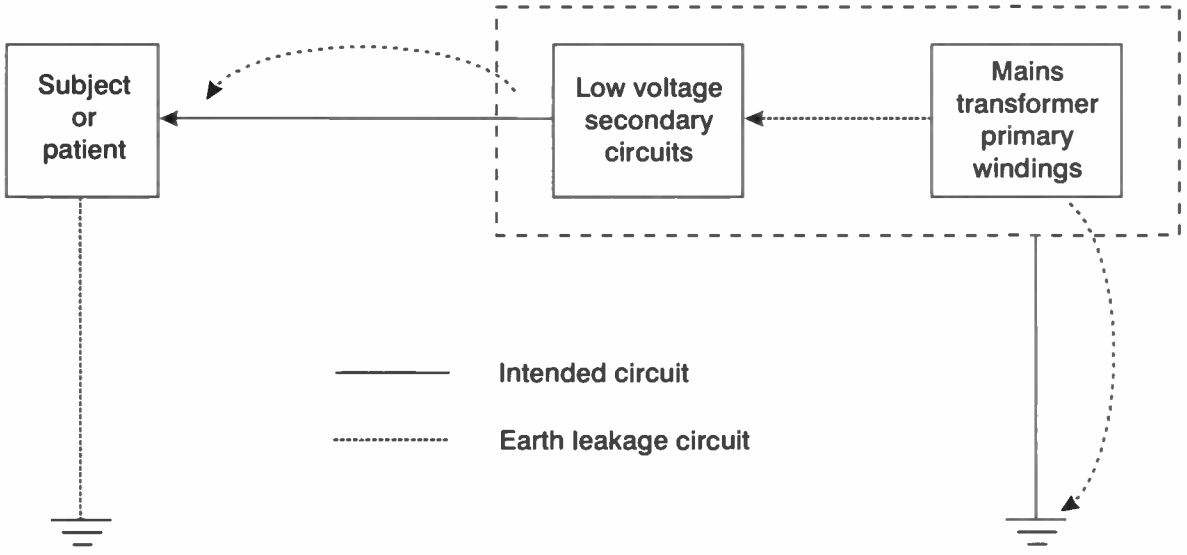


Figure 1. Earth Leakage Paths.

the frequency range to which the heart is particularly sensitive. (Interestingly, the piece of equipment which is used to restart the heart in the event of heart failure, the cardiac defibrillator, relies on deliberately applying an electric shock across the heart.) Thus pieces of equipment which rely for their operation on electrodes which connect a client to a piece of mains powered equipment need to be particularly carefully designed. Battery powered equipment obviously carries less risk than mains powered types but there are still hazards to be considered where the current might pass through the chest, and there are other risks associated with the possibility of burns in the case of ac and of skin ulcer effects even at low voltages and dc currents.

As a consequence account has to be taken of very small currents which can occur but which for most pieces of domestic and office equipment are not significant to the same degree that they are for medical equipment. (This is not to imply that any less care is taken over the safety design of these types of equipment - as will be seen there are official safety standards required for medical equipment, and other versions apply to domestic and office equipment.)

For example it might be thought that a step-down mains transformer with an output of only a few volts must be safe. But in fact there will always be a small amount of current which can leak across an insulator no matter how good it is, and of course the higher the voltage the higher the leakage current. So transformers, and also capacitors, will have a leakage current for both ac and dc voltages where present. Also all insulators have a breakdown voltage above which they become conductive, even if only temporarily - a spike on the mains may merely be a nuisance if it causes a computer to 'crash', but the consequences of such a current surge in a piece of medical equipment could be potentially fatal. At ac voltages there are further complications. Capacitors and transformers don't block ac current, and it's not just discrete components that have inductance and capacitance. There is a small amount of capacitive coupling between the windings of a transformer, both between the windings of the same coil but also between the primary and the secondary, and importantly also between the windings and any earthed parts ie the transformer or equipment chassis or housing. This provides a path for an ac leakage current. Figure 1 shows the main current paths.

So great care must be taken with the design of the equipment and choice of components. Electrode connections to a subject should certainly be via isolation amplifiers which often use an optical isolation system using LED's and photodiodes (see Figure 2).

Transformers usually provide satisfactory isolation if the primary and secondary coils are wound on separate formers. A capacitor can provide satisfactory isolation if only dc is involved but again care must be taken in case voltage spikes occur, and of course there is also the possibility that a capacitor or other component might go faulty and short-circuit. There are international safety standards which define allowable limits for leakage currents, protective earth resistance, breakdown voltages etc., and which also cover transformer and equipment construction requirements. I'll be discussing this in a further section of this article.

Electromagnetic Interference

A further safety requirement concerns electromagnetic interference (EMI). All electrical equipment must be tested to

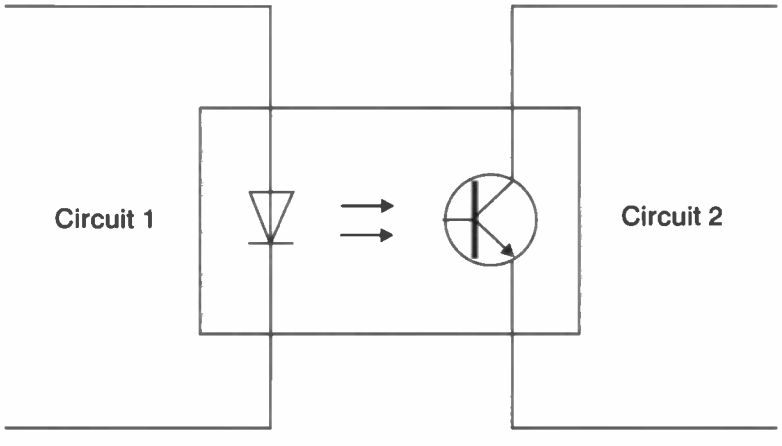


Figure 2. An Optical Isolator.

make sure it neither emits excessive EMI nor is susceptible to failing to work safely when subjected to EMI. This is to ensure that annoying interference does not occur in normal radio or TV communications. It is also that safety related equipment is not affected, for example ambulance communications or even devices such as heart pacemakers.

Safety Standards

As part of the continuing harmonisation of many aspects of our lives with those of our fellow Europeans (a process favoured more by some than others!) there are a series of European Standards which apply to the safety of electrical medical equipment. Since the term electrical medical equipment covers an enormous range of items of varying complexity and the possibility of causing harm if faulty or incorrectly used, attention is divided between electrical safety and functional safety. Electrical safety obviously must apply to all equipment and so there is a general standard for this. It is applied to all types of electrical medical equipment; and additionally each individual type of electrical medical equipment has its own standard which addresses the safety aspects and is unique to that type of equipment. So while a common standard for electrical safety applies equally to both haemodialysis equipment and cardiac defibrillators for example in such matters as the isolation of low voltage circuits from the mains parts, there are separate safety standards for both which address the unique safety requirements of each. In the case of haemodialysis machines then, an important issue is the control of a blood pump, and in the case of cardiac defibrillators, the preventing of a defibrillation shock being applied if the subject's heart is in fact beating regularly. For clarification, haemodialysis equipment is used for treating people with kidney failure, and cardiac defibrillators are used to 'jolt' the heart into beating properly in the event of heart fibrillation, where the heart muscle 'quivers' rapidly and randomly and so loses its ability to pump blood.

In what some people might say is a classic example of euro-logic, the safety standard for electrical medical equipment is called standard EN 60601; the common standard for electrical safety is called EN 60601 Part 1, and each type of equipment has its own EN 60601 Part 2, the Part 1 and all Part 2's each being individual documents. However, when a piece of electrical medical equipment is being assessed for safety it must be tested with the Part 1 and its own Part 2 together, EN 60601 Part 1 being considered a part of an EN 60601 Part 2 document.

Single Fault

Deciding what makes a piece of equipment safe or not is not always a straightforward issue, and the philosophy which has been adopted is that the equipment should be safe during normal operation, and also in the event of any single fault occurring. If a single fault occurs it must be detectable either by the equipment itself indicating a fault or by routine checking, for example before every use for operational faults, and by routine maintenance for the case of earth connections for example. (See Figure 3 for a flow diagram of a simplified overview of checking an equipment design for safety.)

Assessment as to whether equipment satisfactorily complies with these requirements or not is assessed by a testing organisation which is itself approved to do the work by a government agency.

This means that if a piece of electrical medical equipment is assessed in one country in the European Union (EU) and found to comply with requirements it can be marketed in all the other EU countries without further assessment. This in theory should keep costs down while still ensuring that safety standards are maintained.

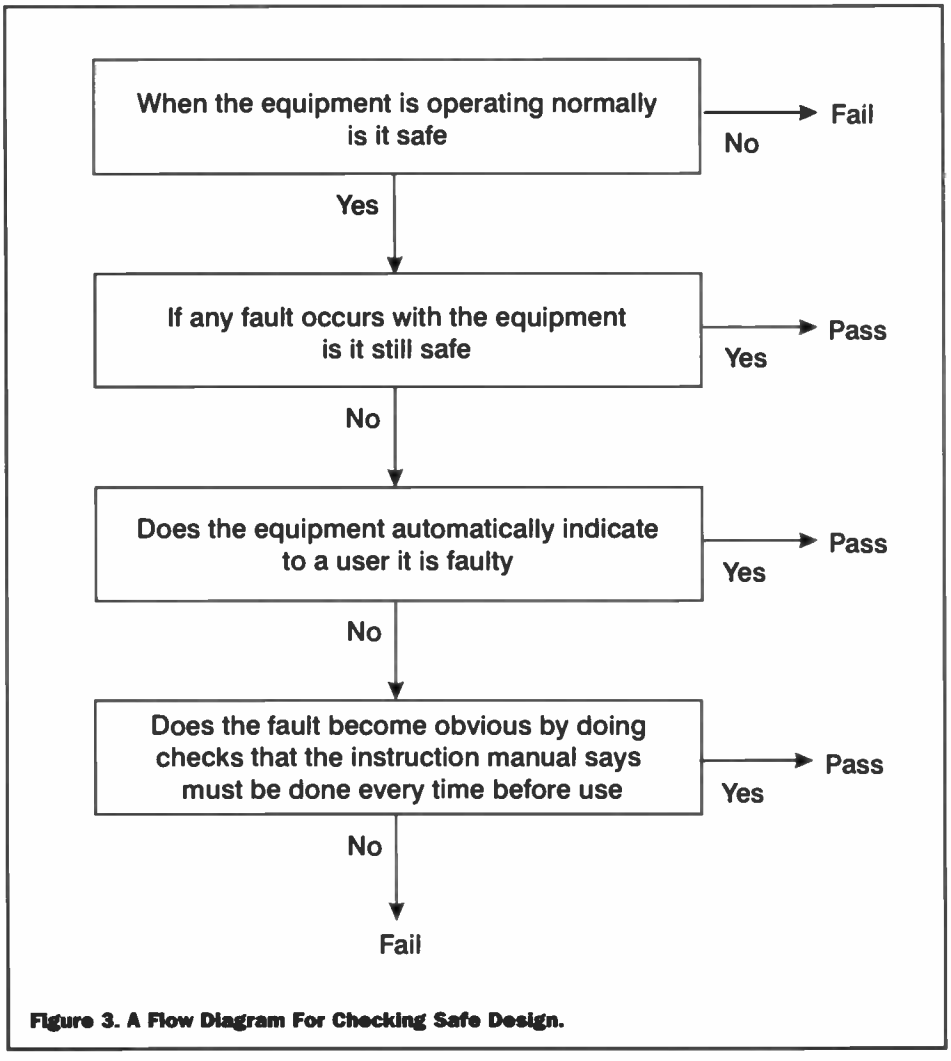


Figure 3. A Flow Diagram For Checking Safe Design.

Related Equipment

There are some other types of equipment which are gaining in popularity, some of which will be found advertised in magazines such as New Scientist, and some of which are available at high street chemist outlets. These are similiar to bio-feedback in that they operate on the same systems of the body but rather than the subject controlling the effect, the equipment applies electrical stimulus directly.

TENS Equipment

TENS stands for Transcutaneous Electrical Nerve Stimulation, and as the name implies this class of equipment stimulates the nerves directly via electrodes placed on the skin. The effect is achieved with pulses of high voltage but very low currents. The intention is to control pain by blocking the nerves which transmit pain impulses to the brain. The positioning of the electrodes, and the voltages and pulse frequencies used, are selected in order to affect only the appropriate nerves.

Muscle Toning Equipment

This type of equipment is intended to firm up muscles by applying a stimulus, via electrodes, large enough to tension the muscles slightly but not enough to cause movement, a form of micro-exercise!

Cranial Electrotherapy Stimulation (CES)

This form of therapy is intended to encourage relaxation and sleep by influencing brainwave activity through electrical stimulation achieved via electrodes attached to the earlobes.

A Health Warning!

Aside from requirements for electrical and functional safety, a piece of medical equipment or a therapy should of course have a beneficial effect. An important point

BRIEF EXAMPLES OF EQUIPMENT SAFETY TESTING REQUIREMENTS

Markings: Supply voltage, power consumption and other details must be marked on the outside of equipment. See Figure 4 for a hypothetical example of suitable labelling.

Documents: Specific instructions for the use and maintenance of the equipment must be included in the accompanying manuals.

Enclosures: The housing, including any control shafts etc. must comply with requirements regarding preventing anything touching live parts, for example through ventilation holes, with things like pens or dangling necklaces or chains.

Protective Earthing: The housing must also comply with requirements regarding earthing and insulation.

Isolation: Any connections to things such as electrodes must be protected from any kind of mechanical or electrical contact, including via leakage currents, with mains wiring or transformer parts etc.

Mechanical Hazards: The equipment also musn't have any sharp edges, or things liable to trap fingers etc.

Normal Operation: It must be safe in normal use, ie it shouldn't get hot for example.

Resistance To Fluids: It must not be possible for spilt liquid to get into the equipment.

Human Errors: It must not be possible to cause danger through things like connecting electrodes wrongly.

Overheating In Single Fault Condition: If the equipment does get a fault on it, the transformer for example should not get hot enough to cause hazards ie burns, fires or damaged insulation of mains wiring.

Constructional Requirements: There are certain requirements about how the equipment is put together, for example internal wiring should be fixed so it can't rub against metal parts so that eventually the insulation wears away, or the wire breaks.

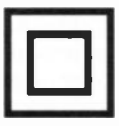
to mention here is that bio-feedback with electronic enhancement can only control the symptoms of primarily stress related conditions. Similiar symptoms can result from underlying conditions which will not be cured using bio-feedback techniques any more than they would be by chanting a mantra, and so it is necessary to recognise that these therapies are as implied complementary and not a substitute for conventional treatments. Many of the alternatives with which bio-feedback has similiarities are used in many societies and cultures simply because the people of those societies and cultures have no access to conventional medicine, either through poverty or lack of education. The alternatives are by no means intrinsically superior to the conventional medical techniques found throughout the developed world. As the Buddhist philosophy believes, the best way is the middle way, avoiding extremes. Perhaps this is the best medicine of all, learning to take the best from all options, and avoid rejecting anything blindly and out of hand.

Bio-feedback Heart Monitor
Model BHM-01
S/N 00001

230V 50Hz
25W

The Medical Equipment Company Ltd.
London

Manufactured in the UK



The label must include the type of equipment, a model number, a unique serial number, the supply voltage and frequency, power consumption, the place of manufacture and the name of the supplier. The 'box in a box' symbol indicates that protection against electric shock is by double insulation; no symbol implies the equipment uses a protective earth.

Figure 4. An Example Equipment Label.

The Future

One indication perhaps of the effectiveness and the future of this type of therapy is the fact that American medical insurance companies are beginning to provide cover for this (and other) methods of alternative healthcare particularly when used as part of healthcare schemes for reducing cardiovascular disease. This disease is of course widespread in the western world where the stress of the day-to-day lifestyles of many is considered to contribute to the development of the disease.

A further indication is the increasing number of companies selling bio-feedback equipment and offering courses, and many have their own web sites. A straightforward Internet search using the text 'bio-feedback' will highlight many sites; the majority have equipment for sale, and some provide more detailed explanations of the therapies provided. Some useful ones include:

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www.webideas.com/biofeedback/
www.brainwavetx.com
www.7hz.com
www.alt.medmarket.com
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Full Circle?

The major advances in scientific and medical knowledge of this millenium have been made in the last one hundred years. Before then, and still continuing in some quarters, there were philosophical arguments raging over the nature of life itself. One school of thought held that there is something, a vital force, that makes living things living and not just an inanimate collection of chemicals and molecules. Another group believed that living things are in fact simply extremely complex machines that could ultimately be completely understood by discovering some sort of built-in program that completely explained everything about that machinery. A third group subscribed to a philosophy called organicism, subtly different to the 'vital force' theory, which held that although an organism could be scientifically analysed and understood, it was somehow more than the sum of its parts as a result of the complex arrangement of all those parts, and in fact had to be looked at 'wholistically' as it was then called. As science has advanced, and biochemistry and medicine in particular, living organisms have become more and more metaphorically 'broken down' into their component organs, tissues cells and commonly now genes and DNA. Possibly sight has been lost of the whole being; maybe there is a bigger picture to be seen, and conventional and alternative medicines both have a place in that picture. Bio-feedback has an important role to play, and modern electronic technology has given an extra boost to that technique. If brainwaves have sometimes been described as 'the gateway to the unconscious', perhaps bio-feedback with electronic enhancement is the key that unlocks that gate.

Acknowledgements

Encyclopaedia Brittanica CD ROM.

Easy Web Page CREATION

PART 3

In part 3, Mike Holmes Explores things to do with pictures.

Pictures are represented in HTML documents by <IMG> (image) elements. These elements have no content - that is, they are not 'wrappers' that contain something between an opening <IMG> part and a closing </IMG> part, there is only one <IMG> part - that which specifies a URL *(Uniform Resource Locator)* pointing to an image file name. This may include a path to where it is stored as necessary, as in this *relative* URL example: 'images/maplin1.jpg'.

Therefore, images are not component parts of an HTML document, but quite separate physical files, and every image on a page is an individual file, 'included' in the display by the browser. What this means is that if you have a page that includes say 12 pictures, the browser downloads 13 files - the page, plus 12 image files. Thus, the more pictures you have on a page, the more time it takes the browser to display the complete document. This total download time or delay can become quite an issue in itself but there are ways of minimising it, more about which later.

The subject of pictures also precludes that in order to be able to create, modify and otherwise manipulate your own original images requires that you possess the necessary image editing software, perhaps in addition to a colour scanner to capture photographs or drawings, a digital camera, etc. In any event, the software must be able to recognise (load and save other types as) the two basic HTML image file types.

The Two Basic Image Types

GIF - The most common image format on the Web is the GIF format, as created by CompuServe. GIF files are always compressed and can contain images of 2 to 256 colours, that is, in the range of 2-bit monochrome through 4-bit (which may be the 16 standard Windows colours or a customised palette of 16 colours), to 8-bits. Also, one of the colours may be *transparent*, that is, whatever is behind shows through all areas in the colour designated as transparent. This is extremely valuable for making Windows like icons and special fonts (see later).

In addition, a GIF can actually be an animation, denoted as the latter type 89a format, comprising a series of individual pictures or frames, compiled into an independent module using special software, more of which later. All Web browsers, with the exception of line-mode browsers, can display GIF images in the document window.

Moreover, a GIF may be an interlaced type, that is to say, it is first displayed in the browser fairly quickly at a low resolution, and then in successively higher resolutions, until the whole image has been downloaded. The quality of reproduction steadily improves as more and more of the file is retrieved, until the maximum is achieved on completion. This feature was added for no other reason than that the user need not wait too long to see what the picture might be about.

This is sometimes referred to as *progressive display*, but not all browsers support this feature. As a guide, most support interlaced GIFs to at least the 87a format, latterly superceded by 89a (whether animated or not). Rarest at this time is compatibility with *progressive JPEG*.

JPEG - The next commonest format type - and which incidentally is showing a tendency to supersede GIF in respect of offering greater colour depth as Web pictures become ever more sophisticated - is JPEG (an acronym for *Joint Photographic Export Group*). It is by now fairly safe to say that this format is also accepted by most if not all modern browsers.

JPEG is also a compressed picture format where the depth ranges from 256-level grey-scale to 24-bits ('true-colour'), therefore JPEG is the first choice for storing and transferring high quality full-colour photographs. The degree of compression may be variable to optimise file size, as can a property called 'smoothing' (subject to availability depending on the image editing software used).

The compression ratio of the JPEG system is very efficient and can be as much as 10:1, in other words an uncompressed bitmap file of several hundred kilobytes or more may be reduced to a JPEG file of only a few tens of kilobytes, but note that this is achieved by 'throwing away' or 'smearing together' some minor details present in the original.

Because JPEG is typically used to store photographic type images, this loss of detail largely goes unnoticed - usually! Compression can also be helped by reducing the number of colours in the image, but this doesn't always work. So, for much simpler pictures, it is quite common to find that actually saving them as GIFs offers the smallest file sizes, so it is a case of choosing whichever of the two types is most suitable for a particular kind of picture - more about this subject later on.

So, your graphics must be in GIF or JPEG format if you want to display them on the Web. Suitable image editing software able to convert graphics from other common formats such as TIFF (the industry standard Tagged Image File Format), BMP (bitmap), metafile, etc., to GIF and JPEG is required, and also to manipulate these images. In the browser, non GIF or JPEG formats may normally be displayed by launching external applications (if at all). File names for GIFs usually have the extension '.gif'; while for JPEGs, '.jpg' or, for a 32-bit platform, '.jpeg'.

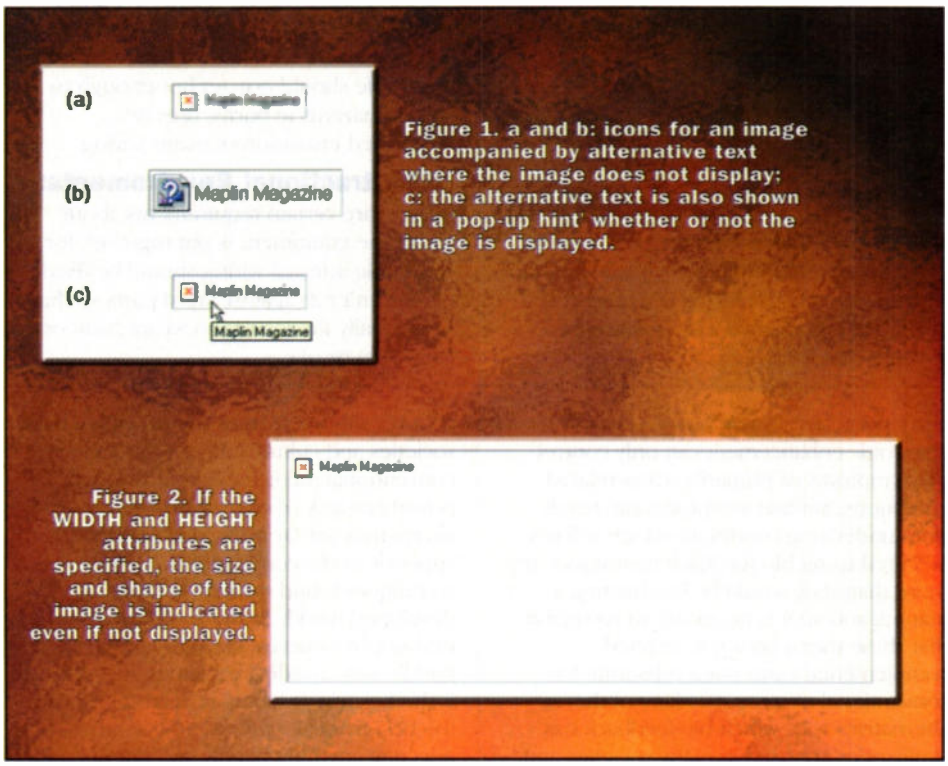


Figure 1. a and b: icons for an image accompanied by alternative text where the image does not display; c: the alternative text is also shown in a 'pop-up hint' whether or not the image is displayed.

Figure 2. If the WIDTH and HEIGHT attributes are specified, the size and shape of the image is indicated even if not displayed.

The HTML Image Element

Also called in-line images, pictures are inserted into an HTML document using the <IMG...> element. In addition, the element can be contained in an anchor element to become a clickable hyperlink, and further, can itself be divided up into separate parts or areas, each area being defined as a clickable link through the use of image maps, comprising <MAP> and <AREA> elements.

Inserting Images

The Image element is used to incorporate in-line graphics (typically icons or small graphics) into an HTML document. This element cannot be used for embedding other HTML text.

The <IMG> element, which is 'empty' (has no closing part, i.e. is not a 'wrapper' or container for more elements), has these attributes or 'properties':

ALIGN The ALIGN attribute accepts the values TOP or MIDDLE or BOTTOM, which specifies if the following line of text is aligned with the top, middle, or bottom of the graphic.

Extensions To The <ALIGN> Property

Initially added to Netscape Navigator and specific to this, other late browsers may also recognise the following extensions (as does Microsoft's Internet Explorer):

<IMG ALIGN=left|right|top|texttop|middle|absmiddle|baseline|bottom|absbottom>

Images with the alignments 'left' or 'right' become an entirely new *floating image* type when embedded in text:

ALIGN= **left** the image will float down and over to the left margin of the text (into the next available space there), and subsequent text will wrap around the right hand side of that image and below.

right the image aligns with the right margin, and the text wraps around the left side and below.

Otherwise:

top the image aligns itself with the top of the tallest item in the text line.

texttop the image aligns itself with the top of the tallest *text* in the line.

middle the *middle* of the image is aligned to the text baseline of the current line.

absmiddle the middle of the image is aligned to the middle of the current line.

baseline the bottom of the image is aligned with the baseline of the current line.

bottom aligns the bottom of the image with the baseline of the current line.

absbottom aligns the bottom of the image with the bottom of the current line.

SRC The value of the SRC attribute is the URL of the image to be embedded. Its syntax is the same as that of the HREF attribute of the <A> (anchor) element.

Browsers that cannot render in-line images *ignore* the image element *unless* it contains the **ALT** (alternative text) attribute (the text displayed in lieu of, see below). In a similar way, browsers that have image displaying *switched off* in user settings or user preferences, or where the image file cannot be found, or could not be downloaded for some other reason, will display something equivalent to that shown in Figure 1a.

This comprises a rectangular icon containing a red cross (Internet Explorer), or some such equivalent, as Figure 1b (from Netscape Navigator). It indicates that there should be an image here but it cannot be displayed. In the absence of width and height attributes, the size of the total area is that of the icon plus the alternate text if any.

ALT Optional text as an alternative to the graphic for rendering in a non-graphical display or in the absence of the graphic. Alternate text *should be provided* for such instances where the graphic is not or cannot be rendered.

Furthermore, in any event later browsers show this text as a 'pop-up' or 'hint' type display when the mouse pointer is placed at rest over the image, as illustrated in Figure 1c. Borrowing from the template HTML page mentioned in earlier parts of this series, this example can be written as a simple demonstration in HTML form as follows:

```
<!DOCTYPE HTML PUBLIC "-//SQ//DTD HTML 2.0 +
all extensions//EN">
<HTML>
<HEAD>
<TITLE>Image Demo</TITLE></HEAD>
<BODY BGCOLOR="white" TEXT="black" LINK="navy"
VLINK="purple" ALINK="red" LEFTMARGIN="10"
TOPMARGIN="10">

<DIV><CENTER>
<IMG SRC="maplin1.gif" ALT="Maplin Magazine">
</CENTER></DIV>

</BODY></HTML>
```

WIDTH, HEIGHT Added mainly to speed up display of the document. If you specify these, the viewer will not have to wait for the image to be loaded over the network for its size and shape (at least) to become apparent. Specified in pixels, from the actual size in pixels of the image, these attributes can be added as follows:

```
<IMG SRC="maplin1.gif" ALT="Maplin Magazine"
WIDTH=500 HEIGHT=200>
```

and the result - still without showing the actual image yet - is as per Figure 2.

Specifying An Images Sub-Folder

The reason why the image still won't show is because, in this instance, a relative URL is being used but the picture is not stored in the same place as the document.

Budding HTML authors typically start out by putting all the files, including images, in the same path as their HTML pages - I was going to say, 'make the mistake' of so doing, but which isn't really fair - there's nothing wrong with it while the total number of files is fairly small.

However, pretty soon you will find yourself in the same boat as having all your files confined to the root of your hard drive - the sheer quantity of different files quickly makes disk management extremely difficult.

The same will be true of your Web-space. Consequently, another one of these 'unwritten rules' has evolved where, while HTML pages are typically confined to the 'root', pictures are stored in a sub-directory or folder called 'images'. At least you then have two different kinds of files (text and pictures) split up into two slightly more manageable groups in different locations.

On the basis, therefore, that *maplin1.gif* will actually be stored in the path *www.my.webspace.co.uk/images*, we can amend the URL, but still keeping it relative (see Part 2), to: <IMG SRC="images/maplin1.gif", with the result shown in Figure 3 (background). Eureka!

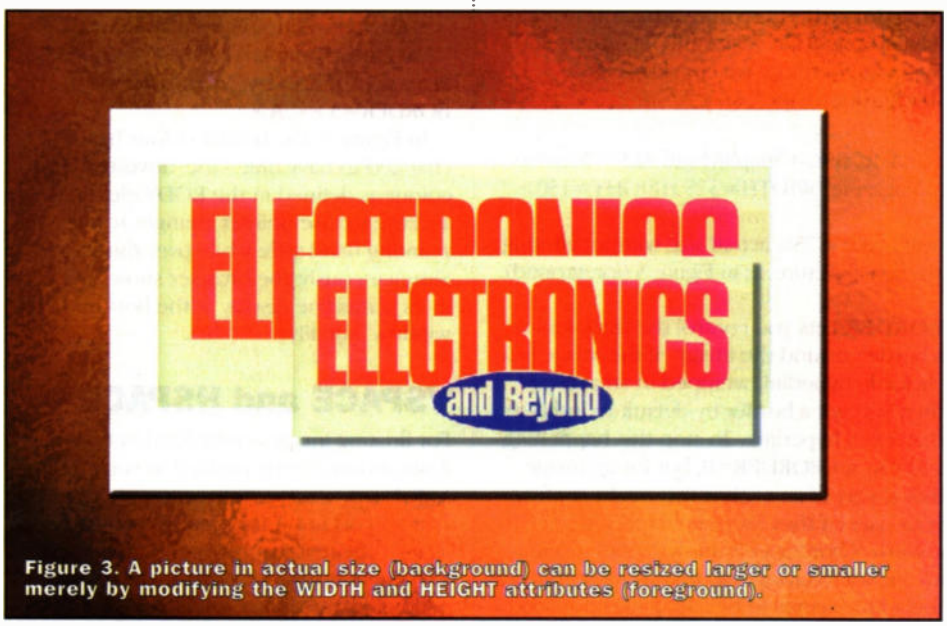


Figure 3. A picture in actual size (background) can be resized larger or smaller merely by modifying the WIDTH and HEIGHT attributes (foreground).

Figure 4. The border attribute is used to outline images if required.

Figure 5. If the image is part of a hyperlink, a border is generated by default, in the colour set in the BODY element or failing this, in 'user settings'. To suppress it, set BORDER=0.

Figure 6. If ALIGN is "left" or "right", the image becomes the 'floating type'. When embedded in text, the text flows around.

Rescaling Pictures

As an aside, Netscape Navigator is the only browser able to scale the whole image where either the WIDTH or HEIGHT attributes are specified singly, the other being deduced from the aspect ratio.

Note, however, that you can also *rescale* the displayed size and shape of the image by specifying different values for width and height, to make the image bigger or smaller. This is a usefully quick and simple method of so doing, because otherwise you would have to physically resize the picture itself. Suppose therefore we consider Figure 3 (background) 'too big':

```
<IMG SRC="maplin1.gif" ALT="Maplin
Magazine" WIDTH=375 HEIGHT=150>
```

will make it 75% actual size without altering the actual picture, as in Figure 3 (foreground).

BORDER Lets you control the thickness of a border around the image. If the image is a clickable hyperlink wrapped in an anchor then you get a border by default to indicate that it is a hyperlink. To stop this happening you can set BORDER=0, but for an image that is part of an anchor this might confuse your users if they are used to seeing a *coloured* border indicating that an image is an anchor. (Having said that though, the technique seems to be falling into disuse.)

Otherwise, specifying a border for an image that is *not* contained in an anchor merely creates a black line:

```
<IMG SRC="maplin1.gif" ALT="Maplin
Magazine" WIDTH=375 HEIGHT=150
BORDER=2>
```

This is illustrated in Figure 4. The value for BORDER is roughly in pixels and is almost limitless.

As an extension to hypertext links, the image may now be made the clickable focus for an anchor jump:

```
<A HREF="http://www.maplin.co.uk/">
<IMG SRC="maplin1.gif" ALT="Maplin
Magazine" WIDTH=375 HEIGHT=150
BORDER=3></A>
```

In Figure 5, the border colour has changed to navy blue - the 'unvisited' link colour as defined in the BODY element - and the mouse pointer changes to the pointing hand style while over the image. Simultaneously, the browser shows the URL in its status line display at the bottom of its window (usually).

VSPACE and HSPACE

For floating images embedded in text that flows around them, defined as such by ALIGN being set as 'left' or 'right', it is likely that you do not want them pressing up against the text wrapped around the image. VSPACE controls the vertical space above and below the image, while HSPACE controls the horizontal space to the left and right of the image. Figure 6 shows the previous example, now embedded in text, created with the <P> element. The coding is modified to read:

```
<P><A HREF="http://www.maplin.co.uk
/"><IMG SRC="maplin1.gif" ALT="Maplin
Magazine" WIDTH=375 HEIGHT=150
BORDER=3 ALIGN="right" VSPACE=3
HSPACE=3></A>Paragraph text starts here...
```

What is more, the alignment still works even though the image is part of a containing <A> (anchor) element.

A Touch On The Large Side?

Although the Maplin Magazine logo example shown here works perfectly alright, there is a slight complication with it - as a GIF type image, as used so far, the file size is 74K-bytes. So what? So this - take six different images like this on just one page (a modest quantity by current standards), and the total download 'bandwidth' online becomes something in the order of half a megabyte, just to get the pictures.

The point being, not everyone surfing the Web has the latest super-fast PC incorporating tens of hundreds of Gigabytes of disk space and a trillion bits-per-second modem. I mean to say, just the other week I received an E-mail from someone who currently browses the net with an 8-bit home computer of mid-1980's vintage (don't ask me how!).

So it makes sense to think about how to minimise Internet traffic and download times, which in addition will greatly conserve your web space usage. The aim is to keep all files as small as possible, where practicable. While HTML documents are generally quite small and efficient - unless you really have a great deal of text - one area where a golden rule can be applied is to do with images - in other words, no huge pictures!

A Real Example

When a friend of mine was starting up his own Web site a while ago, and being a bit of a photographer, one of the things he wanted to do was present some of his own photos. One landscape (of Glastonbury Tor, as it happened) scanned a bit large, but that was okay, he thought, he could resort to the width and height attributes to make it fit the page.

While this was technically correct, and worked, and the file was a compressed JPEG, its uncompressed size was, shall we say - well, put it this way, my machine had 36Mb of RAM, and it wasn't enough. The remaining two thirds or more of the image had to be kept in the Windows swap file at any one instant, which made scrolling the page exceedingly slow!

Small, Smaller and Smaller!

Table 1 shows some comparisons for a choice between the two file types, either GIF or JPEG, depending on the nature of the content. Generally, GIF is best for simple pictures, while JPEG is the choice for

complex pictures with a very wide gradient of hues, such as photographs. (For a more complete description of an image elements attributes refer to: **http://www.mc-h.demon.co.uk/maplin/glossary.htm#img).**

The Maplin logo image shown here, while it doesn't seem very big, being 500 X 200 pixels, actually saves as an uncompressed bitmap of 294Kb. Although it does not seem to contain a great variety of different colours, in actual fact it does because it was scanned like a photograph, so in reality it has 44,420 different colours stored as 24 bits per pixel ('true-colour').

In the process of being turned into a GIF, the number of colour levels was reduced to 224 (a GIF cannot be more than 256 colours). This is still quite high; the GIF file is 74Kb.

A much better option is to convert the original bitmap version to JPEG. Not only does this preserve the 24-bit format, but the final compressed file size reduces to 26Kb - a ratio of 11:1 compared to the original! - much of which is achieved by 'dumping' 14,761 colour levels, and optimising the remainder so you won't notice.

The JPEG version, then, is much preferable to the GIF version used hitherto. Download time to the browser is reduced by 60%, and storage space on the Web site and, therefore, the ISP's server (and all other machines used in the network), is one third that for the GIF version. Plus, hopefully, the client's telephone bill is comparable.

Can it be made any smaller? Two methods are available - lowering the 'quality' level (65%, 44%, 45%), or, as I discovered recently, by finding the minimum number of colours that the image must have before it begins to look too rough. This image has basically three colours (pale yellow, red, dark blue). With a bit of judicious editing the number of colours can be reduced to sixteen (4 bits per pixel).

Unfortunately this does not significantly reduce the size of a JPEG file when saved as such, because JPEGs can only be 24-bits (turns out to be a 21Kb file). However, it can be saved as a 4-bit GIF, and this is - voila! - 10Kb! It is all a matter of experimentation to find the best compromise.

A. by Required Level of Resolution:

Colour Depth	Suitable for:
Monochrome	simplest line drawings or diagrams
16 colours	simple colour pictures or diagrams, icons, graphical anchor buttons, etc.
16-level greyscale	"
256 colours	medium quality colour photographs or pictures †
256-level greyscale	high quality black-and-white photographs
16.7 million colours ('True-colour')	high quality full colour photographs

B. by File Size:

Layers/ bits/pixel	Colour Depth	Smallest File Type	Interlacing	Transparent Background	Animation
2	Monochrome	GIF	✓	✓	✓
4-bit	16 colours	GIF	✓	✓	✓
4-bit	16 greyscale	GIF	✓	✓	✓
8-bit	256 colours	GIF	✓	✓	✓
8-bit	256 greyscale	JPEG	*	–	–
24-bit	'True-colour'	JPEG	*	–	–

✓ optionally. NB: animations are combined from a series of separate GIF image 'frames' using special software.
* interlaced (also called 'progressive') JPEGs are a recent addition and should be avoided - earlier browsers cannot use them and so they will not show.
† not as bad as it sounds, actually!

Table 1. Choosing An Image File Type.

For Next Time

These are the basics of inline images. Next month we shall continue this subject a little bit further by investigating image mapping and presenting texts in special or unusual, non-standard fonts on your pages by making them into GIF images.

Reworking SURFACE MOUNT COMPONENTS

By Jonathan Atkins I eng., Technical Manager, Antex (Electronics) Ltd.

Introduction to Surface Mount Components

The development of electronic products has been characterised by more complex circuitry being fitted into smaller areas. One of the main factors in enabling this has been the development of surface mount (SM) devices.

With the conventional through-hole technology the device is located with its connection pins in holes drilled in the PCB. A solder connection is then made to the pad on the other side of the board. With SM technology the pads have no holes and the pins are soldered to them directly, on one side of the board only. Almost all of the soldering is now automated and very high levels of quality can be obtained.

The components range in size from single resistors and capacitors a few mm square, to integrated circuits about 30mm square. They are generally organised into families, each having a common construction but differing the number of pins. The most widely used types of IC are the Small Outline (SOIC) or Quad Flat Pack (QFP), which use the 'gull-wing' style of pin. There is also the Plastic Leaded Chip Carrier (PLCC) , which uses the 'J lead'.

The advantages of SM technology are clear:

- Holes do not need to be drilled and plated through, so manufacture is cheaper;
- Finished assemblies are more reliable;
- A higher connection density can be achieved, i.e. more pins per area of PCB. 256 in 1 inch² is now commonplace.

SM technology does have one significant disadvantage; it demonstrates the classic trade-off between ease of manufacture and ease of servicing. Removing a faulty device and replacing it is significantly more difficult than with the familiar through-hole technology. With the widespread introduction of these devices the electronics enthusiast or service technician may be expected to repair a board containing them. How can this be achieved with out using high specification equipment at high specification prices?

The ANTEX Surface Mount Rework Kit

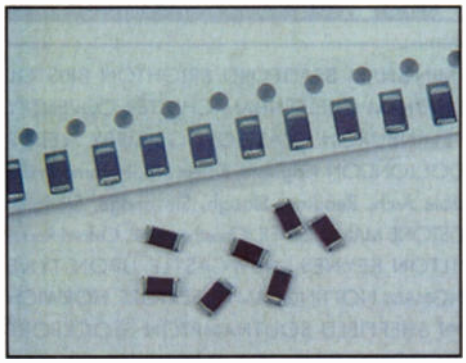
This kit provides the occasional surface mount user with a very cost effective rework capability. At it's core is the 690SD digital soldering station which provides the temperature control necessary to remove components without overheating adjacent pads and tracks.

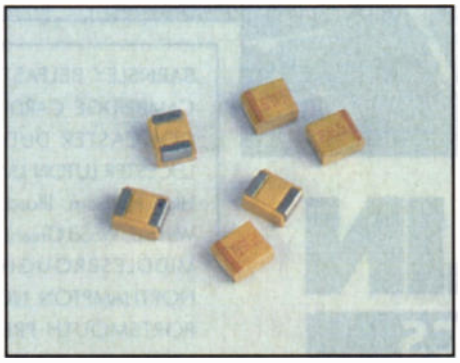
For each of the common surface mount ICs (SOIC, PLCC, QFP) and discretes, a specific desoldering tip is included. The profile of the tips fit closely over the component and will apply heat evenly to each pin. The tip type can be selected on the 690SD display to ensure that the station maintains the optimum temperature profile.

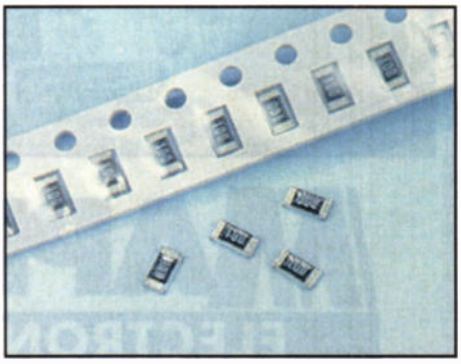
Removing Components

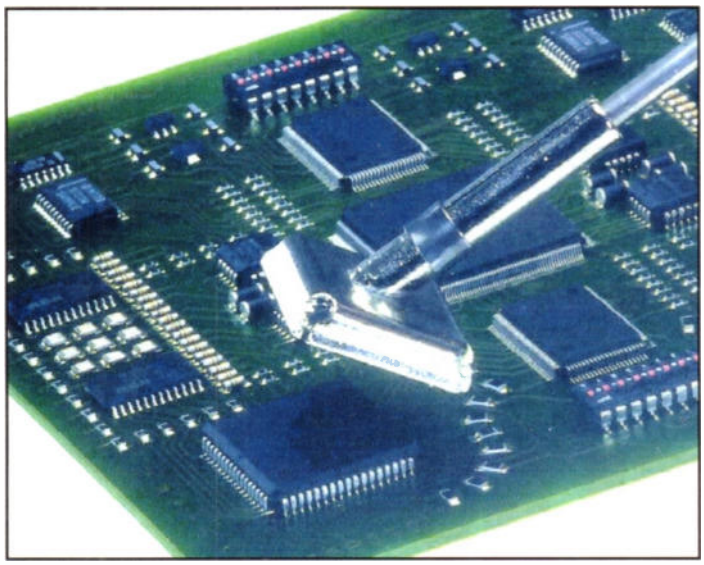
Firstly, ensure that the component in question is actually the one that you need to take off, mistaken identity can produce expensive errors! To remove the component we need to evenly heat it so that all of the soldered joints melt at the same time.

The secret of good surface mount rework is the use of flux, in liberal quantities. This cleaning agent is activated by the heat of the soldering iron and is designed to ensure that the joint surfaces are cleaned of any impurities that might impede the formation of the joint. In this particular application it also helps to conduct heat into the









pins and minimise the chances of solder bridging. A dispenser based on the 'felt-tip' pen can apply the flux directly to the joint.

Fit the correct desoldering tip to the iron and ensure that the inside surfaces of the tip are fully tinned with conventional solder. Flux all of the pins and place the tip onto the component, ensuring that all the pins are in solid contact with it. Wait for about ten seconds, for any adhesive under the component to melt, before applying a slight twisting motion to the iron. Do not apply any further force, as this will increase the risk of pad damage. When all of the joints have melted, the component will come loose and can be lifted from the board.

Once removed using this process it is likely that the component will have been thermally damaged, reuse is not recommended.

Replacing Components

The soldering of a replacement component onto the board can be a delicate task, and preparation is vital in achieving optimum results.

Firstly, the pads need to be cleared of all old solder and thoroughly cleaned, this is usually achieved using a copper desoldering braid. The braid is laid flat over a number of pads and a soldering iron with a large tip, such as the Antex DST-K , applied to it. As the braid is heated it will melt the solder on the pads and draw it up into the weave. This piece of braid is then cut off and a fresh piece used on the next set of pads. Once all the pads have been cleared it is advisable to complete the cleaning process by wiping with a small amount of solvent; cotton buds are particularly handy for this.

Before the soldering of the new component can begin its pins must be correctly aligned with the pads on the board. Make sure that you have plenty of illumination and, if necessary, some kind of magnification when attempting this. A single drop of "superglue" gel on the underside of the component will ensure that it stays exactly where it was placed.

When soldering the individual joints a fine pointed bit will be required, especially in the case of ICs, which typically have a pitch of between 1.0 and 0.5mm. The iron plating that is usually applied to soldering tips can have the effect of blunting them off making them too thick for this type of work.

This can be avoided by using a bit made from unplated Chrome Copper such as the Antex 1107. Although the point of the tip will be eroded by the flux, it can be re-established with gentle filing.

Begin by soldering one pin at each corner of the device before completing each side in turn. Melt a small amount of solder onto the tip and apply it to the joint. Once both surfaces have 'wetted' add further solder to complete the joint. Keeping the solder wire thin, 22SWG (ø 0.7mm), will make this more manageable. Remember that surface mount joints will require only a fraction of the solder needed for conventional joints. When finished, carefully inspect the joints for correct formation and solder bridging. The flux residues that remain are generally not corrosive and do not need to be cleaned off.

Top Tips for Surface Mount Rework

- Check you are working on the correct component.
- Use the correct size of desoldering tip and plenty of flux.
- Don't rush the component removal; allow the heat to melt all the joints.
- Clean the pads thoroughly.
- Use adhesive to locate the new component in place.
- Use thin solder wire and plenty of flux.
- Inspect thoroughly before powering-up the reworked board.

If you have any further soldering queries, try the FAQ section of the Antex website, **(www.antex.co.uk)** ELECTRONICS

Antex (Electronics) Limited

Manufacturers and Suppliers of Manual Soldering Equipment

Points of Contact

Points of Contact: Antex Ltd,
2 Westbridge Industrial Estate,
Tavistock, Devon, PL19 8DE
Tel: 01822 613565
Fax: 01822 617598
Website: **www.antex.co.uk**

Multifunctional CLOCK DISPLAY

John Mosely looks at this new kit from Velleman.

This kit was supplied ready-made from Velleman because of time constraints, but the new Catalogue will list the Multifunctional Display as a kit.

First impressions were that this is not a small display, and so would be quite visible across a large room. The board measures 252 x 80 mm and includes six 36 x 6mm digits made-up from high-brightness red LEDs, and features a range of useful functions. A UHF (433.92MHz) two button key fob is used to control and set-up the display, and a small red LED is included on the board to indicate that the key fob is operating - a very useful feature. The board is powered from a 12V DC 300mA supply fitted with a 5.5mm power plug (which appears to be the Velleman norm), and a 9V PP3 back-up battery will maintain settings in the event of a power failure. Alternatively, a Molex connector is provided for connection to a rechargeable 3.6V/190mA battery pack. One other useful feature is a relay output that is controlled by either a set temperature or time alarm. This does offer a surprising number of external control options.

Construction

Construction looks rélatively straight forward, but the board is densely populated - there are 132 LEDs, so be extra careful to avoid solder shorts. On the assembled board from Velleman, the LEDs had 5mm stand-offs included, which makes for a much easier assembly.

Velleman use a pre-program PIC to provide all functions, and a LM335Z precision temperature sensor for temperature measurement. This device deliberately hangs over the edge of the board, so be very careful when moving and handling the board. A 4MHz (approximately) crystal is used for the timing circuits. There is a small on-board piezo transducer for the alarm functions.

The board will obviously require setting up, and small variable capacitors are provided for time calibration, receiver adjust (frequency), and a variable resistor for temperature calibration. Additionally, there are test pins to aid these adjustments.

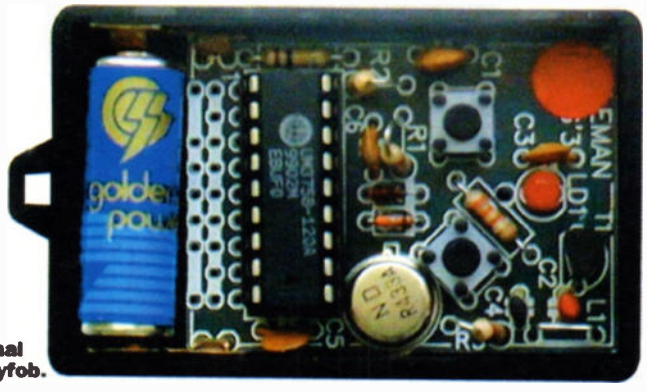
In-Use

At power-on, the board will automatically enter the 'set hour' mode and wait for your input. On the key fob the left hand button '1' is pressed to scroll through the menu and the right hand button '2' for confirmation. During each function set-up, button '1' will increase the displayed number and button '2' is used to move on to the next section/digits. Alternatively, button '1' will toggle, and button '2' is for confirmation. So in the time/temperature/date format setting, button '1' will toggle between European or U.S format, and button '2' will confirm your selection. In this instance, the default mode is European, which is a 24-hour clock, day-month-year and Celsius temperature reading, while U.S. setting is 12-hour clock, month-day-year, and Fahrenheit temperature reading.

Similarly, you can toggle between time or temperature alarm format and alarm on/off. In this mode you will be asked to enter either time or temperature. When time alarm is selected, the buzzer will sound and the relay will be activated, until a key is pressed. The temperature alarm function will only activate the relay output i.e. closes the contacts. A red LED in the upper right hand corner of the board will light to indicate this operation. This relay is rated at 24V/1A, but obviously can be used to operate an external device or a heavier duty relay - such as a mains rated type - to operate a cooling fan for example. However, there is one small catch, namely if the countdown function is used then the relay will also be activated when the target date is reached, and similar will hold until a key is pressed. Therefore, take care when using both functions.

Once all the required functions have been selected, and set, the unit then reverts to normal operation, that is time, date and temperature which toggles through at a predetermined rate. As I have said earlier, the display is very bright and can easily be seen at a distance, and in bright ambient conditions. In, fact it is easier to read the display at a distance.

The operation of the remote control can be affected by interference from other transmitters operating on the same frequency, electrical fields or large metal objects. Such influences can reduce transmitter/receiver performance, or limit the range of operation. If necessary, move the unit to a different position to reduce the external influences. An LED in the lower right hand corner of the board lights when a transmitter button is pressed. Note that the transmitter is powered by a small 12V battery (see photo).



Internal of keyfob.

Conclusion

I can genuinely say that I was impressed with this kit, it offers a range of very useful functions, is relatively easy to set-up and provides a large bright display. Not only is it suitable for home, but also pubs and clubs were its range of facilities such as score, counter etc. can be readily exploited. The countdown function can be used to count off the days to the Millennium for instance, or a special birthday holiday or anniversary. For best effect it will need to be installed in a case.

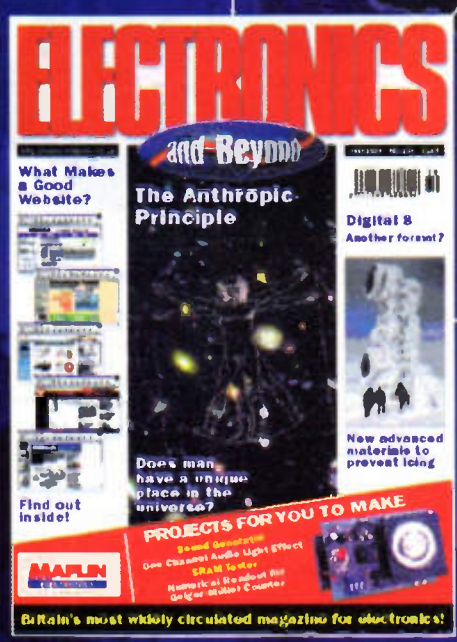
Order Code	Price inc. VAT
UT32K	£49.99

Features

- Time, Date & Temperature indication (US/Europe - °F/°C)
- Temperature indication from -20°C to +70°C (1° resolution) or 0°F to +150°F (2° resolution)
- 1s resolution chronometer with lap function
- Count down function to a specific date
- Scoreboard function
- Random Generator from 00 to 99
- 2-digit dice
- Chime beep option
- Counter Display
- Relay output (24V 1A) for temperature control or time alarm

BACK ISSUES

are available at all Maplin Stores or by mail order. Only £2.65 each. Call the Sales Hotline on 01702 554000 and include them in your order.



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★ The New Cambridge Store
★ Easy Web Page Creation

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PROJECTS Ultrasonic Detector
★ Measuring Small Temp Changes
FEATURES The Integer House
★ Cavorting with Chaos ★ Bio-Feedback
★ Future Reusable Space Vehicles
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★ Revox Restoration

INVENTIONS NEWS

Cars powered by Air

Every so often a news report comes through and sometimes you wonder whether they are to be believed. Pollution free cars with lots of cheap fuel sounds like a dream that's too good to be true. However, a French company CQFD Air Solution has been developing pollution free engines, mostly for an urban cycle activity. They have been developing four types of cylinder engine. The first is a thermal engine with a three cycle mode of operation of intake/compression; combustion; and expansion/exhaust in three separate chambers. The overall effect is a large increase in efficiency giving a consumption of 2 litres of fuel for 100km at 90km/hour or 140mpg at 56mph.

The second engine type is a bi-fuel internal combustion engine which runs on compressed air and thermal fuel. This was designed for wide range urban and long distance vehicles. Below a speed of 60km/h the engine runs on compressed air only, the air being stored in a high pressure tank at 300 bars. The vehicle can be refilled with compressed air using a small compressor powered by the engine particularly when braking or slowing down or at a service station.

The compressed air engine only option is particularly suited to urban vehicles and three types of vehicle have been developed. They are the Pick-up truck, van and Taxi, all emitting zero pollution. The Taxi will go into production in 2000 and will carry 5 people, will run around for about 10 hours or 200km on an urban cycle. For refilling purposes, they could be filled with air in 2-3 minutes at a service station.

The last option, a bi-fuel external combustion engine for long distance and urban driving uses petrol and compressed air. There are four separate chambers; intake/compression; the heating chamber for heating compressed air; expansion chamber and expansion/exhaust. The petrol is used to heat the compressed air before being injected into the expansion chamber. In this way sufficient energy is recovered to greatly improve the performance of the engine in range, torque and power.

Which-ever engine becomes most popular, the French car industry might just be on to a winner here. It is understood that these designs are protected by world patents. We should have more detailed news of these discoveries soon

Flexi-black Solar Panels

Texsun Energy AB, a Swedish company has produced 'the most interesting innovation since Tetrapak' according to the Swedish Patent Office. The company has produced the most flexible and versatile solar panel to date. It is a simple absorber made from polyurethane-coated woven fabric. Its chief advantages are that it does not corrode or scale, is efficient and is of low weight.

The inventor, Per-Gunner Eriksson got the idea when he noticed his daughters, inflatable rubber mattress on holiday had got water in it and had quickly become warm He also noticed in the more southern climes that LPG was used to heat swimming pools despite there being an abundance of sun for solar heating. The reason was that desalinated water can not

be used in conventional solar panels as it corrodes and causes rust. After thinking about this Per-Gunner spent three years developing a solution. He then patented the Texsun solar panel

Production will start at the end of the year in Sweden and the main markets for this product will be Australia and Asia but will also be available in the Nordic region.

Contact: Texsun Energy AB Sweden
Tel: +46 910 717880

Smart Card Phone

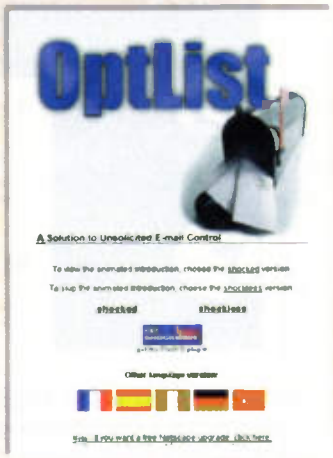
A French company Inventel Systems has launched a cordless digital phone which conforms to the DECT standard. The DG102 has a built-in smart card reader. The extra services this brings is that it provides personalised and secure access to the telephone so nobody else can use it. Secure on-line payment for products can be made over this phone and it can read telecoms phonecards. Electronic smart card wallets can be credited using this phone. The DG102 provides 100 hours of standby and 8 hours talk time and are 10-15% cheaper than competitor products.

Inventel is looking for a UK and Irish Distributor for its products.

Contact: Inventel Systems, France
Tel: +33 142 174545

ELECTRONICS

It's your call



Unsolicited email messages are becoming a problem on the Internet. Generally they are sent by marketers who - for the very best of reasons - want to sell products. They see email as just another marketing medium, much like advertising, and telephone or door-to-door cold calling. To give such email messages a technical name or two, they can be classed as unsolicited commercial email (UCE) where the marketer is sending messages to specific email addresses (probably taken from a list of known email addresses) or unsolicited bulk email (UBE) where the marketer is sending email messages to addresses whether they exist or not. To this end, marketers can find lists of email addresses to send UCE to from the many message boards, chat rooms, newsgroups and Websites around the Internet. Software to extract email addresses from such places is common. Indeed, it's not impossible to find outlets that actually sell email address lists for a small fee to these marketers. Where UBE is concerned, cheap software exists that effectively makes up email addresses to send UBE to. The fact that most of these made up email addresses don't actually exist is irrelevant to UBE marketers - so what if the vast majority of email messages are returned as undelivered? - at least a small proportion will get through to real email addresses.

Technical terms for such unsolicited email messages are by-the-by - to most recipients the term for UBE and UCE is not very technical - it's spam.

The problem arises in two general ways. First, most people don't particularly like to receive spam. It's time-consuming to go through received email messages and filter out unwanted unsolicited messages. It can also be highly irritating to do so on a regular basis. Second, as the rates of spam increase, so does the overall traffic that passes across the Internet. Internet service providers don't like spam for that very reason - it simply bungs up their networks and so is an expense they could do without.

If you're fed up yourself with receiving spam, take a look at a new system in the US (although it's a global service) that alms to cut down the amount of spam that's sent. It's a free service, located at: <http://www.optlist.com> for both individual users that do not want to receive spam, and for marketers. For this very reason, it's a good attempt at taming the problem. Other services actually charge marketers for the ability of checking which users do not want spam, so are unlikely to work. For the individual, the system allows users to opt out of spam altogether, or even specify which areas of internet they actually do want to receive email messages about.

Optlist is a simple-to-use system that allows users to register an email address and password, then define which areas are of interest. Following this, any marketers who wish can check on the Optlist database to locate users that want email messages on those particular topics (or who don't) before a mail-out takes place. For this very reason therefore, if every email marketer used it, and every email recipient who suffers with spam registers, then the world would be a nicer place.

While the Optlist system is good in theory, however, it falls down in practice as it's not a binding solution - there is no legal obligation for marketers to use the system. Unless this happens (if it ever could do, considering the Internet is a global phenomenon which is out of the auspices of any one country) then the problem of spam is likely never to go away totally. Nevertheless, Optlist is a remarkably good attempt to keep it under control.

Unified, at last

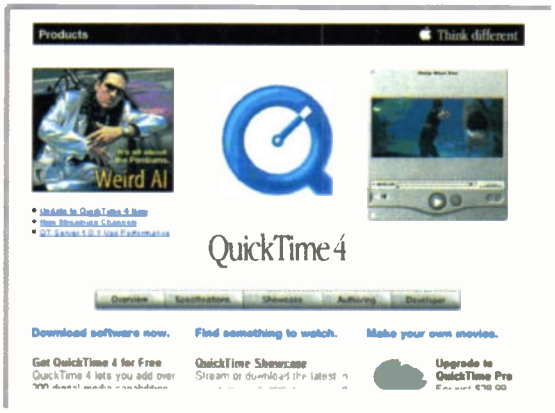
The term unified messaging refers to some new - rather clever - attempts to centralise all available message systems: voice, fax and email, into a single system that takes care of them all. The idea is that any of the three types of message can be received by a unified messaging user in a single operation, and that anyone sending you a message via telephone, fax or email is unaware of the procedures involved. Effectively, you have a telephone for voicemail messages, a number for fax, and an email address. You can pick up any of the three message types by any of the three methods you choose to use.

Where this is of interest to @Internet readers is in something like Digital Mail's unified messaging system, where all messages can be delivered to your existing email mailbox within seconds of being received by Digital Mail. After registering with Digital Mail and providing your email mailbox details, at: <http://www.digitalmail.com> the system is instantly usable. You can give your two personal digital numbers (PDNs) - one for voicemail, one for fax - to anyone likely to want to contact you. When a voicemail message is left on your voice PDN it'll be converted to a computer file in RealAudio file format and attached to an email message to you. Likewise, when a fax is sent to your fax PDN, it'll be automatically imaged, zipped, and attached to an email message in a standard .dcx image file format. Once you've next received email, you've then got the attachments, ready to listen to or view on screen. It's all very simple and easy to use, and works incredibly well.

It's for either Windows or Mac personal computers, and all you need is an email program that allows attachments (such as Outlook Express), together with a suitable sound file player (such as RealAudio or RealPlayer) and a suitable image viewing program (such as Imaging on Windows, or GraphicConverter on a Mac). Users with Windows personal computers can also download and use Digital Mail's own DOLiFACE program to hear voicemail messages and view faxes if RealAudio and a suitable imaging program isn't already on the computer. Of course, PC users also need a sound card and speakers to hear any voicemail messages received - Mac users just need a Mac.

The Digital Mail unified messaging system is really rather good and well worth a try. It's probably best suited to people who travel a lot (you can even get your messages to be relayed to a GSM mobile phone - so it could work around the world), or for ex-pats who want to maintain a UK point of presence. Best of all it's free to register and use in its basic form.

Apple Premieres QuickTime TV



Apple has introduced QuickTime TV (QTV), the Internet's highest-quality network for Web-based video and audio. QTV seamlessly integrates four key elements: Apple's award-winning QuickTime 4 Player software; Apple's open-source QuickTime Streaming Server software; the Apple/Akamai Technologies streamed content delivery service (see related release); and compelling content from leading providers. QTV is provided free of charge to viewers.

New intercasters on the QTV network include ABC News, Disney, ESPN, **RollingStone.com**, VH1 and Virgin Radio. They join BBC WORLD, Bloomberg, FOX News Online, FOX Sports Online, HBO, NPR, WGBH Boston and The Weather Channel.

Macintosh and Windows users can view QTV's diverse content via Apple's state-of-the-art QuickTime 4 Player, which provides one-click access to users' favorite QTV channels as well as the ability to bookmark content from anywhere on the Internet. The QuickTime Player is available as a free download from **<www.apple.com/quicktime>.**

Free Access Providers Bring Subscription Market to a Standstill

The advent of subscription-free ISPs such as Freeserve over the last 12 months has had a significant impact on the subscription-based market with annual growth slashed from over 80% to less than 1% and a decline forecasted over the next 12 months according to Internet analyst Durlacher at **<www.durlacher.co.uk>.**

Taking into account the fact that many users have multiple accounts, which is particularly the case with subscription-free services according to Durlacher – and the high number of users per account for other ISPs – Durlacher estimate the total number of dial-up users has grown 66% over the last 12 months to 5.8 million.

Durlacher believe that the total number of Internet users, including academic and business users, in the UK has now reached 10.5 million. See tables below for top 5 players in each market.

UK subscription-free dial-up market			UK subscription-based dial-up market		
Freeserve	1,250,000	32%	AOL	600,000	29%
X-Stream	270,000	7%	CompuServe	400,000	20%
Currant Bun	250,000	6%	Demon	175,000	9%
Breathenet	225,000	6%	BT Internet	115,000	6%
Line One	200,000	5%	Global Internet	100,000	5%
Other	1,735,000	44%	Other	644,000	31%
Total	3,930,000		Total	2,034,000	

There are now over 95 subscription-free ISPs and Durlacher believe the number will rise to as many as 200 by the end of 1999. As anticipated, the widespread adoption of the subscription-free business model has forced considerable change in the UK dial-up market with traditional ISPs being increasingly forced to re-price, differentiate their service, add-value to their offering or face extinction.

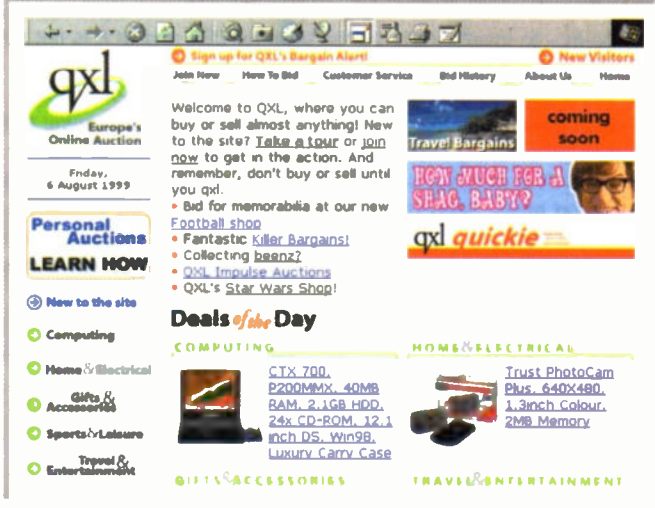
Convergence Will Not Occur Says Digital Mogul

US online media analyst, Digital Mogul at **<www.digitalmogul.com>** believes that the much-anticipated convergence of disparate devices, such as the PC and television, will not occur. Instead, content will continue to be delivered by myriad suppliers through myriad pipes to a variety of divergent devices.

High-speed broadband is not deliverable across a slow Internet, and as consumer access to high-speed broadband increases, the speed of the Internet will slow exponentially, according to a report released by Digital Mogul.

Digital Mogul counsels its clients not to wait for the promises of broadband. The report, which includes insights from leading technology researchers and venture capitalists, is available online at the Digital Mogul site.

QXL Funding to Support Growth



QXL at **<www.qxl.com>** the leading pan-European Internet auction company has closed over $17 million in private equity financing. Group Arnault, the primary investor, is the private holding company of French businessman Bernard Arnault.

The funds raised will be used for the acceleration of QXL's advertising campaign, expansion of its sales and marketing organisation, increased promotion of the QXL brand, further development of the QXL technology and further expansion of the QXL web site into additional European languages.

The investment can only make what is already an excellent site even better. Here at Electronics and Beyond, we're addicted to its simple auction format as well as the chance to pick up the odd bargain.

E*TRADE UK Revolutionises Online Investing

E*TRADE UK, the first 'born-on-the-Web' UK broker, has launched <www.etrade.co.uk>, its definitive online investing service for personal investors.

Using any Internet-connected PC, individuals can take decisive control over their personal investments, with the fastest access to market moving intelligence, dynamic portfolio management and secure instant trading in UK shares.

E*TRADE UK is simplifying stockbroker charges with flat rate commission prices from £14.95, no percentage charges and frequent trader benefits.

Fully authorised by the Securities and Futures Authority (SFA), E*TRADE UK is the first Internet-only trading and research service to be regulated in the UK. Unlike other services that are primarily telephone-based, E*TRADEUK uses the Web as its interactive channel to investors.

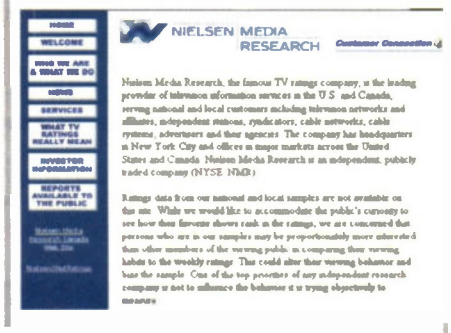
Virgin Broadcasts 24 Hours Using QuickTime Streaming

Virgin Radio has started broadcasting high-quality stereo sound over the Internet using Apple Computer's QuickTime streaming media technology. The radio station is the first commercial operation in the UK to make use of this technology, which offers superior sound quality for the user and doesn't impose a per stream server tax on the broadcaster.

The new streaming channel is produced by Ginger Online. Ginger chose QuickTime streaming for Virgin Radio, primarily, because of its ability to stream high-quality audio. The QuickTime file format has additional benefits as it allows the station to use audio and video assets from across the Ginger Media Group, mixing them across their programming and Web presence, quickly and easily. Listen to Virgin Radio at <www.virginradio.com>.

Women Shopping More Online

Reporting a dramatic increase in the past year in the numbers of females using the Internet, Nielsen Media Research at <www.nielsenmedia.com> reckons that the percentage of shoppers on the Web who are women has jumped nine points in the last 12 months, from 29% to 38%.



Europe Caught in DTI Web

A new Web site at <www.dti.gov.uk/europe> detailing the DTI's business in continental Europe has been announced by Lord Simon, Minister for Trade and Competitiveness in Europe.

The Web site covers a range of issues such as information on using the Euro, competition policy, exporting, working in the rest of Europe, small business programmes and government aids.

CMGI Buying AltaVista

Internet investment company CMGI has agreed to purchase Compaq's AltaVista Web site at <www.altavista.com> for almost £1.5 billion, in the hopes of creating a Web destination to rival Yahoo! and Excite.

AltaVista is fast loosing ground to its competitors in terms of recognition and popularity - last month it was ranked number 15 among networks of Web sites, with 9.5 million visitors, compared to 31.1 million for Yahoo!

Top Ten Apple Web Sites

1. **iBook/AirPort**
The new consumer notebook looks like another hit for Apple <www.apple.com>. Apple's AirPort technology brings wireless networking capabilities to the iBook at an affordable price.

2. **Studio Artist**
This self-described 'graphics synthesiser' from Synthetik Software <www.synthetik.com> offers a new metaphor for painting software. With it, you can create your own painting tools by modifying any of 200 painting parameters.

3. **Epicture**
Beatware <www.beatware.com> makes its Mac OS debut with a Web graphics program that holds it own against offerings from Adobe and Macromedia.

4. **SkyLine Wireless Network Card**
This PC card from Farallon Communications <www.farallon.com> brings industry-standard wireless networking capabilities to the PowerBook G3.

5. **Rio PMP 500**
RioPort <www.rioport.com> finally gives the Mac its due with the first Mac-compatible MP3 player.

6. **SoundJam MP**
New from Casady & Greene <www.casadyg.com>, SoundJam is the first Mac software that encodes and plays back MP3 song titles. It's bundled with the Rio PMP 500, but you can also use it without an MP3 player.

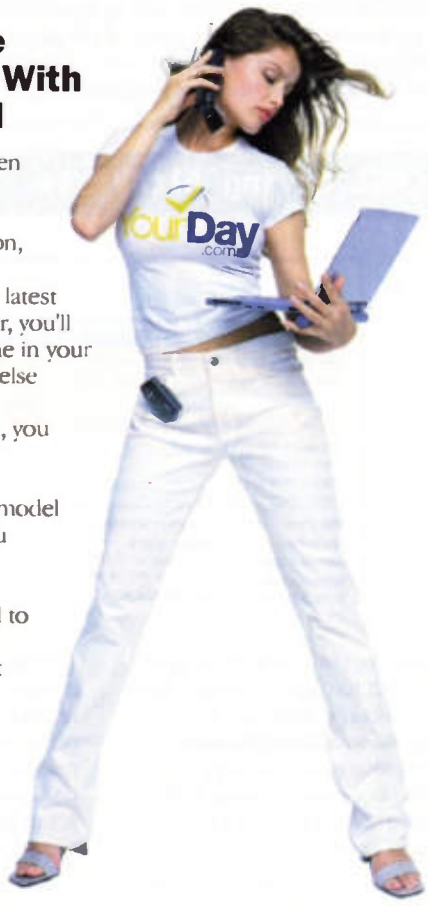
7. **Microsoft Outlook Express 5.0**
The latest version of Microsoft's <www.microsoft.com> free e-mail client offers an improved interface, an easy-to-use junk-mail filter, and direct access to Hotmail accounts.

8. **LiveStage 2.0**
Totally Hip Software <www.totallyhip.com> has spruced up its QuickTime scripting software with an improved interface and simpler scripting tools.

9. **Mach Carrier Upgrade**
This G3 accelerator from XLR8 <www.xlr8.com> makes it easy to keep current with processor upgrades by letting you replace the chip when faster versions are released.

10. **MultiPass C635**
The first multifunction peripheral for the Mac, the C635 from Canon <www.canon.com> combines printing, scanning, and stand-alone copying and faxing capabilities.

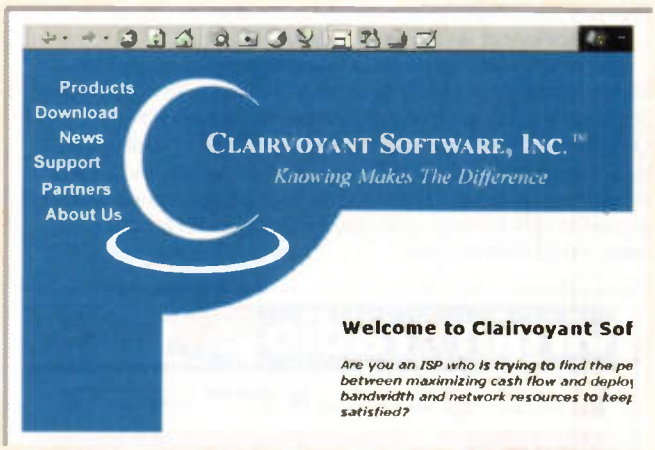
Now Everyone Can Wake Up With A Supermodel



Supermodels - you've seen them strutting down catwalks and gracing the covers of magazines. Soon, with YourDay.com at <www.yourday.com>, the latest personal online organiser, you'll be able to wake up to one in your own home or anywhere else you're staying.

Through YourDay.com, you also can be reminded of meetings and other engagements by a supermodel and be warned when you have double-booked appointments. YourDay.com is designed to make people's everyday lives easier. It is the most simple to use online calendar and scheduling system that seamlessly integrates the Internet with voice technology, palm pilots and all telephones.

Clairvoyant Predicts Internet Demand



Clairvoyant Software <www.clairvoyantsoftware.com>, the only company enabling Internet service providers (ISPs) to effectively predict when and where to deploy networking resources, announced it has raised $1.9 million in first-round private funding from two venture capital firms and a group of 14 private investors.

The funds will be used to accelerate distribution and sales of Clairvoyant's existing products as well as new product development.

Introduced April 26, 1999, the company's ForeCAST Resource Manager is a predictive software application enables ISPs to predict when and where to purchase and deploy network resources.

Most of the Web is off the Map

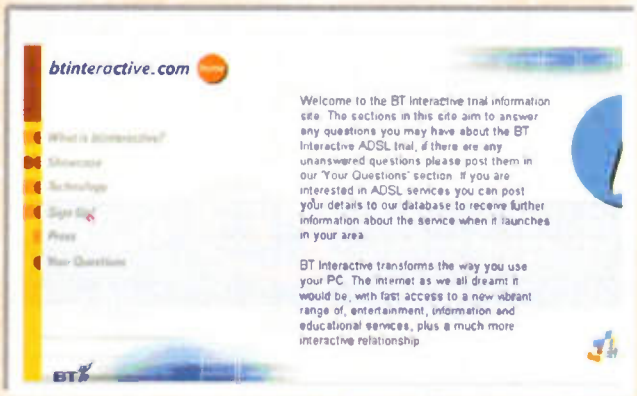
A study by the NEC Research Institute has found that the vast majority of 600 million Web pages open to the public are not indexed by search engines.

The report at <www.wwwmetrics.com> says the top search engines in terms of coverage are Northern Light (covering 16% of the Web), Snap (15.5%), AltaVista (15.5%), Hotbot (11.3%). Other search engine coverage figures are: Microsoft (8.5%), Infoseek (8%), Google (7.8%), Yahoo (7.4%), Excite (5.6%), Lycos (2.5%), and Euroseek (2.2%).

According to the report search engines are biased toward sites that receive the most traffic, and use a site's popularity to decide whether it should be indexed.

Search engine coverage has decreased	Search engine coverage has decreased substantially since December 97, with no engine indexing more than about 16% of the web
Unequal access	Search engines are more likely to index sites that have more links to them (more 'popular' sites). They are also typically more likely to index US sites than non-US sites, and more likely to index commercial sites than educational sites
Out of date	Indexing of new or modified pages by just one of the major search engines can take months
Information distribution	83% of sites contain commercial content and 6% contain scientific/educational content. Only 1.5% of sites contain pornographic content
800 million pages	The publicly indexable Web contains an estimated 800 million pages, encompassing about 15 terabytes of information or about 6 terabytes of text after removing HTML tags.

BT to Launch Interactive Content Service Over ADSL



BT's Internet & Multimedia Services division (IMS) at <www.btinteractive.com/info> is to launch a revolutionary high-speed interactive content service for consumers over ADSL, synchronised with the company's roll out of ADSL announced in July.

The broadband portal service - available from March next year - will be the first of its kind in the UK, combining high speed Internet access, enhanced Internet applications and a compelling range of content services.

The new content service is based on BT IMS' current trial of BT Interactive running in north and west London and findings from the company's video-on-demand trials in East Anglia in 1994.

Through the current BT Interactive trial, more than 800 customers have access to high-speed Internet and a range of video and audio services via ADSL technology. In addition to very fast access speeds, ADSL enables users to be 'online all the time' as it enables a single telephone line to be used for both voice and data calls simultaneously, without any loss in data speed.

BT also announced today that it will soon be streaming Sky News to PCs on the BT Interactive trial. This demonstrates BT's determination to build on the already significant content provided by leading media companies.

Programming includes news, weather, travel and finance information together with high-quality on-demand video and audio-rich content ranging from entertainment - such as films and music - to education resources.

Register.com Slashes Prices for UK Domains

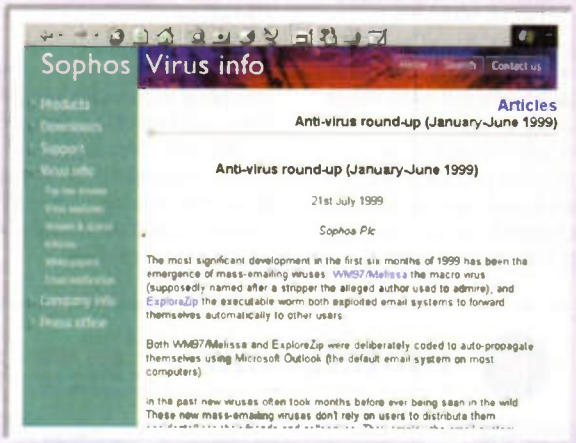
Register.com at <www.register.com> has slashed its prices to register .co.uk and .org.uk extensions to £49, making it the most affordable domain registration service available for all companies and individuals who want to build presence on the Internet using the .uk Top Level Domain Name.

"At register.com, one of our top priorities is to help businesses and individuals easily take advantage of the Internet's global reach," said CEO and President Richard Forman.

Western Europe is one of the fastest growing e-commerce markets in the world, but currently companies and individuals can pay between £80 and £200 to register a .co.uk or .org.uk domain name - almost twice as expensive as registering .com, .net and .org domains.

To register a domain name, users logging on to the register.com site at <www.register.com> can check the availability of UK country code domain names at no charge by directly entering their desired name and checking the .co.uk and .org.uk boxes displayed on the homepage. If that domain extension is available, customers can get a two-year registration within three minutes.

New Age of Mass-Mailing Viruses Dawns



Happy 99, Melissa and ExploreZip are just the beginning of the virus evolution into the next Millennium.

A report of viruses striking in the first six months of 1999, by anti-virus specialists, Sophos at <www.sophos.com/virusinfo/articles/roundup.html>, shows virus writers are making infections more damaging by no longer relying on users to spread them unintentionally. The analysis highlights three self-propagating viruses in the Top Ten.

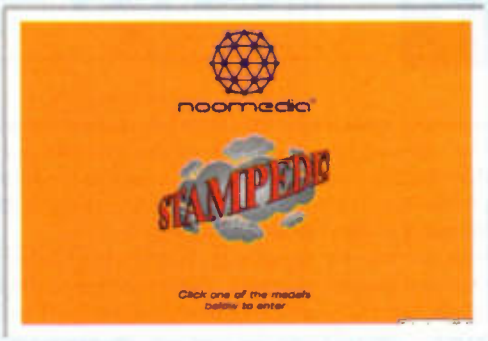
Instead of taking months to spread into the wild, the new types of strains attack globally within days. Sophos is expecting the trend to continue as new viruses exploit even more loopholes for self-distribution.

Prehistoric Sites Stonewalled By Cybershoppers

A consumer survey by noomedia at <www.noomedia.net> has found that 63% of customers site-hop within 30 seconds if a Web site is slow to load, looks bland or if navigation is difficult. Respondents cited lack of interaction, unclear links and pages under construction as prime symptoms of a poor shopping site.

In response to this, noomedia has launched the checkpoint-based 'CyberStyle Guide', designed to help companies attract customers and maintain a 'sticky' Web site, which will keep potential clients interested.

The booklet covers areas such as planning, image, design and navigation, and aims to help businesses differentiate themselves through look, feel and functionality.



Virgin Net Finds Its Ideal Match.Com

Match.Com at <www.match.com> has struck a deal to become Virgin Net's exclusive provider of online dating services. This deal will offer all visitors to Virgin Net at <www.virgin.net> access to Match.Com members around the globe. To date 1.9 million singles have registered with Match.Com and already more than 50,000 people living in the UK and Ireland have tried the service.

Match.Com will offer Virgin Net users an anonymous, fun, secure and reliable online dating service. Anonymous e-mail and a monitored meeting place provide online security, whilst the intuitive and friendly interface makes the service extremely easy to use.

Offering users the opportunity to attend both real and virtual social events combined with the ability to conduct highly specific matchmaking searches, Match.Com creates a lively and supportive environment for singles.

The site is designed to make users feel comfortable and be able to enjoy meeting potential friends or partners on the Web. Match.Com's service has already led to at least 700 marriages around the world and thousands of thriving relationships.

Want A Job? Only Infected Applicants Need Apply

Research by Star Internet at <www.star.co.uk> has shown that a growing number of corporate computer virus infections are caused by home users submitting their CVs via e-mail.

Despite recent lessons from Melissa and Explore.Zip, Star has identified that a large number of organisations have not installed any form of anti-virus protection

A surprisingly large number of the infected e-mails were sent by job applicants, including CVs, and came from Hotmail and other personal accounts to avoid detection at work.

In general, the majority of virus infections were caused by incoming e-mail from home accounts, rather than company e-mail.

Start-up Wants Users to Adopt new Desktop Philosophy

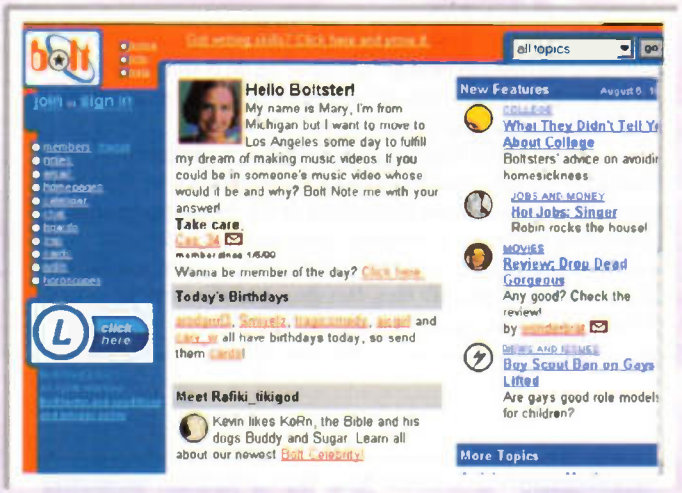
aQtive has ambition. Aside from expecting journalists and editors to come to terms with odd use of lower and upper case letters in its company and product names, the company wants users to adopt a new approach to handling desktop and Internet applications.

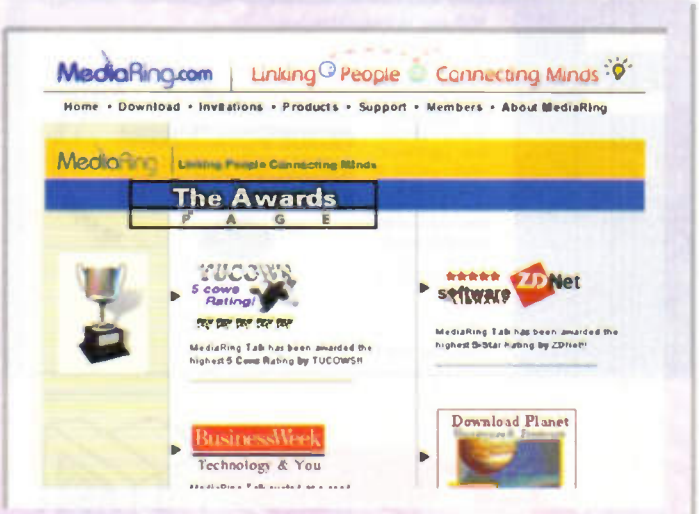
aQtive's first product, onCue packages together functionality held anywhere in desktop applications or on the Internet, presenting the right applications at the right time. It also suggests ideas for things you may want to do — and all of this is based on helping the user to complete the task in hand and not around any one application.

onCue is made up of a number of different recognisers and 'Qbits', which work together to anticipate what you might want to do and what is available to do it. Fundamentally, its single-click access to a range of Internet-based services, such as specific search engines, and desktop functionality, which is often held in existing applications.

onCue is free to users and a full version is available now to download at <www.aqtive.com>. There will also be a developers toolkit available shortly to allow developers to integrate aQtive's technology into their Web sites and applications.

What's In a Standard? Internet Voice Technologies





While voice activated chat has been one of the hottest applications for portals and content sites recently, voice activated ecommerce is not far behind according to leading Internet pundits.

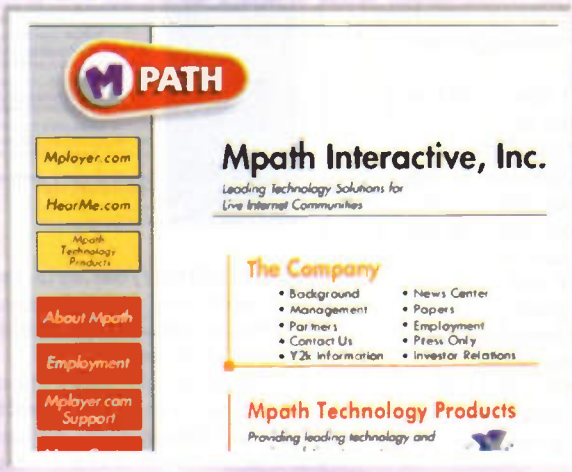
Voice activated chat is available on Yahoo! at <www.yahoo.co.uk>, the teen-oriented site Bolt.com at <www.bolt.com>, and E! Online at <www.eonline.com>, amongst other sites. Mpath at <www.mpath.com> announced this month that it will provide free voice chat for any Web site.

The beginnings of ecommerce with voice activation, also known as vcommerce, are taking shape. For example, broadband content portal ChannelSEEK and voice communications producer VStream have entered into a partnership that will enhance ChannelSEEK's Remind Me feature using VStream's voice-over-e-mail technology.

Here's how it works. Remind Me is an event notification service. The agreement will allow users of the service to receive personal voice messages from celebrity performers prior to scheduled Webcast events, in addition to traditional text-based reminders. The new reminder technology, Audio Autograph, is based on VStream's voice-over-e-mail service, Beep.

Beep allows its users to publish and send voice greetings via e-mail. Picture this: when e-mailing someone details of a new product, you can accompany the message with a voice over that says, 'check this out - new product alert'.

But here's the killer ecommerce application - let's say Columbia Records wants to utilise this technology to promote Bruce Springsteen's tour when it hits the UK. Columbia can e-mail an opt-in list of Springsteen fans in the UK with a personal message from Springsteen complete with audio sample, that includes a 'buy tickets' button or even a 'buy the album' button.



Finally for personal communication, MediaRing.com has introduced voice mail for everybody who has an e-mail account in a move that brings the world's first free Web steaming voice mail system to the Internet.

Instead of having to rely on text e-mail to communicate with people over the Internet, Net users will be able to send and receive voice messages, simply by downloading the MediaRing Talk software for free from MediaRing.com's Web site at <www.mediaring.com>.

The introduction of MediaRing's VoizMail service will allow Internet users the choice of a full range of communication methods over the Internet. Users who might find typing on their keyboard slow or cumbersome, or who have hundreds of e-mails to create or respond to every day, will be able to send voice messages over the Internet as simply as making a traditional phone call.

Technology Barrier to Beat Porn-Stalkers

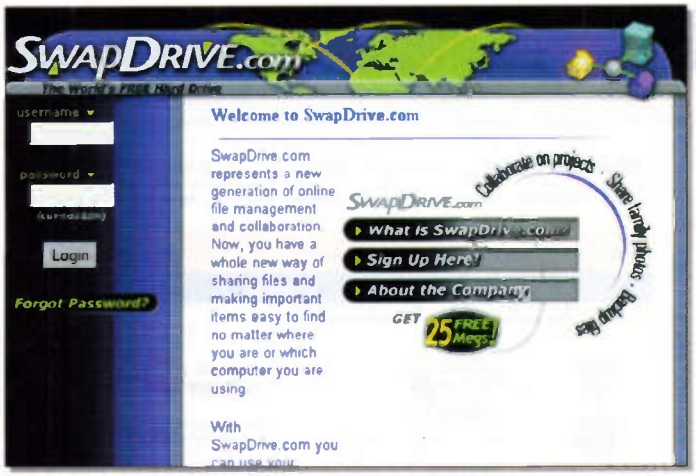
In the last month MPs at Westminster had been specifically targeted with offensive e-mails containing explicit pornographic messages. Many contained details of hardcore porn clubs and sexual fantasies. Scotland Yard is currently investigating ways to prevent such incidents from occurring again.

Content Technologies, a worldwide Internet security company, is warning organisations that they risk damaging their credibility, performance and employee morale, unless incidents of this nature are taken more seriously.

The company monitors trends in Internet content threats such as spam, the name for unsolicited e-mail, as part of the ongoing development of its policy-based software product family, MIMEsweeper at <www.mimesweeper.com>. It has identified a steep increase in the number of malicious or obscene e-mails over the past few months.

MAILsweeper, part of the MIMEsweeper family, scans incoming and outgoing e-mail and identifies threatening attachments and messages. It can prevent pornographic images and text from reaching desktops.

The product can also identify and 'quarantine' e-mails containing viruses, virus hoaxes, confidentiality breaches, and malicious information.



SwapDrive.com Debuts File Storage and Sharing Site

SwapDrive.com at <www.swapdrive.com> has announced the launch of its free file storage and sharing Web site, which provides users with a virtual hard drive that can be accessed from any computer with an Internet connection.

SwapDrive.com's Java-based technology is platform independent and requires no additional software or plug-ins. Users can now store any document or file in their personal SwapDrive folder in cyberspace using a simple, intuitive interface. SwapDrive.com not only provides access anytime, anywhere to individual's files, but also enables users to collaborate on files worldwide.

Site Survey

The months destinations

Information is the key to all the links in Site Survey this month, and we've given readers sources to find out just about everything they'll ever need to know (except next week's winning lottery numbers, that is).

If your computer's problems are getting you down, and you'd like some technical advice, checkout No Wonder, at <http://www.nowonder.com/>. It's a free service, where you can locate help on just about every computer problem you (or your computer) care to need help on. The idea is that you describe your problem then sit back and wait for an email response with help to get you sorted again. There a sizeable team of knowledgeable helpers on board at No Wonder, and it's quite likely that you'll get the answer you need very quickly.

If you're a Mac user and need answers to technical queries, Apple's own Technical Information Library is one of the best places to start. It's a searchable database of articles that have been written by Apple's own engineers, so is probably the best source of information and data that's available for the Mac. It's at <http://til.info.apple.com>.

Although it's no longer in dead-tree form, one of the most informative computer publications available is still Byte. It's

online, at: <http://www.byte.com> and is worth checking out every online issue, if only because it's also one of the most unbiased and influential computer publications (virtual, or otherwise) you can read.

Finally, if you need information about any topic at all, try the folks at about.com found at: <http://www.about.com/>. This is a system that tries to hold information on just about anything you'd care to know about. It's rather like an on-line encyclopaedia, but very much better in that it's constantly being updated with information as and when requested.

Car Audio CAPERS

PART 1

First Among Equalisers

Looking for better sound on the move? Martin Pipe gets on his high horse, but makes some practical suggestions whilst he's at it.

Modern day driving? Frustrating, right. Let's put on some music while we're stuck in yet another twenty-mile tailback. Ugh... The problem with car audio is that it tends to be of poor subjective fidelity when compared to the domestic equivalent. Quite often, the fidelity of the sound experienced has little to do with the quality of the equipment - cassette or CD 'head unit', amp, speakers or whatever. I have a friend who has spent nearly £3000 professionally kitting out his Golf TDi 'hot hatch', but the result doesn't sound any better than a £500 midi system. In fact, in some respects it's worse (sorry, Kickin' Joe!). The reason is undoubtedly the car itself - its metal frame and thin panels don't do much for acoustics, and neither does the often-stupid factory positioning of the speakers. What genius thought that putting the door-mounted front speakers at slightly above foot height was a good idea? Probably the same one who decided to mount the rear speakers horizontally in the same vehicle, relying on the rear windscreen to 'bounce' the sound from the rear shelf towards the listener - with appalling results... Such aspects can often be corrected by relocating the offending items.

Replacements?

At the same time, the factory-fitted speakers could be replaced with better-quality drive units. Maplin sell a fairly comprehensive range from the likes of JBL, Jensen and Audax. Standard impedances and sizes - including 'round' (4, 5¼ and 6½ in. diameter) and elliptical units - are stocked to make replacement as easy as possible. Indeed, anybody can do it! Remove the grille, unscrew the old unit, lift it out and unclip the terminal leads. In most cases the spade terminals are of a slightly different size to ensure correct polarity. The leads can then be attached to the new unit, which can then be screwed back into the door frame. The grille can then be re-attached. External tweeters, located on the dashboard, can be wired up in parallel with the door speakers. These aren't expensive, and can brighten up the sound and improve stereo imaging - particularly if the door speakers are located near the floor and cannot be sensibly relocated anywhere else! The better-quality types, such as the Audax models sold by Maplin (NA21X, £29.99) are supplied with the required crossover network. If your current door speakers have coaxially-mounted tweeters, these can be disabled by snipping off one of the coupling capacitor's leads.

The Wrong Environment

The route to in-car nirvana is seldom this easy, though. Other crucially important factors for sound quality are the shape, size and furnishing of the often-cramped passenger cabin. The listening environment influences how hi-fi sounds - the car is no different to the home in this respect. In fact, one can argue that the listening space is the final link in the audio reproduction chain. Unfortunately, designers of car interiors appear to give little priority to sound reproduction - despite all the flashy advertising (white-coated scientist types, standing in an anechoic chamber) that would appear to suggest otherwise! The soundwaves from the speakers are not only heard directly, but also indirectly; various surfaces will reflect the sound towards the listener, and in some cases will also absorb some of the energy responsible. Within a car, there are plenty of these surfaces in a very restricted space.

The confined space of the cabin will lead to abundant cancellation and combination of wave motions, and this property varies with frequency. Add to this the indirectly- and directly-heard sound, and you have a highly-complex acoustic environment that would be nigh-impossible to accurately simulate or model! Hardly surprisingly, audible colourations are extremely commonplace. My own Rover 216 seems to have a nasty peak somewhere between 200 and 300Hz - this was noticed with the car's

A pair of external tweeters, suitably located, can brighten up the sound considerably. This JBL model, which is sold by Maplin, benefits from flexible mounting options. Note the in-line capacitor, which 'blocks' lower frequencies.

original factory-fitted speakers, as well as upgrades. The result is ghastly 'thrummy' reproduction of vocals - a characteristic that crops up over and over again on all manner of supposedly 'hi-fi' vehicular installations. It's not just the cabin that introduces problems. A closed boot is hardly an ideal place for a subwoofer. It's simply put there because it's convenient to do so. For a start, there's little air for the sub's speaker cone to shift. The volume of a car boot varies from model to model. As a result, the same subwoofer installed in a Mini could sound quite different when moved to a Lexus.

Sadly, the average in-car installer or salesperson doesn't seem too bothered. Then again, they're often from the boy-racer 'sound-off' school of thought - in other words, if it's loud it's good! Subtlety, detail and accuracy? - out of the window, mate! It has to be said that the dance music such youthful people tend to enjoy has been engineered to sound good in clubs, which are hardly hi-fi environments. The music - which is heavy on bass and treble, rather than the more telling midrange - consequently sounds quite passable on just about any car sound system. This is particularly true if you chuck in a subwoofer! There are obviously some exceptions, though. Goldie's Inner City Life, a ground-breaking jungle track from 1994, has a superb vocal as well as a bassline that will test any sub! Generally, though, other forms of music - from classical to soul/R&B - will soon show up the limitations of an in-car sound system.

Graphic Liquidiser

There is a partial cure, though - the graphic equaliser (or the 'graphic liquidiser', as the sneering audiophile would put it). These give you considerably more control over tonal control than the bass and treble knobs fitted to the average car stereo. Most allow you to boost or cut the levels of ten (or more) frequency ranges, allowing unwanted resonances to be tamed and other deficiencies (lack of treble sparkle, for example) to be compensated for. OK, they don't solve the poor acoustics of a car - but they go some way to minimising their effects. In recognition of this fact, some companies sell graphic equalisers designed specifically for in-car use. The problem is that such devices are associated with power amps, and tend to be located in the boot. It's hence difficult to adjust them and listen to the effects of such adjustments! Because car-specific equalisers have line-level inputs and outputs, they're not much use if:-

STEP-BY-STEP SPEAKER

STEP 1. LEVER OFF SPEAKER GRILLE

Remove the protective/decorative grille to provide access to the speaker. Sometimes the grille is held in by (concealed) screws. In other cars - such as this one - the grille unclips.

STEP 2. REMOVE OLD SPEAKER

Remove the old speaker - it's usually held in place by four self-tapping crosshead screws

STEP 8. TWEETER INSTALLED ON DOOR

Door-mounted tweeter. The door is an ideal mounting position for small high-frequency drive units, not least because the wiring is easier to route.

STEP 9. SCREW REPLACEMENT

When the connections to the new speakers have been made, it can be fitted to the door and the grille re-fitted.

STEP 7. ROUTING TWEETER WIRES

If you're mounting an external tweeter on the door, it's easy to conceal any wiring behind the door panelling. Ensure, however, that the speaker leads don't foul the lock or window mechanisms.

STEP 6. SOLDER

Soldering the wires directly to the speaker may result in a more reliable connection. Protect the joint by enclosing it within heat-shrink sleeving.

REPLACEMENT

STEP 3. REMOVE SPADES FROM OLD SPEAKER

Unclip the lugs from old speaker's terminal spades. You might need to be careful here, because corrosion might have made the bond stronger than it looks!

STEP 4. FIT SPADES TO NEW SPEAKER

Once the old drive unit has been removed, the lugs from the wiring harness can be mated to the spades of the new speaker. The + and - terminals are of different sizes to avoid misconnection.

STEP 5. WOOFER SHOWING TWEETER CONNECTIONS

Here, there are two sets of wires. One pair is from the sound system, while the others go to a door-mounted tweeter. Many of the better-quality drive units have extra pairs of spades, which are intended for the easy connection of tweeters and other speakers.

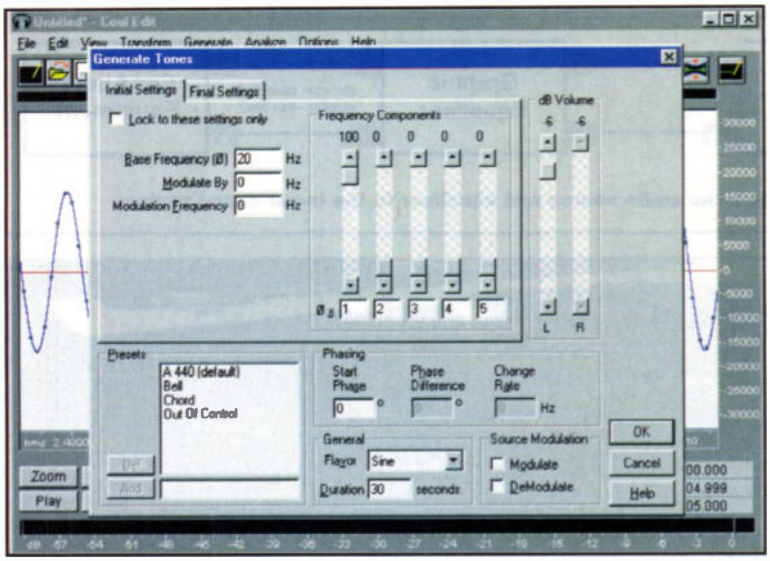
Figure 1. Wiring up the audio source and equaliser to the in-car sound system.

Cassette deck and equaliser wired up to the car audio system, in this case via a cassette adaptor

- your car stereo doesn't have a pre/power 'loop' into which the equaliser can be inserted or
- you have a more upmarket model with a 'pre-out', but you can't afford - or don't want to bother with - external power amps.

In any case, I have found that car-grade graphic equalisers sound rather poor - if you don't believe me, run one off a heavy-duty lab power supply and connect it to your hi-fi system! You can get high-end gear from the States, but it's ludicrously expensive. In my experience, graphic equalisers sold for home-hi-fi use sound rather better. In the early 1980s, graphic equalisers were exceptionally popular amongst hi-fi enthusiasts, and most of the Japanese marques offered at least one in their product ranges. They have since fallen out of favour, thanks largely to the minimalist/purist audiophile philosophy. Fortunately, second-hand prices are low because they are now so 'unfashionable'. My own Soundcraft unit (independent left/right 12-band controls, pretty but useless spectrum analyser, etc) was picked up for ten quid at a boot sale nearly a decade ago! Some minor repair work was required, though. It was originally sold by Maplin back in 1984. Fifteen years later, Maplin still sells graphic equalisers - a

If your cassette/radio doesn't have a line input (normally marked 'CD'), then you'll to feed it with the equalisers output via one of these cassette adaptor. Next month, we'll discuss how a line input can be added to most car audio 'head units'.



The ever-popular shareware program Cool Edit '96 can be used to generate frequency sweeps. These are ideal for pinpointing any peaks and troughs in your car audio system's frequency response.

15-band stereo model (DU84F, £180) is typical, but do check the latest Catalogue for newer models.

Pre-Equalisation

So what use is a mains-powered graphic equaliser in a car? Is the secret an extension cable several miles long? Ha, no. The idea is to pre-equalise your recordings for car use. Basically, the idea is to take the equaliser to your car, together with a cassette deck (or some other audio source), and power them via an extension cord - taking all sensible safety precautions. The audio source is connected to equaliser input, and the equaliser's output is in turn fed to the car audio system as shown in Figure 1. Some car stereos have a line-level input - typically for a CD or Minidisc player - and the equaliser could be hooked up to this. If your car stereo doesn't have such connectivity, an alternative is to use a cassette adaptor (such as Maplin's CB47B, £9.99). These devices resemble a standard audio cassette, but have a trailing cable that plugs into the line output of your source equipment. This cable is wired to a cassette head that is brought into contact with the car stereo's playback head when the device is inserted. The adaptor's head converts the audio signal into a concentrated AC field, which is treated like a normal cassette by the car audio equipment. Ingenious and convenient, but not without its sonic limitations (frequency response, signal-to-noise ratio, potential distortion). We'll describe how you can add a line input to your existing car stereo next month.

With the equipment wired up, and the equaliser positioned somewhere convenient (the passenger seat, for example), it's time to power it up. Play some music, and adjust the equaliser for the best overall sound. If your car stereo has Dolby noise reduction, switch it off. As an alternative to an audio source, you could connect a sine wave oscillator to both input channels of the equaliser, and sweep the audio band. When an un-natural peak is heard, the relevant frequency slider on the equaliser can be turned down to even out the overall response. Audible troughs in the frequency response (in some more complex systems, this would be the cross-over point between the subwoofer and the other speakers) can be corrected by boosting the appropriate frequency band.

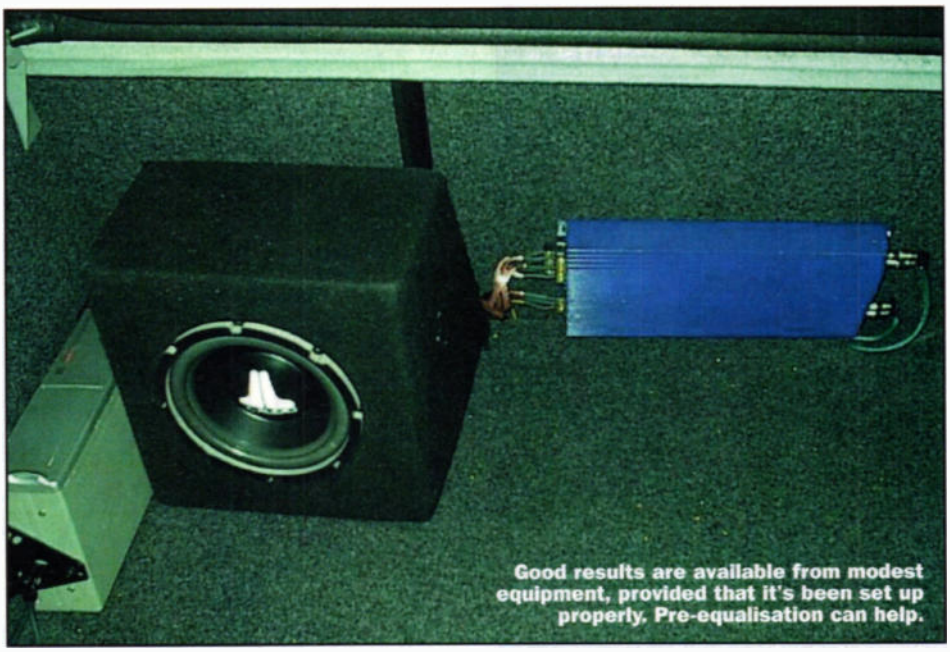
If you don't have a signal generator, test tones can be generated by some sound editing software. The excellent Cool Edit shareware program for Windows 9x, for example, can easily be programmed to produce audio frequency sweeps by setting the initial and final frequencies to 20Hz and 20kHz respectively. You can also define the sweep period. The WAV files produced could be recorded onto a cassette, or burnt onto a CD, according to your source equipment. If using cassette, there's probably no sense in sweeping above 15kHz. We would recommend concentrating on the 150Hz to 1kHz bands, where most audible problems occur. The computer-generated frequency sweep is, however, no substitute for the variable oscillator, the frequency of which can be 'held' as soon as you hear the colouration-inducing peak it is responsible for. Next, try playing some music through the equaliser. Most units have a 'bypass' switch, so that you can compare the equalised signal with the non-equalised one. The difference in sound quality can be quite startling!

Once you've achieved the best possible sound, make a note of the sliders' positions (how much boost or cut has been applied to each frequency band, in other words). Take the equipment indoors, and wire the graphic equaliser between your source equipment and your cassette deck, as shown in Figure 2. You can now make recordings with a frequency response that's tailored to your car audio system. Now for some caveats. First of all, there's little point in boosting the low-frequency bands if you don't have a subwoofer and the associated power amp. If you do, all you'll get is distortion - and possible speaker damage as the cones flap around in vain. Secondly, there's no point in whacking the treble up high, or you'll end up oversaturating your recording! The result will be high-frequency distortion and noticeable sibilance. In my experience, the greatest treble (8kHz or higher bands) lift you can get away with is around 3dB, although this does depend on the capabilities of your cassette deck.

Digital Media

But what if you're into digital media? No problem. it's just as easy to make 'pre-equalised' CDs if you have a self-contained CD or Minidisc recorder. Just connect the

Figure 2. Setting up your hi-fi equipment for making equalised recordings.



Good results are available from modest equipment, provided that it's been set up properly. Pre-equalisation can help.

outputs of your source deck to the equaliser, and the equaliser's output to your digital recorder's line input. Things aren't quite as easy if your CD recording equipment is PC-based. Here, the equaliser would be connected between your source equipment and PC soundcard. You would then capture the equalised audio as a WAV file, and then burn it to CD in the usual way. With a PC and CD burner, though, you can keep things totally in the digital domain. Extract a song from your CD digitally, and save it as a WAV file. You can then open it in an audio editing program. Some of these - notably Cool Edit and Dart Pro 32 (an 'effects rack in software') - have comprehensive multi-band boost/cut facilities. Enter in the band-by-band level settings from your 'physical' graphic equaliser, and apply them. In some cases, the software's bands might not correspond exactly to those of your equaliser, but you can make an intelligent guess. Some editing programs, out of interest, offer a considerable amount of customisation. You could, in essence, 'build' a software version of the graphic equaliser you used during the experimentation stage. The equalised track can then be saved, and burnt to disc.

I myself have an archive of music stored on my PC as a series of 44.1kHz/112kbps stereo MP3 (MPEG Audio Layer 3) files. The PC's soundcard is a very cheap PCI one that's been modified to offer SP/DIF digital audio input and output - I'll be discussing this in a forthcoming update to my 1997/8 series on CD audio mastering. The SP/DIF output is connected to a MiniDisc deck's digital input, as shown in Figure 3. When the MP3 files are played by Winamp - an excellent MP3 player available from http://www.winamp.com - they're passed to the SP/DIF output as well as the soundcard's own audio circuitry. The MP3 files can thus be recorded onto MiniDisc with no degrading analogue intervention. WinAmp has a 10-band graphic equaliser that raises or lowers the various MPEG sub-bands during playback. It's thus easy to make pre-equalised end-to-end digital MiniDiscs for the car in this way. Note that

The excellent WinAmp MP3 player has a graphic equaliser function.

when the equaliser was enabled on earlier versions of Winamp, audible artefacts were noticeable. This problem appears to be fixed on the latest versions of the program - I'm using 2.23, which doesn't suffer from any obvious aural nasties.

Sony Minidisc

Out of interest, most - if not all - Sony Minidisc decks can be used as high-quality DACs by pressing 'record' when no disc is loaded. Feed it with the SP/DIF output of a soundcard and connect your Minidisc's stereo outputs to your hi-fi instead of the soundcard's 'line' output - this is shown in Figure 4. You'll get an audio quality that's far superior - there's no background hash or 'whining', and clarity is infinitely better. Note, however, that the SP/DIF output of Creative's Soundblaster Live is always 48kHz, regardless of the source's recording characteristics, thanks to a sample rate converter. To the best of my knowledge, only DCC and DAT decks can handle digital audio at this rate. My Sony Minidisc deck only accepts 16-bit digital audio sampled at 44.1kHz, and I can imagine that the same will apply to other Minidisc equipment. If your soundcard and captured files are up to spec, though, go for it. If you only have cassette in your car, you'll get the best recordings from computer-derived audio if you feed your tape deck from the Minidisc DAC rather than the soundcard. If you're making cassette recordings from MP3 files, then you'll still be able to take advantage of Winamp's 'software equaliser'. Of course, the Minidisc deck can still be used as a DAC during normal 'hi-fi' listening.

The results obtained can be quite astonishing - pre-equalisation is clearly effective. In my case, colouration was greatly reduced, while clarity improved significantly. It has to be said that the benefits will only extend to recorded media. If you spend most of your time listening to the radio, I'm afraid that the described approach isn't for you! The only available option would be to install an equaliser in the car itself. If your car audio system doesn't make provision for an equaliser, don't worry. You could, in theory, break the internal link between the unit's source selector and tone controls. At this point, the audio signal tends to be at something approaching the line-level (100mV or so) that is compatible with equalisers. An in-car graphic equaliser can hence be inserted at this point, once any DC offsets have been dealt with. The tone controls would, however, have to be set to their central 'flat' positions. Note that the same break in the signal path would allow a line input to be added to an existing 'head unit' that doesn't have this useful feature. As a result, you'll be able to enjoy the best possible quality from your CDs. All of this will be detailed in the next instalment. Betcha can't wait!!!

ELECTRONICS

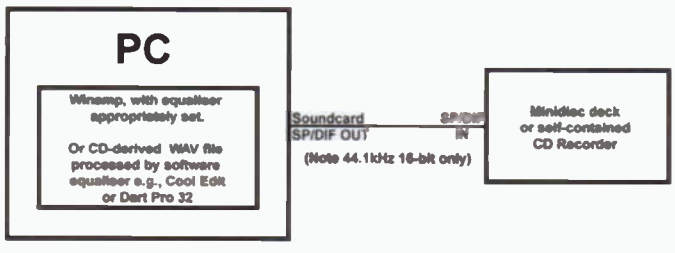


Figure 3. Making equalised MiniDisc recordings digitally.

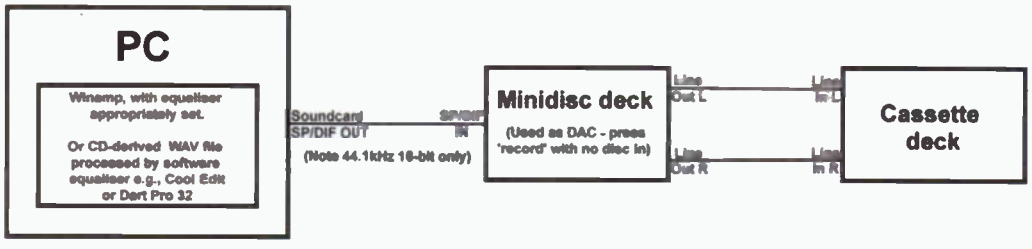


Figure 4. Using a Minidisc deck as a high-quality DAC for computer-sourced recordings.

What's in Store

AT DUBLIN

Maplin Electronics opened the doors to its new store in Dublin on 17th July and very quickly got off to a good start. The store was so popular in the first week that it can now boast a place in the top 5 Maplin stores. Uri Geller, the well known paranormalist and writer of a column in this magazine, opened the store and kept customers entertained with his spoon bending and informal chat.

Maplin Electronics has serviced customers by mail order for many years in the Republic of Ireland, but now shoppers in Dublin can experience the wealth of products in the new store in Jervis Street first hand. Since its establishment in 1972 Maplin Electronics has grown consistently and in the past five years customers have seen the store network double to 52 and an international store in Cape Town, South Africa. This

makes the company a leading retail and mail order business in the UK boasting a vast product range including Electronic Components, Sound & Vision, Computer Technology, Home and Office, Modelling, Hobbies & Books and Communications. Internationally Maplin products are now available by an On-line ordering facility on the Internet at **www.maplin.co.uk** This gives the customer the ability to order 24hrs a-day via a fully interactive secure site.

To aid business customers the Maplin Freedom Card offers a convenient efficient method for paying for goods on account in store. The card can be used in any of our branches.

The Dublin Store Team, including Manager Thomas Baker (centre).

The new Dublin store in Jervis Street occupies 5000 sq.ft and has over 5,000 products in stock, with a further 25,000 available to order via the Maplin Store Catalogue. Specialist features include a Cable and Component Counter, Computer

Centre, Music and Disco Sound Stage. The Jervis Street store is the first outlet in the Republic of Ireland.

" We've been trying to come to the Republic of Ireland for some time" comments Retail Operations Director Graham Caldwell. "People are increasingly coming to us because of our vast range and quality service. Now we are bringing Maplin Electronics to them!"

"Maplin Electronics already have a strong trade and mail order base over here" commented Store Manager Thomas Baker, " but we wanted to offer people an exceptional retail service".

First for choice

The new store will give business customers and local shoppers access to over 30,000 products from the store via the Maplin Catalogue, coupled with a team of highly trained staff who are on hand to offer practical advice. The store team of nine has been training for the last three months in branches of Maplin Electronics across the UK. Brian O'Connor the Assistant Manager recalls "its amazing how many different things you can find at Maplin Electronics, its like working in an Aladdin's cave.

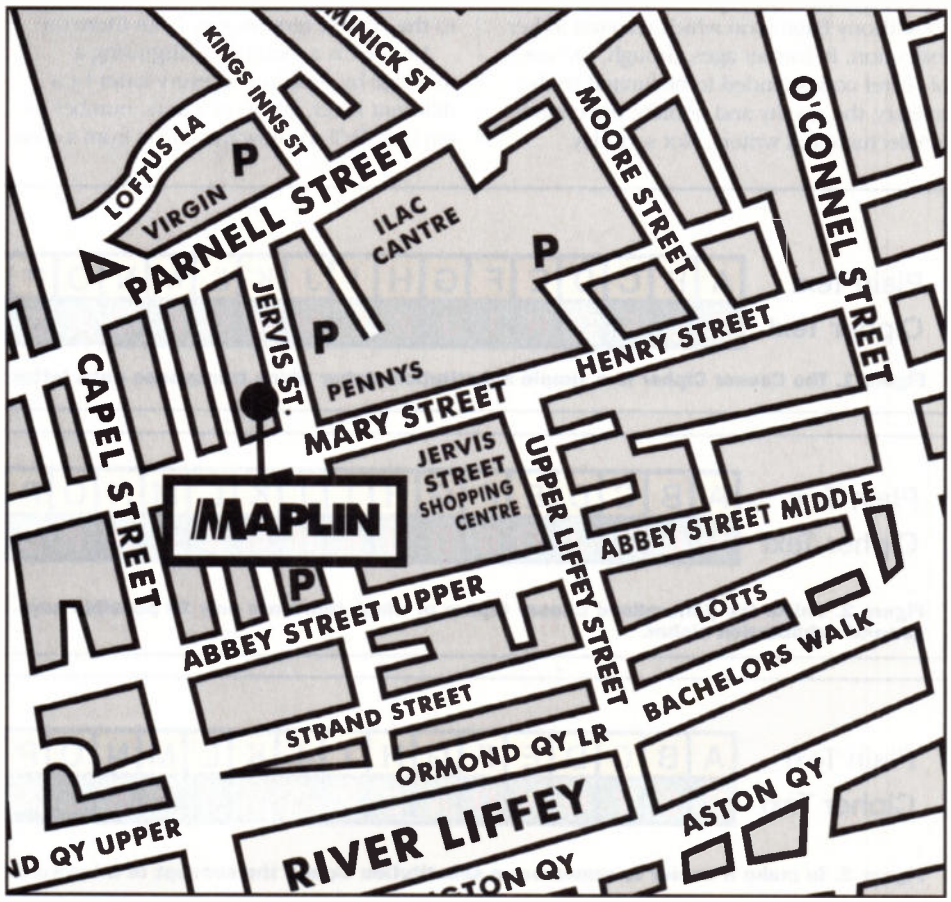
Maplin covers everything, from the latest sound and vision developments, in-car hi-fi, computer accessories, communications products, to specialist tools. A wealth of this range is on display in the store, many with special introductory pricing.

First for value and price

The first customer through the door at the openng was a young Dublin lad who had camped out all night in order to purchase a HP Brio Pentium III PC for only £129.99 a massive saving of over £1,700 on the recommended retail price.

"We had some exceptionally priced opening offers," Mr Baker said. "I would like to welcome all the people of Dublin to our new store, and feel confident that they will enjoy the visit".

So don't delay, hurry down and see for yourself what is on offer at the new Maplin Electronics store at Unit 1-4, The Symths Building, Jervis Street, Dublin 1. For more information call the store team locally on 01 878 2388 and they will be happy to assist you.



Code Making & CODE BREAKING

PART 1

In part 1, Mike Bedford looks at the 'basics' in this fascinating article.

The fascination of secret codes is one which many people will recognise immediately. Schoolboys invariably play around with them at one time or another and their interest in secret codes often doesn't entirely go away in adult life. Simple code breaking is an ingredient in many brain-teasers and puzzles and the more mathematically-minded have even been known to make a hobby out of code making and code breaking. And to a degree the fascination is fuelled by the fact that secret codes bring to mind the spy novels of Ian Fleming and John le Carré. Not that codes are just a form of recreational mathematics, an intellectual curiosity or an integral part of any James Bond film. For many years the primary application of secret codes has been for communication of sensitive military information. But, throughout the ages, civilians have used codes too. Samuel Pepy's use of a secret code in his diaries, for example, is well known. And it was the decipherment of a secret message from Mary Queen of Scots to Anthony Babington which resulted in her execution. In former ages, though, the use of secret codes tended to be limited to the military, the royalty and nobility, the church, intellectuals and writers. Not so today. Encryption is now an important commercial tool and one which will grow all the more as e-commerce becomes established.

This article is the first of our new three part series on code making and code breaking. This is now a very high tech discipline and we'll look at the technology involved later in the series. To set the ball rolling, though, we'll simply set the scene by looking at some elementary background information and describing some of the most basic codes.

Codes and Ciphers

Before we start to get into this subject in any detail, I need to clear up some terminology. So far I've used the word 'code' or sometimes the phrase 'secret code' since these words and phrases as in everyday use. To be strictly correct, then every occurrence of the word 'code' in the introduction should be replaced by the word 'cipher.' So I guess the first job is to differentiate between the two. Having done this I'll stick to the correct terminology from there on.

A cipher is a method of disguising a message by substituting every letter by a different letter, group of letters, number or symbol. We'll see how this differs from a code shortly but before we go on we also need to introduce a handful of other words and phrases which are commonly encountered in cryptology (the science of making and breaking of ciphers). First of all plain text is just what it sounds like, freely readable text – the text before the application of a cipher. Cipher text, on the other hand, is the result of applying the cipher – text in which each letter has been substituted for a different letter, number or symbol according to the rules of the cipher. Encryption is the conversion of plain text to cipher text. Decryption is the reverse process carried out by someone with a knowledge of the cipher used. However, cryptanalysis is the conversion of cipher text to plain text by someone who doesn't have full details of the cipher used in the encryption process. In everyday terminology, therefore, crytanalysis is code breaking.

In contrast to a cipher, a code is a method of expressing a message as a series of symbols, letter groups or numbers, each of which represents a particular word or concept. A code may be used for the same purpose as a cipher, that is for secrecy, although most codes are not used for this purpose. Codes are frequently used, for example, in radio communication. The use by radio amateurs of the Q-code is one such example. The purpose of using these three letter codes in place of the full textual equivalent is to shorten the message and so speed up transmission by the inherently slow Morse Code. Another common code is the 10-code which is used by the police and CB enthusiasts to streamline verbal communications by radio. An important point about codes is that, unlike ciphers which can be used to encrypt any message whatsoever, a code can only be used to represent a message if all the words and concepts in that message have corresponding codes defined. For example, the Q-code allows a radio amateur to ask for another

Plain Text	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
Cipher Text	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C

Figure 1. The Caesar Cipher is a simple substitution cipher which transposes each letter by three places wrapping round at the end.

Plain Text	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
Cipher Text	N	E	Z	J	O	B	D	U	K	H	M	X	A	R	P	C	I	Y	F	V	T	W	L	Q	G	S

Figure 2. Unlike the generalised Caesar Cipher of which there are only 25 possible keys, there are 26 factorial variants on a truly general substitution cipher.

Plain Text	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
Cipher Text	B	E	Y	O	N	D	A	C	F	G	H	I	J	K	L	M	P	Q	R	S	T	U	V	W	X	Z

Figure 3. To make it easier to remember a substitution cipher, the concept of a keyword (in this case 'beyond') was often employed.

ANxhH xSIis bTHEg kxISA buAxS hkgqI SIgfA bINTH ESENS ETHAT ITISg
NbxAH xhgTH ESISA Ntxgp iANNE qEkhk gqEIT NgcAT TEkHg ucANx TIcES
THEkE SpbTS geEvh EkIcE NTSAr kEEuI THSgc ETHEg kxxgp iANNE qEkwE
SpkET HATTH ENEvT TIcET HEkES pbTuI bbNgT igNTk AtIiT THETH Egk

Figure 4. Any substitution cipher can be cracked using a knowledge of the frequency of occurrence of single letters, digrams and trigrams. Here we see the partially cracked message we discuss in the text (lower case black letters are cipher text, upper case red letters are plain text, i.e. the letter we have already deciphered).

station's location simply by sending QTH? It would be impossible, on the other hand, to use the Q-code to represent the message 'the quick brown fox jumps over the lazy dog.'

Before leaving the topic of codes and ciphers, I must point out that some well known codes are not, in the strict sense of the word, codes at all. We've already met one such non-code. The Morse code has a symbol (specifically a series of short and long tones, often referred to as dots and dashes) for each letter of the alphabet, for each figure, and for many of the punctuation signs. It is, therefore, a cipher, albeit not a secret one. ASCII, which is familiar to most computer users, is another example. Here each letter, figure and symbol is replaced by an eight bit binary representation which can be stored in files or transmitted across communication channels. Officially the American Standard Code for Information Interchange, ASCII should really stand for American Standard Cipher for Information Interchange.

A Simple Cipher

The world's first cipher is attributed to Julius Caesar and is summed up in the table below. You'll notice that each letter is changed into the letter three places ahead of it in the alphabet, wrapping round when we get to the end. Frequently, this is summed up as a table which makes encryption and decryption much easier to carry out. Figure 1 is the table for the Caesar cipher. So A becomes D, B becomes E and so forth until we get to Z which becomes C. I guess this is pretty self explanatory but to give a simple example, the word ELECTRONICS would become HOHFWURQLFV. If you've never encountered a cipher before, and I guess it's reasonable to assume that this would be true of Caesar's contemporaries, then you'd be totally baffled by this cipher. However, even if we generalise the cipher so that the sender can choose how many places in the alphabet each letter should be moved forward, this cipher is trivially simple to crack. There are only 25 possible variants on the Caesar cipher so it wouldn't take too long to try each of them out manually. And with a simple computer program this could be carried out extremely quickly.

Let's now make this a bit more mathematical and, in so doing, introduce another important bit of terminology. The process of encryption, in general, is defined by the following formula:

ciphertext = cipher(plaintext, key)

where cipher is the mathematical function which defines the operation of the cipher and key is a constant which is kept secret. The theory is that even if the rules of the cipher are known, communication is still secure so long as only the sender and the intended recipient know the key. In the case of the Caesar cipher, the function is defined as:

ciphertext = (plaintext + 3) modulo 26

where modulo 26 is just a mathematical way of saying "start at one again when you go past 26". And the generalised version of the Caesar cipher which we discussed is defined as:

ciphertxt = (plaintext + key) modulo 26

We've already indicated that there are only 25 variants of this cipher and, now we've introduced the correct terminology, we can rephrase this by saying that there are only 25 possible keys. Actually there are 26 but one of them – the value zero – is of no value since it would result in the ciphertext being identical to the plaintext. In general, a cipher's level of security is dependant on the number of possible keys or, when we come to look at binary keys, the key length.

More Keys

It's not hard to extend the simple cipher we've already seen to increase the number of possible keys very significantly. Rather than the cipher text alphabet simply being a shifted version of the plain text alphabet, let's jumble up the ciphertext alphabet. Figure 2 shows one such scheme. Using this table, the encryption process is much the same as before – find the plain text letter on the top row and read off the cipher text equivalent from the bottom row. The major difference, however, is that the key is now the sequence of letters on the bottom row and the number of possible sequences of 26 letters is 26 factorial which equals 26 x 25 x 24 x 23 ... x 4 x 3 x 2. Needless to say, this is a huge number, in fact if you could manage to write a computer program to try out a million possible keys per second, it would take over 12 trillion years to crack this cipher by this sledge hammer approach. Naively, therefore, you might think that this is a secure cipher, but you'd be wrong. First of all, it's not easy to remember a key which consists of a random sequence of 26 letters and writing it down is a security risk. So, as an aide memoir, a word or phrase has tended to be used to generate the key. Here's how it works. First of all write down the plain text alphabet. Now underneath the alphabet and starting on the left, write down the word or phrase, missing out the second and subsequent occurrences of any duplicated letters. After the end of the word or phrase, write the letters of the alphabet which don't occur in that word or phrase in alphabetic order. An example using the word "Beyond" is shown as Figure 3. Admittedly this is much easier to remember than 26 random letters but since the key is effectively reduced to a word or phrase of the English language, the combinations are far fewer. And if the user picks the keyword as many computer users pick their passwords (e.g. wife or kids's names etc.) guessing the keyword becomes a real possibility. Note also that the letter Z encrypts to Z and with most keywords a greater number of letters would end up encrypting onto themselves. However, this can be overcome in various ways – writing the letters not found in the keyword in reverse order, for example. However, there's a much more fundamental problem with this type of cipher, even if we stick with a truly random key and hence a phenomenal number of combinations. Imagine that the following encrypted message has been intercepted. And let me point out that I found the following cipher text on the Web but this was given as an exercise in a cryptology course so the solution wasn't provided. So, at the time I wrote the following paragraph, I had no idea what the

sfxhl xmais bolzg kxams busxm hkgqa magfs bafol zmzfm zolso aoamg
fbxsl xhgol zmams ftxgp isffz qzkhk gqzao fgcso ozklg ucsfx oaczm
olzkz mpbom gezvh zkacz fomsr kzzua olmgc zolzg kxxgp isffz qzkwz
mpkzo lsool zfzvo oaczo lzkzm pboua bbfgo igfok staio olzol zgkx

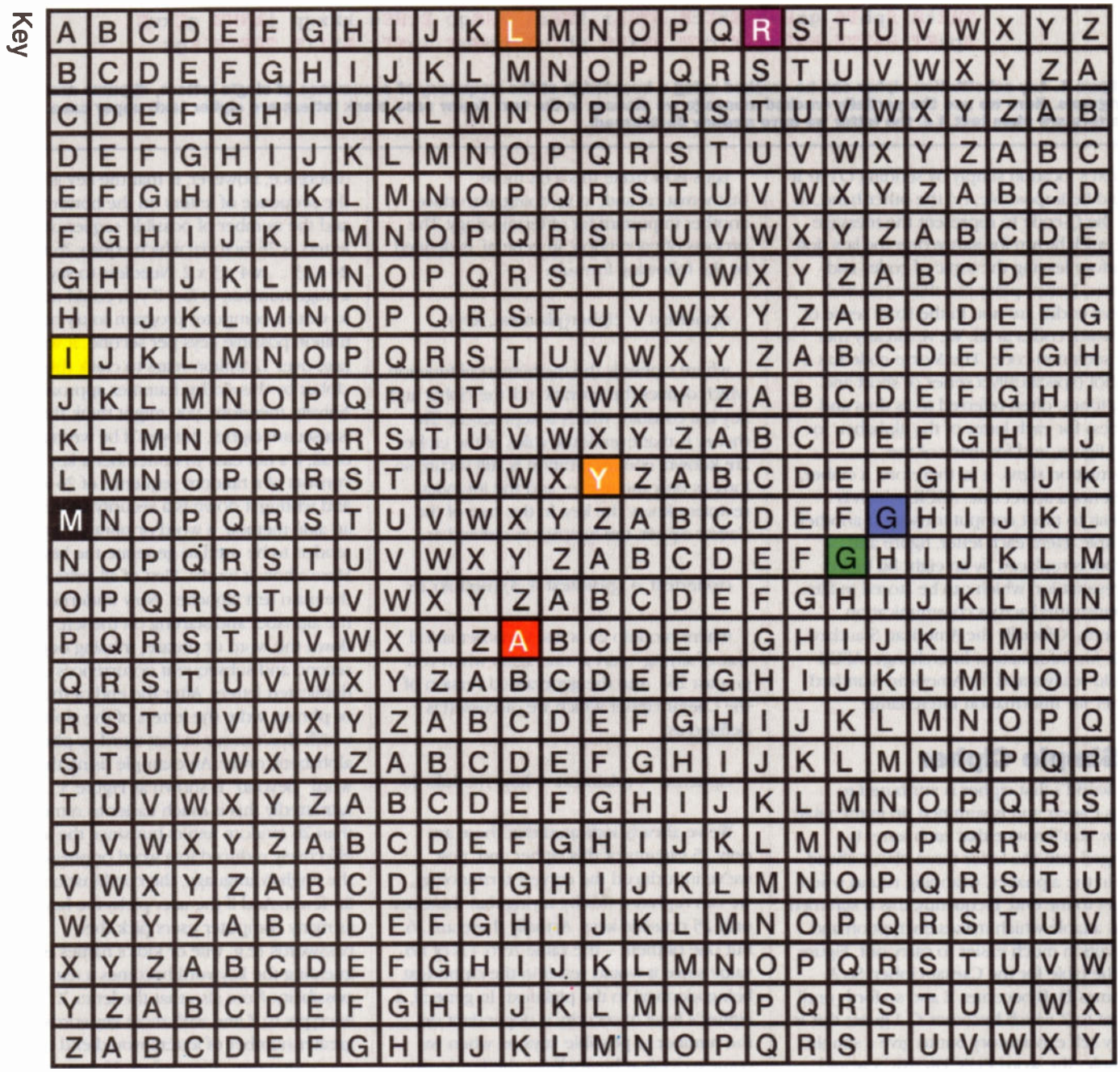


Figure 5. The Vigenere Cipher was one of the first polyalphabetic ciphers. This is the table used for encryption and decryption. The coloured squares refer to the specific example discussed in the text.

plain text message was. Note, by the way, that the cipher text is presented in 5-letter groups. This is common practice in any cipher as it makes cryptanalysis much harder. For example, if the cipher text was presented in the same way as the original plain text, that is with all the word spacing preserved, single letters by themselves would immediately be recognisable as either the letter A or the letter I since these are the only single letter words. Lots of other clues would also be apparent.

To do this job quickly and reliably, I'd have needed some sort of software to count occurrences of individual letters, two-letter groups (digrams) and perhaps three-letter groups (trigrams). I did it purely by eye, though, and, as you'll see, it worked. The first thing that stuck me about the cipher text was the frequency of occurrence of the digram OL and the fact that OL was very frequently followed by Z to give OLZ. Since TH is the most common digram in the English language, followed closely by HE, and THE is by far the most common trigram, there's a high degree of likelihood that O translates to T, L to H and Z to E. My first job, therefore, was to make these substitutions. Looking at what was left, I noticed that SF is another common grouping. The third most common digram in English is IN, followed closely by ER and with RE, ON, AN and AT not far behind. Tentatively, therefore, I tried substituting I for S and N for F but the results didn't look too convincing. The sequence ETHIT would have appeared twice and although this is possible (remember there could be a word space somewhere in there) it didn't seem too likely. Looking at the other common digrams, RE isn't a possibility, since we already know that Z translates to E, and whereas the others are possible, AT looked the most likely as these questionable sequences would then become ETHAT. I therefore substituted A for S and N for F. At this point I couldn't identify any other particularly common digrams (undoubtedly there were some but remember I was just doing this exercise manually) so I turned my attention to single letters. I noticed that M, X, A, G and K were about the most common letters not already assigned. In a number of occurrences of A, the context suggested that I (itself, one of the most common letters) was the most likely plain text equivalent so, once again I made some tentative

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OVDPH EHMVF PLVHS NTPHD VIUNC MEPDP KJFVY VHHNF JVMJN IHVJK MEVMR
IKPCM EPCPS RAYJF VISYV IKNFM NCHJI MEPHM VIKVC KDPKJ FVCPS CNZCV
DBPCP UVFJI ZINMN IYLVF RMJIM EPZCN BMENU DPKJF VCPSV LDPIM HARMV
YHNVI VAHNY RMPCP KRFMJ NIJIS VLDPI MUNCD VILHP CWJFP H
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substitutions. Again everything looked OK and once I'd made this substitution a substitution of S for M looked likely so once again I made this substitution. We're now getting to the point where we have reasonably long strings of translated letters – the following is one example: "inth esens ethat it is". Clearly when spaces are added this beacons "in the sense that it is" and this gave me a good degree of confidence that I was on the right track. Figure 4 shows the story so far. Here the red capital letters are plain text and the black lower case letters are the ones which are still in cipher text.

From here on things start to get easier. Remember that we still have to assign X, G and K, all of which are commonly occurring in the cipher text. And common plain text letters which we don't already have are O and R with D, L, M, U, C and F a bit further behind. The next thing I noticed was that the letter already translated as N has the cipher text letter g before it on a couple of occasions. O is a reasonably common letter which we have yet to assign and ON is a common digram so my next substitution was of O for G. The message now ends with "theth eo" followed by the cipher text letters k and x. After a few seconds puzzling, the words "the theory" leapt out of the page so I made the substitutions R for K and Y for X. From here on it was increasingly like solving a crossword puzzle and within a few minutes I had the message "Any physical theory is always provisional in the sense that it is only a hypothesis and you can never prove it no matter how many times the results of experiments agree with some theory you can never be sure that the next time the result will not contradict the theory.". It rather seems that something got lost from the middle of the cipher text but clearly we've cracked the cipher. So much for those 26 factorial combinations! And if you want to try your own hand at cryptanalysis, here's another message for you to try. This is another one I found on the Web and I've no idea what it means.

Polyalphabetic Ciphers

Clearly the number of possible keys is not the only measure of a good cipher. Even though the brute force method of cracking ciphers such as those we've seen so far is, in many cases, impossible due to the vast number of possible keys, an attack based on a knowledge of the frequencies of single letters, digrams and trigrams is perfectly feasible. All the ciphers we've looked at so far are referred to as monoalphabetic which means that a given plain text letter will always be encrypted into the same ciphertext letter. Clearly, if this was not the case, then cryptanalysis using the technique we've already seen becomes impossible or, at the very least, it requires major modifications and becomes much more difficult. Ciphers in which one plain text letter will translate to different cipher text letters depending on where they appear in the message as called polyalphabetic.

A common encryption method used by military intelligence for many years made use of something called a one-time pad. The one-time pad is a book containing a long list of random numbers – numbers in the range 0 to 25 would work well for encrypting plain English text. Note, though, that these must be truly random numbers, computer-generated pseudo random numbers would not give as a secure a cipher. Let's assume that the one-time pad starts with 14, 3, 20, 15, 7, 1, 22 and the message to be encrypted starts with "Only now". These letters correspond to the 15th, 14th, 12th, 24th, 14th, 15th and 23rd letters of the alphabet respectively. So to encrypt the message, subsequent values from the one time pad are added to subsequent letters of the message wrapping round if the value exceeds 26. The result of such an addition is 29 (3), 17, 32 (6), 39 (13), 16 and 45 (19), the figures in brackets being the result of subtracting 26 for those values which exceeded 26. And converting these back to letters we come up with CQFMPS as the encrypted message. Note that both occurrences of O have become different cipher text letters as have both occurrences of N. And similarly, although it hasn't happened in this short sample message, different plain text letters will often translate to the same cipher text letter. Clearly an encrypted message of this type cannot be cracked using the technique we've already seen. In fact, so long as the one time pad is used only the once, there is no way of cracking this cipher at all other than capturing a copy of the one-time pad, of course. Despite this apparent security, though, the fact the key (i.e. the pad) has to be written down does limit its applications. It's suitable for communication between secure fixed locations but not, for example, by a spy in the field since the likelihood of capture is unacceptable. What is needed in this case is a compromise between the monoalphabetic which can have an easy to remember key but which is easy to crack and the one-time pad which is impossible to crack but the key has to be written down. One of the first polyalphabetic ciphers which achieved this is called the Vigenére cipher after its sixteenth century inventor.

The Vigenére Cipher

The Vigenére cipher makes use of a table of the letters of the alphabet arranged as the 26 x 26 square shown as Figure 5. Now to encode a message, write down the message and above it write your keyword repeatedly until there's a letter above each letter in the message. Here's a message with the keyword MAPLIN written repeatedly above it. The message, by the way, is a quotation from Laise de Vigenére.

Now each cipher text letter is determined by finding the intersection of the plain text row and the keyword column. So, the first plain text letter is A and the first keyword letter is M so the cipher text letter is found at the intersection of row A and column M – this is the letter M. Similarly row L, column A is A, row L column P is A and so forth. The location of the first eight cipher text letters in our encrypted message are shown on the Vigenére table, coloured according to the resistor colour code – black, brown, red, orange, yellow, green, blue, purple. Decryption is achieved using the reverse process.

Another way of looking at the Vigenére cipher is that it involves the use of a number of monoalphabetic ciphers used in rotation. And the number of monoalphabetic ciphers in use depends on the length of the keyword. In the case of the true Vigenére cipher each of the individual monoalphabetic ciphers are very simple ones which, like the Caesar cipher, involve adding a fixed value onto each plain text letter. And this is one of the Vigenére cipher's greatest weaknesses. However, it is possible to devise a variant of the Vigenére cipher in which each of the columns in the table are more complicated monoalphabetic ciphers, perhaps making use of their own keywords. Perhaps a phrase or sentence could be used as a means of remembering the sequence of keywords. You might think that in this case we've got to the point, at long last, of having a cipher which is almost impossible to crack. Surprisingly, therefore, it's not as hard as you might think as we'll see next month.

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MAP LINMAP LI NMAPLI N MAPLIN MAP L INMAPL INMAPLI
ALL NATURE IS MERELY A CIPHER AND A SECRET WRITING
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PROJECT

Constructing A VALVE RECTIFIED HT POWER SUPPLY

Mike Holmes discusses how to use the GZ34 full-wave rectifier.

Maplin's valve range includes the GZ34 full-wave rectifier. This follows the Bantal construction, combining two separate diodes into one envelope with connected cathodes, and is mounted on an octal base. It was introduced and manufactured by Mullard as one of their 'World Series' of valves (by way of a reference, this series included the EF86, ECC83, EL84, EZ81 and EL34).

At a time when, although they existed, the performance of solid state ('metal') rectifiers was very poor, the supply voltage for all active electronic (read 'valve') circuits was derived from an AC source by either a half-wave rectifier (single diode), or, more efficiently, a full-wave rectifier, and these were themselves valves. Aside from selecting a new GZ34 to replace same in existing equipment, how would you implement its use in a new circuit?

History

Lower power rectifiers of this type, for example the EZ81, were restricted to providing for radio receivers, record players, tape recorders, 'radiograms', etc., that is to say 'consumer' goods having audio output amplifiers usually of the single-ended class A type with very modest output, and hence comparatively low HT current and voltage.

Conversely the GZ34 was specifically developed for, and is mostly found in, push-pull power amplifiers for hi-fi, PA and the stage. Such amplifiers have much higher HT levels than for your average AM radio. Hence, whereas say the EZ81 has an insulated heater rated at the standard 6.3V AC, and which may therefore share the same grounded potential heater supply along with all the other valves, This cannot be done for the GZ34 because the HT may be anything up to 500V and over.

In fact no attempt is made to insulate the heaters from their surrounding cathodes in the GZ34 - it is simply not possible to maintain this as under the high voltage stress the insulation is going to break down sooner or later. Instead the rectifier is given its own 'private' heater supply, which explains what appear to be two rather odd features of the GZ34 - that its heater is rated at 5V not 6.3V, and that one end is internally connected to the cathode.

These features have repercussions on the design of other components. In Figure 1 it will be seen that the design of the mains transformer is dictated by the choice of the rectifier. The HT secondary is actually double-wound and centre-tapped, the centre-tap connected to ground (0V), the two ends causing each half of the rectifier to conduct on alternate positive half cycles. The final DC level is of course double that for a half-wave rectifier at approximately two thirds of the peak voltage, with a corresponding improvement in power throughput. Plus, a 'mains hum' of 100Hz is easier to smooth out than 50Hz.

On negative half cycles no current flows in the 'unused' side although a potential is present, indeed the total back EMF can be substantial. With reference to Table 1, it will be noted that the *Peak Inverse Voltage* (PIV) rating for the GZ34 is 1.25kV - the value arrived at having more to do with avoiding flashover between the base pins than the internal workings of the valve, nevertheless it sets a limit on the maximum HT level. (In fact, unused pins are physically removed from the base. Much more than this and the electrodes will need to be at opposite ends of the glass envelope...)

It is, of course, a compromise - while constructing a bridge rectifier is not impossible using four thermionic valves, it was seen as too expensive and complicated and anyway the R_{int} (internal limiting resistance) of each would make for an unacceptably low final HT level.

As shown in Figure 1, T1 has an extra winding specifically to power the heater of V1. Voltage levels for these were typically in the range 4 - 5V; the whole configuration, that of having a centre-tapped HT secondary and a separate heater supply for the rectifier, became the long established norm. Indeed, in early versions where the heater was also the cathode, the rectified DC was taken from a centre tap of the 4V winding.

In fact, the configuration is perfectly valid and was used for insulated heater rectifiers, such as the EZ81.

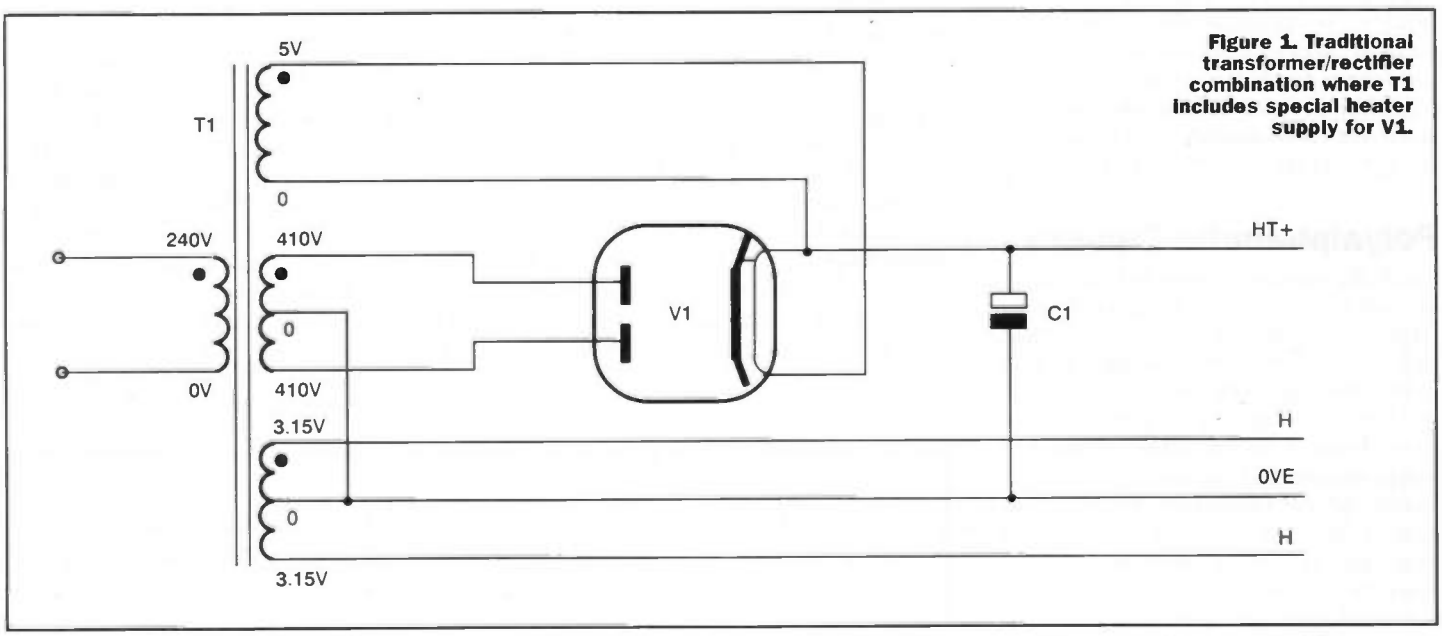
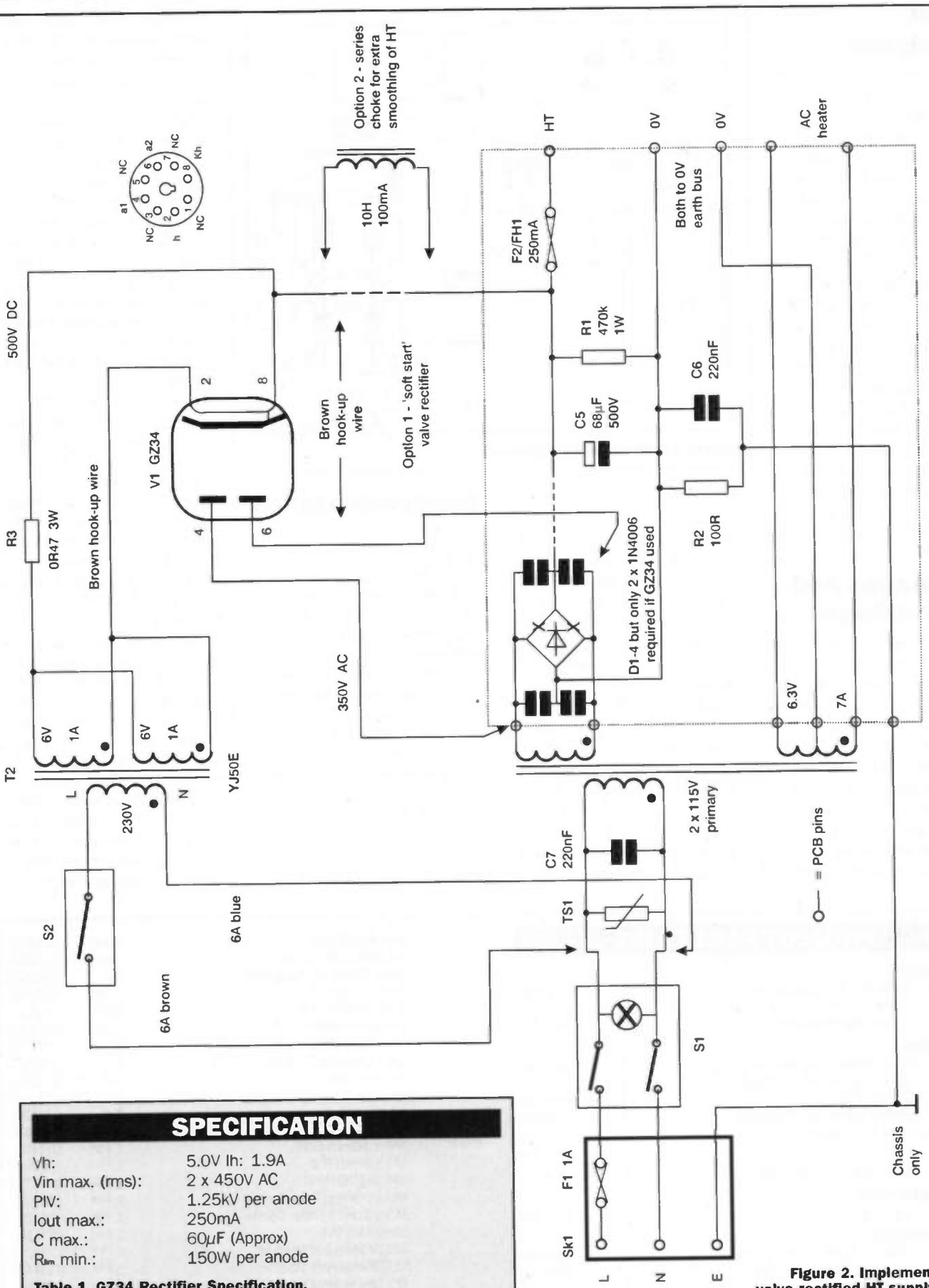


Figure 1. Traditional transformer/rectifier combination where T1 includes special heater supply for V1.



SPECIFICATION

Vh:	5.0V Ih: 1.9A
Vin max. (rms):	2 x 450V AC
PIV:	1.25kV per anode
Iout max.:	250mA
C max.:	60µF (Approx)
R_{dm} min.:	150W per anode

Table 1. GZ34 Rectifier Specification.

Figure 2. Implementation of valve rectified HT supply using a combination of available parts.

Implementing The GZ34 In New Designs

The first problem is finding a transformer with the necessary extra winding, if any such still exist. This can be got around by simply adding a second transformer. However, once-upon-a-time you *could* obtain single 5 V heater transformers for just this purpose, these are, again, obsolete.

The answer is to use a 6V transformer with a resistor added to drop the output to 5V for the valve heater. According to Table 1, the GZ34's heater current is quite high at 1.9A. A good candidate for a transformer is then YJ50E having 2 x 0 - 6V secondaries of 1A each. Wired in parallel, a resistor of 0.47Ω then provides the necessary reduction approaching the required 5V.

Circuit Description

Following from this, Figure 2 shows an adaptation of what was the Millennium 4-20 PSU module for an audio power amplifier (see also 'Electronics' issue 73 or leaflet XU45Y for more details). A GZ34 as V1 replaces the function of what were D1 & D3 on the PCB, becoming one half of a bridge rectifier with D2 & D4. This is satisfactory as the R_{int} of 150W (see Table 1) has no more effect than that for the case in Figure 1. Capacitors C1 - 4 are retained.

A heater supply for V1 is added by including T2 as YJ50E, with dropper resistor R3 as described above, which should be 3W wirewound type. The primary is simply connected across that of T1. All bare connections must be sleeved.

Advantages And Disadvantages

At HT currents much exceeding 100mA, the internal resistance of the valve will reduce the final HT by up to 20V, so the adaptation is best limited to single amplifier supplies, or 'monoblocs'.

One singular advantage, however, is that of a 'soft-start' effect - that is, eliminating the 'shock' at switch-on experienced by all supply decoupling and other capacitors further down the line, *especially* electrolytics rated at 450 V (the highest working voltage now commonly available); the no-load HT level is initially an instantaneous 500V DC, using DM54J for T1, before the amplifier valves warm up. Watching little 10µF electrolytics going 'pop' may be entertaining, but not very constructive!

In fact switch S2, originally added to provide for amplifier valve heaters to be powered up before the HT line, is rather redundant because actually this is what happens normally - amplifier valves are ready to begin conducting when the HT voltage first appears.

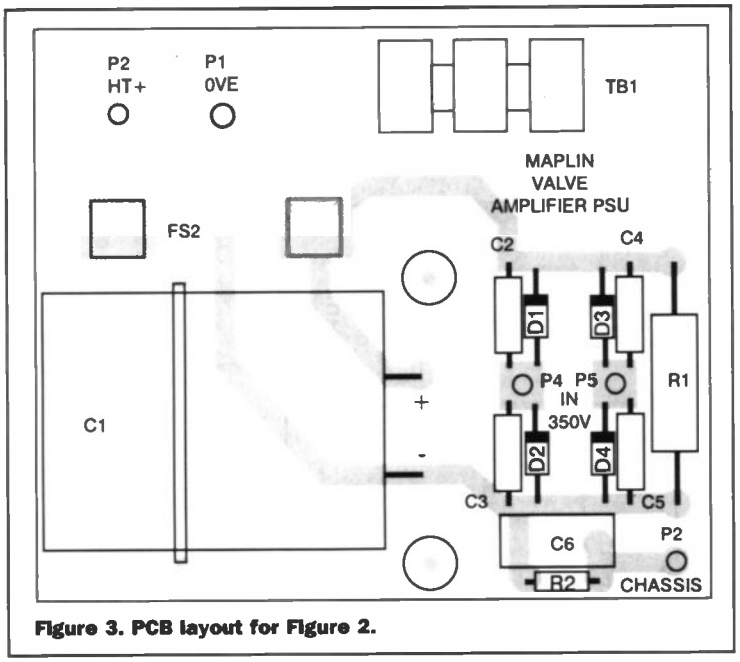


Figure 3. PCB layout for Figure 2.

Construction Notes

Figure 3 shows a PCB layout for the PSU; it is the same as the Millennium 4-20 PSU PCB GH59P, now discontinued. Alternatively this can be made from a 3.5 x 3 inch piece of plain stripboard with components placed in the equivalent locations. This should be quite easy to do as there are hardly any 'tracks'!

Octal valveholder for V1 is located more or less centrally in the remaining free space left in front of the T1 position on the top panel (chassis is XB68Y), not quite fully in between the two PCB mounting pillar screws. To ensure enough room between the solder tags and the underside of the PCB, the height of these pillars (12mm) must be augmented by adding an M4 nut to each.

T2 can be accommodated inside the PSU chassis in the space between the PCB or stripboard and the side plate, in other words rear of the on-off switch(es), and bolted to the side plate, see Photo 1. All connections to tags must be insulated with heat resistant sleeving, *plus* you must add 5-way terminal covers (DM30H) to both primary and secondary sides - the secondary will have DC HT on it!

The same applies to 10H choke L1 (ST28F) if used, the same size terminal cover fits, although this item will be working at its limit, so its inductance will be considerably reduced and of course its DC impedance further lowers the final HT level. However, it is useful in reducing HT ripple in combination with the large value of C5.

You may be able to find room inside the chassis to mount it internally, but with the risk of inductive coupling with either T1 or T2, adding hum to the HT line rather than reducing it, so if possible it should be mounted externally with its core offset 90° relative to the core of T1, for example on the rear panel. A two wire lead can be brought into the interior through a small grommet.

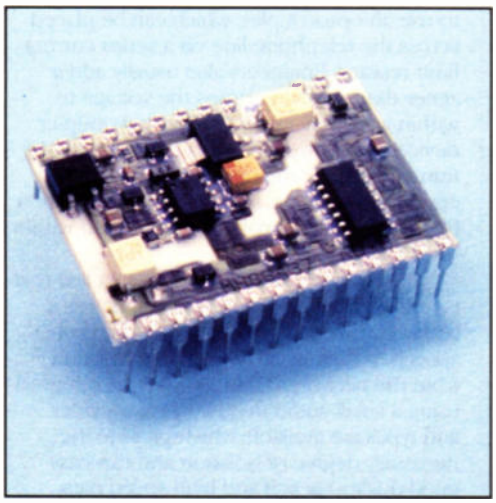
PROJECT PARTS LIST

RESISTORS			
R1	470k 5% 1W Carbon Film	1	(C470K)
R2	100R 0.6W 1% Metal Film	1	(M100R)
R3	0.47R 3W Wirewound	1	(W0.47)
CAPACITORS			
C1	68µF 500V Can Electrolytic	1	(DM57M)
C2,3,4,5	10nF 1000V Ceramic Disc	4	(JL04E)
C6	220nF 250V Mylar	1	(WW83E)
	220nF 500V Polypropylene*	1	(FA22Y)
* connect across T1 primary			
VALVES			
V1	GZ34 Full-Wave Rectifier	1	(LA97F)
SEMICONDUCTORS			
D1,2	1N4006 Rectifier	2	(QL78K)
MISCELLANEOUS			
	Chassis AC86 2.5 x 6 x 8in.	1	(XB68Y)
T1	ValveAmp Mains Transformer	1	(DM54J)
T2	2 x 6V 1A Transformer	1	(YJ50E)
	5-Way 25VA Terminal Cover	2	(DM30H)
SK1	Fused Mains Inlet/Filter Euro	1	(CT81C)
FS1	Fuse 20mm 1A Type F	1 Pkt	(DA06G)
TS1	Suppressor 250VAC (Europe)	1	(HW13P)
or:	Suppressor 130VAC (US/Canada)	1	(CP75S)
FH1,2	1.25in. PCB Fuse Clip	2	(KU28F)
FS2	Fuse 1.25in. 250mA Type T	1	–
TB1	Terminal Block 5A	1	(HF01B)
VB1	Base Octal	1	(CR30H)
	Bell Wire Black	1 Pkt	(BL85G)
	3A Wire 10M Black	1m	(FA26D)
	Heat Resist Sleeving Red	1m	(BL70M)
	1mm PCB Pin	1 Pkt	(FL24B)
	1.5mm PCB Pin	1 Pkt	(FL21X)
	0.25in. Push-On Connector	1 Pkt	(HF10L)
	Insulating Cover (fits CT81C)	1	(JK67X)
	Std Grommet 9.5mm	1	(JX63T)
	6A Wire Black	1m	(XR32K)
	6A Wire Brown	1m	(XR34M)
	6A Wire Blue	1m	(XR33L)
	M4 x 10mm Threaded Spacer	1 Pkt	(FG39N)
	M4 x 10mm Bolt	1 Pkt	(JY14Q)
	M4 x 6mm Bolt	1 Pkt	(JY13P)
	M4 Tag Washer	1 Pkt	(LR63T)
	M3 x 20mm Steel Screw	1 Pkt	(JY25C)
	M3 x 10mm Steel Screw	1 Pkt	(JY22Y)
	Steel Nut M3	1 Pkt	(JD61R)
	M5 Shakeproof Washer	1 Pkt	(BF42V)
	M3 Shakeproof Washer	1 Pkt	(BF44X)
	M3 Shakeproof Washer	1 Pkt	(LR64U)
	Tie-Wrap 140mm	2	(BF92A)
SW1	Dual Rocker Neon Red	1	(KU99H)
S2	Single Rocker	1	(CL91Y)
	Mains Warning Label	1	(WH48C)
	HV Warning Label	1	(DM55K)
OPTIONAL:			
	10H 100mA Choke	1	(ST28F)
	5-Way 25VA Terminal Cover	1	(DM30H)
	Plain Stripboard	1 pc	(JP53H)

A New Approach TO BUSINESS PHONE SYSTEMS

Neil Lewis takes a look at the design of a new PBX and the complexities of interfacing electronics to the telephone line.

This month sees the launch of Maplin's new catalogue featuring many new components and products, including a new design of telephone PBX (Private Branch eXchange). The EasyCall T1000 and T1000M is designed for use by SoHo (Small Office / Home Office) enterprises, workshops, retailers, suppliers and automated dial-up information service providers. It automatically answers incoming calls and plays a user-recorded greeting message, for example "Thank you for calling XYZ Limited..." and invites a telephone keypad response from the caller; "Please dial 1 for sales 2 for accounts...". The caller's response dictates which department (extension) the call is automatically routed to. This system is called an 'Auto Attendant' with 'Direct Inward Access'. The major feature of EasyCall's T1000/M is it's innovative desktop design which has integral BT-style sockets for the extensions. Standard telephones plug- directly into BT-style sockets on the product's rear panel. Fax machines and modems are fully compatible with the T1000/M, as well as answering machines which, added to each extension, prove ideal for implementing voicemail facilities. The customer will therefore find that he or she can easily – and for relatively little cost – create a comprehensive and totally automatic business telephone system without the need for tools or technical knowledge. In this article we will take a look inside EasyCall's T1000 Call Management System and find out more about some of its features. But beforehand, it's worth taking a look at some of the problems that face engineers when designing today's telephone apparatus.



In the Beginning

Alexander Graham Bell's experiments in the 1870's, lead to the device we now take for granted the world over: The telephone. The fast growth of the telephone network meant that a protocol was quickly established, the basic format of which hasn't changed to this day. So despite the fact that the telephone system could have been improved since its introduction, it would have been impossible to update millions of subscribers' equipment. Let alone the huge network of cabling and exchanges. As a result, new designs of Telecommunications Terminal Equipment (TTE) have to remain 'backward compatible' to this somewhat antiquated system. Early designs of subscriber telephones used bulky transformers and electromechanical bells, which required high voltages to drive them. Today's electronic versions draw little current and require only a fraction of the available voltage to activate their ringer circuits, but they still must work with the same exchange phone system as their predecessors.

Take a look at a phone line and you will see that there are just two wires. One would be forgiven for thinking that making a telephone call is just a simple process of connecting two circuits together at the exchange and that the whole system is pretty simple. The fact is, despite its age, the Public Switched Telephone Network (PSTN) is an ingenious and quite complex system. The two wires that connect a phone to the Central Office (CO) – often referred to as the 'Exchange' – not only carry speech, they also carry the ringing 'signal' and power for the 'loop', which is used to signal whether the phone is on or off hook. These different signals take advantage of the fact that AC can easily be 'superimposed' on DC. The telephone line is essentially a two wire, balanced, AC transmission line. The CO supplies – 48V DC to the TTE, often referred to as the VBAT supply. When the device is 'on-hook' there is no loop connection and no current flows. But as soon as the telephone's receiver is lifted, a built-in cradle switch completes the loop – known as the 'Local Loop' – and allows current to flow. The CO recognises this new condition, at which point the speech path is completed. The CO must allow for a wide window of voltages and currents since telephone lines can suffer losses due to their considerable length. The CO signals an incoming call by sending an 80V AC ring voltage. A telephone's bell is connected to the line via a capacitor which blocks the DC power but allows the AC ring voltage to pass, causing the bell to ring. The ring signal is a sine wave with a frequency of around 25Hz, and was chosen to ensure a good drive for electromechanical 'clappers' in the days when telephones were fitted with bells. As soon as the DC path is completed (when the called party answers their phone), the CO must terminate the ringing signal instantly so that the 80V AC cannot be heard as a deafening, and potentially damaging, 'buzz' in the telephone's earpiece. The speech circuit is then connected.

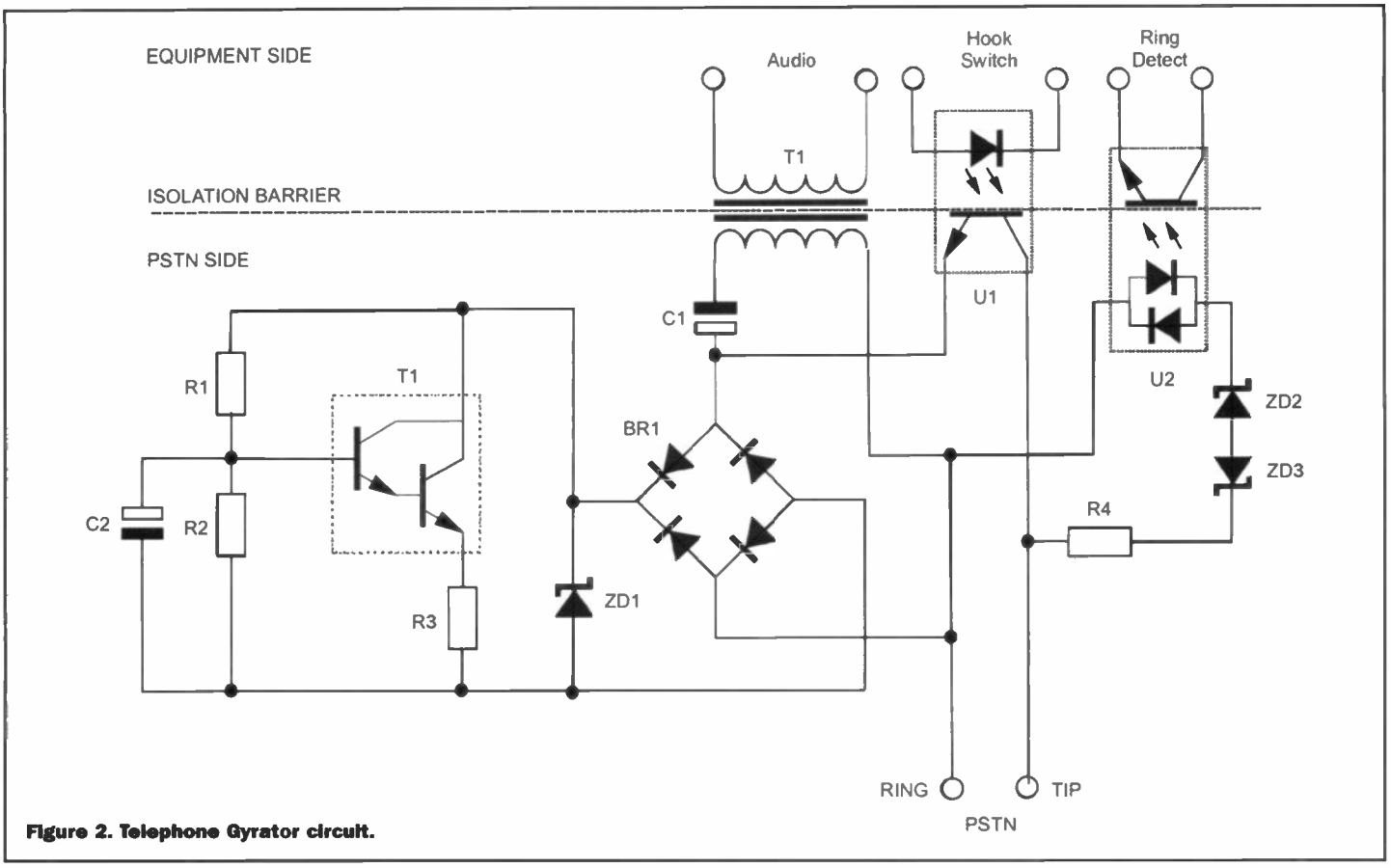


Figure 2. Telephone Gyrator circuit.

In the past, dialling was achieved by quickly connecting and disconnected the DC loop. Or, put another way, by going on-hook and off-hook in quick succession, creating pulses of the same number as the digit being dialled. For example, four pulses to dial the number four, nine for the number nine and ten in the case of zero being dialled. This method has now been replaced by Dual Tone Multi-Frequency (DTMF) dialling. As the name suggests, an audio frequency signal made up of two simultaneous tones at pre-set frequencies is recognised by the CO as the digit to be dialled (see Figure 1).

	1209Hz	1336Hz	1477Hz
697Hz	1	2	3
770Hz	4	5	6
852Hz	7	8	9
941Hz	*	0	#

Figure 1. DTMF tone frequencies

Interfacing to the Line

Engineers designing telephone equipment like PBX's, fax machines, modems, etc., have to take into account the PSTN's weird voltages and signals. Plus there's another problem: The circuitry within the terminal equipment must not be directly connected to the telephone line. A safety barrier is required by telephone companies, between the line and the TTE. This is to provide a two-way protection for both the user and for the PSTN. Hazardous voltages that may be present within the customers' apparatus under fault conditions must be prevented from reaching the PSTN and dangerous voltages present on the PSTN must not reach the customers' TTE. After all, a significant risk of shock or fire is presented, for example, during an electrical storm or if telephone cables were to come into contact with high voltage electricity cables at any point between the CO and the subscriber. The barrier should be capable of isolating at least 3kV.

Gyrator

So, how exactly does equipment interface to the PSTN, whilst keeping circuitry totally isolated from the network and without using heavy, bulky transformers? Firstly, the transformer used to create an 'off-hook' condition can be replaced by its electronic equivalent. The load and inductance that a transformer presents to the line can be easily replicated by a 'Gyrator' circuit, which uses just a handful of components (Fig 2). It can be switched into circuit using an optocoupler (a light sensitive transistor optically coupled to an internal LED light source). So now the line can be 'seized', and an off-hook condition presented to the CO. But how is the ringing voltage detected? Remember, this is an 80VAC sine wave signal and there must be an isolation barrier in place here, too. Again, the easiest and most common way is to use an optocoupler, which can be placed across the telephone line via a series current limit resistor. Engineers also usually add a zener diode, which clamps the voltage to within a suitable range for the optocoupler device. When the CO sends a ring signal, the transistor inside the optocoupler will conduct. From this, a 5V logic pulse can then be generated to signal a ring condition within the TTE's circuitry.

We now have the ability to detect a line that is ringing, then seize and hold the line as a result. But we still need to send and receive speech or data while maintaining isolation from the network. This can easily be achieved using a small audio frequency transformer and types are available which provide the necessary degree of isolation and can pass good quality speech and high speed data.

So, one might ask; if a transformer is required after all, why implement the gyrator circuit mentioned earlier? It's all down to size and weight. A transformer capable of sinking the current from the CO would have to be big, heavy, and relatively expensive. Design engineers therefore favour the gyrator circuit. However, the winding of a small audio transformer will be damaged if it is not protected from the high current on the line. The simple addition of a DC blocking capacitor (C1 in Figure 2) will achieve this.

All-In-One Solution

When the British Approvals Board for Telecommunications (BABT) issue a 'green spot' approvals mark for manufacturers' TTE it means that they have certified the results of stringent tests relating to operating parameters, termination characteristics and safety. To help speed-up product development time, an all-in-one solution exists for interfacing equipment to the telephone network. A Data Access Arrangement (DAA) is a module that can be soldered into the main circuit. This component provides everything necessary for interfacing equipment to the telephone line, for example audio to – and from – the line, a gyrator circuit, ring detection, loop current monitor, etc. DAA's have become a popular solution for manufacturers of modems, in-store credit card EPOS terminals, and Digital Televisions – including Set-top Boxes (for transmission of internet data and 'Pay Per View' subscription information). DAA's can be also used as Central Office Interface Circuits (COIC's) in voice equipment like answering machines and PBX's. Most DAA's can be configured externally by 'programming components' (usually a handful of resistors and capacitors) to provide easy matching to telephone networks in a number of different countries.

The T1000 – How it Works

Once interfacing to the PSTN has been correctly accomplished, the resultant audio can be used in the desired way. In a PBX like the T1000/M, the audio is switched between extensions using solid state switches or relays. It's important to remember that, for each extension on a PBX, the same operating voltage and signals that are generated by the CO have to be 're-generated' by the PBX device internally. Most PBX systems require a certain amount of expert installation – even so called 'self-fit' ones, however the EasyCall T1000 and T1000/M have been designed to sit on a desktop and plug into a standard BT-style socket, more like an answering machine than a traditional PBX. The free-standing, easy to set-up nature of the product is further demonstrated by the way in which the extension phones – or answering machines – are then plugged directly into sockets on the rear of the unit.

At the heart of the T1000/M PBX is a microcontroller that controls all of its functions including the Auto Attendant and the Direct Inward Access sequence.

As far as the user is concerned, the initial setting-up the PBX is simple. They record the out going greeting and menu option messages using the phone connected to extension port number one. Voice sensing circuitry simplifies the processes, by automating the record sequence and by using 'cue tones' similar to those on an answering machine. The T1000/M stores the messages on audio chip that retains speech even when the unit is disconnected from the mains supply, even without the need for a back-up battery.

In everyday use, both the T1000 and T1000M are 'transparent'. So if you pick up a receiver on a telephone connected to one of the extensions, you can immediately access the 'exchange line' without having to dial '9' or press any buttons (provided, of course, that there isn't a call already in progress to or from another extension). And, due to the fact that calls automatically arrive at the correct destination, thanks to the Direct Inward Access system, complicated call transfer procedures are not required.

The interesting use of a separate dual-rail AC adaptor (supplied with the T1000 and T1000M) enables power supply circuitry to produce all of the voltage rails, including the negative VBAT voltage to drive the extension ports. A module capable of delivering a powerful 25Hz sine wave output generates the ringing voltage.

To Conclude

Whilst it may appear that a telephone is a relatively simple device, a closer look will prove otherwise. For those with more than a passing interest in such technology, books will provide a safe way of learning more about this interesting subject. Experimenting with equipment connected to the telephone line is not recommended and is dangerous for both the experimenter and for the phone company. Products like the EasyCall T1000/M have passed a number of stringent tests to attain BABT approval and manufacturers invest in expensive test equipment that simulates CO lines, to enable testing during product design and development. Anything connected to the PSTN must include an isolation barrier and present the correct 'load' characteristics to the central office. Its worth remembering that telephone companies can monitor each exchange line at the CO.

SPECIFICATION

Size:	55 x 176 x 231mm
Colour:	polar white
Supply:	230V plug-in AC adaptor (supplied)
Telephone line connection:	standard BT-style plug (431A)
Extension sockets:	standard BT-style sockets (603A)
REN:	1
Out-going messages:	user recorded, digital storage

Product	Order Code	Price inc.VAT
T100 plug-in PBX with auto attendant	KL14Q	£249.99
T1000M plug-in PBX with auto attendant and facility for music-on-hold	KL17T	£279.99
Recommended Accessories		
10m telephone extension cord	BD13P	£6.99
10m telephone extension kit	BD05F	£7.99

TECHNOLOGY WATCH

with Martin Pipe

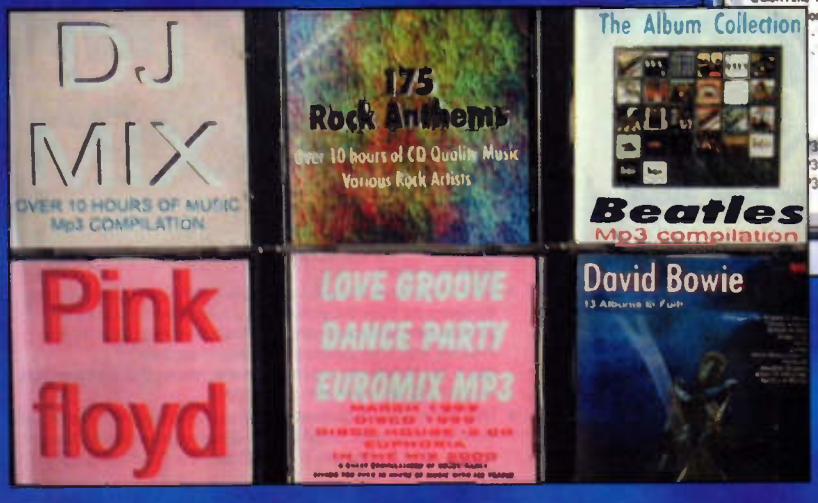
Unless you've been living on Mars for the last few months, you'll be aware of all the hype surrounding the MP3 compressed audio format. Log onto the Internet, and a quick search will reveal hundreds of often-erratic FTP sites offering MP3 files for download. DJ remixes, Mozart, Europop or Radiohead - it's all out there somewhere! Most of these files are illegal bootlegs of commercial CD-sourced material, but an increasing number of legitimate sites offer free demo tracks from unsigned performers. One of these latter sites made $200 million when it made an appearance on NASDAQ. Not bad for an organisation that has, to the best of my knowledge, not made a cent in profit! Such is the interest in MP3, which has all kinds of implications as far as music delivery is concerned. Soon, you will be able to buy music over the Internet - enter your credit card details, and the track of your choice will wing its way to your hard disk. Data rates will need to improve first of all, but cable modems (community-specific IP music 'jukeboxes', anyone?) and satellite delivery systems will undoubtedly help.

Originally developed in Germany, the lossy MP3 compression system can reduce a PCM audio file (a WAV/AIFF file or CD track, for instance) to a tenth of the original size, whilst retaining all of the original's sonic essentials. MP3, which is derived from the MPEG audio standard, supports a variety of data rates, compression ratios, resolutions and sample rates. If stereo isn't needed, then you can opt for mono at half the data rate. Extremely flexible, in other words. MP3 achieves its impressive efficiencies by discarding information that cannot be perceived. It relies on the fact that the ear can only hear sounds above a certain threshold. The level of this threshold is dependent upon the frequency of the signal, and is at its lowest point in the midrange (around 2 to 5kHz). Below and above these frequencies, ears become progressively less sensitive. In addition, some sounds will mask out others close in frequency but lower in amplitude.

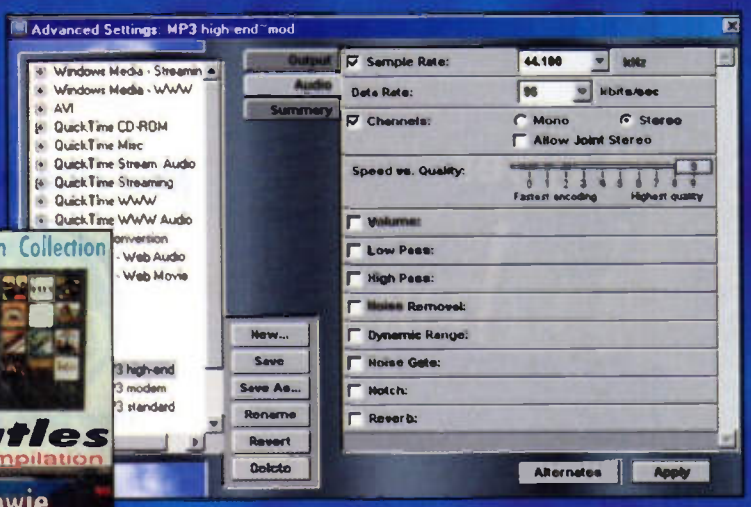
The audio signal is split into 32 sub-bands by filters, each of which has the same fixed bandwidth. Next, the thresholds are determined for each sub-band by examining the amplitude of each sub-band, and the immediately-adjacent ones. Any signals above these thresholds are encoded; the others are discarded. During playback, the audio signal is synthesised out of these encoded spectral components. This system, known as PASC (perceptual adaptive sub-band coding) is used in all variants of MPEG audio encoding, including MP3 and the slightly less-compact MP2 format specified by VideoCD and DVD two-channel audio. PASC's basic principles are also adopted by other compressed audio systems, including Dolby Digital and Sony's MiniDisc. There are some differences, though. MiniDisc's ATRACS audio system, for example, has a fixed data rate of 285.3kbps and 52 audio sub-bands.

The lower-quality MP3 files are suitable for real-time 'streaming' playback - although other codec technologies, such as the latest RealAudio, are better-optimised for the delivery of reasonable audio at low bitrates. It's at the other end of the spectrum where most of the interest lies. There's little perceptible difference between a 128kbps stereo MP3 file and the CD-sourced original. Although 128kbps is too high a rate for Internet streaming, the file can be transferred to the PC for subsequent real-time replay. A four-minute song could theoretically be downloaded in less than ten minutes with a 57.6kbps modem, although in the real world the average user will wait for at least twice as long.

At many computer fairs, you can purchase - 'under the counter', naturally - highly-illegal pirate CDs containing complete music collections. These discs, which typically sell for less than £10, can contain the complete recorded works of a particular artist. I've seen Pink Floyd, Jimi Hendrix and Bowie collections amongst others. A



Just some of the highly-illegal MP3 pirate CDs being sold by the smaller traders at computer fairs. The sound quality tends to be rather variable, while the CD-R media that tends to be used is of rock-bottom quality. Caveat emptor!



One of the highest-quality MP3 codecs has been developed by the Fraunhofer Institute in Germany. This one has been included with Terran's Media Cleaner 4 - a highly-regarded file optimisation and compression software suite for multimedia developers.

frequently-seen Beatles 'MP3' compilation has a pretty user interface, but was in fact put together before MP3 technology had become available. Instead, the 22kHz-sampled audio was compressed with a 1995-vintage ADPCM codec. It sounds rather nasty, and suffers from noticeable distortion, limited top-end and - even if you transfer the files to your hard disk first - plenty of annoying 'pops' and 'squeaks'. All of the titles I've seen have been supplied on unbranded blank CD-Rs of extremely dubious quality, and don't read reliably on all CD-ROM drives. Even so, one can understand why the music industry now sees MP3 as the biggest piracy threat since the invention of tape recording...

So how were the songs converted into MP3 format in the first place? Basically, a track from the CD is 'grabbed' via a CD-ROM drive that supports digital audio extraction (DAE) and stored on the hard disk as a 'raw' 16-bit 44.1kHz PCM WAV file. The Internet is awash with freeware and shareware 'CD rippers' - others are built into programs like Adaptec's Easy CD Creator mastering software. The WAV file can then be compressed off-line by a MP3 conversion program. There are plenty of these around for Windows 3x/9x/NT, MS-DOS, Linux and MacOS. Some, such as MusicMatch's Jukebox program for Windows 9x, will also do the CD ripping for you. MP3 conversion is seldom a real-time process, and the speed of the mathematically-intensive conversion is determined primarily by the power of your computer.

The best converters, notably the commercial Fraunhofer MP3 Encoder package (PC and Mac), will allow you to trade conversion quality against speed. If you're prepared to wait for a slower conversion to run its course, it is possible to get excellent quality at a lower data rate. Although 128kbps is a common rate, a decent encoder will allow you to obtain similar quality at 96kbps. This latter rate works particularly well with recordings made off radio, which are less than CD-quality to start with. I am surprised that 96kbps is not more common, since it reduces download times quite considerably. An important issue if you're downloading a demo song from a group you've never heard before! Some MP3 sites are, mercifully, adopting RealAudio streams for preview purposes. If you like what you hear, you can tie up your modem with the full MP3 download.

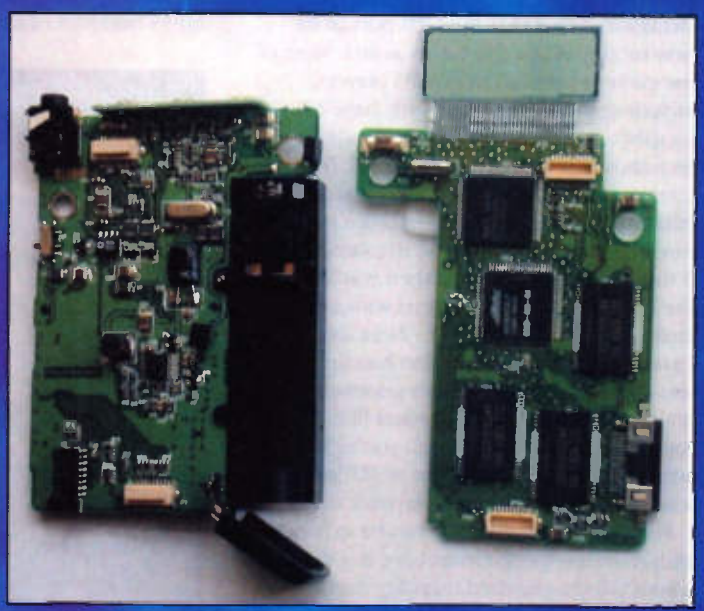
The extremely sucessful £150 Rio PMP300 from Diamond Multimedia, available from Maplin amongst others. It took us weeks to get hold of this review sample - 'Diamond simply can't make 'em fast enough', or so its press agent tells us...

Once the file is on your hard disk, it can be replayed at will through the PC speakers, or through your hi-fi system if its auxiliary input is fed by the soundcard's 'line out' terminal. It's also possible to 'expand' the MP3 file into a raw PCM WAV one. The WAV file can then be burnt, with several others if need be, to a CD-R as a 'Red Book' audio disc. Nullsoft's popular Winamp MP3 player offers an 'output to file' option. More recently, a fourth way of experiencing MP3s has become popular. This is the stand-alone personal audio player, the first of example of which quietly appeared over a year ago. Sales of this player (Sangean's MP3man) never really took off - it was quite expensive, and distribution/publicity was not what it could have been.

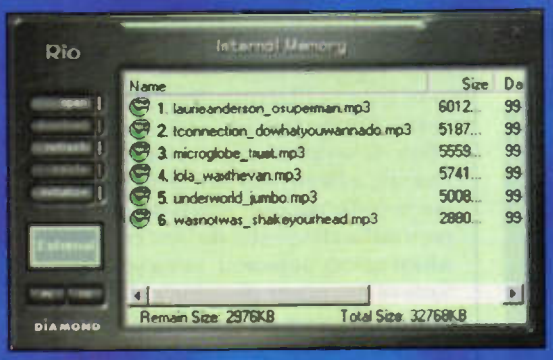
The world's second MP3 player came, thankfully, from a larger organisation with a lot of clout behind it. This is the Rio PMP300 from Diamond, a company best known for its graphics cards. Diamond heavily promoted the Rio, much to the chagrin of the music industry. Indeed, the RIAA (Recording Industry Association of America) tried to put a stop to the Rio through the US courts. Its action failed, and a spokesman said that Diamond is suing the organisation for loss of earnings. Since these landmark happenings took place, other manufacturers have emerged from the wings. Players have been announced by a host of other 'big-name' companies including LG (despite plenty of promises, we still haven't received a review sample of its product), PC motherboard manufacturer Pine, and Samsung. Even Sony is reputed to be looking seriously at MP3 players, although it is currently collaborating with Philips on a copyright-sympathetic alternative to MP3.

The basic idea behind these players is that you download the songs - whether sourced from the Internet or your own CD

Expect to see a lot more MP3 players in the shops soon. This model, the D-Music from motherboard manufacturer Pine, has yet to make an appearance in the UK.



The dissassembled Rio player - there's more circuitry in these gadgets than you would believe. Future cheaper models will, no doubt, employ custom LSI chips to reduce the component count.



This is the download/song manager software supplied with the Rio. The screen shown here tells you what songs are currently loaded in the player's memory.

Side-by-side comparison of the Sony MZ-E55 and Diamond Rio PMP300. Note the difference in size (and expense) of the SmartMedia memory card and recordable MiniDisc.

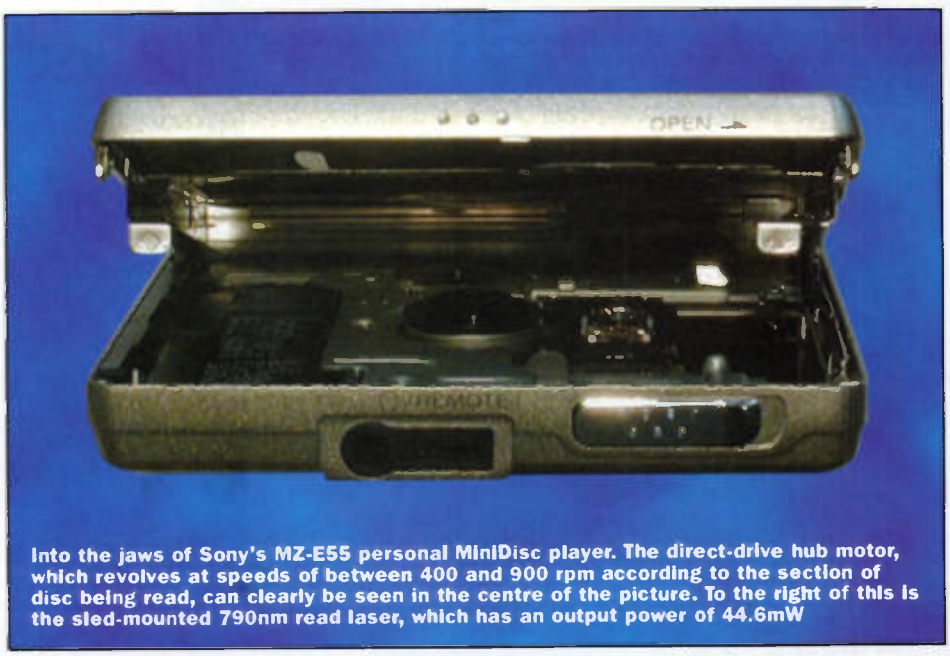
collection - from the PC into the player's non-volatile flash memory. The player can then be detached, and the transferred music enjoyed 'on the move'. All of the players produced so far have employed a parallel-port connection for data transfer, and are hence only good for PCs. However, the latest Rio PMP500 model announced by Diamond has a USB interface. Not only is this a good deal faster than the parallel port, but it's also Mac-friendly (well, if you've got a very recent G3 Mac, that is...). The speed of transfer is a critical issue. Remember that every time you want to listen to a new song, you'll have to wait for it to zap across the PC link. In most cases, you'll have to delete an existing song from the player's memory first.

The Rio takes just under a minute to transfer a 4 minute song across to its memory - in other words, it's rather slow. Diamond claims that the USB port of its new model will be five times as fast. Most of the current generation of MP3 players, including the Rio PMP300, only have 32 megabytes of memory - enough for just over 34 minutes of 128kbps MP3 music. This, of course, is a severe restriction. If you opt for 96kbps, then you'll be able to store just over three quarters of an hour in the same 32Mb. If the material is in mono, then you'll get the hour-and-a-half associated with an analogue C90 cassette tape. Note that Diamond's Rio range will also handle the less-compact MP2 audio files generated by real-time MPEG audio recorders like Iomega's RecordIt - although you're best advised to recompress them as MP3s if you want the longest-possible playback times.

Fortunately, the PMP300 can be expanded with more memory. On its base is a slot for a SmartMedia-standard memory card. Unfortunately, these devices - which are normally associated with digital cameras - are rather expensive. A 32Mb card costs around £60, compared with £2.50 for a blank 74 minute MiniDisc or £1.50 for a reasonable chrome C90. The latter two media can, of course, be easily changed if you want a change of music. Eject one MiniDisc or cassette, and replace it with another - it's a good deal quicker than messing around with data transfers. What's more, you don't have to have a PC handy.

On the other hand, solid-state audio storage has its advantages. For a start, battery life is excellent because there are no power-hungry motors or solenoids. The Rio, for example, will deliver around 15 hours of playback from a single AA alkaline cell. Sony's current state-of-the-art pocket MiniDisc player, the MZ-E55, will manage 10 hours on a similar power source. A modern high-end personal cassette player, however, will give you only five to six hours before the battery dies. Another advantage of the MP3's freedom of moving parts is its complete freedom from wow or 'skipping' when you're on the move. Cyclists and joggers take note! The compact size of the Diamond player - it has the same volume as a cigarette packet - is an advantage here too.

The Diamond Rio PMP-300, which is a recent addition to Maplin's product range (its order code is UA78K), is a neat and well-designed device. The controls will be familiar to anybody who's operated a CD player - there are buttons for track access/cueing as well as intro-scan, track repeat and random track selection. You can also select part of a track for multiple playback - this can be useful for long passages of classical music. All track-related functions, together with MP3 data rate and battery life information, are displayed on a very readable LCD screen on front of the unit. It's just a shame that the MP3 filename isn't shown...



Into the jaws of Sony's MZ-E55 personal MiniDisc player. The direct-drive hub motor, which revolves at speeds of between 400 and 900 rpm according to the section of disc being read, can clearly be seen in the centre of the picture. To the right of this is the sled-mounted 790nm read laser, which has an output power of 44.6mW

Other controls adjust volume level, and select one of four preset equaliser curves. An 'menu' button tells you how much internal (and, if fitted, external) memory is available. On the base of the player is a slot for the SmartMedia card, and the battery compartment. The standard 3.5mm stereo headphone socket is located on the top of the player. It doesn't like right-angled plugs, which can foul the similarly top-mounted 'menu' key. Fortunately, a slide switch on the left-hand side of the player will 'lock out' the controls. Beneath this switch is a rather fragile-looking multi-pin connector for the parallel port cable, which features a printer-pass-through port and can hence be connected to your PC at all times.

The player is also supplied with MP3-transfer software, a demo copy of the MusicMatch jukebox program (no MP3 conversion above 96kbps) and a collection of MP3 songs from the popular MP3.com site. There are some 'in-the-ear' headphones in the Rio box, but to be quite frank their sound quality is awful. The problem is that a 1.5V power source places all kinds of restrictions on the headphone amplifier, not least a restricted potential voltage swing. As a result, efficient headphones are essential - and that's about the only tangible quality of the supplied devices. We tried Sennheiser's HD470 'phones, and noted an instant improvement in the amount of detail, coupled with a reduction in colouration. The HD470s are an 'open' design, which means that you can still hear sounds from the outside world. This type of headphone is essential for those who must have music while they're riding their bikes along public roads.

At the same time we had the Rio, we were also able to audition Sony's MZ-E55 MiniDisc player. This £250 top-of-the-range device isn't much bigger than one of the discs, and has roughly the same volume as the cheaper Rio. The controls (track select, play/stop, volume level/limiter, bass boost) are located around the sides of this handsomely-finished player, but are rather small and fiddly. On the plus side, a remote control unit with comprehensive multi-function (track time/name, battery life, etc.) electroluminescent display is supplied. Into this can be plugged the headphones of your choice. As with the Rio, you get a pair of those horrible in-the-ear types (which have the tendency to slip out). It must be said that the Sony models do sound a lot better than the ones supplied with the Rio. Although the E55 is supplied with an internally-fitted rechargeable NiMH battery pack and charger, you also get a screw-on holder that accepts standard AA-type alkaline cells. Unfortunately, this adds to the bulk and spoils the player's elegant lines.

But now the 64 megabyte question - how does the sound compare? We 'ripped' some CD tracks to a PC's hard disk using a SCSI CD-ROM. The WAV files were then loaded into, and played from, the Cool 96 shareware audio editing program. The SP/DIF output of the PC's soundcard fed a Sony JA3ES MiniDisc deck, which recorded the datastream onto a blank 74-minute disc. This 'test disc' was subsequently inserted into the E55 player's clamshell-like loading mechanism. We encoded the same WAV file into a 128kbps MP3 using the Fraunhofer MP3 codec, and downloaded that into the Rio. Headphone listening was experienced via the Sennheiser HD470s, and a pair of 'closed' Sony MDR-D33s. In each case, we fed the audio output into an Arcam Alpha 10 amplifier and Acoustic Energy AE109 speakers. Comparison with the original CD source was undertaken courtesy of an Arcam Alpha 9 CD player. We found that the E55 had the sonic edge over the Rio - there was little deviation from the original source, and the excitement of the music was conveyed accurately. The soundstage of the Rio, conversely, was somewhat muddled. Finer details were missing, and the overall experience could be described as rather 'flat' and 'uninteresting'.

Nevertheless, in most respects the Rio's sound surpasses that of analogue personal cassette players! We then switched the JA3ES into DAC mode (press 'record' with no disc present), and fed it with the soundcard's SP/DIF output. Playing the MP3 file via WinAmp into the Arcam/Acoustic Energy combo brought back most of the missing information - clearly, the DAC and analogue audio circuitry of the Rio lets the side down. But then again, Sony has over 50 years of audio experience to its credit. Out of interest, the E55's shock resistance is excellent. In use, it's just as good as the solid-state Rio. Why? The ATRAC datastream is stored in a buffer memory, which is good for 40 seconds of playback. We gave the player a rigorous shaking, yet playback continued as normal.

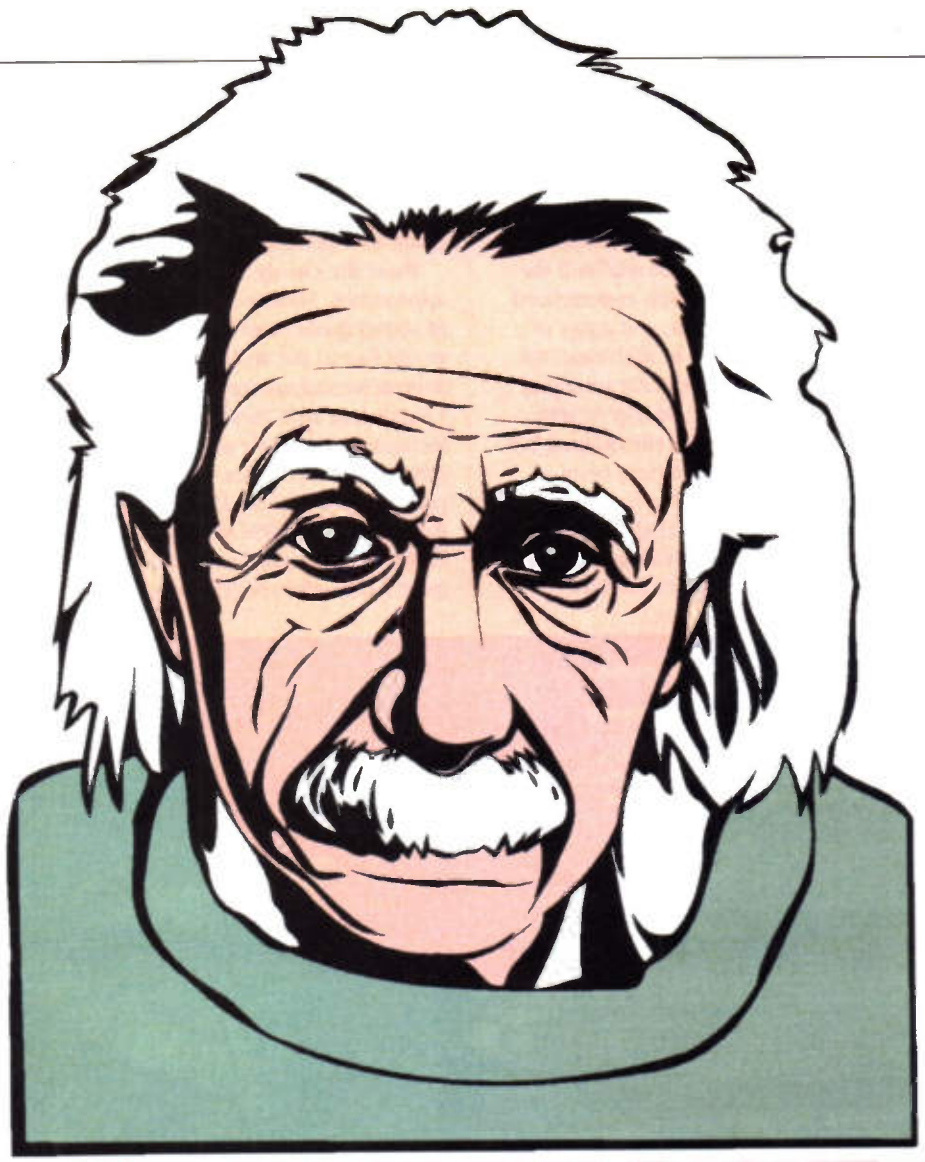
There are clearly benefits to both approaches. MiniDisc has the edge in terms of sound quality and flexibility, though. We would like to see an MP3 player with an alternative storage medium - say, an Iomega Clik! disk or IBM Microdrive. This would increase the amount of playback time and quicken transfer times. My own ideal MP3 product would be a CD player-like device that would read MP3s straight from CD-ROMs. Hours of audio playback from a single CD is quite a powerful concept (not least for party animals!). An American company by the name of the Memory Corporation announced something similar some time ago, but little has been heard since. It's mooted 'Music Store' has a CD drive, 6Gb hard disk and dockable 'SoulMate' MP3 player. Basically, audio tracks are ripped from audio CDs and stored on the hard disk as MP3 files. Those files can be transferred to the MP3 player, which can be detached from the main unit and used on the go. The SoulMate is said to store an hour's worth of FM-quality MP3 audio, so 32Mb is the likely memory capacity. ELECTRONICS

To get the best from a portable audio device, buy some replacement headphones. These £35 Sennheiser HD470s are superior to any factory bundles. They're of an 'open' design, which is ideal for 'safe' portable use.

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

Order Code	Product	Price inc. VAT
UA78K	Diamond Rio PMP300	£149.99
UW75S	LG FD330 MP3 Player	£149.99
UW76H	LG FD770 MP3 Player & Radio Cassette	£199.99

See the latest Maplin Catalogue for more information.



WAS EINSTEIN RIGHT?

PART 1

In part 1, Graham Marett discusses the birth of Special Relativity.

We often think of art as being subjective ('beauty is in the eye of the beholder'), science as being objective ('you can't argue with the facts'), and current affairs as being a mixture of the two depending on one's point of view (politicians may be reviled or revered, depending on one's political leanings).

Some may consider Damien Hirst and the Turner prize to be at the cutting edge of contemporary art, while others may consider that they lie beyond the artistic pale. Science often provokes a similar division of views: we may love or hate nuclear power, genetically modified food, mobile phones, and a host of other benefits (or curses) of modern life. Nevertheless, we usually have no difficulty distinguishing between the 'science' (how nuclear reactors, genetics, and modern communications technology work) and the 'effects of science' (how we want the knowledge to be put to use).

But do the supposed 'facts' of science also have a point of view? Certainly much of our science has a point of view centred on our own planet, with an expectation that things may be very different elsewhere. In the life sciences, for example, all living things on earth are believed to share a common ancestry, and carbon-based organic chemistry and the mechanism of genetic inheritance based on DNA and RNA are believed to be universal characteristics. Whether life elsewhere in the universe would follow a similar pattern is a hotly debated issue. A surprise discovery from interplanetary probes has been the realisation that geological processes on earth are also rather unique (at least within our own solar system). The dynamics of plate tectonics and sedimentary deposition seem to be very different or even absent on other planets and satellites (including our own Moon), for a variety of reasons (too hot, too cold, too gaseous, not enough atmosphere, too different chemically, and so on).

In physics, however, we like to think that things don't change much from place to place. The same force of gravity which pulls us towards the ground is also responsible for the stability of the solar system, as Isaac Newton realised (and to prove it he even invented a new form of mathematics called differential calculus, or 'the method of fluxions' to use his own terminology). That same gravitational force governs the motion of our sun in the Milky Way galaxy, the structure of the galaxy itself, and the interaction between the billions of other galaxies and exotic objects which make up the known universe.

Classical Physics Comes of Age

$$F = GM_1M_2/d^2$$

The force of gravitational attraction between two objects is given by the product of their masses divided by the square of the distances between them ('G' is the universal constant of gravitation).

Newton's Law of Universal Gravitation

Newton specifically acknowledged the all-encompassing scope of gravitational force when he formulated his law of universal gravitation, built on his concept of force as expressed through his three famous laws of motion. The application of Newton's laws to the unlocking of the secrets of the solar system was a crowning achievement of eighteenth and nineteenth century physics, and the sophisticated and complex computations required to calculate the trajectories of missiles, satellites and interplanetary probes depend on these laws to this day.

1. An object remains at rest or in a state of uniform motion unless acted upon by a force (law of inertia)
2. Force is the product of mass and acceleration
3. Action and reaction are equal and opposite

Newton's Laws of Motion

Newton constructed his ideas as a logical extension of the Copernican Revolution, which had dethroned the earth from the centre of the universe by demonstrating that the sun was the hub of our solar system. Newton was an early advocate of the central idea of relativity, that the expression of the fundamental laws of physics should be the same for all observers, regardless of their particular location in the universe.

Michael Faraday and James Clerk Maxwell

Another thread of scientific endeavour also reached its pinnacle at the end of the nineteenth century. The work of many scientists, and notably our own Michael Faraday, had led to a growing understanding of electricity and more particularly the strange links between magnetic and electric forces. The culminating achievement was the work of the great Scottish physicist James Clerk Maxwell, ranked by many as

second only to Newton himself for his fundamental contributions to scientific knowledge. Maxwell's most important work was in electromagnetic theory, and he constructed the four elegant and beautiful equations which bear his name.

$$\text{div } D = 4\pi\rho \text{ (Gauss's law)}$$

$$\text{div } B = 0$$

$$\text{Curl } H = 4\pi j + \frac{1}{c}\frac{\partial D}{\partial t}$$

$$\text{Curl } E = 4\pi j - \frac{1}{c}\frac{\partial B}{\partial t}$$

Maxwell's Equations
For a full apreciation it helps to know your divs and curls!

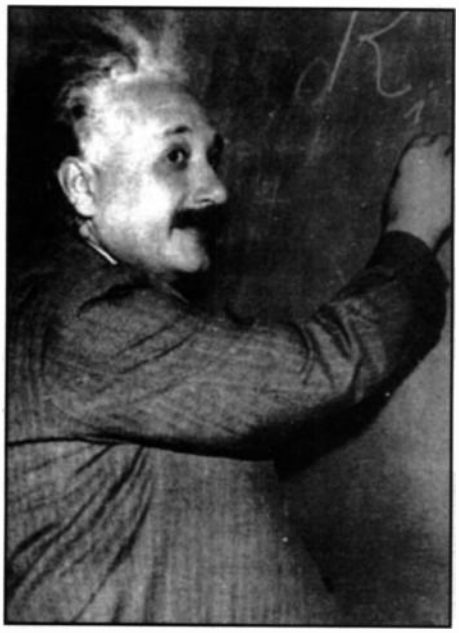
Although of similar importance to Newton's laws of motion, Maxwell's equations are much less well known because their understanding requires a knowledge of vector algebra which lies beyond the scope of high school mathematics. The equations demonstrate the perfect symmetry between electrical and magnetic forces, which are shown to be different manifestations of a single electromagnetic field. Perhaps the most startling conclusion to Maxwell's work was a solution of his equations which predicted that electromagnetic fields could propagate through space at the speed of light. This was an as-yet undiscovered phenomenon, but by the end of the nineteenth century the German physicist Heinrich Hertz and others had demonstrated the transmission and reception of radio waves, and shown that they do indeed propagate at the speed of light (and of course light itself was shown to be a form of electromagnetic radiation).

The exploitation of this discovery has been one of the wonders of 20th century science, and today we can hardly imagine a world without radio, television and the whole host of telecommunications technologies on which we have come to depend.

By the end of the last century it seemed as if the most important secrets of physics had finally been unlocked, and that future developments would largely be a matter of dotting the i's and crossing the t's as measurements were made to higher degrees of precision and the newly discovered laws of physics were put to practical use. It took the genius of Albert Einstein to show that this golden vision of the future was fatally flawed. He saw that the two great pillars of modern science, Newtonian mechanics and electromagnetic theory, were in conflict in a fundamental way which could not be fixed within the framework of classical physics.

Einstein's Revolution

How could such successful and widely used scientific theories be suspect? Einstein's remarkable conclusion was that there was no particular problem with the theories themselves: what caused the conflict was our underlying and unspoken assumptions about the nature of our universe. In Shakespeare's As You Like It, Jaques states in his famous speech in the Forest of Arden that 'All the world's a stage, and all the men and women merely players'. Einstein tells us that in the universe there is no stage but



only players, and that the cast of players includes the backdrop of time and space themselves. One person's time and space differ from another person's in ways which subtly affect the way the laws of physics interact between their two world views. Einstein showed that this was not merely a matter of abstract philosophical ideas, but had implications leading to phenomena which could be measured and quantified, and which could dramatically affect our lives.

Annus Mirabilis

Albert Einstein was one of the most creative intellects in human history. In 1905, his annus mirabilis, he published four research papers, each containing a great discovery in physics and destined to change forever our view of the universe. At the time he was not even pursuing an academic career, but was working as an examiner in the Swiss Patent Office. His special genius was his insistence on pursuing questions ignored by others. He once commented on why he had been able to make such important and fundamental discoveries, and said 'Normal adults do not stop to think about such concepts as space and time: these are things children ask about. My secret is I remained a child. I always asked the simplest questions. I ask them still'.

Einstein was also a master of the 'gedanken' (thought) experiment, in which ideas are pursued to their logical conclusion, regardless of whether practicalities would allow the experiment to be performed in real life. His work on relativity was triggered by such a thought experiment which occurred to him at the age of 16, and which continued to nag at his mind for many years. What, he asked himself, would be the consequences of travelling at the speed of light? What would it be like to race along beside a light beam as it sped across the universe? He soon realised that such a concept had far-reaching implications which challenged the laws of physics.

One consequence was that relative to the observer the light beam would appear stationary (just as a book you are reading on a train appears to be stationary relative to you, although both you and the book are travelling along with the train). Einstein saw that this immediately posed a fundamental problem. According to electromagnetic theory, a stationary force field had to be associated with fixed electrostatic charges or magnetic dipoles. According to Maxwell's equations the light beam was an electromagnetic wave propagating through space, but where were the charges and dipoles associated with Einstein's 'stationary' viewpoint?

There was another problem. The electromagnetic wave solution of Maxwell's equations specified that the waves would propagate at the speed of light (commonly designated as 'c'), but did not specify what this velocity should be referred to. Was it relative to the source of the radiation? Or to the observer? Or was it relative to the all-pervading ether which was imagined to fill space and act as the medium for wave propagation? This last idea highlighted yet another intellectual difficulty: if electromagnetic radiation propagated as waves (and there was compelling evidence that it did), what exactly was waving? We are used to the idea of waves in water, or of sound propagating as waves in the air, but what can wave in empty space?

The Michelson-Morley Experiments

Solving these last questions had been the objective of one of the most famous experiments in the history of physics, when Albert Michelson and his colleague Edward Morley attempted to measure the earth's speed through the ether by comparing light beams travelling in perpendicular directions. Michelson was most famous for his accurate measurement of the speed of light, in an experiment which still stands as a monument to the power of detailed and careful experimental techniques, and which won him the first Nobel prize for science to be awarded to an American.

The negative results of the Michelson-Morley experiment puzzled scientists, but there is no doubt about its validity: the experiment was repeated at different times of day and year to eliminate the effects of the earth's orbit and rotation, and it has been repeated by other scientists many times since, to ever increasing degrees of accuracy. The result is always the same: no difference can be detected between the two measurements, and no conclusive evidence can be found regarding the earth's motion through the ether.

It is usually assumed that the Michelson-Morley result (announced in 1887) strongly influenced Einstein in his thinking, but in fact there is little evidence of this. Einstein preferred the power of abstract thought, and he saw experimental results merely as confirmation of the way he had concluded that things logically had to be. He was once asked what he would say if his theory (of relativity) was not supported by the evidence, and replied that 'I would have to pity our dear Lord. The theory is correct all the same'. Of course Einstein and God did not come into conflict, and Einstein's theories have stood the test of time and been verified to a degree almost unique in any branch of science.

Einstein did not, as is popularly imagined, base his theory on the idea that 'all things are relative'. In fact it is said that he considered naming his ideas the 'invariance theory', since he was concerned with investigating properties of the universe which would remain unchanged under different conditions of motion and gravity.

PROJECT

Using Voltage REFERENCE & TEMPERATURE SENSOR ICS

PART 3

In this final episode of this 3-part series, Ray Marston shows how to use a further selection of popular 'temperature sensor' ICs.

Parameter	TC02	TC03
Supply voltage range	3.0V to 12V	2.2V to 12V
Supply current (typ.)	40µA	40_A
Output source current (max.)	1mA	1mA
Thermal range	-20°C to +125°C	-20°C to +100°C
O/P voltage at -20°C	+300mV	-200mV
O/P voltage at +25°C	+750mV	+250mV
O/P voltage at +100°C	+1500mV	+1000mV
Non-linearity	±0.8°C	±0.8°C
Average O/P slope	10mV/°C	10mV/°C

Figure 1. Basic operating parameter values of the TC02 and TC03 temperature sensor ICs.

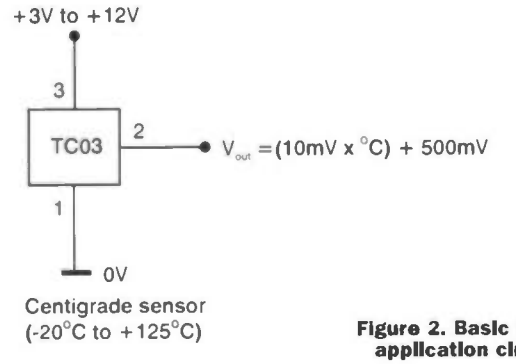


Figure 2. Basic TC02 application circuit.

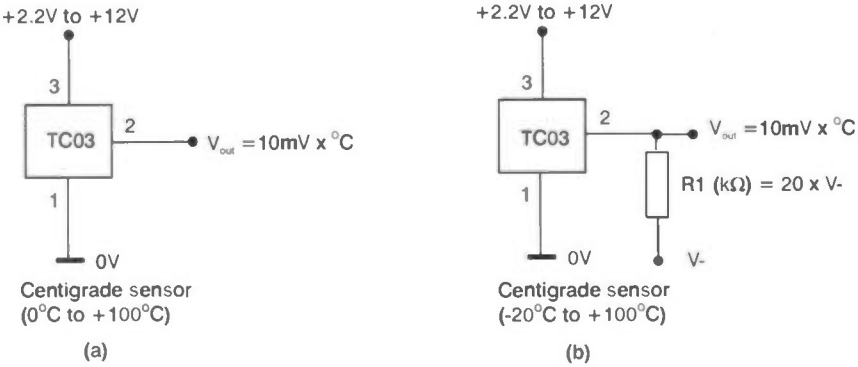


Figure 3. Basic TC03 application circuits (see text).

The first two episodes of this 3-part mini-series presented practical 'application' information on popular voltage reference ICs, current source ICs, and on three popular temperature sensor ICs manufactured by National Semiconductor. This month's concluding episode of the series gives practical usage information on four popular and widely available temperature sensor ICs manufactured by TelCom Semiconductor.

Miscellaneous Temperature Sensor ICs

Several companies other than National Semiconductor manufacture popular types of temperature sensor ICs; the best known of these is TelCom Semiconductor, who produce four very popular ranges of such devices. Two of these devices - the TC02 and the TC03 - are precision temperature-to-voltage converter ICs that generate a linearised output voltage that is proportional to the IC's temperature and has a slope of 10mV/°C. The other two devices - the TC07 and the TC622 - act as presettable thermal switches with complimentary logic-type outputs that change state when the IC's temperature goes above or below preset limits, which can be accurately set via one or two external resistors. The rest of this article presents practical usage information on these four devices.

The TC02 and TC03 (TelCom Semiconductor)

The TC02 and TC03 are precision temperature-to-voltage converter ICs that generate a linearised output voltage that is proportional to the IC's temperature and has a slope of 10mV/°C. Figure 1 lists the basic operating parameter details of the two devices.

The TC02 IC is specifically designed for use with a simple single-ended DC supply with an output voltage in the range 3V to 12V, and acts as a precision converter over the -20°C to +125°C temperature range; its output voltage equals (10mV x °C) + 500mV, and is thus 300mV at -20°C, 750mV at +25°C, and +1500mV at +100°C. Figure 2 shows the basic application circuit of the TC02 IC.

The TC03 IC is specifically designed to generate an output voltage that is directly proportional to temperature at a rate of 10mV per °C, over the -20°C to +100°C temperature range; its output voltage is thus -200mV at -20°C, 250mV at +25°C, and +100mV at +100°C. Figure 3 shows the IC's basic application circuits; if the IC is to be used only at temperatures within the range 0°C to +100°C, the simple single-ended circuit of Figure 3(a) can be used, but if it is to be used at temperatures down to -20°C the dual-supply circuit of Figure 3(b) must be used. In the latter case, the negative supply rail (V-) needs a value of at least -1.5V, and bias resistor R1 needs a value (in kilohms) of 20 x the V- value, e.g., 30k at a V- value of -1.5V, or 90k at -4.5V.

The TC02 and TC03 are widely available in a TO-92 packaging style, in which case their device numbers carry a 'VZB' suffix, as indicated in the package outline diagram of Figure 4(a). When using the TC02 or TC03, note that they have a very limited ability to drive capacitive loads; if they are used to drive loads greater than 50pF (between the output and ground), wire a 2k2 or greater resistor in series with the IC's output, as shown in Figure 4(b). If the IC is used in

an electrically noisy environment, wire a 0.1μF decoupling capacitor between the IC's V+ and GND pins, as shown in Figure 4(c).

The TC07

(TelCom Semiconductor)

The TC07 IC is a resistor-programmable solid-state thermal switch with complimentary logic-type outputs; it is designed to by powered from a 2.7V to 5.5V DC supply and consumes a typical quiescent operating current of 130mA; the device is intended mainly for use as an automatic temperature controller in power supply units and computers, etc., and its trip (activating) temperature and hysteresis value (deactivating temperature) can each be set ('programmed') via a single external resistor.

The TC07 is produced in two different 8-pin packaging styles (SOIC and MSOP), each with an option of three different temperature operating ranges; the TC07 is thus available in a total of six sub-variants, each denoted by a 3-letter suffix to the basic TC07 part number, as shown in the table of Figure 5, which also shows the pin notations that apply to the TC07.

Figure 6 shows - in block diagram form - the basic internal circuitry of the TC07. The IC houses a temperature-to-voltage converter of the basic TC02/03 type, and its output is fed to one input on each of a pair of Schmitt voltage comparators, which each have their other input driven by the output of an externally resistor-controlled dual voltage reference generator. The outputs of the two Schmitts are fed to the inputs of a SET-RESET flip-flop, which provides anti-phase logic-type outputs (Q and not-Q); when the outputs are active, Q is high and not-Q is low; these states are reversed when the outputs are inactive. The basic IC action is such that both outputs become active when the IC temperature exceeds a preset TSET (temperature) value, and remain active until the IC temperature falls below a preset HSET (hysteresis) value, at which point the outputs become inactive.

Figure 7 shows a basic way of using the TC07 as an automatic cooling fan controller, which activates the fan if the IC temperature exceeds a 'T_{SET}' value determined by R_T; once activated, the fan remains on until the IC temperature falls below an 'H_{SET}' value determined by resistor R_H. Alternatively, Figure 8 shows the circuit modified for use as an automatic heater controller, which activates a 12V heater unit if the IC temperature falls below an 'H_{SET}' value determined by resistor RH; once activated, the heater remains on until the IC temperature exceeds a 'T_{SET}' value determined by R_T.

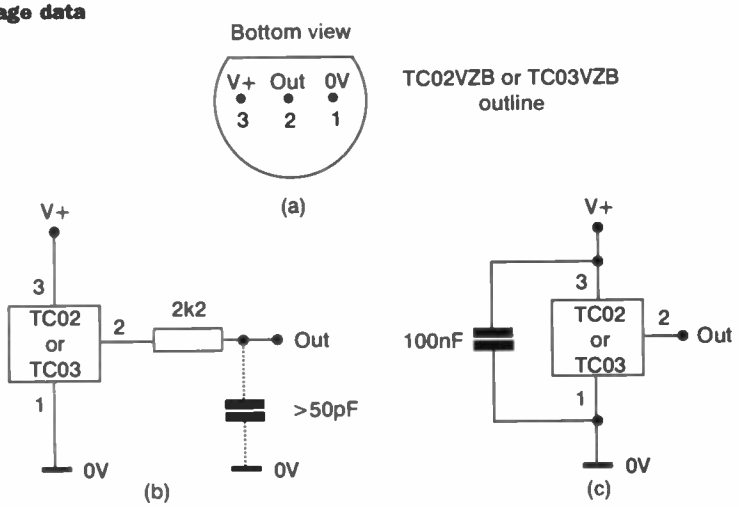
The trip temperature values of the TC07 are determined by the values of R_T and R_H, and these values are determined (with a typical precision of ±1%) by the formula:

$$R = 0.6\,(T + 273.15)^{2.13}$$

where R is the required R_T or R_H value in Ohms, and T is the required T_{SET} or H_{SET} trip temperature in °C. Thus, for a T_{SET} value of 50°C, R_T needs a value of 132.8k, and for an H_{SET} value of 30°C, R_H needs a value of 115.9k.

As an aid to calculating R_T and R_H values, Figure 9 show a basic resistance versus temperature

Figure 4. Additional TC02/03 usage data (see text).



Part number	Package	Temp. Range
TC07COA	8-pin SOIC	0°C to +70°C
TC07CUA	8-pin MSOP	0°C to +70°C
TC07EOA	8-pin SOIC	-40°C to +85°C
TC07EUA	8-pin MSOP	-40°C to+85°C
TC07VOA	8-pin SOIC	-40°C to +125°C
TCO7VUA	8-pin MSOP	-40°C to +125°C

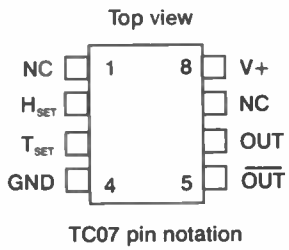


Figure 5. TC07 type-number coding and pin notations.

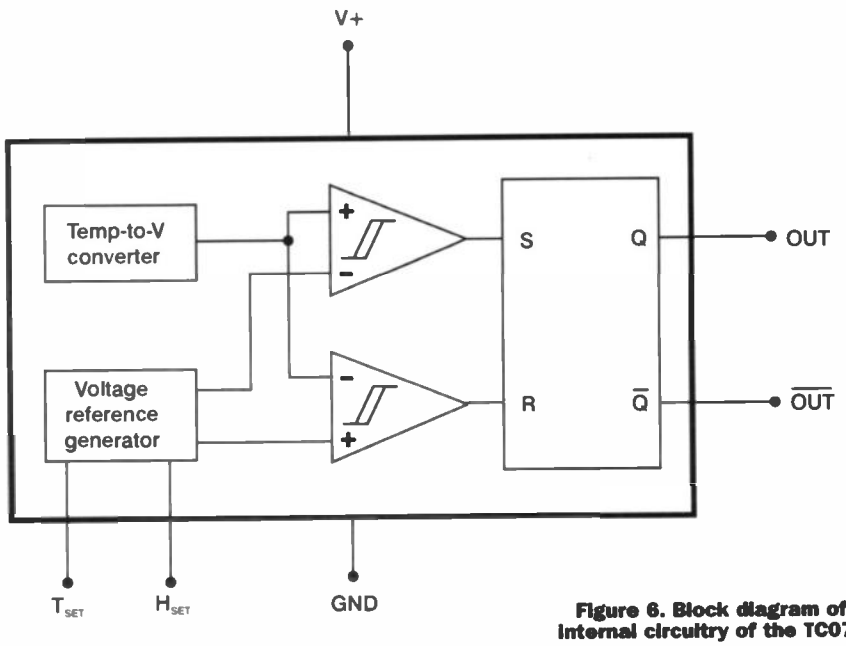


Figure 6. Block diagram of the internal circuitry of the TC07 IC.

graph for the TC07. Note that the graph has a mean slope of 0.85kW/°C over the temperature range 0°C to 100°C; thus, in the above example (in which H_{SET} is 20°C lower than TSET), R_H must be 17k smaller than RT. It is important to note that, in the TC07, the H_{SET} temperature must be at least 5°C lower than the T_{SET} temperature value.

The TC622

(TelCom Semiconductor)

The TC622 IC is a dual-output thermal switch in which the trip temperature value can be set via a single external resistor; the device can be regarded as a simplified general-purpose semi-precision version of the TC07 and has a fixed (built-in) thermal hysteresis value of 2°C.

The basic TC622 IC is available in various packaging styles and with a variety of voltage and temperature operating ranges; 'standard voltage' types can use 4.5V to 18V DC supplies and carry the basic TC622 type number followed by a 3-letter suffix that denotes the IC's package style and thermal operating range; 'low voltage' types can use 2.7V to 4.5V DC supplies and carry a TC624 type number followed by a 3-letter suffix that denotes the IC's package style and thermal operating range. A total of fourteen sub-variants of the basic TC622/624 IC are available, and all use the same basic internal circuitry, which is shown in block diagram form in Figure 10.

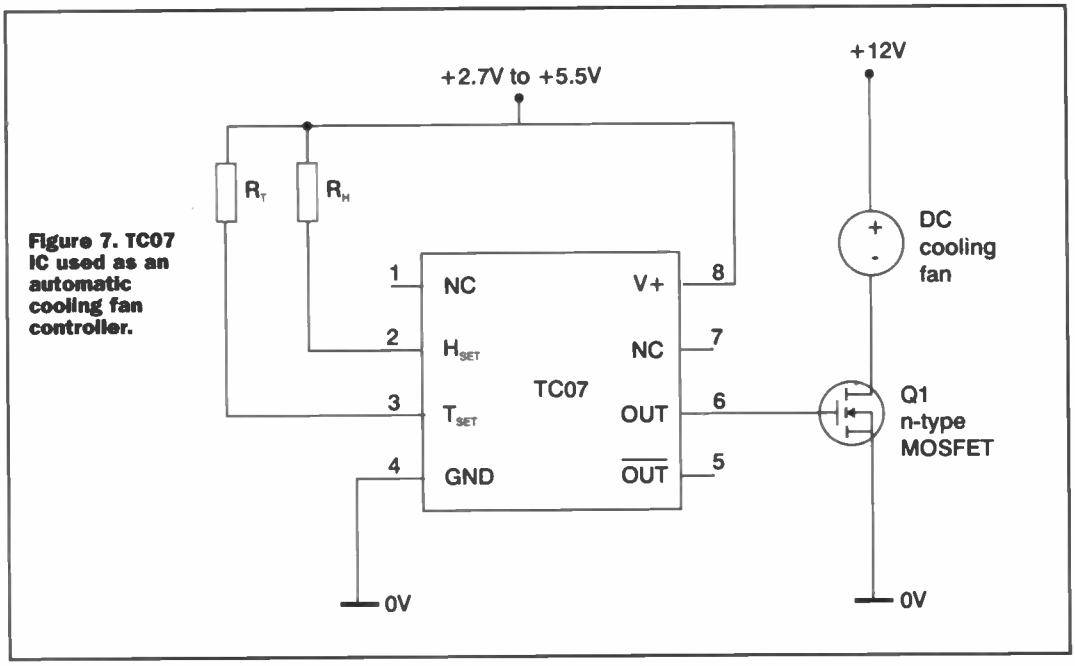


Figure 7. TC07 IC used as an automatic cooling fan controller.

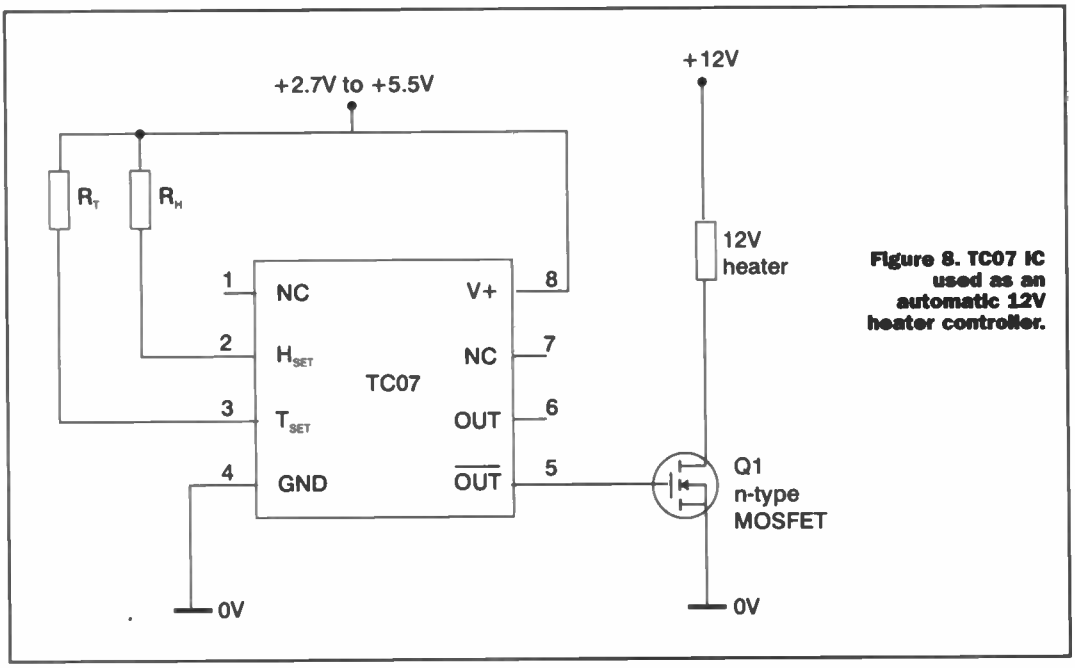


Figure 8. TC07 IC used as an automatic 12V heater controller.

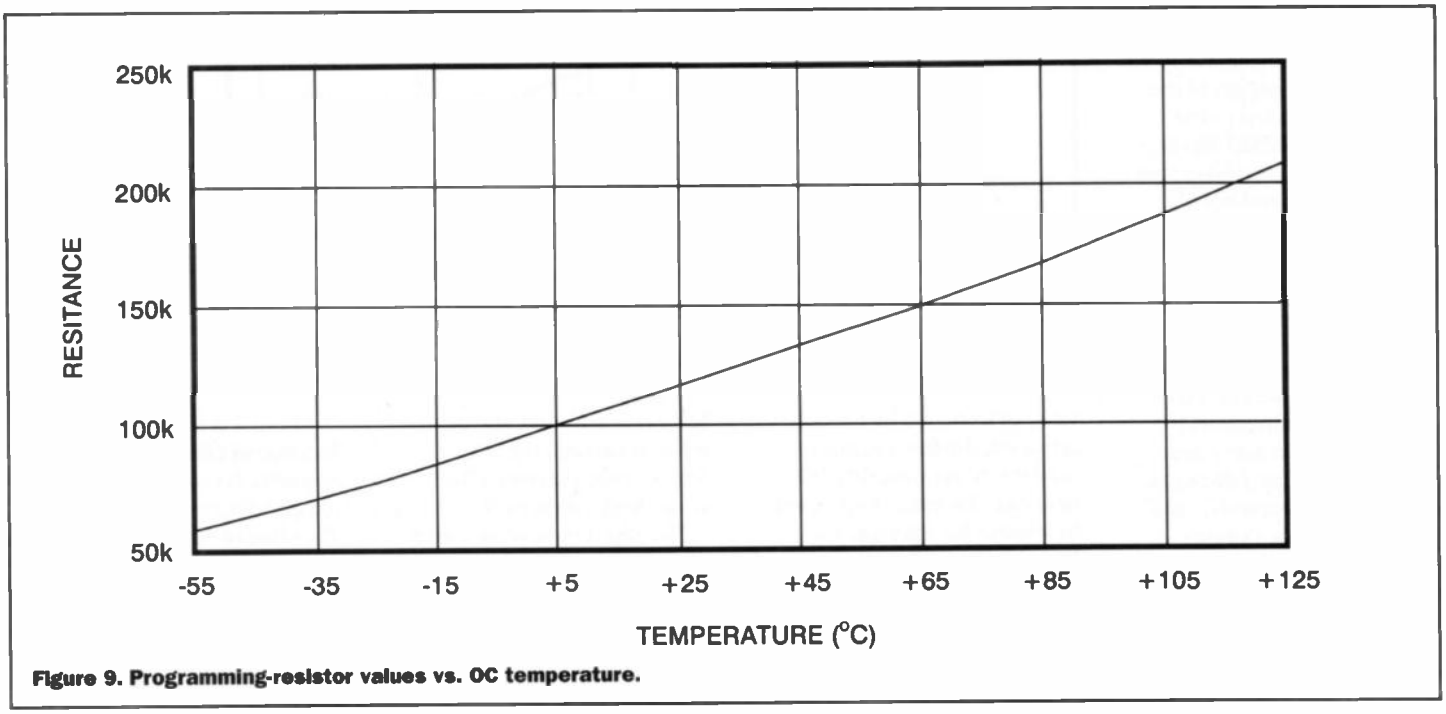


Figure 9. Programming-resistor values vs. OC temperature.

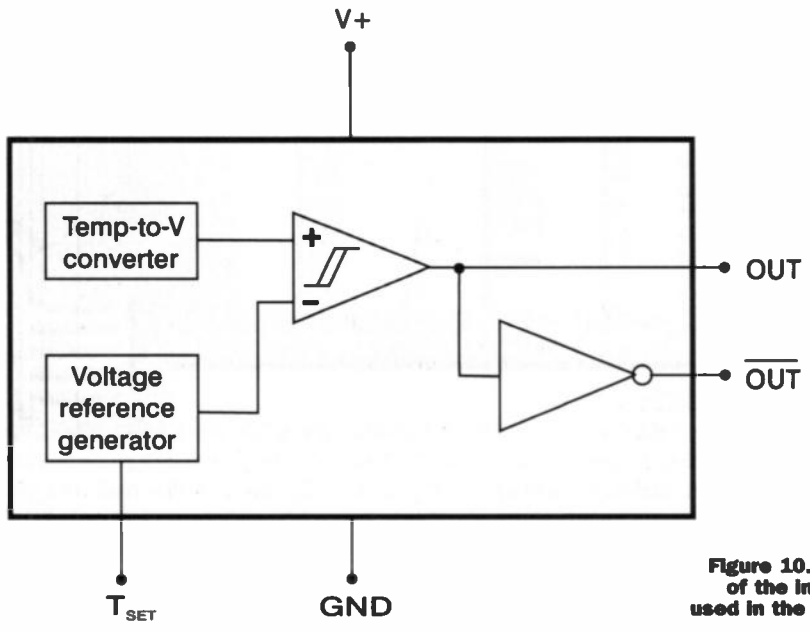
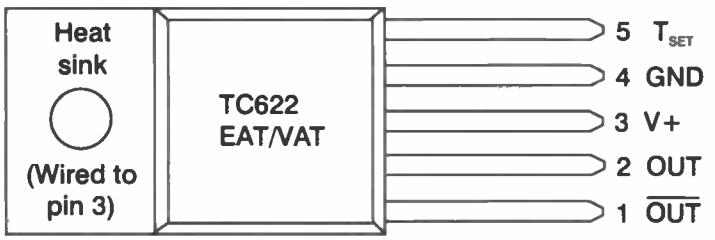


Figure 10. Block diagram of the internal circuitry used in the TC622/624 ICs.

Parameter	TC622EAT	TC622VAT
V+ range	4.5V to 18V	4.5V to 18V
Supply current	200µA typ.	200µA typ.
Temp. range	-40°C to +85°C	-40°C to +125°C
Temp. accuracy	±1°C typ.	±1°C typ.
Trip point hysteresis	2°C	2°C

Figure 11. Basic specifications and package details of the TC622EAT/VAT ICs.



The most popular devices in the TC622 range are the TC622EAT and the TC622VAT, which are each housed in 5-pin TO-220 packages with an integral heatsink (which is internally connected to the IC's pin-3 'V+' terminal). Figure 11 shows the basic specifications and package details of these two particular ICs.

The TC622 devices are used in the same basic ways as the TC07 ICs, but without the use of an R_H resistor. Figure 12(a) shows a basic way of using a TC622 IC as an automatic cooling fan controller, which activates the fan if the IC temperature exceeds a 'T_{SET}' value determined by R_T; once activated, the fan remains on until the IC temperature falls 2°C below the 'T_{SET}' value. Alternatively, Figure 12(b) shows the circuit modified for use as an automatic heater controller, which activates a 12V heater unit if the IC temperature falls 2°C or more below a 'T_{SET}' value determined by R_T; once activated, the heater remains on until the IC temperature exceeds the 'T_{SET}' value.

Finally, note when using the TC622 IC that the RT value is determined in exactly the same way as in the case of the TC07 IC, using the formula:

$$R_T = 0.6\,(T + 273.15)^{2.13}$$

as described in the 'TC07' section of this article. ELECTRONICS

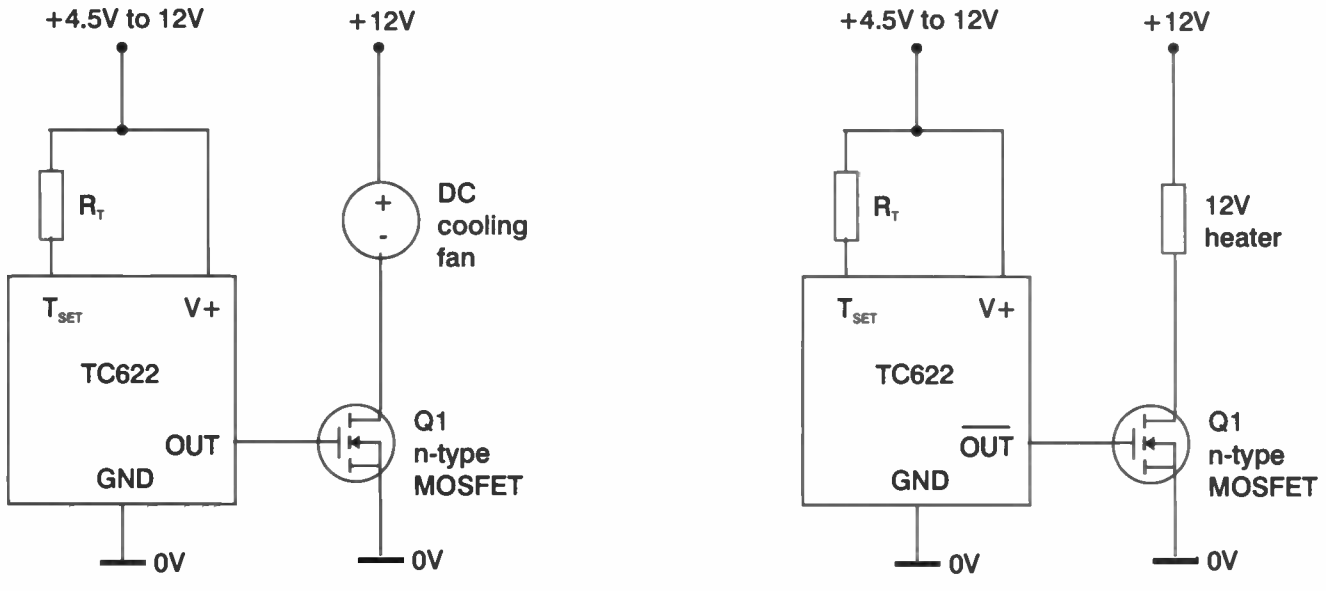


Figure 12. Basic ways of using a TC622 IC to automatically control (a) a cooling fan or (b) a 12V heater.

COMMENT

by Keith Brindley

Digital television is still in its infancy, despite quite a healthy birth at the end of last year aided and abetted by mid-wife BSkyB. At the satellite hospital, SkyDigital was born, like a new Messiah, to try and catch the Christmas buying spree last year along with significant hype and media coverage. BSkyB's baby is a satellite television service, of course, which has technical advantages and disadvantages. Its main advantage is that, as it is a satellite service, it is receivable by anyone within the satellite footprint (the area of earth's surface that the satellite transmitter's signal falls upon). All that's needed is a satellite dish to pickup the signal, and a satellite receiver to transform the satellite signal into a signal that a television receiver can display. Its main disadvantage, on the other hand, is the fact that it needs a satellite dish at all. True, the satellite dish is smaller than the satellite dishes required to receive non-digital broadcast satellite television signals, and considerably smaller than the satellite dishes required to receive other satellite television services. But, to receive satellite television services at all, you need a satellite dish, which is not to everybody's tastes.

But, of course, there is an alternative to satellite digital television. OnDigital's digital television system was born shortly after SkyDigital. It is a terrestrial broadcast digital television service - that is, it is broadcast by transmitters on the ground, in the same way that existing non-digital terrestrial television signals are transmitted. The added bonus is that it is received with the use of television aerials (usually roof-mounted), as terrestrial television services have been received since television services have been broadcast for years. Of course, a new digital receiver is required to convert the received signals into a viewable signal, but the fact remains that nothing new is required externally, a fact that gives OnDigital a significant plus point over satellite television services.

Yet there is soon to be a third alternative to these - cable digital television services, which are to be launched on 1 September on many of the cable networks already in place around the country. Cable networks have come into the scenario from scratch. A few years ago there were no cable networks at all (apart from a few long-standing simple systems covering minuscule parts of the country), but now coverage is such that there are over three million subscribers (indeed, only a third of a million short of BSkyB's total subscriber base). Cable networks have two distinct advantages over both terrestrial and satellite television services. First, no external reception equipment (neither a satellite dish nor a television aerial) is required at all. Second, as it is a wired broadcast medium, typically optical fibre, two-way interactive communications can easily exist, which means that interactive television services can be easily implemented. Actually, there is a third advantage that cable networks have over the other two television service supply methods. This bonus is related to the second advantage, but is not necessarily an advantage in television service terms, which is why it's of only supplementary interest here, and it is that other services (such as digital Internet access, and existing interactive television services) can easily be implemented both now and in the future.

Cable's main disadvantage, on the other hand, is that the networks have to be installed in the first place - roads have to be dug up, footpaths have to be broken, the lawn must be de-turfed, all to get the cable to each property in the cable network. This incurs a significant up-front expenditure before any income at all can be received from subscription fees. What this means is that cable networks themselves are only in their infancy. But as they grow and mature - which they will do, simply because of their two main advantages over satellite and terrestrial services - they will undoubtedly become more and more popular. Historically in the UK, cable networks achieve penetration (that is, the number of people who subscribe to their services, against the total possible) of 44%. As cable networks expand then, if they continue to achieve this 44% penetration, the numbers of subscribers will continue to expand. Cable network operators are aiming to increase penetration to 60% over the next few years, too. At some stage in the not-too-distant future therefore (in the next year or two, if things continue in this vein), cable subscribers will be greater in numbers than satellite television subscribers. In the future beyond that, it's possible to see a scenario where cable subscribers outnumber even terrestrial television users.

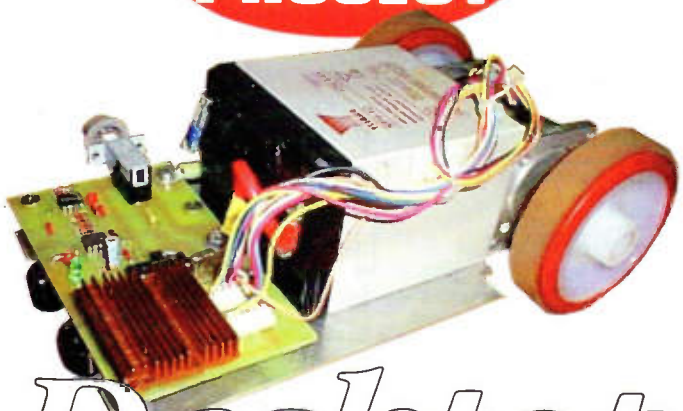
Actually, the fact that digital television services are there at all is really not of concern here. The main fact is that digital television services are superimposed on top of the existing traditional television services of satellite, terrestrial and cable. And it's simply because of this fact, that things are going to change over the coming years. In the past, non-digital satellite television services had a serious advantage over non-digital terrestrial television services, in that there were greater numbers of channels to select from - five terrestrial television channels against twenty-odd satellite television channels. But now, with the onslaught of digital television services, OnDigital has a multiple selection of channels too (admittedly not as many as SkyDigital's potential, but probably as many as most people can cope with). As you might expect, SkyDigital now has a very tricky task convincing people that it's a better service than OnDigital. The fact that cable television networks now will also feature digital television services only means that satellite television services have an even trickier task in hand.

As you might expect, it's all about money, and how viable all these alternatives are. If you consider BSkyB's three-and-a-half million or so customers, and take a guess that each customer is paying an average of something like, say, £20 per month for subscription, then you can work out that BSkyB earns a tidy £840,000,000 a year from subscription fees. Add to this any advertising revenue and you can see that stakes are incredibly high.

So is digital satellite television dead in its tracks. Probably not dead, although it's my personal theory that satellite television - and this includes digital satellite television - isn't in such great shape these days, so a better way to put it might be to say that satellite television is ill and needs significant treatment. If I had shares in BSkyB I think I'd be selling them and buying cable network shares. Whether the surgeons at BSkyB's hospital have sufficient ability or capacity to treat the patient remains to be seen. Cable doctors, on the other hand, must be rightly looking forward to a long and very healthy future for their new baby. ELECTRONICS

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

PROJECT



Desktop ROBOT

Richard Grodzik describes a simple programmable robot.

The term robot is derived from the Russian word for 'robotnic' - meaning worker. The Robot described here is based on two high precision 12V stepping motors and has an ultra sonic sensing mechanism for it's 'eyes.' It's controlled by a single inexpensive PIC chip. This robot has been programmed to 'roam-free' and avoid any abrupt edges such as a desktop edge and take avoiding action. It will also detect any object directly underneath it at a height of one inch. So switch on, and watch the Robot merrily dance around your desktop whilst you are downloading that extra long file on the Internet!

Full source code listing is given and the author will describe the various routines used in the program, so that readers may alter the speed and movement of the Robot as well as adjusting the ranging properties of the ultra sonic eyes for their own purposes.

WARNING

This Robot weighs several pounds so it is not recommended as a small child's play toy. It also uses a 12V high capacity battery and so should not be short-circuited. The battery must not be charged from a standard car battery charger as it is a sealed type and requires a constant voltage source of 13.5V. Suitable chargers are available from Maplin.

Design Philosophy

I have always wanted to build a Robot ever since I saw a stepper motor in action on a training course back in 1981. But the engineering complexities of such a machine held me back. So this year, I sat down with pen and paper to design a minimal-engineered Robot. A plain aluminium sheet chassis is used to which two stepping motors are super-glued. The battery and castor is also 'super-glued and the only drilling requirements are 4 holes to mount the PCB on spacers. When gluing to aluminium use a file to remove any oxide deposit and to ensure good adhesion. No steering mechanism is required in order to turn left or right since the two motors drive the two wheels in opposite directions for turning. A central ball castor mounted near the front provides stability and ease of movement. Note that the Robot is designed to tractor over smooth surfaces only.

How it Works.

Two large stepping motors provide the motive force. These are precision 1.8°/step motors requiring 200 steps for 360° of motor shaft rotation. Since at low speed they produce maximum torque, no gearing is required and the motor shafts drive the wheels directly. To increase the torque, a half step sequence is used to drive the four phases of each unipolar motor. The reader has a choice of two motors: a 12V/75R and a 12V/20R version. The latter consumes a total of 2.4A of current (two motors) and is powerful enough to climb mountains! The small 75Ω version used in the prototype requires 160mA per phase and so the total current consumption is just under 1A. Still a hefty current and so the need for a 4Ah capacity battery is required, which should last for about four hours of use. See Figure 1 for the full circuit diagram

Port B lines of the PIC feed two Darlington drivers IC3 and IC4. Each consist of eight separate drivers which are

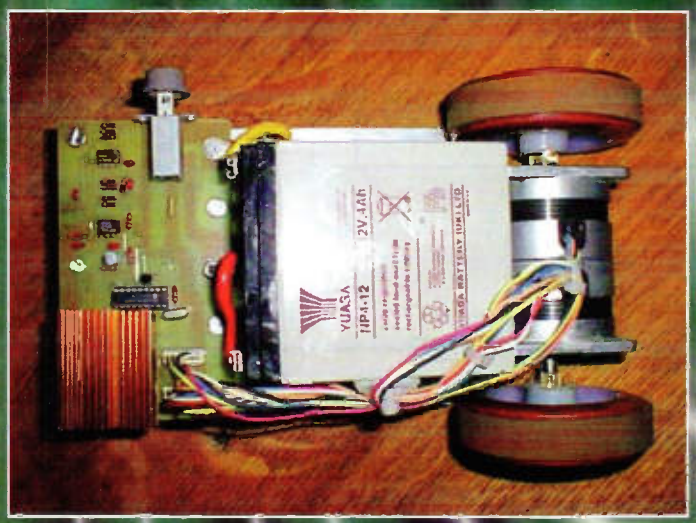
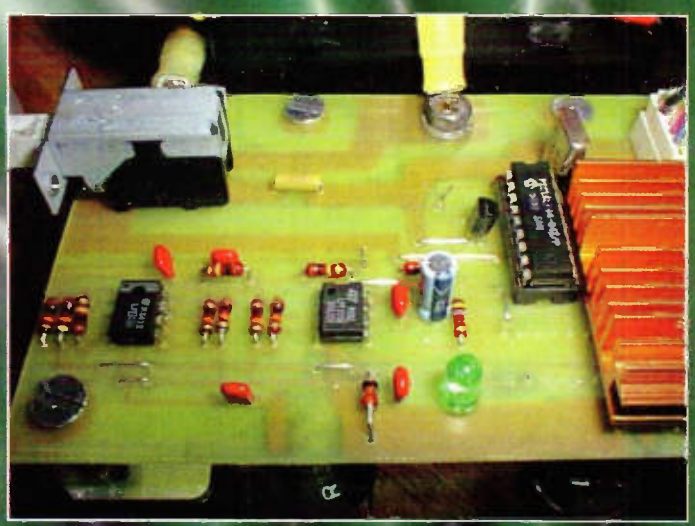


Photo 1. Top view of Desktop Robot.

Photo 2. Close-up of PCB



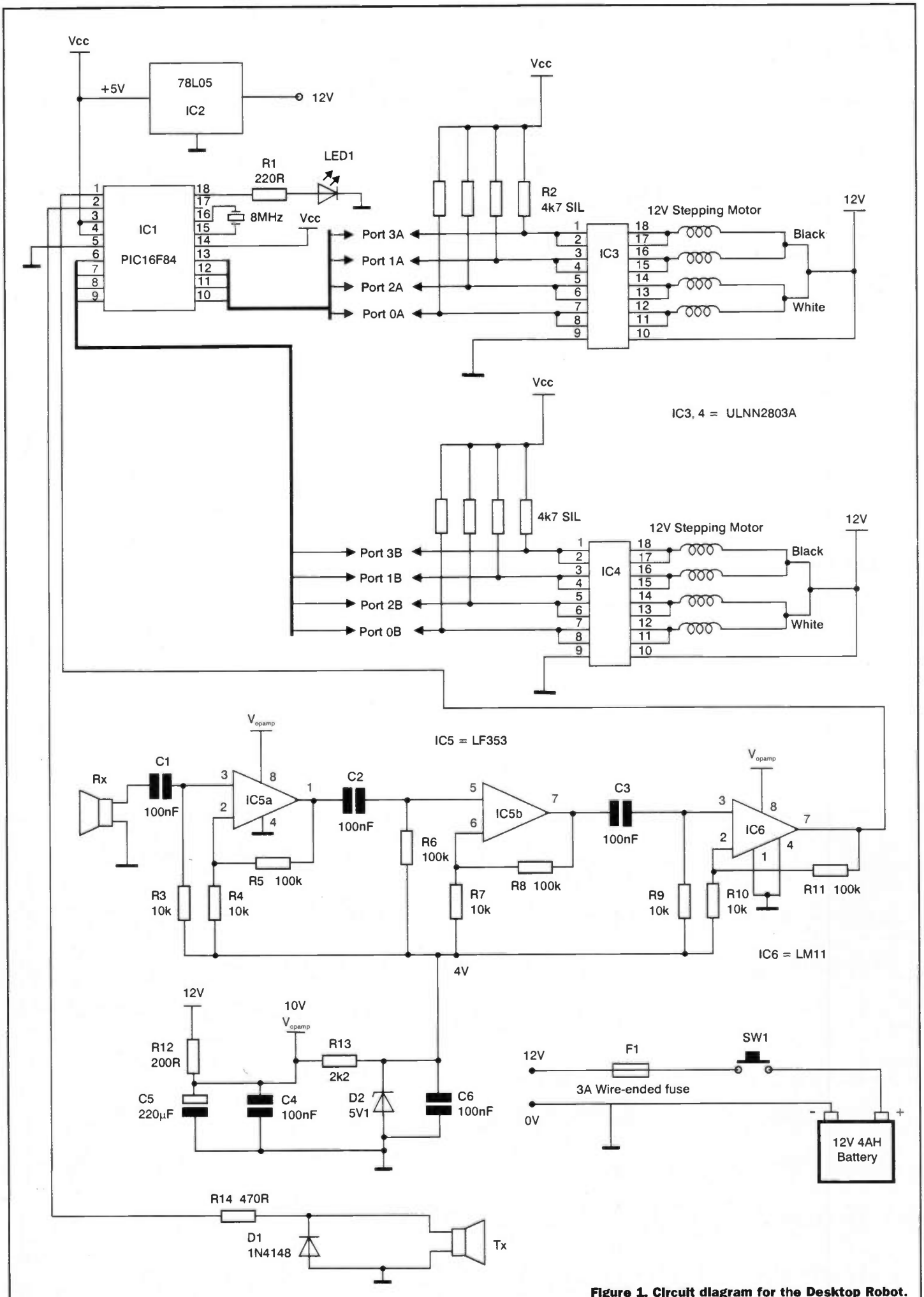


Figure 1. Circuit diagram for the Desktop Robot.

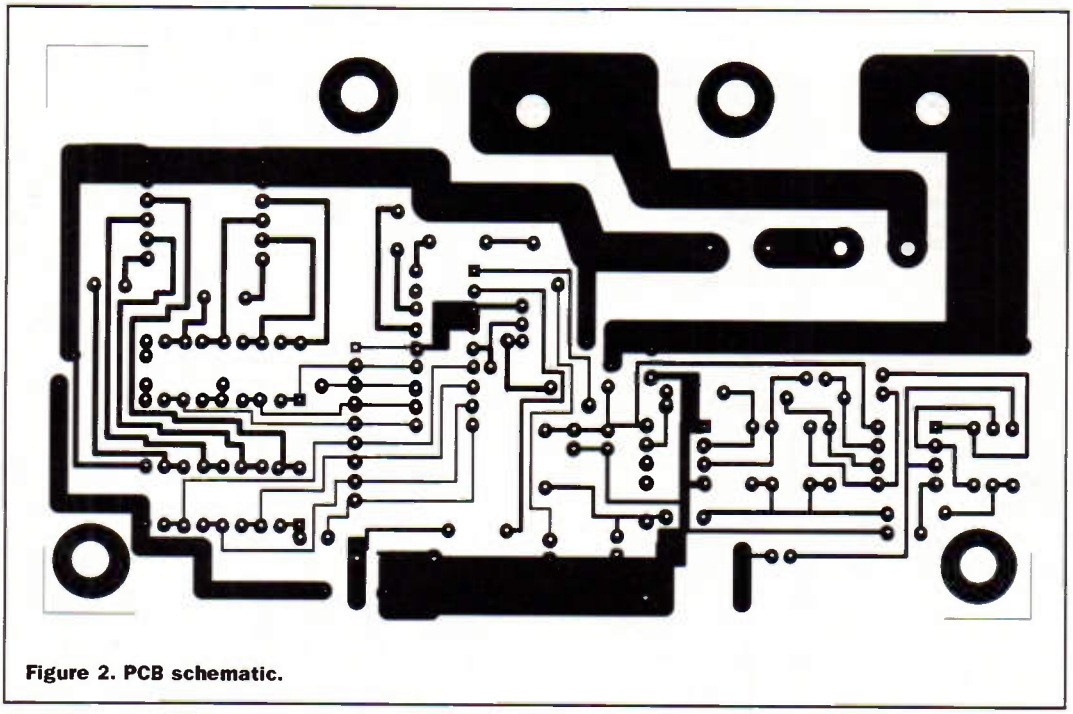


Figure 2. PCB schematic.

connected in pairs to increase current throughput. A heatsink is required and is simply glued to the two ICs. They get quite hot when running for extended periods. Since these drivers have CMOS inputs a SIL array of eight 4k7 resistors (R2) is used as a pull-ups. The stepper motors are fed directly from the 12V battery via switch SW1 and fuse F1 which is of a wire-ended type and mounted on the PCB. A simple 78L05 5V regulator is used to supply power to the PIC.

The ultrasonic transceiver circuit consists of a matched pair (40KHz) of transducers marked Tx and Rx. The transmitter is fed directly from the PIC via a 470Ω (R14) resistor to limit the current to 20mA - the maximum permissible current for each PIC port line. Several 40kHz cycles are generated by the PIC to directly drive the transmitting transducer. The ultrasonic receiver circuit consists of IC5 and IC6. IC5 is a dual MOSFET input pre-amplifier providing two stages of amplification. IC6 is a simple comparator and provides a current to voltage conversion to drive the RA2 pin of the PIC. A differential voltage supply for the op-amps is derived from circuit consisting of R13, D2 and C6. This provides a voltage of 4V DC on the cathode of Zener D2. The voltage measured on pin 8 (Vcc), the supply for the op-amps, was 8V, producing a voltage difference of -4V enabling IC5 and IC6 to function.

Figure 2 shows the PCB schematic, and Figure 3 provides the component overlay.

Photo 3. Underside view.

Firmware

Listing 'EDGE5.LST' shows the full source code for the Robot. Readers can experiment and change the Robots movements by simply re-editing the code and re-compiling. A stepping motor operates by energising each of four stator coils in turn, thereby producing a continuous rotating magnetic flux which interacts with the solid magnetic rotor to produce motor rotation. The speed of rotation is directly dependent on the speed at which each phase is switched on and off, and equates directly to the time delay between each switching.

Sub-routine 'DELAY-STEP consists of two identical programs:

```
        MOVLW .100 ;SPEED VARIABLE
        MOVWF RTCC
SHORT     BTFSS RTCC,7
        GOTO SHORT
        CLRWDT
```

- Loads 100 (decimal) into the real time clock counter (RTCC)
- The RTCC is incremented automatically at 1/256 the system clock rate.
- A time wasting loop to SHORT is executed.
- When the 8-bit value reached 10000000 b, instruction BTFSS RTCC,7 causes the loop to terminate.

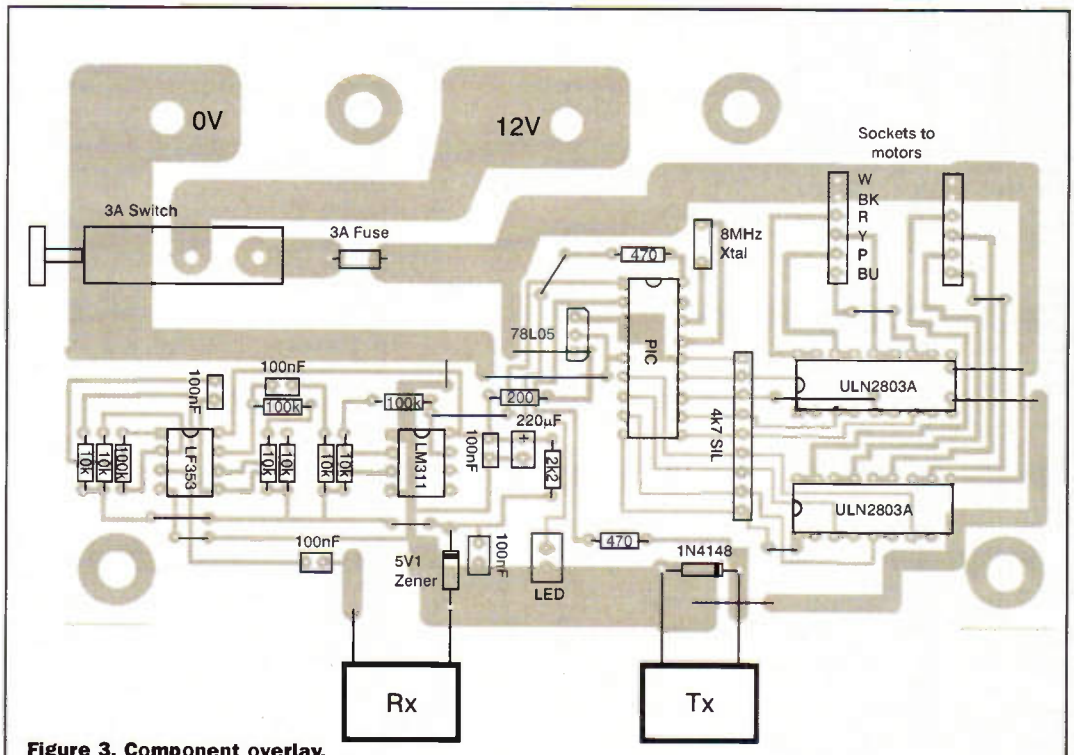


Figure 3. Component overlay.

```
LOC  OBJECT CODE     LINE  SOURCE TEXT
     VALUE
                     0001  LIST    p=16C84         0002
                     0003
     0001            0004  RTCC    EQU 1   ;RTCC   0002
0005 PC              EQU 2 0003    0006    STATUS  EQU 3
;STATUS REGISTER     0005  0007    PORT_A  EQU 5   ;PORT A
0006 0008            PORT_B EQU 6  ;PORT   B
     0002            0009  ECHO    EQU 2
     0001            0010  LED     EQU 1
     0003            0011  PING    EQU 3
                     0012
     0014            0013  BLOW    EQU     014H
     0015            0014  DLYCNT  EQU     015H
     0016            0015  BUFFER  EQU     016H
     0017            0016  REVEQU  017H
     0018            0017  BACK    EQU     018H
     0019            0018  SPEED   EQU     019H
                     0019
                     0020
0000 3004            0021  MOVLW 4
0001 0065            0022  TRIS PORT_A
0002 0185            0023  CLRF PORT_A
0003 1085            0024  BCF PORT_A,LED  ;LED    OFF
                     0025
0004 3000            0026  MOVLW 0
0005 0066            0027  TRIS PORT_B
0006 0186            0028  CLRF PORT_B
                     0029
0007 3007            0030  MOVLW B'00000111'
0008 0062            0031  OPTION
                     0032
0009 3000            0033  MOVLW 0
000A 0099            0034  MOVWF SPEED
                     0035
000B 3008            0036  MOVLW 8
000C 0097            0037  MOVWF REV
000D                 0038 CYCLE_S
000D 3003            0039  MOVLW .3
000E 0799            0040  ADDWF SPEED,1
                     0041
000F 2014            0042  CALL STEP
0010 0B97            0043  DECFSZ REV,1
0011 280D            0044  GOTO CYCLE_S
0012 2038            0045  CALL SOUND_ECHO
0013 280D            0046  GOTO CYCLE_S
                     0047
0014                 0048 STEP
                     0049
0014 202D            0050  CALL DELAY_STEP;FWD
0015 3098            0051  MOVLW B'10011000'
0016 0086            0052  MOVWF PORT_B
0017 202D            0053  CALL DELAY_STEP
0018 301C            0054  MOVLW B'00011100'
0019 0086            0055  MOVWF PORT_B
001A 202D            0056  CALL DELAY_STEP
001B 3034            0057  MOVLW B'00110100'
001C 0086            0058  MOVWF PORT_B
001D 202D            0059  CALL DELAY_STEP
001E 3026            0060  MOVLW B'00100110'
001F 0086            0061  MOVWF PORT_B
0020 202D            0062  CALL DELAY_STEP
0021 3062            0063  MOVLW B'01100010'
0022 0086            0064  MOVWF PORT_B
0023 202D            0065  CALL DELAY_STEP
0024 3043            0066  MOVLW B'01000011'
0025 0086            0067  MOVWF PORT_B
0026 202D            0068  CALL DELAY_STEP
0027 30C1            0069  MOVLW B'11000001'
0028 0086            0070  MOVWF PORT_B
0029 202D            0071  CALL DELAY_STEP
002A 3089            0072  MOVLW B'10001001'
002B 0086            0073  MOVWF PORT_B
                     0074
002C 3400            0075  RETLW 0
                     0076
                     0077
002D                 0078 DELAY_STEP
002D 3064            0079  MOVLW .100
002E 0081            0080  MOVWF RTCC
002F 1F81            0081 SHORT BTFSS RTCC,7
0030 282F            0082  GOTO SHORT
0031 0064            0083  CLRWDT
                     0084
0032 3064            0085  MOVLW   .100
0033 0081            0086  MOVWF   RTCC
0034 1F81            0087 LONG BTFSS RTCC,7
0035 2834            0088  GOTO    LONG
0036 0064            0089  CLRWDT
0037 3400            0090  RETLW   0
                     0091
                     0092
0038                 0093 SOUND_ECHO
0038 0186            0094  CLRF PORT_B;      STOP    MOTORS
                     0095
0039 3008            0096  MOVLW 8
003A 0094            0097  MOVWF BLOW
                     0098
003B                 0099 AGAIN
003B 208A            0100  CALL SOUND
003C 0B94            0101  DECFSZ BLOW,1
003D 283B            0102  GOTO AGAIN
                     0103
003E 300A            0104  MOVLW .10
003F 0095            0105  MOVWF DLYCNT
0040 0B95            0106 REDB DECFSZ DLYCNT
0041 2840            0107  GOTO REDB
                     0108
0042 30FF            0109  MOVLW 0FFH
0043 0095            0110  MOVWF DLYCNT
0044 1905            0111 REDA BTFSC PORT_A,ECHO
0045 2849            0112  GOTO HIT
0046 0B95            0113  DECFSZ DLYCNT
0047 2844            0114  GOTO REDA
                     0115
0048 284C            0116  GOTO NOHIT
                     0117
0049                 0118 HIT
                     0119
0049 3008            0120  MOVLW 8
004A 0097            0121  MOVWF REV
004B 3400            0122  RETLW 0
004C                 0123 NOHIT
                     0124
                     0125
                     0126
                     0127
004C 1485            0128  BSF PORT_A,LED
004D 20BB            0129  CALL DELAY
004E 1085            0130  BCF PORT_A,LED
                     0131
                     0132
004F 3014            0133  MOVLW .20 ;90 DEGREES
0050 0097            0134  MOVWF REV
0051 300A            0135  MOVLW .10
0052 0098            0136  MOVWF BACK
                     0137
0053                 0138 REVERSE
                     0139
0053 202D            0140  CALL DELAY_STEP   ;REVERSE
0054 3089            0141  MOVLW 089H
0055 0086            0142  MOVWF PORT_B
0056 202D            0143  CALL DELAY_STEP
0057 30C1            0144  MOVLW 0C1H
0058 0086            0145  MOVWF PORT_B
0059 202D            0146  CALL DELAY_STEP
005A 3043            0147  MOVLW 043H
005B 0086            0148  MOVWF PORT_B
005C 202D            0149  CALL DELAY_STEP
005D 3062            0150  MOVLW 062H
005E 0086            0151  MOVWF PORT_B
005F 202D            0152  CALL DELAY_STEP
0060 3026            0153  MOVLW 026H
0061 0086            0154  MOVWF PORT_B
0062 202D            0155  CALL DELAY_STEP
0063 3034            0156  MOVLW 034H
0064 0086            0157  MOVWF PORT_B
0065 202D            0158  CALL DELAY_STEP
0066 301C            0159  MOVLW 01CH
0067 0086            0160  MOVWF PORT_B
0068 202D            0161  CALL DELAY_STEP
0069 3098            0162  MOVLW 098H
006A 0086            0163  MOVWF PORT_B
                     0164
006B 0B98            0165  DECFSZ    BACK,1
006C 2853            0166  GOTO REVERSE
                     0167
006D                 0168 TURN
                     0169
006D 202D            0170  CALL DELAY_STEP   ;FWD
006E 3099            0171  MOVLW B'10011001'
006F 0086            0172  MOVWF PORT_B
0070 202D            0173  CALL DELAY_STEP
0071 3011            0174  MOVLW  B'00010001'
0072 0086            0175  MOVWF PORT_B
0073 202D            0176  CALL DELAY_STEP
0074 3033            0177  MOVLW B'00110011'
0075 0086            0178  MOVWF PORT_B
0076 202D            0179  CALL DELAY_STEP
0077 3022            0180  MOVLW B'00100010'
0078 0086            0181  MOVWF PORT_B
0079 202D            0182  CALL DELAY_STEP
007A 3066            0183  MOVLW B'01100110'
007B 0086            0184  MOVWF PORT_B
007C 202D            0185  CALL DELAY_STEP
007D 3044            0186  MOVLW B'01000100'
007E 0086            0187  MOVWF PORT_B
007F 202D            0188  CALL DELAY_STEP
0080 30CC            0189  MOVLW B'11001100'
0081 0086            0190  MOVWF PORT_B
0082 202D            0191  CALL DELAY_STEP
0083 3088            0192  MOVLW B'10001000'
0084 0086            0193  MOVWF PORT_B
0085 0B97            0194  DECFSZ REV,1
0086 286D            0195  GOTO TURN
0087 3014            0196  MOVLW .20
0088 0097            0197  MOVWF REV
0089 3400            0198  RETLW 0
                     0199
                     0200
                     0201
008A                 0202 SOUND
008A                 0203 CYCLE
008A 1585            0204  BSF PORT_A,PING
                     0205
008B 0000            0206  NOP
008C 0000            0207  NOP
008D 0000            0208  NOP
008E 0000            0209  NOP
008F 0000            0210  NOP
0090 0000            0211  NOP
0091 0000            0212  NOP
0092 0000            0213  NOP
0093 0000            0214  NOP
0094 0000            0215  NOP
0095 0000            0216  NOP
0096 0000            0217  NOP
0097 0000            0218  NOP
0098 0000            0219  NOP
0099 0000            0220  NOP
009A 0000            0221  NOP
009B 0000            0222  NOP
009C 0000            0223  NOP
009D 0000            0224  NOP
009E 0000            0225  NOP
009F 0000            0226  NOP
00A0 0000            0227  NOP
00A1 0000            0228  NOP
00A2 0000            0229  NOP
                     0230
00A3 1185            0231  BCF PORT_A,PING
                     0232
00A4 0000            0233  NOP
00A5 0000            0234  NOP
00A6 0000            0235  NOP
00A7 0000            0236  NOP
00A8 0000            0237  NOP
00A9 0000            0238  NOP
00AA 0000            0239  NOP
00AB 0000            0240  NOP
00AC 0000            0241  NOP
00AD 0000            0242  NOP
00AE 0000            0243  NOP
                     0244
00AF 0000            0245  NOP
00B0 0000            0246  NOP
00B1 0000            0247  NOP
00B2 0000            0248  NOP
00B3 0000            0249  NOP
00B4 0000            0250  NOP
00B5 0000            0251  NOP
00B6 0000            0252  NOP
00B7 0000            0253  NOP
00B8 0000            0254  NOP
00B9 0000            0255  NOP
00BA 3400            0256  RETLW 0
                     0257
                     0258
00BB                 0259 DELAY
00BB 30FF            0260  MOVLW 0FFH
00BC 0095            0261  MOVWF DLYCNT
00BD 0064            0262 REDO CLRWDT
00BE 0B95            0263  DECFSZ DLYCNT
00BF 28BD            0264  GOTO REDO
00C0 3400            0265  RETLW 0
                     0266
                     0267  END
                     0268

SYMBOL TABLE

LABEL     VALUE

AGAIN     003B
BACK      0018
BLOW      0014
BUFFER    0016
CYCLE     008A
CYCLE_S   000D
DELAY     00BB
DELAY_STEP          002D
DLYCNT    0015
ECHO      0002
HIT       0049
LED       0001
LONG      0034
NOHIT     004C
PC        0002
PING      0003
PORT_A    0005
PORT_B    0006
REDA      0044
REDB      0040
REDO      00BD
REV       0017
REVERSE   0053
RTCC      0001
SHORT     002F
SOUND     008A
SOUND_ECHO          0038
SPEED     0019
STATUS    0003
STEP      0014
TURN      006D
__16C84   0001
```

PROJECT PARTS LIST

RESISTORS		
R1,12	220R	M220R
R2	4K7 SIL	RA29G
R3,4,6,7,9,10	10K	M10K
R5,8,11	100K	M100K
R13	2K2	M2K2
R14	470R	M470R
CAPACITORS		
C1,2,3,4,6	100nF Met Poly	BX76H
C5	220µF 16V Elect	AT41U
ICS AND SEMICONDUCTORS:		
IC1	PICF84	See Note
IC2	78L05	QL26D
IC3,4	ULN2803A	QY79L
IC5	LF353	NP85G
IC6	LM311	QY09K
D1	1N4148	QL80B
D2	5V1 Zener	QH07H
LED	5mm Green	CK37S
MISCELLANEOUS		
TX/RX Transducers	Pair 40KHz Ultrasonic Transducers	HY12N
X1	8MHz Crystal	UJ06G
BATT	12V 4Ah Sealed Lead Acid Type	XG76G
F1	3A Wire-ended Fuse	UN62S
SW1	5A SPST SW	
Stepping Motors	12V 75R(160 mA/phase)	RS 440-436
	or 12V 20R (0.6A/phase)	RS 440-458
	Castor	RS 687-944
	80mm Wheels (from hobby shop)	
	Aluminium Sheet	
	Heatsink	
	Nuts & Bolts	
	Spacers	
	Heavy-duty Leads.	

A pre-programmed PIC priced at £14.50 including p&p is available from R. Grodzik (MICROS), 53 Chelmsford Road, Bradford BD3 8QN, U.K.

If a higher initial value is loaded into the RTCC it can be seen that the binary value 10000000 b will take a shorter time to reach and so the total delay time is reduced. Conversely reducing this initial value will increase the delay time and cause the stepping motors to rotate more slowly.

Ultra Sonic Ranging System

See sub-routine 'SOUND_ECHO.' Here eight cycles at 40KHz are sent to the transmitter transducer. To compute whether a table edge is detected is a simple matter of determining if an echo is received back or not. If the transducer is above the table an echo will be present at all times. If it is located over the edge the echo will be lost. The maximum range of this sonar is 455mm, so hopefully your desktop is above this height. Please note that the transducer positioning has to be accurate and is set at a distance of 35mm from the desktop, or flat surface.

A value FFH is loaded into variable DLYCNT. The instruction BTFSC PORT_A,ECHO loops round 255 times polling the port line RA2 of the PIC (the received echo line), and tests if it is clear (logic low). During this looping a received echo will set port line RA2 high and routine HIT is executed - the Robot continues travelling forward. As soon as the Robot approaches the edge of the table and the echo is lost, the routine jumps out of the loop and executes procedure NOHIT, which causes the Robot to reverse, turn and continue forward away from the edge of the table.

It was a joy to watch my colleagues faces as they anticipated that the Robot would tipple off the edge, but it never did! Be warned though - do not put your hand at the edge of the table as the Robot will interpret it as an extension of the table and plunge over into disaster!

Well. I hope you have as much fun with the Robot as I have. Mark II is now on the drawing board with an infra-red telemetry link enabling it to be controlled from a Laptop. Watch out Mars

Paranormal Again!

Dear Sir,

I have been reading the on going debate regarding whether or not the paranormal is a suitable topic for your magazine for some time. The debate seems to be three sided, those who support the inclusion of these articles, those who oppose them, and those who amiably propose tolerance. I would like to propose an alternative position.

I was an electronic engineer for the first half of my career and a science teacher for the remainder of my career. One of the first things I noticed about electronics in the 40's, was that its participants were usually both workers and hobbyists in this field. Many of the skills and techniques were empirical, but they worked. Perhaps because of this, perhaps because it was a new technology, electronic engineers were open-minded and had an intense interest and enthusiasm for all aspects of science. This was often reflected in the electronic/radio magazines of those times, there were many articles on what would now be dubbed fringe science. I particularly remember a series of articles in one of F.J.Camms magazines, I think Practical Wireless, for the construction of what was called a 'Hieronymous machine'. This was a device with a tactile plate for identifying metals and minerals, it used a three valve amplifier - drawn on paper!

These 'speculative science' articles were interesting, stimulating and engendered constructive debate. This no longer seems to be the case, most of your correspondents seem to possess hardened viewpoints. Perhaps this is simply a reflection on the present state of electronics, it is no longer part "art" part science, the fun and excitement has passed away - the sense of discovery. My first 100W amplifier using a pair of 807's in push-pull, two home made transformers, and a weight guaranteed to give you a hernia, is now replaced by what appears to be a small block of aluminium - how exciting! Electronics is now taught in schools as an exact science, regulated and controlled, the perfect formula for killing any hobby.

Well, my age is showing, I am starting to ramble, so let me make a suggestion that if practicable should satisfy everyone. Remove all the 'offending' non electronic articles from your magazine, add a few others of similar ilk, then in the manner of a Sunday Newspaper combine them as a supplement. This way those who object can throw them away, just as I do with the sports supplements. I am sure Uri would be happy to edit such a supplement, if not then there are plenty of retired engineers like myself who still possess an open and enquiring mind.

Yours sincerely
Ian McAlister

Yes I can see your viewpoint and would tend to agree with societies hardening of views. I still have my fathers' old pre-war Newnes Practical Mechanics edited by FJ Camm and they certainly contained some 'risky' or speculative material, but as you say - a joy to read. As time goes by there seems to be a greater accumulation of unusual facts and figures and it could therefore warrant a supplement in the future. However, like you, I never read a typical sports section of a newspaper and wish that you had the option to buy the various supplements. But as marketing is a very powerful force in our consumerist society, we seem to have to buy a lot of what we don't want these days. Maybe that will change.

Anthropic Principle Revisited

Dear Sir

This letter is in response to the letter by Brian Loveless (printed in issue 140) following my article on the anthropic principle).

As Brian Loveless points out, the linking of quantum theory, Buddhist teachings and the Participatory Anthropic Principle raises many interesting issues, and I would like the opportunity to expand on one or two of the points he raises.

If the universe began as a quantum fluctuation in the limitless void, one must first ask what it was that was fluctuating (remembering that the 'limitless void' was (and is?) something entirely beyond our comprehension, being devoid of both space and time). One can of course ask the same question about quantum events today, and the mathematical physicist will perhaps tell us that it is a fluctuation in the domain of probability. But what does 'probability' mean in a universe which does not yet exist?

Brian Loveless describes the concept of a 'multiverse' of all logically possible states collapsing into actuality when observed by a being with a mind. He describes this as occurring when a sufficiently advanced animal had evolved in one of those logically possible universes, which suggests the idea that Darwinian evolution was taking place in a 'possible' universe which had not yet collapsed into reality. Not an impossible idea perhaps, but once again our imagination is stretched to and beyond its limits. And why should we discriminate against those universes which are NOT logically possible? Surely we can also dispense with logic in the infinite void!

Buddhists concepts and the Participatory Anthropic Principle link the universe to the human mind, but other great religions (and notably the Christian faith) would make the linkage with the mind of our God, who presumably predates not only the universe but the 'infinite void' as well.

The 'multiverse' concept is similar in some ways to the 'many worlds' view of quantum mechanics, in which all possible outcomes of any event occur, with the universe branching into different versions to accommodate them. I like to use this idea to predict that I will be immortal, since at any moment in time when I may or may not die there will be one branch of the universe in which I survive.

Brian Loveless closes his letter by commenting on which came first, the universe or the mind? This raises deep issues of causality, which recent developments in quantum theory have called into question (showing that the strict temporal sequence of cause and effect is not always obeyed at the quantum level).

As always these big issues bring physics, religion and philosophy into sharp focus, and we realise that even the language we use is sometimes inadequate. What do we mean by the difference between a 'possible' universe and an 'actual' universe? What do we mean by the 'limitless void'? Answers on a postcard please...

Graham Marett
Rickmansworth

I think they may have to be big postcards!

Dear Sir,

I am somewhat dismayed that Electronics & Beyond seems to be going increasingly down the road with articles on the paranormal and philosophy route. While they can make interesting reading, I would not subscribe to magazines that had this as there primary interest. As a Christian, I believe that the answer to the question "Why are we here ?" is found in the Bible.

That is, God created the universe and all living things, and created man in His own image. That Jesus Christ came to this earth as a human being, yet embodied the person of God within him, both to be an example as to how we are meant to live, and the means by which we could be rescued from sin. Jesus came to show us how much God loves us, and to enable us to have a loving relationship with the living God who both created us and sustains us day by day.

I have always had a keen interest in electronics since my youth, and at no time have I felt any conflict between that and my faith. In fact, the wonder of discovering how something works and has been put together has strengthened my faith. However, I am concerned that most scientific reporting is based on atheistic or agnostic premises, yet many renowned scientists have strong religious beliefs. If you are to include more articles of this type I think you should give a platform to those with orthodox views as well as the more fringe type.

The magazine has had some great projects, and interesting technical features, but I don't think other electronics magazines have resorted to filling column inches with the philosophical and paranormal. How about more space for letters, or for readers ideas, or hints and tips.

G. Lee
via e-mail

It is certainly not our intention to make the Magazine a paranormal or philosophical one, but this all started from a practical project that we included some months ago (Psycho-Kinetic Bio-feedback and Movement Detector). We have always tried to publish diverse and, hopefully, interesting technical articles and projects. Graham Marett's article on the Anthropic Principle was a follow on from the debate that took place in Air Your Views. Although we obviously respect your Christian views as to how it all started, there are many people who do not hold those beliefs and strive for a more 'scientific' explanation, and to be honest, I do not believe they are a 'fringe' type. We have said several times in this column that we will always consider publishing articles that offer 'alternative' or even 'conventional' views.

Overstated Horizontal Takeoff

Dear Sir

With respect to the considerations of Horizontal Takeoff (HTO) versus Vertical Takeoff (VTO) in Dr Chris Lavers article, I think the benefits of HTO are overstated.

Aft mounted engines do result in a large centre of gravity travel during ascent, but this is not a problem for VTO. An HTO vehicle requires powerful trim forces (produced by the elevons) to cope with centre of gravity shift. I cannot see how the engines could be mounted at the vehicle's centre of gravity in order to minimise centre of gravity travel (such as on an Airbus) without either heavy heat shielding or the weight and complexity of a wing tip installation. The HTO climb phase requires the wings to carry the weight of the full vehicle, which, with a fuel fraction of 90%, would require them to be 10 times as strong (and consequently as heavy) as that required merely for landing. With a payload fraction of 1% this extra mass cuts straight into a vary small margin.

The advantages of HTO are, presumably, airliner style operations. Similar merits were suggested in the justification for the Space Shuttle, when a two-weekly turnaround was proposed. There are three problems with using normal airfields, even assuming that the turnaround problems can be overcome.

First, rockets are noisy. The Saturn 5 generated the equivalent sound level of a full orchestra playing fortissimo at a range of 3 miles. I do not think Windsor would take that lying down! Second, the low lift-drag ratio and high descent speed require a runway appreciably longer than that used by airliners. The flare alone takes a kilometre. Third, safety - all rocket ranges (except the Chinese) launch over unpopulated areas which is usually the sea. The Japanese have to clear the range of fishing fleets before every launch. The Chinese wiped out a village with heavy loss of life when one of their boosters lost control. For all these reasons, the HTO would also require special facilities, negating its stated advantages. I would love to see such vehicles operating.

After Apollo, great hopes were invested in the Shuttle for cheap and regular access to space. The NASP, with its scramjet powered airborne ascent, also stimulated enthusiasm, butwas horribly flawed technically. Maybe the Lockheed VentureStar will be the answer, but I think there are good reasons (other than the availability of launch facilities) for its being a VTO. SSTO is a very hard and expensive task, with very small margins. T he advantages of HTO remain to be proven.

Richard Dell
via e-mail

Only time will tell!

Software HINTS & TIPS

by Mike Bedford

You either love them or hate them – Windows sound effects, that is. If you love them, this month's column is for you.

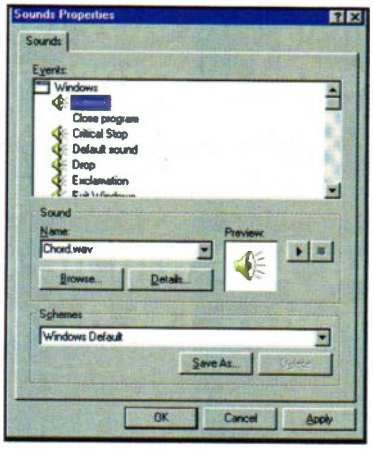
Long gone are the days when a sound card and speakers were just optional extras. Virtually all PCs now have them and, as a result, Windows makes full use of them. This means having different jingles for anything and everything from announcing that it's started up, to indicating that you've got to the end of a file or that you've made a mistake. To some people, this is a rather crass characteristic of modern computing. Other PC users just can't get enough of this sort of thing. If you're in the first category we'll tell you how to turn these noises off. If you revel in having a PC which is thoroughly ostentatious and different from anyone else's, however, we'll show you how to replace the sounds which Windows makes either with others sounds bundled with Windows or even with your own sounds. And in so doing, we'll introduce you to some of the sound manipulation tools available in Windows 98.

Sound Properties

OK, let's start with something simple – turning these sounds off. Of course, one way of doing this is to unplug your speakers but let's assume that you still want to be able to continue to use them for games, music or muti-media applications. From Start, select Settings > Control Panel. Now, from the Control Panel window, double click on the Sounds icon.

The Sound Properties window, which is shown in the article, is displayed. In the Schemes list box at the bottom of this window select 'No Sounds' and then press the Apply button. You'll now find that you can use your PC without any distracting jingles.

If this is all you wanted to be able to do, the rest of this column won't interest you. If, however, you want to be able to customise the sounds your PC makes, the rest of the column is for you. And the first thing we need to look at – in rather more detail – is the same Sound Properties windows which we used to turn off the jingles. First of all, try out some of the packaged groups of jingles which are a standard part of Windows. In all probability, your PC will currently be configured to use a scheme called Windows Default. If so, this is what will be displayed in the Scheme list box. Try out some of the other schemes – Jungle, Robotz, Utopia and Musica – to see whether you like them.

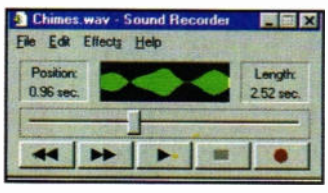


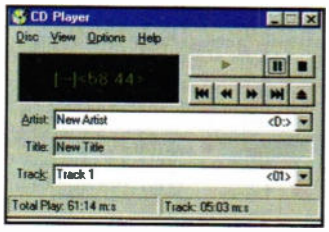
Don't forget to press the Apply button once you've selected a scheme. If you're like me you'll find some of these schemes to be interesting but it does get rather annoying when every single action, even pulling down a menu, has a jingle associated with it. And most of these alternative schemes do have sounds associated with far more actions than the Windows Default scheme does. However, it is also possible to modify the sounds for each and every action. You can use this either to turn off some of the sounds in a scheme or to put together your own customised scheme. In either case, if you want to keep the scheme be sure to save it when you've got it right. The key to this level of customisation is the Events list box at the top of the Sound Properties window. You'll notice that this lists all events which can have sounds associated with them. Next to any event for which a sound is defined there will be an icon. And if you select the event, the name of the associated sound will appear in the Sound Name list box. Pressing the play button (the one which looks like a right arrow) will cause the sound to play. And if you want to select a different sound for that event, press the Browse button and then select any .wav file. The ones which will be displayed initially are in the Windows\ Media folder but you can select .wav files from anywhere on the hard disk.

Your Own Sounds

So much for using the sounds bundled with Windows but if you want something truly unique, you'll need to create your own sounds. And the key to doing this is the Sound Recorder which is found at Start > Programs > Accessories > Entertainment > Sound Recorder. First of all, let's use it to take a look at one of the standard Windows sounds. Open any of the .wav files in the Windows\Media folder.

Open the file and play it by pressing the play button (right arrow). Watch the waveform as it plays. Now try altering the sound. For example you can increase or decrease the volume and you can speed it up or slow it down. Both these latter two options will also have the effect of altering the pitch. You can also select a portion of the sound (by moving the slider and then selecting Delete before Current Position or Delete After Current Position in the Edit menu), you can copy and paste and so cause the sound to repeat, or you can mix





in the sound from another file. By using combinations of these effects you can create some truly unique sounds, even using the standard Windows .wav files as your starting point.

Recording

However, we mustn't loose sight of the fact that this utility is called the Sound Recorder, not the Sound Editor, even though it does that too. So in the final stage of customising Windows sounds, let's try recording our own sounds. If you've got the gift of the gab, you could simply plug a microphone into your sound card and record some jingles. If you're not as theatrical as this, on the other hand, CDs and video tapes are an obvious source of sounds. In any case, having plugged your microphone, CD player or video recorder into your sound card just press the record button on the Sound Recorder – this is the button with the red circle. Of course, unless you're extremely good at cueing your CD or video tape you won't capture exactly what you require. However, don't forget that you can easily use the Sound Recorder to get rid of portions at the start and/or end of your recording.

You'll notice above that I specifically talked about plugging a CD player into your sound card. You might reasonably expect, as I did, that you'd be able to record from an audio CD playing in your CD-Rom drive and using the CD Player utility which is at Start > Programs > Accessories > Entertainment > CD Player. And this might be possible – certainly I've done it with a previous PC. However, the sound card on my present PC seems to prevent recording from a CD. My only suggestion if your PC is like this (an idea I didn't actually try out for lack of a suitable lead) is to loop the line output socket back to the line input socket on the sound card in which case everything should work just the same as if you had a microphone or other sound source plugged into the line input socket.

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.

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