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THE MAPLIN MAGAZINE

ELECTRONICS and Beyond

April 2000 Vol. 19 No. 148

Projects

13 TV Remote Control
Richard Grodzik describes a simple 3-Button remote control using a PIC.

16 30W Stereo Amplifier
John Mosely builds this compact stereo amplifier that produces a nice sound.

41 Garage Protection with Convenience of Use
David Ponting describes additional protection for the garage.

45 Hardware MP3 Player
In the final part, Martin Pipe concludes the construction and discusses the software needed for the standalone MP3 player.

56 Using Servos and Stepper Motors
In the second part, Gavin Cheeseman looks at some practical applications for servos and stepper motors.

Features

7 Uri Geller's Extended Reality
Uri returns to George Egely and his 'Wheel' and describes what it's for and how it might possibly work.

8 DVD - The Next Generation
Reg Miles looks at the digital replacement for the VHS recorder.

20 Valves In the 21st Century
In Part 4 Mike Bedford looks at the big power devices used in high power RF engineering where valves reign supreme.

28 The Quantum World
In final part of this series, David Clark explains the fundamental structure of protons and neutrons, and looks at some quantum devices in the 'real' world.

53 Y2K: KY2?
Gregg Grant asks if there really was a 'bug' in the systems - or was it all media hype.

62 FET Principles and Circuits
Ray Marston looks at practical MOSFET and CMOS circuits in this penultimate episode of this 4-part series.

67 An Electrifying Century: The Rise of Electronics 1900-2000
In part 4, moving towards 1975, Gregg Grant recalls the marvel of miniaturisation.

Regulars

2 News Report
18 Air Your Views
19 Software Hints & Tips
25 Technology Watch
33 @ Internet
61 Comment
70 What's On & Diary Dates
72 In The Pipeline

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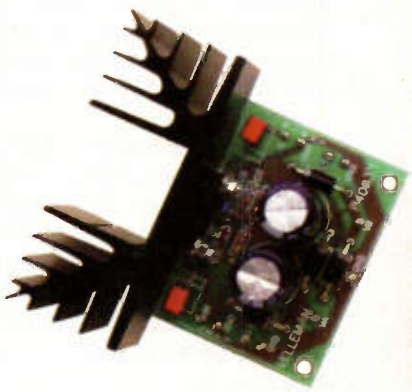


ELECTRONICS and Beyond

This month, both Martin Pipe and Reg Miles look at the forthcoming demise of the analogue video recorder, and investigate the range of possible replacements. We have mentioned this on several occasions in the past, but the end is certainly now in sight for the faithful old VHS.

With Microsoft now teaming up with a large book publisher in the USA, are we now on the road to the demise of the printed word? Will libraries of the future not stock books as we know them, but as electronic files that we download into our electronic book display system? The technology is already there.

Also, Casio has released what it claims to be the world's first digital camera with an advanced 3.34 mega pixel CCD for personal use. It also features primary colour filters to create 2,048 by 1,536-pixel images of very high-definition and natural looking colour, and a new 3X optical zoom, wide-aperture lens. This probably makes the images as good as existing 35mm film cameras even when blown up to a large format.

Progress in battery power supplies has nowhere matched the rapid advance in electronics. This could soon change, for scientists at Motorola Labs and Los Alamos National Laboratory have developed a new, miniature fuel cell that may replace traditional batteries. The immediate application for such a power source is, of course, mobile phones, laptop computers and cameras. The energy density of these new fuel cells is ten times that of conventional rechargeable batteries. At the same time, they will be significantly lighter in weight and less expensive to purchase. Stephen Waddington looks at this latest development in this months News Report.

Britain's Best Magazine for the Electronics Enthusiast

NEWS REPORT

Computer Car Due by Summer

Technology that merges life's conveniences with a powerful driving experience is featured by Visteon Automotive Systems a concept car.

Visteon has unveiled its car computing system, called ICES (Information, Communication, Entertainment, Safety and Security). Available to consumers from summer this year to retrofit into existing vehicles, ICES allows drivers to optimise time traditionally spent away from home and office.

With the use of simple voice commands, ICES provides drivers with access to the Internet where they can check email and obtain real-time information such as news, weather reports and business information. ICES also provides access to a turn-by-turn navigation system.

ICES is activated by Visteon Voice Technology, which allows drivers to stay connected while keeping their eyes on the road and their hands on the wheel.

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

Contact: Visteon, Tel: (01268) 705300.

Wyse Unveils Plan for Windows Terminals

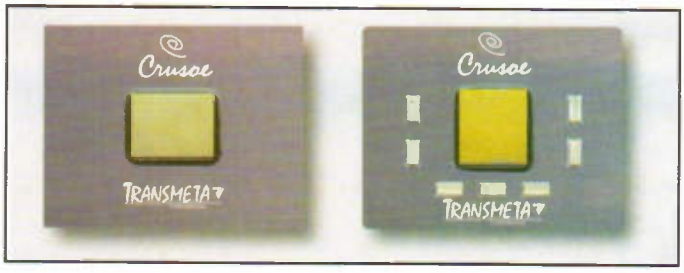
Wyse Technology will deliver a Windows-based Terminal Standard product based on Windows CE and featuring an optimised version of Internet Explorer 4.0 in the second quarter of 2000.

This product complements the previously announced plans to deliver its first Windows-based Terminal Professional product, based on Windows NT Embedded 4.0, featuring a built-in customised version of the Internet Explorer 5.0 browser and streaming media support.

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

Contact: Wyse, Tel: +1 39 44 00 44.

Crusoe Chip Takes New Approach to Mobile



Transmeta has ended four and a half years of secrecy with the introduction of Crusoe, a new family of smart microprocessors.

Designed to create a new category of Mobile Internet Computers, the Crusoe processor family is based on a breakthrough software approach that will revolutionise the field of mobile computing.

The evolving class of Mobile Internet Computers includes a rich set of products that spans from Web pads to ultra-light (less than four pound) Mobile PCs that share the common need of x86 software compatibility and long battery life.

It represents a shift from today's mostly stationary laptops or incompatible handheld devices to a platform that offers greater mobility and access to the Web from most anywhere at anytime.

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

Contact: Trasmeta, Tel: +1 408 919 6393.

Tadpole and Espial Create Handheld Platform

Espial, the leading provider of embedded Java technology for Internet appliances and Tadpole Technology have struck an alliance that will put Espial's tools and Internet applications into their J-Slate technology.

The Tadpole J-Slate, a diskless, rugged hand-held computer is a Java-based, industrial pen computer that allows mobile workers to run applications via wireless networks.

The Tadpole J-Slate is a diskless, rugged, hand-held pen computer that has been specifically designed for mobile workers in industrial or field applications.

For further details, check: <www.tadpolerdi.com/jslate>

Contact: Tadpole, Tel: +1 760 929 0992.

Algae has Potential as Power Source

A metabolic switch that triggers algae to turn sunlight into large quantities of hydrogen gas, a valuable fuel, is the subject of a new discovery reported for the first time by University of California, Berkeley scientists.

Currently, hydrogen fuel is extracted from natural gas, a non-renewable energy source. The new discovery makes it possible to harness nature's own tool, photosynthesis, to produce the promising alternative fuel from sunlight and water.

So far, only small-scale cultures of the microscopic green alga Chlamydomonas reinhardtii have been examined in the laboratory for their hydrogen production capabilities.

"I guess it's the equivalent of striking oil," said UC Berkeley plant and microbial biology professor Tasios Melis. "It was enormously exciting, it was unbelievable."

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

Contact: UC Berkeley, Tel: +1 510 642 6000.

Gates Quits as Microsoft Boss

Bill Gates has resigned as Microsoft's chief executive, handing the role over to the company's president Steve Ballmer. Gates will remain chairman and will fill the new position of chief software architect. The announcement comes shortly after reports that the Justice Department is seeking to divide Microsoft into three separate companies.

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

Contact: Microsoft, Tel: (0870) 6010100.

NEWS BYTES

Megapixel Camera is Picture Perfect

Casio has released what it claims to be the world's first personal-use digital camera with a 3.34 mega pixel CCD.

The QV-3000EX employs an advanced 3.34 megapixel CCD that captures every nuance of the subject you are trying to record. It also features primary colour filters to create 2,048 by 1,536-pixel images of very high-definition and natural looking colour, and a new F2.0 Canon 3X optical zoom, wide-aperture lens.

All of this gives the QV-3000EX the means to record images of subjects that are too difficult for existing digital cameras with high definition and clarity.

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

Contact: Casio, Tel: (020) 8450 9131.

Sony Launches Elegant PC

Sony has introduced its third-generation of VAIO Slimtop computers with its new PCV-L630 Slimtop LCD computer. Designed with more power, speed and multimedia software extras to meet increasing performance expectations.

Distinctive style, flexible functionality, and convenient connectivity are all features of the latest Slimtop model. The svelte PCV-L630 weighs less than 12lbs and requires very little desktop space - roughly 70% smaller than standard desktops, yet powerful enough to operate multimedia software quickly and easily.

But such quality is not cheap. European pricing for the new machine has still to be determined, but it is likely to be in the region of £2,000.

For further details, check: <www.sony.com/pc>.

Contact: Sony, Tel: (020) 7533 1400.

Throwaway movies

Start-up SpectraDisc has developed a technology for making time-limited DVD disks that will become unusable after a specified period, such as two days. The technology would allow consumers to buy movies rather than rent them, and just throw them away when they expire.

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

Contact: SpectraDisc, Tel: +1 401 274 4700.

NEWS BYTES

Zoom Introduces Hayes PCI Modem

In keeping with its commitment to provide Hayes customers with the latest technology, Zoom is now shipping its Hayes ACCURA V.90 PCI Modem. The Hayes ACCURA V.90 Modem integrates popular features of traditional Hayes modems with the most up-to-date V.90 technology. PCI modems currently represent the industry's highest volume category.

The ACCURA PCI modem takes full advantage of the high speed PCI bus architecture commonly found on today's fastest computers and provides high quality voice mail and Class 1 fax. It includes V.80 capability for point-to-point video and supports the H.323 and H.324 videoconferencing standards.

For further details, check: <www.zoom.com>. Contact: Zoom, Tel: (01493) 748818.

Casio Introduces Wearable MP3 Player

Casio has announced the WMP-1V Wrist Audio Player, a wrist-type wearable MP3 player. The MP3 player is one of the latest additions to the growing line-up of new wrist data devices.

The Wrist Audio Player has enough memory to store approximately 33 minutes of CD-level quality sound in the High Quality Mode, 44 minutes of near CD-level quality sound in the Medium Quality Mode, or 66 minutes of FM broadcast-level quality sound in the Low Quality Mode.

Digital circuitry provides stable, non-skip playback, even when the Wrist Audio Player is subjected to strong vibration or impact.

For further details, check: <www.casio.com>. Contact: Casio, Tel: (020) 8450 9131.

Chipmakers Team Up In Memory Deal

Six of the world's top producers of dynamic random-access memory (D-RAM) chips have reached an agreement to collaborate on developing the next generation of high-performance D-RAM chips. Joining in the pact are Intel, Micro Technology, Samsung and Hyundai of Korea, Japan's NEC and Germany's Infineon Technologies.

For further details, check: <www.intel.com>. Contact: Intel, Tel: (01793) 403000.

Miniature Power Source in Sight

Scientists at Motorola Labs and Los Alamos National Laboratory have developed a new, miniature fuel cell that may one day replace the traditional batteries that now power everything from cellular phones and laptop computers to portable cameras and electronic games.

The energy density of these new fuel cells is ten times that of conventional rechargeable batteries. At the same time, they will be significantly lighter in weight and less expensive to purchase.

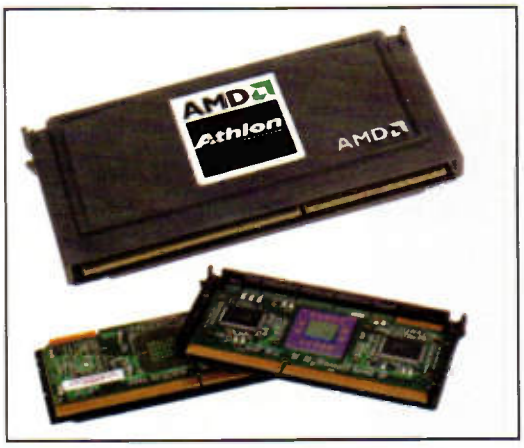
The new fuel cells, each measuring about one inch square and less than one-tenth of an inch in thickness, are powered by liquid methanol and can easily be installed into numerous existing and future electronic devices. Use of the fuel cells, for example, could safely power a cellular phone for more than a month and eliminate the need for battery chargers and AC adapters.

The new fuel cell uses a reservoir of inexpensive methanol that, when combined with the oxygen in the air, produces electricity. Since fuel cells have low voltage outputs, typical designs normally would require stacking several cells together to increase voltage. However, Motorola Labs has designed unique circuitry that efficiently converts the low voltage of a fuel cell to the higher voltage required to replace conventional batteries and directly drive portable electronics.

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

Contact: Motorola, Tel: (01256) 790790 .

AMD Athlon Named Best Processor



The AMD Athlon processor has won a prestigious award from one of the microprocessor industry's leading technical publications. MicroDesign Resources, publisher of the Microprocessor Report, has announced that the AMD Athlon processor beat out the Intel Pentium III Coppermine and the Motorola PowerPC G4 to win the publication's first ever Analyst's Choice Award for Best PC Processor.

With 35 awards in hand since the product was launched in August 1999, the AMD Athlon processor is also the first AMD microprocessor to win multiple awards as a top-performing workstation processor.

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

Contact: AMD, Tel: (01276) 803299.

Blue Pole Mystery Explained

Ever wondered what the blue speed camera like objects are that have started to appear at the side of major roads in the UK. The good news is that they are not speed cameras.

They are in fact part of a £10 million expansion programme which has tripled Trafficmaster's existing network. This has involved the installation of over 5,000 infra-red sensors and 3,500 roadside beacons on over 7,500 miles of the country's motorways and trunk roads.

The system is believed to be the most comprehensive, nationwide, live traffic monitoring network in the world. In addition to providing information on traffic conditions, it also provides the motorist with real-time information on journey times on over 95% of the country's main roads.

A further enhancement of the system's software is that it will be able to predict when traffic is at its worst and therefore the best time to travel. It works by using specially developed infra-red sensors, installed approximately four miles apart, to measure the time taken for a vehicle to travel between each sensor site.

Computers at each site continuously transmit this information back to Trafficmaster's National Control Centre in Milton Keynes, where it is processed and transmitted directly to vehicles fitted with Trafficmaster receivers.

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

Contact: Trafficmaster, Tel: (01908) 249800.

Bigger Mouse is Best

University of Cornell professor Alan Hedge believes that using a larger mouse might help reduce the wrist pain sometimes associated with mouse use. Hedge studied the wrist movements of people using a standard Microsoft mouse and those using a larger mouse called the Whale.

The Whale, was about one inch larger than the Microsoft mouse and can be extended an additional inch for larger hands. Hedge says he wanted to determine whether a larger mouse would help keep the fingers flat and prevent people from moving their wrists into uncomfortable angles.

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

Contact: University of Cornell, Tel: +1 607 254 4636.

VCX Defines Transaction Platform for IP

The Virtual Component Exchange (VCX) has announced the completion of its first member-approved specifications focusing on automating the business and legal transactions necessary to acquire virtual components - also known as intellectual property - over the Internet.

At the same time, the VCX said Synchronicity, a San Jose, California supplier of Web-based design management, IP reuse and e-business solutions will work as a development partner in building the technology infrastructure for the VCX trading system. Spektra Systems of Livingston, Scotland, had previously been announced as a technology partner in the venture.

The VCX Transaction Platform 1.0 Requirements Specification combines the joint efforts of the Contact development working group (DWG) and the Contract DWG, staffed from the 22 VCX member companies. The specifications cover all the basic elements of the VCX system needed to conduct a VC trade at considerable time and cost savings to both parties to the transaction.

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

Contact: VCX, Tel: (01506) 404100.

On Semiconductor Plans High-Bandwidth Strategy

ON Semiconductor has announced a new corporate initiative to advance its proprietary high-bandwidth integrated circuit (IC) products in a bid to creating a 'Super Internet'. The company plans to increase its design and application engineering resources for a push on developing new products and packaging technologies.

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

Contact: ON Semiconductor, Tel: (01296) 395252.

Be is Free

Operating system developer Be says it will offer the newest version of its operating system for free to individuals who pre-register. Commercial users of BeOS 5 will still need to acquire a separate license from the company. The company is repositioning BE OS in a bid to target Internet appliances.

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

Contact: Be, Tel: +33 1 55 91 77 30.

NEWS BYTES

DNA Computer Does Complex Calculations

A research team at the University of Wisconsin has successfully used synthetic DNA attached to a solid surface to perform calculations, moving DNA computing closer to real-world use. Traditional computers run on chips, but chip technology might be reaching the limits of its potential.

A number of research teams in the US are now working to build computers that leverage the tremendous storage capacity of DNA and RNA. Most DNA computers that have been created in the past confine the DNA to test tubes filled with liquid, but the University of Wisconsin team was able to attach the DNA strands to a piece of glass.

For further details, check: <www.uwsa.edu/vgsc.htm>.

Contact: University of Wisconsin, Tel: +1 608 263 3961.

IBM Smart Agent Combats Server Bottlenecks

IBM has announced smart agent technology that monitors the health of Intel processor-based computers anywhere on the Internet and can make repairs, avoiding costly downtime and keeping them working at peak performance.

The new Netfinity Director incorporates Software Rejuvenation and Capacity Management technologies pioneered on its mainframe systems to scout out potential computer problems, automatically correct them, and alert the administrator to upgrades that will improve performance or prevent downtime.

For further details, check: <www.ibm.com>. Contact: IBM, Tel: (0870) 0102500.

The New Maplin Catalogue is due for launch in April 2000

The new April 2000 issue of Maplin Electronics catalogue has been redesigned in order to give customers a more user-friendly browse. All the familiar categories still remain. The newly formatted catalogue is segmented into seven discreet product worlds. The segments include; Communications, Components & Cable, Computers, Electrical, Leisure & Hobbies, Sound & Vision and Tools.

The traditional issue date of March 1st has been moved to April 1st to accommodate these changes, due to product range reviews and additional value-added services being implemented in to the April 2000 issue of the Maplin Electronics catalogue.

For further details please contact Maplin Electronics on 01702 554 002.

NEWS BYTES

Intel to Launch Appliances

Intel is planning a new line of simple-to-use consumer appliances based on its Celeron microprocessors. The appliances will run on Linux operating system software, and are expected to incorporate hard drives for storage and speedy Internet access via ADSL or cable modem.

Intel says that it will target the appliances at very specific tasks, such as e-mail retrieval or online shopping, and likely will be provided free with a subscription service linked to their function, such as home shopping or online banking.

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

Contact: Intel, Tel: (01793) 403000.

Nanotechnology Used to Dectect Poison Gases

Deadly gas leaks are an everyday hazard of modern life. Unfortunately, conventional gas alarms often fail to detect the presence of toxic fumes until it's too late. But a team of scientists at Stanford University has developed a gas detector that is a thousand times more sensitive than any commercially available device operating at room temperature.

The experimental sensor uses carbon nanotubes only one nanometer thick. A nanometer is one-billionth of a meter - about 50,000 times smaller than the width of a human hair. Researchers placed two miniature metal pads at opposite ends of a nanotube, creating a semiconductor capable of detecting tiny changes in an electrical current when only a handful of gas molecules are present. Scientists tested the device using two common forms of noxious gas: ammonia and nitrogen dioxide.

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

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

Sun Launches New Operating Environment

Ed Zander chief executive of Sun launched the Solaris 8 Operating Environment at the end of January. Solaris 8 runs hardware for large Internet sites such as AOL providing the continuous uptime needed to serve their rapidly growing customer base.

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

Contact: Sun, Tel: (020) 7628 3000.

IBM Adopts Cadence Router for Processor Designs

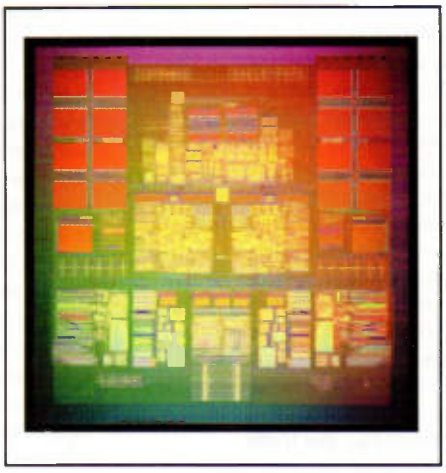
IBM is using a chip assembly router from Cadence Design Systems to design the next versions of the G5 and G6, two of the world's fastest microprocessors.

Used in IBM's world-standard mainframe and server products, the G5 and G6 are highly sophisticated semiconductor designs and, notably, both achieved first-silicon success in manufacturing.

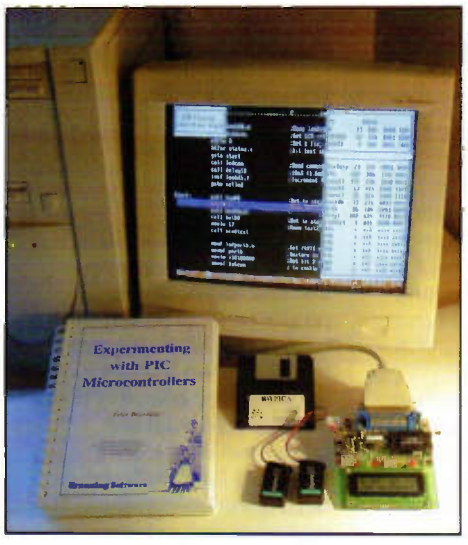
The assembly router from Cadence is a constraint-driven, shape-based, place and route solution for custom and structured custom integrated circuits (IC). It provides correct-by-construction implementation of strict timing, noise control, and topology requirements for deep-submicron (DSM) designs.

For further details, check: <www.cadence.com/technology/chip>.

Contact: Cadence, Tel: (01344) 360333.



New PIC Kit from Brunning Software



Brunning Software has announced the third release in their "Experimenting with....." series. The latest system consists of the book, a programmer/experimental module, and an integrated suite of programmes to run on a PC.

The book with its abundance of flow diagrams and circuit diagrams is the heart of the system, and the software suite is the brains. A text editor with word processor power is the key stone supporting the assembler, disassembler, simulator and programming software. As the text is typed in the assembler works in the background testing each line so that errors are immediately highlighted. When the typing is done the program can be single stepped or run using the simulator which also improvises the operation of a standard 2 line by 16 character display. If the programme works correctly plug the programmer/experimental module onto the end of your printer lead and test it using a real live PIC16F84. All this is being done directly from the assembler text in the editor which makes an ideal system for complete beginners and experienced programmers.

All the experiments are performed using the programmer/experimental module which is already wired with LEDs and an alphanumeric liquid crystal display. Flashing LEDs, text display, real time clock, period timer, beeps and music, including a rendition of the Beethoven Für Elise. Then there are two projects to work through; building a sinewave generator covering 0.2Hz to 20kHz in five ranges, and investigating measurement of the power taken by domestic appliances.

The book is £24. The programmer/experimental board with the software suite is £64.

Contact: Brunning Software Tel: 01255 862308.

3Com Announces e-Networks Strategy

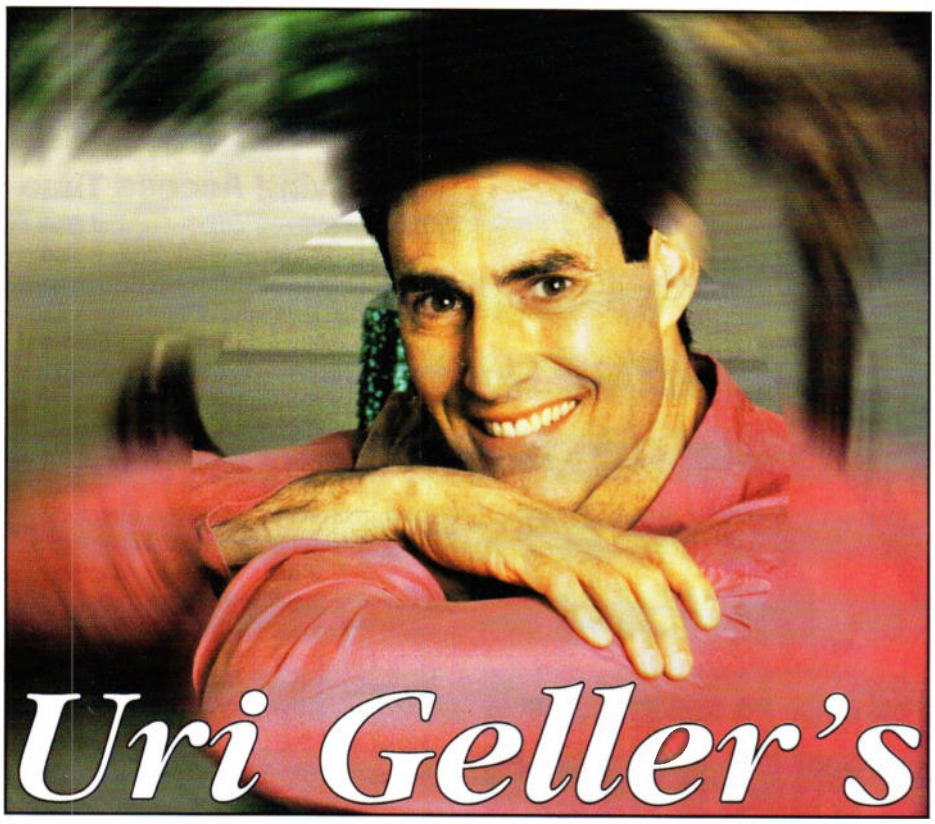
3Com has announced its strategy for delivering e-Networks to service providers. Based on the company's CommWorks architecture, 3Com is delivering versatile, multi-service packet-based networking solutions that offer service providers a complete migration path from legacy analog networks to next generation converged multimedia networks.

With its robust layers of media processing, call control and service creation, the CommWorks architecture enables customers to evolve their existing disparate infrastructures for remote access, IP telephony, wireless data, and broadband access into a single, integrated IP network for the delivery of multiple services.

These packet-based networks give service providers greater flexibility to differentiate services, create new revenue-generating business opportunities, and establish a unique position in the highly competitive communications market.

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

Contact: 3Com, Tel: (0118) 922 8200.



Uri Geller's EXTENDED REALITY

The Egely Wheel - Part 2

In last month's column, I talked about how the Egely Wheel came to be invented and patented, I did not have the space to describe what it actually is, so let me get that out of the way. It is a high-tech computerised version of a simple toy you can make in a couple of minutes with nothing more than a pin and a piece of paper.

Tap the pin into a piece of wood, and check that it is absolutely straight. Cut a small piece of paper into a square and fold it from corner to the diagonally opposite corner, then open it up to make a pyramid. Drop it on top of the pin and voila! - you have a prototype Egely Wheel.

Now cup your hand around it taking care not to touch it and you'll notice that your paper wheel starts to wobble. This could be because you are near an open door or window, or a blazing fire, so make sure that air currents do not affect your wheel. Also, avoid breathing too heavily, or talk while you are using it. A handkerchief over the mouth is a good idea.

The Egely Wheel is an aluminium disc balanced on a pin of melted steel encased in a plastic box about the size of the palm of a medium-sized hand. Two rows of small lights, numbered from 1 to 24, light up when the Wheel starts to revolve, and you can also turn on the bleep switch and get an audio signal at the same time. The device is beautifully designed and manufactured, and would not be out of place in a design museum.

Most people in good health find that when they put their hands near the Wheel, it starts to revolve, sometimes very slowly and sometimes quite fast. Usually, they find that they get more movement with one hand than the other, and if they experiment several times at different parts of the day, they will find a wide variation in speed. Sometimes, the Wheel will whizz around, and sometimes it just refuses to budge. So, what is making it move (or not move)?

This is where it becomes controversial. George Egely is in no doubt as to what he thinks the device is measuring - your VO or Vitality Quotient. After hundreds of experiments with people young and old, healthy and sick, he claims to have found a direct correlation between their general state and rotation rate of the Wheel. As if that were not outrageous enough, he also claims that what people are thinking with positive thoughts or visualisations speeding it up, and negative ones slowing it down affect the rate.

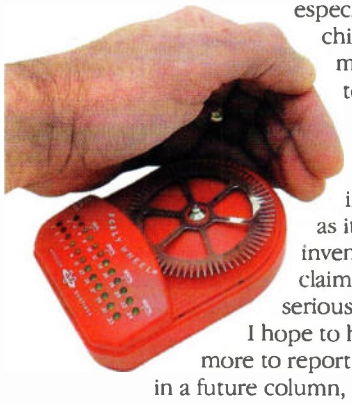
The lights on the box are in three colours, like a traffic light - red, yellow and green. The first five are red, indicating what Egely calls a very low or below average vitality level. Number 6 is what he reckons to be average level, while green lights 13 to 24 indicate outstandingly high level. The Wheel has no upper limit to its rotation rate although in its present form it only measures up to 24. However, a few people have made it go even faster. The current world champion is Egely's fellow Hungarian Erno Rubik, inventor of the famous Cube which has driven people crazy all over the world. Testing him with a special measuring device, Egely recorded a level of 35, or about six times 'normal'.

Several scientists have examined the Egely Wheel, and nearly all of them have come up with a different explanation. The most currently popular one seems to be the thermal-hydrodynamic one, whereby the blood flow rate can be altered by activity in the brain, although this does not seem to be the whole story by any means.

"I placed the Vitality Meter on the stage and put a small radio microphone next to it. Then I stepped back about five meters from the device. I asked the audience to concentrate so that the wheel would start to rotate clockwise. There was such a complete silence in the hall that you could have heard the buzz of a fly. It kept still at first but then it started to rotate faster and faster, until it reached the maximum number on the scale."

This, he reckoned, showed that something more than just thermal interaction was, at work. There seems to be, he said "something inside all of us that, if there is no better word for it can be called life energy."

I certainly have no better word for it. I very much hope that there will be more research into this engaging gadget. I am doing a number of experiments myself, but am not yet ready to announce my findings. Yet never mind about science for now - the Egely Wheel is great fun. People love it, especially children. It makes a terrific party game. It is indeed, as its inventor claims, a serious toy, and I hope to have more to report about it in a future column,



Sole importer for the Egely Wheel in the U.K. is Klara Heltay, fax no: 0181 287 1079 or email: kheltay@compuserve.com. Visit George Egely's Website at **http://www.ambro.hu/broze/egely**

Uri Geller's latest book MindMedicine is published by Element Books at £20.00, and his novel Dead Cold is published by Headline Feature at £5.99.

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

DVD NEXT GENERATION

Reg Miles looks at the replacement for the VHS recorder

As DVD grows in popularity so companies are already developing the next generation of optical disc to eventually replace it. This will employ a blue laser for much increased storage capacity. And, whereas the emphasis of the original DVD development was on replicated discs to carry mainly movies - with Recordable and ReWritable versions following more or less as an afterthought for computer uses, the emphasis is now being placed on ReWritable discs for home recording.

2nd Generation DVD

This third generation optical disc (second generation DVD) is therefore intended as an eventual replacement for VHS, S-VHS and D-VHS; with advantages of direct and rapid access, clear indexing of contents, and, in the case of replicated discs, no wear during play (although the disc's surface is vulnerable to careless use by software renters). The latest DVD ReWritable disc already has the capability to be used for recording standard definition TV programmes - just as DVD-Video already carries standard definition movies, etc; so the next generation will have the capability of recording high definition (HD) programmes or an increased number of standard definition ones, and the same will be true for the replicated version. It will also open up additional applications for interactive multimedia in which tape, with its long access times, would be very much at a disadvantage.

Improving Access Time

The slower access times of optical discs by comparison with magnetic disks is also being addressed: Philips has demonstrated an average seek time of 11ms with existing DVD by splitting the optics into fixed and moving parts coupled with a linear motor capable of acceleration rates of 60G. This combination of quicker access times and greater storage capacity will also give the disc a greater role to play in computing.

For the present, however, attention is being focused on its potential consumer role. And, as there was with DVD, there are two competing camps - with the same companies rivalling each other. Philips and Sony have proposed the HD Digital Video Recorder (HD-DVR) - as last time they proposed the MultiMedia CD; and Hitachi, Matsushita (Panasonic), Pioneer and Toshiba have proposed the High Definition DVD (HD-DVD) - as before they proposed the Super Density disc. Philips and Sony have also proposed a standard definition red laser DVR with almost twice the capacity of red laser DVD. Obviously, the two groups will get together and arrive at a compromise solution based on the best of both proposals; and choose a marketable name, as they did with DVD - although that had to be changed from Digital Video Disc to Digital Versatile Disc as the potential became apparent.

There is no great rush, because they do not want to kill off DVD at this early stage in its life. But, then again, HDTV is already in use and is very slowly spreading, so they cannot wait too long to get together and produce the final specifications that will enable manufacturing to begin. And, as the CD variants are overlapping with their DVD counterparts, so the new disc will overlap with its predecessor - its market share increasing as DVD slowly declines

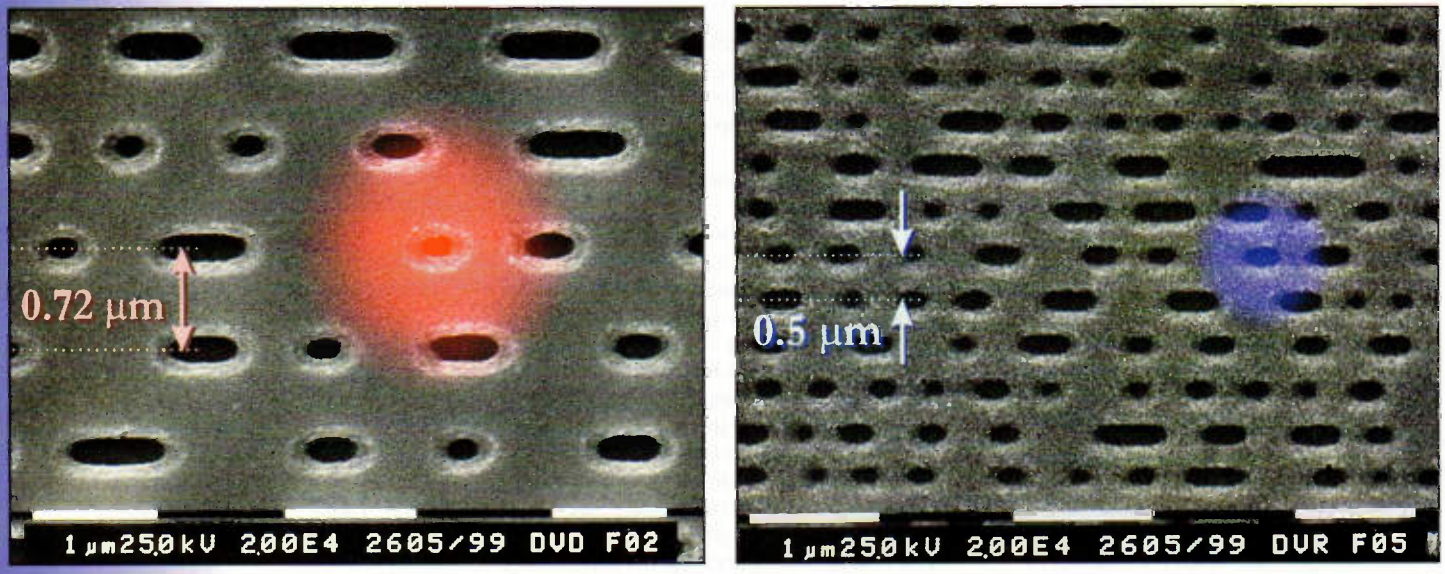


Figure 1a/b. The reduction in pit and laser spot size

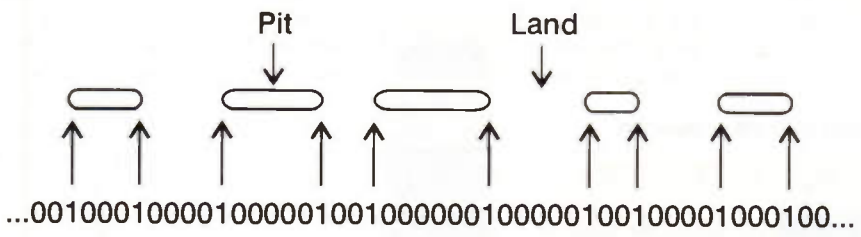


Figure 2. Channel code represented by pits and lands

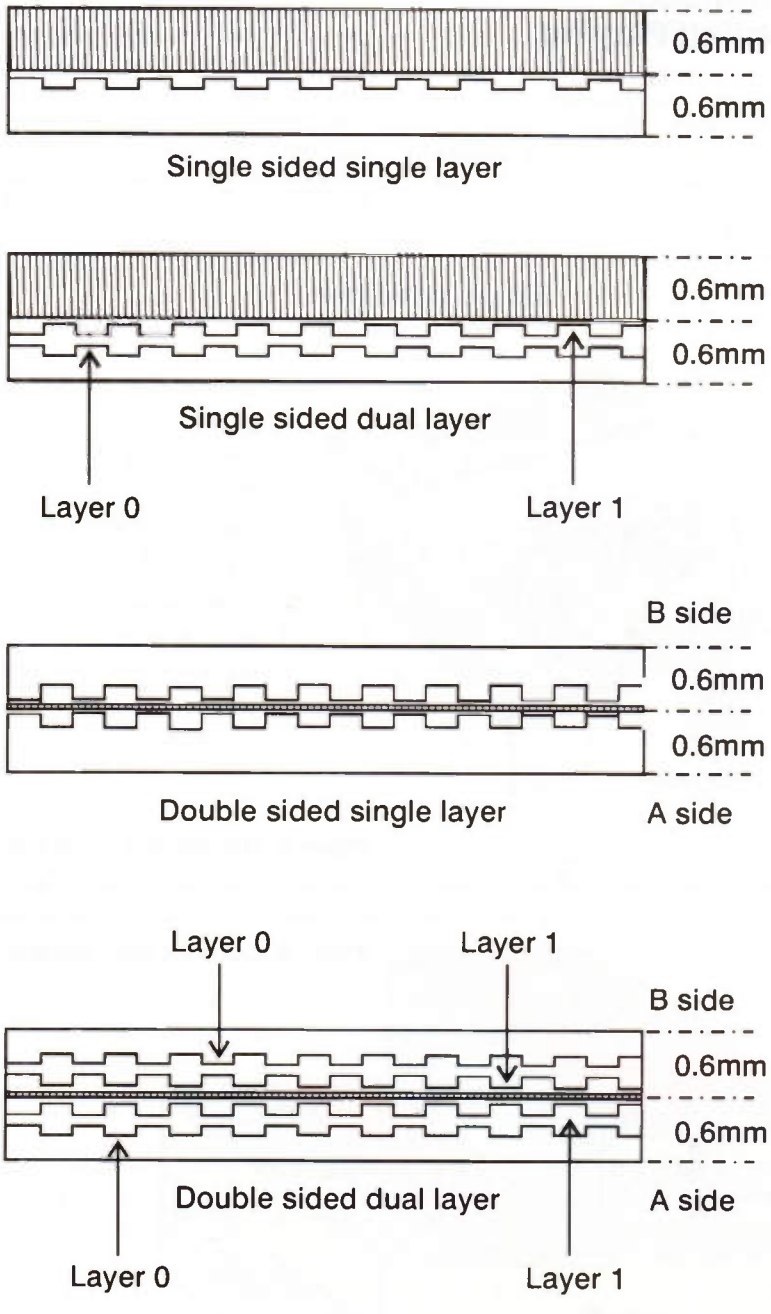


Figure 3. The four types of DVD disc constructed

Double-Sided Discs

The DVD specifications already allow both sides of the disc to be used and each side can employ two layers, so the only way left to squeeze in more bits is to reduce the size of the pits that carry them (Fig. 1). And the most effective way to do that is to reduce the wavelength of the laser that is used to read/write them. This has already been done with DVD, where a red laser of 650nm replaced the CD's infrared laser of 780nm. A blue laser will bring a more significant reduction in bit size with a wavelength of only 400nm (actually, that is in the violet region, so it is more correctly a blue/violet laser).

All optical discs rely on differences in the brightness of the laser light that is reflected back from the surface to read the stored information. With a pressed disc this difference is achieved by having pits in the surface separated by lands. Recordable and ReWritable discs rely on darker marks in the surface to produce the same effect as pits, and make all three compatible. Recordable discs are coated with a dye that will darken permanently with heat (the laser power is turned up for recording the marks so that darkening does not occur during playback at normal power). ReWritable discs are coated with a phase change material that goes from polycrystalline to darker amorphous (non-crystalline) with the application of heat, and the resultant marks are 'fixed' by rapid cooling. To rewrite the disc an annealing process is used with the laser at lower power to return the amorphous areas to their former state.

It is the changes to the amount of light reflected back that is the key to the programming information. The abrupt changes in reflectance at the leading and trailing edges of the pits represents a digital '1'; the length of the pit or land between (constant reflection) represents digital '0's (Fig. 2). The shortest representing two '0's, the longest representing ten '0's. In order for this to work repeatably the disc must obviously be rotating at the correct speed, or else the number of '0's would vary. This is achieved by detecting and locking onto the nine discrete frequencies from the nine pit lengths that make up the high frequency signal reflected back during playback (Recordable and ReWritable discs incorporate a wobbled groove that reflects back a constant frequency signal to maintain speed during recording).

Because the pits and lands are limited in the sequences they can represent the original data bits must be converted into channel bits for replication or recording to conform to the pit pattern rule. In DVD this is achieved by 8/16 channel modulation. The original eight bit data numbers are converted into sixteen bit channel code numbers that conform to the rule of '1's separated by not less than two and not more than ten '0's - (2,10) Run Length Limitation code - by a conversion table in which each data bit number has a channel code assigned to it. On playback they are returned to the original data bits.

Channel Modulation

DVR has adopted a different system of channel modulation. This uses a (1,7) RLL code, with runlengths of 2 to 8, achieved by a 2/3 conversion rather than 8/16. The result is that the channel bit length is increased for the same data bit length by comparison with 8/16, allowing greater tolerance in the timing. Additional features of the channel code are said to increase system tolerances and improve playback reliability. Its short name is 17PP, which stands for (1,7) RLL Parity-Preserve Prohibit Repeated Minimum Transition Runlength.

DVD (-Video and -ROM) can be single sided or double sided, and each side can have one or two layers (Fig. 3). In the latter case the upper layer is semi-reflective, and the laser is refocused between it and the fully reflective lower layer. A single side has a capacity of 4.7GB, the second layer adds another 3.8GB; two sides with two layers make a total of 17GB. DVD Recordable and ReWritable do not have the dual layer facility, but can be single or double sided. DVD-R has a single side capacity of 3.95GB, with 4.7GB to come. The ReWritable disc actually comes in three versions: DVD-RAM with 2.6GB, DVD-RW with 3.95GB, and the new DVD+RW with 4.7GB (although they may all be referred to as DVD-RAM or DVD-RW). DVD-R, DVD-RAM and DVD-RW are for computer use, whereas DVD+RW can also be used for recording video. The proposed red laser DVR has a preliminary single side capacity of 9.2GB, the blue laser HD-DVR 22GB; while the HD-DVD camp is quoting 15GB.

The use of a blue laser will presumably require new photo-sensitive dyes for record-only discs; and will limit backwards compatibility with DVD-R and CD-R, with their dyes that have been formulated for the 650-780nm range. This should not be a problem with rewritable phase change materials. However, the latter will need to change phase more quickly to cope with a high definition video bit-rate of 25Mb/s by comparison with ReWritable DVD of about 10Mb/s. If the disc is to be recorded and played simultaneously, mimicking a hard disk, then the rate will need to be considerably greater, about 75Mb/s: 50Mb/s for recording and playing, and another 25Mb/s for switching between the two modes (DVR holds the record at present with 60Mb/s reported, using a coating of silver, indium, antimony and tellurium - AgInSbTe). A red laser DVR has been demonstrated with a user data rate of 33MB/s, and will thus record and play standard definition video simultaneously - or high definition separately. Incidentally, the smaller the marks, the more quickly they can be changed, so the blue laser has an initial advantage

Pioneer DVD video recorder

Simultaneous Recording/Playing

This facility for simultaneously recording and playing is already a feature of such hard disk products as the TiVo box that selects and stores programmes from a programme provider for personalised viewing, and PC-based home entertainment systems, and will be included in the proposed European STORit box that takes the process further (see Multimedia - Selection & Storage, February issue). Given the extra dimension that it brings to timeshifting - one can be recording a programme and when it is halfway through sit down and play it from the beginning, or be recording one programme while playing another, or pause playback for a time while recording continues - it seems probable that it will be in demand.

A digital video recorder could have a hard disk for daily recording (with simultaneous recording and playback), and just use an optical disc for archiving. Realistically, though, it is likely to be one or the other. Probably removable optical. Particularly given the Japanese launch of the Pioneer DVD recorder in December last. This uses the DVD+RW disc. Recording uses the real-time encoding, variable bitrate MPEG Video Recording Format (VRF) specified by the DVD Forum. Which is essentially the same as that used for replicated DVD-Video, so the machine will also play DVD-Video (this has to be a prerequisite for any updates on

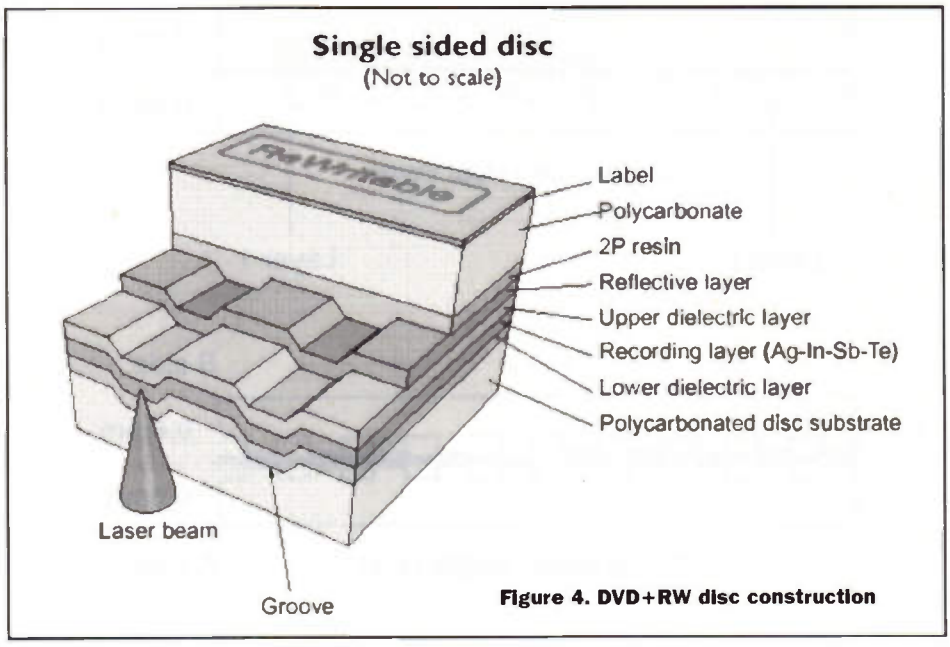


Figure 4. DVD+RW disc construction

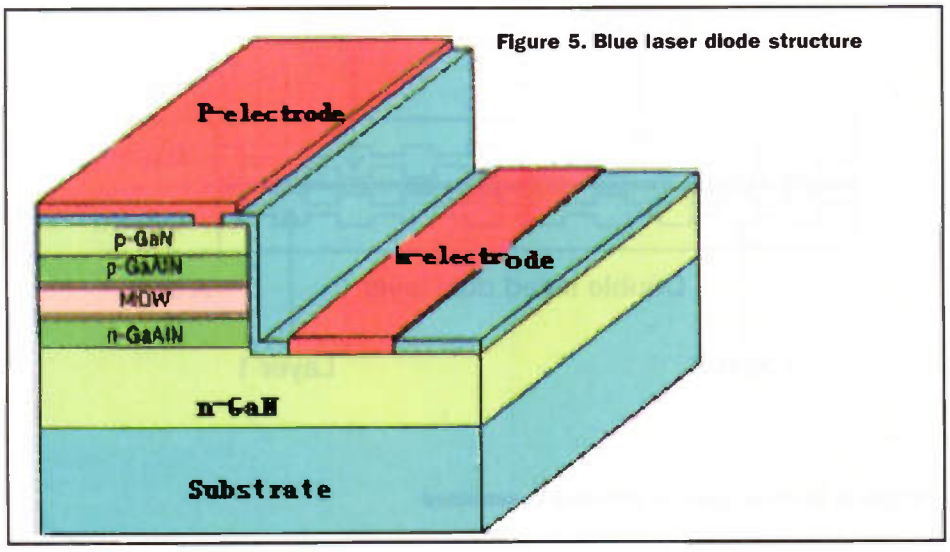


Figure 5. Blue laser diode structure

DVD Blue Laser with two lenses

DVD). There are two recording modes that govern the amount that can be recorded and, thus, the quality: SP allows up to two hours; while manual mode (MN) allows the user to select from 32 different times that give from 1-6 hours. There is also a full range of non-linear editing functions; a Dolby Digital Consumer Encoder to provide two channel audio; disc navigation using thumbnail images; etc. A number of other major manufacturers have expressed their support for the concept; and they along with Pioneer will apparently be bringing out VRF-ready DVD Video players that will play both DVD+RW and DVD-Video discs.

Incidentally, because VRF has a variable bitrate whereas writing on DVD+RW is done at a constant bitrate there must be a means of maintaining links despite the constant starting and stopping. This lossless linking is achieved by a groove with a high wobble frequency of 817kHz, allowing the placement of any data block to an accuracy of 1μm (Fig. 4 shows the grooved, multi-layer construction).

Basic Specification

The DVD Forum, the body composed mainly of manufacturers that establishes the specifications and proposes the standards for DVD developments, has decided that there will be two rewritable versions of DVD: one using VRF for recording from analogue sources and decoded digital, the other recording a bitstream directly from digital sources - like D-VHS. Philips and Sony, conversely, are aiming for a single DVR recording standard for all analogue and digital sources. This will be difficult to achieve, given the variations in broadcast formats.

There is another significant difference in the DVR proposal: the transparent cover layer through which the replicated/recorded information is read is only 0.1mm whereas with DVD it is 0.6mm, and the laser's lens is closer to the disc. This has been necessitated by the use of a higher numerical aperture for the laser to reduce its spot size - NA=0.85 by comparison with DVDs NA=0.65 (hence the nearly double capacity of the red laser DVR). This thin cover layer reduces coma aberration and makes disc tilt tolerable at this large NA. DVDs 0.6mm cover layer was reduced from CDs 1.2mm for the same reasons. A two lens system has also been adopted to ensure the accuracy of focus at the closer distance - for both red and blue lasers.

Blue Laser

A practical blue laser was first developed by 3M in 1991, using a semiconductor that required liquid nitrogen cooling, and emitted a wavelength of 490nm. But it had a very limited lifespan; and this has been one of the holdups in the commercialisation of the blue laser diode. 3M are continuing the work, now with lasers operating at room temperature, and have been joined by many others. Since the mid-Nineties most of the significant results have been achieved by Nichia in Japan. Recent reports of their work show they have achieved 10,000 hours for 2mW output, falling to 400 hours for 30mW (the latter is approximately the output that will be required to record on the high definition ReWritable discs).

Gallium Nitride

Different approaches have been taken to arrive at the same blue emission. Gallium nitride (GaN) is the clear favourite now for the active layers, but these are being grown on either a sapphire or a silicon carbide substrate (Fig. 5 shows the general structure for both). The crystal lattice structure of silicon carbide can better align with GaN,
and it is a more effective heat sink; it is therefore beginning to replace the earlier use of sapphire. Matsushita has announced a GaN laser; but has also adopted a parallel approach by developing a second harmonic generation (SHG) laser that halves the wavelength of an infrared laser to produce the blue light - from 850nm down to 425nm (Fig. 6). This infrared laser is a wavelength-tunable distributed-Bragg-reflector (DBR) semiconductor type with a 100mW output, which is reduced to 26mW of blue light. Matsushita has also achieved 340nm from a 680nm red laser.

This reduction in laser wavelength has prompted speculation about an ultra definition (UD-DVD) disc using lasers with wavelengths of less than 300nm. Such a disc would have a capacity of about 50GB for a single side. And some have called for development to concentrate on that and miss out HD-DVR/DVD altogether. However, as the likelihood of that is remote, we can expect to hear a lot more about HD-DVR/DVD and blue lasers over the next two to three years, when a launch is predicted.

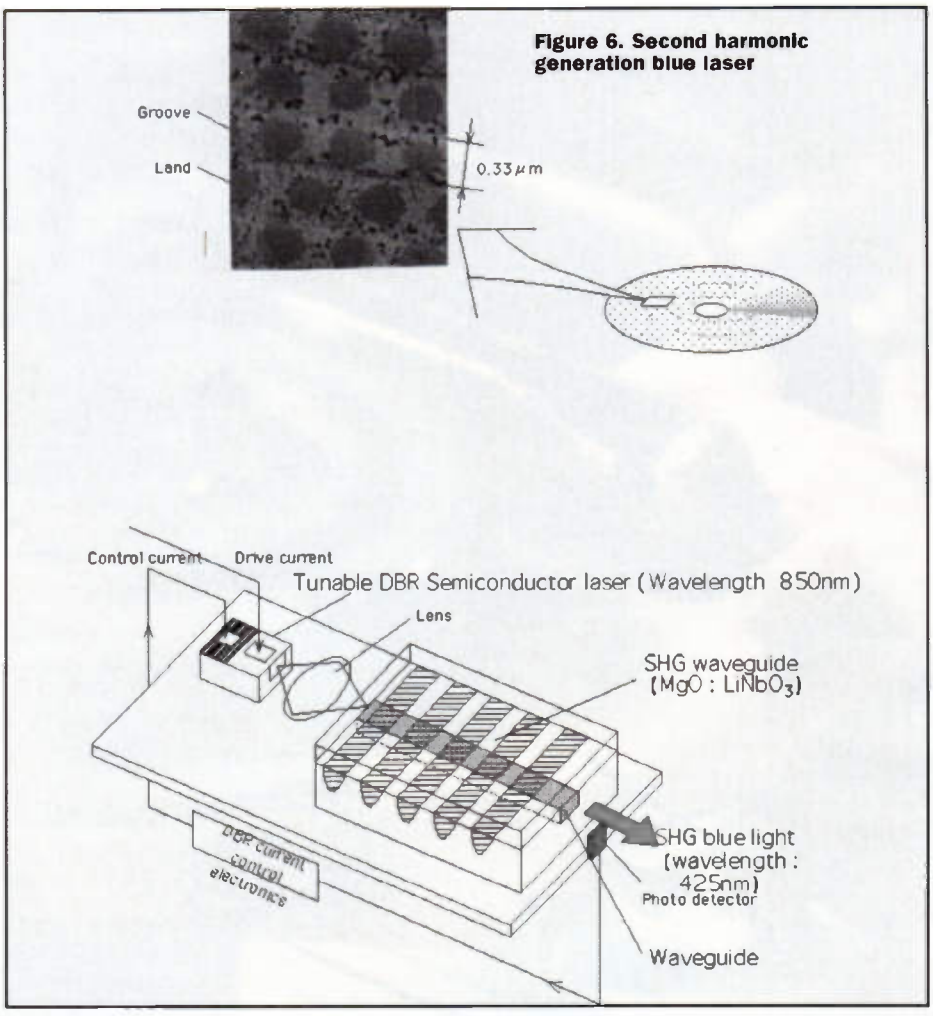
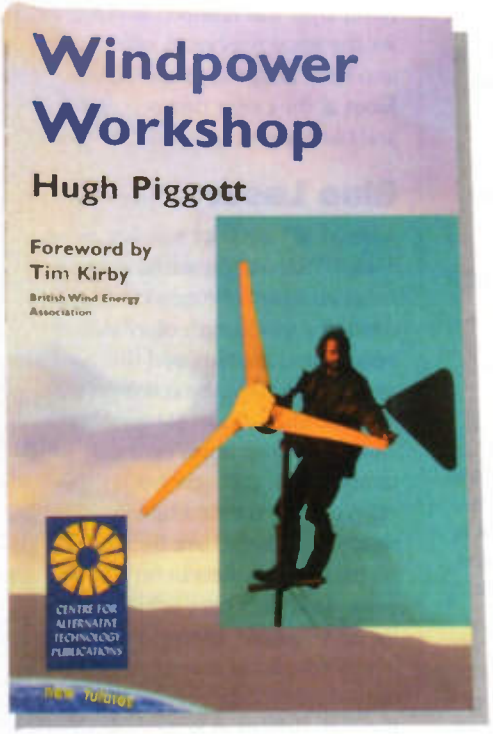


Figure 6. Second harmonic generation blue laser

Quick BOOK Review

Windpower Workshop

by Hugh Piggot



Every so often books come through that are a refreshing change from the norm. Windpower Workshop is just such a book. This paperback is for creatives and practical people who get great satisfaction and a sense of achievement out of 'doing it for themselves'. The book shows you how to make a wind generator from scrap parts and even make your own rotor blades from wood.

There are detailed chapters on electrical and mechanical safety, rotor designs and making your own rotor blades. Alternators and generators are dealt with in a detailed and very readable way. Understanding all the control mechanisms is also important with such a variable and directional power source such as wind. This is dealt with adequately along with providing the right sort of towers and guy ropes.

The book is published by the Centre for Alternative Technology and is available direct from them.

Contact The Centre for Alternative Technology
Tel:01654 702400 Price £10-00

About the author

Hugh Piggott has taught many courses and written are best selling book called Scrapyard and Windpower. He runs his own company, Scoraig Wind Electric, has made and installed hundreds of turbines and generators, and is a consultant to several wind turbine manufacturers.

PROJECT

TV Remote CONTROL

Richard Grodzik describes a simple 3-Button remote control using a PIC

Introduction

The 12C508 PIC is ideally suited for applications requiring a low battery drain and where intermittent operations are followed by long periods of inactivity - here the PIC is in 'sleep mode' consuming just a few microamps of current and can be 'woken up' by a simple press of a switch. A television remote control has these operational characteristics, switching an infra-red LED briefly before going to sleep - have you seen an on/off switch on a remote control?

This project describes a simple three button remote control for the following operations:

1.channel hop (ch.1-5) every 5 seconds and stop at that channel when the same button is pressed.
2.increase/decrease volume.
3.switch on/off the TV

Since only three simple press to make switches are used and we have five functions an embedded processor - PIC12c508 is used to make sense of the switches.

Description

In Figure 1, the 12C508 has three pins which sense when a logic level changes either from Hi to Lo or Lo to Hi, and so wakes up the device. These three pins are connected to switches SW1, SW2 and SW3. When one of the switches is activated i.e. change of logic level from low to high, the firmware sees which switch has been pressed and executes the software routine associated with that switch and sends a sequence of codes to the infra-red LED. These signals are received by the television to operate the various functions. You may be asking the question "how do I know what codes to send as every TV manufacturer has different codes?" Well, it is a simple matter of digging out the old oscilloscope and accurately measuring the signals produced by one's own remote control. Open up the battery compartment and apply the earth lead of the scope to the -ve terminal of the battery, the signal end of the probe is attached to the active terminal of the infra-red LED. However, this means that your remote has to be opened up to access the LED, but first try removing the red filter. A friend told me a far simpler method would be to connect a pin diode (Maplin order code YH71N) directly to the BNC connector of the scope with anode to ground. Then just aim the remote at the scope and, bingo, you should see your waveforms! Press each channel number in turn (1 to 5) and draw the oscillograph accurately for each channel. Those of you with a storage scope can print out the results. Repeat the process for the ON button (the OFF signal is identical since the TV has a toggle action), and also scope the volume UP and DOWN signals.

Figure 2 shows the oscillograph for an ON/OFF signal for a JVC television. All television infra-red remote controls use pulses of 40kHz cycles. The pulse width modulation of this 40kHz carrier varies according to the function pressed. Note that some manufacturers use two different width pulses in their coding. The entire pulse train is then repeated several times according to how long you hold the button pressed. However, in this design, the PIC's software determines how many times the code is sent thus reducing finger wear. Once all the codes have been documented, they can be entered into the source code using the listing shown as a template.

PIC Software

The software provides the following functions: Channel Hopper (Switch 1). The PWM signal for channel 1 is transmitted from pin 2 of the PIC. Note that a 33R resistor is used to limit the current through the led to approximately 25mA. A long delay of five seconds is then generated using the PIC's internal RTCC. Channel 2's signal is then sent with a delay between successive channels. The channel number will then change continuously until switch 1 is pressed again. at which point no further signals are sent, the PIC goes to sleep, and the channel number remains unchanged.

ON/OFF (Switch 2). Pressing this switch will either turn the TV on or off.

Volume Control (Switch 3). Pressing this switch, and holding it down continuously, will cause the volume to decrease at a rate determined by the time delay in the software. Pressing this switch rapidly will cause the volume to increase. This is achieved in software and known as 'ballistic programming'. It makes use of

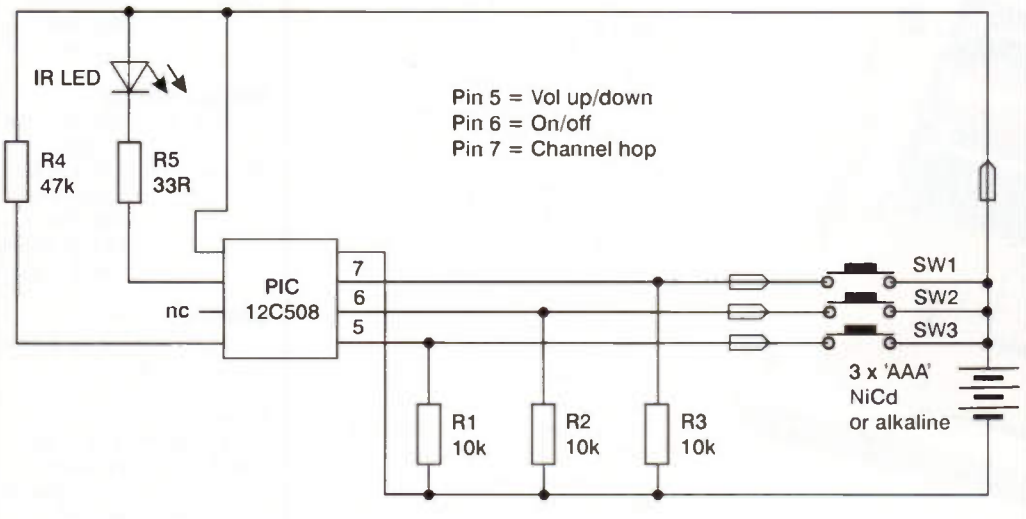


Figure 1. Complete circuit of three button TV remote control

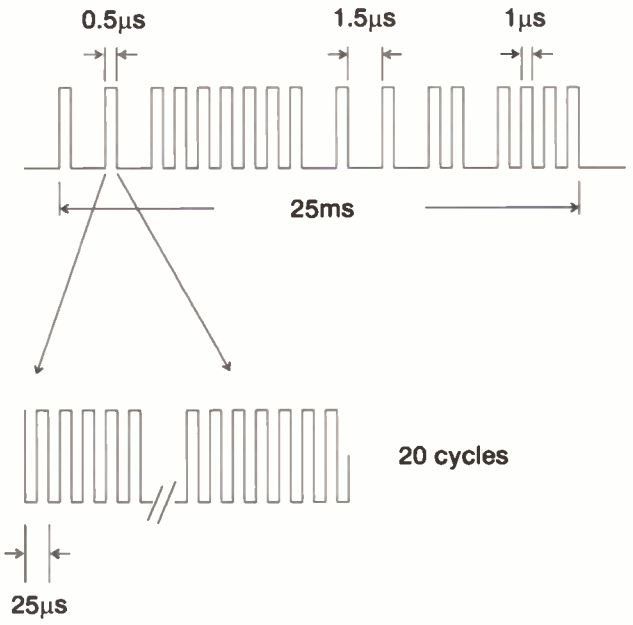
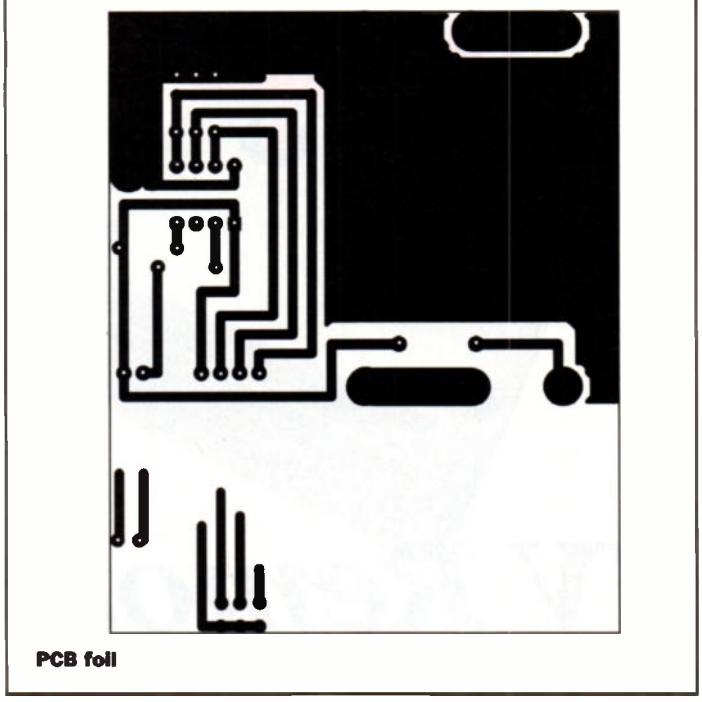
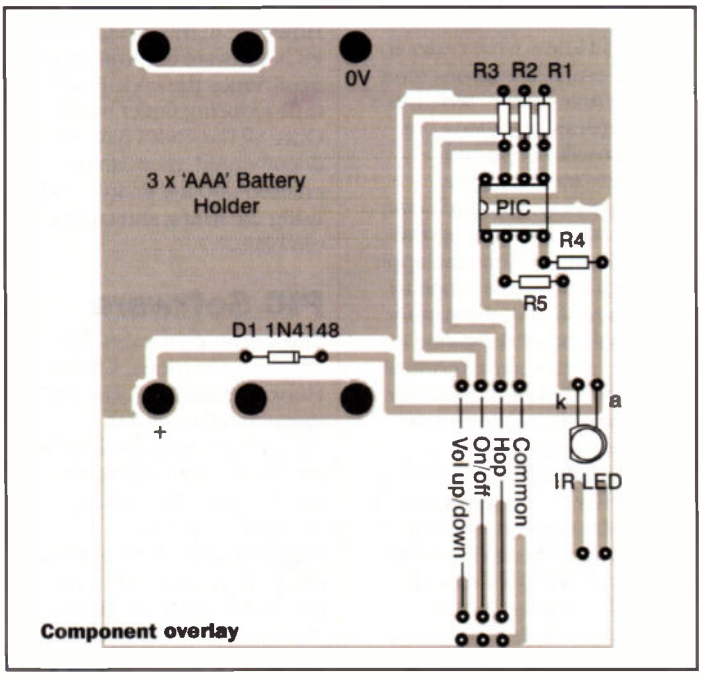


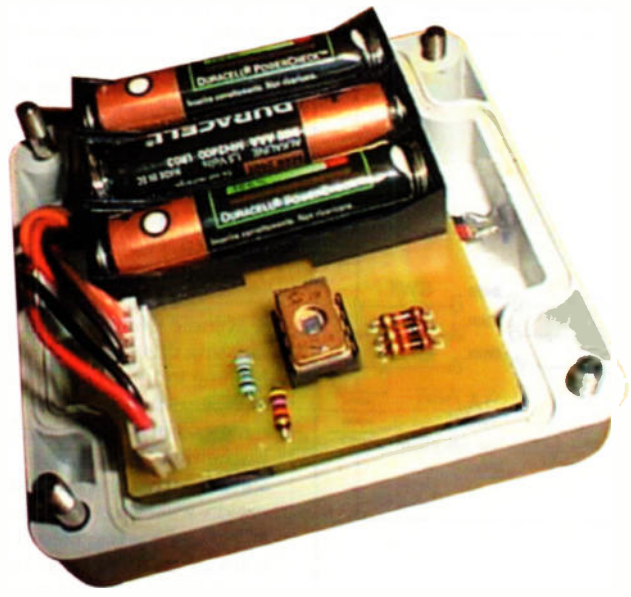
Figure 2. The code for ON/OFF for a JVC television



PCB foil



Component overlay



the 'bouncing' time of a typical press to make a switch of 200ms. Different switches have shorter or longer debounce time so some experimentation may be required. If the switch is pressed quickly, the software will detect a logic high on pin 5 and a software delay of just longer than 200ms is then introduced and the pin polled for a logic low - a logic low will be detected, since the switch has been released and switch debouncing has stopped. Alternatively, if the switch is pressed continuously for a few seconds, a logic high is detected after the debounce time. The software can thus determine whether to send the code for volume increase or decrease.

Design Considerations.

It was found that the PIC12C508 in this design will only 'wake-up' with a supply voltage in the range of 2V5 to 4V18. using internal reset or 2V7 to 4V18 with an external resistor of 47k and external reset. Internal/external reset is selected when programming the PIC's fuse. Just as well I used a 3V6 NiCd when prototyping this design since a standard 5 volt supply would have got me nowhere! A 1N4148 diode inserted into the battery circuit thus has two functions -to limit the terminal voltage of three 'AAA' size alkaline batteries to 3V9 and also serves as a reverse polarity protection. Three 'AAA' NiCd cells come within the PIC's operating characteristics i.e. 3V6 - 0V6 (diode volts drop) = 3V.

Construction

A polycarbonate IP65 box was used and the PCB was housed in the lid. Simple plug and socket connecting leads salvaged from a scrap printer were used to terminate the 3 switches and the led to the PCB. Four spacers are superglued to the lid and then superglued to the PCB which makes for easy maintenance and insertion of batteries which should last several months.

PARTS LIST

RESISTORS:

R1, 2, 3	10k
R4	47K
R5	33R)

SEMICONDUCTORS

IC1	PIC12C508 (see note)
D1	1N4148

MISCELLANEOUS

SW1, 2, 3	Press-to-make Switches
IR LED	Infra-red LED
	Polycarbonate IP65 Box
	3 x AAA battery holders 4 spacers

OPTIONAL

Miniature plug and sockets 4 way and 2 way.

NOTE

Pre programmed PIC's are available from the author Futher details may be found on the author's website at: http:/members.netscapeonline.co.uk/dgrodzik

```
LOC  OBJECT  LINE  TEXT
VALUE  CODE  SOURCE
                00001
                00002       LIST  P=12C508
                00003
00000001  00004  RTCC    EQU 1
00000002  00005  PC EQU 2
00000003  00006  STATUS EQU 3 ;STATUS REGISTER
00000006  00007  GPIO    EQU 6;PORT
00000005  00008  LED     EQU 5;LED
00000005  00009  OSCAL   EQU 5
                00010
                00011
                00012
00000007  00013  COUNTR   EQU 7
00000008  00014  COUNTR2  EQU B
00000009  00015  DLYCNT   EQU 9
0000000A  00016  CYCLES   EQU AH
0000000B  00017  CLICKS   EQU BH
0000000C  00018  SECS     EQU CH
0000000D  00019  FLAG     EQU DH
                00020
                00021
0000            00022     ORG
                00023
0000    0025    00024     MOVWF OSCAL
0001    0066    00025     CLRF GPIO
0002    0C1F    00026     MOVLW
1FH
0003    0006    00027     TRIS GPIO
                00028
0004    606     00029     BTFSC GPIO,0
;CYCLE  HANNELS
0005    A10     00030     GOTO SW1
0006    626     00031     BTFSC GPIO,1
;SWITCH ON/OFF
0007    AE7     00032     GOTO SW2
0008    646     00033     BTFSC GPIO,2
;VOLUME UP GOOD PIN 5
0009    B04     00034     GOTO SW4
                00035
000A            00036     CONT
000A    C07     00037     MOVLW
B'00000111'  ;ENABLE WAKEUP
000B    002     00038     OPTION
000C    50D     00039     BSF FLAG,0
000D    5A6     00040     BSF GPIO,LED  ;IR
LED OFF
000E    206     00041     MOVF GPIO,0
000F    003     00042     SLEEP
                00043
                00044
                00045
0010            00046     SW1
0010    C87     00047     MOVLW
B'10000111'  ;DISABLE WAKEUP
0011    002     00048     OPTION
0012    9AE     00049     DEBOUNCE
ALL MS15
0013    606     00050     BTFSC GPIO,0
0014    A12     00051     GOTO DEBOUNCE
0015    50D     00052     BSF FLAG,0
                00053
                00054
0016            00055     CHANNEL1
0016    0C0A    00056     MOVLW .10
0017    002B    00057     MOVWF
LICKS
001B            00058     ALL1
                00059
0018    070D    00060     BTFSS FLAG,0
0019    0A0A    00061     GOTO ONT
001A    9C5     00062     CALL TWO
001B    9CA     00063     CALL SEVEN
                00064
                00065
001C    9AE     00066     CALL MS15
                00067
001D    9B6     00068     CALL PING
001E    9A8     00069     CALL MSHALF
001F    9B6     00070     CALL PING
0020    9A8     00071     CALL MSHALF
0021    9B6     00072     CALL PING
0022    9A8     00073     CALL MSHALF
0023    9B6     00074     CALL PING
0024    9A8     00075     CALL MSHALF
0025    9B6     00076     CALL PING
                00077
0026    09AE    0007B     CALL MS15
                00079
0027    09B6    00080     CALL PING
0028    09A8    00081     CALL MSHALF
0029    09B6    00082     CALL PING
002A    09A8    00083     CALL MSHALF
002B    09B6    00084     CALL PING
002C    09AE    00085     CALL MS15
                00086
                00087
002D    99F     00088     CALL MS250
002E    2EB     00089     DECFSZ
LICKS,1
002F    A18     00090     GOTO ALL1
                00091
                00092
0030    9D8     00093     CALL DELAY5SEC
                00094
                00095
0031            00096     CHANNEL2
0031    C0A     00097     MOVLW .10
0032    02B     00098     MOVWF
LICKS
0033            00099 ALL2
                00100
0033    70D     00101     BTFSS FLAG,0
0034    A0A     00102     GOTO ONT
0035    9C5     00103     CALL TWO
0036    9CA     00104     CALL SEVEN
0037    9AB     00105     CALL MSHALF
0038    9B6     00106     CALL PING
                00107
0039    9AE     00108     CALL MS15
                00109
003A    9B6     00110     CALL PING
003B    9AB     00111     CALL MSHALF
003C    9B6     00112     CALL PING
003D    9AB     00113     CALL MSHALF
003E    9B6     00114     CALL PING
003F    9AB     00115     CALL MSHALF
0040    9B6     00116     CALL PING
                00117
0041    9AE     00118     CALL MS15
                00119
0042    9B6     00120     CALL PING
0043    9AB     00121     CALL MSHALF
0044    9B6     00122     CALL PING
0045    9AB     00123     CALL MSHALF
0046    9B6     00124     CALL PING
0047    9AE     00125     CALL MS15
                00126
                00127
0048    99F     00128     CALL MS250
0049    2EB     00129     DECFSZ
LICKS,1
004A    A33     00130     GOTO ALL2
                00131
004B    9D8     00132     CALL DELAY5SEC
                00133
004C            00134     CHANNEL3
004C    C0A     00135     MOVLW .10
004D    02B     00136     MOVWF
LICKS
004E            00137 ALL3
                00138
004E    70D     00139     BTFSS FLAG,0
004F    A0A     00140     GOTO ONT
0050    9C5     00141     CALL TWO
0051    9CA     00142     CALL SEVEN
                00143
0052    9AE     00144     CALL MS15
                00145
0053    9B6     00146     CALL PING
                00147
0054    9AE     00148     CALL MS15
                00149
                00150
0055    9B6     00151     CALL PING
0056    9A8     00152     CALL MSHALF
0057    9B6     00153     CALL PING
0058    9A8     00154     CALL MSHALF
0059    9B6     00155     CALL PING
005A    9A8     00156     CALL MSHALF
0058    9B6     00157     CALL PING
                00158
005C    9AE     00159     CALL MS15
                00160
005D    9B6     00161     CALL PING
005E    9A8     00162     CALL MSHALF
005F    9B6     00163     CALL PING
0060    9A8     00164     CALL MSHALF
0061    9B6     00165     CALL PING
0062    9AE     00166     CALL MS15
                00167
                00168
0063    99F     00169     CALL MS250
0064    2EB     00170     DECFSZ
LICKS,1
0065    A4E     00171     GOTO ALL3
                00172
0066    9D8     00173     CALL DELAY5SEC
                00174
                00175
0067            00176     CHANNEL4
0067    C0A     00177      MOVLW .10
0068    02B     0017B      MOVWF
LICKS
0069            00179 ALL4
                00180
0069    70D     00181     BTFSS FLAG,0
006A    A0A     00182     GOTO ONT
006B    9C5     00183     CALL TWO
006C    9CA     00184     CALL SEVEN
006D    9A8     00185     CALL MSHALF
006E    9B6     00186     CALL PING
006F    9A8     00187     CALL MSHALF
0070    9B6     00188     CALL PING
                00189
0071    9AE     00190     CALL MS15
                00191
0072    9B6     00192     CALL PING
0073    9A8     00193     CALL MSHALF
0074    9B6     00194     CALL PING
0075    9A8     00195     CALL MSHALF
0076    9B6     00196     CALL PING
                00197
0077    9AE     00198     CALL MS15
                00199
007B    9B6     00200     CALL PING
0079    9A8     00201     CALL MSHALF
007A    9B6     00202     CALL PING
007B    9A8     00203     CALL MSHALF
007C    9B6     00204     CALL PING
007D    9AE     00205     CALL MS15
                00206
                00207
007E    99F     00208     CALL MS250
007F    2EB     00209     DECFSZ
LICKS,1
0080    A69     00210     GOTO ALL4
                00211
0081    9D8     00212     CALL DELAY5SEC
                00213
                00214
0082            00215     CHANNEL5
0082    C0A     00216     MOVLW .10
0083    02B     00217     MOVWF
LICKS
0084            0021B ALL5
                00219
0084    70D     00220     BTFSS FLAG,0
0085    A0A     00221     GOTO ONT
0086    9C5     00222     CALL TWO
0087    9CA     00223     CALL SEVEN
                00224
0088    9AE     00225     CALL MS15
                00226
0089    9B6     00227     CALL PING
008A    9A8     0022B     CALL MSHALF
008B    9B6     00229     CALL PING
008C    9A8     00230     CALL MSHALF
                00231
008D    9AE     00232     CALL MS15
                00233
008E    9B6     00234     CALL PING
008F    9A8     00235     CALL MSHALF
0090    9B6     00236     CALL PING
0091    9A8     00237     CALL MSHALF
0092    9B6     00238     CALL PING
                00239
0093    9AE     00240     CALL MS15
                00241
0094    9B6     00242     CALL PING
0095    9A8     00243     CALL MSHALF
0096    9B6     00244     CALL PING
0097    9A8     00245     CALL MSHALF
0098    9B6     00246     CALL PING
                00247
0099    9AE     00248     CALL MS15
                00249
009A    99F     00250     CALL MS250
009B    2EB     00251     DECFSZ
LICKS,1
009C    A84     00252     GOTO ALL5
009D    9D8     00253     CALL DELAY5SEC
009E    A16     00254     GOTD CHANNEL1
                00255
                00256
009F    CFF     00257     MS250  MOVLW
FFH
00A0    C07     00258     MOVLW
OUNTR
00A1    C1F     00259     LOOP13 MOVLW
.31
00A2    027     00260     MOVWF
OUNTR
00A3    2E7     00261     LOOP12 DECFSZ
OUNTR,1
00A4    AA3     00262     GOTO LOOP12
00A5    2E8     00263     DECFSZ
OUNTR2,1
00A6    AA1     00264     GOTO LOOP13
00A7    800     00265     RETLW
                00266
                00267
00A8            00268     MSHALF
00A8    C80     00269     MOVLW
80H
00A9    027     00270     MOVWF
OUNTR
00AA    000     00271     LOOP6 NOP
00AB    2E7     00272     DECFSZ
OUNTR,1
00AC    AAA     00273     GOTO LOOP6
00AD    800     00274     RETLW
                00275
                00276
00AE            00277     MS15
00AE    CFF     0027B     MOVLW
FFH
00AF    027     00279     MOVWF
OUNTR
00B0    606     00280     LOOP5 BTFSC
GPIO,0
00B1    40D     002B1     BCF FLAG,0
00B2    000     00282     NOP
00B3    2E7     00283     DECFSZ
OUNTR,1
00B4    AB0     00284     GOTO LOOP5
00B5    800     00285     RETLW
                00286
                00287
00B6    C14     00288     PING  MOVLW .20
00B7    02A     00289     MOVWF
YCLES
00B8            00290     LOOP3
00B8    4A6     00291     BCF GPIO,LED
;LED ON
00B9    C03     00292     MOVLW 3
00BA    027     00293     MOVWF
OUNTR
00BB    2E7     00294     LOOP1 DECFSZ
OUNTR,1
00BC    ABB     00295     GOTO LOOP1
00BD    5A6     00296     BSF GPIO,LED
;LED OFF
00BE    C03     00297     MOVLW 3
00BF    027     00298     MOVWF
OUNTR
00C0    2E7     00299     LOOP2 DECFSZ
OUNTR,1
00C1    AC0     00300     GOTO LOOP2
00C2    2EA     00301     DECFSZ
YCLES,1
00C3    AB8     00302     GOTO LOOP3
00C4    800     00303     RETLW
                00304
00C5            00305     TWO
00C5    986     00306     CALL PING
00C6    9AE     00307     CALL MS15
00C7    986     00308     CALL PING
00C8    9AE     00309     CALL MS15
00C9    800     00310     RETLW
                00311
00CA            00312     SEVEN
00CA    986     00313     CALL PING
00CB    9A8     00314     CALL MSHALF
00CC    986     00315     CALL PING
00CD    9A8     00316     CALL MSHALF
00CE    986     00317     CALL PING
00CF    9A8     00318     CALL MSHALF
00D0    986     00319     CALL PING
00D1    9A8     00320     CALL MSHALF
00D2    986     00321     CALL PING
00D3    9A8     00322     CALL MSHALF
00D4    986     00323     CALL PING
00D5    9A8     00324     CALL MSHALF
00D6    986     00325     CALL PING
00D7    800     00326     RETLW
                00327
00D8            00328     DELAY5SEC
00D8    C07     00329     MOVLW
B'00000111
00D9    002     00330     OPTION
00DA    061     00331     CLRF RTCC
                00332
00DB    C64     00333     MOVLW .100
00DC    02C     00334     MOVWF SECS
                00335
00DD    061     00336     WAIT  LRF RTCC
00DE    606     00337     BTFSC GPIO,0
00DF    40D     00338     BCF FLAG,0
00E0    004     00339     WAIT1
LRWDT
00E1    7E1     00340     BTFSS RTCC,7
00E2    AE0     00341     GOTO WAIT1
00E3    061     00342     CLRF RTCC
00E4    2EC     00343     DECFSZ SECS,1
00E5    ADD     00344     GOTO WAIT
00E6    800     00345     RETLW
                00346
                00347
                00348
00E7            00349     SW2
00E7    C87     00350     MOVLW
B'10000111  ;DISABLE WAKEUP
00EB    002     00351     OPTION
00E9    9AE     00352     DEBOUNCE2
ALL MS15
00EA    626     00353     BTFSC GPIO,1
00EB    AE9     00354     GOTO DEBOUNCE2
                00355
                00356
00EC    C14     00357     MOVLW .20
00ED    02B     00358     MOVWF
LICKS
                00359
00EE            00360     ALLOFF
00EE    9C5     00361     CALL TWO
00EF    9CA     00362     CALL SEVEN
                00363
00F0    9AE     00364     CALL MS15
00F1    9B6     00365     CALL PING
00F2    9AE     00366     CALL MS15
00F3    9B6     00367     CALL PING
00F4    9AE     00368     CALL MS15
                00369
00F5    9B6     00370     CALL PING
00F6    9A8     00371     CALL MSHALF
00F7    9B6     00372     CALL PING
                00373
00F8    9AE     00374     CALL MS15
                00375
00F9    9B6     00376     CALL PING
00FA    9A8     00377     CALL MSHALF
00FB    9B6     0037B     CALL PING
00FC    9A8     00379     CALL MSHALF
00FD    9B6     00380     CALL PING
00FE    9A8     00381     CALL MSHALF
00FF    9B6     00382     CALL PING
                00383
                00384
0100    99F     00385     CALL MS250
0101    2EB     00386     DECFSZ
LICKS,1
0102    AEE     00387     GOTO ALLOFF
0103    A0A     00388     GOTO ONT
                00389
                00390
0104            00391     SW4
0104    99F     00392     ALL MS250
0105    99F     00393     ALL MS250
0106    99F     00394     ALL MS250
0107    99F     00395     ALL MS250
0108    99F     00396     CALL MS250
0109    99F     00397     CALL MS250
010A    99F     00398     CALL MS250
0108    99F     00399     CALL MS250
010C    99F     00400     CALL MS250
010D    99F     00401     CALL MS250
010E    99F     00402     CALL MS250
010F    99F     00403     CALL MS250
                00404
0110    C87     00405     MOVLW
B'10000111'  ;DISABLE WAKEUP
0111    002     00406     OPTION
0112    646     00407     BTFSC GPIO,2
0113    B2C     00408     GOTO DOWN
                00409
                00410
0114    C0A     00411     MOVLW .10
0115    02B     00412     MOVWF
LICKS
                00413
0116            00414     VOLDOWN
0116    9C5     00415     CALL TWO
0117    9CA     00416     CALL SEVEN
011B    9A8     00417     CALL MSHALF
0119    9B6     00418     CALL PING
                00419
                00420
011A    9AE     00421     CALL MS15
011B    9B6     00422     CALL PING
011C    9AE     00423     CALL MS15
011D    9B6     00424     CALL PING
011E    9AE     00425     CALL MS15
011F    9B6     00426     CALL PING
0120    9AE     00427     CALL MS15
                00428
0121    9B6     00429     CALL PING
0122    9A8     00430     CALL MSHALF
0123    9B6     00431     CALL PING
0124    9A8     00432     CALL MSHALF
0125    9B6     00433     CALL PING
0126    9A8     00434     CALL MSHALF
0127    9B6     00435     CALL PING
                00436
                00437
0128    99F     00438     CALL MS250
0129    2EB     00439     DECFSZ
LICKS,1
012A    B16     00440     GOTO VOLDOWN
012B    A0A     00441     GOTO ONT
                00442
012C            00443     DOWN
012C    0C05    00444      MOVLW 5  ;10
012D    002B    00445      MOVWF
LICKS
                00446
012E            00447     VOLX
012E    09C5    00448     CALL TWO
012F    09CA    00449     CALL SEVEN
                00450
0130    09AE    00451     CALL MS15
0131    09B6    00452     CALL PING
0132    09AE    00453     CALL MS15
0133    09B6    00454     CALL PING
0134    09AE    00455     CALL MS15
0135    09B6    00456     CALL PING
0136    09AE    00457     CALL MS15
0137    09B6    00458     CALL PING
0138    09AE    00459     CALL MS15
                00460
0139    9B6     00461     CALL PING
013A    09A8    00462     CALL MSHALF
013B    09B6    00463     CALL PING
013C    09A8    00464     CALL MSHALF
013D    09B6    00465     CALL PING
013E    09A8    00466     CALL MSHALF
013F    09B6    00467     CALL PING
                00468
0140    099F    00469     CALL MS250
0141    02EB    00470     DECFSZ
LICKS,1
0142    0B2E    00471     GOTO VOLX
0143    0646    00472     BTFSC GPIO,2
0144    0B2C    00473     GOTO DOWN
0145    0A0A    00474     GOTO ONT
                00475
                00476
                00477  END

ALL1  0000001B
ALL2  00000033
ALL3  0000004E
ALL4  00000069
ALL5  00000084
ALLOFF  000000EE
CHANNEL1  00000016
CHANNEL2  00000031
CHANNEL3  0000004C
CHANNEL4  00000067
CHANNEL5  00000082
CLICKS  0000000B
CONT  0000000A
COUNTR  00000007
COUNTR2  0000008
CYCLES  0000000A
DEBOUNCE  00000012
DEBOUNCE2  000000E9
DELAY5SEC  000000D8
DLYCNT  00000009
DOWN  0000012C
FLAG  0000000D
GPIO  00000006
LED  0000005
LOOP1  000000BB
LOOP12  000000A3
LOOP13  000000A1
LOOP2  000000C0
LOOP3  00000088
LOOP5  000000B0
LOOP6  000000AA
MS15  000000AE
MS250  0000009F
MSHALF  000000A8
OSCAL  00000005
PC  00000002
PING  000000B6
RTCC  00000001
SECS  0000000C
SEVEN  000000CA
STATUS  00000003
SW1  0000010
SW2  00000E7
SW4  0000104
TWO  00000C5
VOLDOWN  0000116
VOLX  0000012E
WAIT  0000000D
WAIT1  000000E0
12C508  00000001
```

Program code

PROJECT

30W STEREO AMPLIFIER

John Mosely builds this compact stereo power amplifier.

There is often the need for a small, compact amplifier such as this one from Velleman - as a standalone unit for a personal CD or cassette, for surround sound applications, for use as a power amplifier or with a PC etc. This kit will certainly meet these needs and numerous others. The kit requires a suitable 12V-0-12V 50VA transformer (order code WB26D), suitable housing, hardware, wire and fuses etc. and, of course, speakers to provide a useable system. You may find it helpful to add a volume control, but if you are using it as a high quality amplifier for use with a PC, then even that is not really necessary, as you can use the software 'volume control' on the PC.

The kit includes a bridge rectifier with smoothing, and relies on a TDA1521 IC to provide the stereo power output, and includes short circuit and overload protection. A Zobel network is included on the output for improved stability. Sensitivity is a reasonable 300mV, and so the kit can be used with a wide range of sources. The circuit is shown in Figure 1.

SPECIFICATION

Output power:	2 x 30W/4Ω total music 2 x 15W/4Ω, 2 x 10W/8Ωrms
THD:	0.07% (1W/1kHz)
Channel sepparation:	70dB
S/N ratio:	98db (A weighted)
Input sensitivity:	300mV/20kΩ
Supply voltage:	2 x 12V ac 2A

Construction

As usual, start with all the small components first. For the non-electrolytic capacitors Velleman conveniently provide 'extra' holes to accommodate different size capacitors. All the PCB pins are included for connections to the outside world. Be careful to mount the large diodes and electrolytics with the correct orientation.

Before mounting the power IC to the heatsink, you will need to position and assemble the heatsink to a suitable box. The heatsink can be secured to the box using suitable self-tapping screws. Two mounting holes are provided on the board - on the opposite side to the heatsink - for mounting the board to the case. Use two insulated stand-offs that correspond to the position of the IC when mounted to the heatsink. You may wish to mount the heatsink on the outside of a metal box, and secure the IC through the wall of the box, onto the heatsink.

Velleman supply a shaped T03P insulating washer for mounting the IC to the heatsink, which is not the ideal washer. Using a pair of scissors, I carefully trimmed the washer to provide better thermal contact, and to nearly match the shape of the washer to the shape of the IC.

The Velleman instructions are very straightforward, so you should experience no difficulty

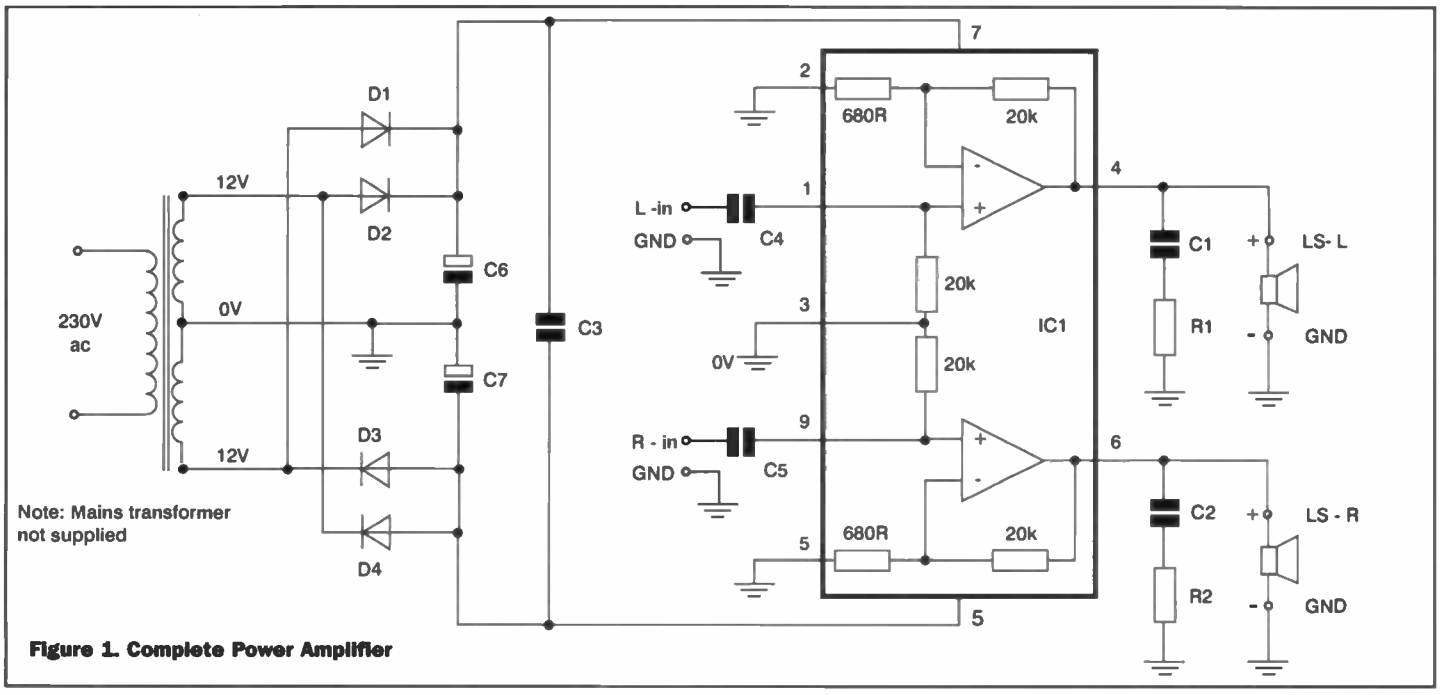


Figure 1. Complete Power Amplifier

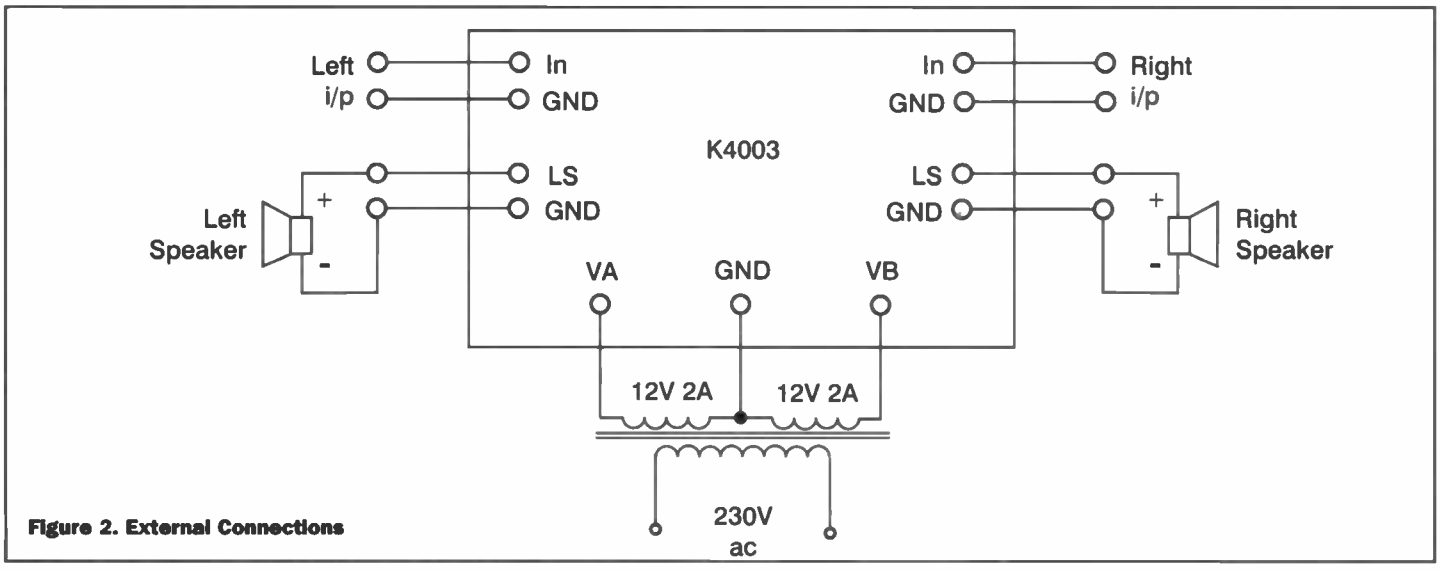


Figure 2. External Connections

in building the kit. Remember before testing to thoroughly check the board for dry joints etc.

Testing

You will need to provide a suitable 12V-0-12V 50VA transformer, which must be suitably fused on the mains and secondary windings. You will also need a mains switch, and sockets to connect to the audio input and the speaker output. Figure 2 shows the external connections.

When everything is connected switch on and you should hear very little, there may be a very small amount of hum. If there is a lot of hum, then switch off and check earth connections etc.

When testing I used a personal CD player to check the quality and a pair of old Wharfedale Diamond speakers from the 70s. In passing, these speakers are one of my all time best buys - £5 from a charity shop! The cabinets and units were, and still are, perfect, and the sound quality, even by today's standards, is excellent.

Listening to various CDs, I soon came to the conclusion that this is a nice little amplifier, clean and detailed. Don't expect it to produces lots of volume - it can't. But for a small room or bedroom, and with decent speakers, it will be adequate. Bass response is excellent and I monitored over 1A current drain when driving it to just below distortion levels, so do not skimp on the mains transformer.

Conclusion

This is a small, excellent sounding amplifier, that is perfect for applications where vast amounts of power are not required. It is also a possible replacement for failed power stages in portable radio cassette/ CD players etc.

PROJECTS PART LIST

RESISTORS

R1, 2,	8R2

CAPACITORS

C1, 2	22µF Monores
C3	100µF Monores
C4, 5	1µF Metallised Polyester
C6, 7	4700µF 25V Elect

SEMICONDUCTORS

D1 - 4	1N5400
IC1	TDA1521

MISCELLANEOUS

Mains Transformer (order code WB26D)
Pins
Insulating Washer
Heatsink
Nuts, Bolts & Washers
Mains On/off Switch
Audio Input Sockets
Speaker Output Sockets

Order Code VF53H, £24.99 including VAT

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

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

Environmentally Unfriendly Solar Power

Dear Sir

The people at BP Solarex and other supporters of solar power have a lot to answer to when it comes to environmental issues.

The following facts and figures are from calculations used to measure the greenhouse gas index for vehicles in the Energy Challenge, sponsored by the Office of Energy and the NRMA in Australia.

Burning a kg of petrol produces 3.51kg of CO_2

Burning a kg of methanol produces 2.27 kg of CO_2

However, you need to burn at least 2kg of methanol to produce the same energy as 1kg of petrol!

To make 1kg of steel produces 3.20kg of CO_2

To make 1kg of aluminium produces 27.5kg of CO_2

When solar panels are made they produce 450kg/m²

Note that a 75W panel is just over one square metre!

Your article states that BP Solarex is going to install 3.5MW of solar panels to save a mere 3,500 tonnes of CO_2 each year, but I calculate that to manufacture these panels will produce 21,000 tonnes of CO_2! That will take six years to 'recover' the CO_2 produced in manufacturing.

BP Solarex will need to use these panels for 30 years so that the installation is only 1/5th as environmentally damaging as conventional energy. I suspect that they will be replaced in less than six years, so doing more environmental damage than conventional energy!

There is another problem that I have never seen addressed and that is of lighting and hail protection. For if these panels are damaged within a year and replaced, then that is another additional six years damage!

You talk of a cost breakdown point of 51 months assuming the panels are always operating at their maximum power rating and none of this power is wasted. Note, this figure is likely to be nearer 10 years in the UK with its weather patterns. Also no account is taken of the cost and damage caused in the purchasing and manufacture of the batteries associated with solar panels. The cost of solar panels installations should be increased accordingly to pay for the cost of environmental damage.

On the subject of environmentalists, they are somewhat hypocritical. They support mini/micro hydroelectric installations which in most cases dump their excess electrical energy, yet oppose the damming of rivers for large hydroelectric stations which offer economies and efficiencies of scale.

They support electric cars although overall they produce at least twice as much CO_2 as petrol burning cars. Plus they support wood burning for heat, cooking, steam cars and similar inefficient installations, yet oppose people clearing land to have somewhere to live - and they support solar panels.

What do I support? - to a limited extent wind farms, but if we all relied on wind power, then surely we would affect the world's weather somewhat!

Brian Boggs
New South Wales
Australia

Brian challenged us to print his letter in full, but we felt it was legally sensible to 'tame' his language somewhat, and to abridge the contents accordingly. I would add that the Editor does not necessarily share his views! We are also unable to verify the statistics and calculations, shown here.

Having said that, Brian's letter does raise some interesting points, in particular, calculating the amount of CO_2 produced by a power generating process. We could extrapolate back all the processes involved for instance in oil-fired power stations, or petrol cars, to see how much CO_2 is produced in their production. How much CO_2 is produced in the production of the interior of a car? How much CO_2 is produced in the manufacture of a generating set in a power station. If we are not careful we can easily get carried away with ourselves!

For many parts of the world, solar power is the only practical form of power, no only for producing electricity but hot water as well.

We have to remember that gas and oil are both finite resources, and we will have to find alternatives eventually, whether we like it or not, and that alternative may well have to be nuclear power. In order to make these resources last longer, would we not be better to reserve oil derived products for large transportation systems such as aircraft and ships and stop using it for cars. We now have the capabilities for producing practical electric cars (no pollution), which ideally should be charged using electricity from non-fossil burning power stations.

Or are you advocating we carry on and do nothing?

The Millennium Date Bug

Dear Sir

I have recently given a talk upon the very topic that E. C. Barrie takes up in issue 157 - the problem of the date of the millennium.

The problem starts in the year 527CE with a mane called Dioysius Exiguus which can be translated as 'Little Denis.' He calculated the year Jesus was born by adding up how long each Emperor reigned from his own day back to the time of Augustus Caeser. There were at least 84 of them all with different lengths of reign, and worse, sometimes sharing their reign with other Emperors. Between 282 and 395 there were four Emperors who's reigns overlapped with another. He took all this in to account, but one Emperor, Gallienus, was ill and his son, Valerian, acted as his regent for seven years (260-268CE), and it is not known what he did about those seven years.

If he got it right and Jesus was in the year we call 1CE, then we should be celebrating the Millennium on 1st January 2001. If he did get it right, then St. Mathew and St. Luke got it wrong.

It may be that Little Denis added that seven years in twice, once for his father and once for his son, so the time he calculated was seven years longer than it ought to have been. If that is the case, then St. Matthew is right and King Herod the Great was still alive when Jesus was born. Jesus must have been born in 6BCE or 7BCE.

If Little Dennis forgot to add in that seven year overlap of reigns altogether then he was seven years shorter than he ought to have been, and Jesus would have been born in 6CE or 7CE, so according to our current calendar, St. Luke is right.

This path gets complicated, but whatever, we cannot have it both ways

In the church to which I belong we had a Millennium watchnight service on 31st December 1999, and prayed in the New Year. But we did it with tongues firmly in our cheeks, knowing it was not really the millennium from any point of view, but with all the media hype it was what we were expected to do. Next December, assuming Little Dennis got it right, we will have a real millennium watchnight service. Then, maybe in 2006 we can have another - assuming St. Luke got it right!

Who Knows? What does it matter?

Reverend Cyril D. Blount
Huddersfield

Interesting reading Reverend, and you are right about the media hype. One can only hope that they don't have another go at the end of this year. Indeed - does it matter?

Software HINTS & TIPS

by Mike Bedford

If you don't have a separate drawing package, you can produce some pretty smart sketches using Word 97.

As we continue to look at some of Word 97's less well-known facilities, the use of fields is the next topic to be investigated.

Conventionally, the content of a word processor document is fixed - set in concrete at the time the document is created. However, there are times when it would be useful for certain parts of the text to be updated automatically. For example, let's assume that you're running a basic IT literacy course and you have a Word 97 document which you print out to provide your students with a certificate. That certificate will show the date on which it was issued and normally you'd have to edit the document to change the date for each course. By using fields - the Word 97 facility we're investigating this month - this can be done automatically. In this example the use of fields doesn't exactly result in a big improvement in productivity. However, I just give this as a simple example and in other instances, the use of fields can save a lot of work.

Inserting Fields

To set the ball rolling I'll show you how to add a date field to a document. We'll also look at some of the basic actions associated with fields. We'll then move on to look at how to manipulate fields. So lets start by creating a new document and entering the text 'Today's date is' followed by a space. Now select Insert > Field... The Field window is displayed.

Select 'Date and Time' in the Categories list box and 'Date' in the Field names list box and click on the OK button. The current date will appear in the document as shown below. You'll notice that it appears on a grey background to identify it as a field. When the document is printed out on paper, though, the grey background will go.

Today's date is 13/01/00.

Manipulating Fields

But although the grey background indicates that the highlighted text is the result of entering a field, it may not always be obvious just what that field is. For example, the current date is just one of four fields which produce a date. To reveal more details of fields in a document press Alt F9 and all the fields in the document will change to show their actual content. The following shows how a date field would appear.

is {DATE * MERGEFORMAT}

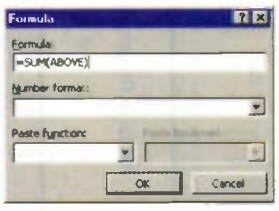
You'll notice that fields are always enclosed in curly brackets (although you can't enter them by just typing the appropriate syntax enclosed in curly brackets) and that the text between those brackets shows what the field represents. You might not understand everything which appears between the brackets (e.g. what does the * MERGEFORMAT mean in the above example?) but you should be able to understand enough. Pressing Alt F9 again will cause the fields to change back to the way they were originally displayed on the screen.

One other thing to notice about fields is that they don't normally update automatically. They will update every time you open the file but if you put a date field in a document and leave the document open until after midnight, the date won't change as the new day starts. However, you can tell Word to update a field. To experiment with this, I suggest that you use the Time field rather than the Date field - now you only have to wait a minute rather than a day to see if it's updated.

Create a new document and enter the text 'The time is' followed by a space. Now enter the Time field - this should be pretty easy having already used the Date field. You'll notice that the current time is displayed in the document. Wait until the minute ticks over on your PC - you can see when this happens by watching the clock at the right hand edge of the Windows taskbar. But as the minute changes on the taskbar, you'll notice that he time doesn't change in the Time field. However, there is a way to update a field, one that's easier than closing and then re-opening the document. Select the field and press F9 - the selected field will immediately update. And, of course, if you want to update all the fields in a document, just select Edit > Select All before pressing F9.

Arithmetic Fields

Fields allow you to perform simple spreadsheet-like functions within a word document. Let's see how this works. Create a 3 x 3 table and enter the figures 1, 2, 3 and 4 into the top left four cells of the table. Now move the cursor into the bottom left cell and select Table > Formula... The following window is displayed.



You'll notice that the suggested formula is =SUM(ABOVE). This is what we want so accept it by clicking on OK. Do the same in the second cell in the bottom row. Now put the cursor in the top right cell and select Table > Formula... This time you'll see that =SUM(LEFT) is the suggested formula and, once again, accept it. And finally, do the same in the right hand cell of the second row. You should end up with the following table.

1	2	3
3	4	7
4	6	

You'll notice that the table now has row and column totals. As before, these totals won't update automatically but, having changed some of the values in the table, if you select the whole table and press F9, the totals will update in just the same way as the date and time fields updated. And if you want to confirm that formulae in tables are indeed fields, just press Alt F9 and you'll see them change to the usual form, enclosed in curly brackets.

In this example we just accepted the default formula which was suggested. However, in some cases you won't want just to sum rows or columns. You may, for example, want to average the values in the columns and we'll use this is an example of how to enter a different formula.

Create a 3 x 3 table as before and enter values into the cells in the top two rows. Now move the cursor into the bottom left cell and select Table > Formula... As before, the formula for a column total will be suggested but, in this case, delete that formula from the text box except for the initial =. Now, from the Paste function list box select Average and the word AVERAGE() will appear after the = in the Formula text box. Type the word ABOVE between the brackets and click on OK. The average of the values above it should appear in the bottom left cell.

As always we've only scratched the surface of the topic we're looking at and, as always, my suggestion is that you now experiment on your own. One thing to try out is formatting. In all our examples we've just accepted the default formatting but dates, for example, can be shown in various formats. The same goes for the results of formulae.

And finally, if you really want to be clever you can actually enter the syntax for fields manually but it's probably better to start off the easy way entering fields in a manner similar to that we've already seen.

Valves in the 21ST CENTURY

PART 4

In Part 4 Mike Bedford looks at the big power devices

If you've been with us from the start of this series and if you're a confirmed advocate of all things solid state, you're probably now feeling that you've been taken for a ride. After all, the series is titled Valves in the 21st Century and, in the introduction, we promised to look at applications of valve technology in areas where a solid state solution is either impossible or impractical. But after three articles, you're probably still of the opinion that you've seen no such applications. In last month's article we did look at the continuing popularity of valves in audio amplification, especially in top-end Hi Fi. However, although this application is one of the biggest users of some types of valve, and although many musicians will argue that semiconductors can't produce the same quality of sound as valves, we have to acknowledge that this is an application in which solid-state techniques can and are employed in the mass market. So what of these elusive applications for which valves are still eminently suitable, even fifty years or more after the invention of a solid-state alternative? One of the main applications for which valves are uniquely suitable is high power RF engineering and this is the subject of this month's article.

Applications

Before we look at how and why valves are still used in RF engineering, it would be helpful to clarify what I mean by high power RF and why it's important. The RF or radio frequency spectrum ranges from, say, tens of kilohertz to a few terahertz. Perhaps the most obvious reason to generate RF signals is in association with communication and broadcasting. Broadcasting, in particular, uses high power levels, sometimes hundreds of kilowatts, and is carried out at a whole range of frequencies. These range from the LW and MW bands used for local and national radio through the SW bands which are used to broadcast foreign services to the VHF band which is used for FM radio broadcasting and the UHF bands which are used for TV.

The other main applications of high power RF are industrial. In inductive heating, for example, a signal within the range 80kHz to 500kHz is passed through a coil to generate strong magnetic fields. Conducting objects in the vicinity of the coil will be heated up. Pipe welding is one possible application, but the technique can also be used to produce much more localised heating than this. Heating can be precisely targeted, for example, to surface harden metal at an exactly pre-set depth. Another industrial technique is dielectric heating. Now it is a non-metallic or dielectric materials which are being heated and this requires a much higher frequency, typically in the range 13MHz to 40MHz although higher frequencies are sometimes used. In dielectric heating an RF field is passed through the material causing a rapid oscillation of the polarisation of individual molecules. This causes friction and hence heating of the material. Applications include plastic welding, wood gluing and RF drying.

A rather specialised form of dielectric heating - albeit not an industrial application - is microwave cooking. Indeed more magnetrons (a special type of valve which is especially suitable for generating microwaves at high power) are produced for microwave ovens than any other single application. Other applications we should mention are medical - the generation of microwaves at high power levels is key to radiotherapy and the battle against cancer - scientific research, satellite communication and radar.

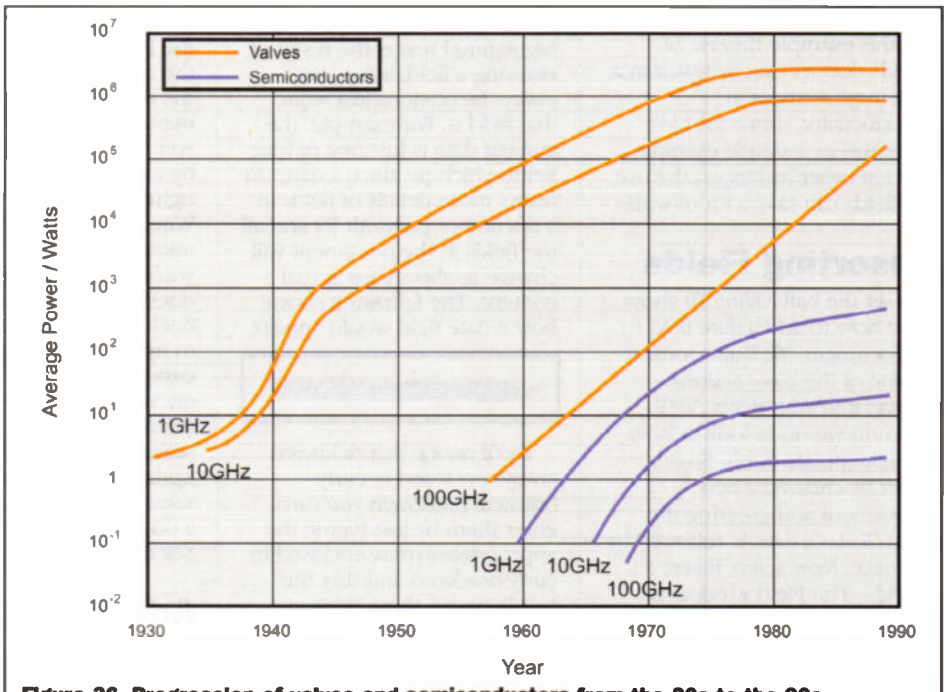


Figure 36. Progression of valves and semiconductors from the 30s to the 90s

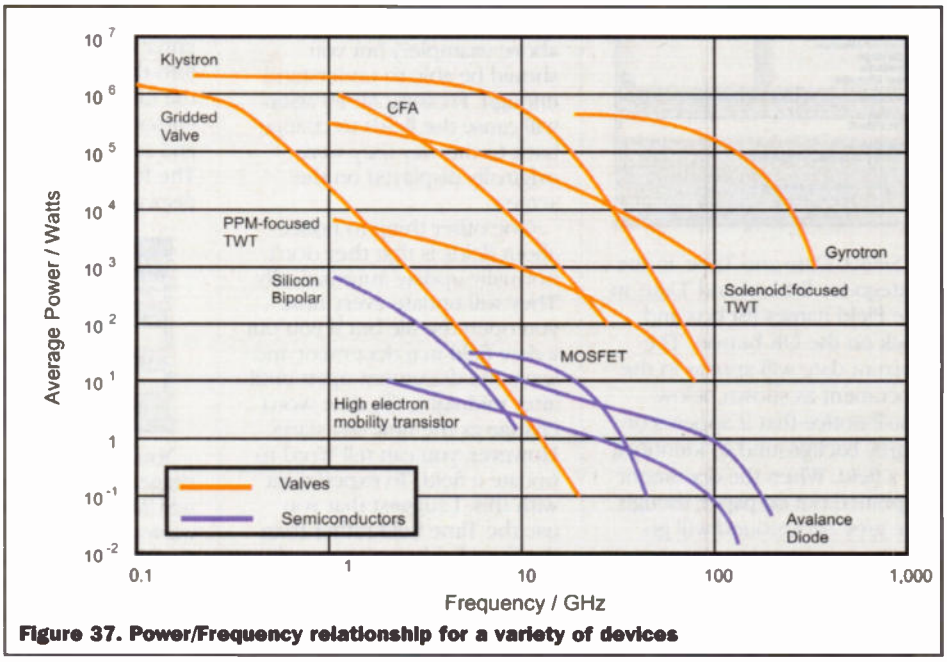


Figure 37. Power/Frequency relationship for a variety of devices

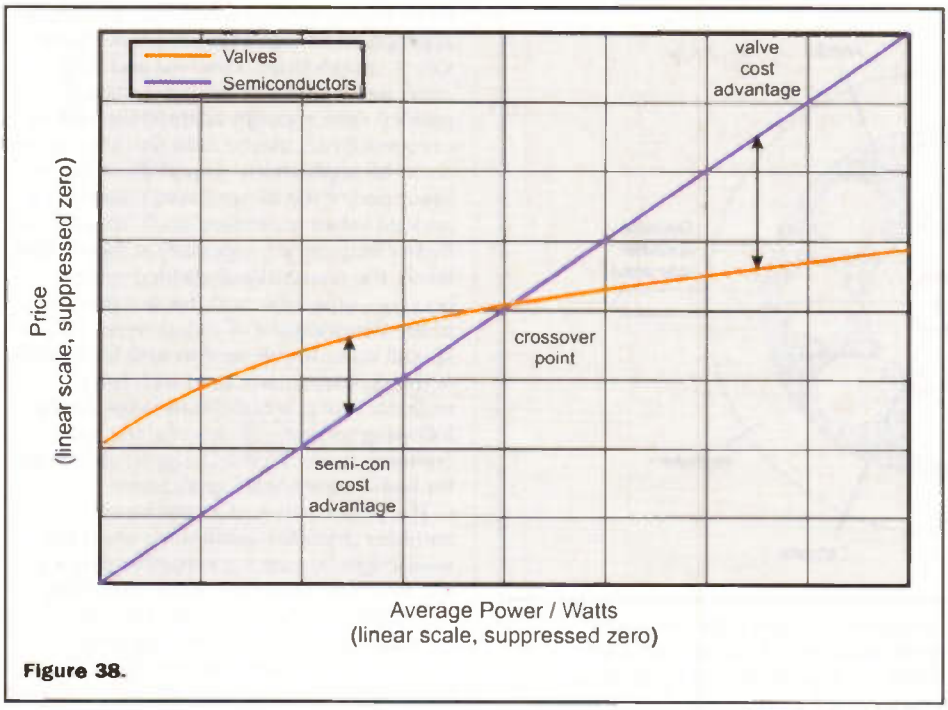


Figure 38.

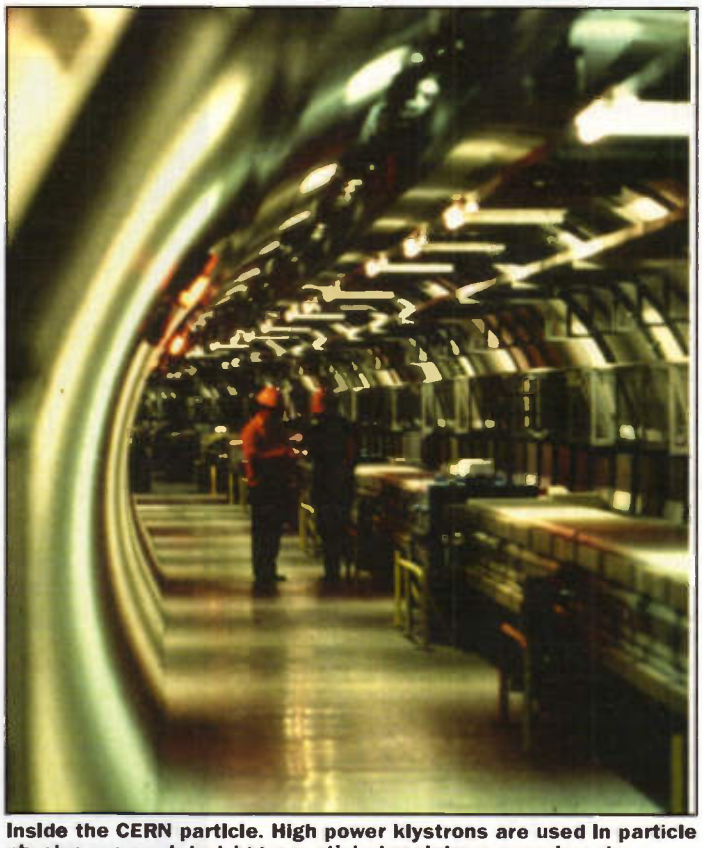
Why Valves?

Semiconductors are, of course, used extensively in RF applications - this isn't the sole domain of valves. You certainly won't find valves in mobile phones for example. So the first question we need to tackle is how designers decide between solid-state and valve techniques and what it is about valves which makes them uniquely suitable in some applications.

Figures 36 and 37 (source: Robert K. Parker of the Naval Research Laboratory) will be eye-openers to many readers. The first of these figures shows the progression of valves and semiconductors from 1930 to 1990, as the power per device at various RF frequencies. To appreciate this you don't have to understand what all the different device types are although we will look at some of the more common ones later in this article. The second graph shows the state of play today as the relationship between frequency and power for various classes of valve and solid state device. You'll notice that, depending on the frequency, thousands of times more power can be obtained from a single valve than from a single semiconductor device. Furthermore, you'll see that the rate of improvement of some types of valves continues to outpace that of any solid-state device. At first sight this might not seem to be an impelling reason to favour valves in preference to semiconductors, after all, it's common practice to use multiple semiconductors where one or perhaps two valves would have been used. However, it's important to consider economics here. The cheapest possible valve will always be more expensive than the cheapest possible semiconductor, there's no doubt of that. And this would suggest that semiconductors are more economical than valves at low power levels. However, as we move up the power scale, some interesting facts come to light. A high power valve costs more than a lower power valve as most people would expect. An important question, though, is how much more and a generally accepted answer is that the cost increases with the square root of the power. Really this isn't too surprising. A high power valve will be larger than a low power valve and so it needs more raw materials, but the number of elements remains the same so the manufacturing cost should remain largely constant. Turning to semiconductors, once we exceed the power obtainable from a single device, increased power is achieved by using multiple devices and so the cost will increase in almost direct proportion to the power. Taking these facts together, it's fairly obvious that a semiconductor solution will be cheaper at low power levels but that there will be a cross-over point at which valves will become more cost-effective. Figure 38 shows this relationship graphically.

This is the economic argument but there are also various technical arguments, perhaps the most compelling of which relates to heat dissipation. You might intuitively feel that since valves run hotter than semiconductors that cooling valves would be more of a problem than cooling solid-state devices. In fact, the converse is true and because of this fact, high frequency, high power solid state amplifiers could be much bulkier and much heavier than the valve alternative. In any high-power amplifier, heat is generated as a by-product and this must be dissipated to prevent the amplification device from destroying itself. The amount of heat that can be transferred from the device is proportional to the area from which heat is dissipated and the temperature difference between the device and the coolant. In the case of low power devices this coolant will be air but, in high power amplifiers, it could be water or some other fluid. Since semiconductors have to operate at a quite modest temperature compared to valves, the only way to provide the required heat dissipation is to provide huge heat sinks. Clearly this impacts both the size and weight of the amplifier. However, all of this would apply if valves and semiconductors were equally efficient. In fact, this isn't the case - in high power applications, valves can be much more efficient than solid-state devices and this further complicates the problem of heat dissipation associated with solid-state amplifiers. It has been estimated by Robert Symons, technical director at Litton Electron Devices Division, and designer of high-power microwave devices of over 40 years standing, that high power solid state amplifiers could be as much as 50 times the size and 50 times the weight of an equivalent valve-based amplifier.

So at what sort of power levels do we see valves starting to become more attractive than the semiconductor alternatives for the reasons we've just looked at? There's no easy answer since this depends on the frequency we're talking about. As the frequency increases, semiconductors generally become less efficient so the problem of heat dissipation becomes more severe. Accordingly, semiconductors tend to be used at higher power ratings at the low end of the RF spectrum than at the high frequency end. At the bottom end of the RF spectrum, at the one or two hundred



Inside the CERN particle. High power klystrons are used in particle physics research to trigger particle breakdown experiments.

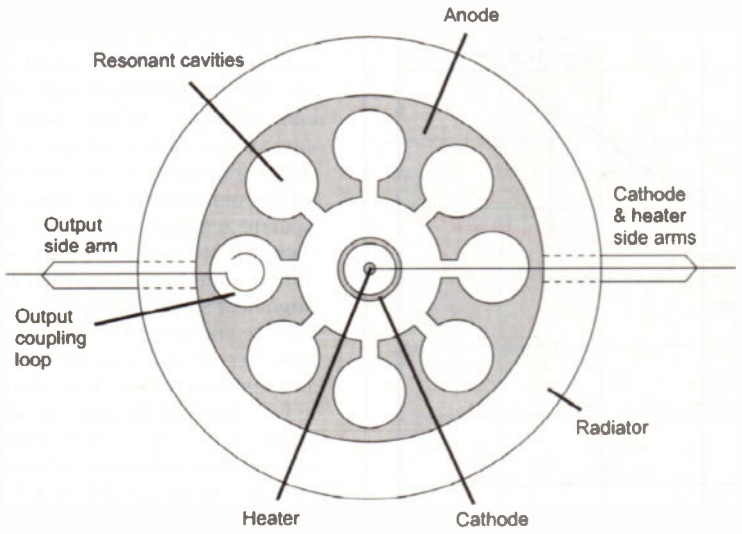
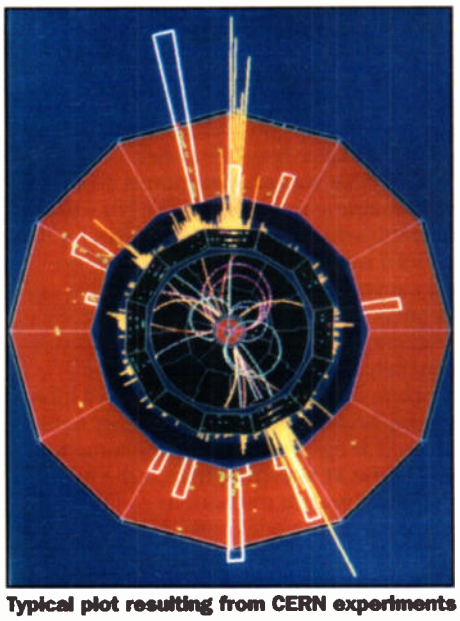


Figure 39. Typical magnetron structure



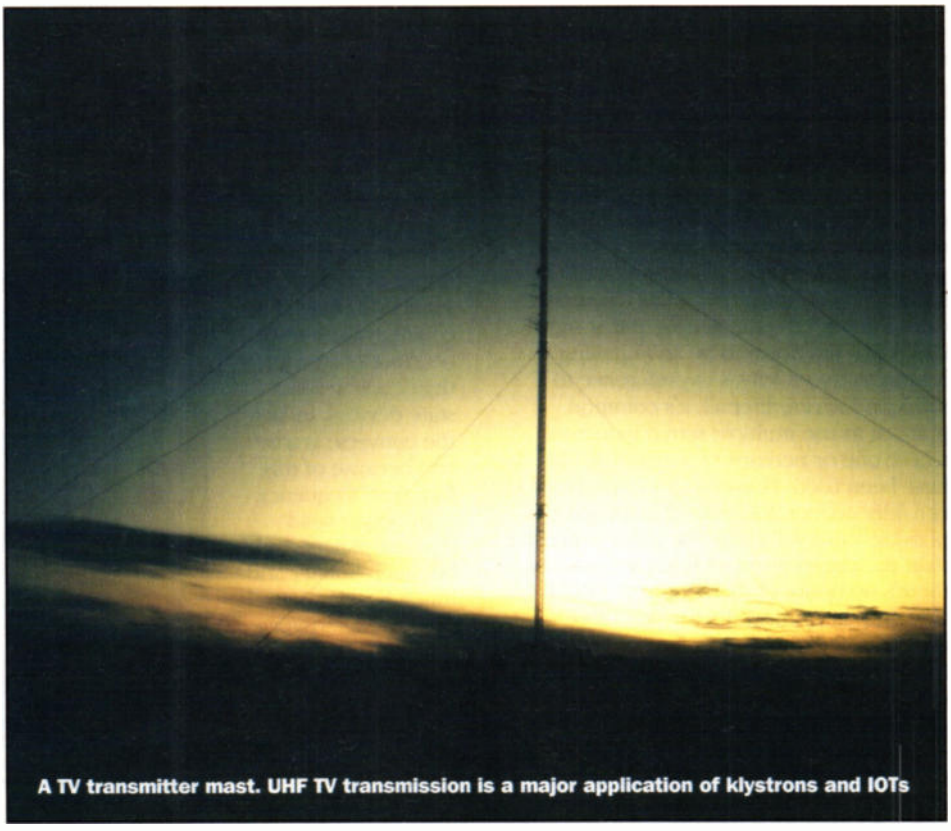
Typical plot resulting from CERN experiments

kilohertz often used for inductive heating applications, semiconductors are viable even at powers of a few hundred kilowatts. As we move up to the HF region, either for industrial or broadcast applications, valves make their appearance at a few tens of kilowatts. Turning now to the UHF spectrum, Geoff Clayworth of Marconi Applied Technologies told me that they, as valve manufacturers, could give solid state a run for its money from about 3.5kW for use in TV transmitters. This applies to their IOT product range, a special type of valve we'll look at later. TV transmitters employing semiconductor devices can be viable up to about 30kW, though, so we have a 3.5kW to 30kW region which can be considered the cross-over region. Above 30kW, valves remain the undisputed champions at UHF. In the microwave spectrum (1GHz - 100GHz) we find a very different picture. Typically, microwave applications require RF pulses with the peak power being, perhaps, a thousand times greater than the average power. Radar, for example, might use 1,000 pulses per second, each pulse with a duration of a microsecond and a peak power of 5MW, thereby requiring a mean power rating of 5kW. Semiconductors are particularly unsuitable for this type of operation and tend to be limited to applications which require just a few milliwatts. One of the few applications which comes into this category is the low power radio being developed for collision avoidance systems on cars. Ironically, despite the trend we've seen, namely that valves become ever more attractive in comparison to semiconductors as the frequency increases, solid-state devices make something of a come-back at the top end of the magnetron's frequency range. Here magnetrons are, perhaps, only 1%-2% efficient compared to 90% at 1GHz, and so semiconductors can offer some major advantages.

Limitations of Conventional Valves

So far in this article I've talked about valves in broad terms and I've mentioned various types of special valve which are particularly appropriate to high frequency use. These valves - magnetrons, klystrons and IOTs - aren't just versions of the conventional gridded valve specially adapted for UHF or microwave use, they're radically different. In some RF applications - especially at the lower end of the RF spectrum - standard gridded valves are indeed used. However, at higher frequencies, especially at high power levels, the conventional gridded valve becomes unsuitable and this fact gave rise to the development of various types of special valve. In this section we'll look briefly at the problems associated with using ordinary valves at high frequencies. In the following sections, I'll describe the more common types of valve designed specifically for high frequency RF applications.

The performance of a valve-based amplifier degrades significantly when the wavelength becomes comparable in size to the structural elements of the valve. This degradation occurs when the electron transition time between the electrodes becomes longer than the period of the input signal. Furthermore, the inductance of the connecting wires and the capacitance between the electrodes increase with frequency, effectively short circuiting the amplifier. An obvious solution is to reduce the size of the valve, indeed microwave valves featuring a reduced electrode area and shorter connecting wires were produced from the 30s onwards. The negative impact of these changes, however, is a limit on the valve's power-handling capability. Early high frequency gridded power valves were limited to about 1W at a maximum operating frequency of 4GHz. And although much improved performance (e.g. 20kW at 860MHz) has been achieved in recent years, more specialised valves designed solely for high frequency use continue to keep ahead of ordinary gridded valves.



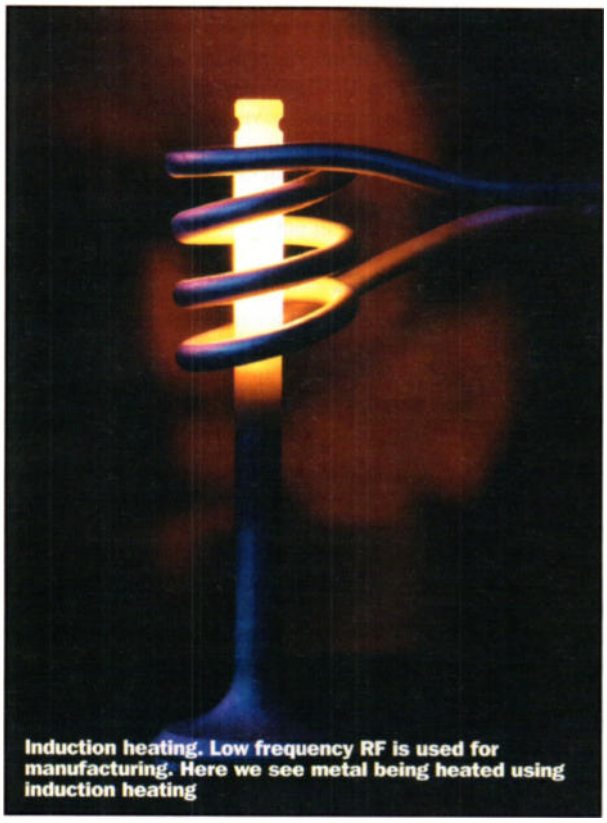
A TV transmitter mast. UHF TV transmission is a major application of klystrons and IOTs

The Magnetron

The magnetron was the first type of valve designed specifically to generate microwaves at higher power levels. Its development was spurred on, to no small extent, by the requirement for an effective radar system during the Second World War. Figure 39 is a top view showing the construction of a typical magnetron and the first thing you'll notice is that it bears little similarity - from a physical viewpoint at least - to the sorts of valves we looked at earlier in the series. The one thing magnetrons do have in common with ordinary gridded valves though, something which differentiates them from solid-state devices, is that they rely on the passage of electrons through a vacuum.

Clearly the cathode and the anode are arranged in a coaxial configuration and the anode consists of a series of cavities. These are resonant at the operating frequency so their dimensions define the operating frequency. What isn't obvious from the diagram is that the anode and cathode assembly is positioned within an axial magnetic field. Since a magnetic field deflects the passage of electrons, at high fields strength the electrons from the cathode are constrained to orbit near the cathode. As none can reach the anode, no current flows and no power is generated. If the intensity of the magnetic field is reduced then the electrons are able to move out as the radius of curvature of their path decreases. As they pass across the open end of the anode cavities, the cavity spontaneously resonates - this is exactly analogous to blowing across a bottle top to make a note. If the field is further reduced, electrons begin to reach the anode and the device begins to conduct current and generate power. Effectively, the electrons give up their electrical potential energy to the microwave field on the anode, causing amplification and hence RF power generation. The RF energy is extracted from the magnetron via a coupling loop in one of the resonant cavities.

You'll notice that the magnetron is fundamentally different from most other types of valve in that it is an oscillator rather than an amplifier. Conventional valves can operate as oscillators, of course, but their basic operation is as an amplifier and it's only the presence of an external feedback path which causes oscillation. Low power magnetrons are produced in vast numbers and at very low cost for use in domestic microwave ovens. Higher power magnetrons are used in radar systems, in medical applications, and for use in scientific research.



Induction heating. Low frequency RF is used for manufacturing. Here we see metal being heated using induction heating

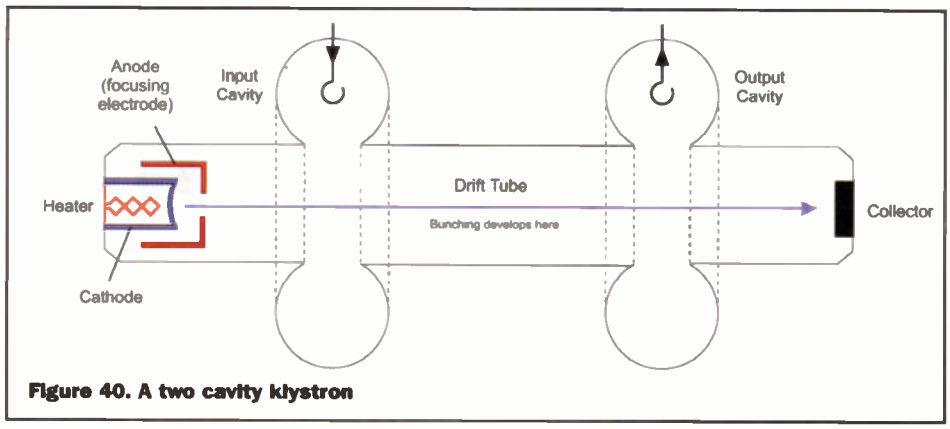


Figure 40. A two cavity klystron

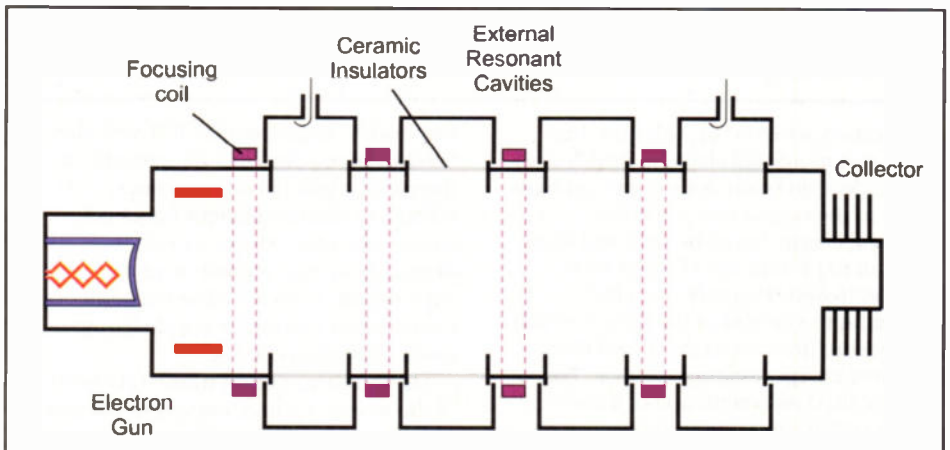


Figure 41. More typical construction of a klystron

The Klystron

If you're familiar with the construction of a cathode ray tube, a klystron is similar in that it has an electron gun at one end which fires a stream of electrons down the tube. The electron gun consists of a heated cathode and a doughnut-shaped anode to which electrons are drawn but actually end up passing straight through and so down the remainder of the tube. The electrons are kept in a tight beam partly by the concave shape of the cathode, partly by the effect of the adjacent focusing electrodes, and partly by the magnets which are positioned along the tube. Also along the length of the tube are a number of resonant cavities which are key to the klystron's operation. The first cavity is the input cavity and has the input signal which is to be amplified coupled into it. As the electron beam passes the input cavity (which effectively acts as a pair of grids 180° out of phase), the effect of the input signal is to velocity modulate it. Electrons are either speeded up or slowed down depending on the phase of the input signal at the time they pass the input cavity. As the electrons continue down the main body of the klystron - the drift tube - they become bunched up as the faster moving electrons catch up with the slower ones. The separation between the bunches corresponds to the wavelength of the input signal. At a particular distance along the drift tube the bunching will be optimum - this is the position at which the output cavity is placed. Here an electrical current is induced in a loop and this is coupled to heavy duty coaxial cable which transfers the RF signal to the antenna or some other load.

What I've just described is a two cavity klystron but far more common are klystrons with additional cavities along the length of the drift tube - each located at positions of optimum bunching. Effectively, this corresponds to two or more two-cavity klystrons connected in series and the effect is a reinforcing of the bunching and improved amplification. The presence of intermediate cavities can also increase the bandwidth of the klystron. This is achieved by tuning the intermediate cavities to slightly different frequencies. This completes the explanation of the

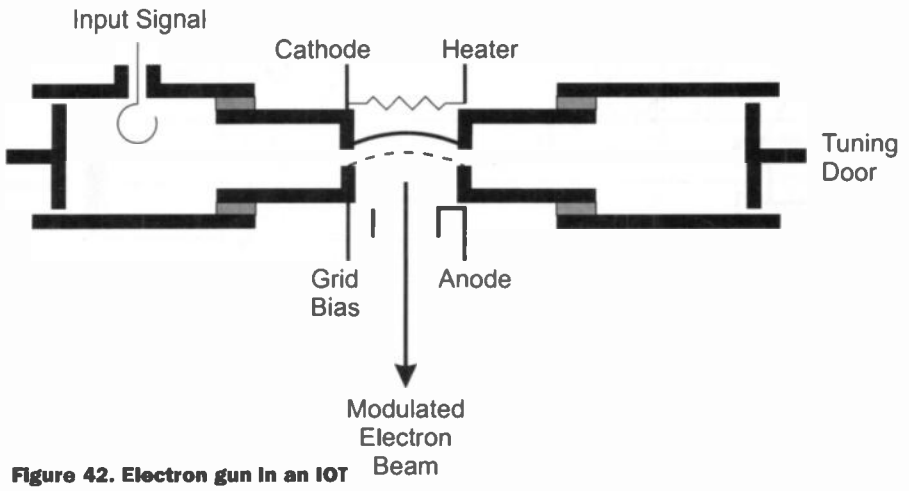


Figure 42. Electron gun in an IOT

amplification achieved by a klystron but there's one more vital element. Needless to say, the electron beam doesn't give up all its energy to the output cavity and the remaining energy has to be removed from the beam to prevent the klystron from being destroyed. This is done in the collector at the far end of the tube in which the electrons are slowed down and the remaining energy dissipated as heat. Figure 40 is a stylised representation of a two cavity klystron whereas Figure 41 is more typical of the construction of a real-world klystron with intermediate cavities.

UHF TV transmission is one of the main applications of klystrons although their production is now mainly for use in existing transmitters. As you can read in the next section, an alternative technology is now in the process of replacing the klystron in this key application.

The Inductive Output Tube

The inductive output tube or IOT can be thought of as a sort of hybrid valve - somewhere between a klystron and a conventional gridded valve. In many ways an IOT is similar to a klystron but the major difference is the way in which the electron beam is bunched. As we saw in the previous section, the klystron uses velocity modulation and a long drift tube to generate bunching. In the IOT a grid - located just in front of the cathode, and coupled to the input cavity - is used. The electron beam is, therefore, density modulated within the electron gun. There are clear similarities between its operation and that of a conventional triode or tetrode although there is also one significant difference, and that is the input signal is applied between the cathode and grid via a tuned input cavity. A major implication of the IOT's method of modulating the beam is that a long drift tube isn't required in order to achieve the bunching and this accounts for the fact that IOTs are much more compact than klystrons of an equivalent power handling capability. Power is extracted from the IOT in an output cavity, as it is in the klystron, but the absence of intermediate cavities means that these cannot be used to increase the bandwidth. To provide the IOT with the bandwidth required in a TV transmitter, therefore, a pair of output cavities, each tuned to a slightly different frequency, tends to be used. Figure 42 is a diagrammatic representation of the electron gun in an IOT. The remainder of the assembly consists of the dual output cavities and the collector.

The inductive output tube (IOT) is one of the newest vacuum devices developed for use at RF and is now the component of choice for UHF TV transmitters. Although still in use, klystrons are in the process of being phased out for this application and virtually all new transmitters use IOTs because of their better efficiency and smaller size. IOTs are also especially suited to the high peak to mean power ratio characteristics of digital TV transmission.

Some Real Products

So we've seen the various special types of valve designed specifically for UHF and microwave applications and diagrams showing their construction have been provided. What these diagrams don't do, though, is give much of an impression of the characteristics of real world products. You'll be familiar, no doubt, with the types of valves which were used in radio receivers until the 60s and, if you read last month's article, you'll have seen photographs of audio amplifiers which employed some rather more impressive looking valves, albeit ones which are still only four to six inches or so in height. A first impression might be that the valves used in high power RF applications might not be too different from these valves. However, a bit of thought will surely convince you that they must be very different from a physical viewpoint. After all, it's barely conceivable that valves like these could possibly work at power levels measured in hundreds of kilowatts. The sorts of valves we're looking at in this article would, therefore, either have to be significantly larger than run-of-the-mill valves or they would have to employ a much more efficient cooling system. In practice, high power RF valves are both large and they employ a highly efficient cooling system. Also, to achieve adequate robustness, glass envelopes are abandoned in favour of a ceramic and metal construction. With that bit of preamble out of the way, let's now take a look at some typical products. This section is based on information provided by Marconi Applied Technologies, one of the UK's major manufacturers of klystrons, magnetrons, IOTs and gridded valves for high power RF applications. The photographs which appear in this article were also provided by Marconi Applied Technologies.

Up to about 1.2kW, conventional gridded valves may be not too dissimilar in construction from the more modestly-sized valves you'll be familiar with. As such, the anode is inside the vacuum envelope and is cooled, therefore, by radiation. Above this sort of power level - and gridded valves with power ratings up to a few hundred kilowatts are available - the anode forms a part of the vacuum envelope rather than being enclosed by it. The anode is, therefore, accessible from the outside of the valve and can be cooled by forced air, by water or by vapour. In vapour cooling, liquid water is introduced into the valve and steam is extracted. The cooling process takes advantage of the water's latent heat of vaporisation. A high-end gridded valve rated at, say, 300kW, would be about fifteen inches in diameter and two feet high. However, this doesn't include the pumps, condensers and other equipment associated with the vapour cooling which would be integral to such a high powered valve. Needless to say, lifting gear would be required to move a valve like this.

Klystrons can be huge. A 60kW UHF TV klystron will probably be about five feet high and weigh around 80kg. Such a klystron would typically be cooled by a combination of air and water. But these are dwarfed by the klystrons which are intended for particle physics research. Now we could be talking of a device capable of outputting 1MW and standing sixteen feet high. For reasons we've already seen IOTs tend to be more compact - a tube with an average power rating of 30kW and a peak power of 110kW, for example, would be about three feet tall.

Contact

If you have a need for the rather specialised valves we've been looking at this month, point your browser at **www.marconitech.com** or call Marconi Applied Technologies on 01245 493493.

Next Month

Next month will see our series on valve technology come to a close. Although we've now looked at how valves work and at their major applications, this by no means concludes the story of valves in the 21st century. However, most of the subjects which remain to be covered are pretty much unrelated to each other. The concluding article in this series will, therefore, take the form of a roundup of miscellaneous snippets.

TECHNOLOGY WATCH

With Martin Pipe

Some interesting developments in video recording could well spell the end of tape. Although it's not without its advantages - the primary ones being low cost and widespread availability - it's beginning to show its limitations in this age of multimedia. Interestingly, tape has successfully made the transition from analogue to digital, certainly with video. But then again, it's only because there was no practical alternative at the time they were being developed. Most important of these are the digital camcorder formats DV and, more recently, Digital 8. Both formats employ a helical-scanning rotating-head technique similar to that which formed the basis of previous-generation analogue systems. In order to balance picture quality, tape running times and available bandwidth, video and audio compression are used. DV, which dates back to 1996, has proved popular with enthusiasts. There's even a 'pro' version, known as DVCam. Digital-8, which was introduced into the UK by Sony last year, offers similar picture and sound quality to that of DV, but is backwards-compatible with analogue 8mm and Hi-8 recordings. It's targetted primarily at enthusiasts.

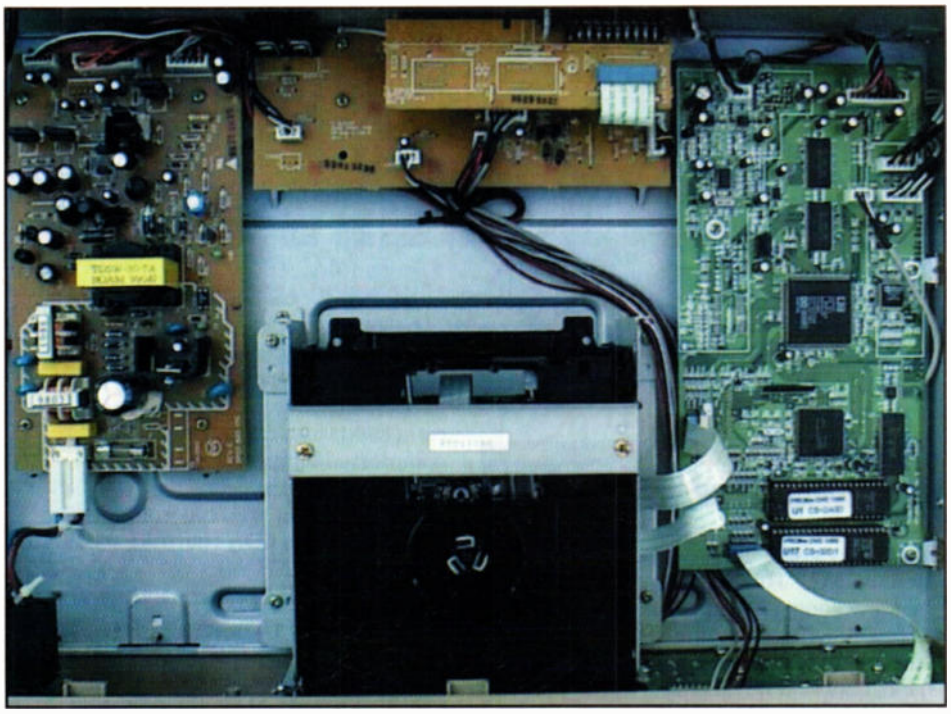
Although tape has been fairly successful as far as digital video is concerned, it has largely failed in the world of digital audio. Philips' DCC disappeared without trace, despite its much-touted compatibility with analogue cassette recordings. Another system, DAT - which employs a VCR-like helical scanning system - is now relegated to professional applications, and the backing-up of computer data. On the other hand, digital audio recording formats based around discs have been extremely successful. Sony's MiniDisc has exceeded all of the expectations of the industry, and the vast majority of the bigger manufacturers now offer compatible hardware. MiniDisc recorders, and perhaps more importantly blank media, are now fairly cheap. Minidisc, like DCC and the digital video systems, employs compression to irretrievably 'throw away' redundant or imperceivable information. As far as audiophile-quality sound is concerned, this is unacceptable. For these guys, CD Recordable is king. CD Recordable, when employed for audio recordings, adheres to the same 'Red Book' standard of ordinary CD. As a result, you get the sound quality of CD, which isn't compressed, plus the ability to play your recordings on pretty much the entire installed base of CD hardware.

Pentium III PCs are able to encode and decode MPEG-2 video in real-time. This opens up the possibility of using your PC as a video recorder.

As far as audio is concerned, then, the tape has lost out. Indeed, the only thing that has stopped the same thing from happening to video recording is the leap in extra bandwidth concerned. Even compressed digital video streams of acceptable quality occupy data rates several times higher that available from existing carriers (such as CD). That said, there is a version of the CD - VideoCD - capable of conveying moving pictures and stereo sound. Unfortunately, the picture quality of the MPEG-1 system is generally fairly poor - some pre-recorded discs are worse even than analogue VHS! On the plus side, VideoCDs can be produced with existing CD duplication plant. Although the format never really took off in the West, it has been very successful in the East, where VHS penetration is low and home-grown movies form one of the dominant sources of entertainment. Interestingly, it's possible to make your own VideoCDs with a PC, video capture card (like the Pinnacle MP10) and CD recorder. Some corporates and computer enthusiasts have toyed around with making Video CDs, but it's pretty much a minority interest.

VideoCDs Failure

There are two reasons behind VideoCD's overall failure. The first is undoubtedly the video quality - which has since been addressed by another playback-only digital videodisc format, DVD. The second is the very fact that it is a restricted (one hour per disc) playback-only medium. Even if cheap VideoCD recorders had been introduced, they wouldn't be able to compete with VHS decks capable of offering better performance and ridiculously cheap media. DVD, on the other hand, has been phenomenally successful of late - indeed, one analyst reckons it has been the most successful consumer launch ever! The big draw has been the excellent picture quality (compared with VHS), its ability to accommodate an entire movie on one disc, the potential of multi-channel surround sound, the user interface and a visible public presence. As far as the latter is concerned, one of the main culprits is the movie rental industry. Discs, unlike tapes, don't wear out. Even after several hundred rentals, you get the same picture quality experienced by the first viewer. To this end, some UK chains - notably Blockbuster and MVC - are now offering DVDs for rental and purchase. Even the larger public libraries are now getting in on the act. DVD has benefitted from a worldwide ecomonic situation that is far more favourable than it was six years ago, when VideoCD was launched. As a result, people have more money to spend



Future DVD players may well have emchanisms able to cope with Hitachi's DVD-RAM discs

on consumer items, and are prepared to overlook DVD's primary limitation as a playback-only format.

Its early success among home cinema enthusiasts - particularly in the well-heeled US - has brought down the ownership cost of DVD software and hardware. The greater availability of UK-compatible software has also improved (DVDs are 'regionalised', so that the studios can regulate who can watch what, although most players can be 'hacked' to play all DVDs, regardless of their origins). So why the shift away from tape? Most obviously, tape is a 'linear-access' system. In other words, you have to forward or rewind a videotape in order to find a particular scene. Although formats have attempted to address this issue through search modes of varying complexity - witness the 'index search' tacked on the recording - even the manufacturers will admit that getting from Point A to Point B can be a rather time consuming process. After all, Point A may be at the beginning of the tape, while Point B - where you want to go - might be close to the end. As your local video hire shop knows, tape isn't a particularly rugged medium, particularly when you consider the stresses placed on it by the deck mechanism. After a few tens of recording and playback cycles, wear and tear becomes apparent in the form of drop-outs. These are visible as random 'specks' on analogue recordings, and occasional pixellation on digital ones. As the tape wears further, drop-outs become more noticeable. More specks on analogue, while the digital picture freezes periodically. Fortunately, tape is fairly cheap - and so if a cassette is proving problematic, a new one can replace it. This won't be much consolation, however, if the recordings are prized ones.

Rewritable Optical Discs

The manufacturers are working towards other solutions, which store video on rewritable optical discs of high capacity (typically 4.7GB). Unfortunately, at this time there are a plethora of incompatible standards - just as there was in the beginnings of domestic video (VHS, Betamax/V2000). It's too early to determine which - if any - will ultimately win. All of these disc-based video recorders have built-in tuners and timers, and have various digital (FireWire) and analogue (phono/composite/S-video) AV input and output connectivity options. In addition, most employ the MPEG-2 video compression system that forms the basis of digital broadcasting and DVD. The main difference between these systems concerns the media. Although they're similar in overall principle, they're difficult enough to be totally incompatible with each other. Analogue home video was just the same! One of the first such products is NEC's GigaStation, which has been available in Japan since September. The 'MVDisc' (Multimedia Video Disc) media involved is a cartridge-enclosed CD-sized (120mm diameter) single-sided disc with a capacity of 5.2GB. This disc, which is incompatible with DVD players, is sufficient to store 2 hours of Japanese-standard (NTSC, 525-lines, 60Hz refresh rate) video of S-VHS quality. If the VHS-quality mode is selected, recording time is doubled. The random-access nature of the disc gives rise to features impossible with tape, such as instant access and basic editing (the reorganisation and trimming of recorded sections). You also get the high-quality noise-free still and search modes associated with DVD. In Japan, the price of the recorder and disc are 350,000 yen (around £2,100) and 3,900 yen (around £25) respectively.

Incompatibility

Unfortunately NEC is going its own way, and to the best of my knowledge the MVDisc is not being adopted by anybody else. Philips, Pioneer and Hitachi have announced similar products, in prototype form. All are based on DVD-type media, although the issue of compatibility with DVD players is rather contentious at present. The Philips system, DVD+RW, is optimised for multimedia purposes - so too is the Pioneer system (DVD-RW). Both single-sided, single-layered discs have a capacity of 4.7Gb, although 20Gb discs (which use two recording layers on each side to increase the capacity) have been touted. With at least one of these systems, error correction has been sacrificed for greater recording times. After all, the occasional missing pixel caused by a drop-out is unlikely to be noticed when watching a recording. Unfortunately, this sacrifice makes such formats unsuitable for data storage. The Hitachi system - DVD-RAM, which is also supported by Panasonic, Toshiba and Samsung - has a lower capacity, but employs error correction. As a result, Hitachi is flogging it as a back-up medium as well a potential means of storing digital video and audio.

Note that of the four systems, only DVD-RAM and DVD-RW have been approved by

In Japan, Pioneer has just launched this DVD-RW based video recorder. The price? 350,000 yen - that's £1,500 to you, guv.

If you're in Japan, you'll also be able to buy this hard disk-based video recorder from Panasonic. The AVHDD is intended primarily for video editing purposes.

Here's another product that's exclusive to Japan - the Sony MD Discam. It employs a new 650Mb version of the Minidisc to record around 20 minutes of MPEG-2 video footage.

the DVD Forum. The DVD-RAM disc is, like the MVDisc, enclosed in a caddy. A Pioneer DVD-RW video recorder (the Pioneer DVR-1000) is available in Japan for 250,000 yen (around £1,500). The £20 4.7GB disc will store between one and six hours of footage, depending on which of the 32 quality 'modes' has been selected. Philips has demonstrated a prototype of a DVD+RW recorder. Another option under investigation at the moment is the building of hard disks into digital set-top boxes and IDTVs (integrated digital TVs). Here, the raw MPEG datastreams would be recorded onto the hard disk, as a streaming file, at the time the desired programme was broadcast. The file can then be decoded by the MPEG circuitry of the set-top box when the owner returns home. A neat way of dispensing with the extra box that is the video recorder - but with obvious disadvantages. What, for example, if the disk is full up and you want to record something else in a hurry? You would have to delete one of your unwatched programmes! It's not yet known whether these systems would provide the decoded output to one of the AV Scart sockets for dubbing onto VHS or some other medium. Another option is using your PC as a video recorder. One software company, MGI, is attempting to sell such a system to the OEM industry. Its product, DIVA, uses the Intel Pentium III's streaming-multimedia instruction set to encode and decode MPEG-2 in real-time.

What About Camcorders?

As far as camcorders are concerned, one of the most promising developments so far is the DZ-MV1 prototype from Hitachi. Instead of tape, this employs a rewritable optical disc (DVD-RAM). The dual-sided disc is three inches in diameter, and will store up to 1GB of data per side. Conventional DVD-RAMs - which have a 4.7GB capacity - are the same size as an audio CD, but they're too big for camcorders. Hitachi took the smaller disc size, which dates back to an unsuccessful audio CD-single format of the late 1980s, but partly redressed the capacity issue with a second-generation version of DVD-RAM. According to the company, the 2GB disc is capacious enough to store up to an hour of MPEG2 video. Even if the DZ-MV1 does make it to market - which could be by the end of the year - you won't be playing home movies on your existing DVD player. This is because DVD-RAM is incompatible with the current generation of DVD hardware. There is some movement forward, though. Hitachi claims that an increasing number of computer DVD-ROM drives will be DVD-RAM-compatible - mainly because DVD-RAM is currently being seen primarily as a high-capacity hard disk back-up medium. As a result, you'll be able to read your movie discs directly on your PC - which is excellent news for those who edit video with their home computers.

Although the 3-inch audio disc was a commercial failure, all CD-compatible equipment (a list that includes DVD players and CD/DVD-ROM drives) makes provision for the smaller discs. It's simply a case of removing the disc from its protective caddy, and slotting it into the DVD-ROM's tray. In addition, the very same DVD-ROM/RAM drive mechanisms may well form the basis of a future generation of DVD players. In other words, you may eventually be able to play your DVD-RAM movies on your home DVD player, and enjoy them on the 'hang-on-the-wall' plasma screen that you will of course (ho ho ho) have by then. Other advantages of the Hitachi DZ-MV1 include a picture quality that approaches DV's, hi-fi stereo sound, and very quick access to recorded selections. If you want to record on a disc that is full, you'll have to delete unwanted sections of the disc first - in this respect, Hitachi's camcorder is rather like a Minidisc audio deck. Talking about Minidiscs brings us, appropriately enough, to Sony's 'MD Discam'. This is a compact camcorder that, funnily enough, records on Minidiscs, and thus has the same editing prowess.

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

NEC launched the first digital video recorder based around rewritable optical disks. Unfortunately, the Gigastation is only available in Japan - it's not known if it will see the light of day elsewhere.

This is Hitachi's innovative DZ-MV1 camcorder, which is capable of storing up to one hour of MPEG-2 video footage on a miniature double-sided DVD-RAM. It might be available in Europe by the end of the year.

The Quantum WORLD

PART 3

In part 3, the final part of this series, David Clark explains the fundamental structure of protons and neutrons, and looks at some quantum devices in the 'real' world.

Unity

Parmenides, the Latin philosopher of the fifth century BC grappled with the idea of 'Being' and 'Unity', or 'Oneness', as he and other philosophers struggled with concepts of reality, existence and material things. To them the only alternative to being was 'not-being', a void or nothingness, which seemed impossible and inconceivable. So the concept that gave stability to their known universe was that everything was part of a 'Oneness'. Classical physics came to understand that the stability of everything is based on the balance of equal and opposites. The concept of the quark being the fundamental particle of the hadrons put forward in 1964 was the breakthrough that has defined particle physics ever since, but it meant a rethink of some fairly fundamental ideas, one of which was the fact that quarks came in groups of three to make up a stable unit, whereas most of the large scale world is based on two forces in equilibrium.

Threeness

The concept of 'threeness' is perhaps difficult to accept because in the macroscopic world the 'twoness' of electric charge and magnetic poles prevails. However, once 'threeness' is accepted the structure of subatomic particles falls neatly into place. The existence of three different types of quark, called 'up', 'down' and 'strange' allows for the composition of all the baryons, including the proton and neutron (antiquarks are also needed to explain the mesons). It is necessary to accept that in the Quantum World at quark level electric charge has quantum values of +2/3 and -1/3, and the baryon quality has a quantum value of 1/3. All the quarks have a baryon value of 1/3, the up quark has a charge of +2/3 and the down and strange quarks have a charge of -1/3. Thus for example a proton is composed of two up and one down quark, and so it has the required baryon number of 1 (3 x 1/3), and a single positive charge (2 x +2/3) + (-1/3). Similarly a neutron is composed of one up and two down quarks, thus it also has a baryon number of 1 but zero charge (+2/3) + (2 x -1/3). See Figure 1.

Charge		Baryon Number	Strange -ness	Top -ness	Bottom -ness	Charm	Label
Quarks							
up	+2/3	1/3	0	0	0	0	u
down	-1/3	1/3	0	0	0	0	d
strange	-1/3	1/3	-1	0	0	0	s
top	+2/3	1/3	0	+1	0	0	t
bottom	-1/3	1/3	0	0	+1	0	b
charm	+2/3	1/3	0	0	0	+1	c
Anti-quarks							
up	-2/3	-1/3	0	0	0	0	(u)
down	+1/3	-1/3	0	0	0	0	(d)
strange	+1/3	-1/3	+1	0	0	0	(s)
top	-2/3	-1/3	0	-1	0	0	(t)
bottom	+1/3	-1/3	0	0	-1	0	(b)
charm	-2/3	-1/3	0	0	0	-1	(c)

Table 1. Table Of The Qualities Of Quarks

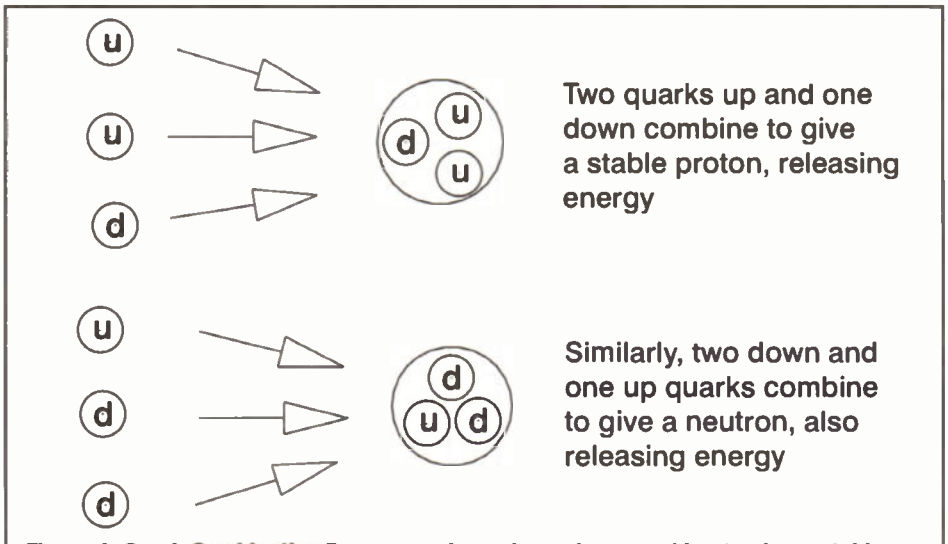


Figure 1. Quark Combination Two up quarks and one down combine to give a stable proton, releasing energy Similarly two down and one up quarks combine to give a neutron, also releasing energy Quarks combine to give stable baryons such as protons and neutrons.

Sixness!

Inevitably this wasn't the complete answer for it transpires that three more quarks are needed to explain all of the particles found in high energy particle interactions. These are the charm, bottom and top quarks, each also having its own quality of 'charm', 'bottomness' and 'topness', just as the strange quark has 'strangeness'. Table 1 shows the qualities that give six unique, fundamental, quark particles, and Table 2 shows the quark composition of the subatomic particles.

Figure 2 gives an example of how quark qualities are conserved in interactions.

In summary then, it appears that the universe is composed ultimately of fundamental quarks and leptons, with forces mediated by the bosons. Is that it? If there are different types of quark and leptons why can't there be something more fundamental that makes up quarks and leptons? There seems to be no evidence that suggests that the leptons are anything other than indivisible, and the incredible thing about

Particle	Quark Composition (see table 1 labels)	
proton	uud	
neutron	udd	
lambda	uds	
sigma plus	uus	
sigma minus	dds	Baryons
sigma zero	uds	
xi minus	dss	
xi zero	uss	
omega minus	sss	
charmed lambda	udc	
pi zero	u(u)	
pion	u(d)	
K zero	d(s)	
kaon	u(s)	Mesons
J/Psi	c(c)	
D zero	c(u)	
D plus	c(d)	
upsilon	b(b)	
electron		
muon		
tauon		Leptons
electron neutrino		
muon neutrino		
tau neutrino		
photon		
W		Bosons
Z		
gluon		

Table 2. Table Of The Composition Of The Subatomic Particles

quarks, and what makes them appear to be truly fundamental, is the fact that if enough energy is applied to them, they break down into - more quarks! Furthermore, in some subatomic particle interactions one type of quark will change into another type. So, there is more to explain, and that is the interactions between the quarks, and a major problem still, gravity.

Quantum Colour

To understand the interactions between quarks a new concept was needed to explain the stable, 'neutral' state of particles consisting of three quarks. In the case of a 'two-way' system, charge for example, positive and negative cancel out to give an electrically neutral state. In a three way system the quality of colour was chosen. Note that this is in no way of any similarity to colour in the macroscopic world where colour is the effect on the eyes of electromagnetic radiation which has a far larger wavelength than the distances involved at the quantum level. By choosing the three primary colours red, green and blue the combination of all three gives 'neutral' white (see Figure 3).

So each quark can be one of three colours, and in a baryon, say a proton composed of three quarks, each quark has a different colour and the proton is colour neutral. The force holding quarks together occurs in the same way that photons carry the electromagnetic force, i.e. via the exchange of bosons, and the strong nuclear force equivalent of the photon is the 'gluon' (see Figure 4).

Unlike photons however, gluons also have a 'colour' associated with them, and as they are exchanged in strong nuclear force interactions, they 'carry' colour with them in such a way that the colour neutrality of the baryon is maintained.

Particle	Proton	+	Anti-pion	⟶	Neutron	+	Pion	+	Anti-pion	+	Pi zero
Quark content	uud		(u)d	⟶	uud		u(d)		(u)d		u(u)
Baryon number	3/3		0	⟶	3/3		0		0		0
Charge	+1		-1	⟶	0		+1		-1		0

Figure 2. Quark Quality Conservation For the interaction shown on the top line, the lines below show how the qualities given to quarks by theory explain how it can occur because all qualities balance - they are conserved. Similar balancing interactions can be drawn up for all subatomic particle interactions which include other qualities such as 'strangeness'.u = up quark, d = down quark, ( ) = antiquarks

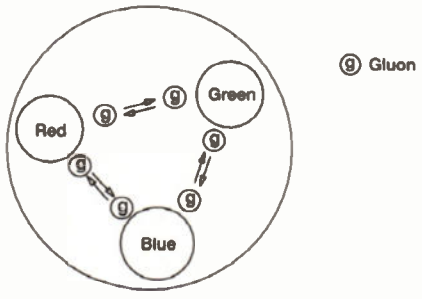


Figure 3. Quark colours Gluons carry the colour quality between quarks, ensuring that a stable subatomic particle such as a proton is colour neutral.

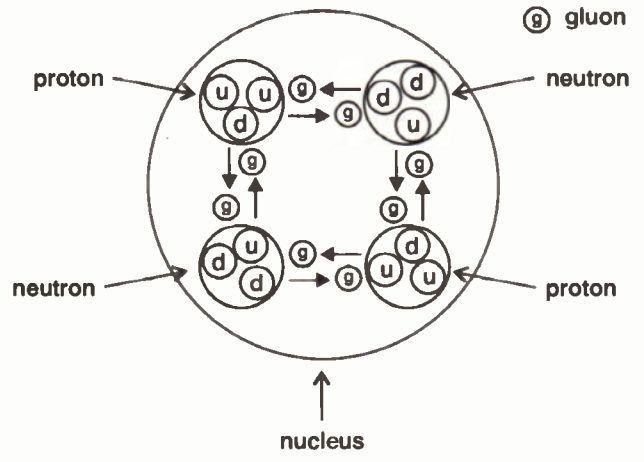


Figure 4. Strong Nuclear Force Just as photons carry the electromagnetic force between charged particles, another 'boson' type particle, the gluon, acts between quarks and holds them together. This is the strong nuclear force which holds nucleons together overcoming any repulsive force eg between protons. One difference between photons and gluons is that photons can carry an attractive and a repulsive force depending on the charge of the particle; gluons can only carry an attractive force.

Weak Nuclear Force And Unification

The weak nuclear force, involved in radioactive beta decay, is mediated by particles called W and Z particles which act like photons and gluons (see Figure 5).

These particles carry charge however. (There is a W plus particle, a W minus, and the Z particle has zero charge.) Leptons such as electrons are affected by the electromagnetic force, mediated by photons. Quarks are affected by the strong nuclear force mediated by gluons, but both quarks and leptons are affected by the weak nuclear force. There is evidence to suggest that the weak force and the electromagnetic force are both manifestations of an underlying force, the 'electroweak force', that explains them both, or 'unifies' them, but an even 'bigger' theory is looked for - one which links the strong force and the electroweak force. This is the Grand Unification Theory. However there is still no experimental evidence or successful theories which include an explanation for gravity, which should be a force mediated by particles called 'gravitons'. A solution that links all the forces together is attractive because apart from it being a tidy solution it also links in with studies of the evolution of the universe where of course if the 'big bang' theory is accepted the earliest moments of the universe involve the highest energy concentrations and everything would have existed as fundamental particles and forces. A name sometimes given to a single unified force which came into existence with the universe is 'supergravity', and the theories that attempt to explain gravity as well as the 'normal' forces are the 'super-' theories, namely supersymmetry and superstring theories.

Supersymmetry

Theories and experimental evidence indicate that there is a symmetry involved in the existence of subatomic particles, for example there are particles and antiparticles. These are the same except they have exactly opposite qualities and so completely annihilate each other if they interact. One of the problems of including gravity with a Grand Unification Theory is that huge energies are involved, which

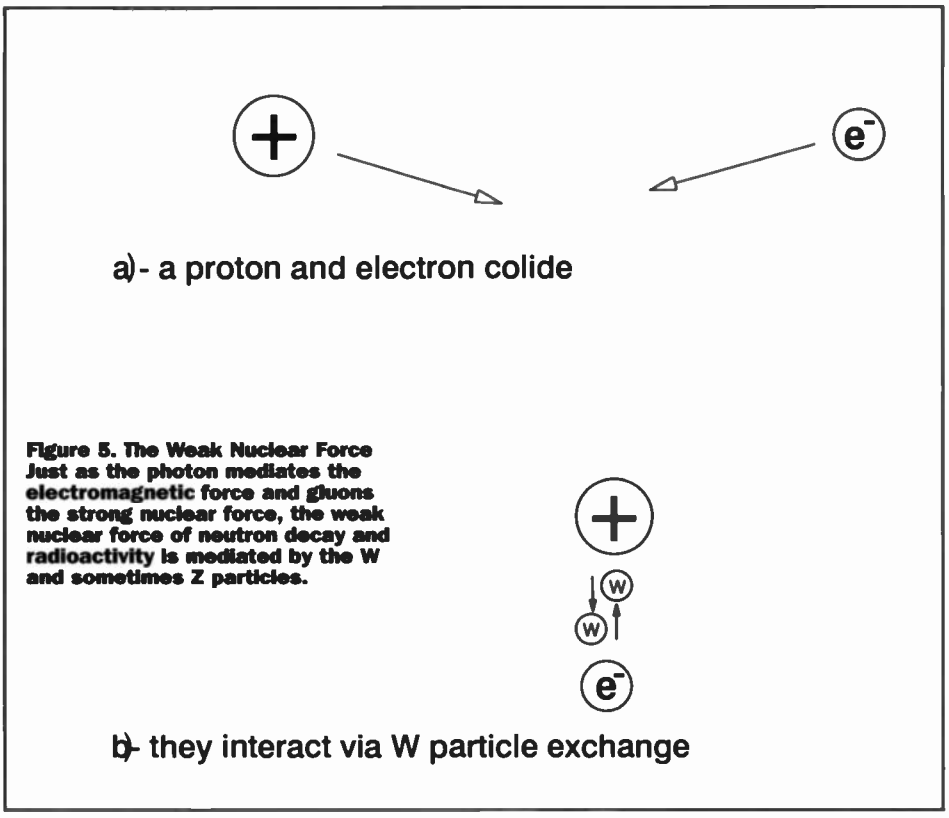


Figure 5. The Weak Nuclear Force Just as the photon mediates the electromagnetic force and gluons the strong nuclear force, the weak nuclear force of neutron decay and radioactivity is mediated by the W and sometimes Z particles.

correspond to huge mass, and these don't fit in with known values. The supersymmetry theories account for this by choosing a division of particles on the basis of a quantum quality called spin, a measure of the angular momentum of a particle. Using this division means that both groups can contain heavy, middle and light-weight particles. Then symmetry would suggest the existence of a whole new range of particles having symmetry with the quarks, leptons, photons etc. These have been given names like squarks, sleptons and photinos, and the effect of these if found to exist would be to interact to give the masses and energies of particles actually found.

Strings

In the 1970s and 1980s some radical new ideas were put forward that suggested fundamental particles were not points in space but had a length, and that these 'strings' could vibrate, the different vibrations conferring different properties to the string. The string theories account for gravity by including a graviton type string. String theory lost its popularity but it does simply illustrate how quarks break down to form more quarks - if a quark is stringlike, it has two ends, and so dividing a quark string gives two quark strings, each with two ends (see Figure 6).

The Higgs Boson

If this particle exists it could hold the answer to the mystery of gravity, as it may be the mediator for the gravity force, the graviton. If so it will be massive and the accelerators don't exist that can create it. However, a new hadron collider is under construction which will have that capability; unfortunately it is not scheduled to be ready for several years.

Neutrinos - Dark Matter?

The quantum world holds another mystery, a mystery that links the microscopic and macroscopic worlds. Apparently massless and chargeless, neutrinos could have the power to bring down two major theories of physics. Because they are massless and chargeless they only weakly interact with other particles and so are difficult to detect, and measurement techniques are not sensitive enough to determine whether they have zero mass or only an incredibly small mass. In the current model explaining the fundamental forces, neutrinos don't have any mass. However, cosmologists want the neutrinos to have some mass, because they are the most likely candidate for being the invisible 'dark matter' that should make up the 'missing mass' (90%) of the universe, the existence of which explains the observed movement of stars and galaxies. Perhaps in the Quantum World it can be both! Almost unbelievably there is an as yet unproven theory called neutrino oscillation which allows neutrinos to change between three different types, changing mass, as they travel through space!

Superstrings And The Ultimate Question

Although string theory did not turn out to be a 'Theory Of Everything', superstring theory nevertheless does gives rise to some incredible possibilities. Superstrings involve a fundamental characteristic called the Planck length, which combines Planck's constant, the speed of light and the universal gravitation constant of classical physics. As such it incorporates several fundamental properties into a single fundamental constant. Planck's constant defines uncertainty in the Quantum World, and as previously shown this allows a quantum of energy to come into existence as long as it only exists for a period of time less than that which makes the product of energy and time less than the Planck constant. The Planck length divided by the speed of light is known as the Planck time - if 'nothingness' is allowed to be a state in which all opposing forces, matter and anti-matter balance each other out exactly, then a quantum of energy could have come into existence from 'nothingness' in less than the Planck time, due to a random quantum fluctuation. A particle and anti-particle pair would be created. In the 'normal' world such a pair would be instantly attracted to each other and annihilate each other into energy again. But space and time would come into existence at the same instant as the particle anti-particle pair. Within the Planck time and the Planck length space and time would be expanding so rapidly that the pair would separate and have individual existences; supergravity and fundamental particles would then exist and eventually form all matter - the universe would have come into being from literally nothing! A further fascinating consequence of superstring theory is that the four dimensions of space and time that we perceive are but four of ten or possibly 26 dimensions, the others being somehow 'squashed' inside the Planck length.

A fundamental (and philosophical) dilemma thrown up by this theory is that the existence of space and time are necessary for the particle-antiparticle pair to separate and so create mass and energy. This contradicts Einstein's theory which says that the curvature of space and time, which gives rise to gravity, is a consequence of the existence of mass and energy. A chicken and cosmic egg question - which came first? Does this place the creation of the universe once again outside science?

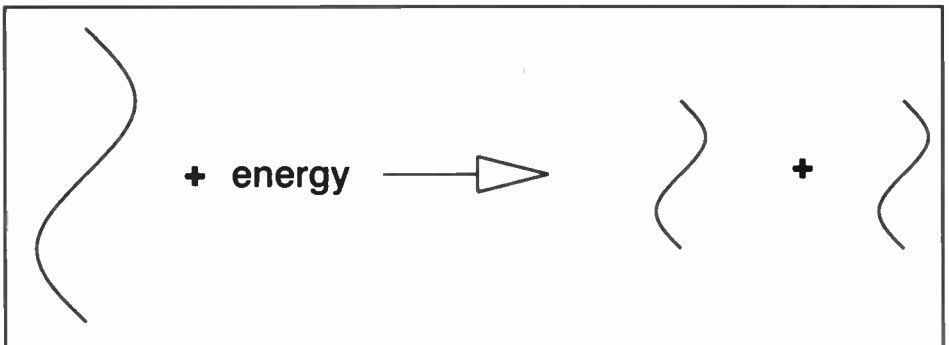


Figure 6. Quark String Quarks are never found in isolation; if enough energy is provided to split a quark, more quarks are formed. This is easily visualised in string theory; if a quark is a string entity with a vibration pattern that defines it, and it is then split, two more strings or quarks result.

Back To Reality

In the one hundred years that quantum theory has been around it has gone from a beginning as an obscure part of theoretical science to the point where it gives us the best understanding so far of the behaviour of materials and the structure of matter. The next sections of this feature look at some particularly relevant practical applications of the Quantum World - the scanning tunnelling microscope, the charge coupled device (CCD), the phenomenon of superconductivity, and a particularly spectacular device the SQUID, or Superconducting Quantum Interference Device

Scanning Tunnelling Microscope

The scanning tunnelling microscope (STM) must be the ultimate quantum instrument operating in the 'real' world at atomic level (see Figure 7).

Using the principle of quantum tunnelling where electrons can cross a barrier through probability, the STM can generate images of individual atoms on the surface of a material. An electrode scans over the material being imaged at a distance from the surface approximately equal to the distance between the atoms of the material. The electrons of the atoms then randomly tunnel either into an adjacent atom on the surface, or into an atom on the tip of the electrode, so the electrode current is proportional to the density of the electrons at the surface (the more electrons there are, the higher the probability of tunnelling). This current then easily translates into the brightness on a display which literally gives the image of the outline of the atoms at the surface of the material. The major problem of this technique is in keeping the instrument isolated from external vibrations; to this end electronic damping and positioning feedback systems are needed to keep the instrument stable. The other problem is making the electrode tip as sharp as possible since for maximum resolution it needs to consist of a single atom. This is achieved by applying a high electric field to the tip so that all but preferably one atom is stripped away. Metals, chemical and even biological molecules have been examined, but silicon is the substance most studied this way as it is of course the basic substance of most electronic devices; the fastest silicon computing devices will be those where the electron paths are the shortest, ie via the least number of atoms. A further function of this device is made possible by the application of an electric field at the tip of the electrode which strips an atom from the surface of the electrode and places it on the substrate surface. Using this technique, patterns of single atoms can be designed onto the surface of a material. The potential for electronic device design is enormous.

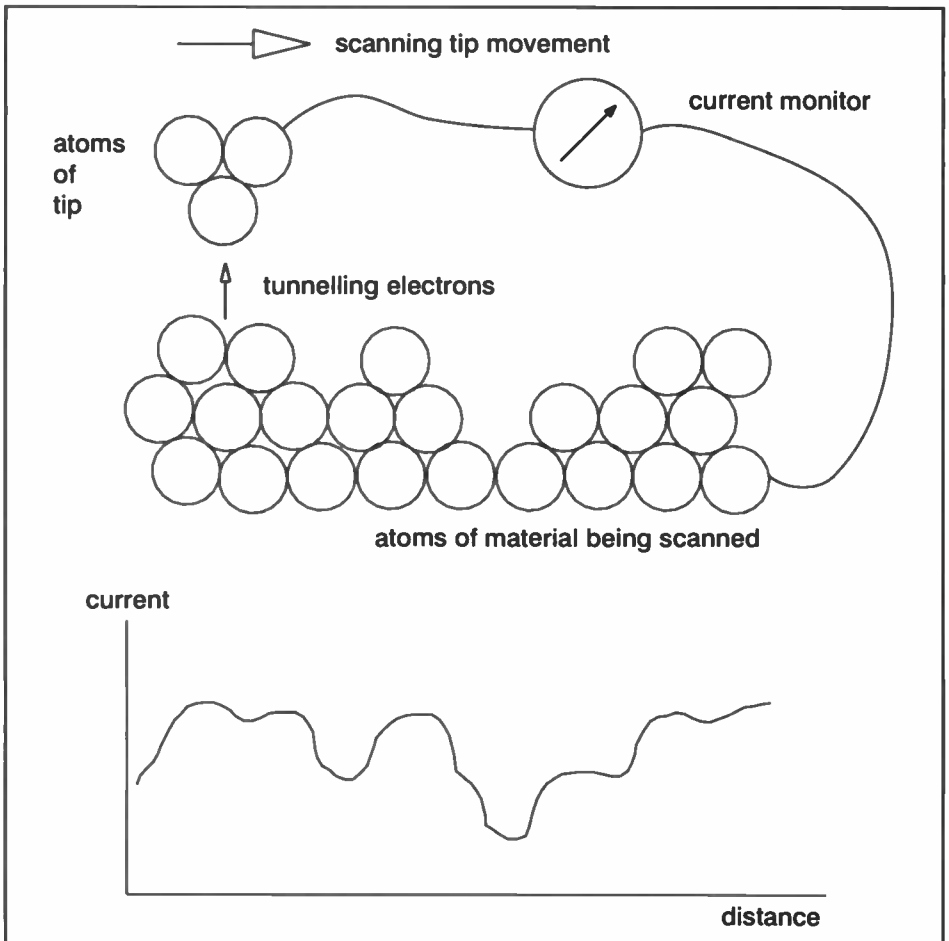


Figure 7. The Principle Of The Scanning Tunnelling Microscope The currents measured as the tip scans the material can easily be processed to give a 3D image of the surface of the material to atom level.

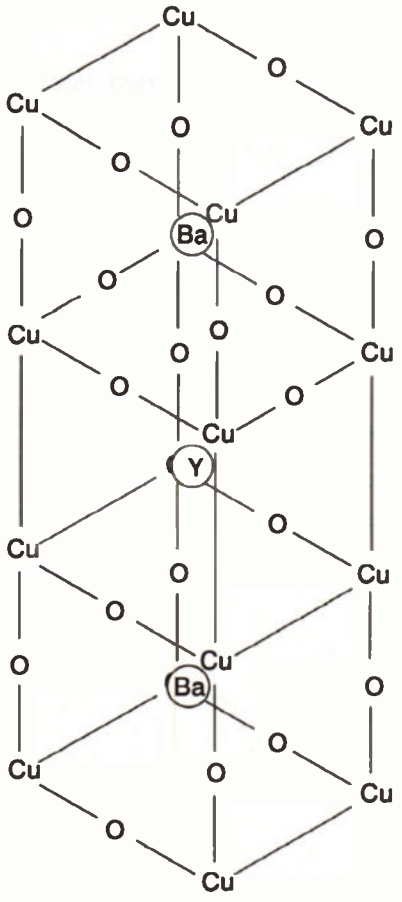
Charge Coupled Devices (CCDs)

The CCD is probably now the most widely used device in the imaging of planets and galaxies at optical and near infrared wavelengths. From humble beginnings in video cameras it is now the basis of applications ranging from barcode readers and digital cameras to the Hubble telescope. A basic CCD array costs only tens of pounds and CCD telescopes are available that are within financial reach of amateur astronomers. A CCD device is an array of cells (the Hubble space telescope CCDs are 1024 x 1024 arrays) which collect the charge of individual photons striking them. The electronics associated with the CCD scans the cells, producing a current proportional to the charge accumulated by each cell. This is easily converted into an image, which being in electronic digital format can be manipulated and analysed using computer techniques. The CCDs can be built to be particularly sensitive at different wavelength ranges of interest and have yielded, and continue to yield, many images from telescopes and spacecraft. Its effectiveness in providing an image is indicated by the fact that it is 70% efficient in its response to a photon striking it compared to the 4% of photographic film emulsion and 1% for the light sensitive cells of the human eye.

Superconductivity

Another of the consequences of the energy rules of the Quantum World is superconductivity (see Figure 8).

In normal conductors there is resistance because the free electrons collide with the atoms of the material, losing energy. In superconducting material the energy levels of the electrons and materials are such, as determined by quantum theory, that free electrons travel in channels, for example, between the non-conducting copper oxide 'layers' of Yttrium Barium Copper Oxide (YBCO). The free electrons only collide with other free electrons, exchanging and conserving momentum, ie not losing energy, so there is no resistance to electron flow i.e. current. A major disadvantage with superconducting materials is that they need to be cooled to extremely low temperatures before they exhibit superconductivity. Early superconductors needed to be cooled to the temperature of liquid helium, but modern superconductors will superconduct at the higher temperature of liquid nitrogen which is more easily (hence less expensively) produced. Even so, being crystalline they are brittle materials and their use is limited. Superconductors find their most common use in specialised applications such as Superconducting Quantum Interference Devices (SQUIDs) and the medical imaging technique of Magnetic Resonance Imaging (MRI). Superconducting materials promise great advances in many areas not least of which is yet faster computers, but already they are



Cu Copper atom

O Oxygen atom

Ba Barium atom in center of 'top' and 'bottom' cubes

Y Yttrium atom in centre of 'middle' cube

Figure 8. A Crystal Of The Superconductor Yttrium Barium Copper Oxide (YBCO)

used in the coils of powerful electromagnets in the super-synchrotrons needed for the investigations of fundamental particles.

Superconducting Quantum Interference Device

A particularly sensitive device which depends on quantum effects for its operation is the Superconducting Quantum Interference Device (SQUID). This device uses two Josephson junctions connected in parallel (see Figure 9).

A Josephson junction consists of two superconducting metals on either side of an insulating junction, and in the presence of a magnetic field electrons can tunnel through the insulator due to quantum effects. If two are connected in parallel, and in a ring configuration, the total current depends upon the magnetic flux inside the ring, and this device can detect magnetic fields many orders of magnitude smaller than the Earth's magnetic field. (As a point of interest, it is named an interference device because the quantum currents through the two junctions demonstrate interference in the same way that a light wave passing through two slits gives an interference pattern, the classic experiment used to demonstrate the wave nature of the photon.) With such a sensitivity it is used in geophysical measuring instruments, but a particularly fascinating use is in the study of the magnetic fields generated by the tiny electric currents that occur when the neurons of the brain 'fire'. This would truly make quantum physics the ultimate tool in the search for the 'Theory Of Everything' - the nature of matter, the reason for the beginning of the universe, and the mechanism of thought.

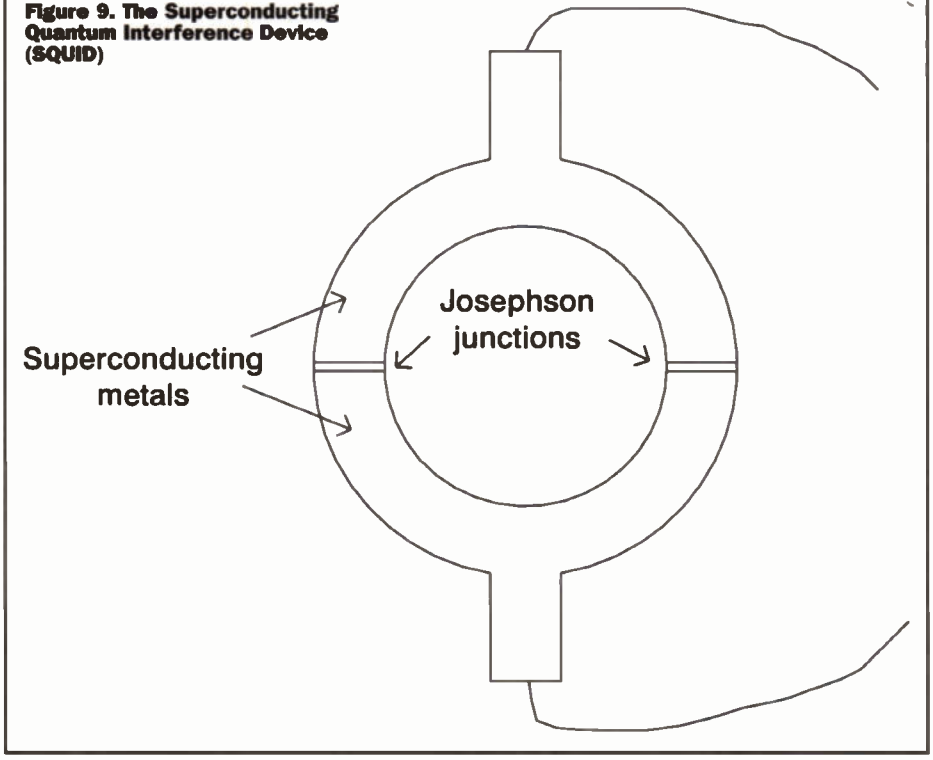


Figure 9. The Superconducting Quantum Interference Device (SQUID)

Conclusion

It appears that we are now possibly on the point of explaining literally everything that physically exists and how it came from nothing. Is there anything more, now that we think that we know everything there is to know about matter and the beginning of the universe? Perhaps for the last word we should go back to the ancient Greeks - they thought they knew for certain that the smallest particle that could exist was the atom and that there could be no such thing as 'nothingness'!

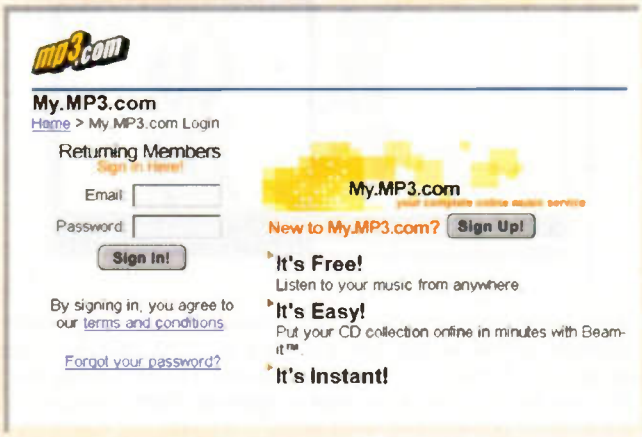
Acknowledgements

Encyclopaedia Brittanica CD ROM

5th century BC	Leucippus and his disciple Democritus originate atomic philosophy
1896	Wien's equation for black body radiation
1896	The discovery of radioactivity
1897	The discovery of the electron
1900	Planck - particles emit radiation in quanta
1905	Einstein - radiation itself is quantised
1911	The Rutherford model of the atom
1927	The wave nature of electrons is established
1930s	Field theory is accepted for all four basic forces
1932	The discovery of the neutron
1964	The quark is introduced
1970s	Supersymmetry theories
1977	The concept of quantum 'colour' is introduced
1981	The first scanning tunnelling electron microscope is built
1980s	Superstring theories
1995	The top quark is discovered
The Future	
	The Higgs particle?
	Sleptons, squarks, gluinos?
	Neutrino oscillations?

Table 3. Significant Events In The Exploration Of The Quantum World

Just Whose Music Is It?



MP3 is causing quite a stir on the Internet at the moment - in more ways than usual. The MP3 Website MP3.com (located at: **<http://www.mp3.com>**) has recently set up a service called My.MP3.com that allows music lovers around the world to access their music collection wherever they are - anywhere in the world.

The service works quite easily. You sign up with it, leaving personal details and email address, then register your own audio CDs. This works by your computer supplying each CD's unique ID code to the MP3.com database, which are thereafter registered to your name. Once done, MP3 versions of your CDs are accessible from your personal catalogue, available on-line. So, wherever you happen to be, you simply log on to the MP3.com Website and access your music. Currently MP3.com has over 40,000 CDs encoded in this way, so there's a good chance any CD you own will already be available on-line for you to access as soon as you register your ownership of your CDs. As the service becomes more popular, more and more audio CDs will be available. If this wasn't enough, best of all for the user is that the service is effectively free - it's paid for totally by on-line advertising which the user can choose to watch (or not) while listening to the music.

The major record labels, however, don't see this as being a good service. As MP3.com converts audio CDs to MP3 files, the record companies are viewing MP3.com's actions as a breach of copyright and are taking action in the courts to prevent MP3.com from continuing. The record companies perhaps, think that MP3 means the end of any effective copyright control methods, because MP3 files are so simple to encode and transmit. Yet they realise the potential too, of being able to sell MP3 files over the Internet, thereby cutting out the manufacturing and distributorship problems concerned with audio CDs.

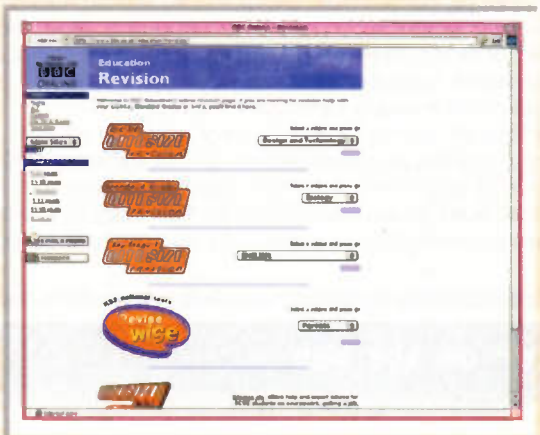
Home Alone

Schoolkids having problems with their homework can access Channel 4's new Website called Homework High - it's an interactive site that aims to answer any questions that pupils may have with their work. To this end, qualified, practising teachers will be available to answer any questions between the hours of 4pm to 5.30pm, and 6.30pm to 9pm, fours nights a week (the teachers have Friday night off).

The aim is to provide answers to questions within 24 hours during the week, even if questions are asked when teachers aren't online, and to answer something like 200 questions a night. It doesn't take long to work out that within only a short time, these questions and answers will form the basis of a huge database of homework related questions and answers for children to access. Some 10,000 questions and answers should be in the database within just a little over three months. Better than this, because it's the children themselves that ask the questions in the first place, it's a database that should provide direct and relevant information for homework problems. Homework High is at: **<http://www.homeworkhigh.com>**.

BBC Too

No look at education provision on the Internet could be complete without a look at the BBC's comprehensive educational resources on the Web, and its Revision Website, at: **<http://www.bbc.co.uk/revision>** is a great boon for schoolkids wanting help with their homework and revision. Check out also the rest of the resources offered by the Beeb - all are linked from the Revision Website.



Mac Cool

When Steve Jobs, Chief Executive Officer of Apple, announced Mac OS X in January, he also announced a new suite of Internet tools specifically for Mac users called iTools. They are all available on the Apple Website, at: **<http://www.apple.com>**, and are free for Mac users. Some of these are specifically only available to Mac users with the current latest Mac operating system (Mac OS 9). However, some Macs running earlier versions of Mac OS can access some. Mac.com is one of these. It is an email service that gives a Mac user an email account in the form username@mac.com. It's easy to use, you simply set your email program up with the Mac.com POP3 mailbox details for incoming mail, and use your existing Internet service provider's SMTP mailbox for your outgoing mail. In fact, Outlook Express users can opt for iTools to set up the program automatically with these details.

Ostensibly, the service is only available for North American Mac users, as you need to enter a North American state and Zip code to set up the account in the first place. But any state (NY, for New York, for example) and a made up Zip code (12345 works well) will get any Mac user worldwide in. Now every Mac user can have a cool Mac.com email address. But hurry, the good names are disappearing fast.

Altavista Reports Significant User Gains

Altavista at <www.altavista.com> has announced significant growth in users following the launch of its new network of Internet services in October last year.

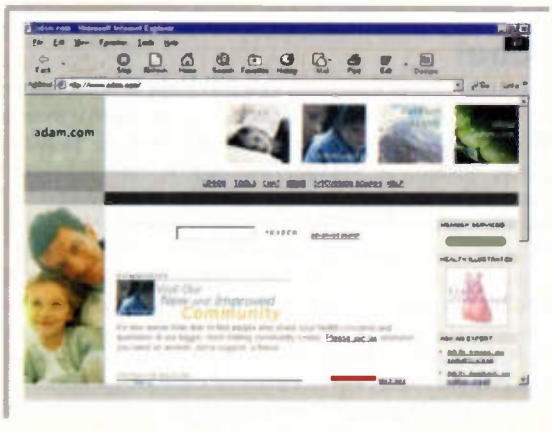
The company claims that more than eight million additional users visited the new AltaVista Network in the final quarter of 1999, bringing AltaVista's worldwide base up to 47 million unique users in December, based on the company's traffic data.

AltaVista was the second fastest growing Internet company in December, adding new users 4.5 times faster than the average for all top Internet networks, according to measurement data by Media Metrix. The industry average month-to-month growth for networks competitive with the AltaVista Network was 2.5% in December.

The AltaVista Network is designed for Web enthusiasts with services that provide relevant, useful and immediate results by unlocking the potential of the Internet's resources. Since the premiere of its new network, AltaVista now provides one of the most advanced destinations for search, shopping, and personalised information services for Internet users.

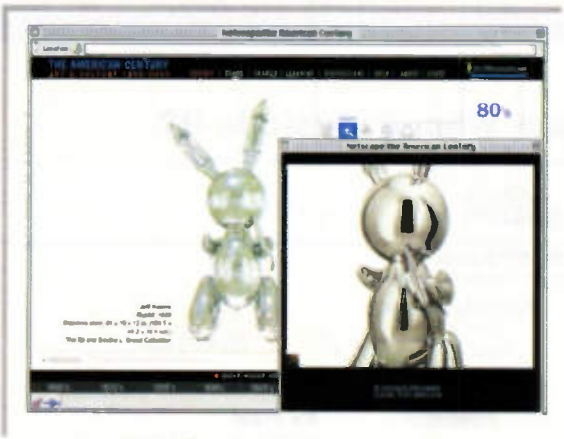
In December, AltaVista launched three new local Internet services in Europe, providing users in the UK, Germany and Sweden with search services in their native languages. In addition to homegrown country specific Web indexes, the sites also have access to AltaVista's comprehensive World Wide Web index.

Doctor on the Web



Adam.com at <www.adam.com> is an anatomical Web site that allows visitors to explore the human bodies online. Proprietary pixel-level recognition lets users point and identify more than 10,000 individual body parts, a virtual tour of lifelike anatomical layers. Precise and visually inspiring, the colourful illustrations are designed to attract and hold the attention of viewers.

21st Century Museum Has No Walls

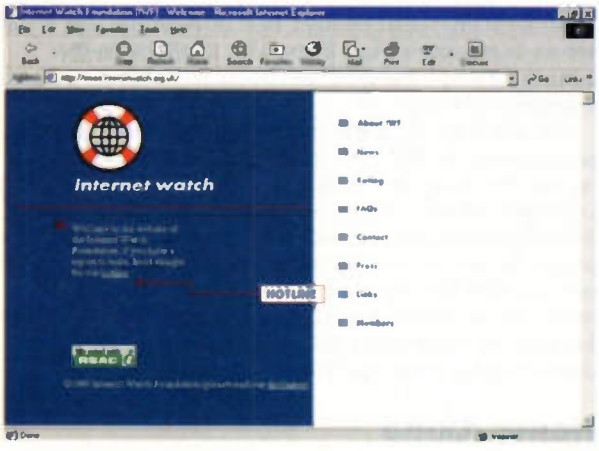


What if there where a gallery where you could see blockbuster exhibitions from world-class museums any time, from anywhere in the world? Intel has made that futuristic fantasy a reality by creating ArtMuseum.net at <www.artmuseum.com>, a unique Internet-based museum experience.

ArtMuseum.net has just launched two additional, major online art experiences. Just unveiled is a state-of-the-art 3D enhancement to the Van Gogh area that permits viewers to experience the illusion of stepping inside selected paintings and looking around in realistic, three-dimensional space.

Also, Part II of The American Century is now live on ArtMuseum.net. For Intel, the addition of these blockbuster enhancements to ArtMuseum.net is part of the company's ongoing collaboration with the world's leading museums to bring art to the Internet.

ISPs Crack Down on Hate

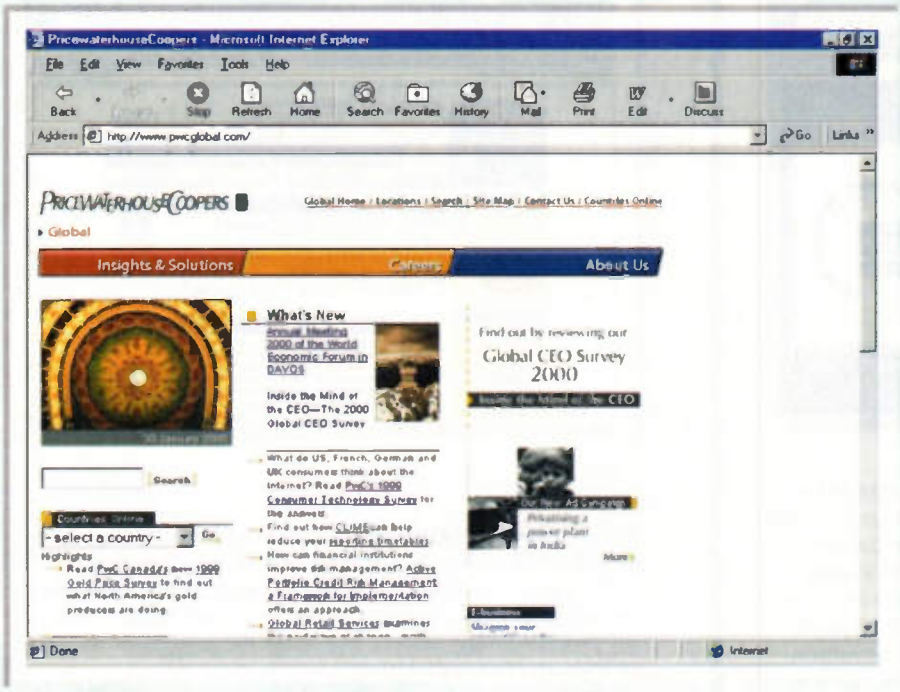


The Internet Watch Foundation (IWF) at <www.internetwatch.org.uk>, a self-regulating agency funded by UK Internet Service Providers (ISPs), has announced that it will begin rooting out illegal hate speech on the Internet.

The IWF was initially created in 1996 as part of a deal between the Internet industry and the government to battle child pornography online. The new focus on hate speech expands the agency's watchdog role, and although companies are not legally required to acquiesce to its requests, those that do will be immune from governmental prosecution.

The IWF has set up a hotline, and will investigate all complaints it receives to gauge whether the offending speech is illegal under UK law.

Internet Failures Take the Buzz Out of E-Business



Almost seven out of 10 UK businesses with an e-business offering are failing to trial their service before launch, according to research from management consultancy PricewaterhouseCoopers at **<www.pwcglobal.com>**.

Almost all are likely to have had problems and already over one fifth have suffered significant customer service disruption as a result of unforeseen additional demand or server overload.

Charles Johnson, PricewaterhouseCoopers e-business expert in the UK, said, "E-business is the buzzword of commerce and industry today. An accelerating number of businesses - brand leaders and new start-ups alike - are looking to the Internet as a means of broadening their product reach and engaging directly with customers.

"But the explosion in Internet-based services comes at a price. Whatever service is being provided - on-line shopping, ticket-booking, banking or share dealing for example - companies which don't meet expectations are in danger of losing customer trust.

Hundreds of new e-business services - not just Web sites - have been launched in the UK in 1999 - from e-banks to insurance and pension providers - and PricewaterhouseCoopers predicts that this figure is set to explode with over £60 billion worth of consumer sales over the Internet by 2003. But with market share values impacted as a direct result of Internet service disruptions, the consequences of e-business failure can be significant.

Charles Johnson added, "It needn't be this way. 'Prevention is better than cure' and by taking some simple steps to build in operational resilience and security into Internet-based services, the significant impact of failure can be avoided."

However, this message has not yet struck home, with the research showing that over half of companies currently operating Internet-services or planning them do not appreciate the need to build in operational resilience.

Charles Johnson concluded, "The most successful and enduring e-businesses minimise and prevent customer disruption before it happens. Our research shows that of those with e-businesses, 70% are committing more than 10% of total e-business investment in resilience measures. A significant outlay, but one which will pay dividends for them in the future."

To build resilience into Internet-based services and minimise the potential for 'electronic extinction,' PricewaterhouseCoopers suggests the following 10-step approach:

1. Test the service in a realistic pilot phase: in this way, customer behaviour patterns can be learnt, systems and operational processes can be more accurately scaled and the consequences of early teething troubles are contained.

2. Don't invite overload and blanket advertise a new service: instead, market the service progressively by area and region.

3. Build in contingency capacity: use a scalable server architecture and have spare bandwidth and computer processing power beyond the best-guess estimate of demand. In this way businesses are prepared for surges and accelerating growth. Additionally, build in alternative resources, for example connections through two telephone exchanges rather than one. In this way, if one connection fails, it is quick and easy to switch to another.

4. Eliminate single points of system failure, duplicate key resources: ensure that data is stored in duplicate and across storage capacity, for example through RAID technology and mirrored servers. If one storage device fails, your data is immediately available from the remaining resources.

5. Initiate an early-warning system and monitor continuously: use monitoring tools, trends analysis, risk-based forecast and pre-set stress tolerances which trigger the action to increase capacity with enough warning time to respond. It can take 30 minutes to open a 'dark' 2MB line, but more than three weeks to install the back up line in the first place. Ensure your service is scrutinised 24 hours a day seven days a week. At the same time, agree 24 hour emergency cover from your service provider.

6. Publish details of service standard, security and privacy policies: demonstrate your integrity and service standards, build customer trust in your service.

7. Have a contact for when things go wrong: make it easy for your customers to get help at any stage in their use of your service. And at the same, encourage two-way dialogue and get to know your customers even better by adding a feedback button on screen. Actively pursue data on performance and customer satisfaction.

8. Step up your recovery and back-up capability: the impact of disruptions is much more acute for an e-business than traditional business models. Recovery times need to be automatic or scaled in terms of minutes rather than hours or days.

9. Select your service provider with care: agreements with providers of hosting services and connectivity need to be in tune with your business drivers, be capable of meeting your service standards, and accommodate rapid and significant changes as your e-business takes off. Choose a major provider, even when starting out, and take the time to reach an effective agreement. The cheapest will probably not be a good choice.

10. Build equal resilience into the rest of the business: remember you are running an end-to-end service, not just the easy bit of operating a web site. You need the people, processes, operations and facilities to make sure heightened consumer expectation of instant gratification is met. There's no future in a service which can order a book at the push of a button, if it takes 30 days to deliver the wrong book to the wrong address, and charges the wrong amount twice.

Virtual Hard Drive Gets Upgrade

SwapDrive.com at <www.swapdrive.com> has upgraded its service, including a new interface, the ability to save files from any Web site directly to SwapDrive.com and what it claims to be the lowest prices on the Internet for additional storage.

The new interface, SwapDrive Light, is the company's multi-platform solution that also supports users behind corporate firewalls. For those who prefer more advanced functionality, including drag and drop file transfers, multiple file uploads and folder synchronisation.

Another new feature, SwapDrive PowerPack, is a small browser window that users can take with them everywhere they surf and quickly download photos, music, articles or any other type of file directly to their SwapDrive. It can be kept unobtrusively open and in the background and since the data is sent directly from the Web site to SwapDrive.com, it bypasses the user's local computer, making transfer speeds incredibly fast.

Netzip Classic 7.5 Released

Netzip at <www.netzip.com> has released Netzip Classic 7.5 to provide easier unzip functionality and improved help files.

The Update includes a host of new features that help users zip, unzip and download files more easily and quickly than any product on the market, and make the program a valuable addition to any user's desktop.

New features in Netzip Classic 7.5 include an Unzip Wizard, Skins, Tool Tips, an improved Self-Extract Wizard and ZIP Comments. The update also includes Netzip Download Demon, a free download management application that helps users download, install and save files.

Netzip Classic was the sixth most popular download from CNET's Download.com in 1999 and outperformed all other file compression utilities in a comparative review conducted by CNET's editorial department in October 1999.

Diamond Releases AudibleReady Upgrade for Rio Player

Diamond Multimedia Rio digital audio players will now be able to store and play back approximately 28 hours of spoken audio downloaded from audible.com thanks to a software upgrade at <www.audible.com> or from <www.diamondmm.com>. audible.com uses a proprietary encryption method to protect against piracy and fraud.

This also means Rio owners can easily access more than 20,000 hours of programming from audible.com, the leading source for Internet-delivered premium spoken audio for playback on PCs and AudibleReady mobile devices.

The Rio 500 will become the first digital audio device to play both Audible spoken word audio and MP3 music files.

Audible.com features daily, selected audio content from The Wall Street Journal, and daily digests of The New York Times, The San Jose Mercury News, The Los Angeles Times, The Economist Audio Digest, Forbes and Harvard Management Update.

The site also features a powerful collection of audio books from proven best selling authors, including Stephen King, John Grisham, Robert Ludlum, Jon Krakauer, Scott Adams, Sue Grafton, John Gray, Sidney Sheldon, James Redfield, and James Patterson.

net2gether.com Announces n2g Agent

net2gether.com at <www.net2gether.com> has announced the beta launch of n2g, the first and only free Web application that enables its users to surf together, in-sync, through the Web, and communicate with each other in real-time.

n2g takes online communication out of the one-dimensional chat rooms and instant messengers, and dynamically expands it to leverage the entire Internet. Consumers can join the public beta test of n2g by visiting the company's Web site at <www.net2gether.com>.

net2gether.com designed n2g to be a small, user-friendly download application that sits within the Web browser's window. With n2g Web surfers can synchronise their surfing with friends, colleagues, customers or anyone who shares their interests. Utilising n2g's beam-up technology, Web surfers can invite any other user into their location anywhere on the Web in an instant.

internet.com Acquires Linux Portal - JustLinux.com

internet.com at <www.internet.com>, the E-Business and Internet Technology Network, has acquired JustLinux.com at <www.justlinux.com>, a portal dedicated to Linux and open source development.

JustLinux.com will be incorporated into internet.com's newly developed Linux/Open Source Channel and will be closely integrated with LinuxStart.com, LinuxCentral.com and LinuxToday.com. The Complete Linux Guide is a one-stop resource for Linux professionals, offering a directory of Linux resources with discussion boards and daily news summaries. The portal features free Dynamic DNS, homepage redirect and e-mail forwarding services.

The acquisition is part of internet.com's continuing expansion of coverage of Linux and Open Source computing and strengthens internet.com's position in this market.

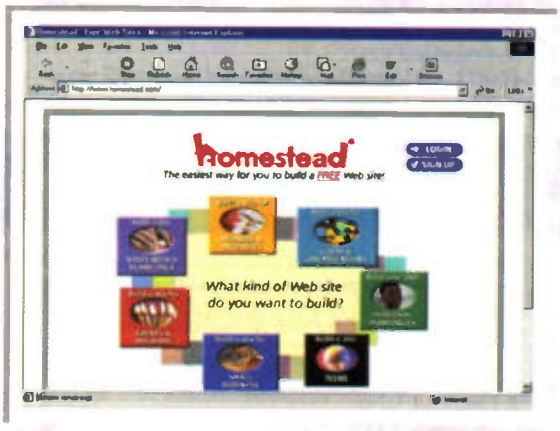
Mac AOL 5.0

AOL at <www.aol.co.uk> has shown a beta version of its next-generation software, AOL 5.0 for Macintosh. AOL 5.0 introduces new features that make AOL even more convenient and central to everyday life.

Through an innovative new Welcome Screen, AOL 5.0 for the Macintosh will provide immediate and convenient access to the service's newest and most popular features and will allow members to easily personalise their online experience.

The AOL 5.0 Welcome Screen will deliver direct access to the AOL Channel Guide, e-mail - with new e-mail signatures - top news headlines, weather, and sports.

Homestead.com and HearMe Bring Voice to Consumers



HearMe and Homestead.com, have announced a partnership through which Homestead.com will incorporate HearMe's live voice capabilities into its Web page-building services through use of the HearMe VoicePresence communication product.

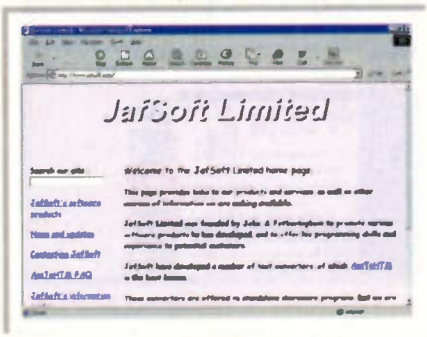
The partnership will allow the millions of consumers building Web sites through Homestead.com at <www.homestead.com> to 'drag and drop' a live voice chat Element to their Web pages, bringing live voice home for a fast-growing audience.

Through the agreement, Homestead.com will integrate HearMe VoicePresence into its suite of free Web page services - called Elements - that are customisable for clubs and organisations, small businesses, teens, special events, and personal Web pages.

Web page creators who use Homestead.com's services can now easily add VoicePresence to their Web site, providing visitors with a new and powerful reason to go to and stay on their sites.

Using VoicePresence, users can instantly talk with other people on a Web page using a computer microphone. Users without a microphone can also participate by listening in on other visitors' voice conversations and taking advantage of the product's real-time text chat capabilities.

Turn Text Files into Web Pages in Seconds



JafSoft has released AscToHTM 3.2 for Windows 95/98/NT, a program that converts plain text files (.txt) into good looking HTML Web pages in seconds.

AscToHTM converts text files using clever text-recognition algorithms that detect the document's structure. These can recognise headings, bullets, lists, indentation, URLs, tables, ASCII art and much more. The resulting HTML faithfully reflects the structure of the original document.

This easy-to-use applications turns URLs into hyperlinks and adds colour to Web pages. It also creates a hyperlinked contents list from your headings. These extra features make the software suitable for use as an authoring tool as well as a conversion tool.

At its simplest you just choose the files to be converted, press a single button and the results are displayed in your browser. For the advanced user a large number of options allow you to add a title, colours, tags and many other features. Selected options may be saved in policy files for reuse next time you run the program.

AscToHTM 3.2 costs approximately £25. A 30-day trial can be downloaded from <www.jafsoft.com/download/windows/aschtm32.zip>.

Agilent Laboratories Web Site Launched

Agilent Technologies, which until last year was the research and development arm of Hewlett-Packard has announced that its central research organisation, Agilent Laboratories, has launched a new Web site at <www.labs.agilent.com>.

Designed for academia, recruits, the media and Agilent customers and stockholders, the Web site provides information about Agilent Labs' leading research programs in areas critical to Agilent - foundation technologies, communications, measurement, health care and bioscience, and new business.

New feature articles describing the Labs' latest research are introduced monthly. The site also includes in-depth information about Agilent Labs' research organisation, its collaborations, and its past successes including patents and news archives. For individuals interested in employment, the site provides current job opening and an overview of the work environment.

RealNetworks Acquires Netzip

RealNetworks at <www.realnetworks.com> has acquired Netzip at <www.netzip.com>, a developer and provider of Internet download management and utility software. Netzip has been a pioneer and leader in developing consumer-friendly technology to improve the reliability of downloading media and software files over the Internet.

RealNetworks intends to widely distribute Netzip products to its existing base of more than 95 million unique registered RealPlayer users and more than 22 million unique registered RealJukebox users.

Bank and Electricity Single Service on Internet

The Royal Bank of Scotland at <www.rbs.co.uk> is joining with Scottish Power at <www.scottishpower.co.uk> to offer customers a single service that bundles utilities, telephone, Internet access, insurance and banking, with bills consolidated into a single monthly payment.

CMGI and @Ventures Launch Billion Dollar Technology Fund

CMGI at <www.cmgi.com> and its venture capital affiliate, @Ventures at <www.ventures.com>, have announced the launch of the @Ventures Technology Fund.

The new venture fund will focus exclusively on investing in and supporting the rapid development and growth of Internet enabling technologies and infrastructure companies that are synergistic with the CMGI and @Ventures network.

The fund will total up to $600 million in capital and is immediately available for investment in this sector of the Internet economy.

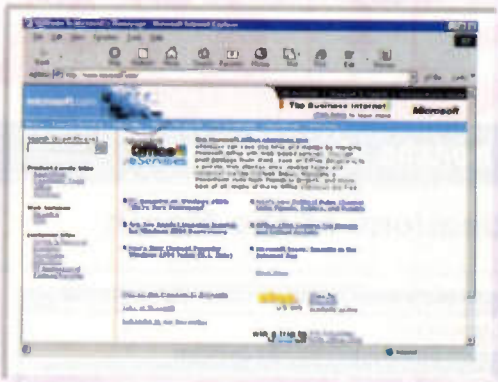
Word Shortage of Internet Domains

Internet domain-name broker GreatDomains.com at <www.greatdomains.com> says that an estimated 97% of the words in Webster's dictionary have now been registered for Internet use. Names originally registered for a $40 fee are now being resold at prices in the millions. WallStreet.com sold for $600,000, Autos.com for $1.3 million, Business.com for $4.5 million, and the asking price for America.com is $6 million.

MP3.COM Lets Users Store Music Files

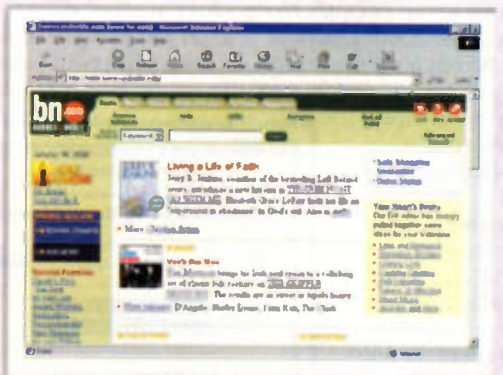
MP3.com at <www.mp3.com> has launched a service that allows users to store music online and access it from any computer connected to the Internet. MP3.com's new service will allow users to record CDs as digital files and to listen to these files on computers, and eventually on wireless Internet devices. Users will insert CDs into their CD-ROM drives, and if MP3.com has the title, an electronic copy will be added to the user's my.MP3.com account.

Microsoft Forms E-Book Venture



Microsoft at <www.microsoft.com> and Barnesandnoble.com at <www.barnesandnoble.com> have announced an alliance called the eBook Initiative that aims to move readers to a digital format. The partnership will provide thousands of online books that consumers can download onto Microsoft's new Pocket PC handhelds or PCs using Microsoft Reader e-book software.

Microsoft will begin promoting its e-book software, which translates books into a digital format, on the Barnesandnoble.com site by the middle of the year.



SuperSpeed.com Reduces Windows NT Disk Defragmentation

SuperSpeed.com at <www.superspeed.com> has enhanced its disk caching software to allow system operators to simultaneously perform disk defragmentation operations with either SuperSpeed-NT 4.3 or SuperCache-NT 4.3 enabled.

This enhancement relieves system operators from manually shutting down disk caching before performing routine defragging operations. Since disk caching continues to enhance performance, it significantly decreases the length of time disk defragmentation takes. Defragmentation may be improved by up to 15 times.

SuperSpeed-NT and SuperCache-NT are designed to work with all major Windows NT defragging tools, including Speed Disk from Symantec, PerfectDisk from Raxco and Diskeeper from Executive Software International.

Site Survey

The months destinations

Destinations of the Month

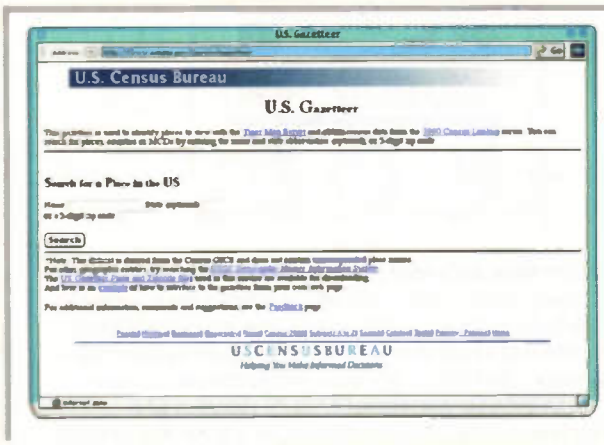
If you need a map of Outer Mongolia, or are considering trekking in the South Americas, or even just going to the Norfolk Broads for the weekend, it's always helpful if you have a map. There are quite a few resources on the Internet that can help you with maps - either real (that is, paper-based maps) or on-line.

If you want a paper map for anywhere in the world, check out Elstead Maps' Website, at: <www.elstead.co.uk/>. You can search for, locate, and order any

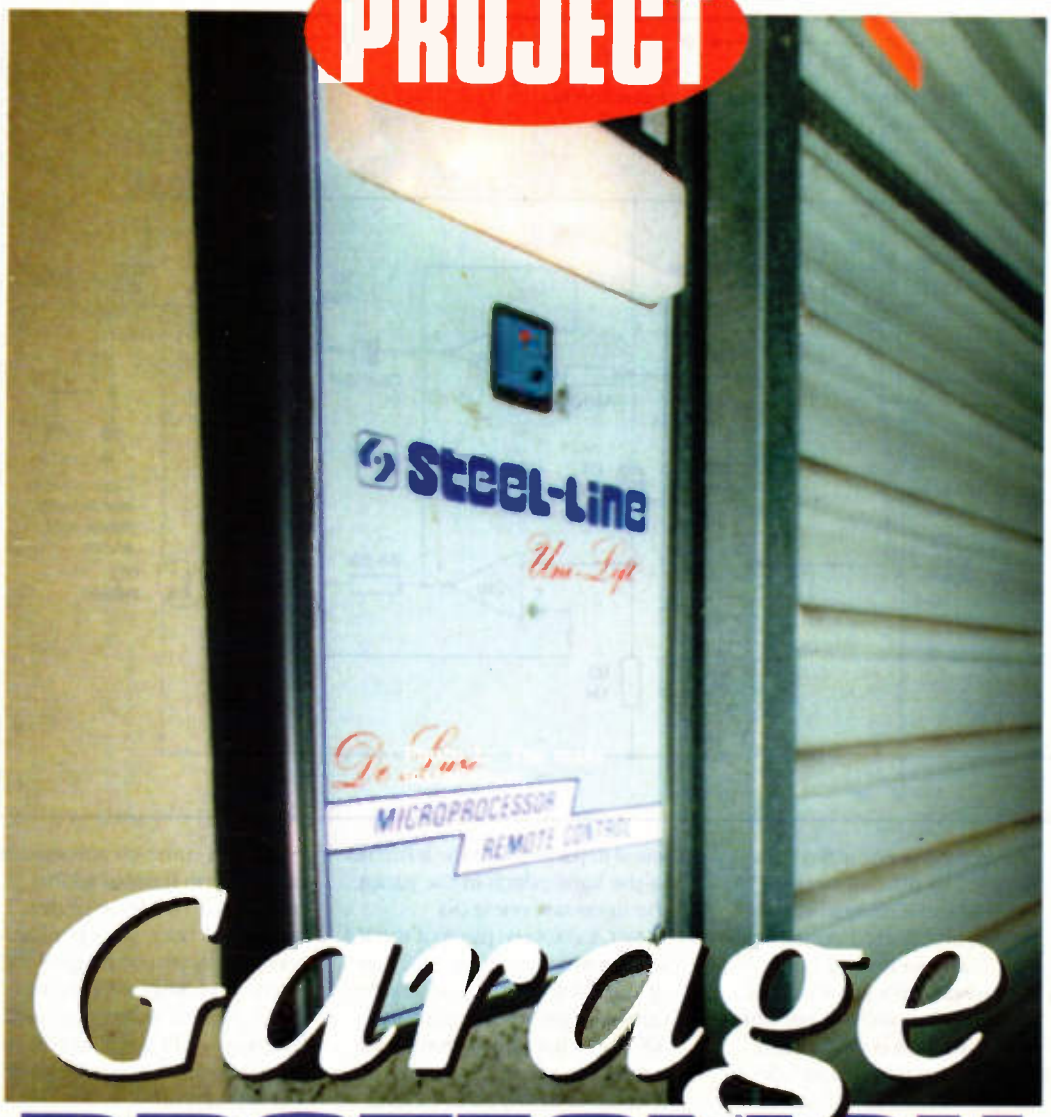
just about any map published in the world, all online.

If the UK forms the basis of your itinerary, there are a couple of Websites that can help. First, the UK Streetmap site, at: <www.streetmap.co.uk/> lets you locate a map that you can print off anywhere on mainland Britain. Searches can be by postcode or map references, or by streetname in London. Second, Yellow Pages has a Website at: <www.yell.co.uk/yp> that allows a similar search and map production for companies in the UK.

If you're heading stateside, the US Census department has a good gazetteer reference, at: <www.census.gov/cgi-bin/gazetteer>, where you can locate most towns and cities in the US, together with maps and other details.



PROJECT



Garage PROTECTION

David Ponting describes additional protection for the garage

We had just moved into our retirement house - lots of space, horses in the field next door, wonderful views. And what is more, it has a large garage, plenty of room for a work bench, and a main door electrically driven from a control box via a transmitter in the car. All very exciting and very convenient.

Then our new next-door-neighbour popped in to say Hi. "Welcome," he said, "nice house, good area. Pity about the burglaries," he added. "What burglaries?" I said.

"Oh," he said, "everyone along here has been broken into recently. Mainly the garages. Probably kids. Generally not much taken, a few cars but usually lawn mowers, tools and so on...."

So I began to look at my new house and garage in a different light. "But it's the inconvenience, isn't it?" he went on. "Getting the windows and the doors repaired, sorting out the insurance. And I'll tell you another thing. Your garage is just like mine. Have you noticed? The lighting's not very convenient. They only fitted one light switch and it's over by the pedestrian door. So when you come back in the car at night you have to stumble through a dark garage to get to the switch. Or leave your car lights on so that you can see. And then you really ought to leave the engine running for the sake of your battery. And then the garage fills up with fumes....."

"Have a beer," I said, "and tell me more." He continued "Well, there's a lot of damp you know, when it rains...."

"Well I can't do much about the damp but I can do something about the garage and the safety of its contents!"

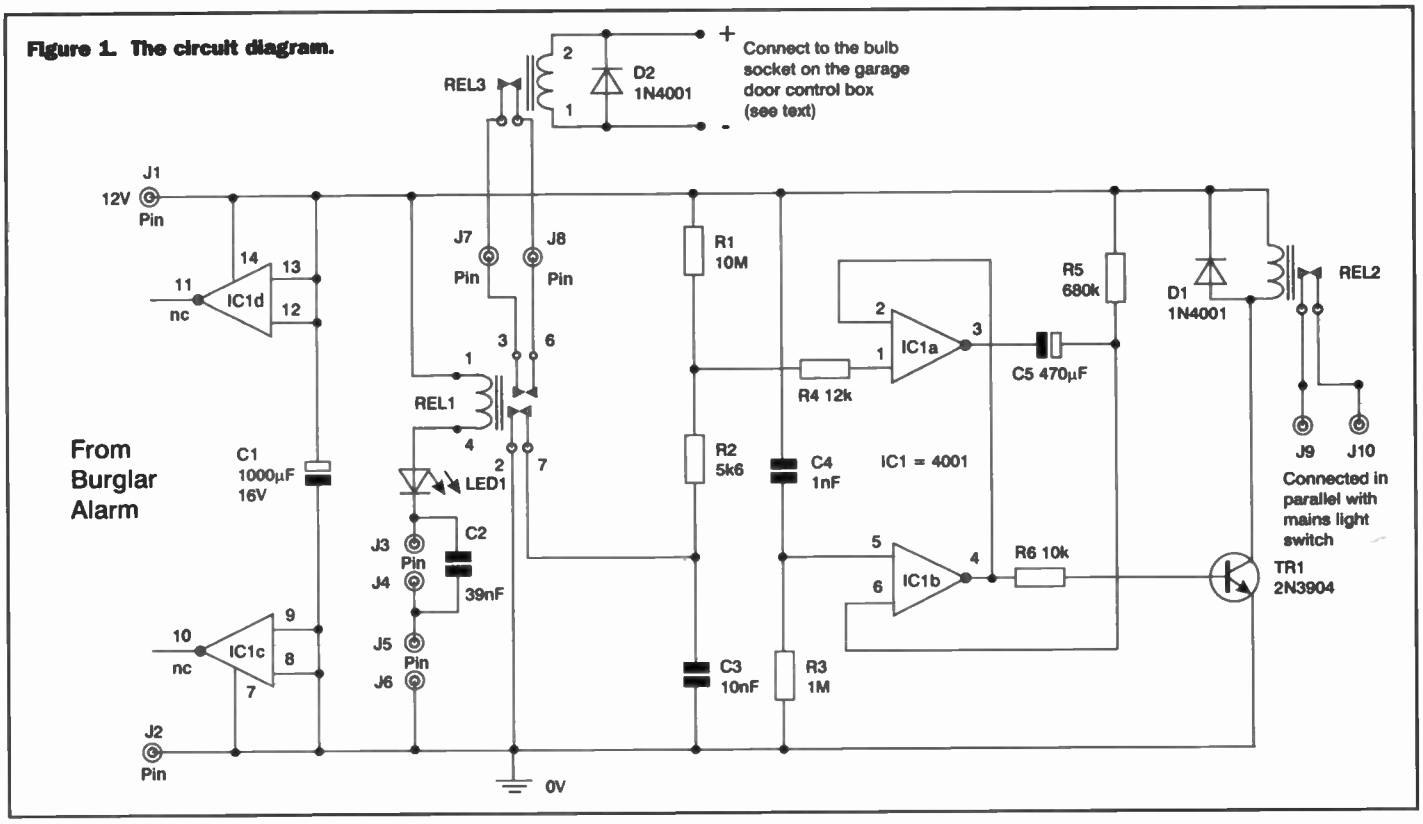
So what would be the ideal set-up? I need light when I go into the garage at night. So automatic switch-on when either the pedestrian door or the main garage door is opened would be good. That is going to deter burglars - surely lights turning on suddenly would encourage them to rush off to softer targets? Again, it would be nice - and indeed a good economy - knowing how easy it is accidentally to leave switches on, if the lights are also automatically turned off after, say, several minutes. But if I'm going to do all that, wouldn't it also be a good idea to add an alarm as well? Many alarm circuits have been published over the years. In fact I had built and fitted one in the previous house and now brought it with me to my new home. They are all fairly similar but mine is sophisticated enough to use a keypad, requiring a 4 digit number to be entered for arming and disarming the alarm.

Now, if I used that type of alarm, wouldn't I also need a keypad at both the pedestrian and the large garage door so that arming and disarming could be done at both entrances? Now it is getting slightly complicated. And would I be able to reach a keypad from the driver's seat? And how long did it take to raise and lower the main garage door and then disarm the alarm? The alarm I had built gave a delay of about 15 seconds between entering the code and then exiting the area before the siren sounded. 15 seconds was never going to be enough time to deal with opening and closing the main door and disarming the alarm. I could make the delay much longer with a couple of small component changes, but a car-less garage is a big empty place and I didn't want to give a burglar who has just broken in a long period of time to look around, check out the system and then disable the whole alarm network. There must be an easier way.

The System

First of all I fitted a magnetic reed switch to the pedestrian door. This switch is embedded in the frame and held closed when the door is shut. Then I found a convenient place on the main door of the garage to fit a micro switch with single-pole-double-throw contacts, and used the normally-open pair so that this switch was also

Figure 1. The circuit diagram.



closed when the door was down. Both these switches were positioned so that even a small movement of the door caused its switch to change state.

Then I designed and built the following simple circuit - see Figure 1.

Theory & Circuit

The 12 volt supply from the power output on the burglar alarm is joined to pins J1 and J2. The magnetic switch is wired to terminals J3 and J4, and the normally-open contacts of the micro switch are wired to J5 and J6. Consequently, when both doors are shut, Relay 1 will pull in, lighting the LED as it does so. I found that a 39nF capacitor across the contacts of the magnetic switch was necessary to avoid unreliable operation of the relay due to switch contact bounce. Curiously, the micro switch worked perfectly without a parallel capacitor.

With Relay 1 pulled in, its contacts 2 and 7 are joined. (So are contacts 3 and 6, of course, but more about them later.) Let us consider how this affects the inputs and outputs of the CMOS IC 4001. This is a package of four, 2 input NOR gates. This kind of gate is one where the output is high only when both inputs are low. For the IC 4001, pin 5 is held low via R3, pin 6 is held high via R5 and hence the output of IC1b at pin 4 is low. Consequently, the transistor TR1 is switched off and Relay 2 is not activated. Further, with Relay 1 pulled in, pin 1 of the IC is held low via R4, R2, and Relay 1 contacts 2 and 7, and with pin 2 low (because U1:B's pin 4 is low), the output at pin 3 is high which means that C5 is discharged.

There are three capacitors so far not mentioned. C3 and C4 are needed at the moment of initial switch-on: C3 very briefly holds IC1a pin 1 low before it charges, and C4 does the reverse for IC1b pin 5, holding it high before charging. The third capacitor, C1, may seem to have a very large value for such a low current circuit but I found that when a general mains power failure requires the burglar alarm's back-up battery to run the whole system, there is a significant gap in the 12V supply at switch-over. During this delay, C1 has to provide all the necessary current to hold the two relays in this circuit in their correct state of readiness.

Now, if either garage door is opened, Relay 1 will drop out, opening both sets of contacts. Then pin 1 of the IC will be pulled high via R4 and R1, resulting in the output at pin 3 going low. So C5 will start to charge via R5. Initially, with pin 3 low and C5 still uncharged, pin 6 of IC1b sees C5 as a dead short to the low of pin 3. Consequently, with both IC1b inputs low, its output at pin 4 goes high, the transistor switches on and Relay 2 pulls in. If the contacts J9 and J10 have been wired in parallel with the terminals of the light switch in the garage, the lights will come on.

As C5 charges, pin 6 of the IC will eventually see the junction of C5 and R5 as high, when the output at pin 4 will switch low. All of this happens whether the door through which you have entered is left open or closed. In fact, C5 takes around four to five minutes to charge enough to reverse the state of the output at pin 4. During that time the garage lights are on. This time delay can be varied to suit by varying the value of R5 and/or C5.

So that takes care of automatic control of the lights. Of course if you sometimes want to spend long periods of time doing work in the garage, the normal light switch will allow you to switch the lights on (but not off until the circuit has timed out) independent of this control circuit.

Having got this far, I fitted into the roof space of my garage the burglar alarm I had made for my previous house. Like most devices of this kind, the alarm is triggered when a closed control circuit of some kind is broken. It was very simple therefore to wire J7 and J8 into the normally closed detection circuit of the burglar alarm. Now opening the contacts of Relay 1 (pins 3 and 6) will trigger the burglar alarm. That solved the second problem I had set myself. Whenever a door into the garage is opened, the lights come on automatically and stay on for four to five minutes. In addition, if the alarm has been set, opening a door immediately triggers the alarm and, after a 15 second delay while a warning sounds, the alarm will go off unless the correct code has been entered on the keypad.

That left the final problem of how to set the alarm and leave it set after driving out of the garage. As I've said above, 15 seconds delay between setting the alarm, and then loading the car, opening the main door, driving out and shutting the main door, was nowhere near long enough. It would be very simple to lengthen this time to the few minutes which would be necessary to complete all these arrangements. However, that would mean that if an intruder broke into the garage, she/he would have all that time to render the alarm ineffective. What I needed was some way of delaying the full setting and resetting of the alarm system at the beginning and end of a journey but still make it trigger pretty well immediately in between. The solution was relatively simple.

When the garage door transmitter is operated to open the main door there is a tiny bulb on the interior control box which lights immediately the transmitter is operated and which stays on just about four minutes. I did some checking and found that almost all makes

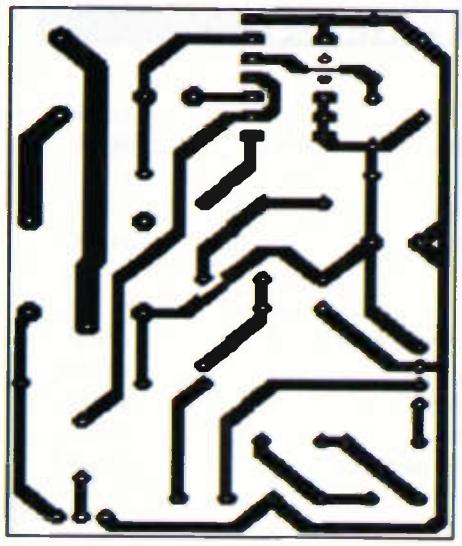


Figure2. The PCB foil.

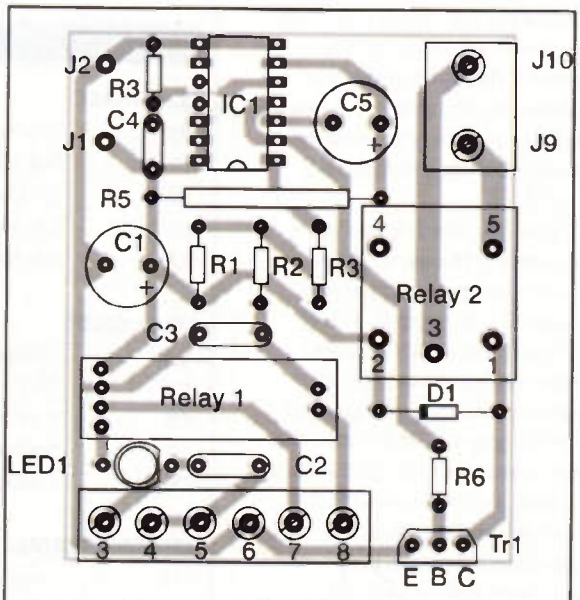
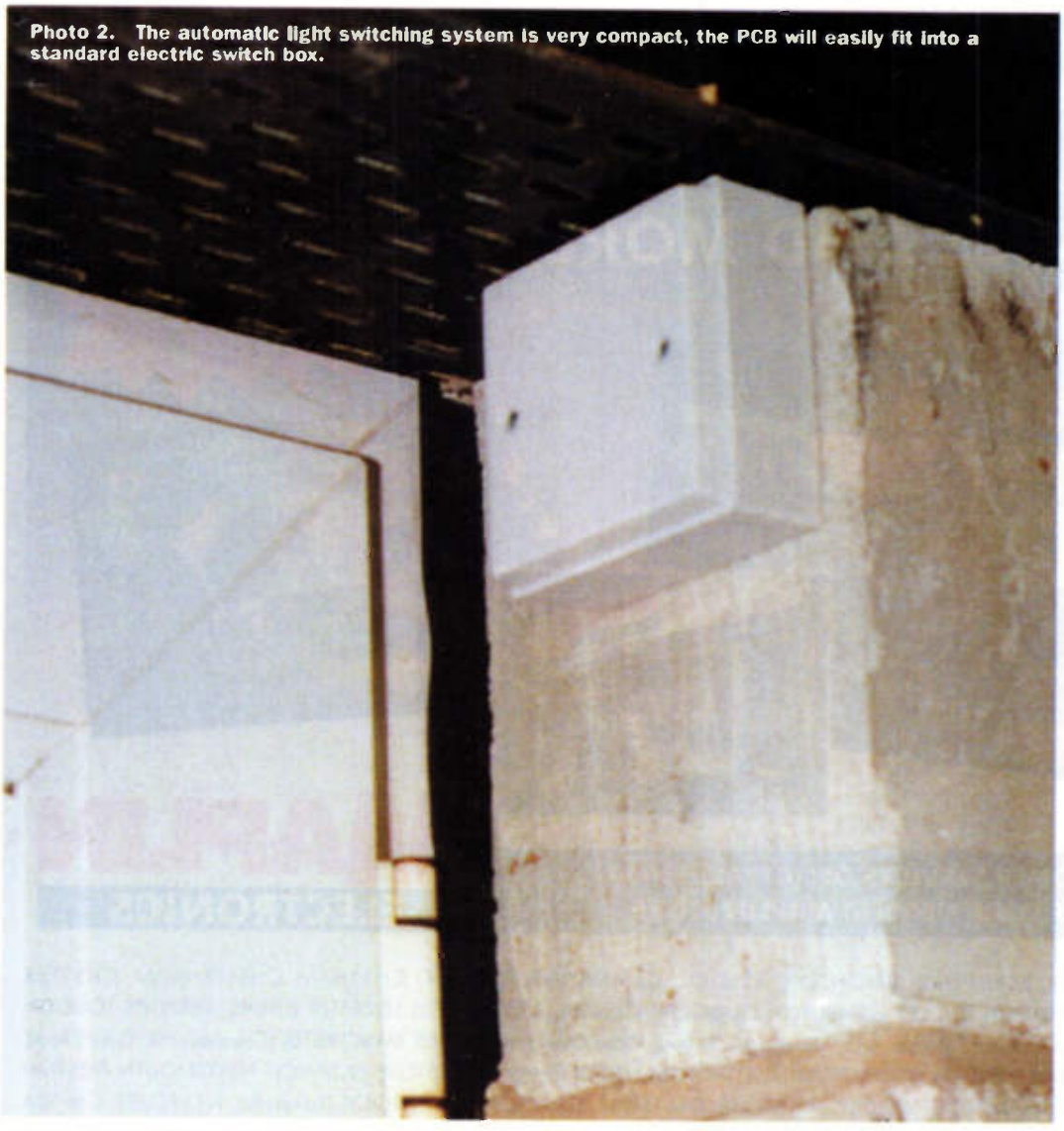


Figure 3. Component overlay.

of garage door-opening control boxes use a similar system. I was also told that the purpose of this bulb is to illuminate the garage when the transmitter is operated at night. But even the manufacturers and distributors recognised that most lights on control boxes, including mine, are so feeble as to be virtually useless for this purpose. Mine was so inadequate that I felt it must be running on a very low voltage.....I took the bulb out and had a look at it. It was stamped 3W, 12V. I checked the bulb's socket and sure enough the supply was 12 volts DC. The socket was quite standard and so it was a simple matter to use this 12V supply to operate a tiny reed relay. I had no idea how the control box circuit was designed to switch this light so, taking no chances, I shorted the coil of the reed relay with a diode (cathode to positive supply). This is done to ensure that any back electro-motive force, created when an inductor such as a relay coil is switched off, is safely bypassed to the supply rails and does not damage the switching transistor - if that method really is being used. The normally open contacts of this reed relay I then wired to J7 and J8 as well, so that this relay's switch was in parallel with contacts 3 and 6 of Relay 1.

Now it might seem that all this does is duplicate the function of the micro switch at the bottom of the main garage door but this is not really so. Effectively, opening the garage door and hence its micro switch merely makes Relay 1 drop out and so switch on the lights. But when the transmitter is used to open the main garage door, the reed relay now driven by 12V from the control box, rapidly closes its contacts (which including bounce time it does in a maximum of a millisecond) some time before the opening of the micro switch contacts on the door. In other words, when the reed relay driven by the control box is closed, the alarm is not triggered since the alarm does not see that any circuit has been broken.

Photo 2. The automatic light switching system is very compact, the PCB will easily fit into a standard electric switch box.



The Procedure

So the procedure at the start of a car journey is to enter the garage, at which time the lights will come on. Shut the door. Set the alarm; the 15 second timer will time out. Now you have about 4 minutes to get yourself organised and load the car, even with the garage door open if you wish, but providing you have opened it with the in-car transmitter. When ready, drive out of the garage and use the transmitter to close the main door. All the time this door was open, the alarm was not triggered because the triggering circuit was closed via the reed relay in the control box. Four minutes into your journey and the little light on the control box would have gone out. But now it's the replacement reed relay which drops out, still without triggering the alarm because the main door is closed, and with it, its micro switch.

However, if a burglar forces any door while you are away there will be no trigger delay. The alarm will activate and 15 seconds later the full siren

output will sound. No way is this long enough to completely disable the system even for an expert.

On your return, the main door is opened by the in-car transmitter and fractionally before the door starts to move, the output from the little light circuit in the control box will close the reed relay. So as the door rises, the micro switch will open but without triggering the alarm. However, the lights will come on, so you now have four minutes or so to get yourself out of the car and close the main door. If during this time you can even get yourself completely clear of the garage via either door, the alarm will still not be triggered but will remain set. If you spend longer than four minutes dealing with the car, going out through either door will trigger the alarm and you then have 15 seconds to enter your 4 digit code to disarm it. Entering your code again will of course reset the alarm.

Construction

Building this circuit should present no problems. All the components are readily available and strip circuit board can be used for mounting them if that is what you prefer. Alternatively, a printed circuit board can be made using the patterns shown in Figures 2 and 3.

Just one word of caution is necessary. The garage light switch will be switching live mains if it is correctly wired. Consequently all the proper precautions should be taken when connecting the printed circuit board from J9 and J10 to the contacts of the light switch. Consequently the new PCB should not be connected to any external circuit before it has been fully tested and checked to be functioning properly. Then, before making the final connections, do make absolutely sure that the mains to the garage lighting circuit has been switched off and check that this is so with a meter or neon screw-driver.

The burglar alarm system I have described above has been fitted and operational for over 2 weeks now. No burglaries so far, I'm glad to say.

PARTS LIST

RESISTORS:

R1	10M Min Res	M10M
R2	5k6 Min Res	M5K6
R3	1M Min Res	M1M
R4	12k Min Res	M12K
R5	68k Min Res	M68K

CONDUCTORS

C1	1000µF, 16V GenElect	AT44X
C2	39nF Poly Layer	WW36P
C3	10nF Monores	RA44X
C4	1nF Monores	RA39N
C5	470µF, 16V GenElect	AT43W

SEMICONDUCTORS

LED	As preferred	
D1, D2	1N4001	QL73Q
IC1	4001B	QX01B
TR1	2N3904 (or similar)	QR40T

MISCELLANEOUS

Relay 1	12V, 2-pole, normally open	JH16S
Relay 2	12V, 1-pole, normally open, 240V ac 2A	SD95D
Relay 3	12V, miniature reed,- 1-pole, normally open	JH13P
	Magnetic reed door switch (2 parts - magnet and switch)	
	Micro switch	
	Pins, connectors, plastic box, 4-core cable, etc.	

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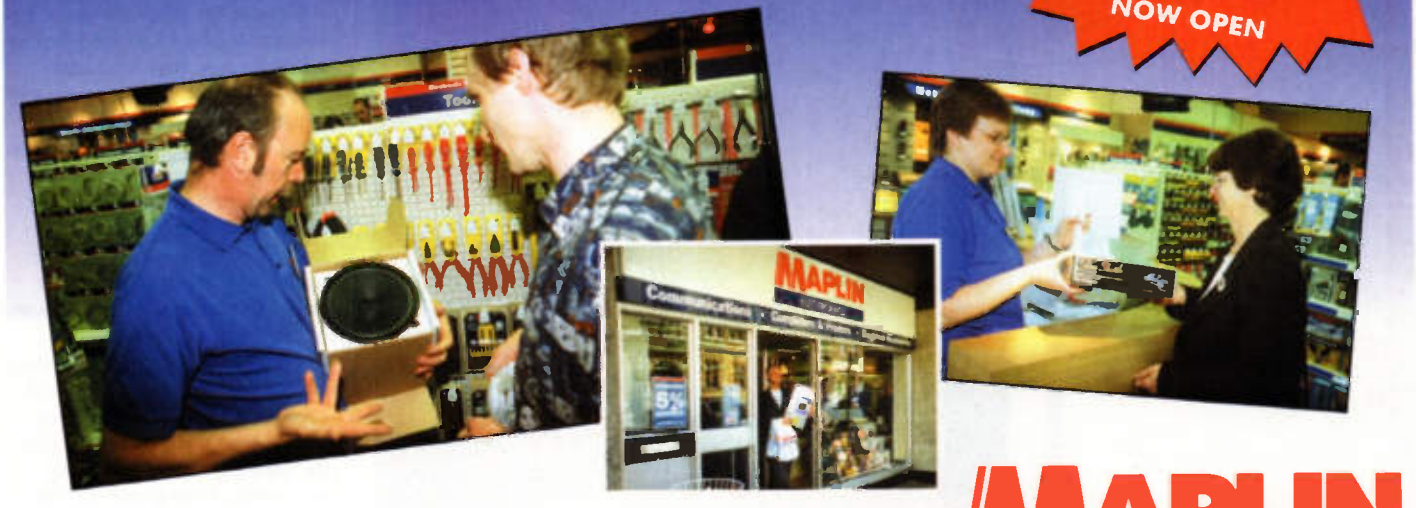

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PROJECT

A Hardware MP3 PLAYER

PART 2

Martin Pipe continues the construction of a standalone PC based MP3 player.

Software

Key to the system's operation is the menu-driven boot system, which has been implemented through a modified MSDOS.SYS, and CONFIG.SYS/AUTOEXEC.BAT. There are two menu options - 'MP3' and Windows. The MP3 option is automatically selected if the Windows option isn't selected from a keyboard within a user-definable period (10 seconds, in the prototype). I started with a clean formatted hard drive for this project. Windows '98 was then installed, although identical comments will apply to Windows '95, should that be the GUI of your preference. The next stage is to modify MSDOS.SYS so that the Windows GUI doesn't load at boot-up. In other words, it stops at the command prompt - and its at this point that the boot menu will appear when the completed system is in operation. To change the file, press down the 'F8' key at boot-up to display the Windows start-up options menu. Select the 'command prompt' item, and wait for the C:\ prompt to appear. Type DIR MSDOS.SYS and you won't see anything. This is because MSDOS.SYS is a hidden read-only system file. To edit it, you'll need to change the file's attributes:

```
attrib -r -h -s msdos.sys
```

The file should now appear when you type DIR. Now it's time to make the changes:

```
edit msdos.sys
```

The contents file will now appear in the MS-DOS editor. Look for an entry that says

```
bootgui=1
```

and change it to read

```
bootgui=0
```

Add the following line underneath:

```
Logo=0
```

Save the file, exit the editor and revert the characteristics of MSDOS.SYS as follows:

```
attrib +r +h +s msdos.sys
```

Reset the machine, and you'll find that when the machine has finished booting, you'll end up with a DOS-style command prompt.

Now it's time to create the startup files:

Here's config.sys

```
[menu]
menuitem=MP3, MP3 DOS Mode
menuitem=W98, Windows 98 Mode (Bypass DOS Drivers)
menudefault=MP3,10
menucolor=15,0

[MP3]
files=60
buffers=20
stacks=18,256
dos=high,umb
DEVICE=C:\CDPRO\VIDE-CDD.SYS /D:MSCD001

[W98]
[common]
device=C:\WINDOWS\COMMAND\display.sys
con=(ega,,1)
Country=044,850,C:\WINDOWS\COMMAND\country.sys
```

The CD-ROM device driver (line 11) should specify the name and location of the MS-DOS driver supplied with your drive. The number at the end of the 'menudefault' option (line 4) specifies how long the system waits for manual input (10 seconds) before automatically entering the default mode (MP3). It's easy to specify a different period.

Here's autoexec.bat

```
mode con codepage prepare=((850) C:\WINDOWS\COMMAND\ega.cpi)
mode con codepage select=850
keyb uk,,C:\WINDOWS\COMMAND\keyboard.sys

@echo off

goto %config%

:W98
cls
echo Type WIN to start Windows 98
goto end

:MP3
MSCDEX /D:MSCD001 /V
C:\SNDAPP\CMINIT /WA:530 /WI:9 /WM:0 /VA:220 /VI:5 /VL:1 /VH:5 /MD /MA:330 /MI:9 /GS:200 /FM:388
SET BLASTER=A220 I5 D1 H5 T4
C:\SNDAPP\CMMIX/MFF000 /F00000 /WFF000 /L000EE /E000EE /A000EE /D00100 /C00170 /300000 /O00000 /S10200
cls
c:\damp.exe d:\*.mp3 -lcd -q 0 -noscope

:end
```

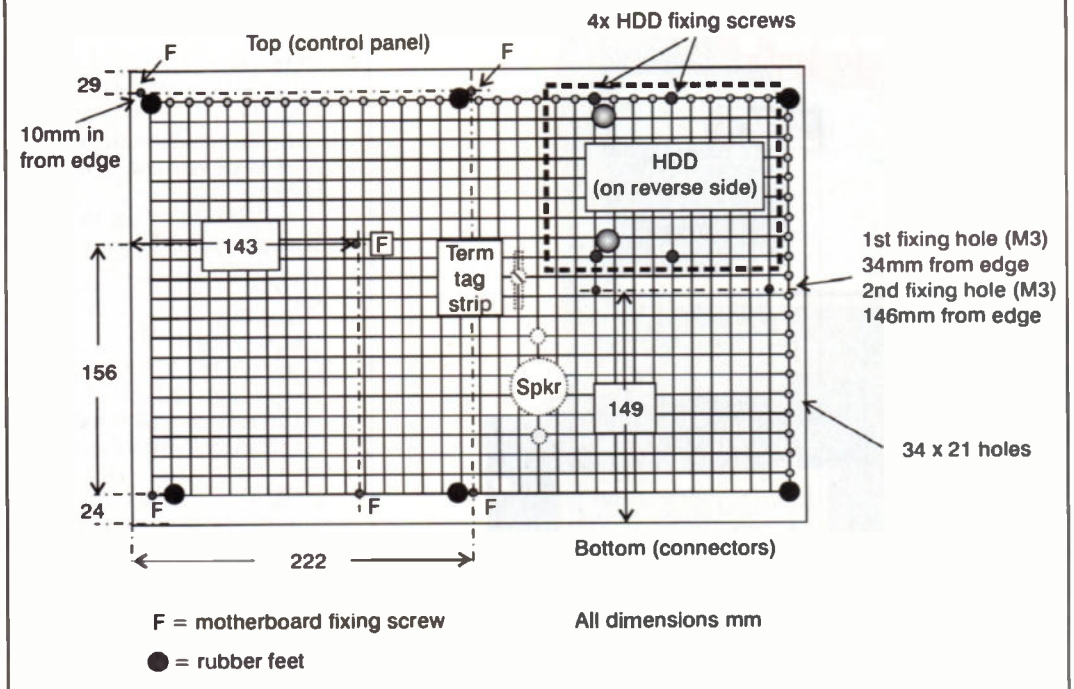


Figure 5. Drilling details for base. To make matters easier, there's a matrix of holes already punched into the metalwork, and these have been used wherever possible. In the prototype, the standard 'baby-AT' sized motherboard is held in position at six points (marked F). The same points should apply to other motherboards. If you're using an ATX motherboard, different arrangements will apply. In particular, a slot for the motherboard's 'outside world' connectors (serial, USB, keyboard, etc) would have to be cut into the rear panel.

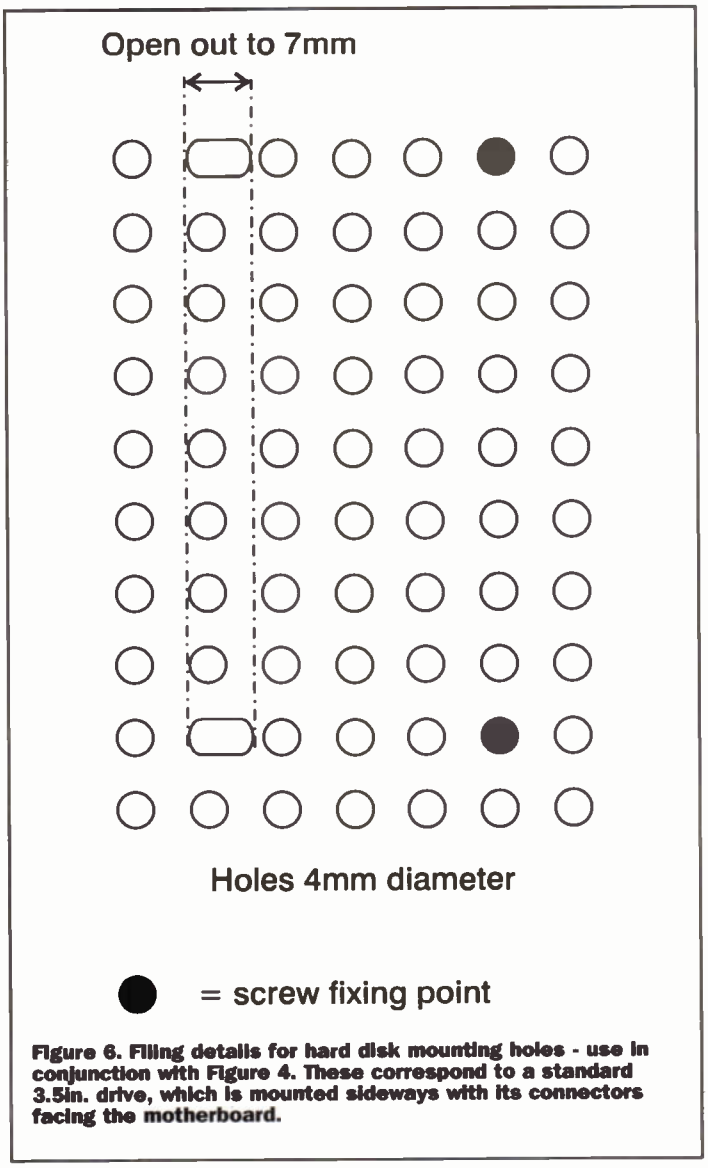
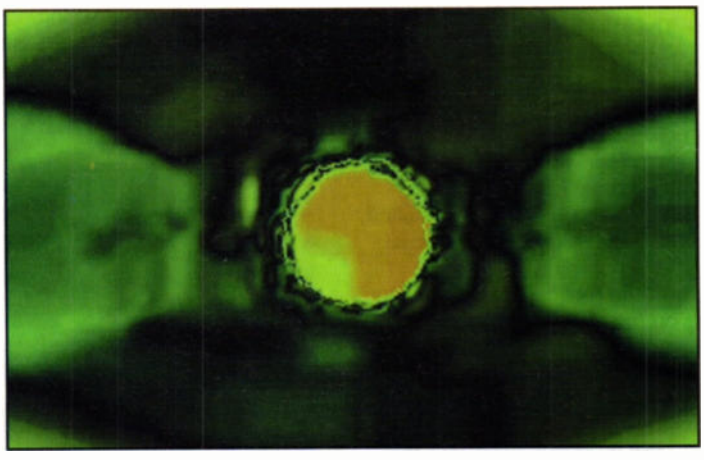


Figure 6. Filing details for hard disk mounting holes - use in conjunction with Figure 4. These correspond to a standard 3.5in. drive, which is mounted sideways with its connectors facing the motherboard.

Lines 12 to 14 (C: SNDAPP...) are the drivers for the M5?1's internal sound hardware. They should be replaced with the DOS drivers specific to your particular soundcard. Line 16 loads up the DOS MP3 player, which starts playing all of the MP3 files stored on the CD-ROM. In this case, the MP3 player (DAMP) is located in the root directory, as is the LCD driver (lcdwire3.sc). The LCD option is enabled by the '-lcd' switch. The -q 0 -noscope option turns off all of DAMP's pretty visualisation options (discussed shortly), in order to deliver the best sound quality.

DAMP is an excellent freeware program from Hedgehog Software, which can be downloaded from its homepage (http://www.damp-mp3.co.uk/). LCD drivers also reside there, as well as beta programs with support for the keypad. Before you can run DAMP, you also need a copy of CWSDPMI.EXE in the same directory. Fortunately, this program is available from the DAMP web site. CWSDPMI.EXE is designed to safely provide MS-DOS with Windows-style protected-mode services, such as the ability to access extended memory. Quite important, seeing that software-based MPEG decoding is rather memory-intensive! DAMP is highly configurable - an editable start-up file (damp.ini) allows for many parameters to be tweaked. You can specify input and control devices (joystick, and keypad eventually) and make tweaks for the best sound quality. Not all soundcards are supported, though - as we mentioned earlier the card must, for best results, be 100% Soundblaster 16-compatible. The latest Soundblaster Live, for example, won't work.

DAMP has an intriguing mode that produces pretty graphics in time with the music. Hook up one of these units via a VGA scan converter to your computer, as well as your hi-fi system, and you've got quite an effective audiovisual music source for parties and the like! The program will read MPEG Layer 2 (mp2) files as well as MP3 ones. MP2 files are generated in real-time by the excellent RecordIt program for Windows 9x (downloadable from www.iomega.com). In this sense, RecordIt turns your PC into a high-capacity hard-disk digital audio recorder. It will record from a specified source



Groovy baby! Some of the psychedelic sound-to-light patterns produced on-screen by Damp in its graphical output mode.

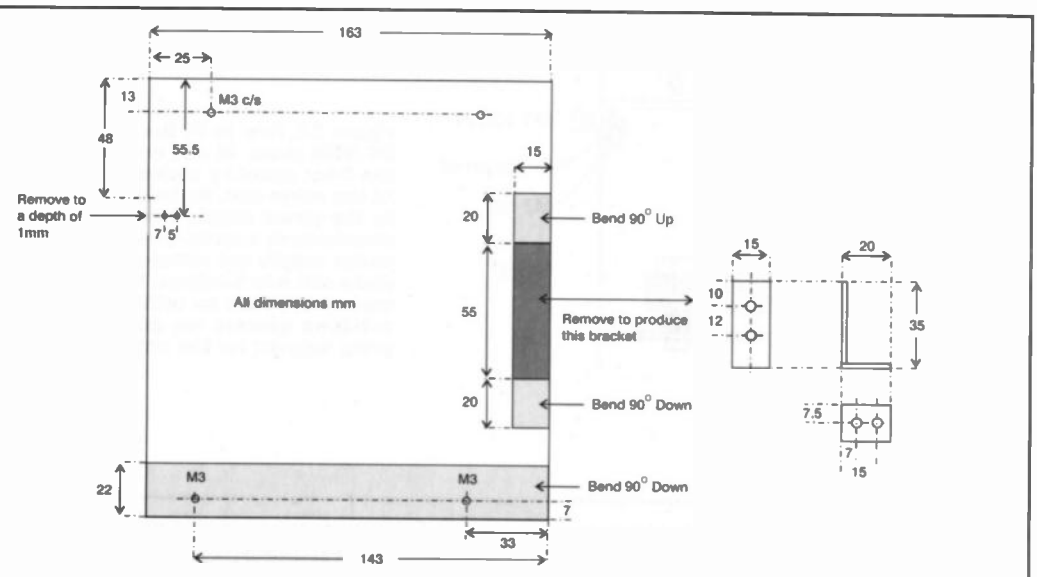


Figure 7. How to prepare the aluminium plate. This is used as an internal mounting platform for the CD-ROM drive. A section of the plate is removed, bent through 90 degrees and drilled as shown - this is a bracket that hold the drive in position.

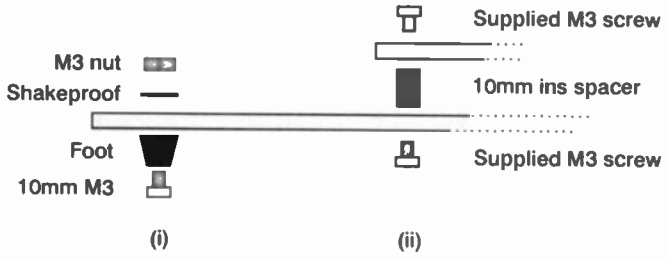


Figure 8. How to fit the feet (FW19V) and 10mm motherboard spacers (FS36P).

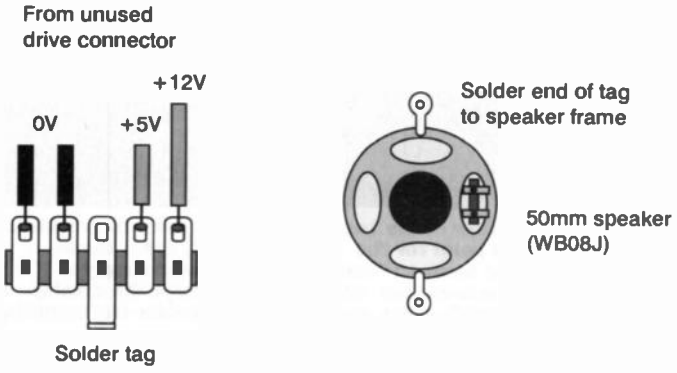


Figure 9. M3 tags are soldered to the frame of the speaker (used by the motherboard as a status 'beeper') as shown. The tags can be secured to the chassis base using a pair of 10mm M3 screws, shakeproof washers and nuts. Similar hardware is used to secure a 5-way tagboard (FM34M). The four outer tags will provide convenient access to 0V, 5V and 12V power supply rails, for the amplifier and display. One of the power supply's unused drive connectors is cut off, and the wires soldered to the tagboard.

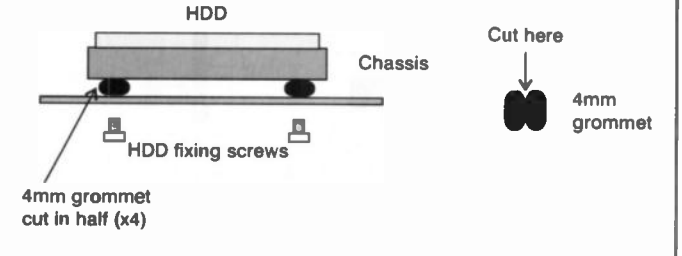
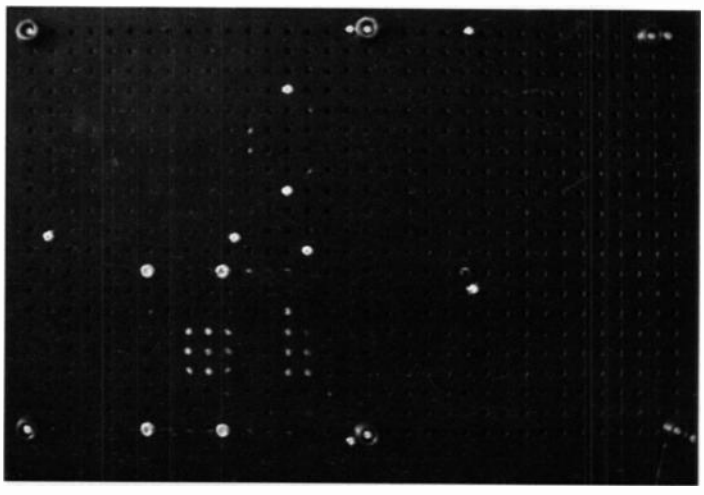


Figure 10. To provide a limited amount of shock resistance, the hard disk is separated from the chassis using 4mm grommets (JX64U) cut in half. They're held in position by the mounting screws, as shown.

connected to your soundcard (microphone or digital/ analogue line input). I myself use Recordit for archiving concerts and comedy programmes from the radio. The second quality ('three stars') option of 192kbps results in recordings that are indistinguishable from the original source. Unfortunately, DAMP doesn't recognise the .mp2 extension. The files can be played back, but only if they're renamed to .mp3! MP2 files could be recompressed to MP3 - various programs, including the Windows-based Cool Edit 2000 shareware (www.syntrillium.com), support this. Unfortunately, the process is very time consuming.

A shareware player program, MPxPlay, resides at www.members.tripod.com/~padara/ This program is happy with mp2 extensions (indeed, you can specify something like 'mpxplay *.mp*' in your startup file if you want it to play a mixture of .MP2 and .MP3 files). MPxPlay is also capable of graphical output, in the form of a spectrum analyser display. Another neat feature is the ability to customise the PC keyboard layout for different playback functions, such as next/previous track selection. Basically, it's a matter of modifying the mpxplay.ini file to specify the keys that you would prefer. A file supplied in the package, keycodes.lst, contains a table of the required hexadecimal keyboard codes. MPxPlay's most significant advantage over DAMP, however, is its ability to produce considerably higher audio output levels - DAMP's developer, Matt Craven, is aware of the relative quietness of his software, which requires you to turn up the volume. DAMP's low-ish audio output is apparently down to the way in which Allegro (the library Matt uses for sound output) mixes the audio. MPxPlay uses a different library that doesn't have these limitations, and so the audio levels take full advantage of the soundcard's potential dynamic range - in this respect, the program is comparable to the industry-standard Windows-based Winamp which also has a spectrum analyser display.

If you want MPxPlay to work with LCDs and keypads, though, you need a front-end shareware program known as MPXF (http://mpxf.mp3car.com/). No fully-functional drivers currently exist for the 2-line, 16-character 4-bit interfaced LCD configuration used in this



The M3PO can be remotely operated from an infra-red handset. This image does look suspiciously like a drawing made on computer, though.

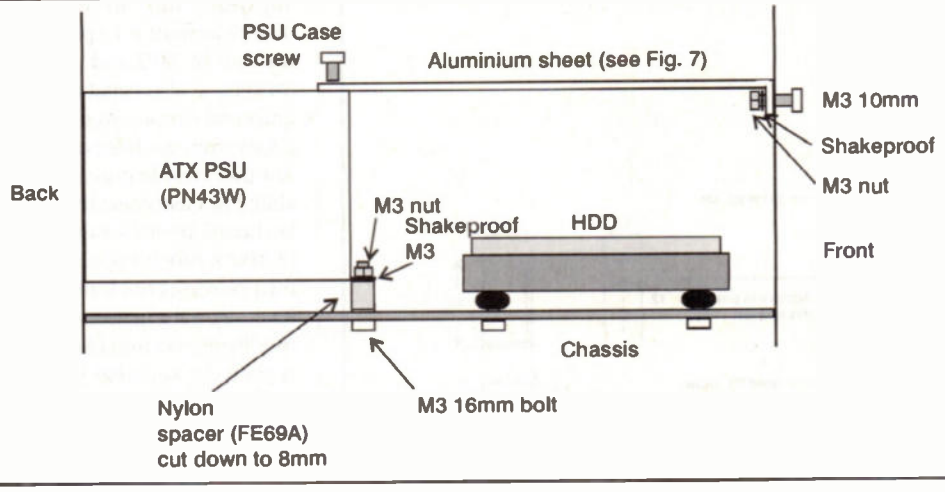


Figure 11. How to fit the aluminium CD-ROM plate. At one end, its held to the front panel by 10mm M3 screws. At the other end, its held in position by the power supply. Here, the two countersunk screws on top of the power supply are removed, and the plate slid into position. The two screws can then be refitted. Note how cut-down spacers are used to provide extra support for the power supply.

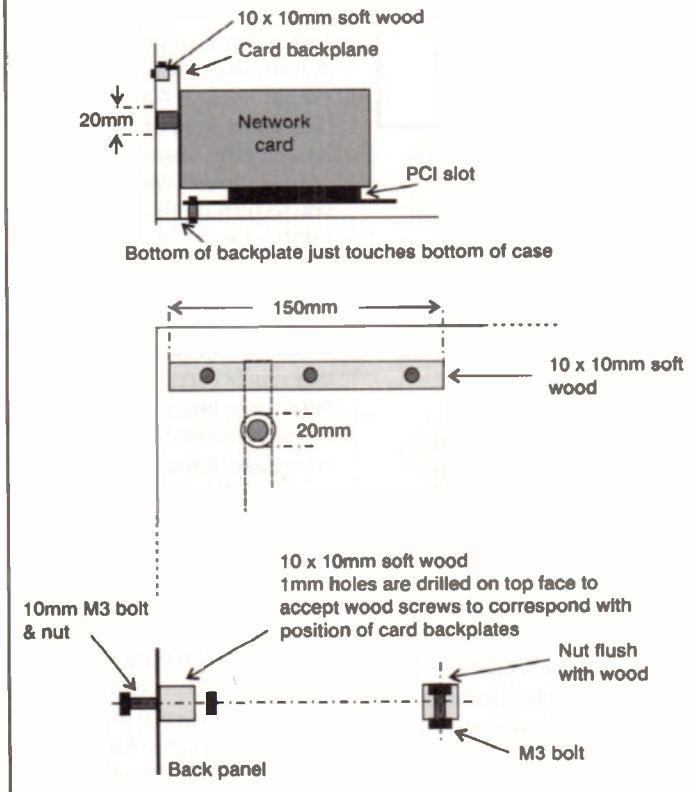
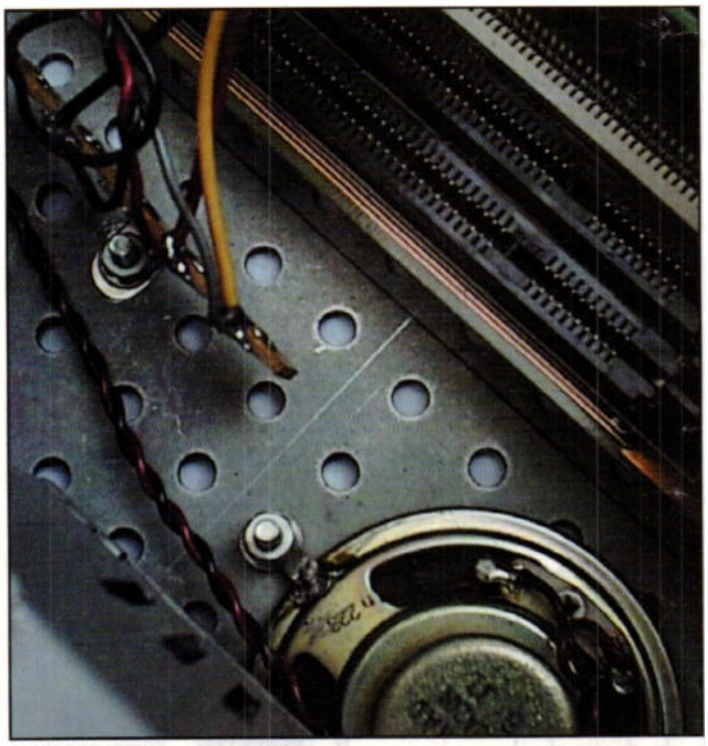
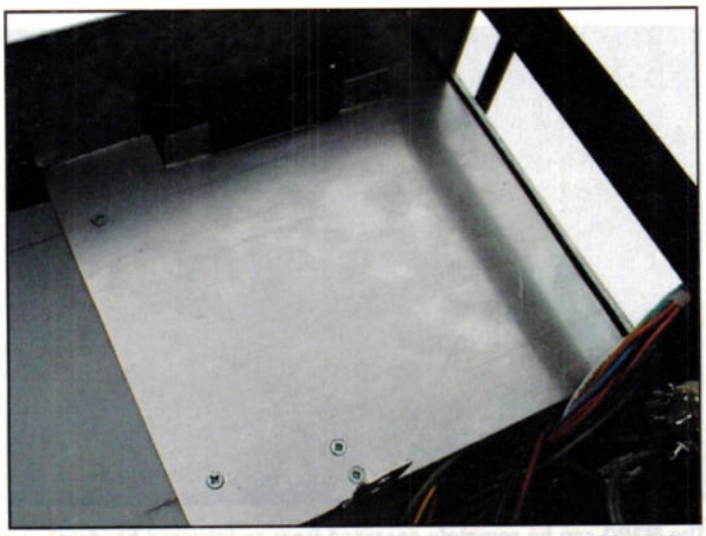


Figure 12. Details of card mounting, showing position of wooden dowelling used to secure any expansion cards (sound/network, etc.)



Here's a close-up view of the tag-strip, which is used to provide a convenient access point for the +5/+12V supply rails. These voltages, which are sourced from one of the power supply's unused disk drive connectors, are needed to power the display and headphone amplifier. The speaker, and its solder-tag mounting arrangement, can also be seen.



An aluminium plate provides support for the prototype's CD-ROM drive. This plate, which can be seen here, is fitted between the power supply and the front panel.

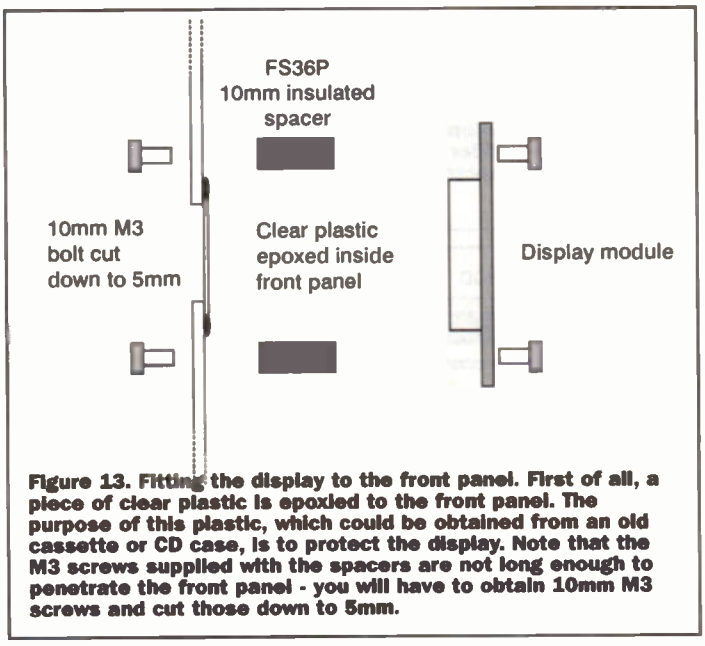
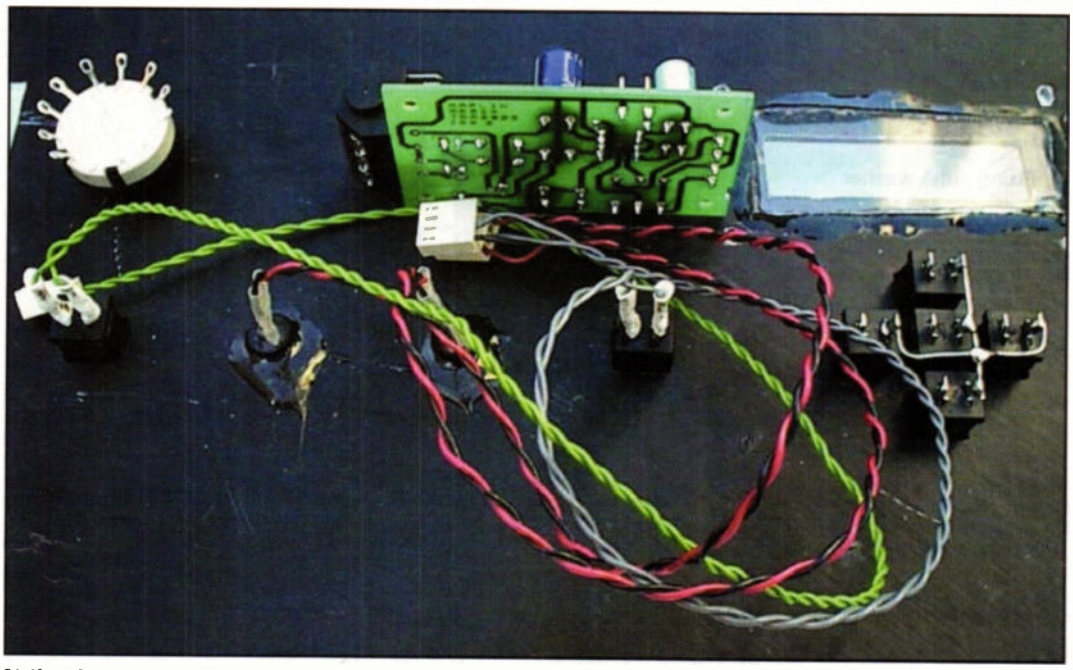


Figure 13. Fitting the display to the front panel. First of all, a piece of clear plastic is epoxied to the front panel. The purpose of this plastic, which could be obtained from an old cassette or CD case, is to protect the display. Note that the M3 screws supplied with the spacers are not long enough to penetrate the front panel - you will have to obtain 10mm M3 screws and cut those down to 5mm.



At the time this photo was taken, the front panel was in the process of being fitted out. Note the clear plastic that has been epoxied to the display cut-out. This sheet, which was cut from an old cassette tape, has been provided to protect the LCD screen.

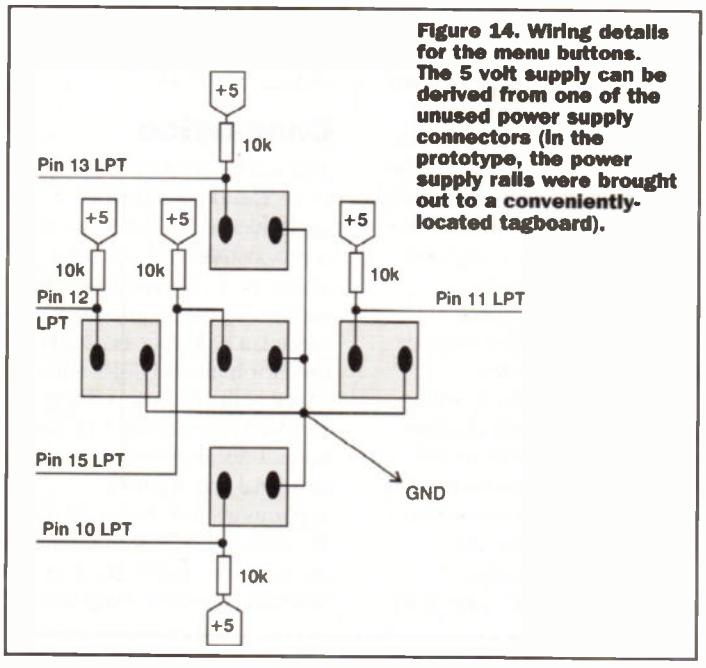


Figure 14. Wiring details for the menu buttons. The 5 volt supply can be derived from one of the unused power supply connectors (in the prototype, the power supply rails were brought out to a conveniently-located tagboard).

project, although the developers are working on them. There's a beta, but it didn't work properly. Note that 4-line/30 character and serial LCD support is available already. MPXF doesn't yet support the parallel-port keypad arrangement, although one of the DAMP betas does (unfortunately, the beta in question - v0.95 WIP 4 - won't work at all on the prototype hardware!). Both programs are compatible with playlist files generated by Winamp. The programs will also recover the CD-Text like ID3 tag that's embedded into many MP3 files. If you're running a LCD driver, then the information is passed to the display! DAMP, for example, presents you with a scrolling display of artist and track name. Very neat, in other words! If the song doesn't have an ID3 tag, then the display tells you the MS-DOS (8.3) filename of the song currently being played. Both programs are also capable of being operated by a PC keyboard - I use a compact 'mini' IBM one with built in 'joystick' mouse, and will continue to do so until DAMP's keypad drivers are fully operational.

CD Playback

As you can see from the design, our magic black box will play audio CDs as well as MP3 ones! To obtain the best sound quality, the CD audio is not routed via the soundcard mixer. Instead, the stereo signals from the drive's rear-mounted audio connectors are fed to a front panel switch that selects between CD audio and soundcard-derived MP3 audio. The sound quality of the average CD-ROM drive's audio circuitry is fair, but obviously not up to audiophile standards! If your CD-ROM drive has a SP/DIF digital output, this could be used to drive an external DAC for better sound quality. If your soundcard has a SP/DIF output, then one of the rotary selector switch's spare poles could be used to simultaneously choose between digital sources.

If your soundcard has a digital audio output, then so much the better! With an external DAC (such as a Minidisc deck switched to 'record' without media present), then you'll get the best possible sound quality from MP3 and other multimedia files! Note that the digital output of a CD-ROM drive, where fitted, tends to be at TTL level. The same is also true of some of the soundcards fitted with a SP/DIF output. The pukka SP/DIF standard specifies a voltage of 0.7v peak-to-peak - you'll need a matching circuit like that shown in Figure 20. As an alternative, you could go for an optical (TOSlink) connection. TOSlink transmitters are designed to be driven by TTL sources directly. TOSlink has the added advantage of electrical isolation.

Until software is written to drive the front-panel menu buttons, you'll have to rely on

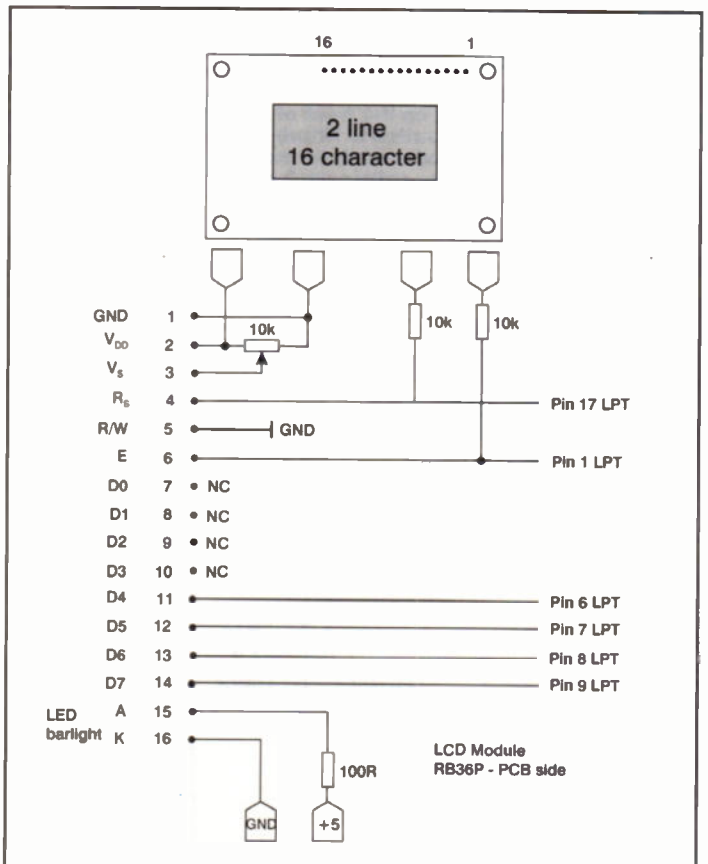


Figure 15. Wiring up the 16-character 2-line LCD panel to the power supply and parallel port. The 10k preset adjusts display contrast.

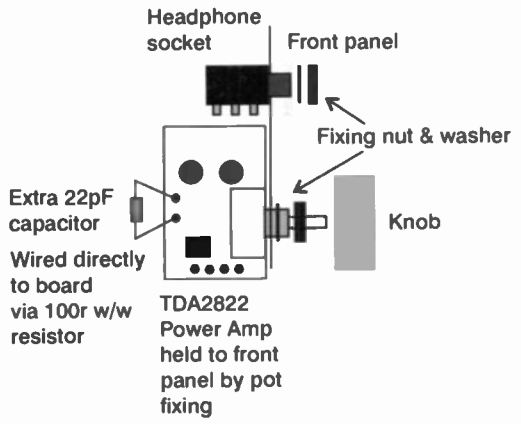


Figure 16. The TDA2822 amplifier module is held to the front panel by its volume control. Quite safe - the board is quite light! A 220nF decoupling capacitor wired across the power supply terminals helps to reduce noise from the switch-mode power supply.

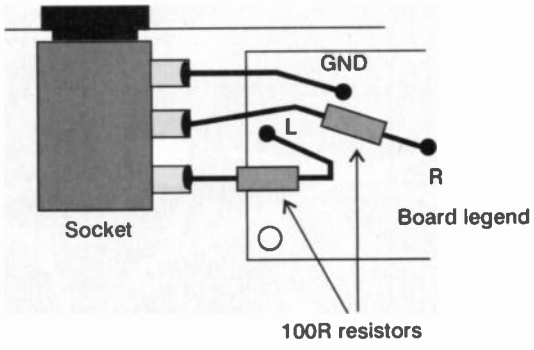


Figure 17. How to wire up the 6.3mm headphone socket - the drawing is specific to the 3.5mm headphone socket of Maplin board legend. Note the use of 100R resistors - these limit volume, but also attenuate noise.

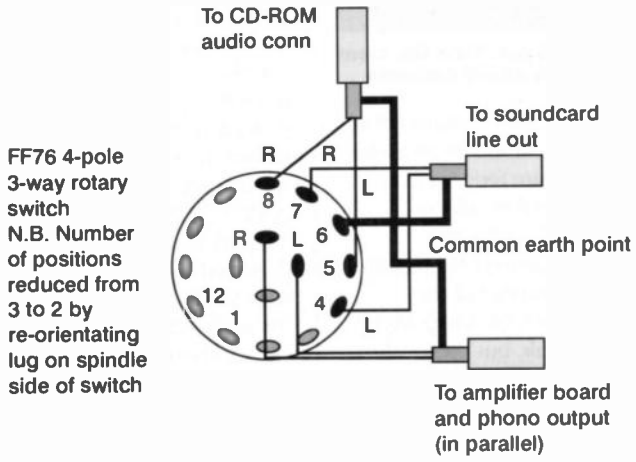


Figure 18. Wiring up the source selector switch, which allows the stereo audio output from the CD-ROM drive or the soundcard to be fed to the amplifier board and phono sockets. The switch is modified from three positions to two by reorientating the lug on the front of the switch (loose, but held in place when the switch is fitted) from '3' to '2' If a third source (DVD MPEG decoder card, for example) is to be added at a later stage, then the extra switch connections can be added and the third switch position restored. The two extra poles could be used to switch other signals, such as SP/DIF digital audio or composite video.

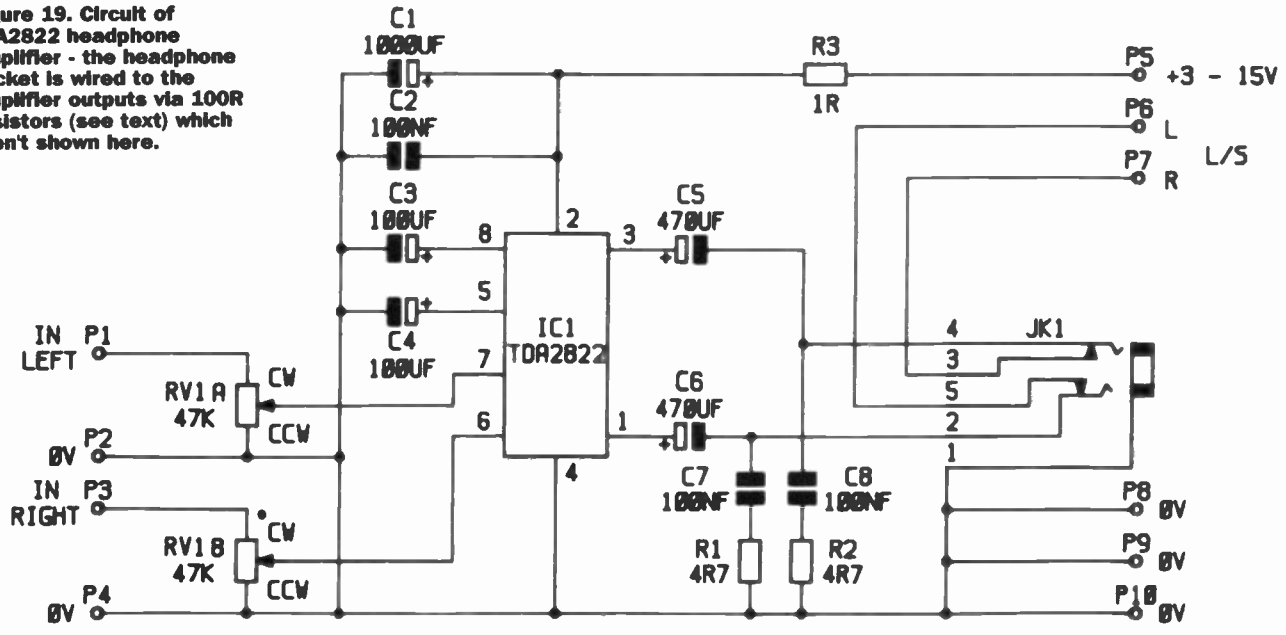
the usual Windows or DOS CD player programs when playing standard CDs. As an alternative, you could specify a CD-ROM drive with play/track advance/stop buttons - there are plenty of these beasties around! The prototype unit has an old 10x IDE drive left over from a previous system upgrade. The ultimate solution would be support for CD-Text - essentially, an extension of the Red Book standard that allows song and artist information to be displayed on compatible players. An increasing number of CDs feature CD-Text.

Hopefully, somebody will write a CD-ROM and display driver that would extract the CD-Text information via the IDE (or SCSI) port and show it on the LCD screen. Not all CD-ROM drives are CD-Text compatible, though. One of the few that are is the (expensive) Plextor SCSI range - see the Plextor web site . For now, though, you may be pleased to know that some individuals are working on keypad control of the CD-ROM drive when playing audio CDs.

Conclusion

This has been an interesting project, and a worthwhile application of PC hardware that is now considered obsolete! That's not to say you can't use cutting-edge PC components - indeed, a high-spec PC could be used for high-end tasks, such as digital audio capture, editing and MP3 conversion. A PC built into a 19in. rack may have some industrial and scientific applications too! Although 19in. PC cabinets for rack-mounting are available, they're hard to find and extremely expensive.

Figure 19. Circuit of TDA2822 headphone amplifier - the headphone socket is wired to the amplifier outputs via 100R resistors (see text) which aren't shown here.



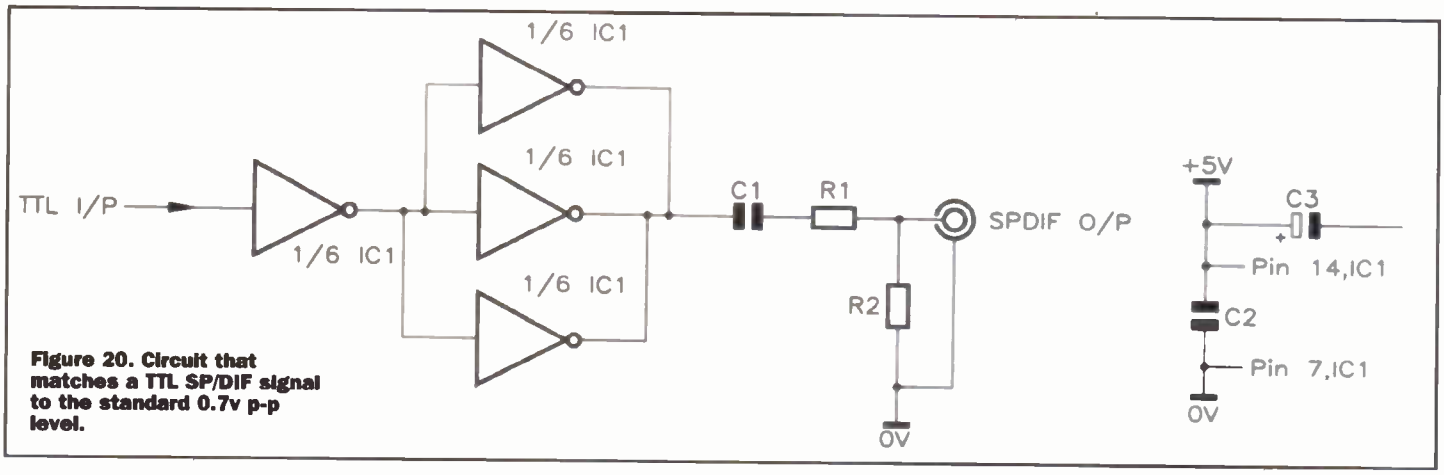


Figure 20. Circuit that matches a TTL SP/DIF signal to the standard 0.7v p-p level.

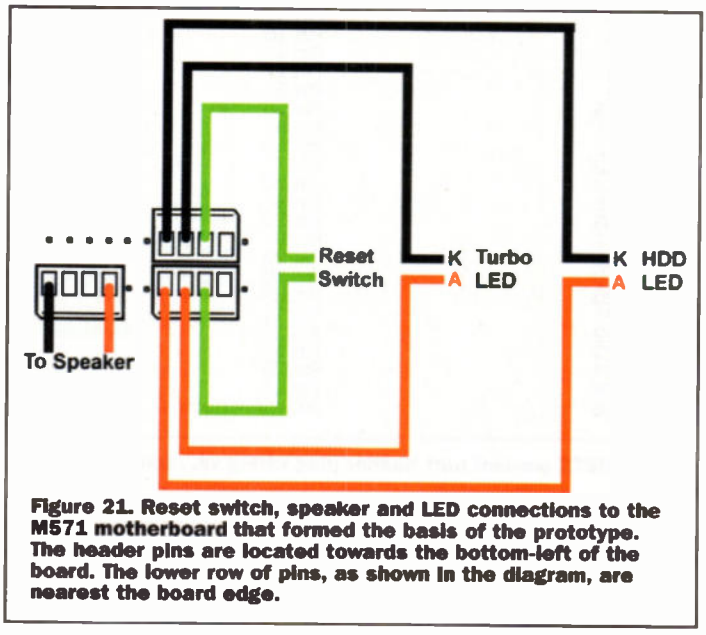


Figure 21. Reset switch, speaker and LED connections to the M571 motherboard that formed the basis of the prototype. The header pins are located towards the bottom-left of the board. The lower row of pins, as shown in the diagram, are nearest the board edge.

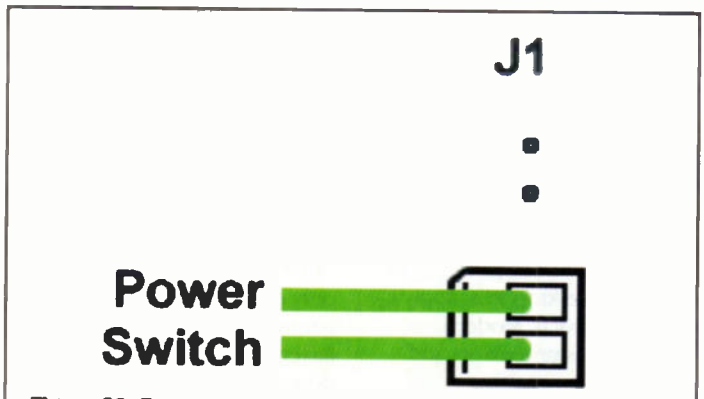


Figure 22. Front panel power switch connections to the M571 motherboard that formed the basis of the prototype. The header pins in question are marked 'J1'. Note that the unused pair of pins shown on the diagram are closest to the expansion slots.

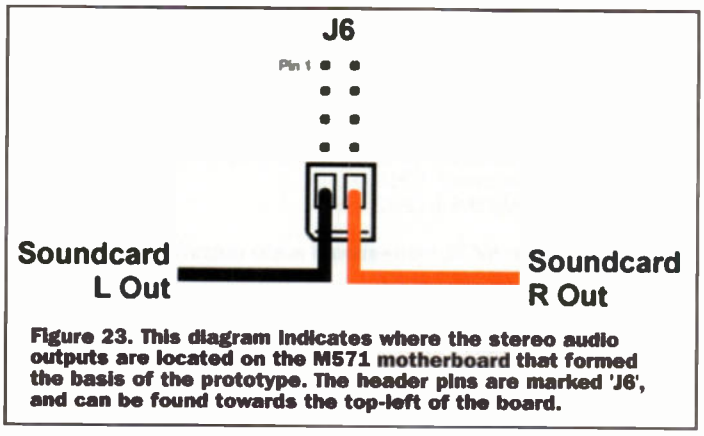


Figure 23. This diagram indicates where the stereo audio outputs are located on the M571 motherboard that formed the basis of the prototype. The header pins are marked 'J6', and can be found towards the top-left of the board.

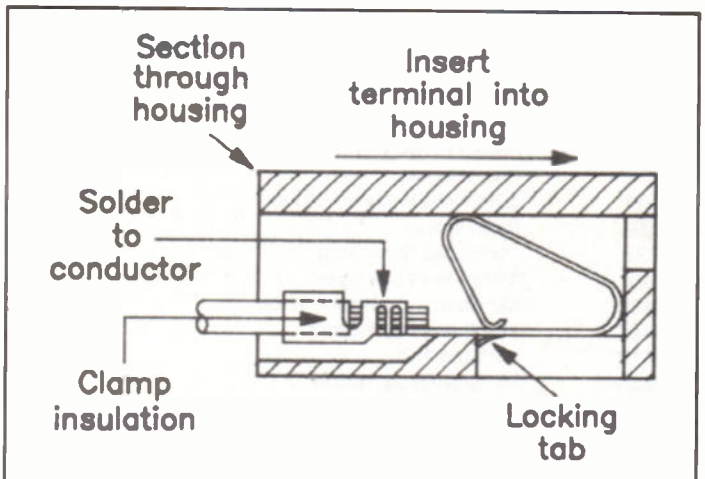
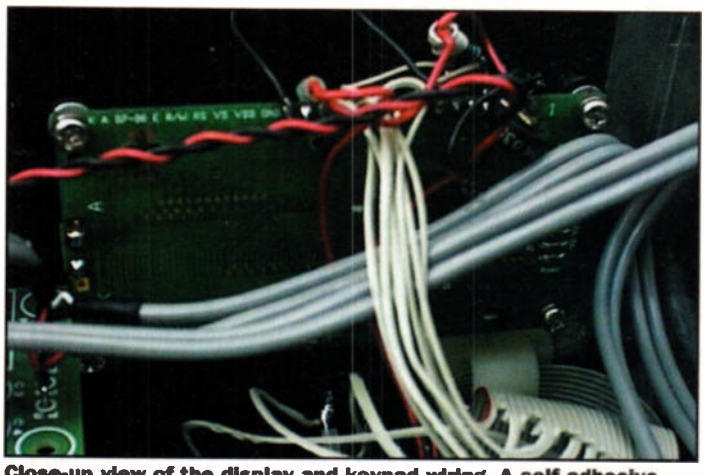


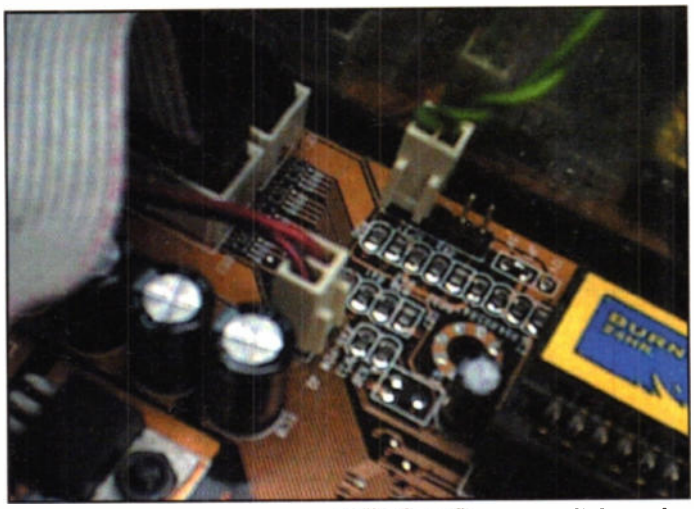
Figure 24. Fitting and inserting the Minicon terminals.



Close-up view of the display and keypad wiring. A self-adhesive cable tie (VK43W) clips the ribbon cable to the front panel.

It's worth keeping an eye on the web sites of individuals and companies providing DOS-based MP3 playback software. They're supporting all kinds of new input and output devices, many of which will add flexibility to the system described here. As it stands, though, the idea of a self-contained MP3 player has now been realised. Although conceptually-similar home players based around dedicated hardware - such as the Terratec M3PO - will undoubtedly arrive on these shores soon, none of them will double up as PCs, or have the same levels of upgradability as a system based around standard PC components! Until such players become generally available, this project can be seen as an ideal way of providing uninterrupted background music at parties without the worry of CDs being half-inched...

Future improvements? There's no doubt that the sound of microprocessor and power supply fans can be quite off-putting in smaller rooms. There's no reason, however,



Close-up view of JP1 - the M571 motherboard's power switch - and the Minicon connector that's attached to it (refer to Figure 22). The other connector supplies power to the microprocessor's fan.

why heatsinks cannot be used instead. With careful design, the side of the case could form part of the heatsink. Notebook computers, the latest examples of which are just as powerful as the fastest desktop PCs, apply a similar approach. Modern Pentium-class processors and the switching regulator transistors built into PC power supplies do generate a fair amount of heat. Thermal runaway could be disastrously expensive here! Perhaps the best solution for reliability would be to supplement additional heatsinking with temperature-controlled fans. In other words, the fan would only cut in when things started getting a little too warm. The faster notebook PCs are designed in this way - fans do, after all, place a noticeable load on the battery and reduce operating times 'on the road'. That said, we're seeing a trend towards more efficient processors operating at lower voltages, and these would generate considerably less heat. Lower power drain from the computer circuitry has obvious implications for power supplies. Again, one only has to look at some of the processor and electronic design techniques being applied to notebook PCs.

Other items

Motherboard, RAM, CD-ROM drive, processor/fan, hard drive, network card, graphics and sound cards (if not integrated into motherboard), keyboard, mouse, monitor, Microsoft Windows 95/98/MS-DOS; aluminium sheet; length of 10mm x 10mm wooden dowelling

Header	PC LPT 25 'D' pinout
Pin 1 (red stripe on ribbon cable)	Pin 1
Pin 2	Pin 14
Pin 3	Pin 2
Pin 4	Pin 15
Pin 5	Pin 3
Pin 6	Pin 16
Pin 7	Pin 4
Pin 8	Pin 17
Pin 9	Pin 5
Pin 10	Pin 18
Pin 11	Pin 6
Pin 12	Pin 19
Pin 13	Pin 7
Pin 14	Pin 20
Pin 15	Pin 8
Pin 16	Pin 21
Pin 17	Pin 9
Pin 18	Pin 22
Pin 19	Pin 10
Pin 20	Pin 23
Pin 21	Pin 11
Pin 22	Pin 24
Pin 23	Pin 12
Pin 24	Pin 25
Pin 25	Pin 13
Pin 26	not connected

Table 1. M571 parallel port header plug wiring vs. standard 25 'D' pinout.

PARTS LIST

Basic Chassis

XM71U	4U 19in. Instrument Case	1
PN43W	200W ATX Power Supply	1
JU26D	80mm Plastic Fan Guard	1
FM34M	5-way Tagstrip	1
FS36P	10mm M3 Insulated Spacer	2pkt
FE69A	Nylon spacer	1pkt
JY22Y	10mm M3 Steel Screw	1pkt
JY24B	16mm M3 Steel Screw	1pkt
BF41U	M2 6mm Countersunk Screw	1pkt
BF44X	M3 Shakeproof Washer	1pkt
JD61R	M3 Steel Nut	1pkt
LR61R	M2 Shakeproof Washer	1pkt
JD63T	M2 Steel Nut	1pkt
NP03D	5mm Std LED Red	2
YY40T	5mm LED Clip	2
JB00A	Square Push Red	1
JB01B	Square Push Blk	1
HB59P	PCB Latch 2-way	1
HB58N	PCB Latch 4-way	3
YW25C	Contacts for above	1
BL00A	Equipment Wire Black	1pkt
BL07H	Equipment Wire Red	1pkt
WB08J	50mm 8ohm Speaker	1
LR64U	M3 Solder Tags	1pkt
PJ95D	5-Minute Epoxy	1

Additional requirements for display and keypad

RB36P	2-line 16chr. Display	1
JB00A	Square Push Red	1
JB01B	Square Push Blk	4
M10K	10k 0.6W Resistor	7
M100R	100R 0.6W Resistor	1
UH16S	Vertical 10k Preset	1
FS36P	10mm M3 Insulated Spacer	1pkt
JY22Y	10mm M3 Steel Screw	1pkt
XR75S	Flat IDC Cable 26-way	1m
FG85G	26-pin (2x13) Header Plug	1

Other items

Cassette or CD case (for display - see text)

Additional requirements for input selector and audio wiring

FF76H	4-pole 3-way Switch	1
FD76H	HD Knob	1
XR21X	Shielded Twin Cable	2m
JZ06G	Insulated Phono Socket Red	3
JZ05F	Insulated Phono Socket Black	3
BF86T	Heatshrink CP16	1
BF88V	Heatshrink CP32	1

(For connection of M571 motherboard audio output)

HB59P	PCB Latch 2-way	1
YW25C	Contacts for above	1

Additional requirements for headphone amplifier

UJ38R	TDA2822	1
GE21X	TDA2822 PCB	1
D100R	100R 2W Resistor	2
M4R7	4R7 0.6W Resistor	2
FX11M	47k Dual Pot Log	1
VH38R	100µF/35V Axial	2
VH46A	470µF/16V Axial	2
VH50E	1000µF/16V Axial	1
WW41U	Polyester Layer 100nF	2
YR75S	100nF Minidisc	1
JL01B	220nF Minidisc	1
FL23A	PCB Pin 2144	1pkt
BW79L	6.3 Skt Chrome	1
FD76H	HD Knob	1

Additional requirements for CD-ROM/soundcard SP/DIF output

M330R	330R 0.6W Resistor	1
M100R	100R 0.6W Resistor	1
RA49D	100nF Monores	2
AU01B	47µF/16V	1
UB04E	74HCU04	1
FJ64U	14-pin DIL Socket	1
XR88V	Min Coax	1m
JP54J	Matrix Board	1

Y2K KY2?

Gregg Grant ask if their really was a 'bug' in the systems

Leading Up To It

The predictions, naturally, were dire. What else could they have been since they were supposed to make us all aware at the very least, if not exactly scared out of our late, 20th century technologically-dependent complacency.

Even a brace of governments - the last Conservative administration and its new, improved-formula, Labour successor - decided to take, as they saw it, this probable event seriously. And, to give credit where it's due, they were far less panic-stricken about it than the Conservative government of the day had been about the greatest medical non-event (maybe for UK) of our time: AIDS. Who could forget the spectacle of Norman Fowler - as he was then - urging us all to practice safe sex!

The quantity of headlines, special features, informative supplements, government posters, booklets and other material generated by this chimera must, conservatively, have consumed a small forest. Therefore, this seems a good moment to look at some of the literature churned out as well as the disasters that were likely to come our way, not only on New Year's Day, but also into the New Year, indeed as you read this.

The Government's View

This was expressed in the booklet The Millennium Bug: FACTS Not Fiction which was compiled by Action 2000, a company created by the government to, in its own words, ' . . provide information free of charge, to help business get ready.' Some 71 organisations provided expert information and specialist knowledge, ranging from Airbus Industrie to Visa International by way of Cresta Holidays, the Inland Revenue and regulatory bodies such as OFWAT.

The booklet described what the bug actually was and how it could strike, and not simply after midnight on December 31st 1999. Generally speaking it was a useful publication, designed for the general reader who had little - if any - knowledge of technology.

Throughout, a fictional statement was juxtaposed with a factual paragraph answering said fictional remark, for example ' your microwave won't work because of the Millennium Bug' was countered by " you can probably program your microwave to cook tomorrow's dinner but you could never program it to cook a meal next year. That's because microwaves don't have a year function which means the date change won't affect them."

The subjects covered ranged across most peoples' concerns from public utilities to domestic appliances; home computers to travel. Throughout the booklet boxes with a blue background headed Beating the Bug, briefly described how organisations such as the supermarkets and the clearing banks took early action to ensure that the change to 2,000 would not create problems for their customers. In fact, Barclay's Bank enclosed a leaflet with my October bank statement ticking off 10 major customer concerns as sorted, in what they termed a Year 2000 Checklist. Another feature - this time with a green background - were the Tips boxes, with headings such as Computer Testing Tip and Travel Tip.

In May last year, Action 2000 issued a report on the general state of national readiness assessing companies, organisations and public utilities as either red, blue or amber, as shown in Figure 1, overleaf. A further report was published in July, which revealed the status of crucial areas of the nation's infrastructure such as water and sewage, the financial services industry, gas, telecommunications, the police and fire service, weather forecasting and the like. How did they fare? Not too brilliantly, was the short answer. On August the 18th, the 'Times' newspaper carried a critical report from the House of Commons Public Accounts Committee.

It had noted that the July data indicated that some 98% of police forces and 41% of fire brigades remained on amber which, as Figure 1 shows, meant the likelihood of some material disruption. The committee's chairman thought that - with a mere four months to go to the end of the year - the time had come to 'name and shame' those services and public utilities that were not up to standard.

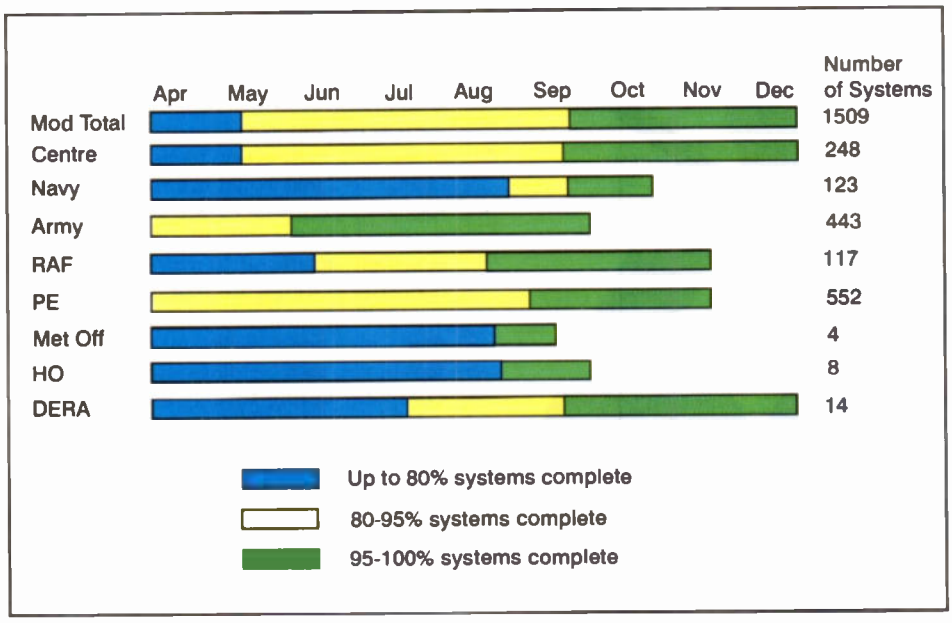
In the October edition of their booklet, Action 2000 included international events, as well as those in local areas, and expanded on some areas hitherto covered somewhat lightly.

The Defence Community's Perception

One of the largest users of computer equipment in government is the Ministry of Defence (MOD). In their Year 2000 Programme Newsletter, Issue 6, of April 1999, they dealt with progress within the organisation itself, the Pay and Personnel Agency and crucial outside bodies such as Microsoft.

On the 23rd March last year, the Minister for the Armed Forces Douglas Henderson stated in the House of Commons that "so far, well over 30,000 systems employing

From the pamphlet 'The Millennium Bug: Facts Not Fiction.' Published by HMG. Page 14



From the MOD pamphlet 'Action 2000.'

computer-based technology have been assessed within the Ministry of Defence and its associated agencies. Work on many of these is already complete. For example, the MOD Centre and the Armed Forces have so far completed work on around 65 % of all systems."1

Figure 2 broadly bore this out, although some areas appeared to be somewhat sluggish, which could be due to a number of things including the complexity of systems, their availability for checking and the need for operational readiness. By October 1998, the MOD had set up a programme of critical system audits and as the Newsletter went to press, some 24 systems had been verified as Y2K compliant, by a team from the consultants Logica. Some 50 more systems had been earmarked for audit and the MOD's intention was to focus on what it termed 'computer-rich' systems, between April and September 1999.

These audits would be looking for such things as whether system components were documented along with their Y2K status; had interfaces been documented and tested and finally, had the Y2K compliance and assessment tasks been quality tested by a knowledgeable, independent body.

The Newsletter ended with Microsoft's issuing of their Y2K compliance statement for their major business products, the Internet address where you could check up whether any - or all - of your suppliers were Y2K compliant and finally, where you could get hold of the CD-ROM, floppy disc or video that had been in the MOD briefing pack.

Despite one of the most unnecessarily secretive organisations in the world attempting to appear more open and technologically competent, matters still went awry. The September edition of the journal Computer Active reported on a demonstration of supposedly Y2K-compliant radio equipment that was anything but.

In front of an audience of military big-wigs at RAF Oakhanger, the system failed totally in sending a single-word message to a tent, some 100 metres distant. After the operator had made four attempts to transmit the message, the demonstration was abandoned. The message took another 12 minutes to get to its destination!

Engineering Expressions

In the August edition of Engineering Technology, the journal of the Institution of Incorporated Engineers, the editor was somewhat less than impressed by what had been achieved so far. In her Comment column, Anne Wilkinson noted that there were " . . two sectors still reporting a percentage of 'red' ratings, that is, severe risk of material disruption with possibly not enough time to rectify the problem." [2]

The sectors concerned - local government and the financial institutions - had thus far failed to evaluate, let alone take measures, to ensure millennium compliance. This, the editor pointed out, was worrying and could have far reaching implications for us all.

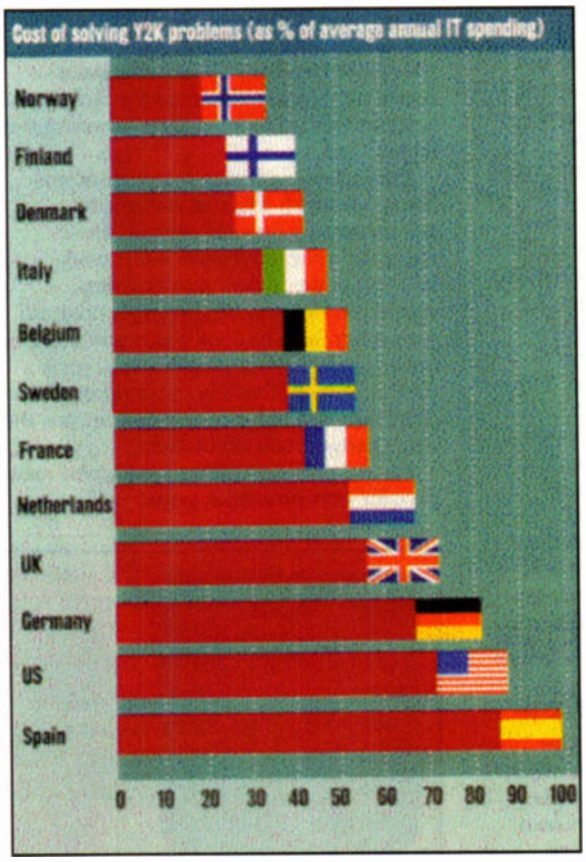
The column went on to discuss the pressure for 'naming and shaming' such bodies, it pointing out that the Financial Services Authority, (FSA), had - up to that time - refused to do so, using the limp excuse of the 'Catch 22' situation: either way, damage would be done. In short, the 'Pontius Pilate Position' so frequently used by the City spivery was still the standard defence against technology, outsiders, or anything that could vaguely be considered regulatory, or likely to lead to such an imposition.

Britain's Engineering Council was no less concerned. In the August edition of its journal Engineering First, the Council pointed out that networks too " . . throw up a multitude of other potential issues. You need to check server software, client software, operating systems, shared applications and utilities such as communications, message handling, back-up routines etc." [3]

Nor was its concerns a matter of software alone. It went on to point out that hardware such as ' . . workstations, terminals, routers, bridges, hubs, gateways and anything else connected to network systems' [4] required close attention also.

IT's World View

The 7th July 1999 issue of Information Week devoted itself to the Y2K problem, designating itself a special issue and reminding its readers that there was a mere 177 days to go to what - at this juncture at any rate - could be termed big bang. It opened the issue by verifying what Engineering Technology's editor had already noted, namely that the FSA had refused to name and shame " . . the one 'high impact' and seven 'medium impact' City firms it has found with inadequate Y2K measures in place." [5]



From the journal 'Information Week' of 7th July 1999. Page 22

The piece also revealed that of the 8,000 or so companies the FSA regulated some 300 were classified as 'medium impact' and more than 100 were regarded as 'high impact.' In other words more than 1/20th of the firms within its remit were either lax in regard to the Y2K situation, or thought it hardly worth bothering about.

Moreover, the Agency refused to name a deadline for these companies to show that they'd taken steps towards Y2K protection. In its Opinion column, the journal looked back - from the vantage point of 3,000 AD and with tongue most decidedly in cheek - at what it termed 'the so-called Y2K crisis.'

The piece took an iconoclastic sideswipe at our computer-

dependent world, as well as predicting that Windows 3000 would be released in time for the Fourth Millennium!

Information Week also interviewed Action 2000's chief executive, Gwynneth Flowers, who pointed out that the government's creation had no statutory powers to compel corporations - large and small - to take measures against the possibility of business meltdown through computer date failure. She pointed out however that she was fairly confident that the nation's infrastructure was in relatively good shape. Small glitches in short, but no major catastrophes.

Finally, in their article The Global Menace, Alex Straunik and Stuart Lauchlan outlined just how little many foreign and European countries had done compared to the UK effort.

One worrying example the authors gave involved the oil industry. According to one London-based oil consultancy, International Monitoring, world-wide crude oil deliveries could be delayed by as much as 23 days.

The reason given for the likelihood of this happening was that the major 10 oil-exporting countries were simply not prepared for Year 2000. Figure 2 gives some indication of how big the Y2K problem was throughout much of the developed world

Some Trumpeted Trailers

Like all good matinée performances of course, the Y2K spectacular came with a number of advertisements and a couple of trailers for coming - or in this case possible - events. The New Scientist flagged up the likelihood of the Global Positioning System (GPS) going feet up on the 21st of August, 1999.

The satellites' date counting mechanisms - the journal explained - 'roll over' in weeks, beginning with the first week in the year 1980, yet only counted up to1023 before returning to 0000. And the result? Some civilian GPS receivers might have difficulty in interpreting the satellite signals.

A fortnight later, the journal posted another possible coming attraction. In its Newswire feature, it carried a short piece entitled 'Bug bites early' in which it touched on the date of the 9th September 1999 or, put another way, 09/09/99. In some programming languages, 9999 meant 'end of file' and so some programmers reckoned that this could induce system failure in some systems.

Others again thought this highly unlikely, for they took the view that problems would only arise if a date consisted of six nines, i.e. 99/99/99. The piece concluded that all agreed, whatever happened, that the date change would be a worthwhile trial run for 01/01/00.

Costs and Coughing Up

In its broadsheet enclosure Beating the Bug of the 14th July, the Times newspaper took a comprehensive look at the situation, dealing with much the same problems as other newspapers, journals and periodicals had done.

Supermarkets, domestic alarms, the National Mentoring Scheme run by Action 2000, how small businesses were coping or not, Air Traffic Control, the Royal Mail and the Insurance industry all came under the spotlight.

Above all however, on page three, it asked 'But shouldn't the IT industry pay?' Chris Partridge pointed out that, all in all ' . . the computer industry should fix the millennium bug without charge. After all, they caused it.' [6]

The piece went on to point out that many financial institutions has been throwing large amounts of dosh at the problem and - surprise, surprise - re-engaging on a consultancy basis the very engineers who were responsible for the problem originally!

In fact the fees demanded, and duly coughed up, for this work had reached a level such that many consultants were able to take early retirement, or simply reduce their working week to two or three days at most. This of course resulted in one thing: a skill shortage.

True, there were software packages that could check smaller systems, aids such as Check 2000, Norton 2000 and WRQ Express. Nevertheless such solutions were not cheap, for even their accompanying manuals ran to £40 to £50 a piece!

The computer industry was not alone in taking a cavalier attitude to Y2K. The insurance companies were no less ruthlessly self-centred in their approach, they taking the line that there should be no major change to policies as a result of the bug. They even re-wrote almost every extant insurance policy so as to exclude any direct liability for Y2K-related claims.

All this from a section of commerce which - along with other financial service outfits already touched upon - was the least prepared to ride out the crisis, should it come. So much for advertising slogans such as "getting the strength of the insurance companies behind you" and that other gem about not dramatising a crisis!

Finally, Information Week's Andrew Cromby - a solicitor by profession - in his article "I'll see you in court . . " pointed out that the computer manufacturers were hardly in the strongest of legal positions since ' . . in the context of Year 2000 claims . . . the IT industry . . . has known of the problem for many years and . . . arguably, there has been sufficient opportunity to take preventive action.' [7] Quite!

On the 6th November the Daily Mail' newspaper carried a short piece entitled Ten Countries TO AVOID at New Year. It pointed out that Taskforce 2000 was advising the general public to avoid the countries listed in Table 1, as they - the countries that is - would face computer problems.

Table 1: Countries Not To Fly to In the New Year

Czech Republic	Finland	Germany
Italy	Hungary	Poland
Portugal/Spain	Russia	Switzerland

Taskforce 2000's executive director, Robin Guenier, castigated the Government for being less than forthcoming about the state of Y2K readiness in other countries. A Department of Transport official dismissed his claims, stating that the general world view was that the majority of services would operate with their usual efficiency. The list nevertheless was alarming in one respect: the countries on it were all European.

End Game: Who Got It Right?

It's the 4th of January, and I'm back in harness after the holiday break. Thus far - the US Government's spy satellites apart - the majority of the world's computers appear to be functioning normally, although some interesting comments appeared in the press as 1999 drew to a close and 2000 came galloping headlong to meet us.

In the Mail on Sunday newspaper of the 26th December, Ruth Sutherland interviewed Don Cruickshank, the Government's Y2K guru, who revealed that February 29th could bring further trouble, on top of the £20 billion the Y2K damage limitation exercise has - allegedly - already cost. Four days later the Times newspaper noted that small businesses - many of whom lost considerable sums because their credit card terminals crashed - are determined to sue over the problem.

Lawyers nationwide are, apparently, gearing up to aid those intent on going to court. The leading IT legal firm of Tarlo Lyons intends setting up a Y2K Helpdesk, which will be known as Millennium SOS. Nor is this all, for British industry, in general, has begun to ask awkward questions concerning the cost of the Y2K compliance exercise.

So who - in the end - got it right? Certainly not the computer industry, for at no time has it apologised for the Y2K debacle, at least not in any of the newspapers, periodicals or journals that I've been able to monitor. I suspect that it is too early to say exactly who has come out of this with credit. One thing's for certain: this story will run for some time yet!

1: Kalnth, Ranj [Editor] (1999): Year 2000 Programme, Issue 6, MOD Year 2000 Newsletter, April 1999. Page 1.

2: Wilkinson, Anne [Editor] (1999): Engineering Technology, Volume 2, Number 8, dated August 1999. Comment column, Page 3.

3: Engineering First, Issue No.8 (1999): Article Year 2000: Are Your Computers Ready? Page 10.

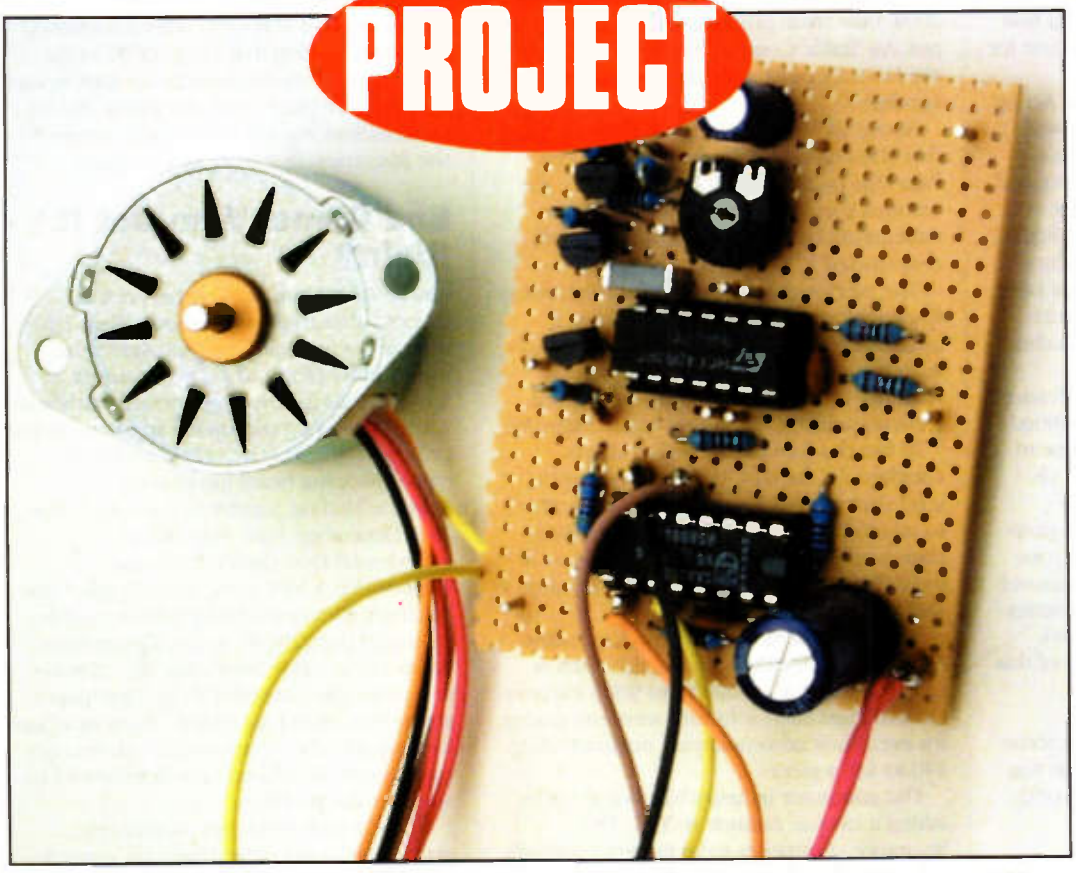
4: Ibid [2], Page 10.

5: McNiven, Ambrose [Ed-in-Chief] (1999): Information Week No. 75, dated 7 July 1999. Article City Watchdog Under Fire, Page 6.

6: Partridge, Chris (1999): Article But shouldn't the IT industry pay? In the 'Times' supplement of July 14th, 1999. Page 3.

7: Op. Cit. [5], Page 56.

PROJECT



Using Servos & STEPPER MOTORS

PART 2

In part 2, Gavin Cheeseman looks at some simple practical control circuits and applications

In part 1 we investigated the concepts behind servo and stepper motors. Let us now look at some simple practical control circuits and overview some of the practical considerations that must be taken into account when using the devices. The circuits described are intended to provide a starting point for further experimentation. Therefore the component values and circuit configurations are not necessarily fully optimised.

Servo Control

The first circuit makes use of a radio control servo (Maplin stock code FS35Q). As mentioned in part 1, these devices provide a comparatively simple method of motion control for small models, robots etc. as the fundamental control circuitry is contained within the servo housing. Therefore all that is required is to apply the necessary control pulses to the control input of the servo.

There are many different ways of generating the pulses. A simple method is to use an oscillator and a retriggerable monostable as illustrated by the block diagram shown in Figure 1. The frequency of the oscillator determines the pulse repetition rate. The pulses need to be repeated approximately every 18ms, corresponding to an oscillator frequency of about 55Hz. The tolerance for this parameter is relatively wide and accuracy is not particularly critical.

It is the pulse width that controls the position of the servo output shaft. Therefore unlike the pulse repetition rate, the pulse width must be comparatively stable and accurate. This may be achieved by selecting high tolerance components for use in the circuit and regulating the supply voltage.

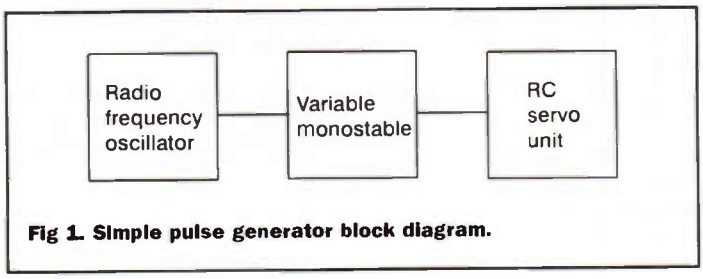


Fig 1. Simple pulse generator block diagram.

A Circuit Example

Figure 2 shows an example of a circuit using this principle. The circuit makes use of a CMOS quad NOR gate IC (4001BE). These devices are relatively inexpensive and can provide acceptable results. The same concept may also be applied using other logic families with any necessary adjustments to the component configurations. Supply regulation (5V nominal) is provided and the regulated output is also used to supply the servo unit.

Circuit Description

Referring to Figure 2, the power supply is connected between terminals P1 (+V) and P2 (0V). Capacitor C1 decouples the supply at the input to RG1, a 5V regulator. The regulator provides a stable supply voltage for the rest of the circuit. Additional supply filtering is provided by C2 and C3. IC1a and IC1b are configured as a simple oscillator. The frequency of this stage is set by the values of resistors R1 and R2 together with capacitors C4 and C5. This oscillator sets the pulse repetition rate of the circuit. The output of IC1b is fed to the input of the next stage comprising IC1c and IC1d. The two gates form a simple monostable stage that is used to set the output pulse width of the circuit. The pulse width is determined by the values of C6 and R3 and variable resistors VR1 and VR2. VR1, a panel mounting potentiometer, is used to adjust the pulse width and hence the servo position. VR2 is a preset variable resistor and is used to set the centre point. Terminals P3 and P5 give access to the regulated supply voltage with the pulse output on P4.

Circuit Construction

Most standard methods of construction may be used when building the circuit. A simple method is to use matrix board. Construction is relatively straight forward, as the main part of the circuit is based around a single logic IC. Layout is not particularly critical as long as connections between components are made as short as possible. Capacitor C3 should be positioned close to IC1.

The usual fundamental considerations apply to both circuits covered in this article. In particular make sure that all

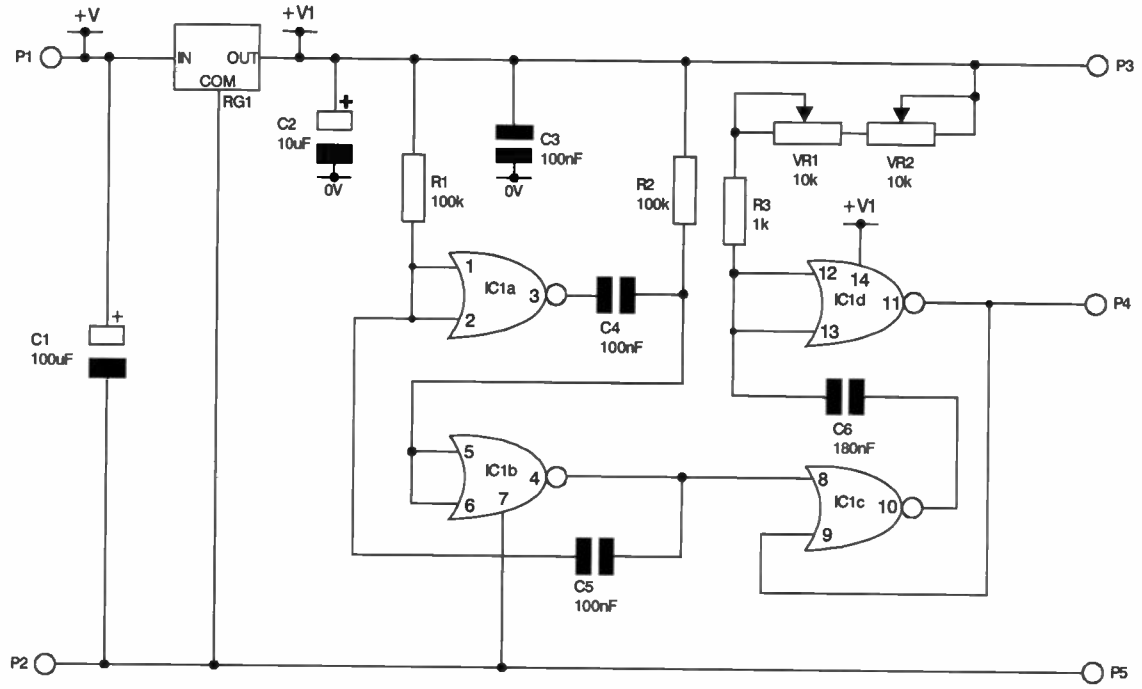


Figure 2. Typical servo control waveform.

components are connected correctly and observing the correct polarity. This is essential both for operational and safety reasons. IC pinouts are shown in Figure 3. It is best to use DIL sockets with the IC's. The polarity of the electrolytic capacitors is indicated by markings on the component case. Usually the negative lead is marked and is the shortest of the two leads but always double check.

Regulator, RG1 may or may not require a heatsink depending on the application and the duty cycle. The current consumption is at its highest when the servo motor is active. Also the regulator dissipates more power at higher power supply voltages due to the increased voltage drop. It is best to use the worst case current drain as a basis to determine whether a heatsink is required or not.

Variable resistor VR1 may be mounted directly onto the circuit board, or soldered to PCB pins.

Servo Control Wiring

Figure 4 shows the necessary off board wiring to the servo control circuit. As can be seen, only 5 connections are required including those for the power supply. Please do not forget to include the fuse as this helps to provide protection in the event of a short circuit. If necessary the 5V supply for the servo motor can be derived from a separate power source and in this case terminal P3 should not be connected. The 0V connection is still required as this also functions as the 0V return for the control input. Power supply switching is not shown. If the circuit is wired as shown, a single pole slide or toggle switch (at least 1A current capacity) may be connected in series with the +V supply line if required.

Power Supply

The circuit is designed to operate from an 8V to 12V DC supply. The supply does not need to be particularly well regulated but should not drop below 8V under full load conditions (around 500mA). The supply should provide a smooth DC output that is comparatively free from ripple, although RG1 helps to reduce small amounts of ripple that may be present. Of course if a battery supply is used, this is not an issue.

Operation From a 5V Supply

Alternatively, the circuit can be powered directly from a regulated 5V DC supply. In this case RG1 must be omitted and terminal P1 linked to P3. When used in this configuration the power supply must never be allowed to exceed 5V and good regulation is important. Also, it is even more important that any ripple present is reduced to a minimum.

Testing the Servo Circuit

Testing and alignment is relatively straight forward and does not require specialist test equipment. However if an oscilloscope and a multimeter are available these can simplify the procedure. It is a good idea to attach a suitable horn to the servo so that the movement of the output shaft can be easily seen. A number of different attachments are supplied with the servo unit. The simple

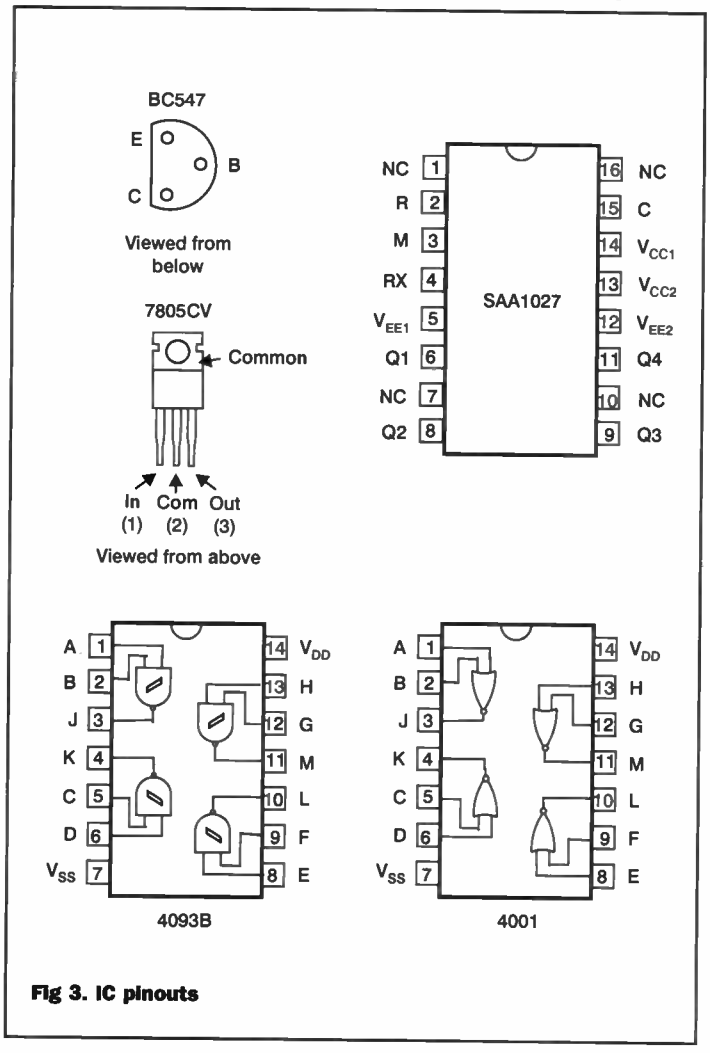


Fig 3. IC pinouts

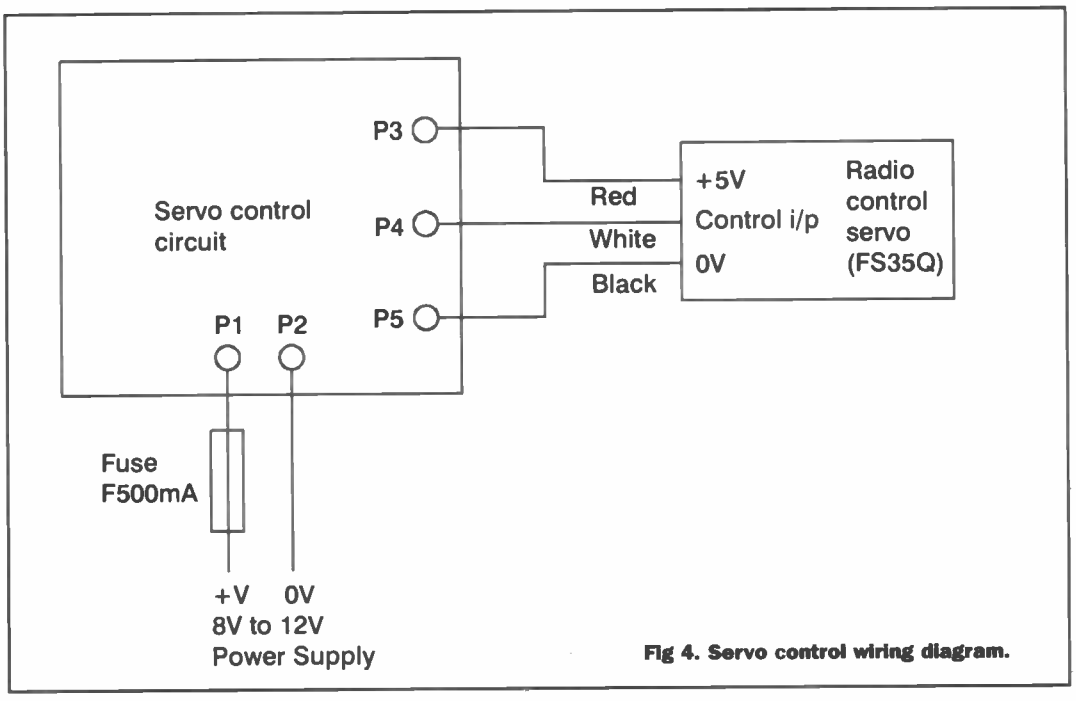


Fig 4. Servo control wiring diagram.

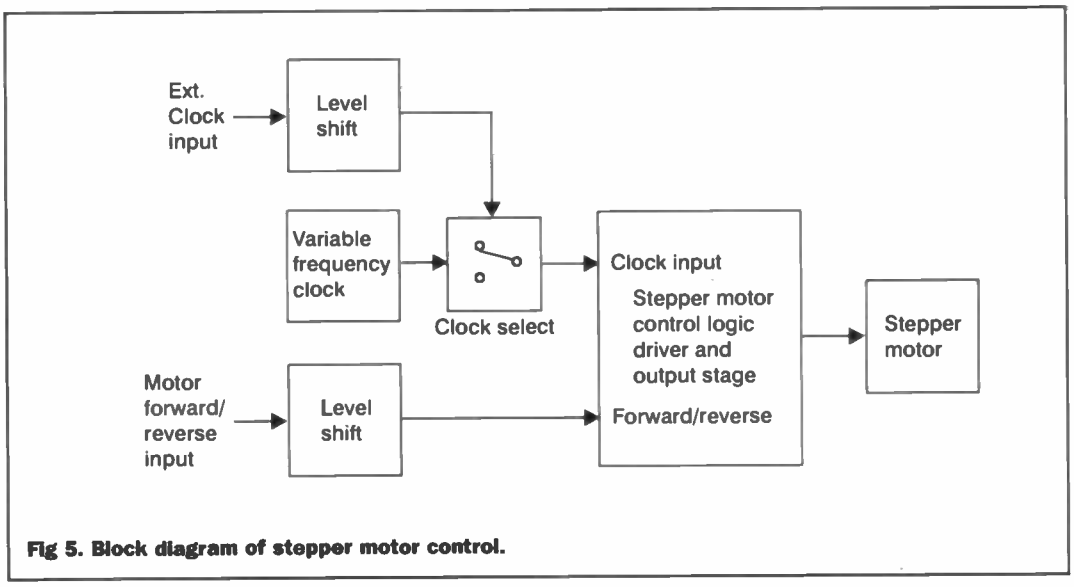


Fig 5. Block diagram of stepper motor control.

straight attachment is ideal when testing the unit.

Before applying power to the circuit set both variable resistors (VR1 and VR2) to centre position. When testing the circuit for the first time it is useful to connect a multimeter set to read current in series with the +V power supply rail to allow the supply current to be monitored. Select an appropriate range on the multimeter so that the reading does not exceed full scale deflection (at least 2A F.S.D. recommended).

If you have access to an oscilloscope the output of the servo control circuit can be checked before the servo is connected. This helps to ensure that when the servo unit is connected the pulse width is approximately within the required range avoiding the rotor hitting the end stops. To set up the unit in this way, apply power to the servo control circuit with the servo unit disconnected and monitor the output pulse produced on terminal P4. Adjust preset variable resistor VR2 so that the pulse width is approximately 1.5ms with VR1 set to the centre of its travel. The pulses should repeat approximately every 18ms but this may vary significantly without any detrimental effect to the operation of the system. Once the pulse width is set up, disconnect the power supply and connect the servo unit. Reapply power and carry out any final adjustment to VR2 to set the servo output shaft to the centre of its travel.

As mentioned, an oscilloscope is not essential and the circuit may be set up by trial and error without too much difficulty. In this case, apply power to the circuit with the servo unit connected. As with the above method, adjust VR2 so that the servo output shaft moves to the centre of its travel with VR1 set to centre position. When power is first applied the servo output shaft may try to move to a position past the end stop if the pulse width is outside the required range. Do not allow the servo to remain energised in this condition for a long period as it may become damaged. Make the adjustments as quickly as possible. If it is not possible to attain the correct response disconnect power and double check the circuit configuration and component values.

When the centre position has been correctly aligned try adjusting VR1 to either end of its travel. The servo output shaft should also move to each end. Using VR1 it should be possible to set the servo to various positions between the two end stops. Avoid setting VR1 or VR2 to a position where the servo is trying to move outside its normal operating range as this will result in excessive current drain and possible damage.

Stepper Motor Control

As we have seen, radio control servo units of the type discussed above simply require a pulse input to determine the position of the output shaft because most of the control circuitry is integral to the servo unit. However, as described in part 1, stepper motors use an entirely different control system and requirements vary depending on the type of motor in use. Coils within the motor are energised in a specific sequence to move the motor through a series of predetermined steps.

Circuit Example

The following circuit can be used to control a small stepper motor (Maplin stock code FT73Q). The circuit makes use of a purpose designed IC, the SAA1027 to provide the correct switching sequence for the motor and allows the motor drive shaft to be rotated (stepped) continuously in either direction. Alternatively the rotation may be in individual steps. Figure 5 shows the block diagram.

Circuit Description

Figure 6 shows the circuit diagram of the stepper motor controller. The power supply is connected between terminals P1(+V) and P2 (0V). Local power supply decoupling is provided at various points throughout the circuit to avoid switching transients being coupled onto the supply rail. IC1b and associated components form a simple oscillator that is used to supply clock pulses to IC2 when the circuit is used in continuous rotation mode. The oscillator is enabled by connecting P3 to +V. Variable resistor VR1 allows adjustment of the clock frequency and hence the speed at which the stepper motor output shaft rotates. Transistors TR1 to TR3 and IC1a, IC1c and IC1d. are used to switch the control inputs of IC2. Use of this configuration allows the circuit to respond to a wide range of

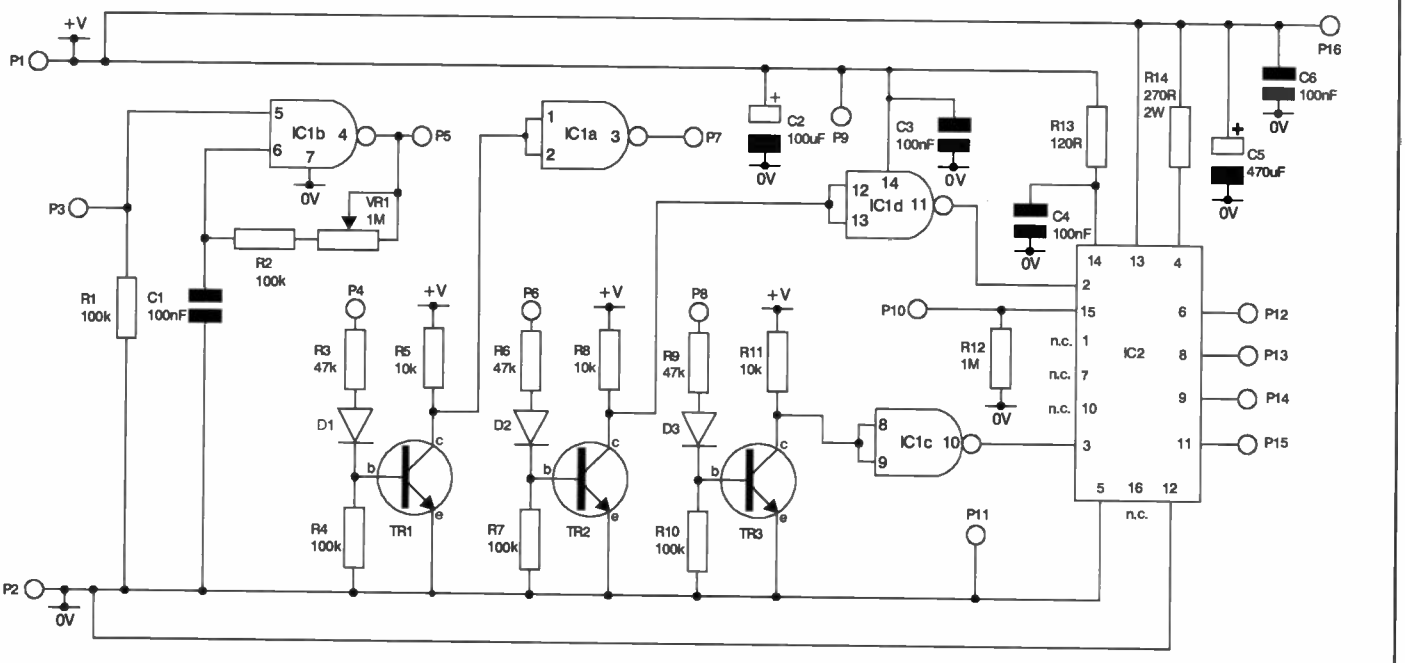


Fig 6. Stepper motor control circuit diagram.

input levels. This is useful when controlling the circuit from 5V logic levels. The operation of the control terminals is discussed in more detail below. Terminals P12 to P16 are connected to the stepper motor. Depending on the status of the control inputs, IC2 switches terminals P12 to P16 in an appropriate sequence to move the stepper motor drive shaft in the required direction.

Constructing the Stepper Motor Control

Most of the general constructional requirements are as discussed for the servo control circuit and it is recommended that you read the section headed 'Construction' above. It is recommended that a separate power supply rail is used for the higher current sections of the circuit as shown on the circuit diagram. Also, supply decoupling capacitors should be positioned close to the relevant sections of the circuit. So C2 and C3 should be positioned close to IC1, C4 near to IC2 pin 14 and C5 and C6 close to P16. Resistor R14 normally operates at an elevated temperature and should be fitted such that the resistor body is positioned away from the surface of the circuit board. Variable resistor VR1 is normally mounted directly to the circuit board. However, a panel mounting linear potentiometer of the same value may be used in place of the specified preset type if required. The potentiometer may be wired off board via short lengths of hook-up wire. Wiring to the component should be kept as short as possible as VR1 forms part of the clock oscillator RC network.

A typical wiring configuration using mechanical switches to set the control inputs to the circuit is shown in Figure 7. This arrangement will drive the stepper motor without the need for additional logic circuitry and is a suitable configuration to use when testing the unit. Depending on the final application, electronic inputs may be used to replace the mechanical switches. Figure 8 shows the function of each terminal for reference.

It is important that the stepper motor connections are wired in the correct sequence. If the wiring is incorrect the motor will not respond correctly to the control signals. The stepper motor lead colours shown on the wiring diagram are believed to be correct at the time of writing but readers are advised to double check the manufacturers data if unsure, as specifications can sometimes change.

Power Supply Requirements

The stepper motor control circuit is designed to operate from a 12V regulated DC supply. However, supply voltages as low as 9.5V can be accommodated. The main effects of varying the supply voltage are to modify the operating frequency of the clock oscillator. Power dissipation is also affected. Once again please do not omit the fuse as this helps to provide protection in the event of a short circuit. As with the servo circuit, a power switch is not shown as the unit may be driven from a

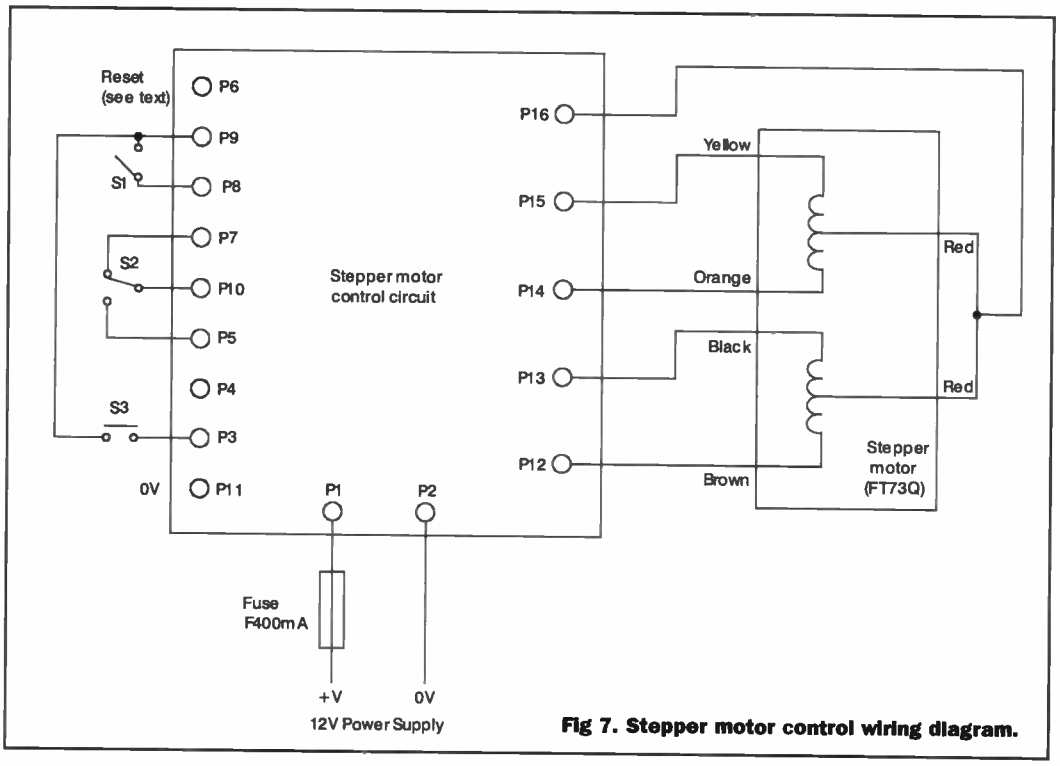


Fig 7. Stepper motor control wiring diagram.

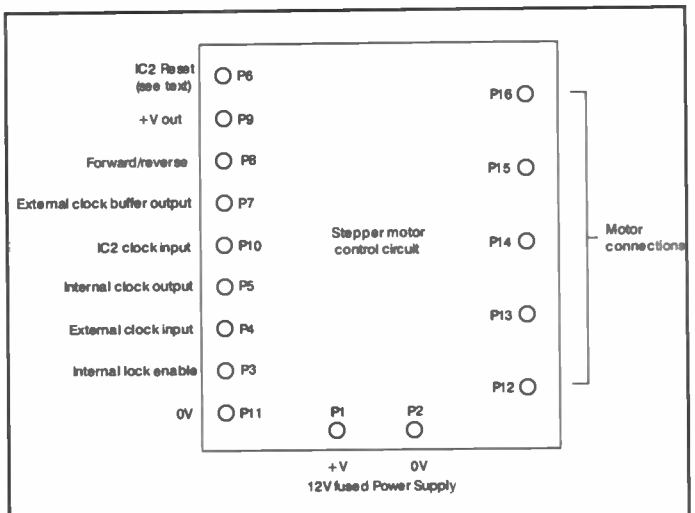


Fig 8. Stepper motor control terminal designations.

power supply that already has a power switch. A single pole switch may be connected in series with the +V supply line between the fuse and terminal P1. It is recommended that the current rating of the switch is at least 1A.

Testing

When testing the stepper motor control, the circuit should be connected as shown in Figure 7. The operation of the switches is as follows:

S1 - forward/reverse rotation;
S2 - internal/external clock pulse;
S3 - on-board clock enable.

Before applying power to the circuit set S1 to the open position and set S2 such that terminal P5 is connected to P10. Terminal P6 should be connected to +V. This terminal resets the outputs of IC2 and should always be connected to +V when not in use. Apply power to the circuit. If you have a multimeter you may wish to measure the supply current. With power applied to the circuit and the motor drive shaft stationary the current should be in the region of 250mA but this may vary slightly.

Press and hold switch S3. The motor drive shaft should start to rotate. When the switch is released the rotation should stop. Set S1 to the closed position. Press and hold S3 again. This time the drive shaft should rotate in the opposite direction until the switch is released. Note that the motor remains fully energised even though the drive shaft is stationary.

In order to test the external input set switch S2 such that terminal P10 is connected to P7. An external clock pulse (5V to 12V) may be applied to P4. This should drive the motor in a similar way to the internal clock. S1 should continue to control the direction of rotation. Single clock pulses may be applied to P4 to advance the stepper motor by one step. The input is not debounced so the use of mechanical switches to apply pulses to the input is not recommended unless steps are taken to ensure a clean switching action.

The motor may operate at a relatively high temperature if powered for long periods. In order to improve heat dissipation, the motor may be bolted to a suitable metal plate or similar heatsinking arrangement.

Applications

The circuits described in this article are primarily intended to provide a starting point for those interested in experimenting with motion control. They have been designed for simplicity and allow basic operation without the need for additional logic etc. Switches S1 to S3 shown on the stepper motor control wiring diagram may be removed and the inputs driven from suitable logic devices, microprocessors etc. Additional buffering may be required in some cases. Care should be taken to ensure that any equipment connected to the stepper motor control is capable of driving the inputs and will not be damaged.

Because the stepper motor control circuit creates all of the necessary switching sequences, control software does not need to be as complex as would be necessary if only a simple driver stage were being used. To determine the position of the motor drive shaft all that needs to be known is the start position and how many clock pulses have been applied to the input of the stepper motor control. By applying the correct number of pulses the motor drive shaft may be precisely positioned. If required, confirmation of the final drive shaft position may be obtained using an appropriate position sensor but for many applications this is not necessary.

Simple remote speed control may be achieved using an external clock oscillator. A simple variable frequency square wave oscillator based around an IC timer such as the NE555 provides good performance for general purpose use. If accuracy is required then the clock frequency can be derived from a crystal oscillator using an appropriate divider. It should be noted that the stepper motor circuit is not suitable for high speed applications.

SERVO CONTROL CIRCUIT PARTS LIST

RESISTORS			
R1, 2	100k	2	M100K
R3	1k	1	M1K
VR1	Pot Lin 10k	1	FW02C
VR2	Hor Encl Preset 10k	1	UH03D
CAPACITORS			
C1	GenElect 100µF 16V	1	AT40T
C2	GenElect 10µF 63V	1	AT77J
C3	Minidisc 0.1µF 16V	1	YR75S
C4, 5	Poly Layer 100nF	2	WW41U
C6	Poly Layer 180nF	1	WW44X
SEMICONDUCTORS			
DRG1	L7805CV	1	QL31J
IC1	HCF4001BEY	1	QX01B
MISCELLANEOUS			
P1 - P5	Pin 2145	5 pins	FL24B
	DIL Socket 14-Pin	1	BL18U
	Economy Servo	1	FS35Q

STEPPER MOTOR CONTROL CIRCUIT PARTS LIST

RESISTORS			
R1, 2, 4, 7, 10	100k	5	M100K
R3, 6, 9	47k	3	M47K
R5, 8, 11	10k	3	M10K
R12	1M	1	M1M
R13	120R	1	M120R
R14	270R 2 Watt	1	D270R
VR1	Hor Encl Preset 1M	1	UH09K
CAPACITORS			
C1	Poly Layer 100nF	1	WW41U
C2	GenElect 100µF 25V	1	AT48C
C3, 4, 6	Disc 0.1µF 50V	3	BX03D
C5	Genelect 470µF 25V	1	AT51F
SEMICONDUCTORS			
IC1	4093BE	1	QW53H
IC2	SAA1027	1	QY76H
TR1-3	BC547	3	QQ14Q
D1-3	1N4148	3	QL80B
MISCELLANEOUS			
P1-16	Pin 2145	16 pins	FL24B
	DIL Socket 14-Pin	1	BL18U
	DIL Socket 16-Pin	1	BL19V
	Stepper Motor Size 1	1	FT73Q

COMMENT

by Keith Brindley

MP3 Again!

Occasionally, there's a leap forward in the effects of technology. Technology itself, on the other hand, improves at a more or less standard rate, with each of its steps forward being usually only a small addition of new processes, software, manufacturing improvements, component size reductions and so on. But the effects that a small technological step forward can generate are sometimes not always proportional to the technological step forward itself.

MP3 is such an effect. In technological steps it's a relatively minor step forward from MP2, and, indeed, from every technological process that has used electronic and electro-mechanical means to record and playback sound files since the year dot (or, at least, since the phonograph saw the light of day). It is, merely, a method whereby high-quality audio files can be stored on computer disk in a compressed format, and played back simply by running the files themselves.

The effects of this ability, however, are far more important than this might suggest. First, the compressed files are quite small (a rule-of-thumb is that a minute's worth of audio will take up approximately 1Mb of disk space - compare this with CD audio files that take up around ten or twelve times this). Second, simply because they are comparatively small, they can be transmitted over the Internet. Third, they are also small enough to be stored in solid-state storage devices such as RAM or flash cards, so can be transported easily (much like audio files can be recorded on audiocassette tape or Mini-Discs - though, of course, with no moving parts!).

Which leads us to the actual leap forward in technology. As files are stored in solid-state form, they can be played back on solid-state portable players. The first of these portable MP3 players started to arrive last year, and have proved themselves quite popular among the gadget freaks and nerds. But typical portable music lovers never got to grips with them. Downloading music files from a computer to the players was slow and cumbersome, and the price of storage cards was high.

But second-generation MP3 players will improve on this, as they will nearly all use the USB socket that is common on most computers these days. This allows the potential of much faster downloading. The price of the storage cards is set to decrease rapidly too, as more and more users increase the sales. So the time is probably right for MP3 portable players, like never before.

First of these second-generation MP3 players to arrive on the streets is the Diamond Rio 500. (Diamond's Rio 300 was one of the first first-generation players, too). Sporting USB, under test, over 60 minutes worth of high-quality MP3 format files were downloaded to the Rio 500 in less than four minutes. With a battery-life from its single AA-sized cell of over 13 hours, and offering additional storage of MP3 files on plug-in Smart Media cards, the Rio 500 represents what must surely be the ultimate in portable music - at least, to date that is.

Around the size of a Swan Vestas matchbox, and around the same weight, the Rio 500 fits easily into any pocket. All main music player-type controls are provided - play, stop, forward, reverse, shuttle forward and reverse, volume and so on. The volume control doubles as a function key to access further controls. A browse button lets you scan through tracks quickly, and a bookmark button lets you bookmark tracks or track parts.

The thing about MP3 is that it achieves its fantastic compression ratio because the encoding process strips out part of the original sound file. CD files, for example, are recorded as a very high quality format - the information that makes up a CD file is far greater than a human ear can ever hope to hear. In audio terms CD files are simply wastes of space. When an MP3 file is encoded all the extraneous and unhearable sound information is stripped out, leaving just the sound and nothing but the sound. The trick is to encode the file so that not too much sound information is removed in the encoding process, otherwise the drop in sound quality might be heard. But this depends on the software that's used to encode MP3 files.

Sound quality from the Rio 500 is nothing short of extremely good, which proves that the encoding software, which comes with the player, is good too. Windows users have Audio Manager to allow encoding of CD tracks to MP3, while Mac users have SoundJam MP. Both of these tools do their respective jobs on each computing platform with ease. Apart from allowing downloading of these encoded MP3 files, both programs allow a computer user to catalogue and access MP3 files in a database manner, as playlists or albums, which can be played on a computer when desired. It's also feasible that users could encode a whole collection of CDs into MP3 format and play individual tracks and complete albums as and when wanted. Both programs too, allow users to link to Websites where MP3 files can be purchased and downloaded.

On a practical basis, in a direct comparison with a portable Mini Disc player it was impossible to detect any sound quality difference between MP3 files on the Rio 500, and digitally recorded CD tracks on a Mini Disc - at least with the reviewer's relatively untrained ears. The fact that a Mini Disc player is significantly larger and heavier than the Rio 500, as well as using much more power so drains batteries more quickly, means that the Rio 500 wins hands-down in terms of usability. On the other hand, the Rio 500's only current drawback is the price of storage cards.

Storage card price aside (it is just a question of time until they become cheap enough for everyday use), this all adds up to the fact that MP3 portable players (if they can match the Diamond Rio 500's quality) are at last on target to beat other forms of portable music players. There's already nothing quite like it when it comes to coolness factor - and the Rio 500 currently sets the coolness pace.

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

FET Principles & CIRCUITS

PART 3

Ray Marston looks at practical MOSFET and CMOS circuits in this penultimate episode of this 4-part series.

Part 1 of this series explained (amongst other things) the basic operating principles of the MOSFET (or IGFET), and pointed out that complementary enhancement-mode pairs of these devices form the basis of the digital technology known as CMOS. The present episode of the series looks at practical applications of MOSFETs and CMOS-based MOSFET devices.

A MOSFET Introduction

MOSFETs are available in both depletion-mode and enhancement-mode versions. Depletion-mode types give a performance similar to a JFET, but with a far higher input resistance (i.e. with a far higher low-frequency input impedance). Some depletion-mode MOSFETs are equipped with two independent gates, enabling the drain-to-source currents to be controlled via either or both of the gates; these devices (which are often used as signal mixers in VHF tuners) are known as dual-gate or tetrode MOSFETs, and use the symbol shown in Figure 1.

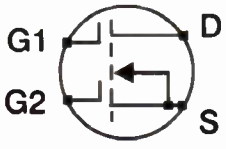


Figure 1. Symbol of the dual-gate or tetrode MOSFET.

Most modern MOSFETs are enhancement-mode devices, in which the drain-to-source conduction channel is closed when the gate bias is zero, but can be opened by applying a forward gate bias. This 'normally open-circuit' action is implied by the gaps between source and drain in the device's standard symbol, shown in Figure 2(a), which depicts an n-channel MOSFET (the arrow head is reversed in a p-channel device). In some devices the semiconductor substrate is made externally available, creating a 'four-terminal' MOSFET, as shown in Figure 2(b).

Figure 2. Standard symbols of (a) three-pin and (b) four-pin n-channel enhancement-mode MOSFETs.

Figure 3 shows typical transfer characteristics of an n-channel enhancement-mode MOSFET, while Figure 4 shows the VGS/ID curves of the same device when powered from a 15V supply. Note that no significant ID current flows until the gate voltage rises to a threshold (VTH) value of a few volts, but that beyond this value the drain current rises in a non-linear fashion. Also note that the Figure 3 graph is divided into two characteristic regions, as indicated by the dotted line, these being the 'triode' region, in which the MOSFET acts like a voltage-controlled resistor, and the 'saturated' region', in which it acts like a voltage-controlled, constant-current generator.

Because of their very high input resistances, MOSFETs are vulnerable to damage via electrostatic discharges, and for this reason, MOSFETs are sometimes provided with integral protection via diodes or zeners.

The 4007UB

The easiest and cheapest practical way of learning about enhancement-mode MOSFETs is via a 4007UB IC, which is the simplest member of the popular CMOS '4000-series' digital IC range, and actually houses six useful MOSFETs in a single 14-pin DIL package.

Figure 5 shows the functional diagram and pin numbers of the 4007UB, which houses two complementary pairs of

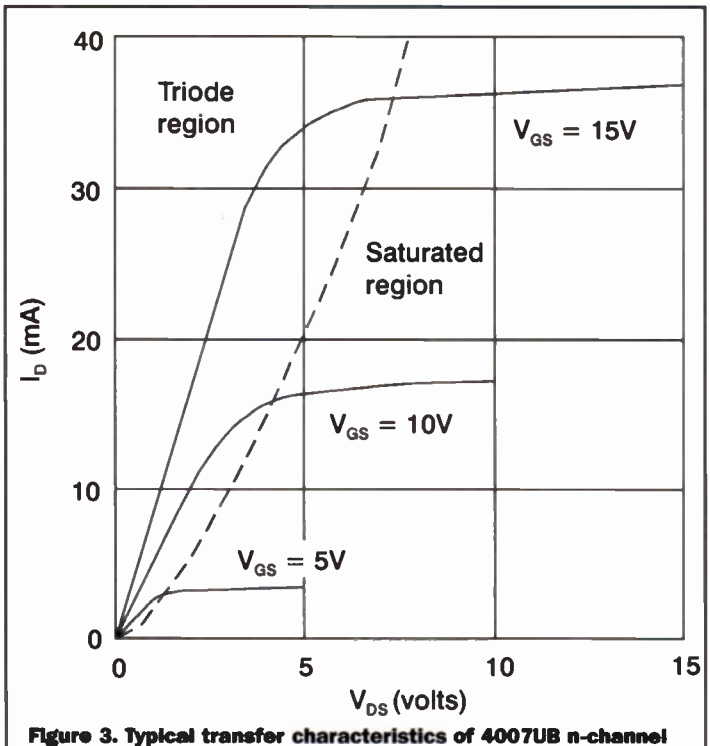


Figure 3. Typical transfer characteristics of 4007UB n-channel enhancement-mode MOSFETs.

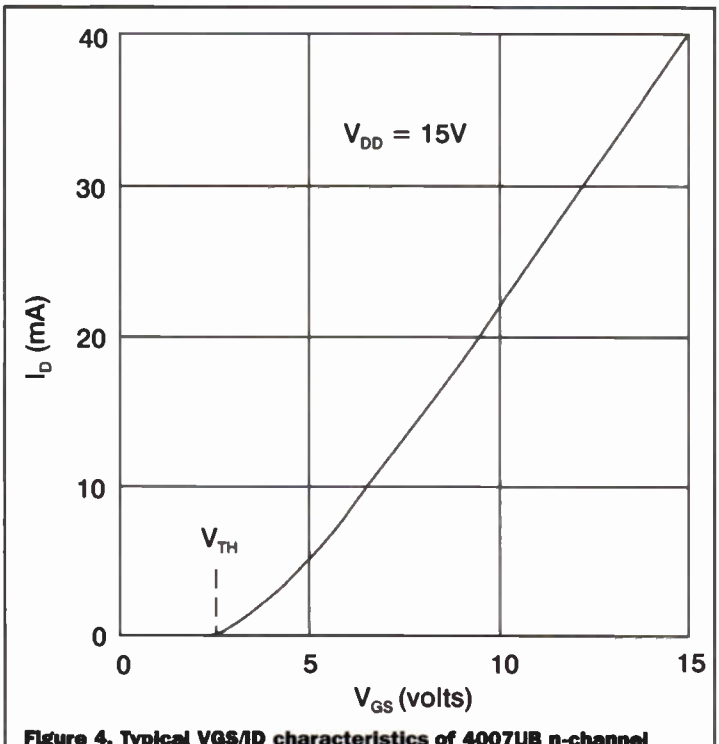


Figure 4. Typical VGS/ID characteristics of 4007UB n-channel enhancement-mode MOSFET.

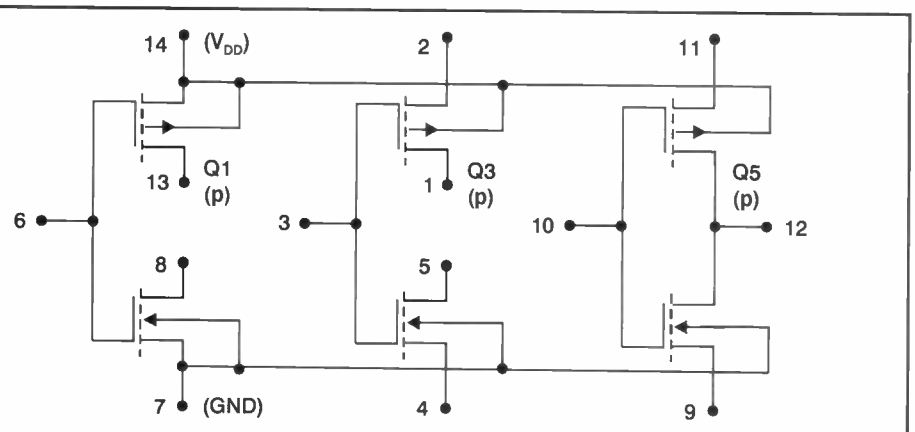


Figure 5. Functional diagram of the 4007UB dual CMOS pair plus inverter.

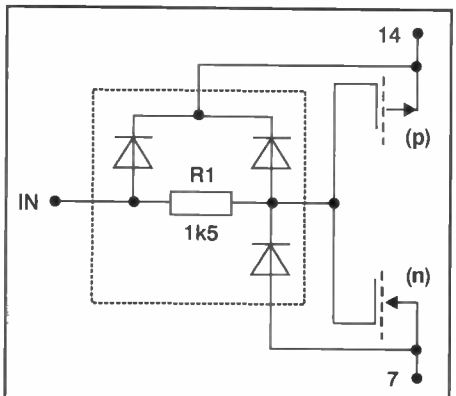


Figure 6. Internal-protection network (within dotted lines) on each input of the 4007UB.

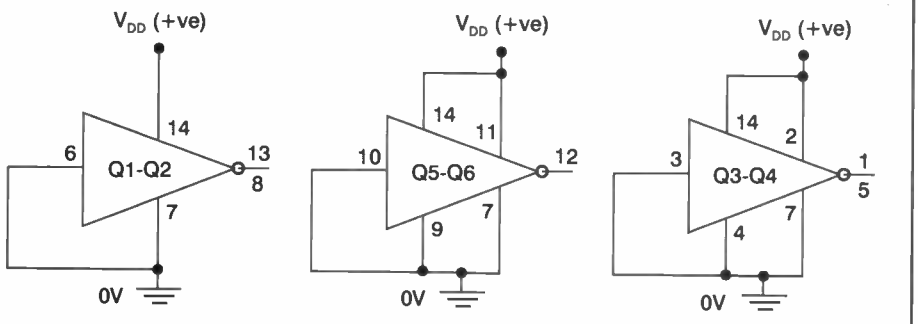


Figure 7. Individual 4007UB complementary pairs can be disabled by connecting them as CMOS inverters and grounding their inputs.

independently-accessible MOSFETs and a third complementary MOSFET pair that are connected as a standard CMOS inverter stage. Each of the IC's three independent input terminals is internally connected to the standard CMOS protection network shown in Figure 6. Within the IC, Q1, Q3 and Q5 are p-channel MOSFETs, and Q2, Q4 and Q6 are n-channel types. Note that the performance graphs of Figures 3 and 4 actually apply to the individual n-channel devices within this CMOS IC.

The 4007UB usage rules are simple. In any given application, all unused IC elements must be disabled. Complementary pairs of MOSFETs can be disabled by connecting them as standard CMOS inverters (i.e., gate-to-gate and source-to-source) and tying their inputs to ground, as shown in Figure 7. Individual MOSFETs can be disabled by tying their source to their substrate and leaving the drain open circuit. In use, the IC's input terminal must not be allowed to rise above VDD (the supply voltage) or fall below VSS (zero volts). To use an n-channel MOSFET, the source must be tied to VSS, either directly or via a current-limiting resistor. To use a p-channel MOSFET, the source must be tied to VDD, either directly or via a current-limiting resistor.

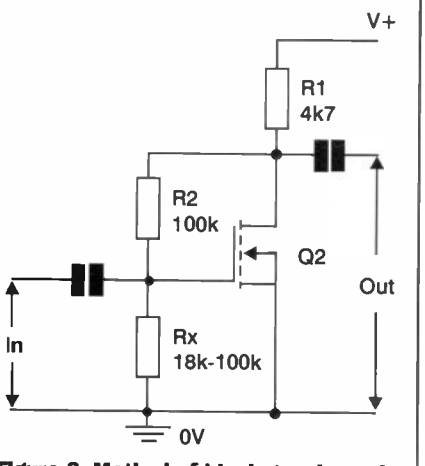


Figure 8. Method of biasing n-channel 4007UB MOSFETs for use as a linear inverting amplifier (with medium input impedance).

Linear Operation.

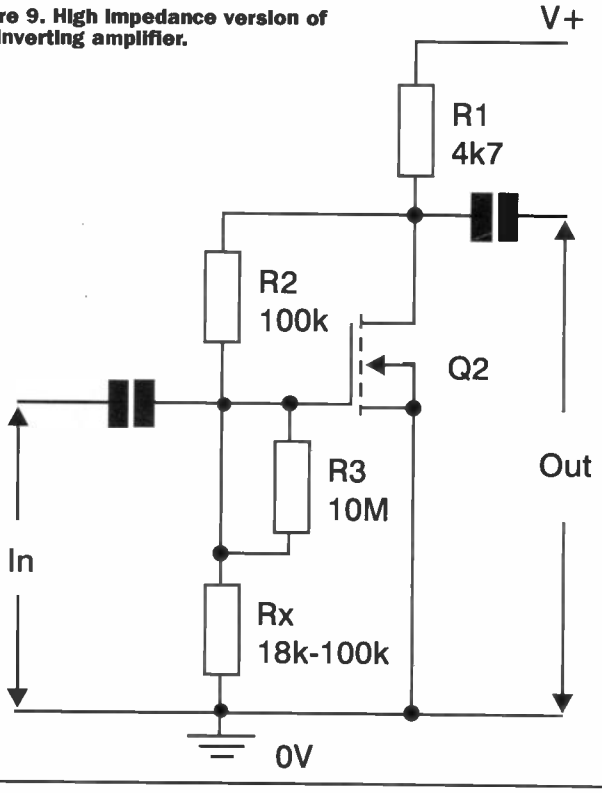
To fully understand the operation and vagaries of CMOS circuitry, it is necessary to understand the linear characteristics of basic MOSFETs, as shown in the graph of Figure 4; note that negligible drain current flows until the gate rises to a 'threshold' value of about 1.5V to 2.5V, but that the drain current then increases almost linearly with further increases in gate voltage.

Figure 8 shows how to use an n-channel 4007UB MOSFET as a linear inverting amplifier. R1 acts as Q2's drain load, and R2-Rx bias the gate so that Q2 operates in the linear mode. The Rx value is selected to give the desired quiescent drain voltage, and is normally in the 18kΩ to 100kΩ range. The amplifier can be made to give a very high input impedance by wiring a 10MΩ isolating resistor between the R2-Rx junction and Q2 gate, as shown in Figure 9.

Figure 10 shows how to use an n-channel MOSFET as a unity-gain non-inverting common-drain amplifier or source follower. The MOSFET gate is biased at half-supply volts by the R2-R3 divider, and the source terminal automatically takes up a quiescent value that is slightly more than V_{TH} below the gate value. The basic circuit has an input impedance equal to the paralleled values or R2 and R3 (=50kΩ), but can be increased to greater than 10MΩ by wiring R4 as shown. Alternatively, the input impedance can be raised to several hundred megohms by bootstrapping R4 via C1 as shown in Figure 11.

Note from the above description that the enhancement -mode MOSFET performs like a

Figure 9. High impedance version of the inverting amplifier.



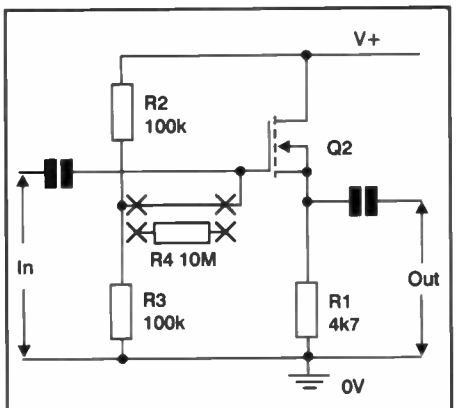


Figure 10. Methods of biasing n-channel 4007UB MOSFET as a unity-gain non-inverting amplifier or source follower.

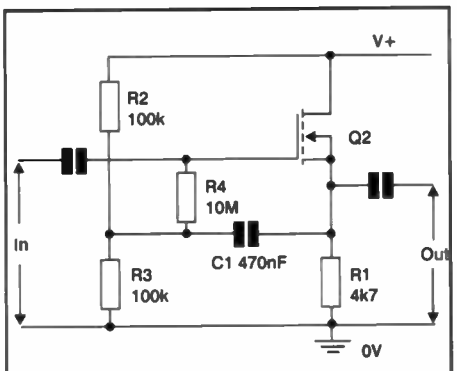


Figure 11. Bootstrapped source follower has ultra-high input impedance.

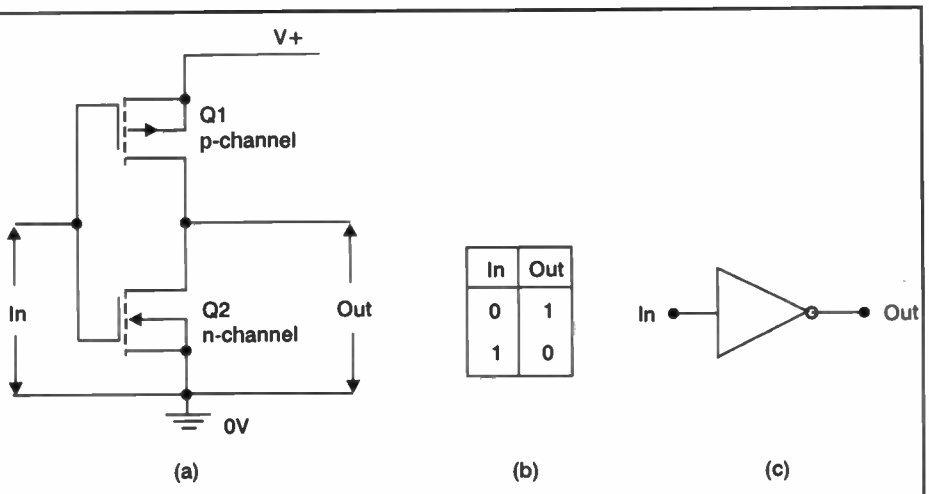


Figure 12. Circuit (a), truth table (b) and symbol (c) of the basic CMOS digital inverter.

conventional bipolar transistor, except that it has an ultra-high input impedance and has a substantially larger input-offset voltage (the base-to-emitter offset of a bipolar is typically 600mV, while the gate-to-source offset voltage of a MOSFET is typically 2V). Allowing for these differences, the enhancement-mode MOSFET can thus be used as a direct replacement in many small-signal bipolar transistor circuits.

The CMOS Inverter

A major application of enhancement-mode MOSFETs is in the basic CMOS inverting stage of Figure 12(a), in which an n-channel and a p-channel pair of MOSFETs are wired in series but share common input and output terminals. This basic CMOS circuit is primarily meant for use in digital applications (as described towards the end of Part 1 of this series), in which it consumes negligible quiescent current but can source or sink substantial output currents; Figures 12(b) and 12(c) show the inverter's digital truth table and its circuit symbol. Note that Q5 and Q6 of the 4007UB IC are fixed-wired in the CMOS inverter configuration.

Although intended primarily for digital use, the basic CMOS inverter can be used as a linear amplifier by biasing its input to a value between the logic-0 and logic-1 levels; under this condition Q1 and Q2 are both biased partly on, and the inverter thus passes significant quiescent current. Figure 13 shows the typical drain-current (ID) transfer characteristics of the circuit under this condition; ID is zero when the input is at zero or full supply volts, but rises to a maximum value (typically 0.5mA at 5V, or 10.5mA at 15V) when the input is at roughly half-supply volts, under which condition both MOSFETs of the inverter are biased equally.

Figure 14 shown the typical input-to-output voltage-transfer characteristics of the simple CMOS inverter at different supply voltage values. Note that the output voltage changes by only a small amount when the input voltage is shifted around the VDD and 0V levels, but that when Vin is biased at roughly half-supply volts a small change of input voltage causes a large change of output voltage: typically, the inverter gives a voltage gain of about 30dB when used with a 15V supply, or 40dB at 5V.

Figure 15 shows a practical linear CMOS inverting amplifier stage. It is biased by wiring 10M resistor R1 between the input and output terminals, so that the output self-biases at approximately half-supply volts. Figure 16 shows the typical voltage gain and frequency characteristics of this circuit when operated at three alternative supply rail values; this graph assumes that the amplifier output is feeding into the high impedance of a 10MΩ/15pF oscilloscope probe, and under this condition the circuit has a bandwidth of 2.5MHz when operating from a 15V supply.

As would be expected from the voltage transfer graph of Figure 14, the distortion characteristics of the CMOS linear amplifier are quite good with small-amplitude signals (output amplitudes up to 3V peak-to-peak with a 15V supply), but the distortion then increases as the output approaches the upper and lower supply limits. Unlike a bipolar transistor circuit, the CMOS amplifier does not 'clip' excessive sinewave signals, but progressively rounds off their peaks.

Figure 17 shows the typical drain-current versus supply-voltage characteristics of the

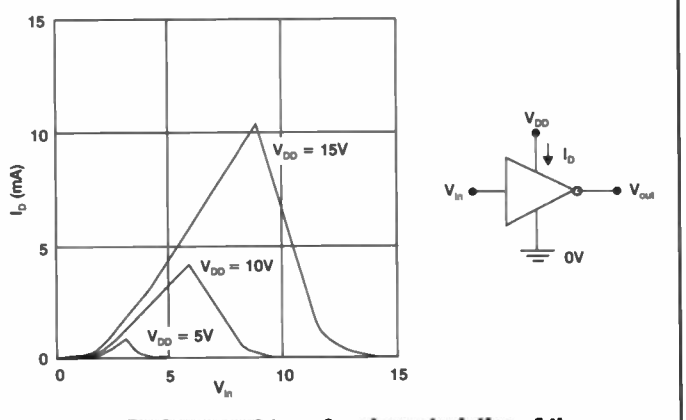


Figure 13. Drain-current transfer characteristics of the simple CMOS inverter.

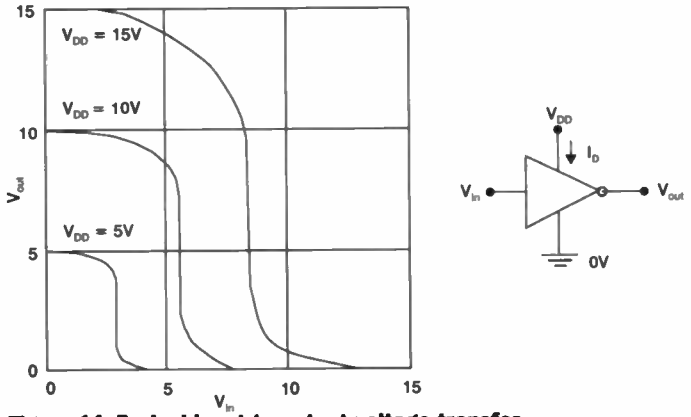


Figure 14. Typical input-to-output voltage transfer characteristics of the 4007UB simple CMOS inverter.

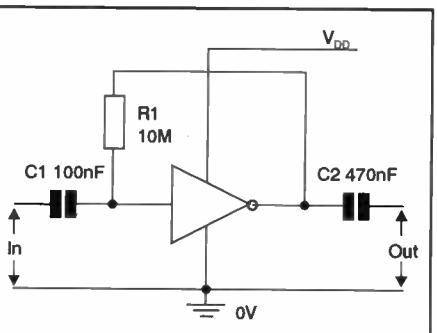
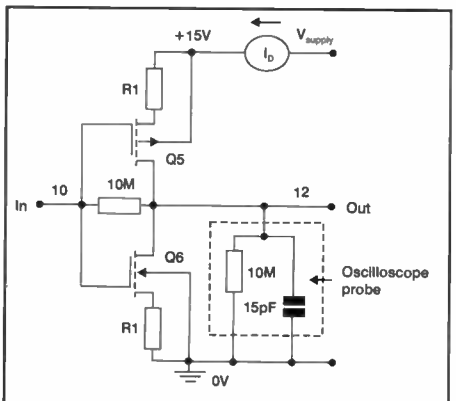


Figure 15. Method of biasing the simple CMOS inverter for linear operation.



R1	I_D	AV (V_{out}/V_{in})	Upper 3dB Bandwidth
0	12.5mA	20	2.7MHz
100R	8.2mA	20	1.5MHz
560R	3.9mA	25	300kHz
1k	2.5mA	30	100kHz
5k6	600µA	40	25kHz
10k	370µA	40	15kHz
100k	40µA	30	2kHz
1M	4µA	10	1kHz

Figure 18. Micropower 4007UB CMOS linear amplifier, showing method of reducing ID, with performance details.

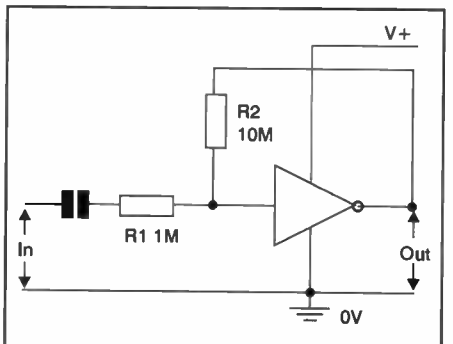


Figure 19. Linear CMOS amplifier wired as x10 inverting amplifier.

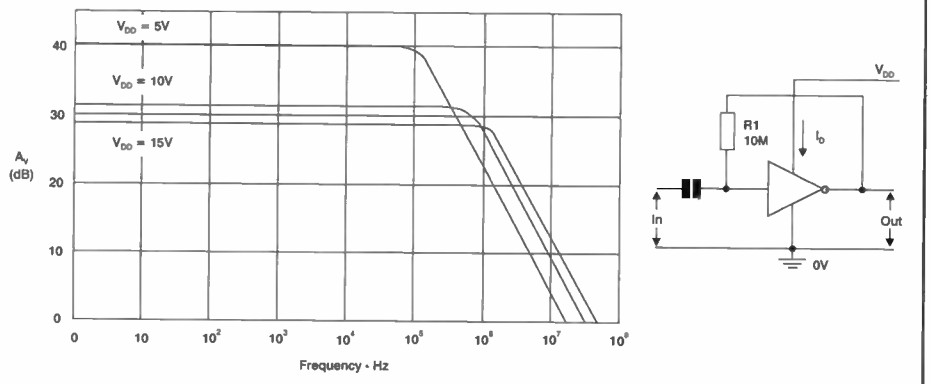


Figure 16. Typical AV and frequency characteristics of the linear-mode basic CMOS amplifier.

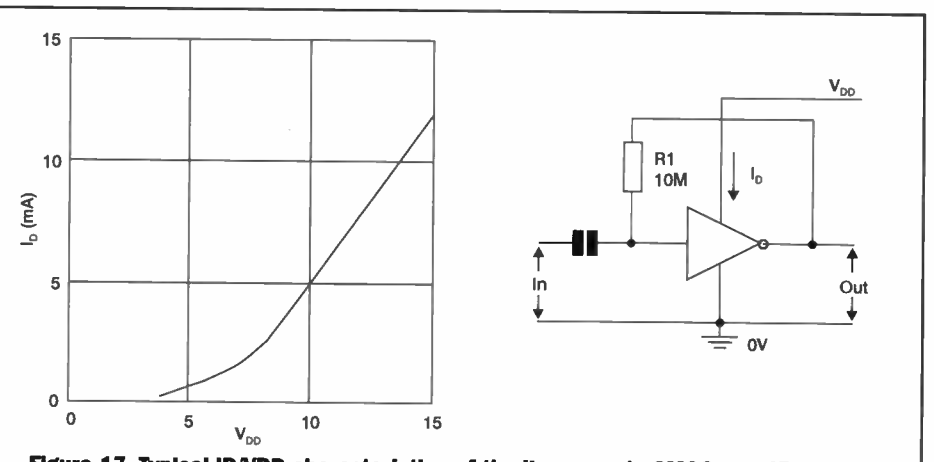


Figure 17. Typical ID/VDD characteristics of the linear-mode CMOS amplifier.

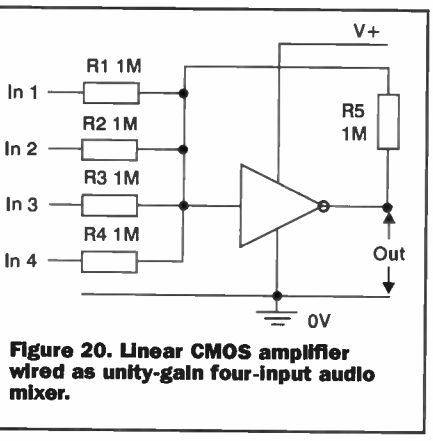


Figure 20. Linear CMOS amplifier wired as unity-gain four-input audio mixer.

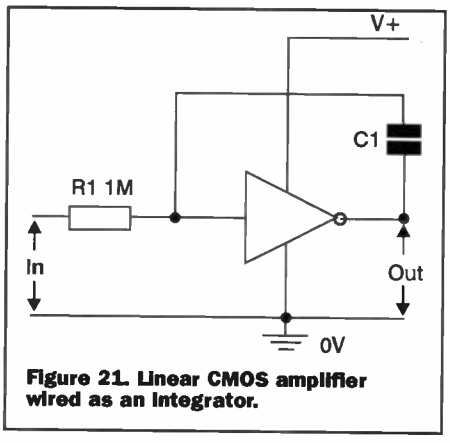


Figure 21. Linear CMOS amplifier wired as an integrator.

CMOS linear amplifier. The current typically varies from 0.5mA at 5V, to 12.5mA at 15V.

In many applications, the quiescent supply current of the 4007UB CMOS amplifier can be usefully reduced, at the cost of reduced amplifier bandwidth, by wiring external resistors in series with the source terminals of the two MOSFETs of the CMOS stage, as shown in the 'micropower' circuit of Figure 18. This diagram also lists the effects that different resistor values have on the drain current, voltage gain, and bandwidth of the amplifier when operated from a 15V supply and with its output loaded by a 10MΩ/15pF oscilloscope probe.

Note that the additional resistors of the Figure 18 circuit increase the output impedance of the amplifier (the output impedance is roughly equal to the R1-AV product), and this impedance and the external load resistance/capacitance has a great effect on the overall gain and bandwidth of the circuit. When using a 10kΩ value for R1, for example, if the load capacitance is increased (from 15pF) to 50pF the bandwidth falls to about 4kHz, but if the capacitance is reduced to 5pF the bandwidth increases to 45kHz. Similarly, if the resistive load is reduced from 10MΩ to 10kΩ, the voltage gain falls to unity; for significant gain, the load resistance must be large relative to the output impedance of the amplifier.

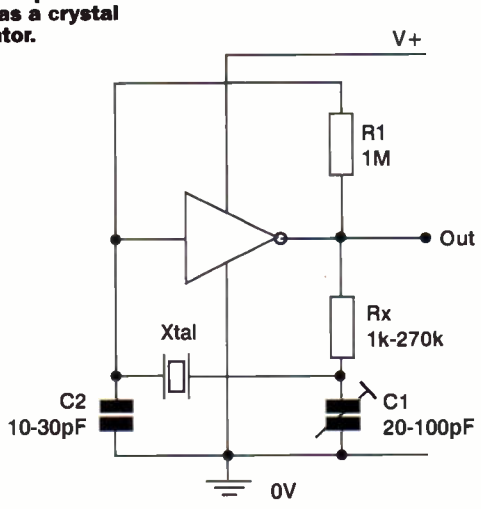
The basic (unbiased) CMOS inverter stage has an input capacitance of about 5pF and an input resistance of near-infinity. Thus, if the output of the Figure 18 circuit is fed directly to such a load, it shows a voltage gain of x30 and a bandwidth of 3kHz when R1 has a value of 1MΩ; it even gives a useful gain and bandwidth when R1 has a value of 10MΩ, but consumes a quiescent current of only 0.4mA.

Practical CMOS

The CMOS linear amplifier can easily be used, in either its standard or micropower forms, to make a variety of fixed-gain amplifiers, mixers, integrators, active filters, and oscillators, etc. A selection of such circuits are shown in Figures 19 to 23.

Figure 19 shows the practical circuit of a x10 inverting amplifier. The CMOS stage is biased by feedback resistor R2, and the

Figure 22. Linear CMOS amplifier wired as a crystal oscillator.



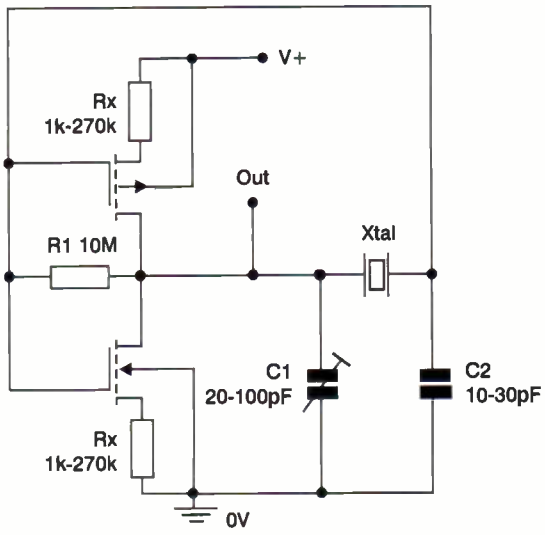


Figure 23. Micropower version of the crystal oscillator.

voltage gain is set at x10 by the R1/R2 ratio. The input impedance of the circuit is 1MΩ, and equals the R1 value.

Figure 20 shows the above circuit modified for use as an audio 'mixer' or analogue voltage adder. The circuit has four input terminals, and the voltage gain between each input and the output is fixed at unity by the relative values of the 1MΩ input resistor and the 1MΩ feedback resistor.

Figure 21 shows the basic CMOS amplifier used as a simple integrator.

Figure 22 shows the linear CMOS amplifier used as a crystal oscillator. The amplifier is linearly biased via R1 and provides 180° of phase shift at the crystal resonant frequency, thus enabling the circuit to oscillate. If the user wants the crystal to provide a frequency accuracy within 0.1% or so, Rx can be replaced by a short and C1-C2 can be omitted.

For ultra-high accuracy, the correct values of Rx-C1-C2 must be individually determined (the diagram shows the typical range of values).

Finally, Figure 23 shows a 'micropower' version of the CMOS crystal oscillator. In this case, Rx is actually incorporated in the amplifier. If desired, the output of this oscillator can be fed directly to the input of an additional CMOS inverter stage, for improved waveform shape/amplitude.

An Electrifying CENTURY

THE RISE OF ELECTRONICS 1900 - 2000

In part 4, As we move towards 1975 Gregg Grant recalls the marvel of miniaturisation

Introduction

In 1950 Richard Hamming - whilst working as a research mathematician at the Bell Telephone Laboratories - invented the Hamming Code. This was the first method devised specifically for correcting machine-generated computer errors.

Computers could now identify errors in the data and instructions and tell where they occurred. This would - in time - develop into the separate discipline of error-correcting codes.

Two years later the British reliability engineer G.W.A. Dummer read a paper to an electronics component symposium in Washington, DC., entitled simply Electronic Components in Great Britain. In this seemingly staple fayre for such gatherings was the statement that, since semiconductors were now very much a part of electronics, future electrical components could possibly be manufactured in a solid block of material, thus doing away with interconnecting wiring, among other things.

A mere six years later, the Texas Instruments design engineer Jack Kilby created the first Integrated Circuit, (IC), a phase-shift oscillator. The first patent was filed in February 1959 and a press announcement followed in March. The miniaturisation of electronics had begun.

Minis and Micros

The real breakthrough came with the development of Transistor-Transistor Logic, or TTL, initially invented by R.H. Beeson at the Fairchild Corporation's research and development laboratories. Further developed by another Fairchild engineer, Heinz Rüegg, the technique used '. . . the multiple-emitter transistor, in which two or more emitters share a common base and collector.'[1] TTL became as fundamentally important almost as the development of semiconductors themselves. Further variations - based on Beeson and Rüegg's work - included Schottky TTL, high-speed TTL and low-power TTL, to name but three.

These developments, along with General Electric's introduction of Emitter-Coupled Logic, or ECL, in 1961 not only greatly reduced the size of components, but also substantially increased circuit speed. By 1963, the Motorola Corporation had created a family of ECL devices with gate delays of one nanosecond (1ns).

Four years later the expression minicomputer first appeared, it beginning life as a buzzword for small physical size, short word length, above all affordable computers. In 20 short years, the containment/support structure for a computer had gone from the large room required to accommodate ENIAC, to the cabinet housing modules whose own capacity was under constant and rapid change.

In the beginning, such modules held about 1-binary digit (bit) of information. Shortly they would hold a whole register and very rapidly, the register was manufactured as an IC, such was integrative progress. A computer - albeit a limited function one - could now be located on the single frame of a standard rack. This was the minicomputer.

The next stage in this relentless reduction in size was the microprocessor, first introduced by the Integrated Electronics, (Intel), Corporation in 1971. Fabricated as a 3 x 4mm slice of silicon, the device comprised 2,250 transistors and had a 4-bit word length, and for the day, was a radical design.

This development was timely for the floppy disk had appeared in the previous year and, in its original form was '. . . simply a component of the IBM 370 . . and a pretty obscure one at that.'[2] All the elements were now in place to take the computer into a market hitherto ignored by the manufacturers: the home.

In 1974, the American magazine Radio Electronics published an article in which the construction of what it termed a Personal Computer, or PC, was given. In the following year the first ever PC - the Altair 8800 - was introduced in kit form in the United States, it having a mere 256 bytes of memory!

Satellite Communications

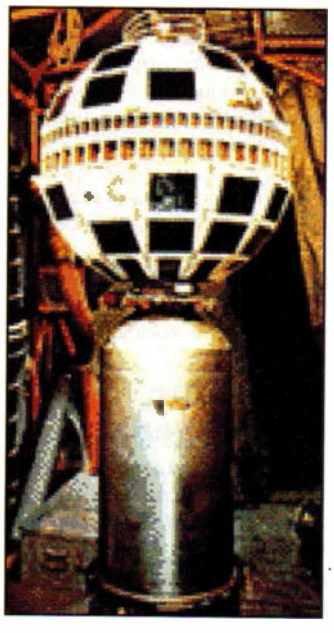
In October 1945, the much respected British electronics journal Wireless World carried an article entitled 'Extra Terrestrial Relays' written by a Royal Air Force communications officer called Arthur C. Clarke. The author's theme was that the use of satellites would enable communicators to get above the radio horizon, and so bridge the oceans via microwave communications.

Clarke went on to point out that, at 22,300 miles above the earth, a satellite would be in an orbit which matched the earth's rotation, thus enabling it to remain directly above one particular location on the earth's surface.

The earliest attempts at satellite communications were two huge '. . metallized balloons, Echo 1 and Echo 2 [which] were orbited for this purpose in mid 1960 and early 1964 respectively.'[3] Meanwhile, development of satellite relay systems as envisaged by Clarke was forging ahead and in July 1962 Telstar 1, a satellite designed at Bell Labs, was placed in orbit. It was this relay that provided the first, high quality, Trans-Atlantic TV transmissions.

By the end of the year Telstar had an orbital companion, the National Aeronautics and Space Administration's (NASA's) Relay 1 satellite, built by the Radio Corporation of America (RCA). Like its companion, it was employed in demonstration broadcasts and communications experiments generally. In 1964, the International Telecommunications Satellite Consortium (Intelsat) was formed, with a start-up membership of 14 national telecommunications authorities. A decade later the organisation had 91 members. A year after its creation it launched its first satellite, Early Bird, which contained 240 voice circuits.

Placed in an equatorial orbit some 22,400 miles above the planet, this satellite had some 45W primary power from its solar cells. Its end-product was either 120 voice circuits or a single TV channel.



By 1970, the facilities a communications satellite could offer had expanded considerably, as illustrated by the North Atlantic Treaty Organisation's (NATO's) NATO 1 vehicle, placed in orbit in March. Located near the equator at roughly 18°W longitude, this was a multi-facility platform, its 7,000-odd solar cells supplying power to a wide variety of communications channels carrying wideband information as well as voice, telegraphic and facsimile data.

In April 1974 the United States launched the Westar-1 vehicle, the first American domestic communications satellite. Capable of transmitting either 14,400 one-way telephone circuits via five terrestrial stations in Los Angeles, Atlanta, Dallas, New York and Chicago or 12 colour TV channels, this satellite was indicative of how far extra-terrestrial communications has come in 15 short years!

Indeed, the growth of satellite communications was such that, by 1974, some 60 countries possessed around 104 dish antennas with 359 recognised satellite communications pathways. This was made possible by the astonishing developments in electronic devices between 1950 and 1975, some of which are itemised in Table One.

With three quarters of the most progressive century in man's history already over, the above developments indicated that the electronic medium really had become the message, whatever your language, culture or background.

In production terms, the development of the printed circuit board with dip soldering, coupled with the planar photo-mask technique for integrated circuit manufacture, meant that volume production of components and platforms was now possible and competitive prices. Moreover, it was obvious that ' .. reliability and miniaturisation were intertwined: the smaller the device, the fewer the parts and interconnections; the fewer the parts and interconnections, the higher the reliability.'[4]

Device	Inventor(s) and Country	Date
Thermo-Compression Bonding	O.L. Anderson, P. Andreatch & Howard Christensen (Bell Labs, USA)	1950
Darlington Pair transistor circuit	Sidney Darlington, [Bell Labs, USA]	1952
Trans-Atlantic Telephone Cable (TAT-1)	United States of America/United Kingdom	1956
Nickel-Chromium Thin-Film Resistors	R.H. Alderton & F. Ashworth (UK)	1957
Tunnel Diode	Leo Esaki (Japan)	1958
Video Tape Recorder	Ampex Corporation (USA)	1958
Integrated Circuit	Jack S. Kilby, Texas Instruments Inc., (USA)	1959
Computer Aided Design	United States Armed Forces	1960
Light Emitting Diode	J.W. Allen & P.E. Gibbons (UK)	1960
Metal Oxide Semiconductor IC	Steven R. Hofstein & Frederick P. Heiman (RCA, New Jersey)	1962
Electronic Calculator	Bell Punch Company (UK)	1963
Packet Switching Communications	P. Barcan (USA)	1964
Word Processor	International Business Machine Corporation (IBM, USA)	1964
Computer Mouse	Douglas Englehart (USA)	1965
Audio Noise Reduction System	Ray M. Dolby, (USA)	1967
Complementary Metal Oxide Semiconductor IC (CMOS)	Paul Richman & Walter Zloczower (GT&E Laboratories USA). Hung C. Lin (Westinghouse)	1968
Semiconductor Memory System	B. Augusta, R.D. Moore & G.K.Tu (USA)	1969
Unix Operating System.	Ken Thompson & Dennis Ritchie (USA)	1970
Microprocessor.	Marcian E. Hoff [Intel Corporation, (USA)	1971
Computerised Axial Tomography (CAT)	Godfrey Houndsfield, (EMI, UK)	1972
Video Disks.	Philips Gloeilampenfabrieken (Holland)	1973
4-kBit Random Access Memory	Fairchild Corporation (USA)	1975

Table 1: Electronic Device Developments 1950-1975.

Computer Languages

Hardware of course was by no means developing in isolation. The first computer programming language was developed as early as 1956, by John Backus and his team at IBM. They termed their brainchild Formula Translation language, which was swiftly abbreviated to FORTRAN. As its name implied, it was created for mathematical work, specifically scientific calculations. Until this development, computer programs had to be installed in machine language.

Three years later, Grace Murray Hopper invented a Common Business Oriented Language, or COBOL, another language designed for computer professionals, or the specific needs of a particular segment of the world of work.

However, in 1965 two American college lecturers, John Kemeny and Thomas Kurtz, developed a language to aid them in their work, the teaching of programming to students. Subsequently their creation - Beginners All-Purpose Symbolic Instruction Code, or BASIC, would have considerable influence, later becoming the main programming language of the early PC owners, although the majority of commercial programs for PCs are now in more sophisticated languages.

By 1971, Niklaus Wirth had developed PASCAL - called after Blaise Pascal, the inventor of the first calculator - another language popular with PC users. By early 1975, there were in excess of 500 programming languages both in existence and in use.

Lingua - in Latin - means tongue, yet paradoxically almost all programming languages remain 'eye' languages. Moreover, programming languages are unlike all other languages known to man in that they have but one tense: the imperative.

Whilst conventional computer languages are growing ever more enormous they are not - necessarily - getting stronger or more efficient. One reason for this is that each successive language develops from those that have gone before, or elements of them. Since some of those languages have manuals running to 400 pages and more, the difficulties are obvious.

Another limitation on language strength and efficiency is that all languages are programmed in a basic, word-at-a-time style, because the von Neumann architecture has three parts namely a Central

Processing Unit, or CPU; a Store and a Connecting Tube, known as the von Neumann bottleneck.

Nevertheless, software IS becoming more efficient. Currently, most programmes have as little as one error in 1,000 lines of code, although the efficiency taken for granted with hardware has yet to become apparent in software.

Goodbye to Copper

In July 1966, two research engineers at Standard Telephones and Cables, (STC) laboratories' published a paper entitled Dielectric-Fibre Surface Waveguides for Optical Frequencies in the journal "Proceedings of the IEE."

Charles Kao and George Hockham thought that 'a fibre of glassy material constructed in a cladded structure represents a possible practical optical waveguide with important potential as a new form of communication medium.' [5] They were, in effect, serving notice on the long hold of copper cable on the communications industry.

Nevertheless, some formidable problems had to be overcome before copper would be easily dislodged from the pole position as carrier of the world's information. To begin with, the attenuation in the fibres of the time was of the order of 1,000dB/kilometre. Secondly, the bandwidth would not be great and perhaps - more to the point - the fibre bundles were far from robust.

As their work progressed, the STC team found that a major problem was the impurities in the glass itself, in particular iron. Furthermore, the theoretical limit of scattering loss turned out to be around 1dB/km at a wavelength of 1m, much less than the horrendous 1000dB/km which had been found in earlier tests.

Kao and Hockham's paper had been reviewed on behalf of the IEE by John Bray, at that time Director of Research at the laboratories of British Telecom, who set up his own research programme into the possibilities of fibre optic communication.

By 1970, the Corning Glass Corporation in America had produced fibres with an attenuation figure of 20dB/km. A mere six years later an attenuation figure of 1dB/km was achieved and the first fibre optic system for use in telephone communication was trialed in the United Kingdom (UK).

The Internet

Revolutionary is - undoubtedly - the most overworked word of the twentieth century, used almost daily to describe the latest ideas and products in practically every field imaginable. Yet one outstanding example of something that is truly revolutionary is taken for granted virtually everywhere: the Internet. The reason for this may be its somewhat quiet, not to say inconspicuous, beginning

In the autumn of 1969 the Advanced Research Projects Agency, (ARPA), of the American Department of Defence, (DOD), decided to fund an experimental computer network. This system - shown at stage 1 of Figure 1 - linked the University of California at both Los Angeles and Santa Barbara with the University of Utah and the Stanford Research Institute. This embryo Wide Area Net or WAN, came to be known as the ARPAnet.

Today, a generation on, this military-financed initiative has become the foundation stone for what can only be called Cyber Planet: the information/shopping/entertainment/education complex of the electronic world. How was this achieved, and what was the object of creating it in the first place?

As noted earlier, Packet Switching communication was developed in 1964 and appeared to offer significant advantages over traditional networks. To begin with it made the efficient use of bandwidth its primary feature, in that bandwidth is strapped to a connection only if that particular connection is generating traffic packets. If it isn't, then the bandwidth is made available to the other connections.

Another feature of a Packet Switching network is its ability to tolerate failures. If, for example one communication link fails, the information packets can be re-routed along another path through the network. It was these perceived advantages that made the DOD decide to invest in the ARPAnet. In this way, it reasoned, it could trial the claims made for Packet Switching.

The Internet - a generic term that simply means a collection of interconnected networks - is arranged as a myriad of interlinked sub- and sub-sub networks, which is the key to understanding its near-unbelievably rapid growth. The 'net' in short is the result of the strapping together of existing sub-nets.

These sub-nets are composed of X.25 Wide Area Nets, (WANs), Ethernet Local Area Nets, (LANs) and networking arrangements, the whole bolted together by the Internet Protocol, (IP), and the Transmission Control Protocol, (TCP), usually linked together as TCP/IP. These were Stage Two developments, brought on stream in 1983. Three years later the NSFnet was begun and, in the following year, the ARPAnet was closed down.

The Internet is today's telegraph, for ' . . common rules and protocols that enable any sort of computer to exchange messages with any other - just as messages could easily be passed from one kind of telegraph apparatus (a Morse printer say) to another (a pneumatic tube).' [6]

The Laser

In November 1957, a Columbia University graduate student called Gordon Gould put forward his idea for what would later become the LASER, or Light Amplification by Stimulated Emission of Radiation. The LASER was a further development of the MASER, the 'M' standing for Microwave. LASERs, of course, use light waves as opposed to microwaves.

In the following year Charles H. Townes of Bell Labs and Nicolaus Bloembergen were using ruby and potassium-cobalt-chromium-cyanide in an attempt to generate laser action.

In 1960, the American physicist Theodore Maimen succeeded in developing the first operating LASER, by building a ruby cylinder whose ends were accurately polished flat and parallel, prior to being coated with a thin film of silver. Maimen then fed energy into the cylinder from a flash lamp, which resulted in the emission of a beam of red light.

The light which resulted was coherent light, which spread only very slightly. Moreover, it could be concentrated into a spot so small that, at its point, gave temperatures far greater than that of the sun. Shortly this device - for which, initially at least, no-one could find a use - proliferated into a wide variety of types, with any number of different uses. Five years later Joseph Giordmaine and Robert Miller developed a continuously tunable laser and by 1970, carbon dioxide lasers had been introduced into industry, for cutting and welding.

Shortly they would find their way into surgery, heat treatment, range-finding, weapons guidance systems and even artistic lighting.

Thus by the beginning of the final quarter of the twentieth century, the world had communications systems more extensive and pervasive than any the early electrical communications pioneers had ever dreamed of. And more - much more - was to come as the century, and indeed the millennium, drew to a close.

References

1 : Atherton, W.A. (1983): From Compass to Computer. San Francisco Press Inc., San Francisco. Ch. 11, Page 302.
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6 : Standage, Tom (1998): The Victorian Internet. Weidenfeld & Nicolson, London. Ch 12, Page 193.

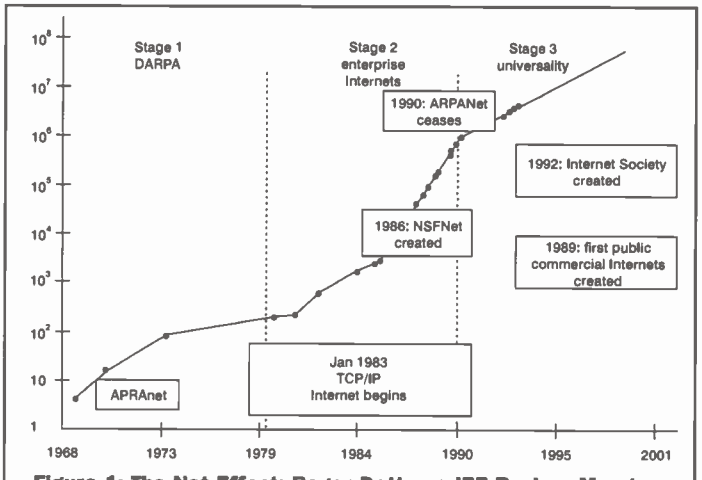


Figure 1: The Net Effect: Roger Dettmer, IEE Review, March 1995. (In 'Electronic Inventions & Discoveries,' Page 213).

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.

March 2000

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

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

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

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

April 2000

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

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

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

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

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

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

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

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

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

May 2000

9 to 10 May. Dealer Expo and Channel Expo, NEC Birmingham. Tel: (01923) 676 867.

23 to 25 May. Internet World Conference and Exhibition, Earls Court, London. Tel: (0208) 232 1600.

June 2000

16 to 18 June. Theme World - Theme Park & Attractions, Alexandra Palace, London. Tel: (0208) 451 6385.

27 to 29 June. Networks Telecom 2000, NEC Birmingham. Tel: (0208) 742 2828.

27 to 29 June. Computer Telephony Expo, NEC Birmingham. Tel: (0208) 742 2828.

September 2000

21 to 24 Sept. Live - Consumer Electronics Show, Earls Court, London. Tel: (0208) 742 2828.

October 2000

3 to 5 Oct. Coil Winding 2000, NEC Birmingham. Tel: (0207) 417 7400.

November 2000

14 to 16 Nov. EID - Electronic Information Display 2000, Sandown Exhibition Centre Esher. Tel: (01822) 614 671.

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?

Sun Shows Dot Com Future Home

Giving consumers the opportunity to experience the home of the future, Sun Microsystems' chairman Scott McNealy unveiled the dot com Home at the Consumer Electronics Show (CES) in Las Vegas in January.

The .com Home introduced consumers to a broad range of innovative everyday appliances, products, technologies and services using Java and Jini technologies that are expected to revolutionise the way that people work and play.

The exhibit demonstrated Internet-enabled solutions using Sun's technologies from leading industry partners and manufacturers in the wireless, interactive television and home gateway markets.

McNealy said that the growing interactive television market is clearly an area where content developers are looking for a reliable software platform upon which to build the next generation of interactive television services, such as Electronic Programming Guide, Video-on-Demand and Enhanced Broadcasting.

The Java platform, along with the Java TV application programming interface (API), provides an ideal development and deployment platform for emerging interactive services for content developers.

The development of consumer products and services using Java and Jini technologies has increased as Sun's consumer technologies have been embraced as a standard for a wide range of devices across multiple industries.

Java technology's open, cross-platform capabilities appeal to device manufacturers and service providers, allowing them to develop and deploy products for consumers rapidly and cost-effectively.

Several industry and standards groups including Home Audio/Video Interoperability (HAVi), Global System for Mobile Communications (GSM), Digital Video Broadcasting (DVB) and the Open Services Gateway Initiative (OSGi) have adopted the Java platform into their development specifications.

For further details, check: <www.sun.com>. Contact: Sun, Tel: (020) 7628 3000.

Hewitt Opens Airwaves to Multimedia Access

Patricia Hewitt, the small business and E-commerce Minister has announced that internet users at home and in the office will soon benefit from fast always-on access to the internet over radio links.

The Government plans to make radio spectrum licences available for the new broadband fixed wireless access services in two tranches. It intends to make the 28GHz licences available this summer and 40GHz licences in the autumn. This follows the consultation 'Wireless in the Information Age'.

Business and domestic users will have access to broadband services, such as fast always-on Internet access over radio links without the need for cable or telephone connections and, high capacity data transfer and video conferencing.

Ms Hewitt said, "There is a high demand for interactive multimedia services that is set to grow dramatically over the next few years. Radio links can offer quick access to these services and more choice and benefits for consumers and the economy.

"I want to make sure that innovative services can be developed as quickly as possible and this will be a major consideration in our decisions on how best to package the spectrum and award licences."

The Government put proposals to industry for spectrum packaging at the first meeting of a Broadband Fixed Wireless Access Consultative Group on in January and is seeking expert advice on financial and market issues.

Proposals for the number of licences to be awarded and the geographical scope of licences are expected to be announced in March.

Anyone wishing to participate on the Broadband Fixed Wireless Access Consultative Group should contact the Agency by e-mail at: <sonkej@ra.gtnet.gov.uk>.

For further details, check: <www.dti.org.uk>. Contact: DTI, Tel: (020) 7215 5000.

Apple Unveils New Operating System, Previews Internet Strategy

Apple chief executive reasserted Apple's leadership in consumer PC and Internet technology at Apple Expo last month when he unveiled Mac OS X, the next generation Macintosh operating system. Jobs also took the wraps off Apple's highly anticipated

Internet strategy, introducing a new category of Internet services called iTools and a completely redesigned Apple.com Web site featuring iReview and iCards.

Mac OS X is a completely new implementation of the Macintosh operating system, featuring state-of-the-art technology throughout, including an entirely new user interface called Aqua.

Mac OS X is designed to make computing even easier for consumers, while simultaneously extending the functionality for professional users. Over 100 developers have pledged their support for the new operating system, including Adobe and Microsoft. Mac OS X will be commercially released this summer.

At the core of Apple's Internet strategy is iTools, a revolutionary new category of Internet services that takes advantage of Apple's technology on both ends of the Internet - Mac OS 9 on the client side and services software (iTools) running on Apple's Internet servers.

Apple announced its first four iTools: KidSafe, a way to protect children on the Internet; Mac.com, an e-mail service run by Apple, giving users an exclusive address on the Internet; iDisk, an entirely new way to store, transfer and share files over the Internet; and, HomePage, claimed to be the easiest way to build your own personal Web site - in less than 10 minutes.

The newly redesigned Apple.com Web site at <www.apple.com>, which currently draws over nine million visitors per week, also features iReview and iCards. iReview is the Internet's finest Web site review guide, with Web sites reviewed and rated by Apple. iCards is Apple's electronic greeting card site, offering premium greetings cards that can be sent and viewed via standard e-mail.

For further details, check: <www.apple.com/uk>. Contact: Apple, Tel: (020) 8218 1000.

Mobile Phone Keypad Displaced by Natural Interface

Mobile phone and pager keypads are set to be replaced by a touch pad or pen interface within two years according to Advanced Recognition Technologies (ART) and Synaptics.

The two companies showcased their solutions at GSM World Congress in Cannes, France at the beginning of February.

ART and Synaptics unveiled two mobile phone interfaces, one using a touch pad and a second using a pen interface. The demonstrations are a showcase for ART's simpliWrite natural handwriting recognition

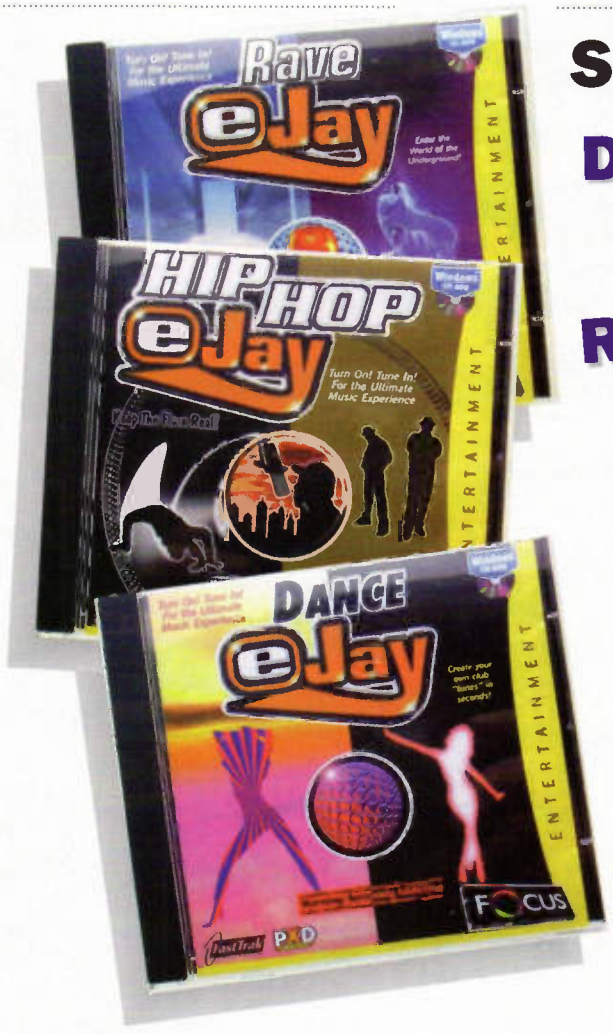
technology and Synaptics' ClearPad touch sensing technology and SPIRAL pen based interface.

The technology will make sending and receiving e-mail via a mobile phone more practical and will provide a substantial up turn in usage, the two companies say.

ART and Synaptics say that mobile phone users can enter numbers or write messages easily and quickly by entering the information by writing with the tip of a finger or using a pen, rather than struggling to decode the push button alphabet or on-screen keyboard.

Using this solution from ART and Synaptics, users do not need to learn a special set of characters and do not need to train the software to recognise their style of writing.

For further details, check: <www.synaptics.com>. Contact: Synaptics, Tel: (01223) 875220.



Software Quick Review

Dance e-jay
Hip Hop ejay
Rave ejay

£9.99 each

from Focus Multimedia

These are mean pieces of software and for the price of a tenner you cannot go wrong. These have just got to be the quickest fixes for dance and party music ever. With full 8 track arrangement and stereophonic effects you can pick your voice samples, base line, melody, percussion and effects on a drag and drop basis from over 1000 samples on each disc. The simplicity is breathtaking for even young kids can get to operate it in seconds and put together these samples. Autosynchrony means you can never be out with your timing and each sample is quantised and can be joined seamlessly. The sound quality of the samples are excellent. If you get fed up with all the sounds on the disc you can import your own .wav files or go on to the internet to down load some more. Store your creations on hard drive or record straight to tape or CD and party the night away! OK, you are limited to a fixed tempo, but for the sake of a tenner for each music type, you really cannot go wrong. As it says on the front: **Warning: Seriously Addictive** - they certainly are!

Available from selected Maplin Stores along with the full range of Focus Multimedia.

Maplin order codes are:

Dance TH48	Rave TH49	Hip Hop TH50

Project Ratings

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

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

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

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

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

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

Ordering Information

Kits, components and products stocked at Maplin can be easily obtained in a number of ways:

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

Internet

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

Prices

Prices of products and services available from Maplin shown in this issue, include VAT at 17·5% (except items marked NV which are rated at 0%). Prices are valid until 7th April 2000 (errors and omissions excluded). Prices shown do not include mail order postage and handling charges. Please add £2.95 to all UK orders under £30.00. Orders over £30.00 and MPS Account Holding customers are exempt from carriage charges.

Technical Enquires

If you have a technical enquiry relating to Maplin projects, components and products featured in *Electronics and Beyond*, the Technical Service Dept. may be able to help. You can obtain help in several ways; ● Over the phone, telephone 0906 550 1353 between 9.00am and 5.30pm Monday to Saturday, except public holidays (calls charged at £1/min BT rates); ● By sending a facsimile, Fax (01702) 554001; ● Or by writing to Technical Services, Maplin Electronics PLC., P.O. Box 777, Rayleigh, Essex, SS6 8LU. Don't forget to include a stamped self-addressed envelope if you want a written reply! Technical Services are unable to answer enquires relating to third-party products or components which are not stocked by Maplin.

Kit Building

A kit building service is on offer for any of our kits. Please contact our customer service department for any pricing details.

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