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ELECTRONICS WORLD

INCORPORATING WIRELESS WORLD

NOVEMBER 1998 £2.45

Austria Asch. 68.00
Denmark DKr. 69.00
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Greece Dra.1300.00
Holland Dfl. 12.50
Italy L. 9000.00
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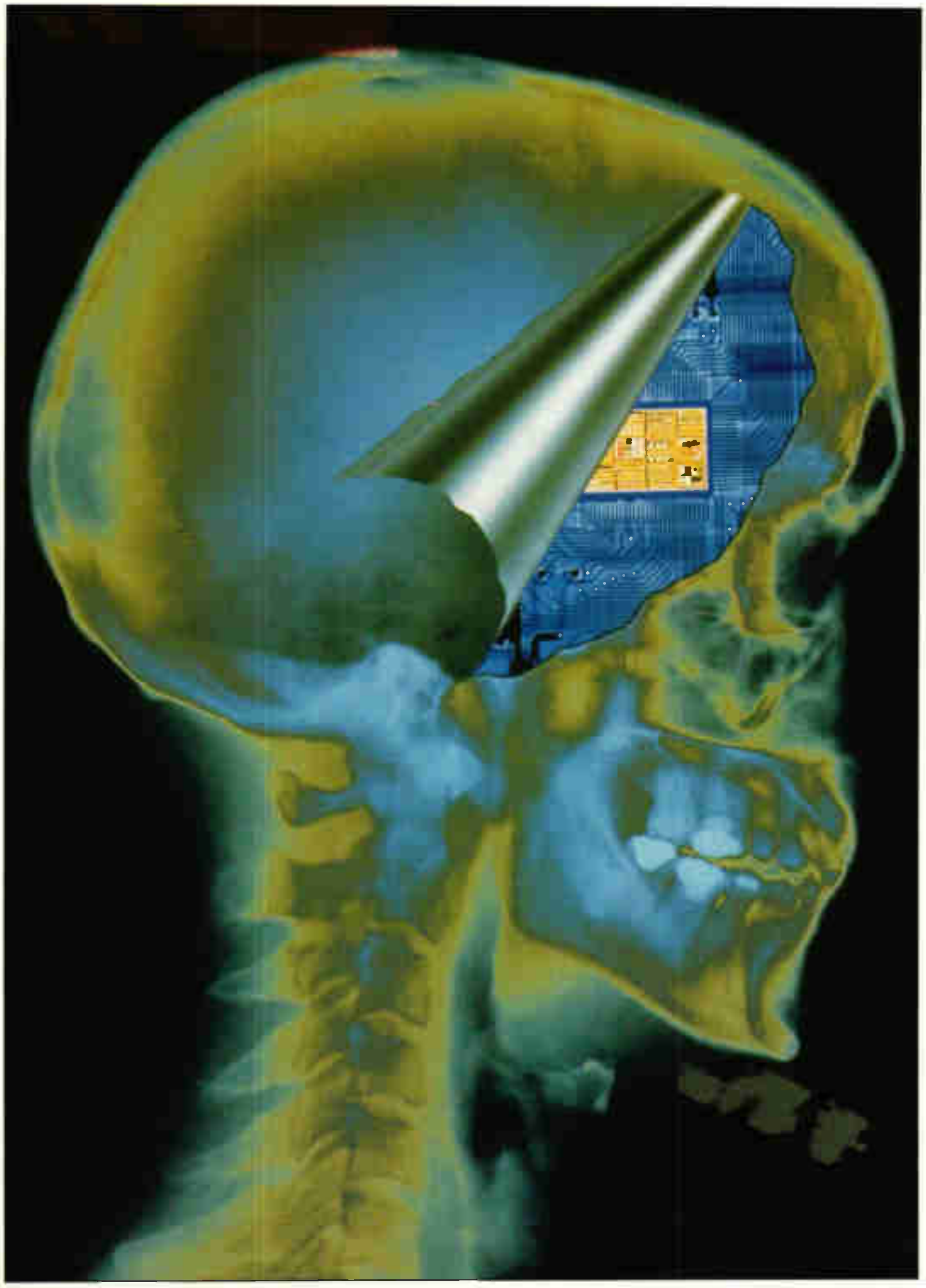

Brains – and how to grow them

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Improved watchdog

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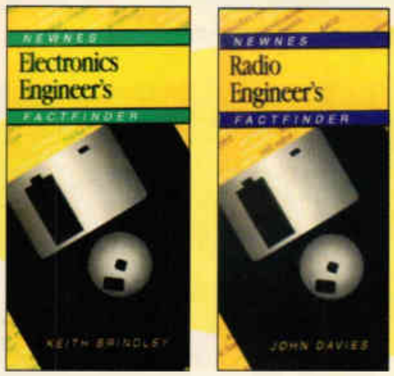

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December ISSUE ON SALE 5 November

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0171 261 7704

ISSN 0959-8332

SUBSCRIPTION HOTLINE
01622 778000

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Tel 01444 445566
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REED BUSINESS INFORMATION

Enhanced-functionality flexible system technology

There can't be many occupations in which practitioners are expected to make real words take on obscure meanings or to learn nonsense words aside, perhaps, from the darker corners of particle physics. Even electronics could, at one time, be vaguely understood by those of a non-electronic persuasion.

English has always been in a state of change: there have been influxes of European tongues since prehistory and then bits of language brought back by adventurers overseas, and the last great modification from the USA. Whenever a word or expression has seemed to be imaginative or more useful and expressive than the one in use, it has been adopted. There has rarely been any feeling of "not invented here" about the assimilation of new expressions. How could there have been, since the language came from such a mixture of sources? Danish; Greek; old, young and middle-aged French; Old High German, whoever he was; Latin and any number of bits and pieces from other languages have all been delightedly taken in. And so it went, each acquisition enriching our language.

Until recently. What we have now is Press Relations. What we do not appear to have is much respect for readable and understandable English, at least not amongst our PR brethren, whose job it is to send out on behalf of the makers information on new products, among other things, to magazines like this one in the hope that we can find space in the new products pages to mention them. Some even suggest that the handouts should simply be printed as they are. Well, that would certainly cut down on editorial time, but anyone reading the result would probably need to work fairly hard to get the message.

A former editor of this august organ would often, very often, remark that "Easy writing makes for hard reading", frequently adding "young man!" to make the relationship clear. And he was absolutely right; it does. It does pay to spend a moment finding the best word rather than using an inapposite one or perverting the meaning of a perfectly good word when a better choice already exists.

For example, we don't have oscilloscopes, resistors, power supplies or microprocessors now. Instead, we are inundated with *solutions*. Everything is a solution. To what, it is sometimes hard to fathom. It seems to be hopelessly old-fashioned to use the real noun because 'solution' is the easy way out; it is almost as though the writer has forgotten what he is writing about. And anyway, 'solution' sounds sophisticated (one of whose meanings is "deprived of natural simplicity"). *Interface* is another good word to use when (a) you are in a hurry or (b) you can't think of a better one or (c) you want it to sound up-market. Looking at a handout before me, I see a relay described as a power interface. Plugs and sockets have been known to take on new lives as interfaces, which is on a par with calling a soldering iron in a stand a solder workstation.

I do not want to turn this into a list of such examples, but one or two more will better illustrate the point. *Functionality* is one. If you want to say that a new oscilloscope does more things than usual, what you say now is that it has enhanced functionality. Another is the back-formation *configure*. Things get configured. It isn't just that the verb does not exist; it never has and, let us pray, never will unless the electronics PR industry succeeds in persuading us all that it is a better word than "arrange" or "order" or "organise" or "dispose". There are masses of others: *technology* instead of technique; *flexibility* rather than versatility; *system* to mean just about anything; all used constantly as fluff words when more appropriate ones are there for the taking. (I realise that dictionaries equate flexibility with versatility, for example, but dictionaries reflect usage. It would be unnecessarily confusing to say "flexible shielding material", meaning that it could be used for many tasks.)

I am unsure of the reasons for PR people's adopting this approach to promoting goods for sale; it seems perverse to camouflage what you want people to understand and consequently buy your products

Of course the language changes all the time. If it stopped changing, it would be dead. But there has to be framework of reason behind the changes, if only to ensure that people know what they are talking about. There is a school of thought that says it doesn't matter how you speak or write so long as people understand what you have to say, but the language of PR fails even that pathetic test.

All this doesn't matter too much, of course, because it gets filtered through people who work on the magazines; not that we are all-knowing, but most of us like to try and get the message across, if at all possible. We do try to keep up with the argot when it makes sense, but when it doesn't, we feel justified in changing it. The trouble is that, exposed to it most of the time as we are, it begins to rub off on us and we find ourselves typing the most awful gibberish without turning a hair until we read the finished piece and promptly click on "Cut". Our hope is that we succeed in being efficient filters and that readers don't even notice. ■

Philip Darrington

Electronics World is published monthly. By post, current issue £2.45, back issues (if available £3.00). Orders, payments and general correspondence to **L333, Electronics World, Quadrant House, The Quadrant, Sutton, Surrey SM2 5AS**. Tlx:892984 REED BP G. Cheques should be made payable to Reed Business Information Ltd

Newstrade: Distributed by Marketforce (UK) Ltd, 247 Tottenham Court Road London W1P OAU 0171 261-5108.

Subscriptions: Quadrant Subscription Services, Oakfield House Perrymount Road, Haywards Heath, Sussex RH16 3DH. Telephone 01444 445566. Please notify change of address.

Subscription rates 1 year UK £34.00 2 years £54.00 3 years £68.00. Europe/Eu 1 year £49.00 2 years £78.00 3 years £98.00 ROW 1 year £59.00 2 years £94.00 3 years £119

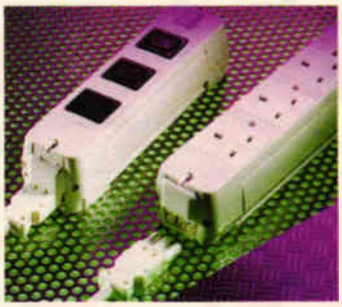
Overseas advertising agents: France and Belgium: Pierre Mussard, 18-20 Place de la Madeleine, Paris 75008. United States of America: Ray Barnes, Reed Business Publishing Ltd, 475 Park Avenue South, 2nd Fl New York, NY 10016 Tel; (212) 679 8888 Fax; (212) 679 9455

USA mailing agents: Mercury Airfreight International Ltd Inc, 10(b) Englehard Ave, Avenel NJ 07001. Periodicles Postage Paid at Rahway NJ Postmaster. Send address changes to above.

Printed by BPCC Magazines (Carlisle) Ltd, Newtown Trading Estate Carlisle. Cumbria, CA2 7NR

Filmsetting by JJ Typographics Ltd, Unit 4 Baron Court, Chandlers Way, Southend-on-Sea, Essex SS2 5SE.

Power distribution system combines aesthetics and versatility



The DB2000 modular power distribution system offers a stylish and flexible mains-power solution for office-based applications such as computer workstations, dealing desks, high-technology office furniture and LAN racking.

Modules are available with up to 15 standard BS1363 sockets and can be specified in horizontal or vertical configurations, with a single switch and/or fuse for each module or for each individual socket. In addition, there is a wide range of support modules to protect against earth leakage, overcurrents and mains transients.

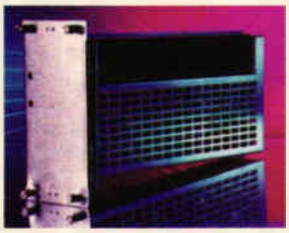
Power may be fed from other modules or direct from the mains supply through re-wireable or pre-wired ST18 connectors.

Designed for safe and easy installation, the DB2000 modules incorporate a sliding shutter/locking mechanism which serves as a lock when the Wieland connector is inserted and as a safety shutter when the connector is removed.

The DB2000 system enables users to quickly configure a customised power distribution system, which can easily be altered at a later date to accommodate changing requirements.

CIRCLE NO. 139 ON REPLY CARD

200W switch-mode PSU for datacomms



Byfleet-based Safety Power Group has introduced a switch-mode power supply specifically designed for use in modular data-communications systems.

Known as the 48FS200-121, this high-reliability 200W PSU accepts input voltages in the range 42-72VDC and provides a single output of +5V at 40A. Its high MTBF figure of 100,000 hours is backed by a 2-year guarantee as standard.

Key features of the 48FS200-121 include convection cooling, reverse protection and undervoltage protection on the inputs, POWER OK and OUTPUT OK signals on the outputs, and a power-sharing facility that makes the PSU suitable for n+1 redundancy designs and 'hot' insertion/removal applications.

Mounted on a 4U x 9TE panel, the power supply carries a CE mark and complies with all relevant European standards for safety and EMC, including EN60950, EN55022, EN61000 and IEC801-5. In addition, it is designed to meet the BTNR 2511 in-rush specification.

Equipped with H15 DIN connectors as standard, the 48FS200-121 can also be fitted with additional accessories such as handles, mains switches, LEDs and test points. Operating temperature range is specified as 0 to 70°C, derating by 2.5%/°C above 55°C.

CIRCLE NO. 140 ON REPLY CARD

New 250W power supply features compact design

The new FL250 switch-mode power supply, available exclusively from the Safety Power Group, uses double-sided plated-through-hole PCB technology to achieve a low profile of just 43mm, thereby providing equipment designers with a valuable space-saving opportunity.

Manufactured in the UK by Ferrus Power, the FL250 is CE marked and carries all the necessary international safety approvals, including EN60950 and UL1950, as well as meeting the requirements of the EN55022 Class B, FCC Class B and CISPR 22 Class B standards for electromagnetic interference.

This new 250W power supply is available with single outputs of 5V @ 50A, 12-15V @ 17A, 24-28V @ 9A or 48V @ 5.2A or a choice of four multiple-output configurations.

The single-output models feature remote-sense capability and power-fail signals, and all versions offer overcurrent protection and 24/48V DC input facilities.

The FL250 has a typical full-load efficiency of 75% at 240Vrms and its operating temperature range is specified as 0-50°C, derating by 2.5%/°C up to 70°C.

CIRCLE NO. 141 ON REPLY CARD

150W PSU features universal input

Available from the Safety Power Group is a versatile 150W switch-mode power supply that offers a universal input and a wide choice of single or multiple outputs, making it suitable for use in applications.

Manufactured in the UK by Ferrus Power the FW150 is designed to comply with the EN55022-B, EN61000-4 and IEC801-5 electromagnetic interference standards, as well as the EN60950, UL1950 and CSA22.2 No. 950 safety standards.

The power supply can be specified with single outputs of 5V @ 30A, 12-15V @ 13A, 24-28V @ 6.5A or 48V @ 3.2A, all of which feature remote-sense capability and power-fail signals. Alternatively, four multiple-output configurations are available.

All versions feature a 90-264V universal input, together with 24/48V DC input and overcurrent protection facilities.

The FW150 comes complete with a 2-year guarantee as standard.

CIRCLE NO. 142 ON REPLY CARD

750W SMPSU for telecoms applications

Now available exclusively from Safety Power Group is the FR750 switch-mode power supply - a 750W unit that offers a wide range of single or multiple outputs and an array of advanced features that make it ideal for use in telecommunications applications.

The FR750 can be specified with single outputs of 5V @ 120A, 12-15V @ 56A, 24-28V @ 28A or 48V @ 16A or any one of six multiple-output configurations. Multiple-output versions achieve an MTBF of 80,000 hours, and for single outputs this figure rises to 120,000 hours.

Providing facilities such as current sharing, remote sensing, adjustable 'Power OK' signals, programming outputs and 24/48V DC input capability, the new power supply can be tailored to meet the requirements of most telecommunications systems.

The FR750 carries a CE mark and complies with all relevant European standards for EMC and safety, including EN55022, EN61000, IEC801 and EN60950.

Housed in a chassis-mounting enclosure, the PSU is equipped with screw and stud terminals and is supplied with a 2-year guarantee.

CIRCLE NO. 143 ON REPLY CARD

£1m campaign for more 'proper' MPs

A £1m campaign to persuade more engineers, and other workers with so- called 'proper jobs' to become Labour MPs has been launched by a major trade union.

The Amalgamated Engineering and Electrical Union is switching half its £2m a year annual contribution to the party to stop its parliamentary representation being dominated by lecturers, lawyers and career political advisers.

Leaders of the 730 000 strong union fear that the working class roots of the party and its knowledge of real life are being swamped by career politicians from the professional classes who know nothing about industry.

General Secretary Ken Jackson said: "If Parliament is to be truly representative, it needs electricians, truck drivers, engineers and nurses."

The cash will be used to back such candidates in bruising selection battles for seats in the Westminster, Scottish and Welsh Parliaments.

A spokesman for the Union said it was not a direct challenge to lawyer Tony Blair's remodelling of New Labour but was, "a shot across the bows of the future direction of the party".

The campaign mirrors the views of former Labour Chief Whip Michael, now Lord, Cocks who believes too many political hacks, lawyers and lecturers now get into Parliament and too few workers, businessmen, engineers and others with real industrial expertise.

NRPB comment sought in mobile-phone health label action

A court action to force mobile phones to carry health warning labels has been adjourned following defence requests that the National Radiological Protection Board (NRPB) comments on the evidence.

The private action by Roger Coghill of Coghill Research Labs, a bio-electromagnetics laboratory, is seeking to have labels fitted which warn that prolonged use of a mobile phone, in excess of 20 minutes, may endanger health (See *EW*, October).

The action is at pre-trial stage when the start date and length of the trial is determined. The next stage will be in October. A decision, based on the report, will then be made on whether to call the NRPB to the stand, and a trial date will be set.

The trial is already attracting much attention. "It is something of interest to the public," said Coghill. "We don't have any rules for mobile phones and I'm worried we might find out the hard way."

FEI: "don't over-react to recession rumours"

The Federation of Electronics Industry (FEI) has warned against over-reacting to the current so-called world economic crisis and its effects on the electronics industry.

"It's not that the whole of the electronics world is falling apart, it's just the semiconductor business," said Richard Hinds, director of components at the FEI. "We shouldn't talk ourselves into a recession," he said.

Shares in electronics companies have not been affected any more or less than other businesses following the recent fall in stock market prices around the world, pointed out Hinds.

He admitted that the semiconductor industry has suffered much with memory prices continuing to fall, but said the markets that semiconductors are being used in are still buoyant.

The telecoms industry remains strong for the moment in the face of the Asian situation, said Adrian May, an analyst with Ovum. However, he warned of a lack of consumer confidence that talk of a world economic crisis creates.

"I have spent a long time tracking the Asian crisis. It can affect confidence in the mobile phone business," said May. People thinking about buying a mobile phone may now decide not to, he said.

One continuing problem that is affecting UK businesses is the strength of the pound working against the UK electronics industry, said Hinds. "It means that importing into the UK has become cheaper and exporting from it is more expensive."

Remote meter reading trials

The biggest UK trial of an automatic meter reading (AMR) system involving 2500 homes started recently.

If successful, the trial by Yorkshire Electricity will result in a rollout of the technology to all two million of its customers.

"It's a substantial investment and when it comes to rollout it will be quite an undertaking," said a spokeswoman for Yorkshire Electricity.

The AMR system on trial is supplied by Ramar Technology, a UK specialist in AMR. The system uses signals in the government's recently allocated 184MHz radio band over a fixed network.

"This will allow the deregulated industry to work as it should," said Marcus Lovell-Smith, Ramar's chief operating officer.

The equipment allows readings to be made every half hour so tariffs can be altered whenever required and charged accordingly. It will also automatically tell the supplier if there is a power cut or if the meter has been tampered with.

Copper-interconnect firsts

IBM shipped the industry's first copper interconnect chips with a pair of fast PowerPC microprocessors.The copper-based 740 and 750 PowerPC microprocessors, running at 400MHz, are likely to be used by Apple Computer in a future line of Power Macintosh systems.

IBM also said that copper based chips will be included in a range of server families, and will be aimed at embedded systems markets.

"By combining leading process technology like copper with a powerful, flexible architecture, we're able to offer electronics designers a new range of options, such as single-function processors for embedded applications," said IBM Microelectronics general manager John Gleason.

New contender producing Intel x86 clones?

Another x86 clone company called Transmeta Corporation is said to be preparing a product in the shadow of Intel's HQ in Santa Clara.

Transmeta is backed by one of the world's richest men – Paul Allen who co-founded Microsoft with Bill Gates. It is headed by David Ditzel from Sun Microsystems.

Transmeta describes its primary business as, "alternative vlsi engines for multimedia pcs".

However, the company is being extremely secretive about its plans and is not prepared to comment on prospective products.

"I have people calling and stopping by all the time but we've made no announcement and no statements," said Brian Hurst, Transmeta's director of worldwide sales.

Hurst declined to either confirm or deny that the company is working on an x86 clone.

The word on the street in Silicon Valley is that Transmeta is taking a particularly drastic approach to x86 cloning - an approach which could challenge Intel's entire pc strategy.

That's because the Transmeta chip is said to be aimed at working outside the existing infrastructure surrounding Intel's chips - i.e it will have its own surrounding chip sets and will not work with Intel's chip sets.

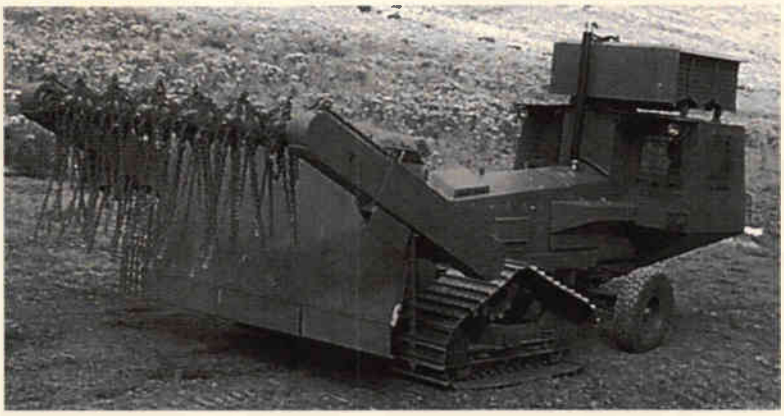
This is a high risk strategy and a huge task. It is easy to see why the company is being secretive. Intel will be keen to stifle such a direct assault on its hegemony.

There is a suggestion, however, that the Transmeta chip will only target the portable PC market.

Paul Allen, still a director of Microsoft, has invested in several companies in what he calls his 'Wired World' strategy to produce the technologies that can seamlessly link personal computers.

Like Rise Technology - another new x86 cloner - Transmeta is located in Mission College Boulevard - the same street that Intel inhabits.

David Manners, *Electronics Weekly*



Wireless telemetry modules from Baughurst-based Wood & Douglas have been incorporated in the Aardvark mine clearer. The modules have been used by the company AHC for remote control of the vehicle. The Aardvark is capable of removing tons of top soil, and uses metal chains to detonate buried landmines.

UK researchers find a way to store facial images in just 50 bytes

Researchers at the University of Kent in Canterbury have developed a way to store a facial image in 50 bytes of memory – small enough to fit on the magnetic stripe of a credit card.

"There is enough spare capacity on credit and bank cards to store the card-holders image," said Jamie Booker, a PhD student working on the project.

Each byte is a coefficient for a template stored in the reading equipment. The final image is the sum of 50 templates multiplied by their coefficients.

The templates are generated once only, from 300 facial images of real people chosen to cover the population concerned, using the Karhunen-Loeve expansion.

The templates are ordered in significance. The first is a general human face. Adding template two makes it more masculine, subtracting template two makes it more feminine. The image is honed as each successive template is included.

Single chip modem for 56k V90 *and* 1.5Mbit ADSL

Fabless Cambridge chip company Virata is aiming to introduce the first single chip modem for the 1.5Mbit/s ADSL derivative G.Lite.

"The chip will include everything except the d-to-a and a-to-d converters. It will be called Beryllium and will implement both G.Lite and V.90 [56kbit/s] protocols," said Charles Cotton, CEO of Virata. "This means that a modem using it will always be able to make best use of the bandwidth of any connection available to it."

The chip is aimed at internal and external G.Lite modems for pcs and includes, says company spokesman Chris Williams, level two (bridging) and level three (routeing) ATM protocol processing. This reduces processing demands on the host processor compared with a dumb 'data pump' modem.

In addition to G.Lite, the chip will also operate with standard ADSL up to 1.5Mbit/s.

New flash memory fast enough for 80MIPs signal processors

Lucent Technologies claims its high speed flash memory product line can keep up with digital signal processors (dsps) running at 80MIPS, or twice the speed of other flash memory dsp products.

"Lucent is ahead of the pack with this new fast-flash offering," said US analyst, Alan Niebel at Semico Research. "Having fast flash is very much of a market differentiator and will be in the future. It's important for the speed of the flash to keep up with the dsp as demand for fast cycling continues to grow."

Using flash memory instead of rom chips will let manufacturers reprogram the dsps in their products.

Sample chips are available now with volume production starting by the second quarter of 1999.

The flash dsp technology is for applications in wireless communications devices such as cellular and cordless phones, modems and other electronics products.

GPS is favourite for tracking mobile phones

Global positioning system technology (GPS) will be the main approach for locating mobile phone handset users. So claims Kanwar Chadha, founder and v-p marketing of US firm SiRF Technology after his company announced agreements with leading handset makers Ericsson and Nokia.

Ericsson has licensed SiRF's GPS technology – which includes GPS chip sets, a core and software – for use in a range of wireless handheld devices. It expects to have first GPS enabled mobile products by the year 2000.

The other adopter, Nokia, has also invested $3m in the privately held company, gaining an observer seat on the board.

"While it is not 100 per cent resolved, the market is clearly converging towards GPS," said Chadha. "But that doesn't mean other technologies won't be there – GPS won't solve all the problems."

GPS is competing against network based solutions which use the cellular infrastructure rather than just the handset to locate the user.

Cambridge Positioning Systems' *Cursor* system, which calculates the handset location using time of arrival differences, is one example; the network based GPS system *SnapTrack* is another.

ERA Technology has also demonstrated a location scheme based on an adaptive antenna whose primary purpose is to increase user numbers in a radio cell.

Cambridge Positioning Systems' CEO, Geoff Morris, disagrees that the technological argument has been won by GPS. "We are addressing the GSM market worldwide," said Morris. "Cursor is something that can be added to the existing network – it does seem a very attractive formula."

The company is in discussion with several UK mobile phone operators and expects to have a nationwide roll out of Cursor by July 1999.

The main instigator for handset location schemes is the Emergency 911 directive from the US Federal Communications Commission which stipulates that from October 2001, the location of emergency callers in the US must be identified to an accuracy of 125 metres.

***Roy Rubenstein,** Electronics Weekly*

Audio and modem functions on the pc diverge

Intel is preparing to separate audio and modem functions from the PC motherboard as it promotes its latest PC architecture.

Intel's plans will be revealed later this month at its Intel Developer Forum in California. The goal is to encourage the use of the audio/modem riser (AMR) card and the mobile daughter card (MDC) which will hold audio and modem ICs.

The full AMR specifications will be announced at the Developer Forum and Intel will try to convince developers to use the specifications for AMR and MDC in future powerful PC systems. AMR is part of Intel's AC '97 specifications and coincides with efforts to rid the pc of the ISA bus.

With audio and modem functions on a separate sub-system, motherboard makers will be able to produce a generic design leaving the audio and modem functions up to pc builders and customer requested options.

Intel will also announce a list of approved AMR products among which is the RipTide chip set from Rockwell Semiconductor Systems. The first PCs with AMR sub-systems are expected in mid-1999.

Processor clocks head for 1.5GHz

Sun's microprocessors will reach clock speeds of 1.5GHz by the year 2002, the company says.

The information comes from Sun's publication of its road map for the UltraSPARC series of 64-bit Risc microprocessors. While clock speed will quadruple over the next four years, performance will increase eight-fold with the move from today's UltraSPARC II to UltraSPARC V.

For the gigahertz processors and beyond, Sun will use a 0.10μm manufacturing process under development at Texas Instruments.

"Because we're fabless, we partner with the very best," said Nigel Ross, Sun Microelectronics' business development manager. "We focus our R&D expenditure on the processor design."

The UltraSPARC product family includes three variants on the basic processor; a scalable version (s) for multi-processor servers and workstations, an integrated chip (i) adding system functions, and embedded devices (e) for products such as high speed network cards.

The next generation UltraSPARC III, expected later this year, is slated to run at 600MHz.

Digital seal marks time and keeps an eye out for tampering

An electronic seal, which shows whether a lock has been tampered with, has been developed by Encrypta Electronics, a UK firm.

Developed in partnership with the Rifkin Company of the US, the Arcolock seal is being fixed to bags used for transporting confidential documents, money or other sensitive material.

Whenever the lock is closed, it randomly generates a four digit number. If the bag is opened in transit, the number will be different upon arrival at its destination.

A timer also shows the period since the bag was locked, important in certain applications, says Encrypta.

The company claims that because of its reusability, the Arcolock is up to 50 per cent cheaper than disposable seals.

Cameras set to boom

Lower prices for image sensor chips will dramatically boost sales of digital cameras, a US study predicts.

International Data Corporation (IDC) says that the digital camera market will be worth $5.4bn by 2002. Cheaper cmos-based image sensors are a key market driver, helping to reduce the price of digital cameras.

"Simplified conversion of dynamic ram manufacturing plants to cmos manufacturing sites in Ireland, Korea, and Taiwan will drive pricepoints well below $500 in 1998," said IDC analyst Ron Glaz.

Glaz added that the production of highly integrated chips that combine image capture with image processing functions, such as LSI Logic's *DCAM-101*, are another factor in reducing manufacturing costs. ■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CIRCLE NO. 108 ON REPLY CARD

Electronics World Info CD

This month's cover mount CD* contains fully-working demonstrations of EDWin NC and Pico Technology's virtual instrumentation software featured on the adjacent page. There's also a demonstration of Newnes Factfinder software tools, copies of which you may win by entering our prize draw.

When installing any software, it is advisable to quit any applications that are currently running.

How to use the CD

• EDWin NC

On the CD is a fully working demonstration of EDWin – the professional CAD/CAE tool. File saving has been inhibited, there are no output facilities and the libraries are limited, but otherwise, all features of the full package are available for you to use and evaluate. There is also a guided tour on the CD, which is loaded via the same start menu.

You will need Windows 95 or 3.1 to run the package on a pc with 8Mbyte of memory or more. If you are running Windows 98 NT, call Swift on 01992 570 006 for details. From File Manager or Windows Explorer, double click the folder called 'edwincd' then double click the file Start.exe. Alternatively, select Run on the start menu (or file manager under Windows 3.1) and type 'D:\edwincd\Start.exe' followed by carriage return. The letter D represents the letter of your CD rom drive.

At this point, you can select whether you want to see the EDWin tour or load the program to experiment with.

• Pico's virtual instruments

There's a suite of programs in the Pico folder, as described on the adjacent page. Once the demonstration is loaded, you can select each one of the six items individually via their icons or via File Manager.

You will need Windows 3.1, 95 or NT to run the package on a pc with 8Mbyte of memory or more. From File Manager or Windows Explorer, double click the folder called 'Pico' then double click the file Setup.exe. Alternatively, select Run on the start menu (or file manager under Windows 3.1) and type 'D:\Pico\Setup.exe' followed by carriage return. The letter D represents the letter of your CD rom drive.

• Newnes Factfinders

This is a demonstration version of the Newnes Factfinder library, the new technical library on a pc, giving access to a wealth of engineering information from the leading publisher, Newnes. From the Bookshelf, you can choose a title, or search all five for a particular topic. The contents list shows the complete contents of the full versions. Grey page icons and folders with a cross through them show sections not available in the demonstration. The Search function shows you the sections you can access and take you straight to them.

This demonstration runs under Windows 3.1 or 95. From File Manager or Windows Explorer, double click the folder called 'Newnes' then double click the file Factfind.exe. Alternatively, select Run on the start menu (or file manager under Windows 3.1) and type 'D:\Newnes\Factfind.exe' followed by carriage return. The letter D represents the letter of your cd rom drive.

Newnes engineering factfinders for Windows

Engineering Factfinders are the first technical electronic library providing access to a wealth of data published by the leading source of engineering information, Newnes.

This concept provides convenient, cheap, low memory access to engineering data via a standard pc.

Each Factfinder builds up into a coherent data library, and the user has the option of searching for a topic or item of data across other Factfinders.

The software data base is easy to use, and can be searched by keyword, chapter heading, or by pages sequentially, or even book-marked and annotated for future use.

At only £20 including VAT, the Factfinders are an affordable and useful pc reference tool that load simply from two 3.5in disks onto any Windows- based PC.

Each Factfinder is:

- Fully illustrated
- Essential reference tool
- Keyword search facility
- Master search across a bookshelf of titles
- Based on the best-selling Newnes Pocket Books
- Runs under Windows 3.1 or Windows 95

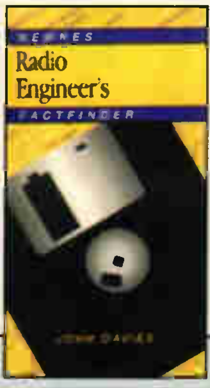
The Radio Engineer's and Electronics Engineer's Factfinders can be ordered from Electronics World Editorial, Quadrant House, The Quadrant, Sutton, Surrey SM2 5AS for £23 including UK postage. Fax 0181 652 8111 for overseas postage costs and credit card ordering details, e-mail jackie.lowe@rbi.co.uk.

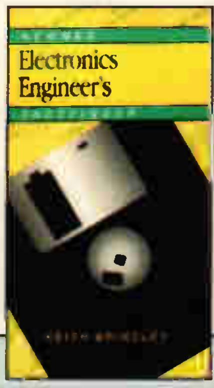
Win a pair of Factfinders

Electronics World has ten sets of two Newnes Factfinders that anyone could win. Entries will be accepted until 31 December 1998 and the winners will be drawn from a hat as soon as possible after that date. Simply send us your name and address in, or on, an envelope marked 'Factfinders'.

All entrants will be eligible for **20% discount** on either the Radio Engineer's or Electronics Engineer's Factfinders, or both. Simply request your 20% discount voucher on your entry. Only one entry per person is allowed.

Send your entry to, Factfinders, Electronics World Editorial, Quadrant House, The Quadrant, Sutton, Surrey SM2 5AS.





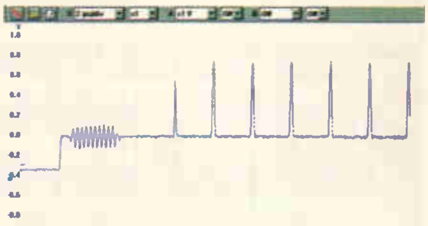
Cover CD and reader offer

Test Equipment has come a long way over the last few years, traditional `benchtop' instruments such as oscilloscopes are giving way both to smaller hand held units and more recently to PC based instruments. Pico Technology are at the forefront of these developments and are giving you the chance to save 15% off the purchase price of some of the highest quality test equipment available today. You can order either the ADC200 or osziFOX oscilloscopes using the order form below. This offer is valid until the 15 Dec 1998.
See how good the software is for yourself by installing the demo versions on this months cover CD.

Transform your PC.... Into an oscilloscope, spectrum analyser and multimeter

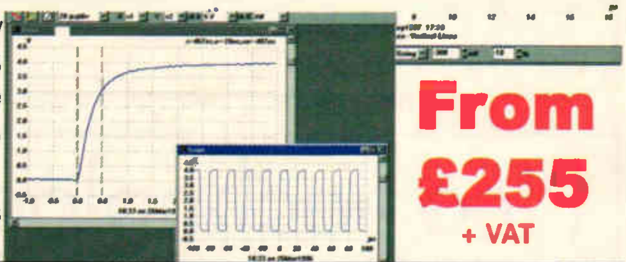
The ADC200 range of PC based oscilloscopes offer performance only previously available on the most expensive `benchtop' scopes. By intergrating several instruments into one unit, the ADC200 is both flexible and cost effective.

Connection to a PC gives the ADC200 the edge over traditional oscilloscopes: the ability to print and save waveforms is just one example. Advanced trigger modes, such as save to disk on trigger, make tracking down those elusive intermittent faults much easier. The ADC200 is supplied with PicoScope software (DOS & Win 3.1, 95/98 and NT) which is powerful, yet simple to use, especially with its comprehensive online help. Installation is easy and no configuration is required; simply plug into the parallel port and it is ready to go.



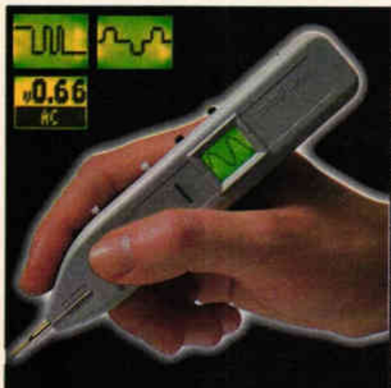
There are three models in the ADC200 range: the ADC200/20, 200/50 and 200/100 offering a 20, 50 and 100 MS/s scope and a 10, 25 and 50 MHz spectrum analyser respectively. The ADC200 is the ideal solution for applications such as video and automotive testing, electronics design and fault finding.

The ADC200 is also supplied with Picolog software, which enables it to function as an advanced data logger and chart recorder.



From £255 + VAT

A scope at your fingertips.....



Once oscilloscopes were heavy and clumsy to handle, but over the years they have got smaller and smaller. The latest development in this field has just arrived: a digital storage oscilloscope in a handy slim housing, scarcely longer than a pencil and about as thick as your thumb.

Despite its small size, its performance can match that of a service oscilloscope. With a sampling rate of up to 20MS/s even signals in microprocessor circuits can be recorded. Using its voltmeter function, numeric AC and DC voltages can be easily measured. The low cost of the osziFOX, together with the units small size makes it ideal for any electronics engineer who needs the ultimate in portability.

Only £68 + VAT

Order form Broadway House, 149-151 St Neots road, Hardwick, Cambridge CB3 7QJ
● Tel: 01954 211716 ● Fax: 01954 211880 ● E:mail post@picotech.co.uk

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Please send me: Free information on the whole Pico range ❑

osziFOX	Qty:__	@ £68	+P&P+VAT	= £84
ADC 200/ 20	Qty:__	@ £255	+P&P+VAT	=£302
ADC 200/ 50	Qty:__	@ £340	+P&P+VAT	=£406
ADC 200/ 100	Qty:__	@ £425	+P&P+VAT	=£506

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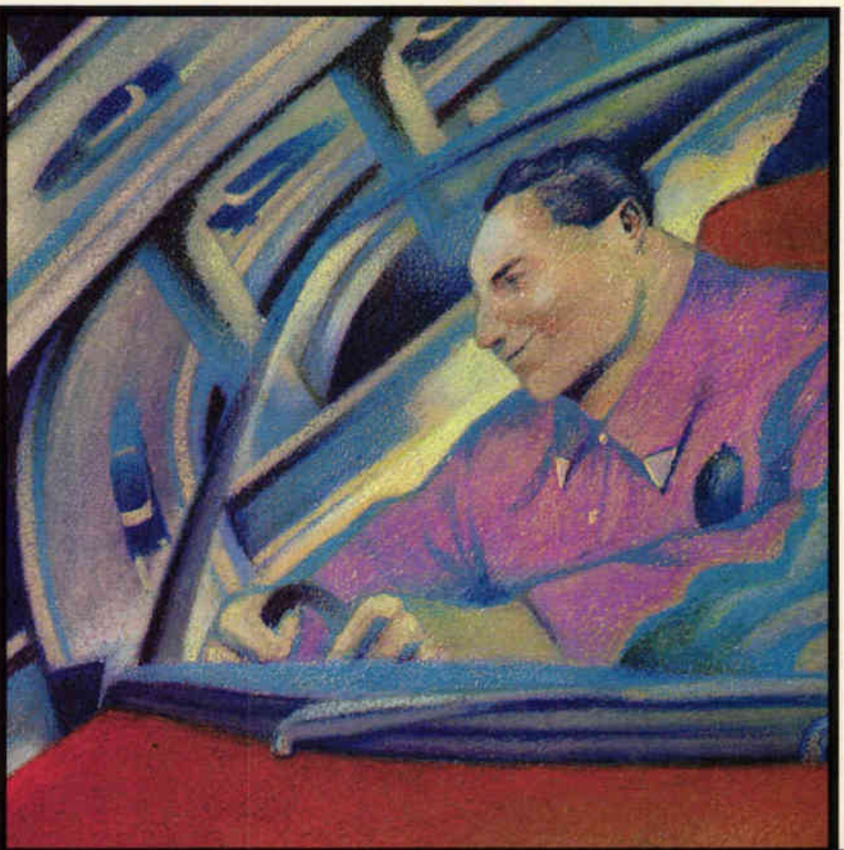
CIRCLE NO. 109 ON REPLY CARD



Melanie Reynolds looks at how electronics is being used to make drivers pay directly for each mile they travel as part of the government's efforts to reduce traffic congestion and pollution.

Driving home greener roads

Everyone seems to be in agreement about at least one thing: something must be done to curb the ever increasing traffic on the roads.

The problem is so obvious that even the Government is starting to act. In its white paper 'New Deal for Transport', it says it is going to deliver a transport system that does not continue to damage the environment and people's health.

Much to the joy of ITS Focus, the UK's industrial and institutional voice on transport telematics, the white paper dedicates two whole paragraphs to telematics – otherwise known as intelligent transport systems or ITS. "This is the first time I've seen a government actually spell out the advantages and importance of ITS," said Viscount Chelmsford, president of ITS Focus.

ITS involves the application of IT and telecoms in all forms of transport to try and improve the efficiency, safety, economics and greenness of surface, maritime and air transportation, both public and private.

One part of this is road tolling which is one of the measures proposed in the white paper to reduce traffic congestion. Tolling will allow local authorities to dissuade traffic – and generate income – by charging people to drive into town centres.

The infrastructure required to operate a road tolling system is complex and there are many problems to be ironed out. To find some of the answers, there have been various trials worldwide. The UK's Department of the Environment, Transport and the Regions (DETR) carried out its own trials between November 1996 and June 1997. Its purpose was to assess the suitability of certain technologies for use on motorways.

The programme was not well conceived. After a lot of uncertainty, the tests finally happened with only two out of the original eight consortia taking part: Bosch Telecom and GEC-Marconi communications.

Among those that pulled out before the tests was Siemens Traffic Control (STC). It does not believe anything tangible will be in place much before 2004. "The white paper says it's going to be experimented with in the next few years," said John Turner, business development manager.

For now the company has backed off development in this area. "We're not going to sink money into something where there's no market for six years," said Turner. "We put a lot into infra-red and the market really hasn't taken off. The company around the world has the technology it needs so if and when the market starts to move we're going to be doing things."

In-car entertainment? This Bosch on-vehicle smartcard unit was used in DETR trials of road tolling.

Although the infrastructure is complex, the technology needed to implement the road-side communication part is already available.

The DETR trials involved systems that used 5.8GHz microwave communication for the transaction process. The

DETR trials involved tolling and enforcement systems mounted on gantries over the road. Wake-up beacons fitted on the gantry or at the roadside activated the in-vehicle unit before it passed the tolling equipment.

The GEC on-vehicle smartcard unit, also used in DETR trials, operates on similar principles to the Bosch unit.

tolling and enforcement systems were mounted on gantries over the road. Wake-up beacons fitted on the gantry or at the roadside were used to activate the in-vehicle unit before it passed the tolling equipment. This enabled the transaction process to occur even in vehicles that were exceeding 70mile/h.

A mechanism for communicating the vehicle class was also part of the transaction process. In fact, the GEC system could measure vehicle width and length to determine the class and inhibit potential fraud.

The enforcement systems used digital video cameras. In the GEC system an image of every detected vehicle was captured and then discarded if the transaction was satisfactory. Otherwise the image was retained for enforcement purposes.

This included when a detected vehicle did not conform to the class it was expected to belong to, in these trials a car with a motorcycle onboard unit fitted.

Over 74 000 tolling transactions took place during the trials. The conclusion drawn was that the technologies were evolving and could form the basis for multi-lane tolling systems within the foreseeable future. But, "although a great deal has been learnt, no unequivocal statement of technical feasibility could be made based upon the test track trials alone."

Part of the reason for this reticence was the lack of an 'off-the-shelf' solution for the trial. The report said that further trials in a live environment would be needed before a recommendation to commit to a national system could be given.

A road tolling trial with a different purpose was completed recently. The eight month trial by Leicester City Council was designed not to test the technology but to see what people's reactions were to the charges.

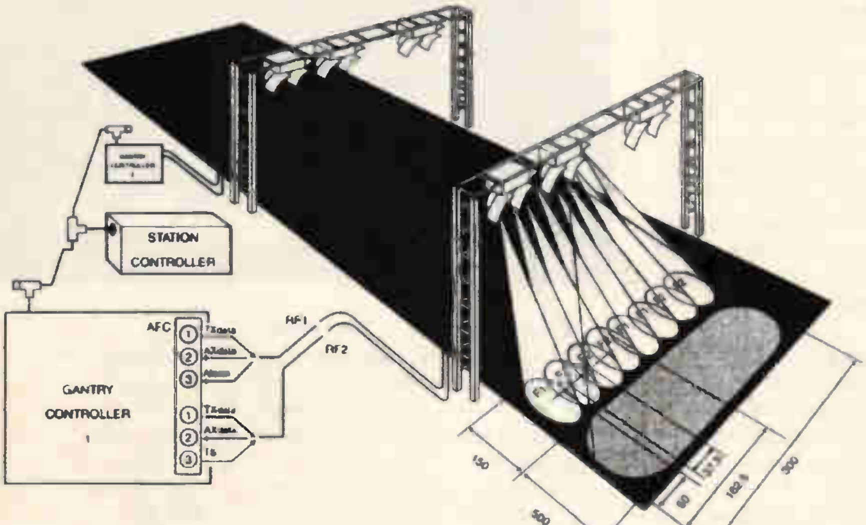
The equipment used was again based on 5.8GHz microwave technology, this time supplied by the Norwegian firm Micro Design.

The trial started with a toll of £1.50 to drive into town during the morning peak. It was varied in four week stages until there was a charge all the time, £5 peak and £2 off-peak. A simulated pollution incident doubled these prices. A park-and-ride transport system priced at £1.30 return was offered as an alternative.

The final report has yet to be compiled but first indications are that people are prepared to pay around £4 to £6 before they will transfer to the park-and-ride. "If you work it out, £5 a day, for a year, is a lot of money," said David Wright, project team leader. "If I had the alternative of a bus I'd probably use it."

The Council realises it is a delicate balance between reducing congestion and driving people away from the city centre. "We're trying to aim at the people who drive into town in the morning, park the car all day and then drive back out again. The main problems are during the morning peak," said Wright. "What we don't want to do is stop people coming in and doing all their shopping."

Although these trials are finished more are envisaged. "There's nothing definite in terms of what we're going to do, but we're not taking the equipment down yet," said Wright.



Full coverage of all of the lanes is provided by beacons fitted on the over head gantry. The "footprint" transmitted by the beacons for detection is kept small so that only one vehicle can be in it at any time. Each gantry has a separate controller which in turn communicates with the station controller.

Road to car communication

There are two basic methods of communication available: long and short range.

Long range communication systems are being developed based on GSM and

RDS These use extra bits hooked into the radio or telephone in the car to provide whichever service is required.

The short range communication method has tended to concentrate on either infra-red or microwave.

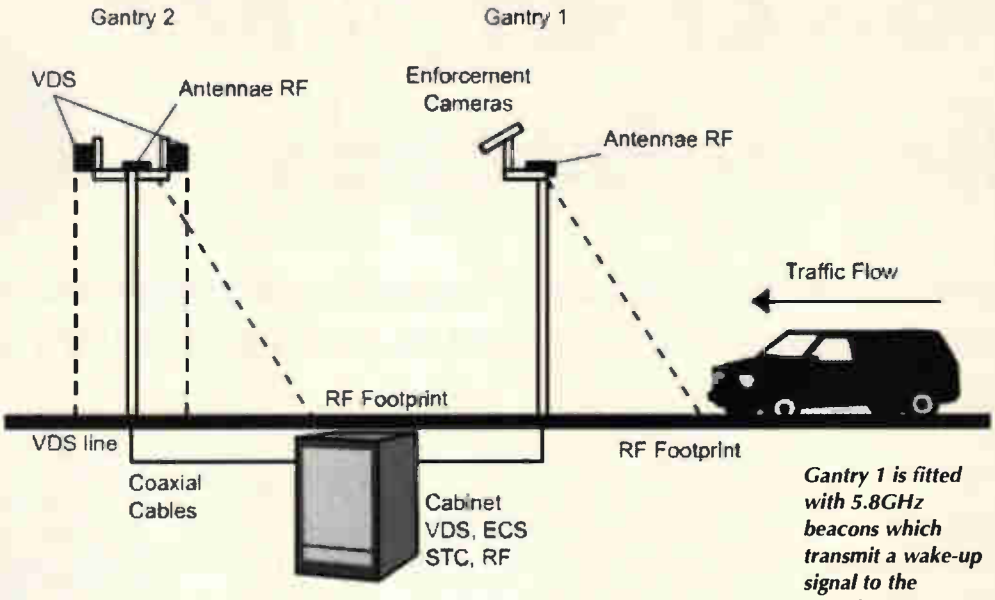
Tolling requires each vehicle to be fitted with a unit which can be interrogated by a beacon at payment points. The simplest and cheapest on-vehicle unit is a tag fitted to the windscreen or an under-vehicle electronic number plate.

This operates from an internal battery for up to ten years and needs no other power connections from the vehicle. The tag has a unique identity which is transmitted every time it is interrogated and the information is sent to a centralised billing system.

More sophisticated on-vehicle units can involve a smartcard and may have a display. The smartcard is used as a charge-card and money or travel credits are stored on it. Every time a payment point is passed the card is interrogated and money or credits are deducted. The display gives information on what has been paid and how much is left.

The beacons, which are generally fitted on gantries over the road, are able to transmit and receive signals. Information from the beacons is connected back to a central office, generally through a cable network. The network needs to be secure for tolling systems because the data exchange becomes a financial transaction. Overhead cameras are used for enforcement purposes.

Once a communication system exists, other features like navigation can be added. Information can be transmitted from beacons to an on-board car computer to allow it to work out route information, display maps and direction signs. These systems use 'probe' vehicles which are equipped to send information to the roadside beacons after collating such data as speed assessments, journey times and delays which can be passed to users of the system. ■



Gantry 1 is fitted with 5.8GHz beacons which transmit a wake-up signal to the on-vehicle unit and activate the smartcard. Gantry 2 has the Vehicle Detection System which detects and classifies the vehicle at the time of transaction.

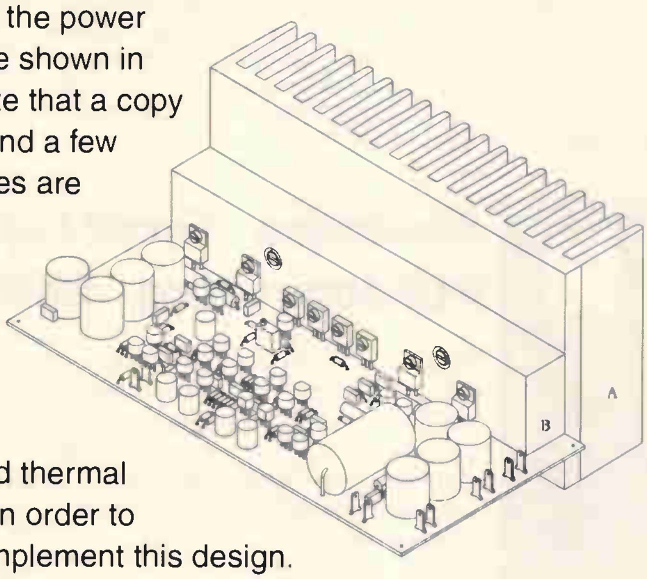
Power amplifier circuit boards

£42 per pair fully inclusive or £25 each

Professionally designed and manufactured printed circuit boards for Giovanni Stochino's no compromise 100W power amp are available to buy.

These high-quality fibre-glass reinforced circuit boards are designed for Giovanni Stochino's fast, low-distortion 100W power amplifier described in the August 1998 issue. Layout of the double-sided, silk screened and solder masked boards has been verified and approved by Giovanni.

This offer is for the pcbs only. The layout does not accommodate the power supply scheme shown in the article. Note that a copy of the article and a few designers' notes are included with each purchase, but you will need some knowledge of electronics and thermal management in order to successfully implement this design.



Giovanni's high-performance power amplifier mounted on its heat sink.

Please send me___ pcbs @ £25 each or £42 a pair.
I enclose my cheque for £ _____
Please debit my credit card for £____
Card type MasterCard/Visa.
Card number __________ Expiry date ___/____
Signature __________
Name __________
Address __________
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Cheques made payable to Reed Business Information.
Post to: PCB Offer, Electronics World, Quadrant House, The Quadrant, Sutton, Surrey, SM2 5AS. Please alow 28 days for delivery.

Specifications

Power into 8Ω lood	100W
Smoll-signal bondwidth before the output filter	20Hz (–0.1dB), 1.3MHz (–3dB)
Unity gain frequency before the output filter	22MHz
Output noise (BW=80kHz, input terminated with 50Ω	42μV rms
Measured output offset voltoge	+32mV

Distortion performance

V_{out}, pk-pk	1kHz	20kHz
5	0.0030%	0.0043%
10	0.0028%	0.0047%
20	0.0023%	0.0061%
40	0.0028%	0.0110%
80	0.0026%	0.0170%

Slew rate

Positive slew-rote	+320V/μs
Negative slew-rote	–300V/μs

CIRCUIT IDEAS

Over £600 for a circuit idea?

New awards scheme for circuit ideas

● Every circuit idea published in *Electronics World* receives £35.

● The pick of the month circuit idea receives a Pico Technology ADC42 – worth over £90 – in addition to £35.

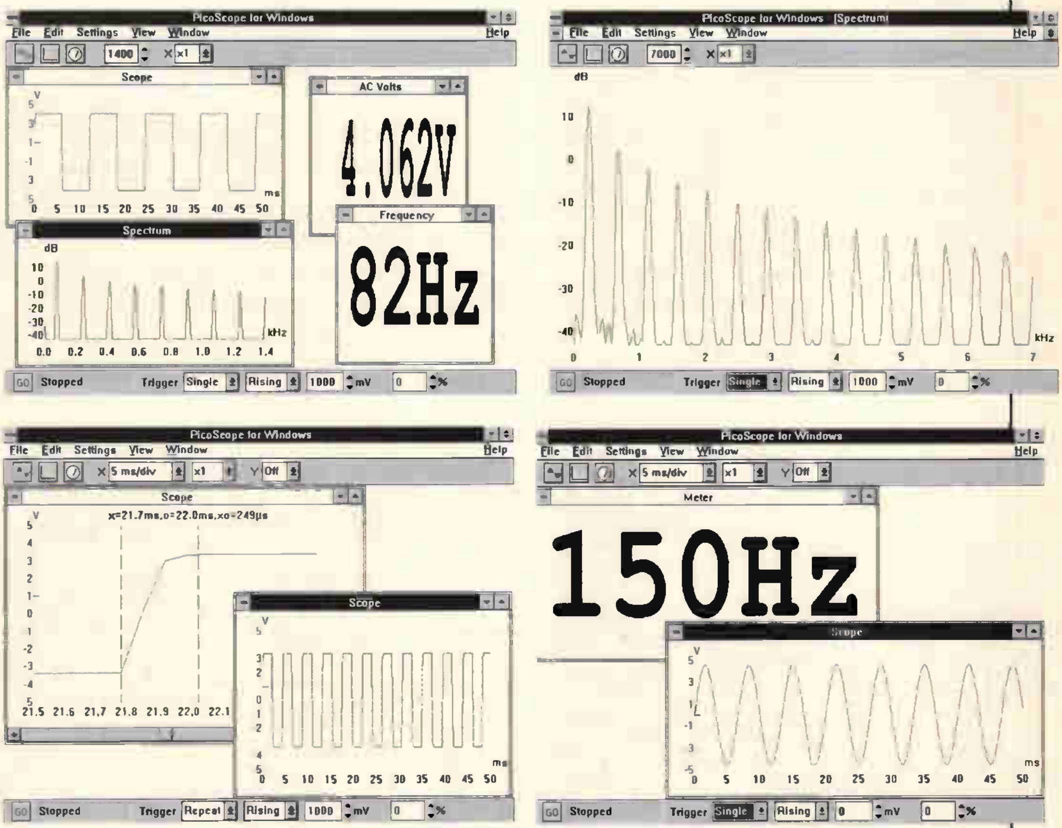
● Once every six months, Pico Technology and *Electronics World* will select the best circuit idea published during the period and award the winner a Pico Technology ADC200-50 – worth £586.

How to submit your ideas

The best ideas are the ones that save readers time or money, or that solve a problem in a better or more elegant way than existing circuits. We will also consider the odd solution looking for a problem – if it has a degree of ingenuity.

Your submission will be judged on its originality. This means that the idea should certainly not have been published before. Useful modifications to existing circuits will be considered though – provided that they are original.

Don't forget to say why you think your idea is worthy. We can accept anything from clear hand writing and hand-drawn circuits on the back of an envelope. Type written text is better. But it helps us if the idea is on disk in a popular pc or Mac format. Include an ascii file and hard-copy drawing as a safety net and please label the disk with as much information as you can.



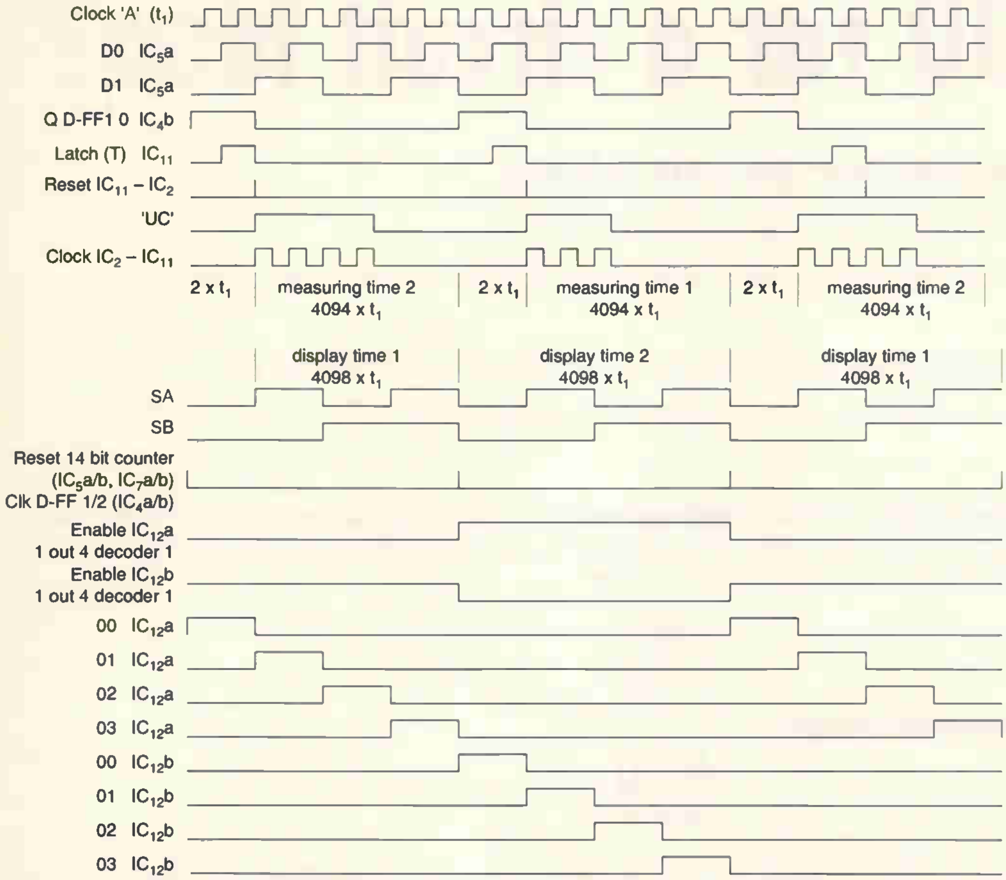
Turn your PC into a high-performance virtual instrument in return for a circuit idea.

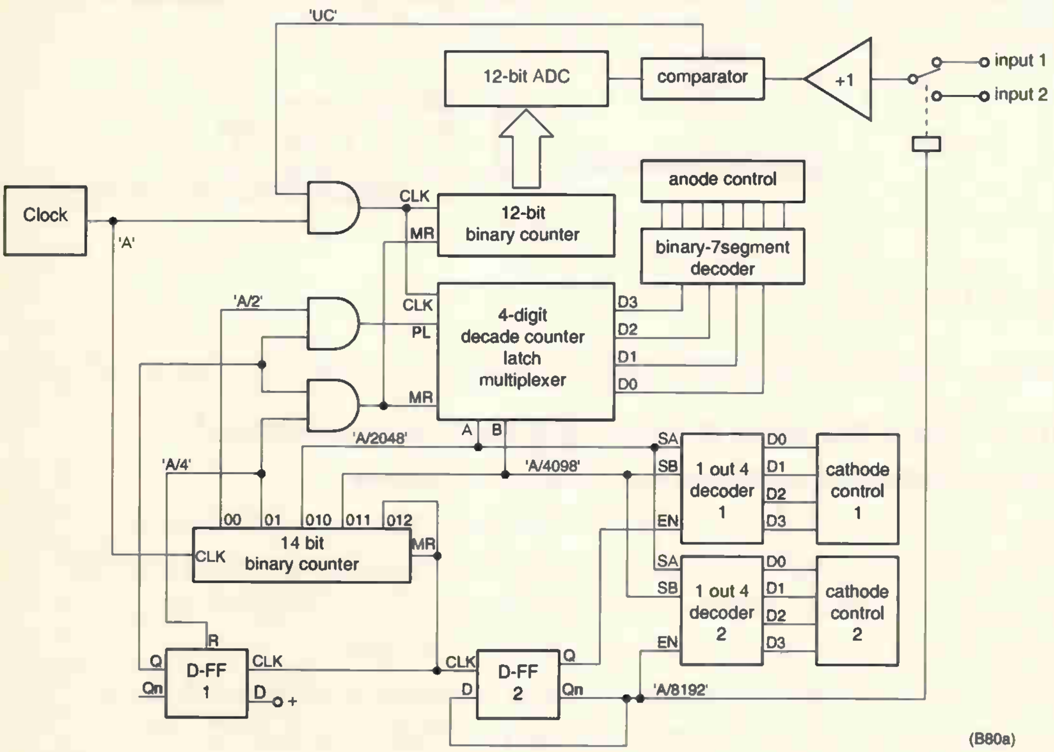
The ADC200-50 is a dual-channel 50MHz digital storage oscilloscope, a 25MHz spectrum analyser and a multimeter. Interfacing to a pc via its parallel port, ADC200-50 also offers non-volatile storage and hard-copy facilities. Windows and DOS virtual instrument software is included.

ADC42 is a low-cost, high-resolution a-to-d converter sampling to 12 bits at 20ksample/s. This single-channel converter benefits from all the instrumentation features of the ADC200-50.

ADC42 Winner

Dual dvm





(B80a)

You often have only one meter to monitor two parameters. Working with a power supply for example, it is useful to be able to look at output voltage and output current simultaneously. Two voltmeters can be expensive so I designed this solution.

Figures 1-3 show the block diagram, circuit diagram and pulse sequence chart respectively. Assume for the moment that decoder inputs SA and SB are null. First comes the display-time for cathode control 1 (4096×clock time *ti*). Next, two clock periods occur during which the state of the decade counter is latched into the built-in memory of the counters. There follows a reset of the 12-bit and decade counters after which the measuring time of input 2 starts. This can be a maximum of 4094 clock pulses.

The 12-bit d-to-a converter, 12-bit binary counter and comparator form a 12-bit a-to-d converter. After a reset to the 12-bit counter, the output of the comparator goes high provided that the input-voltage is higher than 0V, so count pulses are fed to the counters.

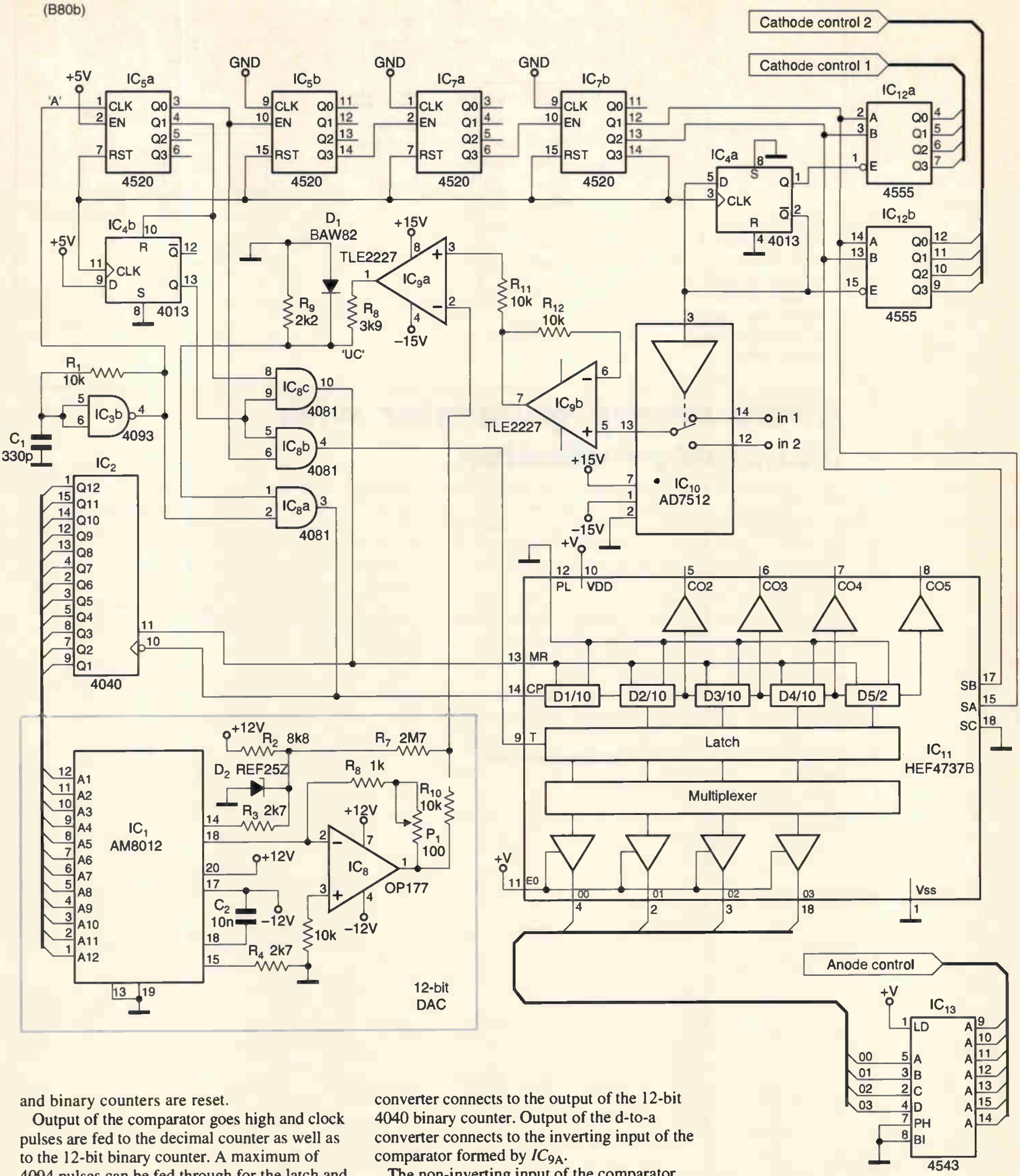
If the output voltage of the d-to-a converter is equal to the input voltage, the output of the comparator goes low, stopping the feedthrough of count pulses. As a result, the output of the binary counter holds the binary value of the input voltage.

A four-digit binary counter runs simultaneously with the binary counter providing binary to decimal conversion. A 14-bit binary counter together with three AND gates and two D-type bistable devices form the control of the counters and display, Fig. 3.

After a fixed display time of 4096 clock pulses the 14-bit counter is reset and a pulse is fed to both of the D-type bistables through which output Q of flip-flop 1 goes high. Output of flip-flop 2 changes state, activating one of the 1-of-4 decoders and switches over the inputs.

Two clock pulses follow during which the first the state of the decimal counters is latched in the built-in memory. It is then fed via the built-in multiplexer to outputs 01 to 03 and can be read out by means of SA and SB; immediately after the latch pulse, the decimal

Figs 1-3. Digital voltmeter with 12bit resolution and dual independent displays.



and binary counters are reset.

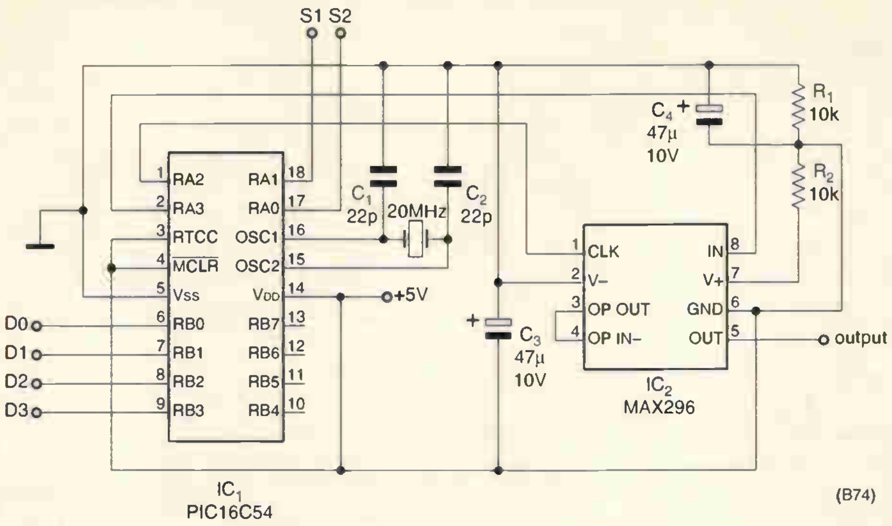
Output of the comparator goes high and clock pulses are fed to the decimal counter as well as to the 12-bit binary counter. A maximum of 4094 pulses can be fed through for the latch and reset takes up two clock pulses. So when the value of input 1 is measured, the value of input 2 is displayed and *vice versa*. This process cycles so fast that no flickering of the display occurs. Clock frequency is then about 380kHz, which is low enough to allow functioning the input switch and the a-to-d converter.

Looking at Fig. 2, you can see the 12-bit a-to-d converter within the dotted line in the lower left corner. The digital input of this converter connects to the output of the 12-bit 4040 binary counter. Output of the d-to-a converter connects to the inverting input of the comparator formed by IC_{9A}.

The non-inverting input of the comparator connects to the output of the *AD7512* electronic commutating switch, IC_{10}, via buffer IC_{9B}. The comparator's output feeds one input of IC_{6A} which gates through pulses from clock generator IC_{3B} to the counters.

The 14-bit counter is formed by $IC_{5A/B}$ and $IC_{7A/B}$. It supplies pulses to two D-type bistables, two 1-of-4 decoders and gates $IC_{6B,C}$. Output of IC_{6C} resets the counters in IC_{11} and 12-bit counter IC_2; the output of IC_{6B} is a pulse to latch the state of counters in IC_{11} in the chip's memory for reading out via SA and SB.

W. Dijkstra
Waalre
The Netherlands
B80



Microprocessor-controlled stepped audio sweeper generates a 1-2-5 sequence of sine outputs from 20Hz to 20kHz at constant output voltage.

Audio sweep generator with frequency indicator

At constant output voltage regardless of frequency, this microprocessor circuit generates pure sinewaves at frequencies of 20Hz-20kHz in a 1-2-5 sequence. Output is about 0.5Vpk-pk at less than –70dB thd and there are a 4-bit frequency indicator and output pulses to synchronise other equipment.

The *MAX296* is a low-pass. switched-capacitor filter whose –3dB corner frequency is determined by that of the clock, its response above that falling off rapidly. If the clock-to-corner frequency ratio is less than 40, the output is a good sinewave even with a square input.

PIC16C54 is an 8-bit controller with an independent. free-running watchdog timer having a 2.5s timeout, which sweeps the output frequency at 2.5s intervals. stepping from low to high frequency and continuing from low frequency to maintain a continual sweep. At each change from maximum frequency back to the lowest. a pulse appears on S_1 and at each frequency change another pulse appears on S_2, both with 150µs width; these may be used as synchronisation signals. Outputs $D_{3\text{-}0}$ indicate output frequency – 0001 meaning 20kHz.

Yongping Xia
Torrance
California
USA
B74

List. PIC16C54 listing for controlling the programmable oscillator.

```
STATUS  equ     3
PORTA   equ     5
PORTB   equ     6
i       equ     7
cnt1    equ     8
cnt2    equ     9
cnt3    equ     10
cnt4    equ     11
cnt13   equ     12
cnt14   equ     13
freq    equ     14

        org     0x1ff
        goto    main
        org     0x0
main    movlw   0x00      ;
        movwf   PORTA     ;
        movwf   PORTB     ;
        tris    PORTA     ; set ports direction
        tris    PORTB     ;
        bsf     PORTA, 0  ; send sync 2 signal
        movwf   cnt1      ;
dly00   decfsz  cnt1, 1   ;
        goto    dly00     ;
        bcf     PORTA, 0  ;
        movlw   0x0f      ;
        option            ; set watch dog timer to
2.5 seconds
        movlw   0xf5      ;
        addwf   i, 0      ;
        btfss   STATUS, 0; if i out of range, set
i=0x0a
        goto    tp1       ;
        movlw   0x0a      ;
        movwf   i         ;
tp1     decfsz  i, 1      ; if i=0; set i=0x0a
        goto    tp2       ;
        bsf     PORTA, 1  ; send sync 1 signal
        movlw   0x00      ;
        movwf   cnt1      ;
dly01   decfsz  cnt1, 1   ;
        goto    dly01     ;
        bcf     PORTA, 1  ;
        movlw   0x0a      ;
        movwf   i         ;
tp2     movf    i, 0      ; if 9>i>1
        movwf   PORTB     ; send out though RB0-RB3
        movwf   freq      ; move i to freq
        decfsz  freq, 1   ;
        goto    t1        ;
        goto    s1        ; if freq=1, set output
20KHz
t1      decfsz  freq, 1   ;
        goto    t2        ;
        goto    s2        ; if freq=2, set
output=10KHz
t2      decfsz  freq, 1   ;
        goto    t3        ;
        goto    s3        ; if freq=3, set
output=5KHz
t3      decfsz  freq, 1   ;
        goto    t4        ;
        goto    s4        ; if freq=4, set
output=2KHz
t4      decfsz  freq, 1   ;
        goto    t5        ;
        goto    s5        ; if freq=5, set
output=1KHz
t5      decfsz  freq, 1   ;
        goto    t6        ;
        goto    s6        ; if freq=6, set
output=500Hz
t6      decfsz  freq, 1   ;
        goto    t7        ;
        goto    s7        ; if freq=7, set
output=200Hz
t7      decfsz  freq, 1   ;
        goto    t8        ;
```

ADC42 Winner

```
        goto    s8         ; if freq=8, set output=100Hz
t8      decfsz  freq, 1    ;
        goto    s10        ; if freq=10, set output=20Hz
        goto    s9         ; if freq=9, set output=50Hz
                           ;
s1      movlw   0x0f       ; output is 20KHz
        movwf   cnt1       ;
lp1     bsf     PORTA, 2   ; set clock high
        bcf     PORTA, 2   ; set clock low
        decfsz  cnt1, 1    ;
        goto    dly1       ;
        bsf     PORTA, 3   ; set signal high
        nop                ;
        nop                ;
        nop                ;
lp2     bsf     PORTA, 2   ; set clock high
        bcf     PORTA, 2   ; set clock low
        decfsz  cnt2, 1    ;
        goto    dly2       ;
        bcf     PORTA, 3   ; set signal low
        nop                ;
        goto    lp1        ;
dly1    movwf   cnt2       ;
        goto    lp1        ;
dly2    movwf   cnt1       ;
        goto    lp2        ;
s2      movlw   0x01       ; output is 10KHz
        movwf   cnt3       ;
        movwf   cnt4       ;
        goto    s11        ;
s3      movlw   0x02       ; output is 5KHz
        movwf   cnt3       ;
        movlw   0x01       ;
        movwf   cnt4       ;
        goto    s11        ;
s4      movlw   0x05       ; output is 2KHz
        movwf   cnt3       ;
        movlw   0x01       ;
        movwf   cnt4       ;
        goto    s11        ;
s5      movlw   0x0a       ; output is 1KHz
        movwf   cnt3       ;
        movlw   0x01       ;
        movwf   cnt4       ;
        goto    s11        ;
s6      movlw   0x14       ; output is 500Hz
        movwf   cnt3       ;
        movlw   0x01       ;
        movwf   cnt4       ;
        goto    s11        ;
s7      movlw   0x32       ; output is 200Hz
        movwf   cnt3       ;
        movlw   0x01       ;
        movwf   cnt4       ;
        goto    s11        ;
s8      movlw   0x64       ; output is 100Hz
        movwf   cnt3       ;
        movlw   0x01       ;
        movwf   cnt4       ;
        goto    s11        ;
s9      movlw   0xc8       ; output is 50Hz
        movwf   cnt3       ;
        movlw   0x01       ;
        movwf   cnt4       ;
        goto    s11        ;
s10     movlw   0xf4       ; output is 20KHz
        movwf   cnt3       ;
        movlw   0x02       ;
        movwf   cnt4       ;
        goto    s11        ;
                           ;
s11     movlw   0x0f       ;
        movwf   cnt1       ;
lp11    bsf     PORTA, 2   ; set clock high
        bcf     PORTA, 2   ; set clock low
        decfsz  cnt1, 1    ;
        goto    dly11      ;
        bsf     PORTA, 3   ; set signal high
        movf    cnt3, 0    ;
        movwf   cnt13      ;
        movf    cnt4, 0    ;
        movwf   cnt14      ;
        movlw   0x0f       ;
        movwf   cnt2       ;
dly31   decfsz  cnt13, 1   ;
        goto    dly51      ;
        decfsz  cnt14, 1   ;
        goto    dly52      ;
        movwf   cnt1       ;
lp12    bsf     PORTA, 2   ; set clock high
        bcf     PORTA, 2   ; set clock low
        decfsz  cnt2, 1    ;
        goto    dly12      ;
        bcf     PORTA, 3   ; set signal low
        nop                ;
        movf    cnt3, 0    ;
        movwf   cnt13      ;
        movf    cnt4, 0    ;
        movwf   cnt14      ;
dly32   decfsz  cnt13, 1   ;
        goto    dly61      ;
        decfsz  cnt14, 1   ;
        goto    dly62      ;
        goto    lp11       ;
                           ;
dly51   nop                ;
        nop                ;
dly52   nop                ;
        nop                ;
        nop                ;
        nop                ;
        nop                ;
        nop                ;
        nop                ;
        nop                ;
        nop                ;
        goto    dly31      ;
                           ;
dly61   nop                ;
        nop                ;
dly62   nop                ;
        nop                ;
        nop                ;
        nop                ;
        nop                ;
        nop                ;
        nop                ;
        nop                ;
        nop                ;
        goto    dly32      ;
                           ;
dly11   nop                ;
        movf    cnt3, 0    ;
        movwf   cnt13      ;
        movf    cnt4, 0    ;
        movwf   cnt14      ;
dly21   decfsz  cnt13, 1   ;
        goto    dly41      ;
        decfsz  cnt14, 1   ;
        goto    dly42      ;
        goto    lp11       ;
dly41   nop                ;
        nop                ;
dly42   nop                ;
        nop                ;
        nop                ;
        nop                ;
        nop                ;
        nop                ;
        nop                ;
        nop                ;
        nop                ;
        goto    dly21      ;
                           ;
dly12   nop                ;
        movf    cnt3, 0    ;
        movwf   cnt13      ;
        movf    cnt4, 0    ;
        movwf   cnt14      ;
dly22   decfsz  cnt13, 1   ;
        goto    dly43      ;
        decfsz  cnt14, 1   ;
        goto    dly44      ;
        goto    lp12       ;
dly43   nop                ;
        nop                ;
dly44   nop                ;
        nop                ;
        nop                ;
        nop                ;
        nop                ;
        nop                ;
        nop                ;
        nop                ;
        nop                ;
        goto    dly22      ;
                           ;
        end
```

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049

3-terminal regulator works down to 0V without a negative rail

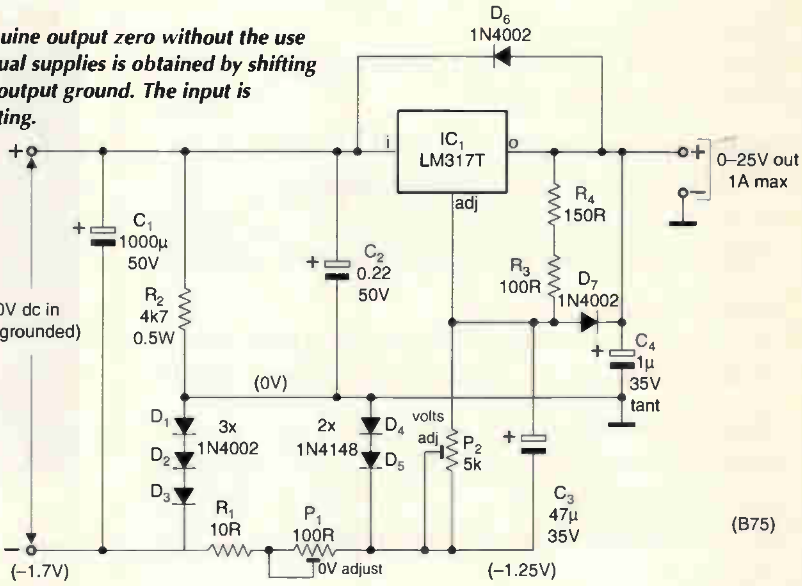
Three-terminal, adjustable, linear voltage regulator ics have a host of virtues to recommend them and one drawback: you cannot adjust the output to zero volts because there is a 1.25V reference voltage between the adjustment pin and the output. Applying –1.25V to the adjust pin will do the trick, but that normally requires a dual supply voltage.

At the cost of reducing the output range by about 1.8V, this circuit avoids that requirement. Raising the 0V output rail to 1.8V above the input negative rail by means of the three diodes and regulating the 1.8V by the two diodes to around 1.25V gives the effect of a negative rail.

Potentiometer 1 adjusts the new 0V level, with potentiometer 2, the output voltage adjustment, set at zero. Resistor R_2 maintains a minimum current through the three diodes. Diodes $D_{6,7}$ prevent damage to the ic by discharge of $C_{3,4}$ during input short-circuit conditions.

A good-sized heat sink may be needed, in particular at low voltages and high currents.

Steve Carroll
Timmsvale
New South Wales
Australia
B75



Genuine output zero without the use of dual supplies is obtained by shifting the output ground. The input is floating.

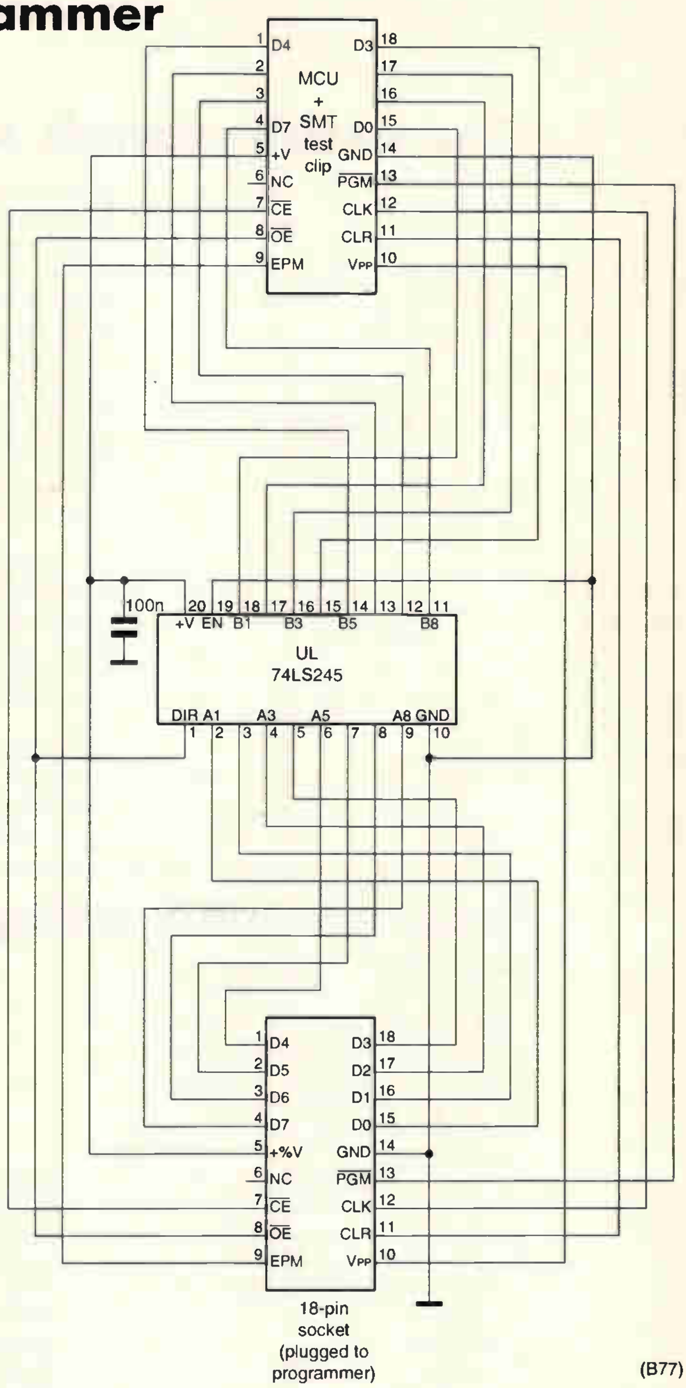
Adaptor from dip zif programmer sockets to s-m devices

Adaptors to connect dip zif surface-mounted microcontrollers or memories to programmers in SOIC form cost more than £100. Wiring a surface-mount test clip to a dip wire-wrap socket to plug into the zif socket was inadequate, at least for one particular programmer, since a programmed chip showed anomalies on test.

This circuit provides proper logic levels on data lines, using an octal transceiver, whose DIR input goes to the /OE line from the programmer to the programmee – a*Z80* in this case. When the /OE line is low, data goes from the programmed chip to the programmer and data through the transceiver from port B to port A. Otherwise, the programmer sends programming data to the programmed chip through port A to port B. The transceiver derives its power from the programmer.

No other lines needed buffering, but, depending on the programmer in use, more or less circuitry may be required. I found it a good idea to use strain relief wherever possible to reduce bending of the wires and also to mark pin 1 of the test clip to reduce the chances of putting a chip in back to front.

Dana Romero
Utah
USA
B77

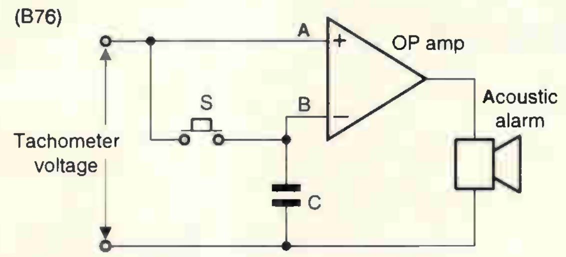


Adaptor allows microprocessors to use programmers with incompatible pins.

Car speed alarm

Because of my tendency to watch the speedometer more than the road ahead, I am at present without a car; I mention this to point out that this idea is, as yet, untested.

The circuit removes the need to worry about speeding, since it



Speed alarm avoids the need to watch the speedo.

sounds an alarm if you go faster than a speed you set. If you drive at the selected speed, pressing the switch for a second equalises the voltage on the amplifier inputs, which corresponds to the speed.

When the switch is again open, V_B stays constant, while V_A varies with the speed. As a result, if speed exceeds that at which the switch was closed, the alarm sounds.

You need to operate the switch after changing gear and also every hour or so, or V_B will decay and the alarm will sound at lower and lower speeds.

Scott Arnesen
Oslo Norway

Variable-frequency, variable pulse-width generator

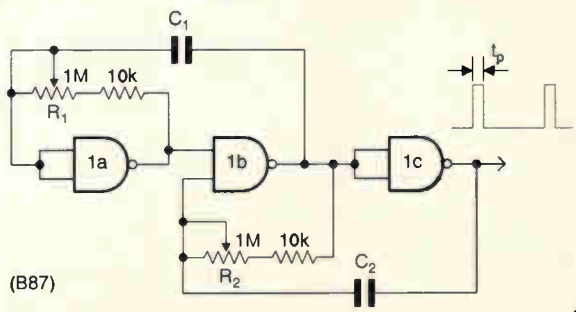
Varying this oscillator's frequency by means of R_1 has no effect on the pulse width; varying the pulse width does affect the frequency. The ic may be a *CD4011AN* or *CD4001AN*.

Using a 560pF capacitor in the C_2 position gives the results shown in the **Table**.

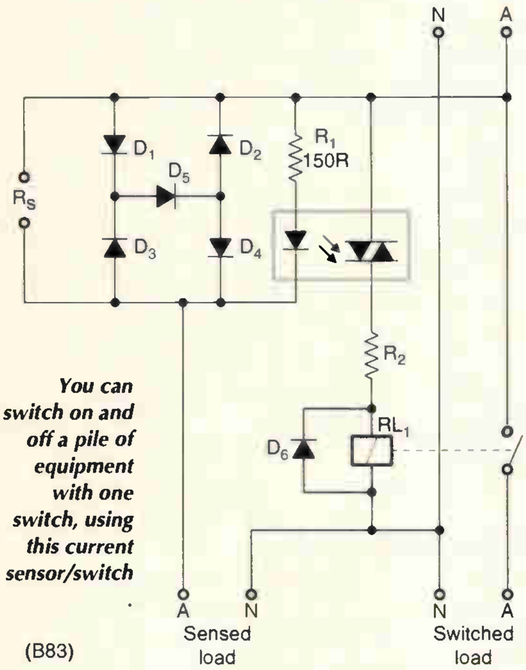
Vasiliy Borodai
Zaporozhje Ukraine B87

Table. Frequency ranges for three different values of C_1.

C_1	t_p (ms)	f_{min} (Hz)	f_{max} (Hz)
33nF	0.01	140	10k
33nF	0.4	70	1k
0.1μF	0.01	100	500
0.1μF	0.4	20	500
1μF	0.01	20	5k
1μF	0.4	2	2k



One switch controls several pieces of equipment



You can switch on and off a pile of equipment with one switch, using this current sensor/switch

(B83)

If your computer, or any other collection of equipment, has only one front-panel switch and all the rest must be switched on and off by other means. this circuit controls them all by the one switch.

When the main switch applies the supply, the first 10mA or so flows through the optoisolator led, the rest being shunted by the power diodes. With no shunt resistor at R_S, the scr/triac starts to conduct at 4mA over only 90°, going up to 20mA over 170°.

A 1Ω shunt these figures are 1.14A over 90° and 3.63A at 170°, which means that it is impracticable to use a further scr/triac to switch the load without more circuitry to prevent partial switching; a relay is therefore used.

Since the triac switches on alternate half-cycles, a shunt diode across the relay coil allows the stored energy in the coil field to increase its release time and prevent chatter. Resistor R_2 should be selected to make the relay pull in at about 90% of mains voltage; a 12V dc , 120Ω coil needed 5kΩ and a 230V ac, 6kΩ type required 15kΩ.

Diodes $D_{1\text{-}5}$ must carry the maximum load current (13A on the UK domestic supply) unless protection is used in the sense feed. The relay diode is a *1N4007* and the optoisolator a *MOC3021*. A shunt resistor of 0.47-1Ω gives cleaner switching.

The case can be a plastic type big enough to handle the heat generated, with outlets for the equipment, or a diecast box is may be used with the diodes thermally connected to the box.

Care must be taken to observe the safety regulations.

Rodger Bean
Watson
Australia
B83

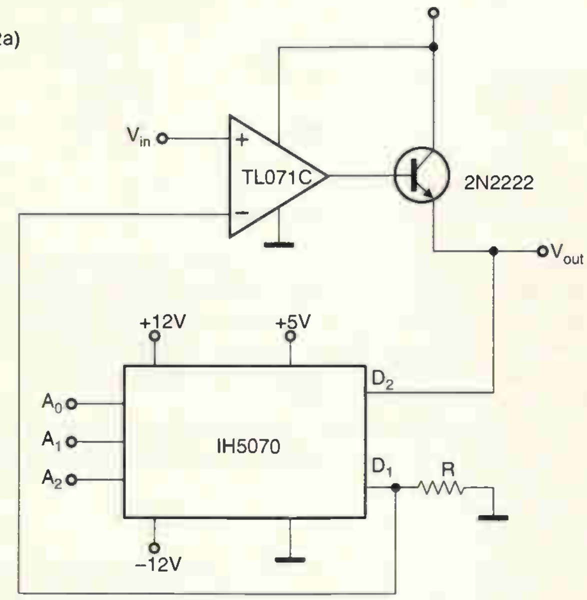
Programmable voltage divider

Intersil's *IH5070* is a two-from-sixteen analogue multiplexer. In this case, it is used to connect a number of external resistors of various values. $R_{1\text{-}8}$. in the feedback loop of a voltage regulator, the value selected being controlled by three binary inputs $A_{0,1,2}$. as shown in the table.

Since the amplifier gain is $1+nR/R$, where n is the ratio of the selected resistor to R, output voltage is $1+n$ times the input reference. In the internal switching diagram shown, R_1 is selected.

Kamil Kraus
Rokycany
Czech Republic
B72a

(B72a)

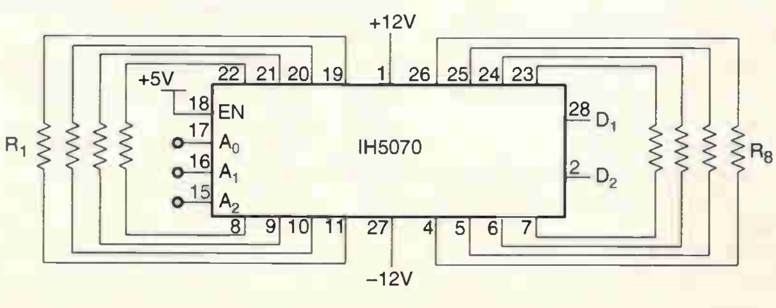


Output of this voltage regulator is programmed by the resistor selected by the three logic inputs.

These addresses are used to select one from the eight divider resistors.

Address line

A_0	A_1	A_2	EN	Resistor connected
x	x	x	0	none
0	0	0	1	R_1
0	0	1	1	R_2
0	1	0	1	R_3
0	1	1	1	R_4
1	0	0	1	R_5
1	0	1	1	R_{16}
1	1	0	1	R_7
1	1	1	1	R_8



Did RCA invent the Iconoscope? Was magnetic tape recording a war secret? Is it true that Baird worked on Colossus? Andrew Emmerson's version of history might not match up with what you have learned.

Rewriting history

Discovering the unsuspected truth can be a shocking experience, whether it's learning for the first time that Father Christmas does not really exist or else that concentration camps were an all-British invention of the Boer War period.

It comes as no less of a shock when you hear that the established history you learned many years ago as a fact is a sham, indeed a fiction created to enhance the reputation of an individual or of a large manufacturing corporation.

Perhaps we should not be surprised after all. It would be delightful to imagine that all historians record nothing but fully corroborated facts in a completely objective and unbiased fashion.

In fact most history is written for a purpose and frequently for money and as they say, he who pays the piper calls the tune. As the American author Eric Barbour wrote recently when discussing the true inventors of the digital computer, every age tries to re-write history to suit its leading personages. People with power and money manage to uncreate the past, even while they feed upon its very foundations, while the populace at large accepts the official version as fact.

First, RCA

One organisation that falsified history for its own ends is the late lamented Radio Corporation of America. This company is now reduced to a mere brand name or trading title of General Electric in America and assigned in the consumer electronics field to Thomson of France and in sound recordings to the German Bertelsmann Music Group.

Once an organisation of far greater status, RCA was created by American anti-trust legislation out of the US subsidiary of Marconi's Wireless Telegraph Company. The RCA corporation had much to be proud of.

Sadly, RCA had plenty to be ashamed of too. One example is the way it harassed worthy inventors such as television pioneer Farnsworth, and Armstrong, the inventor of the frequency modulation technique for broadcasting.

But what is now coming to light, thanks to the efforts of a number of investigative historians, is the fact that RCA deliberately distorted history in order to portray the company in a more favourable light. Loyal and decent American citizens brought up on the gospel according to RCA may wish to skip the rest of this article; everyone else should read on.

The world's first successful all-electronic television system has long been ascribed to Vladimir Zworykin. From 1911-12 Vladimir was a pupil of television pioneer Boris Rosing in St Petersburg and from 1930-1932 leader of RCA's television development laboratory. It was he who in 1935 turned the Iconoscope image pickup tube into a working product suitable for series production.

Tihanyi in his true light

It is now clear, however, that the Iconoscope was not RCA's unaided work. In fact it fell to a Hungarian, Kálmán (Coloman) Tihanyi, to first patent the concept of a light-sensitive image storage tube in 1928. This was at a time when Zworykin had already abandoned electronic pickup tubes and returned to mechanical scanning.

Thanks to diligent work lasting two decades by Tihanyi's daughter, Katalin Tihanyi Glass and publicity by German researcher Antje Grabenhorst, Tihanyi is now belatedly acknowledged as the forgotten inventor of the Iconoscope. Records indicate that RCA dealt with him over the period 1930-1935 in connection with the purchase of his patents. But the company never acknowledged that Zworykin was unable to make his camera work without external assistance.

Tainted hero

Another commonplace of RCA history is that the powerhouse behind the company – David Sarnoff, another Russian émigré – had begun his career as a wireless operator at the time of the sinking of the Titanic and received its final trans-

Kálmán Tihanyi, 1897-1947

The Hungarian Kálmán Tihanyi was a prolific inventor, who following studies in electrical engineering and physics sold several designs to RCA and the German companies Loewe and Fernseh AG. His fully electronic television system was patented in 1926 and though superficially similar to other proposals, it represented a radical departure. Like the final, improved version he patented two years later in 1928, it embodied a new concept in design and operation, building upon a phenomenon that would become known as the "storage principle".

The invention was received with enthusiasm by Telefunken and Siemens, but in the end they opted for continued development of mechanical television.

RCA approached Tihanyi in 1930, after the publication of his patents in England and France. Negotiations continued until 1934, when RCA, ready to unveil its new television system based on Tihanyi's design, purchased his patents. These covered key design features that caused the U.S. patent examiners, citing Tihanyi's prior publications, to deny Zworykin's 1930-31 applications. US patents assigned to RCA were issued to Tihanyi in 1938-39 with 1928 priority. Now it is becoming increasingly obvious that the originator of this pivotal invention was Kalman Tihanyi.

• A detailed article in English setting out Tihanyi's contribution to television as well as the various patent documents can be found on the Hungarian website,

http://www.mtesz.hu/scitech/history/tihanyi/index.html missions. Safely located on dry land throughout the disaster, he relayed the information to the press and became something of a hero at the time.

Or so the story goes. But not if you listen to Michael Biel, Ph.D, professor of radio and television at Morehead State University, Kentucky in the USA. Michael is quite emphatic...

"There is no contemporary evidence that David Sarnoff ever had anything to do with the Titanic story. It was a myth that he promoted and his name is not mentioned in any of the news accounts at the time. Accordingly it is highly doubtful that he was 'something of a hero at the time'. He was a Marconi operator of a low-powered station at the New York branch of the John Wanamaker store which only had the duty to communicate with the home office in Philadelphia. The station was operating only during the hours the store was open. Therefore, he was not on duty when the ship sank in the middle of the night, therefore he did not 'receive the transmissions from the Titanic'. It is probable that he listened in on the relays of the reports from other stations once he got to work the next morning. He might have put up bulletins inside the Wannamaker store but that is probably as far as his influence was."

Biel continues:

"The fairy-tale some books report that the President ordered all other stations off the air so that Sarnoff's station could be in the clear is pure egotistical fabrication. So is just about all of the story. He probably told someone that he had stayed up 72 hours to hear the Titanic reports, and the story just grew from there - and he loved it and never corrected it. The story that has been reported all these years makes just about as much sense as the story above that he had jumped ship and became a hero."

War secret that never was

Yet another historical myth accepted as fact is that that the Allies had no knowledge of the magnetic tape recorder until American troops over-ran Radio Luxembourg and found German Magnetophon machines playing out propaganda tapes.

Apparently the development of tape had been a war secret, developed by the Germans so they could play Hitler speeches at all odd hours to deceive the Allies from finding out his true whereabouts. A charming story but without any basis in fact!

In reality, the Magnetophon had already been on public display at the 1935 Radio Show in Germany and an improved version of the machine was sent to the American General Electric organisation in Schenectady in 1938. A report describing the same machine was published in this magazine – then called *Wireless World* – on 1 June 1939 concerning broadcasting arrangements for the forthcoming Olympic Games in Finland. These were subsequently cancelled.

As it is estimated that at least 25 simultaneous commentaries will have to be radiated each day, it has been necessary to resort to recording on a large scale. An order has therefore been placed for 40 AEG Magnetophon iron-powder film recorders. It has also been decided to provide a fleet of seven vans, several of which will be equipped for handling two different recordings at once.

Admittedly the expression 'iron-powder film recorders' as applied to recording tape looks strange. But how else would you describe a technology too new to have a handy name?

This report would have been taken from a Finnish or German press release using such strange language that it's obvious that the editorial staff at *Wireless World* had no idea what it was about and just printed it verbatim. Consequently, no-one took much notice!

Yet more revisionism

In each of these examples of corrected history, the fictionalised 'fact' has finally been replaced by an authenticated version. Unfortunately there are also revisionists at work trying to achieve the converse, embroidering existing and long-established fact with new, unsubstantiated speculation.

One such 'victim' of this reassessment is television pioneer John Logie Baird, whose memory is sufficiently notable that no false embellishments are needed. Nonetheless one writer is now alleging all manner of secret achievement during World War II by John Logie Baird,

Among other things, the protagonist cites that BBC television transmissions before the war were in fact a cover for radar research, aerial reconnaissance and secret signalling systems. He also alleges that Baird developed components for the Colossus computer which helped break enemy codes at Bletchley Park during the second world war. This is all based on supposition. So far, the writer has not offered any demonstrable evidence to support these claims.

In fact Baird's own autobiography states unequivocally that he sent his name to the authorities and expected to be approached with some kind of government work, but no such offer materialised. Likewise, in her own book, his wife Margaret writes: "John expected to be called on, but as in World War I but with less excuse, his country passed him over. This hurt him deeply."

Sydney Moseley, a close friend of Baird who was much involved in the wartime Ministry of Information, has written: "To this day I am baffled as to why the British authorities did not seek him out and harness his magnificent inventive genius to the war effort." If people are to contradict this irrefutable evidence 50 years later, they must produce cast-iron proof capable of independent verification.

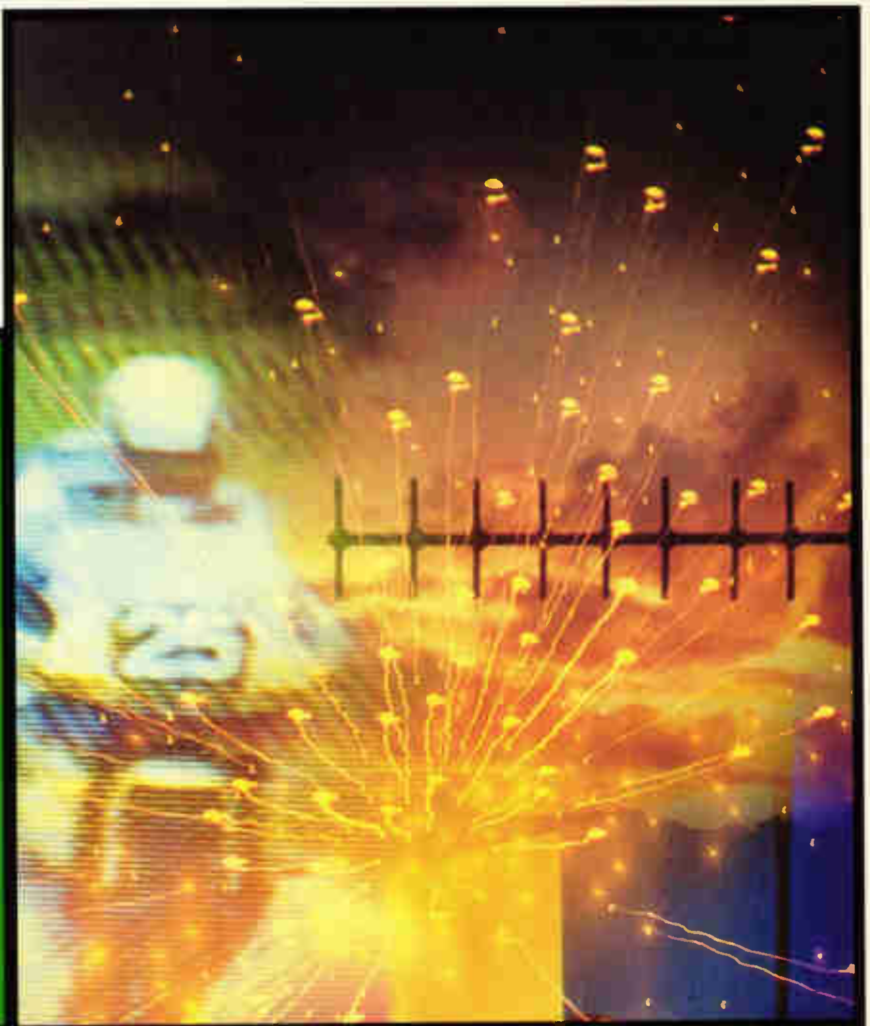
It has been said that Baird's refusal to move to the USA at the outbreak of World War II may well have been due to his involvement in secret work. During the war he received a fee of £1000 a year from the crown corporation Cable and Wireless. According to Baird's son, Dr Malcolm Baird, the services performed for this fee are still not known exactly, but his work is believed to have been on the use of television methods for high-speed coded signalling.

On the other hand, Cable & Wireless has copies of Baird's letters and reports of wartime meetings but there is no evidence at all that Baird produced anything other than a laboratory demonstration of high-speed signalling using intermediate film techniques. Minutes of a meeting held at the company during the summer of 1944 indicate that Baird had produced nothing of technical advantage to the company.

As Malcolm Baird says, research is continuing on this aspect of Baird's life but until something more substantial turns up, the secret life of John Logie Baird must remain no more than unsubstantiated supposition.

The irony, as one of the surviving employees of the Baird company points out, is that Baird's real life was so singular and his achievement quite sufficient that it should not now require adornment; authors who allege information which cannot be corroborated detract not only from the credibility of their own research but that of others.

He declares: "When some people are endeavouring to ensure that the history of television is being accurately recorded for posterity, it is absolutely deplorable that a few others deliberately distort information given to them in good faith in order to support some fanciful theory of their own." ■



Ian Hickman describes a simple yet high performance field strength meter suitable for evaluating antenna radiation patterns.

How strong is your field?

Field strength measurements, such as those for establishing the radiation pattern of an antenna, are tricky at the best of times. And these are only relative measurements. Absolute field strength measurements are fraught with difficulty, and repeatable results accurate to within a modest-sounding 3dB in fact represent good going.

It is frequently rewarding to keep an eye out for the best of the latest crop of new components. While new and improved passive components are appearing all the time, it is often among the actives – especially ICs – that the really exciting innovations are found.

Such a newcomer is the *AD8307* logarithmic amplifier from Analog Devices, with its exceptional 92dB range. The earlier *AD606*, with its 80dB log range, was described in reference 1. I have used it in the past in a number of designs, including a simple spectrum analyser that has also appeared in these pages.[2]

The *AD8307* not only possesses 12dB more dynamic range, but wins hands down on bandwidth too. While the earlier device operates to 50MHz, and is thus suited to logarithmic IF amplifier stages, the newer device offers a staggering 500MHz bandwidth. It can be used connected directly to a test antenna, to indicate relative field strengths at frequencies right up to uhf.

Solution in search of a problem

The problem in this case was a project I had had in mind for some time – a simple general purpose field strength monitor.

A superheterodyne monitor with a logarithmic IF is a versatile solution. Its front-end tuning permits measurement of the field strength at any given tuned frequency, without interference from other signals at different frequencies. And, operating at IF, an *AD606* logarithmic amplifier is entirely suitable. But such a superheterodyne receiver is hardly simple, and is not likely to be either small or suitable for battery powered operation.

For some applications, these are not important considerations, but for one application in particular, they can be a distinct drawback. This is antenna radiation pattern testing. The problem is the coaxial feeder from the test antenna to the field strength monitor, **Fig. 1**.

If the lead can be carried away indefinitely along a line joining the antenna under test and the test antenna, there is no problem. Clearly, the distance does not need to be infinite, just large compared to a wavelength.

Antenna tests

The solution just mentioned is manageable for measurements at an elevation angle of zero, as in Fig. 1, but becomes impracticable for other elevations.

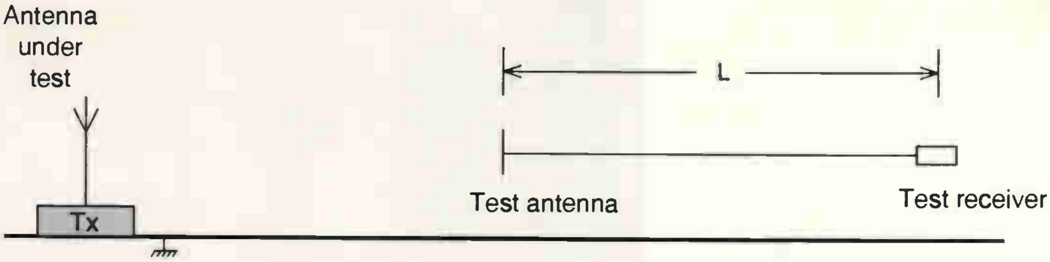


Fig. 1. Simple set-up for relative field strength measurements.

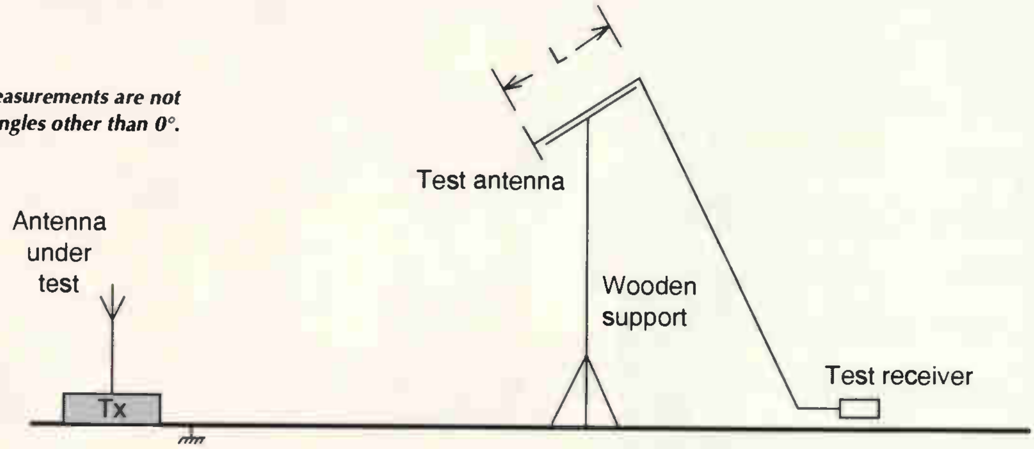


Fig. 2. Antenna field measurements are not so simple for elevation angles other than 0°.

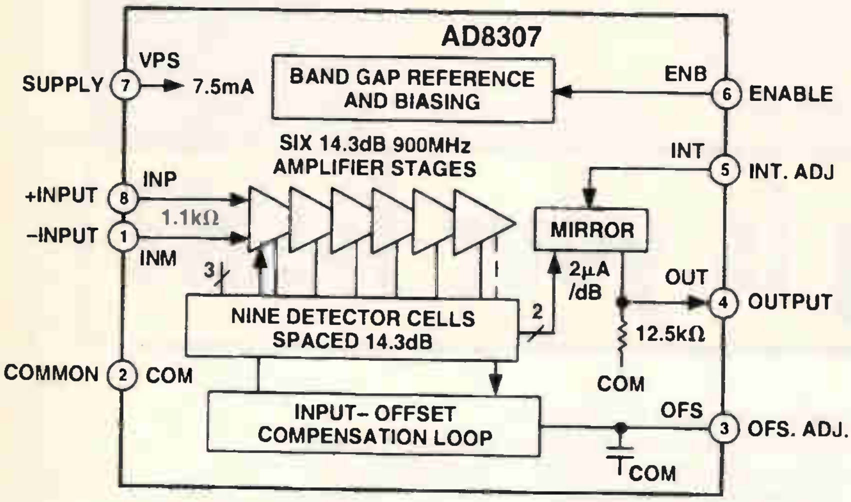
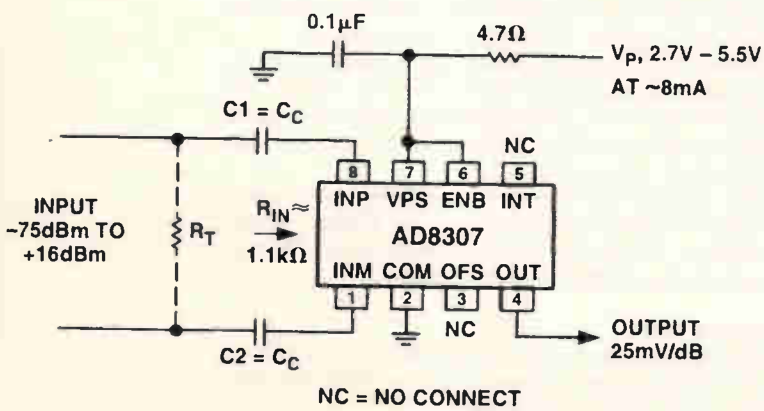


Fig. 3a) Block diagram of the internal arrangements of the AD8307 logarithmic amplifier.
b) Basic connections for using the AD8307.



There is then no option but to bring the lead from the test antenna down to the field strength monitor, **Fig. 2**. The result is that the lead is irradiated by the transmitted field from the antenna under test, since a large value for *L* is not practicable. The feeder then reradiates energy. This energy is picked up by the test antenna, giving an incorrect figure for the true field due to the antenna under test alone.

Various palliatives are possible, such as ferrite rings used as "braid breaks", but it is difficult to be certain as to the effectiveness of such measures. Indeed, I had trenchant proof that such attempts were frequently ineffective, during extensive trials on an experimental hf direction finding system, funded by RSRE (as it was then).

However, a method used by some test houses avoids the possibility of reradiation from the feeder entirely. The field strength monitor is small, self-contained, battery powered and located just behind the centre of the test antenna. The output of the logarithmic amplifier is fed to an a-to-d converter and transmitted as digital data down a fibre optic link to remote recording equipment on the ground.

The advent of the *AD8307* opens up the possibility of an extremely simple field strength monitor, readily designed in a small plastic case and powered by a dry battery. Such an instrument is eminently convenient for antenna testing.

With a dc voltage proportional to the logarithm of the field strength, available right there near the centre of the test antenna, the only remaining problem was how to get the information down to ground level. An elegant solution – and simpler than an a-to-d converter – is a voltage-to-frequency converter driving an LED coupled to an optical fibre.

At the ground-based recording end, an opto transistor provides a pulse train feeding frequency-to-voltage converter to recover the logarithmic amplifier output voltage from the light pulses.

Lateral thinking

In the event, I adopted an even simpler solution. For some years I have had in stock, left over from an earlier design, some miniature digital panel meters. These meters have an LED readout and are readily powered by a 9V PP3 (IEC style 6F22) battery.[3]

I used one of these meters, housed in a plastic hand-held case[4] complete with panel cutout for a display and a battery compartment with cover. The dc output of the logarithmic amplifier appears on a display within a centimetre or two of the antenna.

The antenna consisted of two six-section telescopic aerials[5] projecting through holes in the side of the case, at the end remote from the battery compartment. In retrospect, the longer seven-section aerials would probably have been more generally useful.

Output from the logarithmic amplifier, representing the field strength is thus available for reading at the ground-based recording station – provided your eyesight is good enough.

The *AD8307* logarithmic amplifier

As the whole instrument revolves around the remarkable performance of the *AD8307*, a word or two about how it works may be be of interest.

Figure 3a) shows a simplified block diagram of the device's internal workings. A cascade of six logarithmic stages covers the lower two thirds of the device's dynamic range, while three "top-end detectors", tapped down a passive attenuator, account for the top third. This extends the log range up to +15dBm.

Pins 1 and 8 are the inputs while pins 2 and 7 the supplies. Of the remaining pins, offset adjust on pin 3 is only required under special circumstances. Such a circumstance might be using the device at audio frequencies.

Pin 6 carries the enable signal, and is usually strapped to +5V on pin 7. If grounded instead, invoking sleep mode, the current drawn by the device is reduced to a fraction of a milliampere. The output at pin 4 is scaled to a nominal 25mV per decibel, ±2mV.

The logarithmic response cannot continue down indefinitely, and so the output voltage never falls to zero, but levels out at some point. This point is set, among other things, by the device's noise floor, which – with a bandwidth in excess of 500MHz – is certainly not negligible. In fact, thermal noise in 50Ω in a 500MHz bandwidth is –84dBm, which actually makes the device quite a quiet performer.

Pin 5 enables the 'intercept' to be adjusted. The intercept is the input level in dBm at which the linear part of the characteristic, projected on down, would correspond to zero output voltage. Knowing this, the output voltage indicates not merely the relative, but also the absolute value of the input signal.

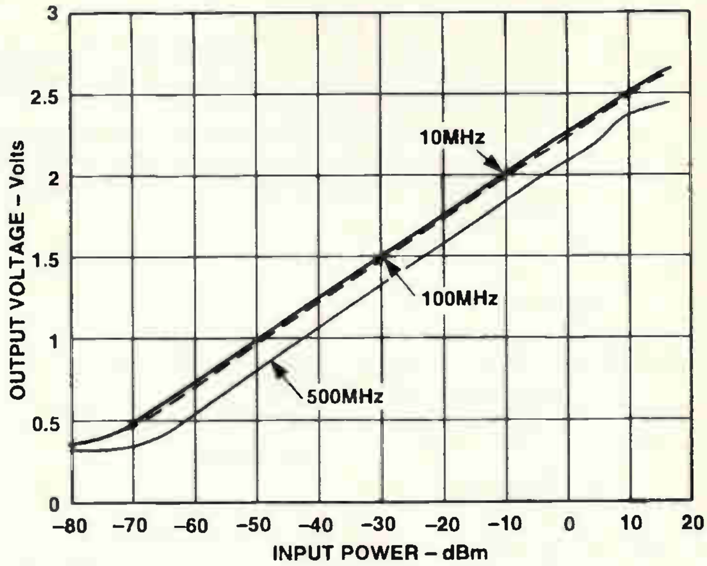
Figure 3**b)** shows the basic connections for using the *AD8307*, while the excellent performance of the device is illustrated in **Fig. 4a)**, which shows the logarithmic response of output voltage versus input signal level.

Figure **4b)** shows the very low departure from exact logarithmic conformance, over a wide range of input levels and frequencies. Note that although the data sheet frequently refers the output voltage to an input expressed in dBm referred to 50Ω, this is purely by convention. The device responds to the input signal voltage, not to signal power. So – assuming a sine wave input – for 0dBm, simply read 0.225V rms and so on.

Field strength monitoring circuitry

The *AD8307* is housed in an 8-pin plastic case, available as either N-8 DIP or R-8 SOIC. Both are characterised for operation at either 3V or 5V supply – the absolute maximum rating being 7.5V

I obtained a sample of the DIP version, and this was powered powered via a 79L05 5V negative regulator. As noted in reference 6, some digital panel meters have a very restricted common mode input range. As a result, they are awkward to implement unless powered from a floating supply such as a PP3 battery.



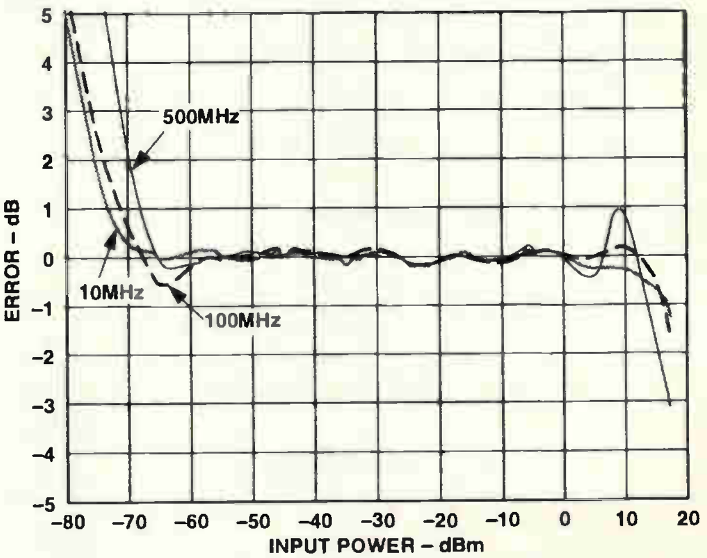


Fig. 4a) Response shows a logarithmic characteristic over a wide range of levels, regardless of frequency... b) ...with very low departure from the ideal.

The digital panel meter I used has a very wide common mode input capability, extending from 1V above the negative rail to 0.5V below the positive. This made it possible to power both the logarithmic amplifier and the panel meter from the same battery. as shown in the circuit diagram of the field strength monitor, **Fig. 5**.

The basic range of the meter is 0-200mV, so a 10:1 attenuator comprising 910kΩ and 100kΩ resistors was used to interface the output of the logarithmic amplifier. The amplifier was scaled down from its nominal 25mV/dB to 20mV/dB by a 50kΩ potentiometer and 33kΩ resistor shunting the output.

Figure 6 shows the internal circuit diagram of the panel meter module. Split pad DP3 was bridged with solder, activating the appropriate decimal point to display a full scale reading as 1.999V.

Given the 20mV/dB scaling, this provides a potential reading range of 100dB – more than adequate to cover the expected range of outputs. Both the input terminal and reference terminal pairs are floating, and the unit can be used for ratiometric measurements with split pad 1 open circuited, isolating the reference.

For this application, split pad 3 was solder-bridged, connecting the REF LO pin to COMMON, while IN LO was connected to the logarithmic amplifier's ground rail.

Implementing the design

A piece of single sided copper-clad SRBP 105 by 55mm was cut, and drilled with holes to pick up on the three mounting bosses moulded into the case bottom.

The copper was scored and peeled off in various areas as indicated in Fig. 7. This is quite easy in the case of SRBP, if the copper just ahead of the peel point is heated with a soldering iron.

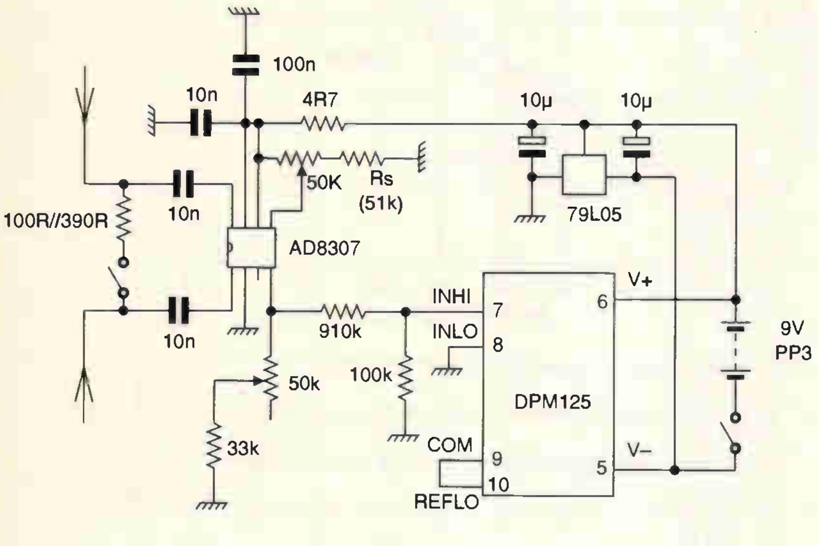


Fig. 5. Circuit diagram of the field strength monitor.

Pads were thus created for the two aerial connections, and one for pin 7 of the *AD8307*. The construction was perhaps a little cavalier, but I think that it can be justified. The amount of sophistication it is sensible to invest in a prototype should be related to its ultimate purpose.

If I was designing an instrument for production and sale, a proper pcb would of course be mandatory. But for what was only ever intended as a one-off for my own use, a little ingenuity can save a lot of time, without sacrificing fitness for purpose.

Following this philosophy, the pins of the logarithmic amplifier were bent out sideways, with the exception of pin 2. Just the tip of this was bent out, and soldered to the groundplane as indicated in Fig. 7.

A 10n chip capacitor was mounted between pin 7 and the groundplane, pins 2 and 7 thus supporting the device. Pins 1 and 8 were connected via 10n capacitors with short stiff leads to the two pads forming the antenna connections, providing further support for the logarithmic amplifier DIP.

The six section telescopic aerials each had a solder tag secured to the base by the tapped hole provided, the tag being bent up and soldered to its associated pad. One of these pads also supported a subminiature single-pole changeover slide switch, the other a chip resistor connected to it. In fact, 100Ω and 390Ω chip resistors in parallel were used. When switched into circuit, they provided – in conjunction with the 1100Ω input impedance of the logarithmic amplifier – a termination of 74Ω. This is just about right for a half wave dipole.

The panel meter was mounted in the meter cut-out in the

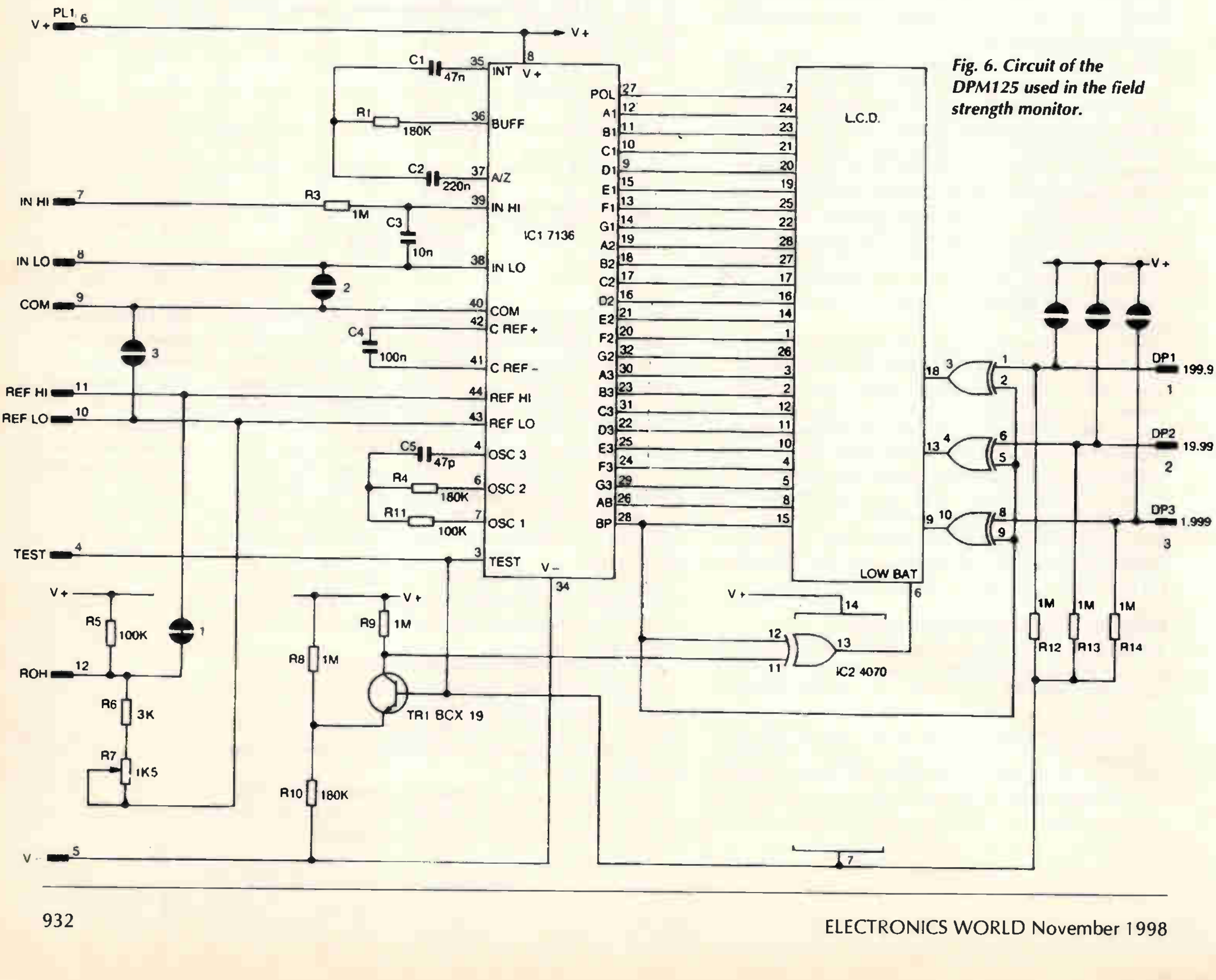


Fig. 6. Circuit of the DPM125 used in the field strength monitor.

top half of the case. Another subminiature slide switch, mounted on the right-hand side of the lower half case, formed the on/off switch.

Calibrating for field measurements

I carried out the calibration at 400MHz, using an appropriate length of stout copper wire, connected to the output socket of a signal generator, as a quarter wave vertical monopole. The field strength monitor was place about 300mm away, with the antenna rods adjusted to full length, a little short of an exact 400MHz vertical dipole.

The monitor was placed on its side, so that the aerial rods were vertical. The signal generator output was set to +10dBm and the reading on the panel meter noted. The output was then reduced to –20dBm and the reading again noted. The difference was close to 600mV, and the 50kΩ potentiometer was adjusted to make it exact, and the change rechecked.

Between readings, the signal generator was set to 'Carrier off', to make sure the field strength monitor was not 'hearing' any other stray signals floating around what was a busy laboratory.

Although the 50kΩ potentiometer and resistors were fitted at pin 5, no attempt was made at this stage to set the intercept to any particular value. This will differ depending on the conditions of use.

Using the field strength monitor

The unit is of course untuned, and as such more or less completely broadband. A useful degree of selectivity is provided by the antenna, at frequencies where it can be adjusted to act as a half wave dipole. At lower frequencies, the antenna will represent an electrically short dipole, and sensitivity will be improved if the internal termination is switched out of circuit.

Given the comparatively high input impedance of the *AD8307*, the antenna then acts almost like an ideal *E*-field probe. If the dipole is short compared to a half wavelength, then the voltage induced by the incident field is simply E times l, where l is the length of the short dipole, and E is the field strength in volts per metre.

In such an application, it may be useful to adjust the intercept, as described in the *AD8307* data sheet, so that the reading on the panel meter indicates dBV. Then, from the reading and the antenna length, the actual field strength can be estimated.

I designed this meter for examining the radiation patterns of antennas. For this purpose, the antenna of the monitor should preferably be several wavelengths away for the antenna being tested. However, a much smaller separation than this is enough to ensure that the monitor is in the plane-wave Z_0=377Ω 'far-field' region.

In the case of a transmitter, measurements are relatively straightforward. But in the case of a receiving antenna, a signal generator followed by an amplifier may be needed to raise sufficient radiated field to make measurements. In any case, the radiation from the amplifier under test should be turned off from time to time, to ensure that the readings are not due to some other signal.

A large open outdoor test site is ideal. I am fortunate in living not a thousand miles away from just such a place, called Stoney Cross in the New Forest. Used as an airfield in the Second World War, it is a large clear flat area, unobstructed by trees, well removed from any high power transmitters and ideal for such measurements.

Doubtless many other such sites, with public access, exist.

And for my next trick...

Being such a versatile device, the *AD8307* can be used for many other purposes. It can be used to monitor rf pulses over a very wide dynamic range, thanks to its rapid response to changes in signal level, **Fig. 8**. At the other end of the frequency spectrum entirely, the data sheet also gives application details for using the device at audio frequencies – right down to 20Hz.

But to return to antenna measurements, **Fig. 9a)** shows how the input can be tuned, providing greater sensitivity at a given wanted frequency, and further discrimination against other frequencies. Figure **9b)** shows the results at a tuned frequency of 100MHz. Figure **9c)** gives the component values for various frequencies, for two different values of input impedance.

Typically, 10dB or more of extra sensitivity is achieved, while the values given incidentally also match an unbalanced input to the balanced input of the device.

For use with a dipole, C_1 and C_2 should both be equal to the average of the two values of capacitance in the table in Fig. 9c). And taking the geometric mean of figures for 50Ω input and 100Ω input will provide an indication of the required values for use with the 75Ω impedance of a resonant half wave dipole.

If a lot of testing is to be carried out at a given frequency, it is worth making up such a tuned version of the field strength monitor as a permanent equipment. This is not an

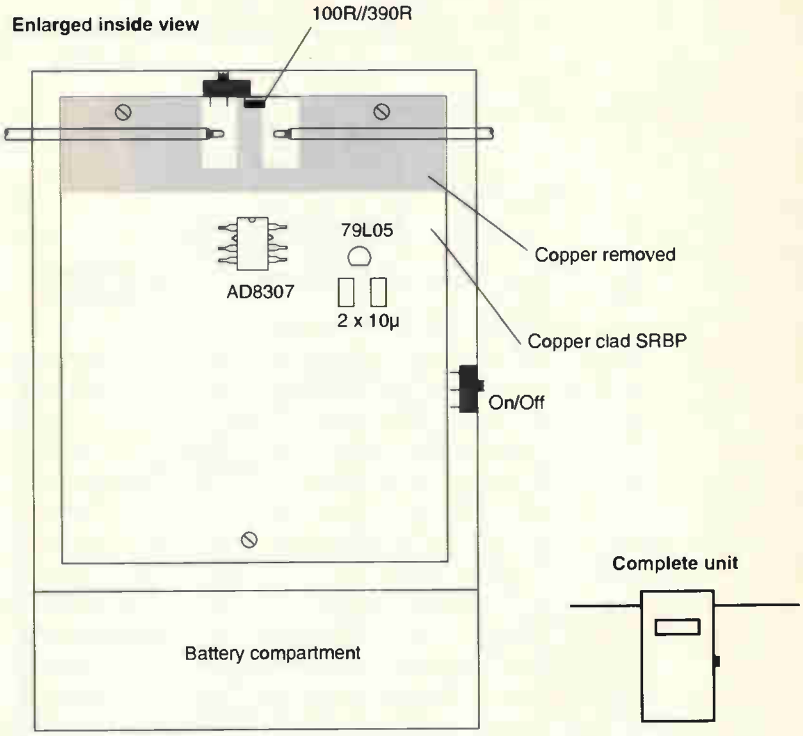


Fig. 7. Sketch of the layout used.

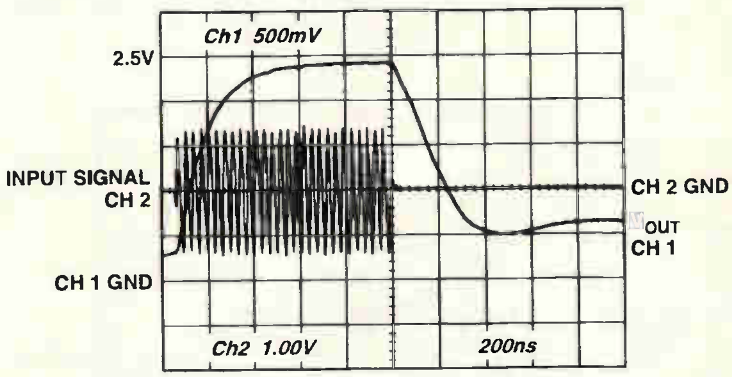
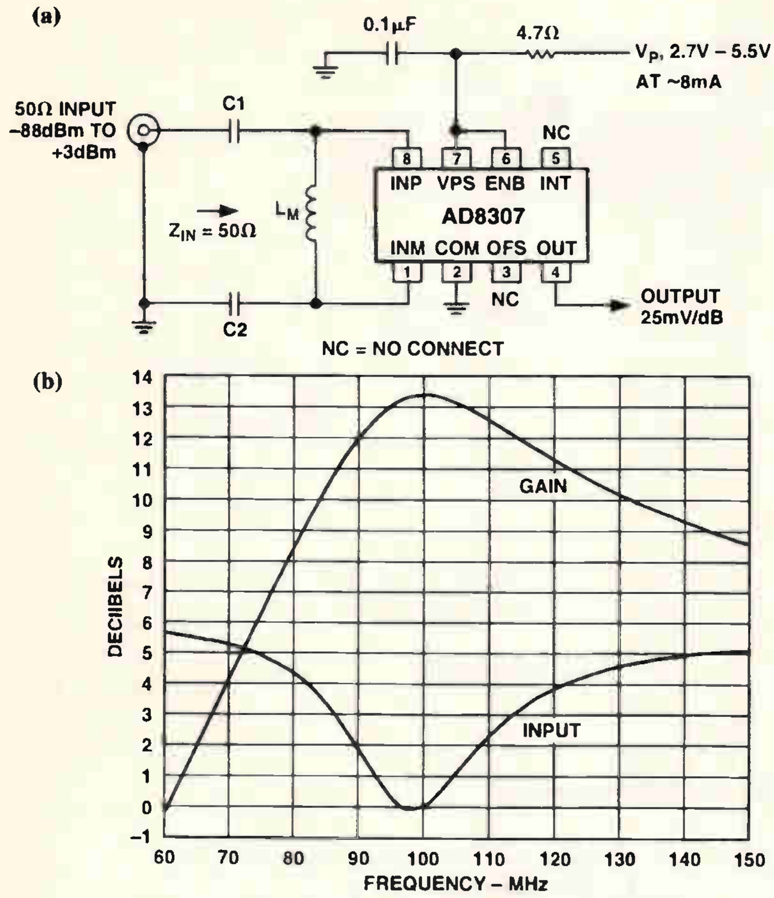


Fig. 8. Fast response of the AD8307 to changes in signal level permits monitoring of rf pulses over a wide dynamic range.



(c) I. Narrow-Band Matching Values

F_C MHz	Z_{IN} Ω	C1 pF	C2 pF	L_M nH	Voltage Gain (dB)
10	45	160	150	3300	13.3
20	44	82	75	1600	13.4
50	46	30	27	680	13.4
100	50	15	13	330	13.4
150	57	10	8.2	220	13.2
200	57	7.5	6.8	150	12.8
250	50	6.2	5.6	100	12.3
500	54	3.9	3.3	39	10.9
10	103	100	91	5600	10.4
20	102	51	43	2700	10.4
50	99	22	18	1000	10.6
100	98	11	9.1	430	10.5
150	101	7.5	6.2	260	10.3
200	95	5.6	4.7	180	10.3
250	92	4.3	3.9	130	9.9
500	114	2.2	2.0	47	6.8

Fig. 9a) Addition of simple single pole front end tuning.
b) This increases sensitivity to a wanted signal, and provides selectivity to reject off tune signals.
c) Listing of component values for various frequencies, for two different input impedances.

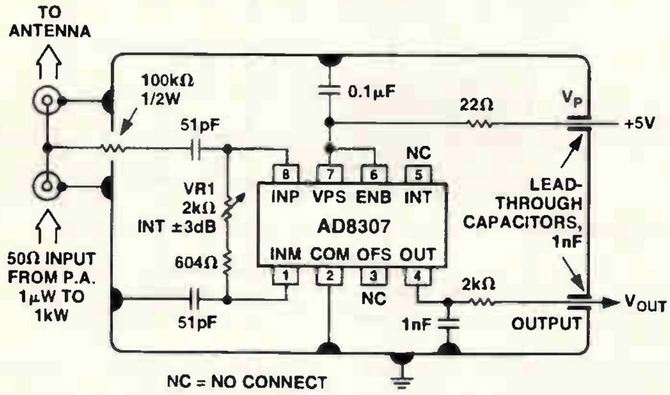


Fig. 10. Another application for this versatile device, a 1µW to 1kW rf wattmeter.

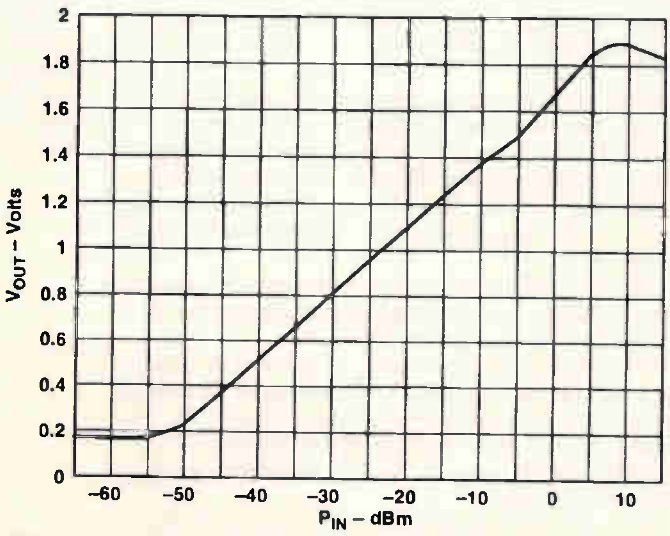


Fig. 11. Although only listed as suitable for use up to 500MHz, the device is usable over a 60dB range at up to 900MHz.

unduly expensive exercise, given the very modest cost of all the component parts.

Alternatively, with a little ingenuity it should be possible to make up the tuning components for any given frequency as a little exchangeable plug-in unit, permitting the field strength monitor to be used at a variety of different spot frequencies, while still retaining the advantages of tuning.

Figure 10 shows yet another use for the *AD8307*, as an rf wattmeter covering the range 1µW to 1kW. The arrangement simply measures the voltage on the feeder, and thus is not capable of distinguishing between forward and reverse power. To do this, a 20dB or 30dB directional coupler would be required, and the 100kΩ resistor at the input would of course be omitted.

As if a 90dB dynamic range were not enough, the data sheet gives an application circuit using an *AD8307* in conjunction with a variable gain amp type *AD603*, for a 120dB range measurement system.

The six internal logarithmic amplifier stages of the *AD8307*, shown in Fig. 3a). each have a 900MHz bandwidth. However, due to the accumulated effects of the frequency roll-off of each, the device is only specified for the full 90dB dynamic range up to 500MHz.

Nevertheless, over a somewhat smaller 60dB dynamic range, the device provides useful performance right up to 900MHz. This is illustrated in **Fig. 11**, which shows excellent log linearity over the range –50 to –510dBm, and on up to +10dBm if a bit of a bump at –5dBm can be excused.

Some of the illustrations in this article are reproduced by kind permission of Analog Devices (AD8307) and Lascar Electronics Ltd (DPM125). ■

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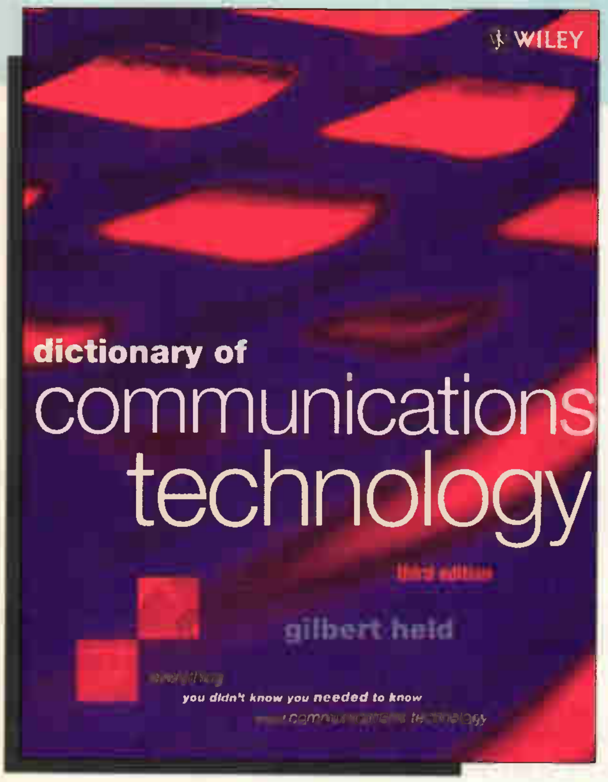

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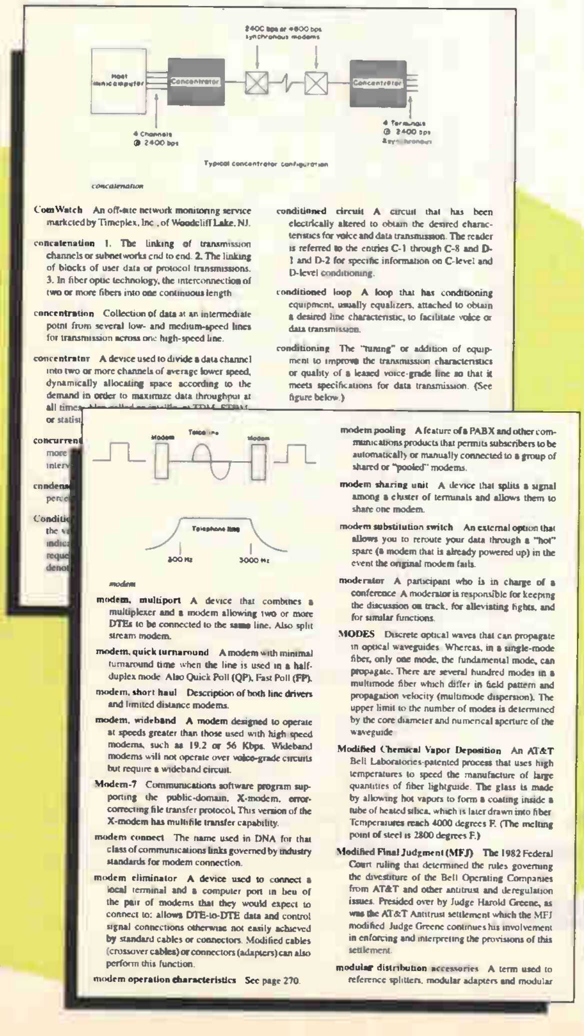

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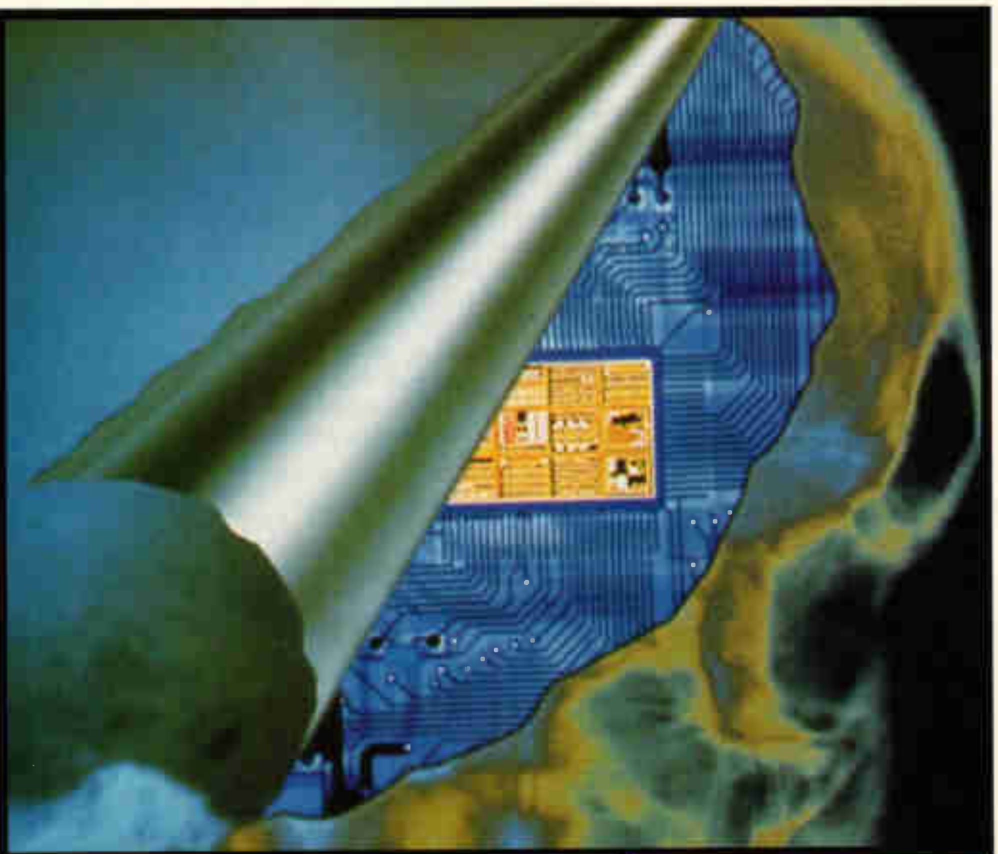

BRAINS and how to grow them

How close are we to the Holy Grail of intelligent electronics – real artificial intelligence? Here, Chris MacLeod and Grant Maxwell attempt to answer that question, and they present a new breed of techniques that appear to be leading us closer to real AI.

Suppose we want to create a complex circuit but we don't know how. No design rules have been laid down or the circuit has never before been made. Perhaps we're not even quite sure what the circuit is to do.

Are there methods for synthesising solutions to problems like this? The answer is yes; they are called 'genetic' or 'evolutionary' methods – and the most important of these is the genetic algorithm.[1,2]

Think of it this way. An animal is infinitely more complex than any system man has developed. How did these complex natural systems arise without a designer? The answer of course is evolution.

So why not use a computer model of evolution to 'evolve' complex circuits? Well, researchers have done just that. And they have produced working circuits so complex that no one understands them.

Natural evolution

Take a population of animals of the same species. Let's say a tortoise living on a desert island.

Many of the individual animals within the group will have different characteristics. For example, some will have longer necks than the others. Now, let's say the climate on the island dries up and the trees lose most of their foliage near the ground.

The animals born with longer necks will be more successful. They will be able to reach the higher leaves, be in better condition and therefore will have a better chance of mating. They will pass the genes for longer necks onto the next generation and so more of the population will have longer necks.

Over eons of time a new species of long necked animals will come into being. All this is possible because all living things use the same code, i.e. DNA, to build their bodies.

Another factor, which also changes the population, is that the DNA code occasionally changes by accident – it mutates. Most of these mutations are bad. They cause the animal to develop characteristics that put it at a disadvantage. But occasionally they cause a change which gives the animal an advantage in the wild and so are passed onto the next generation.

Simulating evolution

The computer simulation of this is known as the genetic algorithm. To illustrate how it works, we'll use a much simplified genetic algorithm. For more details and examples of 'real' genetic algorithms, have a look at references 1 and 2.

In the genetic algorithm, we encode the system as a row of ones and zeros – i.e. a simple binary string. Each string represents a different system. In the case of a digital circuit, the string is a code which corresponds to the wiring of the circuit: I'll show you how this is done shortly.

At the start of the genetic algorithm, we generate lots of random strings; of course, each of these therefore corresponds to a randomly generated circuit. In real genetic algorithms there are often about 50 strings, but for the sake of this example, let's say we generate four random strings as shown below.

```
10001010
01010100
11100101
00111001
```

Now we make a circuit that corresponds to each of these strings. In practice we do this with a simulator or via an fpga or complex pld. On testing the circuits, we find that some perform better than others. We can assign each of the strings a fitness grading, which corresponds to how well the string or circuit performed.

```
10001010     10
01010100     34
11100101     18
00111001     22
```

So, string two performed the best and string one the worst. What we do now is form a new population of strings. To do this, we delete the really poor strings and copy the really good ones several times.

```
01010100
00111001
01010100
11100101
```

Here, the best string, i.e. string number two, has been copied twice and the next best two strings have been copied once. String one, which was the worst, has been deleted.

We now move to a stage known as crossover. Here we pair the strings up and swap the ones and zeros between the strings. This is difficult to explain, but **Table 1** should make it clear.

This might seem a very strange thing to do. In fact, its exactly what happens in sexual reproduction. Half the chromosomes come from the mother and half from the father. A new individual is formed that has some of the traits from both.

In genetic algorithms, the idea is that some of the strings may be good for one reason and some for another. When they cross over some of the new individuals will have good traits from both.

In the final stage of the process, some of the bits are chosen at random and inverted – ones become zero and *vice versa*. Usually about 4% of the bits are changed in this way. This part of the algorithm is known as mutation. This adds a random element to the algorithm and helps it to explore circuits which were not in the original population.

Once this has been done, the algorithm repeats itself and the circuits get better until we have evolved into a working circuit. That

Table 1. Crossover – i.e. pairing the strings and swapping the ones and zeros between the strings.

Before cross over,

01010100 } pair 1
00111001

01010100 } pair 2
11100101

| This line represents a randomly selected crossover point.

After cross over,

00110100 } In this pair, the first three bits, which were originally part of string
01011001   number 1, are now the first three bits of string 2 and *vice-versa*.

11100100 } Here, the first five bits of string 1 are now the first five of string 2.
01010101   Likewise, the first five of string 2 now belong to string 1.

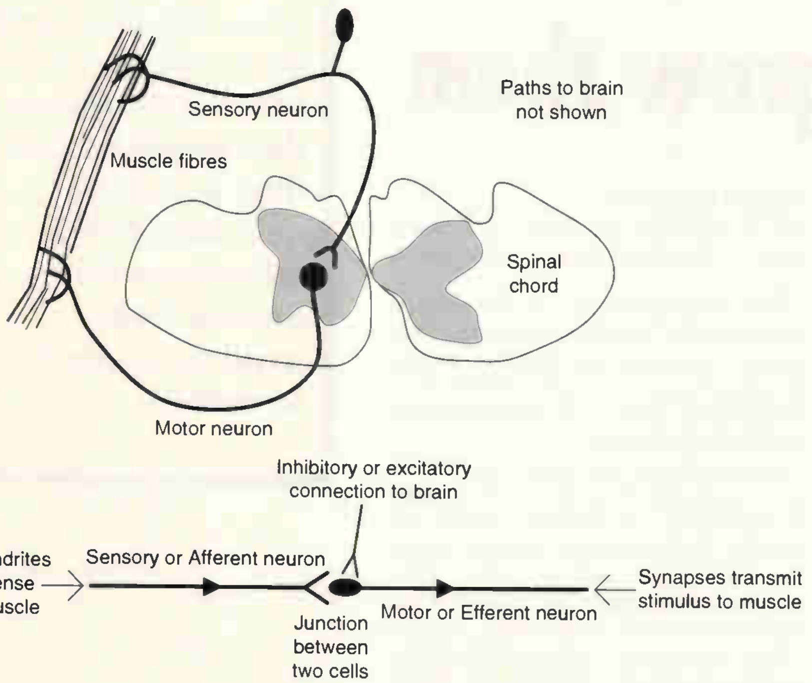

Fig. 1. At the lowest level, the nervous system is built up of simple reflexes like this.

Table 2. Coding the circuit for use in a genetic algorithm, after Thompson, but simplified.

Bits	Function
0-4	Not Used
5-7	Node function, NAND, OR, NOT, etc
8-15	Connection to Input 1
16-23	Connection to Input 2

This code represents the function at one node, 100 of these 23 bit codes joined together make up one string in the Genetic Algorithm.

is how the algorithm works; taking systems with good traits and 'breeding' them with one another while deleting others with poor traits.

Note that there are several other algorithms which can perform a semi-random search like this. Examples are: simulated annealing, evolutionary programming and evolutionary strategies. But none is as easy to code and configure as the genetic algorithm.

Digital designs and neural networks

If we can figure out how to encode a circuit in the string of our genetic algorithm, then we could leave the algorithm to figure out the circuit topology for us. This is exactly what Adrian Thompson at the University of Surrey has done[3]. He has taken one hundred fixed gates and encoded information about them in the following way, **Table 2**.

He then let a genetic algorithm loose on the circuit. His experiment is quite subtle. The circuit runs asynchronously. As a result, the gate delays interact with the circuit timing and affect its operation. These delays add another dimension to the circuit's behaviour, rather like configuring an analogue circuit using digital gates.

Thompson has used the idea to evolve a 4kHz clock and suggested how the technique might be used to evolve a robot controller. One fascinating aspect to Thompson's work is that *why* the circuits work is not obvious. Such is the subtle interplay in the timing of the system.

The interesting thing about the system is that you don't have to understand the detail as long as you can specify the fitness for the result. That is what makes these techniques so interesting for artificial intelligence.

For designing normal electronics, this method cannot compete with Heuristic techniques[4]. For more insight into Thompson's experiments, visit his web page http://www.cogs.susx.ac.uk/users/adrianth/ade.html.

Other researchers have applied the technique to analogue circuits[5] and artificial neural networks[6]. For a discussion on these other technologies, see our previous article in the June 1998 issue.

And now, to the holy grail...

So, given that we can evolve a circuit to do anything we want, what is stopping us from making intelligent machines or, for that matter, an artificial brain?

The answer is this: when we evolve a circuit, it will usually perform well for some particular task. As soon as we let it loose in the real world – where it has to solve many tasks at once – it breaks down completely, often unable to do any of the tasks satisfactorily.

Why does this happen? Well, look at the real biological brain. It is structured in individual modules. Each part of it has a particular task.[7] For example, one small area is specialised in recognising vertical lines in vision; another horizontal lines.

Each of these modules consists of a small group of neurons, performing just that task, but communicating the result to the next level of a hierarchy of networks.

How did this come about? Very simple animals, such as sea anemones, have a homogeneous network – i.e. circuit – of neurons covering their whole body.[8] A neuron is the biological equivalent of an electronic processing unit, for example a gate.

The function of these neurons is to monitor the outside world and cause the body of the animal to react to a stimulus – ultimately the function of all nervous systems.

This type of homogeneous network shows no modularity. The partitioning of the network probably occurred with the development of limbs. These would have started off simply as immobile appendages, sticking out of the side of the animal which allowed it to grip a surface and lever itself along. This would have

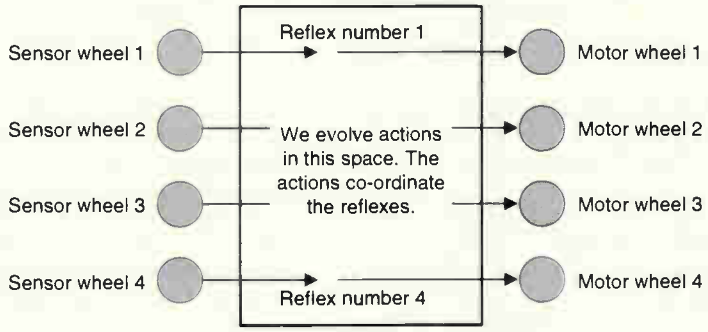

Fig. 2. We can evolve actions around reflexes.

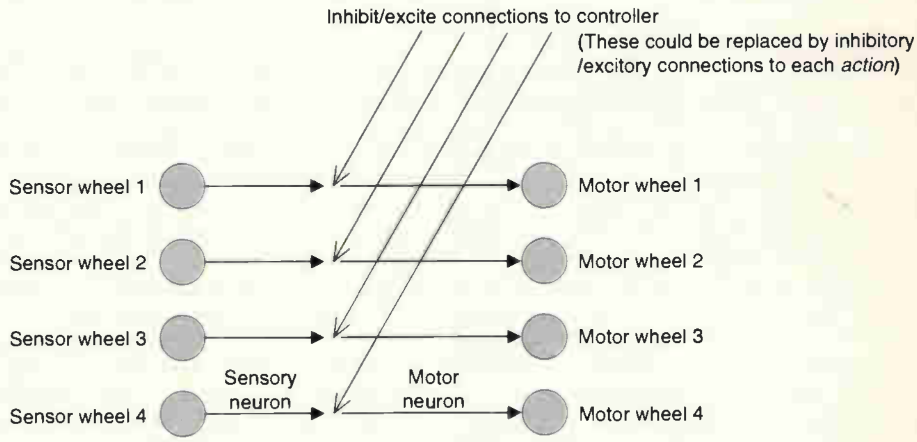

Fig. 3. Actions are excited or inhibited by the brain.

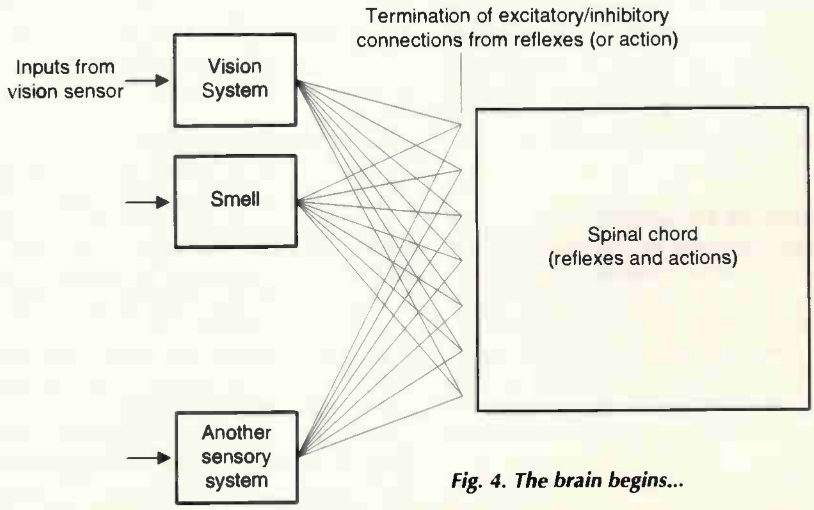

Fig. 4. The brain begins...

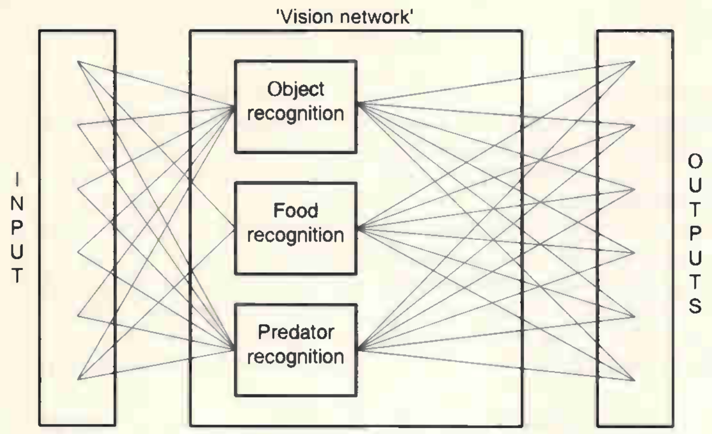

Fig. 5. Smarter and smarter.

caused the network in these areas to become a more complex subsystem and eventually a subnetwork optimised for controlling that particular appendage.

Much can be learned about this process by studying simple animals. These have no brain as such, but rather, groups of cells controlling individual functions, known as ganglions. So, if we know a little about how modular networks formed in nature, can we apply this to our artificial circuits ?

Realising modular networks

Most workers in this field recognise that developing modular circuits or networks is the key to the next generation of intelligent systems. Therefore, much effort has been directed towards this aim.

There have been successes too. But an examination of these successes shows that they are not always what they seem.

Many researchers set up wholly artificial schemes to create modularity in their networks. A common example is having fixed networks which are placed in a grid formation so as to produce a modular structure.

Some others have variable sizes of networks, but only within fixed limits. These schemes are artificially constrained, and are quite at odds with the flexibility of the biological circuitry.

In the next section we will examine the situation more closely. Natural evolution affects not just the nervous system of an animal but every physical part of its structure. Therefore the answer to this problem may not lie in the intelligent electronics, but in the evolution of the whole system.

A framework for intelligence

The basic function of the nervous system is to connect a sensor to an actuator. If you doubt this, read the section on sea anemones again.

In very simple animals the stimulus may be light or touch and the reaction a strong muscle contraction which causes the animal to speed off to safety. Either way though, the purpose is to connect the sensory structures with the reactionary ones – i.e. the muscles.

Even in today's humans, we can still see these structures. The basic building block of the nervous system is a *neural reflex*,[9] **Fig. 1**.

The sensory neuron monitors the muscle and the motor or stimulating neuron excites it. This represents a closed loop control system controlling a simple limb movement.

The example in Fig. 1 is very simple. In the body there are more complex examples; however, they are also made up of a small number of neurons. In an artificial animal, each reflex may be designed directly – they are usually very simple – or, alternatively, evolved from an homogeneous network.

Evolving the network requires us to also evolve the limbs they actuate. This is an example of the systems approach we described earlier; after all, how could we expect to grow reflexes without knowing to what they would be attached.

Once we have our reflexes – designed or evolved – next in the network hierarchy come the coordinating *actions*. These are circuits which coordinate reflexes together to provide actions such as walking or swimming.[10]

Researchers are a good way down the road in investigating these. Each action – walking as opposed to swimming – has a separate coordinating network.[11] These networks have no point of contact with each other.

This is where the 'evolutionary' techniques described at the beginning come into play. We can use them to design these action networks, the fitness being how well the system walks, for example. **Figure 2** shows how actions might be evolved in an artificial animal – a wheeled robot in this case.

The controlling network

Finally we come to the highest level: the controlling network. Examination of the biological nervous system shows that the lower networks – either the actions or the reflexes directly – are controlled by inhibitory and excitatory connections from the brain, **Fig. 3**.

Very simple animals have only the facility to recognise the difference between light and dark. They don't have eyes as such, but rather simple, light sensitive, patches of skin.

If a predator leans over the animal, everything will suddenly go dark and this triggers a flight response from the animal. This would be controlled by a very simple network of the type shown in **Fig. 4**.

As the sense organ develops[12] – back to evolving systems again – more visual information becomes available to the animal. Further networks will develop in parallel, **Fig. 5**. Ultimately, a multilayered hierarchy of modular circuits or networks will form.[13]

Pieces and puzzles

We are at a turning point in the science of artificial intelligence. The tools now exist to develop truly intelligent systems. What we don't know is how to configure these tools properly and how to develop a working system from the individual components available to us.

Our view is that this will take a systems approach to the subject, evolving not just the control mechanism but also the sensors, actuators and 'body' of the system in parallel.

Many researchers are looking at the human brain and trying to figure out how it works; the approach above is bottom up, looking at the simplest aspects of the system before evolving the most complex. After all, how can we evolve a Man if we can't evolve a flatworm? ■

For more information and further discussion on the subject visit the authors' home page at *http://www.eee.rgu.ac.uk/staff/cmhome.htm*

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Don McLean reveals how a home-recorded videodisc made in 1933 challenges established views on the quality of Britain's first Television Service.

First frames

Few people today realise that the BBC Television Service started broadcasting in 1932. Programmes were at that time transmitted on the early Baird standard of 30 lines per picture. Today, this first BBC Television Service is largely forgotten, overshadowed by the tremendous technological achievement of electronic television.

As far as most people are concerned, BBC Television started in 1936. The perceived wisdom is that any earlier transmissions were so poor as to be not 'television' as we know it today. The BBC, partly through long-forgotten prejudice and partly through ignorance, has over the years reinforced[1] a vision of poor quality in both content and technology.

Today, it continues to dismiss its heritage of making excellent programmes. While the 30-line system did indeed give a crude image, the mistake is in assuming that the programmes were just as crude. The image we have been handed down over the years is of amateurish production, stilted performances and stiff presentations.

A home-recorded aluminium 78rev/min audio disc, **Fig. 1**, with "Television 1933" hand-written on the label, has recently been restored using computer-based image processing. The recovered pictures give us our first-ever view of what people watched on television. In doing so, the disc challenges the half-century-old myth of poor quality. BBC 30-line television programmes were professional, slick, full of movement and packed with entertainment.

Before TV, there was... television

In the years after his string of 'firsts' in television, John Logie Baird's attempt to promote television and encourage broadcasting failed to impress the BBC.

Elsewhere, notably in the USA and Germany, similar systems to Baird's received national commitment. Such support allowed those countries to advance their capability in the new medium. This challenged – and occasionally beat – Britain's hard-won head start.

After much lobbying, the Baird Company started and funded its own experimental television service in 1929 using the BBC's existing radio transmitters. This was the world's first television broadcasting service with regular scheduled programmes.

Eventually, the BBC came round to support the idea of its own television service. In August 1932, with equipment leased from the Baird Company, the BBC Television Service began regular broadcasting, **Fig. 2**.

Developed in the twenties when there were no practical alternatives, Baird's mechanically scanned 30-line television

Fig. 1. An enthusiast made the earliest known 'home video' recording in 1933 onto an aluminium disc intended for audio. The extensive damage caused by corrosion shows up as light patches on the disc surface.

B.B.C. TELEVISION
BEGINS TO-NIGHT

FIRST PROGRAMME TO BE CONTROLLED BY BROADCASTING HOUSE

BY OUR WIRELESS CORRESPONDENT

To-day, August 22, 1932, will be a date long to be remembered

B.B.C. TELEVISION STATION OPENED

CEREMONY SEEN SIX MILES AWAY

By L. MARSLAND GANDER,
Our Television Correspondent

The opening ceremony of the BBC

Fig. 2. News-clippings show that the BBC Television Service started first in 1932 (above) then again in 1936 (below). Today, the BBC dismisses its first television service – a case of modifying history?

Donald F McLean
BSc(Hons) CEng FIEE

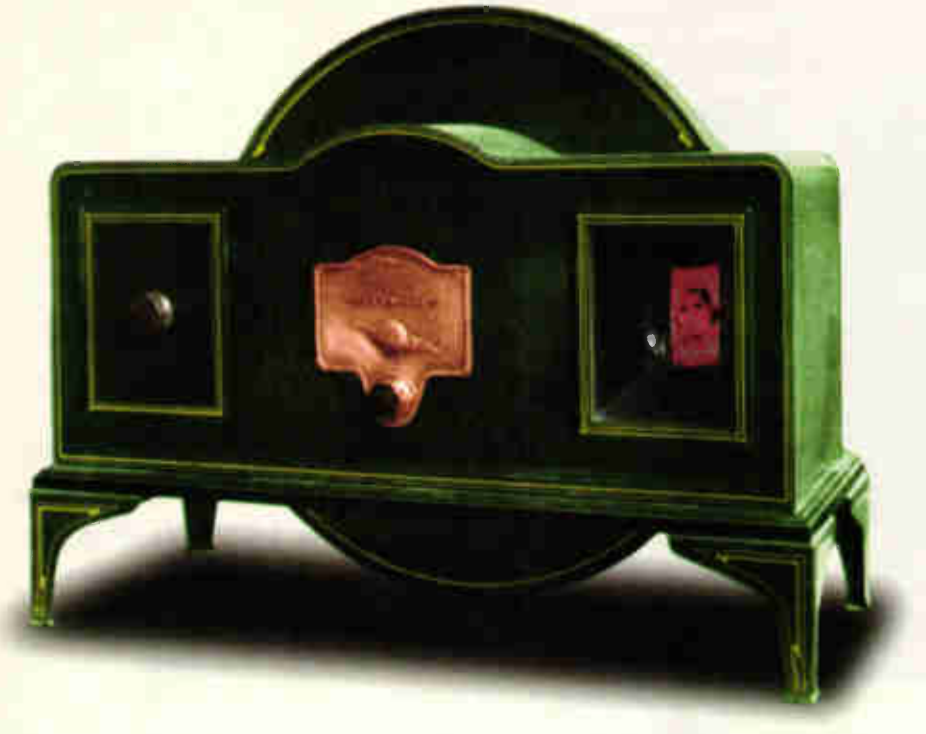


Fig. 3. The Baird 'Televisor' was a display device driven by the 30-line video signal from a dedicated radio receiver. Despite the maturity of 30-lines, 'Televisors' such as this one were expensive – equivalent to nearly £500 at today's prices – and only 1000 were sold. As a result almost 90% of all viewers in the UK built their displays from kits.

system was, in 1932, mature, **Fig. 3**, rather than experimental. Long gone were the bits of plywood, 'bulls-eye' lenses and bicycle chain – the "pile of junk"[2] image that TV journalists still love to promote for that whole pre-1936 period.

The engineering was now of the best quality, limited only by the 30-line format. And thirty was the maximum number of lines that could fit the permissible bandwidth on the medium wave band – the only available band for television broadcasting.

Despite its age, Baird's 30-line system was the only 'off-the-shelf' system available. High definition television and ultra-short-wave transmitting hardware were still under development.

The BBC called its service 'experimental', despite the term being incorrect.[3] The service was 'experimental' only in the sense that new programme-making techniques were being explored. Also, with major developments underway, this was going to be a temporary service.

Fig. 4. After two years of broadcasting programmes from the basement of BBC Broadcasting House, The Television Service moved to a larger studio in facilities nearby in Portland Place.

The 'lost' television service

After two years of broadcasting, the BBC in 1934 strengthened its commitment to the 30-line service due mostly to public support voiced through the press. Throughout the industry, major new television developments were being made.

The Baird Company's interest in 30-line television was collapsing. Even though it had the option of stopping the service, the BBC surprisingly continued its programming output, moved to a larger studio, **Fig. 4**, and enhanced the system's quality and performance.

Coverage from the BBC's medium wave transmitters meant that reception was possible – but not intended – across most of Northern Europe. Under special atmospheric conditions, viewers watched BBC television as far away as Iceland and North Africa with excellent clarity.[4] Enthusiasts built dual standard mechanical television sets at least in Scandinavia, **Fig. 5**, and the Netherlands for transmissions from different countries – notably Germany and Britain.

Our knowledge of how good the programmes were in this period is very limited and subjective. Prior to this and the 'Phonovision' restorations,[5] the only material available was from first-hand descriptions and from press reviews of programmes.

The dimness of the tv display meant photography was difficult. Off-screen stills of transmissions never satisfactorily showed the perceived quality of the moving image, **Fig. 6**.[6]

At the other extreme, the public's expectations were raised rather too high by fabrications of exceptional quality, **Fig. 7**.

The earliest recording of broadcast tv

True video-recording technology was decades away.[7] The narrow bandwidth of Baird's 30-line vision signal meant that most of the signal would be preserved if it were recorded onto a conventional audio disc. Baird had attempted this in the late twenties.[8]

In all these years of broadcasting, neither the BBC[9] nor Baird had tried to record their broadcast tv programmes. The engineers were probably put off by their knowledge of the distortion caused by recording – unstable synchronisation and phase errors.

Fortunately, at least one enthusiastic viewer thought otherwise and set about recording a video transmission. Although he was probably disappointed with the result, he fortunately held on to it.

Recently a private collector[10] discovered this recording. One of a collection of privately recorded discs he bought at a stall had "Television 1933" written on the label. The aluminium disc had been recorded using the consumer 'Silvatone' process, **Fig. 8** – one of many domestic recording systems available in the early thirties.

The disc was physically unplayable, being highly corroded and badly recorded. Eliot Levin of Symposium Records professionally and painstakingly transcribed the disc.[11]

I was able to confirm that this was a 78rev/min recording of Baird standard video at 30-lines per frame, 12.5 frames per second. It had no audio. Unlike Baird's 'Phonovision' recordings of the late twenties, this recording had no arc-scan distortion. This meant that a mirror-drum camera was used, dating this disc later than about 1931.

Vision restored

The massive and complex phase errors, high surface noise and occasional gaps were all a major challenge to restoration. All processing was done in software, custom-designed for the disc's

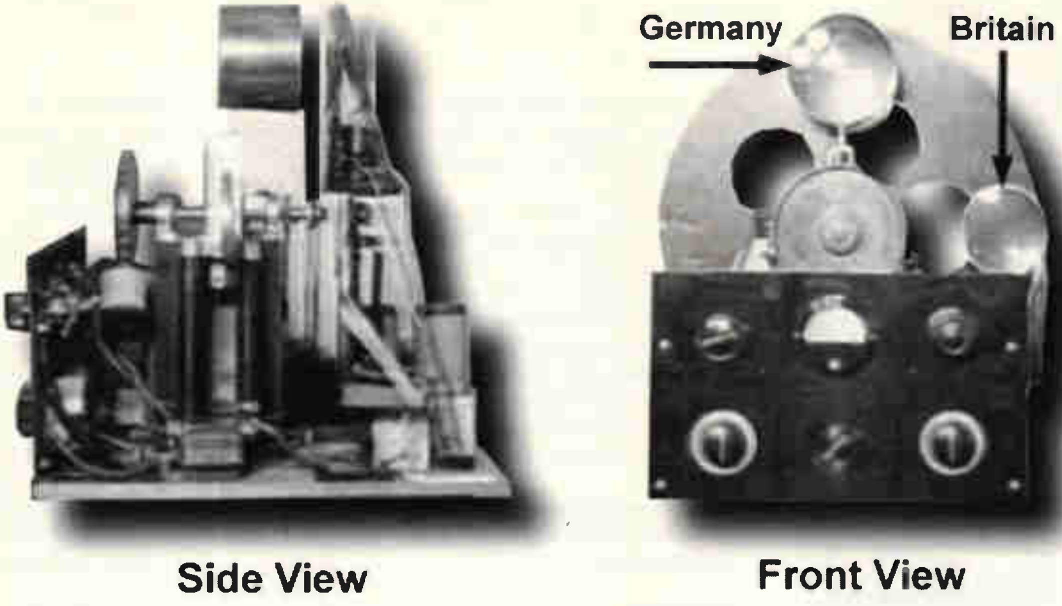


Fig. 5. Side and front views of a kit television display designed for dual-standard reception for continental viewers. This one was used in Sweden for watching television from Germany and from the BBC in London.

Fig. 6. One of the very few existing off-screen photographs from the thirties of a live received transmission. This high contrast picture of Betty Bolton was a long exposure directly from the mirror-drum display onto a photographic plate. The picture on the right shows Betty to be more attractive than the photo indicates.

features. Exploiting the relationship of imagery across lines and across frames improved the performance of noise suppression and timebase correction, **Fig. 10**.

The timebase errors were different from those of 'Phonovision', relating purely to the domestic-quality recording equipment. The errors were partly corrected by a custom algorithm[12] based on a technique developed for military target tracking. This approach corrected for gross fluctuations in play-back speed at up to the frame rate.

Higher speed changes proved difficult with the high surface noise, dropouts and clicks confusing the line-to-line correlation. However, the noise suppression software required the time-base to be corrected first.

Without synchronising pulses to peg the picture in place, small speed changes had a large effect on the displayed image. Simply making the disc play-back slightly off-centre by, say 0.5mm, caused the image near the end of the disc to roll roughly three times one way, then three the other way on every revolution of the disc.

Fortunately, the heavily corroded disc had been professionally transcribed with great care, minimising such effects. Even so, fast speed changes during recording, caused pos-

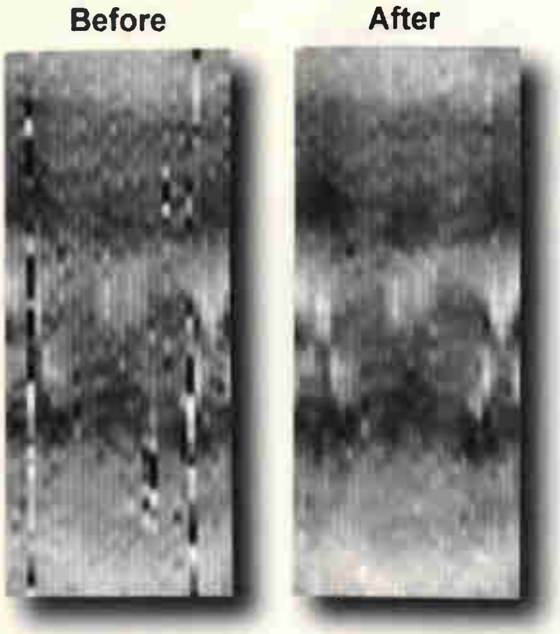
Fig. 8. With the hand-written message "Television 1933" on the disc label as the only clue, the restored material yields the world's first television revue.

Fig. 7. Pictures such as this are misleading. It is a fabrication – a long-exposure photograph looking through the apertures of a scanning disc at the scene beyond. 30-line television was designed for movement though – not stills.

The Silvatone recorder

In the early thirties, there were several competing brands of home-audio disc recorders. In 1930, £4 12s – roughly £100 at today's prices – would buy you a 'CairnMor' for 'Silvatone' discs. Made by Cairns and Morrison Ltd of London, the machine, **Fig. 9**, recorded sounds from a microphone onto a seven-inch aluminium blank disc at 78rev/min using your existing gramophone.

The price included six blanks, which could be recorded only once. When the recording was played back, you had to use a special soft stylus (fibre) to allow the disc to be replayed more than once. The quality of the recordings was worse than that of a 'dictaphone' today.



Drop-out & Noise Reduction

Fig. 10. Digital image processing suppressed the damage of over sixty years on soft aluminium. The sophisticated noise filter tracked movement and adapted to how 'busy' the scene was. The domestic recording technology was exceptionally crude, in itself causing a major part of the distortion.

sibly by uneven drag on the cutter ploughing through the aluminium blank, still created problems that needed correcting.

With over 2700 tv frames, the restored disc dwarfed the 700-odd tv frames of each of the five earlier 'Phonovision' discs.[13] The restoration required a new software suite geared to the unique distortion of this disc. Some errors remain and affect the cosmetic appearance of the images. However, it is unlikely that further processing will reveal more information. ■

Donald's next article details the earliest known recording of broadcast television

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Synchrodyne/homodyne receiver

Michael Slifkin and Noam Dori describe the benefits of synchrodyne and homodyne reception for medium wave, rounding off with a complete design incorporating both receiver techniques.

Since the beginning of World War II, all commercial radio receivers have been superheterodyne receivers. In the future we will see digital receivers, but it is unlikely that they will be completely oust the much cheaper superheterodyne.

The superheterodyne works by beating a local oscillator with the incoming signal so that the signal is converted to a fixed intermediate frequency – normally 455kHz for the medium wave. This system replaced the original tuned radio frequency receiver which suffered from many drawbacks.

Selectivity and sensitivity were both a function of the frequency. As you tuned through a waveband, the properties of the receiver varied considerably. The superheterodyne overcame this problem as the gain and selectivity was carried out at the one intermediate frequency.

But the superheterodyne also has its drawbacks. It is more complex and expensive than the earlier tuned radio frequency receiver. The most obvious drawback of the superheterodyne is image rejection. Strong stations can be heard at twice and even four times the intermediate frequency away from the true frequency.

Furthermore, the presence of a local oscillator means that you can hear harmonics of this oscillator which gives rise to *spurii* – i.e. squeals and birdies – as you tune the radio. There are more esoteric drawbacks too such as reciprocal mixing and phase noise.

Why synchrodyne?

In the mid-forties, Tucker in Australia introduced the synchrodyne direct-conversion radio receiver.[1] This worked by beating or mixing the incoming signal with a local oscillator of the same frequency so that the carrier wave was converted down to zero frequency leaving only the audio frequencies. Thus the incoming wave was converted directly to audio frequency by a simple mechanism.

Another advantage of this system is that synchronous detection of this type is linear right down to zero. In theory, the signal from a synchrodyne receiver is of better quality than that from a superheterodyne using a diode detector. Diode detectors are not linear and the weaker the signal the more the distortion.

Distortion can also occur on very strong signals. Even with moderate strength signals there will be some distortion because of the non-linear characteristics of the diode. Indeed top of the range modern superheterodyne receivers use synchronous detectors working at the intermediate frequencies.[2]

The major drawback of Tucker's synchrodyne receiver was that while tuning between stations there was a piercing whistle due to the local oscillator beating with off frequency

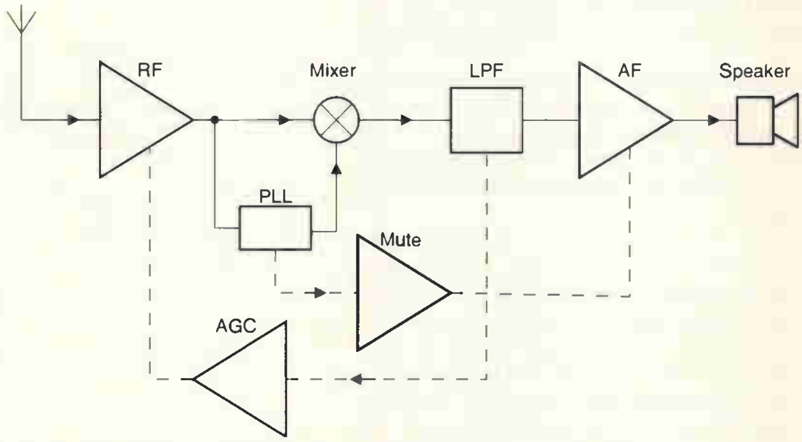


Fig. 1. Synchrodyne receivers work by mixing the incoming signal with a local oscillator of the same frequency, making conversion to audio frequencies simple.

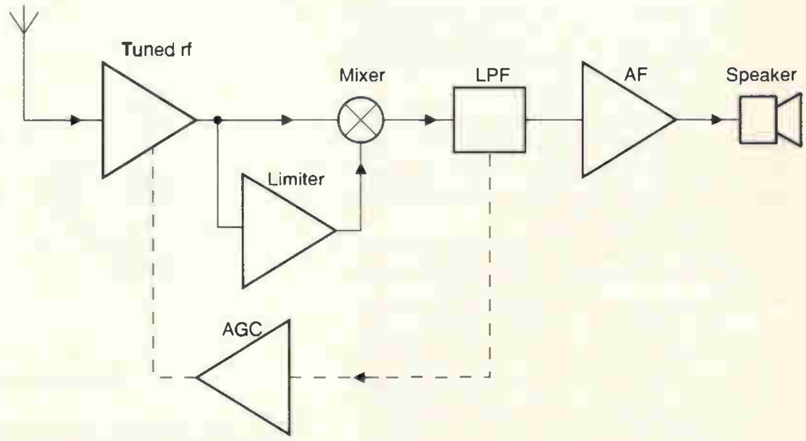


Fig. 2. Unlike the synchrodyne, the homodyne receiver does not suffer from heterodyne whistles while tuning between stations, eliminating the need for muting.

stations. Another problem is that the local oscillator needs to be in phase with the signal.

Nowadays these problems can be solved by using a phase-locked loop, or pll, with a lock detector operating a mute circuit. A description of the pll is given in a separate panel.

The pll not only gives a local oscillator locked to the signal frequency but it also allows the radio to be muted when the pll is out of lock. This gets rid of the heterodyne whistle while tuning between stations.

In spite of Tucker's valiant efforts to popularise his system, it never was accepted commercially. But it did catch on to a limited extent in radio amateur circles. Several manufacturers have sold relatively cheap amateur single side band transceivers incorporating a synchrodyne.

One LO for Tx and Rx

The big advantage for this equipment is that one local oscillator can operate both the receiver and the transmitter, as they operate at the same frequency. In contrast, with the superheterodyne, the local oscillator is offset from the transmission frequency by the intermediate frequency.

I must point out here that a direct-conversion receiver for ssb and Morse code reception has to be considerably more complicated than one intended for simple amplitude-modulation. This is because you can only allow one of the sidebands to be detected which means some form of phasing circuit to remove the unwanted sideband. When the incoming carrier is down-converted to zero frequency, the lower side band, which is now at a negative frequency, folds over and lies on top of the upper sideband. In amplitude-modulated signals both sidebands are identical.

In frequency-modulated signals however, the upper and lower sidebands are not identical so that this technique cannot be used without modification. This means that signals appearing in both sidebands are copied simultaneously. For wavebands intended for ssb and continuous-wave traffic, this is a disadvantage as the channels above and below the carrier frequency might be carrying different signals.

Figure 1 is a schematic diagram of the synchrodyne. The two additions in dotted lines are the mute and the automatic gain control needed to make the synchrodyne a more useful device.

The very earliest version of the synchrodyne contained no radio-frequency amplification. This could cause problems with microphonics due to all the amplification being at audio frequencies. It was not possible to provide automatic gain control either. But by distributing the gain to both radio and audio frequency stages though, you can avoid microphonics and provide automatic gain control.

The homodyne

Another variation of the direct conversion receiver is the homodyne. A description of this was given by J.W. Herbert in the September 1973 issue of *Wireless World*.

With the homodyne, incoming signal is filtered at rf and split into two halves. One half beats against the other to down convert to zero frequency. In theory this sounds simple, but in practice there are problems.

The signal that takes the place of the local oscillator does not have a sufficiently well-defined carrier because of the sidebands from the audio. However by putting this half through a limiting amplifier, i.e. an amplifier working at very high gain so that the signal saturates the amplifier produces a square wave at the signal frequency. The limiting effect removes the amplitude information that is the cause of the sidebands.

Furthermore, it is normally necessary to inject the local oscillator – in this case the signal itself – at a fairly high level into the mixer. Again, this is taken care of by the limiting amplifier. Moreover the detection is synchronous which should give this system an advantage over diode detector receivers.

Figure 2 is the homodyne's schematic. The addition of the automatic gain control shown in dotted lines makes this a more useful device. Unlike the synchrodyne this does not suffer from heterodyne whistles while tuning between stations, and the mute is not required.

John Linsley Hood described an AM synchrodyne receiver in the January 1986 issue of *Wireless World* but it was complex and expensive. The parts alone came to over £75.

About 11 years ago, one of us with a collaborator (Slifkin and Abbott, *Radio and Wireless World* Dec. 1987) presented some circuits for both homodyne and synchrodyne techniques. These were based on Plessey 600 series ICs which were meant for the professional market and carried a commensurate price tag.

Either radio could have been be built for less than £30 sterling. The replacement of the 600 series ICs by the now available cheaper 1600 series would have further lowered the price.

At that time, the pll ICs available had no built-in 90° phase shift. As a result, we had to construct a 90° phase shifter to bring the two signals back into phase and at all frequencies covered by the radio. This added to the complexity and cost of the receiver. Nowadays, pll ICs are available including a 90° phase shifter which greatly simplifies the design.

There are clearly several ICs which can be shared between the two

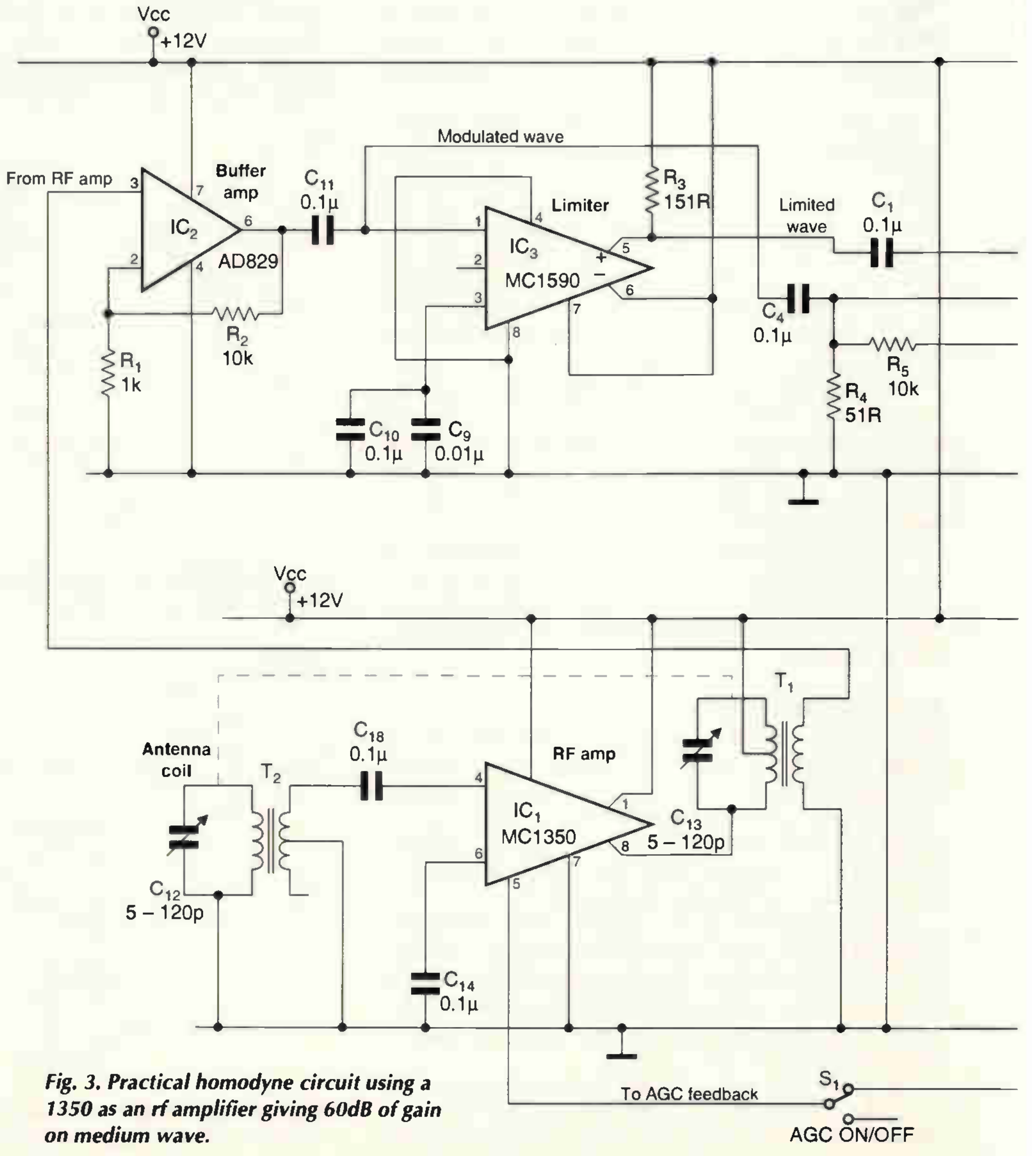


Fig. 3. Practical homodyne circuit using a 1350 as an rf amplifier giving 60dB of gain on medium wave.

designs. Our ambition at the time we published our first circuits was to build a joint homodyne/synchrodyne radio on one baseboard which could be switched from one to the other and using mainly the same components.

We were defeated though by being unable to tune the local oscillator for the synchrodyne by the same elements that were used to tune the homodyne. This problem is solved in the design presented here.

Locking on

The heart of the phase-locked loop device is a free running voltage controlled oscillator, or vco.

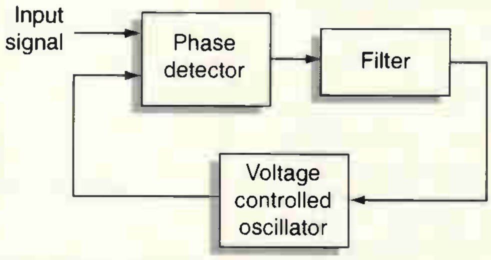
Output from the vco is mixed with the incoming signal. The output from this mixer is amplified by the error amplifier and sent through a low-pass filter to produce a dc signal voltage. This direct voltage feeds back to the vco in such a sense as to move the vco closer in frequency to the incoming signal. There is no output from the mixer when the two signals are exactly at the same frequency and 90° out of phase.

Two important parameters need to be considered, namely the lock range and the capture range. The capture range is that frequency range over which the incoming signal can be captured and locked onto by the vco. The lock range is that frequency range which once locked the signal stays locked to the vco.

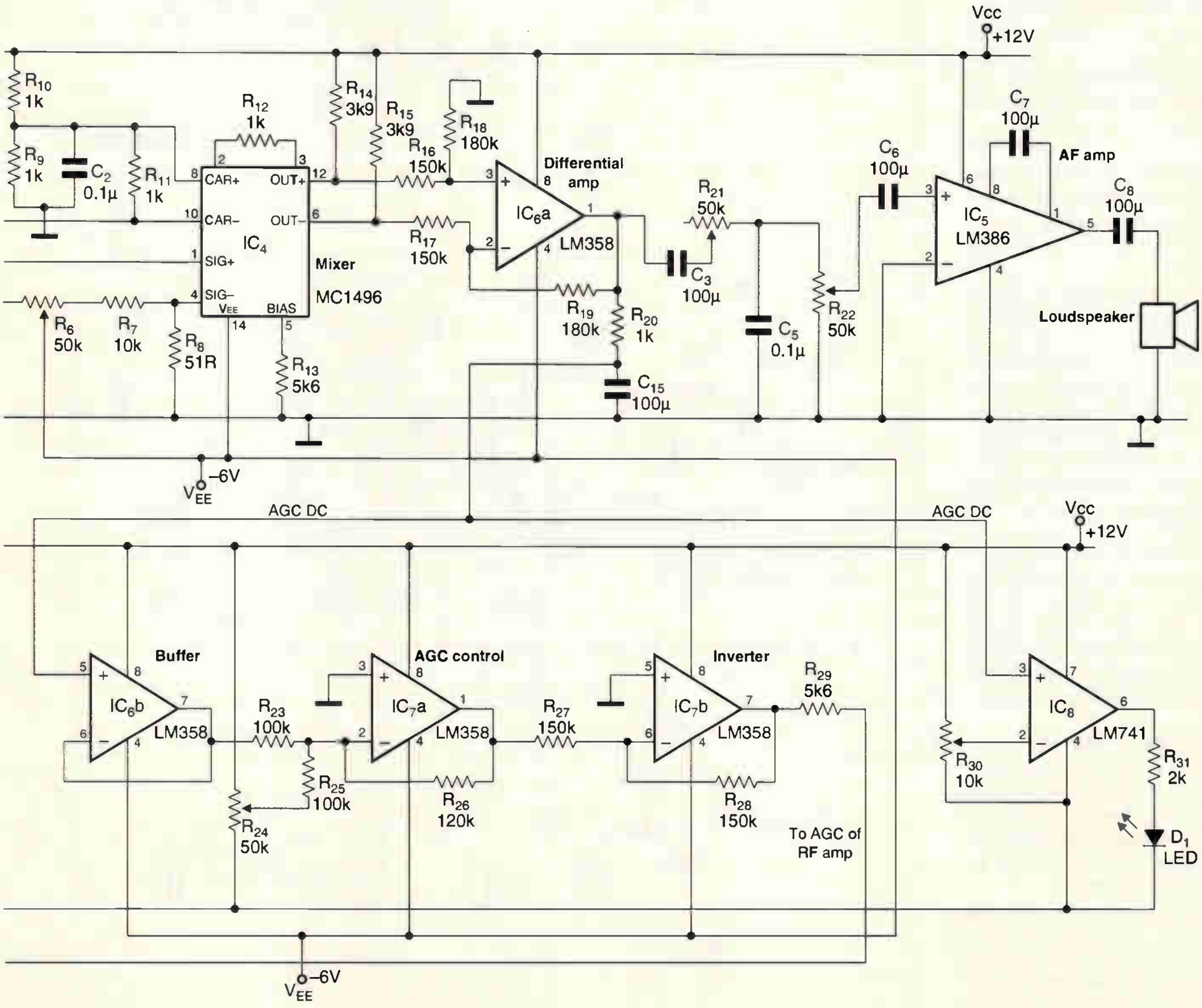
A narrow capture range can cause the system to miss the lock completely if tuning is too rapid. In addition the signal is more easily thrown out of lock by a noise pulse. Too wide a capture range means that one very strong signal in a frequency range locks on to the exclusion of all the other weaker signals.

Another parameter is the time – usually expressed as the number of cycles – that the pll requires to go to lock. This is determined by the low-pass filter in the feedback loop between the error amplifier and the vco.

All of these factors are important when designing a synchrodyne radio receiver.



Elements of the phase-locked loop.



In one small box we have combined the homodyne and synchrodyne using shared components. Both are tuned by the same tuning element. You can switch from one to the other with a simple toggle switch and find yourself on the same frequency.

In designing the circuits described here, we have used cheap readily available components. The layouts of the receivers are not crucial since the frequency range is only 540 to 1600kHz.

A practical homodyne design

A practical homodyne circuit is shown in **Figure 3**. A ferrite-rod antenna forms the input.

The rf amplifier is an easily obtainable *MC1350* device. This is in fact a tuned-frequency amplifier meant for video purpose but it is highly suitable as an AM radio-frequency amplifier as it has a built-in automatic gain controller. At medium wave, its gain is 60dB.

In this circuit, the radio-frequency stage of the homodyne is tuned with a conventional air spaced variable capacitor. Note the use of two tuned circuits with ganged capacitors; one tuned circuit would not provide us with the selectivity we needed.

The tuned circuits and ferrite rod were stripped from an old Pilot radio. We would imagine than any ferrite rod antenna and tuning circuit designed for the medium wave band could be used.

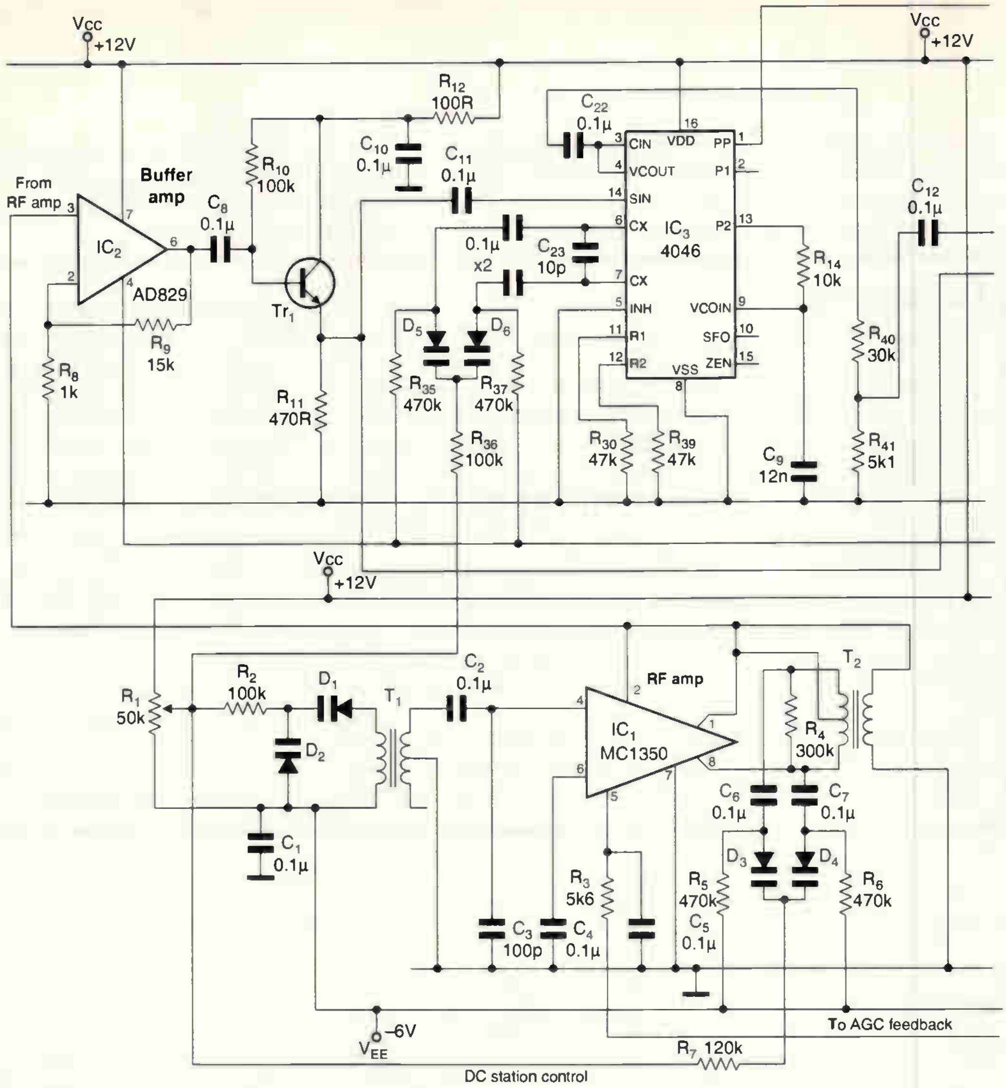
The limiter consists of an *AD829* low noise video operational amplifier used as a buffer, followed by an *MC1590* amplifier which performs the actual limiting. Mixing is performed by an *MC1496* balanced modulator. This has a differential output so an *LM358* configured as a differential amplifier is used to process the signal. Maximum input for this device is 200mV.

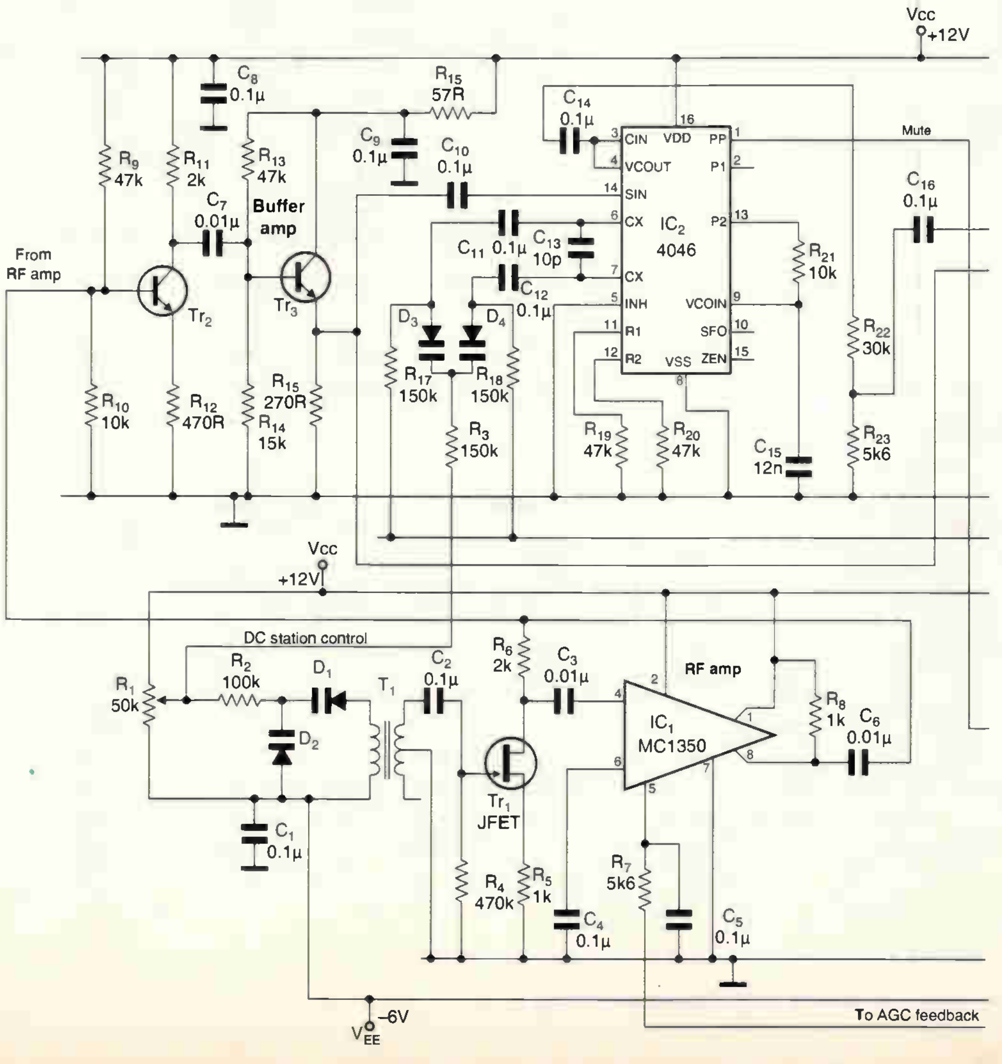
The low-pass filter at the output of the limiter determines its bandwidth, that is, selectivity. This is set for 9kHz. At the output of the mixer, there is also filter with a time constant of 200ms. This produces the rf amplifier's automatic gain-control signal.

Automatic gain control

Conditioning of the automatic gain-control line to obtain the correct amplitude with correct polarity is done by three operational amplifiers. These act respectively as a buffer, an amplifier and an inverter.

Overall gain of the gain control is around 70dB. This gives a rather restricted dynamic range, but it is sufficient if you are only interested in local signals, which is usually the





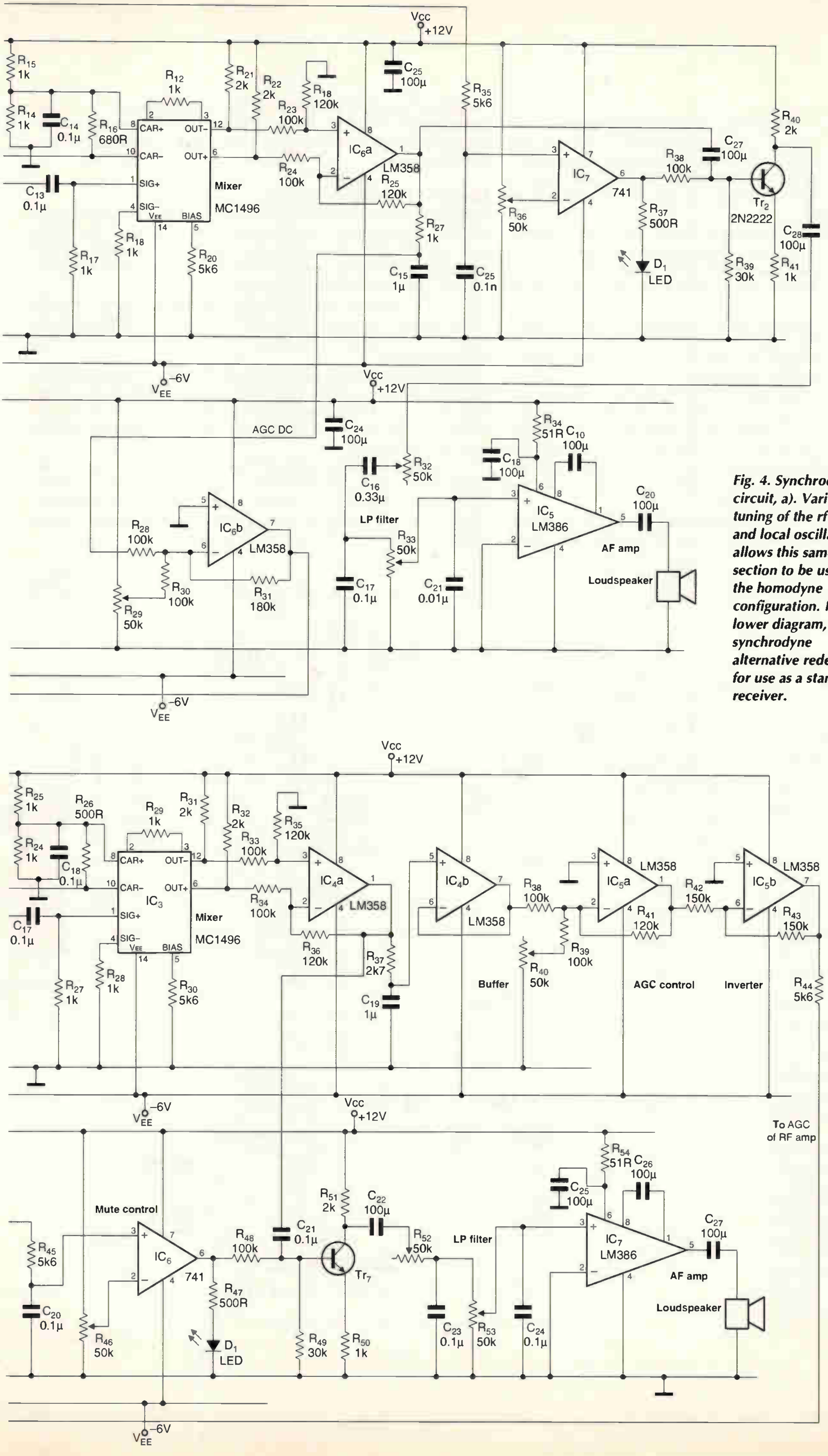


Fig. 4. Synchrodyne circuit, a). Varicap tuning of the rf stage and local oscillator allows this same tuning section to be used with the homodyne configuration. In the lower diagram, b), is a synchrodyne alternative redesigned for use as a stand-alone receiver.

case with the medium-wave band.

Good quality receivers normally have an automatic gain-control range of about 100dB. If you want to receive weak distant signals then you should add a second rf stage and take the gain control line to both rf amplifiers. Gain of the amplifier may need to be adjusted accordingly. If you want to, you can switch off the automatic gain control to increase the gain for very weak signals.

The audio stage uses a conventional *LM386*, with volume control. Performance of the homodyne was as expected. The audio quality is certainly superior to that of a superheterodyne with diode detection. However, particularly at night, we could hear other stations in the background.

Figure 4a) shows the circuit of our synchrodyne. Because we wanted to use the same tuning element for the homodyne as for the synchrodyne, we have tuned both the rf stage and the pll local oscillator using variable-capacitance diodes from the *MVAM* family.

The *MVAM109* has a capacitance ratio of about 15 to 1, or about 500 to 30pF as the reverse voltage is varied from 1 to 9 volts. The synchrodyne does not normally need a tuned rf stage as the selectivity is obtained after the mixer stage from the low-pass filter. However as our intention was to make a switchable homodyne/synchrodyne combination, this was our test rig to see if we could combine a tuned rf stage with a tuned local oscillator using the same control knob .

This section worked well and formed the basis of our final design. For those of you wanting to make a stand alone synchrodyne, the second tuned stage is not required. The first stage also does not need to be tuned, except in the presence of very strong local stations to prevent the front end being overloaded.

Simpler front end

In Fig. 4b) we show the circuit diagram of a synchrodyne with only one stage of rf tuning for those of you who want to build a stand-alone receiver. We are unfortunate to be located very close to a high power AM transmitter, so we need rf selectivity.

Output from the rf stage is fed via an *LF358* buffer amplifier to the pll. The pll obtains the local oscillator locked to the incoming signal. A description of how a pll works is given in a separate panel.

We used the 4046 cmos digital phase-locked loop. There are several analogue plls available but this one has a built-in 90° phase shifter. The built-in lock detector is also useful. We use this to operate the mute.

The lock range has been set at 20kHz with the two resistors at pins 11 and 12. This is the range over which the local oscillator will lock with the incoming signal. If this range is too small, then it is not only possible to tune through the correct frequency without acquiring lock but in addition noise pulses can more easily throw the pll out of lock.

The best lock range is difficult to predict as it depends on the strength and nearness in frequency of the received stations. You should certainly experiment with these values to obtain the best combination for a given location.

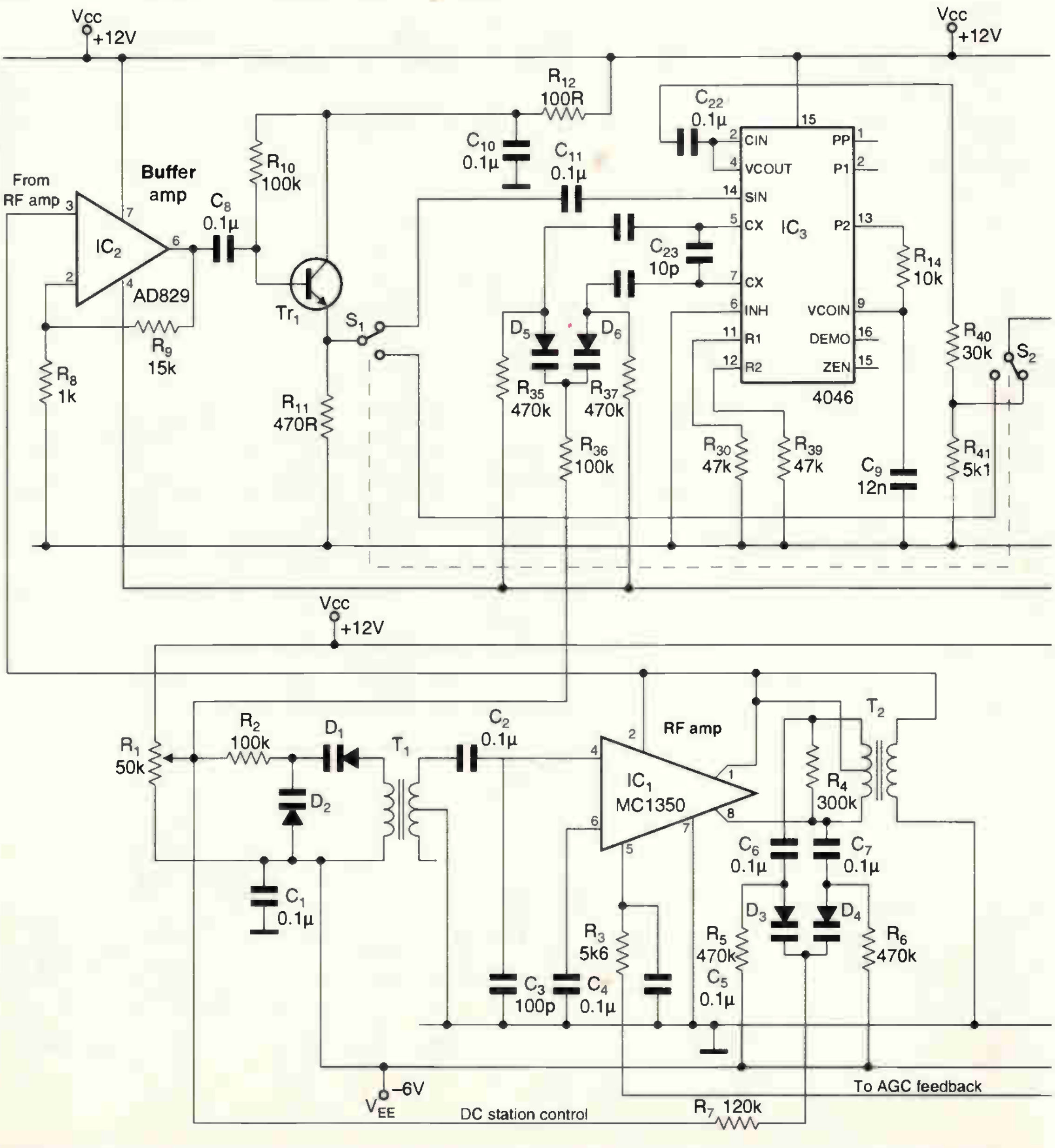
Low-pass filtering for the pll

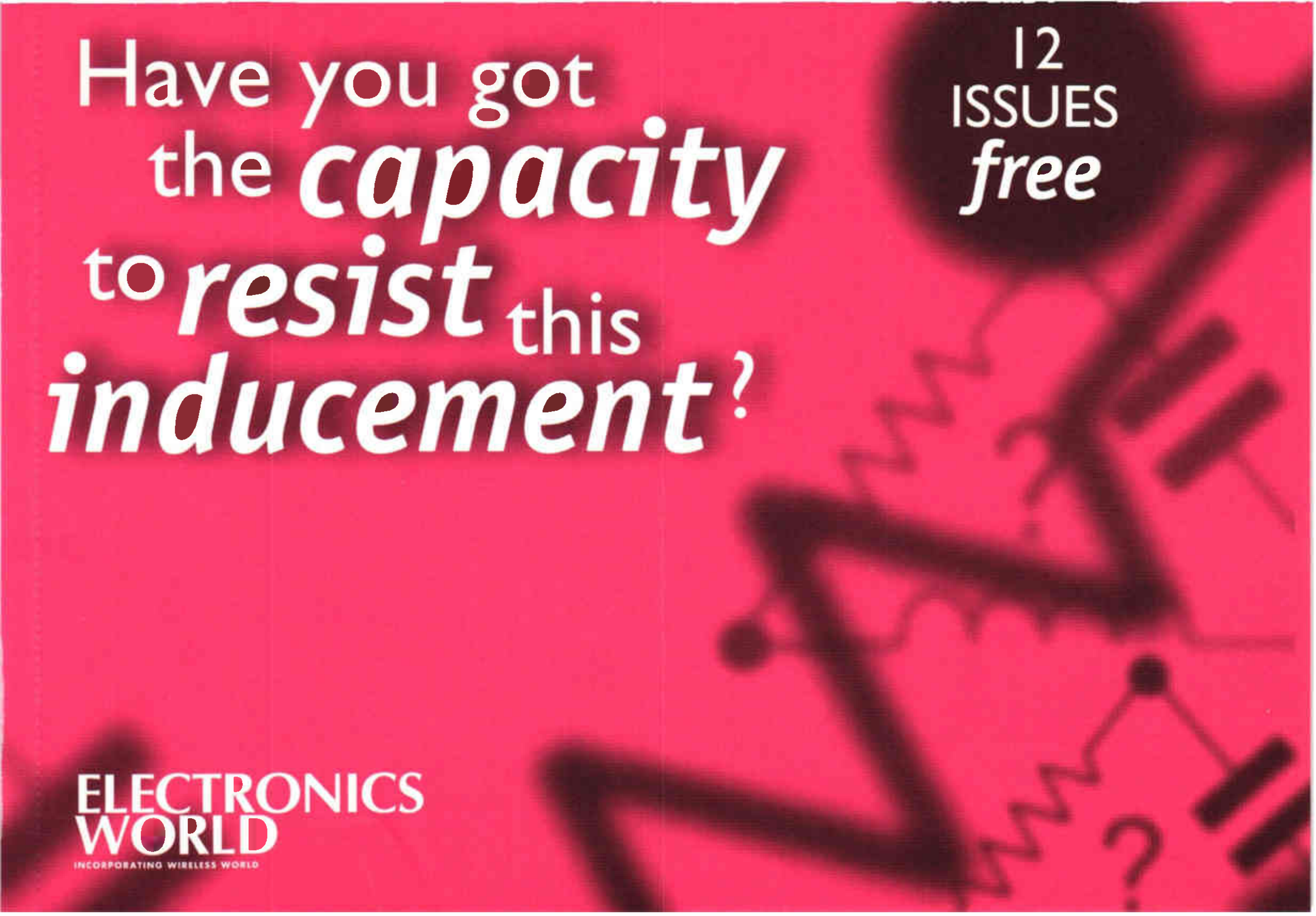
Components R_{14} and C_9 form the low-pass filter in the feedback of the pll. They determines how fast the pll locks into the signal. The values were appropriate for our needs but they may be altered to suit different circumstances. There is a trade off between speed of lock-in and noise. A faster speed is accompanied by greater noise.

Pin 1 of the pll goes high when lock is obtained and mutes the audio circuit via the 741 op-amp. This removes the severe drawback of the original Tucker design – the heterodyne whistle heard when tuning between stations.

The mixer and audio circuits the same as those for the homodyne. But in order to have a common tuning element for the two receivers, we had to design a new circuit using variable-capacitance diodes. In this way, as you can see from the circuit diagram, it is possible to tune both versions with one tuning control.

Varying the capacitance in this way has an additional advantage. As the diodes are tuned by a variable voltage, there are no capacitance effects from the hand. These can be annoying with capacitance tuned receivers. Diode tuning also eliminate the need for air-spaced ganged variable capacitors which are both heavy and expensive.

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Performance of the synchrodyne is impressive. The audio quality is similar to that of frequency modulation. In addition, because of the lock-in ability of the pll, you only hear one station – even at night when the range of distant stations is greatly increased.

The tuning properties of the radio are quite different from those of a standard AM receiver. Too fast a tuning rate results in stations being skipped over. In addition, you do not have the 'out-of-tune' sound of a station that you get from a superheterodyne that is slightly off frequency.

Homodyne and synchrodyne in one

Finally we present in **Fig. 5** the circuit of the combined homodyne/synchrodyne. This was built on a base board measuring 10 by 10cm.

We included an LED to indicate when the synchrodyne is in lock . The tuning dial was calibrated against our local stations.

A simple toggle switch takes you from homodyne to synchrodyne mode. It is possible to hear more stations with the homodyne than with the synchrodyne. This is because with the synchrodyne, weak stations near in frequency to strong ones are never heard as the strong station always locks in preference to the adjacent weak station.

It is possible that lowering the lock/capture range might improve the situation. This obviously lends itself to some experimentation. The homodyne, on the other hand, while having the same audio quality as the synchrodyne, cannot exclude stations on the same or nearby wavelengths. This means that you can hear more than one station simultaneously – especially at night.

For anyone interested in these types of receivers, these combined circuits can be used as an experimental rig to test out the different parameters, and to compare the homodyne directly with the synchrodyne.

Using readily available integrated circuits has enabled homodyne and synchrodyne receivers for the medium wave to be built cheaply *and* easily. If you had to build these devices using only discrete components, it would be a major undertaking.

However the use of these ICs is not without disadvantages. They often have a restricted range of input voltages and require, as in our case, a rather unusual negative voltage supply.

We would advise anyone building such devices to study the manufacturers' data sheets rather than just relying on the circuit values given here.

Although we have limited our design to the medium wave, there is no reason why an AM synchrodyne couldn't be built for the short wave. Analogue plls and mixers are available that operate up to at least 150MHz. Remember that you would need to use a long wire or rod antenna though, as ferrite rods are not efficient above about 2MHz. ■

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1. Tucker, DG, 'The History of the Homodyne and the Synchrodyne' *J. Brit. IRE* April 1954.
2. Hawker, Ps., *Wireless World*, September 1972. (An account of synchronous detection).
3. Herbert, JW, *Wireless World*, September 1973. (Description of the homodyne).

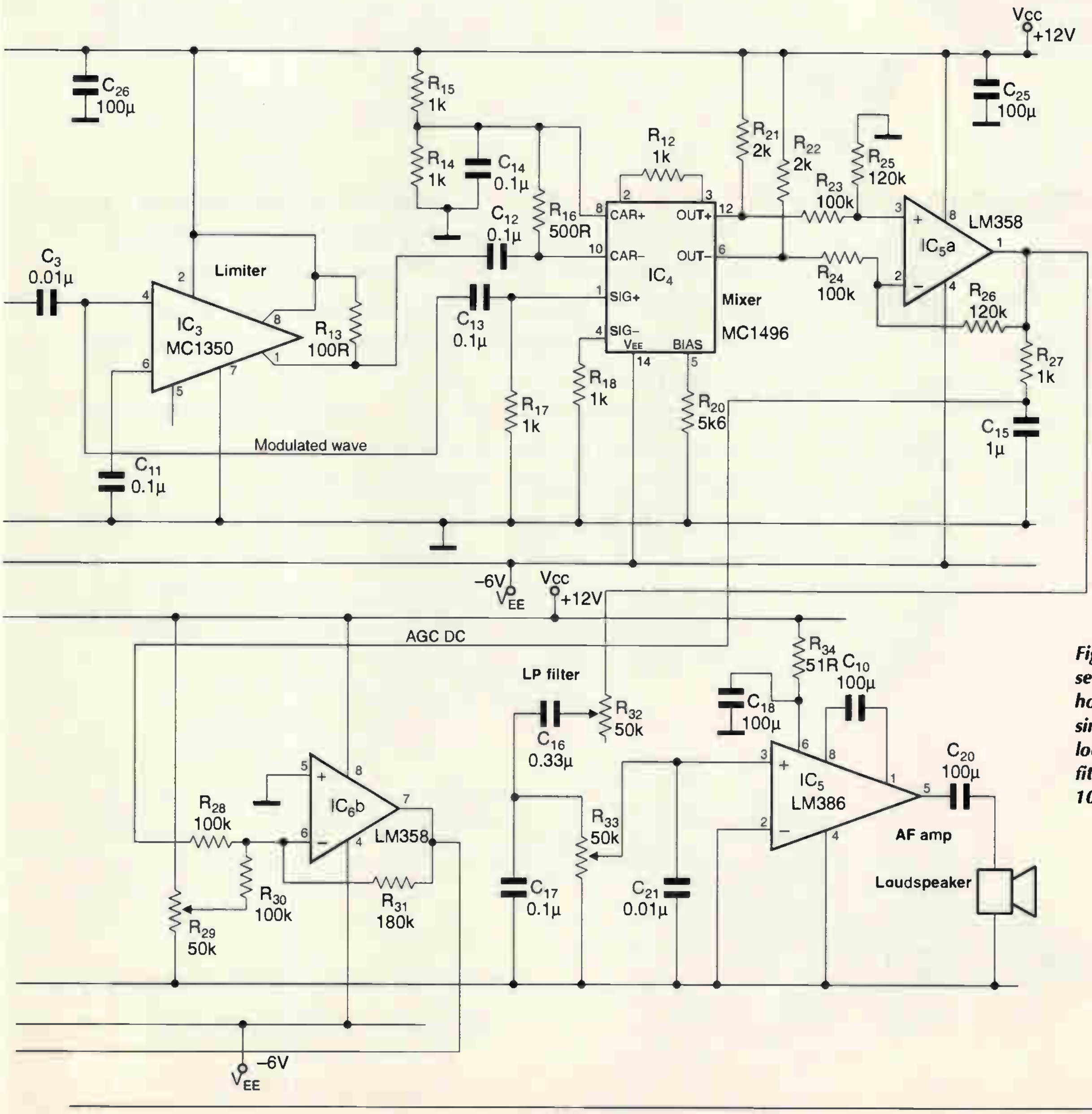

Fig. 5. Combined switch-selectable synchrodyne and homodyne receiver is kept simple by using a phase-locked loop IC. This complete design fits on a pcb measuring 10 by 10cm.


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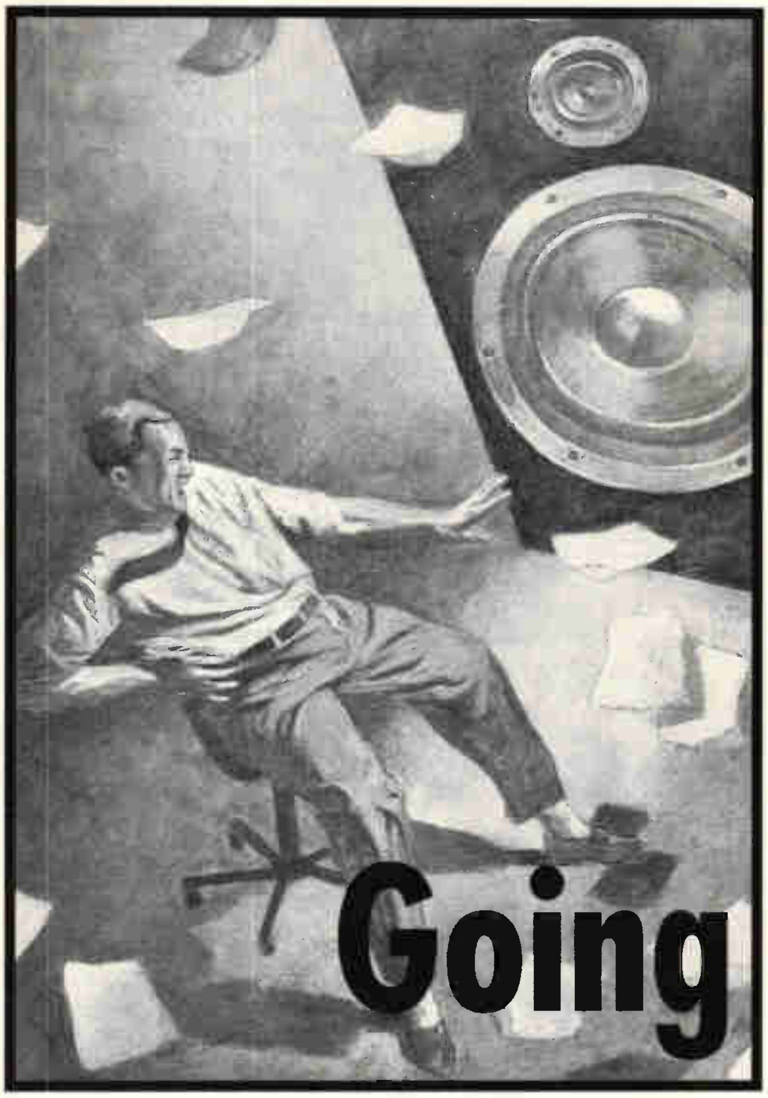


In loudspeaker design, motional feed back is a useful tool, whether the motion feedback signal is derived from a separate sensor of from the voice coil itself. Russel Breeden looks at its uses and limitations in relation to extending bass response.

Going lower

Open any tome on speaker design and you will be forgiven for thinking that obtaining deep bass from a small enclosure is impossible. It's not that the mathematics used are at fault, but rather that as far as bass extension is concerned they miss the point.

The root problem behind designing any kind of speaker enclosure is what to do with the rear wave. Unfortunately a speaker diaphragm radiates equally well from both front and back. The sound waves emanating from either side are in antiphase.

Due to the long wavelength of sounds in the bass register, the driver is too small to prevent both sets of sound waves cancelling out. In effect an acoustic short circuit occurs.

Removing rear radiation

One obvious solution is to make the distance between the cone sides as long as possible. One option is simply to mount the driver on a large baffle. But in practice a baffle big enough to work down to 30Hz would need a shortest dimension of over 5m. Such a dimension is impractical in most domestic environments – especially where stereo is concerned.

A more practical solution is to mount the driver in a sealed enclosure, trapping the rear wave within the cabinet. This has the advantage of simplicity, but unfortunately the enclosed air's stiffness raises the driver's bass resonant frequency. Usually, it does so to a value that is too high for true deep bass response.

Of course other solutions have been proposed. By and large they operate by phase inverting the rear radiation from the cone and adding it to that from the front. With reflex enclosures electronic response contouring has a long history.

However with conventional designs the response cannot be extended much below the vent resonance because of the phase shift between cone and vent. One way of tackling this is to use the microflex technique described in this journal.[1]

Again such procedures have drawbacks. The bass reflex enclosure for example has a deeper bass extension than a closed box but a poorer transient response. The transmission line achieves bass extension by delaying the rear wave and adding it to the driver's, somewhat out of phase. Its operating principle is still only approximately understood despite being around for over thirty years.

Along with these techniques a large body of theory has evolved. Mainly due to the work of Thiele and Small, the bass response of both closed box and reflex systems can be accurately modelled with a few equations. These equations completely describe the behaviour of a speaker system in the bass and appear, at first sight, to rule out small speakers with extended bass response.

Bass resonance influences

Totally dominating the response of any speaker system is the bass resonance. This resonance is due to the mass of the speaker cone reacting with the compliance of the surround.

With only two reactive elements you would expect that the response curve of a speaker would look like that of a simple tuned circuit. That is to say it would look like a single peak with a response that drops off at 6dB/octave either side.

The reason that the response looks the way it does – i.e. like a second-order filter – is because of the reactive nature of the air load into which it works. This effectively tilts the tuned circuit response upward at 6dB/octave.

For a driver to maintain a level output with descending frequency. the driver excursion would have to increase fourfold for every octave extension. In a conventional cabinet, below the resonant frequency the cone excursion levels out with constant drive.

If you take your driver and place it in a sealed box, commonly misdescribed as an infinite baffle, the resonant fre-

Manipulating Q

This circuit diagram shows how, in practical terms the output impedance, and hence Q_{tc}, of a speaker system can be altered. Being able to do this is useful if you need to alter the response of a speaker in an enclosure that cannot be altered, among other things.

In an ordinary power amplifier, the output impedance is kept low by the large amount of negative voltage feedback employed.

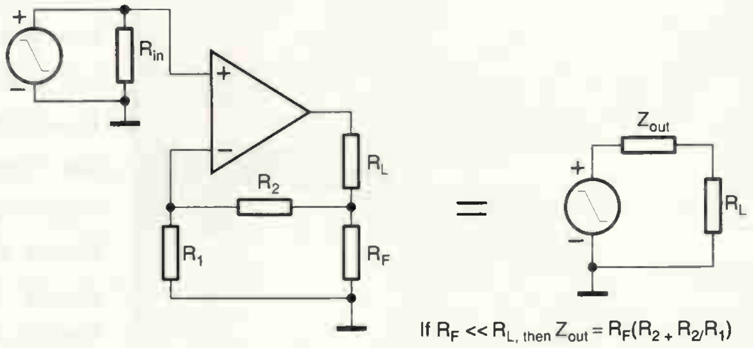
In the upper part of the circuit diagram, introducing a small resistor R_f in series with the load and taking negative feedback from the junction changes the feedback to current mode. Output impedance Z_{out} increases by $A \times R_F$ where A is the voltage gain defined by $R_2 + R_1/R_2$. This is of limited use since it tends to reduce the damping on the speaker.

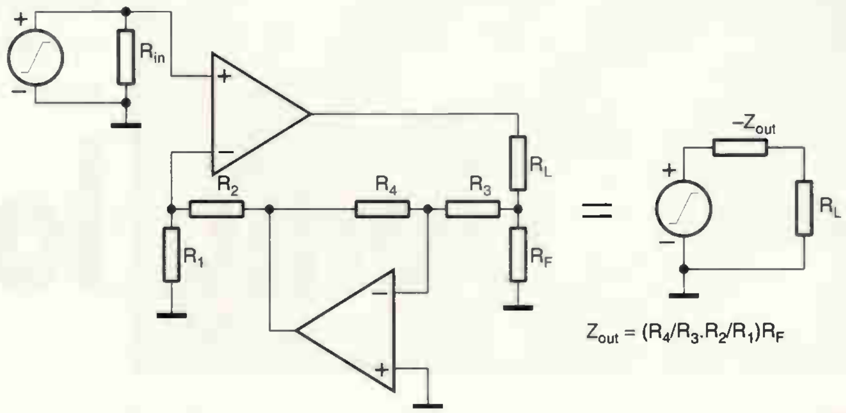
Looking at the bottom circuit diagram, an inverting buffer has been added between R_f and the feedback loop R_2 and R_1. This has the effect of inverting the sense of the signal across R_F providing positive feedback. In this way Z_{out} decreases by $A \times R_F$ and can be made negative.

The positive feedback damps the speaker's resonant peak. The curves shows the response of a hypothetical speaker system. Curve A shows the unmodified response with a turnover frequency of 100Hz and a Q of 1.5. Curve B shows the response when sufficient positive feedback has been applied to reduce the response q to approximately 0.3.

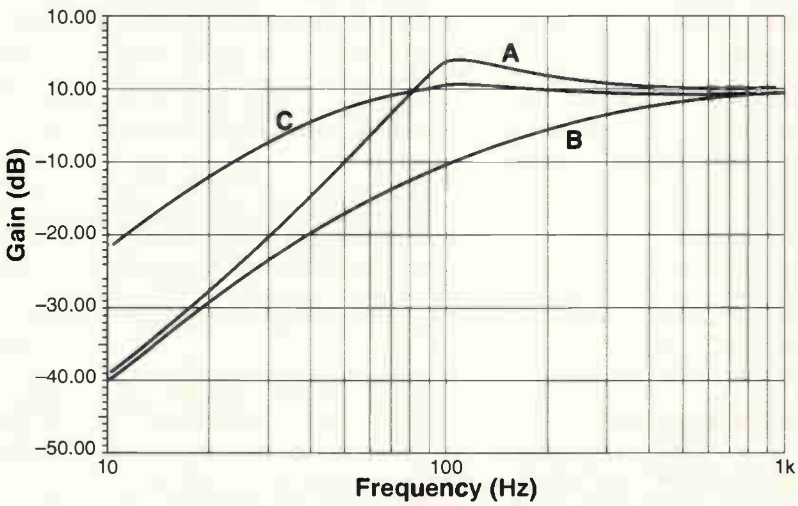
Response curves of sub 0.5 Q have the property of rolling off very slowly and possessing excellent transient response. The speaker system can now be equalised for a –3db point at 40Hz with a simple 6dB/octave bass boost filter. This requires a maximum bass boost, in this example, of 12dB.

If the speaker drive voltage is plotted, it follows the difference voltage between the initial and final response curve.





Two power amp configurations. Introducing a small resistance R_F as in the top diagram and taking negative feedback from the junction changes the feedback to current mode. This can be useful but it reduces speaker damping. In the bottom diagram, adding the inverting buffer causes positive feedback that damps the speaker's resonant peak.



Curve A is unmodified speaker response while Curve B is the same speaker subjected to Q lowering via the second circuit diagram above. Using a 6dB/octave electronic equalisation on curve B results in Curve C.

quency rises due to the stiffness of the enclosed air. The smaller the box, the greater the rise. From basic Thiele/Small theory you can show that speaker efficiency is proportional to the cube of the free air resonant frequency. This means for example that reducing the free air resonance – and hence the system resonance – merely results in an impossibly inefficient system.

Small, but bass-friendly...

How then can a small bass-friendly system be built? There are several possibilities. You can use equalisation to flatten the response. This procedure is well documented and several designs have appeared in this journal over the years.

Unfortunately, second-order equalisers are a little thin on the ground. Perhaps the best known is the Linkwitz filter described back in 1978. The Linkwitz system used a pair of Kef B139s in a small sealed cabinet. The network that he designed is capable of being modified to suit almost any small box system. In the original article the –3dB response of this subwoofer system was extended from 54Hz to 30Hz.

Going back at bit further in time to the early fifties, positive feedback was employed to increase damping on speaker systems. To explain further, the valve amplifiers of the day nearly all exhibited a high output impedance. This led to to a peak in the bass response of the speaker systems that they drove. In order to reduce this peak, zero output impedance was desired.

By using positive feedback the output impedance can be reduced beyond zero to negative values.

Perfect damping

Modern power amplifiers, except perhaps those which still employ valves, have a zero output impedance as a matter of course. However the resonant peak of a sealed enclosure could be completely damped out if the voice coil resistance could be removed. By making the output impedance of the amplifier negative and equal to the voice coil resistance, a theoretically perfect damping of the bass resonance can be achieved.

With nearly fifty years of progress behind us, we can relate these ideas to Thiele-Small analysis. The total Q of a sealed enclosure, Q_{tc} is the parallel sum of both the mechanical and electrodynamic damping. The electrodynamic damping Q_{ec} is imposed by the size of magnet used.

In practice Q_{ec} is usually an order of magnitude greater than the mechanical Q, i.e Q_{mc}. It can be defined as $k(R_e+R_g)$ where k is a constant, R_e is the voice coil resistance and R_g is the output impedance of the drive source.

By inspection, it is obvious that Q_{ec} and hence Q_{tc} can be varied over a large range. In fact they can be varied from zero to Q_{mc} just by manipulating R_g.

As Q_{ec} approaches zero the response of the speaker system approaches a straight line rising at 6dB/octave. In fact, within the piston range of the driver it operates as a differentiator. Simple 6dB/octave bass boost will produce a straight line response.

In practice such a system can be made to work well in the bass range, but it is instructive to look closer at what's really going on. Drivers are two way devices. Move the cone and you generate a voltage, apply a voltage and you get a movement.

The voltage generated by moving the cone is due to the voice coil cutting the magnetic flux lines. This voltage is generated every time the speaker moves. Its output is proportional to the cone velocity. In consequence the impedance of the driver varies.

Negative output impedance

The rise in impedance at resonance is entirely due to this effect. In a positive feedback system this rise in impedance translates into a drop in the positive feedback applied. This reduces the amplifier gain, damping the cone's bass resonance. Hence using negative output impedance is a form of velocity feedback, or in other words, motional feedback.

Negative output impedance has also been successfully employed with reflex systems by tailoring Q_t to a suitable value or, in the case of Stahl's[2] work, removing the voice coil's impedance and substituting electronically generated speaker parameters using gyrator techniques.

Another way of cheating mother nature is motional feedback. Here, a transducer is fitted to the speaker cone and a signal proportional to either the cone velocity, excursion or acceleration obtained.

After some signal processing – equalisation again – this signal is used to control cone motion and extend the bass response. In fact the amplitude response of a speaker system is proportional to the cone acceleration and the feedback signal derived is used in classic servo mode.

Apart from pure equalisation, all these systems derive their control from sampling cone motion. They are all dependent for their success on a knowledge and application of Thiele-Small theory.

No laws of physics are broken by these systems. The same Thiele-Small theory allows the selection of box size so that the speaker cannot exceed its excursion limits even when equalised to sub sonic frequencies.[3]

And what about performance?

No discussion of these systems would be complete without considering their performance relative to conventional speakers. Provided that a reasonably efficient driver is used. domestic listening levels can be obtained with the application of a few watts. Bass equalisation, however obtained, will require extra power.

A 90dB efficient driver will only require 4W of input power to reach the standard 96dB sound-pressure level. This is a deafeningly large sound in a small lounge. A 40W amplifier would allow an extra octave of bass equalisation to be applied. A 160W amplifier would be needed to carry the equalisation down yet another octave. However due to the distribution of sound intensity versus frequency, an extra 6dB of headroom is available at very low frequencies.

This agrees with empirical results obtained from a pair of experimental speakers that I recently designed. These had a bass resonance of 70Hz with a Q of 1. After careful equalisation the –3dB point was lowed to 25Hz – almost two octaves. These are capable of producing powerful bass at high levels without audible distress.

Since the cabinets have a volume of only 29 litres and employed a pair of 250mm diameter drivers this result never fails to impress unwary visitors.

In summary

We live in an age where the audio industry is reduced to selling the same old tired amplifier/speaker combinations whose response is virtually non existent below 70Hz. With the sound sources now available, this state of affairs is becoming untenable to both audiophiles and the general public at large.

I hope that this article will make a small contribution to the realisation that this problem is not only solvable but that the solutions are soundly based on Thiele-Small theory. Indeed they are not possible without it. ■

Running Fourier transforms take the bind out of examining spectra in a run of digital samples. This makes the technique particularly useful for designing digital filters, as Allen Brown explains.

Running Fourier transforms

The Fourier transform has become a well established method for determining the frequency content of signals. There are several variations of the Fourier transform and its implementation, the most common of which is the fast Fourier transform, or FFT.

One particular variation is the running Fourier transform. It has a number of interesting applications, including real-time multi-bandpass digital filtering.

When provided with a batch of digital samples, applying the FFT gives the complex spectral set. If there are N data samples in the original data set, you are required to perform of the order of, $N\log_2(N)$ calculations when using the FFT. Given a second set of N data samples you would be expected to perform another $N\log_2(N)$ calculations.

What if you had a continual stream of data samples and you wanted to calculate a new spectrum every time a new sample arrives? Would you have to perform $N\log_2(N)$ calculations each time?

Using the running Fourier transform makes this unnecessary. In fact the number of calculations is greatly reduced. If you have calculated the m^{th} spectra, the $(m+1)^{th}$ spectra, after the arrival of the new sample $x(N+m)$, using the running Fourier transform is given by,

$$X_{m+1}(k) = e^{j2\pi\frac{k}{N}}\left\{X_m(k) + \frac{x(N+m) - x(m)}{N}\right\} \qquad 1$$

where k is the frequency index, (k=0.1, 2... $N/2-1$). The derivation of this expression is given in the panel entitled 'Deriving...'.

As you can see from this expression, once you have calculated the first spectrum $\{X_0(k)\}$ successive spectra are calculated recursively. The spectrum $\{X_m(k)\}$ has $N/2$ complex values. But in your application you may only be interested in the behaviour of the spectrum at particular frequencies. As a result, you only need to calculate the spectral values of interest.

You can see from equation 1 that you need to remove the oldest data point $x(m)$ and add the newest data point $x(N+m)$. This means that you have to store all the data points N in the current batch. This is best achieved by using a *circular buffer*, which I discuss later.

Monitoring discrete spectral values

To illustrate how the running Fourier transform operates, consider this example.

List 1. Example of how the counter is implemented in C. The percentage sign represents modulus.

```
x[(0+7)%7]=x[0], x[(1+7)%7]=x[1], ...
        x[(6+7)%7]=x[6], x[(7+7)%7]=x[0], x[(8+7)%7]=x[1], ...
```

List 2. Implementing the running Fourier transform counter example in C. Two-dimensional arrays X[0][k] and X[1][k] represent the real and imaginary spectral values.

```
NEW_X[0][k] = OLD_X[0][k]*cos(ak)
    –OLD_X[1][k]*sin(ak)–recipN*(x[newest]–x[oldest])*cos(ak) ;

NEW_X[1][k] = OLD_X[0][k]*sin(ak)
    +OLD_X[1][k]*cos(ak) + recipN*(x[newest]–x[oldest])*sin(ak);

MAG_X[k]=sqr(NEW_X[0][1]*NEW_X[0][1]
    +NEW_X[1][k]*NEW_X[1][k]);
```

A signal is being sampled at 20kHz – i.e. with a sample period of 50µs. New spectral values are required for every new sample produced. But let's say that we are only interested in the frequency components at 3.35kHz, 4.050kHz and 6.650kHz.

If there are 200 real data samples in a batch, so that N becomes 200, the spectrum will comprise 100 unique complex values. The time over which the samples are collected will be 200×50µs=10ms. The spectral resolution for each k value will be 1/10ms, or 100Hz.

This makes the integer values of the index k for the above frequencies 3.350/100=33, 4000/100=40 and 6600/100=66. Out of the 100 values in the spectral set we would only calculate,

$\{X_m(33), X_m(40), X_m(66)\}$.

Since 1/200=0.005, by using equation 1, these become.

$$X_{m+1}(33) = e^{j1.036}\left\{X_m(33) + 0.005\left[x_{newest} - x_{oldest}\right]\right\} \quad 2$$

$$X_{m+1}(40) = e^{j1.256}\left\{X_m(40) + 0.005\left[x_{newest} - x_{oldest}\right]\right\} \quad 3$$

$$X_{m+1}(66) = e^{j2.073}\left\{X_m(66) + 0.005\left[x_{newest} - x_{oldest}\right]\right\} \quad 4$$

To start the calculation it's necessary to calculate $\{X_0(33), X_0(40), X_0(66)\}$. This can be achieved by performing a discrete Fourier transform for the three values. The 200 data samples collected, labelled $x(0)$ through to $x(199)$, are subjected to the discrete Fourier transform, which is defined as,

$$X_0(k) = \frac{1}{N}\sum_{n=0}^{n=N-1} x(n)e^{-j2\pi nk/N} \quad 5$$

but out of the spectrum, in this example, we only want three spectral values so,

$$X_0(33) = 0.005\sum_{n=0}^{n=199} x(n)e^{-j1.036n} \quad 6$$

$$X_0(40) = 0.005\sum_{n=0}^{n=199} x(n)e^{-j1.256n} \quad 7$$

$$X_0(66) = 0.005\sum_{n=0}^{n=199} x(n)e^{-j2.073n} \quad 8$$

Incidentally, you can extend this argument for as many frequency components as you like. It's also worth noting that since the spectral values are complex they carry magnitude and phase information.

Alternatively, each $X_m(k)$ may carry two channels of information since each is a quadrature pair – i.e. a sine and a cosine. The running Fourier transform is in effect filtering the required frequencies. In this example it is operating like a bandpass filter where the three spectral components are be fed into separate channels.

To demonstrate this working, the panel entitled 'A Mathcad model...' shows the running Fourier transform operating on a white noise signal and producing the outputs at the three frequencies. White noise contains components at all frequencies and the effect of the running transform is to isolate the real and imaginary components for the three frequencies cited in this example.

Circular buffering

As mentioned above, the best way of storing N data values is to use a

Deriving the expression for calculating the arrival of a new running Fourier transform sample

The discrete Fourier transform of a batch of N samples, labelled with the index m is,

$$X_m(k) = \frac{1}{N}\left\{\sum_{n=m}^{n=N+m-1} x(n)e^{-j2\pi(n-m)k/N}\right\} \quad A1$$

As a new sample arrives we want to recalculate the DFT for the batch labelled m+1,

$$X_{m+1}(k) = \frac{1}{N}\left\{\sum_{n=m+1}^{n=N+m} x(n)e^{-j2\pi(n-m-1)k/N}\right\} \quad A2$$

Extending the sum to include the sample for $n=m$ in the previous equation gives,

$$X_{m+1}(k) = \frac{1}{N}\left\{\sum_{n=m}^{n=N+m} x(n)e^{-j2\pi(n-m-1)k/N} - x(m)e^{j2\pi k/N}\right\} \quad A3$$

Removing the last term from the sum which involves $x(N+m)$ gives,

$$X_{m+1}(k) = \frac{1}{N}\left\{\sum_{n=m}^{n=N+m-1} x(n)e^{-j2\pi(n-m-1)k/N} + x(N+m)e^{-j2\pi N/N} - x(m)e^{j2\pi k/N}\right\} \quad A4$$

Since $e^{-j2pk}=1$ for integer values of k, equation A4 reduces to,

$$X_{m+1}(k) = e^{j2\pi k/N}\left\{\frac{1}{N}\sum_{n=m}^{n=N+m-1} x(n)e^{-j2\pi(n-m)k/N} + \frac{[x(N+m) - x(m)]}{N}\right\} \quad A5$$

By substituting A1 into A5 we obtain,

$$X_{m+1}(k) = e^{j2\pi k/N}\left\{X_m(k) + \frac{[x(N+m) - x(m)]}{N}\right\} \quad A6$$

which is the required result.

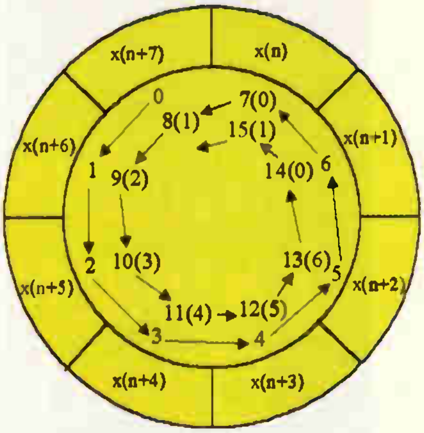
Digital frequency tracking

One possible application for the running Fourier transform is the design of a digital frequency tracker. Output from such a device would be a value – or voltage – proportional to the fundamental frequency of the input signal. By calculating the spectral values $X_{m+1}(K)$ for all the k values, the fundamental frequency will correspond to the maximum spectral value. Finding the maximum spectral value can be achieved by using a for-loop in your C program:

```
float max;
int freq_of_max;
max=0;
freq_of_max=0;
...
for (k=0;k<=N/2;k++)
{
        if(max<MAG_X[k])
        {
                max=MAG_X[k];
                freq_of_max=k;
        }
}
```

On completion of this 'for' loop, variable *max* will the magnitude of the maximum spectral point and *freq_of_max* will be its frequency. These can be used to feed a graphical display or even in some designs as part of a feed-back mechanism to stabilise a frequency at source, such as that of a rotating machine.

Fig. 1. The best way of storing N data values is to use a circular buffer where the newest data value replaces the oldest data value.



circular buffer where the newest data value replaces the oldest data value. **Figure 1** illustrates how a circular buffer operates, $x(n)$ is the oldest sample and $x(n+6)$ is the most recent.

The key aspect of a circular buffer is the address mechanism which is derived from a prime number. In this example, the counter counts from 0 to 6 and repeats. When there are seven addresses and the counter expires, it automatically points to the oldest address where the newest data sample $x(n+7)$ will be stored, assuming that the address counter is zero.

In this example the counter is generated by using,

(n+7) mod 7

which is defined as the remainder integer after $(n+7)$ has been divided by 7 which gives 7 different address numbers before the repeat begins. In order for this to work the divisor must be a prime number. To program this in C, you would use the percentage symbol to indicate modulo operation. **List 1** is an example that would effect a circular counter.

Mathcad model of the running Fourier transform

Define the indices used in the modelling.

Total number of data points $n := 0 .. 800$

The number of data points in a batch, $N := 200$

Number of batches $M := 500$

Batch index $m := 1 .. M$

Number of spectral values in spectrum $k := 0 .. \frac{N}{2}$

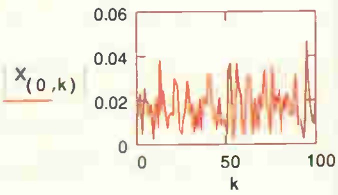
Generate 800 data points of random noise.

$$x_n := (\mathrm{rnd}(1) - 0.5)$$

Derive the spectrum, using the DFT, from the first batch of N data points,

$$X_{(0,k)} := \frac{1}{N} \cdot \sum_{s=0}^{N-1} x_s \cdot e^{\frac{-2j\,p\,k\,s}{N}}$$

The spectrum of the first batch.



Having calculated $X_0(k)$, we go on to calculate the r-FT, $X_{m+1}(k)$ for m=0..M and k=33, 40 and 66 as examples.

$X_{m+1}(33)$, Eq:2

$$X_{(m+1,33)} := e^{1.36j}\left[X_{m,33} + 0.005\,(x_{N+m} - x_m)\right]$$

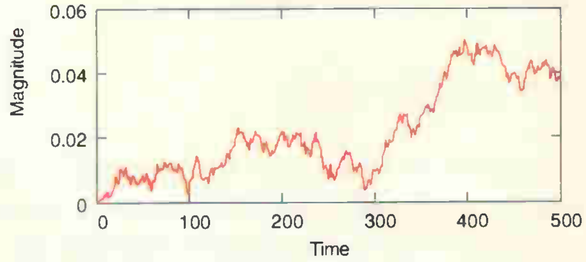
$X_{m+1}(40)$, Eq:3

$$X_{(m+1,40)} := e^{1.256j}\left[X_{m,40} + 0.005\,(x_{N+m} - x_m)\right]$$

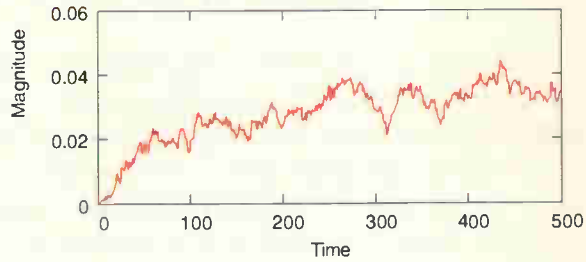
$X_{m+1}(66)$, Eq:4

$$X_{(m+1,66)} := e^{2.073j}\left[X_{m,66} + 0.005\,(x_{N+m} - x_m)\right]$$

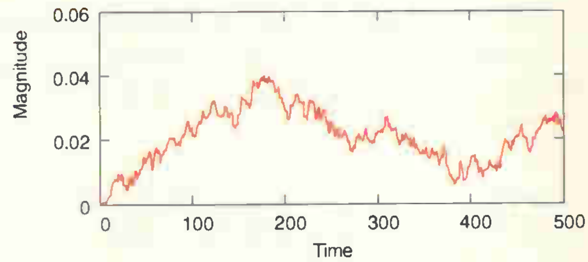
Plot of the growth of $|X_{m+1}(33)|$ vs time.



Plot of the growth of $|X_{m+1}(40)|$ vs time,



Plot of the growth of $|X_{m+1}(66)|$ vs time.



These plots demonstrate how the three spectral values vary as every new data point enters the batch and the new spectrum is calculated.

Implementing running transforms

The running Fourier transform is a very effective means for isolating frequency components from a signal. It is relatively straightforward to implement and code in C.

Since the spectral values are complex, you can use a two-dimensional array to define them, X[0][k] for the real values and X[1][k] for the imaginary values.

Taking equation 1 and equating real and imaginary components you can arrive at **List 2**. Here, $\alpha=2\pi/N$ and recipN=1/N (performing multiplications is quicker than divisions).

These two expressions can be coded directly within a loop and will perform a running Fourier transform operation. If the input data {x} is complex, the expressions can be modified to account for this.

Another attractive feature of the running Fourier transform is its ability to be implemented in real-time on a digital signal processor. You will be faced with the usual problems of having to evaluate the trigonometric functions sine and cosine, but you can use a look-up table or a reduced series expansion.

In the analysis presented here, no mention has been made of rounding effects. Equation 1 is recursive – involving new values derived from old ones. When implemented on a fixed-point processor it would probably show signs of accumulated rounding off.

A means of minimising this would be to perform a discrete Fourier transform for every few hundred thousand data samples or use a floating point processor. Several such processors have sine look-up tables and a circular addressing mode: examples are the Motorola *DSP96001* and the Texas Instruments *TMS320C30*. ■

LETTERS

Letters to "Electronics World" Quadrant House, The Quadrant, Sutton, Surrey, SM2 5AS

Cold junction comments

I have been following with great interest the series of articles by Richard Lines on sensing temperature.

In his article in the February 1998 issue the topic of cold junction compensation is discussed, but it seems to me that the main point has been missed. The need for cjc stems from the fact that emf generated by a thermocouple depends not only on the temperature.

The approximate relationship – up to quadratic terms – is,

$$emf = K(T_1 - T_2)\left[\frac{T_1 - T_2}{2}\right] - T_n$$

where T_1 and T_2 are denote the absolute temperatures of the two junctions and K and T_n are constants depending only on the material composition of the thermocouple pair.

The consequence of this is that the tabulated values of emf have to be produced for a specific reference temperature. Typically the so called standard reference of 0°C is used. Cold junction compensation is then a mathematical algorithm which allows you to amend the standard emf table, with the reference junction at 0°C, to a table of emf with respect to an arbitrary reference temperature.

It is a very simple calculation. One uses the standard reference table to determine the emf of the new reference junction and subtracts this value from the measured emf.

As pointed out in the article, this compensation can be done electronically, albeit not as shown in Fig. 6. You need to simulate the emf that would be produced by the reference junction with respect to the standard reference temperature.

Provided that the temperature variation of the reference junction is not great – kept at ambient temperature for example – one can use a linear temperature sensor, such as a silicon diode. Its voltage output has to be scaled down to give an emf slope identical to the thermocouple used.

Paul Klimo
School of Electrical, Electronic and Information Engineering
South Bank University
London

Simpler 400Hz

With reference to pages 516-517 of the June 1998 Issue, I would like to congratulate the *Trac* Competition Winner for the novel technique employed for synchronisation in

Recycle that Christmas card

We have all seen greetings card that sing to you when you open them. I once left one open, and it played continually for more than one week on one very small SR59 cell.

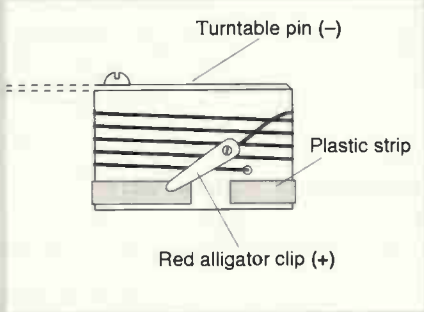
Opening the card closes a switch. I cut away all the paper, made the test terminals a lead with an alligator clip, and a bendable, pointed metal pin. I put it all into a small plastic screw cork, 22mm high and 36 mm diameter. The piezoelectric sounder formed a lid.

I now have an ideal continuity tester. Its cheap, durable, small and handy. The piezoelectric lid is glued to the screw cork with a few drops of glue. It should be possible to force the lid open should you ever need to replace the battery.

With this tester I can check the continuity of resistances up to 20kΩ, verify the conductance one way and not the other of germanium and silicone rectifiers, find out if a capacitor of 10μF or more is short-circuited, ok, or open, and very roughly estimate capacity.

Unfortunately the sound is not very strong. In a very noisy room, I had to form the test lead like a coil close to the ferrite rod of a small radio. I then could hear the radio playing "Happy Christmas to you" just at the sound level needed.

Scott Arnesen
Oslo
Norway



An almost free continuity tester can be made from a musical greeting card – assuming you can bear the annunciation.

Microsoft monopoly? Maybe 100% tax is the solution

I get a bit nervous when an electronics magazine delves into computing and politics but I enjoyed the timely editorial in the July 1998 issue.

But I have several problems with the details of Simon's proposal. I think he spent a little too much space describing the problem and left not enough room to discuss possible solutions, including the one he favours. I suspect that almost everyone except Bill Gates recognises that it is not healthy for any one company to dominate any industry.

It is us as buyers of computing products who must admit much of the blame for the predicament we are in. It is unfair of you to blame software developers – or even to be using words like "blame". In a modern economy, every business must be competitive.

For a strategy to work, I think it needs to include at least one carrot, as well as a jolly big stick.

I think we do need to re-examine at least some of the basic assumptions of our political ideas and systems. A common belief nowadays is that most of our political theory is right and that there are just a few annoying anomalies that need specific attention to repair. That belief encourages politicians to attempt narrowly focussed specific but *ad hoc* solutions for each perceived problem.

The action to split Bell that Simon mentions is just one example. In general, the solution is, "Company B is too monopolistic. Let's do something about company B". Currently, it is "Company M" that is the worry. I think we – the world – will have a healthier economy if we try harder to think of a general solution to the problem.

The legislation Simon proposes, implemented exactly proposed, would be just another expense the Government can't afford. Instead, why not apply a tax?

For software destined for just one operating system, the tax might be substantial – 100% might not be unreasonable. For software able to work on three or more operating systems, it might be zero.

Yes. I know this won't be easy to introduce in a country wedded to a flat or flattish VAT, but I always suspected that VAT was sold by the same merchants that sold the King his new clothes.

But that is still tackling a symptom of the problem, rather than the problem. I think it is necessary to tackle the source. The world needs a tax that will apply to Microsoft software. But it shouldn't be a tax on Microsoft software specifically, or even on software specifically. What the world needs is a progressive tax based on market share.

Curiously, I think that if the tax is exactly the percentage of each company's market share, it would work rather well. A company struggling with a 1% market share would pay 1% tax.

True, I am leaving out some details, like "1% of what?" and the definition of 'market share'. But in the interests of brevity, let me stick to general principles for now.

A company with 30% market share would pay 30%. There would be no need to legislate specifically for any monopoly. Any business selling something so wonderful it could stay in business paying 100% tax probably does deserve to enjoy a monopoly.

Keith Anderson
Kingston
Australia

"400 Hz in three phases".

I am writing to draw your attention to a simpler technique for generating a 400Hz supply used in commercial flight simulator instrumentation designs over 30 years ago. These instruments were produced by a well known manufacturer of aircraft simulators in Crawley, Sussex where I once worked.

Two class D audio amplifiers were fed with 400Hz digitally generated sine waves from a digital process controller via a suitable interface. The two signals were in phase quadrature.

The resultant sine/cosine outputs were fed to a Scott T-connected transformer as found in any power engineer's reference handbook. The three phase outputs were used to drive aircraft instrumentation as appropriate.

***R. Thanky**, FIEIE, I.Eng CEI*
Broadcast Unit,
Spectrum Services Executive
Radiocommunications Agency

One flat, one not

I use two AAA rechargeable batteries in my little radio. When they give up and I take them out and check them I am always surprised to find one of them is flat and the other in quite state of charge.

I have tried various pairs and the same thing always happens. I have even taken 'good' ones from each pair and paired those but the same thing happens.

Can anyone suggest a solution to this problem? Is it possible to match a pair of cells resistance to obtain even performance? How could one go about this? Should manufacturers help here?

Frank Eliason
Plymouth

Rechargeables discharge

If you have equipment incorporating nickel-cadmium cells. you may have wondered why they seem to fail before 500-1000 recharges – or a decade or more of use. My advice is to check the charging current.

I have found over the years that even on top quality items, the supplied charger often runs at many times more than the recommended maximum. This maximum is normally a tenth of the capacity of the cell.

Items such as camcorders deliberately use a very high charging rate to shorten charge times. This eventually affects the cells' charge retention.

Many items have charging holders. These are useful, but I have often found that unless they are left on continuously. the charged equipment does not seem to work properly. This is due to leakage through the charger.

To avoid this problem, remove the unit from the holder/charger after charge, or fit a simple switch in the charger unit's output circuit.

Hot batteries during charging are a warning sign.

Reg Moores
Brighton
West Sussex

Hearing harmonics?

A friend of mine and I carried out some – admittedly rather crude – experiments in the late seventies to try to determine the relative audibility of different harmonic components in a composite waveform. Our initial set-up consisted simply of an audio amplifier and loudspeaker, a mixer, and two good quality sine-wave oscillators.

Our initial intention was simply to feed the loudspeaker with, say, a 1V signal at 1kHz, and then to add a 1mV signal at 3kHz, 5kHz or 7kHz, to determine the audible effect.

The problem lay mainly in achieving frequency synchronisation between oscillators. These were less stable in frequency than we expected. Our later refinements were aimed, amongst other things, at avoiding relative frequency drift.

However, this was irrelevant to the experimental results. These results were the same with both our simple and our more accurate and elaborate later arrangements. The added frequency 'harmonic' component was quite inaudible in the presence of the louder low-frequency tone, until it came into frequency synchronisation with a multiple of this low-frequency signal.

At this point, a 'harmonic', down to an equivalent of – at least – 0.1% became audible as a change in the timbre of the low-frequency tone – an effect lost with a very small shift in relative frequency.

This is a simple experiment, and one which would be easy to repeat to confirm our findings. In the world of digital compact cassettes, mini discs and digital audio broadcasting, where data compression is used to get a gallon into a pint pot, the relevance of this work is that all of these systems rely on the concept of 'audio-masking' to justify the deletion of all low level audio

Harmonic work out

While frequency multipliers using pulse-excited tuned circuits are probably a thing of the past, harmonic content of pulse trains remains interesting.

A simple diagram can be used to determine the harmonic content of any continuous rectangular waveform. While both theory and practice are probably obvious and elementary to university tutors, I had to discover the device for myself. As I have never met anyone else who has come across it, or found reference to it in print, your readers might be interested.

My figure shows a cycle from an arbitrary rectangular waveform aligned with sections of sinewaves of increasing frequency and decreasing amplitude. The first is π radians with unit amplitude, the second 2π with amplitude 1/2, the third 3π with amplitude 1/3 and so on. For clarity I've drawn the sinewaves the same size and varied the y-axis scaling.

Projecting the rectangular wave transition through this set of sinewaves gives the required analysis immediately. Each harmonic amplitude is that at the intercept of this line and the sine curve for that harmonic. This can be read directly from a well drawn diagram.

But calculation is also easy. For example, the **Table** shows equations for a rectangular waveform of unit amplitude where,

$$mark/(mark+space)=1/6.$$

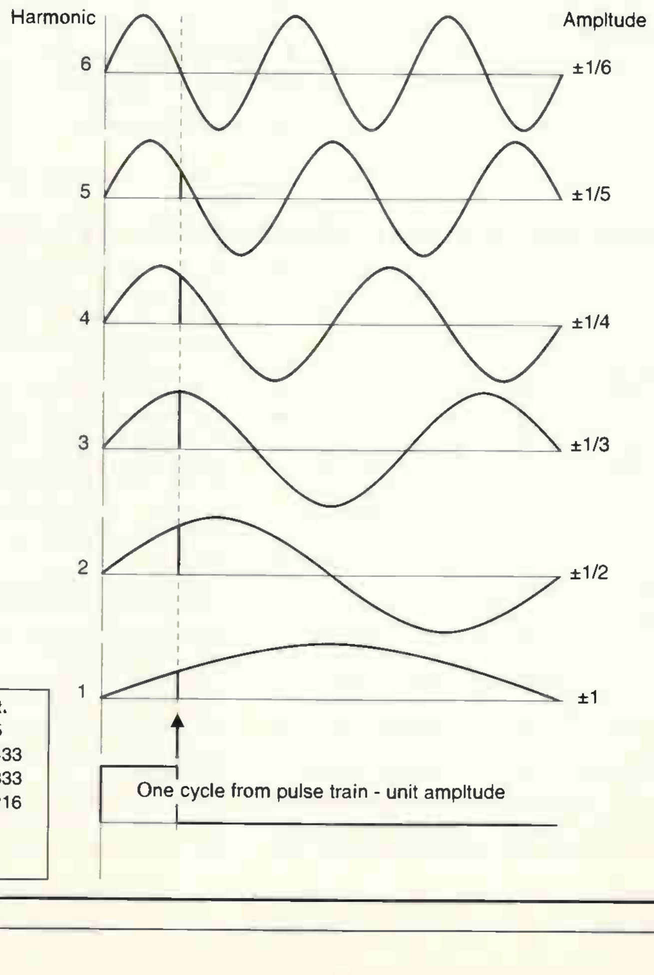
Inspection of a diagram often reveals – to me at least – information more readily than if it were presented mathematically. Here for example the optimum mark-to-space ratios to maximise a given harmonic can be immediately seen.

It is clear that the pulse width required to near maximise a particular harmonic is far less critical than the pulse width needed to eliminate it. The analysis of a square wave is self evident.

DC Simpson
Feltham
Middlesex

Table. Equations for calculating harmonic content.

fundamental	$(\sin(1/6\pi))\times 1$	=0.5
2nd harmonic	$(\sin(1/6\times 2\pi))\times 1/2$	=0.433
3rd harmonic	$(\sin(1/6\times 3\pi))\times 1/3$	=0.333
4th harmonic	$(\sin(1/6\times 4\pi))\times 1/4$	=0.216
5th harmonic	$(\sin(1/6\times 5\pi))\times 1/5$	=0.1
6th harmonic	$(\sin(1/6\times 6\pi))\times 1/6$	=0



signals whose amplitude and frequency would suggest that they would not be audible. But this would surely include a wealth of harmonics or 'partials', whose presence would normally add depth and richness to the recorded signal.

I have had little experience in listening to, or comparing, audio signals compressed in this manner, for economy in transmission or recording, but a number of critics have commented on the blandness and lack of life of such signals. Could this loss of harmonics be the reason why?

John Linsley Hood
Taunton
Somerset

Light gates

Semiconductor logic is fast, but nonetheless limited by capacitance and resistance and the structure of semiconductor materials.

Light on the other hand does not have the same problems, and is very fast.

When light of different wavelengths is mixed together it produces different colours of light, as for example on a television screen. Using this effect together with light filters it might be possible to make gates for data processing.

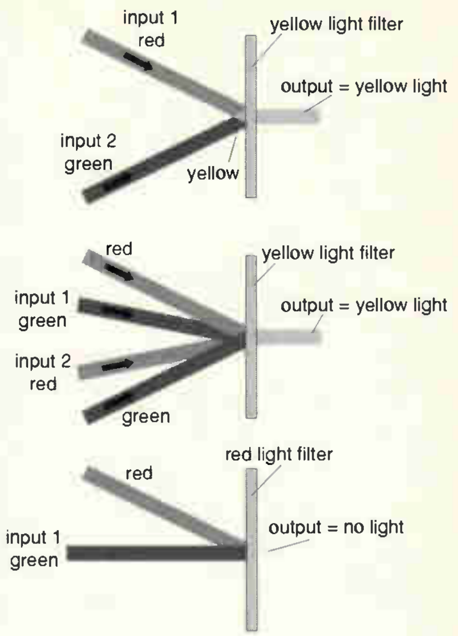
- For an And gate, only when the red and green light are on there is an output.

- With the Or gate, the inputs are mixed so the output is always yellow. If this didn't happen then the output could be yellow, red or green when on, causing problems if feeding to another gate.

- For the Not function, there is only an output when there is no input.

These are the main gates, which all others can be built from. Would any of this work?

Bryce Smith
Hexham



Logic at the speed of light. But will it work?

Tick here please

I have a problem that I am sure one of your readers will have the answer to, bearing in mind that anything electronic is a total mystery to me.

I am a volunteer driver and number one fan of The National Rehabilitation Centre for the Paralysed, currently based in the grounds of Standish Hospital Gloucestershire. The Centre is researching the action of walking in aid of those who have had their 'walking mechanism' damaged in some way.

How can I obtain a metronome at low or no cost that could be adjusted from say, 12 beats minute to say 35? The ideal instrument would be hand held, with flashing lamps, indication of the rate and perhaps a volume control for the tone generator.

The metronome is to be used in conjunction with a treadmill where the client is supported by a harness similar to a parachute harness and parallel bars. The speed of the treadmill can be varied from very slow to quite fast. The metronome will assist the client to make even strides and improve co-ordination.

I have seen people walking who have been told that they will never walk again, but it could not be called functional walking. The research project is about developing this movement into something a lot more substantial.

Stanley Dicker
Stonehouse
Gloucestershire

EMC regulations *versus* the real world

The EMC regulations were introduced with the laudable aim of ensuring that potential noise sources were not aggressive enough to cause problems in potential victims. It was also intended to ensure that potential victims were hardened enough to withstand incoming noise.

I looked forward to the first of January 1990 expecting all my noise troubles to disappear. Nothing changed in my world; indeed it seems to be getting worse.

My own experience of noise problems is in industrial control systems using both programmable logic controllers and and pulse-width modulated motor drives involving 600V slew in 200ns typically. The controllers are potential victims and the drives are certainly an EMI source.

Both come with EMC certification yet we see malfunctions due to noise.

It appears to me that there is a basic problem in that the EMC emission testing is aimed at continuous waveforms, while immunity testing covers bursts and impulses. We typically have problems obtaining a pass because of a microprocessor clock radiating harmonics yet the pwm signal is hard to detect.

The typical pwm motor drive noise consists of 1 to 5MHz ringing at each transition of the 5kHz, 600V pk-pk waveform and can easily reach several volts peak conducted. Nevertheless, the spectrum analyser indicates only millivolts.

Emission testing seems to depend almost exclusively on spectrum analysis. These are inherently averaging instruments, but it is the peak voltage developed in a victim circuit – largely by capacitive coupling – which causes malfunctions in associated digital equipment within our systems. The effect is even more pronounced with single noise events such as the switching of inductive loads in 24V dc circuits.

My contention is that we need an extension of the existing measurement techniques to cover transient events. A simple peak limit would be a great advance for me.

Can anyone with a deeper knowledge of, or involvement in, EMC testing shed any light? Is there any move to address this aspect?

Graham Elvis
Cannock
Staffordshire

Updates

Motor speed controller

In the September 1998 issue, page 739, we published Andrew Little's motor speed controller. There is an error in the circuit for the motor pwm drive. The 339 comparator input connections in the direction-sense module in Fig. 3 on page 740 should be reversed from those shown.

Wow and flutter meter

The September 1998 issue contained David Lane's wow and flutter meter design. A number of small errors crept into the circuit diagrams and some of these will prevent the meter from functioning as intended. In Fig. 3, the lower R_2 should be R_3. Resistor R_7 should be 10kΩ. In addition, R_8 (100kΩ) which connects IC_4 pin 3 to ground was omitted. The –15V rails connect to IC_4 pin 4. This IC should have been labelled 'unipolar-to-bipolar pulse converter.' The second R_{13} should be marked R_{14}. In Fig. 4, the R_{31} connecting to C_{25} should be R_{30}. The correct value for R_{31} is 620kΩ. Output from IC_8 is pin 6, not pin 1. In Fig. 6, output from IC_{12} is at pin 3. In Fig. 7., the –15V regulator is of course a 337T and pins 2 and 3 have been transposed. Apologies for any difficulties this may have caused.

Windows 98 review

At the top of page 685 in Rod Cooper's August 1998 Windows 98 review, two sentences read, "For example, you can launch programs with a single click and the forwards and backwards buttons. This can make life easier". It should have read, "...you can launch programs with a single click, and the forward and back buttons shown in Fig. 2 can make life easier."

Simple linear thermoregulator

Giorgio Delfitto's circuit idea in the August issue had the following misprints. The formula "$P=V_{CC}R_\theta$" should be replaced by "$P=V_{CC}I_C$, the temperature measured by the sensor is $T=DT+T_a$ where T_a is ambient temperature, and $DT=PR_\theta$." In Fig. 2 "I_s" should be replaced by "I_c" between the blocks $h_{FE1}.h_{FE2}$ and V_{cc}. This is the collector current of the darlington Tr_2.

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Frequency Products Ltd. Tel., 01460 57166; fax, 01460 57777; e-mail, sales@frequencyproducts.com
Enq no 501

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13-bit d-to-a converter. Signal Processing Technologies has a 13-bit octal converter having eight voltage-output converters in a single 44-lead plastic package. The *SPT5400* also has a parallel interface with four reference voltage inputs and four analogue output grounds. It is ttl-compatible, needs no external components and works on supplies of ±5V, giving a ±4.5V output swing.

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Signal Processing Technology. Tel., 01932 254904; fax, 01932 254903; web, www.spt.com.
Enq no 502

Discrete active devices

SO-8 power transistor. In overall dimensions of 4 by 5mm, Ericsson's *PTF10027* n-channel fet puts out 18W and is for use in GSM applications to 1GHz. Since cellular traffic is so dense, purity of output is essential and the linearity of this device is improved by the use of the ldmos technique, which also increases gain. Operating supply is 28V, minimum power gain 13.5dB at 960MHz and response over the 960-1000MHz band flat to within ±0.1dB. Class AB two-tone, third-order intermodulation is –35dBc at 12W peak emitted power.
Richardson Electronics (Europe) Ltd. Tel., 01753 733010; fax, 01753 733012.
Enq no 503

Displays

Lcd interface controller. Digital View has a new 8-bit version of its vga/svga lcd panel controller card, which works with most of the leading colour panels and plug/play connection. *AC-9511 v.3* provides quick direct analogue connection to 3.3V and 5V tft colour panels at up to 800 by 600 resolution and to plasma displays. It conforms to VESA DDC-2B, having dip switch setting for the relevant panel, enables sync.-on-green and automatic selection of graphics mode. A 12V supply is needed.
Digital View Ltd. Tel., 0181 2361112; fax, 0181 2361116; web, www.digitalview.com.
Enq no 504

15-In colour lcd. NEC's *NL10276AC30-03* 15-in (diagonal) display provides 1024 by 768 pixels, which is equivalent to PC XGA, and full colour. It takes in RGB analogue signal and its multi-scan capability makes it suitable for use with pcs, Macs or other, special formats. Response time is 15ms typical from white to black, rendering the display usable with animation, and brightness is nearly three times that of a typical panel at 200cd/m^2; contrast is between 200:1 and 350:1, depending on viewing angle (55° horizontal and 50° vertical). Backlighting is supplied by two cold-cathode tubes.
Sunrise Electronics Ltd. Tel., 01908 263999; fax, 01908 263003; web, www.sunrise.co.uk
Enq no 505

Filters

5th-order elliptic filters. Maxim's *MAX7411/5* filters are switched-capacitor, low-pass types in 8-pin µMAX or dip packages, the µMAX module being around 80% smaller than a dip type to give the industry's smallest 5th-order s-c filters. Current drawn from 5V or 3V (7415) is 1.2mA and 0.2µA quiescent. Roll-off is sharp, stop-band attenuation is 37dB and thd + noise 81dB. Corner frequencies may be clock-tuned from 1Hz to 15kHz and the nullable output offset is 4mV.
Maxim Integrated Products UK Ltd. Tel., 0118 9303388; fax, 0118 9305577; web, www.maxim-ic.com.
Enq no 506

Analogue video filters. A range of active filters by Microelectronic Modules Corp. provides optimum filtering in video processing equipment before and after analogue stages, handling analogue buffering, filtering and dc control in sil packages. There are single and multi-channel types designed for use in digital video encoding and video a-to-d converters, having integral selectable-gain op-amps for input and output impedance matching. In the range are single-channel versions for luminance, chrominance, RGB, NTSC and PAL signals and the multi-channel types are for the filtering of S-video, composite and RGB signals. There are also front-end digitisers with full filtering, a-to-d conversion and digital filtering.
Microelectronic Modules Corporation. Tel., 001 414 7856506; fax, 001 414 7856516; web, www.mmcorp.com
Enq no 507

Hardware

Cable tidy. A cable tidy, the Richco *Cableater*, is said to resemble a centipede without legs (nihilipede?), being composed of a circular-section plastic tube with cross slits in it, cut along the length of the tube. These not only make it flexible but allow the rapid insertion of a great bunch of wires with the aid of a tool. Tube is made in black or white and in diameters of 8, 15, 20 and 25mm and in lengths of up to 100m.
Richco International Co., Ltd. Tel., 01474 327527; fax, 01474 327455.
Enq no 508

Outdoor cabinets. *Kinetic* is Vero's name for its thermally managed outdoor equipment cabinet for wireless local loop stations, paging and microwave links dissipating up to 1kW. Aluminium, mild steel or stainless steel may be specified, its double skin simplifying emc and weather screening and allowing a heat exchanger to be integrated into the cabinet. Cooling is by forced draught or by the heat exchanger, dc fans being on all the time or managed by a control and monitoring system that provides local and remote warning of fan failure and high temperature. Kinetic can go on a pole or on the wall.
Vero Electronics Ltd. Tel., 01703 266300; fax, 01703 265126; e-mail, verocf@vero-uk.com
Enq no 509

Linear integrated circuits

Current-feedback amplifier. A single-supply, current-feedback amplifier from Maxim, the *MAX4190*, provides gain flatness of 0.1dB up to 85MHz and differential gain/phase error of 0.03%/0.06%, together with 120ns/35ns enable/disable times and 45mVpk-pk switching transients. It is optimised for a 6dB closed-loop gain or more, giving a –3dB bandwidth of 185MHz. Supply may be either single 4.5-5V or dual ±2.25-±5.5V, from which it draws 1.5mA while supplying ±55mA at the output. Settling time is 22ns to 0.1% and slew rate 340V/µs. A triple version, the *4188*, is available.
Maxim Integrated Products UK Ltd. Tel., 0118 9303388; fax, 0118 9305577; web, www.maxim-ic.com.
Enq no 510

Logic

100MHz bus drivers. Hitachi presents two 18-bit universal bus drivers in its HD74ALVC Series, the *16835* and *162835*, the ALVC meaning "advanced low-voltage

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cmos". These are designed as three-state drivers for sdram memory on a 100MHz memory bus, with a view to reducing reflected noise and ensuring dependable output current at high frequencies. A 0.5μm cmos process is used, supply voltage is 2.3-3.6V, propagation time 2ns at 3.3V and output current 24mA. The *162835* has built-in damping resistors of 26Ω, the *16835* being resistorless.
Hitachi Europe Ltd. Tel., 01628 585163; fax, 01628 585160.
Enq no 511

Materials

Small magnetic cores. Philips *Planar* cores and sample kits are now available from BFi Ibexsa. The cores are for use when a low profile is needed, coils being built up of printed or stamped copper separated by insulant, the windings then going into low-profile E/E or E/PLT cores. Benefits, apart from the size, are about 50% less thermal resistance than with wire-wound types, low leakage inductance, good repeatability and lower cost.
BFI IBEXSA Electronics Ltd. Tel., 01622 882467; fax, 01622 882469; web, www.bfi.avnet.com.
Enq no 512

Television components

Wireless cctv viewer. *VideoWave Viewer* by Radio Data Technology is an extension to the existing VideoWave VRX1394 cctv transmitter, whereby the 1394MHz transmissions may now be monitored on a 2.9in lcd fitted with a light shield for daylight viewing. CCIR Pal transmissions can therefore be relayed over a distance of up to 750m using a quarter-wave whip, the transmissions being scrambled. Current consumption is 600mA from 12V.
Low Power Radio Solutions Ltd. Tel., 01993 709418; fax, 01993 708575.
Enq no 526

Thermally conductive tape. Chomerics' *Thermattach T410* is conductive, double-sided adhesive tape to fix heat sinks onto plastic ics dissipating between 1W and 5W. The tape itself is aluminium foil, with two types of adhesive: a silicone-based pressure-sensitive type to bond to the ics, which sometimes carry traces of silicone release agent; and acrylic PSA to bond to the metal heat sink.
Parker Hannifin plc, Chomerics Division. Tel., 01628 486030; fax, 01628 476303.
Enq no 513

Memory

8Mbyte PCMCIA card. Premier announces a type 2 PCMCIA card with 8Mbyte of sram and a rechargeable data backup battery. Its charging circuit maintains battery power and the static ram will hold data for many years. The card has a write-protection switch.
Premier Electronics Ltd. Tel., 01992 634652; fax, 01992 634616; e-mail, premier@dircon.co.uk
Enq no 514

Microprocessors and controllers

Processor for neural networks. *NC3001* from Neuricam is a digital parallel processor for learning and recognition in artificial neural networks and designed to implement the Reactive Tabu Search learning algorithm, which is an alternative to back propagation giving lower cost and a more compact chip. The design is suitable for use in embedded neural, fuzzy and general filtering uses. Features include 32 fixed-point, fully parallel, digital multiply-and-accumulate processors in parallel with three-stage pipeline and weight memory, a simple chip interface for coprocessor use and 1000Mops performance with a 30MHz clock. Power consumption is 1W at 30MHz.
Neuricam srl. Tel., 0039 0461 260 552; fax, 0039 0461 260 617; web, www.neuricam.com
Enq no 515

Motors and drivers

Motion control. Arcom's *AIM-104-MOTION-1* PC/104 interface module provides motion control and drive for brushed dc servo motors and steppers, which is compatible with pcs to allow the use of pc programming languages such as Visual C++ or C++; Arcom supplies samples in C free. A maximum of 1A per winding is allowed in closed-loop working and the boards may be stacked for synchronised multi-axis control. Encoder input to the boards comes from single-ended or differential quadrature encoders and there are two opto-isolated limit inputs, an isolated emergency stop and a home input for reference. There are also a 24-position counter and a programmable filter.
Arcom Control Systems Ltd. Tel., 01223 411200; fax, 01223 410457.
Enq no 516

Microstep drive. Digiplan has a microstepping drive that operates from any single-phase ac in the 95-264V range with no adjustment. The unit measures 224 by 180 by 70mm and produces shaft power of up to 800W. Innovative control techniques give higher acceleration, more power and lower settling time than found in conventional designs. Active damping is provided to prevent oscillation and stalling of stepper motors There is also a range of CE-marked 34 and 42 frame size steppers for use with the drive
Parker Hannifin plc, Digiplan Division. Tel., 01202 699000; fax, 01202 695750; e-mail,sales@digiplan.com.
Enq no 517

Optical devices

Fresnel lenses for ir sensors. A range of precision infrared fresnel lenses from Anglia is designed for use in motion detection and security systems. The lenses are made in domed or flat form to give beam patterns for particular applications, enhancing sensitivity and reducing the incidence of false triggers. White or translucent polypropylene is used. A custom design service is offered by Anglia.
Anglia. Tel., 01945 474747; fax, 01945 474849. E-mail, angliac.co.uk
Enq no 518

Modulated laser diode. NEC's *NDL7910P* multiple-quantum-well, distributed-feedback laser diodes has an electroabsorption modulator in the same package and is expected to reduce the size and cost of future wavelength-division multiplexing equipment for telecommunications use. The device works at speeds up to STM-16, which is 2.5Gb/s, and will eventually reach 10Gb/s. Peak emission wavelength is 1545nm, output 3mW, return loss –10dB at 2GHz and there is 30dB of internal optical isolation.
NEC Electronics (UK) Ltd. Tel., 01908 691133; fax, 01908 670290.
Enq no 519

Oscillators

Ovened crystal oscillators. C-MAC offers more crystal oscillators by Cepe, this time for GSM and other cellular base stations as well as SDH/Sonet switching. The surface-mounted devices consist of an SC-cut crystal and an asic in the one can within an outer package. *CPO-10H* devices are stable to within ±2 and ±5 parts per billion with temperature, ±1ppb with loading , ±0.07ppb ageing per day and ±0.02ppb in the first year. Frequencies available are 8-13MHz in this range, the slightly less stable *CPO-10* series covering 2-40MHz at ±0.05ppm. Oven power is 5W during a five-minute warm-up and under 1W thereafter.
C-MAC Quartz Crystals Ltd. Tel., 01279 626626; fax, 01279 454825.
Enq no 520

Passive components

Low-value chip resistors. From Koa's *SR73* series of chip resistors, E96 values from 0.2Ω to 10Ω to ±1% can be supplied, the five standard sizes having ratings of 0.125W to 1W. E24 values to ±2% or ±5% are available in the 0.1-10Ω range. Operating temperature is –55°C to 150°C.
Mercator. Tel., 01493 334000; fax, 01493 334050.
Enq no 521

Power semiconductors

Power darlington. Zetex's new darlington, the *FMMT734*, has a voltage rating of 100V and will cope with the transients found in vehicles and motor-drive applications. At a current of 1A, $V_{CE(sat)}$ is 0.9V, so that this SOT23 device is rather more efficient than bigger types. Gain is 15k at 2A and the device is rated to handle 800mA collector current continuously, calculated power dissipation being 625mW.
Zetex plc. Tel., 0161 622 4422; fax, 0161 622 4420; web, www.zetex.com.
Enq no 522

Protection devices

Protective circuit breakers. *TA45* rocker and push-button circuit breakers from Schurter also provide power on/off switching to protect motors, transformers and wiring from overcurrent and consequent overheating. Additionally, they prevent an unwanted restart after a power failure and prevent starting unless safety guards are in place. The overload protection works with single-phase, three-phase and dc motor drives and loads, ratings being 0.1-20A at 230Vac/60Vdc and 8A at 400V ac.The devices are fully approved by the relevant authorities.
Schurter AG. Tel., 0041 413693111; fax., 0041 413693333; e-mail, contact@schurter.ch; web, www.schurter.ch.
Enq no 523

Switches and relays

Miniature power relays. IMO's new range of small power relays includes the *SRC* series, 10.2mm high types switching 10A and having Class B insulation, flux-tight or full sealing and recognition to UL/CSA/TUV; *SRD* types are similar, but a little bigger, both types having 1A spno contacts. *SRF* relays have a 200mW coil and switch 3A with spdt contacts. Finally, the *ET1* type is only 5mm thick, has 5A no contacts and a 120mW coil, 2.35kV isolation and is in a sil form.
IMO Precision Controls Ltd. Tel., 0181 4526444; fax, 0181 4502274; e-mail, imo@imopc.com; web, www.imopc.com.
Enq no 524

Miniature relay. Having a power consumption of 225mW, the *JS* relay by Fujitsu Takamisawa is suitable for continuous energisation and is fitted with silver tin oxide contacts giving a

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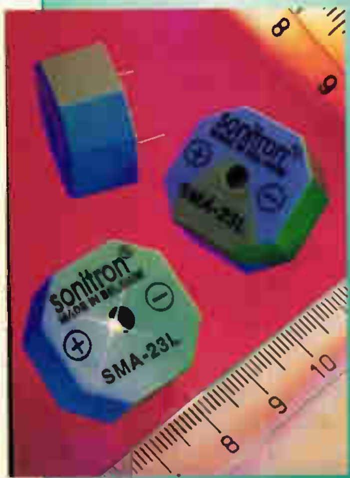
rating of 8A at 250V ac and a life expectancy of over 100 000 operations. There are changeover or spst types and, on the normally open version, a 5mm pitch to allow enough space on the board between open contact pins. There is also a spdt type with pins on a 3.2mm pitch. Surge protection on all is up to 10kV and dielectric strength is 5kV ac for a minute. The relays are fully sealed and certified to EN60950 and EN60063 and conform to various other standards.
Young-ECC Electronics. Tel., 01628 810727; fax, 01628 810807. e-mail, youngecc@compuserve.com.
Enq no 525

Transducers and sensors

Slot sensors. *UZJ* slot-type proximity sensors by Matsushita are general-purpose devices that appear to be able to cope with most situations, being made with a number of mounting facilities and offering the choice of a fixed cable or a connector. Output may be 'on' for light or dark, operating time is about 20μs and the sensors can detect even translucent targets of 0.8 by 1.8mm.
Matsushita Automation Controls Ltd. Tel., 01908 231555; fax, 01908 231599; e-mail, info@macuk.co.uk; web, www.mac-europe.com.
Enq no 527

Small buzzers – loud noise. Sonitron, a Belgian company, believes that its *SMA-23L* piezoelectric buzzer creates the loudest racket yet achieved from a 1.5-15V, 23mm diameter device. It has a height of 11mm, weighs 4.3g and, upon the application of 12V, puts out 95dB(A) at 30cm. The device draws under 6mA and comes in various forms, with leaded and surface types in several pin formations. It is said to be able to run continuously for an unimaginable 2000 hours.
Radiatron Components Ltd. Tel., 01784 439393; fax, 01784 477333.
Enq no 530



Two-wire **Hall-effect switches**. From Allegro comes the *A3161* two-wire, unipolar, Hall-effect switch ic, which operates over a –40°C to 85°C range and contains in the one package a voltage regulator, reverse-battery diode, a quadratic Hall sensor, temperature compensation circuitry, amplifier, Schmitt and a constant-current generator. The unit works from 3.5V to 24V, noise radiation being limited by slew-rate control of the current source. Four package styles are available, including the SOT-89 type and through-hole versions.
Allegro MicroSystems Inc. Tel., 01932 253355; fax, 01932 246622; web, www.allegromicro.com
Enq no 528

Ntc thermistors. *KTP-41-B1* by Shibaura is an ntc thermistor assembly with a resistance of 10kΩ ±5% at 25°C and 4100k ±3% B value in the 25 to 50°C range. Operating temperature is –30°C to 100°C.
BFI IBEXSA Electronics Ltd. Tel., 01622 882467; fax, 01622 882469; web, www.bfi.avnet.com.
Enq no 529

EQUIPMENT

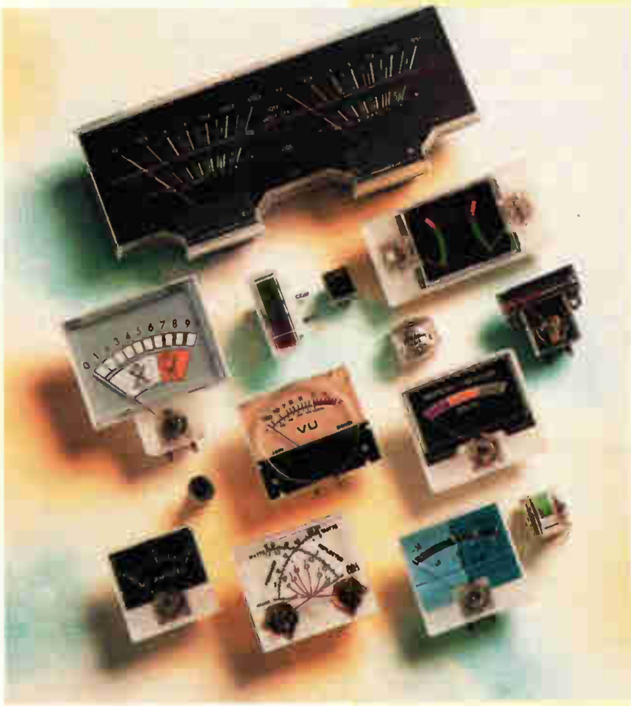
Communications equipment

Modem modules. *SocketModems* by Rockwell enable a single module to handle multiple data, fax and voice, including error correction and data compression, cellular protocols, simultaneous voice and data and speakerphone. The modules are 25.4 by 63.5mm. The modules may be easily up-graded in production or in use and have a separate line interface to allow different configurations worldwide.
Silicon Concepts Ltd. Tel., 01428 751617; fax, 01428 751603.
Enq no 531

Power supplies

Clever battery charger. For use with large batteries, Vicor presents its new 600W compact charger that combines the company's FlatPAC and BatMod units in one unit. The result is a processor-controlled charger having characteristics that are easily adapted for use with batteries of various types and to provide varying monitoring facilities. Float voltage and charge current are adjusted independently as charging proceeds and status data is relayed to a control point.
Vicor UK. Tel., 01276 678222; fax, 01276 681269, e-mail vicor@vicr.com; web, 'www.vicr.com.
Enq no 532

Programmable power supplies. TTi's *PL-P Series* is a range of supplies having both RS-232 and GPIB interfaces as standard, with overriding rotary controls for bench use, and provides the choice of single, dual and triple output versions. Each main output, working in constant-current or constant-voltage mode, puts out between 0V and 30V to a resolution of 10mV or 1mA. The triple-output model has a 4-6V, 7A output to power logic systems which has variable overvoltage protection. Regulation of outputs is better than 0.01% and noise under 1mV; transient recovery occurs within 20μs. In addition to the RS-232 interface, there is the Addressable RS-232 Chain (ARC) for control of up to 30 instruments. from a single pc serial port.
Thurlby Thandar Instruments Ltd. Tel., 01480 412451; fax, 01480 450409.
Enq no 533



3W, board-mounted supply. Eight models in Start Spellman's *MS Series* of pcb-mounted power supplies cover the 300V-3kV output range at 3W. Input voltage is 12Vdc ±1V and outputs are adjustable from zero to the maximum for each model. Ripple: less than 0.01% pk-pk; line stabilisation better than 0.005% for a 1V input variation; and load regulation better than 0.05% for 100μA-$V_{out(max)}$.
Start Spellman Ltd. Tel., 01798 873986; fax, 01798 872479; e-mail, hvsales@start-spellman.co.uk.
Enq no 534

Production test equipment

Protective burn-in sockets. *IC51* test and burn-in sockets by Yamaichi are made in clam-shell and open-top forms and there are versions for sops, plccs and the various types of qfp. To avoid damage to leads, the clam-shell type uses the company's parallel clamp mechanism, which provides for easy insertion and uniform pressure on the package top; it is also faster to use than other designs.

Analogue meters. A range of more than 50 compact moving-coil meters is available from Anders. *Componex Mini-Meters* come in various shapes, including round, rectangular and edgewise and, for volume users, any style can be made quickly; standard types being stocked by distributors.
Anders Electronics plc. Tel., 0171 3887171; fax, 0171 3872951; web, www.anders-electronics.co.uk
Enq no 538

Radiatron Components Ltd. Tel., 01784 439393; fax, 01784 477333.
Enq no 535

Radio systems

GPS module. SiGEM's *SGM5600S* GPS module comes with a claim to be the smallest available receive module at 89 by 33 by 8m in simm form and is thrifty enough with current from a 3.3V or 5V supply to comply with the needs of hand-held equipment. Warm start time is 7s and differential accuracy is to within 1m. No external parts are needed and the simm interface gives plug-and-play connection to remote active patch antennas. A design kit assists with evaluation.
Broadband Technology 2000Ltd. Tel., 01494 474800; fax, 01494 443100; e-mail, 100616.3040@compuserve.com.
Enq no 536

Test and measurement

Digital delay generator. *DG535* from Stanford Research provides four precise delays or two independent pulses with 5ps resolution and trigger-

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to-output jitter of under 50ps. Delays may be set at from 0 to 1000s after the trigger and the pulses are defined by the delay output pairs to determine leading and trailing edges. Triggering frequency is 0.001Hz-1MHz to 4-digit resolution and the instrument may be synchronised to the line voltage. Outputs are independently adjustable from –3V to 4V to within 10mV, rear-panel outputs providing ±35V replicas of the front-panel waveforms. AGPIB interface allows pc control. Timebase is internal or external, the internal one being either a 25 in 10^6 crystal or an optional 1 in 10^6 compensated type.
Thurlby Thandar Instruments Ltd. Tel., 01480 412451; fax, 01480 450409; e-mail, sales@ttinst.co.uk..
Enq no 537

Thermal array recorder. Gould offers the *TA-10* thermal array recorder to measure four or eight channels of direct and rms voltage and current and temperature and four or eight event channels. Delays during recording are avoided by the use of an lcd monitor to display signals under the array head, so that adjustments may be made before recording. Internal memory is 1Msample for the four-channel type and 4Msample for the eight-channel version, a built-in 3.5in floppy drive storing set-up and data. 270mm chart paper is used and sampling rate is 50kHz to a 14-bit resolution.
Nicolet Technologies Ltd. Tel., 01908 225630; fax, 01908 225633; e-mail, Nicolet_Technologies_Ltd@msn.com
Enq no 539

COMPUTER AND DATA HANDLING

Data acquisition

PCI card. Blue Chip announces the *PCI-ADC*, which is a 44-channel, multifunction data acquisition card based on PCI and running under Windows. Inputs and outputs are analogue or digital; eight differential or 16 single-ended analogue inputs give gains of 1, 10, 100 or 1000 and give readings to within 0.1% at varying levels, with auto calibration on high gains to remove offsets. Inputs down to ±5mV may be applied. The four 12-bit analogue outputs produce voltage or current and there are 24 programmable digital i/o channels arranged as three 8-bit ports into ttl. The board is PCI-compatible and it may be plugged and played.
Blue Chip Technology. Tel., 01829 772000; fax, 01829 772001; e-mail, sales@bluechiptechnology.co.uk; web, www.bluechiptechnology.co.uk.
Enq no 541

Data communications

Data baluns. Baluns by Cambridge Connectors allow 150Ω data connectors to interface with 100Ω RJ45 connectors and IBM cabling to be used when extending networks with Cat 5 twisted-pair cabling. The baluns are small and have a 90° entry to make for vertical insertion into the panel; they use both shielded and unshielded twisted pair cables and are available in Token Ring, 10Base T and 100Base Tx form.
Cambridge Connectors Ltd. Tel., 01223 860041; fax, 01223 863625; e-mail, Cambridge_Connectors@msn.com
Enq no 542

Development and evaluation

MACH pld development. Vantis has produced a starter kit to allow the evaluation of in-system programming of MACH programmable logic devices. *Synario Starter* software comes with *MACHPRO* on a cd-rom and the kit includes MACH devices to allow design, simulation and programming and a 44-pin board, manual and data sheets for all available devices.
Farnell Components Ltd. Tel., 0113 263 6311; fax, 0113 263 3411, web ww.farnell.com.
Enq no 543

Software

Thermal analysis. New thermal analysis software from Flomerics, the *FLO/MCAD* package has reduced design time by simplification. FLO/MCAD takes a model created by the Mechanical Computer-Aided Design (MCAD) package, with much detail that is irrelevant to thermal analysis and insufficient data on thermal properties and boundary

Computer board-level products

Dual Pentium II board. ICP's *Rocky-P228* is a dual, Pentium II single-board computer based on the Intel 440LX ISA/PCI chipset and takes dual Pentium II 233/333MHz MMX processors, up to 384Mb of sdram and 72Mb of disc flash. It has the Ultra DMA/33 and ATA-E-IDE dual-channel interface, a floppy interface, two serial 16C550 RS-232C ports, an EPP/ECP parallel port and serves a PS/2 mouse and keyboard. Sideways mounting reduces size and heat dissipation and there is a system to monitor power supply status and fan speed.
Wordsworth Technology. Tel., 01732 861000; fax, 01732 863747; e-mail, sales@wordsworth.co.uk; web, www.wordsworth.co.uk
Enq no 540

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conditions, and simplifies it for analysis, whereas simply using the whole model could take weeks.
Flomerics Ltd. Tel., 0181 9418810; fax, 0181 9418730; e-mail flomerics@flomerics.co.uk; web, www.flomerics.com.
Enq no 544

Tailoring data acquisition. *DIAdem v.3* by Gfs mbH of Aachen is now improved with increased speed and versatility for the origination of data acquisition, analysis and graphical software. No programming is needed to produce extensive applications with dialogues for data entry, displays and help files, all with no requirement to know anything about DIAdem. Users' own software, such as hardware drivers and calculation, may be added, the whole resultant package running with DIAdem. Modification is simple because no programming knowledge is needed.
Strategic Test and Measurement Systems Ltd. Tel., 01203 323160; fax, 01203 323161; e-mail,info@strategic-test.com; web, www.strategic-test.com
Enq no 545

PUBLICATIONS

Catalogues

Molex connectors. Hawnt Electronics has produced a CD-rom that works with the Internet to provide a complete reference to Molex connectors, Hawnt being the largest UK distributor. Apart from technical data, there is also video and a high-speed search engine for cross-reference with other manufacturers. If the rom is used while the Internet is connected, a link ensures that the latest information on the page in use is provided.
Hawnt Electronics Ltd. Tel., 0121 7843355; fax, 0121 7831657; web, sales@hawnt.co.uk.
Enq no 546

Farnell. Farnell's June 1998 CD-rom set is available and contains more than 15,000 data sheets and application notes. It comes with the Semiconductor Applications Directory, which contains help on the use of devices from Siemens, Burr-Brown, Philips, Dallas, Zetex and Motorola. In addition, the Semiconductor New Products Supplement has more than 850 new devices from the major companies. All are free of charge.
Farnell Components Ltd. Tel., 0113 263 6311; fax, 0113 263 3411, web, ww.farnell.com.
Enq no 547

4000 catalogues. For those whose shelves groan with the weight of catalogues, Technical Indexes has produced the *CD-rom Engineering Product Library*, which is not only extremely comprehensive but also much lighter and a lot faster to use. It covers other fields, but the electronic section, available on its own, holds more than half a million catalogue pages from 4000-plus companies. It runs in Windows and includes information on components, hardware, instruments and power sources, being capable of stand-alone working or networked over lans or wans.
Technical Indexes Ltd. Tel., 01344 426311; fax, 01344 424971; web, www.techindex.co.uk
Enq no 548

Application notes

Power supplies. Artesyn Technologies has produced the *1998 Power Supply Handbook*, containing performance specifications and design data for the company's full range of ac/dc supplies, dc-to-dc converters and dc/ac ring generators. Artesyn was formed by the merger of Computer Products and Zytec and the free handbook contains the products of both companies, detailing more than 1200 products.
Artesyn Technologies. Tel., 00353 2425272; fax, 00353 2493510; e-mail, jackie.day@artesyn.com.
Enq no 549
■

WATCHDOG has extra teeth

Watchdog timers shut down a microcontroller system in a controlled manner in the event of a software bug or pending mains failure. Most watchdogs derive their 'power ok' signal from the rectified dc power supply. Ted Crowley's general-purpose design reacts faster, monitoring the power supply on the ac side.

Unlike dc monitoring watchdog supervisory chips, this circuit monitors the incoming ac supply. It is capable of generating a reset after the loss of a half-cycle of the incoming 50/60Hz supply, provided the values of C_2 and/or R_7 on pins 14 and 15 of IC_1, are carefully selected.

If capacitor C_2 is 0.1μF and R_7 is 680kΩ the circuit will ignore a single half-cycle loss, but will normally generate a reset after the loss of one cycle, assuming 50Hz.

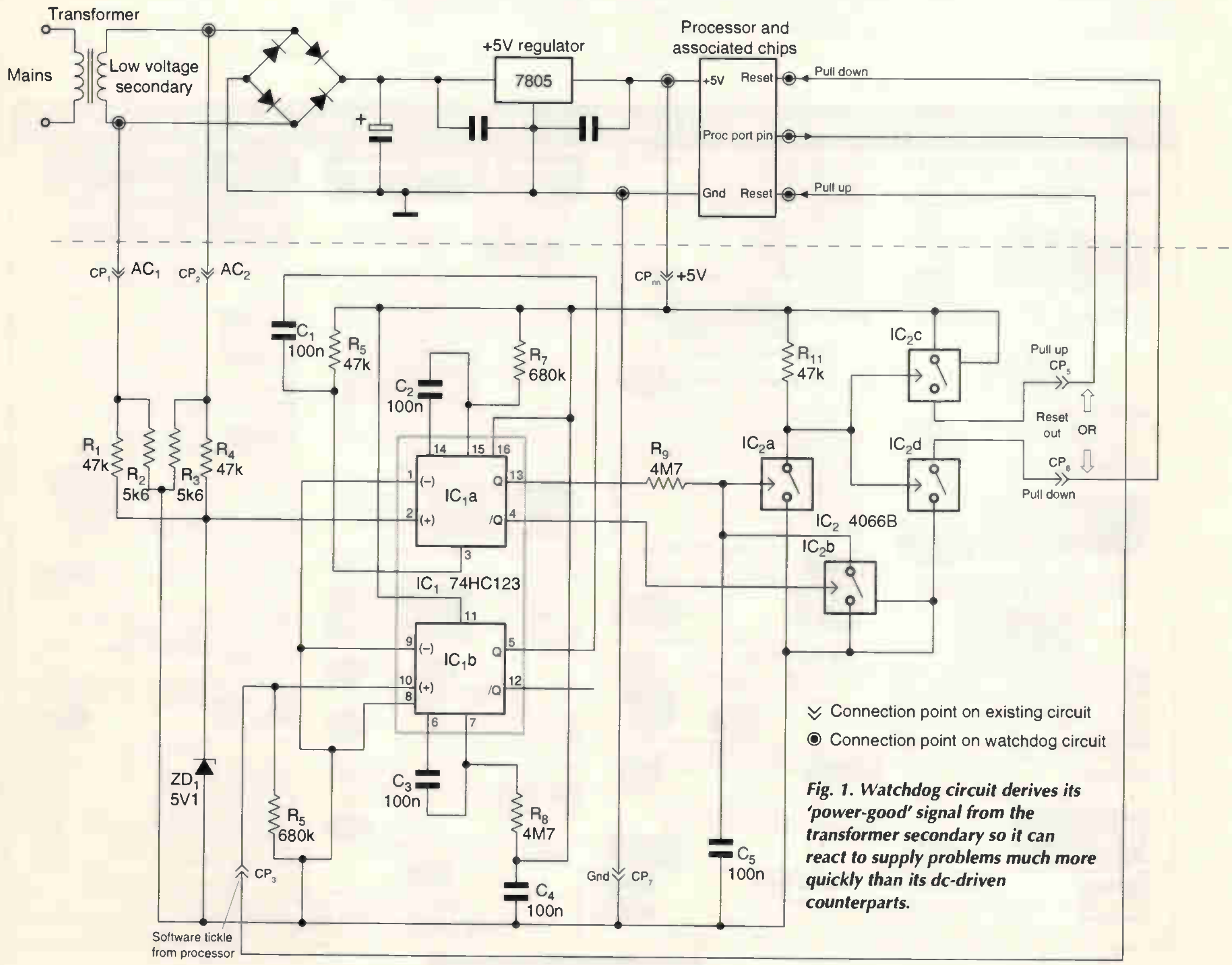

Fig. 1. Watchdog circuit derives its 'power-good' signal from the transformer secondary so it can react to supply problems much more quickly than its dc-driven counterparts.

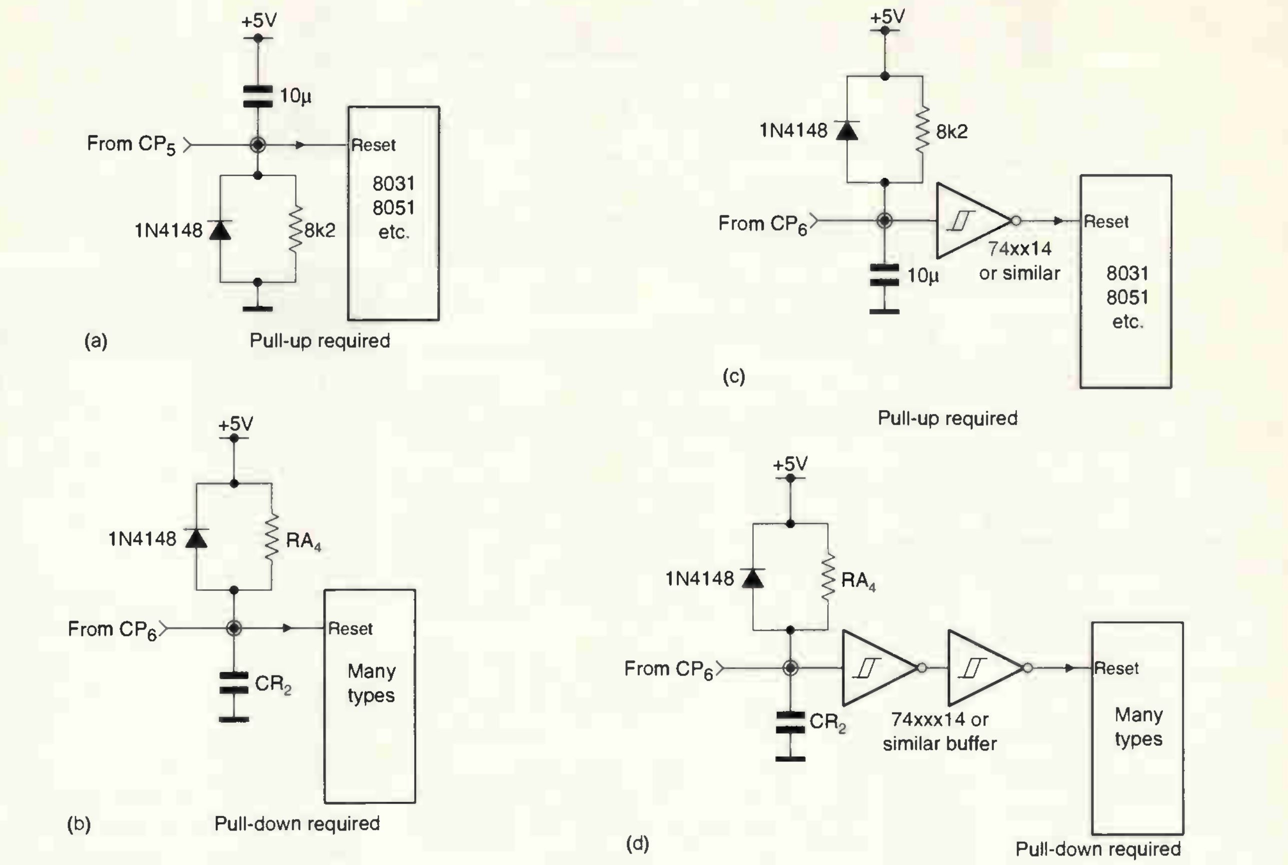

Fig. 2. The general-purpose reset output signals from the watchdog timer need modifying to suit the type of microcontroller involved. These four arrangements should cover most applications.

Connection points

Seven connection points, $CP_{1\text{-}7}$, are provided in the design, **Fig. 1**. They have the following functions:

CP_1 – AC input 1. Connects directly to one terminal of the secondary of the isolated mains transformer, which generates the +5V supply for the processor.

CP_2 – AC input 2. Similar to CP_1. This point connects to the other terminal of the transformer secondary. The waveforms on CP_1 and CP_2 are combined at pin 2 of IC_1, to produce a full-wave rectified waveform. This waveform comprises two positive-going clipped half sine-waves per input 50/60Hz cycle.

CP_3 – Software tickle. This signal comes from the processor. The card accepts a pulse waveform from the processor directly, or from an associated chip, such as a port expander. These pulses indicate to the watchdog circuit that the processor has not crashed.

Should the waveform from the processor at CP_3 fail for a period longer than set by C_3 and R_8, on pins 6 and 7 of IC_1, that part of IC_1 sends a reset pulse to the processor. It does this by resetting the other monostable in IC_1, via C_1.

If the duration determined by C_3 and R_8 does not match the software, C_3 and/or R_8 may be changed in value. If no software tickle waveform is available, or that feature is not required, CP_3 may be left unconnected.

CP_4 – 5V in. Accepts the +5V supply to the watchdog circuit. Normally, the +5V supply will be taken from the same supply as the processor being guarded by the watchdog.

CP_5 – Reset output, pull-up. This connection point is for use with processors that need their reset pin pulled up to +5V to cause a reset, Fig. 2. This connection point is intended for processors, mostly from the 8051 family, including the 8031, 87C51, etc.

CP_6 – Reset output, pull-down. Find out whether there are any reset waveform active shapers or buffers between the watchdog and the processor reset input and use CP_5 or CP_6 as appropriate.

In all cases, connect CP_5 or CP_6 to the point in the passive components where the reset waveform is first generated. **Figure 2** shows typical arrangements found on processor cards.

CP7 – Supply ground. This point connects to the same ground, or common, as used on the processor card, **Fig. 1**.

Circuitry in the top area of Fig. 1 shows a typical connection to the isolated secondary of a power supply transformer.

In all cases, the positive-going peaks of the pulses at pin 2 of IC_1 should exceed 3.5V, above ground. The negative-going crests should reach ground potential, or within 0.2V or so of ground.

Keeping it awake

If a controller output pin is available, a simple software loop called at regular intervals will suffice to toggle the pin driving the CP_3 watchdog input.

It may not be necessary to modify the software at all to obtain a watchdog output for driving CP_3. Examine the controller system to find out whether its software polls an external device at regular intervals. This polling waveform may well be suitable for energising IC_1 at pin 10, via CP_3.

Alternatively, if the software drives a led indicator, and no other processor pin is available, it may be possible to perform a complement – i.e. 'CPL' in the 8051 command set – on the signal driving the led. Alternating the signal in this way produces the tickle necessary to tell the watchdog that the processor software is operating correctly. ■

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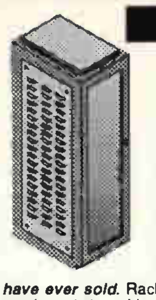

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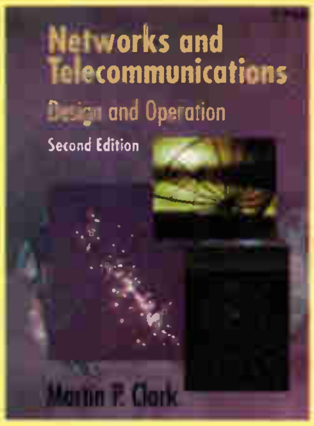

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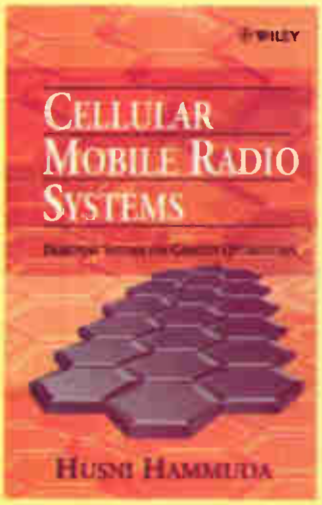

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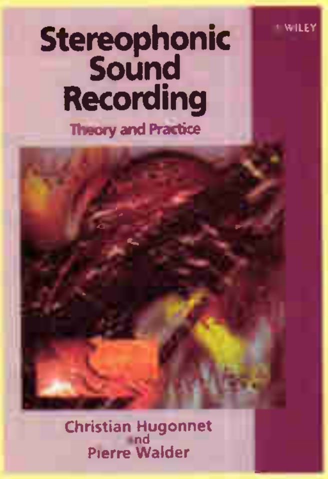

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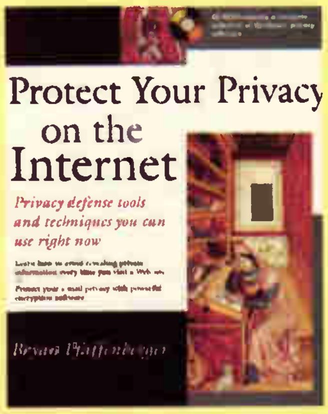

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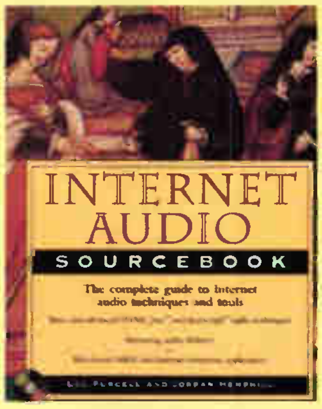

The complete guide to Internet audio techniques and tools
Lee Purcell and Jordan Hemphill

"The World Wide Web has spouted vocal cords, gained a voice, and begun to sing." – Lee Purcell and Jordan Hemphill

Internet Audio Sourcebook offers you a quick, easy way to acquire the knowledge, skills, and some of the tools you need to build cutting-edge audio capabilities into your Web pages, including:

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Finally, the authors show you how to get the most out of new audio technologies, including streaming audio, MIDI applications, voice synthesis and recognition, and Internet telephony, as well as covering hot new products like the Headspace Beatnik audio engine and Liquid Audio.

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Aviel D. Rubin, Daniel Geer, and Marcus J. Ranum

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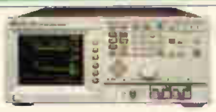

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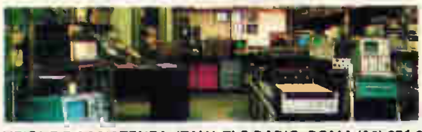

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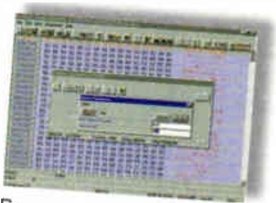

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