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ELECTRONICS WORLD

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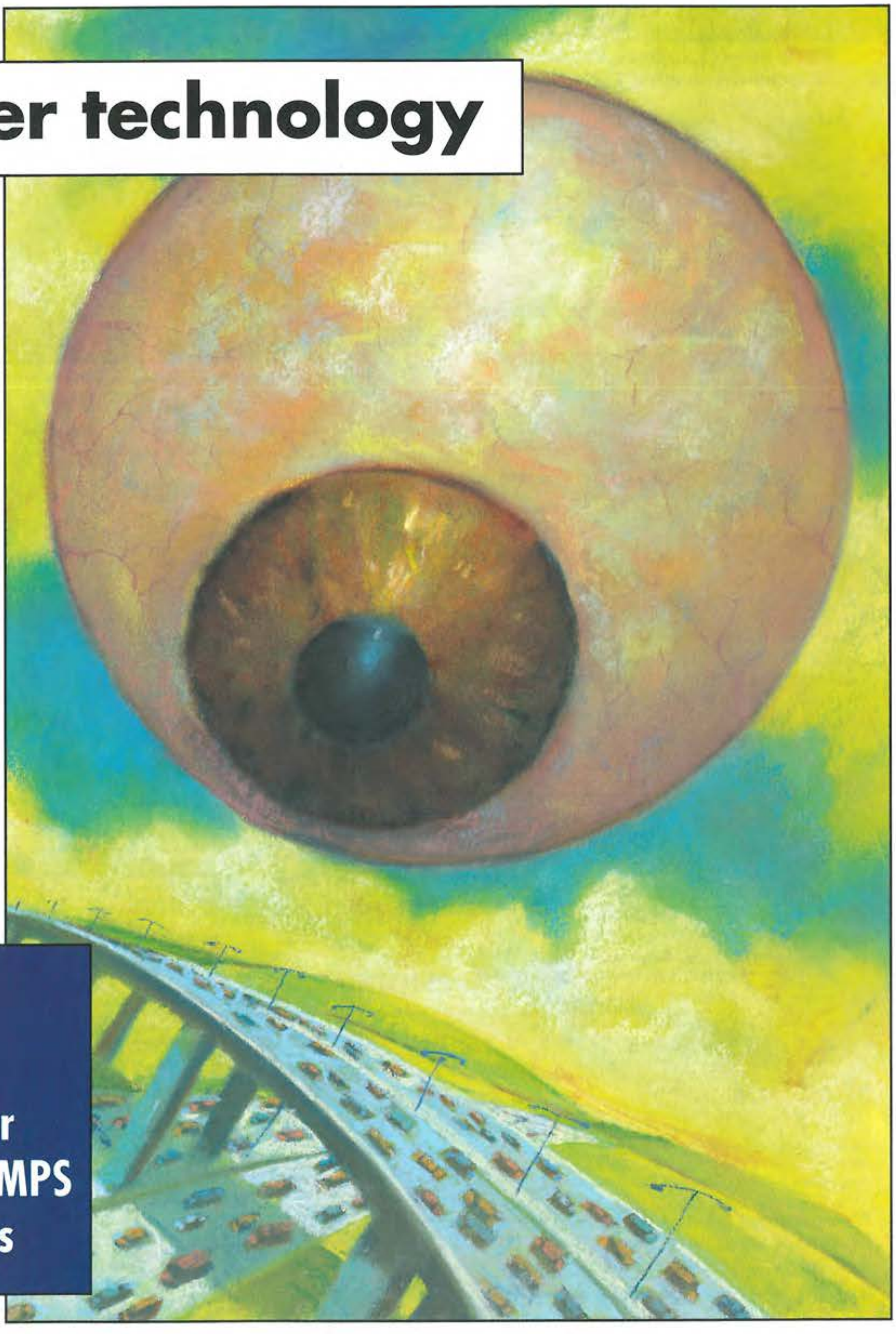

Big brother technology

Adjustable PLL

Variable-gain circuits

Tini Java

Windows 2000 review

EEPROM programmer

Circuit ideas:
- Phase noise meter
- Log sweep generator
- Low-power mains SMPS
- Drive for valve amps

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Illustration : Jamel Akib

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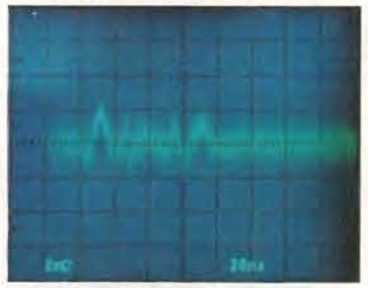
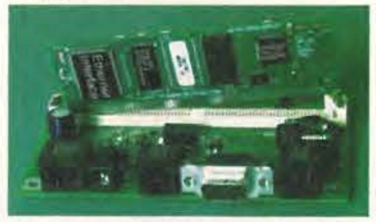
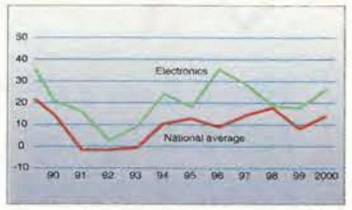


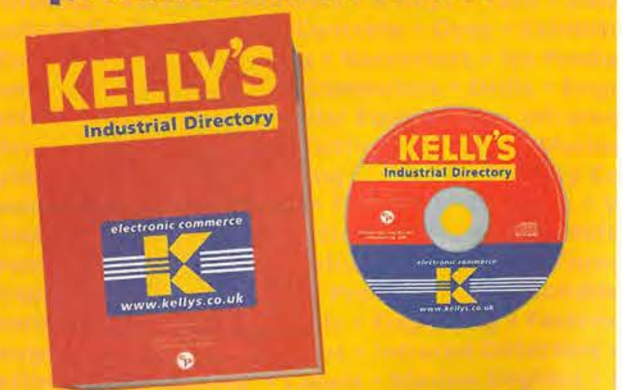
Is this a signal, or random noise? Find out how to tell the difference on page 542.



Java on a stick. This tiny Java controller with networking and Internet capability costs just $50. Les Hughes describes how to use it on page 531.



Electronics engineers are in demand again, with a third of electronics companies looking to recruit in the second quarter of this year. This, and much more news on pages 515-518.



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REED BUSINESS INFORMATION

High-tech pretenders

The so-called 'New Economy' has been having a bad time lately with over-greedy backers and bankers pushing their luck too far, and eroding the credibility of the money men behind these ventures.

One of the backers of two, recent, ill-fated dot.com IPOs, was Intel. The company backed both the Dutch WorldOnline and the UK's lastminute.com. public offerings. Its PR initiatives had helped create lastminute's high public profile in the months preceding the launch.

Both offerings fell below their initial offer price losing the small investors money – though the original backers profited greatly.

The chairman of World Online sold most of her shares before the IPO even occurred, and US investment bankers Goldman Sachs who managed the launch were warned by Japan's Ministry of Finance that its record in the WorldOnline and other launches had made it consider debarring the bank from advising on Japanese government privatisations.

Suddenly the authorities woke up to the fact that the dot.com boom could get out of hand and bring down the whole house of cards. To most of us it was difficult to take seriously the valuations put by banks, stockbrokers and investors on dot.com companies. Now the credibility of the financial sector is being questioned by the authorities.

The same thing is happening with the credibility of the founders of dot.com companies. At one time we were encouraged to think that dot.com companies were started by sparky young people with nothing except a 'good idea': the truth is often very far from that. Dot.com founders are not the innocent young techies operating from a garage of an earlier generation but sharp-eyed marketing men looking for a kill.

Venture capital – once something to be jealously hoarded by high-tech start-up companies for innovative product development – tends to be spent by dot.coms mostly on publicity rather than on developing a service or a product.

Some of the dot.com companies are spending on publicity at the rate of £1m a month – the money coming from venture capitalists wanting to make a quick killing through an early public offering on the stock market.

Now there is a more realistic attitude emerging but the hangover from the dot.com frenzy is affecting the whole of the high technology industry. That's because, very often, dot.coms are regarded as high-tech by newspapers, analysts and television programmes – even though they may be purveying cooking recipes. That means the sharp swings of their share prices can affect the whole high-tech sector.

For instance, some of this year's fall of the US NASDAQ high technology stock exchange – from over 5000 in March to under 3400 by mid-May – is attributable to the excessive expectations generated by the dot.coms. It was then dissipated by the reality of collapsing share prices and even, in some cases, scandal.

It seems very hard on real technology companies to have their shares hit by a general disillusionment with 'high-tech' brought on by some lack-lustre performance from the so-called dot.com companies. Most of these dot.commers have nothing to do with high technology at all.

For instance lastminute.com is basically a travel agency with some add-on shopping opportunities. Internet-based activities like job agencies or even Internet service providers are not high-tech companies; they simply rely on the technology in order to distribute their product.

You wouldn't say Harrods is in the transportation business because it uses vans to deliver its goods to customers would you?

Real high-tech companies are those that develop and sell high-tech products: semiconductor companies, computer firms, networking companies, software companies, manufacturers of printers, mobile phones, scanners, camcorders, smart missiles, radars and the like.

Anyone making the broadband switches, high-speed optical fibre transmission network systems like dense-wavelength division multiplexers, or making the terminals and appliances that hang off the network, is facing a bright future. But these real high-tech companies don't want their shares jerked around by association with commercially unproven dot.com companies purveying dubiously useful services over the Internet.

While real engineers may be entering a golden age – able to make money on a scale which earlier generations never dreamed of – they face the threat of being devalued and tarnished by the dot.com community ■

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UPDATE

Industry warned on environmental policy

The electronics and IT industries have been warned that ignoring their environmental responsibility could have a serious impact on long term growth.

"Environmental responsibility is increasingly recognised as one of the key factors sustaining long-term growth," said Dr Belinda Howell, director of Business in the Environment (BiE).

BiE, the business campaign for environmental responsibility, only received a response from six out of the 28 IT and electronics companies invited to participate in its 'Index of Corporate Environmental Engagement.' These were Racal Electronics, Marconi, STMicroelectronics, Fujitsu, IBM and Sema Group.

The survey assesses performance in five areas: energy, transport, global warming emissions, waste and water consumption.

Set-top box manufacturer Pace Micro Technology was one of the companies which did not participate.

When questioned, a spokeswoman said she was unaware of the survey but Pace definitely had an environmental policy. "It's something we're very, very aware of," said the spokeswoman. "We have some things to be proud of as far as handling the environment is concerned."

Chip design firm ARM also did not participate because it felt the survey was geared towards manufacturing whereas it is an intellectual property company.

"We try to make sure our facilities operate in an energy efficient manner," said John Cornish, ARM's director of product marketing. "We don't regard ourselves as being exceptional but we try to be good citizens where we operate."

Protection against video-link data tapping could become mandatory

Companies handling personal information over video links may have to protect against data path tapping, according to Basingstoke-based videocommunications company AuDeo Systems. This could affect those discussing matters including health, government, defence and legal issues.

"The 1998 Data Protection Act coming into force in March has placed the issue of data security at the top of the business agenda," said AuDeo in a statement. "Videoconferencing comes under the act, which stipulates that businesses handling personal data must take appropriate technical and organisational measures to prevent hacking and data loss through system crashes."

AuDeo is predicting a large growth in the used of video-meeting technology. "As the costs of such technology reduce, videoconferencing products can be used daily throughout any organisation," said Kevin Wilson, MD of AuDeo.

The statement was made at the launch of a secure videoconferencing system, claimed to be the first, which has come out of a deal between AuDeo and security specialist Biodata Information Technology.

The system is based on Biodata's BabylonMETA encryption units and is claimed to be able to secure ISDN lines against tapping.

Government prepares to auction broadband wireless licences

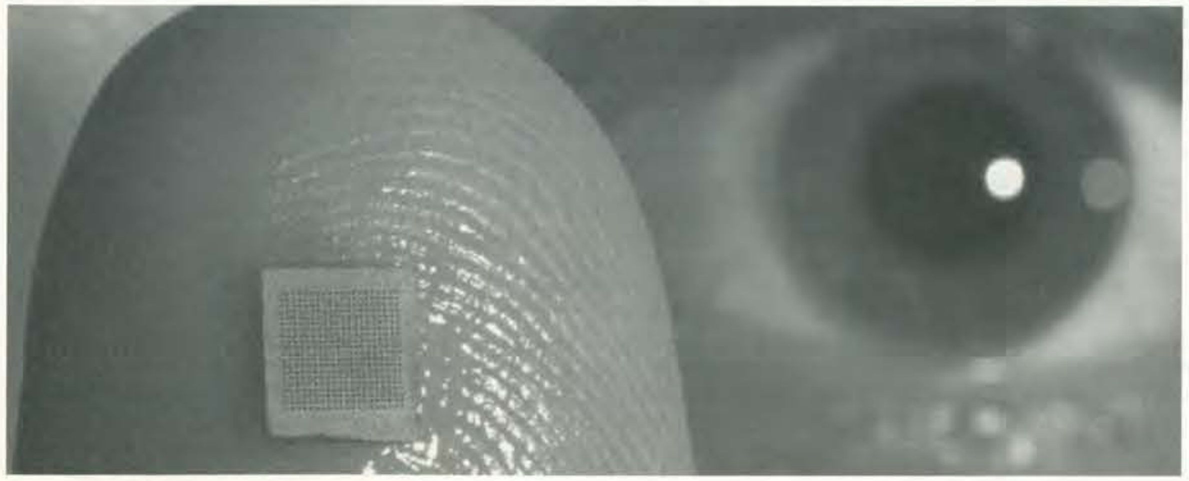
An auction of the airwaves for broadband fixed wireless access services will follow the success of the £22bn auction for 3rd generation (3G) mobile phone licences.

The government will auction the spectrum at 28GHz in September for services which will allow fast Internet and multimedia access via radio links.

Three licences will be awarded in each coverage area which will be defined in May. Each licence will contain a forward and return channel to send and receive data.

At the time of writing the 3G auction had raised £22bn for the government although it is doubtful this second radio frequency auction will be quite so popular.

"Awarding licences by auction will ensure that they are taken up by those operators best placed to develop services most efficiently," said Patricia Hewitt, e-commerce minister. "The licence package is designed to encourage new entrants and the development of a competitive market."



You won't feel a thing... Microneedles could be the basis for a new drug delivery technique. Under development at the Georgia Institute of technology, the needles are short enough not to hit nerves, but big enough to enable large molecules – including insulin – to penetrate the skin.

Excessive mobile licence costs – who will pay the bill?

The multi-billion pound sums generated by bids for third-generation mobile phone licences cannot be justified by the business cases made for the technology before the auction began, according to an analyst involved.

"The licences are now costing more than the business plans will allow," said Andrew Parkin-White, an analyst at Ovum. "They are costing more than the infrastructure."

Ovum worked with several companies on their business case before the auction. Using a conservative estimate, Parkin-White believed all five licences would go for £3.2bn. Infrastructure costs were estimated at £2 to £3bn.

The worry is the prices will result in high costs for the user. "Someone's going to have to pick up the tab," said Parkin-White, "and new entrants won't want to see prices fall too much."

BT refused to be drawn on the subject of the auction in which it is bidding as BT3G. "I'm not going to tell you my bidding strategy," commented Sir Peter Bonfield, BT's chief executive. The company was the first to raise the bid for a licence over £5bn.

Parkin-White's other worry is that the mobile market is being fuelled by the current dot.com mentality as the mobile and Internet worlds converge. "The question is whether the bubble will burst and affect mobile Internet," said Parkin-White.

The five successful bids were, TIW 4.4bn, Vodaphone 6bn, BT 4bn, One2One 4bn and Orange 4bn.

Electronics engineers are in big demand

Electronics engineers are in demand like never before, with job prospects in the sector predicted to be strong over the next few months, according to Manpower's latest Quarterly Survey of Employment Prospects.

Year-on-year figures for electronics show improvements in the forecast for job increases. A third of electronics companies are looking to recruit in the second quarter of this year – 33 per cent up from 28 per cent. Companies looking to shed staff are down from ten to six per cent.

"As one of the few sectors not to suffer downsizing in the second quarter of 1999, it has had a strong base from which to build a lead that keeps it well ahead of the national average," said a Manpower spokesperson.

Unfortunately for the industry – but good for individual engineers – the high demand is not matched by the supply of suitably qualified staff.

"It is exceptionally difficult to find people at the moment: silicon designers, anyone to do with ICs and embedded software engineers are in particularly short supply," said Geoffrey King, managing director of electronics recruitment firm Cambridge Recruitment Specialists. "People are being offered crazy amounts of money to do jobs that aren't worth that much."

King sees the problem as fundamental. "You can only go on so far by stealing from your competitors. The problem is that the supply chain is not keeping place. The number of people reading relevant subjects at university is shrinking.

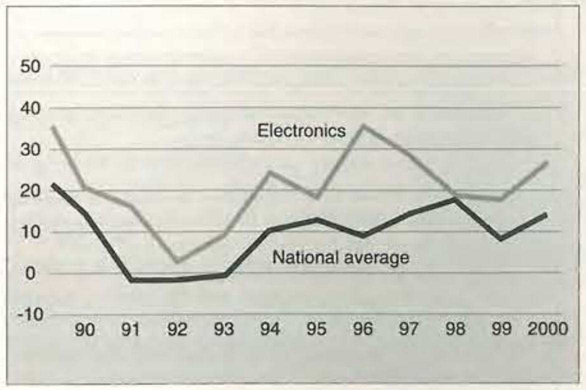
"It is a huge educational issue. Kids need to be tuned in to this much earlier." he added.

Competition for design engineers is as bad or even greater in Silicon Valley and other US electronics centres. As a result some companies are looking to developing design groups in new electronics areas around the world like Bangalore in India.

"There are some excellent engineers there, but it is a slow process to bring engineers from India," said King.

With recruitment so competitive, companies are having to work to keep staff.

"It is not necessarily the money, it is the way people are utilised," said King. "Give them interesting things to do and listen to them."



Experts play down mobile phone health risk claims

A government-sponsored report is set to dismiss claims that mobile phones are a proven health risk.

The Stewart Inquiry, due to report on 11 May, is expected to conclude that allegations that they cause illnesses ranging from memory loss to tumours appear to be unfounded.

The committee of 12 experts is understood to accept evidence that while mobiles tend to heat up the brain, the heating is not enough to affect people's health.

The maximum rise in temperature is just one tenth of a degree, the team were told, while the normal body temperature varies by a full degree over the course of a day.

But as a precaution, the committee is expected to call for tighter controls on microwave radiation emissions bringing them in line with European levels.

The committee will also say there must be more research by the Department of Health into the "non-thermal" effects, which some other studies have suggested can pose a health risk.

But the committee, chaired by Tayside University Hospital Sir William Stewart, does accept that the children, who own 300 000 of the 24 million mobiles in Britain, could be at greater risk if there is any risk.

The report follows 10 months of research and is expected to call for tighter planning controls on the siting of mobile phone masts and urges the National Radiological Protection Board (NRPB) to conduct regular spot checks on the 500 masts sited near schools. It seems that the committee was struck by the strength of public opposition to the masts.

But as the final drafts of the report are prepared, some critics said the committee had been "captured" by the NRPB and recently doubts have been cast on the safety of the hands-free mobiles introduced in response to the health concerns over mobiles.

● According to a BBC on-line news report, Sir William says that he would discourage his grandchildren from using mobile phones until further research is completed.

Conventional chips may be viable to 2005

US researchers are claiming that performance limits on conventional transistors might not be reached as quickly as first thought.

A transistor's gate oxide layer was thought to reach a limit at nine or ten atoms thick, but Bell Labs researchers think it could work down to six atoms, or 1.5nm, thick.

"Achieving such thin dimensions with the required intrinsic reliability was previously thought to be impossible," said Ashraful Alam, the Bell Labs' scientist that led the research.

Alam's team showed that a 1.5nm gate could, in theory at least, run at 1V for up to ten years. Another Bell Labs team proved the result experimentally.

The life extension to silicon dioxide (SiO_2) as a gate material, perhaps until 2005, gives engineers more time to develop alternative materials.

These include group IVB oxides such as hafnium oxide and zirconium oxide which have leakages up to 10^4 times less than SiO_2. These can match the performance of SiO_2, but can be deposited in layers around three times as thick.

Trainee engineers jam military satellite with ham radio gear

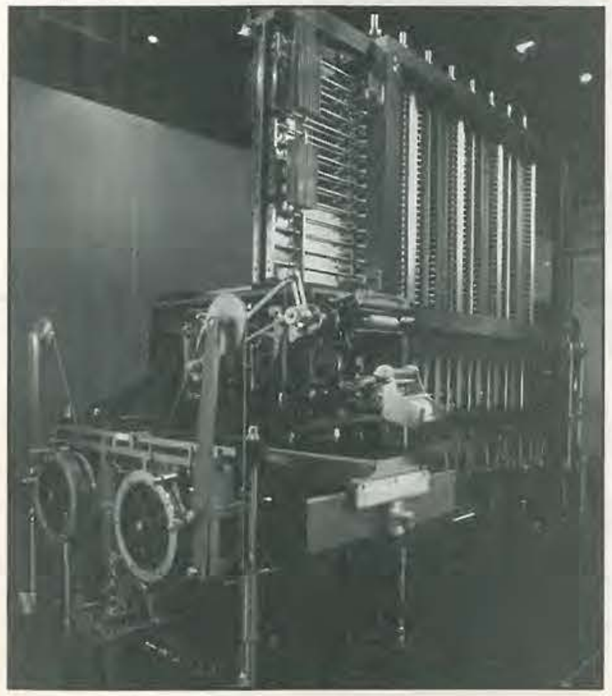
Military satellites can be jammed with easily-bought material using information from the Internet. A report in *New Scientist* magazine, describes how the US Air Force tasked two "rookie" engineers to build a UHF satellite jammer. They succeeded using materials from high street stores and radio ham swap meets. The total cost of the jammer, which runs from a simple petrol generator and can be transported on the back of a pick-up truck, was $7500.

Stress claims triple in six months

Increasing workplace stress is boosting compensation claims on employers – says the Engineering Employers Federation.

Stress related enquires to the Federation have tripled in the last six months. "There is also no doubt that, in the UK, employees are increasingly aware of their rights and are now routinely looking to litigation rather than using it as a last resort," said Sandra Howard, head of legal affairs at the Federation's north west association.

"There is no doubt that we still have a 'long hours' culture in the UK and that can add to pressures," said Howard.



Tool eliminates chip noise errors

EDA start-up Moscape has a tool it claims can eliminate chip design errors due to noise.

Called GateScope, the tool can identify and correct noise problems caused by cross-coupling, being found more as designs move to 0.18μm.

"The devastating effects of noise on functionality and timing are typically unrecognised until test chips are produced. Silencing this noise prior to tapeout is possible only with the new analytical and corrective approach embodied in GateScope," said Fuad Musa, Moscape's president and CEO.

Smaller design rules and more advanced processes are bringing noise problems as cross-coupling between the narrow pitched metal interconnect increases. Logic simulation and static timing analysis fail to isolate these problems, Moscape claimed.

The tool, it said, has the precision to find the smaller errors, reducing the chance that the design fails to meet its timing specification.

GateScope runs on Unix, Solaris and Linux operating systems and costs $75 000 per seat, per year.

Tory presses labour on e-government issue

A former Tory science minister is launching a Parliamentary campaign to force the government to deliver on its 'Information Age' pledge.

Robert Jackson believes the government is falling behind in the drive to put its services on line. The Wantage backbencher has tabled a series of questions aimed at discovering exactly how far each Whitehall Department has got in bringing in e-government.

"The UK's strategy for on-line government is flawed," said Jackson. "They have produced a 34-page book that took a year to write but says nothing."

According to Jackson, none of the Inland Revenue's dealings with citizens or business involved the Internet in 1999, and it will rise by four per cent by 2002. No dealings at the DSS will be Internet deliverable by 2002.

"Ministers make grand promises to have services on line by 2002 and all suitable services electronically available by 2005 but they haven't given any indication of how they will do it," added Jackson.

Babbage gets printer after 150 year wait

Engineers worried about shorter development cycles should spare a thought for Charles Babbage whose printer has just been built, over 150 years since it was designed.

Built by the Science Museum, the mechanical printer can output results of calculations with programmable line width, margins and number of columns.

The printer can also produce stereotype plates for use in a printing press.

The computing part of the system, Babbage's Difference Engine No 2, was built in 1991, but the printer had to wait a few years more.

Both devices weigh in over 2.5 tonnes and contain more than 4000 parts. They were designed to produce tables used in navigation, engineering, banking and insurance. ■

Illustration: Jamel Akib

Never before has the British public been monitored so closely or, it would appear, so willingly. Unblinking eyes now scan the trunk roads and city centres of Britain but with differing aims and using different technologies. *Andrew Emmerson* takes a closer look at who's zooming whom.

Behind big brother

In theory, Trafficmaster's number plate cameras could be used to report speeding vehicles, but the company insists its data is not passed on to any outside agencies.

That prickly feeling on the back of your neck that you are being watched is generally put down to paranoia. Scientific tests at the University of Hertfordshire to measure skin resistance certainly failed to detect any change change the test subjects when hidden video cameras were trained on them.

For the public at large though – and motorists in particular – this suspicion may well be justified. Their movements are coming under increasing surveillance. The UK is now said to have Europe's largest market for CCTV equipment, valued at over £385 million per year.

With most city centres, banks, shops, airports and main railway stations under 24-hour watch by closed circuit television (CCTV) the suggestion is now made that British citizens – 'subjects' may be a better word – may be snapped 14 times a day.

Headlines are no longer made when news reports state that crime suspects were caught on camera, while the police acknowledge that it takes just four seconds now to alert them if a vehicle caught on their cameras is on the wanted file. Crime rates in CCTV zones have fallen by up to 50 per cent, driving wrongdoers out of town centres and into the suburbs.

Initial concern over civil liberties has now subsided into widespread acceptance of these high-profile installations. Indeed, according to Strathclyde Police, the public has now become so accustomed to CCTV cameras that they now view them as "simply part of the street furniture".

But what about the not-so-obvious systems and what are the technologies involved?

Steady as you go

By now, most motorists in Britain will have spotted the distinctive cobalt blue poles carrying cameras and radio antennas that adorn the majority of trunk roads. Many people give them a careful berth, assuming they are a new generation of speed camera but in fact their purpose is PTFM, or passive target-flow monitoring.

The cameras belong to Trafficmaster plc – a company that first made its name by providing information about traffic jams using a network of sensors along main motorways in Britain. PTFM takes the concept much further by measuring the time taken by individual vehicles to cover the known distances between sensors.

These specially developed infra-red sensors, installed approximately four miles apart, 'snap' the number plates of passing vehicles. Computers at each site transmit this information back to Trafficmaster's national control centre in Milton Keynes.

The time taken for a vehicle to travel between each sensor site is calculated. Then, odd spurious results are rejected – for example, drivers who have turned off or stopped along the way – and a pattern is thus built up of the average speed along the stretch of road. This information is then transmitted directly to vehicles fitted with Trafficmaster receivers when they pass the next sensor site.

A potential speed trap

In theory, the system could be used for identifying speeding drivers or for tracking individuals but the company insists the data is not passed on to any other agency. Indeed, to avoid falling foul of data-protection legislation, the first and last characters of each vehicle number taken is discarded. The remaining character string, or 'tag', is still sufficiently unique for processing purposes.

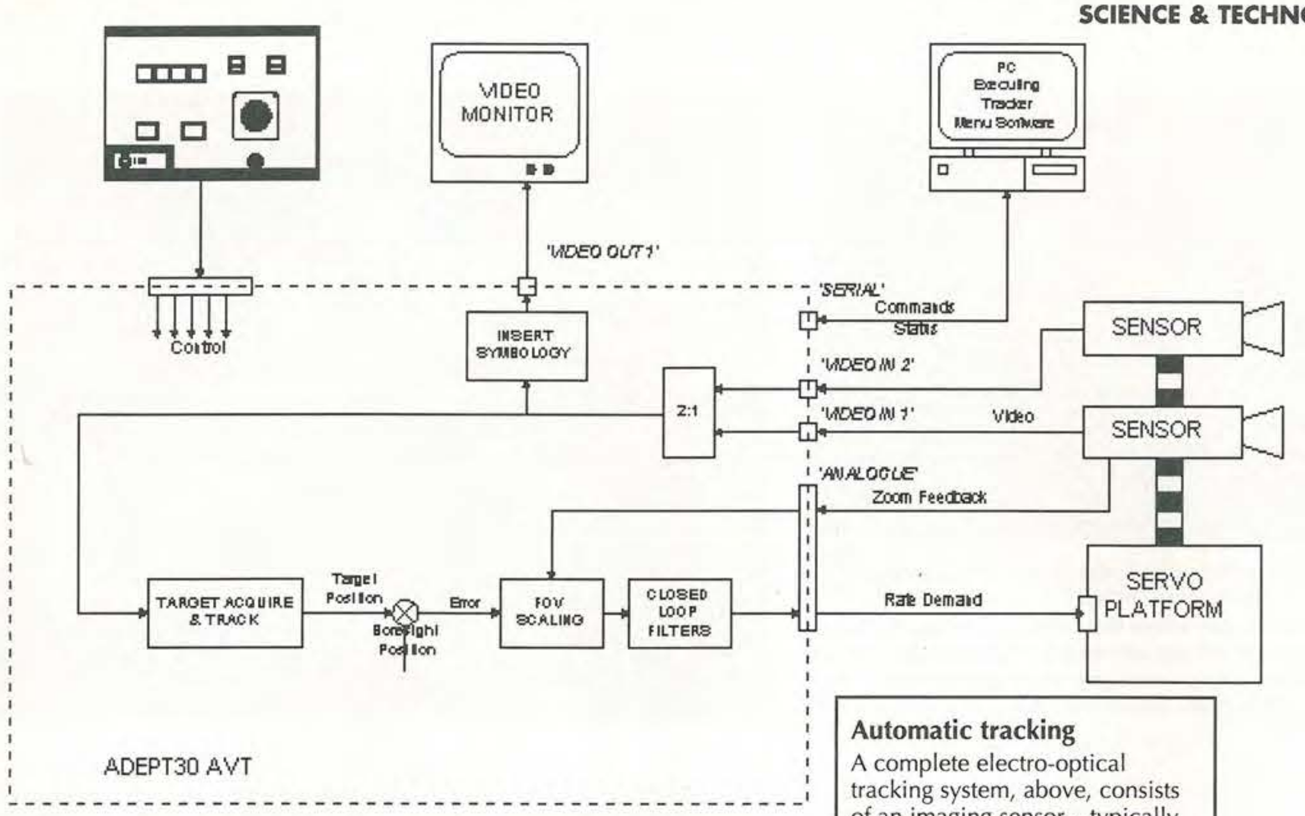
The system is also being developed to use neural networks. This is a form of computer intelligence that allows the software to predict the movement of traffic flows, and recognise when traffic congestion is building up or starting to disperse.

Concern over misuse of data collected is dismissed by a Trafficmaster spokesperson, who told me, "Under the terms of Trafficmaster's licence agreement with the Department of Transport, we must dump the information gathered immediately it has been processed. We only read the central four digits of a car's number plate. In addition, we only read a small percentage of those vehicles that pass by each site. A 100 per cent sample is not only unnecessary, but also not desirable—the equipment needed to process that amount of data would be extremely expensive, and totally unnecessary."

Expanding rapidly...

Trafficmaster's expanded network now covers approximately 8000 miles of motorways and trunk roads in England, with some 5000 cameras in use. The service is being extended to motorists in Scotland and Wales shortly. It provides the most comprehensive, near-nationwide, live traffic-monitoring network in the world.

A further enhancement of the sys-



Serial or VMEbus interfaces can be used in place of the discrete interfaces (Controller, Analogue etc.)

Automatic tracking

A complete electro-optical tracking system, above, consists of an imaging sensor – typically TV or IR – mounted on a two-axis servo platform and a tracker controlling the position of the platform based on the scene observed through the imaging sensor.

The automatic tracking system processes video images directly in real-time to ascertain the position of a designated object with respect to the sensor boresight. An error signal derived by the system from the image is then used to control the platform such that the platform and attached sensors accurately follow the target.

An Octec video tracker is designed to be integrated with a servo platform and video sensor. The video tracker automatically detects and tracks a single target in the video picture from the sensor mounted on the servo platform. From this picture, it provides an 'output demand' that controls the position of the servo platform such that the platform and attached sensors follow the target.

Information on-line

CAATS	http://www.octec.co.uk/trackers/caats2.html
Mandrake	http://www.tssi.co.uk/
	http://www.gifford.co.uk/i-contact/tash/tash20.html
Trafficmaster	http://www.trafficmaster.co.uk
Visionics face recognition	http://www.faceit.co.uk
Conspiracy theories	http://www.spy.org.uk/trafficmaster.htm
	http://www.ultranet.com/~bevanrl/saab/trafficmaster.html
	http://www.geocities.com/MotorCity/2195/speedtrap_notatrap.html#traffic2

Frames from two videos taken from a helicopter fitted with CAATS to illustrate electro-optical tracking, left, and 'scenelock', right, where the camera automatically tracks a particular picture, regardless of the helicopter's movement. The demonstration video samples are available for downloading from Octec's web site.

Mandrake is a face recognition system that automatically monitors live images from closed-circuit tv cameras and captures people's faces as they pass through the field of view. Captured images are analysed and compared to a data base of known, wanted people. On identifying a wanted individual, Mandrake raises an alarm.

tem's software will enable it to predict when traffic is at its worst and hence the best time to travel. The accurate journey time data can be produced in formats that can be integrated into any on-board electronic information system, for example, GPS navigation systems.

Plans are in hand to extend the system to France, Germany and Italy. And the company has recently announced the development of a new patented 'mobile' sensor technology. This will use specially equipped vehicles to *actively* measure journey times between two points.

The resulting traffic information will appear 'seamless' to the end user. It has been designed to be fully integrated with data collected from Trafficmaster's fixed networks.

Eye in the sky

An engaging feature of the numerous 'Police Stop' programmes on television is the aerial view footage of fast-moving felons taken from helicopters. Curious minds may wonder how the cameraman manages to keep the vehicle in shot so successfully and avoid judder on the images. The answer is of course a robot and the technology is significantly more sophisticated than the first 'heli-tele' systems.

Giro stabilisation was all that was available when helicopter-mounted video cameras were first used for public surveillance. That occasion was in 1979, when London's Metropolitan Police observed the Notting Hill Carnival.

Many of today's crime helicopters use the compact airborne automatic-tracking system (CAATS) developed originally for missile guidance and other defence purposes. Infra-red technology tracks vehicle movement through streets and even behind buildings to drive the camera pod and maintain visibility.

How electro-optical tracking works

CAATS is made by Octec Ltd, based in Bracknell and one of the leading independent suppliers of digital video tracking and image processing systems to the defence market worldwide. The company's electro-optical tracking system consists of an imaging sensor – either video or infra-red – mounted on a two-axis servo platform. There's also a tracker that controls the position of the platform based on the scene observed through the imaging sensor.

Automatic tracking is achieved by an electronic system that processes video images directly in real-time to ascertain the position of a designated object with respect to the sensor boresight. This error is then used to control the platform such that the platform and attached sensors accurately follow the target.

Pre-processing, using image enhancement algorithms, is also possible. This allows the target to be enhanced prior to the 'tracking process' and rejecting unwanted elements in the picture, or 'clutter'. A number of selectable options are also available to allow the operator to select 'positive contrast', 'negative contrast', or 'polarity independent' modes of operation.

Thanks to Octec for helping with this description.

Just a face in the crowd?

Even more remarkable to non-specialists is the face recognition capabilities that can be used to enhance CCTV surveillance systems. Notable in this connection is the Mandrake system developed in the UK by Software and Systems International. It is based on neural-network face recognition technology from Visionics in the USA.

The software automatically detects, locates and identifies human faces from live video or static images, using sophisticated algorithms for pattern recognition that mimic how the human brain recognises faces. This is carried out continuously and in real time. Results are tagged with a percentage score of how confident the computer is that the person spotted is one of the individuals in the database.

A high-profile system went live in the London borough of Newham in October 1998, linked to Newham's CCTV street cameras – now 240 in number – and a database of suspects supplied by the Metropolitan Police. At the launch, Newham's chief of security Bob Lack stated bullishly: "We have ten or so active muggers in and around our shopping centres," says. "As the system develops, facial images of known paedophiles may also be added to the automated watch list." He added that the computer had distinct advantages over humans. "If you stare at a screen for hours, you tend to glaze over," he said. "But never forget the need for the human element. None of our cameras has got down off a pole and arrested anyone yet," he added.

Applied responsibly, biometrics can be used in this way to combat crime, although civil liberties campaigners have voiced concern over the system's accuracy and what is done with discarded recordings. According to the council, the system does not need registration under the Data Protection Act since personal information is not held on the face recognition system; only photographs and police reference numbers are held.

Digital does it better

New-generation digital video recording systems have rendered older analogue CCTV systems obsolete, with their ability to monitor, archive and retrieve video data captured on camera. NiceVision, a system designed for organisations using multiple CCTV cameras in one or more locations, is a good exemplar of the new breed, providing 'high-motion' digital video and audio recording along with simultaneous playback.

Operated from a rack-mounted platform of NT-based PC computers, NiceVision offers a high number of camera and channel capacities. Each of the 32 channels can be configured independently to record up to 12 frames a second from each PAL colour camera connected, with pre- and post-alarm, and event-triggered recording options. This allows for optimal recording methods for both event and personal identification and offers enhanced security management capabilities.

NiceVision permits password-authorised users to search and find video segments for playback quickly from a desktop computer. In this way security managers and officers can review, analyse and respond to events immediately while continuing to record

The system's open architecture allows it to be integrated with existing access control, alarms and other intrusion detection systems where users can set different recording modes for each independent camera. Modular and scalable, the system also allows for multi-user control via local-area network (LAN), remote access via wide area network (WAN), and data transmission over fibre optics or ISDN lines.

George Orwell was right...

Where all this takes us is anyone's guess. Law-abiding citizens clearly have nothing to fear from enhanced levels of surveillance. Many indeed welcome any device that secures greater levels of law and order.

In any case, Orwell's prediction from his book '1984' may already be fulfiled – *There was of course no way of knowing whether you were being watched at any given moment; it was conceivable that they watched everybody all the time.*

Old news?

Spying on motorists goes back a lot further than most people would imagine. Doubtless few Automobile Association members are aware that their organisation's origins lie in a club that posted 'scouts' on main roads to warn motorists of speed traps back in 1905.

Setting that aside and confining our attention to electronic surveillance, the first introduction of CCTV for road traffic control was in Durham back in 1959 – a world first. The installation was by Pye of Cambridge, by the way.

By 1970, wide-area computerised traffic control with traffic signals linked to sensors in the roadway had been introduced in major British cities, enhanced with CCTV for visual observation of traffic flows.

Use of these cameras for surveillance of individual vehicles – and persons – dawned a little later. It was in the early 1980s that CCTV cameras were first linked to computers specifically for scanning and capturing vehicle registration numbers. The first experimental installations were on a bridge overlooking the M1 motorway in Hertfordshire near Junction 9 and at the Dartford Tunnel. While the latter's stated purpose was to catch stolen or suspect vehicles, it proved of great value for monitoring the movements of striking coal miners travelling north from Kent during the pit strike of 1984/85.

Public surveillance systems have grown considerably in sophistication, coverage and geographical extent since then. Roadways are no longer the sole targets of coverage. In many towns and cities entirely separate networks have been established for road

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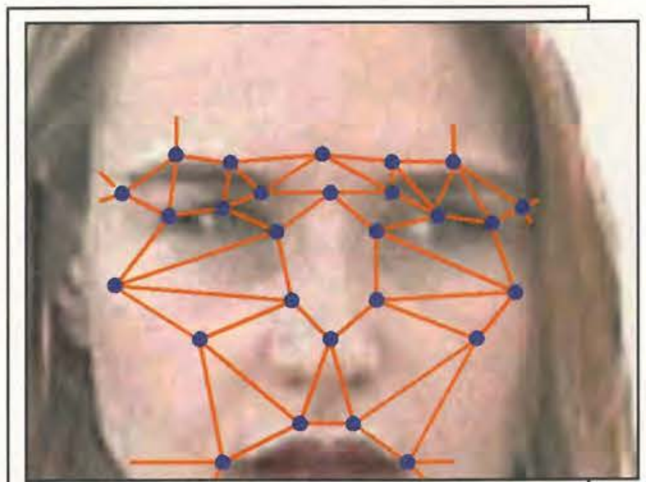

How faces are recognised

Fundamental to any face recognition system is the way in which faces are coded. Visionics' FaceIt uses Local Feature Analysis, or LFA, to represent facial images in terms of local statistically derived building blocks.

LFA is a mathematical technique based on the realisation that all facial images – or for that matter all complex patterns – can be synthesised from an irreducible set of building elements.

These elements are derived from a representative ensemble of faces using sophisticated statistical techniques. They span multiple pixels – but are still local – and represent universal facial shapes, but are not exactly the commonly known facial features. In fact, there are many more facial building elements than there are facial parts.

However, it turns out that synthesising a given facial image to a high degree of precision requires only a small subset – 12-40 characteristic elements – of the total available set.

Identity is determined not only by which elements are characteristic, but also by the manner in which they are geometrically combined – i.e. their relative positions. In this manner FaceIt maps an individual's identity into a complex mathematical formula that can be matched and compared to others.

Honeypot for perverts

"The cameras are already intruding into our private lives. Diana Sampson, who monitors CCTV for the London Borough of Sutton says, 'I know for a fact that one leisure centre has cameras in its women's changing room, monitored by men and they can do anything with those tapes.' CCTV is a honey pot for perverts.

One camera operator in Mid Glamorgan has been convicted on more than 200 counts of using cameras to spy on women, and making obscene phone calls from the control room."
www.videonetwork.org.

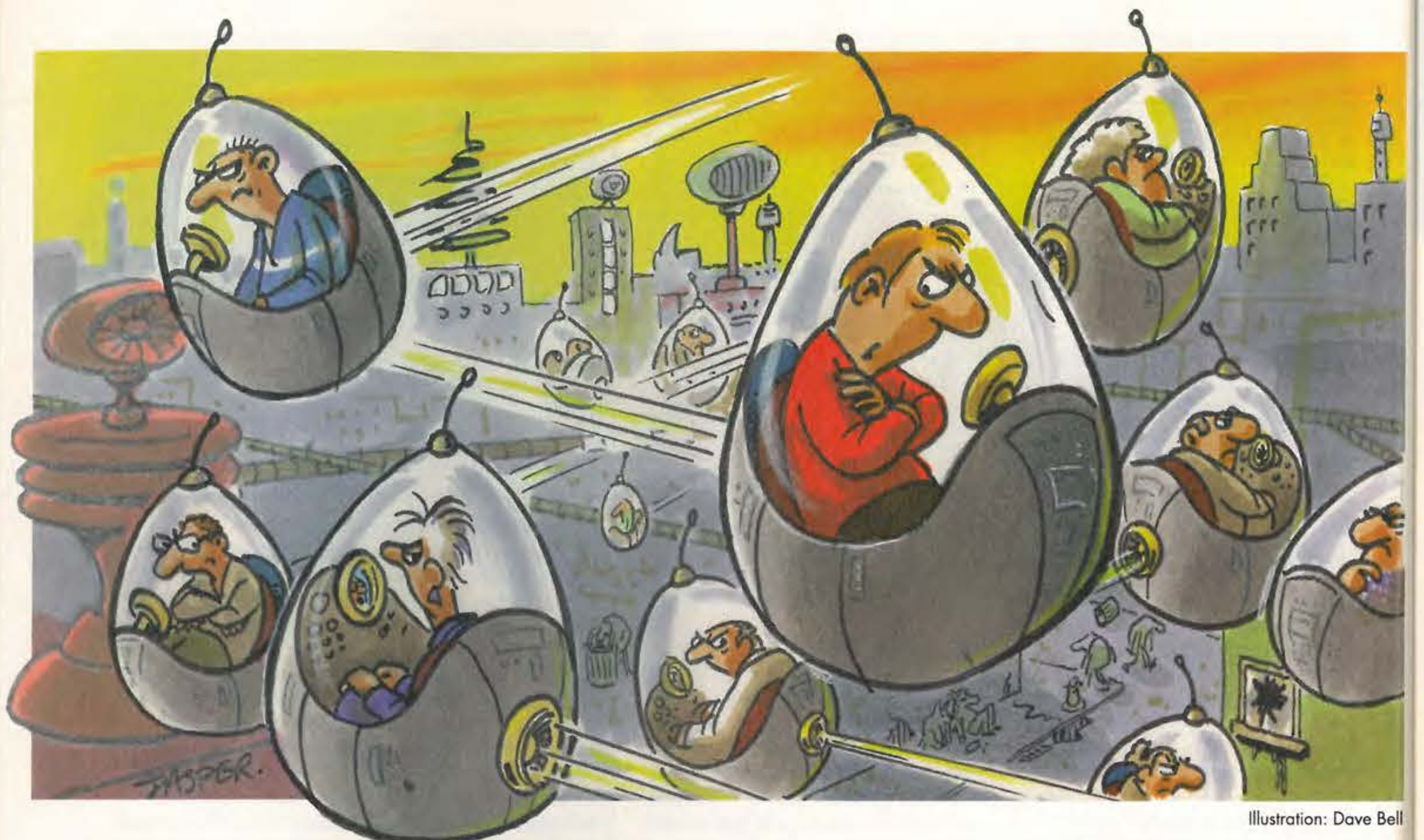

Illustration: Dave Bell

e-prophecies

So the revolution in communications has enhanced all our lives has it? Not necessarily so. It could lead to a breakdown in society. Melanie Reynolds explains.

Hollywood has always had a penchant for portraying future civilisation as being a mad, bad, dangerous place to be. Just consider 'The Terminator' and 'Mad Max'.

The movies always seem dark, portraying an existence full of menace where the fight is for survival. But it is, after all, just the movies we think. It will never really be like that. But could it be?

The advance of technology is usually regarded as improving the quality of our lives, but what if it is a catalyst for the deterioration of it instead? Technology does have the capability to increase the gap between the haves and the have-nots that already exists and with the increasing divide comes trouble – for all of us.

With the breakdown in relationships and family life, and the rise in single person households, the way we live our lives is already changing. Adding the buffer zone effect that communications technology can bring to this change gives you a society where people are isolated and personal interaction is made more difficult.

As society becomes more insular, the social pressures that tend to limit anti-social behaviour will be eroded, leading to a breakdown in society and perhaps the post-apocalyptic world of the movies will seem a bit too close for comfort.

Maybe this scenario seems a bit far-fetched and we will never live in a 'Mad Max' world, but it is a possibility the government is considering in a consultation paper called 'Just Around the Corner' by the DTI's Foresight crime prevention panel.

The report is seeking to provoke people into thinking about the next 20 years where society has evolved along these lines and crime and crime prevention are more technology based.

One of its theories is that technology allows people to choose to be isolated in public places. You can already see this happening with people using mobile phones. Although surrounded by others they are detached from the environment and even from their immediate group.

Where meetings would once be social and static, the progress of technology means they can now be personal and mobile, meaning people have a greater choice about who they meet and how. The down side of this means there is less social interaction.

The report says this could result in physical society becoming a more hostile place which people pass through and do not interact with. In this dehumanised environment, people seem less real to each other, which leads to 'more extreme reactions, interactions and a reluctance to intervene in conflict' when they happen.

Although technology will empower people, it could also further divide society into those who have the technology and those who do not. This technologically devoid underclass would have limited access to mainstream society and be a breeding ground for dissent and crime.

The Foresight report offers extreme scenarios of the future as food for thought. One involves us aspiring to live in safe ghettos, where we view strangers with suspicion and feel deeply unsafe when we venture beyond the walls. The outside world is full of danger – the result of the division of society due in part to technology.

It all sounds pretty dire. But, although technology will undoubtedly change our lives it does not have to change things for the worse. The answer lies with us and how we choose to manage the technology.

Being aware of what can go wrong is half the battle in preventing it from happening. ■

Crime in the e-world

Technology will result in crime taking on a different face. The theft of physical property could pretty much be stopped by technology, for example, by electronic tagging or by tying the operation of an item to an individual or a location. The item then has no value to a thief.

However, if property has no value, that does not mean crime will go away. Technology will be the facilitator of crimes instead.

Fraud is one crime ideally suited to the Internet. It could simply be for financial gain or to get information to facilitate this. False websites could record credit card details or personal and financial details which could be used for identity theft – identity and the way we prove it will become increasingly important in the future.

As individuals become more adept at using the technology, but less knowledgeable about how it works, there is a danger of being at the mercy of a small knowledgeable elite and those criminals without the knowledge may turn to violence or disorder.

The Internet being global also means that crime can go global, making traditional law enforcement unsuitable for policing it.

The speed at which technology crimes can be committed also makes catching the culprits far harder. To stand any chance against the criminals, the police will have to acquire suitable skills.

Behind big brother

...continued from page 523

traffic observation on one hand and for crowd and security control on the other.

The trigger for security surveillance was the terrorist threat; in 1994 a network of more than 100 street cameras were installed in the City of London for anti-terrorist surveillance purposes. Installations established since then have targeted theft and public disorder in shopping centres, car parks and in the streets at large.

Northampton: CCTV centre of excellence

Unlikely as it may sound, the otherwise unexceptional Midlands town of Northampton is the most densely surveyed town of Britain. Its streets and car parks are scanned by 200 cameras – rising to 250 within 12 months – outnumbering those of any other town in Britain and making it the largest urban system outside London.

Car park cameras are interfaced to the Police National Computer for detecting stolen or wanted vehicles. Public reaction is positive – the system is responsible for an average of 100 arrests a month. And study teams have come from the USA, Canada and Italy to see this remarkable centre of CCTV excellence.

CCTV evidence is legally conclusive

Legal history was made in March of this year when confirmation was given that digital CCTV recordings had provided the crucial evidence that secured the conviction of three killers. The case concerned Bradley Bolton, murdered in July 1999 in High Wycombe town centre. This is one of the first times that footage from a local authority-run digital CCTV system has been used as evidence in a major prosecution case.

Wycombe District Council installed the equipment from NiceVision in 1998 to record a number of public areas. Detective Inspector Ashley Smith, who led the murder investigation, commented, "CCTV recordings are a crucial weapon in criminal investigation, and we always view them immediately whenever they are available. These digital CCTV recordings provided excellent evidence and some of the clearest CCTV images we have seen. They allowed the jury to have clear sight of the incident itself, providing a brutal, yet conclusive picture of the event."

The government's view on CCTV

CCTV works as an effective crime reduction and detection tool – particularly when used as part of a wider crime reduction strategy. It has helped to reduce crime in many parts of the country and the current CCTV initiative will bring the benefits of CCTV to a wider community.

Under the Crime Reduction Programme, some £153million is available for schemes in England and Wales for the period up to March 2002, with another £17 million available for Scotland and Northern Ireland. Initial priorities are tackling crime problems in housing areas and measures to improve the security of public car parks.

Closed-circuit tv must also retain public confidence, operating under detailed codes of practice to protect individual rights to privacy and adhere to the principles of the Data Protection Act 1998. It must also meet the requirements of the Human Rights Act 1998. ■

Beginners' corner

Ian Hickman has produced a number of circuits for electronics undergraduates – or anyone – to build, troubleshoot and test. Biased towards rf applications, the circuits become gradually more complex and are chosen to be interesting, as well as instructive. This month's circuit is simple and suitable for those with little or no prior experience of constructing and trouble-shooting hardware. Apart from the components themselves, all that is needed is a dual power supply or batteries, and an oscilloscope – the electronic engineer's magic lantern.

This month's project is an audio oscillator. Oscillators of one sort or another are key components in so many electronic applications, from PCs to mobile 'phones to a simple superhet radio such as the humble pocket 'trannie'. Traditionally, an oscillator used a single active device, such as a single transistor, or in earlier times, a valve.

The following circuit uses an operational amplifier or 'op-amp', resulting in an audio oscillator of good performance but low circuit complexity. A typical op-amp contains a dozen or more transistors, plus a handful of other components such as resistors and the odd capacitor, all implemented in the same tiny slice of silicon.

With semiconductor manufacture and testing so highly automated, an op-amp, while still more expensive than a single transistor, really costs very little. And four op-amps in a 'quad' package cost little, if any, more than four individual transistors.

The integrated circuit

Op-amps were produced originally as modules built up from discrete components. The first readily available integrated circuit op-amp was the 709, produced in bipolar technology.

I remember pouncing on it with glee in the 1960s, when it first became available. It provided me with a replacement for a discrete op-amp, in a 75Ω, 140Ω and 600Ω standard milliwatt test set I had designed and that was bought by the Post Office in large quantities.

Subsequently, the IC became available from many manufacturers as the LM709, the μA709, and various other type numbers. It was widely used, despite various shortcomings, such as its tendency to 'latch-up'.

With this device, the sign of the gain reverses if the limited common-mode input voltage range is exceeded, turning negative feedback into positive! The later 741 op-amp was also bipolar, but unlike the 709 was latch-up free, making it very useful. It was also internally compensated for unity gain, unlike the 709. This was useful, but non-optimum for use at higher gains.

Later still, CMOS devices, such as the CA3130 and others, became available, offering very much higher input resistance than bipolar types.

> ### Op-amp alternatives
> This circuit was designed to use a TL084 JFET-input quad op-amp integrated circuits, but the TL081 single op-amp version, or the TL082 dual op-amp would do equally well. Pin connections of all three are shown in **Fig. 1**; there is even a TL084x2 octal op-amp in a 30-pin package, though I have never actually seen one.
>
> The connections shown are almost universally standard for singles, duals and quads, and almost any internally compensated op-amp, from the 741 onwards, should work in this circuit.

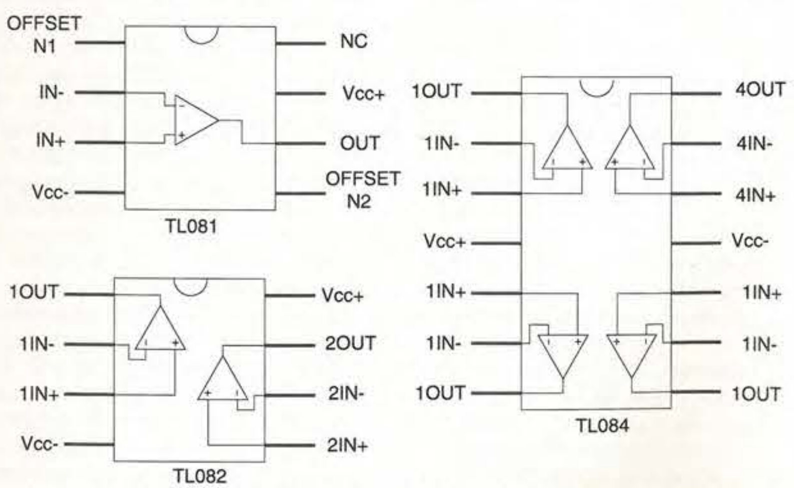

Fig. 1. Showing the pin connections of the TL08x series op-amps. Most op-amps will suffice in this application, and most op-amps have the same pin-out as the TL08x series.

The circuit described below was used as one of the mini-projects for the RF Club mentioned in an earlier article.

How the circuit works

The following describes how the circuit works. But you may want to get started straight away, build the circuit and get it working before reading further. That's fine, but I hope that at some point, you will take the trouble to understand just what makes it all work.

And you might find you *need* to understand, in order to help you trouble-shoot your circuit if it doesn't work. Even if it works first time, you should still want to know just how, for such is the inquisitive nature of an innovative circuit designer.

Figure 2 shows the Wien bridge, invented not surprisingly by a certain Herr Wien. Mr Vienna's bridge was designed not for making audio oscillators, but for measuring audio frequencies, in the days before frequency counters.

At the frequency *f*Hz, where the reactance of *C* in ohms, is numerically equal to the resistance *R*, the voltage across the earpiece detector is zero. Adjusting the value of the two resistors, *R*, keeping them always equal, thus gives a null at the frequency where $f=1/(2\pi CR)$. How this comes about is explained in a little more detail later on.

Figure 3 shows the circuit of an audio oscillator based on the Wien bridge. With the component values shown, it produces a sinewave output of 1.59kHz. This frequency is nominal, the actual value depending upon the tolerances of the components.

Typical tolerance values are ±1% for metal film resistors, ±2% or ±5% for carbon film types. But for capacitors, ±1% tolerance is rare and usually only available in polystyrene- or mica-dielectric capacitors. A tolerance of ±5%, ±10% or ±20% is more typical for the common metallised film types, and worse still for electrolytics.

The circuit oscillates because there is positive feedback from the output, in the form of a potential divider network. The upper arm of this network consists of a resistor and a capacitor in series, and the lower arm of a resistor and a capacitor in parallel.

Analysing the circuit

Figure 4 shows the relationship between the voltages across the arms and the current through the components, at the frequency where the reactance of 1nF, in ohms, is numerically equal to the resistance 100kΩ.

At this frequency, the voltage drop across C_2 must numerically equal that across R_2. But whereas the drop across the resistor is in phase with the current, the voltage drop across C_2 will lag the current through it – and the voltage across R_1 – by 90°.

The impedance of the R_2+C_2 series arm will be the sum of the resistance and the reactance. Although these have the same magnitude, being in quadrature, they must be added root sum of squares-wise (RSS), giving the value 141.4kΩ, i.e. $100k\Omega\times\sqrt{2}$.

For the C_1/R_1 parallel arm, the admittance is given by RSS adding the conductance and susceptance, here both equal to 1/100kΩ. Converting the answer back to impedance gives 70.7kΩ, or just half that of the series arm. So, since the same total current flows through each arm, the voltage drop across the shunt arm is just half that across the series arm.

Furthermore, since both arms present a phase angle of 45°, the voltage at their junction will be in phase with the applied voltage. Thus assuming there is a sinewave of 1.59kHz at the op-

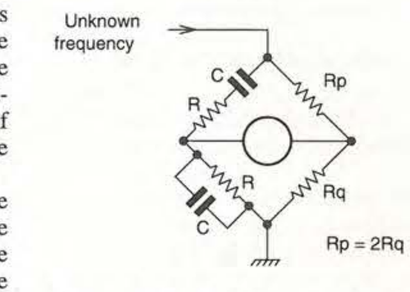

Fig. 2. The Wien bridge is at the heart of this design, but it was originally invented for measuring audio frequencies. Source and detector may be interchanged.

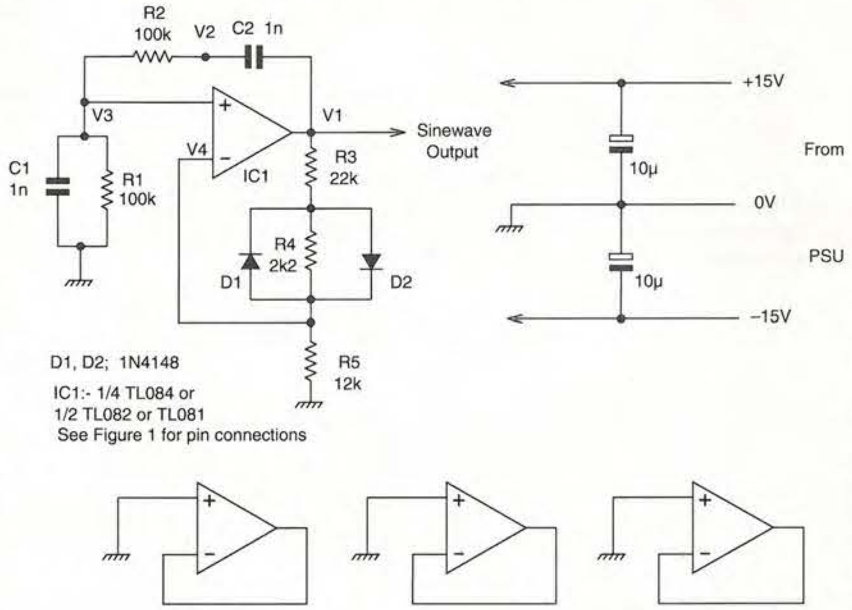

Fig. 3. An audio frequency oscillator circuit together with power supply decoupling, top right, and wiring for the unused sections of a quad op-amp.

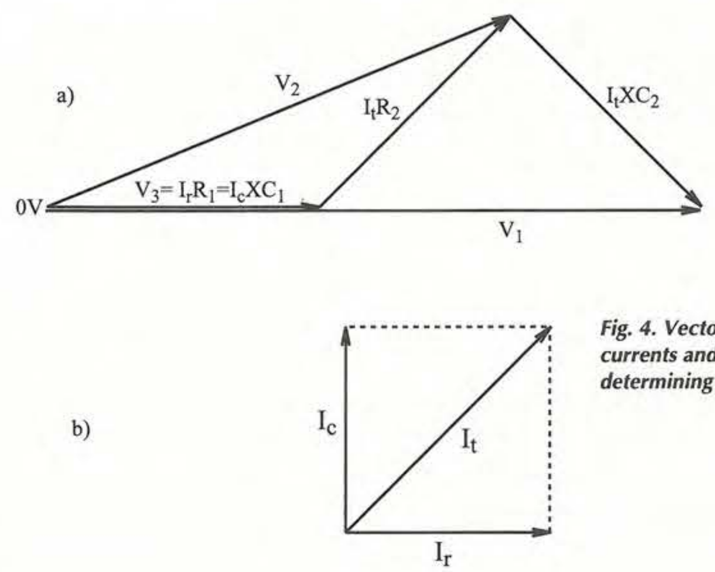

Fig. 4. Vector diagram showing the currents and voltages in the frequency determining arm of the circuit, Fig. 3.

amp's output, there will be a one third size replica at its non-inverting input. All this is actually much clearer from Fig. 4.

An alternative safe start-up method

If the PSU does not have an adjustable current limit, and like some units, is not adjustable right down to zero output voltage, an alternative strategy can be used.

Simply connect a 470Ω resistor in series with the +15V supply lead, and similarly for the –15V supply. The circuit should draw not more than about 12mA if using a TL084, or a half or quarter of this if using a dual or single op-amp. Use 1kΩ resistors for a dual, 1.8kΩ for a single op-amp. If the current drawn is as expected, the resistors can then be removed.

Creating a vector diagram

When drawing a vector diagram such as Fig. 4, to analyse the action of a circuit, the secret is to start at the right place.

In this case, V_1 is definitely the wrong place. Start with a voltage that is simply related to 0V ground, in this case, V_3 in Fig. **4a)**. Immediately, the currents I_r and I_c through R_1 and C_1 can be marked in, as in **4b)**, giving also the total current I_t. This flows through R_2 and C_2, so the voltage drop I_tR_2 across R_2 and I_tXC_2 across C_2 – where XC_2 is the reactance of C_2 at *f*Hz, namely,

$$\frac{1}{2\pi fC_2}=R$$

can now be marked in, in 4a).

The vector sum of these three voltage drops equals V_1, which has been shown slightly offset in 4a), for clarity. You can see that while V_1 and V_3 are in phase, a little third-°form geometry shows that V_2 actually leads them by 22.5°.

If the resistive potential divider at the op-amp's inverting input also results in a one third size replica there, the signals at the two inputs will be identical, the Wien Bridge is balanced. Thus the op-amp sees only a 'common-mode' input, and op-amps have – ideally – zero response to common mode inputs.

If however the voltage at the non-inverting input is slightly *less* than a third of that at the op-amp's output, then there is a net input in phase with the output. In view of the op-amp's very large gain, this is more than enough to produce an output at the said frequency.

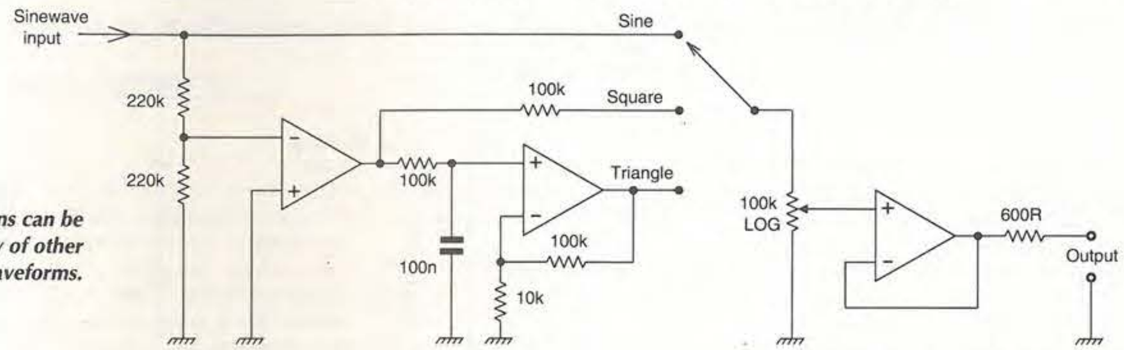

Fig. 5. Spare op-amp sections can be used to produce a variety of other waveforms.

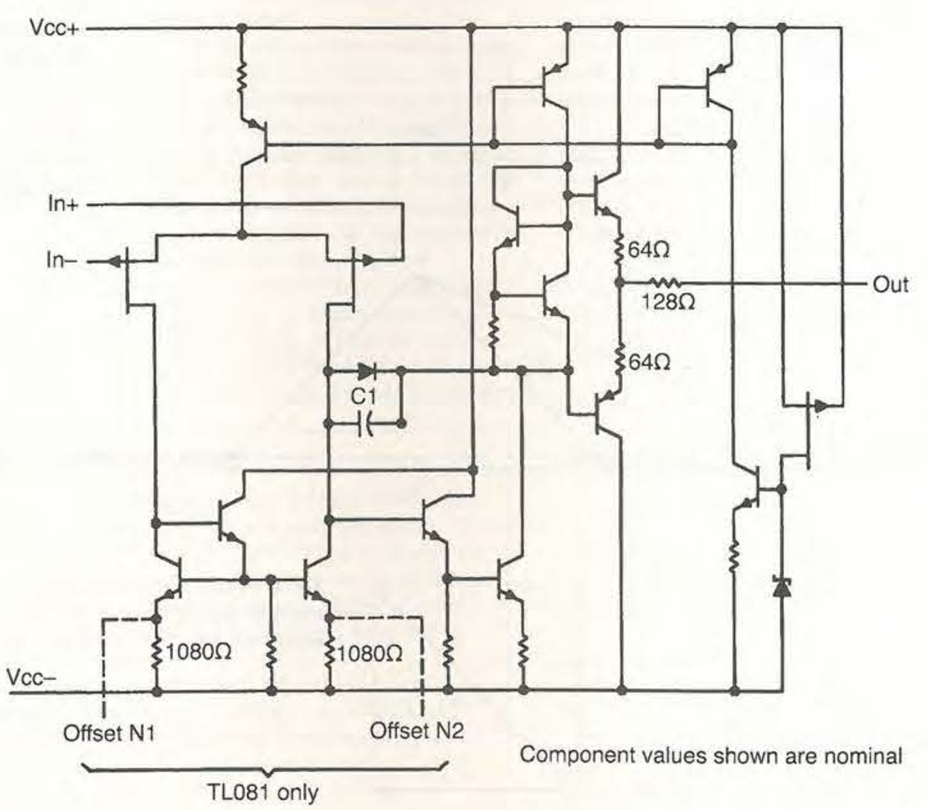

Fig. 6. The long-established and widely used TL081/82/84 series op-amps feature very low input bias and offset currents, thanks to their P-channel JFET input stages. A bipolar output stage contributes high drive capability and the overall design, shown here, results in a 13V/ms slew rate and a total harmonic distortion figure of just 0.003%. (Reproduced courtesy of Texas Instruments)

The trick therefore, to provide just enough net drive to give a modest, stable value of output voltage, is to make the attenuation of the resistive arm adjust itself to a value marginally in excess of ×3.

When the circuit is first switched on, before it has a chance to start oscillating, the resistive arm attenuation factor is,

$$\frac{22k\Omega+2.2k\Omega+12k\Omega}{12k\Omega}$$

which is 3.0167. Thus the positive feedback exceeds the negative, and the circuit will start to oscillate. But as the oscillation builds up, a point is reached where the voltage drop across R_4, and hence across the diodes, reaches something like 600mV. Thus the diodes start to conduct, one on each alternate polarity swing.

When the diodes conduct, their low incremental or 'slope' resistance effectively shorts out R_4. Thus for part of each half cycle, the resistive arm attenuation factor becomes approximately,

$$\frac{22k\Omega+12k\Omega}{12k\Omega}$$

which is 2.833. Now, the negative feedback exceeds the positive, and the amplitude of the oscillation cannot build up much further. In fact, the amplitude will settle at that level where the negative feedback attenuation at the fundamental frequency component of the output is very close to, but marginally greater than three, averaged over the course of a complete cycle.

Note that the attenuation is only as low as a factor of 3 at the frequency *f*Hz. At this point, the reactance of C_1, C_2 equals the resistance R_1, R_2, namely where,

$$\frac{1}{2\pi fC}=R$$

It increases as you move away from *f*, either up or down in frequency. In fact, the attenuation of the R_1 C_1 R_2 C_2 arm is infinite at 0Hz, due to C_2, and also at infinite frequency, due to C_1. So with the attenuation to the inverting input marginally in excess of 3, *f* is the only frequency at which the circuit can possibly oscillate.

The circuit is thus a 'slightly-out-of-balance' Wien bridge, the out of balance voltage being amplified for driving the input to the bridge.

Now try making one...

The circuit can be built up in various ways. A scrap of 0.1 inch matrix copper strip-board, cut from RS stock number 433-595 or 433-602 can be used; the same material, in different size sheets, is available from all the usual electronic components catalogues. Alternatively, you can produce a dedicated printed circuit board, assuming you have the necessary facilities.

But probably the most convenient way is to make the circuit up on 0.1in matrix plug-type prototyping board, after the style of RS 488-618 or 488-933. This has the advantage that the component leads do not need to be cut. They can therefore be straightened out again after use, and the components returned to stock to live another day.

With a circuit operating at low frequencies such as this, layout is completely unimportant, and component leads can be simply bent as required, to plug in wherever convenient.

...and getting it to work

The circuit may not work first time, due to an accidental misconnection, and this could conceivably damage the IC. The first-time power-up can be safely achieved in various ways. For example, a twin power supply unit, or PSU, having an output voltage adjustable right down to zero, and an adjustable current limit is ideal.

First select output tracking – also called master/slave operation – where a single knob controls both the +15V and the –15V output. Set the master to +15V with the prototype circuit disconnected.

Now set the variable current-limit control to minimum, fully anticlockwise. This will cause the output voltage to collapse to zero.

The circuit is then connected and the PSU's output switched on, advancing the current limit control cautiously while keeping a close eye on the current meter. If the current does not exceed the expected ten milliamps or so as the voltage rises to the preset ±15V levels, then all is well.

Even if the circuit is not actually working, at least it is safe to leave on while trouble-shooting. If on the other hand, the current increases alarmingly while the supply voltage is still only a volt or so, it is wise to switch off and recheck the circuit.

If you don't have a suitable power supply, then use the procedure outlined in the separate panel entitled, 'An alternative safe start-up method'.

And if it doesn't

An oscilloscope should reveal a sinewave at about 1600Hz, centred about 0V ground, at the output of the section of the TL084 op-amp in use.

If the dc or average level at the output is not 0V – if it is 'stuck high' or 'low' at near supply rail level – then the circuit is probably wrongly connected. Alternatively, the op-amp is dud, but this is exceedingly unlikely if the device is new.

If the dc level is 0V, but there is no oscillation, then either there is a misconnection, or component tolerances have conspired to result in more negative feedback than positive.

The resistors should preferably be 1% metal film types. Even so, in the worst case, the resistive arm attenuation could be less than 3:1. Swapping over C_1 and C_2 may do the trick; if not then it will be necessary to connect a high value resistor of around 100kΩ in parallel with R_5. The resistor's value can then be increased until the output amplitude is, say, 10V peak-to-peak.

On the other hand, should the oscillation build up to nearly 30V peak-to-peak, with the peaks clipped, then a high value resistor should be connected in parallel with R_3.

Add-ons

When using a TL084, it is good practice to look after any unused sections properly, as indicated in Fig. 3.

But once you have got the oscillator section working, the spare sections can usefully be employed in one or two extensions to the circuit.

Such enhancements are shown in **Fig. 5**, and include a squarewave output stage, and a buffered passive integrator giving a triangular output.

The triangular wave provided by this is only an approximation to the ideal, albeit a good one. But this arrangement does not have the disadvantage of an active integrator – namely a propensity to integrate any offset or asymmetry, resulting in its output becoming stuck at one or other supply rail.

A stage providing a variable output voltage at 600Ω output impedance completes the design. ■

In this series

As explained in a preliminary article in the May 2000 issue, this series is intended to help students – and anyone interested in getting to grips with RF design – a background in practical electronic circuitry and troubleshooting.

The series was originally developed as a response to the government's RF Engineering Education Initiative. Below is a list of the two tutorials that have already appeared, together with my plans for future articles in the series – 'Beginners' corner'.

1. Timer circuit using the 555, June issue
2. Audio oscillator – Wien bridge based, this issue
3. h_{fe} tester
4. Radio-frequency oscillator, Colpitts type
5. Audio frequency filter/oscillator – state variable based
6. Capacitance meter
7. Radio-frequency oscillator/receiver involving negative resistance

Tini Java

Java expert Les Hughes has been experimenting with a tiny controller designed for Internet connection. Although very low cost, this controller is a complete computer with Internet, network and serial i/o capabilities, giving it huge potential for remote i/o and telemetry applications.

Much noise has been made concerning Java. Although originally conceived as a technology capable of powering embedded systems, it is only recently that Java devices have appeared on the market. One of the most interesting of these is the Tiny InterNet Interface – or TINI – from Dallas Semiconductors.

TINI executes a Java Virtual Machine, which in turn executes Java 'bytecodes' – in a similar manner to any other Java platform. However, although TINI runs Java, it is not a hardware implementation of a VM. Instead, the current TINI hardware is based on the Dallas 80C390 micro controller.

The TINI VM, operating system and various user programs are loaded into flash memory. This enables simple updates, which are freely downloadable from the project web site – www.ibutton.com/TINI.

The current TINI board incorporates a plethora of external interfaces: 10baseT ethernet, Dallas one-wire, I^2C and RS232. Besides the processor, the TINI board also contains 512Kbyte of flash memory, 512Kbyte of NVRAM and an RTC. Processor address, data and control busses are brought out to the edge of the board for custom expansion – e.g. memory expansion or custom i/o. That's quite a few features for a device that is no bigger than a normal PC SIMM and only costs $50.00!

At the time of writing, TINI firmware was nearing beta 3. The processor board has been slightly redesigned to fit a more standard 72-pin SIMM socket rather than the original 68-pin connector. Although TINI is still beta for both hardware and firmware, recent releases have enhanced performance, stability and features.

Of course, as with any beta product, revisions often occur and APIs and specifications change, based on

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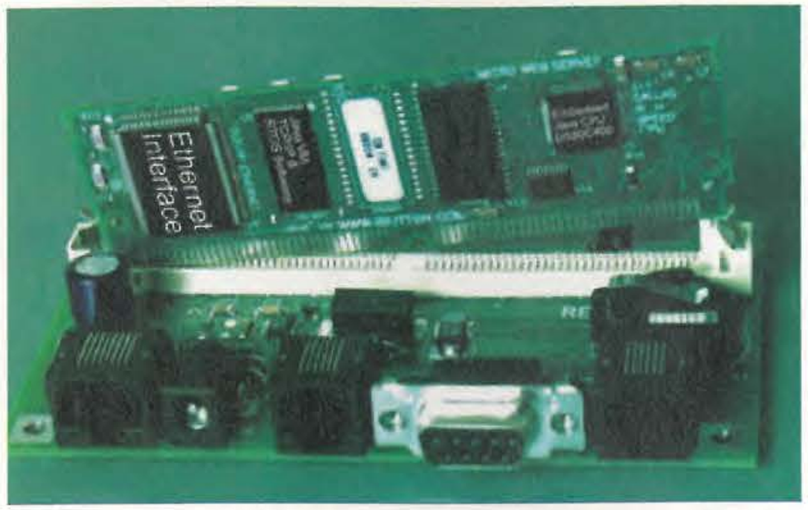
Free software

All of the software required to develop applications for TINI is available free of charge from various Internet sites. Installing and configuring your environment in order to get TINI up and running consists of a number of tasks. Guillaume Fournier's excellent guide at

http://www3.sympatico.ca/guillaume.fournier/

describes in detail the process that you should follow in order to be able to boot your TINI.

user feedback. In a similar manner to open-source software development, TINI has been subject to the input of a large community. This has enhanced the end product in a way that is not possible within a closed environment. Perhaps this open development is the most unusual aspect of the project.



TINI – for around $50, you get 10baseT ethernet, Dallas one-wire, I²C and RS232 interfaces, a processor, 512Kbyte of flash memory, 512Kbyte of NVRAM and an RTC. At its core is a soft Java virtual machine that's easy to update.

Getting started with TINI

In order to take full advantage of TINI's network abilities – it is the tiny Internet interface after all – you will need to connect TINI to a LAN. Many home users won't have their own IP network but this need not put you off. The box 'Establishing a network' shows how simple and cheap it is now to 'get wired'.

As has become traditional in the world of computing, our first TINI program is a network server version of the 'Hello World' classic. Groans aside, this simple application serves a number of purposes.

Firstly, the procedure to compile, build and load an application onto TINI is somewhat different from that of a normal Java application. A simple application can help with establishing that all is working correctly before we attempt something more extravagant.

Secondly, the program demonstrates a standard way of writing a multi-threaded network server. Next time, we'll be looking at something far more interesting but until then...

Listing 1 is the source code for our Hello Server. As mentioned, this program simply waits for a network connection, says Hello to the connecting machine, then closes the connection. Most Internet services such as web servers, etc., operate in a similar way.

Back to the example. Since this program uses Java's network and input/output libraries, these are imported at the top of the file. Next, define the name of the application – i.e. HelloServer. The main method forms the entry point to the program; this method is called by the Java virtual machine when it starts our program.

Our main method defines a `Socket` field called `client`, which is used for incoming connections. However, in order to receive these connect requests from clients, we have to use a '`ServerSocket`' to manage the process.

A `ServerSocket` 'binds' to a particular 'port' and listens for connections. When a `ServerSocket` accepts a connect request from a distant client, it passes the connection on, in the form of a `Socket` object, and goes back to listening. In this way, you don't have to wait for a client to finish using the Server program before others can connect.

It's a bit like phoning your bank's call centre. You dial a single number and your call is routed through to any available operator, allowing more calls to come in.

In order to be able to process multiple connections simultaneously, you can take advantage of Java 'threads' and make our server multithreaded. This is what's happening in the statement new `HelloServer(client)`. Our main method takes the `Socket` returned by the `ServerSocket` and creates a new `HelloServer` object to handle the connection. This object automatically starts a new thread upon creation and starts talking to the client.

This action can be seen in the constructor methods,

```
serverThread = new
Thread(this);
serverThread.start();
```

method calls.

The `start()` method eventually calls `run()` method. The run method first asks the `Socket` for something to write to – the `OutputStream` – and then turns this into something that can be printed to. You then simply print a message to this `Writer`.

Once we've sent our message we wait for a second, to allow you to read the message and then, rather rudely, we close our output channel and the socket, thus cutting off the client before they can respond to our `Hello`.

Building the application

Once you have entered the `HelloServer` code, you will need to turn it into a format suitable for the TINI.

First, compile the `HelloServer.java` file using,

```
javac -bootclasspath
<TINIPATH>/tiniclasses.jar
HelloServer.java
```

replacing the *<TINIPATH>* tag with the location of your TINI installation, for example, `C:\tini`.

The `-bootclasspath` directive allows the compiler, which is written in Java, to use a different set of core classes (java.lang, java.io, java.net, etc.,) from those compiled into the application. You won't be running under the standard JVM

Establishing a network

While it is not actually necessary to network TINI in order to start experimenting, you'll be missing out on the whole idea that makes TINI so special – an embedded network node that runs Java.

Networking hardware has reduced in price dramatically in recent years. Browsing any of the monthly PC magazines shows a whole host of network cards for less than £15.00 and small 'micro' hubs – i.e. those with somewhere between 3 and 10 ports – for less than £30.00.

While it is beyond the scope of this article to delve into the intricacies of network engineering and the selection of networking hardware, we can examine the steps required to establish a simple TCP/IP network at home.

Of course you'll need a network card for your PC. I use a £10 NE2000 clone. Any 10baseT card should do, as long as it's supported by your chosen operating system.

You have two basic hardware options for connecting TINI to your personal computer. You can either use a crossover network cable or buy a small network hub and patch leads.* The crossover network cable has the advantage of being the cheapest but a small network hub offers far greater flexibility for not much more outlay.

Setting up your network

First, you'll need to ensure that you have TCP/IP networking installed for your chosen development platform – but this is the easy part as most systems come pre-configured with this option. If you dial into the Internet, you almost certainly have TCP/IP installed. If not, for a Windows platform, you can add this option in Control Panel -> Network -> Protocols.

Once you have all of the hardware installed and connected, you will need to configure each of the machines on the network with an address. If you use your PC for surfing the net then you should assign a network address from the range 192.168.0.0 to 192.168.255.255. These are from a range of special addresses that, if they 'escape' from your private network onto the Internet, can't cause any damage.

Addresses ending in '.0', '.1' and '.255' should not be used as they have special meaning on the network. For the rest of this article, I'll assume that you've chosen 192.168.0.50 for your PC and 192.168.0.100 for TINI

Addresses are assigned to PCs in Control Panel -> Network. Find the TCP/IP protocol that maps to your network card – not to your dial-up network adapter! Select properties and then the IP address tab. Enter your chosen IP address in the box provided and 255.255.255.0 into the 'subnet mask'. You can leave all of the other boxes empty. You can check your settings by using the commands winipcfg on windows 9x and ipconfig on NT.

TINI's IP address is set using the ipconfig command thus:

```
TINI /> ipconfig -a
192.168.0.100
```

You will need to login to your TINI board using JavaKit over a serial line in order to run ipconfig. Of course, you should have installed the firmware and booted TINI first!

Once you have two devices configured on the network, try pinging each one in turn from the other, e.g.,

```
C:\> ping 192.168.0.100
Pinging 192.168.0.100 with 32
bytes of data
Reply from 192.168.0.100:
bytes=32 time<10ms TTL=64
```

```
TINI /> ping 192.168.0.50
Got a reply from node
192.168.0.50/192.168.0.50
Sent 1 request(s), got 1
reply(s)
```

This shows that all's OK between the PC and TINI and *vice versa*.

*The author means a UTP crossover cable. Note that there are NE2000 clones that only have BNC connectors. Ed.

So what can I do with it?

Interestingly, Tina's manufacturer, Dallas Semiconductor, is still a technology driven company. From the outsider's view – and this is often reflected in Dallas engineers' posts to the TINI mail list – it seems as if the company produces numerous clever solutions just waiting for a problem to come along.

TINI is more than just a rather cool toy though; it is a near-complete implementation of the J2ME platform albeit in pre-production, beta form.

At present, judging from the 'TINI-users' list, real-world TINI applications range from data loggers, security systems and network server monitors to GPS-aware systems and simple dial-up gateways. TINI could be applied in almost any scenario requiring a networked controller; from remote surveillance with an off-the-shelf webcam and wireless LAN technology to home automation using a DS1920 and Tesco Direct to ensure that you always have a good supply of cold beer!

Listing 1. HelloServer.java. This is a simple server that says 'Hello' to any clients.

```
/* HelloServer.java
*/
import java.io.*;
import java.net.*;
public class HelloServer implements Runnable {
    public static void main(String args[]) {
        Socket client;
        try{
            //Create a new server listening on port 1234
            ServerSocket server = new ServerSocket(1234);
            while(true){
                //wait for a call from a client
                client = server.accept();

                //start a new HelloServer for this client
                new HelloServer(client);

            }
        }catch(Exception e) {
            //No error handling - it's only an example ;-)
        }
    }


    Thread serverThread;
    Socket sock;

    public HelloServer(Socket sock) {
        this.sock = sock;
        serverThread = new Thread(this);
        serverThread.start();
    }

    public void run() {
        try {
            //Say hello, wait a bit and then disconnect
                PrintWriter out =
                        new PrintWriter(sock.getOutputStream());

            out.println("Hello from Tini!");
            Thread.currentThread().sleep(1000);
            out.close();
            sock.close();
        }catch(Exception e) {
            //No error handling - it's only an example ;-)
        }
    }
}
```

remember; you'll be using the special TINI VM so special core libraries are needed.

This should produce a file called `HelloServer.class`. Now we need to convert this class file into a .tini file,

```
java -classpath <TINIPATH>\tini.jar
TINIConvertor -f HelloServer.class -o
HelloServer.tini -d
<TINIPATH>\firmware\tini.db
```

again replacing the *<TINIPATH>* tag with the location of your TINI installation.

This command should produce a HelloServer.tini file. You will now need to FTP this class onto your TINI board. Windows and Linux both include command-line FTP clients, or you might like to use something like CuteFTP.

Nearly there! Telnet to your TINI board:

```
C:\>telnet 192.168.0.100
```

(use the standard username root and the password tini)

After logging in, start the HelloServer with the command

```
java HelloServer.tini &
```

Now open another telnet window and connect to your TINI on port 1234:

```
C:\>telnet 192.168.0.100 1234
```

TINI should say Hello and then, after a second or so, disconnect you.

Until next time

That's all for now. Next time, I'll be looking at some of the more useful features of TINI, including the various web-enabling technologies available. I will be showing how to hook up the one-wire iButton interface to a web-server, an RS232 terminal and an i/o port to create a simple web-enabled security system. ■

Resources

http://www.ibutton.com/TINI	TINI homepage – hardware, firmware, mail lists etc.
http://www3.sympatico.ca/guillaume.fournier/	Excellent 'Getting Started' resource
http://java.sun.com/	Source of all things Java inc. JDK, javax.comm. required for use with TINI
http://www.apms.com.au/tini/	Another good TINI resource site

BOOK TO BUY

The definitive biography of the century's godfather of invention–from the pre-eminent Edison scholar "Israel's meticulous research and refusal to shy away from the dodgier aspects of Edison's personality offers a fresh glimpse into the life of the inventor."– New Scientist

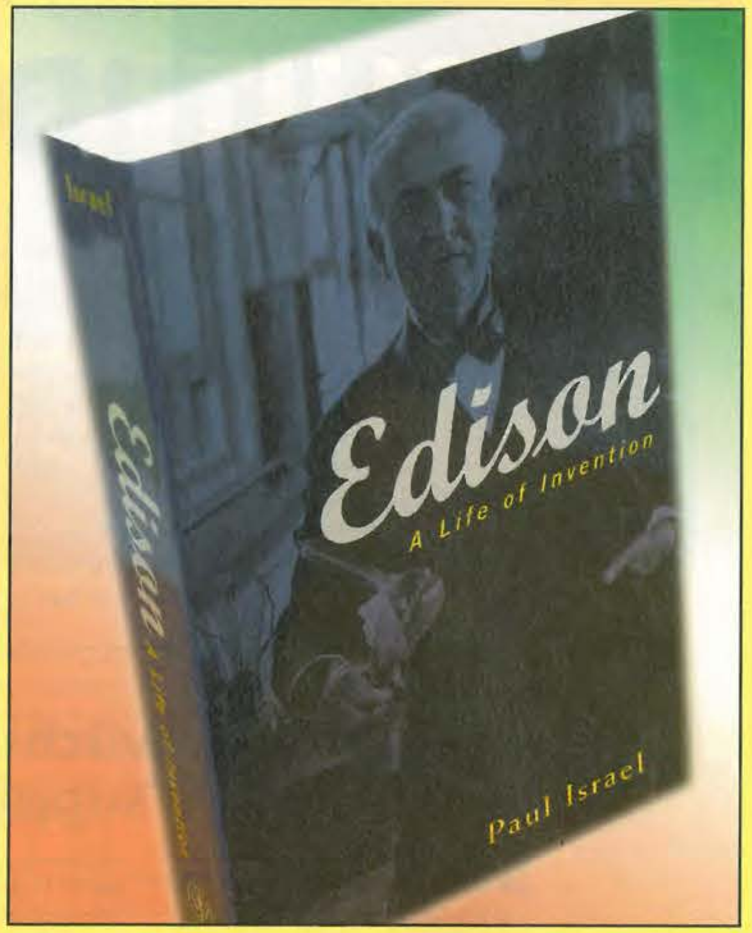
"Remarkable."– Nature

"An authoritative look into Edison's working methods, here leavened by enough personal detail to give the achievements shape."–Publishers Weekly

"Israel's book should go a long way toward taking Edison out of the shadows and placing him in the proper light."–Atlanta Journal-Constitution

"Exhaustively researched, with strong emphasis on Edison's methods and achievements."–Kirkus Reviews

The conventional story of Thomas Edison reads more like myth than history: With only three months of formal education, a hardworking young man overcomes the odds and becomes one of the greatest inventors in history. But the portrait that emerges from Edison: A Life of Invention reveals a man of genius and astonishing foresight whose career was actually a product of his fast-changing era. In this peerless biography, Paul Israel exposes for the first time the man behind the inventions, expertly situating his subject within a thoroughly realized portrait of a burgeoning country on the brink of massive change. Informed by Israel's unprecedented access to workshop diaries, notebooks, letters, and more than five million pages of archives, this definitive biography brings fresh insights to a singularly influential and triumphant career in science.



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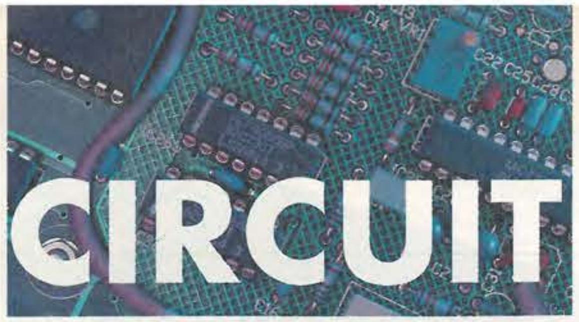


CIRCUIT IDEAS

Fact: most circuit ideas sent to *Electronics World* get published

The best circuit ideas are ones that save time or money, or stimulate the thought process. This includes the odd solution looking for a problem – provided it has a degree of ingenuity.

Your submissions are judged mainly on their originality and usefulness. Interesting modifications to existing circuits are strong contenders too – provided that you clearly acknowledge the circuit you have modified. Never send us anything that you believe has been published before though.

Don't forget to say why you think your idea is worthy.

Clear hand-written notes on paper are a minimum requirement: disks with separate drawing and text files in a popular form are best – but please label the disk clearly.

Low-power switch-mode mains power supply

Small mains transformers of about 1W rating tend to run hot and produce a large external hum field. This switching power supply provides an alternative.

Keeping the pulse length very short in the output device allows the use of a low inductance toroid normally found in low voltage regulators. Obtaining a suitable output is simply a case of winding a few turns of insulated wire over the top of the original winding. Thus this circuit is especially suitable where an output with a very high degree of isolation is required, perhaps up to several kilovolts.

Omitting the high-voltage smoothing capacitor after the bridge rectifier saves one somewhat undesirable component and increases efficiency – although reducing output; however this means the low-voltage outputs will need smoothing to low-frequency standard.

About one watt can be expected with the values shown, but output can be increased to the point where heating of the toroid becomes a problem by increasing the value of the capacitor coupling the Schmidt oscillator to the tripled buffer.

If supplying low power – perhaps as a built-in battery eliminator or nickel-cadmium battery charger – the circuit can easily be built into a 35mm film container. The 4093 was used because several were to hand. More logical choices might be 40106 or 74C14 hex Schmidt inverters.

A surprisingly small ferrite toroid of the type normally used in supply filters proved perfectly adequate, with a primary of 60 turns and a secondary of 7 turns.

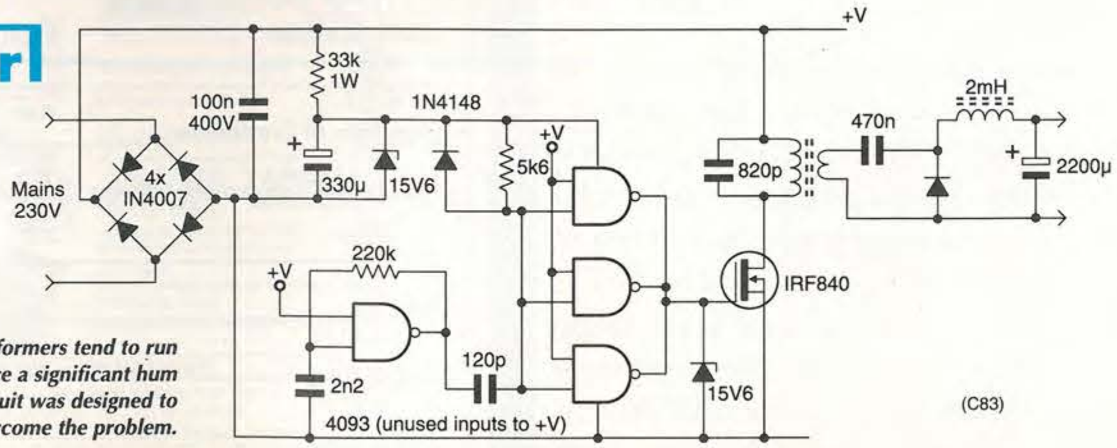
A small load should always be connected to this type of circuit. The original circuit had a second diode in place of the 2mH inductor. If the circuit does not work, reverse the connections from the toroid secondary, as only one way round is correct.

A Ziemacki
Rotherham
C83

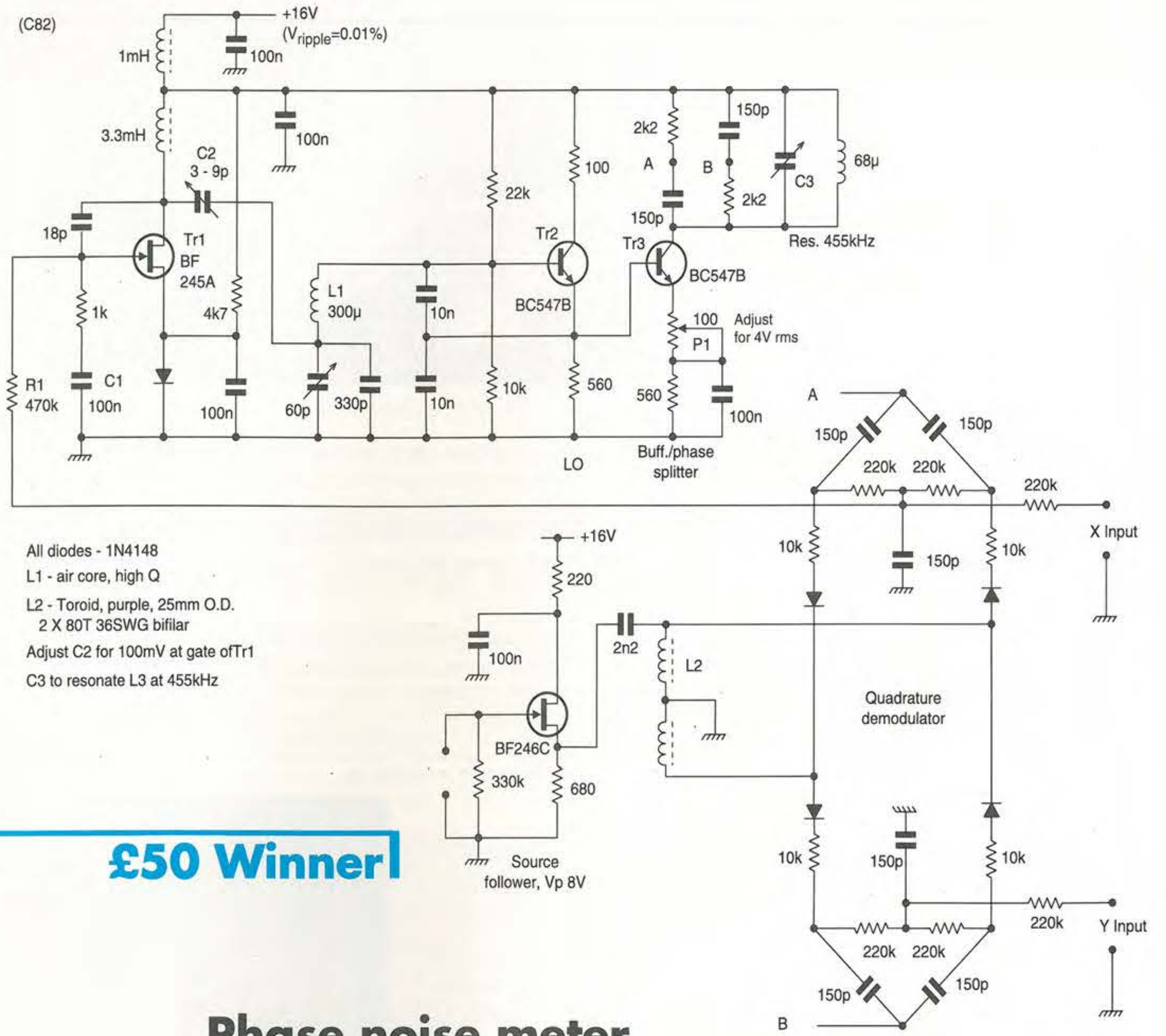
Warning

If you are not fully conversant with the requirements for, and practices relating to, designing circuits that connect directly to the mains, do not attempt to replicate this circuit. Explosion, lethal electric shock or fire could result from the simplest of oversights. Ed.

£50 Winner



Very small mains transformers tend to run hot, and they produce a significant hum field. This circuit was designed to overcome the problem.



£50 Winner

Phase noise meter

Phase noise measurements on a variable-frequency oscillator or synthesiser can be made with a spectrum analyser – an expensive approach. For the specific case of measurements at a fixed frequency of 455kHz, a cheaper solution is possible.

This circuit locks the low-noise reference oscillator to the signal under test by using the phase error to control a reactance modulator, implementing a PLL. The reactance modulator uses a junction FET with a low pinch-off voltage of about 1.4V.

A bipolar transistor in a Clapp configuration forms the reference oscillator. The transistor is very loosely coupled to the tank circuit, thus imposing very little loading on it.

The following buffer's tank circuit suppresses any harmonics, and provides a 90° phase shift. Outputs of the quadrature demodulator are dc coupled to the inputs of an oscilloscope used in the X/Y mode.

Phase noise deviations are indicated directly on the screen, a complete circle indicating ±180° peak phase noise. The probability distribution of the phase deviations is intermediate between Rayleigh and Gaussian normal distributions[1].

The –3dB roll off is 3Hz, determined by R_1 and C_1 – an essential feature of the design. The receiver or transceiver under test must be provided with a 455kHz output.

Trimmer C_2 must be adjusted so that the rms voltage at the gate of Tr_1 does not exceed 100mV. The performance of the completed equipment may evaluated using a FET crystal oscillator.

Wim de Ruyter
Oudkarspel
The Netherlands
C82

Reference

1. Hickman, I, 'Noise', *Electronics World*, Feb. 1998, pp. 146-151.

Related reading

May, Patrick, 'Seeing through noise', *Electronics World*, Nov. 1997.
Downie, N, 'Anti-jitter – new circuits, *Electronics World*, Oct. 1999, p. 859.

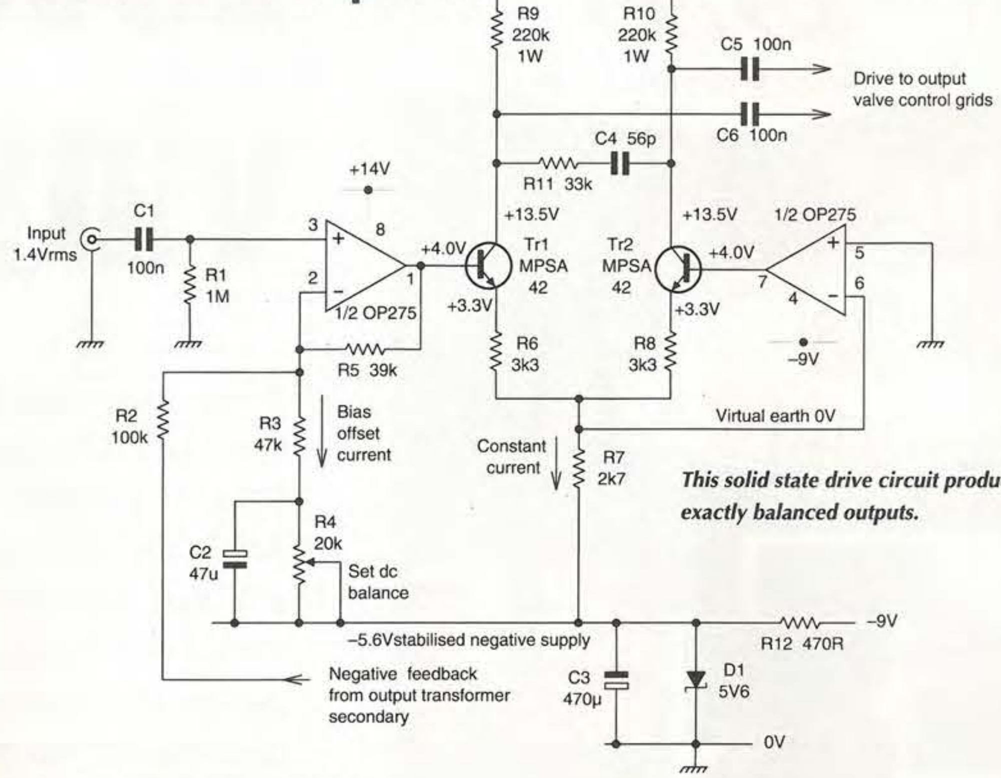
Solid-state drive circuit for valve amplifiers

This solid state drive circuitry was developed to replace the earlier valve stages in my Quad 22 amplifier, leaving just the KT66 output valves and the GZ34 rectifier. Referring to the circuit diagram, Tr_1 and Tr_2 form a long-tailed pair phase splitter.

The op-amp on the right establishes a virtual earth at the top of R_7. So any change in Tr_1's collector current is exactly mirrored, in antiphase, at the collector of Tr_2. Thus the drive to the output valves is completely free of any common-mode component.

Components R_{11} and C_4 form the usual 'step network' or transitional lag, the values being optimised empirically to produce the best squarewave at 2kHz at the amplifier output.

K Cummins
Castle Green,
Isle of Wight
D13



This solid state drive circuit produces exactly balanced outputs.

Log frequency sweep generator

£50 Winner

Swept frequency responses are usually displayed as log amplitude against a log frequency baseline. This circuit generates an exponential waveform to control a generator whose frequency is proportional to an input control voltage. It does so without relying on the transfer function of a semiconductor device.

In addition to the exponential waveform, the circuit generates a linear sawtooth voltage for horizontal deflection of an oscilloscope, giving effectively a log frequency base, and a blanking waveform for the oscilloscope's Z modulation input.

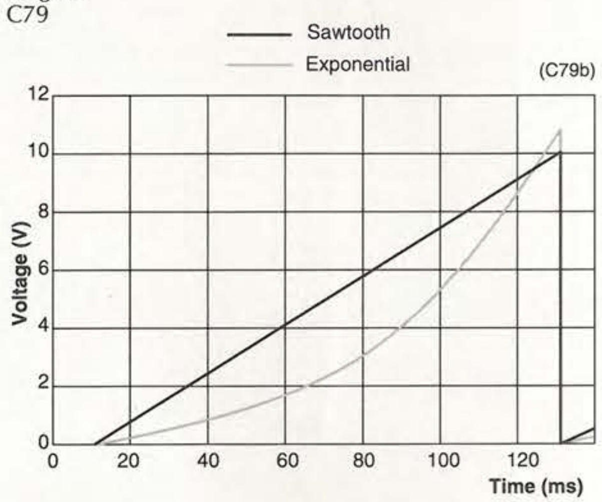
An exponential voltage is developed across a capacitor, $C_{1\text{-}4}$, the transfer function being,

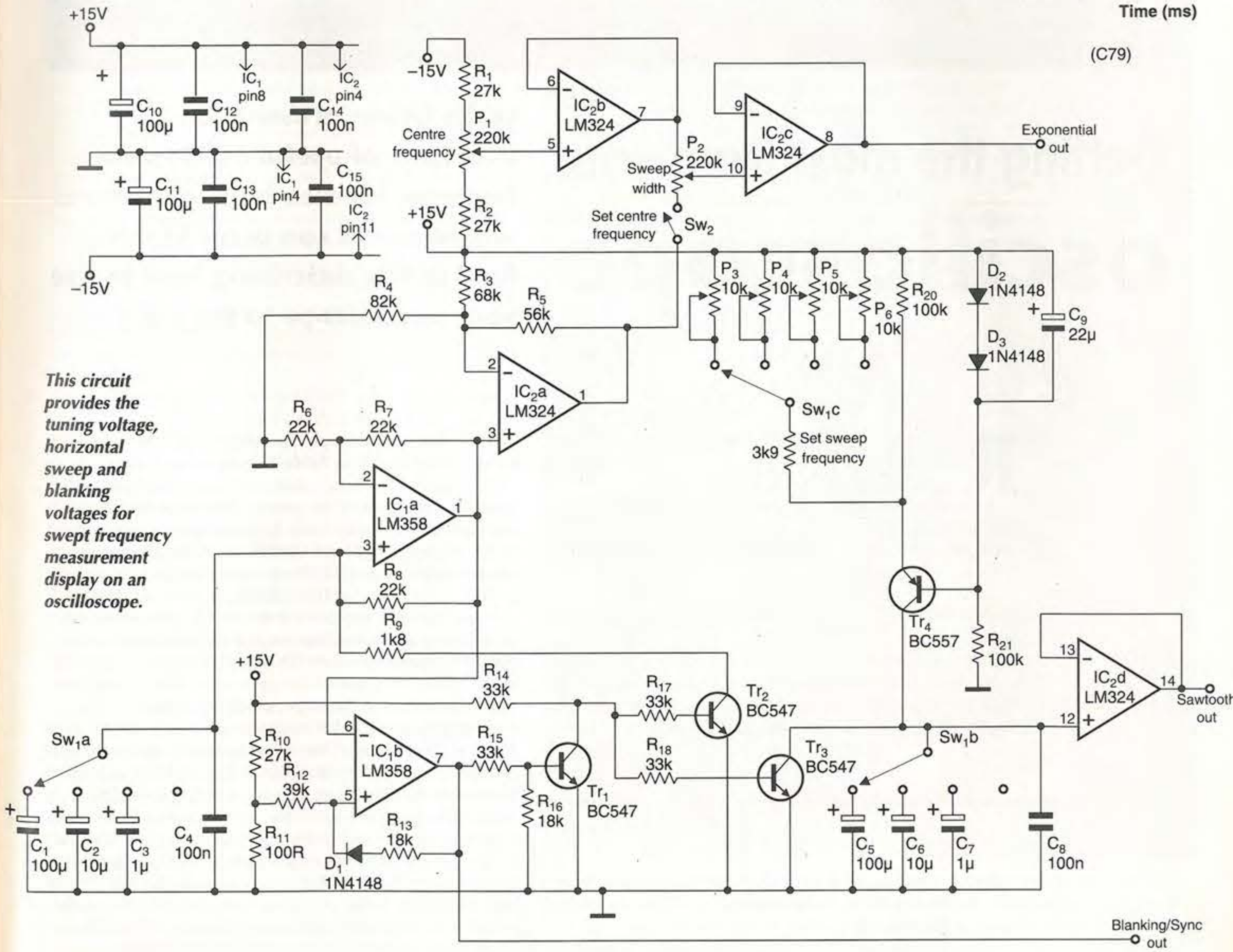
$$U_o = U_i \times e^{\frac{t}{R_1}C_1}$$

The voltage is exponential since the current through R_8 is proportional to the voltage across C_1, so that the rate of increase of voltage is proportional to its present value. The capacitor voltage is amplified by a factor of 2 by IC_{1a}, and applied via R_8 back to the capacitor. Schmitt trigger IC_{1b} discharges capacitor C_1 and also generates the blanking signal. Op-amp IC_{2a} amplifies the exponential sweep, and 220kΩ potentiometers P_1, P_2 permit adjustment of the centre frequency and sweep width respectively, the sweep voltage being buffered by IC_{2c}.

The horizontal sawtooth sweep output is generated across $C_{5,6,7}$ or C_8 by constant current generator Tr_4, giving sweep times of 10ms to 10s, approximately. The sawtooth waveform is reset by Tr_3 at the same time as the exponential waveform is reset by Tr_2. Sawtooth amplitude is adjusted by $P_{2\text{-}6}$ (10kΩ).

Bernard Van den Abeele
Evergem
Belgium
C79





This circuit provides the tuning voltage, horizontal sweep and blanking voltages for swept frequency measurement display on an oscilloscope.

Getting the most from your oscilloscope

Leslie Green presents an overview of useful oscilloscope features. He also highlights areas where errors can occur in this final article describing how to use your oscilloscope to the full.

Regardless of the type of oscilloscope you are using, there will be an error as the measured signal approaches the bandwidth/rise-time of the scope.

A convenient number to remember is that a 100MHz scope has a rise time of 3.5ns. All other bandwidths can be scaled from this; for example a 50MHz scope has a rise time of 7ns. This is expressed by,

$$Rise\ time = \frac{350ns}{bandwidth}$$

where *bandwidth* is in megahertz.

If you can believe the bandwidth of your oscilloscope, then you can get an idea of the possible error at any frequency by using the normalised amplitude factor,

$$Normalised\ amplitude\ factor = \left|\frac{1}{1 + j \times \frac{f}{B}}\right| = \left|\frac{1}{1 + j \times F}\right| = \frac{1}{\sqrt{1 + F^2}}$$

where *f* is the operating frequency and *B* is the oscilloscope bandwidth and normalised frequency *f/B*. This factor was used to plot the graph of **Fig. 1**.

What this means is that at a frequency equal to the bandwidth of the oscilloscope, the factor is 0.7071 – a 29.3% error. Values shown in **Table 1** illustrate the point.

Note that values below about 1% are probably an unreasonable expectation of the general flatness of the frequency response of the oscilloscope. An even more important point is that the scope badge of 100MHz says that the bandwidth should not be below 100MHz; it is possible that you have got a 'good' one with 150MHz bandwidth, or even 200MHz.

There is another way to view the measurement errors introduced by using an oscilloscope and a probe, each having a finite bandwidth/rise-time. The measured value of rise time is the root-of-the-sum-of-the-squares, or RSS, of the individual rise-times of the scope, probe and signal.

Using this theory, a 1ns edge measured on a 350MHz/1ns scope will read 1.4ns. This is not always a good approximation though, as the formula relies on the overshoot on each of the individual step responses not exceeding about 3%.

It is often possible to evaluate the response of your system using this formula and decide that your circuit has more than infinite bandwidth. For example, your scope has a measured rise-time of 3.5ns (100MHz). You measure the rise-time of your circuit as 3.4ns. And you conclude from the mathematics that your circuit's rise time is therefore j0.8ns; the real answer is that your circuit is overshooting heavily.

There is not much point in going too mad specifying a high bandwidth conventional probe for your scope; a 250MHz probe may be adequate for a 200MHz scope. The probe is adjusted to optimise the response of the pair and the result is adequate, within the limitations of measurement with this type of probe.

High-speed measurements

It is not easy to say when a measurement becomes 'high speed'. Certainly, 500MHz/700ps signals are high speed and 1MHz/350ns signals are not – as far as measuring them with a scope is concerned.

Note that the technique of using a probe socket, or tinned copper wire coil, to connect to the circuit is also appropriate for high-frequency measurements, **Fig. 2**. Trying to use the probe hook and long earth-lead supplied with the probe is just not workable at high frequency.

A normal 1:1 scope probe has an input impedance of typically 1MΩ//60pF. The capacitance is so high because it contains the capacitance of the scope input, which is generally 10-30pF, and a long length of coaxial cable. This is no use at all at even modest frequencies.

People generally use 10:1 probes, which have input capacitances in the range of 10-18pF. These capacitances do not depend strongly on the scope input capacitance because of the long coaxial lead. But these probes can not be used to very high frequencies either. The problem is that the 15pF of the probe is too low an impedance at high frequency and it lowers the perceived bandwidth.

The probe may be displaying an accurate representation of what is occurring at its tip, but it has caused the edge to be much slower than it would be in its unloaded condition.

It is important to bear in mind that modern high-speed logic systems can not be considered 'verified' until the logic transitions have been viewed on a high-speed scope and the timings have been measured and toleranced; it is not sufficient just to verify that the prototype works.

Modern CMOS technology can easily produce 1ns edge speeds. These can be a real liability. If they are not correctly terminated, and have to travel more than a couple of inches, then the reflection can cause logic failure. This is a particularly pernicious problem as the logic may work most of the time, but then fall over at high temperatures once every two weeks or so.

The source impedance of a CMOS gate may be around 100Ω so the 15pF probe gives a time constant of 1.5ns and a rise-time of 3.3ns. All the wriggles, bumps and foldbacks on the edge become invisible and you can no longer find the problem in your circuit.

The answer is to use a probe with a much lower capacitance. It is possible to obtain 100:1 probes that have a low input capacitance of around 6pF. But then it becomes difficult to look at low-level signals and the probe bandwidth itself may be a limiting factor.

Conventional 1:1, 10:1 and 100:1 probes are 'passive' probes. A better answer is to use an 'active' probe. This way you can get plenty of bandwidth at a high signal sensitivity.

There are only two drawbacks with active probes. Firstly they cost anything from £100 to £1500 each. Secondly their output voltage is generally limited to around ±0.6V.

The maximum input voltage to the probe is therefore calculated from the probe attenuation. Typically a 1:1 active probe can handle ±0.6V, a 10:1 active probe can handle ±6V and a 100:1 active probe can handle ±60V. Clearly, to look at a 5V logic swing you need to use a 10:1 active probe; this may have an input capacitance in the 1-2pF region.

Because of this source impedance loading problem, active probes may be necessary to make accurate measurements below 100MHz and/or signal levels below 1V. Passive 10:1 500Ω probes with bandwidths up to 3GHz are also available and can be of use on low impedance circuits. In their simplest form, they consist of a 450Ω resistor in series with a 50Ω coaxial cable, terminated in the 50Ω input resistance of the scope.

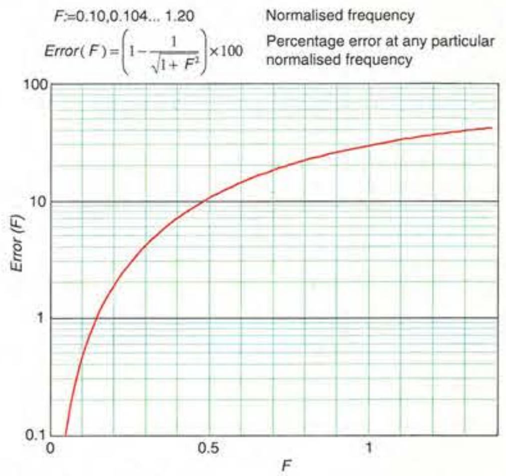


Fig. 1. Error caused by finite bandwidth/ rise-time. F is normalised frequency, i.e. the signal frequency divided by the instrument bandwidth. It can also be considered as the inverse of normalised rise time.

Table 1. Errors due to bandwidth limitation.

Normalised frequency (*f/B*)	Error
0.1	0.5%
0.2	1.9%
0.5	10.6%
0.7	18.1%
1.0	29.3%

Floating inputs

Engineers sometimes want to measure circuits that are mains referenced. This would occur in off-line power supplies, for example.

Some people have a 'solution' for this; they remove the earth from the scope. But manufacturers clearly state that this is not an acceptable connection mode. Also, considering that a manager could be sued from a health and safety viewpoint for allowing this activity, removing the earth connection is out of the question.

In order to meet rf emission limits, it is common for scopes

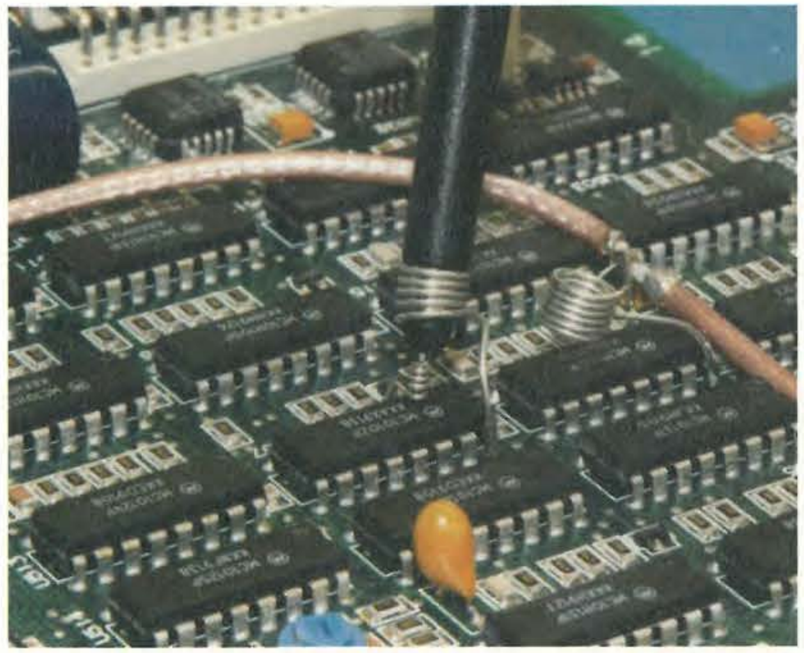


Fig. 2. Discussed in the May issue, this low-noise probing technique lends itself to measuring high speed logic. Note the other earthing coil so that pins on the other IC can be manually probed. Use 24SWG for the probe tip coil and 22SWG for the earth coil.

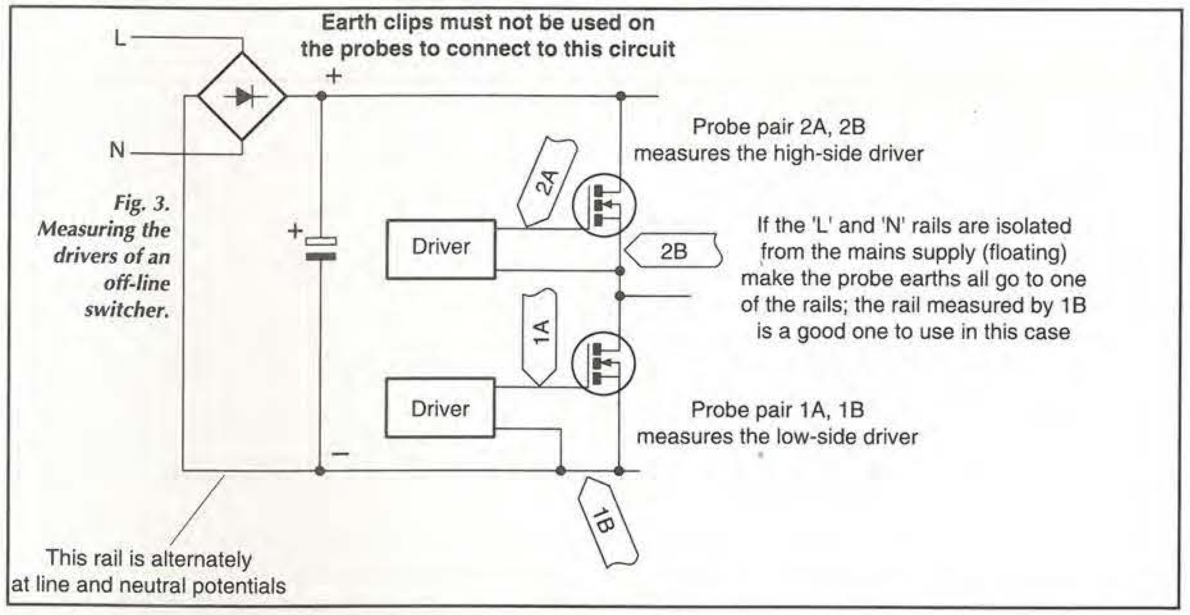


Fig. 3. Measuring the drivers of an off-line switcher.

to have mains filters on them. These have capacitors to earth to meet the filtering requirements. They may also have bleed resistors to earth to stop you getting zapped when you touch the plug pins after unplugging it from the mains. Pull the earth off the scope and the instrument's case floats to some unpleasant potential, due to the earth leakage current having no place to go.

Now the unwise might think that this problem can be overcome by using an isolation transformer. The scope can now be hung onto the output of a mains bridge rectifier – taking the scope's case alternately to neutral and live potentials. Such a set-up is great, provided you don't need to touch the scope to change range and you don't need to connect it to a computer or external plotter – and provided you don't mind hanging a vast capacitance on your circuit.

You see the case has a very large metal area and there is always some earthy material nearby to which it will have capacitance. This capacitance will be charged by drawing a current from the circuit under test. Of course having gone to the trouble of risking life, limb and legislation by removing the scope's earth, it is rather disappointing to find out that it is still not possible to measure both the low-side and high-side drivers of the off-line switcher at the same time.

Running the *circuit* rather than the oscilloscope from an isolating transformer would help with the safety aspects, but you would still have problems with charging currents. The isolation transformer would then need to swing in potential if the output of the bridge were to be earthed by the scope. Also, systems involving large motors would need the mother of all isolation transformers to power them!

Fortunately there are such things as scopes with individually floating inputs; there are also floating-input converter boxes that take a floating input and transfer the signal across an isolation barrier to the measuring equipment. This is OK at low frequencies, but there is still a common-mode charging current. Fortunately this current is much less than for a whole scope as the input guard boxes are physically quite small.

Note that if the isolated scope input's 0V – i.e. the one connected to the scope's internal guard box – is connected to a high impedance point in the circuit under test then the common-mode current will have a much greater adverse effect.

Differential inputs

Another solution to the same problem is to use a scope with differential inputs; a probe with differential inputs is virtually the same thing as far as its use is concerned.

Using this type of equipment, both the high-side and low-side drivers of an off-line switcher can be viewed at the same time; this is vitally necessary to make sure that the timing is set up correctly.

Differential probes are available that convert conventional scope inputs into differential inputs. These cost anything from around £150 to well over £1000, depending both on the performance and the name badge.

Differential technology can require 3 or 4 connections per measurement rather than the conventional 2, the number used depending on the system being probed. When measuring an earthed system, it is not at all obvious whether or not one should use the earth clips of the probes, as the resulting earth loop may cause more trouble than it is worth. Try it and see which works best on your system.

It is essential that the circuit being probed has an earth reference. On a floating system, the scope itself can be used to provide the earth reference via the earth leads on the probes.

Continuing with the task of measuring the drivers of an off-line switcher, **Fig. 3** shows the connections necessary if the switcher is driven direct off-line. Note that the earth clips are not used at all.

If the system is powered from an isolating transformer and there is no defined earth path then it is essential that the earth clips are used; a power rail would be the most sensible place to tie the system to earth.

Two extra terms are necessary for you to see if the differential system you are considering is suitable for your use; these are common-mode input voltage range and common-mode rejection ratio (CMRR).

The common-mode input voltage is the average voltage, *measured with respect to earth,* of the two differential inputs. If this exceeds the common-mode input voltage range of the differential equipment, then overload and malfunction can be expected.

Common-mode rejection ratio is a measure of how much output you get for a given common-mode input voltage. Reading a few specifications will reveal that CMRR is strongly dependent on frequency, getting dramatically worse at high frequencies. CMRR is usually given in decibels; this can obscure the problem for those not so familiar with the decibel. Remember that 40dB is a factor of 100 whereas 80dB is a factor of 10000.

I will continue with the example of a high-side driver directly connected to the mains live, which is also known as the 'line' or the 'phase' connection. Clearly this live line is ultimately referenced to earth and the common-mode voltage is roughly $240\sqrt{2}=339$V peak. Always use peak voltages for common-mode input levels.

With 80dB CMRR, the output voltage, referred to the input, is 339/10000, which is 34mV peak. This is a fairly low noise level for the measurement of a 15V gate drive waveform.

Clearly the situation gets a lot messier when probing after a bridge rectifier. The common-mode voltage is now a half-wave rectified sine wave and therefore contains significant high frequency harmonic content.

Calculating the resultant output voltage is not possible because the relative phases of the harmonics are not specified by a plot of CMRR *versus* frequency alone. A worst-case analysis would add the harmonics, assuming them to be in-phase.

Bandwidth-resolution trade-off

Most designers realise that there is such a thing as a speed-accuracy product. If the fastest available a-to-d converter is 500MS/s at 8-bits, then you to tend to expect that there will be 125MS/s 10-bit converters around as well.

The same thing is true in scopes; if you want a greater number of bits or a more sensitive input then you tend to find that the bandwidth is lower as a result. Thus you either buy an accurate relatively low-frequency scope or a less accurate high-frequency scope. What would be really nice would be to trade off bandwidth against resolution in the same box. Some DMMs and timer/counters trade off number of digits against update rate, which is a similar concept.

A new generation of DSOs can now perform this feat using a combination of ultra-fast digital signal processing and analogue jiggery-pokery. If these are applied effectively, the basic differential non-linearity of the converter is significantly reduced – a factor of four improvement is easily achieved. Small-signal accuracy of the converter is genuinely enhanced. You really have to see this to believe it.

This is in stark contrast to the scopes previously mentioned, whose bandwidth can not be relied on. In these resolution-changing scopes the bandwidth is clearly announced as it is reduced and you get something in exchange for the loss. Note that large-signal accuracy is not improved by this technique on its own.

One particular use of this type of scope is to zoom-in on fine detail in a waveform without overloading the amplifiers. When a waveform fills the screen from top to bottom, that is the limit of fully guaranteed operation on many scopes. A good scope would allow you to click the sensitivity up a notch, so that the signal is 2 or 2.5 times larger than the screen. You would still be able to shift the trace around and see the signal with reasonable accuracy.

Note that this feature is only workable at low frequencies. It definitely does not apply at the upper frequency end of the scope's range. This sort of operation of a scope is not at all well specified and some scopes are much better at it than others. The higher resolution of these scopes allows you to zoom-in on the signal without overloading the amplifiers at all.

Given that the data is stored in high-resolution form, it is then also possible to zoom in on fine detail after the signal has been acquired. This is useful for some transient events – particularly where the expected signal size is relatively unknown.

By setting the amplifiers to a less-sensitive range, the higher resolution means that there is a better chance of capturing the desired transient event and seeing something useful. Another use of this type of scope is that the usual 2mV/div sensitivity can be usefully increased to 125μV/div, albeit for bandwidths below 1MHz.

DSO store length

The question that should be on your lips is "Why would anyone want more data acquired than they can see on the screen?" As screens tend to display only about 500 to 1000 points, why acquire more? In fact there are many different applications where a longer store length is useful, although it is also probably true that many users don't take full advantage of the longer stores.

CMRR *versus* frequency

Caution is needed with isolated inputs. CMRR *versus* frequency may well not be given as a parameter of the equipment but this does not mean that it is invariant with frequency. In fact it is highly frequency dependent as the common-mode current increases linearly with frequency. This is because the admittance of the guard-box to earth capacitance increases linearly with frequency. It is therefore quite likely that an isolated measurement system will give a worse effective CMRR than a differential system at even moderate frequencies – perhaps as low as a few kilohertz.

Buyers' tips

I have often seen test gear left on the shelf because nobody wants to use it. Some manager or accountant bought it because it had a good banner specification and looked like good value. On a real-time scope this banner specification might just be bandwidth; on a DSO it would include sampling rate.

But when it comes down to using the instrument, you find out why it's so cheap. Try to move the traces and change the range and you need to fight your way through the maze of the user interface. Or how about something simple like changing the trigger level? Having once used a scope that has trigger level markers on the screen, I can assure you that you would not want to go back to randomly wiggling the trigger control about, trying to get the scope to trigger.

This is especially true when you want to set the scope up to capture a transient event; you have to set the trigger level half way between where the trace is now and where you expect it to go – a hideous task without trigger level markers.

Try before you buy is the key here. If the manufacturer is too mean to give you a decent demonstration of the equipment, then you can always rent one for a week to ensure that the scope is suitable for your application. The banner specifications don't tell you much about how a scope really performs or whether it is user friendly.

It is necessary to convince managers and accountants that the cost of a piece of equipment does not stop at the initial purchase. A new scope should last for years; this is so much the case that several manufacturers will give you a five-year warranty.

The total cost of the equipment has to be considered. This definitely includes servicing costs and total down-time. When checking out a supplier it is wise to see what their service facilities are like; service costs and turn-around times should affect purchasing decisions.

Another rising consideration in purchasing considerations is the law. With health and safety legislation becoming more significant to employers, there are growing concerns about test equipment sold without the relevant UL/CSA/IEC/EN safety specifications.

Managers purchasing equipment that is not certified as 'safe' to some international safety standard may get prosecuted if something nasty happens. Within Europe, it is illegal to buy equipment unless it is CE marked.

MEASUREMENT & TEST

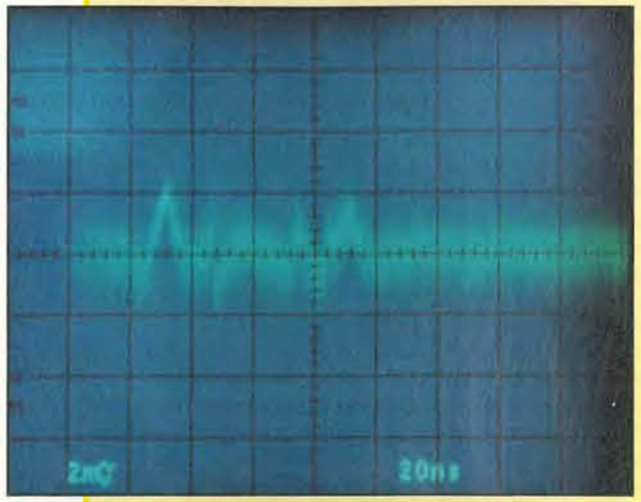
One advantage of a long store is that you can acquire a screen full of data then zoom-in on a particular area to look at some of the fine detail. This is only particularly useful if the event is difficult to reproduce. If you can just re-run the test with the timebase and trigger delay set to a different position then this is the easiest way to view detail. If, however, your test is to blow up an ocean liner then you may want the acquisition system running for an hour before the test until an hour after the test to make absolutely certain that you get the data you need.

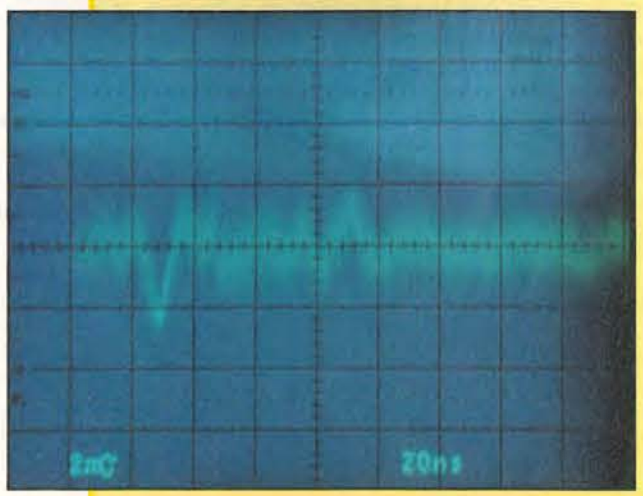
Elusive noise spike with no definite repetition rate

Random noise will produce the leading pulse shown. Adjusting the trigger level seems to show that there is a spike of both polarities present. This is a characteristic of random noise, a rising or falling edge will always occur somewhere and the scope will trigger on it.

In this case the random noise was obtained by setting channel 2 at 2mV/div and feeding the CH2 output (10mV/div) into channel 1. Channel 2 is acting as a wideband amplifier with a gain of 5, so that the noise level is more easily viewable.

Note that the rubbish after the leading pulse is constant between the two traces. This is usually indicative of either a start of sweep or trigger-breakthrough effect on the scope.





Another use of long stores is for signal processing applications. The longer the acquisition length, the lower the potential noise floor in an FFT. Fast Fourier transforms allow you to convert a time-related signal that you have acquired to a frequency-related signal, of the kind seen on a spectrum analyser.

Note that even if your scope does not handle FFTs itself, it is often possible to down-load the data to a pc to get some serious processing power on the job.

Digital games

I have described certain basic measurement situations and illustrated which ones are are best made on a real-time scope as opposed to a DSO. In summary, the point is that with a real-time scope all you can do is look at the waveform. The most you can do by way of signal processing is to invert the trace and/or perhaps add it to another trace that is occurring at the same time on another channel.

However, the possibilities of data manipulation, once the data has been digitised using a DSO, are limited only by your imagination. Automatic measurements of rise-time, overshoot, pulse width, frequency and production limit-testing are just the obvious, everyday ones. The conversion of the time-domain data to a spectral response using an FFT is likewise common place.

Having downloaded the data into a computer, however, you are then free to apply the most hideously obscure filtering algorithms to convert the complete pile of unintelligible rubbish that you acquired into some meaningful result. It is this ability to play digital games, with what was once a real signal, that will inevitably mean that the market for the DSO will increase with time, while that of the real-time scope will fall.

There is also no doubt that more enlightened purchasers of DSOs do so to buy a ready-made acquisition system for measuring whatever it is they really want to be doing. This is a very cheap way of buying decades of experience in acquisition system design, encapsulated in a single box.

Less fortunate engineers, unable to convince their managers/accountants, may struggle for weeks to create a one-off acquisition system to plot widget production, not realising that two weeks of lost production of widgets and three weeks of engineering effort costs more than the DSO would have cost!

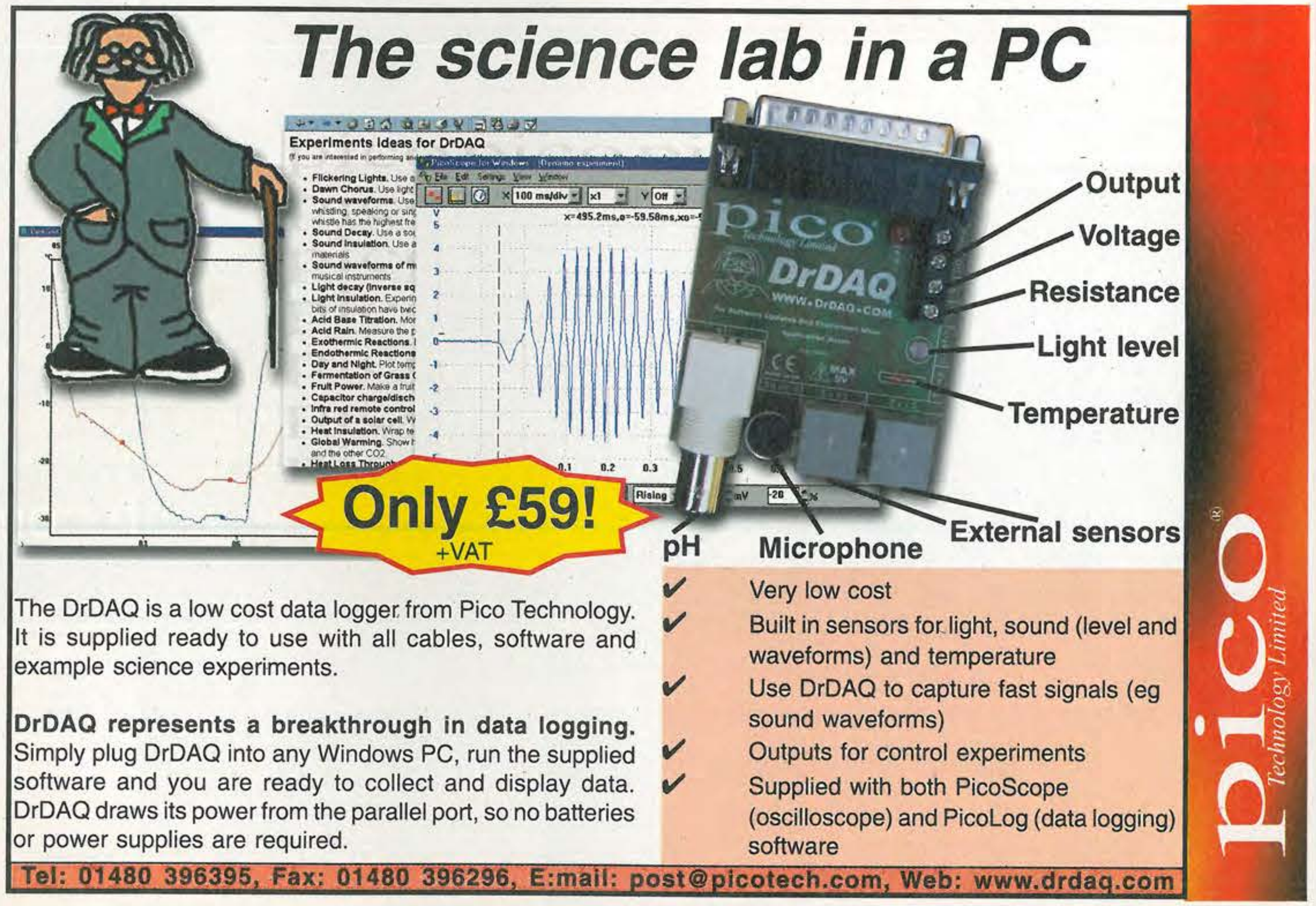
Round-up

In this short series of articles, I hope that I have given you some hints about making better and more meaningful measurements – with or without an oscilloscope. Sometimes a scope is not the correct measuring device, but always the method of connection of the scope to the circuit is crucial.

In this modern world, an engineer who cannot use an oscilloscope is effectively like an adult without a driving licence. If you feel that this applies to you, then you should read your scope manual carefully and play with the instrument until you are comfortable and competent with it.

Once you master the basics of measuring using a DSO, you can go on to more advanced measurements. Did you realise that it is useful to deliberately under-sample (alias) signals on a pair of DSO inputs? The DSO then acts as a frequency transfer standard with sub-ppm accuracy, regardless of the absolute timebase accuracy of the DSO.

Understanding the basics means that you will be able to devise your own tricky ways of getting the most from your oscilloscope. ■



NEW PRODUCTS

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150MHz digital oscilloscope

Four true channels and acquisition speed up to 50GS/s on the Metrix OX2000 digital oscilloscope from Chauvin Arnoux enable testing of complex signals up to 150MHz bandwidth. Measuring four signals at once, it has autoset and undo functions, extended memory, analysis capacity, including FFT function, and a 17.8cm hi-lite fast-scan display. A VGA output provides the full display on a colour computer screen. A dual-time base function allows zooming in on part of the reference signal while displaying the whole recording and up to eight curves on the screen. There can be up to 16 automatic and cursor measurements. Self-calibrating for offset takes 5 minutes without measuring instruments.
Chauvin Arnoux
Tel: 01628 788888

Development system for CPCI

The Vanguard is an off-the-shelf CPCI development system from APW Electronics. The thermally-managed, EMC screened, wired and powered modular unit lets the system integrator specify the combination of components needed. Conforming to IEEE1101.10, the 19in. unit can be fitted with a centrally-mounted eight-slot backplane, allowing for left and right-hand system slots. It can also have a 16-slot CPCI monolithic backplane, in which two eight-slot backplanes share power and ground planes and can be linked by a bridge module to give a system with 14 useable slots. It conforms to PICMG CPCI 2.1 rev 3.0 or, for telecoms, to H110. It is compatible with 32 and 64-bit data transfers and supports 33 and 66MHz operation with 3.3 and 5V signalling.
APW Electronics
Tel: 01489 780078

VDSL transformer

Two VDSL transformers from Pulse, for use with Broadcom's BCM6010 scaleable DSL transceiver chip, support data transfers up to 25.92Mbit/s. The transformers are available as surface mount devices (B4025) or in through-hole packages (B4008) and are used in Broadcom's VDSL transceiver reference design (BCM96011).
Pulse
Tel: 01483 401700

Single board computer

The MAT915 PICMG processor card supports flip-chip PGA Pentium III processors in speeds from 500 to 750MHz. It also supports multimedia AGP video, flat panel and analogue video, Ethernet, SCSI and Compactflash disk. Features include a parallel port, two serial ports, infra-red port, keyboard, mouse, USB, IDE and floppy. Support of AGP video allows dual independent display outputs – TV, flat panel or CRT – with video input and capture. Options include 8 or 16Mbit video memory and Panellink for digital flat panels. The video input channel supports composite or S-video input as NTSC or Pal, with a Samsung decoder. It can also be used with the Celeron 300 to 566MHz processor and suits OEM and embedded applications. Features include best effort boot, automatic recovery and a customisable Award bios. There is a choice of Adaptec or Symbios SCSI, both providing Ultra2 LVD SCSI. Converters to 50-way connections are also available.
Microbus
Tel: 01628 537333

Synchronous buck converter

An integrated synchronous buck converter IC for powering baseband and PA circuitry in satellite phones and other mobile communications handsets is available from Vishay. Capable of delivering up to 600mA output, the Si9167BQ will serve multi-cell and multiple battery chemistry configured cell phones, smart phones, communicators, web phones, PDAs and other systems powered by two-cell lithium ion batteries. It operates at up to 2MHz. Efficiency is typically 95 per cent under full-load conditions.
Vishay Intertechnology
Tel: 001 610 644 1300

24-bit a-to-d converter

Linear Technology has introduced the LTC2402 two-channel 24-bit no latency delta-sigma A/D converter in a 10-pin MSOP. It is for applications where an extra channel is needed for sensor compensation, cold junction compensation and measuring ambient temperature in pressure sensors. The extra channel also allows sensing and compensating for voltage drops in remote RTD connections. It provides automatic channel

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selection (ping-pong) for continuous monitoring of two inputs such as thermocouple temperature probe and a cold junction temperature sensor. Two or three wire i/o allows two channels of 24-bit data over two wires for isolated measurements such as smart sensors. It includes an on-chip oscillator.
Linear Technology
Tel: 01276 677676

2Mbit ternary CAM

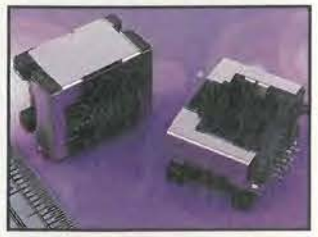
Sibercore Technologies has introduced a packet forwarding engine, the Sibercam Ultra-2M. Based on a ternary content addressable memory (CAM) architecture, it performs up to 100 million multilayer, multi-protocol look-ups per second and can support OC-768 (40Gbit/s), OC-192 (10Gbit/s) and OC-48 (2.4Gbit/s) transmission systems.
Sibercore Technologies
Tel: 001 613 271 8100

Logic analyser software

Tektronix has added Dragonfly Software Development LLC and Synapticad to its embedded systems tools partners programme, bringing the number of partners to 26. Also several embedded systems tools partners announced products at the recent Embedded Systems Conference. These support various applications on the TLA logic analyser family.
Tektronix
Tel: 01344 392243

RJ45 connector

A thinner version of the RJ45 single-line data socket has been introduced by Honda. The MOD connector is 10.2mm deep. With a mating plug, it can be used for connecting a modem, printer or data PBX at up to 19.2kbit/s with untwisted wire. Faster transmission protocols, such as Ethernet, can be



handled via twisted pair wire. It has a standard eight-pin interface with gold plated contacts.
Honda Connectors
Tel: 01793 523388

MOSFETs

Fairchild has announced Powertrench MOSFETs at 60, 80,100,150 and 200V. For use in dc-to-dc converters, servers and PC power supplies, they are suitable for 48V input dc-to-dc modules, such as those used in telecoms. They come in SO-8 and DPAK packages with different on resistances. They are also available in TO-220 and TO-263 packages. The 60, 80 and 100V units are in production and the 150 and 200V models are sampling.
Fairchild Semiconductor
Tel: 01793 856819

Brushless dc motor

An EMA brushless motor from Papst, the 933 7032 100 EMA, provides an output of 400W and measures 90mm diameter by 68.5mm long. Efficiency is 74 per cent and weight less than 1.8kg. The motor is also available as an OEM platform supplied in basic or custom form including different shaft configurations, application specific performances, connection options and factory fitted gearboxes. Drive electronics allow speed control from 300 to 5000rev/min,

variable direction of rotation, and active braking using an external resistor network.
Papst
Tel: 01264 333388

Power supply

Lambda has introduced a 300W version of its JWS power supply for use in process control, industrial ATE,

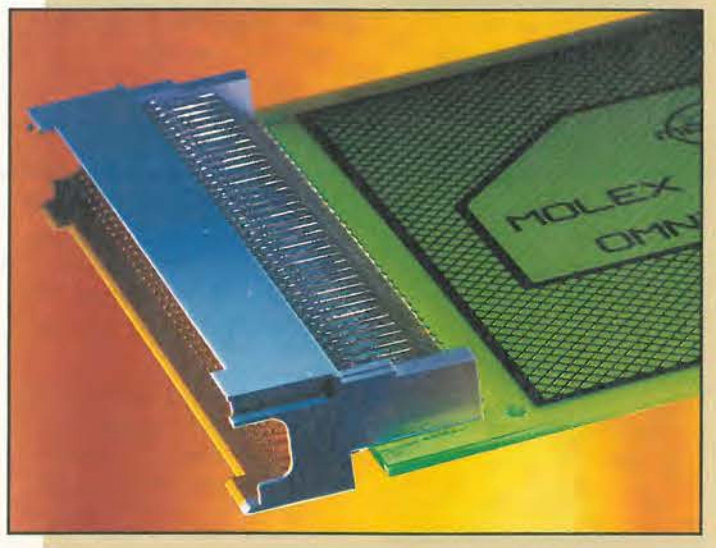
telecoms and industrial computer applications. It accepts an input of 85 to 265V ac or 120 to 330V dc and comes in seven versions from 2 to 48V dc with 60 to 6.5A respectively. Power factor correction is fitted and is rated at 0.99 typical at 100V ac full load and 0.95 at 200V ac. Able to support parallel operation, it has an output current balance circuit for multiple unit designs. Features include overcurrent and overvoltage protection, thermal shutdown, remote sensing and remote on-off control. Fan cooled, it operates between –10 and +60°C and measures 120 by 92 by 190mm.
Lambda
Tel: 01271 856666

Digital multimeter

The 2700 digital multimeter from Thurlby Thandar also works as a data acquisition system or data logger for an IEEE488, RS232, PC-based or stand-alone system. It allows temperature characterisation, data logging, precision measurement and control and mixed-signal data acquisition. There are 13 measurement functions including signal conditioning and mx+b scaling. The unit has up to 80 differential analogue input channels, each individually configurable, in one half-rack system with built-in i/o and

Right-angle backplane connector

Molex has added a right-angle version to its Omnigrid connector range for backplanes in automation and telecoms applications. Contacts, size and configuration can be specified to suit each application. Power and signal contacts can be mixed in the same housing. The right-angle version is based on Chicklet V tails press fit contacts for board extension and front i/o. The 2.5mm grid is adapted for high speed i/o systems. Combined with the Omnigrid Coaxid cable connectors, the 90° Omnigrid front i/o is a suitable interface for single ended transmission up to 622Mbit/s.
Molex
Tel: 01252 720720



isolated switching. Including two slots for plug-in cards, it has the accuracy and traceability of a 6.5-digit 22-bit DMM. A button allows switching between front and rear measurement inputs. Five plug-in cards are available: the 7700 20-channel differential multiplexer with automatic cold-junction compensation; 7702 40-channel differential multiplexer; 7703 32-channel differential multiplexer; 7705 40-channel, single-pole control and actuator module; and 7706 multifunction i/o module. It comes with Windows-based application software to configure the DMM and display, analyse and archive test data to a PC. Testpoint and Labview are also supported.
Thurlby Thandar Instruments
Tel: 01480 412451

TFT colour LCD module

Sunrise Electronics has announced an NEC 46cm colour TFT LCD module with a digital interface and 170° horizontal and vertical viewing angles. The NL128102AC28-04 provides 8-bit RGB in 256 steps for 16.7 million colours at up to SXGA resolution of 1280 by 1024 pixels. It is mechanically compatible with the NL128102AC28-01/01A analogue interface 46cm module that provides electrical compatibility with existing CRT monitors. It uses an analogue signal processing technique that ensures

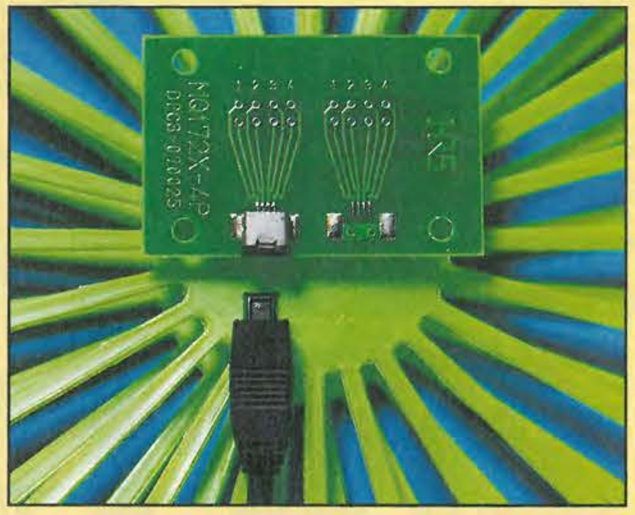
compatibility with CRT displays without an additional analogue-to-digital converter.
Sunrise Electronics
Tel: 01908 263999

Audio power amplifier

Designers of audio systems for portable and desktop applications can use a filterless Class-D audio power amplifier announced by Texas Instruments. The TPA2000D2 is a stereo amplifier with an

Board-to-cable connector

The Hirose MQ172 board-to-cable system from Flint is for making power connections to handheld systems. The three-contact PCB receptacle is 3.9mm high with dimensions of 6.4 by 6.0mm. Current capacity is 3A. It is also available in a four-pin version and both have a two-point contact design and a lead construction that provides shock and vibration resistant connection to the PCB. The use of a snap lock system and keyways helps ensure positive, error-free insertion. Plugs have solder bucket contacts, so they can be used with various cable types. The plug case and cable bushing are integrated into a one-piece body, so assembly is a matter of pressing the case into position once harness work is complete. The receptacles come in embossed tape-and-reel for automatic pick-and-place installation.
Flint SMD
Tel: 01530 510333



output power of 2W rms or 4W peak into 4Ω speakers. The 5V amplifier provides four internal gain settings. Shutdown control helps prolong battery charge life by limiting total supply current to less than 1μA. Using PWM, it samples the input audio signal at a rate of 12 times the audio band and then recreates the audio signal at the speaker.
Texas Instruments
Tel: 01604 663000

Touch-screen controller

Burr-Brown's ADS7846 is a single-chip touch-screen controller for battery-operated systems such as PDAs, pagers and mobile phones. It provides onboard voltage reference, temperature sensing, battery monitoring and touch-pressure measurement. It measures a change in resistance as the screen is touched. The resistive change is then used to determine where contact was made. Power consumption is less than 0.6mW with power-down control and single-supply operation of 2.7 to 5.25V.
Burr Brown
Tel: 001 520 746 1111

Voltage/current calibrator

The Yokogawa CA11 is a battery operated voltage and current calibrator for the field calibration of process measurement and control instruments. The unit combines source and measurement facilities, so it can be used for testing control loops that include measurement functions and transmission outputs. These outputs can include current loops and voltage outputs to devices such as recorders and data-acquisition systems. A one-touch function causes the output to step up or down in five equal steps on the 4 to 20mA or 1 to 5V ranges. For loop checks, it has a sink function in which the loop voltage is used to simulate a two-wire transmitter and a sweep function increases or decreases the output level at a constant rate. Measurement ranges are from 10μV to 30V and 10μA to 24mA. Accuracy is ±0.05 per cent for measurement and source functions.
Yokogawa
Tel: 01494 459200

Temperature sensor

A temperature sensor on a 1206-sized surface mount chip has been developed by Heraeus. For –50 to +130°C use, the sensor can replace a thermistor in temperature measurement or temperature compensation applications. Based on thin-film platinum technology, it is available as a 100 or 1000Ω device in two tolerance classes. Temperature coefficient is positive and complies with Din EN60751. Maximum drift over 1000 hours at 130°C is 0.06 per cent. Sensors come in blister reels that are compatible with automated assembly techniques.
Heraeus
Tel: 01246 454849

Subscriber line IC

Mitel has launched the MT91610 programmable subscriber line IC that provides a line card interface between a switching system and a telephone line. The device uses sine wave ringing above 70V rms to reduce the risk of crosstalk on adjacent lines. It supports battery feed, user-definable line and network balance impedance, and off-chip audio gain programming. The device goes into power-down mode when not in use to reduce power consumption in short-loop applications such as pair gain and wireless local loop. With on-hook transmission and top

ring reversal, it accommodates DID signalling in PBX and CLID applications. The device also has unbalanced detection for applications requiring ground start. It can take a programmable current range between 20 and 30mA, and loop lengths above 1800Ω in voltage foldover mode.
Mitel Semiconductor
Tel: 01793 518000

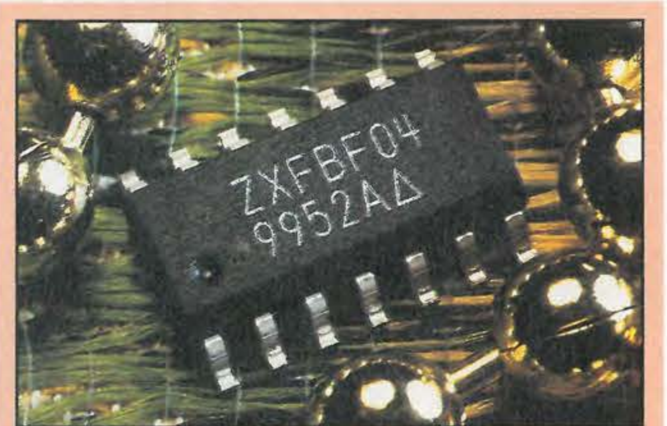
30V and 20V trench MOSFETs

Intersil has announced trench MOSFETs to provide power management in notebook PCs, mobile phones and lithium-ion battery pack protection applications. The 30V ITF861xx and 20V ITF870xx come in TSSOP8 and TSOP6 packages. The ITF861xx logic-level MOSFETs are either single p channel, single n channel or dual n channel devices. The p-channel devices perform high-side load control switching in ACPI circuits and notebook PCs, such as battery disconnect switching and battery charge switching. The n channel devices perform low-side load control switching and can be used in switching regulator circuits such as power control circuits in notebook

PCs. The 7.8mΩ on-resistance single n-channel version is for 5 and 3.3V supply rail switching in hotplug applications such as servers and Raid. The ITF870xx sub logic-level range includes single and dual p and n channel devices.
Intersil
Tel: 01344 350250

Java virtual machine

Scenix has introduced a virtual machine (VM) for embedded applications that is programmable in Java. For use with the company's SX communications controller



Four-channel analogue video buffer

From Zetex, the ZXFBF04 provides four channels of analogue video buffering for multi-channel applications where broadcast quality is not required. These include video switching matrixes and multi-channel a-to-d input buffers in instrumentation, signal acquisition and security. Small signal bandwidth is above 100MHz, while 1V peak-to-peak bandwidth is more than 20MHz. Slew rate is typically 40V/μs. Each channel draws 1.9mA and the buffer is powered from a ±5V supply. It comes in a 14-pin SOIC package.
Zetex
Tel: 0161 622 4560

chips, it occupies 3k 12-bit words of on-chip program memory. It can be stored in the on-chip flash memory of an SX chip and executed as needed to run compiled Java code. The PC-based integrated development environment lets the designer communicate with a VM resident on an SX chip for source-level debugging, variable inspection and setting multiple user-defined breakpoints. It is based on the Java card specification with modifications to improve performance in memory-constrained embedded applications. For example, strings have been added so operations do not need to be done serially, and native methods have been included that can call routines written in assembly language. It runs on a 50MHz, 50Mips Scenix controller, which has 256byte of SRAM and 4k 12-bit words of flash program memory on chip. The controller lets the VM execute Java byte code at up to 1Mips, and the 1k remaining memory can be used for other functions.
Scenix
Tel: 001 650 210 1500

Coaxial connector

Radiall has launched the UMP surface mount coaxial connector comprising a board-to-board link and adaptor. Footprint is 4.4 by 3.6mm and height 2mm when mated. The receptacle and plug weigh 0.03 and 0.08g respectively and mating can take place after the PCB has been installed. Frequency range is dc to 6GHz. Applications include 900 and

1900MHz mobile phones and portable computing devices. VSWR is 1.02:1 at 900MHz, 1.06:1 at 1800MHz and 1.16:1 at 5GHz. It can be mounted on the PCB or used as an edge connector. An extraction tool is provided to disengage the connector. The tool, when inserted, eases up the retaining clip letting the receptacle be withdrawn without damaging the retaining mechanism or the connector.
Radiall
Tel: 020 8997 8880

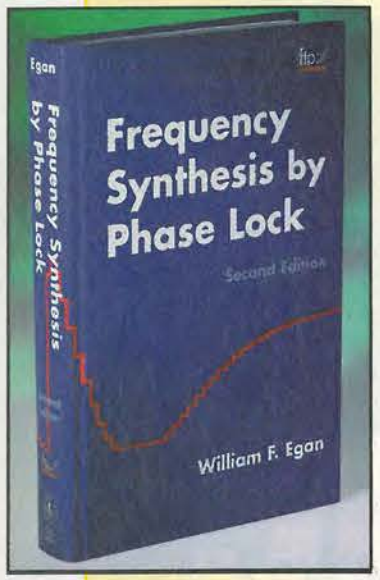
1.8V micros

Hitachi has announced the H8/3847R microcontroller with a 16MHz 8 and 16-bit CPU core that operates from 1.8 to 5.5V. Applications include domestic and industrial electricity meters and battery powered data loggers and sensors. It is pin compatible with the H8/3847 but can execute a 16-bit addition in 250ns and an 8-bit multiply in 1.75μs. Its LCD controller can display up to 160 segments and its asynchronous event counter counts external pulses while the device continues at low power operation. The 32kHz sub-

BOOK TO BUY

Frequency Synthesis by Phase Lock

Frequency synthesis is an important element in the design of all communications equipment, but has taken on new life recently with the advent of new hand-held wireless devices. This technology not only allows wireless transmitters to change frequencies quickly, but also gives high reliability and security in transmissions. Thus, mobile devices such as cell phones can utilise this technology to change frequencies until a suitable one is found for the location in which it is being used.



- Emphasises the fundamentals of frequency synthesis
- Based on a course that Dr. Egan has been teaching for over 20 years at Santa Clara University
- Provides a link to the Wiley ftp site for the use of associated MATLAB exercises
- Taken together with Phase Lock Basics by the same author, the two books provide readers with complete coverage of the field.

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oscillator allows the use of various operating modes, including module standby and watch mode, where the oscillator can be used to provide the timebase for a real time clock. It comes in a 100-pin QFP or TQFP.
Hitachi
Tel: 01628 585163

Single-chip modem

Insight Memec has launched a single-chip modem semiconductor that provides one interface for connection to any telephone network in the world. Developed by Conexant Systems, the SmartSCM combines a modem controller, data pump, ROM, RAM and a universal silicon DAA telephone-network interface. It includes the functions needed to incorporate global internet connectivity into internet appliances such as game consoles and handheld devices. Versions support V.32 bis, V.34 and V.90 modem modulations. Because the devices are pin-compatible, users can start with a lower-speed modem modulation and migrate to a higher speed without changing the hardware design. It comes in a 128-pin TQFP.
Insight Memec
Tel: 01296 330061

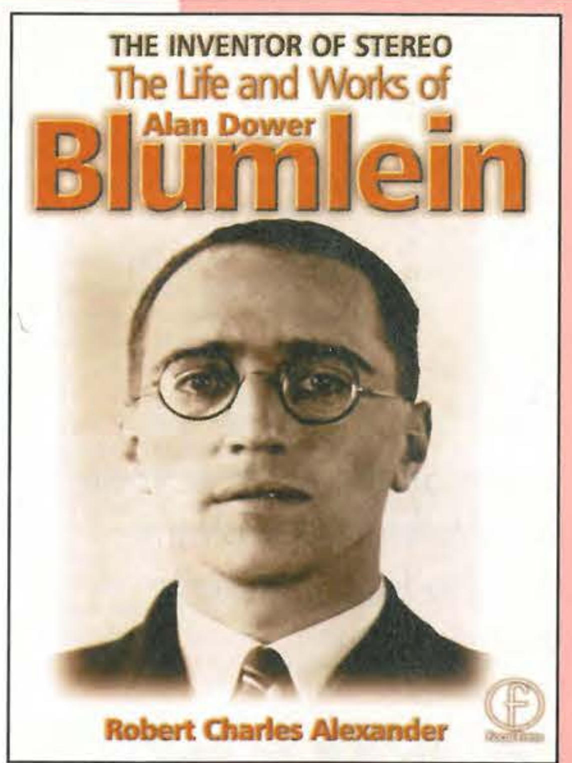
20MHz function generator

Kenwood has introduced a 20MHz microprocessor controlled programmable function generator. The FGE 1202 has a frequency range of 0.2Hz to 20MHz in eight decade ranges with an accuracy of 0.05 per cent in frequency lock mode. Wave shapes include sine, square, triangle and dc. Output level is variable up to 20V with additional attenuation of –20 and –40dB. Internal and external sweep are standard. Microprocessor control lets the start and stop frequencies be digitally set and run in logarithmic or linear modes sweeping positively or negatively as selected. An integral 16 by 2 backlit LCD provides frequency, parameters, set up and operational information. A nonvolatile memory lets up to 30 setups be retained or can be used to cycle test conditions for repetitive applications. An RS232 interface lets the unit be controlled and data saved to and loaded from a PC. An optional Windows software package supports the interface. Features include TTL output, AM and FM modulation modes, symmetry and dc offset.
Kenwood Electronics
Tel: 01923 655292

Safety supplies

Acal has developed two metal-cased power supplies for safety-critical applications. The VLT100 is in an enclosure measuring 97 by 146 by 36mm. Power density is 0.37W/cm^3 and typical efficiency at full load 86%. Weight is less than 340g and it can be convection cooled up to full rated output at 50°C. Single output supplies have outputs of 3.3, 5, 12, 15, 24 or 48V, while multiple output units have ±3.3, ±5, ±12, ±15 and ±24V. All accept inputs from 90 to 264V ac. The VLT130 comes in the same size case. Power density is 0.43W/cm^3 and typical efficiency at full load 82%. Weight is 355g. Quad-output supplies come with 3.3 and 5V outputs as standard, and options of ±12, ±15 and 24V dc outputs. The 3.3V output provides up to 16A and the 5V output up to 14A. Single-wire current sharing is available across V_1 and V_2 outputs for dual-redundant or power sharing applications. The single-output version has dc outputs of 3.3, 5, 12, 15, 24 or 48V. ■
Acal
Tel: 01252 858585

BOOK TO BUY



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This book is the definitive study of the life and works of one of Britain's most important inventors who, due to a cruel set of circumstances, has all but been overlooked by history.

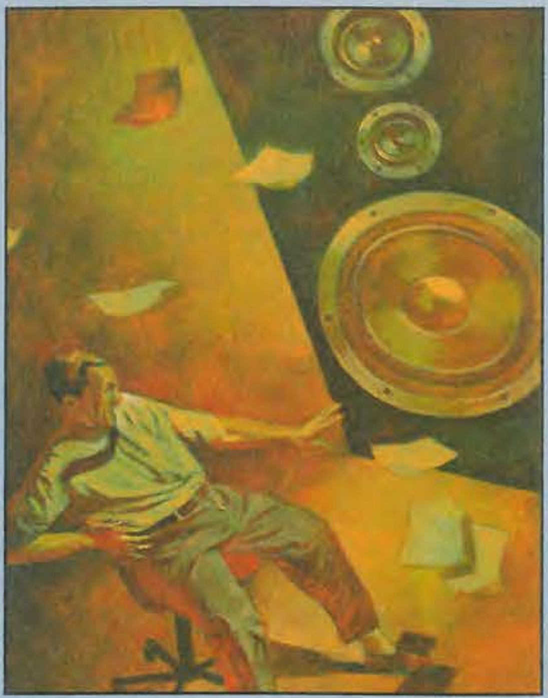
Alan Dower Blumlein led an extraordinary life in which his inventive output rate easily surpassed that of Edison, but whose early death during the darkest days of World War Two led to a shroud of secrecy which has covered his life and achievements ever since.

His 1931 Patent for a Binaural Recording System was so revolutionary that most of his contemporaries regarded it as more than 20 years ahead of its time. Even years after his death, the full magnitude of its detail had not been fully utilized. Among his 128 patents are the principal electronic circuits critical to the development of the world's first electronic television system. During his short working life, Blumlein produced patent after patent breaking entirely new ground in electronic and audio engineering.

During the Second World War, Alan Blumlein was deeply engaged in the very secret work of radar development and contributed enormously to the system eventually to become 'H2S' - blind-bombing radar. Tragically, during an experimental H2S flight in June 1942, the Halifax bomber in which Blumlein and several colleagues were flying, crashed and all aboard were killed. He was just days short of his thirty-ninth birthday.

For many years there have been rumours about a biography of Alan Blumlein, yet none has been forthcoming. This is the world's first study of a man whose achievements should rank among those of the greatest Britain has produced. This book provides detailed knowledge of every one of his patents and the process behind them, while giving an in-depth study of the life and times of this quite extraordinary man.

Contents



In this third article on the topic of room acoustics, John Watkinson explains the importance of a loudspeaker's off-axis response.

SPEAKERS' CORNER

In the first two parts of this debate, I showed that the room and the speaker are inseparable and ideally should be considered as a system. This is not always possible – especially in domestic installations where the speaker designer has little control. However, there are certain criteria that loudspeakers need to meet. Whatever the domestic acoustic may be, meeting these will improve results.

In a stereo system, two speakers can only give spatial accuracy for virtual sound sources located between them. Reverberation in the listening room then provides ambient sound from all remaining directions.

The resulting reverberant sound field can never be a replica of that at the microphone, but a plausible substitute is essential for realism and its absence results in an unsatisfactory result. Clearly the traditional use of heavily damped rooms for monitoring is suspect.

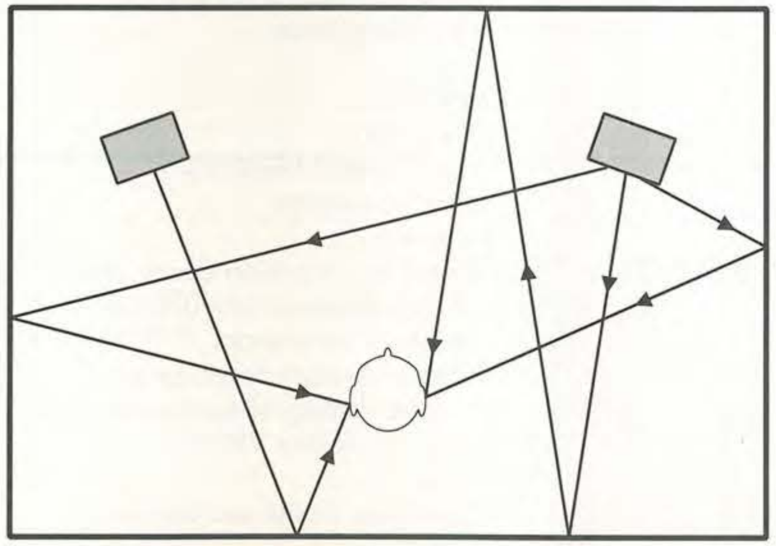


Fig. 1. Reverberant sound is produced off the axis of the speakers.

Achieving reality

If realism is to be achieved the direct sound and the reverberant sound must both be uncoloured. **Figure 1** shows that most of the reverberant sound in a listening room is due to excitation by sound radiated in directions other than the central axis of the loudspeakers.

It is thus clear that the quality of the off-axis sound is just as important as the quality of the on-axis sound. Concentrating on the on-axis performance to the detriment of the off-axis performance produces a loudspeaker with a coloured reverberant field.

An uncoloured reverberant field requires that the loudspeaker should produce the same level and have the same frequency response over a wide range of directions. The output may fall as the off-axis angle increases, but it must do so gradually.

Figure 2 shows that the directivity function or polar response should be broad and independent of frequency. If the directivity varies with frequency, the frequency response off-axis will not be the same as it is on-axis.

It follows that for realistic results the polar diagram of the loudspeaker and its stability with frequency is extremely important. The necessary accuracy is difficult to achieve. The most accurate commercially available units in this respect are the Quad ESL-63 which use an electrostatic phased array and the Manger planar speaker (produced in Germany) which achieves the same result using propagation delays in the diaphragm.

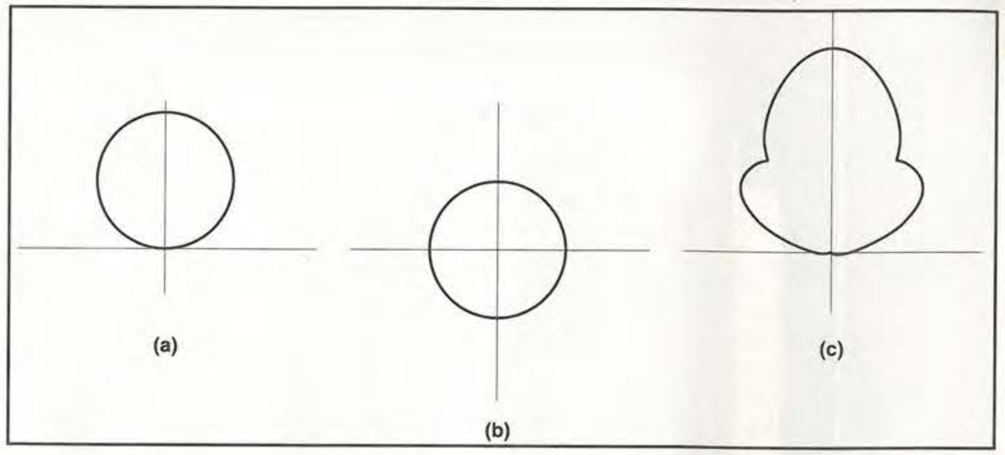


Fig. 2. Directivity functions for loudspeakers. a) cosine – good, b) omni – good, c) typical speaker with lobes – poor.

Crossover problems

A common shortcoming with most loudspeaker drive units is that output becomes more directional with increasing frequency. This is the reason for the multi-way speaker with a frequency-dividing crossover between the units. Unfortunately if the individual drive units are not appropriately specified, crossing over between them produces a step in the directivity.

Figure 3a) shows that although the frequency response on-axis may be ruler flat, giving a good-quality direct sound, the frequency response off-axis may be quite badly impaired as at Fig. **3b)**. In the case of a multiple drive unit speaker, if the crossover frequency is too high, the LF unit will have started beaming before it crosses over to the tweeter which widens the directivity again. Figure **3c)** shows that the off-axis response is then highly irregular. As the off-axis output excites the essential reverberant field, the tonal balance of the reverberation will not match that of the direct sound.

The skilled listener can determine the crossover frequency, which by definition ought not to be possible in a good loudspeaker. Figure 3 also shows why the listening-from-the-next-room test, mentioned last month, works. The radiation leaving through the open door of the listening room will have the frequency response of Fig. 3c) and the colouration will be audible.

Subconcious effects

In the listening room, the resultant conflict between on- and off-axis tonality may only be perceived subconsciously. It may cause listening fatigue where the initial impression of the loudspeaker is quite good, but after a while one starts looking for excuses to stop listening. The hallmark of a good loudspeaker installation is that you can listen to it indefinitely and that of an excellent installation is where one does not want to stop.

Unfortunately such instances are rare. More often loudspeakers are used having such poor off-axis frequency response that the only remedy is to make the room highly absorbent so that the off-axis sound never reaches the listener. This has led to the well-established myth that reflections are bad and that extensive treatment to make a room dead is necessary for good monitoring.

The dead-room approach has no psychoacoustic basis and has simply evolved as a practical way of using loudspeakers having poor directivity. The problem is compounded by the fact that an absorbent room requires more sound power to obtain a given SPL. Consequently heavily treated rooms require high power loudspeakers, which have high distortion and often further sacrifice polar response in order to achieve that high power.

Coloured ears

A worse consequence of monitoring using speakers with a poor off-axis response is that the user's ears become first accustomed and then imprinted with the coloured reverberant sound. In other words prolonged exposure to a poor speaker actually distorts one's ability to assess the quality of another speaker.

I discovered this the hard way when a prototype speaker with a ruler-flat frequency response was loaned to an experienced audio engineer who had worked for years with the same pair of nameless speakers.

The loaned speaker was returned because it was said to have a peak in its response – which it did not have. After a polite enquiry, the frequency of the peak was estimated. This turned out to be exactly the crossover frequency of the loudspeakers to which this engineer was accustomed. He was using a two-way speaker having a small dome tweeter. This requires a high crossover frequency at which the woofer is beaming badly. The resultant is a serious notch in the off-axis power response.

I haven't named the speaker concerned because there are any number of speakers like it and they all sound pretty much the same. These are called 'bookshelf loudspeakers' because by putting a plank across a pair of them a useful bookshelf can be made. The transducers are best left disconnected. ■

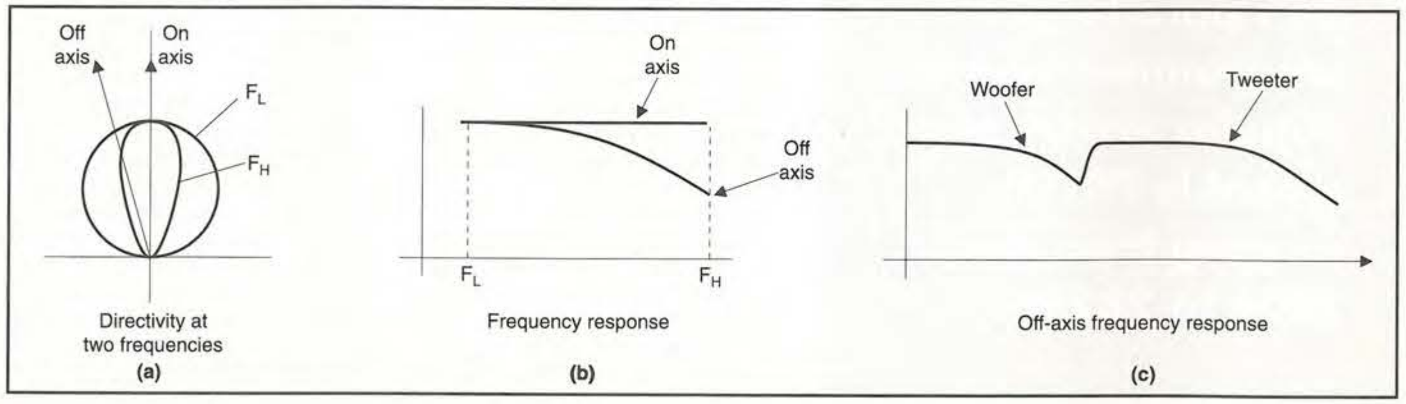
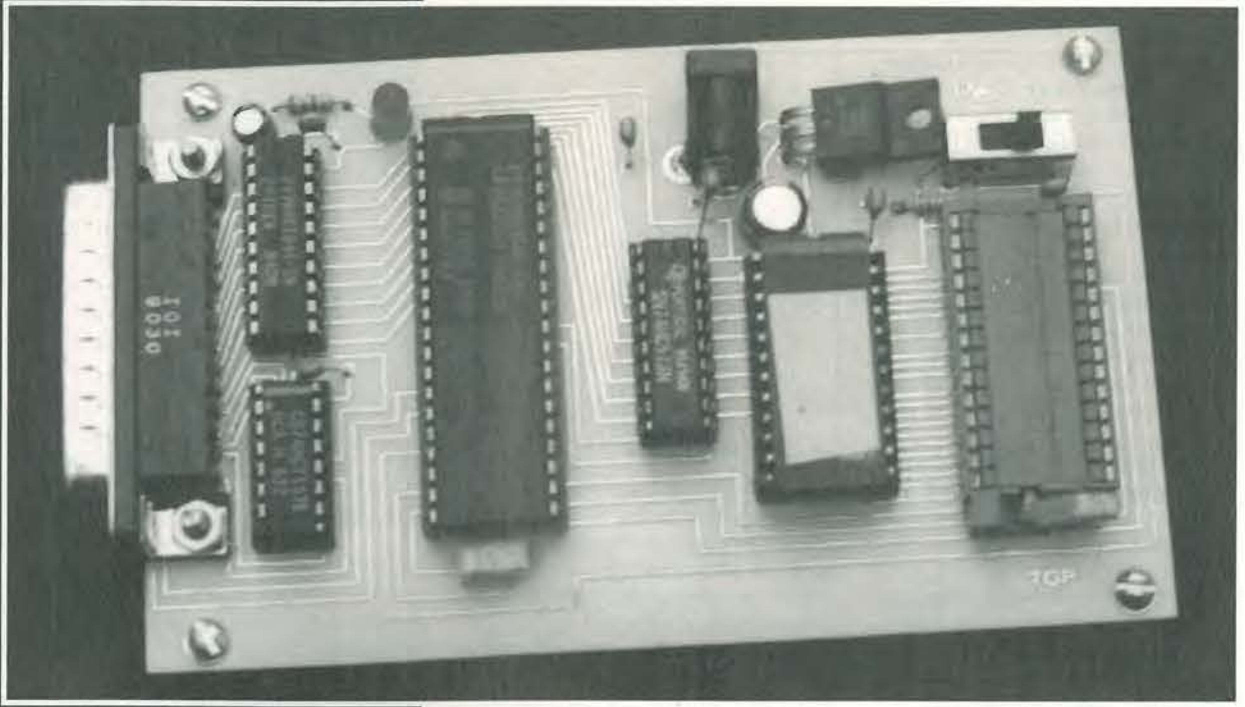


Fig. 3. In a), directivity may be narrower at high frequency, F_H, than low, F_L. b) Frequency response off-axis is then impaired. c) Directivity will improve as the speaker crosses over to the tweeter, but this will put a dip in the off-axis response.



Programming EPROMs?

If you are still using UV-erasable EPROMs, this programmer should save you an inordinate amount of time. Designed to interface with anything from a 386 PC upwards, Guo-yin Xu's parallel port programmer handles popular electrically-erasable PROMs ranging from the 2804 to 28256.

When developing microprocessor and microcontroller systems, you usually need external memory ICs. Ultra-violet erasable PROMs and electrically-erasable and programmable PROMs, i.e. EPROMs and EEPROMs, are two major non-volatile memory alternatives used for storing data or control code in a digital system. They hold what is referred to as the 'firmware.'

The main advantages of EEPROM over EPROM are that it requires no erasure before reprogramming, and it requires only one 5V, or lower, rail. The only disadvantage is that EEPROMs still cost more than their equivalent EPROMs. But the price gaps are becoming narrower or insignificant, especially for the low capacity components.

When you begin developing a project, you might have to modify your code frequently. If that is the case, then you would be better off using EEPROM rather than EPROM. If you opt for EPROM, although the device may be slightly cheaper, you will have to buy an ultra-violet EPROM eraser and wait 15 minutes for erasure. During such a design phase, an EEPROM programmer is invaluable as a quick and economical project development tool.

Programmer for electrically erasables

The PEE-1 parallel port EEPROM programmer described here, and shown in the photograph, is just for that purpose. It programs the most popular,

28(C)04
28(C)16
28(C)64
28(C)256

EEPROMs, and it accepts both binary and Intel hex format files.

The programmer also contains a unique feature that lets you demonstrate some of your programming results using the programmer itself, so you won't have to build a lot of prototypes. This is particularly helpful to the beginning user.

It works with early computers too

The PEE-1 programmer was designed to be used with most existing PCs with original or standard parallel ports. It has been successfully tested on a number of PCs, ranging from turbo XT to 386, 486, and Pentium PCs.

At the circuit's heart is the Intel 8031/8051 microcontroller. The entire circuit comprises five ICs. Octal buffer IC_1 is a 74LS541 with three-state outputs. It acts as an interface between the PC's parallel port data register and the programmer.

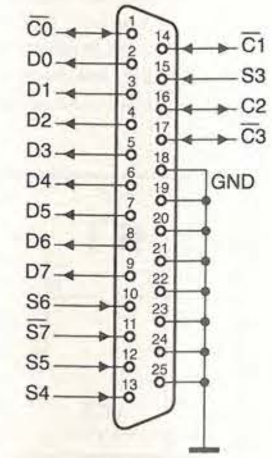
When the control-voltage level at IC_1 pin 1G and 2G, which are tied together, goes 'low', the buffers are enabled and 8-bit data from the PC is transferred through it to the 8031's port P1, that is pin 1 to pin 8. If the control level is set 'high', then the 3-state outputs are in high-impedance and so the data is completely blocked. The control voltage is applied by the 8031's port 3 bit 0, marked as P3.0.

A 74LS157 quad 2-to-1 data selector, IC_2, is responsible for transferring data from the 8031 to the PC via the parallel port's status register, pins S4-S7. Because the status register is not completely available to the outside world, a byte of data input to the PC is divided into two steps.

First the low-order four-bit data D0, Dl, D2 and D3 – called the low-nibble – are transferred. Then the high-order four bits D4, D5, D6 and D7 – the high-nibble – are transferred. Select pin S on IC_2 controls these two steps. When S is in logical '1' level, the low-nibble is selected; when S is logical '0', the high-nibble is selected. It is easy to write software to combine the two nibbles into a byte, including the inversion of bit S7.

Microcontroller IC_3 is an 8031 type. It controls the programmer operations and communications with the PC. As you may know, the 8031 has four 8-bit registers, called ports. Port 0 includes pins 32-39 and carries both data and the low-byte address in multiplexed form. Port 2 includes pin 21-28 and forms the high-byte address register. In this application, port 1 on pins 1-8 is used as a data i/o port between the PC and the programmer, and port 3 on pins 10-17 is used for status and control functions.

Capacitor C_4 connected to 8031's reset pin provides reset operation to put the chip in known state after power up. The LED showing the system status connects to port P3, bit 5 on pin 15. Port P3, bit 0 connects to IC_1 pin 1G and 2G to control the tri-state buffers as discussed above.

> **PC parallel ports, old and new**
>
> This diagram shows the pin-out of the original IBM PC parallel port's DB-25 female connector. This port's hardware consisted of three 8-bit registers: the data register, D_{0-7}, the status register, S_{0-7}, and the control register, C_{0-7}. Each register was accessed using a unique address.
>
> Originally, the data register was designed to output data to printer, so it was unidirectional and has only output capability; the status register was designed to flag the printer's status, providing signals such as 'paper empty', so it has input only capability. But the control register has input *and* output capability.
>
> A few bits in the status and control registers were not used, so these bits, or more precisely the pin that represent them, are not seen on the connector. Furthermore, some bits are inverted for convenience.
>
> Mnemonics indicating inverted signals are often shown with an 'overscore', as opposed to an underscore, or prefixed with a slash character by the way.
>
> 
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Talking to each other

How do the PC and the programmer communicate each other? One solution involves a special control/status signal line between the PC and the programmer that operates a 'polling' scheme. This special line on the programmer side is connected to port 3, bit 4. On the PC's side it connects to the parallel-port control register bit C0, which is pin 1 on the DB-25 connector shown in the separate panel.

The line has a special property in that if, and only if, both sides are held in logical high, state then the line is logic 'high'; otherwise, if any side becomes 'low', the entire wire will be 'low'. Such a property is usually implemented using inverter gates with open-collector outputs.

Another scheme for data communication between a PC and a programmer is achieved through the 8031's external interrupt sources. The 8031 has two external interrupt pins: /INTO on pin 12, or P3.2, and /INTl on pin 13, or P3.3.

When a low external signal is applied to either pin for some period of time, the 8031 suspends its current instruction execution and jumps to execute the instructions written for that specific interrupt service routine. Data transfer between a PC and programmer under such an 'interrupt-driven' scheme can take place much faster than the normal polling scheme, so this is what I've implemented here for EEPROM programming.

Specifically, interrupt 0 is employed for EEPROM writing and erasing routines, while interrupt 1 is used for EEPROM reading routine.

Interruptions

When using interrupt 1 to read EEPROM contents, a typical session would be as follows. First, the PC sends a 'high' level signal to the parallel-port control register bit /C1, on pin 14, where it is inverted to a 'low' level signal to activate the 8031's /INT1.

It will take several machine cycles for the 8031 to respond the interrupt, so, the PC cannot immediately read the data. Rather it needs to wait for that short period of time. The 8031's P3.l pin, which connects to the parallel-port status register bit S3, signifies whether data is actually available.

When the 8031 enters the interrupt service routine, it first puts this pin 'low'. Only after it has read the data from EEPROM and put the data to port 1 does it pull this pin 'high' to signify that data is available. So the PC keeps checking pin S3 until it becomes 'high', then it reads in the data from the status port.

A polling scheme is used for the housekeeping, such as sending a command from the PC to the programmer, or sending the number of bytes to be written to the programmer. I use the polling scheme here because in such cases the number of data bytes to be sent is only one or two, so the speed is not important. Furthermore, human speed to touch the keyboard is still much slower than that.

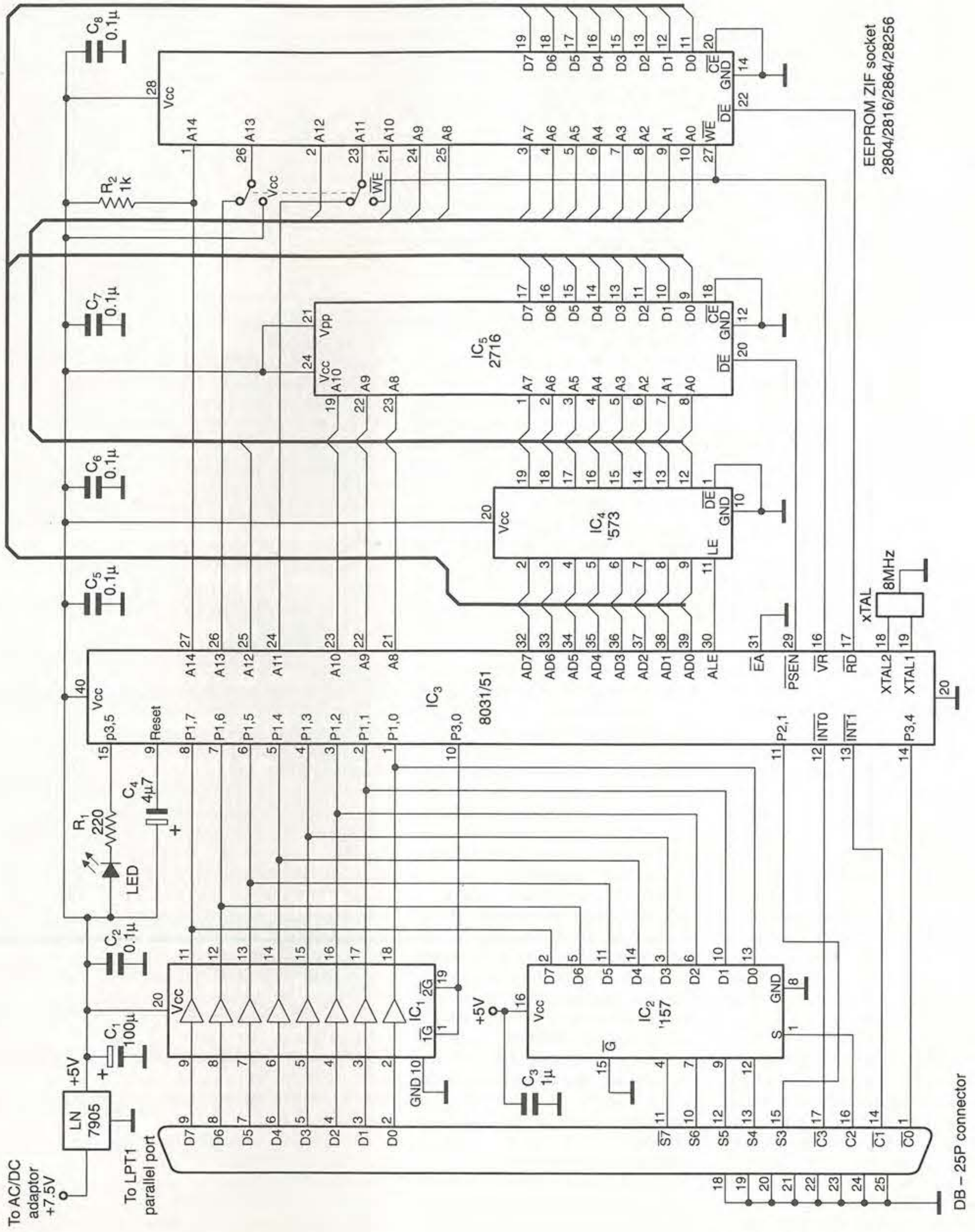
An 8MHz ceramic resonator instead of a crystal provides the system clock signal. The resonator has its own built-in capacitors so no external capacitors are needed.

Demultiplexing the address and data

The 74LS573 octal D-type latches, IC_4, de-multiplex the 8031's data and low-byte address. At the beginning of each machine cycle, the 8031 outputs the low-byte address information to pin 32-39, along with a logic 'high' signal at its address latch enable (ALE) pin. This pin connects to the latch-enable pin, LE, of the 74LS573, so the octal latches are enabled and the low-byte address is appears at its outputs (pin 12-19).

Later, when the 8031 outputs its data information to the same pin 32-39, the ALE signal is changed to logical 'low', so the latches are disabled. Now the data can only go to the data bus.

In the next clock cycles the 8031 outputs its high-byte address information. This is combined with the low-byte information latched at the 74LS573 output pins. By this way the 8031 acts just as if it has 16 address lines.



EPROM IC_5 is shown as a 2716 but it could just as easily be a 28l6 EEPROM if the project were just under development. This device stores the system control program.

Finally, the 28-pin zero-insertion-force socket is used to hold the EEPROM chip to be programmed. For the 28(C)04 or 28(C)16, the chip is placed in the socket with pin 1 to the socket's pin 1, and the slide switch SW is set to the position where A13 is tied to the 5V rail. For the 28(C)64 or 28(C)256 chips, the slide switch SW is set to the other position to provide the additional address lines.

Commissioning tips

A double-sided, plated-through hole printed-circuit board is recommended for this project. You can make your own board, or you can get one from the information source given at the end of this article.

Without inserting any IC, turn the power on. Use a DMM or voltmeter to check the voltages at the LM7805 regulator output pin, and at each IC socket's V_{cc} pin. They all should be about 5V. If this is the case, then your board seems okay.

Now turn off and carefully insert all five ICs in their sockets. Make sure that no pins are bent outside their sockets. Also pay attention to prevent static discharge damage to the CMOS devices.

Turn the power on again. You should see the LED light. This indicates that you've done a good job. You can now proceed to turn the power off and connect a DB-25M/F cable between your programmer and the PC.

Using the programmer

The programmer software is an easy-to-use menu-driven system. There are two programs available to make the PEE-1 programmer work with the host PC: the communication program PEE11.EXE which resides in the PC's memory (supplied on a 3.5in disk) and the controller monitor program P031WX.BIN which resides in the 2716 EPROM of the programmer.

With both your PC and the PEE-1 programmer power off, connect a DB-25M/F straight-through cable between the PEE-1 and your PC's printer port LPT1. Make sure the connection is firm and good at both sides. Otherwise you may get erroneous data when you run the programmer.

There are two example program files, LED1A.BIN and LED2A.BIN, supplied on disk with the programmer. These are the sample programs to light up and blink the LED mounted on the programmer board. It's best to try them out to see if they work as expected when you first run the PEE-1 programmer.

To start using the PEE-1 programmer, put a 28(C)04 or 28(C)16 EEPROM in the ZIF socket and set the slide switch as mentioned earlier. Then turn the power on for your PC and the programmer. From your hard disk or any floppy drive containing the supplied programs., type: PEE11 and press <return>.

A menu now appears on the screen. From there you activate the 'Device Select' submenu to select the device you've already put in the ZIF socket. Then you can proceed to program the device.

Suppose you choose the option "Write a Disk File to EEPROM". When you press <return>, you see another line appearing on the screen asking you about the file name and extension you are going to write. Type in LEDlA.BIN or LED2A.BIN as you like. After pressing <return>, in just a second the EEPROM 'Programming Successful' message appears indicating that the programmer works fine.

To demonstrate your success, turn the PEE-1 power off and temporarily remove the 2716 EPROM from its socket, then replace it with the newly programmed EEPROM. Then power it up again.

If now you see the LED blinking (for LED1A.BIN) or double blinking (for LED2A.BIN), then you have been successful in EEPROM programming and demonstration. You don't have to build your own circuit but simply use the programmer itself to demonstrate your result; this is a unique advantage of this PEE-1 programmer. ■

Parts List

All resistors are 1/4-watt, 5%.

R_1	220Ω	
R_2	1000Ω	
Capacitors		
C_1	100μF, 25V, electrolytic	
C_4	4.7μF, 25V, electrolytic	
$C_{2,3,5-8}$	0.1μF, ceramic	
Semiconductors		
IC_1	74LS541	Octal buffers with 3-state outputs
IC_2	74LS157	Quad 2-to-1 data selectors
IC_3	8031/8051	Microcontroller (Intel)
IC_4	74LS573	Octal D-type latches
IC_5	Programmed 2716 EPROM	
LED	Red light-emitting diode	

Miscellaneous

CR 8MHz ceramic resonator (with built-in capacitors)

SW DPDT slide-switch

Right-angled PC mount DB-25P connector, DB-25M/F cable, coaxial power jack, solder tail IC sockets, 28-pin ZIF socket, AC/DC power adapter, solder, four 4-40 screws and nuts, etc.

Technical support

The following items are available from G. Y. Xu, PO Box 14681, Houston, TX 77021, USA, phone: (713) 741-3125.

Website: www.geocities.com/xumicro

Email: gyxu@cmpmail.com

- Assembled and tested PEE-1 Programmer $59.95
- Complete kit (software, PCB, hardware, cable and AC/DC power adapter) $49.95
- PCB and software only – $25.95
- EEPROM 2816 2K bytes) – $4.50

Send cheque or (International) money order (US funds only). Please add $15 ($5 in USA, $6.00 in Canada) for shipping and handling. The software includes the PC .EXE file, the eprom hexadecimal code and the two LED routines for verifying the programmer's operation.

Alternatively, software only is available from *Electronics World* Editorial, Quadrant House, The Quadrant, Sutton, Surrey SM2 5AS in return for a cheque or postal order for £14 to cover the floppy disk, copying, postage and administration.

Variable-gain circuits

Cyril Bateman has been using he internet to see what the could find on variable gain circuits, including those that feature in Dolby B, companders and automatic gain and level controllers.

In the December 1999 issue, I introduced a wide-bandwidth AGC circuit based on the OPA660 IC from Burr Brown. This circuit provided a constant output voltage when presented with a varying input.

Other circuits provide a similar automatic gain-control mechanism to dramatically boost low-level input signals. Some also reduce high-level inputs, to allow a steadily increasing output voltage with input increase.

When a known input signal is to be processed, a gating circuit can be used to 'clamp' or 'key' the circuit's output voltage levels to a reference in the signal being processed. One early widely used IC that I recall, the Motorola MC1352, was used to key the video IF stages of domestic colour television receivers almost 30 years ago. This circuit effectively eliminated 'aircraft flutter', which plagued early receivers.

Today, similar specialised functions are common for a range of RF signal processing applications. A simple search for AGC on the Global Semiconductor Data sheet site[1] produced 43 application notes available for download. These covered both specialised and general purpose functions.

Bugs

As I write, Microsoft has just released a patch to eliminate yet another security weakness in its Windows 95, Windows 98 and Windows 98 SE operating systems. This most recent bug is called 'DOS Device in Path Name'. It is so called because it has been found that when the operating system attempts to read or write to a file which contains certain reserved DOS keywords within its name, it crashes, showing the 'Blue screen of death'.

This file access can be maliciously triggered when you download a Web page that has been embedded with malicious code, when you open an e-mail message on Hotmail, or similar Web-based e-mail service, or simply when you type the code at a DOS prompt. When the computer encounters the sequence of characters and tries to process them, it crashes.

Internet users with the above operating systems – especially those who use a Web based e-mail service – are advised to download this security patch from Microsoft.

Web E-mail breach - 'Dos Device in Path Name'
http://www.microsoft.com/technet/security/bulletin/MS00-17.asp

A new twist on web e-mail based bugs. If a Windows computer is forced into processing certain reserved DOS keywords, it crashes displaying a blue screen.

Dolby B

Another early variable gain circuit was used to reduce noise levels rather than control circuit gain. The ubiquitous 'Dolby B' circuit was responsible for the universal acceptance of the compact audio cassette.

During recording, loud signals were recorded unchanged, but lesser signal levels received a degree of high frequency boost. A sliding band filter was used to control the frequency and degree of boost. Both varied depending on the immediate spectrum being processed, **Fig. 1**.

This system's success resulted from a perceived quality improvement playing 'Dolby B' processed tapes on all cassette systems – even those not incorporating the Dolby B playback circuits.

Commencing May 1975, *Wireless World* published in a three part article a Dolby-B design, suitable for home construction by the way.

Companders

For professional recording systems, an alternative system called DBX was often used. This compressor-expander, or compander, system achieved significant noise reduction without needing frequency boost or cut. Using compression techniques, it reduced the dynamic range of signals recorded to tape in a controlled manner. The DBX system used the rms rectified input signal as its control voltage.

Tape recordings suffer from two dynamic-range restrictions. Tape can overload when presented with high-level signals. Secondly, tape noise becomes intrusive with low level signals. These combine to restrict the usable dynamic range.

On playback, DBX control circuits were used to reverse the process, expanding signals back to their original levels, offering a much increased dynamic range. The system could produce a 110dB dynamic range, subjectively free from noise.

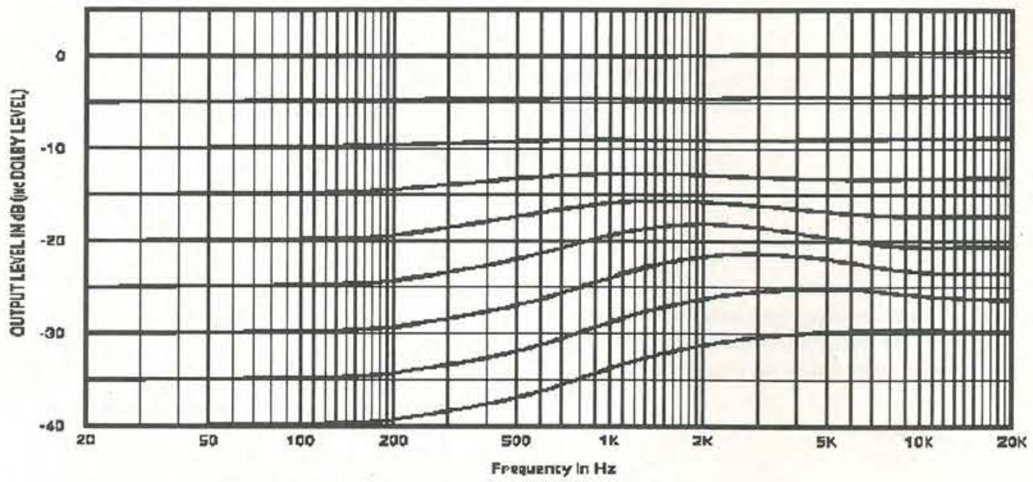


Fig. 1. Depicting the frequency and amplitude of selective boost, applied during the Dolby-B recording processing.

A low cost IC, the Signetics NE570/571[2], was developed to improve the signal-to-noise ratio on crowded telephone circuits. It used exactly this same companding approach, providing a 2:1 compression/expansion of signals. This allows an original dynamic range of 100dB to be transmitted as a 50dB range signal. Reversing this control, it is expanded back to the 100dB range of the original signal, in the process attaining up to 45dB of noise reduction, **Fig. 2**.

The 570 and 571 each comprise two channels containing a full-wave averaging rectifier, a variable gain cell and a summing node operational amplifier. While this variable-gain function could be provided using conventional OTA circuits, gain of an OTA varies with temperature. Philips designed a low noise, low distortion and temperature independent, linearised transconductance multiplier gain cell.

Capable of operating well above audio frequencies and introducing little distortion, this IC became

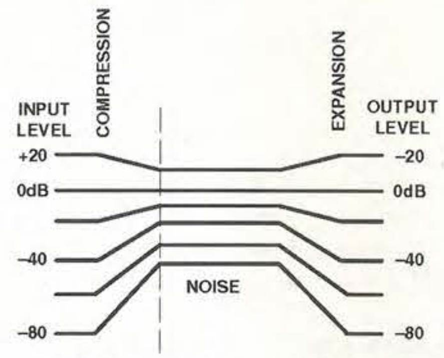


Fig. 2. A 100dB dynamic-range signal compressed to 50dB for transmission (recording), then expanded back to its original dynamic range when received (playback).

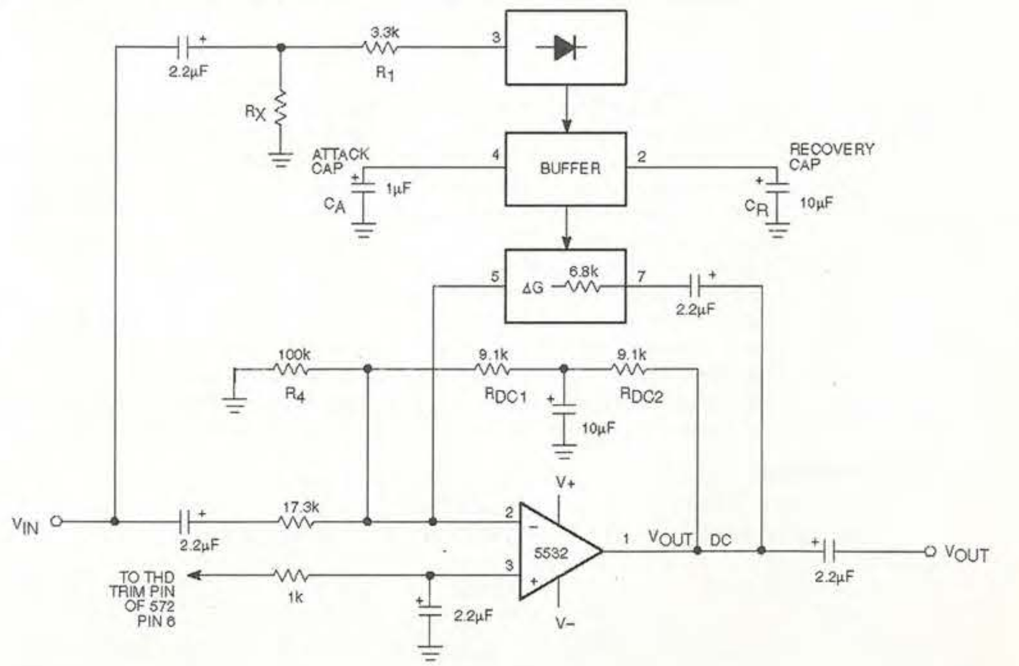


Fig. 3. The NE572 – a compander suitable for use in hi-fi systems – offers high-quality and substantial noise reduction. Its gain-control components have many other uses. Shown here together with an NE5532, it produces a high-performance levelling system.

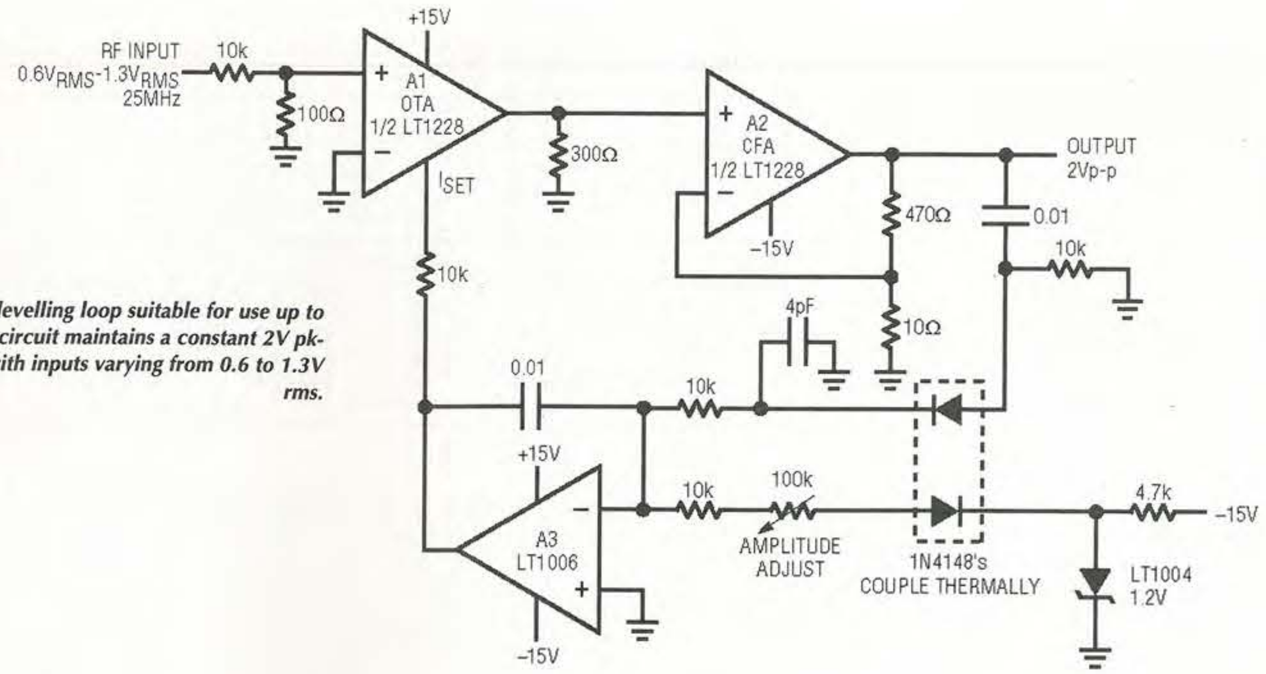


Fig. 4. An RF levelling loop suitable for use up to 25MHz. The circuit maintains a constant 2V pk-pk output, with inputs varying from 0.6 to 1.3V rms.

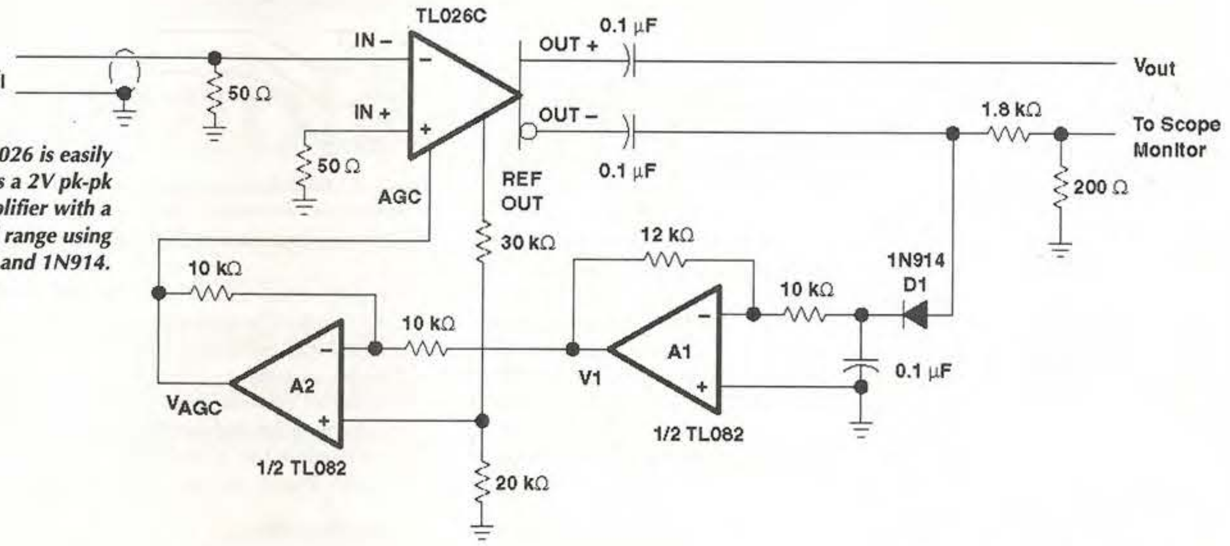


Fig.5. The TL026 is easily configured as a 2V pk-pk output AGC amplifier with a 32dB control range using only a TL082 and 1N914.

popular for high-fidelity home tape recordings. In November 1978, *Wireless World* published a circuit by D. Harrison using the NE570, which claimed to reduce cassette tape recorder noise by 30dB.

The NE570/571 provides three useful building blocks usable to 1MHz. These can be configured to provide a number of functions other than the simple compander shown in the current data sheet. The original Signetics Consumer Circuits handbook for the NE570/571 included 12 pages of application circuits. These included a fast-attack, slow-release limiter, a voltage-controlled attenuator, a variable-slope compander and an automatic level-control circuit.

Other variants on these ICs have since been introduced, including the NE572 which has its 0dB reference set at 100mV. This device is intended for hi-fi studio-quality systems. The SA577/578 provide a resistor-programmable 0dB reference level, adjustable between 10mV and 1V, **Fig. 3**.

A number of application notes on this topic are available for downloading. But perhaps AN1762, which includes an overview of seven Philips compander chips, provides the best introduction. AN1762 can be downloaded as 8020.PDF from Philips' site[2].

As discussed in the January issue, many designs rely on the gain control, made possible using a transconductance amplifier. Essentially a variable-gain amplifier, with its gain control driven from a rectified voltage derived from the amplifier's output signal, can be used to provide automatic gain or level control.

More information...

1. Global Data sheet Library http://www.semi.com.tw
2. Philips Semiconductors http://www-us.semiconductors.philips.com
3. Texas Instruments http://www.ti.com
4. National Semiconductor http://www.national.com
5. Mitel Semiconductor http://www.mitel.com

Automatic level control

The basic automatic level-control circuit, Fig. 2 from the January 2000 issue, provided performance to 10MHz and 20dB gain control. Addition of an output-driven, half-wave rectifier and gain-control buffer, produces a low-cost, RF levelling stage. This simple circuit features low output drift and distortion. Usable to 25MHz, it produces a constant 2V pk-pk output, with inputs from 0.6 V to 1.3V rms, **Fig. 4**.

For higher frequencies, a number of dedicated, variable-gain-amplifier devices are available. Two that caught my attention, the TL026 [3] and the CLC520R[4], offer a large AGC range, wide bandwidth and low phase shift, combined with easy control of gain.

Automatic gain control

The TL026 provides differential inputs and outputs in an eight-pin package. It has a 50MHz bandwidth, peak gain of 38dB, and an AGC range of 50dB. A change in voltage of ±180mV on its AGC pin relative to its reference pin voltage will send its gain from minimum to maximum **Fig. 5**.

The CLC520 offers an increased bandwidth of 160MHz, a 40dB AGC range and differential input to single-ended output, all in a 14-pin package. Maximum gain of the device is preset using one external resistor. Preset gain can range from +6dB to a maximum of +40dB. Set to +6dB, voltage-controlled gain ranges from +6dB to less than –34dB. Set to +40dB it ranges from +40dB to less than 0dB.

The CLC520 provides high impedance, differential voltage inputs with better than 0.5° linear phase deviation up to 60MHz, and 0.04% signal non-linearity at 4V pk-pk output.

With a gain-control bandwidth of 100MHz, the CLC520 simplifies AGC/ALC loop stabilisation. It can also be used for amplitude modulation and voltage-controlled filters. Gain is minimum with zero volts applied to the gain control input, and maximum with +2V applied. An evaluation board is available both for DIP and SOIC package versions[4] **Fig. 6**.

400MHz-bandwidth gain control

The SL6140 integrated circuit was designed by GEC-Plessey Semiconductors, now part of Mitel Semiconductor[5]. Housed in an eight-pin package, this design offers a 70dB gain control range with a 400MHz bandwidth when loaded with 50Ω.

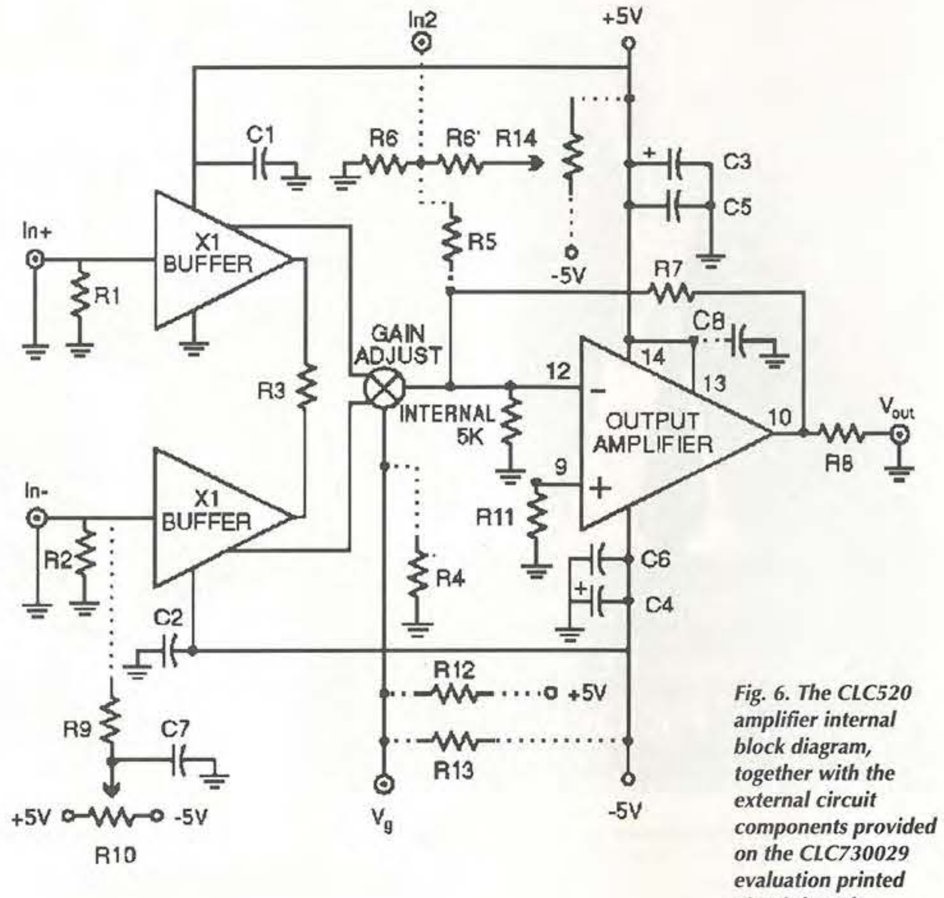


Fig. 6. The CLC520 amplifier internal block diagram, together with the external circuit components provided on the CLC730029 evaluation printed circuit board.

Its open-collector outputs allow you to trade off gain against bandwidth. Loaded with 50Ω, the device provides 15dB gain and 400MHz bandwidth. With a 1kΩ load, gain increases to 45dB but bandwidth reduces to 25MHz.

By tuning, or matching, the inputs and outputs of the device to a 50Ω system, gain can be increased. The SL6140 circuit can be used as a high-frequency, tuned AGC amplifier with narrow-bandwidth and high gain. As described in AN45, with input and output stages tuned and matched to a 50Ω system, the circuit can provide a 35dB power gain at 100MHz, **Fig. 7**.

My next Internet article will explore other, non-standard methods that can be used to control signal amplitudes. ■

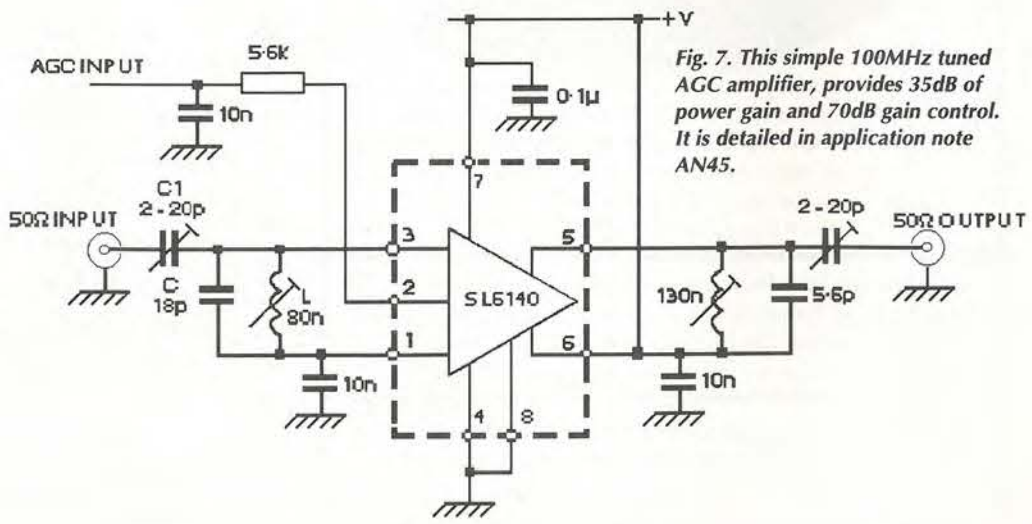


Fig. 7. This simple 100MHz tuned AGC amplifier, provides 35dB of power gain and 70dB gain control. It is detailed in application note AN45.

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For more details on the of range programmers, see Crownhill's web site, detailed below, and the company's advertisement on page 551 of this issue.

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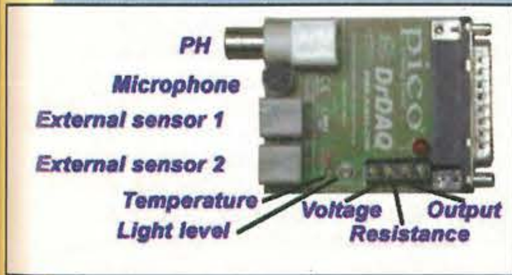

General specifications

Connection to PC	Parallel port D type
Input channels	7 internal, 2 internal
Sampling rate	10 to 15kS/s
Overload protection	±30V
Digital outputs	1 ttl, 1-3kΩ Z_{out}
Dimensions	55 by 70 by 20mm

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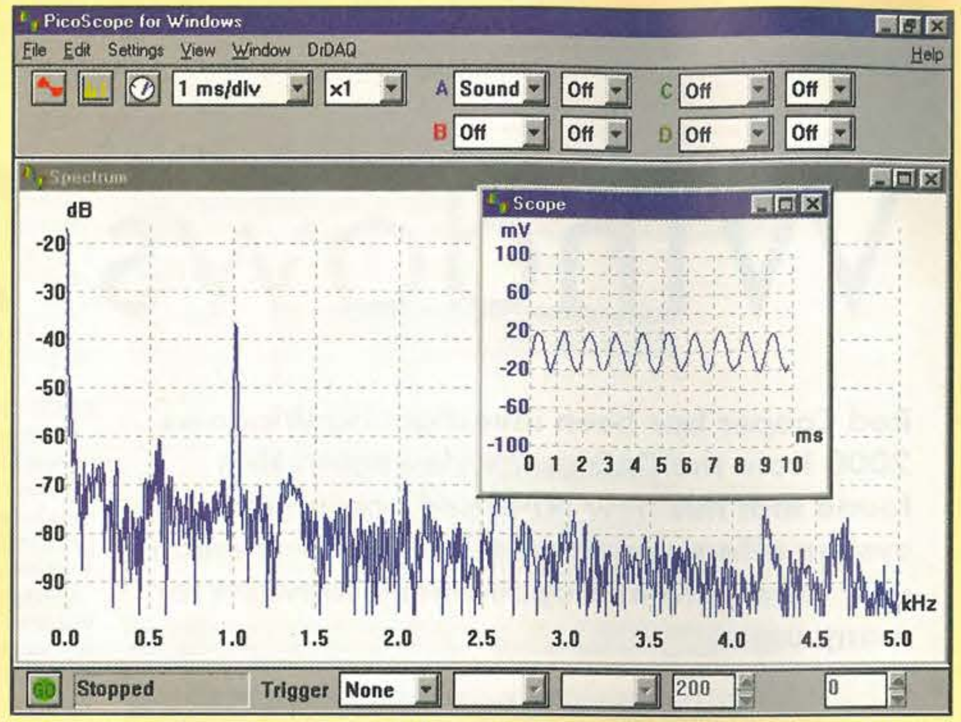

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		400Ω @ 100kΩ	2% @100kΩ
Temperature	0 to 70°C	0.1°C	2°C @25°C
Light	0 to 100	0.1	Not calibrated

External sensors

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Windows 2000

Rod Cooper has been investigating Windows 2000 from the CAD user's viewpoint. He's found that this new NT-based operating system offers major benefits, but it will mean new hardware and applications software for many users.

Now that all the hype and commotion surrounding the launch of Windows 2000 is over, it is a good time for a measured examination of what this OS offers those in the field of CAD/CAM.

As most potential purchasers will already know, there are two versions of Windows 2000, one for servers to challenge Linux, Unix and the like, and the other for general business use.

The business version is called Windows 2000 Professional, and is the topic of this review. Of the huge amount of money spent on developing this system, I think it likely that much of it has gone towards the Server version and the new and much talked about Active Directory. A lot of investment seems to have gone into networking generally, and into administration tools, **Fig. 1**.

The Professional version is an uprated version of NT, with most of the best features of Windows 98 fused in to create what amounts to a hybrid NT5.

The concept of using the existing Windows 95/98 interface with the more robust NT kernel is an excellent one, but Windows 2000 is clearly not the all-purpose definitive version of Windows that the pundits were predicting. It is aimed squarely at the business sector, with many features only a business would be interested in. These include control of individual users on multi-user machines, and other similar tasks you would expect only an administrator to perform.

Indeed, on the side of the Windows 2000 box, it makes this perfectly clear in a section labelled "Which Windows is right for you?" by directing certain potential purchasers away from Windows 2000 and back towards Windows 98 as the platform for consumer software, internet access, music, multimedia, games, video, etc. This is a telling statement, but in fact Windows 2000 does have features like the CD player, sound recorder and media player.

Comments in the computer press centre on the lack of support for such things as 3D hardware. This may be important for certain categories of CAD/CAM user. And there have been comments that some popular high-end AGP graphics cards may give only basic functionality under Windows 2000.

Contrary to what was expected prior to the launch of Windows 2000, Windows 98 is to be developed further with another version currently under development, code-named Millennium. It is scheduled to appear later this year. But Windows launch schedules are, as everyone realises by now, variable quantities.

Table. Comparison of boot-up times from various systems.

PC	Op. system	Time
Pentium, 133MHz 32 Mbyte RAM	WIN3.11	40 seconds
	WIN95	1 minute 20 seconds
	WIN98	1 minute 35 seconds
	WIN2000	4 minutes 30 seconds
AMD K6-2-500 128Mbyte RAM,	WIN2000	1 minute 30 seconds
Dual Pentium 400MHz, 256Mbyte RAM	NT4, SP6	2 minutes 50 seconds
Apple Mac G4 450MHz, 128Mbyte RAM	Mac OS 8.6	1 minute

What hardware will you need?

The absolute minimum for Windows 2000 Pro is a 133MHz Pentium with 32Mbyte of RAM, and a 2Gbyte hard disk with at least 650Mbyte free.

I initially tried loading the system using somewhere near the minimum requirement, but performance was poor. Using the recommended minimum increases the amount of RAM to 64 Mbyte. At this level, Microsoft claims that Windows 2000 is 25 to 30% faster than Windows 98.

However, there are reports that if you use 128Mbyte or 256MByte of RAM there are further significant increases in performance, so this indicates the real amount of RAM you should aim for in order to take full advantage of the operating system's potential. There's no point in buying a high performance car and then running it on paraffin.

This increase in speed is offset by the longer boot-up times though. It is interesting to compare boot-up times, as in the **Table**. This is not a definitive table, but shows a snapshot of the general situation.

Typically, Windows 2000 takes up about 600 to 650MByte of hard disk space. There is less opportunity to lighten the load by omitting components with this version of Windows. For example, I always left out screen savers, Paint, the accessibility tools for the disabled, the games, and a few other things when installing Windows 95/98, but with Windows 2000 you get them whether you want them or not. It is possible to leave out some Internet and networking tools. You can also retrospectively delete some of the things you do not want.

If you have 64Mbyte of RAM, don't be surprised if Windows 2000 consumes 50Mbyte or more. This doesn't leave much memory for heavy-duty applications like CAD. Autorouters, for example, like plenty of memory.

Hard disk space and RAM are cheap. But for a small business with a few machines to upgrade and staff to retrain, the costs can mount rapidly. In this case you will do well to assess the benefits of Windows 2000 carefully and weigh them against the real overall cost.

Human requirements

If you use Windows 95 or 98 regularly, then you will take to Windows 2000 easily. Although several changes have been made to the interface, most of the familiar aspects are still there, albeit in an upgraded and altered state.

If you are trained in NT4 with no experience of Windows 95/98 then no doubt you have some catching up to do.

Installation

Windows 2000 comes on a single CD which gives you the choice of upgrading your existing system, if it is based on Windows 95/98 or NT 3.51 or 4.0, or performing a new installation from scratch. It is not possible to upgrade from Windows 3.x.

If you upgrade an existing Windows installation, the procedure is straightforward. It is very similar to setting up Windows 95 or 98.

If you are sitting in front of a PC with an empty formatted hard disk, then you must have a working CD-ROM, preferably one you can boot from, as most modern ones are. The CD is bootable. You may have to alter the bios to include the CD-ROM drive in the boot sequence.

You could have problems if you are without a CD-ROM drive that is bootable, as I was. In this case, the first part of a fresh installation requires four floppy disks to initiate the setup, and these must be downloaded from the CD. These disks did not come with the shrink-wrapped box. This presupposes you have a working CD-ROM drive, but of course if you have a blank hard disk you don't. You could mess around getting it up and running, download the floppy disks and then install, but this is time-wasting.

Happily, I had access to a second PC already running Windows 95 and this did the trick. However, without this second PC, I would have had much more work to do to download these files. I think these four floppies should be included in the box as part of the package.

Before installation you have to decide whether you want to run the FAT32 disk filing system or Windows NT's own specific NTFS system. The advantages of FAT32 over FAT16 were explored in my Windows 98 review in the August 1998 issue.

NTFS has further advantages over FAT32. For example, if you decide to use NTFS you will not find Scandisk in the system tools, because NTFS already does the job of Scandisk as it goes along, i.e. finding disk faults, marking them down and rescuing data.

This is a much superior system because the inevitable hard-disk faults that crop up will be found by NTFS long before you would find them yourself in the normal course of events using Scandisk. Consequently there is less risk of loss of data.

The other advantages consist of a batch of small improvements rather than any large single step. Amongst these are better file integrity, better use of disk space, and support for very large drives up to 2Tbyte, without the loss of performance you would get with FAT.

Like FAT, NTFS still fragments with time, probably more slowly than FAT, so you will still need to defragment on a regular basis. A fragmented NTFS hard disk eventually becomes just as slow. The defragmenter used is from Executive Software, **Fig. 2**.

However, if you drop FAT in favour of NTFS, you will lose compatibility with systems using FAT. This may be important if you use dual-booting with another operating system and want access to common files.

Also, you will not be able to boot to a plain Dos prompt, which is so useful when things start to go wrong. But if you intend making a clean break with the legacy of the past, the best advice may be to burn your boats and use the demonstrably better NTFS.

Installation takes over an hour, during which time you are asked questions. Earlier versions halted installation until you had answered the questions, which meant that it was not possible to do an unattended installation. This was a particular bind if several machines had to be upgraded.

An interesting feature in WIN2000 is that you can use a template, answering the questions in advance, so you can start the install and then walk away. If you have several machines to set up, I recommend this method. It is not difficult to use, and works well provided all the machines are to be set up with an identical configuration.

If you envisage re-installing on a regular basis, or if you use several removable hard disks on one machine, it is also worth considering this method.

It is wise to check your hardware before starting to install 2000. This can be done from the 'Hardware Compatibility List' on the CD, or you can get a more up-to-date list from Microsoft at www.microsoft.com/hcl.

There is a utility called SysPrep that you can use to check if your system will run Windows 2000.

Compatibility issues

Windows 95/98 had a dual-purpose nature in that it was a 32-bit system that had to accommodate existing 16-bit software. Windows 2000 is not dual purpose so it will not run many Windows 95/98 applications and drivers.

For example, I discovered that my Logitech mouse driver would not work. But I found that Logitech was already offering a new driver for Windows 2000, available for free download on its web site. Logitech advises though that you must remove the old mouse driver before installing Windows 2000 over a copy of Windows 95/98.

It seems there is no clear-cut way of finding out which existing products will work and which will not. From what I can deduce from experiments with various programs, those labelled 'WIN95/98 compliant' are unlikely to run, as they may have some 16-bit code. Those labelled 'for WIN95/98' with no mention of NT have a small chance of

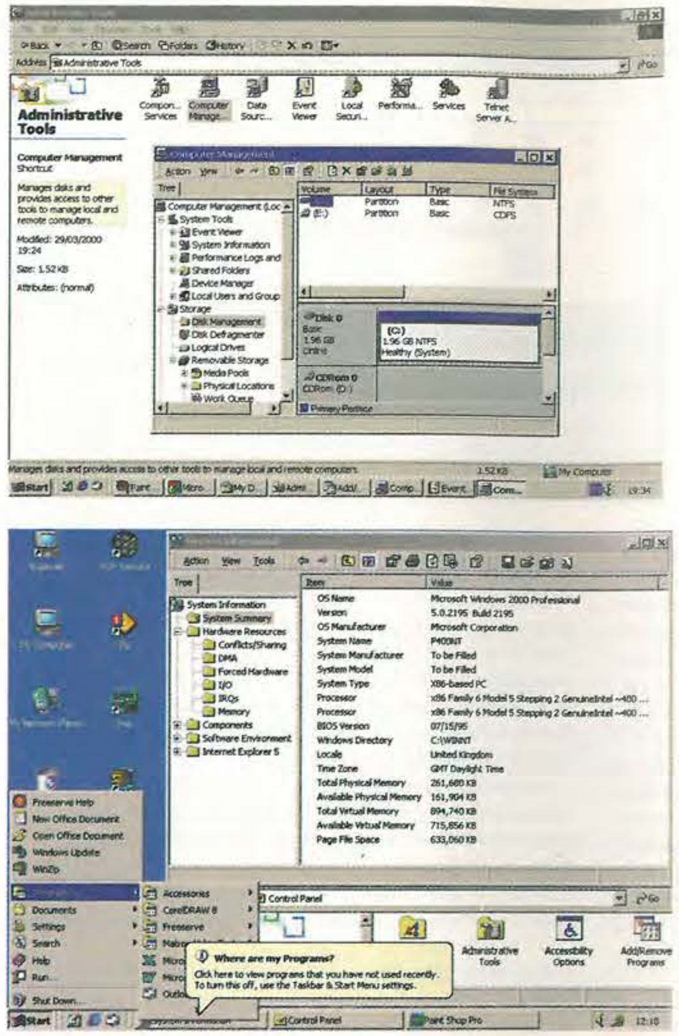


Fig. 1. Windows 2000 provides much more information about the system as a whole and the means to configure and adjust, like these 'administration tools'. But as you may be able to see from the lower screen shot, the operating system can use a lot of memory. Compare the total physical memory with that available. Paint Shop Pro V3.11 was used to do the screen capture and it seems to run fine by the way.

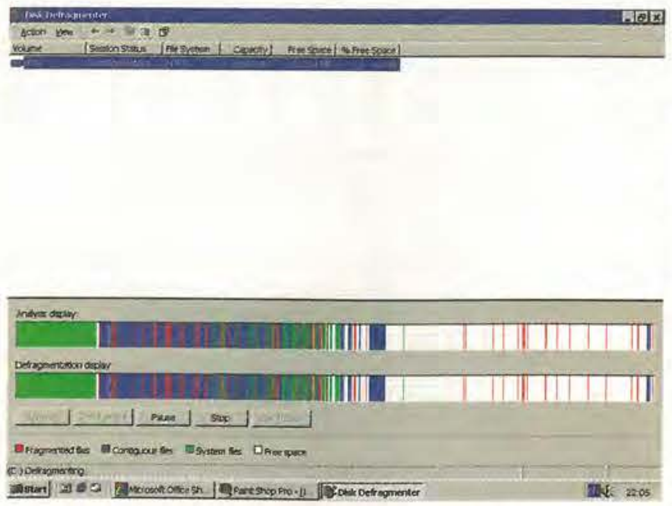


Fig. 2. Windows 2000's defragmenter works with both disk filing system options, i.e. FAT32 or NTFS. Windows NT users will be pleased to see that the defragmenter is now supplied with the operating system.

running, and those with NT in the title will probably run.

Adaptec's Easy CD Creator 3.5c – designed for WIN95/98 *and* NT – is an example of an application that may cause you significant problems. If you succeed in installing this using the Adaptec self-starting installation procedure, it will subsequently prevent Windows 2000 from even starting. If you use the Install Software utility in Control Panel, it will give you a message that the installation cannot proceed.

Adaptec has issued a patch to enable Easy CD Creator 3.5c to be used with WIN2000, and this can be downloaded from their website. However it is only a partial cure because it does not fix the very useful Direct CD part of the Creator suite. To get a working version of Direct CD you are obliged to buy the complete new Easy CD Creator Suite.

Although I have picked Adaptec's software as an example, many other applications fall into the same category. There may or may not be a patch, and the patch may or not do all you require from it. The process of approving applications to run on Windows 2000 is under way but progress seems slow.

It is still possible to run Dos programs in a 'Dos box', even if you have NTFS, provided they don't try to seize control of the machine as some are prone to do. For example, I ran the XTREE Dos utility successfully.

Reading matter

You get two booklets in the box. One is a slim 'Quick Start Guide', about installation, and also describing the setting-up of the system after installation. There is plenty of essential advice in this little guide; how to decide on installation choices, a brief section on the FAT versus NTFS option, a section on improved security against unauthorised users, on creating user/administrator accounts if you are in control of a firm's computer system, configuring passwords, setting up dialling rules, shared resources like printers, etc., and all the other paraphernalia of typical business use. The information is packed tight; skip a sentence and you'll miss something vital.

The other, larger booklet is a 107-page guide which expands on the installation procedure, the use of dual-boot systems, partitioning, and gives a little more information on the differences between FAT and NTFS. It also delves into the basics of working the WIN98-style desktop – essential reading if you are a NT4 convert – the basics of LANs and Internet connections, and adding hardware.

In the appendix are the most important Stop Error Codes, and what to do about them. In the WIN98 manual there was very little in this respect. Including these codes with Windows 2000 is a useful addition – especially if you are looking at a frozen screen with just an error code on it. It should forestall some calls to technical support.

General view

If you come from a Windows 95/98 background then the desktop will seem instantly familiar. You could be forgiven for thinking you were in Windows 98, but on closer inspection you will find many small changes.

In transferring the Windows 98 interface, almost every aspect has been given an overhaul, generally for the better. Strangely though, small things that were criticised in Windows 95/98, are still there. These may be minor gripes, but they have a tendency of becoming major irritations when they are encountered every working day.

For example, the sheer illogicality of using the 'start' button on the taskbar for shutting down the PC, is anathema to logically-minded people – i.e. most engineers – and has become something of a joke. But it remains. It's as though Microsoft is thumbing its nose at the critics.

Another one is the close/minimise/restore buttons at the top right-hand corner, which are still too close together for some people to click on easily. The 'My Computer' logo which many found rather childish – I admit I renamed this immediately – still persists, as well as 'my documents'. Now, for good measure, there's also 'my network'.

Strangely for a business-oriented operating system, four games are included, and the rather elementary Paint program, as well as a splendid choice of wallpapers. Will the average business user welcome these? On the other hand, most of the changes to the Windows 98 interface that have been made are clearly improvements.

Improved driver handling

Although plug-and-play is a feature carried over from Windows 98 that NT4 users will welcome, there are bound to be times when a third-party driver will still be needed.

In the past, drivers for add-on cards such as modems, video cards, etc., tended to be a bit of a mixed bag. Some were excellent, but others were a source of built-in instability unfairly blamed on the operating system. Of course, you could say that a well-designed operating system would fend off these badly-written third-party drivers, and in a sense this is what Windows 2000 does.

Third-party manufacturers can now have their software approved for use in Windows 2000 by being given a digital signature. With this system, approved drivers are installed easily. The system administrator can set the system so that non-approved drivers can be halted on installation, or a warning message displayed to the effect that, if you go ahead and install, it is at your risk.

What a shame this simple system for sorting the sheep from the goats was not introduced years ago. It would have enhanced the reliability and the reputation of the previous versions of Windows no end. Perhaps the obstacle was one of cost, as a fee is charged for this approval.

Help?

The help files are much improved and expanded, with better and longer explanations, better links, and more detail. Some of the help text is written with the assumption of a certain level of Windows know-how and appears to be directed at experts, but the beginner is also well catered for. I think most *Electronics World* readers will welcome this expansion and increased depth.

Stability issues

One of the major causes of unreliability of Windows in the past has come from installing and then removing applications. This type of instability was blamed on so-called 'power users' but in effect we are all in this category, as over a period of time everyone puts on and takes off applications of one sort or another.

I have noticed that Windows 95/98 systems that are left undisturbed, and their applications consistently used in a routine way, run for a much long time without crashing.

The recent review of pcb-CAD and simulators gave me some first-hand experience of this, as Windows 98 would first wobble and then crash as the review programs were installed and removed one after the other.

Even using one of the many uninstaller utilities that are on the market did not provide a dependable cure. I tested Windows 2000 out with a few installs/uninstalls which I knew would have unsettled Windows 98, and the system seemed to carry on unaffected. Also, it seems that if a badly-written application crashes, Windows 2000 will soldier on. This is impressive!

Part of the new reliability comes from Windows File Protection, which runs in the background and guards critical system files from being overwritten. If a file gets corrupted, the most likely source being a badly compiled third-party application, WFP replaces it with a clean file, either from a back-up copy or from the Windows 2000 CD. This throws the responsibility for any shortcoming in this particular respect back on to the originator of the third-party application. File protection works well. You can try it yourself by altering a system file, then checking for its restoration.

Secondly, the Windows installer/uninstaller is also said to be better at its job, leaving less in the way of debris after a program has been uninstalled, or if an install has misfired and collapsed.

It has been suggested that the Registry was one of the main causes of unreliability. Third party programs would insert Registry entries on being installed but not remove them completely on removal. This resulted in a much-enlarged Registry – so-called 'Registry bloat', with many irrelevant and potentially trouble-causing entries. Also, other files such as DLLs would be left lying around at random.

Installation failure

Having an installation fail to complete is common experience. It leaves everything in a state of limbo.

The Windows Installer in Windows 2000 is designed to return the system to a clean state if the install fails. Moreover, it can prevent conflicts between applications using shared resources. It can repair applications by replacing files that are found to be bad, and do a few other unexpected things as well.

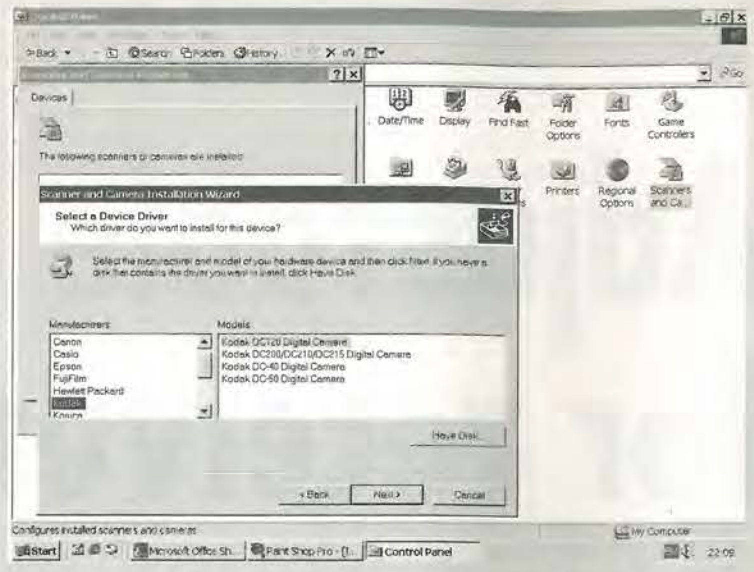
More importantly, uninstalls are more thorough. Registry entries are removed, and there's better control over DLLs and other application files.

The message here is, if you want the increased reliability of Windows 2000, let the operating system handle all the application installs and uninstalls.

In summary

Critics of Windows 2000 will see it as an oversized operating system that promotes yet more technology churn – i.e. a large increase in resources and total cost with not much to show for it. Here is the law of diminishing returns operating with a vengeance.

But in mitigation of this argument, the price of new PCs has fallen considerably, as has the cost per megabyte of hard disk drive space and memory. Given that some improvement to the reliability of the existing product was really needed, it is difficult to see what could be done to Windows and at the same time avoiding the creation of a certain amount of technology churn – without starting again from scratch that is.



Relative to NT, Windows 2000 has improved support for digital imaging devices like cameras.

Cameras and scanners

Support for digital cameras and scanners is much improved. Now that digital cameras with high resolutions have made an appearance, they have become more a part of the technical scene, so engineers will welcome their easier implementation in Windows.

The number of devices catered for is not large, as the screen shot shows, but then the digital camera and scanner world is awash with products. New models appear and old models are discontinued at an amazing rate, so it would be unreasonable to expect an operating system to keep pace.

Also included is a basic image-manipulation program.

Certainly, the extra checks and balances introduced to combat the known instability of Windows 95/98 are to be welcomed, as is the more reliable NT kernel. However, if you are already an experienced user of Windows 95 or 98 and are having no particular problems it is not easy to justify a move to Windows 2000.

The deterrents to adopting Windows 2000 are firstly the incompatibilities with existing systems introduced by the superior NTFS – although you can drop down a notch and adopt FAT on installation if you really want. Secondly, the 32-bit operation may make some of your current Windows 95/98 applications unusable. Thirdly, the increased hardware requirement may make your existing PC redundant. Certain stand-alone CAD/CAM users may find the administrator tools get in the way.

However, if you are running Windows 95/98 and you are suffering persistent and debilitating instability, then Windows 2000 Professional is an attractive proposition, provided you have a machine that can be easily upgraded, or you are prepared to buy a new PC.

If you are running NT4 and you find it unfriendly, then Windows 2000, alias NT5, is a natural progression. By following this route, you will not have the dilemmas listed above that Windows 95/98 users have to face, apart from some staff retraining to cope with the new interface.

For those who have clung on to Windows 3.x waiting for something better than Windows 95/98 to appear – and I have observed many smaller businesses doing exactly that – then Windows 2000 will have considerable appeal. For these users, a clean sweep of hardware and software may make good sense. ■

Adjustable PLL for receivers

Darren Heywood's 46 to 76MHz phase-locked loop module is tuned by simply turning a ten-turn potentiometer. It was originally designed to form the master oscillator of a short-wave receiver, but it is easy to adapt it for other applications.

This phase-locked-loop module was designed to be the master oscillator in a short-wave receiver.

The most common method of overcoming image channel interference is to up-convert the first IF to 45MHz. This PLL spans 46 to 76MHz in 500kHz steps or increments and so covers the entire HF band. It can easily be adapted to cover other frequency ranges simply by adjusting the zero/span potentiometers and/or changing L_7.

Assuming correct set-up, stepping through the frequency range involves the user simply turning a ten-turn potentiometer.

Circuit overview

The module accepts an unregulated 12V supply, regulating it to 8.3V via IC_2 in conjunction with Tr_1, Tr_2, and Tr_{16}. It is capable of delivering up to 300mA. A 5V regulator, IC_1, supplies 5V to the various TTL chips.

A 74HC4060 oscillator/divider produces the reference frequency, outputting a very stable 125kHz on pin 4. There's a 250kHz signal available at pin 5. This feeds a Class-C amplifier, Tr_3, that generates about 60V. Regulation by ZD_2 limits the output across C_{14} to about 33V. This voltage is needed to drive the BB909B varicap diode.

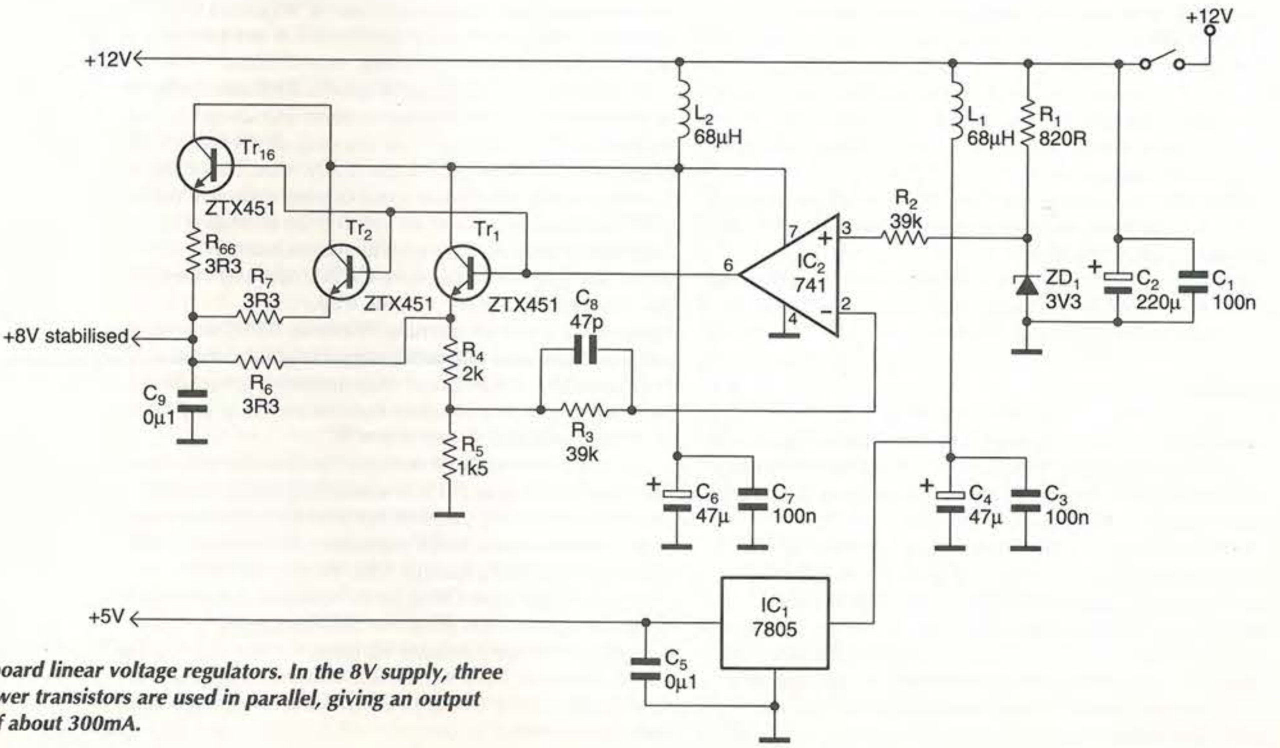


Fig. 1. PLL board linear voltage regulators. In the 8V supply, three medium-power transistors are used in parallel, giving an output capability of about 300mA.

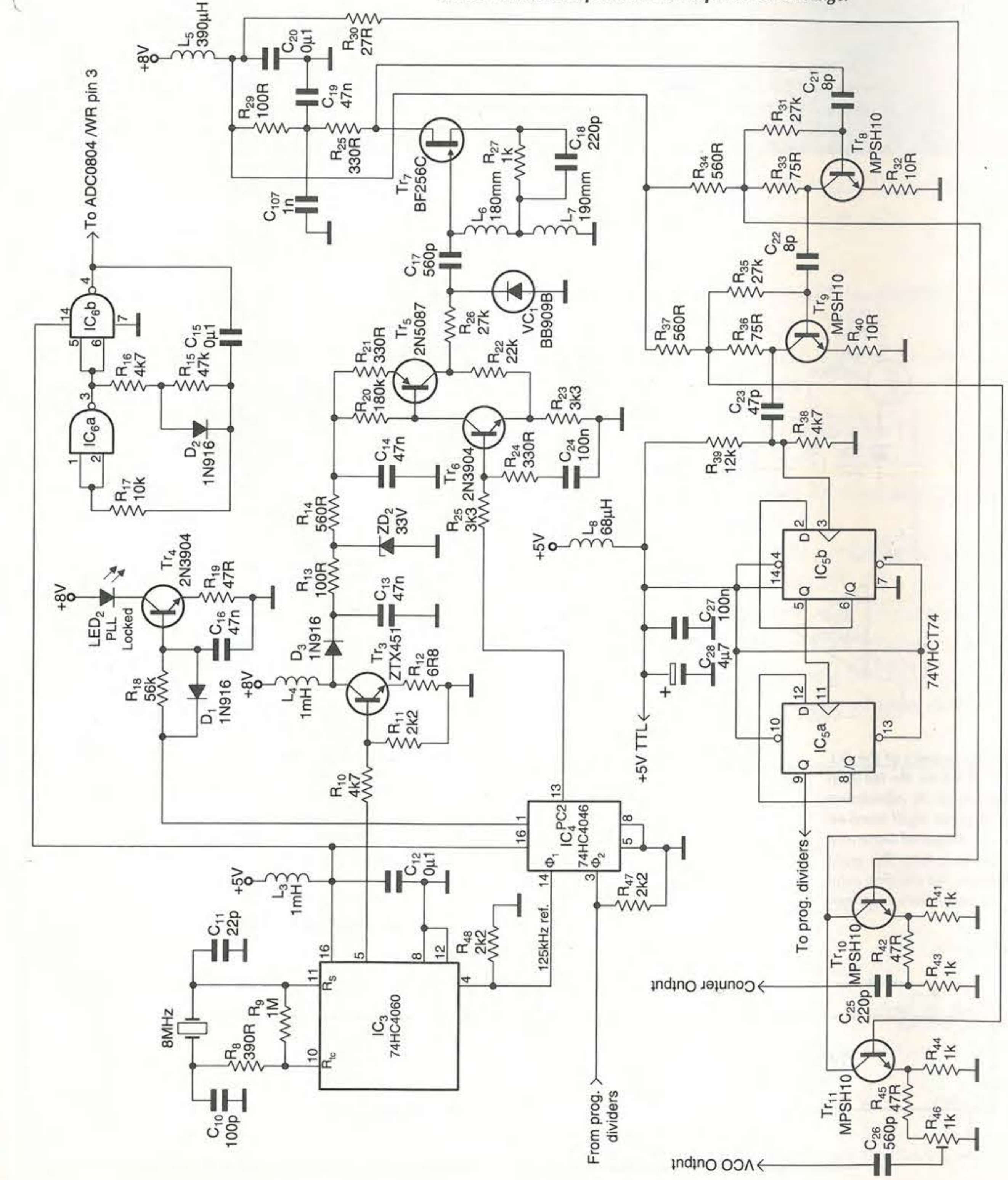
Transistor pair Tr_5 and Tr_6 are designed to have a voltage gain of about 6. As a result, output from the linear phase 74HC4046 detector, IC_4 is 0 to 5V.

When amplified by a factor of 6, the 0-5V signal produces a linear 0 to 30V dc error voltage for the varicap diode. This arrangement allows the module to produce very wide span ranges. Resistors R_{25}/R_{24} and C_{24} make up the loop filter, which in this case is a single-order lag/lead filter type.

An FET, Tr_7, is at the heart of the free-running voltage-controlled oscillator, or VCO, which is a Hartley variant. Where L_6 and L_7 are concerned, it is easier to talk of wire lengths than inductance values, so L_6 and L_7 are 180mm and 190mm respectively. To make these two inductors, simply cut two lengths as stated from ordinary single-core hook-up wire and wind them around a pen, etc.

Output from the VCO is lightly coupled to Tr_8 which amplifies the signal. Further amplification takes place in

Fig. 2. Main PLL board includes a step-up voltage converter for supplying the 33V needed to operate the varicap over its full range.



Tr_9. Resistors R_{39} and R_{38} bias IC_5 just on its switching threshold. Note that IC_5 is actually used as a divide-by-four prescaler; the 'VHCT' TTL family is capable of working up to 160MHz.

Transistor Tr_{10} provides an output to a frequency meter while Tr_{11}'s output can be fed directly into a mixer, such as the NE602.

Output from pin 9 of IC_5 is then fed into IC_{10}. This device, together with IC_9, makes up the programmable dividers. The output of IC_9 at pin 13 is fed back to IC_4 pin 3 for comparison.

Transistor Tr_{15}, combined with ZD_3, generates a stable 3.3V reference. This reference is buffered by IC_{7b}/Tr_{13} and then fed into pin 9 ($V_{ref}/2$) of the ADC0804 analogue-to-digital converter. Potentiometer VR_1 affords span adjustment while VR_2 adjusts zero.

Setting up

To calibrate this PLL, connect a frequency meter to the counter output. Rotate VR_3 to its earthy end and adjust zero, via VR_2, as required. Then rotate VR_3 for maximum and adjust the span, VR_1 for the upper frequency limit. Repeat this procedure a few times until you obtain the correct lower and upper frequencies.

Since the ADC0804 is a successive-approximation type a-to-d converter, it requires continuous active-low strobe pulses on its pin 3. This is achieved by IC_6.

As the circuit stands, it is possible to have a total of 255 500kHz steps. In my application though, I only needed 60 steps of 500KHz to cover a 30MHz range. This covers the entire HF band.

Output frequency of the PLL circuit is found using,

$$f_{out}=4\times125\text{kHz}\times N$$

where N is the eight-bit binary byte generated by a-to-d converter. As a result of this, the PLL should span 500kHz to 127.5MHz, but the VCO, Tr_7, would probably run out of range. As shown, with L_6 180mm and L_7 190mm, 46MHz to 76MHz is achieved with plenty of spare capacity.

Capacitors C_{108} and C_{35} should be mounted as close to the ADC0804 as possible. ■

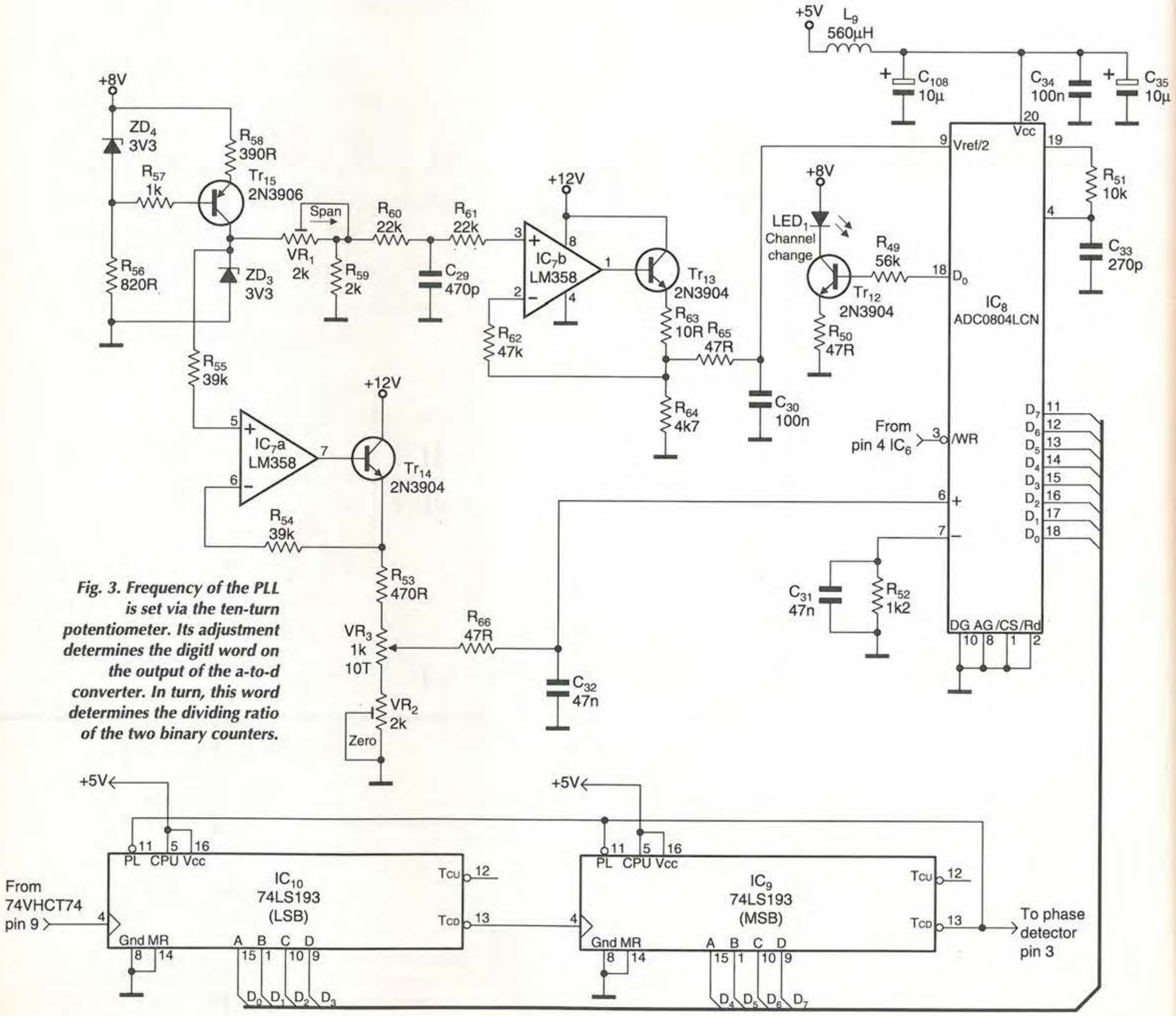


Fig. 3. Frequency of the PLL is set via the ten-turn potentiometer. Its adjustment determines the digitl word on the output of the a-to-d converter. In turn, this word determines the dividing ratio of the two binary counters.

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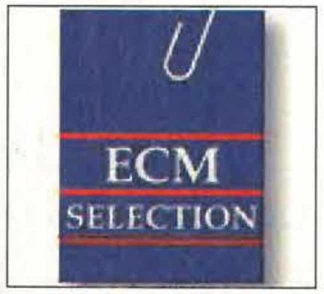

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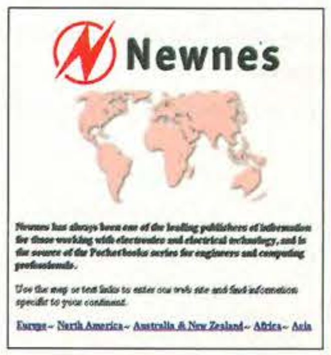

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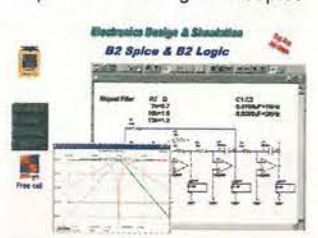

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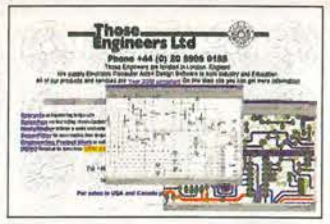

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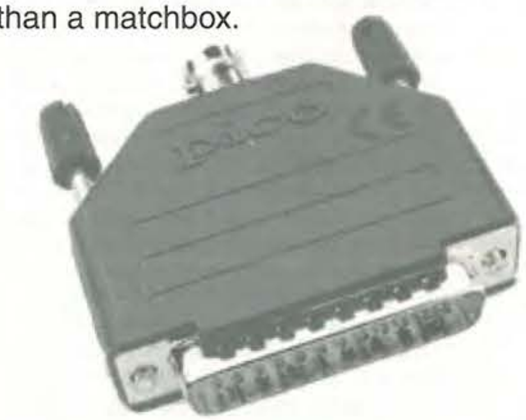

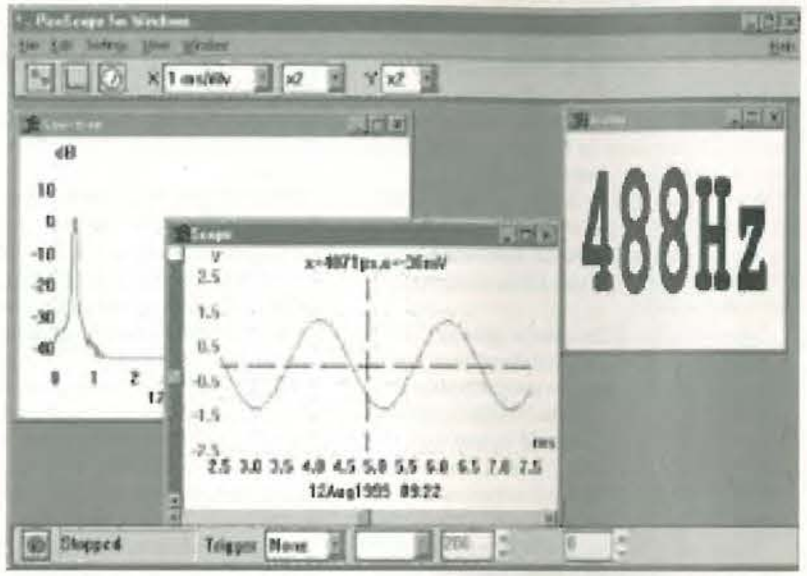

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Letters to the editor

Letters to "Electronics World" Quadrant House, The Quadrant, Sutton, Surrey, SM2 5AS e-mail jackie.lowe@rbi.co.uk using subject heading 'Letters'.

New mobile phone health risk?

I have just read an article in the May issue regarding the new Blue Tooth wireless network system.

I note that the frequency at which it will operate is the same as that used by domestic microwave ovens, namely 2.45GHz.

Does anybody really think that, in light of the recent discussion over mobile phones, it is a good idea to introduce a network using the very frequency most likely to cause personal injury?

I do not know if the people who set out the specification realised what they were doing. Are we now going to have to have another expensive debate as to the merits or health hazards of this new piece of technology? Or will we get stuck with a system that is going to cause future problems for those who are taken in by all the glossy hype?

What sort of antenna will be used to radiate the energy and, how will it all work any way, when a real microwave oven swamps it out?

Some one will probably come up with some answers in the near future. Or will the topic be swept under the political carpet I wonder?

On another tack, I wrote in to ask if any reader could explain why cables are directional.

Ian Johnson
Kidderminster
Worcestershire

Sharing knowledge

I notice pieces such as Ian Hickman's 'An RF initiative' in the May 2000 issue plod along regularly in the electronics literature. Indeed, similar exhortations and initiatives appear in the scientific community's literature in general.

In spite of this, I have noticed over many years that science and technology continues to be unattractive to many youths, who see it as 'boring' or even Frankensteinian. Many older people have a negative view of manipulative science and technology – while consuming the fruits of the enterprise, of course.

The dangers of 'radiation' from mobile 'phones is one of our bug-bears. Genetically modified foods is another. Electronic surveillance, genome projects, powerful technological states, all frighten many people and this fear gets communicated to the young.

My own efforts in youth leadership over many years helped to produce awareness of the subject in some hundreds of young people. Many gained examination passes and a good number went on to university degrees.

My approach operated within the non-selective school population more or less exclusively, the main reason being that selective and public school students do not find time to go the Youth Clubs for any purpose. Also, the democratic and eclectic nature of this work with youth had much wider ramifications for developing citizenship, self confidence; you name it, we did it. Remember, the youngsters were mainly working class.

An article I wrote in *Wireless World* – July 1985 issue, yes, that long ago – effectively told the same story. That article resulted in some interesting correspondence. Many readers offered obsolete or surplus apparatus.

One or two asked if a similar scheme existed in their region. One local employer asked if any youths were, 'really skilled, as I am looking for new junior staff'. But the main call I made in the article, i.e. for volunteer workers to set up clubs or schemes, went unheeded then and has been unheeded ever since. *You can't get leaders to work with kids at grassroots level.* No other Clubs were ever founded.

The TEC Group (as we called it) who met in a workshop that one early group of boys named *The Faraday Room*, went on to its ultimate peak of success in the decade after the article. Even that excellent work has now ceased because of radical changes in the Youth Service and impossibility of finding institutional support.

I *still* receive calls from youths or parents who say, 'I hear you have a science club...'. Although these calls are few and far between now, the response is always crestfallen when I say sorry, but no work is going on at present. Many young people would still flock to a caring, stimulating Club project, that *they* could help run themselves. As my ancient article says: 'Where are the teachers?'

I do not know whether the IEEE ever knew of the work. The Royal Institution was just aware. Certainly the Institute of Physics was well aware and supported me in the role of presenter in one of the 'Grand Schools Lecture Tours'. The Lecture-Demo in 1988 was called *From Whiskers to Walkman* and dealt with the history of Radio. *Electronics World* was an important supporter, as your records should show.

Mr Hickman is fairly on the ball, but still makes the inappropriate argument to 'rob Peter to pay Paul'. Yes, you might convert a few electronic engineers from this or that to RF work, but doing so is a zero sum game. The lack of awareness is overall, and ignorance in general about powerful manipulative subjects like technology, is dangerous for democracy.

Dr Ken Smith,
Canterbury
Kent

Lean and mean

I have a question regarding the electronic computer control system, or ECCS, of my car. Can anyone help please?

I would like to modify my ECCS and/or emission control module, ECM, to make the engine more compatible with driving conditions in my part of Australia.

The Nissan Patrol 2.8-litre turbo diesel that I bought last year was made for European and US markets, where emissions are tightly regulated. All our imported 4WD vehicles run far too lean. They are starved of fuel at low revs, and thus have very little torque.

Regulations for 4WD cars imported to Australia do not demand such a lean burn. I have approached Nissan but the company refuses to make any modifications.

Apparently a few replacement computers exist on the market in Australia and overseas. I would like to hear from anyone who has any experience of them.

Guy Dyson
Brisbane
Australia

Mobile Internet – who wants it?

In the May 2000 issue of *EW*, Mr Manners quotes Sir Alan Sugar: "Who wants to send E-mails from the middle of a field?" – words spoken clearly by one who never has had to work there. Please try and poll opinion from minds with a bit larger perspective.

Thank you very much.

Alan Jeffrey Marcy
Phoenix
Arizona
USA

Misrepresented

I read Mr Ellis' letter on slew-limiting in the May 2000 issue with little enthusiasm. I take considerable exception to being misrepresented in print.

I have never suggested anywhere that 22Ω is the optimum value for input-stage degeneration resistors. It is certainly nothing of the kind. All the amplifier designs I have published use 100Ω degeneration components.

Mr Ellis adopts what appears to be a completely arbitrary criterion that the input-pair currents should not alter by more than 50%, without reference to how much non-linearity this would generate. The rest of his analysis appears to offer no new insights, though it is interesting to note that the base current of the VAS transistor in Fig 1 appears to be flowing backwards.

The values for emitter degeneration resistors are actually chosen as follows:

The higher the resistor value, the more linear the input stage, the lower the open-loop gain, and the smaller the value of C_{dom} required for stability. On the other hand, the higher the value, the more Johnson noise is introduced just where it is not wanted, increasing the amplifier noise output.

The choice of 100Ω reduces the input stage contribution to high-frequency distortion to negligible proportions compared with output stage non-linearities, without seriously degrading noise performance. The value is not critical.

Douglas Self
London

Hot headed drive

We have a Conner ST38410A hard-disk drive formatted in DOS 6.22 that has failed. It overheated, so we took it to a top specialist in Singapore but the problem was beyond the scope of the company's capability.

The diagnosis was probable failure of the head interface IC inside the platter compartment. I expect there are the skills in the UK that can handle this problem and would be much obliged if you could help in any way to contact these professionals.

Ray McKay
Via e-mail

Cadsoft? I met with a brick wall

Rob Graham shouted about his free download of the Eagle Lite software by Cadsoft but kept quite about the web address.

Anyone who logged on to cadsoft.com will have found that those folks are selling software to the brick and mortar industry – a waste of time thus.

Ray McKay
via email

Sorry Ray, and Rob, I should have included the contact details: www.cadsoft.de. The blue iron-on transfer Rob mentioned is from Maplin by the way. Ed.

Class-T

The April 2000 features Ian Hickman's article on the Tripath approach to switching amplifiers, 'Is Class-T hi-fi?' on pages 274-279.

Hickman properly applauds the Tripath scheme for exhibiting lower crossover and IM distortion than conventional class-D designs. But this is achieved at the cost of reduced efficiency due to higher switching-frequency components, albeit distributed in their proprietary fashion over a range of frequencies.

A method that involves none of these compromises has been around for a while now, but perhaps owing to its use in professional audio has received little attention by audiophiles. It is Crown International, Inc.'s 'Opposed current power converter'.

This patented topology – and associated pulse-width modulation scheme – uses two switches and two diodes in an 'opposed current half-bridge'. The bridge is intrinsically free of the shoot-through current fault path of the basic half bridge. As a result, zero dead-time operation – and the elimination of the finite dead-time crossover distortion mechanism – is possible.

Stanley and Bradshaw (IEEE Transactions on Power Electronics, Vol. 14, No 2, March 1999) describe performance results from a 2.5kW full-audio-bandwidth amplifier with 92% efficiency and an open-loop (!) full-scale output-stage THD of about 0.2%.

Appropriately applied feedback eliminates distortion arising from supply voltage fluctuations, as well as further improving linearity. It also yields THD less than 0.02% between 6W and 800W.

The authors use a 'total difference-frequency distortion' test (see A. N. Thiele, J. Audio Eng. Soc., vol. 31, No 6, pp. 443-445, June 1983) to demonstrate the amplifier's outstanding IM distortion performance.

Many other advantages to this approach are discussed too, including its extension to an interleaving approach which results in waveforms in which reduced amounts of ac content accompany increased PWM frequencies. This allows yet simpler output filtering. It also offers the opportunity to apply more global feedback, thereby reducing output impedance and hence better control of real loudspeaker loads.

About the only disadvantage that I can see occurs if the technique is applied to very low-power low-voltage applications, where the forward drops of the diodes entail a bit of power loss. Also, as noted by the authors, two output inductors are needed.

Stanley and Bradshaw conclude: "PWM amplifiers have traditionally been deemed unfit for studio-quality sound reproduction and other precision applications. Such a judgment has been premature. It is possible to have both efficiency and fidelity at the same time."

Brad Wood
Chatsworth
California

Two transistor FM broadcast receiver

Regarding the winning circuit in the June issue's circuit ideas, there doesn't seem to be any such transistor as a BF797. We still haven't managed to track down the circuit's designer so we cannot confirm what was intended to be used, but the circuit has been tested here using two BFR91s.

Ed.

The right spheres

In the article 'Adaptable active loudspeaker' in the February, 'Styropor' spheres were used as enclosures. The article's author, Christof, informs us that Styropor is the trade name used in Germany for expanded polystyrene from the company BASF.

The same product is sold in the UK under the trade names of Montopor and Styrocell. In the USA it is soled as Dylite and Telastan, in France as Afcolene, in Italy as Restical and in Japan as Snowperl.

As to the drive units, many readers have written to ask for more information about the speakers used in Christof's article. Here are the contact details for his supplier:

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Ed.

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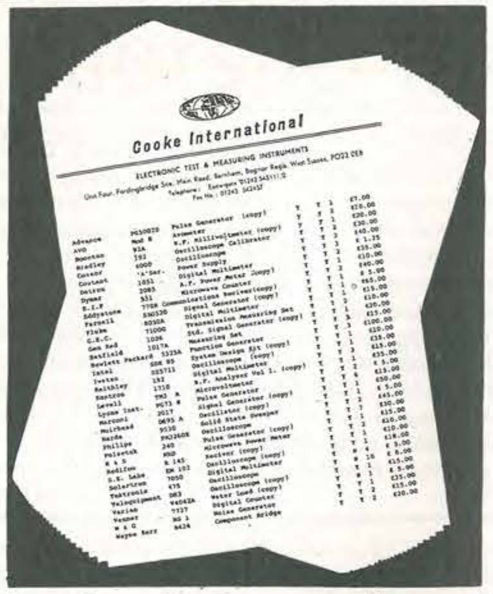

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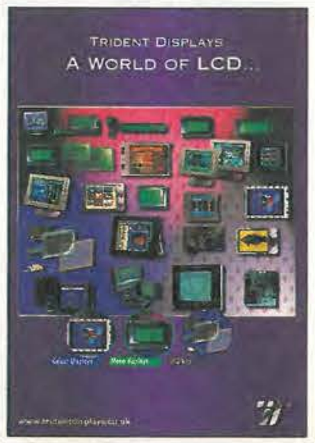

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