THE MAPLIN MAGAZINE

ELECTRONICS and Beyond

MARCH 1998 NO. 123 £2.65

http://www.maplin.co.uk

Getting audio & video onto CDs

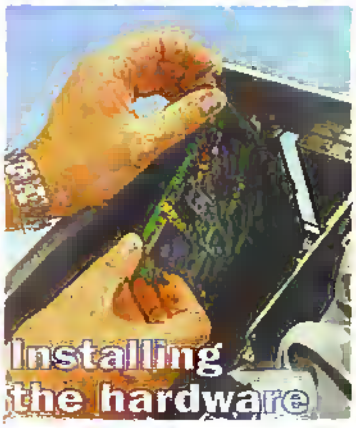
Model Speed Controller

for competition flight

Mysteries of Neptune

Information from the Voyager Spacecraft

Getting on to the Internet



Installing the hardware

Analogue or Digital?

The pro's and con's in sound and vision

PROJECTS FOR YOU TO MAKE

Sentinel Fan Failure Alert
Interface BUS Expansion Module
Making your own audio and video CDs
Loudspeaker Protector • Running Light Display
Model Speed Controller

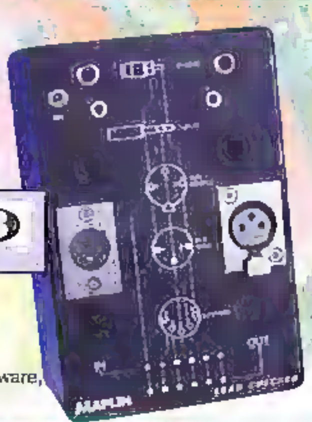
Britain's most widely circulated magazine for electronics!

projects

New Project Kits from Maplin

AUDIO LEAD CHECKER KIT

– No home or professional studio should be without one!



FEATURES:
- Rapidly and clearly identifies connections on most audio cables
- Will test very long cables
- Clear led readout
- Robust design

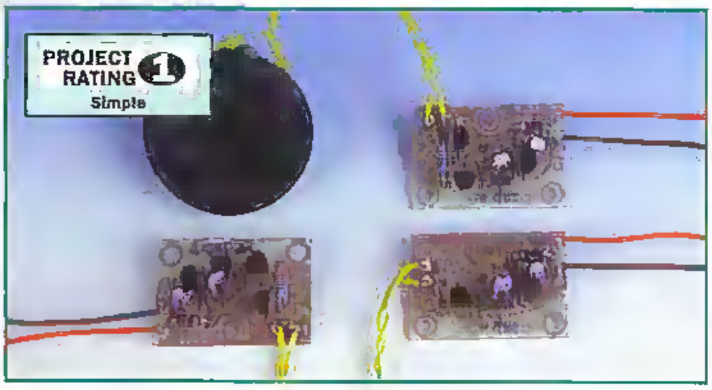
PROJECT RATING 3 Average

IDEAL FOR:
- PA/Sound engineers
- Gigging bands
- Fault diagnosis

Kit includes all components, PCB, fixing hardware, case, front panel label and full instructions.

AUDIO LEAD CHECKER KIT LU26D £19.99
Construction details: Audio Lead Checker Leaflet XZ20W 80p
Issue 114 / June 1997 Electronics & Beyond XD14Q £2.25

MELODY GENERATOR KIT



PROJECT RATING 1 Simple

FEATURES
- Ideal beginners project
- Safe, low voltage operation
- Low current giving long battery life
- Directly drives speakers (included) or piezo sounders
- Large range of melodies supported (15 available)

APPLICATIONS
- Children's toys
- Teaching nursery rhymes
- Turn ordinary cards and gifts into novel presents

Kit includes all components, PCB, speaker, connecting wire and full instructions. One or two 1.5V batteries are required (not supplied).

MELODY GENERATOR KIT

LU64U Happy Birthday	LU66W London Bridge	LU67 Old McDonald
LU68 Greensleeves	LU69 Love Me Tender	LU70 Jingle Bells
LU75 Merry Christmas	LU76 12 Days of Christmas	LU77 You Are My Sunshine
LU80 Just Called	LU81 Twinkle Twinkle	LU84 I'd Like To Teach
LU90 White Christmas	LU91 Warning Tone	LU92 Wedding March

All at £4.99

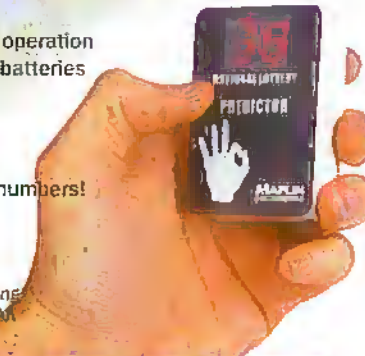
Construction details: Melody Generator Leaflet XZ47B 50p
Issue 120 / December 1997 Electronics & Beyond XD20W £2.65

These kits are:
- Supplied with high-quality fibre-glass PCBs – pre-tinned, with printed legend and solder resist
- Supplied with comprehensive instructions and a constructors' guide
- Covered by the Maplin Get-You-Working Service and 12-month warranty

Kits do not include tools or test equipment. Kits may require additional components or products, depending on application, please refer to construction details or contact the Maplin Technical Support Helpline (Tel: 01702 556001) if in doubt.

NATIONAL LOTTERY PREDICTOR KIT

PROJECT RATING 1 Simple



FEATURES
- Ideal beginners project
- Simple to use – one switch operation
- Automatic switch off saves batteries
- Full source code available

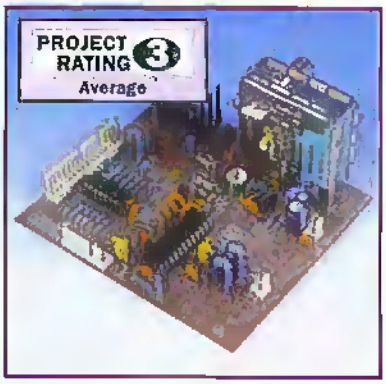
APPLICATIONS
- Use to choose your lottery numbers!
- Excellent introduction to microcontrollers
- Use in other games

Kit includes all components, PCB, fixing hardware and full instructions. Two AAA batteries are required (not supplied).

NATIONAL LOTTERY PREDICTOR KIT LU61R £9.99
Construction details: National Lottery Predictor Leaflet XZ46A 50p
Issue 120 / December 1997 Electronics & beyond XD20W £2.65

PAL COLOUR ENCODER KIT

FEATURES
- PAL and NTSC compatible
- TTL compatible inputs
- 64 colour palette
- Composite video and UHF outputs
- Analogue or digital RGB inputs
- Optional S-video output



PROJECT RATING 3 Average

APPLICATIONS
- Colour bar generation
- RGB to composite and UHF conversion
- Computer displays

Kit includes all components, PCB, Modulator, hardware to connect the Maplin Colour Bar Generator LT50E and full instructions. A +12V DC @ 300mA, regulated supply is required (not supplied).

PAL COLOUR ENCODER KIT LU74R £24.99
Construction details: PAL Colour Encoder Leaflet XZ41U 80p
Issue 115 / July 1997 Electronics & beyond XD15R

ORDER NOW!

Tel: 01702 554000, Fax: 01702 554001, E-mail: Sales@maplin.co.uk
Or write to Maplin Electronics, P.O. Box 777, Rayleigh, Essex, SS6 8LU
Or Tel: 01702 554002 for details of your nearest Maplin or Mondo store.

Please quote **Priority Reference Code MA044** when ordering.

For orders over £30.00 inc VAT goods are dispatched free of handling charges. A small order charge of £2.95 inc VAT is applied to orders less than £30.00 inc VAT. All items subject to availability. All prices are inclusive of VAT and are subject to change. E&OE.

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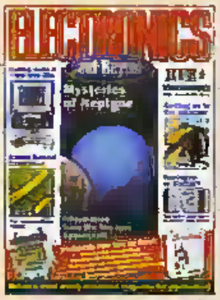
Projects

Features

Regulars



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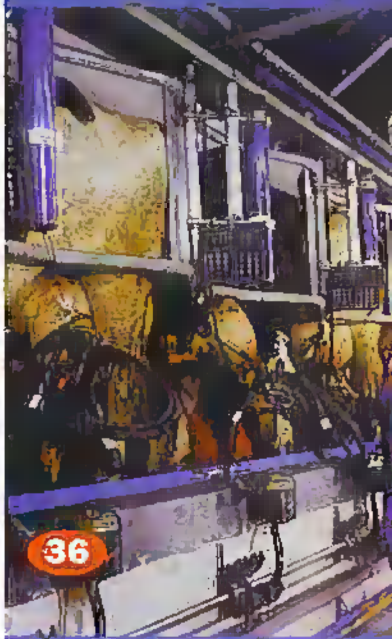

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ELECTRONICS and Beyond

EMC testing small kits

Maplin has for many years, through this magazine, presented many electronic construction kits that end up for sale by mail order and through our stores. The European directive to introduce EMC testing on electrical and electronic systems intended for sale has brought many benefits and some drawbacks. Whilst praising the principles behind the need for it to protect the consumer, there is now a growing concern that with smaller projects such as we have seen in Electronics and Beyond, the time, manpower and equipment required to test each one, seriously eats into the overall development time. It now begs the question of whether it is economically viable on some projects to continue along this route. In essence then, this road of well intended bureaucracy starts to kill off original creativity on the smaller scale projects and the process of product development becomes an even greater barrier to cross.

Maplin Catalogue on CD ROM

Don't forget that next month we will be giving away the first edition of the Maplin catalogue on CD ROM with our April issue. So don't forget to go out and buy a copy at your nearest store.

Paul Freeman-Sear, Publishing Manager

Britain's Best Magazine for the Electronics Enthusiast

NEWS REPORT

Nottingham Canal Becomes Modern Day Superhighway

A vital communications link is being laid along the line of the local canal system in Nottinghamshire, as part of a nation-wide optical fibre network.

Fibreway, subsidiary of GPT, is poised to plug Nottingham and its environs into a new generation of telecommunication services, carried around the UK by a fibre optics network laid mainly along the route of the UK canal system.

Fibreway has no plans to sell its services directly to the public. Its customers will be service providers such as cable TV firms, independent telephone companies and national computer centres such as those operated by banks.

Nottingham is being included in the link as part of the latest phase in the creation of a fibre optics figure of 'eight' loop around middle England. The route takes in London, Birmingham, Nottingham and Leeds, en route to Manchester.

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

Contact: GPT, Tel: (0171) 836 3144.

Mars Photos Show Evidence of Water, Iron and Carbon Dioxide

After studying more than 9,500 images taken during the Mars Pathfinder mission last year, scientists at Cornell University have reported that surface photographs provide strong geological and geochemical evidence that fluid water was once present on the red planet.

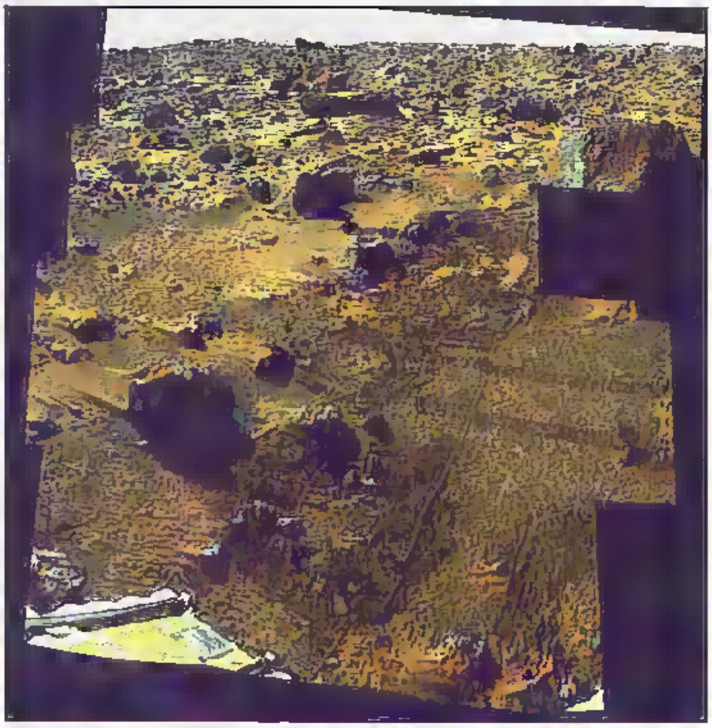
"We now have geological evidence from the Martian surface supporting theories based on previous pictures of Mars from orbit that water played an important part in Martian geological history," said James F. Bell, Cornell senior research associate in astronomy and a member of the Mars Pathfinder imaging team.

During the first 30 days of the Mars Pathfinder mission, the Imager for Mars Pathfinder (IMP) returned 9,669 pictures of the surface. These pictures appear to confirm that a giant flood left stones, cobbles and rocks throughout Ares Vallis, the Pathfinder landing site. In addition to finding evidence of water, the scientists confirmed that the soils are rich in iron, and that suspended iron-rich dust particles permeate the Martian atmosphere.

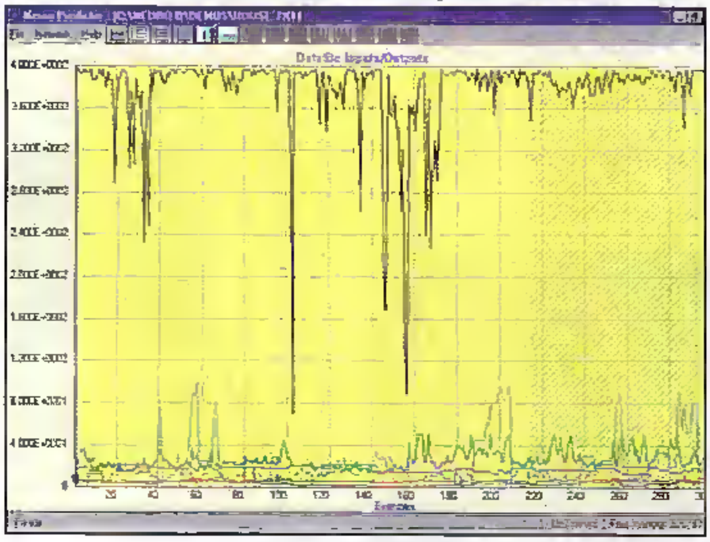
Mars Pathfinder's camera also revealed that Mars' atmosphere is more dusty and dynamic than expected, Bell explained. Surprisingly, the scientists found wispy, blue clouds, possibly composed of carbon dioxide (dry ice), travelling through Mars' salmon-coloured sky. White cirrus-like clouds, made of icy water vapour, also circulate throughout the thin Martian atmosphere.

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

Contact: Cornell University, Tel: +1 607 255 2000.



UK Company Creates Thinking Software



Computers that can think for themselves are no longer confined to the pages of the X-files or science fiction. Thanks to SignalBox, a Sheffield-based company, software that can think for itself is a reality.

The software called Neuropredictor is a new breed of neural network software application. Neural networks are programs that work in a similar way to the human brain, examining data for repetitive patterns and teaching themselves to solve problems.

The potential uses of neural networks are almost limitless. Retailers can use them to plot customer loyalty and buying trends. In engineering they can be used to model complex machinery to predict when breakdowns are likely and minimise downtime.

Potential users that want to trail Neuropredictor can download a demo version from the SignalBox web site at www.shef.ac.uk/~signalbox. Sadly however if you want to predict the lottery results you will still have to rely on Mystic Meg.

Mathematically speaking the National Lottery is a random event and by definition, random events cannot be predicted – even using neural network technology.

For further details, check: www.shef.ac.uk/~signalbox.

Contact: SignalBox, Tel: (01709) 898989.

NEWS BYTES

UK Competes With US and Japan in Technology Stakes

Growth in the British IT sector is presently 9.4 per cent according to recent research by the Computer Suppliers Federation. Japan, by comparison, has an information technology market that is growing by 8.9 per cent.

These statistics are representative of the surge forward in IT adoption by companies in the UK. Britain is hot on the heels of the US whose IT market growth is currently at 11.7 per cent.

To give these figures some perspective, UK IT spend as a percentage of GDP is currently 25 per cent more than the Western European average of 2.04 per cent. UK IT spend in proportion to GDP is also exceeding that of Japan.

For further details, check: www.csf.org.uk.

Contact: The Computer Suppliers Federation, Tel: (01905) 727610.

BT Switches Packets for Burton's Biscuits

BT is to provide food manufacturer Burton's Biscuits with a £500,000 high bandwidth, managed switched multi-megabit data service (SMDS) network linking three production locations and seven depots across the UK.

From its completion the network solution will be used to share stock, manufacturing and production information throughout the company. Burton's Biscuits produces over 100,000 tonnes of biscuits a year at its factories in Edinburgh, Llantarnam and Blackpool.

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

Contact: BT, Tel: (0171) 406 7000.

Psion Announces Messaging Over Digital Phone Networks

Psion users can now transmit Short Message Service (SMS) messages by making a connection to Vodaphone, Orange or Cellnet digital mobile networks via an Ericsson or Nokia handset. Launched this month, Message Express software enables messages of up to 160 characters to be transmitted.

Speaking to Electronics and Beyond, John Jarvis, managing director, Psion said, "There are obvious advantages for the mobile phone user who doesn't want an important meeting disturbed by a voice call. Sending short messages is simpler, cheaper and less intrusive than calling".

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

Contact: Psion, Tel: (0171) 258 7231.

NEWS BYTES

Modem Makers Reach Agreement on Standards

The 12-month battle over technical standards for 56k modems appears to be over. Rival camps have tentatively agreed to compromise between 3Com/US Robotic's X2 and Rockwell's K56flex technologies. The new international standard, approved by an International Telecommunication Union working committee, incorporates details from both transmission techniques.

For further details, check: ties.itu.int/home/index-es.html.

Contact: International Telecommunication Union, Tel: +41 22 730 5111.

Motorola Looks To Single Ship Systems

Motorola giving up its battle with Intel for a piece of the microprocessor desktop business and is refocusing its chip business to concentrate on customised chips that will combine memory, logic and other circuit types. The company has a portfolio of more than 50,000 chips, including the PowerPC microprocessor, which it had sought to promote via Apple Macintosh computers.

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

Contact: Motorola, Tel: (01293) 404343.

Digital TV Software May End HDTV Format Wars

Intel has developed some neat software, that allows PCs to receive digital, high-definition TV (HDTV) signals in any display format. Up to 18 different HDTV standards have been established worldwide by broadcasters and TV manufacturers.

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

Contact: Intel, Tel: (01734) 403000.

UK Electronics Job Prospects up By 25 Per Cent

Electronics industry employers continue to forecast rising recruitment levels in the UK according to the latest Manpower Survey or Employment Prospects. For the first quarter of 1998, 41 per cent of employers in the industry are forecasting increases, representing an increase of 25 per cent against the first quarter of 1997.

Contact: Manpower, Tel: (0171) 253 3300.

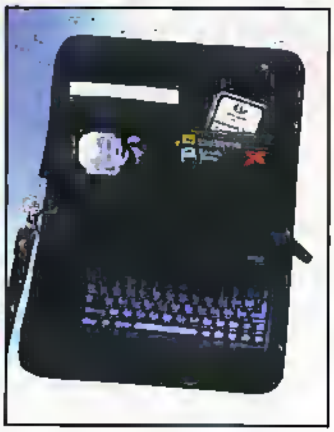
Power Case Breaks Boundaries of HPC Computing

While Windows CE brings the benefits of integration, mobility, high functionality and file sharing using companion applications, users can still be restricted by battery technology. For example the latest Hewlett-Packard colour screen HP320 LX handheld PC (HPC) lasts three hours between charge. And that's without the addition of a power hungry fax/modem.

But now Windows CE users can extend the time between charges of their HPC with Portable Add-ons Power Case, a leather HPC case with integral battery pack. In the HP 320 LX example, by using Power Case, users can increase the time between charges to a huge 72 hours.

The Power Case battery pack is re-charged using a Smart Auto Charger which takes its power from a 12 or 24V cigarette lighter fitting. The integral state-of-the-art Nickel Metal Hydride (NIMH) batteries take 75 minute to reach an operational power level and six hours to reach full power that will deliver up to three weeks operation between charges. NIMH batteries offer faster re-charge times and superior lifetime performance compared to more tradition Nickel Cadmium (NICAD) re-chargeable cells.

Power Case currently supports handheld PCs from Casio, Compaq, Hewlett-Packard and Philips and is priced £139 including battery, case and charger.



For further details, check: www.portable.co.uk.

Contact: Portable Add-ons, Tel: (01483) 241333.

Mobile Phone Turns Homing Device

Law enforcement agencies will soon be able to track mobile telephone users as they move around the country thanks to signals emitted from the phone. UK mobile phone companies have revealed that when required to by court order, they will allow the police and other authorities access to their computer data.

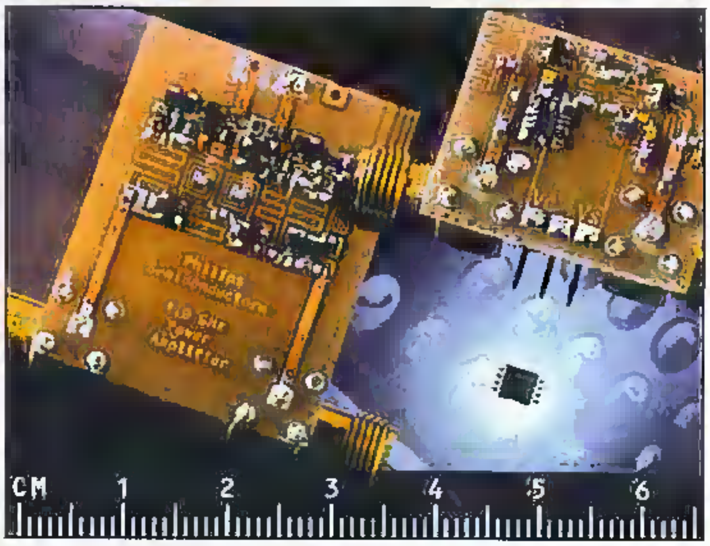
This means that not only could the location of a mobile user be tracked, but that the location of a person's whereabouts could also be traced and used in evidence during a criminal case. This Big Brother type activity is made possible because digital mobile phones emit a log-on call every 30 minutes to register contact with the nearest base station.

Double Poly Simplifies Mobile Design

Even greater scales of integration will be made possible by a new fabrication technology from Philips Semiconductors. Double Poly technology discrete components such as inductance loops, capacitors and resistors to be fabricated in silicon on-chip to create Monolithic Microwave Integrated Circuits (MMIC). Using these new MMICs the external component count in a mobile phone's receiver front end is reduced typically from thirty to around six.

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

Contact: Philips Semiconductors, Tel: +31 40 272 20 91.



Scotland Centre For Single Chip Systems

Plans were unveiled in Scotland at the end of last month for the creation of a semiconductor research and design plant, creating up to 1,895 skilled jobs.

Jointly announced by Scottish Enterprise and Cadence Design Systems, the project is a collaboration between the public sector, industry and academia to create a world class environment for semiconductor design, which will help position Scotland as a centre of excellence for single chip system semiconductor devices.

For further details, check: www.sli-scotland.org.uk.

Contact: Scottish Enterprise, Tel: (0171) 808 6600.

Inteco Publishes Digital TV Forecasts

By the end of 2001, household penetration of digital TV will have reached 22 per cent in France and Germany, and 31 per cent in the UK, according to the latest forecasts from Inteco's Interactive TV European research service.

In 1998, the switch to digital constitutes a discontinuity in the development of the pay-TV market, and presents the cable companies with an opportunity to gain market share, but they will have to compete with digital satellite and, to lesser extent digital terrestrial alternatives.

Speaking to Electronics and Beyond, Adam Daum, Inteco's senior consultant responsible for the Interactive TV European Research service said, "If cable gets left behind this time, it may never get an adequate return on its infrastructure investment. But we anticipate aggressive marketing and expect 25 per cent of UK households to have cable TV by 2001, over half of which will be digital."

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

Contact: Inteco, Tel: (01483) 751777.

Shuttle Experiment to Shed Light on Future of Electronics Miniaturisation

After 20 years of exploring the esoteric nature of liquid helium when it is cooled to ultra-low temperatures in zero gravity, physicist John Lipa suddenly finds that his work could have important ramifications for the miniaturisation in the microelectronics industry.

His latest experiment, currently taking place in space aboard the Columbia, is called the Confined Helium Experiment (CHeX). Its purpose is to determine what happens to a material when it is confined to such narrow dimensions that it begins to behave as if it has only two dimensions, rather than three.

In most materials, this confinement effect surfaces at extremely small dimensions, thicknesses of a few atomic widths. It arises from the fact that fundamental particles have a dual nature, acting sometimes like solid objects and sometimes like a packet of waves.

A particle contained within a layer that is so thin that the waves associated with it come in contact with both edges is restricted to moving in only two dimensions. This constraint can change the physical properties of the material. If the particle in question is an electron, for example, then the electrical properties of the material are affected.

"The size of the transistors in today's integrated circuits is about two tenths of a micron. Intel and the other semiconductor manufacturers are talking about reducing this by a factor of 10 or more in the next decade. That is about the size where we expect these confinement effects to appear in metals and semiconductors. The preliminary indications are that this effect tends to have a depressing effect on properties like electrical conductivity, so it looks as if it might present a roadblock to the miniaturisation process," said Lipa.

Such a roadblock could have serious consequences for the microelectronics industry. The ability to continually miniaturise the circuitry printed on silicon chips has been the primary reason that the industry has been able to simultaneously reduce the cost and increase the performance of everything from computers to telephones. If the confinement effect proves to be relatively small, and reduces the conductivity of silicon only slightly, then the process of miniaturisation can continue until some other factor intervenes. If the confinement effect is large, however, it could slow or block further size reductions.

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

Contact: Stanford University, Tel: +1 650 725 1944.

UK Businesses Fail To Spot the Difference

Nearly 60 per cent of UK businesses do not know the difference between a Net PC and a network computer (NC) according to research published by AST Computer. The 1997 AST IT Barometer Report, also reveals that nearly half of those responsible for purchasing IT believe it will be at least two years before the Net PC and the NC even start to make an impact on the UK market.

According to the survey, 20 per cent expect the Net PC and NC to be widely used business tools within the next twelve months and 27 per cent believe that this will happen in the next one to two years. However, 8 per cent remain to be convinced that the Net PC or NC will ever become fully marketable products.

Of those respondents unsure of the differences between the Net PC and NC, only 14 per cent are considering trailing the new technologies while the remaining 72 per cent said they would not make any further investigations.

The research findings show that those who understand the differences between the Net PC and NC favour the NC, but the margin is slight at only 4 per cent. 57 per cent said that they would never consider trailing the NC, while a slightly higher 63 per cent expressed no interest at all in the Net PC.

For further details, check: www.ast.co.uk.

Contact: AST, Tel: (0181) 587 3000.

Tiny Makes Push on Electronic Hearth

Despite special packaged deals targeting home users, the PC has not made it into the living room to any great extent. Tiny Computers believes this is because users want a single screen rather than a TV screen and a computer monitor.

It's a feeble marketing line, but Tiny is so convinced by this pitch that it has launched the Movie Centre Freedom, which plugs into an existing TV and offers a remote control, cordless keyboard, powerful 68 inch projector and Dolby ProLogic Surround Sound.

Convinced yet about the electronic hearth? This top of the range 266 MHz Pentium II box is an amazing home entertainment system that combines PC, TV, surround sound and games console, but cheap it ain't. The Movie Centre Freedom will set you back a cool £2,600.

Contact: Tiny Computers, Tel: (01293) 821333.

Getting On-Line TO THE INTERNET

PART 3

by Mark Brighton

Having covered the different types of service providers and the general considerations of the hardware and software required to connect your PC to the World Wide Web, we now we get down to brass tacks.

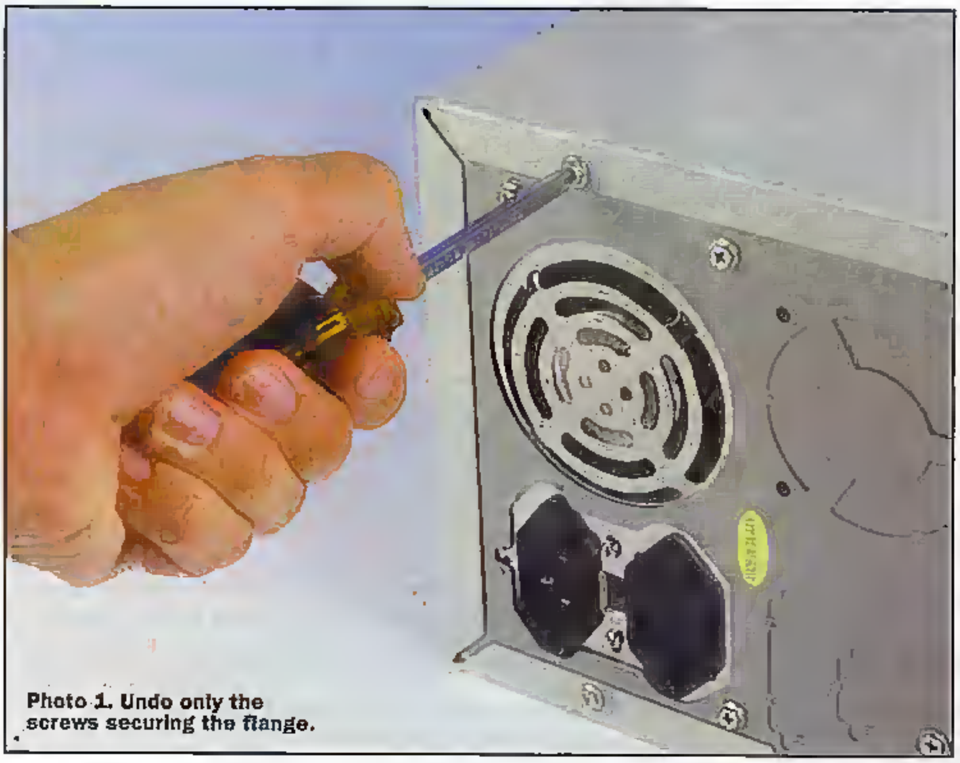


Photo 1. Undo only the screws securing the flange.

The time has come to open up your PC and fit an internal modem into a spare expansion slot on your motherboard. This really is as simple as undoing a few screws and plugging the board in, with just a cross head screwdriver required in most cases, but if you really can't face the thought of opening up the case (or don't want to invalidate a warranty, because many new machines have seals you will have to break to do this), then the external modem solution discussed in last months article is for you. Look no further than the new 56K external modem (order as LY60Q), available from Maplin Direct on 01702 554000.

The internal modem chosen as the subject for this article is the Lasat 560V (Maplin order code LY59P) and will work as a fax machine, answer-phone and modem, once connected to your PC and an ordinary phone line. The unit is supplied as a small plug-in card that will fit into any ISA Bus socket. Accessories supplied include an adaptor that plugs into your phone socket and provides the smaller American style modem socket, a lead to go between the adaptor and the modem, a disk with Windows 3.x and Windows 95 drivers and scripts.

Note that the modem is supplied in a special anti-static bag that protects it from the huge multi-thousand volt static shocks that can easily result from careless handling in an ordinary house. The combination of a dry atmosphere caused by central heating and the number of man made fibres in modern carpets and furniture creates a very unhealthy environment for exposed electronic circuits. More on handling precautions later. For now, leave it in the bag.

Installation

Start by switching the mains supply to your PC off, unplugging the mains lead from the wall socket and clearing anything that may prevent you from lifting the lid of the PC once you have undone the screws fastening it. This may just mean unplugging and setting the monitor aside, or you may have to unplug all of the connectors from the rear of the case if it is in an awkward position to work on such as a shelf on a workstation desk. Do try to make a note of where each connector plugs in, although they are generally all different so it is not usually possible to make any mistakes when reconnecting them.

Once the main PC base unit is in a position where it is easy to work on, Turn it to a position where you can see the back of the case. You will see that there are a number of screws holding the flange at the rear of the case onto the back panel. Unscrew these and set them aside. Try to keep the screws you remove in some logical arrangement as there are a couple of different thread sizes and it is possible to mangle threads if you are careless on re-assembly.

Many desktop cases also have four screws underneath that also hold the case shell on (sometimes on the side, too). Turn the whole case on it's side and undo these. When unscrewing the lid or shell fastening screws, don't get carried away. There are quite a few other screws to undo on the outside of the case, but over enthusiasm may result in the heavy power supply case inside coming adrift and dropping onto other, more delicate things. The case screws should be fairly obvious.

Having undone all of the likely screws, the case lid should basically slide backwards slightly (the lid usually tucks under the front panel) and lift off. It is usually easier to lift the lid from the rear so that it starts to hinge open like a car bonnet, before lifting it clear.

If the lid doesn't want to move, it may be that you have left a screw or two in place. Have another look before applying brute force! Alternatively, your case may just be one of those where the shell is attached to the front panel (the clue is that the rear of the lid does not have a folded flange that wraps around the back panel). These cases come apart from the front, where pulling fairly sharply results in the whole outer case assembly sliding out and off like a drawer.

In either instance, it may be necessary to flex the sides of the case outward slightly so that folds, flaps or indented screw locations clear the case chassis rails and front panel.

Inside your PC

If you have never seen the inside of your PC before, the whole thing may seem a little intimidating (not to mention fairly dusty, depending how old it is). If you do want to clear any dust before continuing, it is far better to use a mini vacuum cleaner or blow through a straw (keeping your eyes closed) than to rake about with a duster, which is guaranteed to catch and pull off some of the little links that configure your motherboard and make it work.

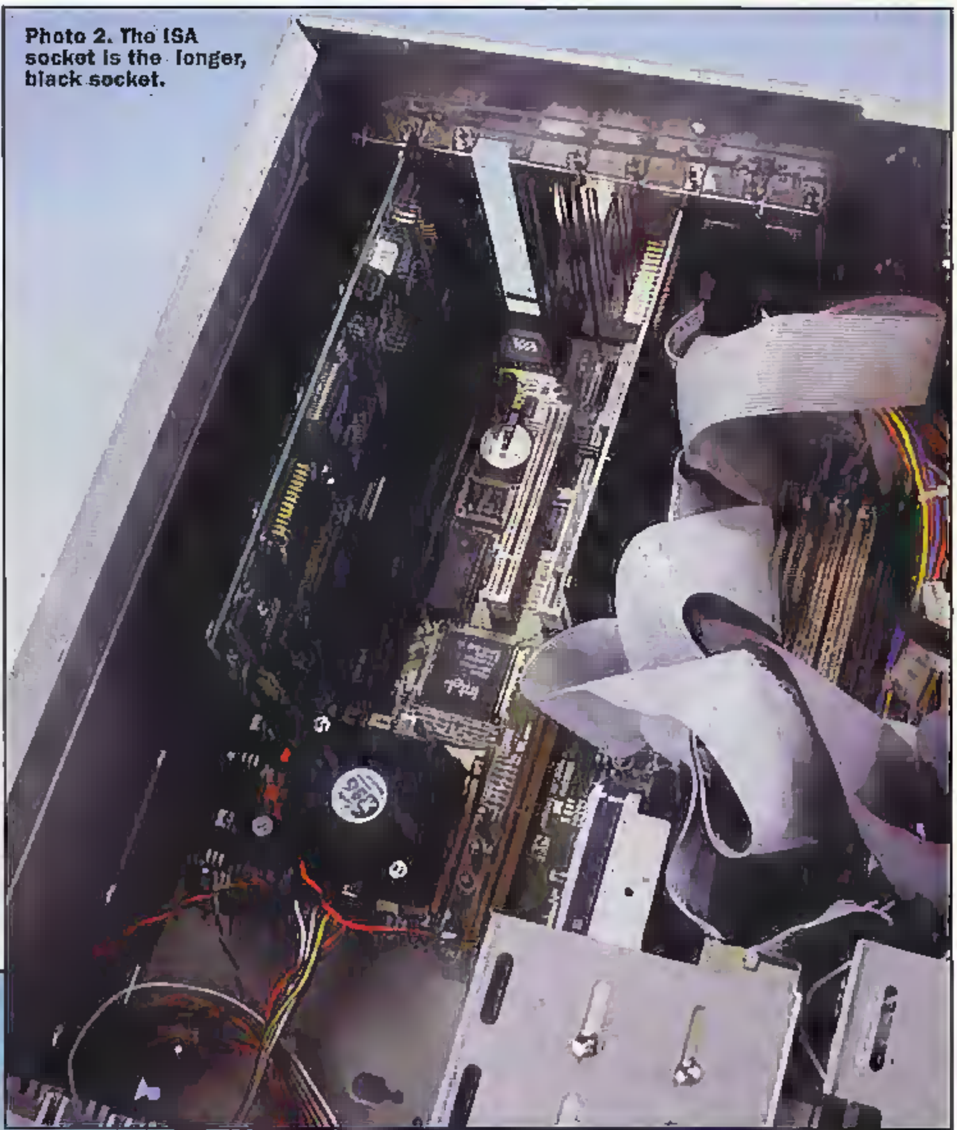


Photo 2. The ISA socket is the longer, black socket.

Photo 3. Ensure the edge connector is aligned correctly.

The PC's main board, called the motherboard because the smaller daughterboards plug into it, has a row of long expansion sockets at the back. You will see that some of these already have boards plugged into them. Your graphics card, sound card and possibly your I/O and disk drive controller cards all plug in here.

Depending on the age of your system, you will see that not all of the sockets on your motherboard are the same. Ignoring the much smaller memory sockets, some of which will have very short circuits plugged into them (these are SIMM's, or DIMM's that make up your RAM), there are black sockets with fairly widely spaced contacts that are split into a longer socket and a shorter socket in a line. These are your 16-bit ISA sockets. If all of your sockets look like this, but two or three of them also have an extra third part, usually brown and with much more finely spaced contacts, you have a VESA motherboard and those are your VESA local bus sockets. This will apply to older machines, usually with 386 or 486 processors.

Most modern motherboards will have four or five of the black ISA sockets as described above, and a few (usually) white PCI bus sockets. Whatever the age of your motherboard, it is usually quite easy to find a spare ISA socket to fit your new modem into.

Before you unpack your new modem from it's anti-static bag, there is one more thing to undo. There are a row of holes in the back panel of your PC to allow the sockets on your plug in cards to reach the outside world, but spare holes are blanked with plates. Undo the single screw holding the plate that lines up with the spare expansion socket you have chosen (be careful not to drop it onto the motherboard), and remove the plate.

Now you are ready to plug the modem card into your PC. Before opening the anti-static bag, reach out and momentarily touch an earthed object such as a radiator to discharge any static you may be carrying. Try to avoid shuffling about on the carpet, or wriggling on your chair, after doing this or you will just build the charge up again. Touch the PC chassis, too. Alternatively, why not invest in an anti static wrist strap? The Maplin FE29G is a very affordable way to protect your PC from damage, with one end strapped around your wrist and the other end clipped to a convenient earthed object throughout the installation process.

The instruction booklet provided with the modem suggests that you "gently lower the PC card" into a free slot (socket) at this point, which is indeed the first thing to do, but what it fails to mention is that a slot that has not been used before is quite tight and that you may have to exert considerable pressure in order to push it fully home, once you are sure that you have aligned the edge connector with the socket correctly! Now take the screw that was holding the small plate on the back panel and use it to fasten the modem socket plate down to the chassis.

That's it! Hardware installation complete. Slide the lid carefully back on, ensuring that any guides or flanges in the bottom or back of the case line up and that the case plugs back under the front panel, and replace the screws. Readers with all in one case lids / front panels may have to fiddle with disk drives in order to coax them into sliding back into the apertures in the front panel. Beware of trapped wires at this point. It's often easy to shut some of the spaghetti connecting the front panel switches and LED's to the motherboard between the case lid and the chassis.

Reconnect the monitor power and video leads, the mouse, keyboard and the mains lead. If you have a soundcard, reconnect the speakers to the right sockets (they are often marked), usually nearest the joystick / midi socket, and plug in the joystick. Connect up any printer or other parallel device and return the whole system to it's usual position. Plug the mains lead back into the wall socket.

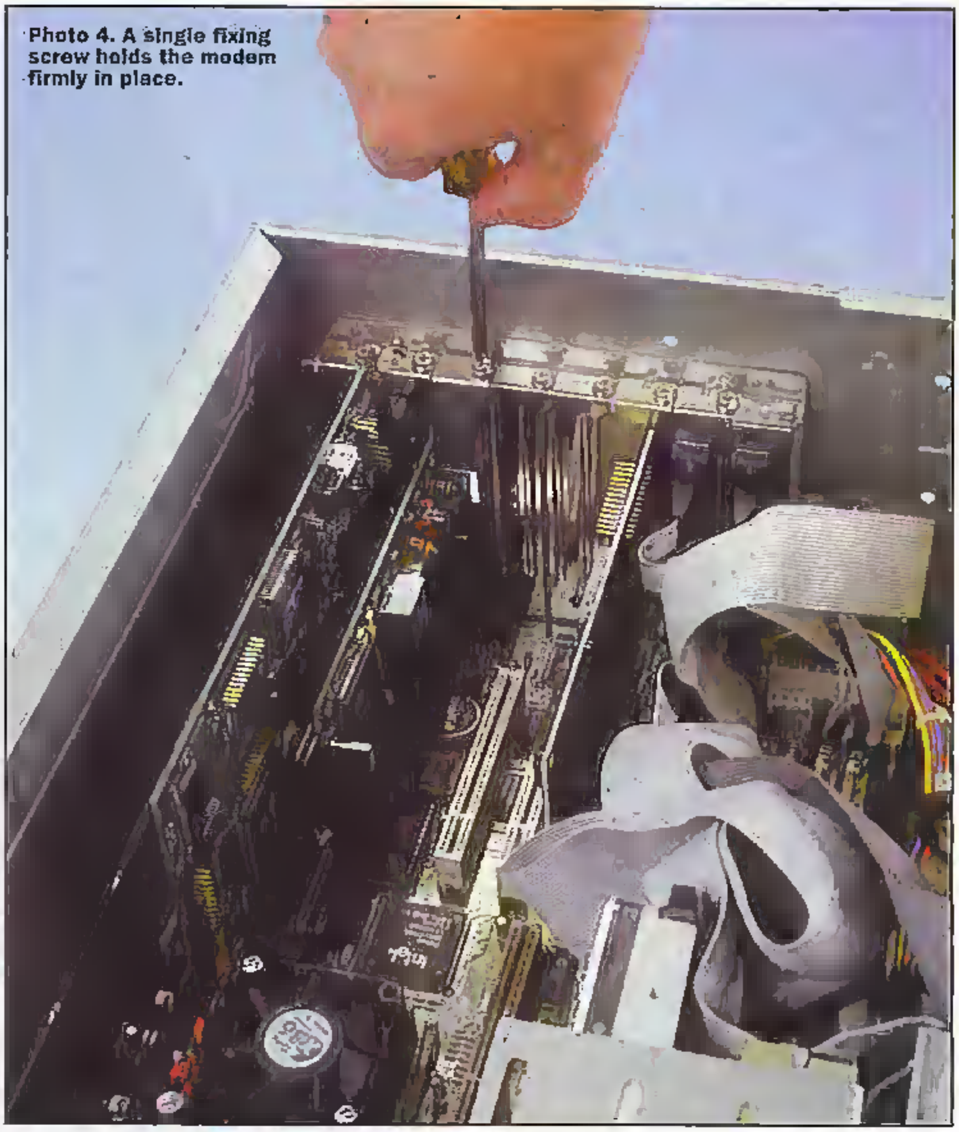


Photo 4. A single fixing screw holds the modem firmly in place.

Software Installation

So, you've got a plug'n'play PC with Windows 95? Just switch the PC on and it will recognise the new Modem and install all the necessary drivers. Well, that's what's supposed to happen! Having installed another "plug'n'play" modem recently, I am aware that there may be a little more to it than that. Having fitted my modem, I took a deep breath and switched my PC on. All seemed OK, until I tried to move the mouse. Locked up!

The reason for this was an IRQ conflict. Basically, hardware devices on a computer circuit use signal lines to tell the main processor or CPU that they are doing something and require attention. IRQ stands for Interrupt ReQuest and each peripheral device should ideally have it's own IRQ identity number so that the CPU always knows where a request for attention (interrupting the main program execution) comes from.

Unfortunately, due to the way the serial communications port circuitry of a PC is designed, Com 1 shares an interrupt with Com 3 and Com 2 shares the same number as Com 4. In this case, on this particular PC, the mouse was on Com 1 and the modem set up as Com 3, on the same interrupt. The CPU tried to look at one device instead of the other with the result that the system locked out the mouse. If this happens to you, you need to change something to remove the hardware conflict. Having said this, some computer and modem combinations are more prone to this sort of problem than others and some don't exhibit the problem in such an obvious way. I once had a modem that refused to operate until I rolled the mouse around, at which point the modem would then start to dial out!

In the old days, before plug'n'play, the modem board would have had a number of adjustable jumper links to set which Com port the modem would appear on. Now that this is configured by Windows 95, you could choose to go to settings / Control Panel / Modems and try to change the port to one where there is no IRQ clash (Com 4 for example, where the mouse is on Com 1), all without using the mouse of course! It is quite possible to navigate your way around Windows 95 with just the Tab, cursor controls and return key, but you are unlikely to find the experience a soothing one.

Alternatively, you could just move the mouse to Com 2, at which point the problem goes away. Naturally, nothing in the world of PC's is ever quite that easy and you will probably find that the connector fitted to Com 2 is a 25 way one instead of the 9 way one the mouse needs. Most mice come with the adaptor needed to fit between 9 and 25 way, but chances are that you lost yours within days of fitting the mouse to that convenient 9 pin Com 1 connector.

Be that as it may, once any conflict is resolved, Windows 95 should indeed detect the presence of the new hardware. The Windows 95 "Wizard" program will prompt you to put the supplied CD into the drive. Pressing next then allows your system to search for a driver and load it. My computer also asked for the Windows 95 CD during installation, which is not mentioned by the procedure in the booklet supplied with the modem. The booklet does mention that the modem type may be incorrectly identified during this procedure, which is just what happened. The modem was identified as a 28.8K type, but you are told to ignore this and carry on. Subsequent tests later showed that speeds of 33.6K were obtainable online to a (non 56K) Internet Service Provider.

The installation instructions in the booklet also state that Windows 95 will display a message showing that a new wave device was found (wasn't new wave the respectable term for punk rock?). This didn't happen when I installed the modem software. I will return to this in a later article if any problems crop up, but for now it just goes to confirm my belief that installation of hardware and / or software on a PC never goes exactly as the instructions specify. This is really down to the infinite diversity of the computer we generically call the PC. Although sharing a staggering number of common operating methods and controls, PC's come in many thousands of variations, with each possible component part made by many different manufacturers in slightly different ways.

Add to that the variety of sound cards, graphics cards, operating systems and other software you may have installed on the machine and it is hardly surprising that an install routine written for one "standard" machine behaves differently on another.

A PC that has been around for a while is a little like a man or woman who has some experience of life and has been shaped by it into the person they are today. Every piece of software you install on a PC these days leaves its mark on the personality of your machine, adding files to your Windows and System directories, altering initialisation and registry files.

Some software replaces files with newer and more capable versions, adds new drivers to your system and so on until the mature PC becomes a changed animal that has "learned" to deal with many more file types and application types than it originally could. This also caused Windows 3.1 to grow large and unwieldy in the past, taking longer and longer to load. This doesn't seem so noticeable with Windows 95, or is it just that our PC's are so much faster these days?

Anyway, the point of all this is that install routines often do something unexpected. It isn't good, but it isn't necessarily bad either. It is usually just a case of working out what disk to poke into the drive to load the necessary file. If you have a problem installation and know what file the program is looking for, the "Find" option (right click the Start button) is very useful for searching directories or whole CD" for odd Dynamic Link Library (.DLL) files, or for whatever is missing. The modem drivers installed fine without having to do this, despite the discrepancies mentioned earlier.

Having installed the modem and it's Windows driver software, all you need to do now to get on line is to choose and install suitable browser software, set up Windows Dial Up Networking (DUN) software to make the connection to your chosen service provider and plug all of the information that the service provider gave you when you subscribed to them. If you haven't subscribed already, have a pen and paper handy when you phone them as there are a lot of details to take down, all of which must be faithfully transcribed into your PC before you may successfully connect to the Internet via their gateway.

Next months article will cover the installation and set-up of the remaining software and the details to be entered on the many screens of information used by those programs.

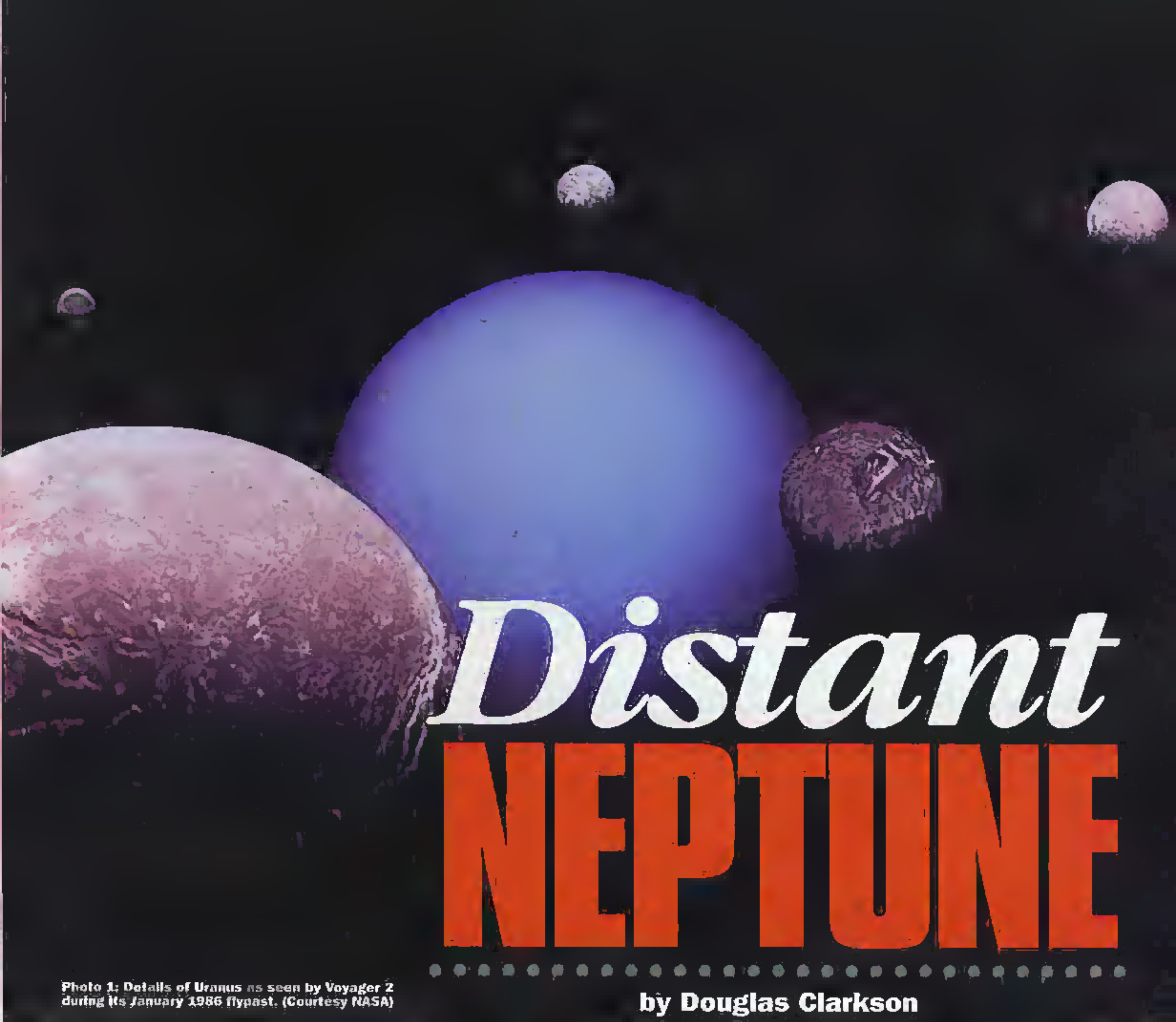


Photo 1: Details of Uranus as seen by Voyager 2 during its January 1986 flypast. (Courtesy NASA)

Distant NEPTUNE

by Douglas Clarkson

In terms of scientific achievement, the twentieth century will be acknowledged for the triumph of its exploration of space. This, principally by way of unmanned exploration, has seen a vast expansion of information about the planets of the solar system. There are insufficient resources to go on the missions that scientists would like, in particular, the exploration of the outer reaches of the solar system is likely to pause with the recently launched Cassini mission to Saturn. The two remaining gas giant planets, Uranus and Neptune are likely to hold onto their remaining secrets for quite some time to come.

Where is Neptune?

The orbits of the planets of the solar system are shown in Figure 1. There is some opinion that while Pluto is considered to be the outermost planet, it could have acquired its present orbit during the development of the solar system. The diameter of Neptune, some 2445 km, is comparable to a variety of the moons of the solar system. Also between 1979 and 1999 Neptune will in fact be the outermost planet in the solar system due to the eccentricity of Pluto's orbit.

Neptune's Composition

Neptune – like the other gas giants, is considered to have initially formed out of the same embryonic materials which led to the creation of the solar system and with the entity of the sun as the gravitational centre of the emergent system. Thus out of clouds of dust and gas of the Solar Nebula a spinning vortex would coalesce into centres of mass that would in time take on planetary shape and form. In a way, therefore, the gas giants preserve details of the solar system's earliest beginnings.

While Neptune is a cold world, the planet is releasing some 2.6 times more heat than would be accounted for from energy from the sun. There is some form of internal heat source driving the planet's various circulatory systems which remains a mystery. The energy from the warmer levels is considered to set in train convection currents which in turn provide energy for surface weather effects. This is in contrast to the earth's weather systems which are largely driven by the energy of incident solar radiation. With Neptune's distance from the sun being some 30 times that of the distance of the earth from the sun, Neptune will receive around 1/1000 th of the incident solar radiation. This will be equivalent to less than one Watt per square

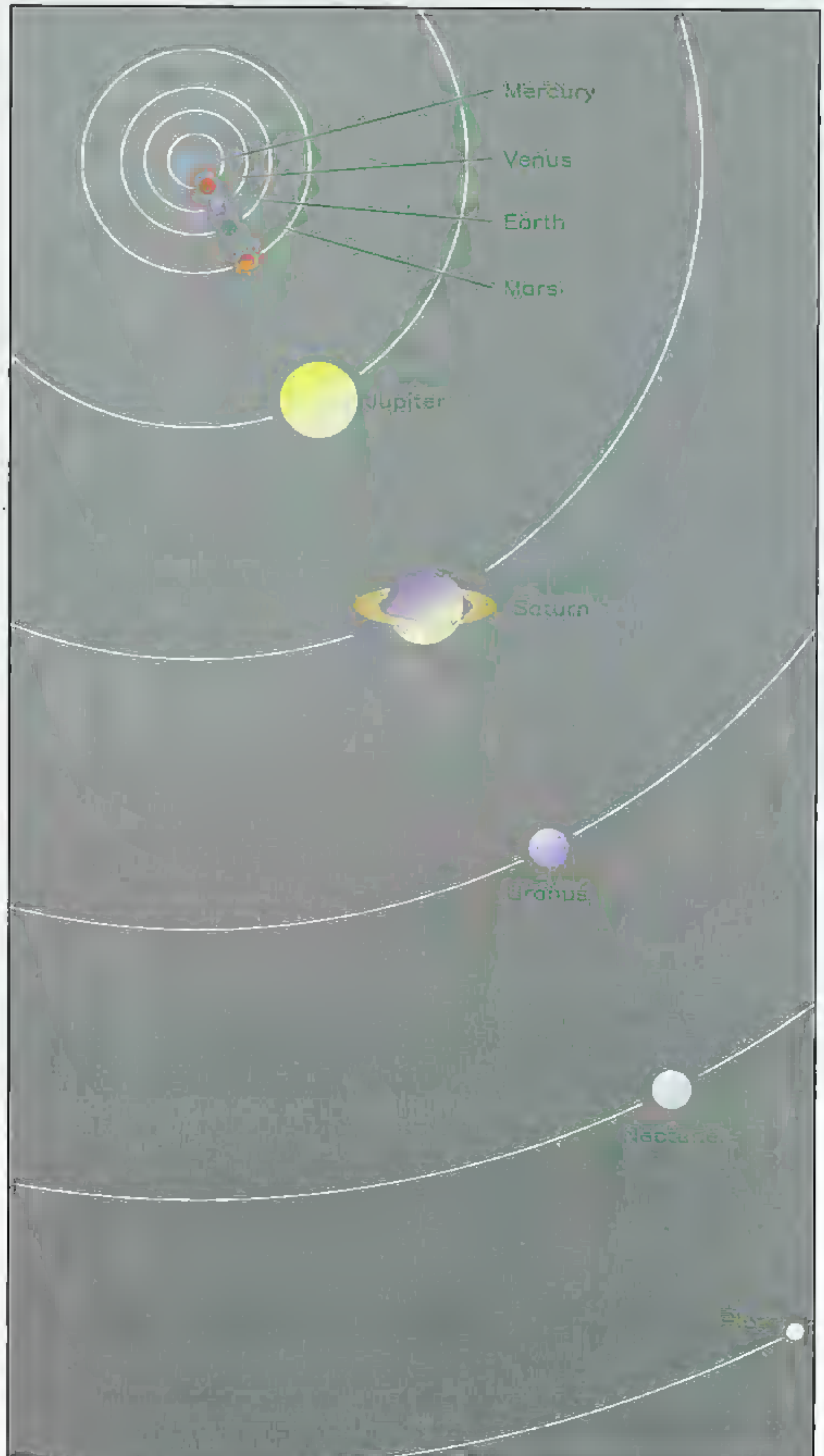


Figure 1: Orbits of the planets of the solar system.

metre. The eccentricity of the orbit, however, is relatively low.

There are two main theories regarding the structure of Neptune but both draw on the notion of Neptune being bombarded during its lifetime by countless comets. With sufficiently large amounts of energy released in this process, an extensive ocean of superheated water at high pressure could have been established under Neptune's atmosphere. It would also be possible for a layer of planetary ices – predominantly those of water to have been formed. The dominant involvement of accumulation of icy 'planetesimals' over millions of years would allow any water or ice in Neptune's deeper layers to be laced by an exceedingly rich mixture of chemical exotics known to exist within the far travelled ice of comets. It is likely, however, that Neptune has a rocky core.

Discovering Neptune

The saga of the discovery of the planet Neptune really begins with the discovery of Uranus by Sir William Herschel in 1781. The object had been observed by him as having a distinct motion relative to the fixed stars. In 1802 its orbit was worked out at 84.02 years.

Telescope observations from the earth of Uranus were of very limited value when trying to determine features of this distant planet. It was only with the Voyager missions that significant amounts of data on these planets became available. The details of Uranus and its five major satellites are shown in Photo 1 and were captured by Voyager 2 during its January 1986 flybye of the planet. This far flung world appears as a uniformly blue globe although subtle processing of such images reveals slight banding in the upper atmosphere. The satellites are in order or apparent size (not relative actual size) are depicted as Ariel, Miranda, Titania, Oberon and Umbriel. In its size, Uranus is very similar to that of Neptune.

It soon became apparent, that the newly discovered planet Uranus was not keeping to its expected orbit. Figure 2 indicates how the influence of Neptune would in the sequence of years 1781 to 1822 tend to speed Uranus up and then in following years to 1840 tend to slow it down. It remains, as then, a complex problem in Newtonian dynamics.

From July 1841 onwards John Couch Adams, as a student at Cambridge anticipated that the Uranus problem was in fact a perturbation caused by another more distant planet. By mid 1845 Adams had calculated an approximate position for the new planet but failed to interest Airey, the Astronomer Royal at Greenwich to take up observations. Meanwhile in France, the same problem had been grappled with by Urbain Jean Joseph Le Verrier who in turn informed Airey at Greenwich and the Paris Observatory. Airey, however, did not seem able to personally direct observations and left this work in the hands of Challis at Cambridge who undertook the scan from the 29th July in a laborious way in which objects as small as magnitude 11 were scanned.

Meanwhile, Le Verrier had lost patience with his colleagues in Paris and managed to interest the Berlin Observatory in his work. Under the direction of the young student Heinrich D'Arrest, the object was rapidly found and confirmed around 25th September. In fact, back in England, Challis had observed Neptune on the fourth day of his observing and observed it subsequently on two more occasions without appreciating what he was seeing. In fact, Neptune had been observed by many erudite observers including even Galileo in 1612 during the very first phase of telescope astronomy. At the time the disputes over the discovery of Neptune initiated a furious scientific controversy between France and England which almost precipitated into an international incident. Adams and Le Verrier, however, did not take any part in this and remained on good terms.

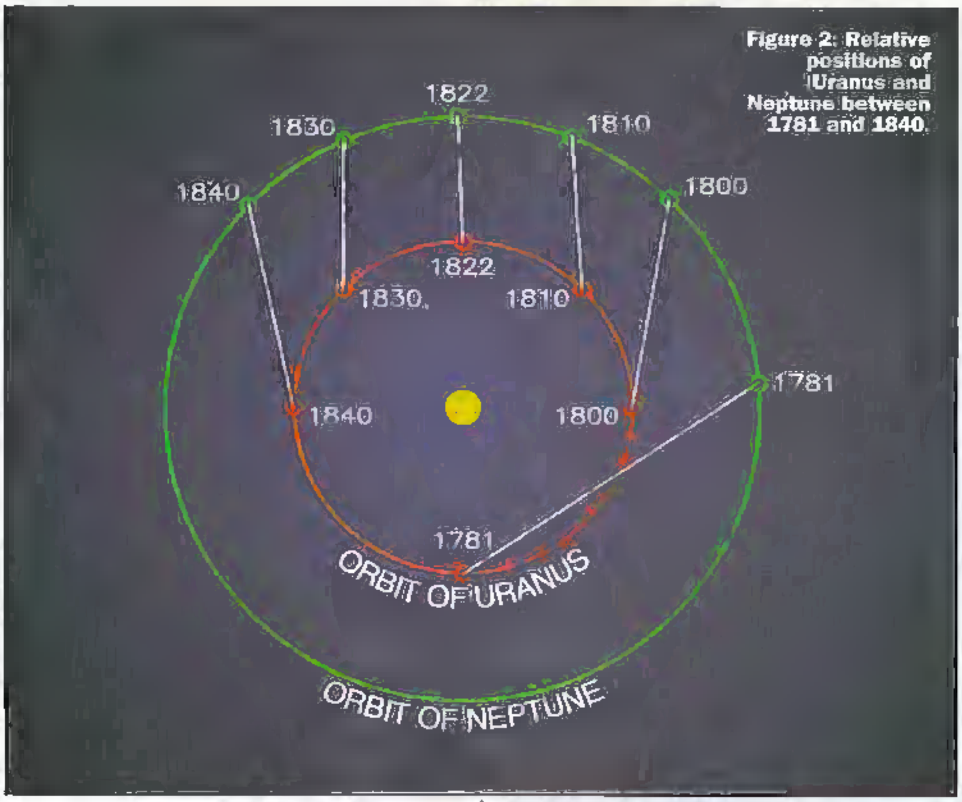


Figure 2: Relative positions of Uranus and Neptune between 1781 and 1840.

Giant Dark Spot

At the time of the Voyager 2 encounter, Neptune's atmosphere was dominated by a feature known as the Giant Dark Spot – with immediate parallels being made with Jupiter's Giant Red Spot. Photo 3 shows this feature taken at a distance of 2.8 million km. It appears to be an immense storm system which is lower in altitude than the associated white cirrus clouds. There is some evidence that the structure was rotating in a counterclockwise direction. The feature tended to essentially keep pace with the rotation of the planet – suggesting possibly that it originated from deeper layers of the atmosphere. Neptune is considered to be the windiest planet in the solar system with winds travelling up to 2000 km per hour in the vicinity of major storms.

Observations by the Hubble Space telescope in June 1994 revealed that the Great Dark Spot as discovered by Voyager 2 was missing. More prolonged observations by Hubble, however, have observed a surprisingly active atmospheric system driven by dissipation of energy from its strong internal heat source to the tops of its ultra cold cloud tops. On the very outer limit as it were of the solar system, Neptune is not a cold and static world.

The Voyager 2 Encounter

The encounter between Neptune and Voyager 2 was in many ways a 'bonus' for the main mission. As a system designed to operate for a maximum of 5 years, the highly successful Neptune encounter was carried out when the craft was some 12 years old. A key feature of the craft was the use of heat from the radioactive decay of Plutonium to produce electricity from thermopile junctions. In the far flung reaches of the solar system, there would have been insufficient energy from solar radiation to power the Voyagers.

The Atmosphere

The image of photo 2 was taken at a distance of 157,000 km from Neptune some two hours before the closest approach to the planet. The fluffy white clouds of frozen methane are estimated to lie some 40 km above the surface. The bright surfaces of the clouds face the sun while the darker regions are shadows cast by the cloud layers. Such shadows have not been seen on other comparable planetary missions. The atmosphere is considered to be 85% Hydrogen, 13% Helium and 2% Methane and with the blue colour predominantly due to the presence of methane in the atmosphere. Table 1 summarises some key details of Neptune.

Parameter	Value
Equatorial Radius	24,746 km
Mean Density	1.64 g/cm^3
Mean Distance from Sun	30.06 × Earth's
Rotational Period	16.1 h
Orbital Period	164.8 years
Orbital eccentricity	0.0097
Tilt of axis	28.31 degrees
Equatorial surface gravity	11.0 m/sec.sec
Mean cloud temperature	-193 to -153 C

Table 1: Key parameters of Neptune


Photo 2: Image of Neptune's surface some two hours before the closest approach and taken at a distance of 157,000 km. (Courtesy NASA)

Photo 3: Neptune's Great Dark Spot (Courtesy NASA)

Moon	Radius (km)	Distance (km)	Discovered	Date
Naiad	29	48,000	Voyager 2	1989
Thalassa	40	50,000	Voyager 2	1989
Despina	74	52,500	Voyager 2	1989
Galatea	79	62,000	Voyager 2	1989
Larissa	104 × 89	73,600	Voyager 2	1989
Proteus	200	117,600	Voyager 2	1989
Triton	1,350	354,800	W. Lassell	1846
Nereid	170	5,513,400	G. Kuiper	1949

Table 2: Satellites of Neptune

Satellites of Neptune

Table 2 summarises the satellites of Neptune. At present there are a total of eight known to exist but there is every chance that others await discovery. The distribution of the satellites around Neptune, however, is an example of extremes. In a very eccentric orbit, Nereid orbits Neptune from a considerable distance. Triton, the earliest discovered moon, is by far the largest of Neptune's satellites. It orbits Neptune in a retrograde direction – suggesting that Neptune acquired Triton at an intermediate phase of the development of the solar system. The relative newcomers, Naiad, Thalassa, Despina, Galatea, Larissa and Proteus all lie within the orbit of Triton.

In the close encounter with Neptune, images were obtained of the newly discovered Proteus and Larissa which indicated that they are heavily cratered rocky worlds. On Proteus, a very large impact crater was evidence that the object had come close to being broken up. Proteus is also a a very dark world – only 6% of incident light is reflected from it.

Triton

The trajectory of Voyager 2 had been carefully configured to engage a close encounter with Triton. This far flung world proved to be the coldest world ever encountered on a planetary mission – with a surface temperature of -235 C. One of the reasons why Triton is so cold is its high albedo or surface reflectivity of around 0.75. Most of the incident solar radiation is simply reflected back into space. The density of the world was higher than anticipated – suggesting that the satellite was two thirds rock and one third ice. A very thin atmosphere was detected of around 14 microbars and was determined to consist of almost pure nitrogen. The surface features are considered to largely be structured in water ice – possibly overlain with other ices such as of methane and nitrogen.

Some of the most detailed features were observed in the south polar region shown in photo 4. The pinkish hues observed there have been interpreted as Nitrogen snow and ice. Within this region there was the suggestion of dark plumes or 'wind streaks' on the surface. These have been interpreted as geysers powered by liquid nitrogen. At depth under pressure, liquid nitrogen could be stable. If the liquid escapes through vents on the surface it will experience less pressure and eventually expand explosively into the near vacuum of Triton's atmosphere. Thus even in a world as cold as Triton, there are still effects of exchange of energy going on. The areas of deposition associated with the geysers was identified typically as 15 to 50 km wide and up to 75 km long. Unlike other moons of Jupiter and Saturn, there is not the suggestion of a layer of liquid water under the outer ice layer. Triton is also considered to experience seasonal effects due to its orbit round Neptune. Thus within this cycle each polar area will experience a cycle of Mid winter and mid summer. The southern midsummer will not occur until 2006.

If in fact Triton was captured at some time by Neptune, the initial eccentric orbit of Triton could have resulted in tidal heating of its surface – which could in turn have initiated a long lived phase of a liquid planet surface. This could have given the conditions for the existence of life in some shape or form during this warm period. Indeed, there is considered to be evidence of areas which one were fluid but which now are in the grip of immense cold.

The retrograde motion of Triton is unique amongst moons of similar size in the solar system. While four moons of Jupiter and one of Saturn have a retrograde motion, they are all less than a tenth of the diameter of Triton.

In the dynamics of Triton around Neptune, energy is being slowly transferred to Neptune whose speed of rotation is consequently increasing. At some time in the far future, Triton will become unstable in Neptune's orbit and either break up to form a ring or crash into Neptune's interior. Thus observations from a future mission could perhaps detect exchanges of energy between the two bodies to determine time scales for this cataclysmic event.

Formal Name	Designated Name	Distance	Width
1989N3R	Galle	41900	15
1989N2R	Le Verrier	53200	15
1989N4R	Lassel,Arago	53200	5800
1989N1R	Adams	62930	<50

Table 3: Details of rings of Neptune (Distance is taken from planet centre to ring's inner edge).

Rings of Neptune

There had previously been some conjecture by earth observers regarding rings around Neptune. The observation of occultations of stars by Neptune outside its known diameter on several occasions had suggested the presence of rings between 41000 and 67000 km from the centre of the planet. The Voyager mission was able, however, to identify four main ring systems as detailed in table 3.

The outermost Adams ring contains three arcs of denser material within an angular separation of around 33 degrees. The detection of the ring system presented immense difficulty for the Voyager cameras on account of the low levels of light present, the diffuse nature of the rings themselves and the low reflectivity of the ring material.

Photo 4: South polar region of Triton: Note the appearance of dark plumes or 'wind streaks' on the surface. (Courtesy NASA)

Neptune: The Guardian of Comets

The discovery of the object Chiron essentially between the orbit of Uranus and Saturn in 1977 has led to the anticipation that this region of the solar system is highly populated by comets in stable orbit round the sun. Any perturbation of these objects by orbits of Neptune and her moons could in theory lead to the propelling of comets towards the sun with the chance of an encounter with the earth. Thus any instabilities in this far flung system could induce ripples of change elsewhere in the solar system.

The capture of Triton by Neptune could also have been associated with massive disruption of comets in previously stable orbits round the sun – with the chance that their orbits could have been directed towards the inner planets including the earth.

Also, there is a great lack of knowledge of the energy processes of the gas giant planets Jupiter, Saturn, Uranus and Neptune. It is assumed that planets behave as stable entities across countless millennia. It may be however, that there are cycles of variation of such processes so that the Neptune of today may be quite uncharacteristic of the Neptune of many millions of years ago. The same may also be true of Jupiter, Saturn and Uranus.

Neptune: The Next Stage

The outer planets of the solar system such as Neptune and its moons act as chroniclers of times past. In studying them, details of the origin and evolution of the solar system become manifest. In contrast, it is very difficult to determine the past history of the earth since so much of its surface features are relatively short lived. A return mission to Neptune would undoubtedly bring about new discoveries – perhaps of a wholly unsuspected nature.

Any return mission to Neptune – presumably of an orbiter type – would require a specially tailored set of instruments for investigation of a much broader range of parameters. During the voyager mission, many of the instrument systems were operating on the limit of their sensitivities.

As with the Galileo probe to Jupiter, it could be an option to drop a probe into the Neptunian atmosphere and determine details of the pressure/temperature and gas concentrations with altitude. As with the Cassini mission to Saturn which is scheduled to deposit a probe on Titan's surface, it may be considered useful to land a craft on Triton – though the very cold surface temperatures may present major operational difficulties. An investigation of Neptune, however, should involve more detailed spectroscopic examination of the atmosphere for chemical composition with also more detailed thermal scanning to determine temperature variations associated with atmospheric circulation.

Even if the go ahead was given for mission now, and this took seven years to plan and construct, the outward journey would take of the order of 10 years so that the encounter would not take place until 2015. This perhaps makes us value all the more the data that Voyager 2 was able to obtain on its memorable visit to Neptune in 1989.

Far Out Plans

In determining future possible missions, groups within and associated with NASA can study a wide variety of options, with the most interesting missions put forward in a formal way for selection. To date some thought has gone into a Neptune orbiter mission but it is unlikely in the short term to be nominated in a formal sense for a specific mission. For a project of this type, it is likely that some form of aerobraking would be required to slow the craft sufficiently to enter into a useful orbit round Neptune. This would save on the mass of fuel required to slow the craft down to achieve orbital capture but introduce tighter tolerances in angle of approach. There would also appear to be more interest in landing a probe on Triton than dropping a probe into the Neptunian atmosphere.

At present within NASA, the next mission to the outer planets looks likely to be a choice between a mission to either Europa a moon of Jupiter or Pluto. Europa has the smoothest surface of any object so far encountered in the solar system – presumably brought about by the outpouring of water from the warm interior layers to its frozen surface. There appears, however, to be no significant desire between NASA and ESA, however, to team up for another joint mission such as the Cassini mission to Saturn.

Neptune the Mystic

As well as acknowledging the scientific associations of Neptune, it is interesting to mention in passing the associations of Neptune – principally through Astrology. The so called trans- Saturnian planets are claimed to be associated with subtle mental energies. Uranus is associated with scientific invention and flashes of inspiration. Neptune is associated with higher realities either as constructive engagement of the mental faculties or escape into substance induced sensation. Pluto is associated with the process of transformation – typically associated of turning to something else through sudden change and alteration. Neptune is also associated in Astrology with musical talent. In Gustav Holst's the Planets, Neptune is described as the Mystic and masterfully conveys the feeling of great distance and great depths. An Astrologer would wish to find the yearnings associated with Neptune coupled with the rigid discipline of Saturn which rules the material life. In this way there will be a balance of things material and things of a higher mental level.

As we are entering more and more into an age of information and data, perhaps there will also be developed subtle systems of sampling of trends in events and happenings that could test some of these aspects which are claimed to be part of our existence.

Further Information;

Atlas of Neptune. Garry E. Hunt and Patrick Moore. Cambridge University Press

Astrologically speaking. Ingrid Lind, published by L.N. Fowler, 1981

http://seds.lpl.arizona.edu/nineplanets/nineplanets/neptune.html

http://pds.jpl.nasa.gov:80/planets/welcome/neptune

http://bang.lanl.gov/solarsys/neptune.htm

PROJECT

The Sentinel FAN FAILURE ALERT

Design by the Maplin Project Team

Many computers use a heatsink and fan assembly to assist their microprocessor keep its cool in this racy world of high speed processing. This is particularly true of the good old PC but what happens when the fan stops working as it appears they invariably do.

PROJECT RATING 2

Kit Available
Order as LU73Q
Price £16.99

FEATURES

- Automatic detection of expensive CPU cooling fan failure
- No special connections or mounting required
- Suitable for beginners
- Clear audible warning
- Compatible with most PCs
- Plugs into PC power supply
- Accessibility option

APPLICATIONS

- CPU overheat protection
- Power supply protection
- Other fan cooled equipment

Some time ago, I remember a colleague phoning one evening and asking if stalling the CPU cooling fan could damage a Pentium motherboard. I had a think, but not being willing to admit to my lack of expertise in this field, replied that I felt it to be highly unlikely. He had a new, working system and had, briefly, been testing the machine without a CPU cooling fan. The machine had failed and subsequent investigations had shown the motherboard to be faulty. The symptoms were unusual because the VDU would not display but the Power On Self Test, POST, routine completed normally. Further, the CPU and graphics card worked when switched to another machine.

Just recently, a work colleague was having problems getting his PC to display anything. His system had been running unattended over the weekend and a failure had occurred during this time. Curiously, his system motherboard had developed a fault that was not detected by the POST at start-up. All other parts, including the CPU worked fine when tested in another machine. Then he noticed his CPU cooling fan was not running!

Could this be a coincidence? I am still unable to answer this question and would be interested in other similar experiences.The latter failure prompted a discussion concerning damage to CPUs and the possibility of secondary damage to the motherboard and plug-in cards. The topic gradually moved to a device to detect a fan failure and alert the user. The result of these discussions is the Sentinel – Fan Failure Alert.

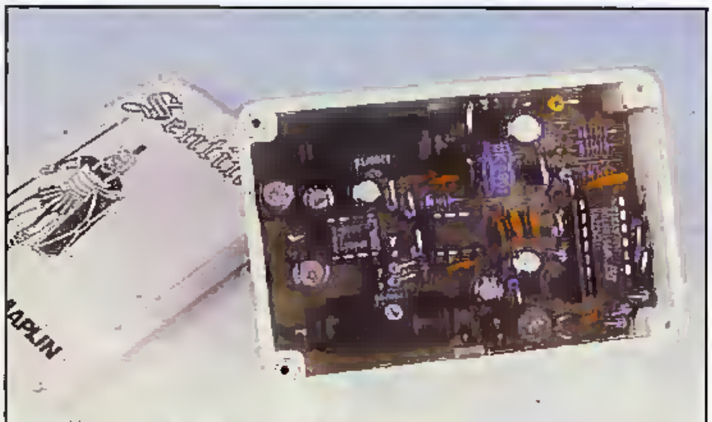


Photo 1. A fully armed Sentinel.

Defence tactics

To detect when an event is not occurring necessitates detecting when it is. To detect a stationary fan meant finding something that indicates when a fan is functioning and then detecting that 'somethings' absence. Three main methods for detecting rotating shafts exist:

1. Magnetic coupling;
2. Opto coupling;
3. Direct connection

Worded simply, magnetic coupling uses a magnet, or magnets, placed around the circumference of the moving shaft. A detector, hall effect or reed switch, is arranged to pick up the alternating magnetic field giving an indication of shaft rotation.

Opto coupling uses a light beam, possibly infra-red, which is either broken or reflected by attachments to the shaft. For example, placing a LED on one side of the fan such that the rotating blades cut the light alternately will give pulsed light when the fan is operating. This can be detected by a light sensitive device on the opposite fan face giving an electrical signal corresponding to the pulsed light.

Direct connection can be made by placing one-half of a switch contact onto a fan blade and arranging the other half such that a contact is made every time the blade passes.

There are many variations of the above but all these methods require mechanical assemblies around the fan periphery; a very dusty area. Several require attachments to the fan which may affect its balance or result in some loss of airflow. However, another method of direct connection exists and is used here.

The type of fan used for cooling CPUs are generally brushless types. As the name suggests, these fans do not use brushes unlike most DC operated DC motors. (Interestingly, nearly all AC motors are actually AC operated DC motors). The coils of brushless fans are electronically switched so do not require any form of sliding contact. This results in longer operational life.

An annoying effect of the high current switching of the coils is noise spikes imposed on the supply rails. It is these noise spikes that are detected by the Sentinel as their presence indicates a working fan.

Unfortunately, the PC is full of spike producing electronics. The CPU, motherboard and support cards are full of digital

SPECIFICATION

Supply voltage	5V and 12V DC (From PC power supply)
Supply current	(5V) 2mA standby. 65mA Alarm
	(12V) 6mA *plus* rated fan current (Standby)
	8mA *plus* fan stall current (Alarm)
Audio alarm	4 x 2kHz tonebursts every 0.6s
Speaker power	100mW (min.)
Sound input	compatible with most motherboards
Sound output	Soundblaster™ and Blaster™ compatible
Accessibility output	Red warning beacon
Flash rate	4 x 5ms pulses every 0.6s
Fans supported	DC, brushless
Fan current	1A (absolute max.)

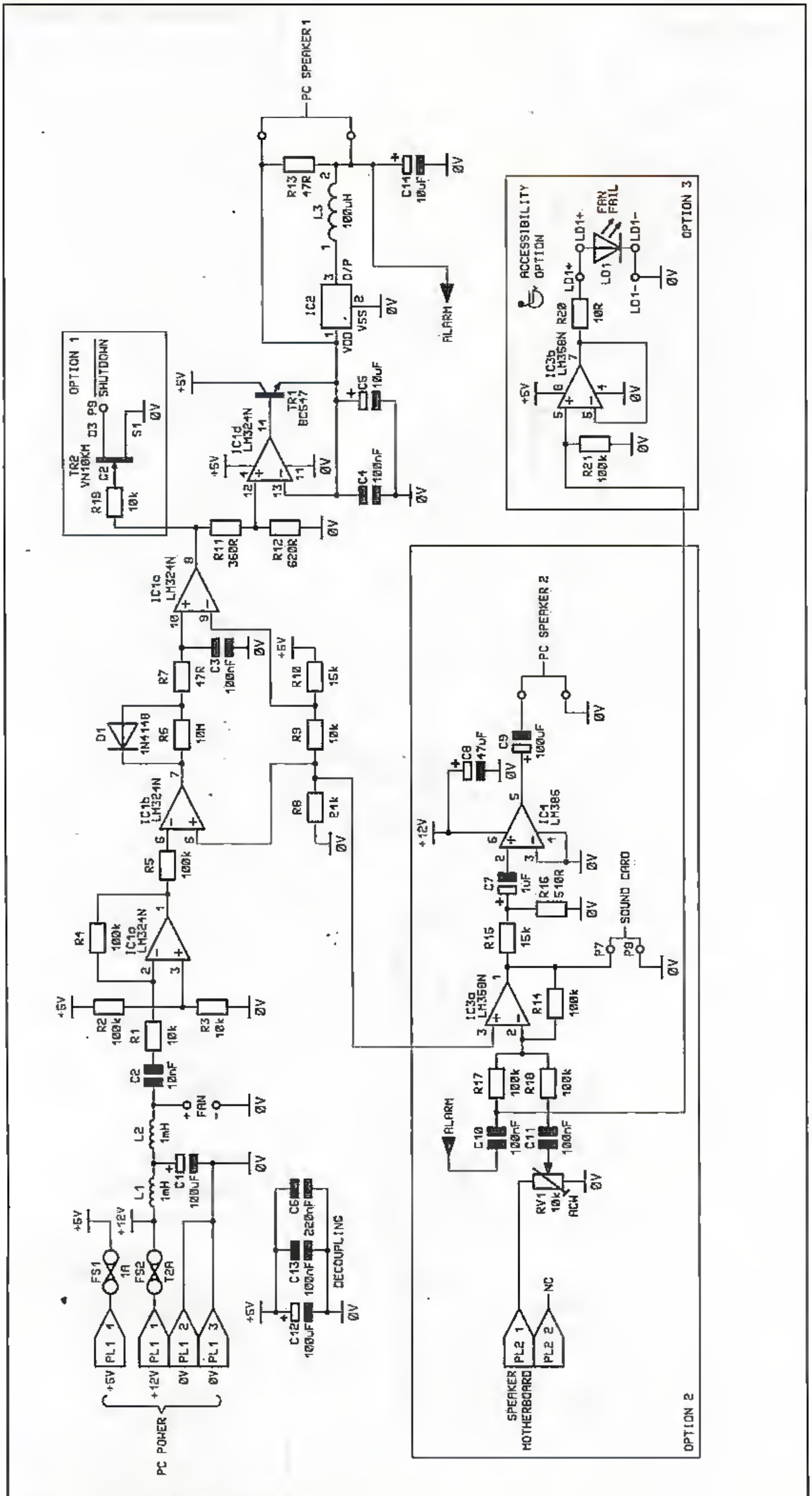


Figure 1. Circuit diagram of the Sentinel.

components that work by switching between two voltages. The disk drives have a brushless motor spinning the disk platters and an electronic device to step the heads over the disk surface. Finally, all PC's come with a power supply cooled by a brushless fan just like the one on the CPU!

Guarding your CPU

The full circuit diagram of the Sentinel is presented in Figure 1. Figure 2 is a block diagram representing the full Sentinel circuit. This should help you follow the description of circuit operation that follows.

The Sentinel receives its power from the PC supply but passes the 12V through a low-pass T filter. This filter structure is used in preference to a PI filter because the input and output impedances, presented to the filter, are very low. Further the load impedance would normally be much higher than the power supply output impedance.

This provides better matching to the PC power supply and CPU cooling fan. The CPU fan is connected to this supply after the filter meaning any significant noise present on the 12V must be produced by the CPU fan. The T-filter presents a high impedance looking back into the filter from the fan. This has the added effect of exaggerating the noise amplitude produced by the fan. This noise is usually attenuated by the PC PSU reservoir capacitors.

The fan noise spikes are ac coupled to IC1a by C2. This op-amp forms an inverting amplifier with a gain around 10, set by R1 and R4, with an offset DC level set by R2 and R3. The DC offset (0.5V) sits above background noise level but below the spike level produced by the fan. This action means only pulses from the fan are amplified.

IC1b is a comparator with its 2.5V (approx.) reference on pin 5, set by R8, R9 and R10. Output pulses from IC1a are inverted by this comparator only if their level is above the reference level. The normally high output of IC1b charges C3 via R6 and R7. With fan noise present, and therefore low-going pulses on IC1b output, C3 is rapidly discharged via R7 and D1. D1 bypasses R6 when discharging C3 so the charge time is long (around 2 seconds) compared to the discharge time (around 10).

As long as C3 is kept discharged, i.e. normal fan operation, then the output of IC1c will be low, the non-alarm condition. If pulses stop arriving, C3 charges slowly until the voltage on pin 10 of IC1c exceeds the reference level (3.5V approx.) on pin 9. The output of IC1c then goes high, the alarm condition. The two comparators, C3 and its timing components together with the reference voltages constitute a missing pulse detector.

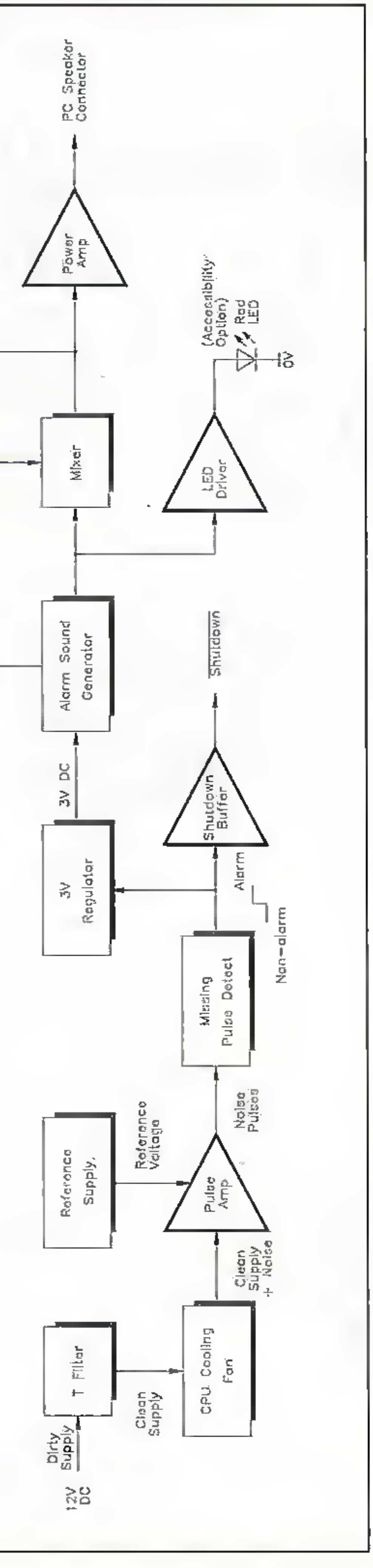
The output of IC1c is buffered to produce an active low shutdown signal via R19 and TR2. R11 and R12 form a potential divider. When the output of IC1c goes high these provide a reference voltage, previously around 0V, for IC1d. IC1d and TR1 form a precision voltage follower, where the output voltage, at the emitter of TR1 is the same as the reference voltage. The high gain of the op-amp and the 100% negative feedback from TR2s emitter guarantee this. The action of IC1d and TR2 is probably better described as a high-current buffer. This stage provides a voltage regulator for IC2 which has a maximum supply of 3V. C4 and C5 bypass this new supply and provide smoothing.

IC2 is the alarm tone generator. Details of the operation of this IC can be found in the catalogue or the data sheet for the device. The output of IC2 is passed through L3 and C14 to remove harmonics not permitted under EC regulations. L3 and C14 form a low pass filter with a steep roll-off above the alarm tone frequencies. The output of IC2 can drive the PC speaker directly. R13 provides a suitable load for IC2 if option 2 is fitted. If the PC speaker is used by other applications, a mixer based around IC3a allows the applications sounds and the Sentinel's alarm to be combined. The mixer takes a signal from the existing source (usually the motherboard) via volume control RV1 and mixes this with the Sentinel's alarm sound.

The mixer's output is amplified by IC4 before being fed to the PC speaker.

The sound generator also drives a LED buffer which gives a visual warning of fan failure for PC users with hearing difficulties. This is a voltage follower, ac coupled to the sound generator, which causes the LED to flash in sympathy. R21 holds pin 5 of IC3b low when the alarm is not sounding. The ac coupling on this input would allow it to float high with leakage currents. R21 discharges these currents and the output, following the input, stays low.

Figure 2. Sentinel block diagram.



Tactical logistics

The Sentinel is provided with all the components to allow fan-operation monitoring and sound a distinctive alarm, through the PC speaker, if the fan stops operating. The Sentinel requires exclusive use of the PC speaker but, if this is already used, option 2 is provided. The *inventory* (parts list) lists all parts required for all options.

Option 1 provides a high current transistor allowing external hardware detect a fan failure. This output could be used to provide a PSU shutdown, drive a louder warning device or provide a hardware interrupt to allow automatic, safe application-closure followed by system shutdown.

Option two provides a mixer allowing the motherboard's speaker output to be used in conjunction with the Sentinel. If only C10, C11, RV1, R14, R17, R18 and IC3 are fitted from this option, the PC sound-card amplifier must be used. Further, the two pin plug should be fitted at P7 / P8, the sound card output. If your sound card does not have the necessary input, or you do not want to use your sound card, then fit all of option 2. Move the two pin speaker plug to its alternative position 'SPEAKER 2'. See Figure 3 for these connections.

Option 3 provides an accessibility option for the hard-of-hearing. A snap-off portion has been added to the PCB. This should be mounted at eye-level on the monitor using a sticky-pad. If the fan should fail the Sentinel will flash the LED in time with the tone. This should help a disabled user avoid a sudden end to their computer session.

NOTE. To use option 3, C10 must be fitted.

Arming your Sentinel

The following procedure for assembly is given for guidance only. It assumes that all options are to be used. If the procedure calls for a component to be fitted that is not to be used, then ignore the reference. Figure 4 and Photo 1 will help you locate the correct place for components. The PCB is very full!

After deciding which options are to be used, fit all the links using the length of 24swg tinned copper wire. If pins are used to make connections to the PCB, fit these next. Fit all the resistors that lay flat to the

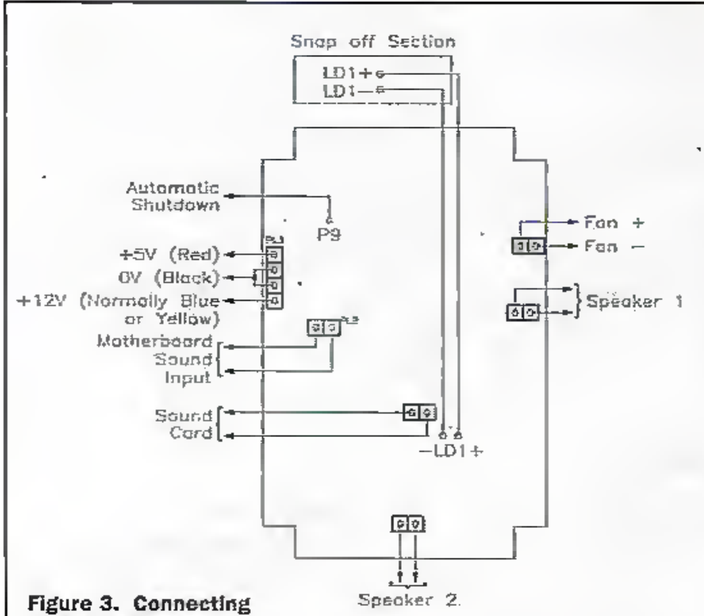


Figure 3. Connecting to the Sentinel.

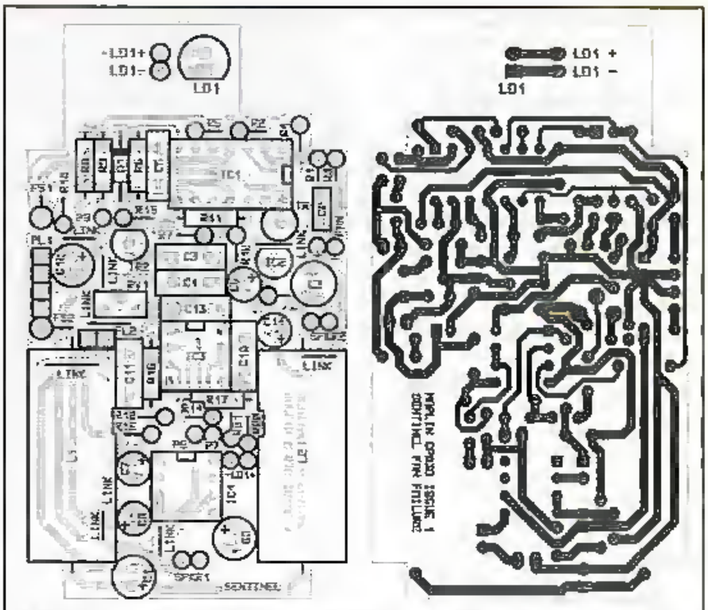


Figure 4. Track layout and component overlay for the Sentinel.

PCB and D1. Next, fit the resistors that stand up followed by the smaller capacitors like C2, C3 and C4. Fit the IC sockets but do not insert the ICs. Fit fuses FS1 and FS2 taking care not to overheat these components. Fit the remaining capacitors and L3. Fit TR1, IC2 and RV1 followed by L1 and L2. Fit the two pin plug. This goes in 'SPEAKER 1' on the PCB for the basic option or 'SPEAKER 2' if option 2 is selected. See *tactical logistics* above for siting of the plug.

Finally fit the remaining ICs in their respective sockets.Check everything! Make sure that the components are in the correct places. Make sure D1, C1, C5, C7, C8, C9, C12 and C14 are the right way round. D1 will not explode but any of the capacitors might. Make sure that the ICs are the right way round. Make sure no parts are left over.

Cut two 100mm lengths from the black wire and 100mm from the red wire. Strip 6mm from both ends of all the wires, including the remainder of the red and black wires, then twist and tin them.

Fit one end of the red wire, one end of the yellow wire and one end of the two 100mm black wires through the PCB holes at PL1. Crimp and solder the pins of PL1, the PC power plug, to the other ends of these wires. Push the pins into the PC power plug shell as shown in Figure 5.

Fit the remainder of the red wire through the holes at P1 and the remainder of the black wire through the hole at P2. Solder the ends in place. Tape the bare ends of these two wires to stop them shorting. The fan will connect here later.

Remove the thin sections on the walls of the box base. See Figure 6. This will allow the cables to pass in and out of the case. Remove any burrs and sharp edges around the cable entries to prevent chafing the insulation. Push the PCB into the case making sure that it clips under the tags near the case bottom.

Preliminary manoeuvres

If you have a spare 8Ω speaker that is expendable, use it. Connect the Sentinel's power plug to a spare power socket in the PC. If the wiring is correct then the red and black leads will connect together. The 'yellow wire' is normally blue or yellow in the PC but may be some other colour. The colour is not important but the connection is so make sure that red connects to red and black connects to black.

Unplug the PC speaker from the motherboard and connect to the two way plug. The polarity is not important. Leave the fan connected as normal, not connected to the Sentinel.

Switch on the PC. After a couple of seconds the alarm tone should sound. Switch off the PC. (If running Windows then let it complete its boot-up sequence and shut it down normally).

Remove the insulating tape on the Sentinel's fan connecting wires. Cut the heatshrink in two equal pieces. Slide one piece over each wire. Solder the PC's fan red (positive) wire to the Sentinel's red wire. Solder the black (negative) wires similarly. Slide the heatshrink sleeving over the soldered joints and shrink it in place.

Shrinking can be done with a hot-air gun but you can use a (very hot) hairdryer instead. If neither of these is available use a soldering iron held close but not touching the sleeving. As a final resort a match or gas-lighter flame held close will do the job but be careful not to burn the wires or other nearby parts.

Brushless fans can usually be connected the wrong way round without any problem, but don't take chances. Switch on the PC.

The fan should spin and the alarm should stay off. Stall the fan by pressing gently on its centre but watch your fingers. After a couple of seconds the alarm should sound.

If all is well, fit the case lid and screw in place using the four self-tapping screws supplied. Using scissors, separate the two labels. Remove the backing sheet from the front panel label, the one with the picture of the Sentinel, and carefully apply this to the front panel. Repeat the process for the rear panel label. The rear panel label has clear zones to allow the two fixing holes to be used.

The Sentinel can now be fixed in some convenient place inside the PC.

If the Sentinel is not detecting your fan: We have found one instance, a 160mm fan, of the Sentinel failure to detect. This fan was a low noise version that smoothed its supply so effectively the Sentinel couldn't see the noise pulses. R4 was changed to 220KΩ and all worked well. If you experience problems this can be cured by increasing R4 in steps. This is inconvenient but unusual and is symptomatic of the wide support provided by the Sentinel.

R4 should be changed as follows:

220K, 470K, 680K, 820K, 1M.

The Sentinel can now be fixed in some convenient place inside the PC.

Sentinel deployment

If the basic option is selected then mount the Sentinel in the PC as explained below. If option 1 is fitted then a connection must be made from P9 to the user circuit(s). This is entirely dependent on the users requirements.

If option 2 is fitted then a cable must be made to connect the PC motherboard to the Sentinel. The cable should consist of a length of 16/0.2 gauge flex, one end of which is stripped, twisted and tinned. These ends are soldered to PL2 1&2 of the Sentinel. The other end should be fitted into a two-way PCB socket. Note that the two-way socket shell that Maplin stock will not fit all PC motherboards, so check first.

Fit the connector to the motherboard Speaker output. Plug the PC speaker onto the plug fitted at 'SPEAKER 2'. Set RV1 to its mid-point position. Switch on. Use an action that triggers a sound through the PC speaker and adjust RV1 until the volume is correct. If no sound is produced it is likely the lead is on the wrong motherboard terminal. Turn the connector at the motherboard end around and re-fit it. Finish by securing the lid and mount the Sentinel.

If the sound card output is used then a two-wire connector will be required. These are available for many sound cards. Please ask for advice.

Option 3 is provided for the hard-of-hearing. A pair of wires must be connected to P10 and P11. These must be passed through the back of the case and up to the monitor. The wires are fitted to the snap-off portion of the board. Note that the wires are connected as shown on the circuit diagram (P10 to LD1+). See Figure 3 for clarification.

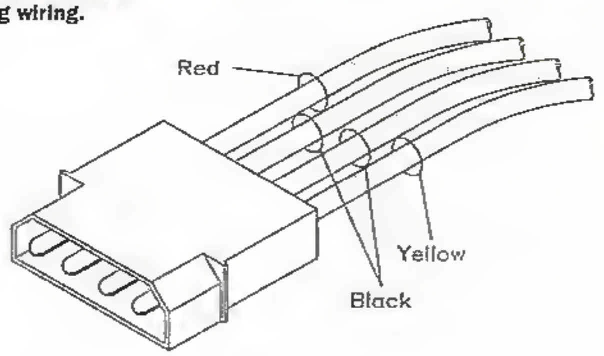
A stick pad can be used to fix the LED to the top, or side, of the monitor. Use a good position at eye level where the LED is not likely to get covered. Test the position by stalling the fan to cause a failure.

Mount the Sentinel inside the PC where it will not foul other cables, the motherboard or the case lid. Two sticky fixing-pads are provided but make sure that both surfaces are clean and grease-free before using them. Alternatively, The box base has two fixing holes which can be used to secure the Sentinel in position. Fixing can be achieved using screws or a cable tie. If using screws make sure that the Sentinel's PCB does not short on the screw heads.

We mounted ours using the provided sticky fixing pads. See photo 2.

WARNING. When testing the Sentinel, do not stall or disconnect the fan for more than five seconds. Fan failure causes CPU overheating and subsequent failure.

Figure 5. Power plug wiring.



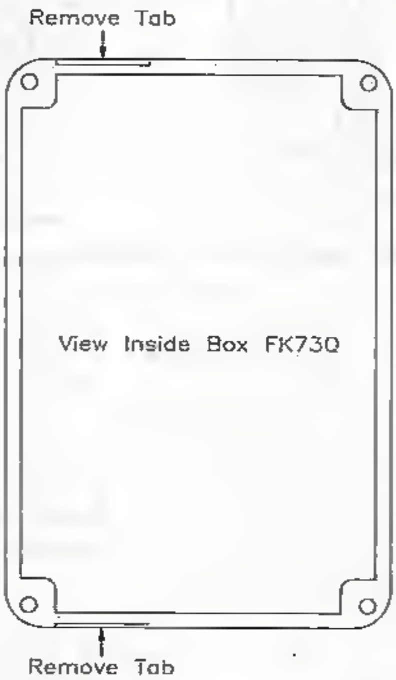


Figure 6. Preparing the Sentinel's case.

Sentinel weaknesses

The Sentinel is not suitable for use with pulse width modulated speed controllers or other controllers that rely on switching techniques to regulate the fan speed. Speed controllers using DC level control can be used. Brushless fans that consume currents below 1A can be used but some may cause the Sentinel to operate irregularly. This is due to the vast differences in implementation of fan drive circuits. The Sentinel has been tested with a significant number of fans and operated correctly with all. See Preliminary manoeuvres.

PROJECT PARTS LIST

Resistors: All 0.6W 1% Metal film.			
R1,3,9	10k	4	M10K
R2,4,5	100k	3	M100K
R6	10M	1	M10M
R7,13	47Ω	2	M47R
R8	24k	1	M24K
R10	15k	1	M15K
R11	360Ω	1	M360R
R12	620Ω	1	M620R
CAPACITORS			
C1,12	100uF Al Elect 16V	2	AT40T
C2	10nF 50V Ceramic	1	BX00A
C3,4	100nF 16V Ceramic	2	YR75S
C5,14	10uF Al Elect 63V	2	AT77J
C6	220nF 16V Ceramic	1	JL01B
SEMICONDUCTORS			
D1	1N4148	1	QL80B
TR1	BC547	1	QQ14Q
IC1	Op-Amp LM324N	1	AV42V
IC2	M66T-215	1	GX60Q
MISCELLANEOUS			
L1,2	Inductor 1200/15	2	UM13P
L3	Inductor 100uH	1	AH36P
FS1	PCB Fuse 1A	1	DA53H
FS2*	PCB Fuse S/Blow 2A	1	PE06G
PL1	Pin Strip 1x36 St	1	JW59P
	Box 321	1	FK73Q
	16/0.2 Wire Red	1250mm★	FA33L
	16/0.2 Wire Black	1350mm★	FA26D
	16/0.2 Wire Yellow	100mm★	FA36P
	24swg TC Wire	100mm★	BL15R
	Heatshrink CP24	30mm★	BF87U
	Quickstick Pads	2★	HB22Y
	Sentinel PCB	1	GP03D
	Sentinel Front Panel Label	1	NV73Q
	Sentinel Leaflet	1	XZ49D
	Constructors Guide	1	XH79L

OPTIONAL ITEMS (not in kit)

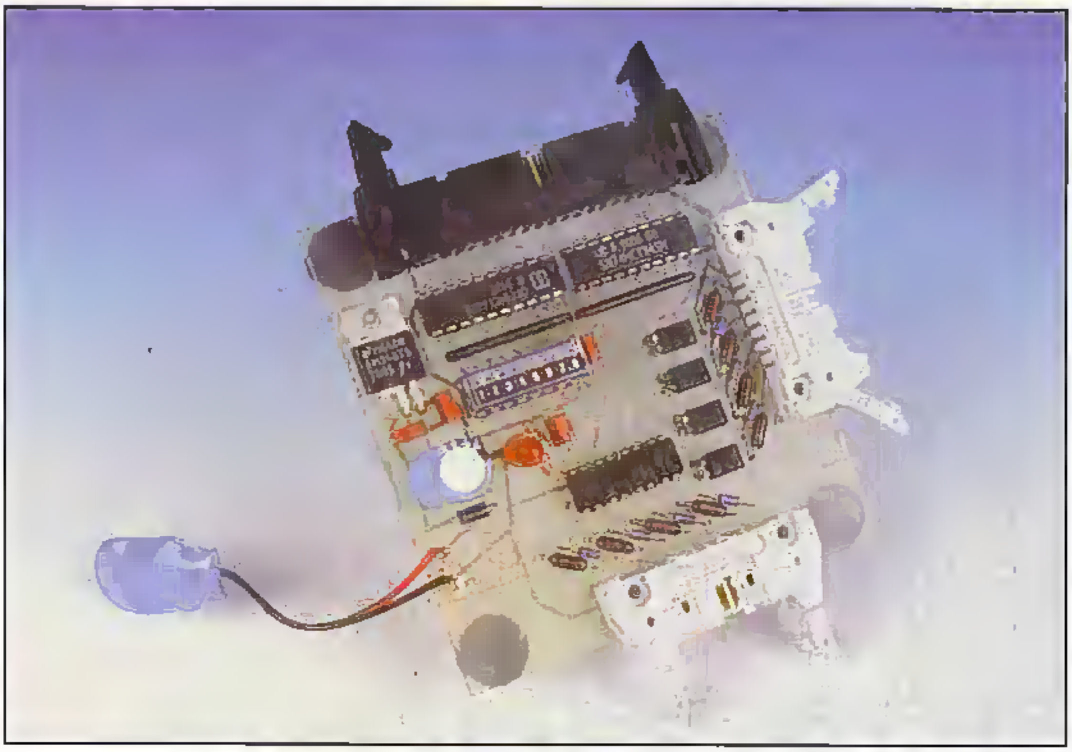
OPTION 1			
R19	10k	1	M10K
TR2	VMOS FET VN10K	1	QQ27E
OPTION 2			
R14,17,18	100k	3	M100K
R15	15k	1	M15K
R16	510Ω	1	M510R
C10,11	100n Ceramic	2	YR75S
C7	1μF Al Elect 63V	1	AT74R
C8	47μF Al Elect	1	AT39N
C9	100μ Al Elect	1	AT40T
IC3	LM358 dual op-amp	1	UJ34M
IC4	LM386	1	UJ37S
OPTION 3			
R20	10Ω	1	M10R
R21	100k	1	M100K
C10	100n Ceramic (in option 2)	1	YR75S
IC3	LM386 (in option 2)	1	UJ37S
LD1	5mm Red LED	1	WL27E
	16/0.2 Wire Red	as req.★	FA33L
	16/0.2 Wire Black	as req.★	FA26D
	Quickstick Pads	1*	HB22Y

The Maplin 'Get-You-Working' service is available for this project, see Constructors' Guide or current Maplin Catalogue for details.

The above items (excluding optional) are available as a kit.

Order as LU73Q (Sentinel – Fan Fail Alert Kit)

Please note: Items in the Parts List marked with a ★ are supplied in 'package' quantities (e.g., packet strip, reel etc.), see current Maplin Catalogue for full ordering information.



IBUS 8 BIT DIGITAL INPUT/OUTPUT MODULE

PART 3

Design & Development by Neil Johnson

This project continues the series of articles based on the IBUS – a simple, slow parallel eight bit expansion bus for the IBM PC and compatibles. This was introduced in Electronics and Beyond – The Maplin Magazine issue number 119, for which back issues are available.

Hot on the heals of last month's eight channel digital input/output module comes this new addition to the family, offering eight opto-isolated digital inputs – ideal for monitoring a number of digital signals without causing any interaction between individual inputs. Some example applications are discussed later on.

Circuit Description

Most of this circuit is based on the eight channel digital input/output project featured in issue number 122. The major difference is the removal of the output circuitry, and the addition of eight opto-isolators and associated input circuits.

The full circuit diagram is shown in Figure 1. Starting at the top left hand corner is the IBUS interface, consisting of the address decoder and enable gates. The IBUS address (A0-A7) is compared with the board address, selected by SW1 and RP1, by 8 bit magnitude comparator IC1. If both bit patterns match and pin 1 is set low by the Read line, then pin 19 is set low, activating the tri-state buffer, IC2.

When buffer IC2 is enabled, the logic signals on its inputs (A1 to A8) drive its eight output pins (B1 to B8) and ultimately the IBUS data bus, D0 to D7. This data is then read into the PC via the IBUS Printer Port Adaptor (PPA) described in issue 119.

The inputs to the buffer are pulled high by resistor pack RP2 – eight 4k7 resistors in a single-in-line (SIL) package with the common wire connected to +5V. The inputs are pulled low by the output transistors of the opto-isolators, IC4-11. While producing a simple circuit this arrangement does mean that the sense of the inputs is inverted – with no voltage applied the respective data bit will be set to a '1', while an input voltage will set the corresponding bit to a '0'.

The input circuits, consisting of resistors R2-9 and diodes D3-10. The diodes protect the opto-LEDs against reverse voltages, the resistors limiting the forward current through the opto-LEDs to about 3mA. The value shown in Figure 1, 2k2, is suitable for input voltages in the range 3.7 to 13 volts.

For different input voltage levels a new value for the current limiting resistors must be calculated. Using a typical forward current of 3mA and voltage drop of 1.5V for the opto-LEDs the new value of input resistor can be calculated from the following equation:

$$R_{in} = \frac{(V_{in} - 1.5)}{0.003}$$

For example, for an input voltage of 24V, a resistor of 7k5 is required. The nearest preferred value would be 6k8, giving a forward current of about 3.3mA.

The final part of the circuit is the power supply. The input voltage, of greater than 9 volts, passes through reverse protection diode D1. The supply voltage is then smoothed by C3 and C5 before being reduced to a regulated +5 volts by IC3, a member of the cheap and cheerful 78xx family of voltage regulators. Second protection diode D2 prevents any reverse voltages from damaging IC3, while R1 and LED1 provide indication of power. The remaining capacitors, C1, 2 and 4, provide local supply rail decoupling.

Figure 1. Main Circuit of Opto-Isolated Input module.

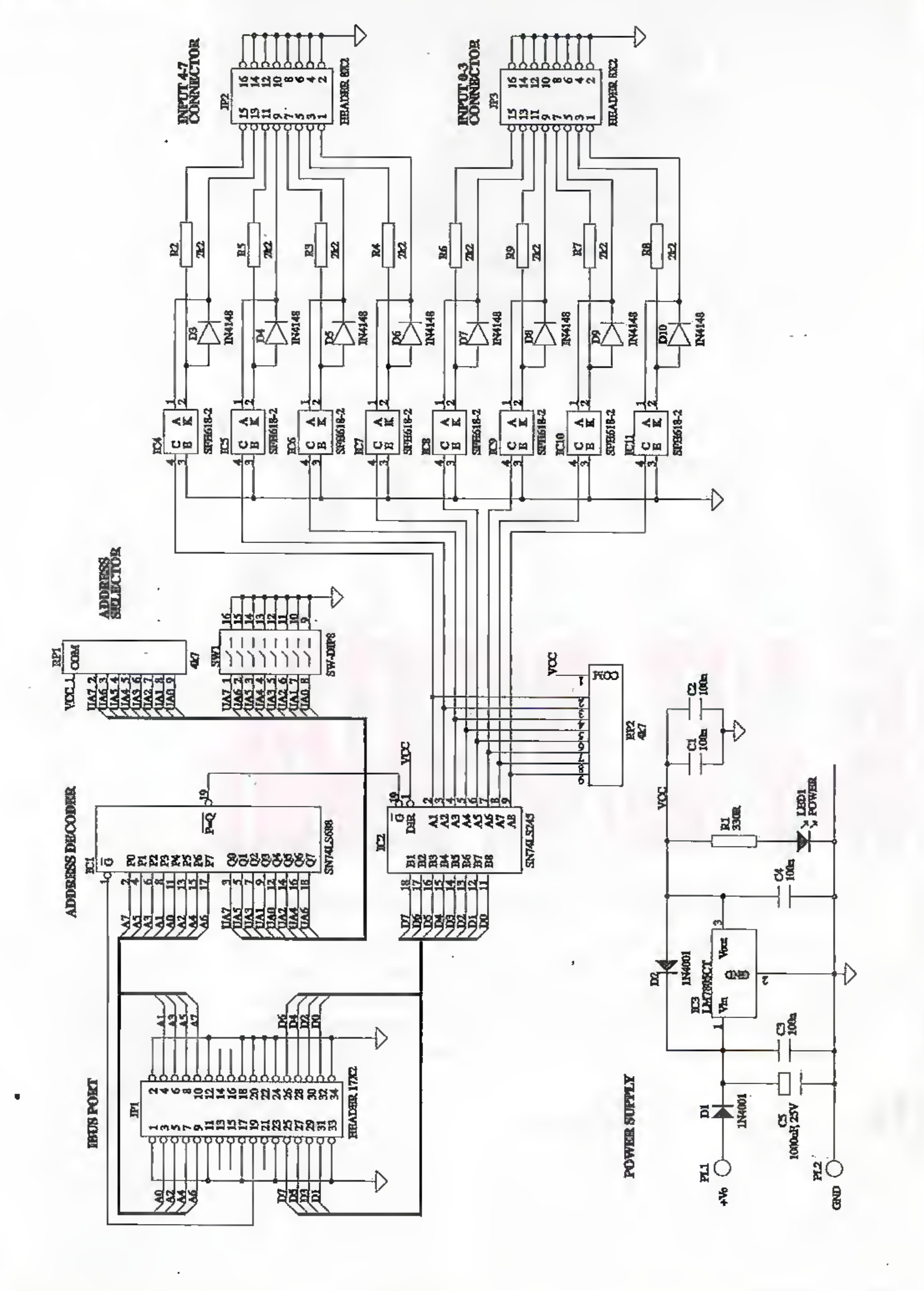
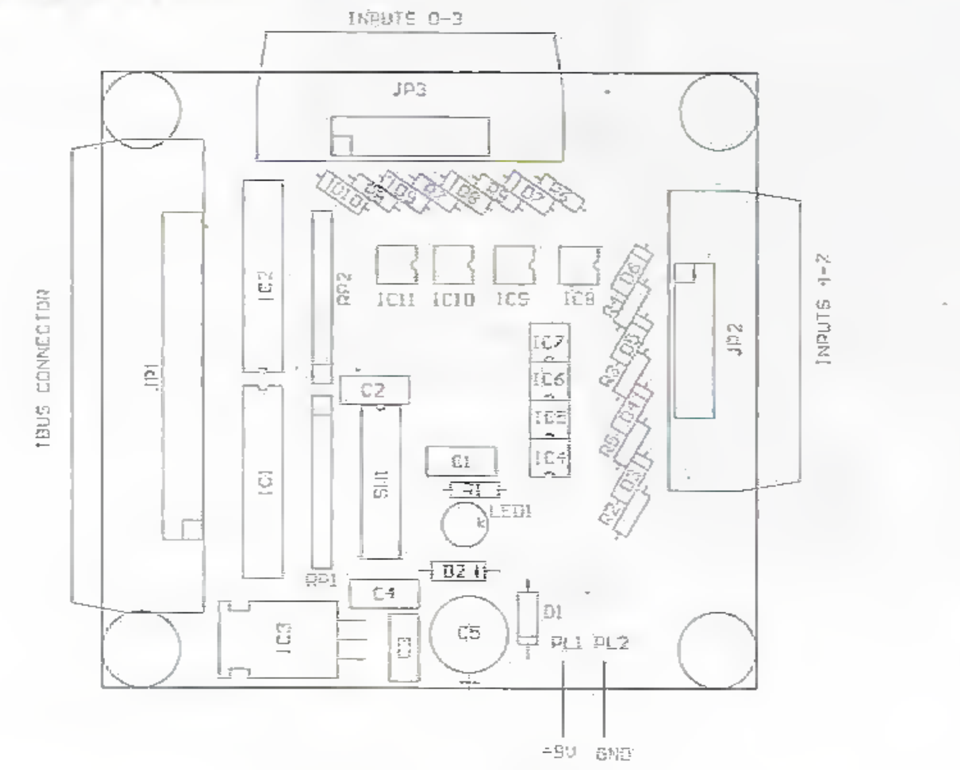


Figure 2. Component positioning on Opto-isolator board.



Construction

As for the previous IBUS module, assembly is very straightforward, with all components mounting directly on the circuit board, as shown in Figure 2.

Begin with the small components – resistors, diodes and small capacitors. Take particular care with the orientation of the two power diodes, D1 and D2. With D1 incorrect the board will not get any power, while an incorrect D2 will blow every semiconductor on the board.

Continue with the remaining semiconductors – IC1 to IC11 – and the address select switch SW1. When mounting IC3 carefully bend the three legs so that the metal face of the package is flush against the PCB and the black plastic body points upwards. Follow with the three connectors and the power LED. Finally, fit the large smoothing capacitor, C5.

Testing

The first test of your assembled board is to give it a thorough visual inspection. Check for the correct orientation of the polarized components, in particular IC2 which is upside down, and the correct orientation of the opto-isolators. Also check that polarized capacitor C5 is the correct way round.

The next test is to power up the board. Use a bench power supply, or one of those small black multi-voltage mains adaptors, slowly raise the input voltage from, say, 2 volts to about 9 volts. Using a multimeter check the output of the voltage regulator, IC3 pin 3, rises up to, but does not exceed, 5 volts.

The final test requires the board to be connected to a PC via a PPA. This should be done with a length of 34 way IDC ribbon cable and matching connectors. The IDC connectors can be crimped onto the cable with careful use of a small bench vice.

With the board connected to the PPA, the PPA connected to a PC, both boards powered up, and the PC running the IBUS software (available from the author – see Parts List) you are ready to send and receive data from the interface board.

The IBUS address to which the board will respond is set by SW1. With a switch closed in the ON position the corresponding address bit corresponds to a '0', and vice versa. The switches are numbered one higher than the corresponding address bit, so address bit A0 is set by switch 1, address bit A1 by switch 2, and so on. So, for example, if all of SW1 was set to ON the board address would be 00000000, or 00 in hexadecimal. Likewise, if all of SW1 was set to OFF, the board address would be 11111111, or FF hex. Once you have determined the address of your interface board this value can be entered into the address box, see Figure 3. To read the input register press the "Read" button, to the left of the window. The data read from the input register is then shown, in hex format, in the box below the button.

Using another power supply (a 9V battery will do) check that all eight inputs work correctly. Remember that with no input voltage the corresponding data bit will be a '1', and when an input voltage is applied the data bit will be a '0'. If at first you do not see a response check the polarity of the input voltage – a reverse connection will not harm the board, but will not provide an input signal either.

Applications

If you are now wondering why anyone would want opto-isolated inputs, this section is for you! Even if you already know what to do with such inputs, please read on as you may find one or two more nuggets of useful information.

An opto-isolated input is, as its name suggests, an input that provides some sort of isolation by optical means. In the case of this project this function is provided by a device known as an opto-isolator (author's note: this reminds me of a TV advert regarding a certain brand of wood varnish – "it does exactly what it says on the tin").

The opto-isolator provides an electrical barrier between its input and its output. When current passes through the input LED, turning it on, it shines infra-red light onto the matching photo-transistor, see Figure 4. This, in turn, passes current through its collector-emitter junction. With the aid of a collector load (pull-up resistor) the opto-isolator thus transfers an electrical signal across an electrical barrier.

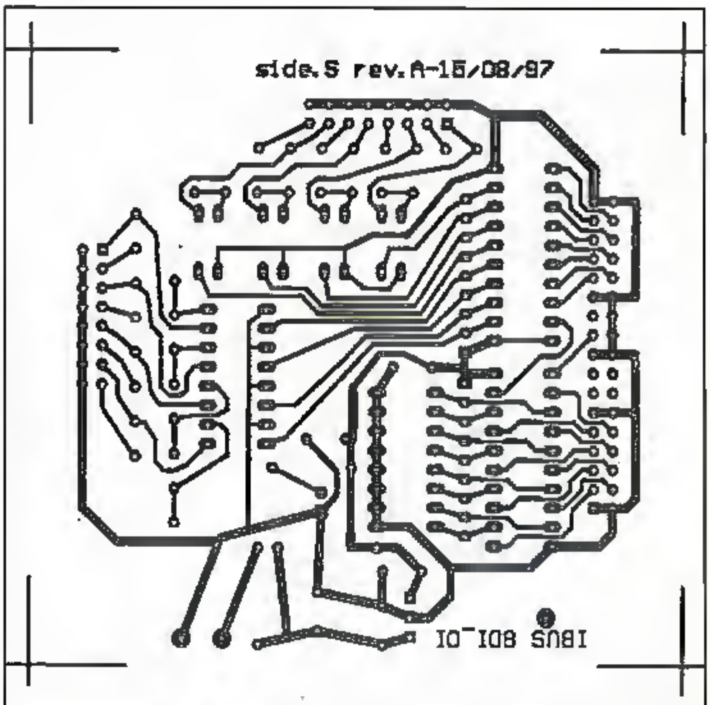
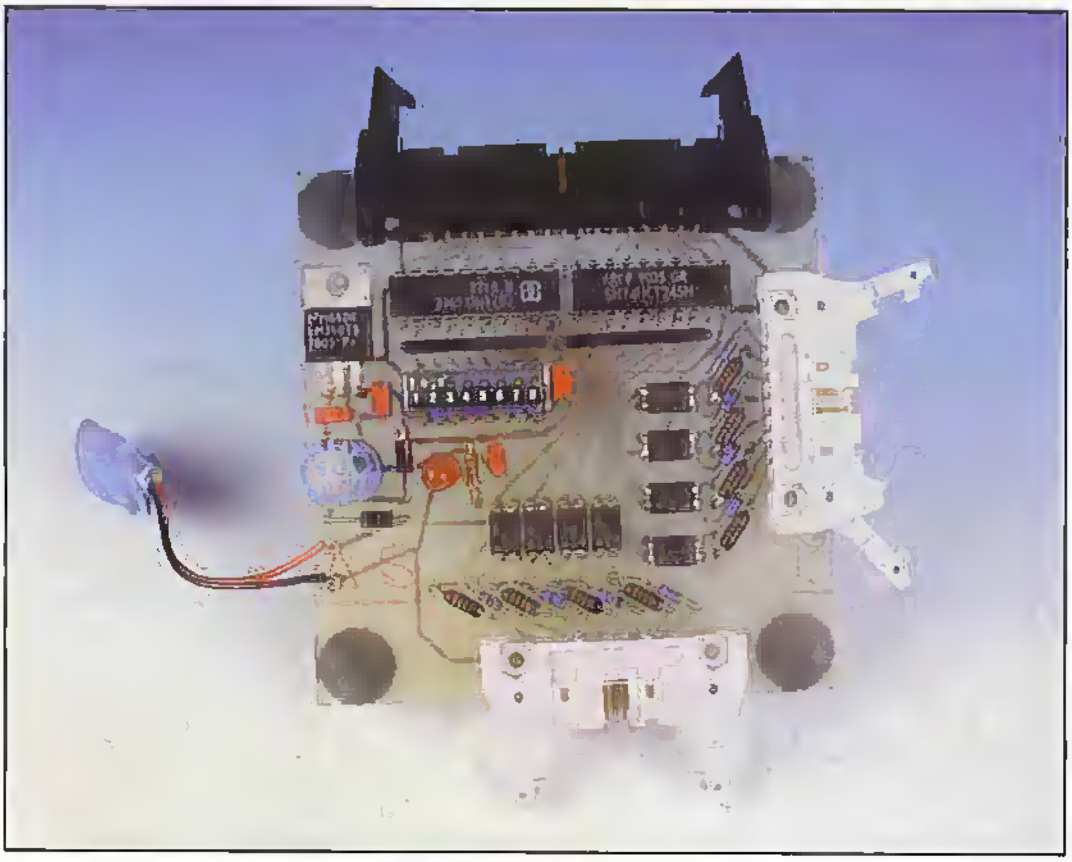


Figure 3. PCB foil.



The light emitter and detector are physically spaced apart, usually by a few millimetres of plastic, which can provide electrical isolation up to several thousand volts. Because of these high ratings opto-isolators are used extensively in mains control systems, providing isolation between the "cold" low-voltage control circuits and the "hot" high-voltage mains switching circuits.

Opto-isolators can also be found in measurement systems, this IBUS module being an example. In this case, the opto-isolator offers electrical isolation between the inputs, particularly essential for monitoring signals that may not have a common reference voltage, eg. ground.

To illustrate this application consider a system of solenoid valves operating at 24 volts, using a common +24V rail and open-collector drive circuits. Conventional input circuits would not be suitable for monitoring this system, as the loads are not referenced to ground. Opto-isolated inputs would be much better suited to this system – with each input circuit electrically isolated from the other you can directly connect the inputs to the solenoid coils, safe in the knowledge that there will be no circuit through the measuring system that could cause a short circuit to ground.

Finally, consider a high-voltage digital monitoring system, which might provide an output to indicate a particular state of operation or failure. Connecting any output from this equipment to your computer would be highly dangerous – should any insulation in the equipment fail, your computer will not survive the experience. However, by careful use of an opto-isolator you can effectively isolate your computer from the high voltages present in the equipment.

The author can, through personal experience, verify that high-voltage equipment will fail in a way most likely to cause injury – what may look like an earthed box may in fact be charged to several hundred volts, only apparent on picking up, and rapidly dropping, the unit! Opto-isolators can, if used properly, avoid this unpleasant experience.

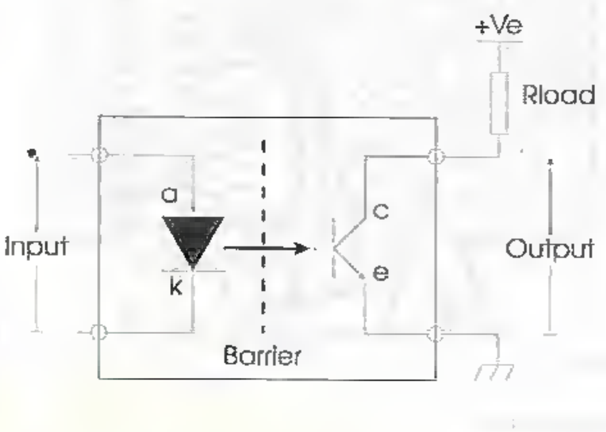
Epilogue

That is all for this month. The next IBUS module will offer eight channels of relay switched outputs, ideal for operating higher voltage loads, each isolated from the other. So, until then, happy interfacing!

Acknowledgements

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

Figure 4. The Opto-Isolator.



PROJECT PARTS LIST

RESISTORS – all 5% 0.25watt unless stated		
R1	330R	G330R
R2-9	2k2	G2K2
RP1, 2	4k7 8-way SIL resistor pack	RA29G
CAPACITORS		
C1-4	100n ceramic	RA49D
C5	1,000μF 25V radial electrolytic	AT52G
SEMICONDUCTORS		
IC1	74LS688	KP49D
IC2	74LS245	YF91Y
IC3	LM7805	QL28F
IC4-11	SFH618-2	CY94C
LED1	5mm red LED	WL27E
MISCELLANEOUS		
JP1	34-way IDC right-angled PCB header	FA44X
JP2,3	16-way IDC right-angled PCD header	FA42V
SW1	8-way DIP switch	QY70M

IC sockets (optional), PCB, solder, wire, 2 veropins for power connection

SOFTWARE DISK

The software accompanying this project, supplied on a 3½" disk, is available from the author at the address below. The disk costs £10. Postage is £2.50 for the UK, £5 for everywhere else. Please send your order, with cheque or postal order payable to "Neil Johnson", to:

Neil Johnson, IBUS Module, 2 Chapel Field, Dixter Road, NORTHIAM, East Sussex, TN31 6PQ. UK.

COMMENT

by Keith Brindley

While 56Kbit/s modems have been around for a little while, they haven't been accepted with open arms the way manufacturers had hoped. Of course, it's the manufacturers' own faults — there isn't a standard yet for 56Kbit/s modems.

Two competing technologies have been developed to production stages. Rockwell is the biggest name in the group heralding the K56flex technology, one of the two main variants. 3Com on the other hand proposes the x2 technology. Both use similar, although largely incompatible techniques to maintain a high data transmission rate from a service provider's server to the user's personal computer. Data flow in the other direction, from the personal computer to the service provider's server is not so high, although that isn't really as important. Most Internet or online service users want high download speeds while the upload speed isn't as critical.

So to date, as I've said, these two competing technologies have been incompatible. This means that for a user to purchase such a modem, the user's Internet or online service provider has to use the same technology — otherwise the user has simply wasted money buying a technology that can't be used. And, as the technology is so new, it has not yet been apparent which of the two main technologies — if either — will become the default. The result has been a decided reluctance to buy modems of either technology.

Recently the two developers met in Orlando in the US to discuss ways of bringing their technologies closer together. The outcome of this meeting is that both sides are claiming victory, saying that their technologies will be used in the final standard. In truth, it's probably safe to say that the final standard is a decent mixture of the two, and have set themselves an ambitious target of defining their merged standard as soon as early February. Once they have done this it's then up to the International Telecommunications Union (ITU) to ratify it, which it hopes to do by September. Both groups however, intend to have products available that use the merged technology by April, so it's likely that the ITU ratification will be merely a de facto approval rather than the final verdict it would otherwise have hoped to have been seen undertaking.

That's good news for most Internet users around the world. For a start it means that service providers who have been understandably reluctant to commit themselves to buying new equipment capable of such high data rates should hopefully be able to jump rapidly in the spring to the new standard. After all, as they have been reluctant to upgrade and so have not purchased modems using either of the competing technologies, they should have some money around to upgrade immediately the new standard products that are available. Well, that's the theory anyway.

Secondly, although it's probably a red herring, having a faster data communication link ostensibly implies that users should have to spend less time hanging on the phone line waiting for data to be downloaded. Hence, phone charges should be reduced. That sounds good in theory too, except that it's probably not true. Users who have been wired for several years will probably remember the same argument being used when they justified to themselves the extra purchase of a 28.8Kbit/s modem to replace the old 14.4Kbit/s modem. Using the Internet is very much like trying to half fill a sponge with water in the bath. You simply can't half fill it. Likewise, when you're logged onto the Internet with a faster modem, you simply do more things that use up the rest of the time originally saved by the modem.

Not so Smart

While modem manufacturers can be congratulated for agreeing (albeit eventually) on a merged standard for two competing technologies, it appears the two leading proponents of electronic cash smartcards Visa and Mastercard don't have the same idea in mind. The two smartcards have different operating systems that don't really allow compatibility. At present there are no plans between the two companies to meet and standardise.

DVD Soon?

The European launch of digital versatile disc (DVD) entertainment machines looks set to be a hyped event. Expect the media to pounce on it as a newsworthy event, despite the fact that there have been several problems — not the least of which is growing concern that there may not be many disc titles available at the launch.

Apparently there are difficulties when producing discs for use with European PAL television systems. Discs for US and Japan television systems are based on the NTSC standard, and discs for that are more easily produced. Nevertheless, manufacturers are hopeful that problems have been ironed out, and that a significant number of titles will be available for the launch date.

Another concern is that standards are expected to change with time — even after product launch. Particularly important here is the audio compression format used. While a Dolby digital format is expected to be used in the system now, it has been proposed that this changes in the future as the MPRG2 audio format becomes the norm for digital media in time to come. Naturally, users will need some reassurance that what they buy initially will not become outdated by each new advance in technology.

Of course, DVD in its personal computer guise as DVD-ROM is virtually guaranteed success as a means of storing huge quantities of data for archival purposes and even as a means of distributing multimedia and new applications to the computer desktop. But it would be nice if DVD as an entertainment medium could follow suit. If it was, prices of both variants would be lower (as it is, prices are going to be very high at least initially), the technology would be the first to bridge the gap between computer and television, and I could drop the virtually when I say it would be guaranteed.

However, even in the United States and Japan, DVD's future is not guaranteed unless it's accepted in large-scale by the consumer. It would be a pity if consumer acceptance is held back (or even is non-existent) simply because of production problems getting software titles into the shops for people to buy (or rent from tomorrow's versions of video hire shops), or because backwards and forwards compatibility is not assured.

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

Making YOUR OWN CDs

PART 3

In the third part of his article on making your own CDs, Martin Pipe examines how to master audio CDs from digital sources, such as DAT, DCC and MiniDisc.

So far, we've concentrated on mastering CDs from analogue recordings – such as vinyl records, cassettes, FM radio and reel-to-reel tapes – using that most versatile of computer peripherals, the CD-R burner. In essence, you're using your PC, sound card and hard disk as a random-access digital audio recorder. Musical (or whatever) selections are captured to your PC as WAV (or, in the case of Macintosh, AIFF) 44.1kHz 16-bit stereo PCM files. In this domain they can be edited and/or modified by noise reduction filters thanks to the features provided in programs like Cool 96, before being written to the CD as Red Book format tracks compatible with regular CD players. The audio files on your hard disk are then deleted, creating room for the next disc-making project – this system, unlike that of hi-fi type digital audio recorders, doesn't have the luxury of cheap removable media.

Direct Digital

But what about digital sources? OK, if you've got a CD-ROM drive that supports digital audio extraction then you'll be able to copy tracks onto your hard disk, and produce a compilation from them. This practice was, indeed, examined in previous parts of the series. If you've built up a collection of music with one of the more accepted forms of digital audio recorder, however, then it's still possible to make CDs from your recordings. You could plug the line output of the recorder into the soundcard's line input – but you're introducing digital-to-analogue (audio recorder) and analogue-to-digital (soundcard) conversion stages that could impair quality. A digital recording format and a digital computer – these intermediate processes seem rather pointless and inefficient, don't they?

Bypassing them, and providing a direct digital path from recorder to computer is however possible. The PCM datastream can then be written to the hard disk directly as a WAV file. You'll need a special sound card, all of which I know are specific to the PC, but we'll come onto that later. But imagine the possibilities! If you're into live recordings, either made with surreptitiously with a pair of microphones and a pocket-sized digital recorder or with a DAT machine hooked up to the stereo mix-down mixing desk, the concept of eliminating all analogue recording and mastering stages is a powerful one. At the very least, that DDD' logo that you'll be entitled to stamp onto your disc sounds very impressive...

Let's move onto compatible digital audio equipment. All DCC, DAT and MiniDisc recorders have digital audio input and output connections of at least one variety. On such terminals, you'll find the raw PCM datastream. They're designed for making digital copies (subject to the restraints of the SCMS copyright protection system, examined in the first part of this article), making the best possible recordings from CDs, and for feeding high-quality external digital-to-analogue converter units. An added benefit is that there is no need to worry about getting recording levels incorrect, and either getting distortion from overload or inadequate resolution. The most common of digital audio interface is the coaxial type, which conforms to a standard known as S/PDIF (Sony/Philips Digital InterFace).

In this case, the PCM signal can be found on a phono socket at a level of 0.5V peak-to-peak. It is typically isolated, on both pieces of interconnected

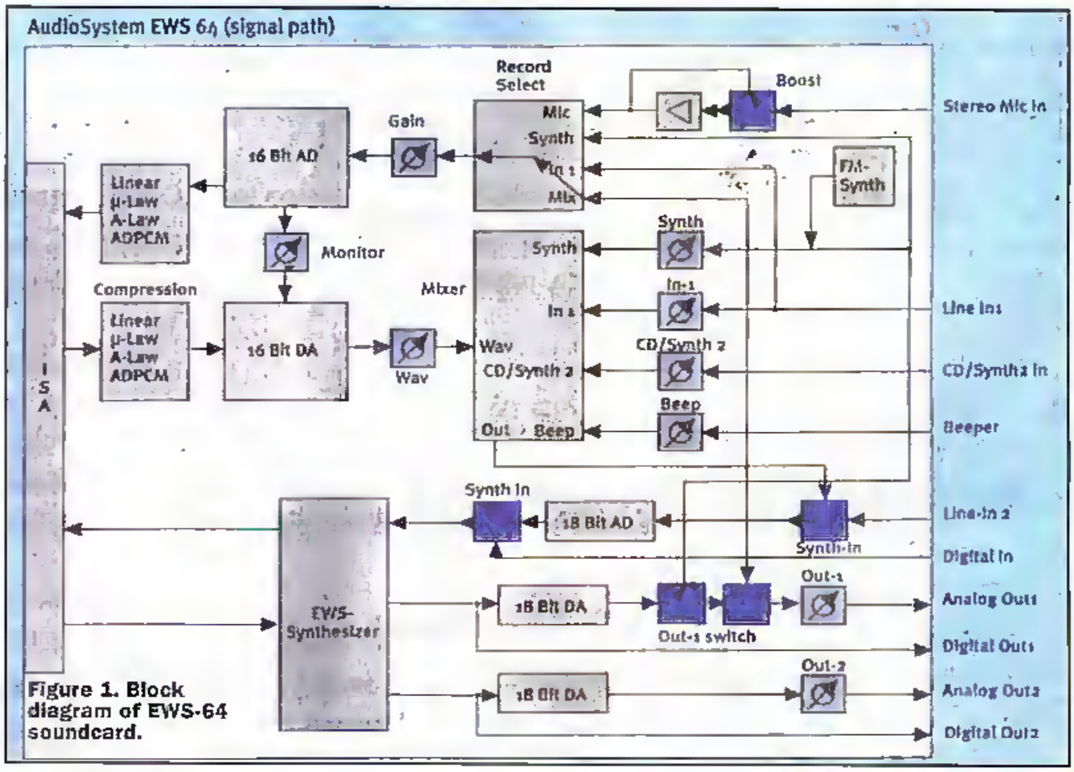
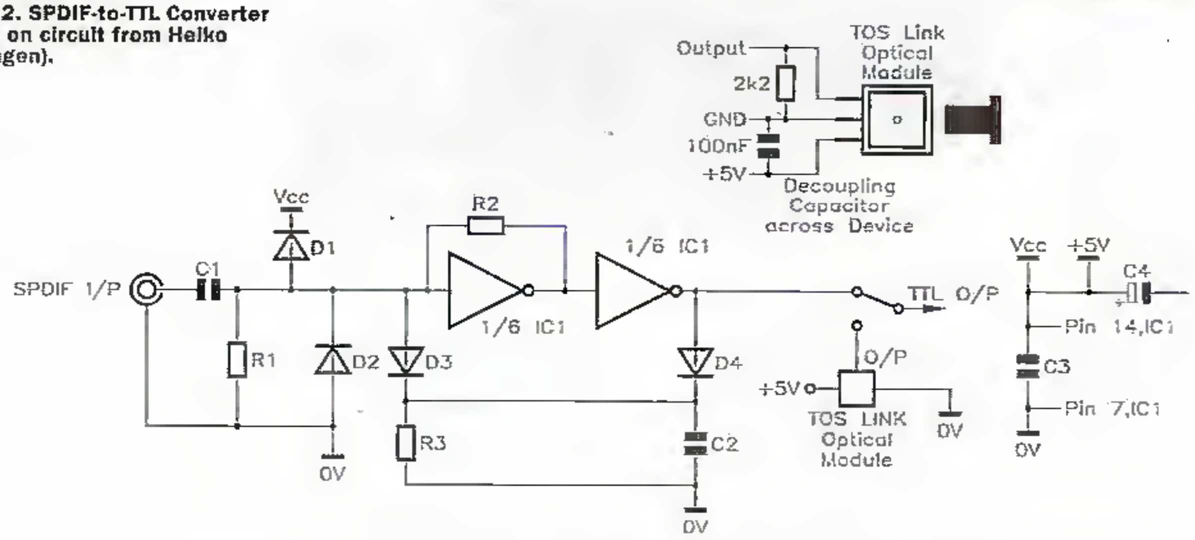


Figure 1. Block diagram of EWS-64 soundcard.

Figure 2. SPDIF-to-TTL Converter (based on circuit from Heiko Purnhagen).



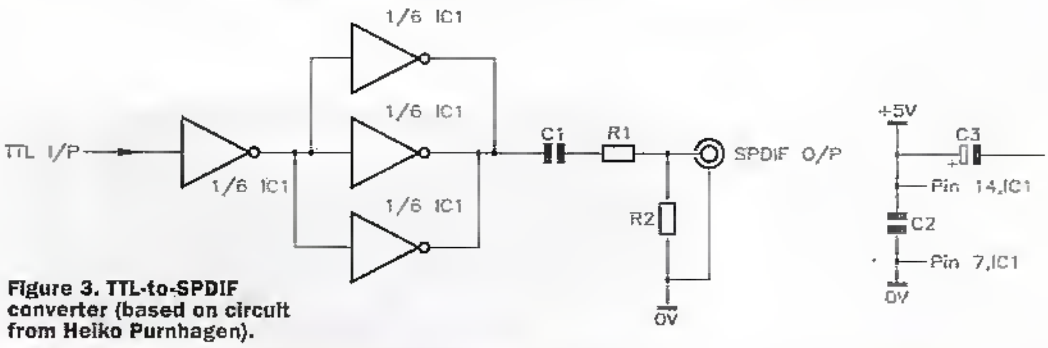


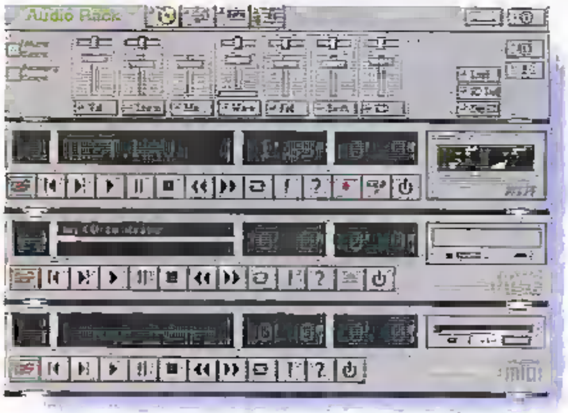
Figure 3. TTL-to-SPDIF converter (based on circuit from Heiko Purnhagen).

equipment. by means of a pulse transformer. The other form of digital audio connector is known as TOSlink, or 'optical'. This also uses the S/PDIF data format although, as its name suggests, interconnects are made via optical fibre cables, terminated at either with a special type of plug. Such cables can be bought from hi-fi dealers (albeit at a price). Maplin also sell these cables (order code CC40T), although they're still quite dear at £15.99 each. An alternative would be to improvise using Maplin's own fibre optic light guide (XR56L). Inside the equipment, TOSlink inputs use a special optical receiver module based around a phototransistor, while the outputs employ a LED-based transmitter. Because the transmission path is optical, complete isolation is afforded.

SP/DIF digital connections support the transfer of digital audio at a wide range of sample rates. Digital audio recorders are capable of working at three sample rates – 32kHz (FM radio), 44.1kHz (CD-quality) and 48kHz (highest quality). DAT machines allow you to select the sample rate by means of a front panel switch. The 32kHz mode was developed for compatibility with digital satellite systems – either Nicam or, as with current DVB equipment, MPEG. Not that I've seen digital outputs on such equipment...). Some DAT decks will record in LP (half-speed) mode at this rate, thus doubling the recording time.

DCC and MiniDisc decks select sample rate automatically. 44.1kHz is selected if recordings are made from CD or analogue sources; the 32 or 48kHz modes are only selected if the machine is fed from an audio source that selects that sample rate (e.g., DAT). If you are transferring recordings made at any sample rate other than the CD-standard 44.1kHz, you will need to convert the sample rate of your WAV capture prior to putting your CD together. The Cool 96 program, which has been featured throughout this series, offers such a facility.

Before we go any further, it is worth pointing out that Nicam TV sound is a bit of a no-no, at least for the present. A shame, because much excellent material in the form of concerts is provided. For a start, no Nicam tuners or VCRs that I know of provide a PCM digital output (which would be located just after the 10-to-14 bit compander, and just before the DAC). The 32kHz sampling rate can be handled by most soundcards (and converted into 44.1kHz by Cool '96). What's more, you should be able to record the 14-bit samples without problem – they would simply occupy the 14 most significant bits of the 16-bit digital audio word. For full compatibility with the CD standard, however, sample conversion to 16 bits may be required; this could be achieved by software, although I don't know of any such programs that will handle this. The biggest problem remains the sourcing of a NICAM chipset that offers a S/PDIF-format output.



Virtual control panel of AV310 soundcard.

Which Recorder?

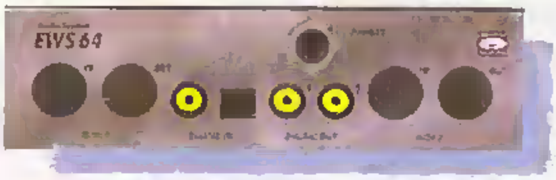
If you're planning on purchasing a digital recorder for this kind of work, then there is much

Edisonwave, the audio editing program that is supplied with EANS64.

choice and there are some bargains to be had. If you're planning on making unattended recordings of radio broadcasts for subsequent transfer to CD, then you may need a digital recorder if you want a higher-quality alternative to analogue tape. Many such recorders, like their analogue cassette counterparts, offer a timer start facility. The best potential quality is achieved from DAT, which doesn't employ any form of data compression. DAT, which uses a complex VCR-type mechanism, is expensive, and is relegated to money-no-object audiophiles and professional users.

Let's move onto the consumer systems, Philips DCC and Sony's MiniDisc, which use MPEG audio type compression systems (examined last month) to reduce data rates to levels that can be recorded by inexpensive-to-produce electromechanics. They work by discarding information that psychoacoustic modelling tells us that we can't hear, whereas DAT records everything that the ADC captures. In both cases, such a good job is done that most ears simply can't notice the missing data. Listening tests demonstrate that the average person cannot tell the difference between the original CD, and recordings made from it on DAT, MiniDisc and DCC.

Despite its excellent performance DCC hardware is, sadly, no longer being manufactured. DCC failed as a consumer format, largely



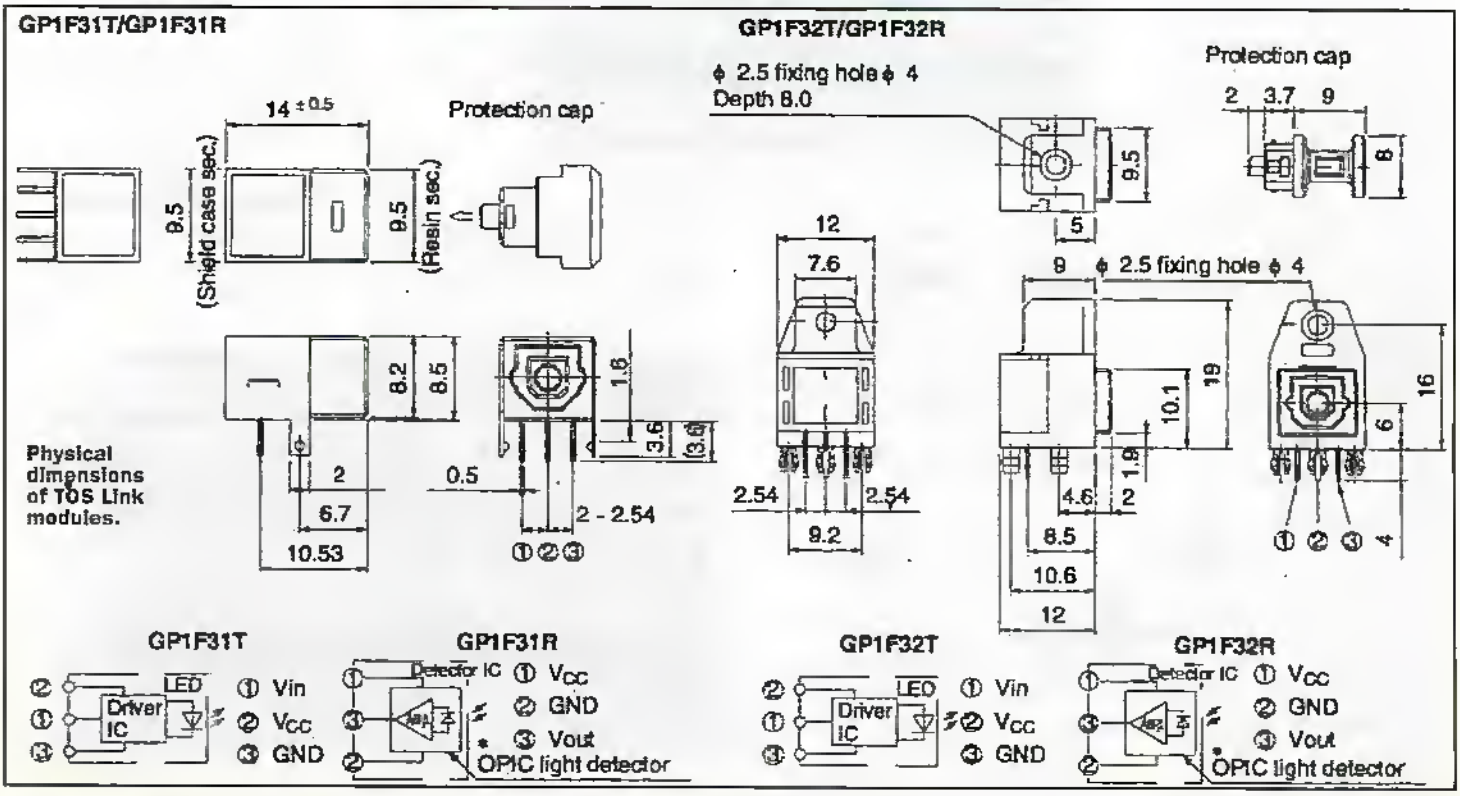
Front panel of EWS64 designed for insertion into PCs space 5¹/₄" drive bay.

because of atrocious marketing by Philips. Tapes continue to be available from some sources, though, and bargains are to be had. One company, SRTL, bought the last few batches of machines from Philips and is selling them at very keen prices. At the time of writing, you could pick up a homedeck (the DCC730) for 180, or the highly desirable pocket-sized recorder (the DCC170) for £230. The DCC170 is a superb machine for making live recordings, although the microphone preamp is perhaps slightly noisier than ideal. I use mine with a superb hassle-free stereo electret microphone from Sony, the ECM5959C. DCC also be acquired inexpensively second-hand. During the course of research for these articles I bought a Marantz DD-82 homedeck, plus a Philips DCC-130 playback portable and 10 tapes, for £130. Keep an eye on Exchange and Mart, and the relevant for sale newsgroups.

After a shaky start, particularly with regard to sound quality, MiniDisc is slowly beginning to establish itself with hardware available from Sony, Kenwood and Sharp amongst others. The

latest machines, particularly audiophile models like the Sony JA3ES, have a sound quality that is at least as good as the best DCC machines. You also get uninterrupted recording of up to 74 minutes (DCC offers up to 90 minutes, but with a side changeover in the middle), plus random track access (which DCC, as a tape-based medium, cannot offer). A very neat portable recorder, which is rather more pocket-sized than the Philips DCC-170, is also available from Sony – this machine has a mono mode in which twice the recording time is available.

But do you need a recorder after all? A possible alternative would be to use your PC with the tuner connected to the sound card's line input. Some shareware programs available will carry out user-defined sequences of commands (such as invoking a particular program) when a particular date and time is reached. There is no reason why such a program shouldn't be a hard disk audio recording program, or the recording element of audio editing software. Unfortunately, PC real-time clocks are horrendously inaccurate and need periodic resetting (unless you've got one of those Rugby receiver peripherals that automatically do this job for you). What's more, PCs are heavy consumers of power – even with the monitor switched off.



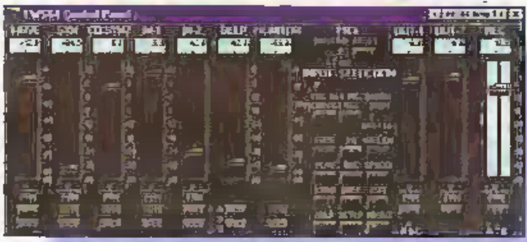
Physical dimensions of TOS Link modules.

Sound Cards

Many recorders, such as the Marantz DD82/92 DCC homedeck, have both coaxial and optical digital S/PDIF inputs and outputs. Others, such as Sony's JA3ES MiniDisc recorder and many portable recorders (including Philips DCC170) have coaxial and/or optical inputs, but only optical outputs. Some audiophile-quality CD players also have coaxial and optical digital outputs. Unfortunately, very few PC soundcards are equipped with these connectors. Those that do tend to be aimed at professional musicians, and are rather more expensive than your common-or-garden consumer types. In most cases, the inputs and outputs are provided for uploading audio snippets of the best possible sound quality into the sampler that tends to be offered.

At least one product available, the 549 AdB MultiWav, is just a 16-bit ISA audio I/O card and offers no synthesiser facilties whatsoever. Its sole purpose is to get audio into and out of the PC with a high standard of performance – and is primarily intended for digital multitrack recording. Digital connections apart, it is equipped with a high-quality DAC and ADC (with up to 24-bit resolution) for the analogue inputs and outputs that it also offers. It will work at sampling rates of up to 48kHz (commonly used by DAT), or even 96kHz if an upgrade is purchased. In comparison, most soundcards only go to 44.1kHz and are hence incompatible with digital audio recordings made at the higher rate. The coaxial sockets support both S/PDIF and the professional AES/EBU standard, and there is also TOSlink I/O. Although it's designed to be a recording tool, it is also possible to employ the MultiWav in the flexible creation of audio CDs with a CD-R burner.

However, the AdB product is rather expensive and is very much a one trick pony. Most readers use their PCs for tasks other than CD mastering; such as playing games, and will want a soundcard that includes other features such as MIDI connectivity and the synthesiser. Two audiophile-quality soundcards with digital audio inputs and outputs are available in the UK. The first is the 349 MultiSound Fiji from Turtle Beach Systems, a 16-bit ISA card that can be upgraded (for a further 50) with a daughterboard to provide



EWS-64 control panel, showing the breadth of facilities offered.

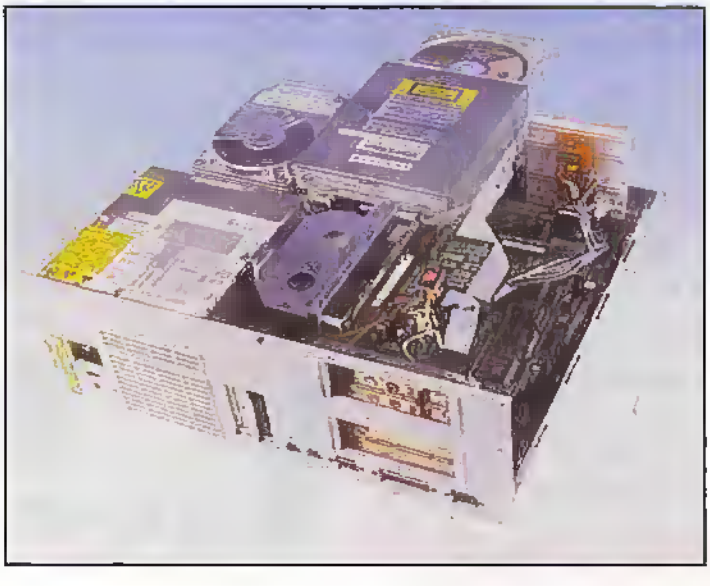
coaxial (but alas no TOSlink) S/PDIF inputs and outputs. This card has also been designed with high-quality analogue stages (20-bit converters are used), and a 97dB signal-to-noise ratio is claimed.

Although it has MIDI connectivity, there's no sampler and the Fiji doesn't have any music generation capabilities of its own. There is, however, a standard WaveBlaster connector for attachment of synthesiser daughterboards, such as the Roland SoundCanvas or Yamaha DB50XG. If you want all of this as standard on the one card, then the Pinnacle, also from Turtle Beach, will satisfy. In addition to the Fiji's facilities, you get a wavetable synthesiser, and a sampler that will accommodate up to 48Mb of RAM. Pinnacle retails for £539, with the SP/DIF input/output module. AdB and Turtle Beach are distributed in the UK by Et Cetera.

EWS64

A European alternative to the Pinnacle is the German-made Terratec EWS64, which is distributed over here by Imago Micro. This 399 product consists of a 16-bit ISA card, and a connector module that sits in a spare 5.25in. drive bay. The latter, which connects to the ISA card via a couple of ribbon cables, offers front-panel access to the MIDI sockets (proper 5-pin DIN types!), headphone socket and digital audio terminals. Here, the EWS64 is particularly well-specified. You get coaxial and optical S/PDIF inputs, plus a pair of coaxial outputs (both of which carry the same signal). Indeed, the EWS64 is the least expensive card with a optical input.

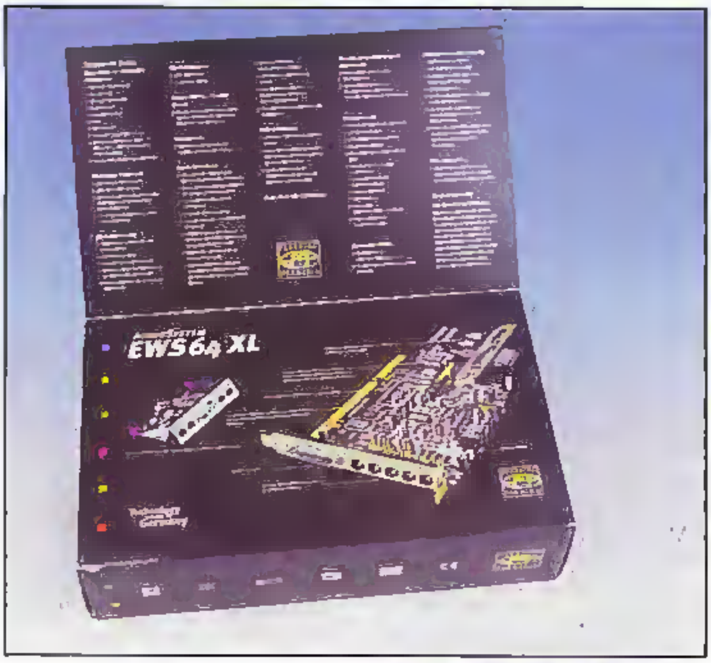
Unfortunately, all of the analogue audio connectivity (and the game port, for that matter) is as per other sound cards – in other words, at the back of the PC. You certainly get a lot for your money with the EWS64. The 64-voice sampler comes with 6Mb of RAM (2Mb on board, plus a 4Mb SIMM), but can be upgraded to 64Mb. On boot-up, it loads up a set of samples that conform to the General MIDI spec, but you can create your own and use those instead. The EWS64 also has a WaveBlaster connector for a synthesiser daughterboard (if fitted, this is treated as Syn 2 by the mixer). There is also a digital effects generator, and comprehensive multitrack digital recording facilities (the card can operate in full-duplex mode, and is supplied with Steinberg Cubasis AV, an audio recording/sequencer program, to make the most of these). Finally we have real-time DSP effects (chorus, reverb and EQ), implemented in hardware (as is MIDI) on the Dream synthesiser chip. All pretty powerful stuff as far as the musician is concerned.



The hardware is rather complex, and this is reflected in the signal path reproduced in Figure 1. There are two sets of analogue inputs and outputs, and both can be treated quite differently. As Figure 1 demonstrates, there are in fact two sets of conversion circuitry. The first is a 16-bit A-to-D and D-A pair, housed within a Crystal codec, and provided for compatibility with Windows software. This codec provides hardware support for a number of real-time compression algorithms (such as ADPCM and A-Law). The second set, built into a pair of Philips chips, has a maximum resolution of 18 bits, and is intended primarily for use with the sampler/synthesiser. These high-quality components are capable of working at 16 bit (and 8-bit, for that matter). Both sets of conversion circuitry are capable at working at sample rates up to 48kHz.

It is possible to use them for writing WAV files to the hard disk. Indeed this is preferable for high-quality work, since you bypass the mixer circuitry; the second (straight) audio input is provided for this purpose. The synthesiser derives its samples from either the 18-bit ADC or the direct digital input. It is connected directly to the ISA bus so that it can read or write samples to or from the hard disk. The digital output from the synth is fed into one of two 18-bit DACs. The first DAC's output is fed into either to the (second) dedicated output (for best results). The second is routed into the mixer (where it can be combined with conventional WAV playback, the line/mic inputs, etc.). It appears as if the synthesiser has a digital input attenuator, as the level of the SP/DIF inputs can be varied using the mixer software.

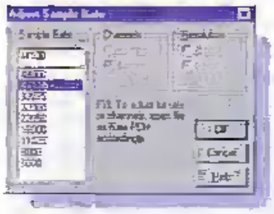
Installing the card proved to be a bit of a pain. The only way I could get it to work properly was to disable the plug and play option, by editing the autoexec.bat file – something which isn't documented in the manual. Doing this had the positive side effect of making the card much quicker to initialise. Some of this might be attributable to the test P133 PC, which had an early plug and play BIOS written some time before the official release of Windows 95. On which point the EWS64 is strictly Windows 95 only – there are no Windows 3.x drivers, and the card doesn't



work under Windows NT. That said, Windows NT drivers will be available soon from the Terratec web site (http://www.terratec.net).

Even after installation, there were some problems. The card wouldn't work with certain programs. Trying to use it with Iomega RecordIt, the real-time MPEG audio program featured last month, caused the PC to lock up altogether – the only way out is a press of the PC's reset button. The same problem was noticed with Spin Doctor, the audio recording program that is supplied with Adaptec's Easy CD Creator Deluxe package. The EWS64 was, however, much happier with the audio editing programs Cool 96 and Goldwave. Just as well – a functionally-similar program that is supplied with the EWS64, Edison Wave, is prone to crashing.

EWS64 does not work fully with the Windows audio mixer, possibly because of all the extra hardware that is provided. Instead, you should use the rather more complex EWS64 mixer. This provides a more user-friendly (but nevertheless still intimidating) way of harnessing the card's complex signal routing arrangements. It allows you to select between the two line-level inputs, switch between TOSlink or S/PDIF digital inputs, and switch on or off (i.e. mute) various channels. As the name suggests you can mix various inputs, and you can (usefully) pan, or adjust the relative levels of each stereo channel. Another useful feature is a PPM (peak program meter), spectrum analyser (which only



Sample rate conversion with cool, 96.

works well on a fast machine) and the ability to save and load various combinations of mixer settings. Another control window, accessible from the mixer, allows you to adjust DSP effects. Unfortunately, some features (such as the master level control) aren't implemented by some programs, and there were some minor bugs. The panning was erratic, for example.

The EWS64 is a new product, and there is a fair chance that the software foibles (and the NT drivers) will have been sorted out by the time you read this. Hopefully so – the product offers analogue capture that is detailed and transparent enough to make the most of the best sources. The digital input is also superb. There is absolutely no discernable difference between a high-quality live DCC recording and the CD-R that was produced from it. It may well be worth hanging on, though: Creative Labs reckon that its new soundcard, which will topple the current AWE64 Gold from the top spot later this year, will feature SP/DIF inputs and outputs as well as a digital mixer (the AWE64, out of interest, does have SP/DIF connectivity – but it's output only). The new card should not cost much more than the AWE64 does at present.

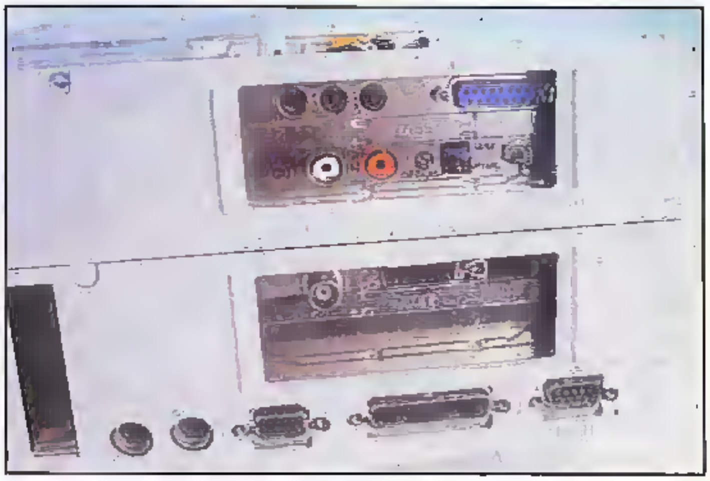
Cheap Digital – It Can be Done!

A visit to the Christmas London Amateur Radio show revealed a quite astonishing bargain – a 17 16-bit soundcard, complete with SP/DIF input and output! The 16-bit Audio Excel AV310, which was bought from the Pivot Systems stand, is a full-duplex card and as such can be used for budget hard disk multitrack recording and Internet telephony. It has a FM synthesiser (aided by software wavetable), although there is a WaveBlaster connector for a wavetable synthesiser daughterboard. The card also has a game/MIDI port and a (defeatable) low-power audio amplifier. It is supplied with drivers for Windows 3.x, 95 and NT. The supplied NT drivers do not, however, work properly – at least if my experience is anything to go by.

As with its more expensive counterparts, the AV310's S/PDIF input allows audio to be written directly to the hard disk as a WAV file, with no intermediate analogue conversion stages. It was intended for connection to one of the relatively few CD-ROM drives with a digital output, such as the Panasonic CR563B some (other CD-ROM drives have the potential insofar as there is space on the circuit board for the connector and associated components, but they were never soldered in). For compatibility with these CD-ROM drives, the AV310's digital output operates at a TTL level (i.e 5V peak-to-peak), and so additional interface circuitry is needed to feed it from a conventional S/PDIF source (which, remember, operates at 0.5V peak to peak). The circuit given in Figure 2, which is based on a circuit by Heiko Purnhagen found on the Internet, is suitable for matching the levels.

The circuit given is capable of accepting coaxial or TOSlink signals. The TOSlink receiver used is the Sharp GPIF32R, which is distributed in the UK by Hero Electronics. Hero do not sell to the general public, but should be able to advise you as to the address of your nearest stockist. Sadly, Maplin don't yet stock these devices, although there is a chance that they make take on this very useful product line if sufficient interest is shown. Using the TOSlink receiver is very easy, and if you have no need of a coaxial input most of the circuitry in Figure 2 can be omitted. It's basically a three-wire device – output (TTL-level), +5V and ground. The +5V line should be decoupled by a 100nF capacitor, connected as close as possible to the device's terminals. A 2k2 load resistor should be connected between the output and ground.

Hero also stock the companion TOSlink transmitter, the GPIF32T, which could be fed directly from the AV310's TTL-level SP/DIF output. Feeding this into a digital audio recorder would enable WAV files to be recorded with the best possible quality; useful if you are, for example, using your PC to generate sound effects for radio or drama productions. The GPIF32T could also be hooked up to a CD-ROM drive, so that you could record music with the best possible quality onto your DCC, DAT or MiniDisc recorder. Out of interest, only the digital sources (WAV files or S/PDIF input) are available on the S/PDIF output. If would you prefer a coaxial connection instead, then build up the level-matching circuit given in Figure 3 (this also originated from Heiko Purnhagen). Out of interest, the two coaxial-TTL circuits don't offer isolation; if this is required, then one of Maplin's pulse transformers



could conceivably be used. Remember that if you take this route, your phono sockets should be isolated from the PC's chassis.

In the prototype, the interface circuitry was constructed on a piece of matrix board and screwed to a convenient location within the PC. The +5V and ground lines were derived from the PC's own power supply – an easy way of achieving this would be to tap into one of the PC's disk drive power leads. The generally accepted code is: black, 0V; red, +5V; yellow (don't use!), +12V. I would recommend checking these supply rails with a multimeter before connecting anything up! In the prototype, the digital audio connections and the input select switch were built into the backplane of the CD-ROM interface card.

The Longshine interface card built into the prototype PC is unusual in that it provides a pair phono sockets instead of the dreaded 3.5mm stereo jack. These are intended for hooking up to the CD-ROM drive's analogue audio output. Since these are not used – the CD-ROM audio is instead routed through the AV-310 – they now serve as coaxial digital input and output connectors. Extra holes were drilled for the TOSlink receiver module (refer to Figure 4) and single pole, double throw (SPDT) changeover switch. If your CD-ROM interface doesn't have such convenient connectivity, then holes could be drilled into a spare backplane plate, and the components mounted on it.

The software that accompanies the AV310 is basic, but functional. You get a mixer application, WAV recorder/playlist editor and mixer. The latter, as with just about any other, allows you to fade and mute the various inputs. The SP/DIF input (labelled CD Dig In) can simply be switched on or off, and cannot be faded – its level is fixed, and hence dependent on the digital source's original recording level. With the Windows 3.x drivers, the S/PDIF input is always accessible. The Windows 95 drivers have a bug, however; the input will only work if a CD is playing in the CD-ROM drive – as a result, you must ensure that the CD you insert is of at least equal playing time to your planned recording!

Excellent results can be obtained from digital sources, using the interface circuitry given in Figure 2. Sadly, the analogue side of things is rather lacklustre. Both capture and playback suffers from audio that lacks sparkle and detail. Although it's fine for regular multimedia PC use, the sound quality is woefully inadequate for mastering CDs from analogue sources. There is, however, a logical alternative – feed your analogue source into your digital audio recorder, and use it as a high-quality analogue-to-digital converter! The resultant sound should certainly better that available from the average PC soundcard, if only because the dreaded analogue mixer and switching stages have been eliminated.

Copyright Warning

With the equipment and procedures outlined in this article, it is possible to make recordings of copyrighted works. If this is the case, such recordings must be made solely for your own use, and then only if you have the original recordings. If you do not own the copyright, or have permission to copy from the the copyright owner, you may be violating copyright law and could be subject to payment of damages and other remedies. If you are in any doubt, please contact your legal advisor. In the final part of this article, we look at making Video CDs and the presentation of your discs.

Points of Contact

SRTL (DCC hardware sales), (01243) 379834. Address: Record House, Emsworth, Hants PO10 7NS. Web: http://www.srtl.co.uk
Et Cetera Distribution (AdB/Turtle Beach distributor), (01706) 228039. Address: Valley House, 2 Bradwell Court, St. Crispin Way, Haslingden, Lancs BB4 4PW. Web: http://www.etcetera.co.uk
Imago Micro (Terratec EWS64 distributor), (01635) 294300. Address: 13 Thatcham Business Village, Colthrop Way, Thatcham, Berks RG19 4LW. Web: http://www.imagomicro.co.uk
Pivot Systems (Audio Excel AV310 sales), (0181) 850 3939. Address: 55 Well Hall Road, Eltham, London SE9 6SZ. Web: http://www.pivotcomputers.co.uk
Hero Electronics Ltd (Sharp TOSlink module distributor), (01525) 405015. Address: Dunstable Street, Ampthill, Beds MK45 2JS. E-mail: hero@heroelec.co.uk

S/PDIF - TO-TTL PARTS LIST

RESISTORS: All 1/4W 5% Metal Film			
R1	1	75R	(M75R)
R2	1	22k	(M22K)
R3	1	47k	(M47K)
R4*	1	2k2	(M2K2)
CAPACITORS			
C1,2,3	3	100nF Monores	(RA49D)
C4	1	Minelect 47F/16V	(YY37S)
C5*	1	100nF Monores	(RA49D)
SEMICONDUCTORS			
D1,2,3,4	4	1N4148	(QL80B)
IC1	1	74HCU04	(UB04E)
GPIF32R	TOSlink Receiver Module*		

TTL-TO-S/PDIF CONVERTER PARTS LIST

RESISTORS: All 1/4W 5% Metal Film			
R1	1	330R	(M330R)
R2	1	100R	(M100R)
CAPACITORS			
C1,2	2	100nF Monores	(RA49D)
C3	1	Minelect 47F/16V	(YY37S)
SEMICONDUCTORS			
IC1	1	74HCU04	(UB04E)

MISCELLANEOUS PARTS LIST

M3 Insultd Spacer (Pkt 4)		1	FS38R
SPDT Ultra Min Tggle	1	FH98G#	
Chassis Phono Skt	2	YW06G	
Matrix Board		1	JP54J
PCB Pins		1 pkt	FL23A
Min Screened Cable	1m	XR15R	
Screened Plug	2	HH01B	
Fibre Optic Lead Dig	1	CC40T*	

Note: Items marked * only needed if optical input is required. Item marked # only needed if both coaxial and optical output are necessary.

Electronics IN AGRICULTURE

PART 2

Computer controlled milking parlours

by George Pickworth

Dairy farming involves tending and milking the cows twice a day on every day of the year. Up to the mid 1930's a moderately large dairy herd consisted of about 30 milking cows and nearly all were hand milked; so all the farm workers, typically four were involved in this operation before and after returning from work in the fields.

Now, with a computer controlled milking parlour, one man can comfortably milk and manage a herd of more than 300 cows. Photo A Moreover, with the imminent introduction of robotics devices that automatically apply and remove the teat cups to the cows, the above figure could well be increased.

However rather than allow a further increase in herd numbers, which in many instances have already reached optimum, the great attraction of robots is to reduce the physical work involved and make life easier for the herdsman/woman.

So, in addition to being a rugged individual highly skilled in animal husbandry, the modern dairy farmer must also be a highly competent manager and be computer literate.

Overview

I felt that it would be meaningless to discuss a sophisticated, computer controlled milking parlour, let alone robotics without first giving readers unfamiliar with the subject an overview of the operation of a dairy farm. So, I decided to devote the first part of this study to the evolution and operation of sophisticated milking parlours.

In the second part we will look more closely at the role of electronics in the actual operation and management of a modern dairy farm. I have also included a few notes on the changes that large computer controlled milking parlours have brought about in the countryside.

Photo 1 Computer controlled milking parlour showing slave units mounted on rump bar at each milking point (Courtesy Alfa Laval).

Evolution

Originally, only a few cows were kept on farms, principally to supply the farmer and his family with milk; the cows were milked in open yards. Moreover, the cows were poorly nourished, especially during the winter; oats and the best hay was always kept for the work horses. As a result the cows yielded only a litre or two of milk which left little to spare after their calves had suckled.

Dairy farming really began around 1840 with the coming of the railways; which made it possible for fresh milk to be delivered to cities within a few hours of the cows being milked. In fact many railway stations or halts were located to serve farmers who brought their milk to these stations in 17 gallon churns by horse and cart. The attraction of dairy farming, unlike grain growing, was that milk production provided a daily income, indeed, it became the mainstay of many farmers.

Cow sheds

To produce a reliable milk supply all year round required that the cows calved at regular periods throughout the year; normally they would have calved only in the spring. So, in order to modify the cow's natural breeding cycle and to produce significantly more milk than that required by the calves, the cows had to be well fed with hay and cereals and housed in warm sheds during the winter months

Photo A General view of a large rotary milking parlour.

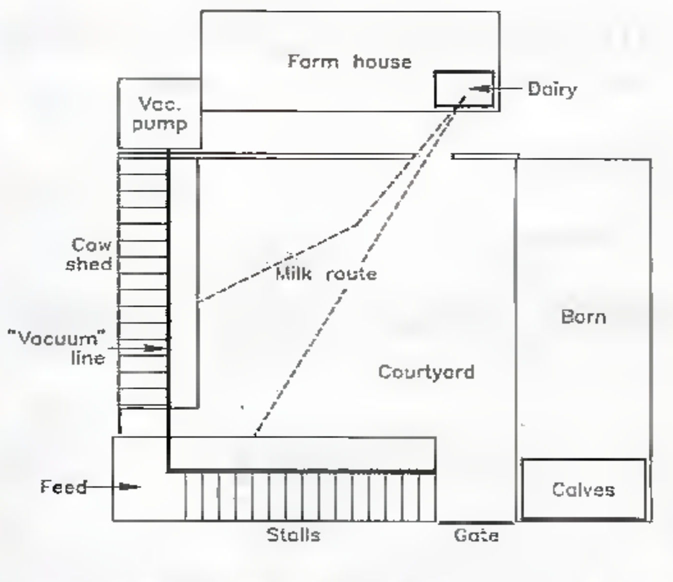
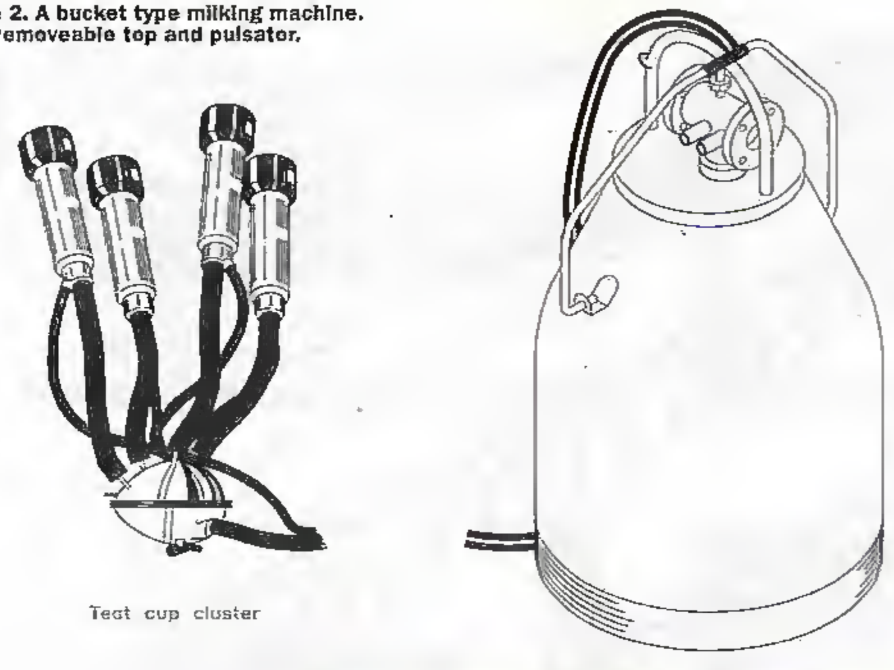


Figure 1. Layout of Buildings on a typical mixed farm circa 1935

Figure 2. A bucket type milking machine. Note removeable top and pulsator.



Records now had to be carefully kept as to when each cow was served by the bull and when the calf would be born but, as we will see, on a modern dairy it is not only the actual milking operations that are computer controlled, but also feeding, breeding and record keeping.


Photo 2 Computer controlled parallel type parlour. Note clear view of cows.

Modifications

During the early years of dairy farming, it was usual for the open fronted buildings that enclosed a typical farm courtyard, (where cattle were kept during the winter months) to be converted to cow sheds.

The open sides of the buildings were bricked, quite often with money obtained from sale of land to railway companies, to form a pair of enclosed cow sheds, each typically having stalls for 20 cows. The stalls were wooden and were arranged parallel along one side of the shed. The floors were brick and being porous were far from being hygienic.

Dairies Act

Nonetheless, these early cow sheds with their parallel stalls were perfectly OK for hand-milking and many of the original (circa 1840) cow sheds remained in use until 1935 when the Dairies Act required them to have impervious concrete floors and tubular steel stalls.

On innovative farms, improvement work to the sheds was complemented by installing bucket type milking machines (more about these later) and automatic drinking bowls for each cow.

The cows still lived in the sheds during the winter months and during the day were fed with hay plus a mixture of chopped straw, ground cereals and chopped mangolds (a root crop) grown specifically for cattle feed. The cows came out of the sheds only for exercise and for water if automatic drinking bowls were not installed.

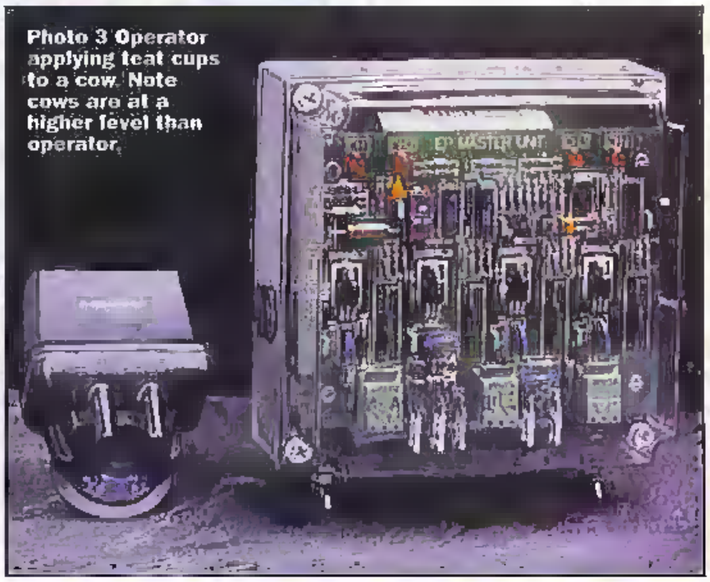


Photo 3 Operator applying teat cups to a cow. Note cows are at a higher level than operator.

Integrated

Before the 1950's, when the evolution of milking parlours and the resultant very large dairy herds, dairy farming was generally integrated with cultivation of other crops such as cereals and potatoes in what was called a mixed farm. Crops were grown specifically to provide feed for the cows, but straw from grain production provided their bedding.

The size of the dairy herd, typically 20-30 cows, was therefore determined primarily by the amount bulk feed, i.e. hay, oats and root crops that could be produced on the farm. Concentrate foods, typically vegetable oil residues after extraction of the oil, were bought in.

With the above arrangement, the resultant manure was kept in balance with the amount of milk and crops produced. But, as we will see, the evolution of milking parlours and the resultant large number of cows on few farms upset this balance.

Hand Milking

Before the evolution of milking machines, it required four workers to hand milk a fairly large dairy herd of about 30 cows within an hour. Practical reasons dictated that milking be completed within about an hour. All the farm staff were involved with the mornings milking before setting off to work in the fields and usually again in late afternoon when they returned from the fields. Moreover, the milk lorry usually called to collect the milk at 8.0am. Only the cowman/woman was involved full time with the cows which involved feeding and cleaning out the sheds. The manure was piled up in the courtyard. (See Figure 1).

As already mentioned, the cows had to be tended and

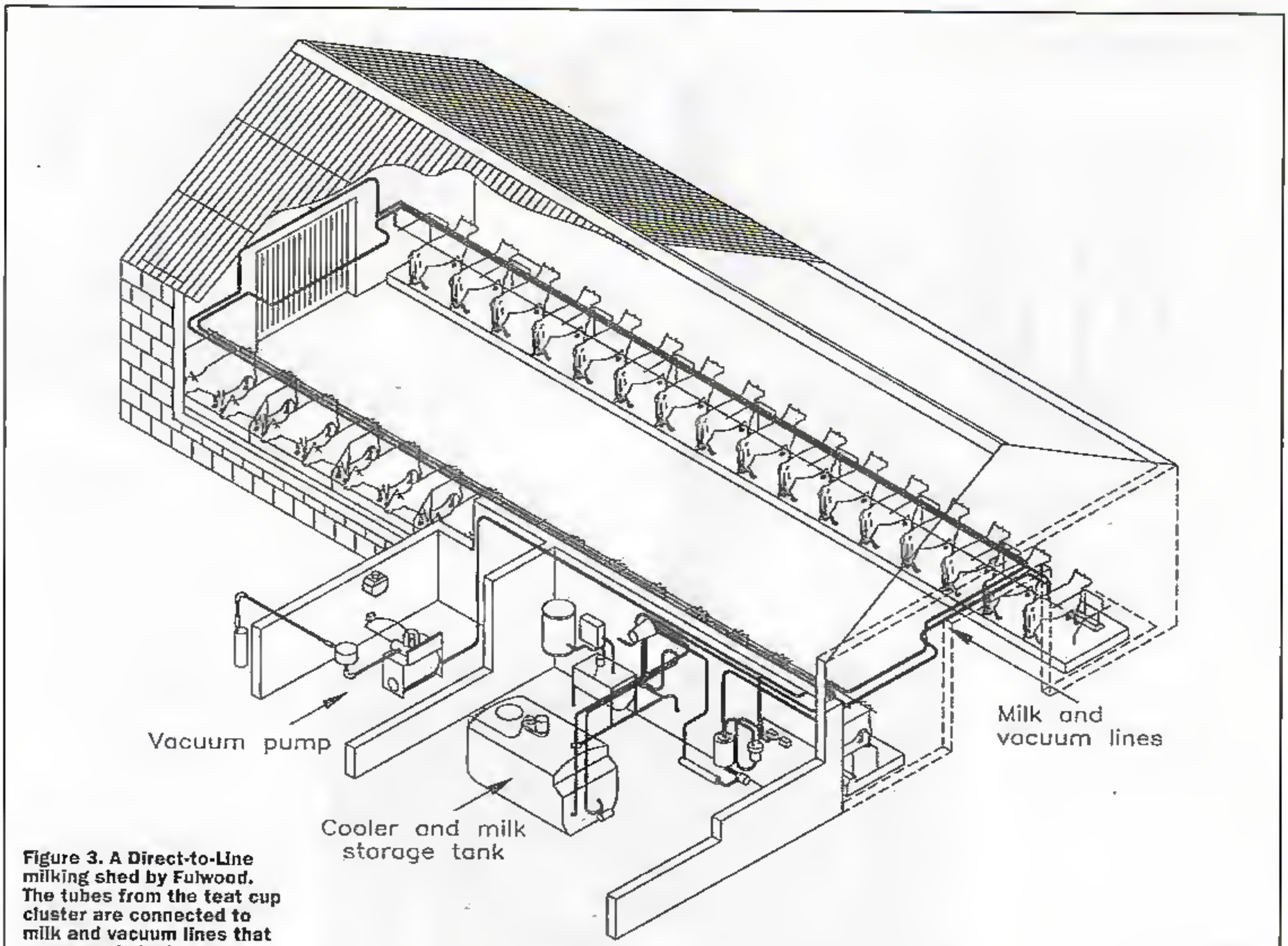


Figure 3. A Direct-to-Line milking shed by Fulwood. The tubes from the teat cup cluster are connected to milk and vacuum lines that run around shed.

milked, twice a day every day of the year. So, during the 1930's when I was a young farm boy, and indeed throughout the war years, farm workers worked all day on Saturday and Sundays mornings, generally finishing at about 10.00am, then returned for afternoon milking at 4.00pm. Indeed, the only break during the week for farm workers was a few hours off during Sunday.

Although the first generation milking machines appeared at the turn of the century, there was no real motivation for farmers to employ these rather primitive machines. Farm workers had little option other than to work long hours and in any case, the pre-1935 cow sheds did not lend themselves to milking machines.

Bucket Type

Whilst the improvements to the cow sheds during 1935 paved the way for bucket type milking machines, their adoption was at first very slow, but gained momentum and by the beginning of the Second World most farmers had installed these machines.

With bucket type machines, each unit was set down beside the cow; then a flexible tube was connected to the "vacuum" line which provided the necessary suction. The pump, which reduced pressure in the "vacuum" line to about 14" Hg was housed in a convenient room. Bucket type machines, operated from a portable "vacuum" still have application on small herds of goats or even sheep.

Photo 4. An electronic master pulsator (Courtesy Alfa Laval).

Operation of the milking machine is described in Part 3 but for now it is sufficient to say it required a device known as the pulsator caused the teat cups to simulate the rhythmic sucking of a calf. Pulsators were mechanical devices mounted on the top of each bucket. The four teat cups, Figure 2. collectively known as the cluster were connected to the bucket by rubber tubes.

Once the cluster had been attached to the cows teats, milking was automatic; milk flowed into the bucket, which behaved as a milk trap, whilst the operator observed flow through of a short length of glass tube inserted in the milk tube.

When milk flow ceased, the operator removed the cluster, then removed the pulsator and pipes assembly from the top of the bucket and then attached it to an empty bucket. The complete unit was then moved the to the next cow.

Two operators, could

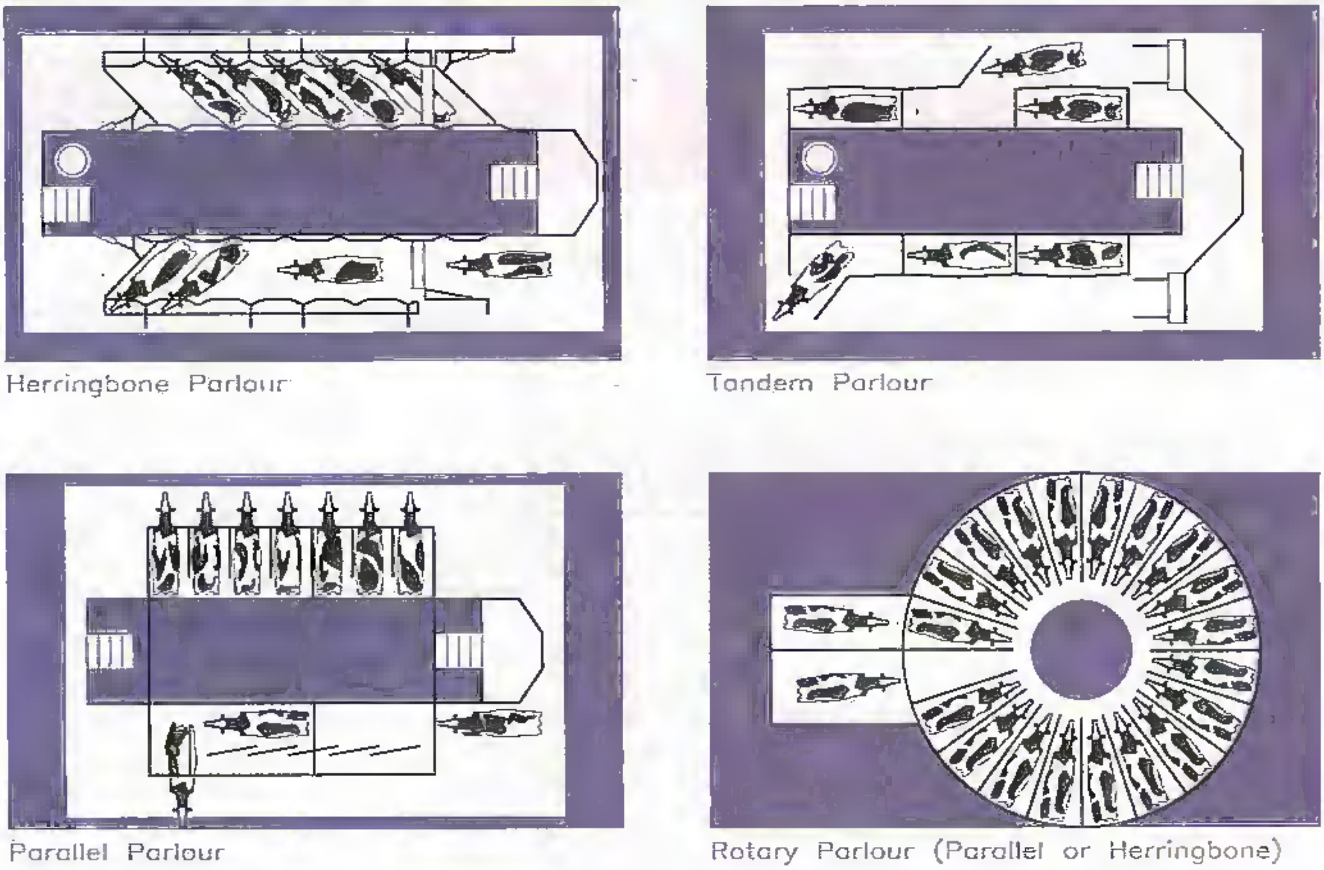


Figure 4. a) Plan views of herringbone, tandem, parallel and rotary milking parlours.

comfortably operate three bucket machines and four if necessary. The two operators generally shared the work of washing the cows udders prior to milking, applying the teat cup clusters, giving the cow its concentrate feed ration and carrying the milk to the dairy.

The two operators could therefore milk an average herd of about 30 cows in about an hour, i.e. 15 cows per man hour. Average yields before about 1950 were about 2,500 litres during the lactation period, or an average of about 4.0 litres/day/cow.

Cooling

In the farm dairy, which was generally a room within the farm house, the milk was immediately cooled by flowing over the corrugated surface of a heat exchanger. The degree to which the milk was cooled depended upon that of the cooling water; this was typically well-water with a temperature in the order of 10°C. Generally the deeper the well, the cooler the water

After cooling to about 15°C the milk was filtered and poured into churns in readiness for collection by the milk lorry at about 8.0 am. The evenings milk was kept in the dairy overnight.

Immediate cooling greatly extended duration over which the milk would remain fresh and this made it possible to keep the milk fresh overnight and to transport it to town and city dairies.

Direct line systems

The logical advance from the bucket system was to dispense with the bucket and "pipe" the

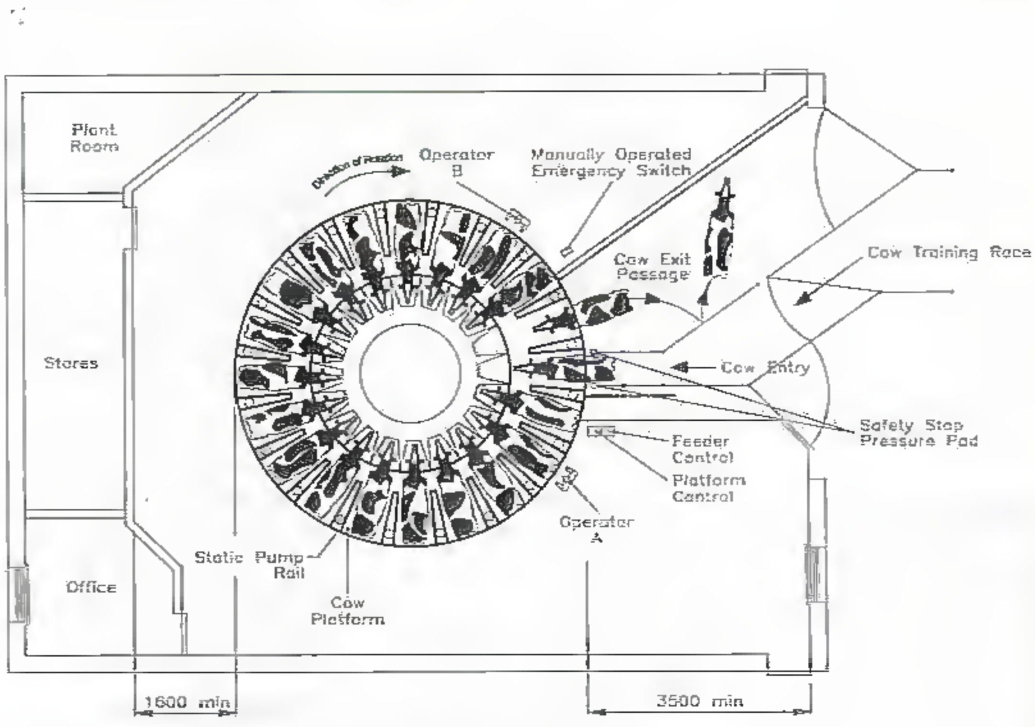
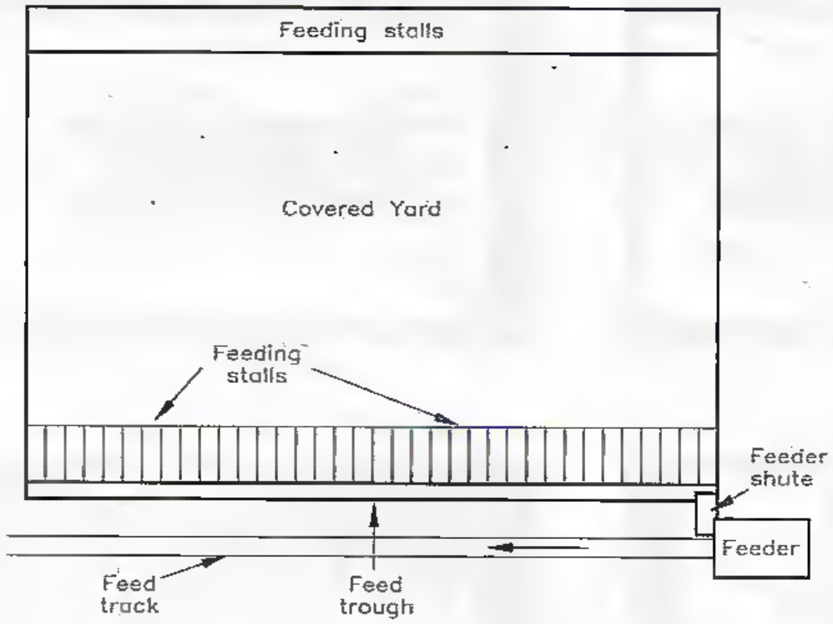


Figure 4. b) Detailed view of a rotary milking parlour (See also photo A).

Figure 5. A computer controlled feeding station.



milk directly to the dairy section; this became known as the Direct Line system and generally required the construction of a completely new cow shed. The new sheds no longer depended on well water for milk cooling, but employed refrigeration.

With the Direct to Line system, operation was now controlled by a single pulsator; these too were originally a mechanical devices but have since been replaced by electronically controlled pulsators.

As the teat cups pulsate in pairs, it required a pair of vacuum lines (one for each pair of teat cups) in addition to the milk line and to facilitate connection triple connectors were used (see photo 3). Otherwise operation was the same as with the bucket units. However, only the teat cup clusters now had to be carried from cow to cow and be re-coupled to the vacuum/milk line as milking progressed. The Direct to Line system is still preferred in some parts of the world.

Milking Parlours

The logical next phase was to have static milking points and make the cows walk in turn to individual milking points. This approach resulted in a new generation of milking sheds that became known as milking parlours. In many cases these were the successor to the Direct to Line Milking sheds.

Unlike the earlier cow sheds in which the cows were milked, fed and lived, the cows were now housed and fed with bulk foods, i.e. hay and silage throughout the winter months in large open span sheds.

Separating the milking section from where the cows lived, overcame the principal hygienic objections to cowsheds. The cows entered the parlour only for milking but, by giving them part of their concenutrate feed ration, encouraged them to the enter the stalls on their own volition.

The early parlours were mechanical devices requiring manual control of entry and exit gates. Nonetheless, by no longer having to move the milking machines from cow to cow efficiency was dramatically increased.

Four Basic types

There are four basic types of parlours, i.e. tandem, parallel, herringbone and rotary.

Parallel

With parallel parlours, the stalls were aligned as the name implies, side by side as with the early cow sheds. The difference was that the cows were milked on an elevated floor which greatly facilitated washing their udders and applying the clusters. The objective of the parallel system was to concentrate the cows udders near to the milking units and close to the operator. The cows entered a group of stalls in batches. A wide "rump rail" prevented them falling to the lower level, where the operator worked, as the cows maneuvered into individual stalls.

Herringbone

With the herringbone system, the stalls are angled so as to facilitate cows entering and exiting.

In a computerized parlour, the rump rail houses the computor slave units which control milking operations and allow the herdsman to access data on each cow (See Photo 1 & 3). More of this in Part 3. Unfortunately, the rail obsured vision of the cows.

Tandem

With tandem stalls, the cows stand lengthwise to the operator; this avoids the "rump-rail" and allows the operator to have an overall view of the cow (See photo 2). However, the tandem arrangement increases the distance between the udders of each cow and this requires wider spacing of the milking units

As we have seen, the cows stand on a higher level than that of the operator; this facilitates washing their udders and applying the teat cup clusters (See Photo 3).

Throughput

Even with pre-computer controlled parlours, one man/woman could operate up to 12 milking units in addition to washing the cows udders and issuing their concentrate feed ration; this was done by pulling a lever. Providing part of their feed during milking persuading the cows to enter the parlour and eating had a soothing effect on the cows. Some farmers even played soothing music.

Throughput was about 60 cows/hour, but as physical effort on the operators part was greatly reduced from that required by the direct-line system, each milking period could be extended to two hours; this enabled one operator to milk 120 cows twice each day; a dramatic increase of one man to 15 cows with the bucket system.

Rotating

As the name implies, milking takes place whilst the parlour rotates and is completed during one revolution of the parlour. These were generally used with very large herds, and in many cases need at least two operators. The cows enter an empty stall and back out of the stall after milking.

With very large installations, the cows exit the stalls to the centre of the parlour and leave by a tunnel under the rotating part. However a large rotating parlour requires two or more operators at specific points around the parlour

Computers

It will by now have become apparent that mechanically operated parlours were inherently suited to computerized control. Indeed, computer control of certain operations began as far back as 1975. Progress was then rapid, for example Alfa Laval Agic introduced their first completely computerized system in 1978.

In more recent years, the application of computers to the operation and management of dairy farms has developed apace.

Indeed as already mentioned, in February 1998, Fullwood will culminate their 65 years quest to eliminate human physical effort in milking cows by introducing their robotic milking machines; these automatically wash the cow's udders with a warm water spray, apply the teat cup clusters and remove them when milking is finished.

These sophisticated parlours will be discussed in Part 3 of Electronics in Agriculture next month.

Digital Technology THE UNIVERSAL PANACEA?

by Mike Bedford

According to the dictionary, the word digital is an adjective derived from the noun digit, and the word digit is defined as any of the numerals from 0 to 9. That remarkable bit of insight doesn't exactly shed a lot of light on the use of the word in phrases such as "digital audio", "digital video" or "digital photography", but those of us who take an interest in matters electronic will appreciate that it refers to the representation of an analogue signal using a sequence of binary samples. So much for the technical definition for now. But if you were to ask the man in the street for a definition of the word digital, you'd get a somewhat different response. Instead of mentioning concepts like binary, sampling, and discrete, you'd be much more likely to get a response on the lines of high quality or perfection. But then perhaps it's not reasonable to expect the layman to understand how digital technology works. All the consumer is interested in is what it means in practice, and the media, aided and abetted by the marketing departments of the consumer electronics corporations, have done a marvelous job of persuading Joe Public that digital is synonymous with quality. And this view isn't the sole domain of the layman. Even those who know what the word digital really means still tend to hold on to the quality tag. After all, it's very hard to claim to be a technical guru, yet to suggest that anything is worthwhile if it's not digital. But is this really a correct view? Have we just fallen hook line and sinker for the digital dogma? Is digital technology the universal panacea? Do digital techniques always provide superior quality? And is there any life left in analogue methods? Let's put aside our preconceived notions and take an unbiased look digital technology, looking at the advantages and investigating whether it necessarily does offer superior quality than the analogue alternative.

Sampling

To start off, let's recap on the basics on digital sampling. If you're already au fait with this, please accept our apologies, but it's important to make sure that these foundations are in place before we proceed. An analogue signal such as that produced by a microphone is continuously variable or, in other words, if you were to display it on an oscilloscope you'd get a smooth trace with no discontinuities or jumps. In order to manipulate or record this signal digitally, it has to be sampled, that is, the amplitude has to be measured and converted to a digital form at regular time intervals. This is done using an analogue to digital converter or ADC. The reverse process – ie the playback – is acheived using a digital to analogue converter or a DAC. However this outputs a

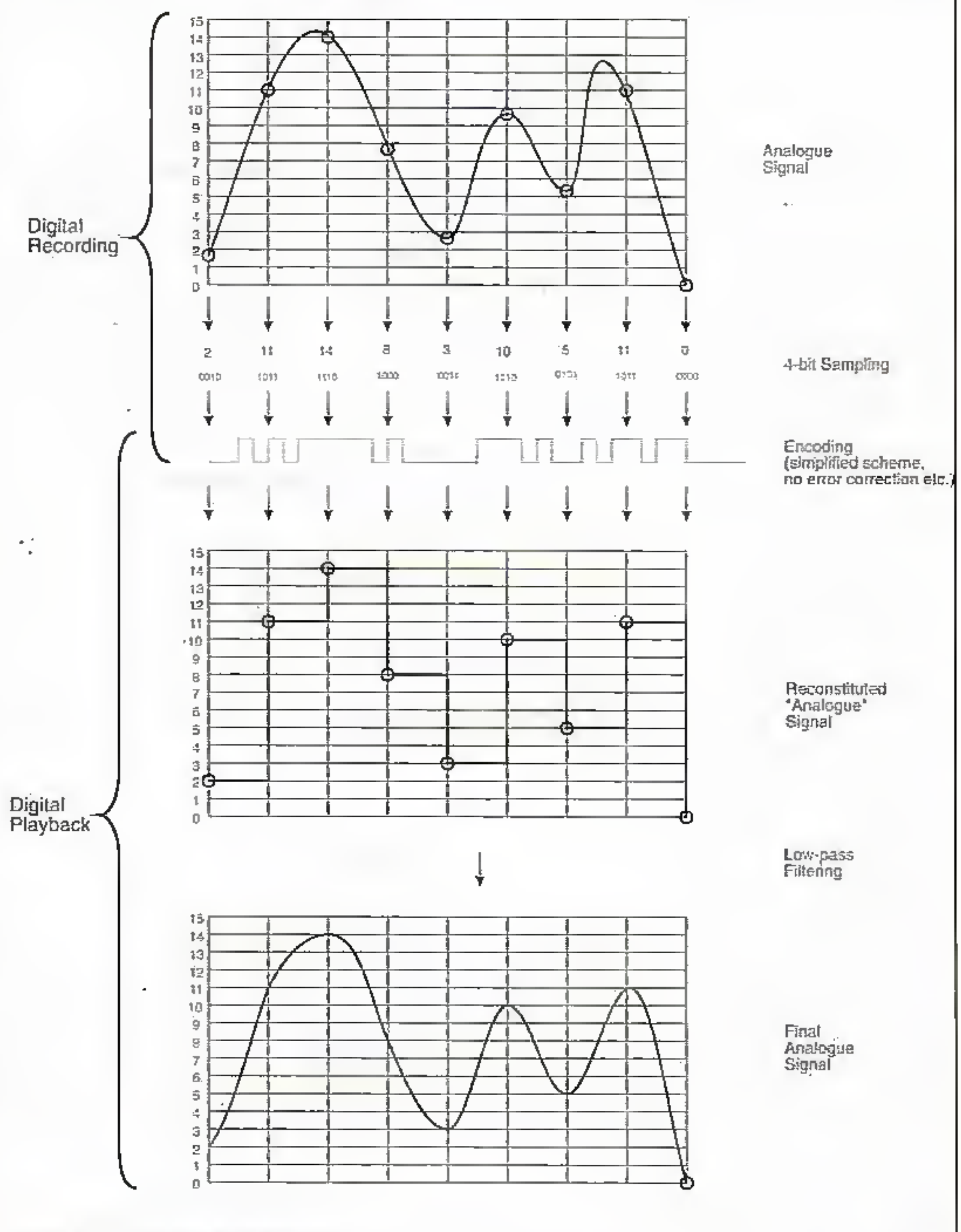
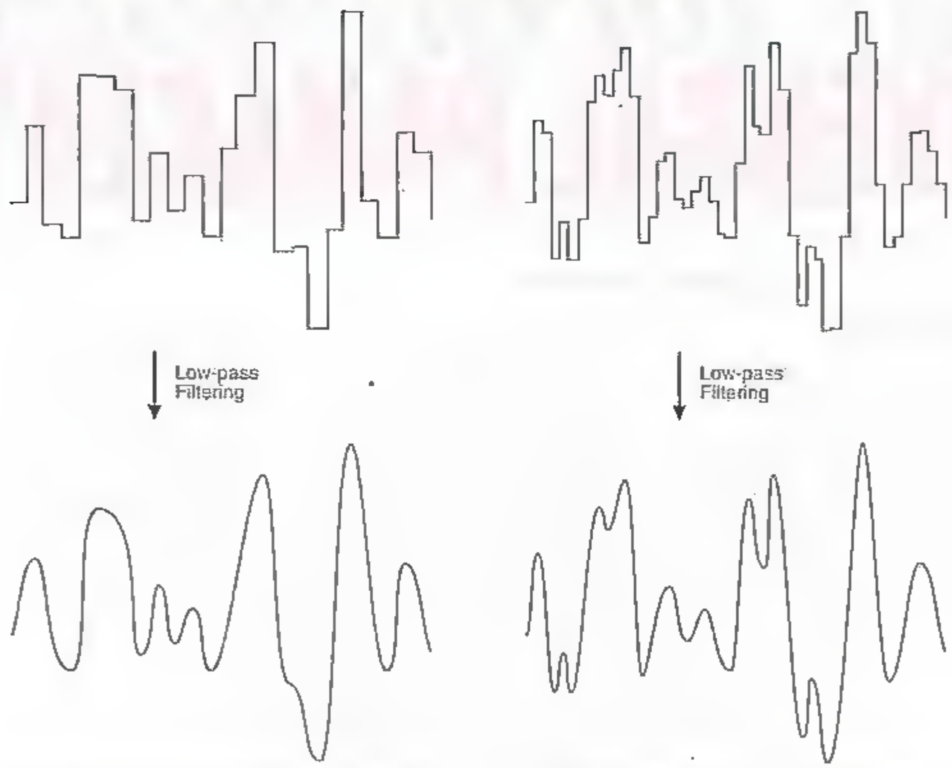


Figure 1. An example of Sampling.

Figure 2. Increasing the Sampling Frequency.



Sampling at nHz and 8 bits (256 amplitude levels) Sampling at 2nHz and 8 bits (256 amplitude levels)

staircase waveform, so the signal then has to be filtered to remove the high frequecy components in the steps and thereby generate a waveform similar to the analogue original. There are two factors which affect this sampling process – the frequency at which the sampling is carried out and the resolution to which each sample is measured and stored.

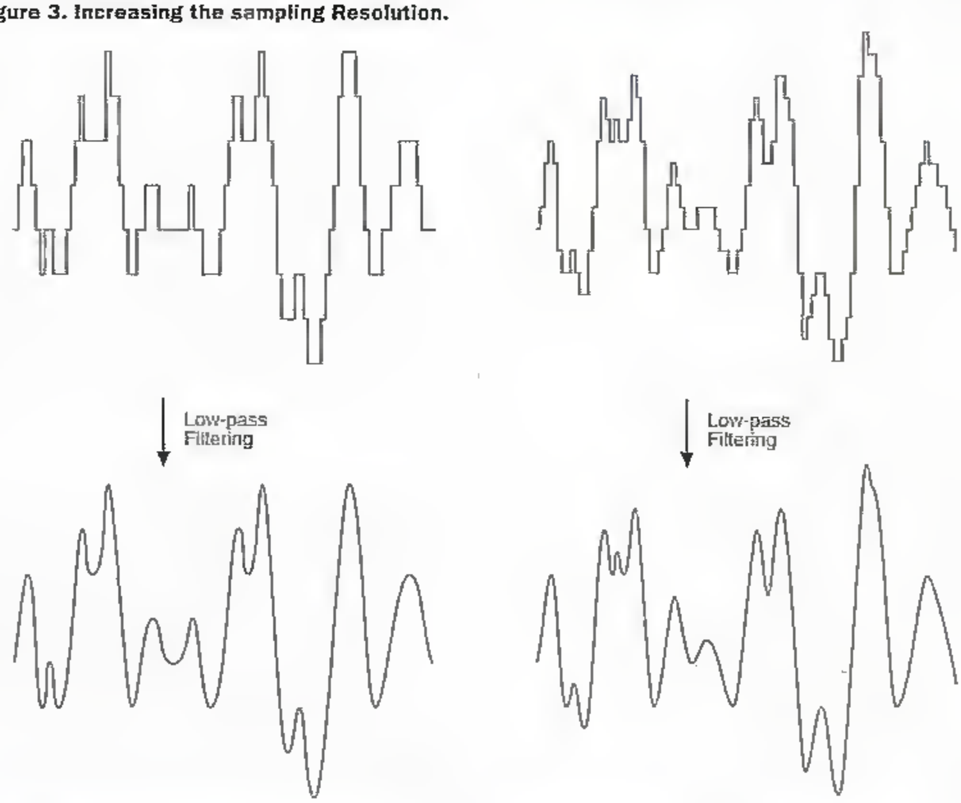
The sampling frequency affects the highest frequency which can be recorded. According to the Nyquest Theorem, it must be at least twice the highest analogue frequency to be reproduced. So if you need to record frequencies up to 10kHz, you'd need to sample at 20kHz. To take a real world example, the sampling frequency used in audio CDs is 44.1kHz so you might reasonably expect that the highest frequency which can be reproduced is 22.05kHz. In fact, due to filtering, the highest frequency specified for CD is 20kHz, but this is still about the top of the human hearing range. In passing, although we've talked here in terms of frequency in temporal terms, in other areas – digital still photography, for example – we'd be concerned, instead, with the sampling frequency in spatial terms as we'll see later.

The sampling resolution – expressed as the word length – affects the number of amplitude levels which can be represented. With 8-bit sampling, for example, 256 levels are achievable and at 16-bits – as used on audio CDs – this rises to 65,536.

However, a better way of expressing the effect of the resolution is as the dynamic range achievable and this is equal to six times the number of bits. So, for the CD's 16-bits, we end up with a dynamic range of 96dB. In the realm of audio engineering, frequency response is easy to appreciate – a lack of high frequencies manifests itself as a shortage of treble. How differences in dynamic range affect audio quality is harder to put into words though (but if you have a PC with a 16-bit sound card, you can experiment by making comparison recordings with 8-bit and 16-bit sampling). However, if you think in pictures, the series of diagrams shown in Figures 2 and 3 will be informative. These show an analogue wave-form plus the wave-forms resulting from digitising at two different sampling frequencies and at two different sampling resolutions. In each case, we show both the raw wave-form reconstituted from the digital data and that same signal after the low-pass filtering which removes the artificial high frequencies that are present in the steps. Clearly, we've picked unrealistically low resolutions in order to exaggerate the effect.

The bottom line, of course, is that a digitally sampled signal will only ever be an approximation to the analogue signal it represents. And at this point, the alarm bells already start ringing. An analogue signal is a perfect representation of reality whereas a digital signal is just an approximation – an interesting twist on the usual perception of the word digital. However, before we go too far

Figure 3. Increasing the sampling Resolution.



Sampling at 4nHz and 3 bits (8 amplitude levels) Sampling at 4nHz and 4 bits (16 amplitude levels) down this track, it has to be pointed out that our eyes and ears, even though they are analogue devices, have their limitations. So if the sampling rate and the sampling resolution of a digital signal are sufficiently high, the human senses won't notice the difference between this and the true analogue signal it represents. The trick, of course, is to choose a sufficiently high sampling rate and resolution to fool our eyes or ears, yet not to pick figures which are so high as to make the hardware prohibitively expensive. Whether this is always achieved remains to be seen.

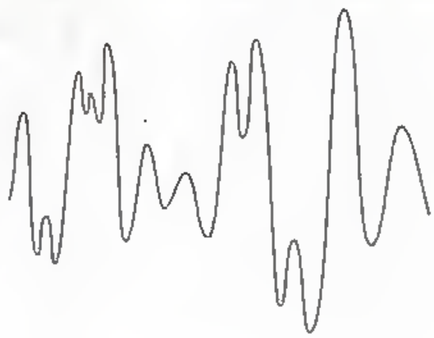


Figure 4. Original analogue signal used to illustrate the effect of increasing the sampling frequency and sampling resolution

Why Digital?

So if most real world signals are analogue, and if we have analogue ears and analogue eyes, and since a digital signal will, by definition, only be an approximation to the real thing, it's pertinent to spend a while thinking about why digital techniques are used at all. It's

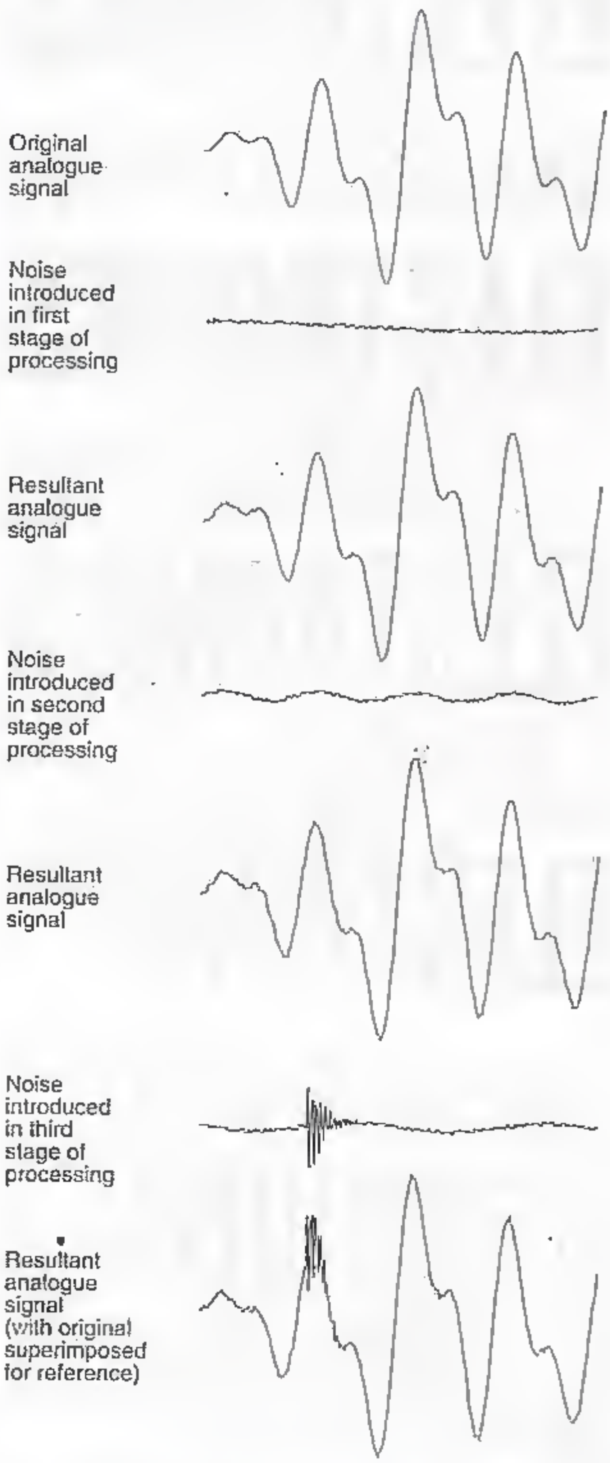


Figure 5. a) Analogue noise.

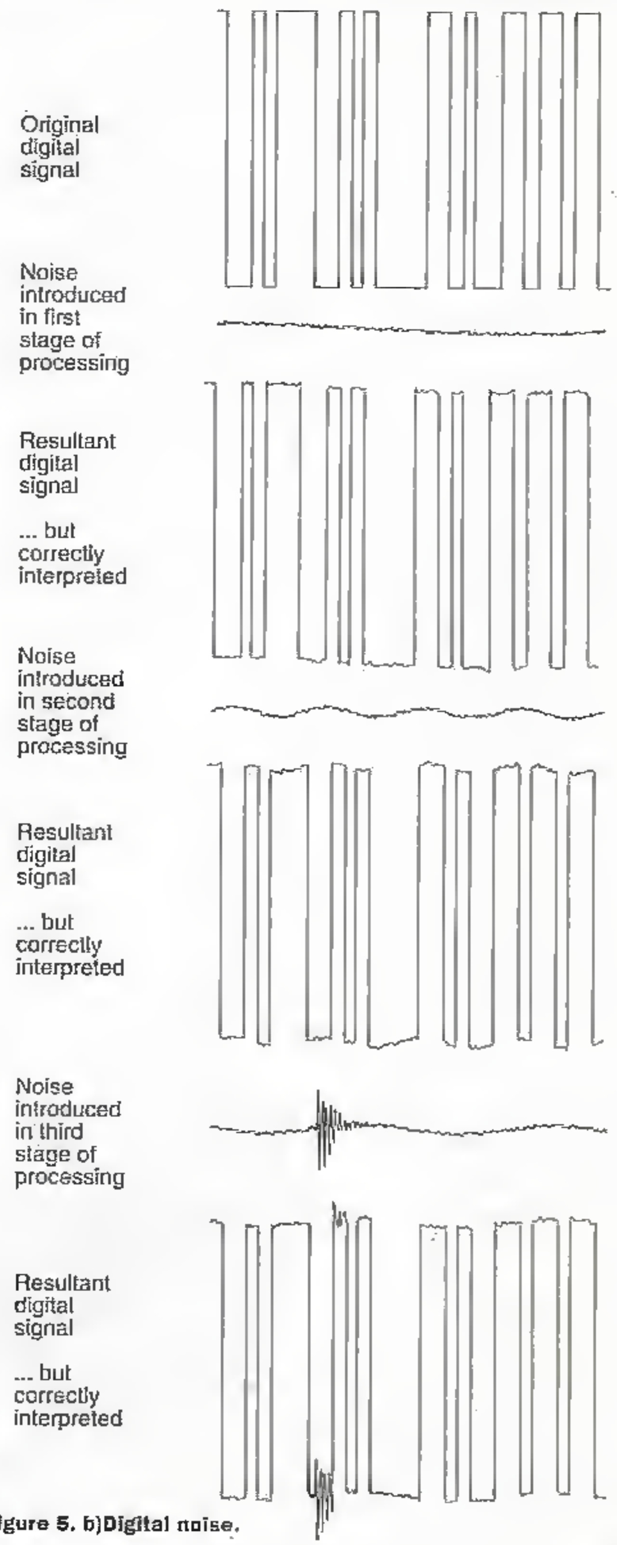


Figure 5. b)Digital noise.

also appropriate to question where the perception that digital is synonymous with quality came from, although we'll leave that discussion until we take a look at the audio CD story.

Noise – Under Control

The most commonly quoted advantage of digital technology concerns noise and by electrical noise, we mean unwanted electrical signals. In the case of audio engineering, noise manifests itself as hiss, hum, crackles, clicks, and so forth, and on a video signal it might be perceived as "snow", or as a lack of definition or contrast. And the bad news is that noise is inevitable. The only way to get rid of electrical noise is to cool the circuitry down to absolute zero, but at this temperature, you'll loose the intended signal too, since all the rules of electronics break down at absolute zero. However, this is only a theoretical solution. Physicists have proved that it's impossible to cool anything to absolute zero in a finite number of steps. But the really pernicious thing about noise is that it builds up. Every stage of electronic processing adds its own element of noise and whereas a little bit of noise may go unnoticed, eventually it will become objectionable. This doesn't mean, however, that quality will always be impaired to a noticeable degree, but it does mean that the utmost care has to be taken in designing the circuitry. And this, of course, can prove to be very expensive. This is the story of analogue processing, but with digital, things are quite different.

Certainly, a digital signal will still be subject to noise just like its analogue counterpart. However, unlike an analogue signal, in which minute changes in amplitude can be significant, and so too, therefore, would be the minute changes in amplitude brought about by noise, digital signals are discrete. In other words, the amplitude can only ever be one of a fixed number of values. Typically, there will just be a pair of amplitudes – perhaps voltage levels of 0V and +5V, and here, the circuitry will be virtually immune to noise. To correctly interpret a digital signal, a threshold is set so that any voltages above the threshold will be interpreted as ones, and any voltages below it as zeros. So we can see that normal noise levels of a few micro-volts or even a few milli-volts won't affect the ability of digital circuitry to correctly interpret the zeros and ones. Furthermore, there's no concept of cumulative noise. Every time a zero or a one is read correctly, a perfect version is passed on to the next stage of the circuitry.

If you're in any doubt about this, a simple experiment will make the point adequately. For the analogue experiment, you'll need a twin cassette deck and a couple of spare cassettes. Record a few seconds of music onto the first cassette and then copy it to the second cassette. Now copy the recording from the second cassette back onto the first and keep alternating between them in this way, listening occasionally to the result. Eventually, you'll get to the point at which the recording sounds pretty appalling, although exactly how long this will take depends on the quality of your cassette deck. Now do the same experiment digitally on a PC. Find a .wav file (digitally sampled sound) or, if you haven't got one on your disk, create one using your sound card and a microphone or audio CD. Now try making copies. You'll certainly get fed up with copying before you find any deterioration at all. In fact, you could even knock up a batch file to make a 10,000th generation copy, and you'll find that it sounds identical to the original. If you can't be bothered to do the experiment yourself, the illustrations in Figure 6 show the results of our experiments at making multiple generation copies of an image. The first sequence shows the original and various generation copies made on a photocopier. OK, this isn't a purely electronic device, it also has optical and mechanical elements but it is essentially analogue and the build-up of noise and distortion is quite apparent. In the second sequence, we used a computer generated image which was stored on disk as a digital graphic file and copied it many times. There's no point in displaying a whole sequence as we did with the analogue copying, since they're all identical. However, you'll just have to accept our word that the second one is a 10,000th generation copy.

A Quart in a Pint Pot

Generally speaking, when you sample an analogue signal at a reasonable sampling frequency and sampling resolution, the resultant digital signal will be far more bandwidth hungry than the original analogue signal. In other words, a given passage of music would require more magnetic tape (I mention this media as one for which there are both analogue and digital recording formats in the form of the Compact Cassette and the Digital Compact Cassette respectively) for digital than for analogue recording, and digital broadcasts would require a larger section of the radio bands than analogue ones. For example, the analogue bandwidth of a stereo audio signal with a maximum frequency of 20kHz on each channel is 40kHz. The raw data

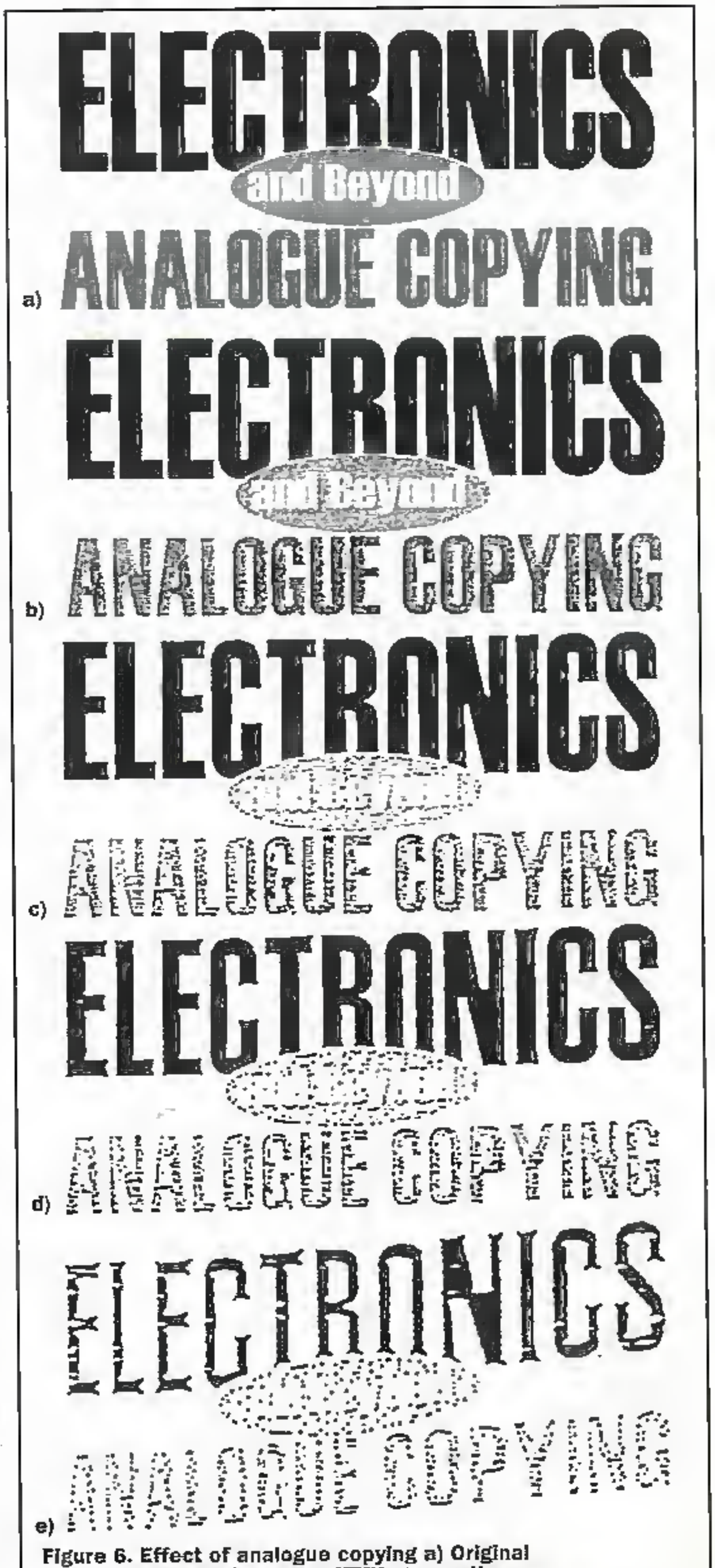


Figure 6. Effect of analogue copying a) Original b) Second generation copy c)Fifth generation copy d)Tenth generation copy e)Twenty fifth generation copy.

on a CD, on the other hand, has a bandwidth of several megahertz.

So far, we seem to be putting forward a very good reason for sticking with analogue, however, we haven't seen the whole story yet. In common with just about all digital data, digitally sampled audio or video signals contain redundant information which means that they're candidates for compression. In fact, this sort of data is much more compressible than computer data and whereas PC users tend to think in terms of a 2:1 compression ratio, audio and particularly video data can be compressed by a factor of up to a few hundred. However, at this point, we need to make a distinction between lossless and lossy compression. Compression of computer data always uses lossless compression. In other words, the process of compression followed by de-compression, doesn't alter the data at all. Clearly this is essential for software – even the changing of a single byte could cause a package to crash. And although this form of lossless compression can also be performed on digital audio or video data, this doesn't result in particularly high compression ratios. OK, you might be able to get back to the original bandwidth of the analogue signal, but to go beyond this, lossy compression is required. And by lossy compression, we're referring to schemes in which the original data stream isn't preserved, but in which the end result is, nevertheless, recognisable. In other words, we're talking about compression which yields an approximation to the original and here we have a trade-off. At one end of the continuum, the end result will be virtually indistinguishable from the original but the compression ratio will be modest, and at the other end, a high compression ratio results in seriously degraded quality. An example familiar to Web users is the JPEG format for graphic files. Here, the quality of images varies greatly, the difference being explained in terms of the amount of compression the Web master had chosen to use.

So, this gives us another undoubted advantage of digital techniques but, ironically, it provides us with another possible reason to take the "high quality" tag with a pinch of salt. For reference, CDs use lossless compression, and rival camps are proposing lossy and lossless compression schemes for a new recorded music format to be based on the DVD. The forthcoming digital television standard, on the other hand, employs the lossy MPEG-2 compression algorithm although the broadcasters are at pains to point out that the perceived quality will be at least as good as that of today's analogue TV. And not only that, it will allow up to 6 programmes to be broadcast in the 8MHz channel currently used for a single analogue programme.

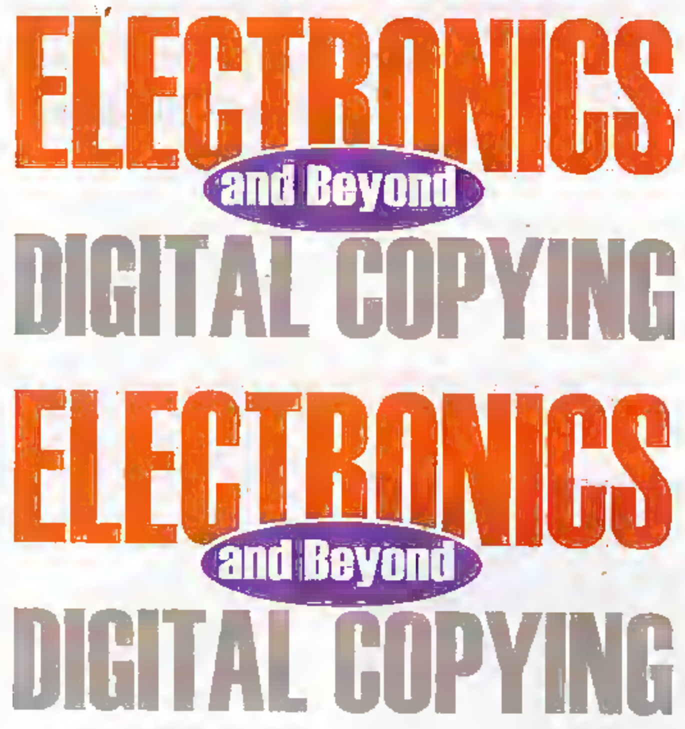
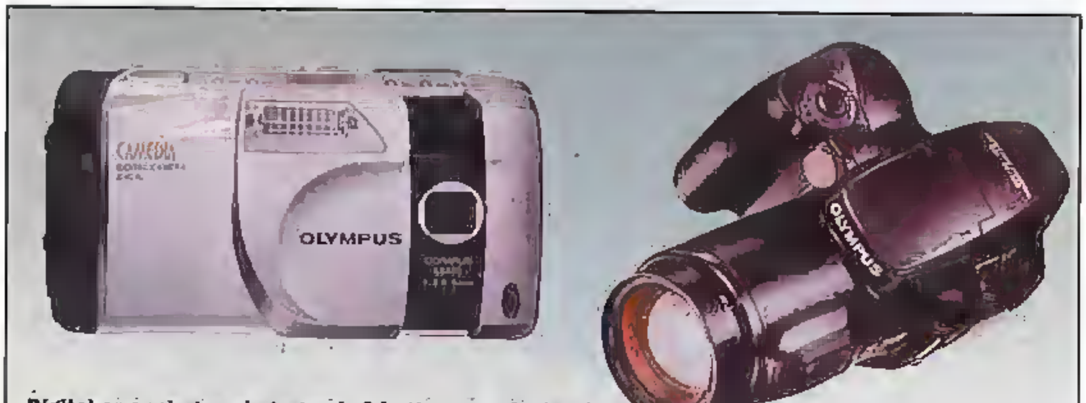


Figure 6. f) Digital copying.

Other Advantages

Much of the advantage of digital, both to the manufacturer in terms of a simpler design, and to the consumer in terms of additional functionality, relate to the fact that digital signals can be processed by microprocessors or DSPs (digital signal processors). A look at some of the modestly-priced midi audio systems reveals a level of complexity which would have been virtually impossible using analogue techniques – certainly at this price level. The sort of features I'm thinking about include bar graphs showing peak and average signal levels across the audio spectrum, and the ability to process the sound such that it exhibits the characteristics of different listening environments (e.g. concert hall, open air, small room etc.). Of course, this sort of thing is anathema to the hi fi purists, since it further changes the sound from its analogue origins, but my aim here is to show what can be done, not to debate what ought to be done. Furthermore, by using digital techniques under microprocessor control, the user interface can be made more sophisticated and perhaps more intuitive. With purely analogue circuitry, user controls don't go much beyond on/off switches, rotary or push-button selector switches and potentiometers for volume and tone control. Indicators are limited to meters and status lamps. Certainly these traditional controls can be provided in the digital world, but there's scope for much more. For example, rotary controls could be replaced by up/down controls, pre-set conditions could be made available at the touch of a button, and status information can be provided at a number of levels ranging from a few LEDs through an LCD display to full GUIs (graphical user interfaces). Alternatively, digital electronic kit could be designed such that it may be controlled remotely, perhaps using a PC with suitable control software.

So, these are some of the advantages of using digital techniques, but to go back to some of our introductory comments, is there a price to be paid for this level of sophistication? In view of the fact that a digital signal is only ever an approximation to the real thing, do we sacrifice quality for convenience or are the hype merchants correct when they equate digital with quality, citing the lack of noise as the main contributory factor? Certainly there's no single correct answer to these questions, but we can view some of the evidence and go on to see what lessons can be learned. Next month in part 2 we'll be concentrating on a couple of key applications of digital technology in areas which, traditionally, have employed analogue techniques. Firstly we will be looking at music reproduction and then we'll move on to consider photography.



Digital or analogue photography? Is there a price/quality trade off with present technology? More of this next month.

In the Workshop

LOUDSPEAKER PROTECTION SYSTEM

Protect your loudspeakers from budget hi-fi and car radio systems with this loudspeaker delay switch. Here Stephen Waddington shows you how to add a professional feature to a budget audio system for under a tenner.

This new series features design concepts that can be built as standalone projects or adopted and incorporated within new designs. The first feature in the series takes a look at an innovative loudspeaker control system.

Design Brief

The motivation to develop this loudspeaker delay switch is a pair of blown Mordant Short speakers. Budget hi-fi stacking systems may represent great value but they lack many of the features of their more expensive separate systems. Particularly lacking is any form of loudspeaker overload protection.

When you switch on a midi hi-fi system or car radio, it is likely that you'll initially hear a crackle in the loudspeakers. In fact you'll notice this effect with any audio system that incorporates external speakers. This is caused by a surge of electricity through the amplifier as the system switches on, before the voltages settle to their normalised levels.

You'll notice a similar thud in the loudspeakers when you switch the system off. Again this is caused by a discharge of electricity as the amplifier switches off and amongst other things, the breakdown of the magnetic forces created in the power supply transformer.

If you have audio separates where the amplifier, CD, tape deck, record player and radio are all discrete devices, as opposed to a stack system; it is probable that you are not aware of this scenario. This is because more expensive standalone amplifier systems often incorporate a loudspeaker delay at switch on and switch off to protect the loudspeakers from damage.

This control mechanism ensures that the listener can enjoy a clean sound environment, and more importantly can be confident that the amplifier is not inflicting damage on the system's loudspeakers. By delaying the switch on and switch off of a sound system's loudspeakers, energy that would otherwise dissipate within the systems' loudspeakers, is forced instead to dissipate in active components of the amplifier's power supply.

Professional Feature

If your audio system incorporates a loudspeaker protection delay system you'll notice the following features. When you initially switch the amplifier on it will take a second or two before the loudspeakers come to life. And they'll come to life with a solid relay click from within the amplifier case, followed by a crisp injection of sound.

Likewise, when you switch off you'll notice the loudspeakers take a second or two to drop out of circuit after the on/off button has between depressed, and when they do, it is with a clean switch-off. Again you'll hear a relay click from within the amplifier case as they fall out of circuit.

Photo 1. Cased version of the loudspeaker control circuit.

The design outlined here mimics the speaker delay system of expensive separates systems and is intended for application in other low cost sound systems. It was designed originally for a budget Sony stereo system of early eighties vintage, but has since been applied to a car radio, a public address system and a record player with external speakers, all with excellent results.

The loudspeaker delay system can be either retrofitted to existing audio systems that lack such as feature, or incorporated within the design of new audio systems. The delay circuit can also be adapted and designed into new amplifier systems before they leave the drawing board. Please note neither Maplin Electronics nor the author can take any responsibility for damage caused to existing equipment by the addition of the loudspeaker control circuit.

Circuit Diagram

The loudspeaker switch on/off delay circuit uses a timer to delay a pair of loudspeakers from switching on by approximately a second, when the on button of the audio system is first switched on. Similarly a timing circuit is used to hold the speakers in circuit for up to two seconds when the audio system is switched off.

The circuit diagram for the loudspeaker switch on/off delay switch is shown in Figure 1. It is based on the popular NE555 timer integrated circuit shown in Figure 2, running in monostable mode. This provides the delay at switch on.

The loudspeakers are switched in and out of circuit using a double-pole-double-throw relay. A 4,700μF electrolytic capacitor placed across the relay terminals holds the relay in circuit after power has been removed.

How it Works

The NE555 is a highly stable discrete device for generating accurate time delays. Terminals are provided for resetting or triggering the device if required. In the time delay or monostable mode a single external capacitor and resistor control the time. The NE555 is capable of operating with a supply rail between 5 to 15V and can source or sink a load of up to 200mA.

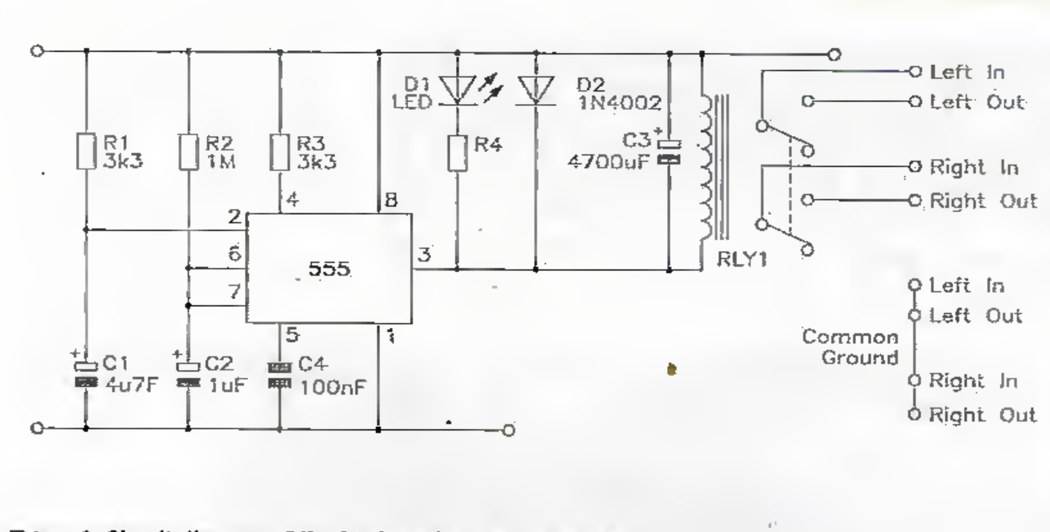


Figure 1. Circuit diagram of the loudspeaker control circuit

The NE555 is triggered on a falling edge waveform. The output at pin 3 goes high for the duration of the timing period, falling to low after the timing period as shown in Figure 3. Connecting reset to ground during on time drives the output low until a new trigger pulse occurs. Additional trigger pulses during on time have no effect.

In the configuration shown in Figure 1, the NE555 is triggered shortly after switch on. A 4.7μF (C1) capacitor strapped from trigger to 0v, in combination with a 3.3kΩ (R1) resistor provides a microsecond delay to enable the voltages across the integrated circuit to normalise after switch on before the timing period is initialised.

The reset pin (pin 2) of the NE555 is connected to Vcc via a 3.3kΩ resistor to prevent it from floating and thus destabilising the circuit.

After self-triggering via C1 and R1 at power-on, the integrated circuit executes the timing period. The length of this delay is determined – according to manufacturers' data sheet – to be equal to 1.1(R2C2). Using a 1MΩ resistor and a 1μF as shown here, gives a delay of 1.1 seconds before RLY1 switches on, connecting the two external loudspeakers in circuit.

The circuit shown in Figure 1 assumes that the audio system has a common ground. In the majority of audio systems this is usually the case, with the audio being driven from individual left and right signals. Consequently a double-pole relay is sufficient to switch both channels.

A 12V DC miniature relay is used, with a coil resistance of 270Ω and an operating switching range of 9 to 14.4V. This means the relay draws between 16 and 30mA, leaving a healthy margin from the 200mA capability of the NE555. If you intend using a relay with a lower coil resistance, it may be necessary to add an additional transistor stage to boost the current handling capability.

A 1N4002 diode (D2) is placed across the relay to prevent back electro-magnetic force (emf) when the relay switches off and the magnetic field created by the relay coil collapses.

When the power to the NE555 drops the relay is held in circuit by C3, which is strapped across the relay. This acts a reservoir, holding energy until the power drops. At this point the capacitor releases its stored energy through RLY1 holding the loudspeakers in circuit for a couple of seconds.

Construction

Prototype versions of this circuit were constructed initially on breadboard, with the completed circuit produced on veroboard. Photo 2 shows an early version of the loudspeaker control system built on veroboard. External LED, power and a single audio connection is also shown.

Interface to Existing Audio System

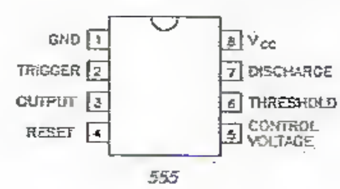
Retrofitting sub-circuits to existing systems is never easy. Unless you are the original designer of a system, you can never completely confident of the how will react when you add additional elements. For this reason the loudspeaker control circuit has been designed to require as little interference with the existing audio system as possible.

Connection to an existing audio system is undertaken at the owner's risk. Neither Maplin Electronics nor the author can take any responsibility for damage caused to existing equipment by the addition of the loudspeaker control circuit.

Making a Power Connection

Inevitably a direct connection with the existing audio system is required. The loudspeaker control circuit works by controlling loudspeakers in

Figure 2. Pin out diagram of the NE555 integrated circuit



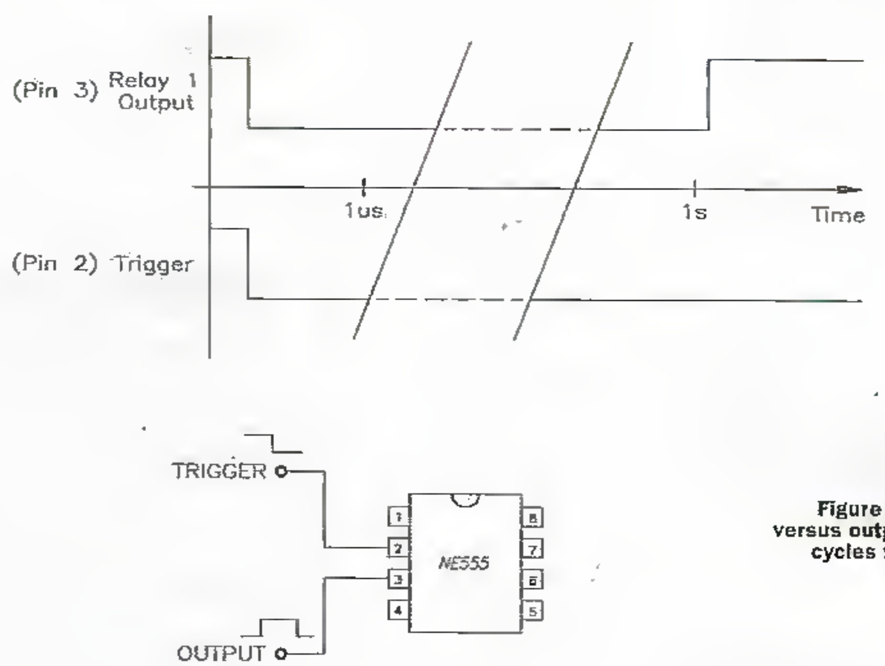


Figure 3. Trigger versus output timing cycles for NE555

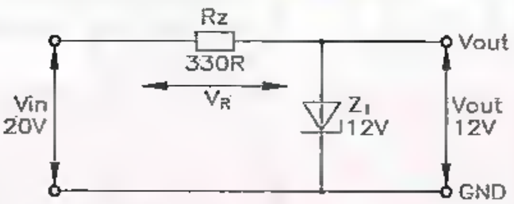


Figure 4. Zener diode is used to bring external voltage within operating parameters of the NE555

response the audio system being switched on and off – consequently a direct feed from the audio systems' power supply is required.

In a car audio system this is easy to locate. In fact the majority of car radio systems provide an output power supply which is switched on when the radio is switched on to supply automatic card aerials and dashboard lights. In a hi-fi stacking system making a connection to the power supply is more difficult.

Consider the budget Sony stereo system for which the loudspeaker delay system was original designed. Here two tape decks are combined with a radio on the front face of the hi-fi, with a record player sitting on top. The on/off switch together with a variety of control switches, tape deck buttons and the tuner dial are contained within a front panel. External audio input connections are provided for a CD player.

Please take appropriate precautions when working with mains powered equipment. Suitably qualified individuals should only undertake connection to mains power equipment.

Removing the rear and bottom panels from the hi-fi reveals a series of circuit boards, the majority of which are fixed to the front panel. The main power supply board is identified by its proximity to the mains transformer, mains fuses, bridge rectifier or wire connection to the on/off switch.

With the judicious help of an AC/DC digital multimeter it is relatively easy to identify where the DC power supply output is located. And by using the multimeter it is possible to check that the power supply switches on and off to the tune of the main on/off switch.

Once identified, a direct connection is made to DC power supply, by smartly soldering two colour-coded wires to existing connections on the rear side of the printed circuit board.

Using the multimeter again, check the DC voltage output from the audio system. If it is above 12V, then some additional work is required to bring it within the working voltage limits of the NE555 and its associated components.

The voltage output from the power supply of the Sony Stereo System was 20V. A 12V zener diode in conjunction with a 330Ω resistor were connected across the 12V power supply output as shown in Figure 4 to bring it within the 5 to 15V operating voltage of the NE555.

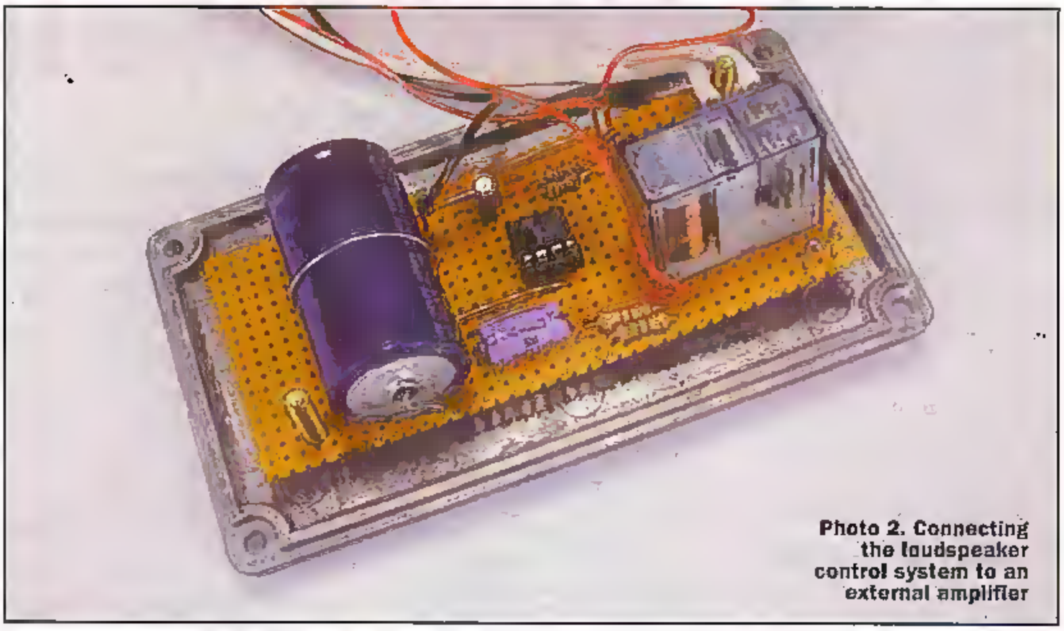


Photo 2. Connecting the loudspeaker control system to an external amplifier

Testing

With the hi-fi reassembled, connection can be made to the loudspeaker delay circuit using a 2.1mm-phono lead to connect to the 12V-voltage output from the hi-fi as the power supply. With this connection made, the relay (RLY1) within the loudspeaker delay circuit should click in and out of circuit a second or two behind the on/off button of the hi-fi system.

The audio connection to the loudspeaker control circuit is made as shown in Figure 5. Here the two ground connections are connected to a common connection, with the left and right audio signals switched using the relay.

The prototype veroboard control circuit is housed in a metal case as shown in Photo 1. This enables the circuit to be tested in the harsher environment of the car audio system.

Single connection phono audio sockets were added to facilitate easy connection, although a terminal strip could easily be used to enable speaker connections to be hard wired if appropriate. A 2.1mm phono socket was added for the power supply input in addition to a red LED to act as a power supply indicator.

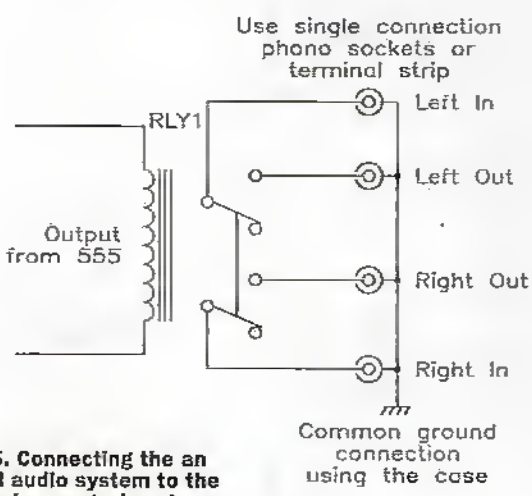


Figure 5. Connecting the an external audio system to the loudspeaker control system

PROJECT PARTS LIST

RESISTORS: All 0·6W 1% Metal Film (Unless stated)			
R1, R3	3.3kΩ, 0.6W resistor	M3K3	£0.05
R2	1MΩ, 0.6W resistor	M1M	£0.04
R4	680Ω, 0.6W resistor	M680R	£0.05
CAPACITORS			
C1	4.7μF, 50V radial electrolytic capacitor	AU05F	£0.15
C2	1μF, 63V radial electrolytic capacitor	AU09K	£0.15
C3	4,700μF, 35V axial electrolytic capacitor	AT24B	£1.99
C4	100nF ceramic capacitor	BX03D	0.25
MISCELLANEOUS			
IC1	NE555 integrated circuit	QH66W	£0.59
D1	5mm red LED	CZ38R	£0.42
D2	1N4002 diode	QL73Q	£0.06
RLY1	12V Relay	YX99H	£2.60

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Low Voltage Transformer - Primary 240V. Secondary - 6 volts 100 amps for sale £45 (trade £75 +VAT) very heavy. Tel: 01274 593382 (Yorkshire).

Maplin Mixer Modules from Projects Books 17 and 18. Line amp, P-U Equalisation, VU meter, general input, power supply. Etc. All assembled and working £20 the lot. Tel: 01902 892 892027.

Club Corner

ARS (Aberdeen Amateur Radio Society) meets on Friday evenings in the RC Hall, 70 Cairngorm Crescent, Kincorth. For details contact: Martin, (CM0JCN), Tel: (01569) 731177.

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

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

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

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

Electronic Organ Constructor's Society. Details of programme magazine, membership and details of provisional dates of regional meetings for 1998 from: Don Bray (Hon. Sec.), 34 Etherton Way, Seaford, Sussex BN25 3QB. Tel: (01323) 894909, Fax 01323 492234.

E.U.G. User group for all 8-bit Acorn Micros, since 1991. Still going strong. Programming, news, information, sales. Contact: E.U.G., 25 Bertie Road, Southsea, Hants. PO4 8JX. Tel: (01705) 781168.

The Lincoln Short Wave Club meets every Wednesday night at the City Engineers' Club, Waterside South, Lincoln at 8pm. All welcome. For further details contact Pam, (G4STO) (Secretary). Tel: (01427) 788356.

The Lincon Short Wave Club Meetings every Wednesday from 7.45pm at Lincoln Railway Sports and Social Club, The Ropewalk London. Lincoln Hamfest 98 on Sunday 13th September. Contact: Cliff Newby G3EBH. 25 Sudbrooke Lane, Nettleham, Lincoln, LN22RW. Tel 01522 750637. Packet BBS G3EBH @gb7dx.#26.gbr.eu.

MERG? 2 first class stamps (or 4 IRCs) to John Weal, 23 Chapel Street, Yaxley. PE7 3LW brings you a substantial introductory pack to the Model Electronic Railway Group – actively applying electronics and computers to the model railway operation.

7th Northern Cross Rally - Sunday 15th February. 1998 - Large hall venue - Thornes Park Athletics Stadium, Wakefield - Details: Pete Smith G0BQB Tel: 01924 218217.

Preston Amateur Radio Society meets every Thursday evening at The Lonsdale Sports and Social Club, Fulwood Hall Lane, Fulwood, (off Watling Street Road), Preston, Lancashire PR2 4DC. Tel: (01772) 794465. Secretary: Mr Eric Eastwood, (G1WCQ), 56 The Mede, Freckleton PR4 1JB, Tel: (01772) 686708.

Science At Your Fingertips. Want to meet friends interested in Science? Send an SAE to: Daniel Gee, S.A.Y.F., 37 South Road, Watchet, Somerset TA23 0HG, or Scott Mason, S.A.Y.F., 58 Park Avenue, Devonport, Plymouth PL1 4BP. http://homepages.enterprise.net/icedragon/says.htm

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

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

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

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

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

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

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

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

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

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

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A Running LIGHT DISPLAY

by Pei An and Guang Lu

This article describes a programmable running light show project and is a gadget of many uses. It gives interesting visual effects and can be used for light decoration at homes, advertising displays in shops, or, simply, used as a toy.

The PCB board and mounted components is shown in Figure 1. Although there are a lot of designs around for light sequencing, the present light show does have some unique features. There are eight LEDs in the display. Their lighting sequences can be programmed. There are 27 lighting programmes which can be easily selected using an on-board DIL pin matrix. The speed of the running light sequence is changeable using an external variable resistor. The circuit is extremely simple, consisting one IC , one capacitor and a number of resistors and LEDs.

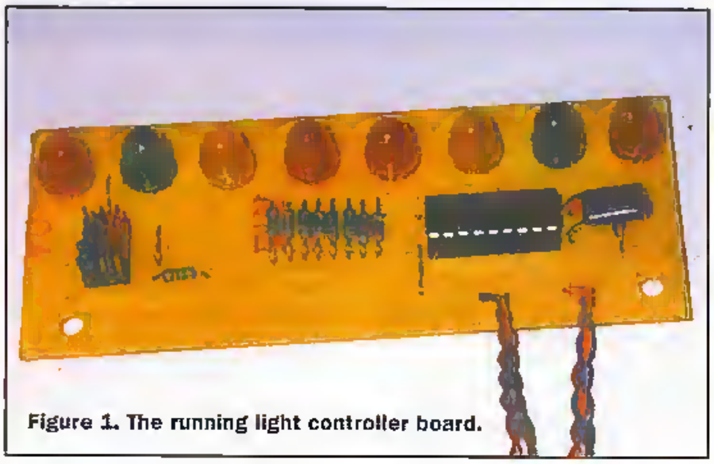


Figure 1. The running light controller board.

How it works

The circuit diagram of the board is given in Figure 2. The heart of the circuit is a specially-designed CMOS light sequencer, SE9201. The pin-out of the IC is shown in Figure 3.

The SE9201 is able to control 8 light channels and offers 27 programmable running-light programmes. It requires a minimum number of external components and provides a low-cost hardware solution for generating sophisticated visual effects. It requires a power supply from +3V to 8V. Pins 1 and 10 are connected to the positive and negative rails of the power supply. Being a CMOS device, power consumption is low. The 8 output, O1 to O8, are from pins 6 to 9 and from pins 11 to 14. Each output can source a maximum current of 20 mA, which is enough to drive two LEDs. It is also enough to drive triacs or thyristors so as to control lights operating at higher voltages. The sequences of the running light are selected by four selection lines (B1 to B4, pins 15 to 18). These pins are either connected to GND, VCC or connected together.

The external components of the circuit include a timing capacitor, C1, a timing resistor, R1, current limiting resistors for LEDs and a DIL pin array. The frequency of the running light is controlled by changing the value of the variable resistor, R1.

Light running programmes

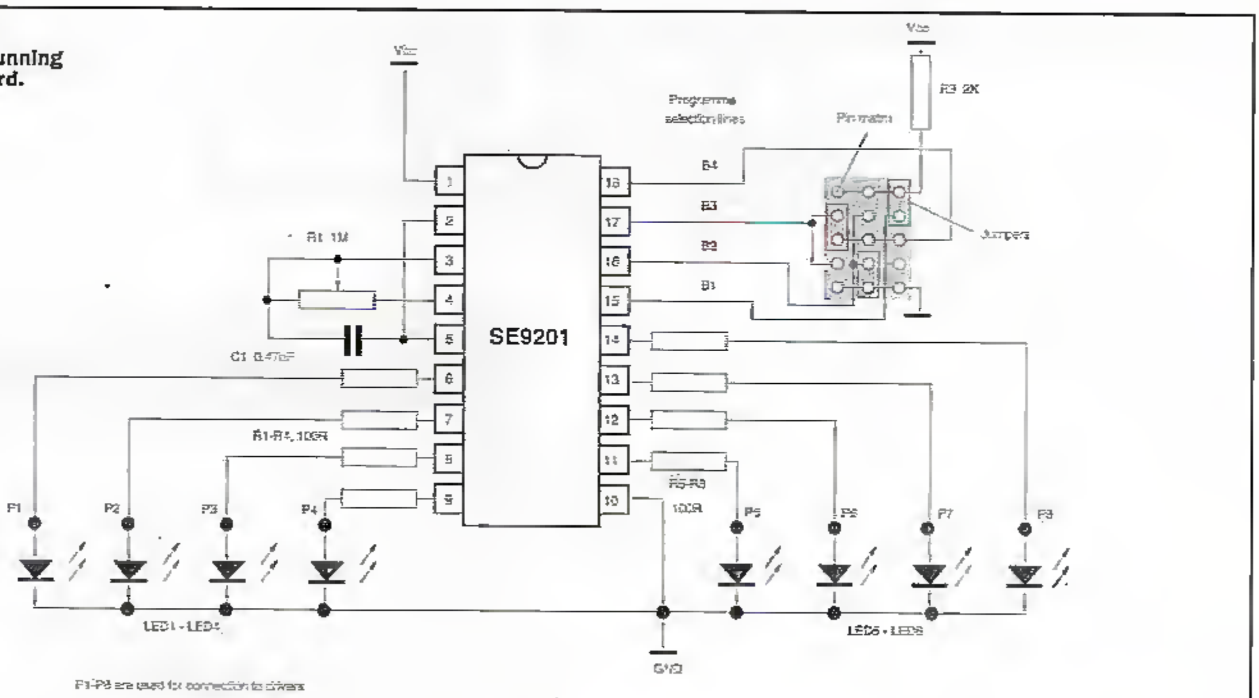
The SE9201 offers 27 running light sequences (see Table 1) and each is selected by B1 to B4 input pins. In Table 1, G and VCC stand for the ground and the positive voltage of the

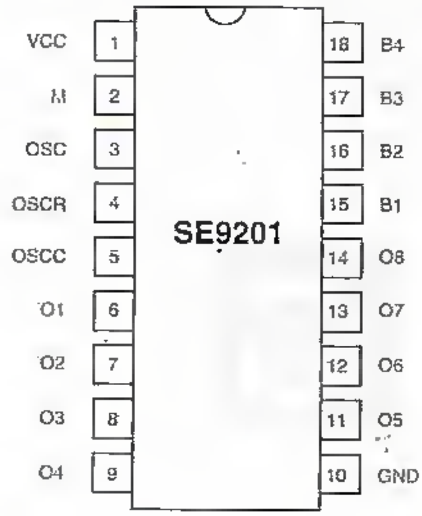
No	B1	B2	B3	B4	Sequences (1=LED on, 0=LED off)
1	G	G	G	float	11110000 _ 00001111 _ 00000000
2	Vcc	G	G	float	00011000 _ 00111100 _ 01111110 _ 11111111 _ .... _ 00011000
3	G	Vcc	G	float	10000000 _ 11000000 _ 01100000 _ 00110000 _ .... _ 00000011
4	Vcc	Vcc	G	float	00000011 _ 00000110 _ 00001100 _ 00011000 _ .... _ 11000000
5	G	G	Vcc	float	10000000 _ 11000000 _ 11100000 _ 11110000 _ .... _ 11111111
6	Vcc	G	Vcc	float	11111111 _ 11111110 _ 11111100 _ 11111000 _ .... _ 10000000
7	G	Vcc	Vcc	float	run sequences 1 to 6 and 8 continuously
8	Vcc	Vcc	Vcc	float	00000000 _ 11111111 _ 00000000
9	G	G		B3	1 and 5
10	Vcc	G		B3	2 and 6
11	G	Vcc		B3	3 and 7
12	Vcc	Vcc		B3	4 and 8
13	G		G	B2	1 and 3
14	Vcc		G	B2	2 and 4
15	G		Vcc	B2	5 and 7
16	Vcc		Vcc	B2	6 and 8
17	G	G	B1	1 and 2	
18	Vcc	G	B1	3 and 4	
19	G	G	B1	5 and 6	
20	G	G	B1	8 and 7	
21	G			B2,3	1 and 7
22	Vcc			B2,3	2 and 8
23	G		B1,3	1 and 6	
24	Vcc		B1,3	3 and 8	
25		G	B1,2	1 and 4	
26		Vcc	B1,2	5 and 8	
27			B1,2,3	1 and 8	

G: GND, Vcc: positive rail of power supply

Table 1 Light sequence programme.

Figure 2. Circuit diagram of the running light display board.





Pin functions

Vcc	Positive rail of the power supply
GND	Negative rail of the power supply
O1 - O8	Outputs
B1 - B4	Programme selection lines
M	Synchronization
OSC	Oscillator common
OSCR	External resistor
OSCC	External capacitor

Figure 3. Pin-out and functions of the SE9201 light sequencer.

Construction

This device is easy to construct. It is recommended that an IC socket is used for the SE9201. After the board is assembled, the device will work straightaway. There is no adjustment needed at all. The assembled display board is shown in Figure 1. Figure 4 gives the PCB foil and Figure 5 shows the component layout. You could change the variable resistor to see the speed change.

Application notes

Adding more powerful lights is needed in some situations. Figure 6 shows some driver circuits which could drive low voltage light bulbs. You need 8 such drivers for the display. The

power supply. Amongst these sequences, there are 7 basic sequences (programme No. 1 to 6 and 8) which are selected by B1, B2 and B3 (B4 is left unconnected). Programme No. 7 is a useful one in which you will see all the programmes played in turns. If B4 is connected to B1, B2 or B3, a combination of lighting programmes is generated. A pin matrix on the PCB board is used for selecting programmes. The two pins can be connected together using jumpers.

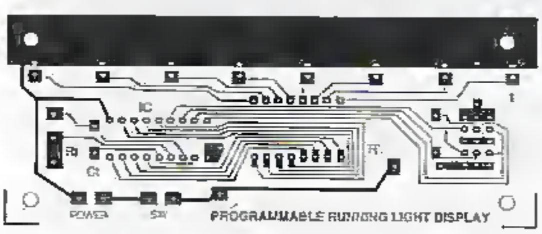


Figure 4. PCB Board of the running light display board.

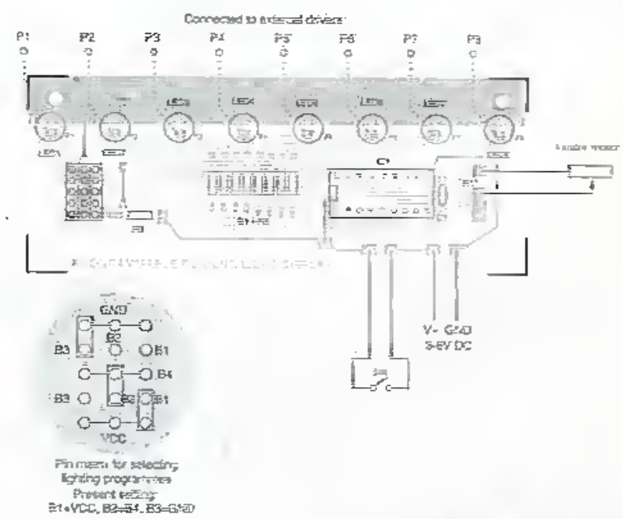
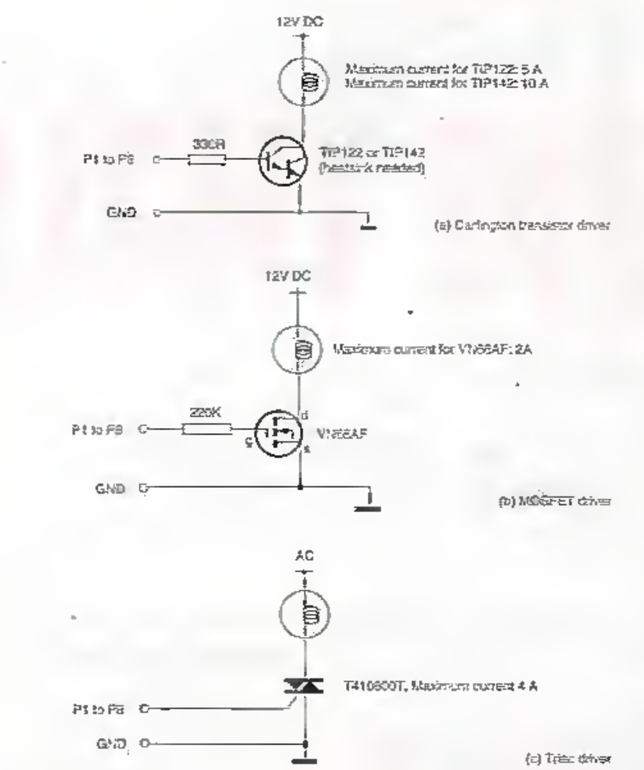


Figure 5. Component layout of the running light display board.

Figure 6. Darlington transistor, MOSFET and triac drivers.



inputs to the driver are connected to P1 to P8 points on the PCB board.

The following example shows how the project is used for a message display application. A message " GOOD LUCK " is to be displayed. Such a message display can be constructed using 8 small boxes, each having a light bulb in it. Each box has a transparent lid on which a transparency with a letter printed on it is attached. The colour of the lid and the transparency should be selected so that when the light bulb is illuminated, the letter will be visible. When the light is off, the letter will not be seen. This arrangement is illustrated in Figure 7.

To display such a message with more fun, the following lighting sequence can be used. First, 'GOOD' is illuminated but 'LUCK' is not. Then 'LUCK' is illuminated and 'GOOD' is not. Next, 'GOOD' and 'LUCK' are all illuminated together and the message flashes for several times. This sequence is repeated. Figure 8 illustrates this message and the sequence. Such an effect can be achieved easily using this board. The lighting sequence is a combination of programmes 5 and 8. The sequence is selected by connecting B1, B2 and B4 together with B3 connected to Vcc.

Technical Support

The project is available as an unassembled kit from the author. The kit includes an SE9201 chip, PCB boards and other components. The price is £15.00 including P&P. Please make your enquiry to Dr. Pei An, 11 Sandpiper Driver, Stockport, Cheshire, SK3 8UL U.K.. Telephone/answerphone/Fax number: +44-(0)161-477-9583.

RUNNING LIGHT DISPLAY PARTS LIST

IC1	SE9201 programmable light sequencer IC
C1	0.47 µF ceramic capacitor
R1*	1MOhm linear pot
R1-R8	100R 0.25W carbon resistors
R9	1K 0.25W carbon resistor
J1	3 way by 5 way PCB pins (made from SIL pins)
LED1-LED8	8 mm standard LEDs
SW1	Toggle switch
PCB board	

All the capacitors and resistors are available from Maplin. The SE9201 and the PCB board are only available from the author. Details as above.

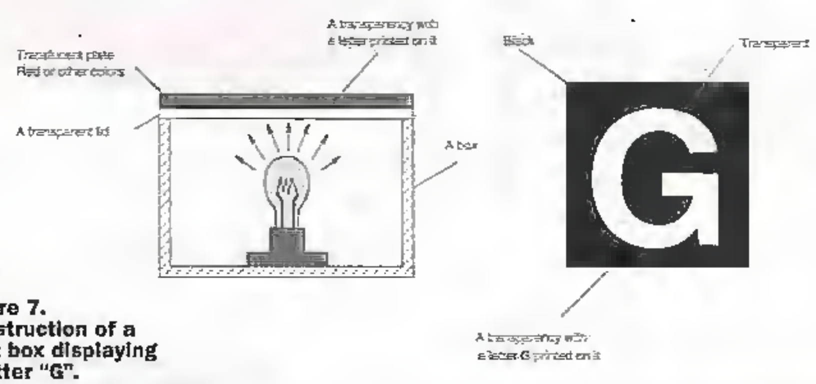
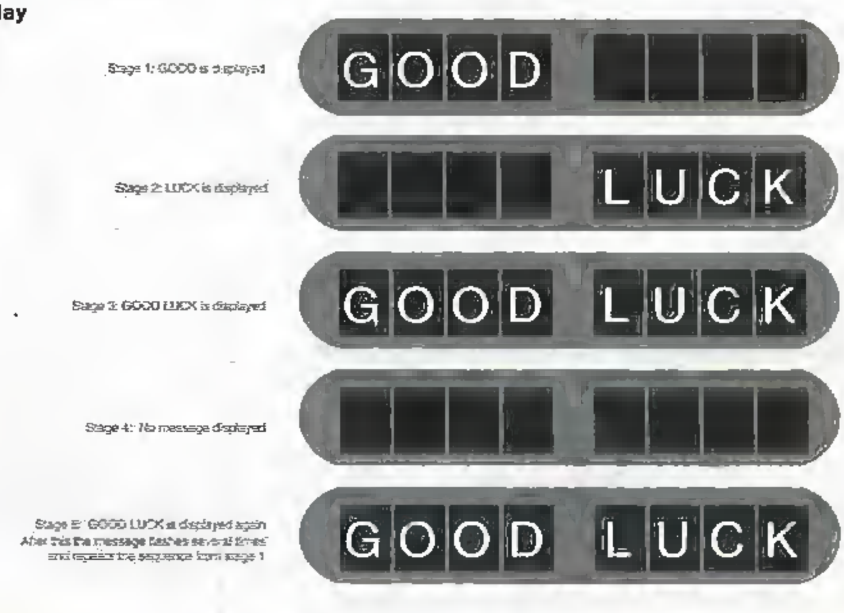


Figure 7. Construction of a light box displaying a letter "G".

Figure 8 Display sequence of the message "GOOD LUCK"



RESEARCH NEWS

by Dr. Chris Lavers

A Radio Telescope Larger Than The Earth

The first stunning high-resolution radiowave 'images' have begun to arrive from a Japanese satellite launched in February 1997 from Kagoshima in Kyushu Japan. NASA and the US National Radio Astronomy Observatory (NRAO), in collaboration with an international consortium of space agencies helped launch a 830kg satellite to create the largest astronomical radio telescope ever built, more than 2.5 times the diameter of the Earth (Figure 1). The launch of the Very Long Baseline Interferometry (VLBI) Space Observatory Program (VSOP) satellite by Japan's Institute of Space and Astronautical Science (ISAS), supported by NASA, Canada and Australia amongst others, uses very long baseline interferometry to provide high-resolution images in the radiowave band (Figure 2). VLBI uses a technique familiar to radioastronomers and modern radar designers alike, to electronically link widely separated radio telescopes (receivers) so that they work as if they were part of a single instrument with extraordinarily sharp clarity of vision or resolving power; the greater the separation between linked telescopes the greater the resolving power, e.g. the human eye's equivalent spatial resolution is important, and is the ability to view two close objects separately. For a well accommodated eye this limit is two lines spaced 1mm apart at a distance of about 3 metres. By combining results from a remotely deployed satellite this technique effectively triples the resolving power previously available with ground-based telescopes. VSOP has a resolving power 1,000 times greater than the Hubble Space Telescope at its optical visible wavelengths, this equates to 'seeing' a grain of rice in Tokyo from Los Angeles with the Hubble telescope. Dr Robert Preston, project scientist for the US Space VLBI project at JPL NASA says, "Using Space VLBI we can probe the core of quasars and active galaxies, believed to be powered by super-massive black holes. Observations of cosmic masers-naturally occurring microwave radio amplifiers- will tell us new things about the process of star formation and activity in the heart of galaxies." Separate NASA results released in December 1995 from NASA's Kuiper Airborne Observatory revealed that even the unlikely event of spontaneous laser activity will occur in hot stars such as in the constellation Cygnus (the Swan). The lasing activity is created as intense ultraviolet light from the star "pumps" or excites densely packed hydrogen atoms in a gaseous, dusty disk surrounding the star. When, infrared light shines on the excited hydrogen atoms, it cause the atoms to emit an intense beam of light at exactly the same wavelength, creating a circumstellar laser.

Throughout 1997 scientists and engineers tested the deployment of a large 8 metre reflectivity mesh telescope (Figure 3), its wide-band frequency data-link from satellite to ground receiving stations, and its high-precision orbital control attitude jets crucial for VLBI observations. Initial scientific measurements began in May taken in concert with ground-based radio telescopes. The satellite is in an elliptical orbit, varying between 1,000km and 20,000km above Earth, each orbit taking about 6 hours. The satellite will concentrate on some of the most distant and interesting objects in the universe during its early operational period, where the extremely sharp 'radio' resolving power will hopefully provide answers to current astronomical mysteries. For years astronomers have been aware that powerful 'engines' in the heart of quasars and galaxies pour out immense amounts of energy. They suspect that supermassive black holes, with gravitational fields powerful enough that even light cannot escape, lie in the centres of these 'engines'. However, the mechanism at work in the centres of quasars and active galaxies is unknown. Ground-based telescopes have revealed fascinating details in recent years and space VLBI is expected to add a wealth of new information on these objects millions of light years distant from Earth. Many of these same objects act as super-powerful particle accelerators to eject 'jets' of subatomic particles close to the speed of light. The VSOP system will monitor these jets to learn more about how they originate and interact with their surroundings. The satellite will also aim at regions in the sky where huge collections of water and other molecules act as natural amplifiers of radio emission much as circumstellar lasers amplify light. These regions, called cosmic masers are found where new stars are forming as well as the centre of galaxies. Observations will provide the detail needed to measure motions of individual masers and provide exciting new information about the star-forming regions and the galaxies where the masers reside. In addition high-resolution studies of cosmic masers can allow astronomers to calculate distances to them with great accuracy helping resolve continued uncertainty about the size and age of the universe. About 40 radio telescopes from more than 15 countries are committed to co-observe with the satellite, including the National Science Foundation's Very Long Baseline Array (VLBA), an array of 10 telescopes spanning the USA from Hawaii to Saint Croix, NASA's Deep Space Network (DSN) sites in California, Spain and Australia (also used in the data relay from the Mars Pathfinder and Global Surveyor), and the European VLBI Network consisting of more than a dozen telescopes ranging from the UK to China.

In the United States, NASA funds critical roles in the JPL mission, who have built an array of three new tracking stations at its DSN sites in Goldstone California, Madrid in Spain and Canberra Australia. A large existing tracking station at each of these sites has been converted to act as an extremely sensitive radio telescope for simultaneous observations with the satellite. Much of the data will be processed at the National Science Foundation's NRAO facility in Socorro, New Mexico, using a special high-performance computer designed to process VLBI data, the VLBA Correlator. This new space based system is the culmination of many years of planning and work by engineers world-wide; tests using NASA's Tracking and Data Relay Satellite System (TDRSS) proved the feasibility of space VLBI in 1986. In 1996 the old data was used again to successfully test the data-reduction facilities and Correlator for VSOP. The VSOP program also includes a Russian satellite, the RadioAstron mission, under development by the Lebedev Astro Space Centre in Russia for launch in 1998. The first images produced by the spacecraft working with ground-based radiotelescope arrays may be viewed at http://www.vsop.isas.jp.

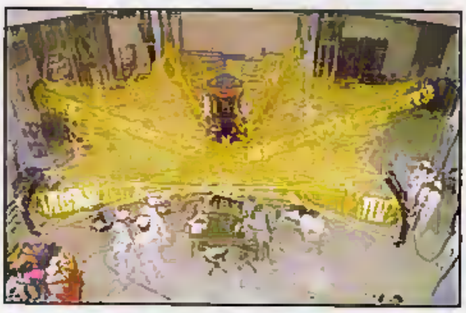


Figure 1. VSOP satellite under development with mesh unfurled.

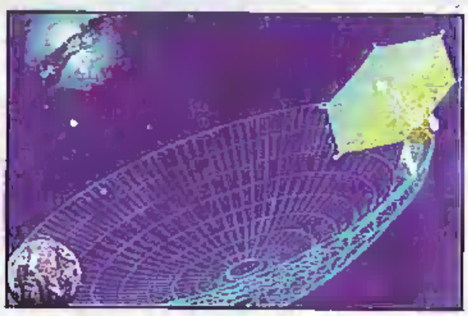


Figure 2. Very Long Baseline Interferometry between Earth and the satellite.

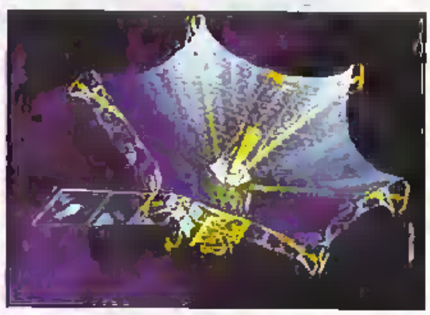


Figure 3. Artists Impression of VSOP with telescope deployed.

Pictures courtesy of NASA.

TECHNOLOGY WATCH

with Martin Pipe

If you, like me, make frequent use of Digital's payment-free Alta Vistasearch engine on the Internet (http://www.altavista.digital.com) then you might have noticed a quiet addition to its feature repertoire. As with most such engines, Alta Vista gives you a list of web pages that meet your search criteria. But now, at the end of each URL and its text description, is an option marked 'translate'. Clicking on this takes you to another element of the site, Babelfish(http://babelfish.altavista.digital.com/cgi-bin/translate?), which is presumably named after the Biblically-referenced (and civilisation-destroying!) translating piscis featured in Douglas Adams' Hitch-Hiker's Guide to the Galaxy.

Babelfish allows you to translate the document in question (or another page, if you enter its URL into a form displayed on your web browser) to a language of your choice. Within a few seconds, the translated page appears – with formatting and layout identical to the original. But that's not all. You can also enter text (or copy it from your wordprocessor, and paste it) into the Babelfish form, and translate that into another language. The translated text can be copied from the browser, and pasted back into your word processor. The Alta Vista system currently handles translation of French, Portuguese, Italian, Spanish or German pages into English – or vice versa.

The system is a great help if you are putting together a letter to a friend overseas, or have received an e-mail or FAQ (Frequently Asked Questions) list with some foreign language elements in it. I wonder if high-school language teachers are aware of Babelfish, which could incite students to cheat! That said, it's not infallible – any words that are not recognised (names and specialised words, such as those relating to science or law) are seldom handled properly. The essential part of a computer-based language translation (or MT – machine translation) system is the parser, a program that completely analyses the sentence. Parsers work with specific dictionaries for each language.

Bearing in mind its broad potential user base, the dictionaries associated with Babelfish have to be rather generalised – with predictable results. Martin Pipe, for instance, is literally translated into French as Martin's pipe'. Technology Watch, the name of this esteemed column, becomes Montre De Technologie', or technology wrist-worn timepiece'. In more important instances, it is rather better at getting the context right – the sign of a well-developed parser. For example, he went down the road' is correctly translated into French as Il a descendu la route'; and not into something that includes references to fluffy feathers cross-Channel style.

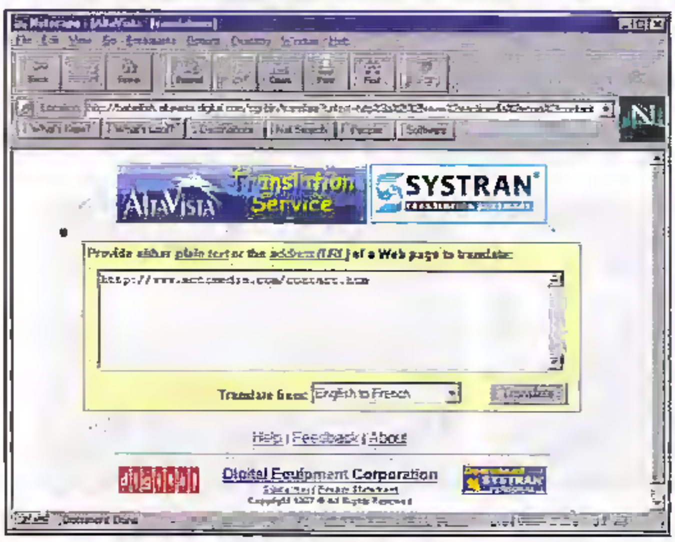
If you have a rough understanding of the language you're working with, then it is relatively simple to do the corrections manually. A more significant (and probably intentional) limitation is that Babelfish will only translate a couple of paragraphs of user-entered text at a time, although it does appear to translate complete Web documents. There is thus an alternative to tedious multiple cut-and-paste operations – put your text up as an HTML document, upload it to the free web space that your ISP gives you on its Web server, and get Babelfish to point to it!

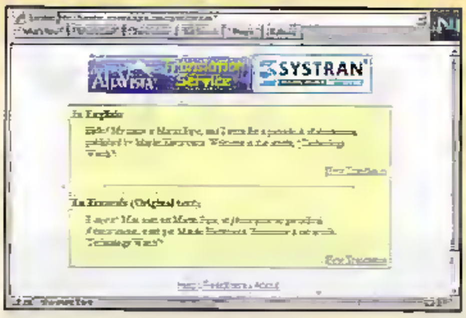
If you want to produce a multi-lingual Web site, then there is nothing to stop you from using Babelfish to cut down the donkeywork. After your English page has been translated and downloaded for display on your browser, it can be saved to your hard disk as a HTML document. It can then be manually proofread and corrected, or passed to a translator. Because most of the work has already been done, the translator has to work fewer hours and your translation bill will be less! I wonder if Digital are aware that their altruism can be abused in this way?

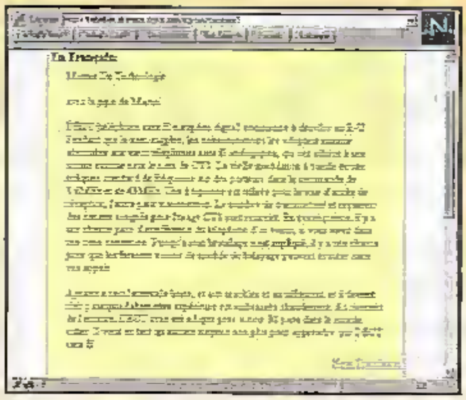
Babelfish's MT software runs on several million dollars of Digital computer hardware, hence the speed. Remember that many Internet enthusiasts (and professionals?) around the world could be using the service simultaneously. The software is provided by a long-established company by the name of Systran (www.systransoft.com). You can buy this software – Systran Professional – to run on your PC. It's currently available in Windows 3.1 and 95/NT variants, but the Mac is (sadly) not catered for. You get the ability to translate to and from various document formats (HTML, Word, SGML, etc.) and the opportunity to create your own application-specific dictionaries.

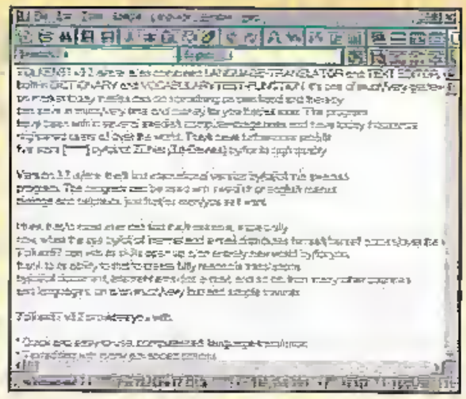
At a VAT-inclusive price of nearly £700 from UK distributor Omega First(0181 410 5215, or sales@omeganet.co.uk) it is rather expensive, however. What's more, Systran Professional only handles English plus one other language – in other words, you need to buy software for every language you want to translate. On the plus side, Systran Professional is available in versions that cater for Russian and Japanese – both difficult languages that Babelfish is not currently geared up to offer.(If you're into Japanese, or want to be, then you should check out the lessons at http://www.webshop.co.uk/japan/index.htm).

Systran stress that software of this type is not intended as a replacement for professional language translators. It can help suchworkers to become more productive,









however, Systran Professional is in use by many organisations, including Ford, Xerox, the European Union and the US Department of Defense. In many cases, it's used to produce technical documentation in multiple languages – note, however, that the appropriate specialised dictionaries have to be defined first. Systran do, however, sell these for common professions, such as computerscience, aviation, chemistry, physics and electronics. MT may be new to Alta Vista, but it's not a new idea. During the 1950s, research on MT started. Early efforts concentrated on literal (word-for-word) translation, and didn't employ any linguistic rules. By 1962, there were 48 working groups deeply involved in the research and development of MT. One of the largest MT projects in the 1960s was the Russian-to-English development at Georgetown University in the US; hardly surprising, bearing in mind the fact that the Cold War was in full swing at that time.

One of the core staff of the Georgetown project was linguist researcher Peter Toma Ph.D. In 1968, Dr. Toma established Systran. Its first contract was to develop a Russian-to-English MT for the US Air Force, which was tested at a USAF base in Ohio. Apparently the software is still in use, providing translations for the USAF's Foreign Technology Division; presumably it has been periodically updated and recompiled to work on successive generations of computer hardware! Systran was also used by NASA during the 1974/5 Apollo-Soyuz mission. Eventually, Systran was rewritten in C and, as soon as PCs became sufficiently powerful, a Windows version was compiled.

If you want MT on your PC, but don't want to spend £700 on Systran, there's a shareware alternative. T97setup.exe is Tolken97, a Windows 3.1/96/NT program that can be downloaded from the ftp server atsrc.doc.ic.ac.uk. It handles translation between various permutations of English, Swedish, Spanish, Danish, Norwegian, French, Norwegian and German. Some languages are covered better than others; French and German documents were translated into English as gobbledegook, while some converted Swedish text was quite readable. This is presumably because the program originates from Sweden! Tolken97 gives you the opportunity to add your own words to the dictionaries; these are quite small, presumably to keep the file download small.

Tolken 97 is not perfect, but it's quite fast and should help you to make at least some sense out of foreign-language documents. Commercial alternatives to Tolken97 include, Systran apart, World Translator (also available from Omega First) and Telegraph. There are other shareware programs out there on the Internet including the wonderfully-obscure thai.exe, a Windows-based Thai editor and Thai-to-German translator!

E-mail your comments or suggestions to Martin Pipe at whatnet@cix.compulink.co.uk

MAPLIN projects TOP 20 KITS

Position This Month	Position Last Month	Stock Code	Description	Price Inc VAT	Catalogue Page
1	9	LP28	Beginners AM Radio	£11.99	765
2	13	LP54	LED Xmas Star	£10.99	0
3	8	LP83	LED Xmas Tree	£15.99	0
4	7	LP77	Lights On Reminder	£7.99	716
5	16	LT09	Music Maker	£4.99	739
6	10	LK42	Car Batt Monitor	£12.99	714
7	5	LP30	1/300 Timer	£8.99	726
8	2	LP56	Mosfet Amp Kit	£24.99	706
9	6	LP69	L200 Kit	£7.99	762
10	1	LK63	Live Wire Det Kit	£6.99	785
11	3	LP16	TDA7052 Kit	£6.99	703
12		LT96	Animal Sound Gen Kit	£7.99	749
13	12	LP66	Courtesy Light Extr	£4.99	716
14	17	LU29	PIC 16C84 Programmer	£19.99	731
15	-	LP96	Flasher	£3.99	739
16	18	LT34	555 Proto Card	£7.99	729
17	-	LP97	Electronic Siren	£4.99	739
18	-	LM35	Mini Metal Dtctr Kit	£9.99	785
19	15	LP03	TDA2822 Stro Pwr Amp	£10.99	703
20	11	LT31	SSM 2017 Pre-Amp	£16.99	709

Over 200 kits available. All kits are supplied with full instructions. The descriptions above are necessarily short; please ensure that you know exactly what the kit is and what it comprises before ordering by referring to the current maplin catalogue. Maplin Projects: Top 20 Kits: based on December 97 sales figures. All items subject to availability. Prices are subject to change. E&OE.

MAPLIN modules TOP 20

Position This Month	Position Last Month	Stock Code	Description	Price Inc VAT	Catalogue Page
1	1	YU49	Clock Module	£4.99	728
2	3	FS13	Counter Module	£9.99	755
3	5	YT99	Temp Mod Wide Range	£13.99	754
4	4	WC20	UHF Modulator 6MHz	£10.99	791
5	12	RJ89	W/Less Clock Module	£26.99	728
6	6	FE33	Temperature Module	£9.99	753
7	-	YU67	Alarm Clock Module	£4.99	728
8	14	LB97	Pre-Amp EQ2S	£12.49	709
9	13	AM03	150W MOSFET Amp Assm	£29.99	706
10	11	GW01	DVM Meter Module	£13.99	756
11	2	AM27	418MHz Tx	£13.99	770
12	16	YU05	Small Clock Module	£9.99	728
13	10	YU07	Small Temp Mod Ext	£10.99	753
14	8	AM28	418MHz Rx	£25.99	770
15	19	YU00	Dual Disp T Module	£14.99	754
16	7	FP64	Min/Max Temp Module	£11.99	754
17	20	LP85	RS232-Digtl ConvAssm	£19.99	724
18	-	AM26	Relay Module	£6.99	714
19	-	AM10	RS232/TTL Conv Assm	£19.99	723
20	-	NV09	418MHz AM SuperhetRx	£19.99	769

Over 100 modules available. Not all modules are supplied with data instructions, however full technical data is available on request from Technical Sales. The descriptions above are necessarily short; please ensure that you know exactly what the module is and what it comprises before ordering by referring to the current maplin catalogue. Maplin Modules: Top 20: based on December 97 sales figures. All items subject to availability. Prices are subject to change. E&OE.

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.

February 1998

2 Feb. The Internet And The Law, Manchester Metropolitan University, Manchester. Tel: (0171) 240 1871.

6 Feb. Personal Communications In The 21st Century, IEE, Savoy Place, London. Tel: (0171) 240 1871.

11 to 12 Feb. Image Processing and Optic Technology, National Exhibition Centre, Birmingham. Tel: (01822) 614671.

12 Feb. Self Learning Robots Seminar, IEE, Savoy Place, London. Tel: (0171) 240 1871.

16 Feb. Serious Low Flying Colloquium, IEE, Savoy Place, London. Tel: (0171) 240 1871.

17 to 19 Feb. Video Forum, Wembley Exhibition Centre, London. Tel: (01273) 857800.

22 to 25 Feb. Focus on, National Exhibition Centre, Birmingham. Tel: (0181) 681 2619.

March 1998

3 to 5 March. Integrating CADCAM, National Exhibition Centre, Birmingham. Tel: (0171) 388 2430.

4 March. Design Of Digital Cellular Handsets Colloquium, IEE, Savoy Place, London. Tel: (0171) 240 1871.

4 March. Electronic Aids For Motor Vehicles, IEE, Savoy Place, London. Tel: (0171) 240 1871.

11 to 13 March. The Production Show, Business Design Centre, London. Tel: (0171) 505 8340.

12 March. MOBILISING UK plc, London. Tel: (0171) 562 7650.

17 to 19 March. NEPCON Electronics, National Exhibition Centre, Birmingham. Tel: (01892) 544027.

19 to 21 March. Communication Skills Fair, Novotel, London, Tel: (01322) 660070.

24 to 26 March. Energy for Industry, Olympia, London. Tel: (01483) 799141.

27 March. Women In Engineering, Lecture By Veronica Perkins Davis, IEE, Savoy Place, London. Tel: (0171) 240 1871.

April 1998

6 April. Space Time Adaptive Processing Colloquium, IEE, Savoy Place, London. Tel: (0171) 240 1871.

7 to 8 April. Intranet EXPO, Olympia, London. Tel: (0181) 742 2828.

20 April. Digital Filters: An Enabling Technology Colloquium, IEE, Savoy Place, London. Tel: (0171) 240 1871.

27 Apr to 1 May. Engineering Lasers Exhibition, National Exhibition Centre, Birmingham. Tel: (01737) 768611.

29 to 30 April. Windows World International Data Group, Ballsbridge, Dublin. Tel: (01784) 210 210.

Please send details of events for inclusion in 'Diary Dates' to: News Editor, Electronics and Beyond, P.O. Box 3, Rayleigh, Essex SS6 8LR or e-mail to swaddington@cix.compulink.co.uk.

What's On?

UK Could Lead Way in Preventing Growth of 'Information Poor'

The UK could show the world the way to bridge the divide between the information rich and the information poor; a divide which could hold back national economies and impoverish society according to the BBC Director of Policy and Planning, Patricia Hodgson.

Speaking in Luxembourg at the end of last year, on behalf of Europe's Public Service Broadcasters, to European Ministers of Culture, Patricia Hodgson, said the coming together of television, telecommunications and computer services "would create the most powerful social and economic driver of the next century."

But achieving the true 'information society', with considerable economic and social benefits for each nation, would depend on broadcasters spreading its benefits beyond the better off to the population as a whole.

Britain, she argued, could show the way. In Britain, commercial operators are working alongside the BBC, the world's most powerful public service broadcaster, to launch a formidable range of new services. The BBC will offer three new channels, BBC News 24, BBC Choice and BBC Learning, with a link to interactive and online services to support those programmes.

"Within ten years we believe that three quarters of UK audiences will have chosen to switch to digital systems." At that point, she says, planning to switch off analogue becomes real, with all the economic benefits that follow from new uses of that spectrum.

She said, "Text and pictures, will draw a wider public in via favourite programmes in the comfort of their homes. The television set can bring tailor-made information and learning, as well as real choice in entertainment and the arts, into every home.

"Free-to-air services will help prevent a divide opening up between the information rich and the information poor, a divide which could hold back national economies and impoverish societies."

She said new services needed new delivery systems but that content would determine their success. Pay-TV operators, she said, were investing in digital delivery systems and infrastructure. "But good free-to-air services must drive take-up and provide real value for all, not just hi-tech enthusiasts and those who can afford to pay,"

She said public service broadcasters would play a vital role, encouraging take up with new services that extended choice beyond light entertainment, sport and programmes bought in from abroad on which new commercial services so often depended.

"The networks hold the key to the popular switch to digital, and so to the final coming together of broadcasting, telecommunications and computing," she said.

Action was needed, she said, to avoid a division in Europe between the 'haves' and 'have-nots'; between those who could afford to buy new services or worked with new technology, and the rest, who would remain 'information poor'.

For further details, check: www.bbc.co.uk.
Contact: BBC, Tel: (0181) 743 8000.

Emily Collins - Winner of the Mercury Communications Prize S.A.F.E. (Sensory Alert for Everyday). A device worn on the wrist, which flashes and vibrates as a smoke/intruder/doorbell/telephone alarm for the deaf.

Young Electronic Designer Awards Head North to Celebrate Birth of Computing

This year's Young Electronic Designer Award (YEDA) presentations are to be held in Manchester on June 29 as part of the celebrations marking the fiftieth anniversary of the world's first programmable computer.

Sponsored in 1998 by Cable and Wireless an the Institute of Electrical Engineers (IEE), the Young Electronic Designer Awards, are presented annually to students in three age groups between 12 to 25, for the development of an electronics based system or devices which meets an everyday need. Prizes include cash awards up to £2,500, equipment, certificates and trophies.

1998 YEDA finalists' projects will be displayed and judged at The Museum of Science and Industry, on Sunday 28 and Monday 29 June 1998, alongside a working replica of the original Manchester programmable computer.

In 1997, winning entries included a device to enable scuba divers to communication under water, a domestic alarm system to let deaf people know if the telephone of door bell is ringing, a device to fit to domestic irons to prevent clothes being burnt, bicycle safety lights and a device to detect if electric fences are switched on or off.

Entry forms for 1998 are now available and must be returned by 1 March 1998. Student projects have to be developed to working prototypes in time for regional judging in April. Further development can take place before the national final in June.

Contact: The Young Electronic Designer Award Trust, Tel: (01798) 874767.

Commission President Announces Winners of the European IT Prize

Speaking at the European Information Technology Conference (EITC'97) at the end of last year, the president of the European Commission, Jacques Santer today announced the names of the three prize winners of the European Information Technology (IT) Prize. The three winners are:

Applied Spectral Imaging

(www.spectral-imaging.com) based in Israel, for its SpectraCube, combining spectroscopy and normal imaging to provide, for example, more effective diagnosis and treatment of cancer.

LCI Computer Group

(www.lcigroup.com) based in the Netherlands, for its SMARTpen, a ball-point pen that incorporates biometric sensors to allow secure authentication of signatures.

Hyperwave

(www.hyperwave.de), based in Germany, for its Hyperwave Information Server, a new approach to Web server technology.

At the awards ceremony at the Brussels Congress Centre, President Santer presented each Grand Prize Winner with a specially sculpted trophy, together with an award of £140,000.

Congratulating the Grand Prize Winners, President Santer said, "Today, knowledge, and innovation based on knowledge, is the key source for jobs within what we call the information society. To make the most of our innovative talent, however, we need entrepreneurship and dynamism. These prizes give recognition to companies who display exactly that entrepreneurial spirit".

The Grand Prize Winners were selected from a short list of 25 Winners by an independent Executive Jury appointed by Euro-CASE and chaired by Dr Björn Svedberg, chairman of Ericsson and Chairman of the Royal Swedish Academy of Engineering Sciences. Each Winner company received a prize of £3,450.

Organised jointly by the Esprit programme and European Council of Applied Sciences and Engineering (Euro-CASE), the European Information Technology Prize is now in its third year. Its objective is to provide recognition to innovative IT products with excellent market potential. Winners must demonstrate creativity and good business sense in using information technology to generate growth and employment. This year the competition attracted more than 300 entries from companies in 26 European countries as well as from Israel.

For further details, check: www.it-prize.org.
Contact: European Commission,
Tel: +32 2 296 65 49.

Security ELECTRONIC SYSTEMS & CIRCUITS

PART 6

Ray Marston looks at anti-burglary and burglar alarm principles in this month's episode of the series.

The best known and most widely used type of electronic security unit is the 'burglar' alarm, which is designed to detect burglars attempting to break into protected premises, but less authorised individuals roam freely within those premises and to easily enter or leave their perimeter zones. To be really effective, burglar alarms must be used in conjunction with various physical defences/deterrents and with reliable locks, latches, and security windows, and their sensors and sirens must be located to give the best possible security to the individual premises that are being protected. Note that the main aim of an anti-burglary security system is that of deterring potential burglars from even trying to break into the defended premises; the burglar alarm is simply a back-up to that system and is thus of value only if the main deterrent security system fails in its task.

To get the best value from any burglar alarm the user must first learn the basic principles of anti-burglary protection, and must then use that knowledge to convert the basic burglar alarm into a device that gives a performance that is tailored to suit some specific security application. This month's episode of the series gives a concise outline of these various principles; next month's episode will show a variety of practical built-it-yourself domestic-type burglar alarm and accessory circuits.

Anti-Burglary Basics

The Burglar

A burglar is a person who forcibly enters houses or other premises with the intention of theft. To be burgled is a vile experience. At best, the burglar may be a professional who will enter your home and steal many of your personal possessions, some of which will have a sentimental value far in excess of their insured monetary cost; the next day that same burglar will probably sell those precious goods for a trivial amount of money, and then go and rob someone else. At worst, your burglar may be a demented amateur who enters your home with a heart full of hate, intent on stealing your cash and destroying or desecrating everything else; he will slash your furniture and clothes, urinate on your bedding, smear excrement and paint on your walls, and try to smash or burn everything else; this type of burglary is so repulsive that many victims never recover from the psychological damage caused by the experience.

Your vulnerability to burglary is greatly influenced by the location and nature of the premises in which you live or work, and by the security precautions that you take to protect those premises. In all advanced Western countries, annual burglary totals are proportional to national population figures and are typified by those of the UK, which has a total population of about 56,000,000. In the UK, the annual total of burglaries in the ten years up to 1997 averaged about 900,000, of which approximately 400,000 were domestic burglaries. Of these domestic incidents, almost three quarters involved actual physical forced entry, and

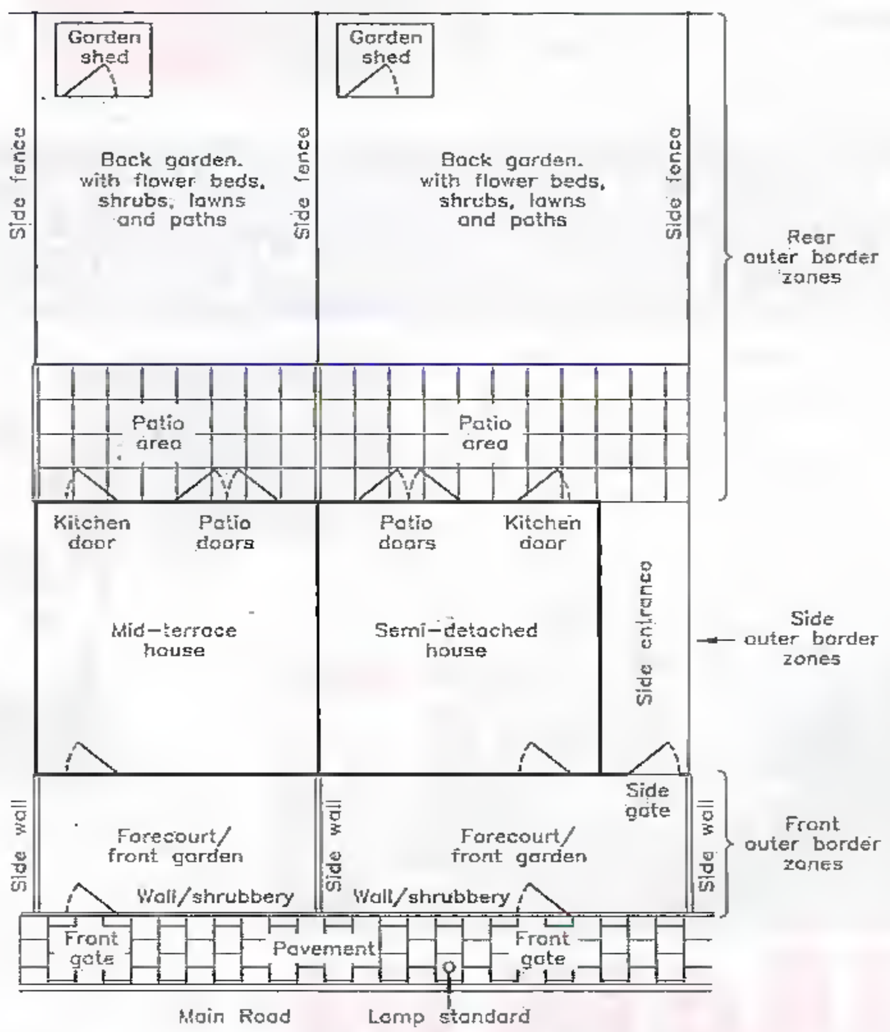


Figure 1. Diagram showing the outer border defence zones of typical UK-style mid-terrace and semi-detached houses (see text).

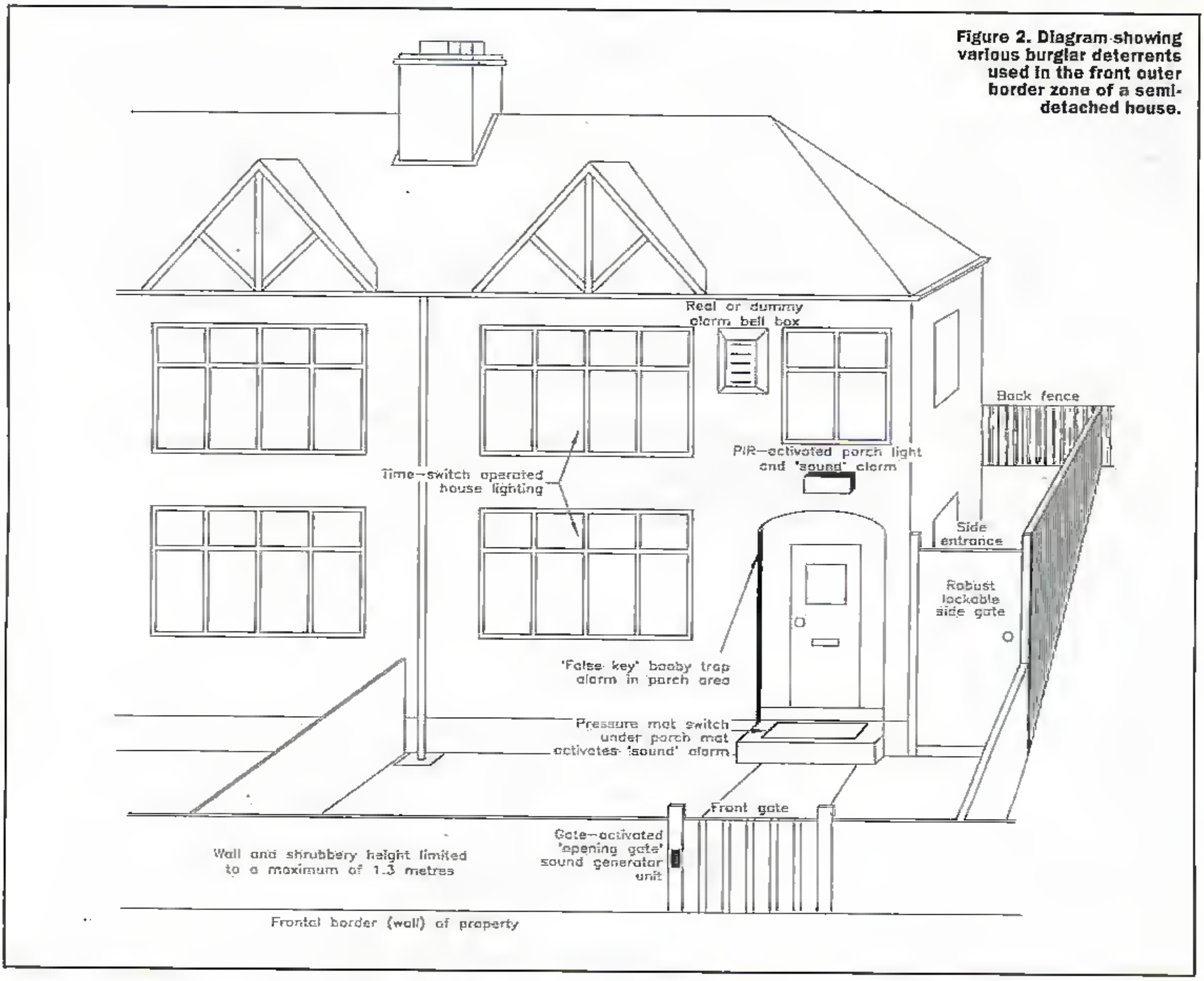


Figure 2. Diagram showing various burglar deterrents used in the front outer border zone of a semi-detached house.

more than a quarter were walk-in burglaries in which the intruder entered the premises via an unlocked door or window or (in a small number of cases) by using a carelessly hidden spare front door key.

For security purposes, all private premises can be regarded as defensible fortresses (houses or other buildings) that are surrounded by defensible outer border zones (private land, with outer fences and hedges, etc.). No burglar can reach your private fortress without first passing through at least one of its outer border zones, which thus form your first and most important anti-burglary defence areas; if you use these areas sensible, you will deter most burglars from even trying to break into your house. Figure 1 and the next two major sections of text help illustrate some of the basic defence principles of these areas, specifically applied to medium-sized houses of the types found in many suburban areas in the UK.

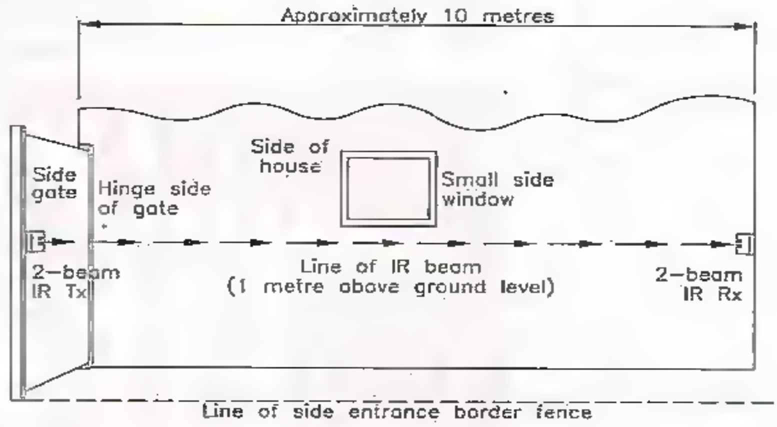
Front Outer Border Defence Zones

Most burglars make an unobtrusive visual study of a building by walking or driving casually past it to determine whether or not it seems an easy or a not-worth-the-risk target for burglary. Their main aim is to get into and out of the premises unobtrusively, and they thus like houses that have their front gardens enclosed by high shrubs or bushes, or are shrouded in darkness at night, and seem to be unoccupied and to have no obvious anti-burglary protection. Most potential burglars can be scared off by taking simple precautions such as fitting the building with time switches that automatically operate house lights at various times, or by leaving a radio switched on when the house is empty, or by fitting a real or dummy alarm bell housing to the front of the house.

If burglars decide to attack a house from the front, they usually enter the garden via the front gate and then try to enter the house by the front door or – if the house has a side entrance – by forcing the side gate and then entering the house from the rear. Burglars know that some people hide a spare front door key in or near the porch when they leave the house, and burglars often make a quick search for such a key. You can take advantage of this fact by making a simple 'false key' booby trap that activates a self-latching alarm if a dummy key or some other object is briefly moved. Thus, basic rules for protecting the house against frontal attack are as follows, and are illustrated in Figures 2 and 3:

1. Limit all front garden shrubbery to a maximum height of 1.3 metres.
2. If your house front is poorly lit at night, fit it with an automatic PIR-activated porch lighting system.
3. If your front gate is a self-closing type, fit it with a device that generates a distinctive sound as the gate is opened.
4. If your front porch is not fitted with automatic PIR-activated lighting, place a hidden pressure mat switch in the porch and use it to activate a bell or other warning device when anyone treads on it.
5. Deter burglars by fitting a real or dummy alarm bell box to the front of the house, by fitting the house with time-switch operated lighting, and by leaving a radio turned on when the house is unoccupied.
6. Fit a simple 'false key' booby trap in the porch area.
7. If you have a side entrance, fit it with a robust and lockable gate at its house-front end. Fit the side entrance with some type of intrusion-detecting alarm device that will activate if any unauthorized person enters the side entrance (even if they do so by climbing the gate), but will not be activated by cats, etc. House side entrances have a typical length of about 10 metres and are best defended

Figure 3. Diagram showing basic arrangement of an IR light-beam side entrance defence system.



by a PIR alarm fitted with a 'corridor' type of lens, or by an IR dual 'light beam' alarm of the type described in Part 5 of this series; Figure 3 shows the basic arrangement of a suitable 2-beam IR light beam alarm system.

In Figure 3 the IR dual-beam transmitter (Tx) is fixed to the side gate, near its 'fence' edge, and is aimed diagonally along the length of the side entrance, at a height of about 1 metre, towards the IR receiver (Rx) unit, which is fixed to the house wall at the far end of the entrance. Thus, the beam's Tx to Rx contact will be broken if the gate is opened, or if any adult person moves along the side entrance when the gate is closed.

Rear Outer Border Defence Zones

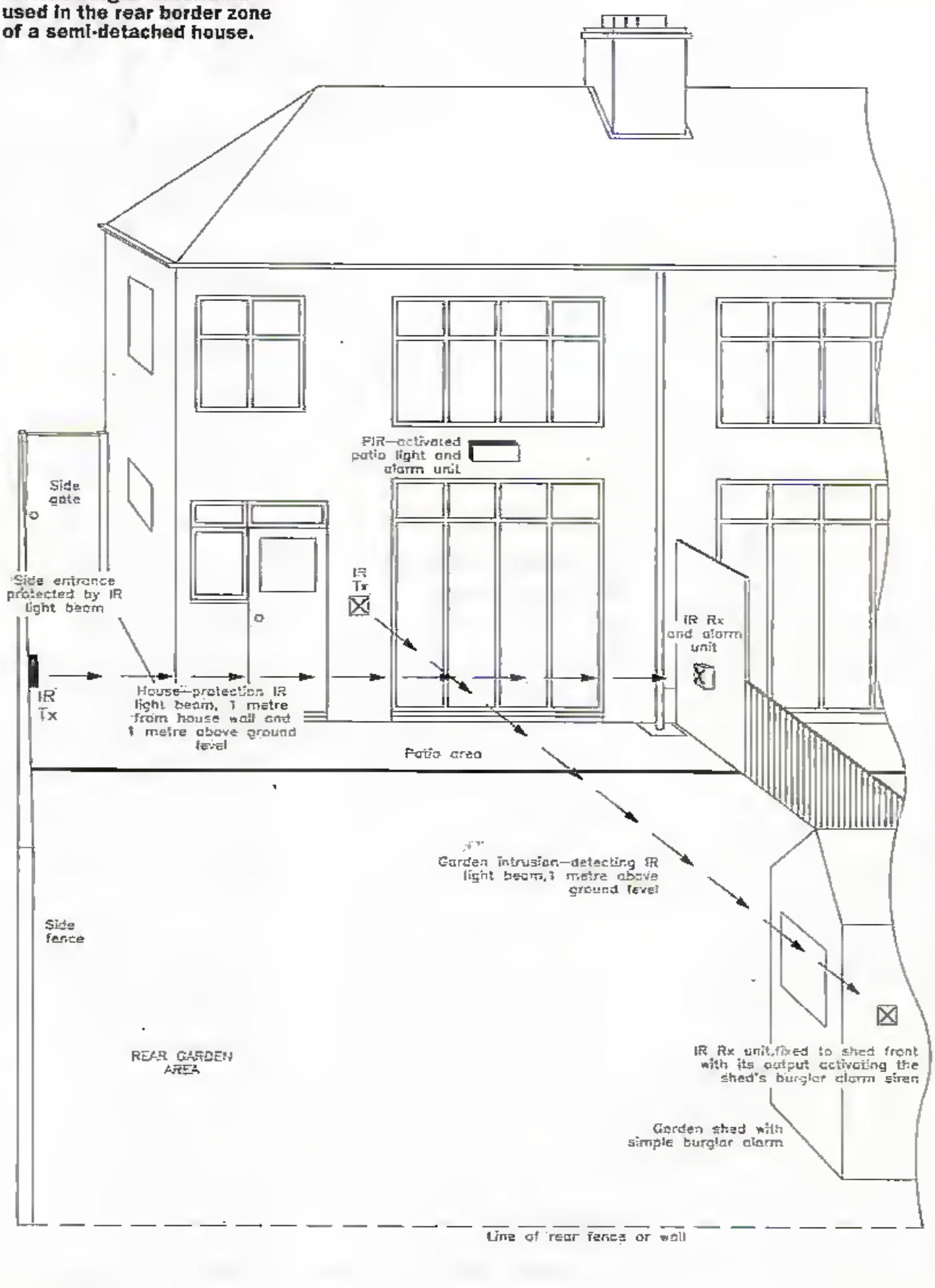
Three quarters of all house break-ins occur at the back of the home (where the burglar is least likely to be seen), usually via a window. To reach the house, the burglar must cross the garden and patio areas, and usually reaches these by climbing a back or side fence or via a side entrance; homes with rear access via a shared passage or driveway are very vulnerable to this type of break-in. Once a burglar has entered one garden he can easily gain access to adjacent houses by climbing over their side fences, sometimes breaking into several houses or their sheds or garages in a short space of time. Thus, basic rules for protecting homes against attack from the rear are as follows, and in some cases are illustrated in Figure 4:

1 Burglars treat garden sheds and garages as valuable sources of tools and equipment for the break-in and for later sale, and often break into them before attacking the actual house. Thus, always fit your shed and garage with a simple battery-powered burglar alarm that activates a loud siren and a light strobe if not disabled (via a secret switch) within about 20 seconds of opening the shed/garage door.

2 If you keep a ladder in the rear defence area, wire it to a simple 'loop' alarm, so that the alarm sounds if the ladder is forcibly moved.

3 If your home has rear access via a passage or driveway, protect the top of your back

Figure 4. Diagram showing various burglar deterrents used in the rear border zone of a semi-detached house.



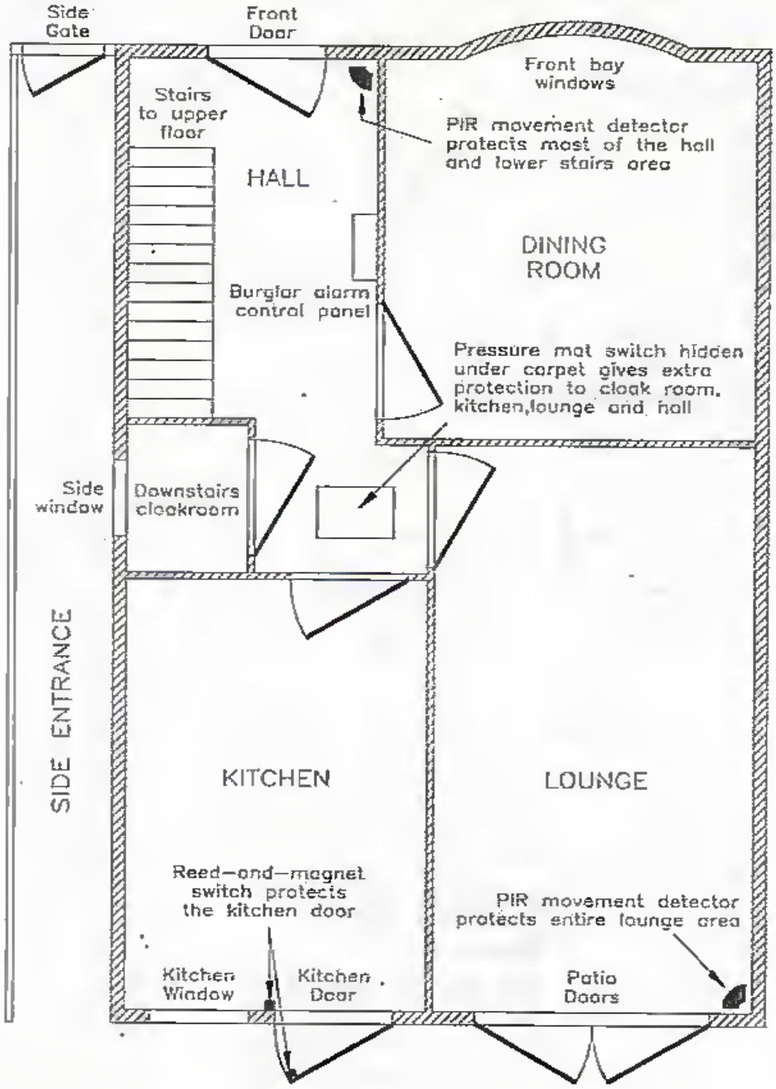


Figure 5. Ground floor plan of a semi-detached house, showing suitable positions for anti-burgiary defences.

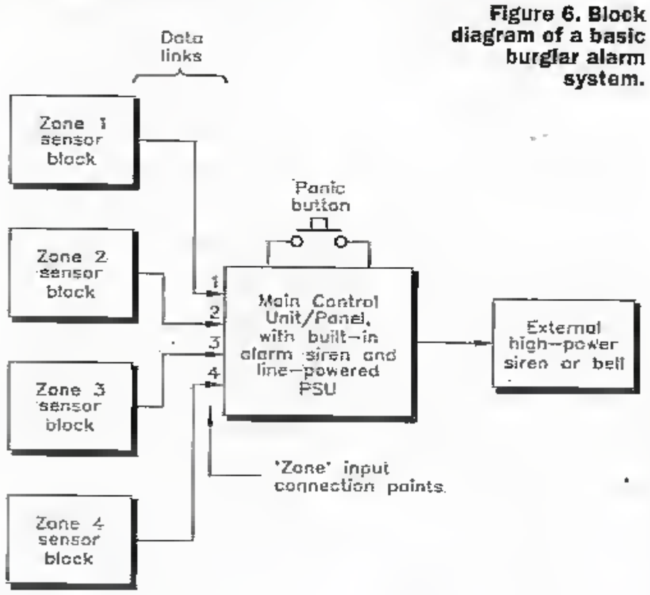
fence/wall with barbed wire or in some other way.

4 It is not practical to protect side fences against a burglar who wants to climb over them. Usually, however, the burglar is climbing them to reach the back of your house via the patio area, which can easily be protected via a PIR-activated flood-light/alarm unit or an IR light-beam alarm unit that is aimed along the back of the house a metre or so above ground level, as shown in Figure 4. If an IR light-beam is used, it must be positioned so that its beam can not be broken by carelessly placed patio furniture or by growing shrubbery.

5 Sometimes the burglar may climb your garden fences to reach an adjacent property. You can detect this type of intrusion with an IR light-beam alarm unit that is aimed along the length of the garden, between the house and the garden shed (see Figure 4).

6 If your house has a shared side entrance that leads to a pair of garages, mount a cheap dummy TV camera (with a built-in flashing LED that is powered from a remote battery) in a hard-to-reach position on the apex of the garages, aiming it along the entrance so that it is clearly visible from the street, as a burglar deterrent.

Figure 6. Block diagram of a basic burglar alarm system.



Front-Door Robbers

The easiest way to get into someone's house is to simply knock on its front door and, when it opens, either barge or trick your way into the premises. Small-time crooks (including small children) often use the latter technique to carry out petty robberies, typically arriving as a pair and getting into the house on a flimsy pretext such as using your 'phone to make an emergency call, or asking for a glass of water, etc. One of the pair then keeps you busy with idle chit-chat while the other person searches the house for loose cash and trinkets. The basic rules for protecting yourself against this type of robbery are as follows:

1 Fit your front door with a security chain, and never unhook it unless you are sure it is safe to do so.

2 Buy a fixed or mobile self-latching panic-button alarm, and keep your finger on its button whenever you open the front door to a stranger.

3 Never allow anyone (including children) into your house unless you are absolutely sure it is safe to do so.

4 Never, under any circumstances, allow two or more strangers (particularly innocent looking children) into your house at the same time.

5 Never, ever, under any circumstances, leave a total stranger alone in any part of your house; if they have the impertinence to ask to be left alone (to make a 'private' telephone call), immediately order them to leave the house and then inform the local police.

The House

If the would-be burglar has successfully passed through your building's outer border defence zones, he will now start to do physical and costly damage to the actual building by trying to break into it. His chances of breaking in are reduced (but the cost of the inflicted damage is increased) if the house is fitted with strong outer doors with robust locks/latches, and with double-glazed self-locking windows. You can greatly reduce the

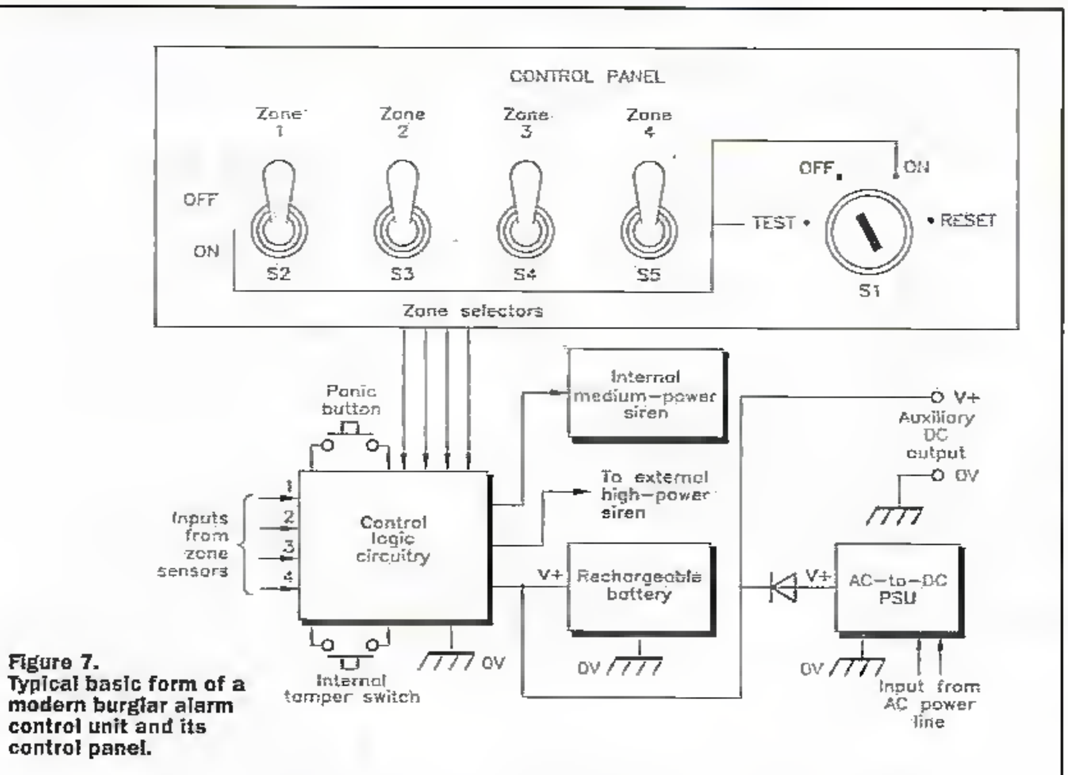


Figure 7. Typical basic form of a modern burglar alarm control unit and its control panel.

crook's chances of committing a successful burglary by fitting the house (or other building) with a properly designed burglar alarm system.

Any building can, for crime prevention purposes, be regarded as a box that forms an enclosing perimeter around a number of interconnected compartments. This 'box' is the shell of the building, and contains walls, floors, ceilings, doors and windows. To commit any crime within the building, the intruder must first break through this shell, which thus forms the owner's first line of house defence. In most houses, the most vulnerable parts of the shell are its doors and windows, but ceilings are also vulnerable (often via a trap door and loft space) in some top-floor flats and apartments and in many commercial buildings.

Once an intruder has entered the building, he can move from one room or compartment to the next only along paths that are predetermined by the layout of internal doors and passages. In moving from one compartment to the next he must inevitably pass over or through certain spots or areas in the building, as is made clear in Figure 5, which shows the ground-floor plan of a medium-sized house, together with suitable positions for anti-burglary devices/sensors such as PIR movement detectors, pressure mat switches, and reed-and-magnet 'contact' switches.

Thus, if an intruder breaks into this house via the kitchen (which has its outer door protected by a reed-and-magnet contact switch), or via the downstairs cloak room (via the side window), he can only reach the rest of the house by entering the hall, which is well protected by a hidden pressure mat switch and by a PIR movement detector, which also protects the front door and most of the stairway. The entire lounge is well protected by another PIR unit, which is aimed away from direct sunlight (a common cause of false alarms in PIR units) but will respond instantly if anyone enters the room via its main door or its patio doors. The dining-room is not individually protected, since it can only be accessed by its doorway (which is protected by the hall's PIR unit), or via its bay window, which (if the windows are clearly visible from the street) is a very unlikely attack point. Thus, the entire ground floor of this house is adequately protected by just two PIR units and two detector switches. The upper floor can be protected with similar simplicity.

Note in Figure 5 that the burglar alarm's main control panel is situated in the hall, where it can be conveniently operated (via a security key) on entering or leaving the house, or prior to going up the stairs (to go to bed), or immediately after coming down the stairs (after getting out of bed). The basic operating details of the burglar alarm system and its control panel are described in the next major section of this article.

Burglar Alarm Basics

The Burglar Alarm System

Most modern domestic burglar alarm systems consist of a number of switched-output intrusion sensors (contact switches and PIR units, etc.) and a 'panic' button, which have their outputs coupled to the inputs of a master control unit that processes the received signals and – when appropriate – activates a built-in medium-power audible alarm and can – if required – also activate a high-power external siren or bell. The burglar alarm system's block diagram thus takes the basic form shown in Figure 6.

Note in Figure 6 that the alarm sensors are arranged in blocks or groups, each of which is allocated a specific 'zone' input connection point on the main control unit. The basic idea here is to divide your property into a number of distinct defence zones, each of which can cover any desired area and can have its defences enabled or disabled via the master control unit's control panel. Suppose that the house shown in Figures 1 to 5 is divided up into the following four defence zones:

Zone 1 = External defences (shed, side-entrance, patio and garden).

Zone 2 = Entire upper floor of the house.

Zone 3 = The ground floor, except the lounge and the hall pressure mat.

Zone 4 = The lounge and the hall pressure mat.

With this defence system, superb round-the-clock anti-burglary protection can be obtained by switching the zones in the following ways, to suit the following circumstances:-

When the house is empty, all four Zones should be enabled, thus giving total protection. When the house is occupied during normal daylight hours but the garden area is unused, only Zone 1 should be enabled. If only the garden and ground floor are in use, only Zone 2 should be enabled. In the evening, if only the lounge is in use, Zones 1, 2 and 3 should all be enabled, thus protecting the occupier against the opportunist burglar who sneaks into the building while the family is watching TV in the evening (almost a quarter of all domestic burglaries occur when the house is occupied, with the occupiers either watching TV or asleep in bed). At night, when only the upper floor of the house is occupied, Zones 1, 3 and 4 should all be enabled. Note that the 'panic' button is normally enabled even when all four Zones are disabled, thus giving the owner non-stop protection against thugs.

Entry/Exit Delay

In the basic type of system described above, the Zone 1, 2 and 4 defence circuitry sounds an alarm instantly if an intrusion is detected, but the Zone 3 defence circuitry (which defends the front door entry/exit and control panel areas) has built-in 'entry/exit' operating delays of about 45 seconds, thus giving the system's key-holder limited freedom to pass through the Zone 3 defence area (to enter or leave the house or to operate the control panel) without sounding the alarm. This delay action is such that, when the owner enables Zone 3 via a key switch prior to leaving the house or going to bed, the Zone does not become active until the end of the 45 second 'exit delay' period; when the owner later passes through Zone 3 again to deactivate the alarm via the key switch, the Zone's sensors instantly detect the intrusion and activates a low-level 'warning' bleeper, but only activate the main siren if the owner fails to reset the alarm (via the key switch) by the end of the 45 second 'entry' delay period. Thus, the entry/exit delay facility gives the key holder reasonably freedom to move about the house without activating the main siren, but gives full protection against unwanted intruders who do not have a suitable key.

The Main Control Unit/Panel

The main control unit is the effective 'heart' of the burglar alarm system, and can be managed via a control panel. In simple units, the panel enables the unit's main functions to be selected via a 4-way master key switch (usually marked TEST, OFF, ON, and RESET). Most modern control units take the basic form shown in Figure 7 and are powered from the domestic AC power lines via a built-in DC PSU that also provides an auxiliary DC power output. The control unit should ideally also have a built-in rechargeable battery that is normally trickle-charged by the PSU but takes over the PSU's main functions if the AC supply fails or is deliberately interrupted.

Modern control units usually have a built-in medium-power siren, plus a facility for activating a high-power external siren; ideally, the external siren should (to minimise the chances of generating publicly annoying false alarms) not activate until at least 30 seconds after the built-in siren has activated, and must (to conform to local noise control regulations) turn off automatically after a maximum period of about 15 minutes. Most units also have a built-in 'tamper' switch that (except when the master key is set to the TEST or RESET positions) activates the built-in self-latching siren if the unit's case is opened.

The unit's control panel usually takes the basic form shown in Figure 7, but in practice often uses electronic keypad (rather than electro-mechanical) control switching. In this diagram, key-operated switch S1 selects the units main functions, and toggle switches S2 to S5 allow individual defence zones to be enabled or disabled. When S1 is set to the TEST position, the unit's tamper switch and the external alarm are disabled, and the internal alarm operates in the non-latching mode. When S1 is set to the ON positions, the system is fully active and the internal alarm operates in the self-latching mode. When S1 is set to OFF, all four sensor zones are disabled, but the self-latching PANIC facility is fully active. If the alarm is activated in the self-latching mode, the alarm can only be turned off by first removing the cause of activation and then unlatching the alarm by moving S1 to the RESET position.

In traditional hard-wired alarm systems, the sensors that connect to the alarm's various 'zone' input points usually take the effective forms of contact switches, which can easily be enabled or disabled by the S2 to S5 toggle switches shown in Figure 7. Figure 8 shows the connections for turning individual sections of the alarm sensor network on or off. Series-connected n.c. sensor networks can be enabled or disabled by wiring them in parallel with S2, as shown in Figure 8(a); the sensors are enabled when S2 is open, and are disabled when S2 is closed. Parallel-connected n.o. sensor networks can be enabled and disabled by wiring them in series with S2, as shown in Figure 8(b); the sensors are enabled when S1 is closed, and are disabled when S1 is open.

The External Siren/Alarm

The medium-power siren built into most modern control units usually drives an efficient piezo-electric output transducer and operates at a fairly high audio frequency (typically 1.5kHz to 4kHz): this type of siren floods the house with sound, but such sound attenuates rapidly with distance. Sirens designed for external use normally use an efficient horn-type loudspeaker as their output transducer and typically operate in the 800Hz to 1.2kHz audio range, which offers good long-distance acoustic coverage. Both types of siren normally generate an attention-grabbing multi-tone (pulsed, warbled, or swept) sound, rather than a tiresome monotone sound.

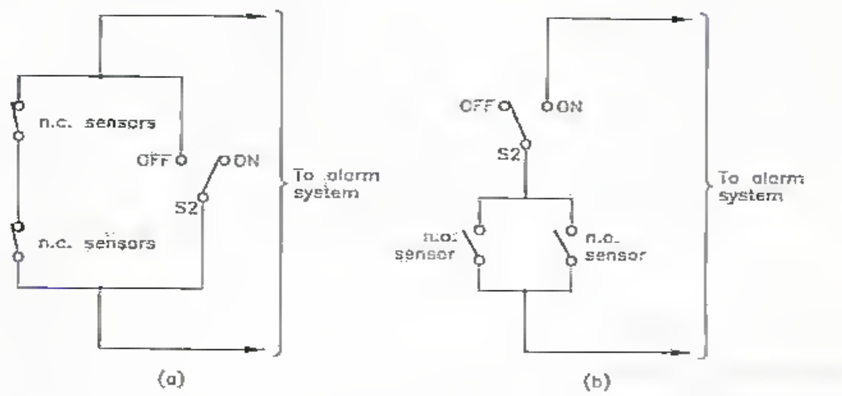
External sirens are usually enclosed in a weather-proof bell-type alarm box that is screwed to the house front; the box often incorporates a flashing alarm beacon that activates at the same time as the siren. Low-cost units of this type are usually powered, via a multi-cored cable, from the auxiliary power output terminals of the main control unit, and can be disabled by simply severing the power cable, which must thus be protected by burying it in brickwork, etc. High-quality external siren units, on the other hand, are self-powered and tamper proof, and should (to conform to current design standards) meet the following basic design specifications:-

1 The siren must be powered by an internal rechargeable battery that is automatically trickle charged in some way and has enough capacity to provide at least 4 hours of continuous alarm operation.

2 The unit must be designed so that the alarm is not triggered by a temporary failure in the trickle charging system, but will trigger if activated by the main control unit or if the unit's main feed cable is cut.

3 The box must incorporate tamper switches that automatically activate the alarm if the box's cover is removed, or if the complete

Figure 8. Method of enabling and disabling sensors switches via S2; (a) series-connected, n.c., (b) parallel-connected, n.o.



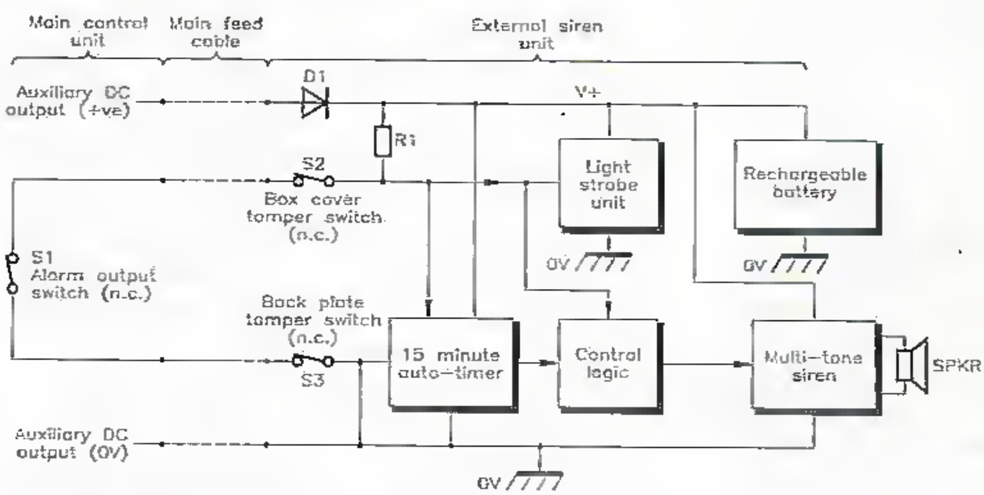


Figure 9. Block diagram of a high-quality external siren unit.

unit is forcibly removed from its fixing point (the wall).

4 The unit must incorporate a timing mechanism that automatically resets the siren (but not necessarily the beacon) after (typically) not more that 15 minutes of continuous operation.

Figure 9 shows the block diagram of a high-quality external siren unit that is powered by a built-in battery that is trickle charged via the control unit's auxiliary DC output terminals. This system is designed so that the control unit's 'alarm' output is connected to the siren unit's input via n.c. switch S1, which is loop-wired in series with the siren unit's two built-in n.c. tamper switches; one of these (S2) is connected to the unit's box cover and opens if the cover is removed; the other (S3) is connected to the unit's back plate and opens if the unit is pulled away from the wall. Thus, the siren activates if S1 opens, or if the main feed cable is cut, or if the box cover is removed, or if the unit's back plate is torn from the wall. If any of these conditions occur, the unit's built-in light strobe activates for the duration of the o.c. condition (or until the battery is exhausted), but the multi-tone siren (which is controlled by a 15-minute auto-timer and control logic) activates as soon as the o.c. condition occurs but resets again when the o.c. condition ends or – if the o.c. condition persists – after a maximum of 15-minutes.

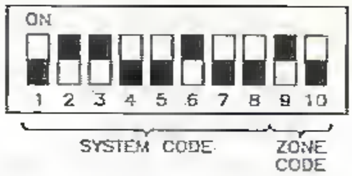


Figure 10. Block of ten miniature switches built into each wireless sensor used in a low-cost wireless burglar alarm, to match the sensor's Tx 'system' and 'zone' coding to that used in the control unit's wireless Rx section.

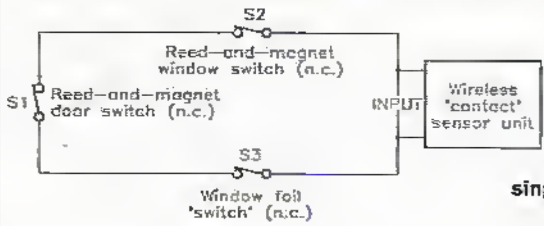


Figure 11. Example of three n.c. sensor switches loop-wired to the input of a single wireless 'contact' sensor unit.

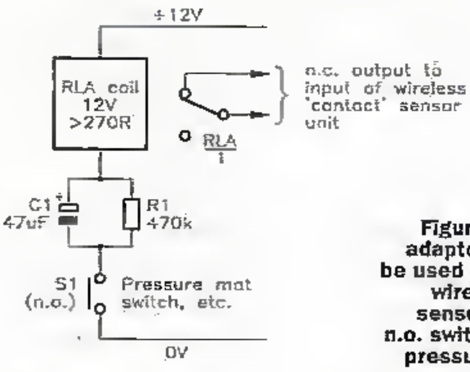


Figure 12. Simple adaptor circuit can be used to activate a wireless contact sensor unit via an n.o. switch such as a pressure mat type.

Wired versus wireless alarm systems

Modern commercial burglar alarm systems are usually microcontroller based, use a keypad type of control panel, and incorporate an event recorder that – if a break-in occurs – records the precise order in which the various defence zones are invaded. Such systems come in two basic types, being either 'wired' or 'wireless' systems. In wired systems, all zone sensors (PIR movement detectors, contact switches, etc.) are cable wired to the main control unit, which in turn is wired to the external siren unit; such units are time consuming and (since they use lots of interconnection cable) messy to install. In wireless systems, all major zone sensors incorporate a wireless Tx unit that communicates (via a coded 418MHz or 458MHz RF signal) with a matching wireless Rx unit that is built into the main control unit; the Tx unit signals to the Rx unit if an alarm, tamper, or low-battery condition occurs; such systems are very easy and clean to install, but are considerably more expensive that normal wired systems.

All domestic wireless systems are provided with a key-fob style Tx unit that can be used to remotely set or unset the main alarm unit and to act as a 'panic' switch that can remotely activate the alarm siren at any time. Sensor units such as contact and PIR transmitters are battery powered (usually by a PP3 type battery) and – in approved designs – give at least six month of continuous operation per battery charge. Such units are permanently active, can transmit pre-settable identification codes, have a built-in tamper switch that initiates a full alarm condition if the unit is illegally opened, have a low-voltage detector that warns of a failing battery condition, and incorporate sophisticated energy-saving circuitry that greatly extends battery life; PIR units, for example, transmit a brief alarm signal as soon as an intrusion is detected, but then automatically go into a (typically) 60 second shut-down mode before becoming active again; this technique conserves power when a defended area is in normal 'zone off' use, but gives an instant intrusion warning if the zone is alarm-active.

Domestic-type wireless alarm systems vary greatly in price and performance. The cheaper systems usually provide a total of 256 possible identification codes and only four sensor defence zones, to which the sensors can be individually matched by a built-in block of ten miniature switches arranged as shown in Figure 10. Here, switches 1 to 8 enable the sensor unit's 8-bit Tx 'system' code to be matched to that used by the system's RX unit (which can be pre-set by the owner), and switches 9 and 10 are used to allocate a 2-bit 'zone' number to the sensor. At the other end of the price scale, some systems offer 10- or 12-bit identification codes, and up to 16 defence zones (identified by a 4-bit 'zone' code).

Note that, in wireless systems, the main control unit identifies individual sensors purely by their zone codes. Thus, if a sensor in (say) Zone 3 transmits a low-battery-voltage warning, the unit's control panel will display the fact; if only one sensor carries the Zone 3 code, the owner can quickly identify this particular unit and change its battery, but if several sensors carry the same code the fault can only by traced by individually testing all of the Zone 3 sensor batteries.

Also note that wireless 'contact' sensors usually activate only when an n.c. input switch opens for a period of at least 200ms (this technique minimising the chances of false alarming due to transient switching or signal pick-up); such sensors can be used with any desired number of n.c. sensor switches (reed-and-magnet switches, window foil, etc.) that are loop wired in the basic manner shown in Figure 11; they can not be directly used with pressure mat switches, which are n.o. devices.

Figure 12 shows a simple relay-based adaptor circuit that can be used to activate a wireless contact sensor unit via a pressure mat switch or any other n.o. type of switch (or by any desired number of parallel-connected n.o. switches). Here, 12V relay RLA has a coil resistance of at least 270R, and has one set of change-over (c.o.) contacts that have their n.c. pins wired to the input of the wireless sensor unit. RLA's coil is wired in series with the 12V supply via mat switch S1 and the parallel C1-R1 combination. Normally, S1 is open, C1 is fully discharged, and the RLA/1 output contacts are closed. If S1 now closes, a heavy pulse of current flows through RLA coil via C1 and S1, thus opening the RLA/1 output contact and activating the wireless contact sensor unit. If S1 remains closed, the RLA current rapidly decays to a very low value (determined by R1) and (after a few hundred milliseconds) the RLA/1 contacts re-open; when S1 opens again, C1 slowly discharges via R1 until – after a delay of a minute or so – the system can again be reactivated by closing S1. This circuit thus draws zero quiescent current, and draws only a few microamps of mean current if S1 is closed for long periods.

Next month's installment of the series will describe some wireless alarm system categories and various types of intrusion sensor, and will present a variety of hard-wired build-it-yourself burglar alarm circuits.

Model Aircraft SPEED CONTROL

A high performance electronic speed control for sports and competition radio controlled model aircraft by Dr Mike Roberts.

This project is another demonstration of the incredible power of those ubiquitous PICs. I originally bought my 'PICSTART' kit with this project in mind. I was inspired by an earlier PIC based unit published in another magazine. This was a vast improvement on the servo amplifier based unit I was using at the time. However I felt there was still scope for improvement in the action taken on low battery voltage. On this other unit when the lowest safe voltage is reached it cut the power off completely. I prefer to have the power reduced gradually maintaining the battery at the safe level. This avoids surprises in the air and enables every last drop of power to be drained out of the battery. This latter feature being valuable both in sports and competition flying. The other change I wanted was to limit the rate of change of speed. This enables the unit to be used as a soft start. However the main reason for this approach was to limit the effect of bad signals/glitches. If a bad signal is received the maximum effect it can have here is to alter the speed by one unit of power (out of 32steps). This limit does not affect normal operation. With one step of change every input signal, at 50 steps a second, the 32 steps are achieved in 0.64 second. From the PIC programming viewpoint this project has presented the greatest challenge of all the projects I have tackled to date. It does however demonstrate the power of PICs to drive high frequency events. Here the PIC is driving the motor with a pulse width modulated power at a frequency of 1.8KHz. With 32 steps of power the PIC is timing the variable length of the pulses insteps of about 18µs. This is only 16 machine cycles! This is only possible with the Reduced Instruction Set Computer (RISC) structure of the PIC which enables one instruction to be implemented every machine cycle. Even with the simple elegance of the PIC language some careful thought and several attempts were required to fit the other functions around this high speed work.

PIC Programming

The PIC has several tasks to perform:

- Measure length of the PWM data from the receiver.
- Decide how many of 32 steps of power to apply to the motor.
- Turn the motor on and off at high frequency.
- Check the battery voltage.
- Start-up, arming and disarming functions.

Getting all this to fit together takes a little planning and organisation since the processor can, of course, only do one task at a time. Ideally one would drive each of the tasks from an appropriate interrupt, e.g.

- interrupt on change from input signal to measure pulse width using a timer.
- timer interrupt to control the motor on / off.
- timer interrupt to trigger the battery voltage check.

Unfortunately it is not possible to do this with the simpler PICs. Although several interrupts can be handled, they all trigger the same piece of

```
org  4     ;interrupt
     movwf      w_temp      ;copy w to w_temp
     swapf      STATUS,0    ;STATUS to w
     movwf      st_temp     ;STATUS to st_temp

     movf PORTB,1     ;read to self to end mismatch
     bcf  INTCON,0    ;clear interrupt flag

     swapf      st_temp,0 ;st_temp to w
     movwf      STATUS    ;back to STATUS
     swapf      w_temp,1  ;swap w_temp
     swapf      w_temp,0  ;restore w
     retfie           ;return from interrupt
```

Listing 1 Minimum Interrupt Routine (PORTB interrupt on change).

OPERATIONAL

- 32 proportional speed settings (appears to be continuous)
- High frequency for smooth running
- Limited rate of change of speed (soft start)
- Brake MOSFET for folding props
- BEC (battery eliminator circuit)
- 7-10 cell
- LED indication of brake, full power, and power level
- Minimum battery voltage set in 0.25V steps from 5.5V to 9.25V
- Case size 38 x 57 x 24mm

SAFETY

- Arming switch (also disarms)
- Audible tone from motor on initial arming
- Arming only effective at zero power setting
- Battery voltage checked >400 times a second and power reduced if below minimum.

PERFORMANCE

- High current/ very low 'ON' resistance (0.0012 ohm)
- Reduces (rather than cut) power when battery low

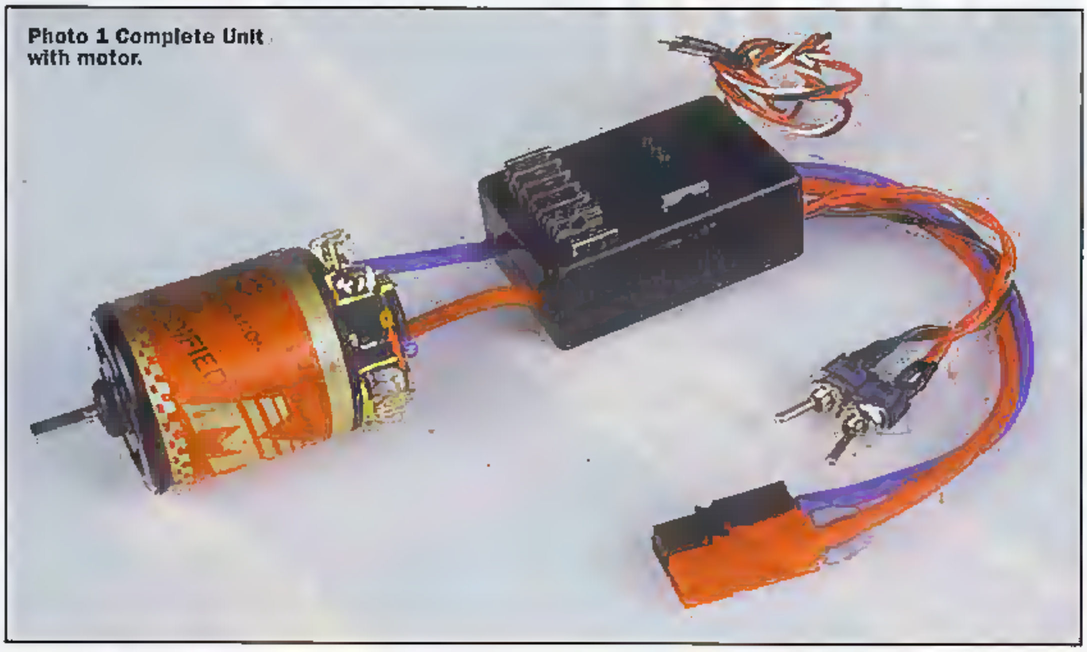


Photo 1 Complete Unit with motor.

code starting at location 0004. The code then has to determine which event triggered it. This adds extra instructions which makes the handling of more than one interrupt impractical with high speed work to perform. Here every instruction counts. Also the events above could use three separate timers. Unfortunately the simpler PICs only have one!

The PIC selected for this project is the PIC16C71-04. This has adequate input/output pins, can accept analogue input (for battery voltage), has 1 timer and interrupt handling capability.

The multiple functions required make life complicated. My earlier projects, Rugby Clock and Soldering Iron Controller (Electronics issues 113, 116) , only had a single task to perform. This was driven by a single piece of code triggered at a set frequency by an interrupt from the timer. In this speed controller, with several tasks being performed, it is almost certain that any 'interrupt' will, as its name suggests, interrupt some other activity. It is therefore important that the interrupt routine saves the contents of key registers (STATUS and W) and returns them to their original state before returning the processor to the task which was interrupted. This gives the interrupt routine a minimum of 14 machine cycles to save and return the 'W' and 'STATUS' registers, including call and return, before it has done any work! See Listing 1.

After a couple of attempts using different arrangements of the routines I concluded that the best programme organisation was to use one interrupt routine to handle the recording of the PWM input from the receiver and use a free running routine monitoring the timer to drive all the other tasks. There is some logic to this approach as it dedicates the interrupt capability to the one event outside the control of the controller. '20-20' hindsight is great isn't it!

The other restriction was 'there is only one timer'. Hence this timer is left free running to be read by all the timed functions and for measuring the length of the input signal. It was this latter requirement that led to the selection of the unusual resonator frequency of 3.58MHz.

I wanted to have 32 steps of power corresponding to input signals in the range 1.2 to 1.8ms. I did not use the whole 1.0 to 2.0ms range as about 0.1ms is lost at each end for the transmitter trimsetting and I wanted another 0.1ms at each stick extreme to give a clear 'full power' or 'brake'. With a 3.58MHz resonator the controller system clock operates at 3.584MHz which gives a machine cycle of 1.117μs. A 'divide by 16' timer then counts every 17.88μs and a count of 32 from the timer is 0.572ms. This is close to my target range of 0.6ms (1.2 to 1.8ms). So I used 68 timer counts (1.21ms) for 'brake on' and 100 timer counts (1.79ms) for full power and the 32 steps in between for my proportional levels of power.

The same timer has to drive the motor. Again 32 timer steps are used. The controller decides how many timer units of power should be applied in every 32

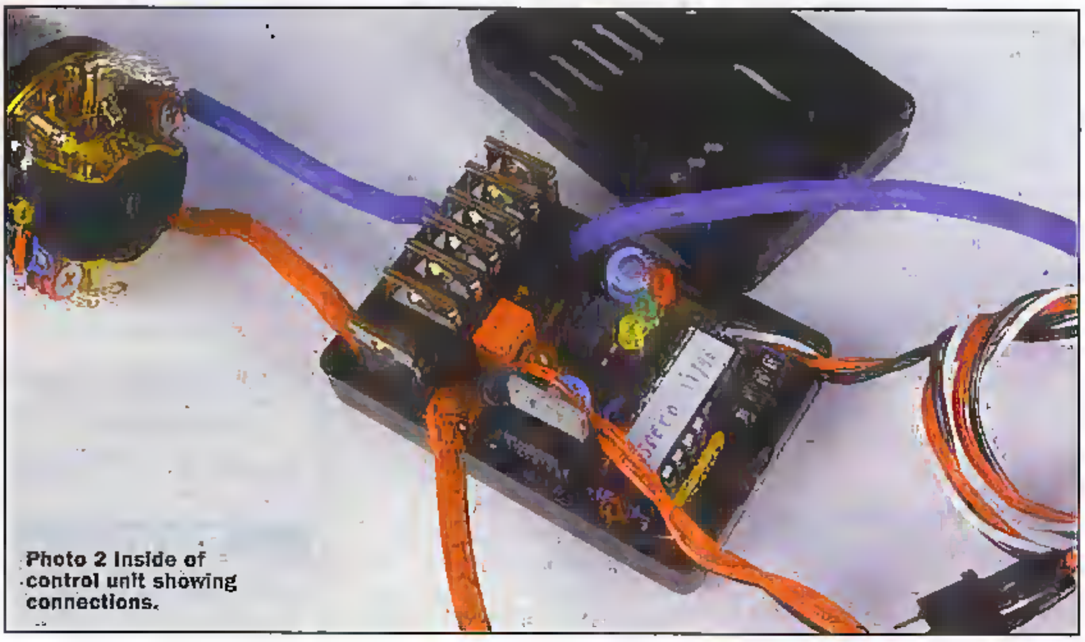


Photo 2 Inside of control unit showing connections.

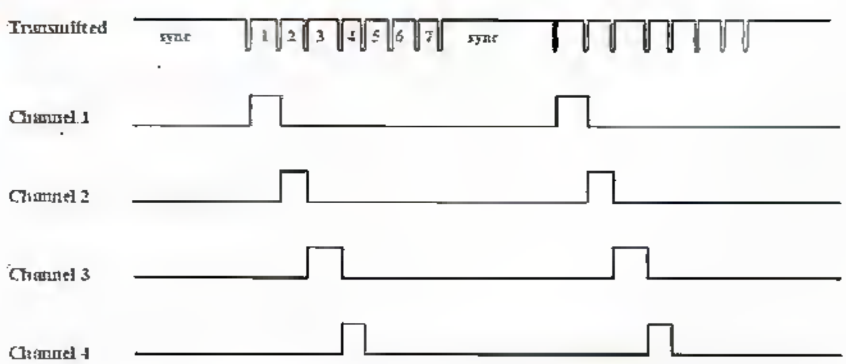


Figure 1. Radio Control Data Transmission.

timer counts. Since 32 timer counts takes 0.572ms this is why the output frequency is 1.8KHz (1 / 0.572ms). Keeping the logic simple like this helps minimise the number of instructions.

With the timer sorted out I could look at the interrupt routine to record the input pulse. Another breakthrough in developing the code was the decision to only have this routine record the start and finish times of the input pulse and leave the calculation of what power to apply until later. This kept the interrupt routine to the minimum number of instructions and then the calculation of the power level could be performed when a suitable slot in processor time becomes available. By having the programme checks the need for this calculation once every time power is applied to the motor this only involves a maximum delay of 0.572ms which I challenge anyone to notice.

The interrupt routine (Listing 2) takes 19 machine cycles including the call and the return. The code returning the 'W' and 'STATUS' registers is duplicated to avoid a 'GOTO' which would have added 2 more machine cycles of interruption. This is an example of trading off code efficiency against execution efficiency.

Unfortunately this routine is just long enough that it will occasionally occupy the processor for the whole of the 16 machine cycles that the timer holds one value. If one of the tasks (e.g. motor on or motor off) is waiting for this number it would be missed out. Hence the main operating routine must take this into account and look for a pair of values rather than just one for each task.

The logic flow diagram for the programme is shown in Figure 2. This does not show the interrupt routine as this is self explanatory from Listing 2. The section during initial arming where a sound is made in the motor was a later addition when I learned that some top of the range controllers had this feature. The sound is made by sending short(22µs) pulses of power to the motor at an audio frequency. This is enough to make a sound but not enough to turn the motor. The sound is a useful check that a good signal is being received. The audio frequency is adjusted as a function of the input signal pulse width. If the transmitter control is already at zero power the sound is only made for two thirds of a second while the controller checks for 32 valid pulses.

```
        org  4      ;interrupt
        movwf       w_temp     ;copy w to w_temp
        swapf       STATUS,0   ;STATUS to w
        movwf       st_temp    ;STATUS to st_temp

        movf PORTB,1     ;read to self to end mismatch
        bcf  INTCON,0    ;clear interrupt flag
        movf TMR0,0      ;TMR0 to w

        btfsc       PORTB,in  ;input low?
        goto ihigh

        movwf       p_end      ;store p_end
        bsf  c_flag,2   ;set do calc flag

        swapf       st_temp,0 ;st_temp to w
        movwf       STATUS     ;back to STATUS
        swapf       w_temp,1  ;swap w_temp
        swapf       w_temp,0  ;restore w
        retfie           ;return from interrupt

ihigh       movwf       p_start    ;store p_start

        swapf       st_temp,0 ;st_temp to w
        movwf       STATUS     ;back to STATUS
        swapf       w_temp,1  ;swap w_temp
        swapf       w_temp,0  ;restore w
        retfie           ;return from interrupt
```

Listing 2 Interrupt Routine to Record Input Pulse.

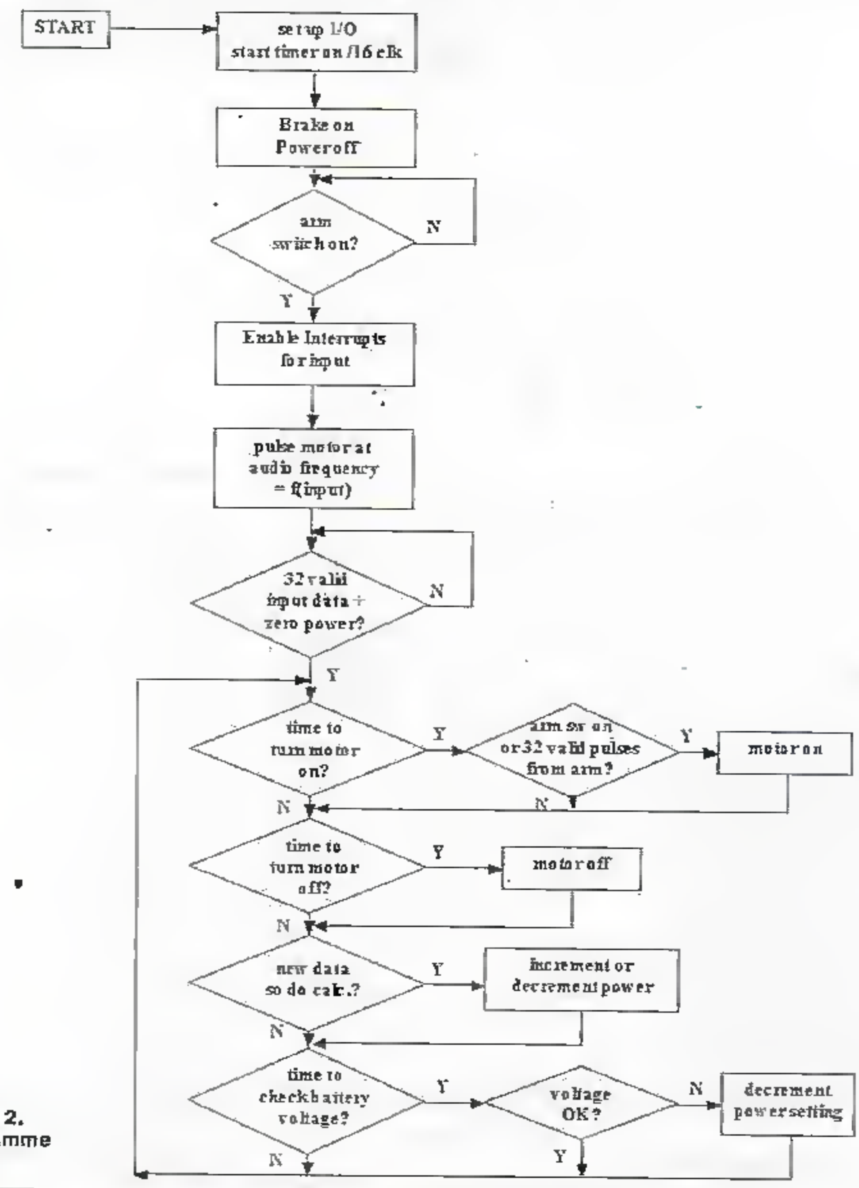


Figure 2. Programme Logic.

Circuit Description

This is simple as all the complication is kept within the PIC. The input signal is applied to PORT B bit 5 as this is can be set up for 'interrupt on change'. The arming switch is connected to PORT A bit 2. The battery voltage is measured by PORTA bit 1 which is set up for analogue input. PORT B bits 0-3 are connected to jumpers which set the minimum battery voltage. No pull-up resistors are required as 'weak pull-up' is set in software. Port B bit 6 drives the full power LED, bit 7 drives the main MOSFETs and the power LED, bit 4 drives the brake MOSFET and the brake LED. The output to the main

MOSFETs goes via one amplifier in the MOSFET driver (IC2). This can push bursts of up to 2A into the gates to ensure the fastest switching. It is powered via R8 either from the 5V regulated supply or the full battery supply. This was originally included so either 'logic' or conventional MOSFETs could be used. However I have only used the full battery voltage setting as it applies the maximum voltage to the gate. Even logic MOSFETs designed to be driven by 0-5V signals usually work better with a higher voltage (up to their maximum specification, typically 15V).

The output to the brake MOSFET also goes via an amplifier in IC2. I only did this for circuit board layout considerations. TR1 and its associated components simply reflect the signal to the positive power rail.

I put a fuse into the circuit, on the PCB, to avoid having a separate fuse to house. With care the fuse should never need changing! The 30A fuse wire is in a short length which handles 40A without blowing.

Selection of MOSFETs

The MOSFETs can easily make up half the cost. These are also the most critical components from the performance viewpoint. So you 'pays your money and takes your choice'. Needless to say both the cost and performance are continuing to improve with time. This design can use both conventional and 'logic' MOSFETs as the gate driver (IC2) can be configured to apply either 5 volts or the full battery voltage to the gate.

The current capability of TO220 MOSFETs is typically up to 60A continuous each (and 240-400A peak!) and hence is not a concern. The main specification of interest is the 'on' resistance. This has to be very low in order to keep the heat dissipation low enough to avoid the need for bulky heatsinks. Beware of the specifications of speed controllers. I dissected a controller described as a '60A' unit and found a single 60A, 9 mohm MOSFET which would overheat generating 3.6 watts at a mere 20A load. The controller described here has six 7 mohm MOSFETs in parallel and hence only generates a total of 0.47 watts at 20A (0.08 watts per MOSFET). It is still quite comfortable at 40A, generating 1.9 watts total (about 0.3 watts per MOSFET).

Figure 4 shows the characteristics of four MOSFETs I have considered. The lower turn on voltage of the 'logic' MOSFETs is apparent. However note that their specification 'on' resistance sometimes requires more than a 5 volt gate voltage! They can usually take gate voltages of up to 12-15 volts compared to 20 volts for typical conventional MOSFETs. Hence I have always configured the gate driver (IC2) to apply the full battery voltage. I would use the 5 volt option only if using more than 10 cells if this might exceed the maximum MOSFET gate voltage. (Note using the BEC above 10 cells is not advised unless an adequate heatsink is attached to the voltage regulator).

The resistances were measured at 5 Amps, equivalent to 30A load from the speed controller.

The MTP60N06 and STP60N06-16 MOSFETs are fine for 'SPEED 600' or milder applications. I have used the latter MOSFET for these duties for some time.

The SMP60N03-10L is used in many commercial units but is difficult to source. I have used these with a 'Volks Racing' pylon racer which has an initial

MOSFET	'on' resistance at 6 volts	Cost
STP60N05-16	20.4	£3.54
MTP60N06	15.4	£3.33
SMP60N03-10L	9.8	£6.15
IRL2203	7.0	£6.29

Table 1. MOSFET options.

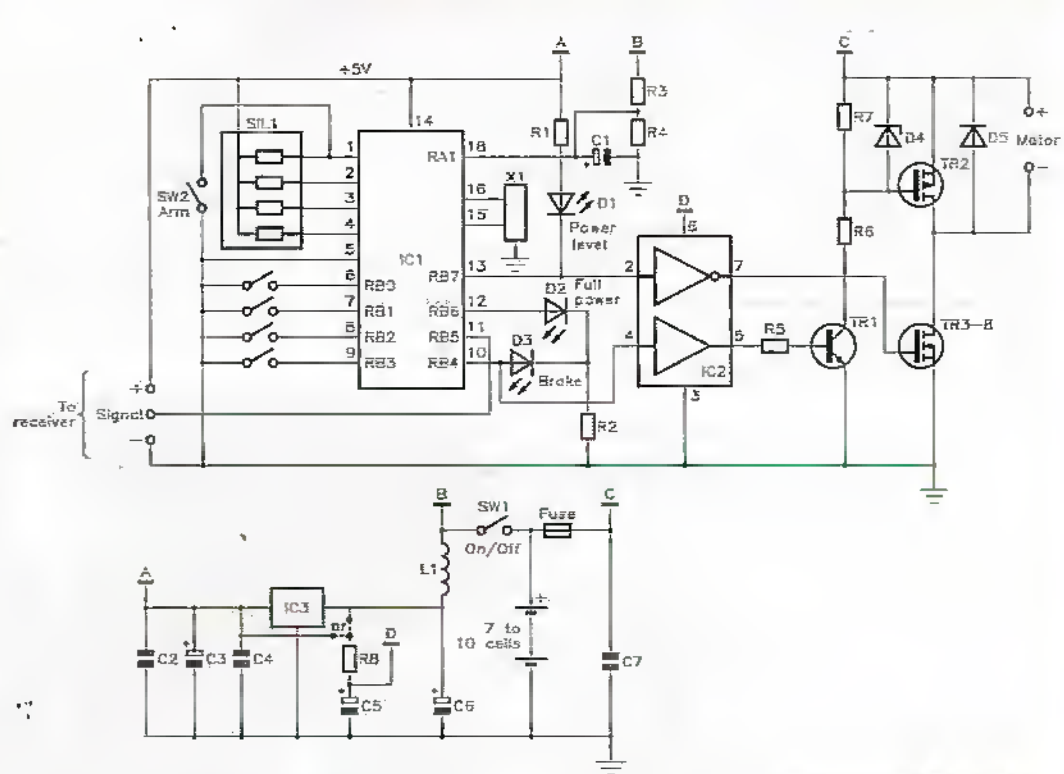


Figure 3. Circuit Diagram.

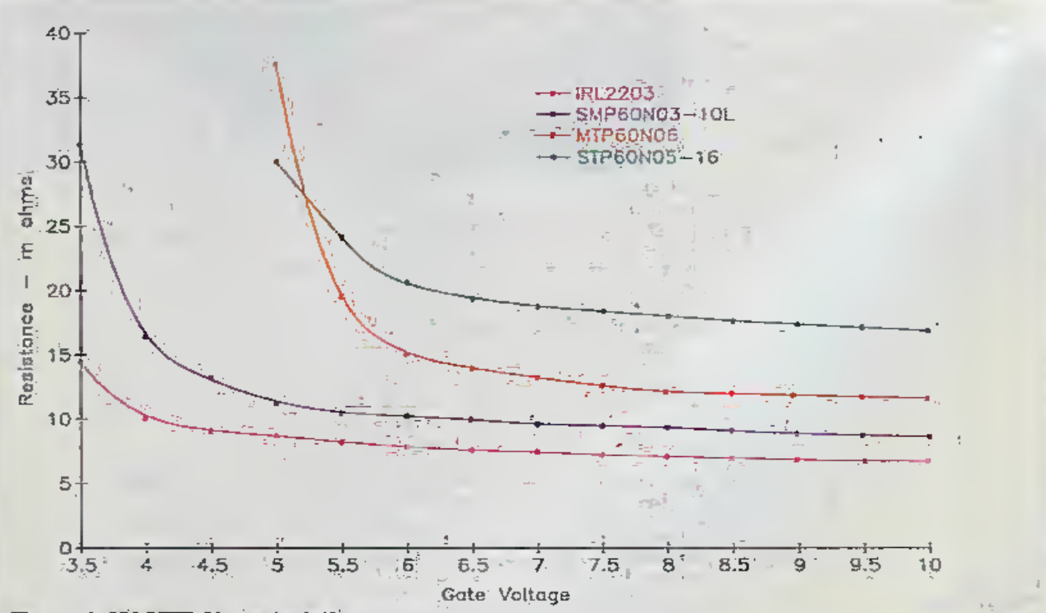


Figure 4. MOSFET Characteristics.

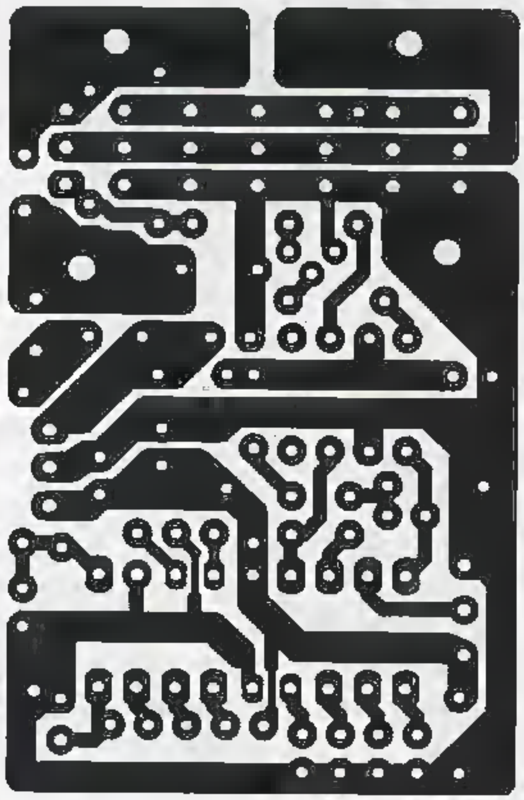


Figure 5a. PCB Foil (twice size).

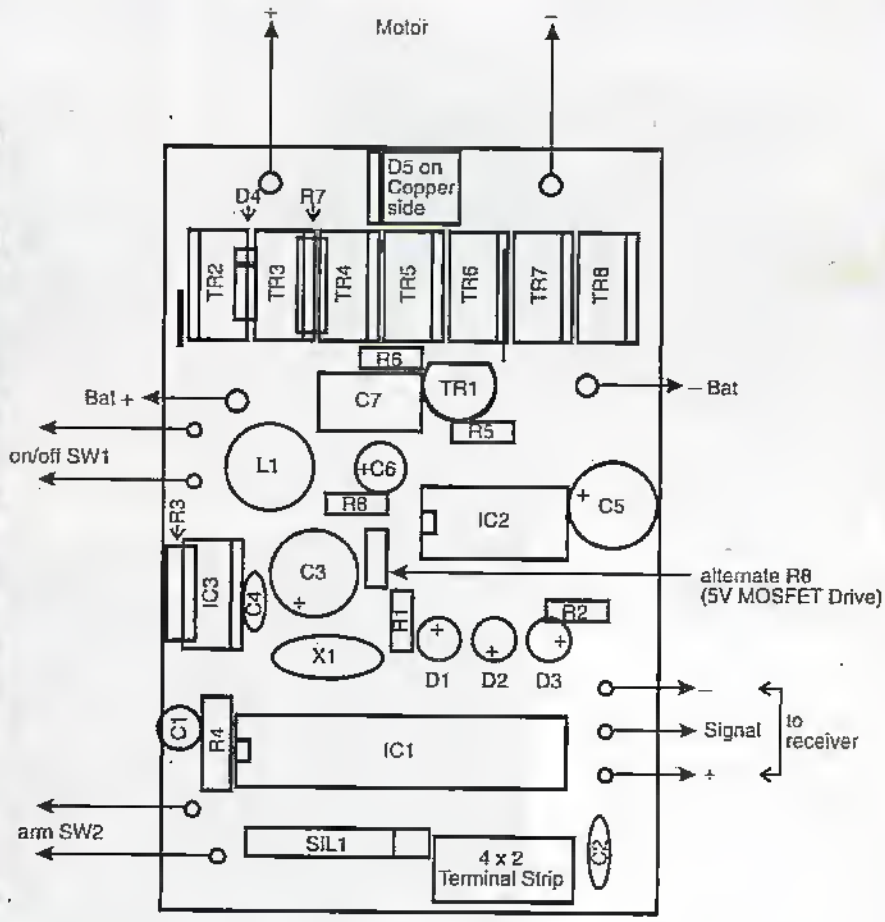


Figure 5b. Layout of Components on PCB (twice size).

current consumption of 40A.

The IRL2203 has better performance than all the above and recent pricing (plus a 20 volt maximum gate voltage) makes it the MOSFET of choice for higher power applications.

Construction

Initial construction is straight forward. I start with resistors, then the IC socket (IC1), then capacitors, IC2 (direct onto board). The fuse is simply a link using 30A fuse wire. Leave the LEDs until last, after the MOSFETs and Schottky diode (SMD device on the copper side). Note the wirelink, R7 and D4 which are fitted underneath the MOSFETs.

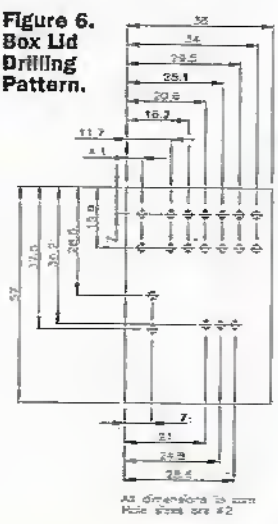
The MOSFETs are the most difficult part of the construction. The target is to fold the protruding part of the leads down onto the board to give a good path for the 40 amps or so that the speed control can comfortably handle.

Insert the 6 main MOSFETS and the voltage regulator. The latter helps set the board level when soldering. Check the MOSFETs are fully home and in line. First solder the voltage regulator IC3 and the gate pins of the MOSFETs (these are not folded over). Trim the soldered leads. Now fold the drain and source leads of the MOSFETs down onto the board, one at a time, starting furthest away from the brake MOSFET. Now fit the brake MOSFET. This sits about 3mm higher than the others. You can trim the sides of the thick part of leads so the brake MOSFET is at the same level.

I do this but it is not easy. I recommend using a high speed cut-off disc in a PCB drill. It is possible using a needle file. Try not to remove too much copper.

Now bend the protruding part of the leads of the brake MOSFET onto the board/other MOSFETleads. Check the leads are neat and tidy like a fallen row of dominoes. Solder the leads starting at one end and moving down the row, iron on one side, solder (use 22swg) on the other. Fill the gaps between the leads without feeding so much solder that you form a bridge to the adjoining row. Leave the board and MOSFETs to cool before attacking the second row.

Figure 6. Box Lid Drilling Pattern.



Drill the box before fitting the LEDs. Using Figure 6 as a template drill 3/32"/ 2.5mm holes. Join the pairs of holes for the MOSFET tabs. This is helped if you have a miniature drill and a 12mm circular saw blade (see Maplin codes JU91Y and JW18U). Open up the three LED holes to 3mm.

By positioning the circuit board in the top of the box you can set the appropriate height for the LEDs above the board. As a guide the bottom of the LEDs are about 12.5mm above the board.

Next fix the leads. This is another job requiring care. I prefer to use 1mm pins for the switches and receiver leads but you can fit them directly onto the PCB. Start with the leads to the power switch. It helps if you can squeeze one lead round each side of the inductor on their way to the PCB. This makes the location of the high current cables easier. Next connect the arming switch leads and the receiver lead. At this

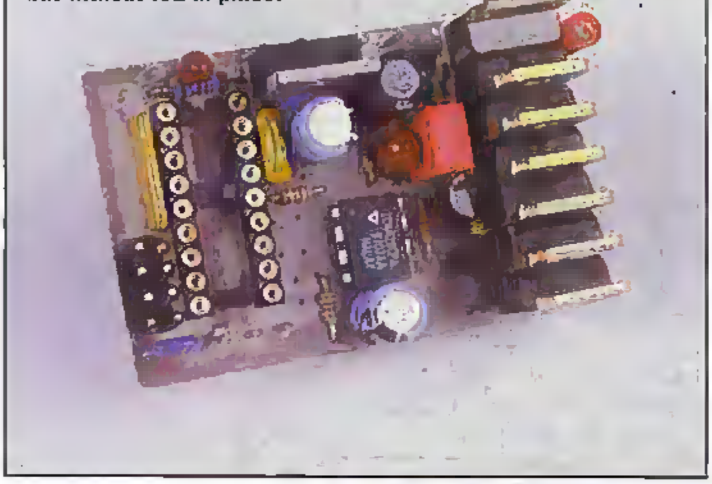


Photo 3a. PCB with components but without IC1 in place.

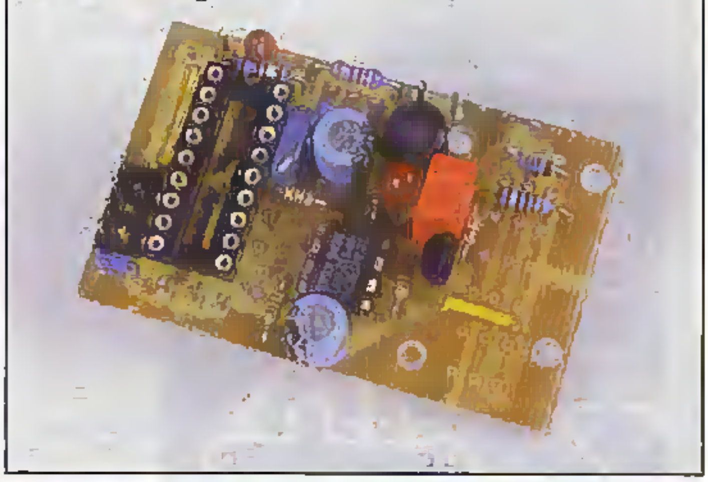


Photo 3b. PCB with components but before fitting MOSFETs.

point it is a good idea to make a couple of ⅛"/4mm holes in the case halves, close to the sides of the case. Check it all goes together OK. Lastly solder in the high current cables. In each case trim 2mm of insulation from the end of the wire. Then push the end through the hole in the PCB so about 1.5mm is protruding on the copper side. Now fan out the strands onto the copper so it looks like a chimney brush. Make sure there are no stray strands on either side of the board before soldering in place. Use plenty of solder to make a good connection to the high current tracks. I recommend keeping the leads to the motor as short as possible (say 40-50mm).

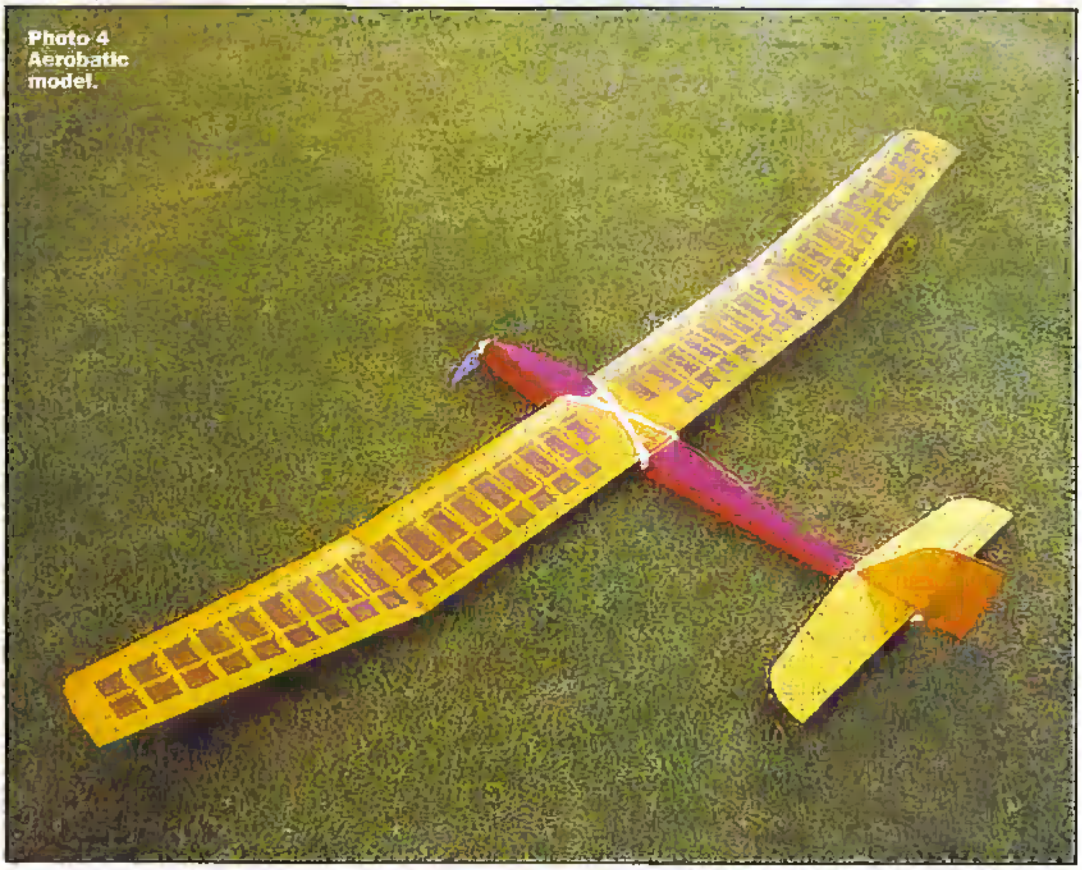


Photo 4 Aerobatic model.

Installation

I try to keep the receiver as far away as possible from the high current switching activity. Hence I keep the leads from the controller to the motor as short as possible and install the receiver as far back as possible, usually behind the main wing.

Operation

First set the minimum battery voltage. The jumpers on RB0-3 are read as a binary number. The minimum voltage is set as 5.5 + 0.25 x n volts. A jumper present is a read as logic '0'. So the jumper settings are shown in table 2.

Given the huge current capability of the NiCad batteries used for model power, the first operation of the controller should be via a laboratory power supply. A 5A supply is enough to test the controller with lower current motors (e.g. 27 wind) if they have no load and are given a hand with an initial spin. Alternatively find a motor of the same voltage rating and lower current consumption. Also note that higher power motors should not be run at full power with no load. The controller consumes 8-25mA without a motor or receiver attached. The higher figure relates to the disarmed condition with the brake LED and MOSFET on.

With a successful lab test the speed control can be operated from a NiCad Battery.

The normal sequence of operation is:

- Check arm switch off (open circuit).
- With the transmitter operating turn the controller power on. The brake LED (only) should be on.
- After checking the area around the propeller clear, switch on the arm switch. The brake LED will go off if the transmitter is not at zero power. A sound will be heard from the motor. If the transmitter stick was not at zero power the sound will continue and respond in pitch to the stick position. The pitch will increase as the

Voltage	RB0	RB1	RB2	RB3
5.5	yes	yes	yes	yes
5.75	no	yes	yes	yes
6.0	yes	no	yes	yes
6.25	no	no	yes	yes
6.5	yes	yes	no	yes
6.75	no	yes	no	yes
7.0	yes	no	no	yes
7.25	no	no	no	yes
7.5	yes	yes	yes	no
7.75	no	yes	yes	no
8.0	yes	no	yes	no
8.25	no	no	yes	no
8.5	yes	yes	no	no
8.75	no	yes	no	no
9.0	yes	no	no	no
9.25	no	no	no	no

Table 2.

power signal is increased. The full power LED will come on when this setting is reached. When a zero power signal and 32 continuous valid signals have been received the brake LED will go on and the sound will stop. It is now ready to run.

- Slowly move the transmitter stick. The motor will run in proportion to the setting. The power LED will get brighter as the power increases and the full power LED will come on when full power is reached.
- The motor can be stopped at any time by switching off the arm switch. Check the temperature of the voltage regulator IC3 with the servos in full operation. If it gets too hot either fit a heatsink or remove it and use a separate supply for the receiver and servos.

Photo 5. Aerobatic model.

The models shown in the photos are a Balsa Cabin 'Sonata E' using a Speed 600 motor driving a 8.5" by 4.5" propeller and this speed controller using STP60N06-16 MOSFETs, and an own design aerobatic model using a Maplin MRI 19 triple wind motor (GZ22Y) driving a 6" by 6" propeller and this speed controller using IRL2203 MOSFETs. Both use 7 cell 1700/2000 battery packs.

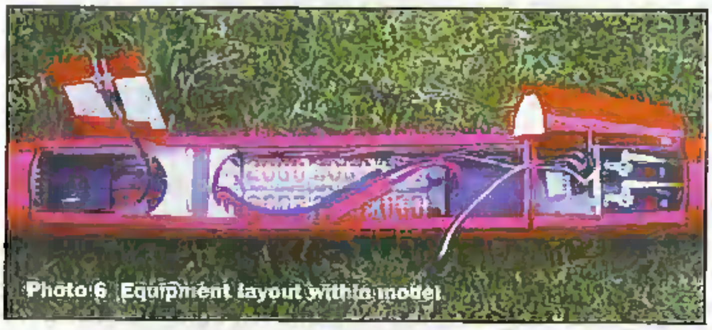


Photo 6. Equipment layout within model.

OVERVIEW OF RADIO CONTROL DATA TRANSMISSION

Model radio control systems use a 'Pulse Width Modulation' (PWM) system to encode the position of the control sticks on the transmitter. Generally a stick mid position is represented by a pulse of 1.5ms. The full range of stick movement and trims gives pulse widths in the range of 1.0 to 2.0ms.

The transmitter sends pulses for each of the typically 7 channels in turn followed by a uniquely long synchronisation pulse of 6 to 8ms (see Figure 1). This sequence is repeated continually and hence sends a set of data approximately every 20ms, i.e. 50 times a second.

These pulses are received by the receiver, decoded and sent to the appropriate pin for each channel/servo. The servos (or speed controller here) receive a pulse of length 1.0 to 2.0ms every 20ms and continually strive to achieve a position (or speed setting) proportional to the pulse width.

Many systems use amplitude or frequency modulation of the transmitter carrier signal (27 or 35 or 40MHz). Modern sets are now using Pulse Code Modulation (PCM) where the stick positions are sent as digital codes. The receiver decodes this digital information but still sends the same type of pulse width modulated signal to the servos.

PROJECT PARTS LIST

RESISTORS			
R1,2	1k5	2	U1K5
R3	8k2	1	M8k2
R4	3k9	1	M3K9
R5	10k	1	U10K
R6	330	1	U330R
R7	4k7	1	M4K7
R8	100	1	U100R
SIL1	10k	1	★
CAPACITORS			
C1	1.0uF 35v	1	WW60Q
C2	470nF 50v	1	RA52G
C3,5	100uF 16v	2	VH13P
C4	220nF 100v	1	RA50E
C6	22μF 16v	1	WW72P
C7	0.47μF 50v	1	CX02C
SEMICONDUCTORS			
D1	LED yellow	1	CJ57M
D2	LED green	1	CJ56L
D3	LED red	1	CJ55K
D4	BZY88C4V7	1	QH06G
D5	30BQ040 or SS34	1	★
IC1	pre-programmed PIC	1	★
IC2	TC4428	1	★
IC3	LM2940CT5	1	AV22Y
TR1	2N3904	1	QR40T
TR2	2SJ174	1	★
TR3-8	MOSFET see text	6	★
MISCELLANEOUS			
X1	3.58MHz resonator	1	★
L1	1.5A 10μH choke	1	AH26D
	IC socket	1	FJ66W
	DIL strip	1	JW62S
	Pin jumpers	4	UL71N
	1mm terminal pins	6	FL248 (100)
BOX 1*			
SW1,2	Sub/Ultra-Min Toggle	2	FH00A or FH97F
	PCB	1	see text
	10AWG Silicon flexible wire	★	
	Heat Resisting wire – black	1	BA43W
	Heat Resisting wire – red	1	XR32K
	30A fuse wire	1	HB51F
	Servo lead	1	model shops
	Battery	1	see Maplin Catalogue
	Battery connectors	1	to suit battery

Printed Circuit Board, Programmed PIC, ★ parts

A PCB and Programmed PIC plus non-Maplin parts are available from the author. Please send SAE for details to:

Dr M P Roberts, 4 Thames Avenue, Guisborough, Cleveland, TS14 8AD

Radio COMMUNICATION PRODUCTS

PART 3

Frequency counters and test equipment in Opto-electronics

by Harry Watkins

This month I thought I would give you an insight into the fascinating range of Optoelectronics products. As frequency counters and related products are not always fully understood by the newcomer to the hobby I think they need some explaining.

With a receiver it is possible to tune into any frequency within its range and monitor the signals. That's all very well if we know where the signals are, but what do we do if we have no idea where to look? Some frequency guides are available (Maplin Order Code WT70M The Complete Guide to the VHF/UHF and WT73Q Short Wave International Frequency Handbook.)

JM38R - Optoelectronics 'CUB' Frequency Counter.

But if the frequency is not known you may think the only alternative is to search the bands and hope. Enter the frequency counter a useful hand-held device that is able to lock on to a local radio signal and display its exact frequency on a digital display.

Frequency counters are referred to as 'nearfield' devices and I think I should explain this term. Nearfield is a term to describe the area in the immediate vicinity of a transmitter and a nearfield device is one that is designed to work in such an area. As you approach a transmitter, the observed signal strength increases to a point where its amplitude becomes greater than any other signal sources. At this point you are in the nearfield of the transmitter and a frequency counter is able to read out the frequency.

The Optoelectronics 'CUB' (Order Code JM38R priced at £139.95) is a relatively simple frequency counter. It covers 1MHz to 2.8GHz and quite simply If you are standing near a transmitter within that range then as soon as a person starts transmitting the frequency that he is using will appear on the 9 digit LCD display. It is then possible to tune your scanner or receiver to that frequency and be able to listen to the transmission. The unit is supplied with built-in nicads (which last up to ten hours after a full charge) a charger and an aerial (BNC). Its usual receive range is about 60m. It has one memory, a battery low indicator and has range and filter switches plus 4 gate times to increase the accuracy.

JM39N Optoelectronics 'M1' Frequency Counter.


NV90X Optoelectronics Micro Frequency Counter.


NV89X Optoelectronics Micro Frequency Counter.

There are other uses for frequency counters. These include using them as digital displays for old analogue type radios and as test instruments for transmitters able to tell you exactly what frequency you are transmitting on.

The Optoelectronics 'M1' frequency counter (Maplin Order Code JM39N) which sells for £239.95 is a similar unit but with higher specification and extra features. The frequency range is 20Hz to 2.8GHz. It comes with built-in nicad pack giving up to 5 hours use, a charger and 50 Ohm aerial. Also included are 3 memories, back light, a 10 digit LCD, 50 Ohm and 1 M Ohm inputs and a serial data output port for data logging on a PC with optional RS232 converter and software (OPTOLINX order code NV98G which sells for £129.95) The M1 also has an RF signal bargraph, this gives you an indication of how strong the signal is and also by walking about you can see which direction the signal is coming from. It is not unknown for people to also use these items for the detection of bugs, that is the electronic kind! This type of practice is more common than you may first think.

A new product from Optoelectronics, and now available from Maplin, is the 'Micro Counter' (Maplin Order Code NV90X) which sells for £99.95. This is a frequency counter which is built into a case the size of a pager complete with belt clip. It runs off 1 x AA cell (Supplied) which gives up to 8 hours use. The unit has a built-in aerial, although in tests I found that its range increased when I used the optional antenna (model number TMC-100). The aerial socket is 50Ohm via a 2.5mm mono jack plug. It has a 12 digit LCD display, the frequency range is 10MHz-1.2GHz, has three memories, and three selectable gate times.

Another new product from Optoelectronics is the 'Micro DTMF decoder' which is also available from Maplin (order code NV89W) and sells for £89.95. It is housed in a case the size of a pager complete with a belt clip and has a 12 digit LCD display. It runs from an internal AA cell (supplied) giving up to 200 hours use. There is a maximum 2000 character memory. The unit has an internal microphone or audio can be connected directly via built in 3.5mm mono jack plug.

Digital Tone Modulated Frequency (DTMF) comprises a series of audible tones identical in sound to those we often hear when using our normal telephones. These tones are sent at the beginning of each transmission and are used for selective calling purposes. If you can imagine a group of people all on the same frequency then instead of all of them receiving the transmission, setting a different DTMF tone will result in the message only being heard by the people you want it to be heard by.

The Optoelectronics 'SCOUT' (Maplin code YE57M) which sells for £349.95 is a very advanced frequency counter. It can differentiate between random noise and coherent RF transmissions. It covers 10MHz to 1.4GHz. It comes complete with built in nicad pack giving up to 8 hours use, a charger, a 50 Ohm aerial and a belt clip. It has a 10 digit LCD display. This device has no less than 400 memories and can be left unattended to download frequencies automatically. There is a back light for night operation and a built in pager style vibrator to alert you when frequencies are recorded. It also has a distinctive double beep that informs you when a new frequency is found and a single beep indicating that a previously recorded frequency has been hit again. A 16 section bargraph is on the LCD front panel display which provides a real time relative indication of RF signal strength. The optional PC interface 'OPTOLINX' permits down loading of stored information on a PC.

Code NV97 Optoelectronics R-11 Test Receiver.

The Scout comes with a 3.5" PC disc which includes a program to log stored frequencies from the Scout to a file on disc and a demonstration copy of a control programme for scanners which can be used in conjunction with the Scout.

The 'SCOUT' can automatically tune the Optoelectronics R11 (Maplin Order Code NV97F), the AOR AR-8000 (RU98G) and Icom's IC-R10 (NV35Q) and R-8500 (NV36P) when connected to one of these receivers. The Scout captures a frequency and then tunes the receiver to that frequency simultaneously. So no more manual tuning of a receiver, let the Scout do it for you. You can even scroll back through the Scouts memories to tune the receiver with memory tuning.

The Optoelectronics 'R-11' nearfield test receiver (order code NV97F) which sells for £369.95 is Optoelectronics latest product. It comes complete with built-in nicad pack (which should give at least four hours use) charger and telescopic whip aerial. Unlike the rest of the range this is a self-tuning receiver covering 30MHz to 2GHz in the FM mode. It is not a single frequency radio receiver in the conventional sense, or a high speed scanner, for it sweeps the entire frequency range in less than 1 second! It can lock onto a 4 Watt UHF signal as far away as 500 feet and demodulate the signal through its built-in speaker, and display the general band the frequency is transmitting in on its LED indicator. There is a socket on the unit for an ear-piece and a data socket.

Frequency lockout, giving the user the capability to manually lockout up to 1000 unwanted signals, this ensures the unit can be programmed to receive only wanted signals. Also there are volume and squelch knobs on this easy-to-use item.

The Optoelectronics 'XPLORER' (Order code KN04E) which sells for £799.95 is the most fascinating of the whole

YE57M Optoelectronics 'Scout' Frequency Counter.

NV98G Optoelectronics 'Optolinx'.

Optoelectronics range. It is a unique near field test receiver with FM demodulator, FM deviation readout, tone decoder, frequency counter and PC interface all in the one unit. Another unique feature is that you can interface it with any Global Positioning System (GPS) receiver that is compatible with National Marine Electronics Association (NMEA)-0183 standard. This will store your current position in longitude and latitude on the Xplorer at the time you captured and stored a frequency.

It is supplied with a built-in nicad pack giving 5-6 hours use, a 100-240 Volt power supply/charger, telescopic whip aerial and a lead terminating in a 9 pin socket to connect the unit to a computer. It has a serial data interface with RS-232C levels. It also comes with a 3.5" PC disc which includes a program to log stored frequencies from the Xplorer to a file on disc and a demonstration copy of a control programme for scanners which can be used in conjunction with the Xplorer.

A real-time clock/calendar is built-in with battery back up. Frequencies can be locked out of the sweep range and there is also a manual skip and automatic or manual hold capability. A rotary encoder is used to easily select the menu when setting up the unit.

Its frequency range is 30MHz to 2GHz and is able to lock on to any FM signal within its range in under a second and demodulate the audio via its built-in speaker. An earphone socket is included for personal listening. There is a two line character LCD display, the top line shows the frequency of the signal being received and the second line can display either the sub audible tone if one is present, such as (CTCSS, DCS or DTMF) or relative signal strength or FM deviation. There are 500 memories for recording frequencies and these can include such information as time, date, latitude, longitude, signal strength, CTCSS, DCS, DTMF and deviation. A back light is incorporated for night time use.

The Optoelectronics 'OPTOLINX' universal interface (Order code NV98G) which sells for £129.95, in its basic form allows communication between a PC and a radio. It adapts for use with a wide variety or receivers, decoders, frequency counters and frequency recorders via an RS-232C personal computer serial port in a star network configuration. It requires power from an external 9-12 VDC supply. The distinguishing feature of the Optolinx is its unique ability to connect both full and half duplex devices and alternate them under software control which allows for multiple radio computer controlled operation. The unit is supplied with a 9-pin plug to 9-pin socket computer lead, a 3.5mm mono jack plug to plug CI-5 data lead (3.5mm to 2.5mm adapter included for the Scout) and a 7-way flexible data cable to connect with the AOR AR-8000 receiver. A 3.5" disc is included which has 5 programs. These include OPTOSCAN 456 test software, OPTOSCAN 535 test software, Radio manager for windows radio control software, utility to download captured frequencies from a Scout and utility to download frequencies from an Xplorer.

As if by magic...

Everyone's a Web designer these days it seems. Give someone some Web space — which most Internet or online service providers do free with an account — and they'll fill it with Web pages for the rest of the world to access.

But not everyone can create Web pages decently. There's more to doing the job than it seems and, certainly, to do it well requires a little bit of expertise in either the use of hypertext markup language (HTML) programming, or using a new what-you-see-is-what-you-get (WYSIWYG) HTML editing application like PageMill or HoTMetaL Pro to make the programming easier. Either way, creating Web pages is not a simple one-step job, simply because a not-so-simple two-step intermediary stage is necessary to turn your ideas into hard HTML coded documents.

Till now, that is. Several tools are popping up that allow you to create HTML pages directly from within the more ordinary programs that everyone is familiar with, like word processors and drawing packages. Some of these are aligned with one particular program. For example, Adobe Acrobat is a common program used to create documents that can be exchanged with, viewed on, and printed from any computer, whatever the platform (Windows, MacOS, Unix) anywhere in the world. It does this by allowing documents to be created in the portable digital format (PDF). Then, with the use of the free Acrobat Reader utility, any other computer can open the document. There are two parts to the beauty of Acrobat. First is just this document portability of course — it doesn't matter who makes a PDF document, or on what computer it's made on, any other computer will be able to open and use it. Second, though, and every bit as important, is the fact that whatever style is used to create the original document, whatever fonts, whatever artwork and so on, it's all stored within the document. The reading computer views the document exactly as its originator intended, without the requirement of having the same fonts or artwork or styles on the computer, and what's more the document can be printed too, and will look exactly as the original's printed form.

As a result, you'll see links to download Acrobat PDF documents regularly around the Internet. All you need is the Adobe Acrobat Reader for the computer platform you use (available for free download from the Adobe Web site) and you can download and use them too.

Another way of viewing PDF documents is with a PDF Plug-in for your Web browser. Once installed in your Web browser, following a link to a PDF document will let you view the document directly within a broser window. You don't actually need to download the whole document if you don't want it all, as you can then just view the pages you want to view. This has benefits for people who create PDF documents of course, simply because it means they can create a PDF document and use it as a quasi-Web page — with the drawback that for other users to access it as a quasi-Web page the plug-in must be installed in their browsers.

Another way to create Web pages (real ones this time, not quasi ones) from PDF documents is to use a couple of new plug-ins for the program (Acrobat Exchange) that creates the PDF document in the first place. Genus HTML and Genus Photo are available from Iceni Technology <http://www.iceni.com> and provide a fairly simple means of creating HTML documents from PDF documents. Genus HTML is the plug-in that creates the actual HTML document, and it allows the user to insert links to graphic images. It works by checking through the PDF document, to define headings, body text, indented paragraphs and so on according to the HTML standard formats, as well as adding page numbers and the document's name. Genus Photo, on the other hand, allows the Web page graphic images themselves to be extracted from the images in the PDF document itself. The result is an HTML document complete with all linked graphic images, ready for viewing with a Web browser and upload to a Web site.

Plug-ins like the Genus ones are available for other programs, too. There are several available for word processors, and quite a few for design and layout programs. However, the principle can be extended significantly. Plug-ins like these work with just the program they plug-in to. What about something (call it a plug-in if you want) that operates right across the operating system and allows any program to export whatever file as an HTML document? Lucky Mac users have Myrmidon which does just that!

Currently just released as version 2, Myrmidon is effectively a printer driver that operates right across any program running on a Mac so that, instead of providing output to a printer, a program provides output in the form of an HTML document, complete with linked graphics. It's a clever method and works well. Best though is the way it attempts to recreate elements visually, so that the HTML document it produces displays in a Web browser as closely as possible to the original format.

Chelsea FC's Virtual Megastore Scores Online

Chelsea FC has opened the doors of its online MegaStore at www.chelseafc.co.uk. Chelsea supporters, from all over the globe, can purchase official merchandise from the MegaStore twenty-four hours, seven days a week.

The MegaStore is claimed to be the first online football stores in the world. Until now fans could only buy goods through Chelsea's MegaStore at Stamford Bridge or by mail order. But now supporters worldwide are guaranteed a wide range of official Chelsea FC merchandise which can be bought quickly and securely from the comfort of their home or office.

Doing the Rounds

Graduates get a helping hand to find employment at `www.milkround.com`, designed to ease the arduous path to the right career. The site gives advice on constructing the perfect CV, and how to present letters to give the right impression. By clicking on a particular profession field, such as engineering, a user can access a database of more than 350 companies.

Students can also submit their details to the CV database, which employers peruse for likely candidates, and can subscribe to a new job-mailing list that saves them from the strain of logging on to the Web site.

Apple Builds-to-Order Over the Web

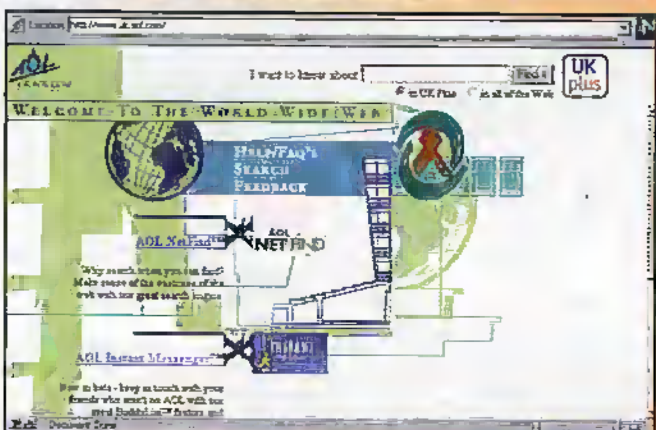
As part of its efforts to re-establish itself as a force within desktop computing, Apple has announced that it intends build and sell its computers in a new and different way.

The company has launched the Apple Store at **www.apple.com** as part of its new distribution strategy that utilises the Internet, along with the company's existing retailers and resellers to sell products.

The Apple Store has been built using WebObjects, the technology developed by Next Software, the company founded by Apple founder and interim CEO, Steve Jobs and acquired by Apple in January. Curiously enough, the same software also powers Dell's online store.

Shopping at the Apple Store is remarkably easy and once a customer order has been placed, Apple will send a confirmation email. In-stock products can arrive as quickly as two business days. Build-to-order products will ship about two weeks after order is processed.

Internet Population to Hit 100 Million in 1998



Similar to a baby boom, a Web boom is on its way this year with the advent of less expensive means for getting online such as set-top boxes, according to a study released today by research firm International Data Corporation (IDC) at **www.idc.com**.

The study predicts that the Web population will reach close to 100 million, fuelling a boom in e-commerce to more than $20 billion. The cause for all this explosive growth will stem from the introduction of more types of less expensive and less technologically complicated appliances for getting on the Internet, including TV set-top boxes, Web-enabled TVs and Personal Digital Assistants (PDAs).

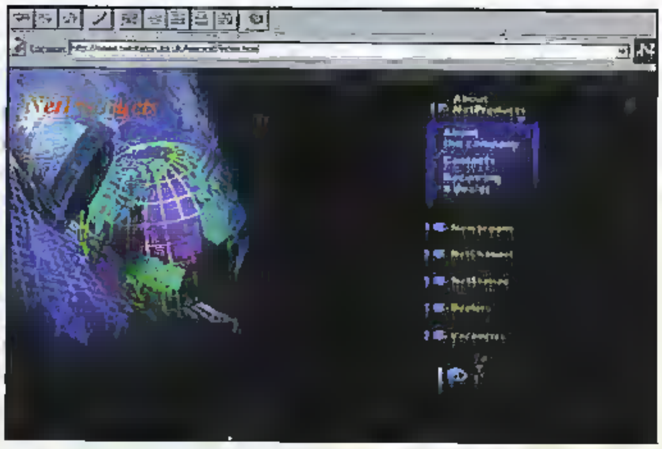
Summarise and Survive

The news from BT Labs under this heading last month misquoted the URL. It should be as follows (transend without a 'c')
www.transend.labs.bt.com.

Companies Count On Quick Payoffs With E-Commerce

A new study by CMP Research at www.cmp.com and Sage Research predicts that electronic commerce among large and mid-size companies will grow more than 50 per cent in the next year, with 64 per cent of the current and future users anticipating recouping their investments within a year. Only about 18 per cent expect to lose money in their electronic ventures.

Stand By For A New Box



The much hyped Internet set-top box has arrived in the UK. If you've ever wanted to surf the Internet without the technical hassles normally associated with home computers then look no further than the NetStation at **www.netstation.co.uk**, an Internet set-top box developed by UK start-up NetProducts.

Installation is very straightforward: there's only a main's lead and a couple of other leads to connect – one goes into the SCART socket on the back of the TV, and the other to the telephone. Once the preliminary log-on procedures have been completed you're ready to send and receive e-mail and surf the Internet.

Navigation around cyber space is achieved using an infrared remote control to control where you want to go and what you want to see. This can be a pain to use, so the option of a cordless QWERTY keyboard is welcome to existing users.

A smartcard system provides full password access to the digital world, preventing younger members of the family from accessing unsuitable material.

NetStation costs around £300, plus, of course, your phone bills and Internet access. For details of your nearest stockist e-mail info@netproducts.net or telephone 0845 60 505 60.

Fernhart Technology Brings Virgin Radio to the Desktop

Virgin Radio is being brought to the desktop of 'listeners' by Fernhart Technology at www.fernhart.com, a UK developer of push technology.

BackWeb at www.backweb.com is a push technology platform that enables companies to build their own Internet broadcast and off-line programming channels which are delivered using a proprietary client/server model. With BackWeb, companies can establish pro-active communications with customers based on their personal interests.

Virgin Radio asked Fernhart to create a channel that used push technology to deliver information, images and music clips direct to the PCs of fans.

Push technology enables information of interest to the user can be delivered directly to a PC screen so the user is made immediately aware of the latest developments that may be of interest.

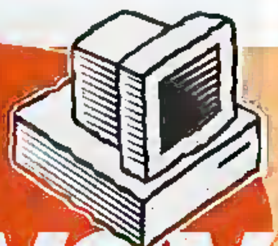
Between 50 per cent to 75 per cent of time connected to the Internet does not involve any activity. The user could be reading a Web page or e-mail message, writing e-mail or simply thinking. During that time, up to information relating to subjects that the user has expressed an interest in can be downloaded.

Fernhart claims that this is the first content-based channel in the UK and the only BackWeb push channel radio station in the world. Within 24 hours of the service going live, more than 1,000 channel registrations had been received.

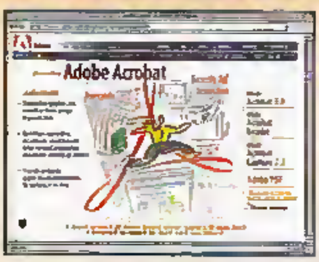
The Virgin Radio channel created by Fernhart will have a two-part roll out. Initially, information on the Chris Evans Breakfast Show will be sent directly to listeners but within a matter of days they will be receiving more generic information from Virgin Radio, including latest play lists, schedules and breaking station news.

Information about Virgin Radio can be found on the World Wide Web at www.virginradio.co.uk/breakfast.html.

Site Survey



The month's destinations

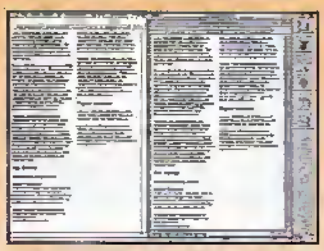


Adobe's Web site at: <http://www.adobe.com> is the place to find a free download of the Adobe Acrobat Reader. With it, you'll be able to download and use any Acrobat PDF file, exactly as the file's creator intended.

Details of Iceni's Genus plug-ins for Acrobat Exchange can be found at the Iceni Web site at <http://www.iceni.com>.

Prospective Myrmidon users should checkout the author's Web site at: <http://www.terrymorse.com> if they can't find a sales outlet locally. You can download a free trial version from there,

Myrmidon — Myrmidon creates its HTML document close to the original document in appearance, creates hyperlinks from Internet URLs in the document, and works from any program running on the Mac.



and even pay electronically if you want.

Finally, with electronic commerce being the hyped news item it is, you can handle all your financial matters electronically with the Nationwide Building Society's new online banking service. While many banks are already looking into the prospect of online banking, the Nationwide is the first building society to do so. Point your browsers at: <http://www.nationwide.co.uk> and throw your wallet away.

Genus — Showing the HTML output (right) from a standard PDF document extracted using the Genus plug-ins.

in the pipeline

ELECTRONICS and Beyond

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

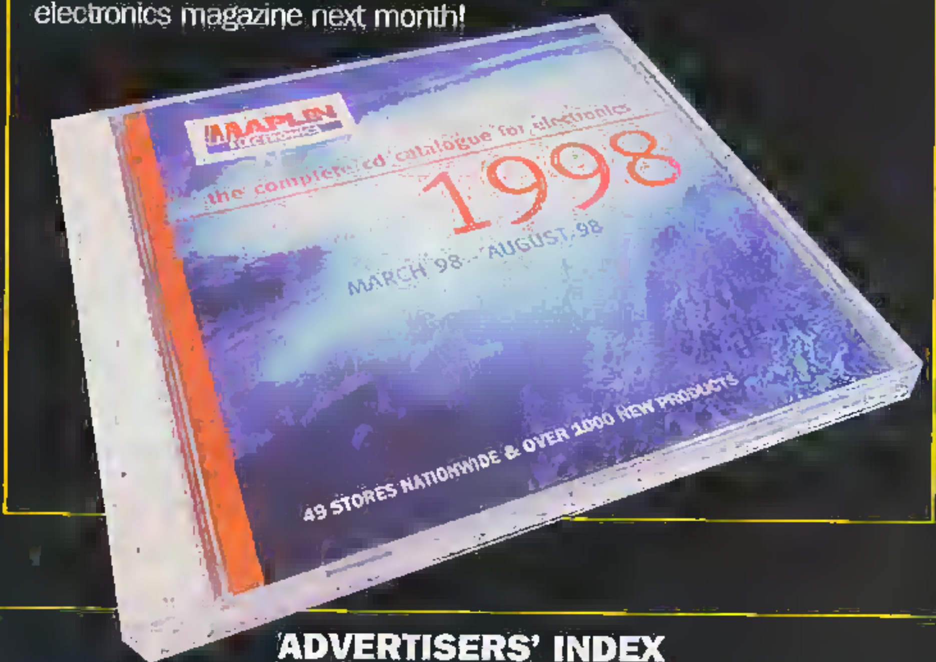
Issue 124 on sale Friday 6th March

Build a Bare-bones PC

Stay with us on this new series and we will guide you through the process of building a top-of-the-range PC together with options that suit your requirements.

FREE with the April edition of Electronics and Beyond the Maplin Electronics Catalogue on CD-ROM.

For the first time you will be able to browse through the Maplin Catalogue on screen. So make sure of getting your favourite electronics magazine next month!



ADVERTISERS' INDEX

Project Ratings

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

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

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

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

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

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

Ordering Information

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

Internet

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

Prices

Prices of products and services available from Maplin shown in this issue, include VAT at 17·5% (except items marked NV which are rated at 0%). Prices are valid until 27th March (errors and omissions excluded). Prices shown do not include mail order postage and handling charges. Please add £2.95 to all UK orders under £30.00. Orders over £30.00 and MPS Account Holding customers are exempt from carriage charges.

Technical Enquires

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

Maplin 'Get You Working' Service

If you get completely stuck with your project and you are unable to get it working, take advantage of the Maplin 'Get You Working' Service. This service is available for all Maplin Kits and projects with the exception of: 'Data Files'; projects not built on Maplin ready etched PCBs; projects built with the majority of components not supplied by Maplin; Circuit Maker ideas; Mini-Circuits or other similar 'building block' and 'application' circuits. To take advantage of the service return the complete kit to: Returns Department, Maplin Electronics PLC., P.O. Box 777, Rayleigh, Essex, SS6 8LU. Enclose a cheque or Postal Order for the servicing cost (minimum £17) as indicated in the current Maplin Catalogue. If the fault is due to any error on our part, the project will be repaired free of charge. If the fault is due to any error on your part, you will be charged the standard servicing cost, plus parts.

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

Beta Trials?

Dear Sirs,

Reading issue 122 of Electronics and Beyond, I feel I cannot read your review of Nuts and Bolts without letting you know of my experience.

I purchased version 1.01 back in August and found several bugs in it – I reported them to Helix Software, who informed me that they would be fixed in the next release, available "in a few days" on their Web site.

After a few weeks the upgrade version 1.03 appeared. I downloaded and installed it, however I then found that half the facilities had more bugs than before.

I was informed eventually by Helix that the version 1.03 problems were caused by me downloading the patch which is only for the US market. I was promised a new CD with the updates in November, and again at the start of December.

Kevin Hyman
khyman@iee.org.uk

Stephen Waddington replies:

You certainly seem to have had a raw deal. Prior to undertaking the review featured in issue 122, I ran Nuts & Bolts on my machine and did not experience any major problems. This may be because I tested version 4.0, which is an international version released in the summer last year, not one of the earlier US-versions you describe. We have forwarded your comments on to Cross Atlantic, the distributor for Nuts & Bolts in the UK. Rolland Leggat, their technical services director should be contacting you to address and resolve your issues. Do let us know if this issue is not resolved to your satisfaction and we'll take it further.

Dear sir,

In the October 1997 "Comment", Keith Brindley states that you can't run windows on anything other than an intel (or clone) microprocessor. Windows NT has been available for the Digital Alpha processor from the very beginning and I am using it now on my 1993 vintage Alpha system at home.

Not only can you run NT (or Unix or VMS) on alpha processors, they are also the basis for some of the fastest computer systems available. Microsoft are developing 64-bit NT systems for alpha processors NOW -alpha has always been a 64 bit architecture – while I believe the intel 64-bit offering will not be available until 1999.

The Alpha processor often seems to be overlooked by the press, perhaps because of the vast noise of Intel's marketing engines, but it remains a viable and very powerful alternative. The Alpha is one alternative that can help diversify the Intel-dominated culture that Keith seemed to be complaining about.

P N Jackson, Acton, London.

The Big Countdown

Dear Sir,

With reference to the article in issue 114 Time Measuremnent by Douglas Clarkson. I wish to correct an error of mine in a letter you published issue 118.

The first 24 days of the 1000 day countdown to the next millenium occur in April 1998, so that the start date is strictly 7th April not the 6th. Thus the countdown that commenced on 4th April 1997 has commenced 368 days early not 367.

J Moloney, Bowen, Queensland, Australia

Oh the magic of numbers. I know we all like an excuse to celebrate for a variety of reasons, even going back to the more deep rooted pagan festivities of summer and the winter solstice. However, to celebrate the millenium, some would argue is so artificial and also that it is inaccurate if it is related to a certain religious birth. Perhaps the logical starting date should have been from the 'Big Bang'. Even then because the unit of the second is man-made and we base our counting on a denary system of tens, it still bears no more significance when we arrive at a nice round number like 1 million, than with any other base of time or numbers. One thing we as humans do like is regularity. The rhythm of human life loves to cling on to periodicity, the most important being the single rotation of the Earth. It must be locked in to our genes to give us our body clocks. So why don't we celebrate every 24 hours! Comments please.

Hi there,

Please could you consider featuring "building your own IrDA serial port adapter".

This would be of great interest since commercially available models seem to be pricey at around £100 and users with Psion 3C/Siena palmtops would probably find this very useful.

Many thanks
Ian Gardner
Oxfordshire

We will see what can be done for you.

Praise be!

Dear Sir,

Thank you for our wonderful new local Maplin store here, at last, in Norwich. It's been worth the wait! No longer do I have to make a 500 mile round trip to your Preston store to get my electronic "fix". I know you have stores a little nearer, but my wife said she didn't mind, and that watching me in Maplin Electronics at Preston, was like watching a child in Santa's Grotto at Toys 'Я' Us. (Can't think what she's talking about!

Thank you for the new section "SOFTWARE HINTS and TIPS" written by Ruth Hewer Very informative. But have you got a hidden camera somewhere in our third bedroom? (our computer room). How on earth could you possibly know that at the time you published both of her articles, I was looking at the exact things Ruth discussed, (print screen/bit map images, Mag.121 – Jan. 1998, and keyboard shortcuts, Mag.122 – Feb. 1998). Only yesterday I was looking at "Keyboard Shortcuts", and this morning through my letterbox pops the latest edition of the magazine, and there is the article by Ruth.

Coincidence? I think not! Go-on, own-up, I will find that camera in the end! (I'll take the clock apart tonight if you don't own up, when my wife has gone to bed. It's got to be there somewhere).

Thank you for the efforts of all your editorial staff in keeping the magazine such an informative and illuminating publication. In the 13 years I have taken it, (my first copy was issue no 21 Dec. 1985) you have striven to keep a bungling amateur, (me), up-to-date. Sorry, I failed on that score, but I suspect that it's not your fault! Seriously though, the very latest information combined with "Basic" circuits etc. keeps the magazine alive for me.

Now a request:

I am sure that there are a good many readers/subscribers to the magazine, who own computers and modems with Fax facilities, like myself but who are not internet subscribers, and cannot therefore use your "E-mail" facility. Could you please consider providing us with the ability to Fax to you documents diagrams etc. I'm sure you must have an underworked Fax machine sitting on a phone line somewhere?

On a final note, I hope that a photocopy of this month's competition form will suffice in place of an original. I just could not bear to cut up one of my precious mags! If it's acceptable, perhaps a very small note on future competition forms that photocopies of the form are acceptable (accompanied by a customer number, maybe? Just to prove authenticity)

Yours (very) Faithfully,
Mr A.Cornwell, Hickling, Norfolk

Thank you for your kind comments and that you are pleased with our Norwich store. Yes you can Fax us on our main Fax number 01702 554001. Yes, you can photocopy competition entries and what a good idea to put your customer number on it. We will do that next time.

PS. We reversed the 'R' Ah, the wonder of DTP!