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PC ENGINEERING

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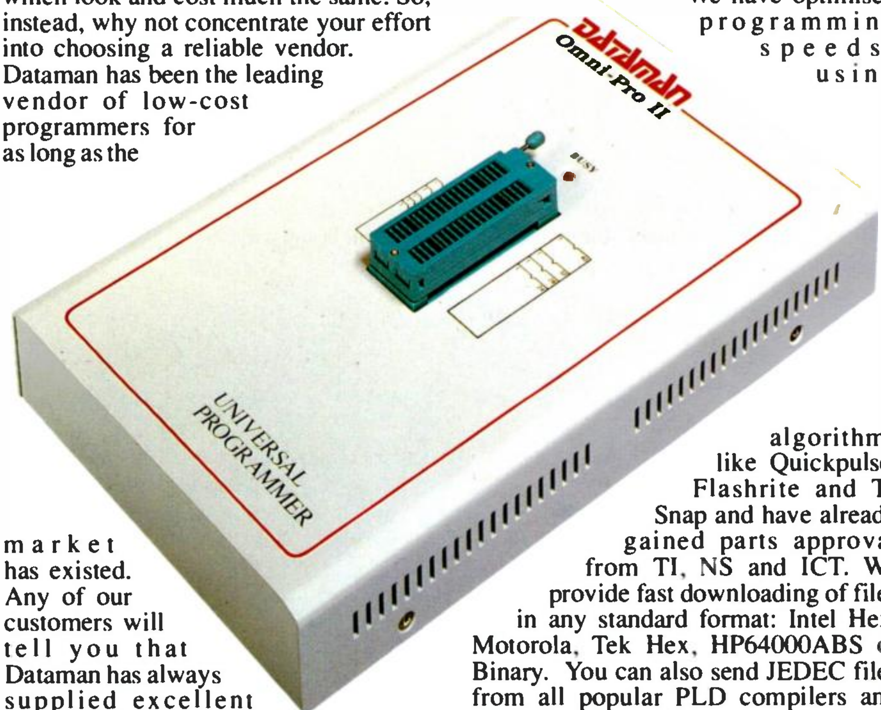
HYPOTHESIS

Holes in the standard theory of electro-magnetism?

Omni-Pro II - The Next Generation

When you get a new product, what are your main concerns? Freedom from frustration is certainly one important consideration, for your time is valuable. You will want a product which is reliable and sophisticated, yet simple to use, with clearly written documentation. You will be looking for a high standard of technical support and regular upgrades for the product.
We at Dataman recognise how difficult it can be to choose between programmers which look and cost much the same. So, instead, why not concentrate your effort into choosing a reliable vendor. Dataman has been the leading vendor of low-cost programmers for as long as the market has existed. Any of our customers will tell you that Dataman has always supplied excellent well-supported products.
That's why we're still here! We take technical support seriously. We give you your money back, if you're not satisfied. These are important points to consider. But now let's take a look at some of the special benefits of owning Omni-Pro II.



What Benefits?
Well, for instance, the interface is not via the computer's parallel port, which is speed-limited, and probably connected to your printer. A dedicated plug-in half card performs fast data transfers.
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CONTENTS

FEATURES

cover illustration Jamel Akib

REGULARS

In next months issue: Don't lose your way in circuit design. Following on from the fluxgate magnetometry article in the September issue, Richard Noble extends the design process to a high accuracy electronic compass.

Space for the dreamers

A highly speculative hypothesis on electromagnetism might seem an odd choice for our cover subject. When you commence reading Dr Julian Millar's article, you might well decide that his arguments are decidedly odd, full stop.

I make no apologies even though I personally take issue with a number of points. At the centre of Dr Millar's argument is an assertion that the common place effects of electromagnetics – attraction, repulsion, induction and remanence could be better attributed to bulk effects of electrons and holes moving dynamically within a body. He suggests that these exchange energy at the external surface boundary with as yet uncharacterised particles. Rather self-consciously, he calls these phaeons.

Mirroring the holes and electrons of conventional solid-state physics, Dr Millar hypothesises that energy exchange at the surface gives rise to n- and p-phaeons. Looking very much like photons, these particles, he suggests, have direction and spin and are thus capable of producing/inducing a polarised force – and charge – at a distance.

A conventional physicist immediately says "but holes move about too slowly to fit the description". Dr Millar ingeniously brings in Lorentz compression to argue that it is the relative velocity of holes and electrons which is important, not their absolute values.

He even finds a place for permanent magnets in his scheme of things although at this point, he admits, the whole thing becomes "highly speculative". An understatement if ever I heard one.

Conventional physics has yet to separate Millar's ubiquitous phaeons. But against this, physicists can't adequately describe gravity.

I subsequently applied Occam's Razor to the Millar hypothesis to decide that his explanation was far too convoluted to be the most likely explanation of observed facts.

It took a subsequent conversation with a physicist friend to remind me that conventional science is paradoxical. Astrophysicists currently maintain that spinning neutron stars emit electromagnetic radiation. Now every schoolboy knows that neutrons are uncharged particles. How can it be that great lumps of uncharged spinning matter radiate energy? Of course they can't unless there is a unification theory waiting to be discovered.

Well considered ideas deserve an airing, even though unlikely at face value. You can't predict where they may lead although the overwhelming odds are a dead end.

I wish Dr Millar and all the other dreamers the best of luck.

Frank Ogden

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Will interactive video electrify the consumer?

Confounding gloomy predictions of missed dates, Philips launched a domestic CD-I player in North America in October, exactly as promised.

The launch on time confirms that a great deal has changed inside Philips over recent years, following the arrival of new supremo Jan Timmer.

It was Timmer who ten years ago, when he was head of Philips' subsidiary record company Polygram, convinced the industry to adopt CD. Timmer has since then been preaching the gospel of DCC, the digital compact cassette. That too looks like being a winner when launched next year.

The official launch of CD-I in the USA was a neat blend of show biz hype and serious business talk. The general consensus of opinion was that Philips was giving CD-I its best shot. Significantly, the Japanese who are supposed to be backing CD-I, Sony and Matsushita, were not in on the launch. True to form they are sitting back and watching how Philips fares. This is exactly how the Japanese cleaned up on the video market over ten years ago.

But Philips under Timmer is a very different company. The Dutch will not be handing the interactive CD market to Japan on a silver platter. For one thing, most of the CD-I software available has been developed by Philips subsidiary company, PIMA, Philips Interactive Media of America, formerly known as American Interactive Media.

Even if the Japanese undercut Philips on CD-I hardware, by leaving Philips to spend over £20 million on advertising to open up the market, Philips will still make money out of the software discs.

Although no-one says it, everyone knows that the American launch is a test bed. The challenge is in getting the public interested in a completely new concept.

"But we need all our marketing flair, all our imagination to get the public to accept this new medium", says Timmer. "We have to devise ways and means of making people aware of what CD-I offers. You cannot describe interactive multimedia on paper".

"It's like trying to describe the smell of a rose to someone whom has never smelled one", says Gordon Stulberg, head of PIMA.

The player will sell for around $800 a time. The launch catalogue has around 30 titles, costing between $20 and $50. PIMA promises more than fifty titles by the end of this year and over one hundred by mid-1992.

In many respects Philips' publicity campaign for CD-I in the US press parallels the publicity which Commodore used for its rival and incompatible interactive video system, CDTV, earlier this year.

"The inventor of CD technology presents a whole new way of looking at television", trumpets Philips.

"Honey, turn on the TV, I'm trying to think", said Commodore of CDTV.

But Commodore failed to follow through. It would be hard to find anyone outside the industry who even knows what CDTV is, let alone what it can do. Commodore in the UK promises that it has learned from mistakes and will now be getting better software and more players into the market with a coherent policy on demonstrations. But we heard this before, at the CDTV launch, when Commodore people brazenly promised players and software that just weren't ready. This kind of behaviour may get by in the computer industry, where they laugh about "vapourware", but the consumer electronics industry has much higher expectations of truth.

Kiss of death for CDTV?

Even if the latest promises from Commodore are true, it may already be too late for CDTV. When asked about CDTV at an Oxford Street branch of Dixons recently, the staff said "Yes, we have them in stock, but they are not on demonstration".

Putting the audience in the picture. Potential punters, like these at the Ideal Home Show, have yet to grasp the importance of interactive video

This smells like the kiss of death from the UK electronics goods chainstore, who are well known for dumping any product that does not sell. They just pile it high at half price or less. Dixons game plan may well be to get CDTV out of the way in time for the CD-I launch in Europe next year. The less noise they make about CDTV, the less confusion there will be when CD-I appears.

Just about everyone in the interactive CD business recognises that there is no point in even trying to tell the public that a five inch disc can store 650 megabytes of digital data, and the player can unravel a mix of 250,000 pages of text, 7000 photographic quality still pictures, 19 hours of sound, cartoon animation and even moving video.

This is computer industry talk. Says Gordon Stulberg, "the computer industry has got it wrong, over and over and over again. They have addressed their products to the business community, not the consumer".

The only way to sell interactive multimedia to the consumer, is to give the public a hands-on opportunity to find out for themselves what it offers. Learning from Commodore's mistakes Philips is launching CD-I in a 1000 retail outlets across the USA, with a hands-on demonstration kiosk in each shop. The kiosk has a CD-I player, tv screen and remote control. Philips claims that it is training 2500 shop staff to help customers use these kiosks and will spend over $20 million over the next year on advertising to bring customers into the shops and within reach of a demo kiosk.

The CD-I player will also play audio discs and the discs for the Photo CD system which Kodak will launch next year. Timmer stresses the importance of this because of the limited space people now have for yet more electronic equipment.

Again with a nod to Commodore's mistakes, the CD-I player does not require the disc to be loaded in a protective caddy before it plays. The Commodore CDTV player will only play discs in a caddy. Caddies are hard to find in theshops and cost almost as much as an audio CD.

All round there are encouraging signs that Philips has thought CD-I through as well as DCC. But whereas DCC can record, CD-I is a playback-only medium wholly dependent on the availability of software which people want to buy.

This is why Philips has spent five years priming the pump with the development of software, first by AIM (American Interactive Multimedia) and now with PIMA.

The CD-I launch titles include material which is well-known to the industry (*Treasures of the Smithsonian Museum*, a *Sesame Street* childrens' program, The Time-Life *photography tutor*, which lets people see the effect of snapshots taken with different exposures, without using any film, and the *Palm Springs Open Golf Tournament*, which lets users challenge professionals to a round of golf). But for the world at large it is a whole new world.

The problem is that although all of this software appeals to someone, none of it appeals to everyone.

Putting the wheels in motion

The Imagination Machine (Philips self-proclaimed name for CD-I in the US) does not yet have full motion video but it is upgradeable. And Philips pledges that when CD-I is launched in Europe next year it will have FMV from day one. Already PIMA is working on a title which tells a story with alternative middles and endings.

Once people have bought CD-I players to play an irresistible game, they will be a sitting target for more serious software, like visual coffee table encyclopedias, and spin-off applications such as photo CD.

Jan Timmer is right when he says that everyone who thinks about CD-I immediately thinks of some piece of software they would love to see and use. Some want to use CD-I to help them mend a broken car, others want to use as an aid for dress-making. The branched choices and visual displays would make it the ideal aid for identifying plants or edible fungi. All round, the opportunities for the software industry are obvious.

But first the public at large must embrace the idea of CD-I. The US launch will give the first real pointers on how long this will take. **Barry Fox.**

Low-cost poserphone plan

Vodafone plans a new low-cost, urban-based portable service aimed at the consumer market in Spring 1993.

Calls to the fixed network will cost 10p per minute for local calls originating in a subscriber's home town,15p per minute for local calls originating in other urban areas and 20p per minute for national calls.

Subscribers will also pay a one-time £30 connection charge and a £20 monthly subscription charge. Vodafone hopes that portable telephones will be available for less than £200

The company plans to introduce the service, known as Vodafone MCN (Micro Cellular Network) into London and towns and cities in the South East of England, and then roll-out to cover the Midlands, North England and Scotland. A third and final roll-out phase will cover the West and South of England, Northern Ireland and any remaining towns by early 1995.

MCN will be based on the GSM (Groupe Special Mobile) pan-European standard.

To access the national and pan-European GSM services, MCN subscribers will need to plug their handsets into a power boosting car adaptor. They will be able to make calls while travelling outside of the MCN service coverage area and will be charged a premium call rate.

The company believes that this approach could be implemented in all GSM systems throughout Europe and so provide the platform for a Europe-wide business and consumer mobile phone market.

Planned coverage map for the UK's GSM mobile phone network.

GSM uses digital audio technology and embodies advanced network features. It is expected to become the standard for cellular radio for the next 20 years. Vodafone MCN will be based on frequencies in the 900MHz band.

Vodafone currently has a 56 per cent share of the UK mobile telephone market.

US television dialling in to BT's numbers?

Britain's cable television companies are about to prove that BT's dominance of the nation's local telephone services may not be impregnable.

Untouched by five years of competition from rival Mercury Communications, BT's virtual monopoly over Britain's 20 million residential telephone lines may be about to face its biggest challenge.

North American backed cable television companies are preparing to take on the giant which the Government and Mercury sense is the best and possibly last chance to attack their old adversary in its stronghold.

Peter Lilley, Trade and Industry Secretary,

Will she be disconnected if the US cablevision companies offer a real challenge to BT's domestic phone monopoly?
Subscribers will soon able to hook their phones into into the networks used for cable TV

told executives from the UK's 28 cable companies at a recent meeting in London that the Government no longer distinguishes between their cable TV and telephony services.

In addition to cable TV services, Lilley said all franchises must make clear their plans to offer local telephone services. And this time he means business.

Any cable companies which have not applied for a telecommunications service licence by the end of January next year risk losing their franchise. "I'll challenge these holders to show evidence of action or make way for others." Lilley warned.

But Lilley is pushing at an open door. Many of the most aggressive cable companies, financed by US telephone operators, have already connected up 16,000 UK telephone subscribers and growth is booming at a rate of 3000 a month.

Over half of the UK's 132 cable franchises are controlled by six cable operators. By far the largest stake holders are the US "baby Bell" telephone operators and North American cable companies: they are drawing up plans to carve up shares of the UK's 20m residential telephone users.

Engaged tone for Mercury

Those plans have started to take shape in the last few weeks with the active involvement of Mercury Communications. Mercury, the UK's second public telephone operator can provide the long distance and international telephone connections the cable companies need for their services.

But Mercury needs the cable companies as much as they need it. Currently Mercury is connecting between five and ten thousand residential customers a month. At that rate it will be 20 years before it has 2 million subscribers or 10 per cent of BT's residential business.

The cable companies are already connecting over 3000 new customers a month to Mercury's network, and according to Andrew Sangster, general manager of Mercury's business with the cable companies, that figure is growing rapidly: "In the last four weeks cable companies have connected as many telephone customers as they did in the whole of last year." says Sangster.

There is a new force in the local telephone market and Mercury intends to take advantage of it. Last week the company signed an interconnect agreement with multiple cable franchise holder Videotron. This, at a stroke, gives Mercury access to a potential 1.1 million new customers in London and Southampton.

This follows a similar interconnect deal with baby Bell US West last year which has interests in a large number of franchises covering 2.4 million potential telephone users.

Mercury is doing more than offering the cable companies exchange lines. According to Sangster Mercury is putting "many millions of pounds" into these cable franchises to promote the telephone services.

The national operator has no plans to take equity stakes in any of these franchises itself but it is working closely with key cable owners such as Videotron, US West and Nynex to increase their cable interests. "We want the telephony expertise spread across a number of franchises." said Sangster.

The creation of large groups controlling a number of important franchise areas is changing the odds in the cable telephony business. Mercury recognises this and so does Sir Bryan Carsberg, director general of Oftel, the UK's telecomms industry regulator.

In future, says Sir Bryan he will more sympathetic to the needs of multiple cable franchise holders trying to build networks in a number of areas.

Sir Bryan is confident that the cable companies are about to mount the long awaited challenge to BT's local monopoly. "I am confident it's starting to happen now" he told the cable companies last week.

BT could be wrong-footed by the growth in cable telephony. Its original interests in ten UK cable franchises were allowed to dwindle in the run up to last year's duopoly review. But the operator's plan to bully Oftel into allowing it to carry TV programmes on its telephone network back-fired.

It will be at least 1998 before it will be allowed to carry TV services in competition to the cable companies. In the meantime its local telephone market will be whittled away by half a dozen cash-rich US operators. BT will be most alarmed by the new co-ordinated approach to the UK market orchestrated by its rival Mercury.

The industry believes BT could regret its policy of getting out of cable. "When you think that the (other) operators are chipping away from the roots of the tree, it was a very bad mistake." comments Chris Quinlan, marketing director of cable systems supplier Cabletime.

No one in the cable industry has any illusions about the difficulty of smiting the BT giant on its home ground. Only now they believe they can win.

Richard Wilson,
Electronics Weekly.

REGULARS

RESEARCH NOTES

Non-stick molecules for tomorrow's electronics

Polytetrafluoroethylene (PTFE) is among the most hyped of all plastics – the space-age material that brought you non-stick frying pans. (It wasn't in fact discovered by the space industry). Now, not content with serving merely the needs of frictionless bearings in the far distant solar system or non-drip fried eggs in the kitchen, PTFE is about to spring another surprise or two.

Jean Claude Wittmann and Paul Smith, working at the University of California at Santa Barbara, have recently published a paper (*Nature*,Vol 352, No 6334) showing how PTFE can be used as a substrate on which to crystallise or synthesise other substances with a high degree of molecular alignment.

The interest in molecular alignment stems from the fact that the properties of many polymers and crystals change dramatically as their molecules are placed in some sort of order. (Just think of the dramatic changes in the properties of liquid crystals as their molecules are lined up by means of electric fields). Ordered molecules can mean an increase in strength or stiffness of two orders of magnitude; they can also lead to improvements in everything from optical transparency to electrical conductivity. Polyacetylene is an example of an ordered molecule which, under certain conditions, can have a conductivity comparable with that of metals.

What Wittmann and Smith have done is to demonstrate how PTFE can be used to produce order from disorder in other molecules that don't themselves show a strong natural tendency to order. To this end they were prompted first of all to consider the well understood process by which PTFE achieves its low coefficient of friction when rubbed against other substances.

If you take a stick of PTFE and rub it across a smooth surface such as a sheet of glass, long molecules of PTFE are dragged out of the bar and form an orderly array on the surface of the glass. Slippage then occurs between these ordered molecules and the bulk of the PTFE bar. But could the glass with its 5nm or so layer of ordered PTFE molecules then be used as a substrate on which to deposit other molecules in orderly arrays ?

Wittmann and Smith have now demonstrated convincingly that a whole range of substances from polyaniline to thallium chloride can indeed by synthesised or crystallised with their molecules orientated to match those of the PTFE substrate. What's more, the PTFE layer is completely unaffected by aggressive chemicals used in the process (polyaniline is precipitated from 96% sulphuric acid). In this respect the PTFE film method in lining up molecules scores heavily in favour of techniques like Langmuir-Blodgett films which require the material to float on water.

The real significance of this latest research is the possibilities it opens up for the manufacture of novel electronics materials. Since electronic mobility is known to be enhanced by the degree of molecular order in a material, it seems highly probable that new practical conductors or semiconductors will emerge from further research – particularly in the area of long-chain polymers. Already several teams have experimented with a polymer sexithiophene as the active material in fets. More practical avenues are now likely to open up.

How to keep a quantum secret

Cryptography has a long and fascinating history going back to 400BC at least, perhaps even further if you include the Tower of Babel as a legitimate attempt to keep communication secret. Today, secret coding plays a vital role, not just in obvious applications such as covert military communications. Virtually anyone who uses a computer employs some sort of key to gain access to their files; all sensitive data travelling over networks – public or private – needs some form of encryption. So too do pay-TV signals.

Throughout history, secret codes have come progressively more difficult to break. Early codes – like those used by schoolchildren – employed some simple key, such as A=l, B=2 etc. Once an eavesdropper had worked out the key, all subsequent transmissions would then be a very open secret.

As time went on, coding techniques became more complex, leading to the inevitable cat and mouse game between code makers and code breakers. The Allied victory in World War II owed much to Britain's cryptographers being one step ahead of Germany's.

Today, the same game is played out using the enormously powerful number-crunching capabilities of supercomputers. A coding key usually consists of a very long string of random digits, so long that even if the encrypting algorithm is publicly available, the chances of intercepting and decoding messages is small. Nevertheless the possibility does exist, especially at the vulnerable stage when the key has to be communicated between the sender and the recipient of the message.

A new approach, proposed recently by Arthur Ekert of Merton College Oxford (*Phys Rev. Lett vol 67 no 6*), makes use of quantum channels. These, in theory, would allow a key to be communicated to two parties without any risk of interception. Or if interception did occur, it would be apparent.

Ekert's idea is based in Heisenberg's uncertainty principle which dictates that certain properties of fundamental particles, such as position and spin cannot simultaneously be known. If you attempt to measure one of these quantities, you disturb the other. So anyone attempting to eavesdrop on a quantum channel would instantly betray his or her presence.

The proposal makes use of a quantum channel created when an atom decays and sends out pairs of particles, in this case one particle to each end of the quantum channel. These particles carry a quantum property known as 'spin', which can be measured as 'up' or 'down'. As emitted, each pair of particles has correlated spins.

Because of this correlation, each legitimate communicator can receive the information needed to create a common key. Independent checks can be made on the presence of an eavesdropper by analysing the statistics of the whole data stream.

Ekert points out in his paper that the eavesdropper cannot extract information from the particle stream because there is no information encoded there, only statistically correlated properties. The information exists only when the legitimate users perform measurements and then subsequently communicate publicly.

The mathematics of these measurements is complex, as is the technology necessary to implement such a system. Ekert is nevertheless confident of some experimental realisation in the near future... provided that someone doesn't steal the idea.

First stable non-metallic magnet

A team at the University of Tokyo, led by Minoru Kinoshita has published details (*Phys Rev Lett*, Vol 67, No 6) of what may prove to be the world's first organic magnet that is chemically stable at room temperature. This qualification is important because other groups have produced organic magnets that exhibit ferromagnetism, but which decompose rapidly on exposure to air. Examples of the latter have been synthesised by chemists at DuPont in the USA and at Leeds and Durham in the UK.

The new Japanese material, called para-nitrophenyl nitronyl nitroxide (p-NPNN) is chemically stable, but unlike the other contenders in the race for a practical organic magnet, has to be cooled to 0.65K to demonstrate its magnetic properties. This transition temperature may be rather low, though in the light of what has happened in the field of superconductivity, it may just be a matter of time before things change rapidly in this area.

The other exciting aspect of this latest Japanese work is that the chemical structure of the p-NPNN is well defined. Most of the other contenders in the field of organic magnetism either have ill-defined or variable chemical formulae. The advantage of a clearly defined structure is that future experimental work – both in terms of synthesis and subsequent analysis – will be readily repeatable and less of a cook-book activity.

Virtually all existing magnets are made from alloys or compounds containing transition metals from groups 3d or 4f of the periodic table. Cobalt, neodymium, samarium and of course iron are familiar examples. Here the magnetism derives from the fact that all unpaired electrons can have their spins aligned in the same direction.

In the case of p-NPNN, the molecule has an unpaired electron which behaves in some respects like a metal ion. The Japanese researchers point out, though, that because organic radicals rarely have the high spin rates necessary for ferromagnetism, there will be great problems ahead with any attempts to make a very strong organic magnet.

A practical, strong magnet made of light plastic material is clearly some way off yet. Nevertheless, if such a goal is ever achieved it will revolutionise a whole range of machinery that currently depends on large, heavy metal magnets. Lightweight motors might even herald the all-electric aeroplane!

Flying robot challenge

In an effort to stimulate thought on a new generation of flying robots, Georgia Tech recently sponsored a student design competition.

It seemed like a simple enough task: move six metal discs from one side of a volley ball court to another in three minutes or less. But for five groups of college students taking part, the assignment proved difficult.

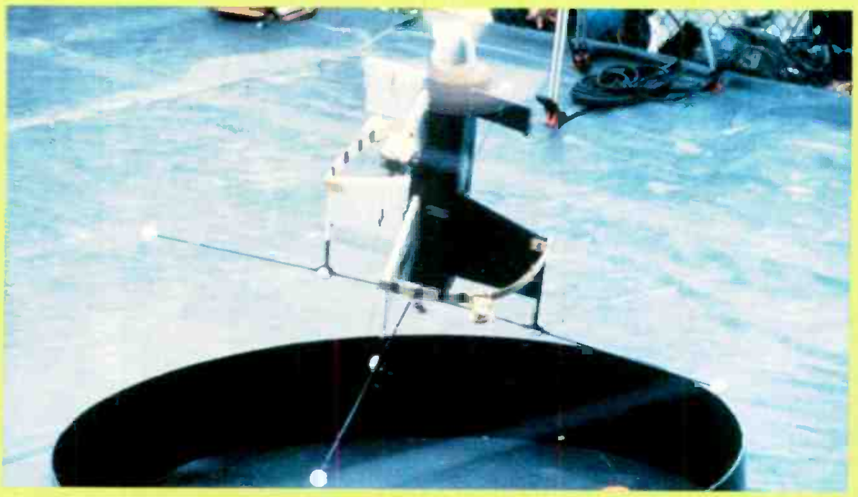
Once the vehicle was started, each robot had to travel on its own, using machine vision to see and interpret where it was going. It had to search for the disc, pick it up, fly across the barrier and drop it in a designated place.

For the most part, the vehicles were built from existing off-the-shelf equipment. The Georgia Tech team, for example, adapted a small radio-controlled helicopter originally designed for use in the movie industry.

None of the five competing teams managed to complete the task. The three judges split the prize between all five teams based on how close they came to the competition's original goal. The top award of $3000 went to the University of Texas at Arlington, whose "tail-sitter" lifted off the ground and reached the bin where the discs were stored before being knocked off balance.

Winning $2000 each for meritorious achievement were the University of Dayton (Ohio) and California State Polytechnic University (San Luis Obispo). Both Dayton's helicopter and Cal Poly's hovercraft attempted the task in the arena, a volley ball court divided by a three-foot high wooden barrier.

Teams from Georgia Tech and MIT each won $1500 for honourable mentions. Last minute engine failure grounded the Georgia Tech helicopter. MIT demonstrated a hovercraft via remote control, but was unable to fly unassisted due to sensor failure.



Picture: Joe Schwartz

Texas star: University of Texas' flying robot turned in the best performance.

Picture: Gary Meek

Georgia Tech's helicopter robot grounded by engine failure

Bright future for silicon

If there's one frustration that surrounds the vast growth of optoelectronics, it's the fact that virtually every light-emitting device – be it a humble led or a quantum well laser – is currently based on III-V compounds. Even the simplest of these, gallium arsenide, is expensive, difficult to fabricate in large wafers and, because of incompatibilities in the crystal structures, difficult to integrate with silicon-based electronics.

If only silicon could be made to emit light. Obstacles are at first sight insuperable, not least the fact that silicon has an indirect bandgap of only 1.1eV. Bandgap in simple terms dictates the precise amount of energy released when an excited electron moves from the conduction band to the valence band. The energy released during such transitions in turn determines the wavelength of any light emitted. So, ignoring any other constraints, it would be impossible to make silicon emit anywhere outside the infra red.

There's another constraint in that silicon's bandgap is indirect. The crystal structure forbids the electronic transition that would otherwise release energy as infra red. If an electron is to make that transition, it must release not only a photon, but also a phonon – essentially a heat wave – into the crystal.

Probability of those two things happening simultaneously is very small indeed. Yet, because of the advantages of being able to make large, cheap and easily integrated silicon light-emitting devices, researchers are pursuing some of the most unlikely avenues in search of this holy grail.

In overcoming the small bandgap of silicon the most promising approach in theory would be to pursue the creation of low-dimensional structures. For a long time physicists have known that the bandgap can be raised if the material is fabricated in the form of wires or dots that are only a few nanometres in size. In such structures, electrons are constrained to behave as if the material had only one or two dimensions instead of three. Low dimensionality has already been used successfully to lift the bandgap of III-V compounds to enable, for example, the creation of visible light-emitting solid state lasers. But as a route to cheap silicon displays, conventional low-dimensional fabrication techniques involving molecular beam epitaxy (MBE) and fine-line photolithography are hopelessly over the top. The serendipitous part of the story came some years ago when workers in a number of UK establishments were examining wafers of p-silicon that had been etched with hydrofluoric acid in the course of developing conventional silicon devices. Under UV light, these wafers were found to glow red!

What apparently happens is that hydrofluoric acid etches the surface of a silicon wafer to create a microporous structure with a void volume of up to 85%. So a straightforward piece of chemistry could well be creating naturally the sort of low-dimensional structures that are extremely hard to fabricate deliberately.

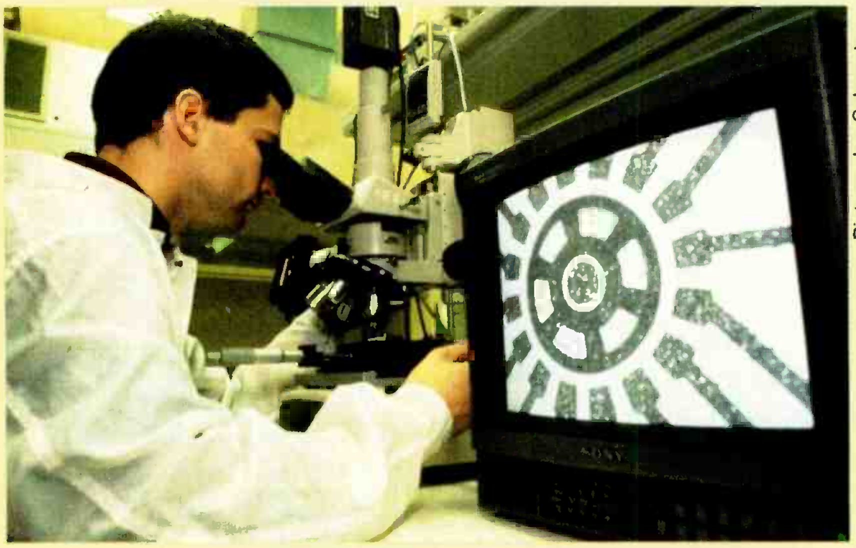
A group from the Electronics Division of the Defence Research Agency (formerly RSRE) has produced silicon wafers up to 5in diameter that emit red, orange and green in response to UV excitation.

Because of the extreme practical difficulty of preparing samples of the etched silicon for transmission electron microscopy (TEM), there's still much debate about what the porous structure actually looks like and what is happening as it emits visible light. A group based at the Joseph Fourier University in Grenoble believes that their green-emitting material consists of 2nm dots of silicon perched on microscopic pillars of silica. A team at Umist is more inclined to believe that the emission comes from tiny pillars of pure silicon – in other words, quantum wires rather than quantum dots.

As for an agreed theory to explain this curious photoluminescence, scientists differ widely. Researchers at Umist and Duke University are convinced, from measurements of luminosity against temperature, that quantum effects are indeed responsible. The Grenoble team are unsure, citing the long luminescence decay – much too long for what ought to happen within a quantum dot. Finally, a team from Johns Hopkins University working in conjunction with AT&T Bell Labs have conducted experiments leading them to doubt whether the light emission has anything to do with quantum confinement at all!

Unknown the effect may be, but its importance is incalculable, and things will really begin to move when a practical way is found to make silicon luminesce, not by UV excitation, but by electrical stimulation. The real attraction of electroluminescent silicon devices will be in large, cheap and easily fabricated displays.

Research Notes is written by John Wilson of the BBC World Service.



Picture: Joe Schwartz

Conventional micromotors in a spin?

It looks as though low cost, variable capacitance micromotors might be produced using electro-plated circuit board manufacturing technology rather than the expensive processes derived from semiconductor industry.

Georgia Tech researchers have developed a system of using standard photolithic techniques to produce microscopic moulds in standard photoresist. These are made electro-conductive and subsequently electroplated in the normal way.

Motors made using the process exhibit superior performance to the earlier method. The silicon components were severely limited by the attainable thickness of the finished part. As a result, they scarcely developed enough torque to overcome internal friction, never mind the completion of any useful work. The moulded parts are much thicker and thus develop far greater torque.

Wheels within wheels. Could this be the start of a new generation of low cost micromotors? Research student Bruno Frazier looks at some of the component parts made in much the same way as the conductors of a printed circuit board.

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SC110A miniature portable oscilloscope

SC110A miniature portable oscilloscope

The SC110A from Thurlby-Thandar is a full feature, single trace analogue oscilloscope packaged into the size of a benchtop multimeter. Fitted with a 32mm x 26mm screen miniature CRT, the bright, sharp image provides resolution and detail associated with much larger instruments. UK designed and built, the internal switch mode power supply draws just 195mA from four C sized batteries (not supplied). The instrument will operate from 4 to 10V DC.

The specification includes a Y bandwidth of DC to 10MHz, 10mV/div sensitivity and an adjustable brightline trigger with AC/DC/TV coupling from both internal and external sources. The X timebase is adjustable from 500ms/div to 100ns/div in 24 steps. The case measures 25 x 5 x 15cm and the instrument weighs about 1kg.
SC110A £249+VAT (£292.58).

1021 general purpose oscilloscope from Leader Electronics

1021 general purpose 20MHz oscilloscope

The Model 1021 general purpose oscilloscope from Japanese instrument maker Leader Electronics more than meets its published specification and is of exceptional build quality. Features include 20MHz dual channel operation, 8cm x 10cm display area, 5mV/div Y1/Y2 sensitivity at 20MHz, DC to 500kHz X-amplifier response, variable trigger response, multiple sync conditioning and an overall accuracy better than 3%.
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PL320K laboratory triple power supply

TS3022S laboratory dual power supply

PL320K laboratory triple power supply

This power supply from Thurlby-Thandar combines three, totally independent power supplies within a single unit: 0–30V at 2A, 0–30V at 1A and 4–6V at 7A for logic supply. The 30V supplies will operate in a bipolar tracking mode for ±30V operation or in a series mode to provide 0 to 60V output. Both supplies incorporate independent remote sensing and independent precision voltage/over-voltage/current-limit preset. Three 3 3/4 digit led panel meters indicate current and voltage to an accuracy of 0.05% fsd. Output stability is typically 0.01% for 90% load change. PL320K £359+VAT (£421.83).

TS3022S laboratory dual power supply

This laboratory quality power supply from Thurlby-Thandar provides two fully floating 0–30V 2A outputs for parallel, series or independent operation. Each supply has its own metering of voltage and current by LCD display; with the output switch to off, the display can be used to preset the voltage and current limits prior to connection of the load. Coarse and fine controls permit output voltage adjustment to within 5mV of a predetermined value. The current limit control employs a log law for precise adjustment down to 1mA. Load regulation is typically within 0.01%. Both supplies incorporate remote sensing. TS3022S £299+VAT (£351.33).

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The TD201 digital storage adaptor from Thurlby-Thandar is a low power, single channel digital storage unit which adds digital storage capability to ordinary analogue oscilloscopes. The maximum sampling rate of 200kHz permits fast transients to be captured while the lowest rate can extend the sampling period to over an hour. The unit stores over a thousand points on the X axis with 256 levels in the Y axis. The internal batteries (not supplied) allow data retention for up to four years.Other features include an AC/DC sensitivity down to 5mV, selectable pre-trigger, roll and refresh modes and a plot mode. The case measures 25 x 5 x 15cm and the unit weighs about 1kg. The TD201 provides the ideal solution for those wanting a well specified and easy-to-use DSO at the lowest possible cost. TD201 £195+VAT (£229.13)

TD201 digital storage adaptor

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Designing digits into audio equalisation

Professional recording studios now look to digital audio processing for even the most basic sound manipulation. Bill Hardman describes the design process for a third octave graphic equaliser.

Greater requirement for precise and flexible control of frequency response in audio signal processing has stimulated evolution of advanced analogue designs, most notably the graphic equaliser.

Unfortunately analogue frequency response control-systems can produce simultaneous and unwanted phase changes. Compensating networks can cancel these phase changes, but they must track the amplitude control, a complexity that is usually impracticable.

The effect of applying a phase shift to some portions of the audio band and not to others is to cause a frequency-dependent time-delay to the signal, usually with low frequencies being delayed more than high frequencies. Transients can only pass through a system unscathed when there are no frequency dependent time delays.

For the listener, the build up of frequency-dependent time-delays in the audio path, from performance – via disc or tape – to ear, gives recordings an "unreal" feeling, in spite of the great improvements in recording media, amplifiers and loudspeakers.

As a result, high quality audio equipment manufacturers have tended to drop frequency-response controls. But this also stops the listener adjusting balance to suit taste or equipment, and does not allow for compensation for variations arising from room resonances and furnishing.

FIR filter

One class of filter that can provide frequency control of amplitude without phase shift is the finite impulse response filter (see FIR box text). It uses a tapped delay line and because of this, can only be realised in practice, in high quality use, in the digital domain.

Describing a filter as producing no phase shift is not strictly accurate. All filters produce phase shift because of the finite time taken for data to be processed.

The solution is to make the phase-shift frequency dependent, with a linear relationship, producing an ideal filter, in series with a time delay – referred to as a linear phase filter.

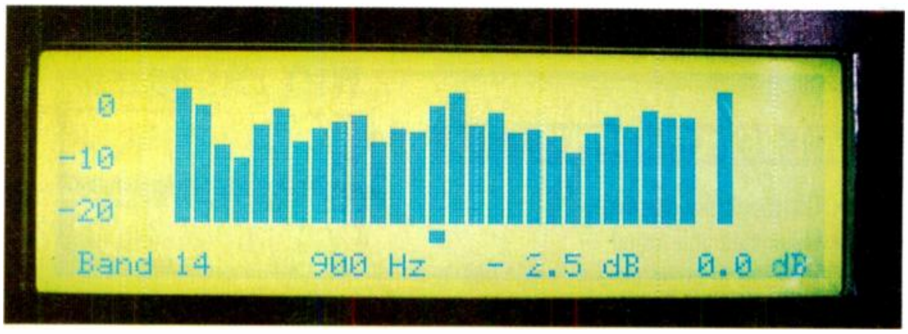
To construct a digital filter that is linear in phase we should first examine the pole zero plot – a convenient method of judging the performance of a filter derived from the mathematical expression of its gain and phase in the X/Y form (see box). Zeros are the factors of X, and poles the factors of Y. Each pole or zero of its response inside the unit circle must be balanced by a corresponding partner outside.

Filters with poles outside the unit circle, are unstable, so we are constrained into making linear phase filters from zeros alone; eg the FIR filter.

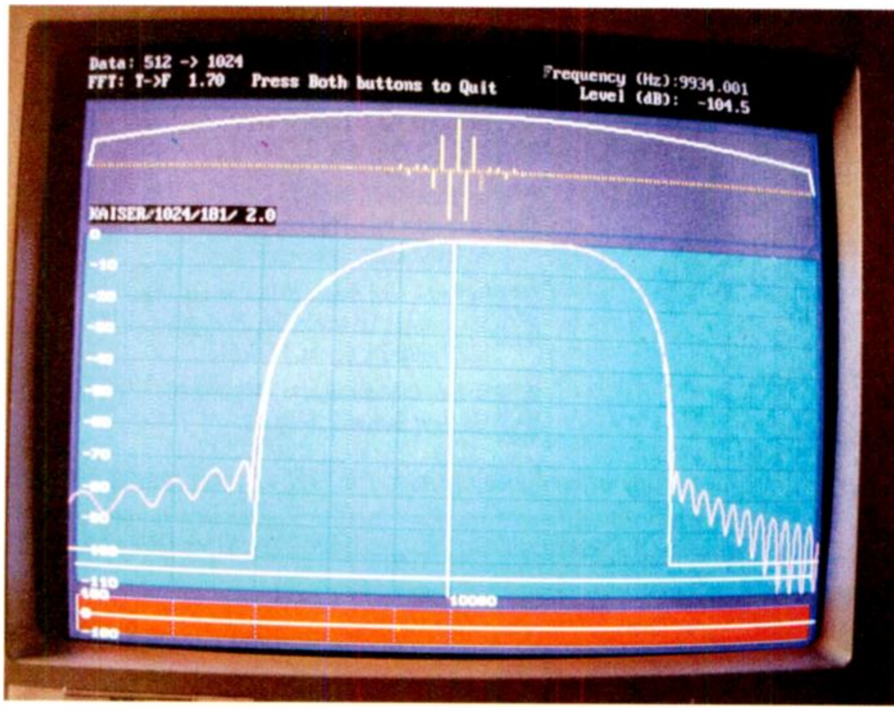
Principal snag is that to make filters with sharp responses, without poles, requires large numbers of zeros. However digital signal processors are oriented toward implementing the FIR filter structure – to such an extent that the FIR can generally be executed in less time than an equivalent lower order pole-zero filter followed by phase compensation.

The longer the filter, the more zeros it has, and the more closely it can match the desired response. Practical constraints are the time to execute the filter, the sample rate and memory requirement.

A sample rate of 44.1kHz allows a maximum of 22µs to do all the processing. With a 100ns instruction time, filter length cannot be greater than 220 stages and in practice, processing time must be allowed for dealing with interrupts, data I/O, and parameter control. So a filter length of 181 stages has been adopted.



Graphic equaliser display



Target response of software (white on blue); achieved response (red on blue). Above is impulse response (yellow) and applied Window (white).

Structure of the equaliser

A graphic equaliser uses a bank of bandpass filters, ideally each having the frequency response shown in **Fig. 1**, with a rectangular pass band, and zero output anywhere else. **Fig. 2.** shows how the filters are used in parallel with the input signal applied simultaneously to all inputs. Output is derived from the summation of all the filter outputs and overall frequency response is set by adjusting the gain of each filter.

In practice, filters cannot be made with infinitely steep sides, and the response of one filter will overlap that of its neighbour. To allow for this effect the shape of the transition regions are controlled, conforming to a $\sin^2 \cos^2$ contour. The method produces very small amounts of ripple when all filters are set to the same level, and smooth transitions between filters set at different levels (**Fig. 3**).

Production of filter coefficients

Designing FIR filters means handling a lot of data; 27 bands of third octave filtering requires, in this case, calculation of almost 5000 coefficients.

Although the coefficients are ultimately to be used by the DSP unit, they come via the controlling processor, with its program written in C. So it is useful to have the filter-design-program-output floating-point-coefficients in ascii text files that can be called directly by the C compiler as INCLUDE files.

The filter design program uses an FFT implementation of the DFT to calculate the filter coefficients. FFT requires input data to be presented in a very precise way as usable output and frequency responses of both amplitude and phase have to be defined. This is only half the FFT input, because both positive and negative frequency components are required.

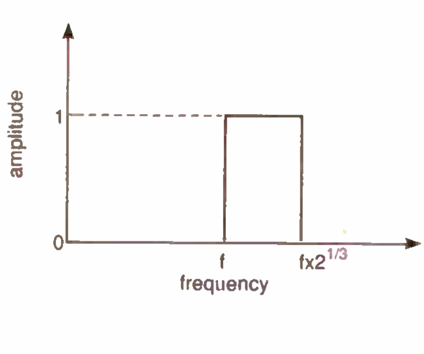


Fig. 1. Performance of the ideal 1/3 octave filter.

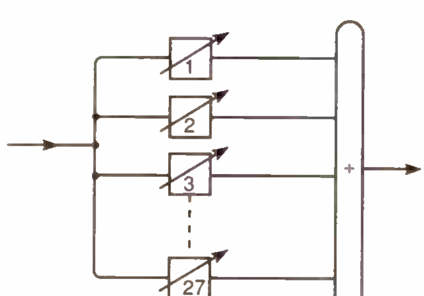


Fig. 2. Implementing a parallel structure.

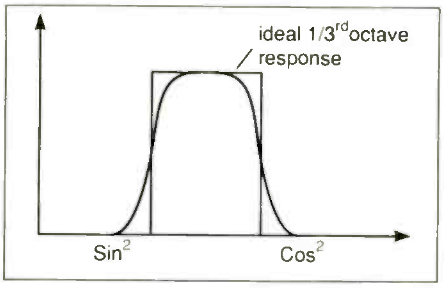


Fig. 3a. Filter's practical response with sin^2 cos^2 transitions.

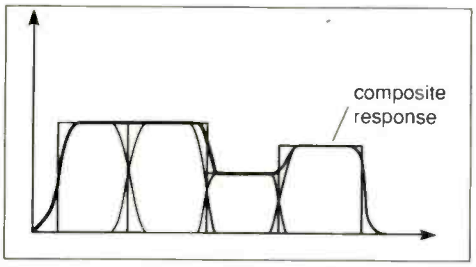


Fig. 3b. Response with bands at differing levels.

Finally the data is converted from polar to complex format.

Figure 4 illustrates the design process. **Figure 4a** shows the shape of a single filter. Width at half amplitude is one third octave and the transition regions, conforming to a $sine^2$, cos^2 profile, are each one sixth octave wide.

This frequency response is sampled at intervals of sample rate/FFT size up to the half sample rate frequency. The filter is to be linear phase, so phase response at each sample point is given by:

Phase = phase at previous point + (frequency/sample rate) x 2π x (FFT size/2)

So far we have calculated data up to the half sample frequency, but above this, up to the sample frequency, the FFT requires the negative frequency part of the input data. If the output coefficients are to be real, that is the imaginary part is equal to zero (necessary for practical realisation), the negative frequency data must be a mirror image of the positive frequency data, with even-symmetry in the amplitude, and odd-symmetry in the phase, as demonstrated in **Fig. 4b**.

Finally data is converted to complex format at each sample point by:

Real data = amplitude x cos(phase)
Imaginary data = amplitude x sin(phase)

FFT output gives the filter coefficients, but many more than can be used in practice so outer values are discarded to give required length. The process causes a deterioration in filter shape, with pass-band ripple increasing, stop-band gain rising, and transition regions broadening.

Any one of these can be improved at the expense of the others by smoothing the coef-

Poles, zeros, linear phase and FIR filters

The pole zero plot, giving a quick visual method of judging the nature and performance of a filter, is derived from the mathematical expression describing the gain and phase of the filter, put in the X/Y form. Zeros are the factors of X, and poles the factors of Y.

Poles and zeros can be plotted graphically, and for a sampled data system, the circle is the line from which the frequency response of the filter can be measured.

Points along the upper semi-circle represent frequencies from DC to half the sampling frequency of the filter (maximum useful frequency).

Response is calculated by the closeness of poles and zeros to the circle; a pole close to the circle will cause a peak in the response, a zero will cause a dip.

The closer they are to the circle the more extreme their effect, so that a zero on the circle will cause an infinitely deep notch in amplitude at the frequency corresponding to that point on the circle.

Similarly a pole on the circle will cause a peak to infinity.

Amplitude and phase is calculated as shown in **Fig. 1**, and note that because zeros only cause decrease in amplitude, they can be placed anywhere. Poles cause an increase in amplitude and can only be placed inside the circle; put them on the circle, or outside it, and the filter is unstable.

Figure 1b shows the importance of being able to place zeros outside the circle. Looking at the phase angles at Z_1 and Z_2, as the frequency measurement point moves anti-clockwise around the circle (increasing frequency), phase contribution of Z_2 increases while that of Z_1 decreases. Amplitude is only influenced by the distance of a zero from the circle, not by whether it is inside or out. The result is that there is the freedom to place zeros inside or outside the circle to obtain the desired amplitude response, and to use the phase shift of those outside, to cancel the phase shift of those inside.

Because poles cannot be placed outside the circle, we cannot use poles inside the circle with phase cancelling poles outside. What is needed is a filter that contains only zeros; the FIR filter.

But there is a price to be paid. Filters with sharp responses, for example a low pass filter with steep attenuation, and flat passband, can be constructed from less poles and zeros, than zeros alone. This is because the effective cancellation of poles and zeros in close proximity can be exploited to enhance the filter shape in the transition region.

To make an all-zero filter to perform as well as, say, a two pole, two zero filter, may take twenty or more zeros.

Advantages of the FIR filter, apart from the all-conquering virtue of linear phase are easy implementation in DSPs, relatively easy design and few problems with limitation on the number of bits used in the filter calculations.

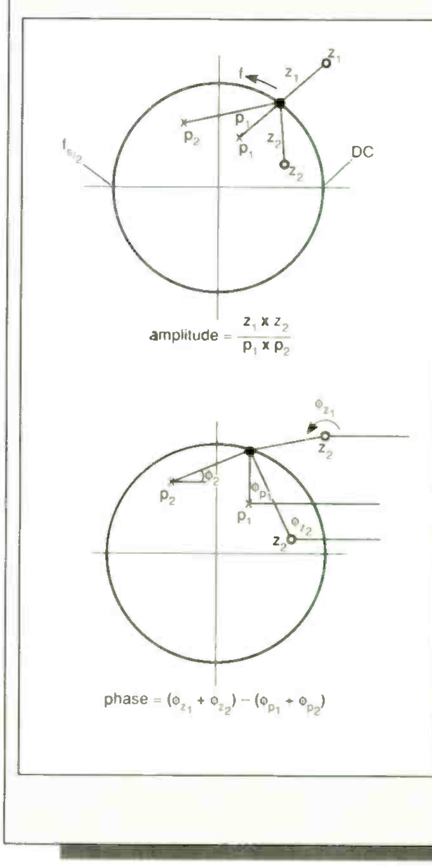
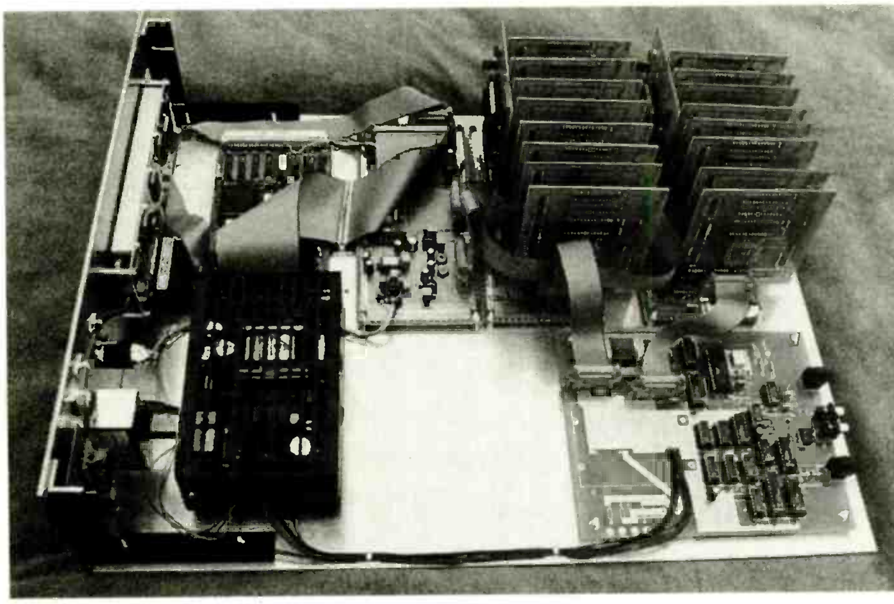


Fig. 1a. (top) Calculated amplitude and phase. Because zeros only cause decrease in amplitude, they can be placed anywhere. Poles cause an increase in amplitude and can only be placed inside the circle.

Fig. 1b. (bottom) The importance of being able to place zeros outside the circle.



Prototype DSP graphic equaliser

ficients towards the ends to zero, with the shape of this smoothing called a "window". There are a number of standard windows and the ones used for the equaliser are from variants of the Kaiser window.

As an aside, for those contemplating writing their own design software tools, the routine is a simple transcription into C of one of the many Fortran versions to be found in text books.

No effort has been made to make it fast, though it runs 1024 points in less than 2s on a 12MHz 80286 machine with 8MHz co-processor. Also note that the FFT routine occupies only 70 lines of code out of several thousand needed to fetch, manipulate, display, and store data.

Practical implementation

A difficulty experienced with using the FIR filter is that its length imposes a limit on low frequency capabilities. Unless the delay line contains several cycles of the signal to be processed, filtering with any degree of precision becomes impossible. The sharper the filter, the more cycles the delay line must hold.

To make an FIR third octave bandpass filter at a sample rate of 44.1kHz for operation below 100Hz would require a filter length in excess of 20,000.

With a 44.1kHz sample rate, the filter length is 181 and for this particular application a filter with 181 taps is useful down to about a fifth of the sample frequency; it will just be able to realise bandpass filters in the range 8kHz-20kHz.

The limitation can be overcome by splitting the digital data stream into several frequency bands and lowering the sample rate, for each, accordingly. The lower the maximum frequency in any band, the lower can be the rate at which it is sampled.

Signal processing is performed at this lower sample rate, and the result converted back to the input sample rate, a process known as decimation and interpolation (see box).

Figure 5 shows the general method of arranging the filtering system and illustrates why so many DSPs are involved in a practical system. Interpolation and decimation are quite processor-intensive and the top levels need a processor to themselves.

The remaining three stages of rate-change can just be handled by a single processor, because the input sample rate has now dropped to 22.05kHz. Decimation and interpolation alone involve four processors, and

Decimation

Decimation is used to reduce the sample rate and is not achieved without sacrifice. For example, a stream of sampled data with information up to 20kHz, cannot be reduced to a 1kHz sample rate why still preserving data above 500Hz.

The process is essentially straight forward. The incoming data stream is filtered to remove any frequency components above the half sample rate frequency of the output. Samples are discarded to give the new rate, meaning that the decimation process can only provide integer reductions, eg 1/2, 1/3, 1/4... of the input rate.

Decimation is useful where high frequency information is not wanted. Band pass filters at a few tens of Hz become unwieldy in length if they have to operate at 44. kHz sample rate. If a band pass filter only outputs data in the range 80-100Hz, then input data at any other frequency is redundant, but still has to be processed. Decimation pre-processes the data, removing the redundant high frequency data and reducing the sample rate, an action that considerably improves digital filters. In general they conform more accurately to the design target when operating at frequencies approaching their half sample rate and FIR bandpass filters benefit in this way.

The FIR does not make a very good job at the high-pass filter action that is a necessary part of a bandpass filter. It can manage infinite attenuation at DC, but has difficulty in providing steep, defined slopes, the further down from its half sampling frequency it is used.

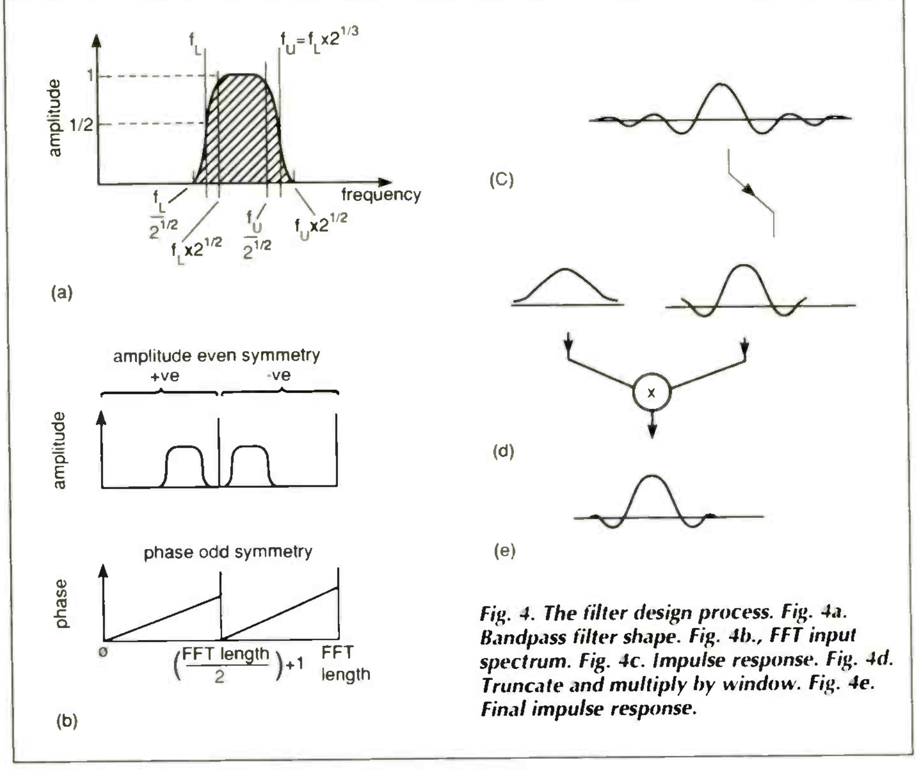


Fig. 4. The filter design process. Fig. 4a. Bandpass filter shape. Fig. 4b., FFT input spectrum. Fig. 4c. Impulse response. Fig. 4d. Truncate and multiply by window. Fig. 4e. Final impulse response.

Finite impulse response filter

To understand the finite impulse response, or FIR, filter some basic facts about its operation must be grasped.

On one hand it can be considered as an advanced version of the moving average filter, shown in **Fig. 1**. Samples come in at the left. As each one is added, the previous samples are moved along and the oldest moves out at the right. When all the samples have been shifted, they are summed and the result optionally scaled by dividing by the number of samples.This type of filter is familiar as a means of smoothing out fluctuations in statistical data such as monthly rainfall or inflation figures, to produce annual averages.

In fact the basic filter is not very good. A single large value passing through it will cause an abrupt change in output as it enters and leaves. By applying test data in the form of a sinusoid at different rates, we could plot its frequency response.

What we would find is the expected response of a low pass filter, but one that had no sharply defined cut-off and poor attenuation above that.

An intuitive approach to filter operation, might suggest improving performance by reducing the effect of data as it enters and leaves the filter; ie multiply each data value by a scaling coefficient that favours those samples towards the centre, as demonstrated in **Fig. 2**.

At this point we should stop to consider another way of looking at the filter operation. If we pass into the filter, a stream of zeros with a solitary data value of "none" sandwiched between them, as the data value "one" passes along the delay, it would be multiplied in turn by each of the coefficients, A, B, C etc.

Result of the transit of this data "one" through the filter would be to make it deliver all of its coefficients in turn, from A through to F. What we have done is to present a unit impulse into the filter; the output is the filter's impulse response. For the FIR filter, impulse response is the same as the filter coefficients.

In DSP terms the process performed by the FIR filter is called the convolution of two impulse responses, that of the data and that of the filter. The effect is the same as multiplying their frequency responses together.

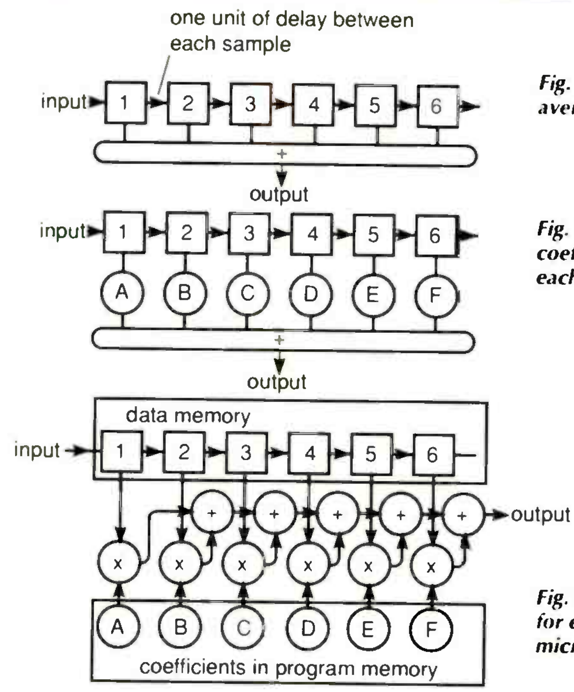


Fig. 1. Moving average filter.

Fig. 2. Filter with coefficient weighting each sample value.

Fig. 3. Arrangement for execution in DSP microprocessor

We now have a means of designing the filter; the DFT is the link between frequency and time and can be used to convert a desired frequency response to an impulse response and hence provide the filter coefficients.

Interestingly, design techniques for the FIR filter are still evolving. Using the DFT to produce coefficients is convenient for many applications, but does not always produce optimum filters; the same filter characteristic could probably be produced with less coefficients by an alternative design strategy.

Complicated iterative design programs have been developed, such as that by McClellan[1].

Structure of the filter has a simplicity and symmetry that make it very suitable for implementation on a DSP microprocessor. **Figure 3** shows the process of operations. Moving from left to right, multiply sample 1 by coefficient A, save the result. Multiply sample 2 and coefficient B, add the result to the previous sum, etc. Most DSP microprocessors have a Harvard structure, meaning that they have separate data and program memory address buses. In addition such processors have a fast hardware multiplier and adder that will be able to function at the same time as making memory fetches. The advantage of this is that the processor can fetch from the two buses simultaneously. By placing the signal samples in data memory and coefficients in program memory, a DSP processor can fetch data and coefficients, multiply them together and add the result to the previous sum in a single cycle. Cycle time will be at the most 100ns – an impressive feat of processing meaning that a 100 stage FIR can be executed in 10µs.

the remaining five processors execute bandpass filtering.

In fact three processors have sufficient power to execute all the bandpass filters, but difficulties arise in handling data at the various rates, so the simplest solution has proved to be to have each DSP operate on a single stream of data at a fixed sample rate.

Filters operating at the same sample rate can be combined by adding their impulse responses – a convenient technique when filters in a group have the same number of coefficients **(Fig. 6)**.

Controlling the frequency response

Frequency response of the equaliser is controlled by changing the coefficients in the filters, coefficients coming from a general purpose microprocessor. Serial interfaces are the most economic and practical means of moving data like this around a multiprocessor system. The ADSP2105 **(Fig 7)** has input and output serial interfaces, efficiently handled by the processor and, in this application, dedicated to the audio data.

To get the additional serial data containing filter coefficients into the DSPs, a simple 24-bit serial-to-parallel shift register is mapped into the DSP program memory. Three 74HC4094s receive the 24-bit data, and the strobe that transfers the internal shift-register data to the output also generates an interrupt in the ADSP2105, causing it to read the data on its program bus, presented by the 74HC4094s.

Figure 8 shows the controller and DSP system. All the DSPs have common data and clock lines, but an addressable strobe. This enables a single 24-bit data word containing 16-bit coefficient data and 8-bit control information to be handled.

Continued on page 1022

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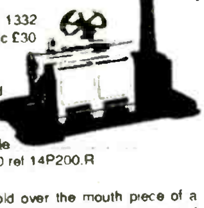

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CIRCLE NO. 146 ON REPLY CARD

The ZTX653 was developed to complement its PNP counterpart. One for one, NPN transistors tend to be less linear than PNP devices and this layout – the result of exensive work into optimising chip geometry to get the best from a given area of silicon – provides PNP performance in an NPN format.

SELF OSCILLATING POWER CONVERSION

David Bradbury, head of applications at UK semiconductor company Zetex, explains the design methodology behind single transistor inverters. His example makes use of the ZTX653 sample transistor supplied with UK copies of this month's issue.

Provided free with the UK circulation of this month's issue of *EW + WW* is a ZTX653 bipolar transistor. This diminutive device has characteristics that will surprise readers familiar only with standard TO92 devices. It is a 100V NPN transistor that can be used at junction temperatures up to 200°C. It will dissipate 1W coupled to a saturation voltage of less than 0.25V at 2A collector current. Switching rise and fall times are typically less than 200ns.

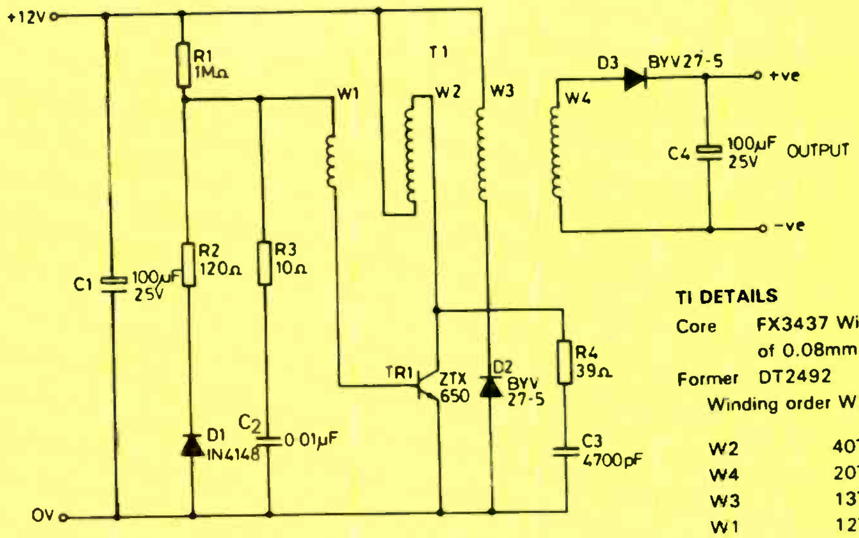
These characteristics make the ZTX653 ideal for automotive relay, lamp and motor drivers, where high temperatures and large current/voltage surges must be withstood. The device is also well suited to low power DC-to-DC converters. Since automotive uses tend to be very specific to particular loads, the application examples shown here concentrate on DC converters.

Portable NiCd battery charger

The self-oscillating flyback converter for charging NiCd cells includes voltage limiting and a low-current biasing circuit. It supplies a charging current of 220mA at 12V. It was designed for over-night charging of 12V power packs found in portable video recorders, using a car battery power source.

Because the NiCd battery's end-of-charge voltage is higher than the lead-acid battery's off-charge output, the car battery can not be used directly. Since the open-circuit voltage of the NiCd battery can vary over a wide range depending on its state of charge, the converter circuit must be able to adapt to this. This feature makes the converter useful for charging batteries of differing voltage and construction too.

Flyback converters are ideal for loads of varying voltage, hence their use in flash guns, capacitor-discharge ignition systems, etc. However, they have no natural control of their final output voltage and can be damaged by short circuit loads. The circuit shown in **Fig. 1** is a basic self-oscillating flyback converter modified to include a voltage limiting winding and a low-current biasing circuit. This circuit withstands indefinite short circuits and will charge battery packs



ZTX653 silicon power transistor

V_{cbo}	120V
V_{ceo}	100V
V_{be}	-5V
I_c	2A (continuous)
$V_{ce(sat)}$	0.23V at I_c 2A
h_{fe}	200 at I_c 500mA
f_T	175MHz
P_{tot}	1W

TI DETAILS

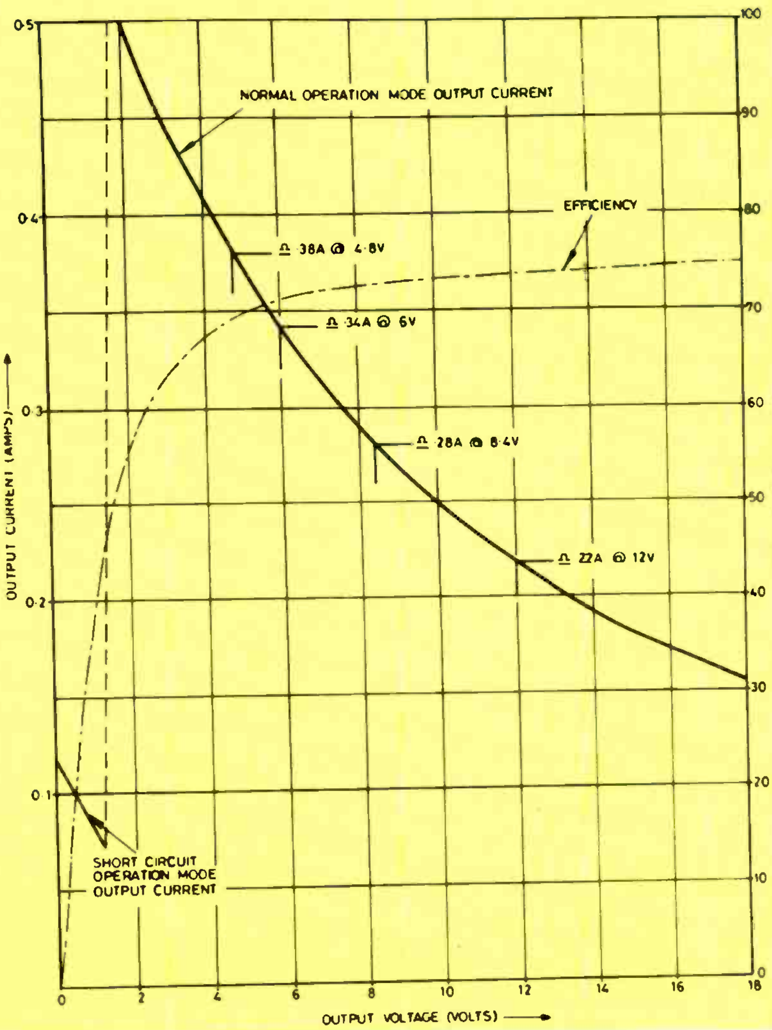
Core FX3437 With Gap/Spacer of 0.08mm

Former DT2492

Winding order W2, W4, W3 then W1

W2	40T	30swg.
W4	20T	30swg.
W3	13T	36swg.
W1	12T	36swg.

Fig. 1. Self-oscillating inverter for NiCd battery charging.



in the range of 4.8 to 15.6V from a supply of 12V. It provides a charging current of 220mA at an output voltage of 12V.

Operation

When power is applied to the circuit, a small bias current supplied by R_1 charges C_2 and via winding W_1 eventually starts to turn on the ZTX653. This forces a voltage across W_2 and positive feedback given by the coupling of W_2 to W_1 increases the base drive, causing the transistor to turn hard on. The drive voltage induced across W_1 forces the junction of R_1 and R_2 negative, forward biasing D_1 to supply the base current necessary to hold T_{r1} on.

With the ZTX653 applying the supply across W_2, a magnetising current builds up linearly until the ferrite core of T_1 saturates. At this point the effective inductance of W_2 collapses and the collector current of T_{r1} increases at a much higher rate. When this current reaches a level that cannot be supported by the transistor's base drive, the device comes out of saturation and feedback action now works to turn off Tr_1 rapidly.

Current flowing in W_2 forces the collector voltage of Tr_1 to swing positive until restricted by the transformer output windings. During this flyback period the voltage induced across W_4 forward biases D_3 to dump magnetising energy into the output capacitor C_4. The current flowing out of W_4 follows a linear ramp falling from an initial peak to zero in a mirror image of Tr_1's 'on'

Fig. 2. Output current and efficiency against output voltage V_{in}=12V of the converter of Fig. 1.

cycle. During this period the collector of Tr_1 is held at a constant level defined by the supply voltage added to the output voltage multiplied by the turns ratio of W_2 to W_4. When W_4's current reaches zero the collector voltage of Tr_1 then falls and feedback given by W_2 to W_1 initiates the next switching cycle of the converter.

Should no load be connected, the converter will charge C_4 until the voltage across it becomes dangerously high. To prevent this the transformer includes an extra output winding W_3 which dumps energy back into the power supply via D_2 should the output voltage exceed 20V.

The network made by R_4 and C_3 was included to limit the rate of rise of collector voltage across Tr_1 so that damaging transients would not be caused as Tr_1 turned off. A second network comprising R_3 and C_2 was added to assist converter operation during start-up and switching.

Capacitor C_2 also has an important effect if the output of the converter should be shorted. During the conduction cycle of Tr_1, C_2 is charged to a negative voltage by W_1 and this charge largely remains during the flyback cycle. This negative bias inhibits the start of the next conduction cycle unless the transformer 'rings' sufficiently at the end of the flyback. Since an output voltage of at least 1.5V is required to produce sufficient ringing, a short circuit load causes the converter to run intermittently, so consuming little power.

Transformer design

As with most self-oscillating designs, the transformer T_1 dominates the operation of the circuit, controlling power throughput, switching frequency, duty cycle and output voltage. The criteria used for selection for this converter were as follows.

The converter must provide 220mA at 12V. Since self-oscillating flyback converters of this voltage and type typically have efficiencies around 75%, the expected average supply current will be:

$$I_s = \frac{I_{out} \times V_{out}}{V_s \times \eta_{(eff)}} = \frac{0.22}{0.75} = 0.29\text{A}$$

For each converter switching cycle, the actual supply current taken will be a linear ramp from zero to I_{peak} followed by a period of no current flow.

This makes the circuit's peak supply current dependent on duty cycle:

$$I_{peak} = \frac{2I_s}{\text{Duty cycle}}$$

The duty cycle is dependent on the turns ratio of W_2 to W_4 and the input and output voltages. The duty cycle selected of 70% for

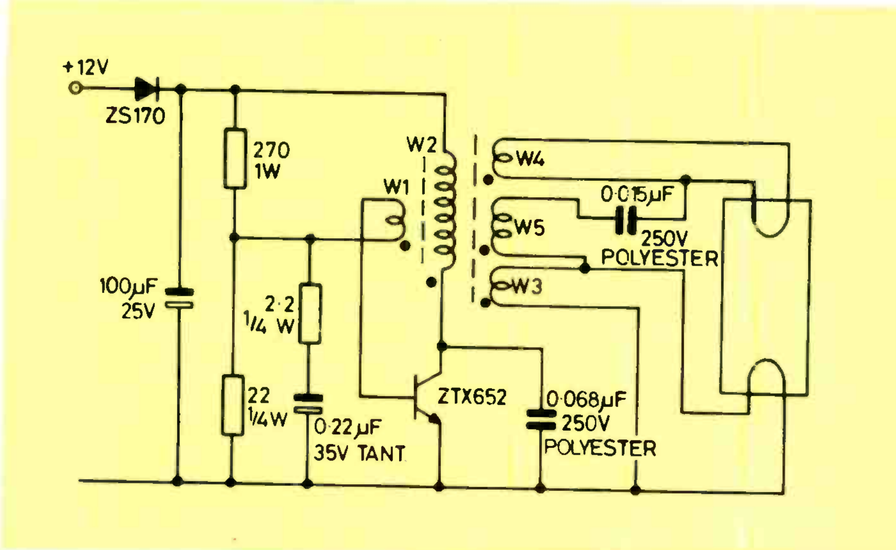


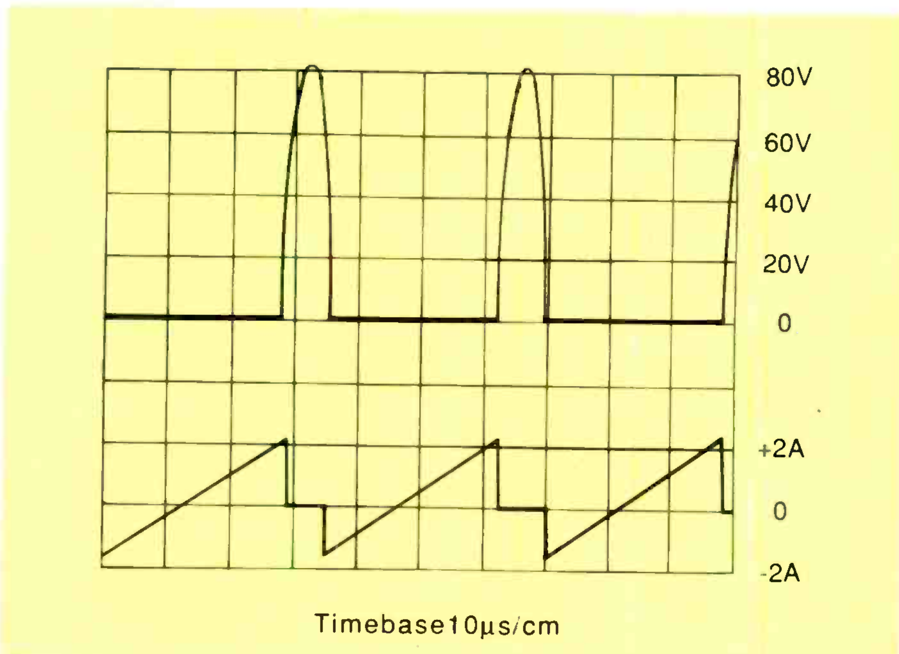
Fig. 3. Driver for an 8W fluorescent tube running at 20kHz. Only one transistor is needed since the ZTX653 supplies energy to the tube in both forward and flyback modes.

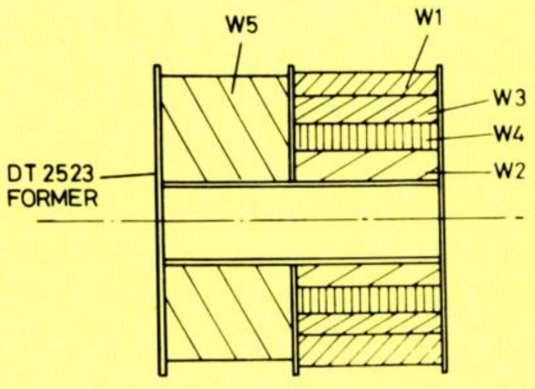
12V output loads gives a reasonable compromise between primary and secondary losses. This sets I_{peak} to 0.83A, which is well within the capabilities of the ZTX653. An oscillation frequency of 25kHz was chosen to minimise switching losses yet give inaudible operation. The inductance of W_2 must be:

$$L = \frac{V_s \times T_{on}}{I_{peak}} = \frac{12 \times 28 \times 10^{-6}}{0.83} = 0.4\text{mH}$$

The energy storage capability of ferrite transformer cores is often described in the form of Hanna curves. These manufacturer-supplied data curves relate the factors $I^2 xL$, IxN and core spacer. Use of the spacer greatly increases the energy storage capability of a particular core set. Hanna-curve data for the smallest core in the common RM range, the FX3437, shows that a 0.08mm spacer is needed for this core set to give an I^2L factor of 0.275×10^{-3}. The curve data shows that a

Fig. 4. Current and voltage waveforms of the fluorescent lamp DC converter before the tube has struck.





Transformer details. Core type FX3439 with 0.005" (0.125mm) spacer.

Former type DT2523
W1 4 turns 34swg. Enamelled copper wire
W2 17 turns 26swg. " " "
W3 7 turns 28swg. " " "
W4 7 turns 28swg. " "
W5 130 turns 36swg. "

Fig. 6. Winding details for the fluorescent lamp circuit transformer.

40 turn winding is needed to obtain the correct inductance for W_2.

The output winding W_4 is determined by :

$$W_4 = \frac{V_o \times T_{off} \times W_2}{V_s \times T_{on}} = \frac{(12+0.7)\times 12\times 10^{-6}\times 40}{12\times 28\times 10^{-6}}$$

$= 18.4$ turns (rounded to 20)

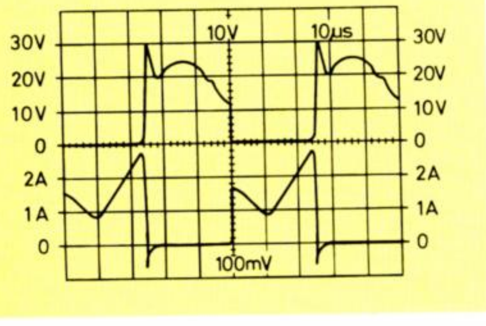
Output voltage must be limited to 20V by winding W_3, giving:

$$W_3 = \frac{V_o \times W_4}{V_{max}} = \frac{(12+0.7)\times 20}{(20+0.7)}$$

$= 12.2$ turns (rounded to 13)

The size of the feedback winding W_1 is a compromise between providing sufficient drive for the switching transistor when the supply voltage is low, and avoiding losses cause by overdriving. To pass 0.83A with a minimum gain transistor at low temperature will need a base current of around 15mA. A drive voltage of 1.4V is required to pass any current at all and twice this value would be desirable to reduce sensitivity to supply voltage variations. A base winding of twelve turns provides a drive of 3.3V with a low supply (10.5V) and a resistor of 120Ω sets the required base current for this drive level.

Fig. 5. Current and voltage waveforms for the fluorescent lamp circuit under normal operating conditions.



Performance

The graph of **Fig. 2** shows both output current given by the converter for a range of output voltages and the efficiency of the converter against output voltage. Its 220mA output at 12V charges 2AH battery packs in around 14 hours and, if accidently left on for longer than this, vented cells will normally stand this charge rate indefinitely. A useful modification to the circuit would be to include a timer so that batteries of other types could be charged unattended without the risk of damage by overcharging.

Fluorescent lamp converter.

Fluorescent tubes are awkward loads to drive since they have highly non-linear impedances that vary greatly as they strike. The converter shown in **Fig. 3** is designed to drive an 8W fluorescent tube, running at an inaudible 20kHz using supplies in the range of 10 to 16.5V. By supplying energy to the tube in both forward and flyback modes, only one ZTX653 is required by the design.

Circuit operation

When power is first applied to the circuit and the converter starts oscillating, the heaters of the un-struck tube present little loading to the transformer. Each time the transistor turns off, the magnetising current built up in winding W_2 'rings' with the capacitor wired across the ZTX653 to generate high-voltage pulses. (Current and voltage wave forms of converter operation during this period are shown in **Fig. 4**.) Transformed up on winding W_5, the voltage of these pulses is high enough to cause the tube to strike once its heaters have warmed.

Once struck, the tube loads the transformer heavily, swamping the flyback ringing action. The sustaining voltage of the tube is now much lower than the open circuit output of the converter. A capacitor is wired in series with W_5 to control the current fed through the tube in this mode setting the output power to 8W. Power is fed to the tube both in forward and flyback parts of the converter cycle. To ensure that the correct amount of energy is supplied during flyback, the saturation current of the converter's transformer was designed to meet half the tube's energy requirements. The other half is supplied during the conduction part of the converter cycle.

The action of both in directly driving the tube and storing energy in the transformer for flyback can be clearly seen in the collector current waveform shown in **Fig. 5**. The early part of the conduction period shows current flow caused by the tube directly but the later part is dominated by magnetising current as it ramps up to saturation, storing energy for the flyback period.

The low saturation voltages shown in the waveforms of Fig. 5 indicate that transistor dissipation is low, around 0.5W under normal operating conditions. Worst-case power dissipation occurs when the circuit is used with a high supply voltage and a broken or missing fluorescent tube, for which a small heatsink may be necessary for the transistor.

Figure 6 shows the winding details of the converter transformer. These should be followed precisely if the converter is to perform as designed.

In the prototype, enamelled copper wire was wound on to a DT2523 former for an FX3439 core with a 0.125mm spacer. Turns are as shown on the diagram.

The ZTX653 is one of a range of high performance NPN and PNP transistors now available in a TO92 style package. The preceding circuits are just a few of the possible applications for these devices. ■

pc engineering

Schema and iPLS: a marriage of convenience?

How well does a schematic entry program perform as the starting point for systems stuffed full of PLDs? John Anderson blows hot and cold.

This review is for two products from different vendors that are promoted by their UK distributor as working together to provide a coherent programmable logic development system.

Schema III from Omation Inc. is the most recent version of its long established schematic capture software. This standard product can be used as the front end to many PCB layout and routing systems from a wide variety of vendors.

Intel iPLS II software is designed to take the information from the schematic capture package and convert it to a macro description language, which in turn can be reduced to a series of Boolean expressions and thus to a jedec file for an Intel PLD.

What you get

Both products come with bulky thick boxed manuals, which describe every aspect of the operation of the software in great detail. The software is contained on three 360K Omation disks and eleven 360K Intel disks.

The Schema III manual contains a series of well prepared tutorials which should allow successful use of the product. However, this is an indictment of the user interface: it is not really possible to run this package successfully without recourse to the manual.

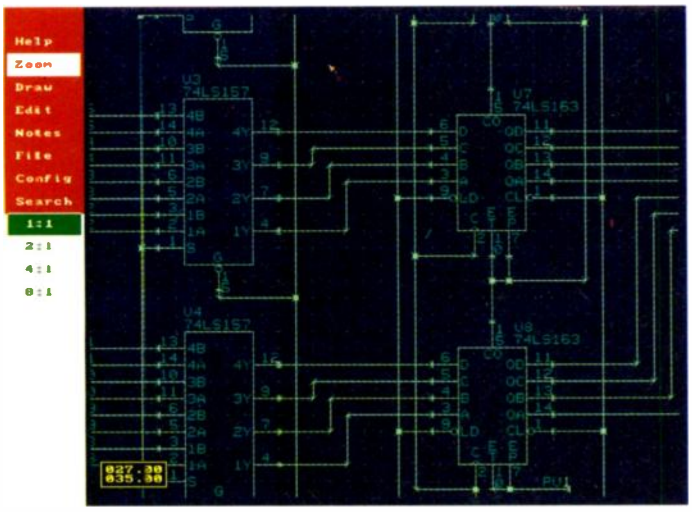
Installation

The files for Schema III are distributed in compressed form and expand to 3.6MBytes. Beware. The installation process altered the autoexec and config files on the computer without prompting or asking.

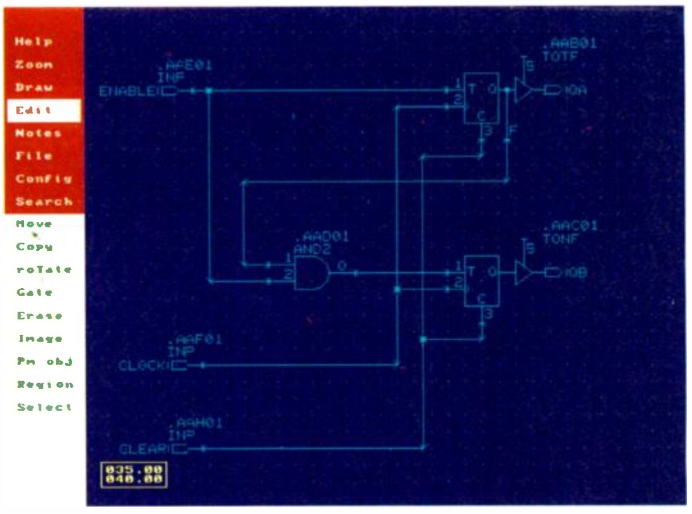
The Intel iPLD installation was different requiring just 15s per disk. The software has a two installation limit. A software bomb ensures that the installation process can be carried out only twice. A saving grace is that the program can be de-installed, increasing the number of available installations. However this whole

The Schema schematic entry package

Left: editing screen



Schematic diagram with logic primitives



process could easily become tedious if one had to move the software about too often. The installation software asked for permission to edit the autoexec and config files.

The Intel software takes about 2MBytes of disk space, although the manual warns that the software uses an additional 500K of disk space for temporary files during execution.

Opening menu

The opening menu is a simple textual affair with a keyboard and mouse interface to allow selection of the required operation. There are three groups of commands, Schema related, IPLS related and utilities. This opening menu is really the only obvious operational relation between the two packages, and has the look and feel of an afterthought.

Schema III in use

The product has a number of different aspects to its operation, subdivided into a number of different programs. There are the drawing editor, printing and plotting programs, a post processor which generates bill of materials, netlist and reports, library manager and a range of utilities including forward and back annotation. The EPLD design manager allows capture of EPLD logic primitives which can be translated to a netlist file compatible with the Intel software.

In many respects Schema III is similar to most schematic capture programs; however it does have some points of difference. Firstly its automatic panning facility is very fast – so much so that in taking the mouse cursor to the edge of the screen to select a function from the action menu can cause the part of the schematic that you are working on to scroll right off the screen. This can be overcome by configuring the speed of pan. Secondly, there appears to be no rubber banding (the ability to move an object with its connections attached). Although referred to in the index to the manual, it did not appear at the indexed page and no help or menu command seemed to assist.

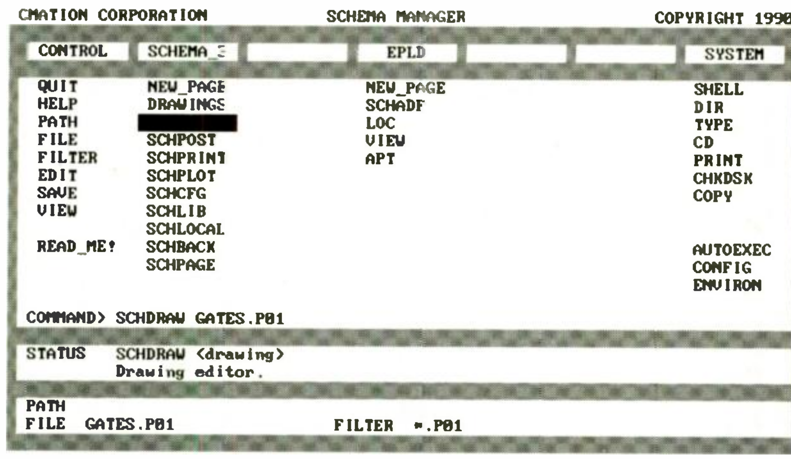
Schema does have on line help which, although brief, was sufficient to provide assistance to the first time user.

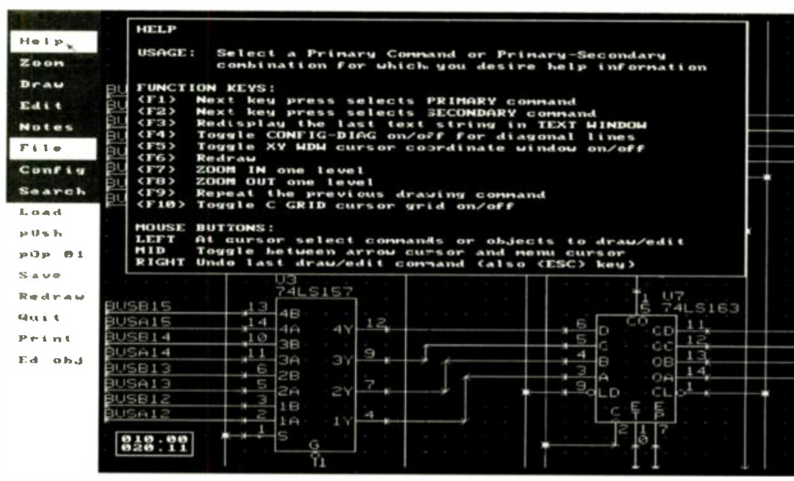
iPLS II on its own

The iPLS software can be used on its own with the logic equations, declarations and I/O primitives for input as a hardware description language (HDL) with a text editor.

Execution of the basic shell confronts the user with a simple menu describing the actions of the program initiated by the function keys. This environment looks and feels very old and unattractive, though in operation it is adequate.

On choosing to edit a pla description file, the user is prompted to use EDLIN, the terrible and ancient dos line editor, though you can fill in your own editor name instead. It surprised me that a product like this is not supplied with a simple ascii editor.





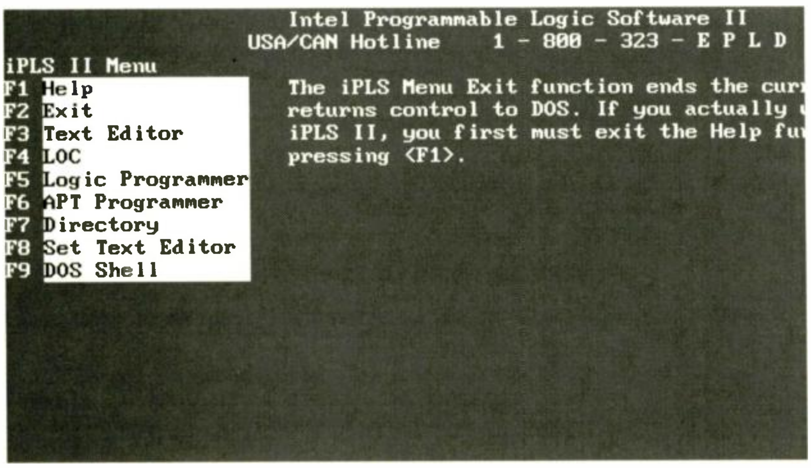
Top: Schema III manager – main menu

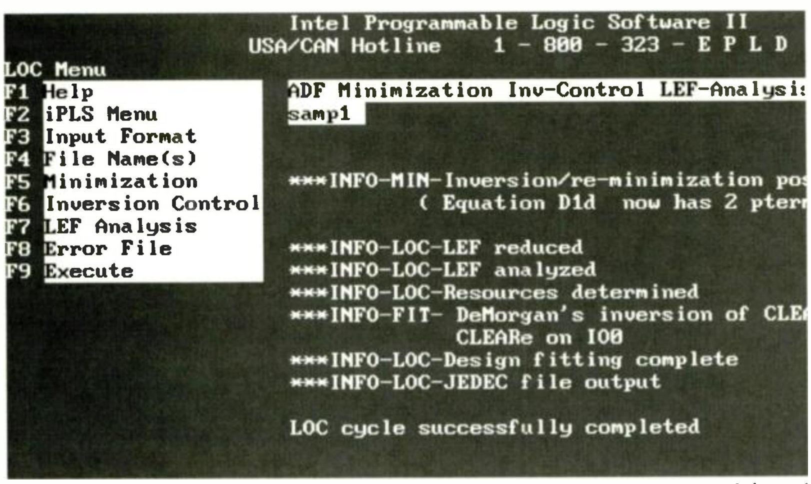
Pop-up context sensitive help

There are some important advantages in excluding the schematic capture part of the PLD development process. By describing the operation of the PLD in terms of its logical equations and state variables, the engineer can fully document the thinking behind the design, information that would have to be supplied as schematic annotation with the schematic capture route.

Further, hardware description language (HDL) is becoming an important part of the logic design process because it allows a hierarchical and structured description of the design. Even though the final Boolean expressions generated by the two routes might be identical, the abstraction of the design to hardware description language improves the description of device function. The schematic route using TTL 74 series look-alikes and other logic primitives only provides documentation which is essentially the schematic of the internals of a device.

In use the Intel software compiled the netlist to boolean expressions and then to a Jedec file within a





Top: Intel PLS II main menu

Loc (the PLS translation program) menu and results screen

PRODUCT INFORMATION
Omation Schema III costs £363.60. Intel iPLS II costs £147.80. Both products available from:

Jermyn Distribution,
Vestry Road,
Sevenoaks, Kent
0732 451251

few seconds. The whole process seemed quick and efficient. Error messages were reported on the right-hand side of the screen and were reasonably easy to understand.

iPLS II contains programmer support and, according to Jermyn, is normally sold with a programmer.

The iPLS manual contains a useful chapter on EPLD design techniques. This introduces the concept of macro libraries, with data on TTL devices, EPLD macros, and user defined libraries. Potentially this could be a boon to designers in that a design might be built up quickly from already proven macro blocks.

Conclusions

These products are supplied by a major component distribution outlet, and this being the case, one would expect informed support not only for the software but for the integrated circuits at which the software is targeted. On calling Jermyn, I found the applications people helpful and knowledgeable, although they admitted to having some problems with the package.

"Has this tool improved productivity or methodology so that its cost can be repaid?" This is the most important question to be asked of any CAD software product. My impression of the pair was one of potential advantage in being able to download TTL macro blocks into a schematic to produce solutions based on these building blocks. However this is outweighed by both the awkward system operation and a design methodology that does not reflect the needs of the designer who wants to work from logic equations and state machines. This latter approach is fully supported by the Intel software alone.

The system only works for Intel 5C/5AC/85Cxxx series devices, a serious limitation of this software. This means that many industry standard products from other vendors cannot be designed or implemented with this system.

The Schema III package is perhaps beginning to show its age. Its user interface is difficult to master and looks and feels awkward. However, the automatic panning at the edges of the drawing are delightfully fast. There are few schematic capture systems that can compete in this aspect.

The Intel software is functional and relatively new. The user interface pre-dates pull down menus never mind a graphic user interface. Since Intel expects to make its money selling devices programmed with this software, it seems strange that the software should be copy protected and awkward to use.

At the combined price of about £500, this marriage does look attractive, especially bearing in mind that the schematic capture may be used as a front end to PCB layout. Do the two products work together? The answer is both yes and no; yes in the sense that iPLS can take data from Schema III, but no in that these packages were not designed to co-exist, and it would seem likely that Schema might follow the Orcad trail and advance to provide its own more broadly based PLD support. This would make the Intel product redundant. ■

SYSTEM REQUIREMENTS
Schema III:
XT/AT/386 Computer
Hard disk with at least 4MBytes free
CGA/EGA/VGA/HGA or Olivetti graphics support
Dos v3+
Plotter or printer for hard copy
Optional mouse

iPLS II: XT/AT/386 Computer
Hard disk drive
5.25in floppy drive
512K ram
DOS v3+
CGA adapter and colour monitor recommended

Unleash the graphic potential of your PC

Data in graphical form is far more appealing than dull tables. Allen Brown finds Graftool opens up new 3-D vistas for the PC.

PCs equipped with EGA, VGA or Super-VGA have long been recognised as suitable vehicles for graphical information. The problem has been to unleash all that stored potential. Graftool, from 3-D Visions Corporation, could be just the application package to do that job, making full use of the graphics capability of the PC.

Graftool can represent data in almost every format; two or three dimensions, projections, histograms, polar charts, contours, vector plots and trajectory plots are possible.

To make the most effective use of the package a PC should be equipped with a Microsoft mouse and a high resolution (colour) monitor. Since it can also perform a reasonable amount of processing then a maths coprocessor is advisable. With this hardware in place installation is well organised and the whole package can be up and running within ten minutes.

User's view

The user interface (**Fig. 1**) consists of an array of menu options, evoked by mouse action, giving rise to pop-up dialogue boxes. The graphics user interface (GUI) is pleasant to work with and a lot of thought has gone into its design.

Graftool's display area is partitioned into four principal regions: the graph area for plots and the dialogue boxes; menu area for options; view area (bottom left) for viewing option, and data status area at the bottom of the screen. For experimental purposes there is a formula solver enabling users to create data. The DATA FORMULA option opens a dialogue box and allows a function along with its parameters (max and min values) and data file name to be defined. The data file created is then stored on disc.

Once the data file has been created its contents can be represented in a variety of formats. Format is selected from the menu option list and its dialogue box (**Fig. 2**), and the user can choose data point symbols, line texture, plotting colours and graph projections. Once these have been defined Graftool produces a graphical placement area whose scale can be adjusted by using mouse handles on the plot boundaries. A great deal of flexibility is allowed in defining axis parameters and labels.

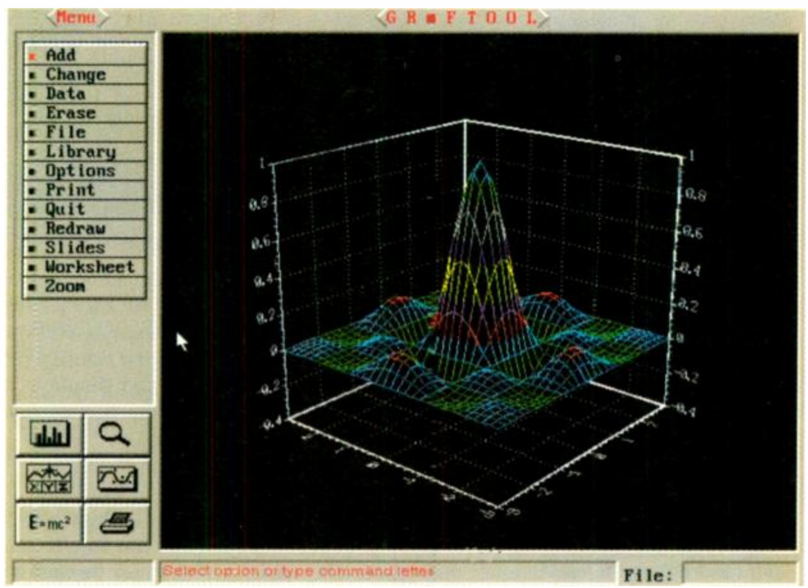


Fig. 1. Graftool front end display with menu options shows a pleasant to use GUI

Two-dimensional plots

Within its 2-D framework Graftool allows several data curves to be plotted on the same graph, complete with secondary definitions of the axis as required. For example (**Fig. 3**) phase and magnitude on the same plot with a common legend. The user can edit the graph as each component on the plot is referred to an object – changeable at will – and can adjust the orientation and size of the object. There is also the option of colour filling different areas of the plot.

Engineers needing bar charts should be happy with Graftool's variety of formats and extensive range of labelling options. For electronics engineers, Smith Charts can be generated where the input data set is defined as an array of impedance values (R,X).

Topographic plots can also be generated from within Graftool, requiring data files consisting of three columns, X, Y and Z where Z is the elevation of the contour. To add to the versatility of this option users can colour map the contour levels, highlighting the contrasts (**Fig. 4**).

For vector plots the display is constructed from arrows showing direction of the vector, and each input

System Requirements
Industry standard PC
Hard disc
MS-dos 3.0 +
Graphics (VGA, EGA, CCA or Hercules)
Printer: dot matrix, laser, PostScript, HP plotter
Optional maths coprocessor

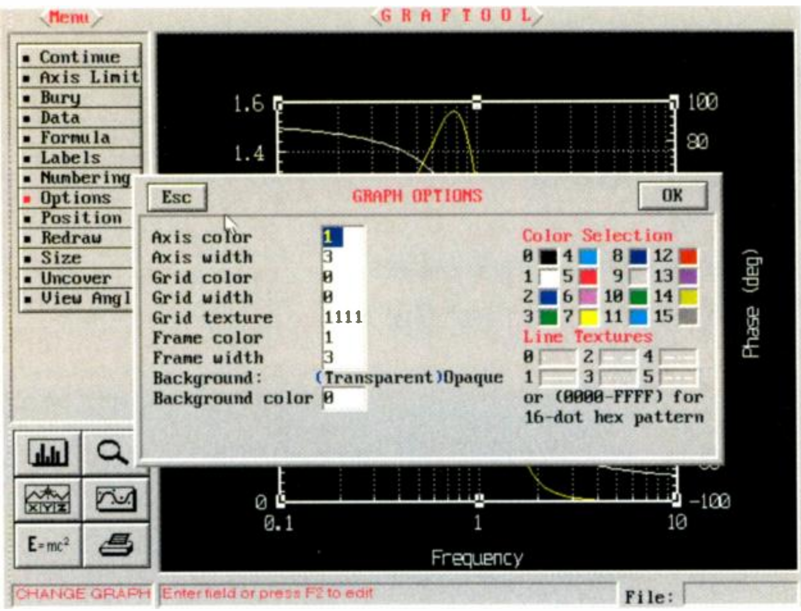


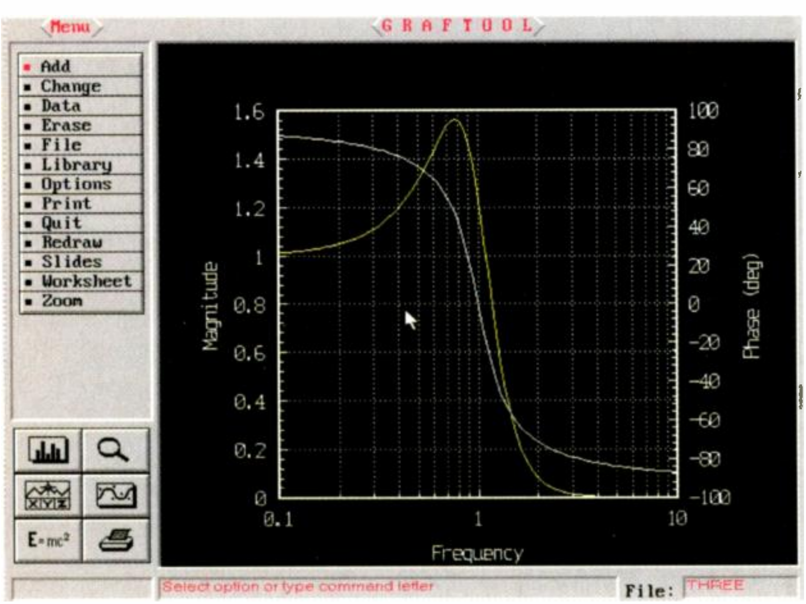
Fig. 2. Dialogue boxes give the user a number of choices.

data point consists of start and end coordinates. Another appealing feature of Graftool for the electronics engineer is the TRANSFER PLOT option which allows mapping of an input waveform with the transfer plot characteristic. Graftool calculates and displays its response to a data file containing the transfer and input waveform data.

3-Dimensional plots

One of the most appealing aspects of Graftool is its 3-D capability – it could be argued that this feature calls upon the artistic temperament of the user through the use of imaginative colour displays.

Fig. 3. Multiple plots and axis can exist on the same graph



Simplest type of Graftool 3-D plot is the "carpet" plot – basically several curves plotted adjacently and not dissimilar to the waterfall display found on most digital spectrum analysers. As expected the well-known surface plot is easily generated with Graftool and the user has the same degree of flexibility in definition of axis parameters as in the 2-D case.

In quality assessment the histogram technique is often used and Graftool can display 3-D histograms, set up with relative ease. In fact 3-D scatter point data can be used to construct three separate 3-D histograms.

Graftool's shadow-contour plot is not only able to generate a 3-D surface but also contour projection of the surface in the three planes as required (**Fig. 5**). In addition to the projections the 3-D surface can be stratified with different colours, each colour band representing a range of height values.

Once a 3-D object has been created, a user can generate, from the VIEW menu, a zoom with pan, an orientation change or can generate a cursor to access each data point. As expected the zoom enables focusing on a particular region of the plot. Resolution should not suffer significantly since Graftool uses 64-bit double precision storage for all its variables. Once the zoom option is in effect, the user can pan across the whole graph area with the zoom pan – though this is not particularly fast even with a 386 PC.

Recognisable spreadsheet

A key feature of the package is its dual-role built-in spreadsheet. It acts as a convenient interface to other data sources (other spreadsheets) and provides a means for importing data into Graftool. One major advantage over conventional spreadsheets is that a mathematical formula can be applied to a range of spreadsheet cells as opposed to individual cells.

Appearance is that of the standard spreadsheet array of elements and anyone familiar with Lotus 1-2-3 will have no difficulty is mastering Graftool's spreadsheet. Definitions required by the graphical format, labels, scaling and units can all be entered into the spreadsheet. When the data is plotted all the information is present and a complete plot is produced.

The spreadsheet can also be used as a pre-processing aid before data is plotted; removal of trends is a frequent requirement.

Data processing

Another attractive feature of Graftool is its data processing options. One of the first processes applied to statistical data is that of smoothing using splines, and Graftool provides three options for smoothing: weighted, uniform and parametric.

In the weighed version, smoothing is dependent on the variance, and input data must have an extra column containing this information.

Parametric smoothing is applicable to monotonically-increasing parallel (X and Y) data sets. To comple-

Fig. 4. Colour can be used, map contour levels highlighting contrasts.

ment smoothing, interpolation and regression options for curve fitting include a Fourier regression which, given a waveform, attempts to calculate the Fourier coefficients of its series.

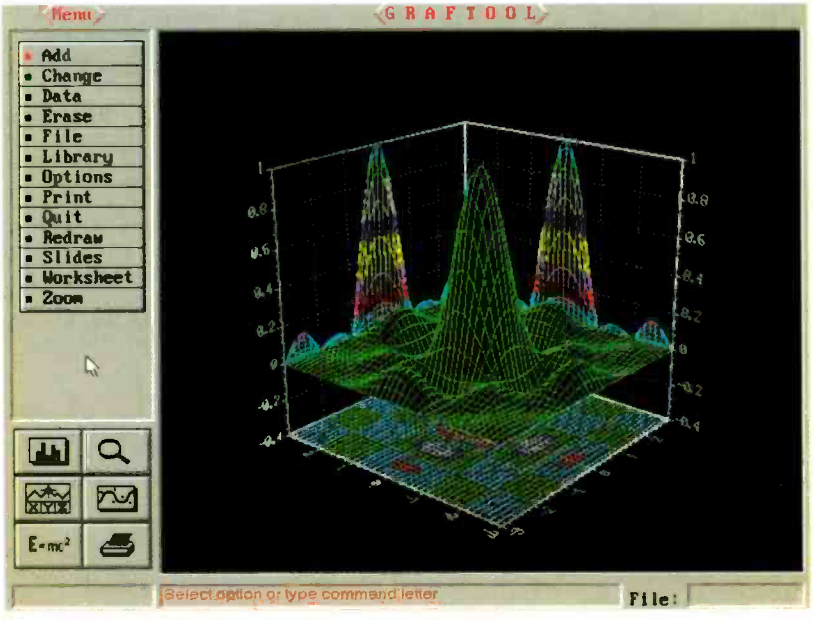
No data processing application package is complete these days without the obligatory Fast Fourier Transform (FFT). Graftool has the FFT andits inverse but alas no windowing functions.

Printing options and slide show

An important requirement for any package of this sort is the ability to generate hard copies of the graphs and Graftool performs well in this respect.

When PRINT is selected the plot is regenerated according to the target printer type. Many printers are supported and I found it especially pleasing that the first time that I linked the package up to a Qume PostScript printer it produced a perfect screen dump. Graftool also recognises several plotters, including Hewlett Packard devices, and the more daring users can define their own printer driver.

Fig. 5. 3-D surface plot with projections and colour stratifying is a powerful illustrative tool.



Slide show is an interesting novelty of Graftool and consists of a sequence of screen dumps which can be played back as a reel. Each screen dump is loaded into a .SCF file and can be accessed individually or as part of a reel. Up to 100 frames or screen dumps can be replayed and the feature is useful for displaying the dynamic characteristics of a surface. For example showing how zero positions change in operation of an adaptive digital filter.

Many good points

Graftool is a well designed package. On the whole the user's manual is well written and leads the user along a gentle learning curve. Sections are well laid out and most of the information makes sense the first time it is read.

My main criticism is of a lack of working examples and sample data files. More information would be helpful on the required format of data files, with more comments on the few examples provided. Graftool's packaging shows 3-D multicoloured plots but you have to use your own imagination to generate the appropriate data files.

An additional disc carrying sample data files to illustrate the major feature of the product would be valuable, and would also serve to complement the manual on the data file formats. But a lot of thought has plainly been given to making the package friendly to work with and there are relatively few irritations.

Main problem must be the speed of plotting. Even with a 386 PC (with shadow-ram to speed up the graphics) a lot of time is spent waiting. But that is more of a hardware limitation than software. For many engineering applications the bridge between Graftool and the data acquisition expansion card needs to be addressed at some stage.

I was rather disappointed with the range of output file formats. With the prevalence of desk top publishing in engineering circles there is an obvious need to export image files in formats which are readily recognised by DTP packages. Encapsulated PostScript files can be produced but this is not enough.

But apart from this small reservation and the lack of data files I feel Graftool is well-engineered and is the sort of package that many engineers will find useful when combating the pressures from the marketing and management sectors of their company. ■

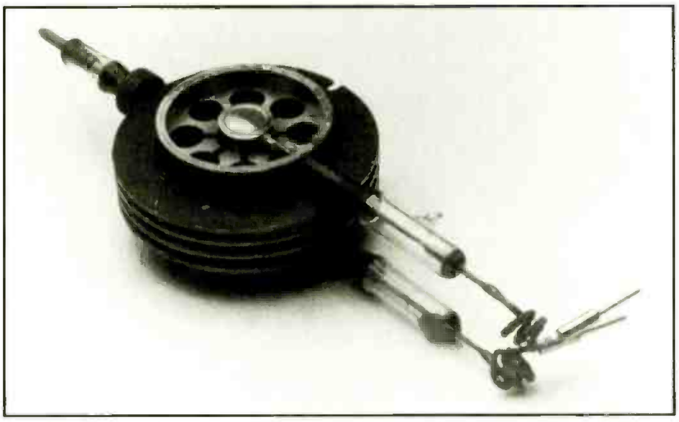
Supplier details
£395. Available from; Adept Scientific Micro Systems Ltd, 6 Business Centre West, Avenue One, Letchworth, Herts. Tel: 0462 480055.

BIRTHDAY CHALLENGE

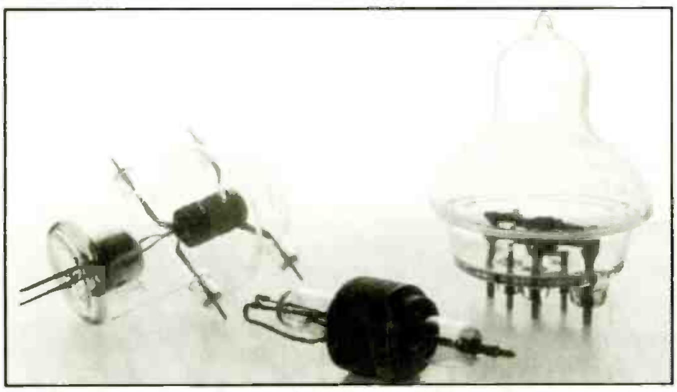
As a parting shot in the celebration of *EW + WW*'s 80th birthday, test your historical knowledge by entering this month's competition sponsored by Pascall Electronics. Simply look at the six valves pictured here and answer the questions below. The ten best entries will receive £10 book tokens. Answers and winners will appear in our February 1992 issue. Closing date for entries will be January 3, 1992.

Each of the items has technical significance in the history ond development of electronics.

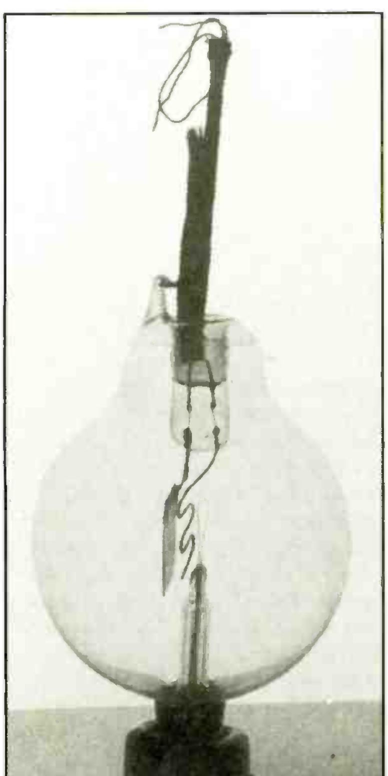
Entries will be judged jointly by Frank Ogden, editor of *EW + WW* and Rod Burman, managing director of Pascall and should be sent to *Electronics World + Wireless World*, Reed Business Publishing Group, L333, Quadrant House, The Quadrant, Sutton, Surrey, SM2 5AS. Please mark your envelope



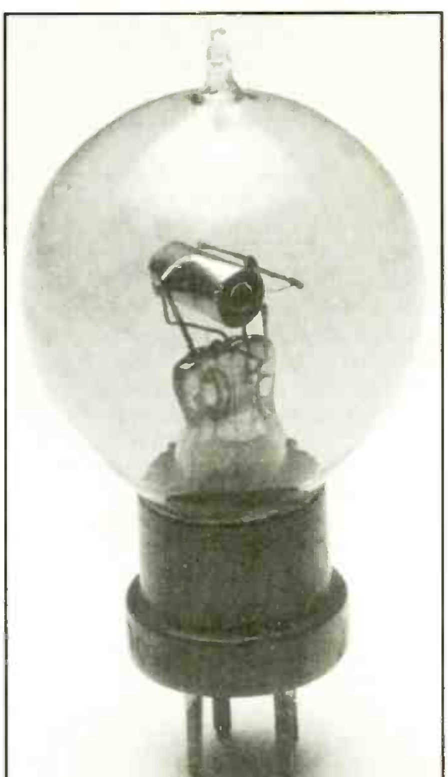
1. This is clearly a prototype 10cm cavity magnetron. What is unusual about it? (Clue: The efficiency would probably have been very low, say, 10-12%)



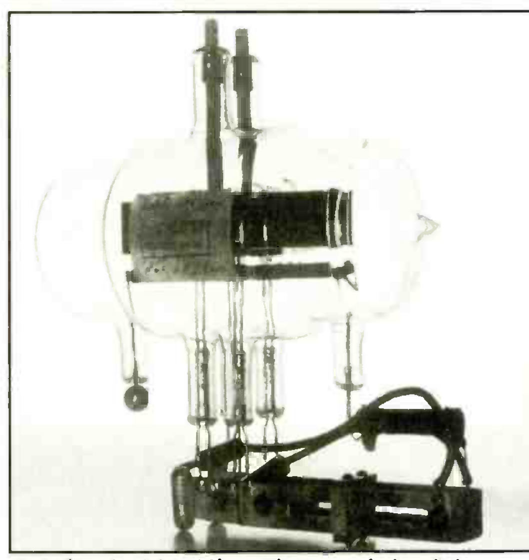
2. Identify each valve and state in which radar it was used. (Clue: WWII)



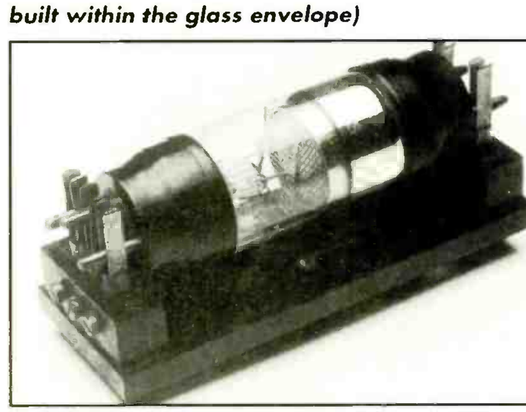
3. What is this and what is its significance?(Clue: New York, around 1909)



4. What is this and what was it known as? (Clue: FOTOS)



5. What is this? (Clue: The tuned circuit is built within the glass envelope)



5. What is this, who made it, and in what year? What was special about it? (Clue: 1927)

Designing digits into audio equalisation

continued from page 1003

Control information allows the processor to decide how the 16-bit data should be used. A non zero value indicates a coefficient and its position in the filter; a zero value indicates completion of the transmission. Transmission times can be almost halved by recognising that the filters are symmetrical about a centre value.

For the purposes of my prototype, where the aim has been to prove the control technique rather than look for the most economic hardware solution, I considered it essential to be able to write the control software in a high level language.

The goal was achieved by using an Arcom SC88PIO board with SourceView development tools allowing Borland C source, written on a PC, to be down-loaded over a serial link and run with all the debug facilities expected of a PC-resident program. All the control software fitted in a single 64K eprom.

Similarly, expediency demanded use of a display with a high level of intelligence that could display a mixture of bit-mapped graphics and standard ascii strings. An Optrex 240 x 64 graphics module with fluorescent backlight provided the necessary ease of use.

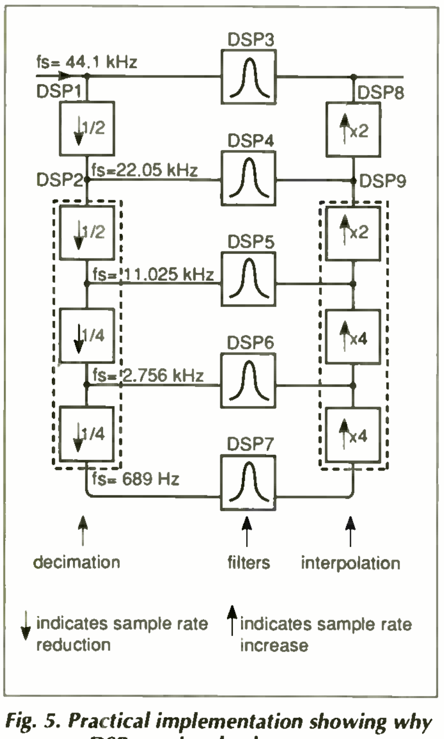


Fig. 5. Practical implementation showing why so many DSPs are involved.

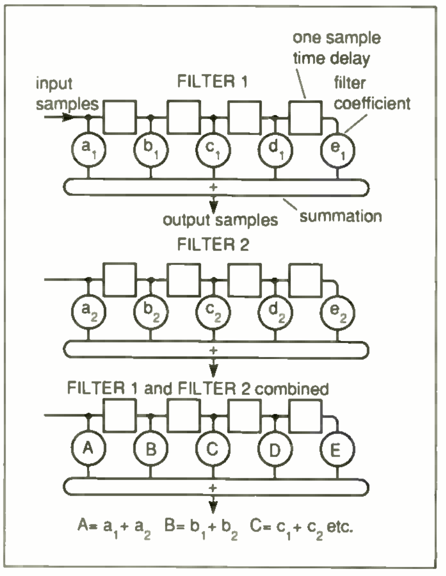


Fig. 6. Combining FIR filters into a single filter.

The user interface is a hand-held infra-red remote controller, with five buttons. Two buttons move a display cursor, left or right, under the filter bands or to the volume control band; two further buttons increment or decrement the selected band, and additional functions are provided through menus selected by a fifth key.

The controller retains, in floating point format, all the coefficients for each of the twenty seven bands, and when a particular frequency band is adjusted, it determines which other bands come in the same group for the appropriate DSP.

The composite coefficient is calculated by summing individual coefficients after multiplying each by the level for that particular band. The 80188 processor was too slow to achieve the target update rate of 10Hz using purely C routines. But the fact that output was to be 16 bit integers enabled some of the maths routines to be moved to simple assembler routines that could make use of the raw 16 bit capability of the 80188.

Implementing a multi-DSP system

The incoming serial data stream has to be converted into parallel data streams at different sample rates, passed through the band-pass filters, and then recombined into single serial data stream.

Starting point is to consider the data format from the digital audio interface, consisting of alternate left and right hand channels

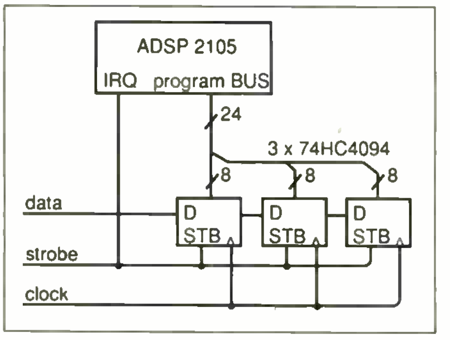


Fig. 7. DSP control interface.

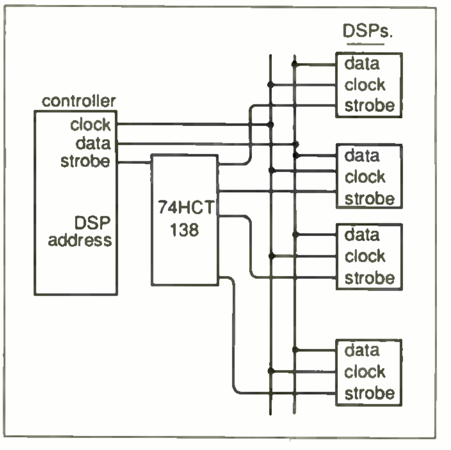


Fig. 8. Passing control data to the DSPs.

at a combined rate of 88.2kHz.

Each DSP filter bank handles only one channel, at 44.1kHz, meaning that there is the unused time slot at the other channel into which a second data stream can be inserted. This is used by the top level decimation and interpolation to produce a sub channel at 22.5kHz sample rate.

Figure 9 shows how the decimation DSPs, DSP1 and DSP2 split the incoming signal. DSP1 produces a single channel at 44.1kHz, but in every alternate space inserts a sample at 22.05kHz, passed to DSP2. DSP2 has four available time slots to output data at the reduced rates indicated. Although these data rates are reduced there is always a point, every 64 samples, when all the time slots are occupied with data.

Figure 10 indicates the processing of DSP9.

Samples at various reduced sample rates, have their sample rates increased by stages of up-conversion and interpolation.

Finally DSP8 takes the output of DSP9,

increases the sample rate by two and adds it to the output of DSP3.

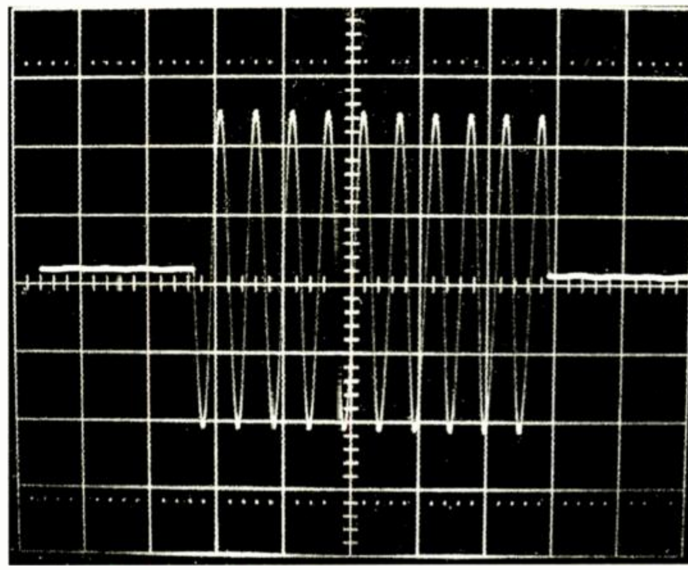
Alignment of time delays

An FIR always has an associated time delay – for a linear-phase FIR filter this is equal to half the length of the delay line. Such a filter can be regarded as having zero phase shift with a parasitic time delay. There is a build up of time delays throughout the equaliser, the longest being through the low frequency filters where there is additional delay caused by the interpolation and decimation filters. Total delay at the low frequencies is about 0.3s.

Delay through the higher frequency filters is progressively smaller, with the shortest being about 2ms. For filters to produce a flat response they must all have the same time delay so an additional delay must be added to all filters other than those at the lowest sample rate. The longest delay is added to those at the full sample rate.

Zipper Noise

"Zipper Noise" refers to the characteristic sound of data being passed through a digital system while parameters, such as filter coefficients are being changed. The equaliser system described is almost completely free from the effect, most likely as a result of the use of FIR filters. Lack of a feedback path limits the time that disturbances can persist. It is also thought that "zipper noise" exhibited by IIR filters with coefficient changes is inherent, because of the phase differences existing between different parts of the filter. ■



Phase linearity of the equaliser – response to 400Hz gated tone-burst. All the bands are set to maximum. The preservation of the tone burst demonstrates the high phase and amplitude accuracy of the filters.

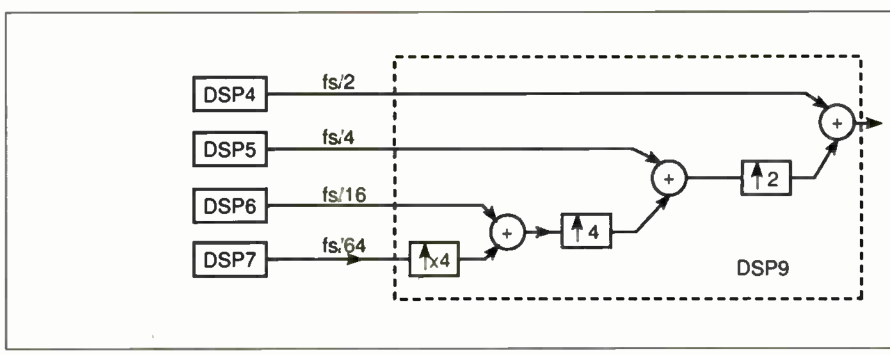


Fig. 10. DSP9 increases the sample rate of DSP4-7 up to 22.05kHz.

Bibliography

1. "Theory and Application of Digital Signal Processing", Rabiner and Gold, Prentice Hall, 1975

2. "Discrete-Time Signal Processing", Oppenheim and Schafer, Prentice Hall, 1989

3. "Discrete-Time Signal Processing", van den Enden and Verhoeckx, Prentice Hall, 1989

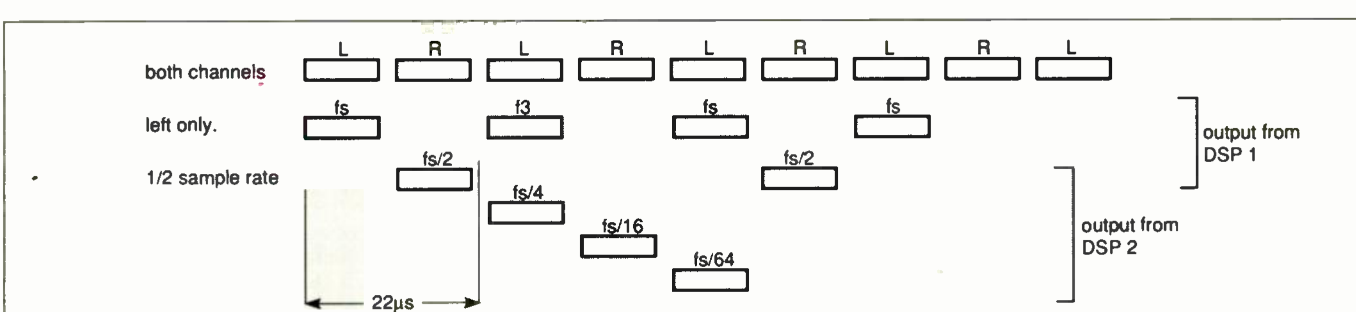
4. "Introductory Digital Signal Processing with Computer Applications", Lynn and Fuerst, Wiley, 1989

5. "The Art of Digital Audio", Watkinson, Focal Press, 1988, revised 1989

6. "Principles of Digital Audio", Pohlmann, Howard W Sams & Co, 1985, 2nd Edition 1989

The first two are a must for the DSP engineer's library. The others are good reading and help understanding by each taking slightly different approaches to the topics. WH

Fig. 9. Digital audio data stream showing how decimation DSPs split the signal.



MEASURING DETECTORS

Ian Hickman discusses pros and cons of various fast response, large dynamic range circuit designs for RF level measurements.

The useful dynamic range of a diode detector could be extended by applying DC forward bias but the improvement made in this way can be very limited – of the order of a few dB. There is also the standing offset (temperature dependent) to cope with, but that can be balanced by another dummy diode circuit, **Fig. 1a**.

Forward bias has another benefit: when the input signal falls rapidly the detected output voltage falls aiming at the negative rail. If the negative rail voltage is large, *R* virtually represents a constant current "long tail", defining a negative-going slew rate limit for the detector of dv/dt = (V-)/*CR*. In this case, if the detected output parts company with a trough of the modulation, it will not be towards the tip, but at the point of maximum slope. For sinewave modulation of v= $E_{max}\sin(\omega t)$, this is given by dv/dt, which equals $E_{max}\omega\cos(\omega t)$. The maximum value of cos(ωt), of course, is just unity and occurs when sin(ωt) equals zero, so dv/dt_{max} = (ωE_{max}) volts per second, giving the maximum permissible value for (V-)/CR for distortionless demodulation.

It would be a small step to replace the detector diode with a transistor, giving an arrangement which in the days of valves was known as the infinite impedance detector, **Fig. 1b**. With no RF voltage swing at either anode or cathode, a triode is perfectly satisfactory. Assuming no grid current, the only loading on the preceding tuned circuit is the loss component of the C_{grid}-all capacitance. This was very low up to VHF and quite negligible at all the usual Intermediate Frequencies then in use.

In the case of the infinite impedance detector circuit, clearly the loading is finite, however low the frequency. But loading will be less for the diode of the forward biased detector circuit (Fig. 1a) by a factor roughly equal to the current gain of the transistor. Substituting an RF jfet such as a BF244 results in a very close semiconductor analogy of the infinite impedance detector.

In either case, a balancing device may be added if the absolute detected DC level is important. When comparing the performance of a jfet with a bipolar infinite impedance detector, the more abrupt cut-off of the latter results in a higher dynamic range, **Fig. 1c**.

The circuit of the infinite impedance detector circuit lends itself to a further improvement not possible with the simple diode circuit (**Fig.2a**). Collector current of Tr_1 in the absence of any input signal is arranged to be much smaller than the current through R_3, which is thus mainly supplied via Tr_2.

When a large input signal is applied, once the steady state condition has established itself, Tr_1 conducts only at the tips of positive going half cycles. These current pulses are amplified by Tr_2, increasing the tail current through R_3, thereby holding Tr_1 cut off except at the very tip of each cycle.

Input impedance may not be quite as high as the infinite impedance detector and is slightly non-linear to boot – due to the voltage swing across R_2 appearing across the collector-base capacitance (CBC) of Tr_1. At low input levels, Tr_1 never cuts off but passes a distorted sinewave where the increase in current on positive swings of the input is greater than the decrease on negative swings.

Tr_2 never cuts off either, so the voltage swing at its base is very small and there is little Miller feedback via Tr_1's CBC. Tr_2's collector current is modulated, increasing more on the positive swings of the input and decreasing less on negative swings, so increasing the average voltage at Tr_1's emitter.

The circuit is in effect a servo-loop system. Linear as far as the envelope of the RF input is concerned, but non-linear over each individual cycle of RF. Tests on the circuit showed a linear dynamic range approaching 60dB, measured in the upper part of the HF. Another variation (Fig. 2b) replaces the inverting PNP stage by an emitter follower; an inversion is not required with this circuit as Tr_1 base to Tr_2 collector is non-inverting.

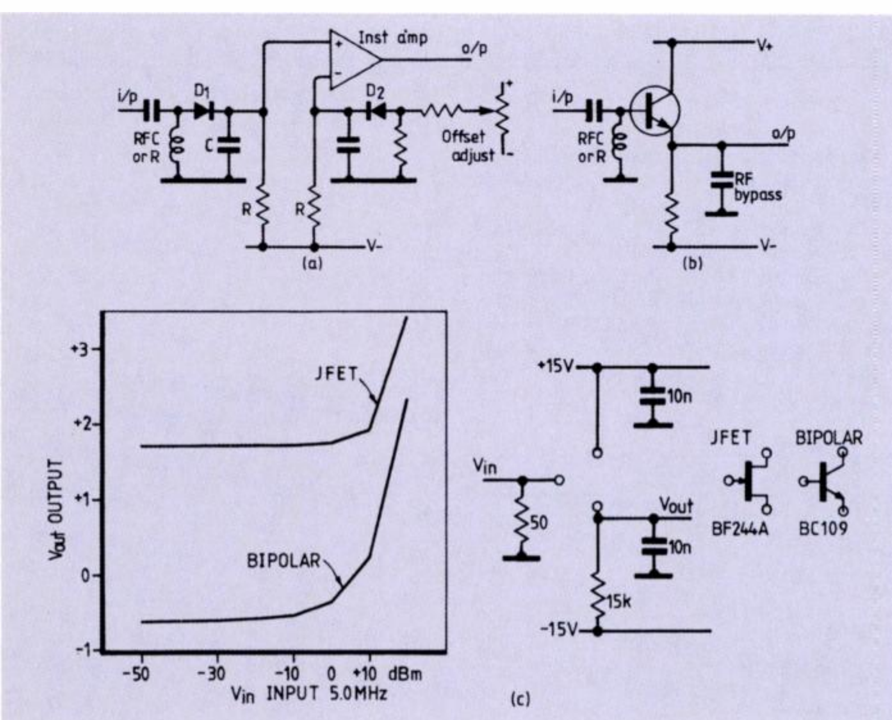
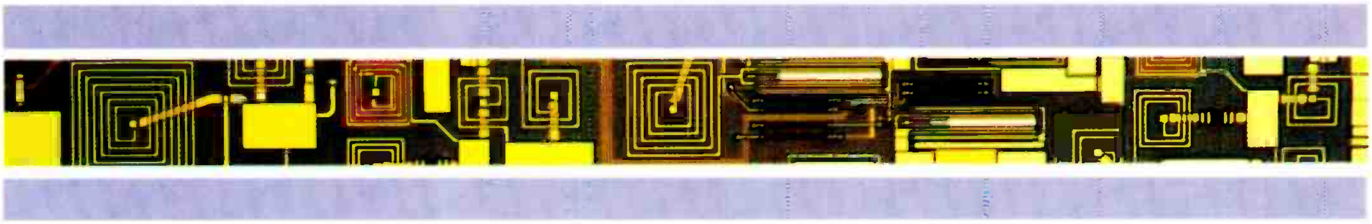


Fig. 1a. DC bias to the diode improves linearity by several dB. If R is made high enough, it becomes a current source greatly extending the linear detection region but this also requires a larger negative rail voltage.

Fig. 1b. This is the functional equivalent of the diode circuit (a).

Fig. 1c. Comparing the performance of a jfet vs bipolar infinite impedance detector. The latter has a more abrupt cut-off providing a higher dynamic range.



There is now no RF voltage at Tr_1's collector at any input level, and the input impedance should be as high as the infinite impedance detector. Although the circuit uses more components, in an integrated circuit implementation this is of little consequence.

The circuits discussed so far **(Figs.1 and 2)** measure the amplitude of the positive peak of the input signal, and this will be a good guide to its RMS value if the input is taken from a tuned circuit, and so virtually undistorted. In the case of a wideband detector however, the wanted input signal may be significantly distorted and this may affect the expected 1.414:1 ratio of peak to RMS voltage. I say "may" because in the case of both odd order and even order distortion, the measured peak voltage could in fact be the same as if the distortion components (harmonics) were just not there. More commonly though, the peak voltage will be affected **(Fig. 3)**.

An even order component, e.g. second harmonic, will reduce the amplitude of one peak but increase the amplitude of the opposite polarity peak by the same amount. It follows that by measuring the amplitude of both peaks and taking the difference - i.e. using a peak to peak detector - no error results, and the RMS value of the fundamental component, if that is what you want to measure, is just the peak to peak value divided by 2.828.

A difference between the absolute values (moduli) of the positive and negative peaks not only indicates the presence of distortion,

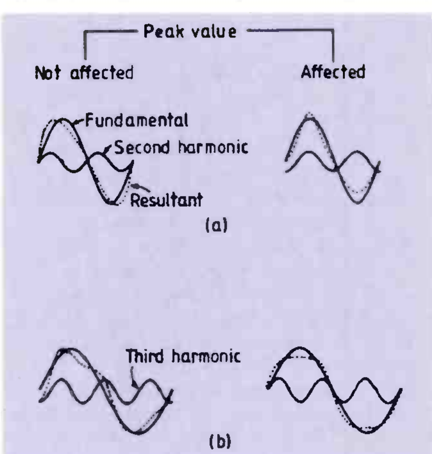
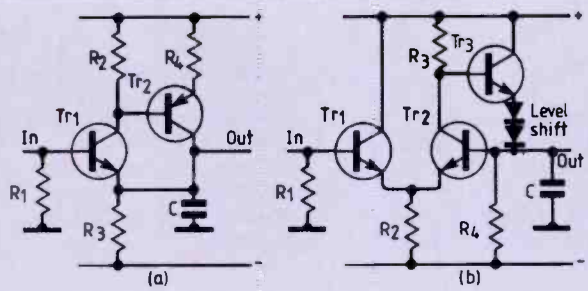


Fig. 3 In a wide band detector measuring the input signal's positive peak may affect the expected ratio of peak to RMS voltage. (a,b) Show resultant phases in second and third harmonics.

Fig. 2a, b Active detectors provide further improvements on the infinite impedance detectors.



it directly gives the value of the sum of the in-phase components of even order distortion. Odd order components, e.g. third harmonic, affect both peaks in the same way: not only will they alter the expected 1.414:1 peak to RMS ratio, but unlike even order components there is no convenient indication (such as unequal +ve and –ve peaks) of their presence.

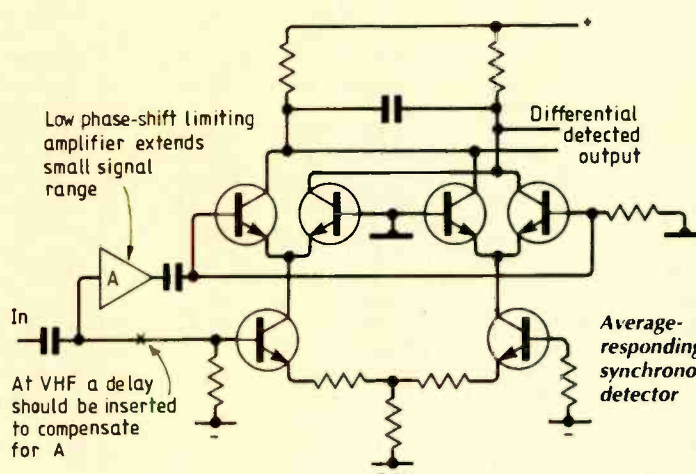
An alternative to measuring peak values or peak to peak values is to measure the average value of the modulus of the input sinewave - the average value of a sinewave itself is of course zero. This takes us to the topic of ideal rectifiers, which are readily implemented with op-amps, but such circuits are limited to audio and video or low RF frequencies. ■

Low error at higher odd harmonics

Twenty years ago I designed a circuit using level measuring sets operating up to 20MHz. It is average responding, linear down to low levels and will work up to VHF with suitable components. Used as a product detector, the amplified signal will provide its own switching (reference) drive.

It operates linearly down to the point where there is no longer enough drive to the four transistor switching cell. In practice, the limit may be where the differential output signal reverses sense, due to device offsets. For use up to VHF, it may be necessary to introduce delay into the signal path to compensate for the lag through the switching drive amplifier.

A little simple algebra shows that the average value of a sinewave is related to the RMS value by $E_{av} \times \pi/2 \times 0.707 = E_{RMS} = 1.11 \times E_{av}$. The presence of even order harmonics does not affect the measured value of the fundamental, but the same is not true of odd harmonics. However, although 10% of third harmonic will give an error in a peak reading somewhere between 0 and 10%, for an average-responding detector, the error is between zero and only 3.3%, i.e. one third of the harmonic amplitude. For the fifth harmonic, the error is only one fifth for higher odd harmonics. So an average-responding circuit is really quite useful.



IF?

In most of his article "No ifs - no buts" (October, pp. 850-852), Mr Pettit tackles the wrong problems. Although it is true that the key to successful programs is good design not skilful application of complex debugging kits, most of the article concerns inessential coding details. Only once is any design issue mentioned, namely the program whose faulty operation was cured by dissecting its components and re-loading them into an unspecified "standard framework".

Blanket condemnation of IF..ENDIF, IF-THEN-ELSE, and IF...GOTO constructions is quite misleading: the first two constructions are essential for implementing well-structured program designs. Only IF...GOTO causes endless problems.

An electronics engineer's first introduction to programming has often been an assembly language where well-structured types of IF are not implemented. This can easily lead to bad programming habits and transformation of IFs into thinly disguised equivalents and "domain partitioning" simply distracts from proper consideration of overall program design.

Pettit asks if are there any jobs left for IF? My simple answer is that there is no satisfactory substitute for fully considering the problem at hand before attempting to write a computer program.

Wherever there is more than one case to consider then the program design must contain one corresponding conditional construction to select between cases. Each such design construction can always be implemented by a straightforward IF or CASE construction (and sometimes, as Pettit demonstrates, by some equivalent means).

Often the program should contain no more IFs than can thus be accounted for.

It may be that inappropriate cases were considered at the outset; if the program has not been properly designed prior to coding (when it is easiest) there is no option but to try to redesign while testing. But frequently the justification for extra IFs – apart from their use in sloppy code-patching – concerns some "optimisation" feature, which only the reckless will attempt until program design has been proven by the most straightforward implementation possible.

Eric Richards
Kibworth Computer Training
Leicester

Shifted opinion

Steve Bennet (Letters, "Light hearted", *EW + WW*, Sept 91) on the subject of Doppler shift, suggested a method of accounting for the change in energy of a blue shifted photon. He required that the mass equivalence of the unshifted photon's energy and the velocity of the source should be substituted into the famous kinetic energy equation

$$mv^2/2$$

after which it was to be added to the original photon energy and divided by Planck's constant

$$E=(mc^2+mv^2/2)/h \quad \text{shifted}$$

I have tried this numerically by working out the shifted photon's energy from the equation:

$$E=hfc/(c\pm v)$$

h is planck's constant; f is the frequency of the source before being Doppler shifted; c is the speed of light in a vacuum; and v is the velocity of source relative to an outside observer, where coefficient v is positive for red shifted photons and negative for blue shifted photons.

I found a marked discrepancy between the resulting value and the one obtained through Steve Bennet's suggested method (the equation I used is the usual equation used in physics). On expanding the denominator of this equation using the binomial theorem and substituting mc^2 for hf, the following expansions were derived.
For blue shifting:

$$E=mc^2+mcv+mv^2+mv^3/c+...$$

For red shifting:

$$E=mc^2-mcv-mv^2-mv^3/c+...$$

There is an infinite number of terms, with each successive added term giving a more accurate value.

At low speeds the latter terms in the expansions are so small they can be ignored; at higher speeds they have to be taken into account. Note that the given expansions are not relativistic.

As it can be seen there is no sign of the kinetic energy equation ($mv^2/2$).

Considering the momentum of a photon and following the above procedure, change in momentum can be given by Newton's equation for momentum of a particle (momentum = mv) at low speeds. At higher speeds the extra terms become more apparent. The expansions found are:
for blue shifting

$$\text{momentum}=mc+mv+mv^2/c+mv^3/c+...$$

For red shifting

$$\text{momentum}=mc-mv-mv^2/c-mv^3/c+...$$

Do not be fooled into thinking that the initial unexpended equation is relativistic in any way by the mere fact that I have mentioned a deviation from Newton's laws at high speeds. To consider the relativistic case, frequency f (or the equivalent rest mass) of the emitted photon must be that which is observed relative to the movingsource. After which the discriminant $\sqrt{(1-v^2/c^2)}$ derived from Special Relativity is included into the denominator of the Doppler shift equation, ie:

$$E=hfc/((c\pm v)\sqrt{(1-v^2/c^2)})$$

As an afterthought, in recalling the

Nuclear response

The nuclear industry continues to campaign for support in the most absurd and blatant manner. We now are confronted by a serious proposal from Lawrence Livermore laboratories, ("Harnessing H-bombs to heat the home", *EW + WW*, October, p.808) to harness fusion by means of what amounts to an untrammelled licence to test nuclear devices underground. What a comfortable bed for the nuclear and defence lobbies to climb into. Is this proposal accompanied by a serious costing? I shudder to think what this would amount to.

In light of the probable investment required, would your readers care to consider the huge amounts of very clean energy available not from such a profligate exercise, but from the earth itself.

Serious and grossly under-reported experiments have been underway to learn how to tap this geothermal power-house. No government has so far felt obliged to pay more than lip service to the possibility of power production from this massive resource. This is despite repeated success of experiments designed to prove the feasibility of such power production. Arguments against proceeding are invariably centred on the probability of economic returns for private investment judged on commercial timescales. Can anyone imagine Calder Hall being built with private capital? What economic returns would have been realised by now?

In truth the nuclear lobby – who have been central to the supervision of geothermal experiments in the UK – see such an abundant source of power as a serious threat to their own cosy arrangements within the establishment.

At depths of only ten miles we find mean temperatures of 600°C to 1000°C. Why do we anguish about pollution and waste disposal when we are quite literally standing on the solution to these problems. A fraction of the resources expended by almost any other means of energy production would ensure clean and safe supplies of power.

Robert Gillatt.
Cornwall

law of conservation of energy, considering every Doppler shift that occurs in the universe the resultant energy change will be zero. This is for those who may worry that the law of conservation of energy is apparently violated in individual Doppler shifts cases, whereas a whole (ie every Doppler shift case) it is not.

Robert J Aldridge
Hatfield
Herts

Clean power

I was impressed by your August 1991 article "The Hydrogen Economy" (pp. 668-671). I have for some time waited for serious debate about the hydrogen powered vehicle. To me it is the panacea for our polluted cities and I only hope the Green lobbyists are as quick to recognise the virtues as they are to dismiss nuclear power. Overlooked, however, is that solar power is also available in other forms, notably hydro-electric power (HEP).

With a plentiful water supply HEP could well be the link in closing the energy cycle, all powered by the sun. Third world countries could be the next world energy basket though this will require vast sums of money and expertise to construct dams in appropriate places.

Perhaps Green lobbyists will rally together with bodies such as Oxfam to help in this matter in the third world.

DT Moore
Basingstoke
Hampshire

Why antennas work – and the CFA won't

Continuing controversy over the crossed field antenna seems to illustrate the fact that few people really understand why antennas radiate. Maybe I am not alone in finding that most textbooks do not give a satisfactory answer. However by viewing wire antennas as perfectly conducting transmission lines, many of their characteristics can be resolved. The treatment also suggests that the crossed field antenna is unlikely to have a low Q.

A two wire transmission line will transmit energy from sending end to receiving end by an electromagnetic field set up in the space mainly between the wires. Energy transmitted in the space outside the line is normally intended to be small. In the case where the wires are not close together but separated by half a wavelength the picture of energy concentration in the total field is inverted. Between the wires the field Is repelled and forced to travel outwards on longer paths. Very little energy is transmitted here. Field lines taking the longer paths with long travelling time effectively never return or return to be repelled; energy is radiated.

The infinitely-long two wire transmission line of this kind has an infinite loss. All energy is radiated and it is easy to see that the loss must be so-many-dB per unit length, in terms of wavelength.

For a single wire transmission line above earth, the lowest optimum height for radiation is thus a quarter wavelength, due to the ground image of the virtual return conductor. The horizontal dipole antenna can be considered as a special case being a centre-fed transmission line.

On unterminated lines the energy not lost by radiation is reflected back towards the transmitter where the line is terminated by the "radiation resistance", causing the remaining energy of the first wave to be reflected once more down the line.

If the antenna is resonant the remnant waves travel in phase with the new incident wave and reinforce it. If energy is entirely radiated in the incident wave's first pass, radiation resistance at the transmitter end corresponds with the characteristic impedance of the line, as it would with the infinite radiating line.

Existence of these travelling waves on the half wave dipole shows it to be less than the ideal antenna it is popularly supposed, and merely one of the shortest naturally resonant antennas. Remnants of earlier waves must build up in phase with the incident wave until energy transmitted in one cycle is equal to energy radiated.

The antenna is said to have a Q factor of a certain bandwidth. Shorter antennas must have a higher Q since they necessarily have greater remnants of previous waves still travelling back and forwards until they finally disappear.

Radiation resistance of a particular configuration depends on the travelling waves present in the antenna and could presumably be deduced from knowing the radiation loss per unit length for a standard configuration – more easily found by measurement.

It is therefore highly unlikely that the crossed field antenna could have a low Q, taking into account its small dimensions relative to wavelength if it is meant to be efficient, and that it must include components which bring it to resonance for highest efficiency.

EC Forster
Phase Track Ltd
Reading

Power line resonance...

I was interested in Dr Aspden's article (*EW + WW*, "Power lines, cancer and cyclotron resonance", pp. 774-775) and his ingenious suggestion that we should either convert to DC or use 100-200Hz.

There is a well documented history of the DC versus AC controversy which raged in the days of Edison and Westinghouse. Westinghouse won because it is not possible to carry DC currents very far before they break down, which is why Edison's "Power houses" had to be built all over large towns.

As for the notion that switching to 120Hz might avoid ion cyclotron resonance effects, surely this ignores the problem that the resonance then simply occurs in slightly different strength magnetic fields (and there are also intensity effects)?

I discussed this with Abe Liboff recently. The total magnetic field in ICR is a mixture of the DC and the artificially created AC field. While the B_0 required for Lithium (Li^+) ICR would be 0.542G at 120Hz, for Magnesium (Mg^{2+}), another common biological ion, it would be 0.95G which is not uncommonly different from the 0.879G required for $45Ca^{2+}$ ICR at 60Hz.

Nevertheless Dr Aspden's surmise that the hydroxyl ICR is the dominant cause in the 50-60Hz hazard risk is well worth following up: it is the covalent hydrogen bond, after all, which lies at the heart of DNA base uncoiling mechanisms.

Roger Coghill
Gwent

...And vibrating bodies

In your September issue Dr Harold Aspden says (*EW + WW*, "Power lines, cancer and cyclotron resonance", pp. 774-775) that ions in the human body can be driven to resonate at 50Hz in the earth's magnetic field, possibly damaging the body.

His proposed cure is to change the main frequency from its present value of 50Hz, avoiding the cyclotron resonance.

But this would be enormously expensive and would waste effort where the problem did not exist.

Instead I suggest that the resonance frequency be changed by altering the standing field dictating it – a solution only needed where problems arise. For example a coil carrying direct current could be installed around affected houses such as those near transformers or power lines.

There have been reports of people who feel immediately ill on going near power lines; it would be interesting to see if their symptoms vanish when the ambient mean field is changed. A uniform field would be the target, since red corpuscles are attracted to positions of maximum field.

M Williams
North Yorkshire

Not ridiculous

I note with irritation the arrogant stance of Alan Boswell (Letters, October) in connection with the CFA antenna. One paragraph would cover the valid part of what he has to say.

Mr Hately has published details of a structure which many find of interest. He would no doubt have expected rigorous examination, but is it necessary to ridicule?

If future examination shows a flaw in the hypotheses it would still be right for *EW + WW* to publish; if not, we will stop talking about our thoughts for fear of being found wrong.

J French
Mariner Radar (Lowestoft) Ltd
Lowestoft

Old valve...

Reference "Any old valves?" (Letters *EW + WW*, September, p.736).

Mr Ellis could do worse than consult "High quality Sound Reproduction" by James Moir, published by Chapman & Hall, 2nd edition, 1961.

If he cannot find a copy in the technical library in his nearest large city (surely there must be a copy in Birmingham Central Library) he ought to be successful at the British Library, Lending Division, Boston Spa, West Yorks.

I hope this helps. My only other suggestion is "that Mullard handbook" and various Mullard leaflets printed around that time.

JM Notley
Tadcaster
North Yorks

...not suitable

To save DA Ellis a great deal of wasted effort in trying to construct valve pre-amplifiers from a bygone era ("Any old valves?", Letters, *EW + WW*, September) can I suggest that he takes out a subscription to *Classical Glass* published by Edward T Dell in the USA.

There he will find projects, ideas and correspondence written by people who appreciate the benefits and limitations of valves in the audio field. While it has a strong North American slant most projects can be converted to European standards and component sources.

My collection of audio publications, including copies of articles from *Wireless World* and the *Audio Engineering Journal* from the late 1940s to the mid 1960s, clearly show that the pre-amplifier designs are rarely able to meet the needs of modern phono cartridges or line level inputs such as CD. In addition, availability of low cost voltage regulators and other components has enabled a level of performance far beyond that of 30 years ago.

If Mr Ellis wishes to construct pre-amplifiers from an earlier period for historical reasons he will find a series of volumes entitled *Audio Anthology*, available from the same publisher, containing numerous articles abstracted from *Audio Engineering*, the predecessor of the *Journal of the Audio Engineering Society*, between 1947 and 1957.

I should add that my recommendation of *Classical Glass* is solely as an enthusiastic subscriber.

Iain Harley
Peterborough
Classical Glass. PO Box 576, Peterborough NH 03458, USA.

Fielding gravity

George Overton's letter (*EW + WW*, September 1991) is reminiscent of a previous letter (*EW + WW*, October 1990) where Bruce De Palma concludes that understanding of the gyroscope is dependent on the absolute motion of the rotating wheel in relation to a stationary ether.

As a fellow member of the Anti-Gravity Society (AGS) I strongly endorse the views expressed by Mr Overton in his response to Hugh Pincherie's letter (*EW + WW*, August 1991). Levitating gyroscopes are a phenomenon that refuses to be ignored. But some modification to current theories is required that few professional scientists are prepared to accept.

Certainly, the possible necessity of restoring the banished ether is strictly taboo though talk of zero point energy and vacuum energy is apparently permissible in the quantum physics of the 1990s.

Harold Puthoff has suggested a new way to describe the vacuum energy in a cosmological context. He refers to the zero point energy field as the ZPF, and concludes that quantum theory must be modified to explain why the ZPF does not appear to produce a gravitational field. Zero point energy is real and produces measurable results, demonstrable by the Casimir force of attraction between two metal plates in a vacuum, and the Lamb shift in the wavelength of spectral lines of atoms. Clearly the ether is not dead only sleeping...

Perhaps those working on anti-gravity theories in connection with gyroscopes (and AGS members in particular) should replace the word ether by ZPF to gain acceptance in the scientific community. Even Harold Aspden, a long time exponent of ether theories, has resorted to using words such as *vacuum lattice structure* to defy the critics.

If accepted theories are correct, anti-gravity has no place in the real world. Only further development of known anti-gravity devices will destroy the dogma underlying current theory, and result in practical spin-off technology.

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The Anti-Gravity Society
14 Churchill Close
Tadley
Hants RG26 6NH

Ether or no

Steve Bennett's letter (*EW + WW*, September 1991) draws attention to the shaky foundation underlying the current theory of light.

Physics books take the reader in a series of leaps and bounds, from corpuscular theory to quantum mechanics, via Newton, Maxwell and Einstein, only to conclude that none of these theories is satisfactory.

At the heart of the problem is Relativity After postulating that the speed of light is the same in all inertial frames, the theory requires that a photon is massless (despite the well-known fact that gravity bends star-light).

Authors of some physics text-books claim corpuscular theory cannot explain refraction. But the claim is bogus. If we assume that photons have mass, then by applying the vector law of conservation of linear momentum, we can readily derive the laws of reflection and refraction.

We can also calculate how incident energy is divided between the reflected and refracted beams (all without reference to Fermat's principle or Maxwell's equations). A similar argument explains the Compton effect in terms of photons rather than waves.

But to return to Mr Bennett's letter, he need not apologise for mixing relativistic and Newtonian physics. The famous "Einstein formula" $E=mc^2$ was first written in 1900 by Henri Poincare, five years before Einstein proposed Special Relativity.

Poincare's formula relates the Energy (E) of a pulse of light to its Newtonian mass (m) and speed (c).

I cannot say what Einstein had in mind in his first (1905) paper. Perhaps someone can enlighten me.

John Ferguson
Surrey

Illegal listening

Proliferation of multimode, wide-band scanning radio receivers, most having many memory channels, means the question of legality of their use has become of general interest, with particular application to Fire/Police/Medical mobile radio, and cellular and cordless phones.

Current legislation seems to mean that though it is legal to manufacture, sell, and buy such apparatus it is illegal to listen to signals on many frequencies.

I suggest that unless the transmitting authority takes reasonable precautions (eg transmitting a signal with digitally scrambled modulation, and/or frequency agile carrier following a "random" frequency sequence – hopping) then confidentiality should not be expected, and it should not be a crime to listen to information so effortlessly obtained. The emergency and law enforcement services literally shout their E-M signals at a front-end deafening volume. If a simple superhet receiver has an image frequency that happens to coincide with an unnecessarily strong and uncoded "protected" signal, whose fault is it that the information carried is not secure ?

The means to achieve scrambling and hopping are now well established and the technology is sufficiently mature to be available at reasonable cost and with little penalty in terms of weight or power requirement. Outlawing unlicensed manufacture/sales/purchases and use of equipment capable of receiving such coded transmissions would be a great deal easier to understand and justify.

Joseph Barry
G8SLP
Chester

Fluxgate equation

We have constructed a Helmholtz calibration coil as described in the article by Richard Noble ("Fluxgate magnetometry", *EW + WW*, September, pp. 726 -732).

We also cut a circular hole in the top of the former, between the windings, so that a compass placed in the centre of the coil could be observed, and conducted experiments to evaluate the coil and compass as a simple tangent magnetometer.

Experiments showed inconsistencies between the predicted and measured values for the earth's flux density. But by checking the initial equation in the article used to calculate the field of Helmholtz coils, it was found that the main cause of the inconsistencies was the inappropriate value for N.

During the experiments, the coil was orientated E/W so that the compass needle aligned at 90° to the axis of the coil. Now if the magnetising force H_i produced by the coil equals that of the earth's magnetic field H_e, the two fields are balanced and the compass needle is deflected 45°. (Arctan H_i/H_e).

Only 60mA was required to deflect the compass needle 45°, but according to the initial equation, 125mA is required to produce a field within the coil equal to the earth's flux density, ie about 47,000 gamma.

The initial equation was (9.1 x 10^{-3} x N x I)/r where N = turns in each pair of coils and r = radius.

The most obvious error was misplacing the decimal point which should of course be 0.395gauss/A. Nonetheless this error seems to have been corrected in the text to give 125mA = 47,000gamma. So the inconsistency appears to be related to the equation.

Taking the basic equation for a field half way between the windings of a Helmholtz coil with permeability of the air core as 4π x 10^{-7}, a constant of 8.992 is obtained – somewhat different to 9.1 given in the equation.

Permeability would however be increased considerably by the toroidal core of the flux gate transducer and presumably that would upset calibration.

But, the significant difference is that the value of N is now the total number of turns, instead of half the total as given. Hence:

(8.992 x 10^{-3} x N x I)/r = gauss;
(8.992 x 10^{-7} x N x I)/r = tesla; or
(899.2 x N x I)/r = nT (gamma)
where N is the total number of turns, r = radius of coil in metres and I = current.

The following worked example is based on I being found by experiment and gave 47,085nT for the earth's magnetic field which is consistent with its known value: B = (899.2 x 48 x 0.06)/0.055 = 47085.382nT where N = 48 turns, r = 0.055 and I = 0.060A.

The result confirms the inappropriate value for N given in the published equation. The very fact that the inconsistency was detected by experiment with the most basic of equipment demonstrates that simple, readily understandable devices can still play a valuable role in this age of "black boxes". Indeed, the tangent magnetometer may well find application in education where a high resolution is not required.

But with regard to employing the Helmholtz coil for calibration purposes, if the coil is orientated NS so that the earth's magnetic field lines pass axially through the coil, the flux produced by the coil, depending on polarity of the current, either adds to or subtracts from those of the earth's magnetic field. So, it would seem as if the Helmholtz coil can only be used for calibration when oriented EW and account taken of any changes in permeability caused by placing devices in the coil.

Terry Arnold** and **George Pickworth
Kettering

Soviet souvenir

In my quest to promote Russian culture around the world, I am offering any amateur radio operator who establishes a QSO with me, the opportunity to obtain a souvenir of my country. To anyone establishing a QSO with RW3PW and sending their name, address and 7 IRCs I will despatch the souvenir by return.

Hams in Europe will find me on 14.270MHz between 20.00-21.00UTC. Please note this does not affect my QSL-card which is available as usual to anyone who requests it.

Igor A Gumilevsky
RW3PW
USSR

c not constant?

In Letters, *EW + WW*, October issue, George Overton mentions that the Michelson and Morley experiment has been repeated recently, and that it showed a variation in the velocity of light. I have often wondered why the various proponents in the Einstein Relativity debate have not cited the Michelson and Morley paper itself[1].

When I first read it I felt that few modern engineers would have dismissed it as showing no variation, though theoretical physicists might well feel differently, even though Hicks[2] is reported to have shown that the variations discovered by M and M could not be dismissed as experimental error.

Physics books assert that Michelson and Morley repeated their experiment many times, and no variation in velocity of light was discovered. But Miller[3] says: "... Michelson and Morley made only one series of experiments in July 1887, and never repeated the ether drift experiment at any other time, notwithstanding many statements to the contrary". More importantly though, he describes a later series of experiments, conducted by Morley and himself, which gave results for an ether drift of 7.5, and later, 8.7m/s, but this was not all.

After the solar eclipse of 1919, when tests were made that were said to confirm Einstein's theory, Miller wrote: "Since the theory of Relativity postulates an exact null effect from the ether-drift experiment which had never been obtained in fact, the writer felt impelled to repeat the experiment in order obtain a definitive result". He then went on to conduct an amazing series of experiments, and in 1925 was able to state that there was an ether-drift of about 10m/s in the direction, RA 17.5h, dec +65°.

His results are at variance with some others, but I find his paper so compelling that, together with the various anomalies that arise with the general adoption of Einstein's theory, I am quite convinced that there is an ether and that its drift has been measured. Indeed. As Miller points out, the crucial test of Einstein's theory would be to obtain an absolute null in an ether-drift experiment; other observations, such as the anomaly of Mercury's orbit and the apparent deflection of starlight by the sun's gravitational field, are not crucial, and it is quite acceptable to seek other theories to explain them.

Taking all this into account the discussion needs to be not about whether Einstein's theory is valid but rather *where* it is valid.

This tacitly presumes a search for a region where the ether is moving with it. Perhaps this could be within atomic particles, or even in quite large regions, surrounded by a lot of very dense mass.

In space, there are very limited cases where Einstein's relativity is relevant: perhaps within stars, or even within dense nebulae. After all it seems conceivable that such very wide-spread masses could move the ether – or perhaps the ether moves them.

So we, who find that physical explanations carry far more weight than theoretical ones, can come out of the closet and unashamedly think about EM waves as being waves in something real. The theoreticians' favourite let-out, that we should not be too bound by practical considerations, does contain an element of truth. But it should not be allowed as an excuse for allowing domination with arrogant mathematical games.

For the engineer, mathematics is a tool, not a master.

On a more intriguing note, perhaps the Anti-Gravity Society could find interest in searching for an ether shield - a real one I mean.

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Lincoln

References

1. AA Michelson and EW Morley, *Phil Mag*, [5], 24, 449 (1887)
2. WM Hicks, *Phil Mag*, [6], 3, 9, 256, 555 (1902)
3. DC Miller, *Rev Mod. Phys*, [5], 203 (1933)
4. A Einstein, *Ann d Physik*, 17, 891 (1905)

Scratching the surface of electromagnetism

Could it be that a better model of electromagnetism may be found in the electrons and holes of solid state physics? Dr Julian Millar suggests that the commonplace effects of a flowing electric current have a different cause: a kinetic model of electromagnetism.

A couple of years ago, while working on some practical problems in screening a signal from electromagnetic interference, I began to discuss with colleagues the idea that the key to understanding electrostatic fields was in the flux of the electric field. Flux normally implies flow, something moving, and this seems at odds with electrostatics where everything is usually thought of as stationary, immobile, and fixed. So flux, which in the early days of electrostatics was an important idea, is nowadays often considered an obsolete concept.

Just as an argument I suggested that flux could be thought of as a form of particle emission from the surface of a charged object. To our surprise, the model seemed to explain the facts of electrostatics rather well, and ideas started falling out about the nature of surface forces on charged objects.

I began to take the idea seriously, and thought hard about how the logic could be followed through into electromagnetism. The results were somewhat surprising: I appeared to have stumbled on a new way of looking at *all* electromagnetic phenomena. My colleagues and I tried to see if this idea had been worked on before, but it is difficult to tell what is going on in electromagnetic research without access to high-powered mathematics, in particular the methods of quantum electrodynamics. We couldn't tell if the model is original or not but the ideas developed to a point where we felt we had to let them out into the open for other engineers to discuss and criticise.

Electric fields from single charged objects

The fundamental Law of electrostatics is Coulomb's Law. This relates the force between two charged objects to their total charge and the distance between them. An electric field is defined in terms of the force due to electric charges that is exerted on a unit charge. But what *is* charge? No-one really knows. It is supposed to be a static, enduring quality of the electron and the proton which generates force at a distance.

Due to some extraordinary property of these two particles, even though they are very different in mass and other properties, the charge on the two of them is found to be exactly equal and opposite with a precision of measurement that is one of the most accurately known in all science.

To give a concrete starting point, consider charge in terms of a deficiency or surplus of the number of electrons in a (macroscopic) object relative to the total number of protons present. Start with a negatively charged object, say a billiard ball. Suppose the capacitance of such a ball were one picofarad. If the ball were charged to 100V then

HOLES IN THE KINETIC MODEL

The model develops the idea that the fundamental entities which underlie electrical and magnetic interactions are not electrons and protons but electrons and holes. Holes are to be understood in the semiconductor sense, that is regions of space that are distorted by the presence of protons to form orbital spaces for electrons. Electrons may or may not fill these orbital spaces; if they do not, the spaces are called holes. This model argues that in negatively charged objects the surplus electrons move about at high speed inside the object. When they reach the surface they are reflected back inwards, and this change of momentum results in the emission of a particle which may be called a "phaeon".

Phaeons are emitted continuously from a charged object because the electrons that have lost momentum can take up rotational or vibrational energy from the stationary electrons in the lattice. Positively charged objects have a surplus of holes, and these holes can be considered to move about the object in a similar way to electrons. Because of the parity of the electron, it is argued that the change in momentum when a hole reflects at the surface of a charged object is distinguishable from the change of momentum when an electron reflects. Therefore different particles must be involved.

The particle emitted from an electron reflection has been called an "n-phaeon" and that from a hole reflection a "p-phaeon". Coulombic forces arise from the phaeon-mediated exchange of momentum between charged objects. These forces are a distortion of surface forces in the charged objects.

The Theory of Relativity states that when two conductors both carry an electric current in the same direction, the electrons in one conductor observe a compression (the Lorentz transform) of the lattice relative to the moving electrons in the other conductor. This compression is the basis of magnetic forces in both the normal theory of electromagnetism and the present one.

However, the current theory argues that this compression of the lattice combined with the axial spin of the mobile electrons generates a turning moment on the electrons similar to that seen in a tilted gyroscope. The result is that the electron trajectories are curved. This curvature is also found in the trajectories of phaeons emitted when the electrons reflect at the surface of the conductor. The interaction of the relativistically curved trajectories of electrons and phaeons generates magnetic forces between the conductors.

When an AC potential is applied to a conductor it is argued that phaeon efflux becomes polarised to the ends of the conductor. Thus for each cycle of the applied potential, a phaeon "dipole" is emitted from the conductor. The polarity of this dipole reverses with each cycle of the applied potential. Electromagnetic radiation consists of phaeon dipoles whose polarity alternates at the frequency of the radiation. Thus a single photon is not a unitary particle, but an oriented pair of n- and p-phaeons.

we would have 10^{-10} coulombs of charge present. This would represent 6.28×10^8 electrons. (If the ball weighed 100g we might estimate, depending on the molecular weight of the material of the ball, the total number of molecules in the ball to be about 10^{23}. This would be something like one excess electron per 10^{15} molecules).

Now the key question is: what is the *disposition* of these electrons? The orthodox models would say that because the charges repel each other they would spread out in a relatively stationary way over the surface of the ball. Our first argument is that these electrons do not stay in fixed positions but have enough energy to move around the molecular lattice. They form a kind of electron "gas" in the solid.

Sooner or later a mobile electron will collide with an electron in a stationary orbital. It is like a game of musical chairs, with the electrons as the players and the molecules as the chairs. The mobile electron may dislodge the stationary electron and take its place, leaving the newly mobile electron to move through the lattice until it in turn can dislodge another electron. A dynamic equilibrium will exist and, inside the ball, electrons will move in all directions equally, with the net effect in any one direction at any point averaging to zero.

But what happens at the surface? We can imagine an electron reaching the surface at some finite velocity; however, most negatively charged objects (except specially designed cathodes) do not emit electrons. The electrons do not have sufficient energy to leave the charged object and so they must either stay near the surface or be reflected back into the bulk of the ball. It seems logical to think that this change in the momentum of the electron must be associated with the emission (or absorption) of some kind of energy, i.e. some kind of particle. Photons are the particles which are normally emitted or absorbed when an electron changes its energy state. But of course we know that charged objects do not normally emit photons.

However, let us suppose that some form of particle *is* emitted by the reflected electrons. I would like to call them "phaeons" (from the Greek φαεθων, the child of the sun god). Suppose that the loss of outward momentum of the electron is accompanied by the emission of one or more phaeons. The electron must throw off at least one phaeon to decelerate itself to zero velocity at the surface, and then either stay at the surface or emit at least another phaeon to accelerate itself inwards again. (If we assume that phaeons always travel at the speed of light, this implies that the energy of the free electrons is quantized and can only change in amounts equivalent to the emission of one or more phaeons). We thus come to the conclusion that a negatively charged object is constantly emitting phaeons, much like a radioactive object is emitting alpha, beta or other particles.

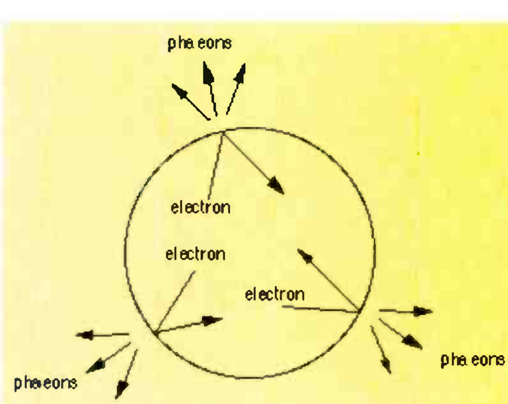
This immediately leads to the question of whether the charge must therefore "run down", in the sense that radioactive emissions have a half-life. Do the electrons gradually lose their kinetic energy and stop moving around the lattice?

Not necessarily. Suppose that, initially, immediately after the charge has been deposited on the ball, there is emission of phaeons caused by electrons moving outwards towards the surface and then staying there. The molecules near the inner surface of the ball will now have a surplus of electrons. The molecules will have energy stored in them related to the absolute temperature, which is expressed as vibration and rotational energy in the chemical or valence bonds between the atoms of the molecules. These chemical bonds consist of electrons in molecular or atomic orbitals.

Suppose that some of this energy can be translated to the outermost electrons by local photon exchange. The exchanged thermal energy could provide a source of energy for continuing movement of free electrons through the lattice. The end result could be a dynamic equilibrium with a constant exchange of energy between fixed and mobile electrons and a constant emission of phaeons as electrons are decelerated and reflected back inwards at the surface of the ball (**Fig. 1**).

Now assume that the phaeons emitted from the charged ball travel in a straight line through space until they reach other electrons able to absorb them. Phaeons would then correspond to the classic idea of the flux of an electric field. Harking back to

Fig. 1. Reflections of electrons at the surface of a negatively charged ball. Phaeons are emitted when electrons are reflected at the inner surface of a negatively charged object.



Gauss's law, we can say that charge may be an expression of the total phaeon efflux from an object.

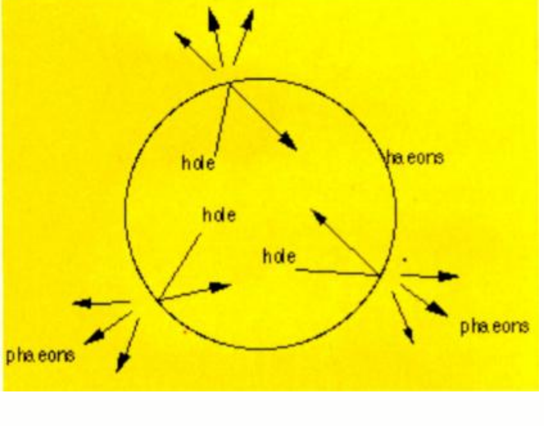
What happens with a positively charged ball? In this case there will be fewer electrons than protons in the ball, in other words a deficit in electrons relative to the orbital "spaces" created by the protons. We can again assume a dynamic equilibrium where electrons are constantly moving through the lattice of the ball, so that no single orbital spaces are permanently filled or permanently empty. There may be a tendency for orbitals near the inner surface of the ball to be less occupied than orbitals in the bulk of the material. Inside the bulk of the material, there will be no net forces in any direction, because the electron movement will be equal in all directions; but there will be a tendency for electrons to migrate inwards *away* from the surface, the complementary situation to that in the negatively charged ball.

Instead of thinking about electrons accelerating inwards from the surface of positively charged objects, it is useful to draw on ideas in semiconductor physics. Conduction in semiconductors can be mediated by both electrons moving one way under an applied field and "holes" (ie spaces around protons that could be occupied by an electron but aren't) moving in an opposite direction. Migration of a hole in one direction is the same as migration by an electron in the opposite direction in terms of charge displacement, but it is not quite an identical process. Instead of a *single* electron moving forwards, the hole migrates by a sequence of movements of a *set* of electrons, each one moving one space backwards in the lattice.

From the arguments above, a positively charged object can be thought of as having holes accelerating towards the surface and being reflected back into the bulk of the object, in the same way that a negatively charged object has electrons constantly reflected back from its surface (**Fig. 2**).

Does the reflection of the hole emit from the surface of a positively charged object the same kind of phaeons that are emitted from a negatively-charged object? Both cases involve a change of momentum of electrons; but for the real electron the momentum change at the surface is from outwards to zero and then inwards; for the hole (which can be thought of as a virtual electron) the change in electron momentum in the *set* of electrons involved is from inwards to zero and then outwards. (Thus the momentum changes are equivalent to those that would be produced by an electron reflection if it were moving backwards in time).

Fig. 2. Reflections of holes at the surface of a positively charged ball. Phaeons are emitted when holes ("virtual electrons") are reflected at the inner surface of a positively charged object.



If the electron had no parity or "handedness", we would be unable to distinguish between these two events, and so we would have to assume the phaeons associated with them were also indistinguishable. However, modern physics has shown us that electrons do have parity. The parity condition can be expressed in a number of ways, but an appropriate way for the current model is to imagine that electrons have an intrinsic handedness or "spirality" like a bolt or screw. We can assert that because of this spirality, when electrons travel linearly through space they also must rotate in a fixed direction about the axis of movement. Put another way, the angular momentum and linear momentum of electrons are linked, and must change together; an electron has to "corkscrew" through space.

Assume that the electron has a left-handed thread in space-time, and so rotates clockwise when travelling towards the observer, or anticlockwise when moving away from him. Thus an electron moving away from the centre of a sphere towards the surface and towards an observer outside the sphere will always appear to be rotating clockwise. If the electron is reflected inwards at the surface, it has to change its direction of rotation relative to the observer. It does not matter whether we think of this change as being mediated by the electron keeping the same direction of rotation and "swivelling around" in space, or by a reversal of rotation without swivelling.

Suppose one phaeon is emitted in order to bring the electron to a halt at the surface, and another to start the inwards movement. The first phaeon can be considered to carry an element of clockwise momentum forwards towards the observer, the momentum that the electron has lost. The second phaeon will also carry an element of clockwise momentum towards the observer, as the electron will have to lose more clockwise momentum in order to start an anticlockwise rotation and start moving back. We might initially assume that the phaeons are emitted outward along the line of the incident and reflected tracks of the electron. But there is a complication. The angular momentum or rotation of the electron can be thought of in the same way as the spin that a rifle produces on a bullet; and when a spinning bullet bounces off a solid object, the spin produces a ricochet, and the bullet may fly off in any direction.

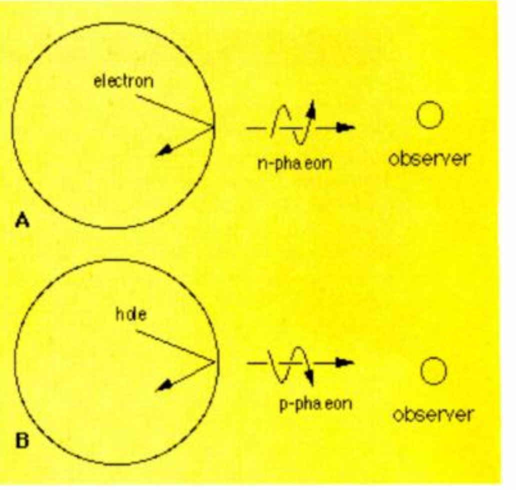


Fig. 3. Phaeon parity.
A. The phaeon emitted from a negatively charged object has one type of parity which can be represented as a clockwise rotation as seen by the observer. We can call this type of phaeon an "n-phaeon".
B. The phaeon emitted from a positively charged object has the opposite parity, ie an anticlockwise rotation as seen by the observer. We can call this type of phaeon a "p-phaeon".

We can assume that the direction of the emitted phaeons will depend not only on the angle of the incident electron track, but also on the precise momentary state of the stationary electrons at the surface. In other words, there will be a probability distribution of the direction of the outward trajectories for the emissions for both the electron deceleration and acceleration events. However, the only unique direction will be normal to the surface at the point of impact, and the net effect of phaeons at other angles will sum to an effective emission outwards along this normal. Thus the effect of many electron reflections will be a flux of phaeons directed radially outwards from the surface.

In summary, to a distant observer, the phaeons emitted from a charged object will radiate radially outwards from the surface; those emitted towards him (which are the only ones he normally detects) from a *negatively* charged object will have an element of *clockwise* (left-handed) rotation or angular momentum (**Fig. 3A**)

Consider the same outside observer watching a hole approach the surface of the sphere and then be reflected. As the hole approaches the surface a series of electrons will move one at a time away from him towards the interior of the sphere. After reflection of the hole the same or another set of electrons will move in sequence towards him. At the moment the hole reflects, the last electron in the first set will throw off one or more phaeons towards the observer to stop its inward momentum, and then the first electron in the second set will also emit phaeons outwards to give itself outward momentum.

However, the change in electron rotation (in both cases) will be from anticlockwise to clockwise. So for a *positively* charged object the phaeons emitted towards the outside observer will all carry an element of *anti-clockwise* (right-handed) rotation or angular momentum. (**Fig. 3B**).

Thus, because of electron parity, we can differentiate between the phaeons emitted when an electron is reflected inwards at the surface of a negatively charged object and those emitted when a hole is similarly reflected inwards at the surface of a positively charged object. The two sorts of reflection will emit phaeons with different kinds of angular momentum.

Taking in the surface tension

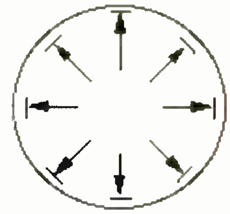
Let us call these two kinds of phaeon "n" and "p". We can define n-phaeons as those emitted from a negatively charged object and p-phaeons as those emitted from a positively charged object.

Finally, we can consider the nature of the forces exerted on the surface of charged objects by electrons and holes. Electrostatic theory tells us that there is an outward force at the surface of both negatively and positively charged objects due to the mutual repulsion of the surface charges. For example in a fluid, the presence of charge on its surface decreases the surface tension, whether the charge is positive or negative.

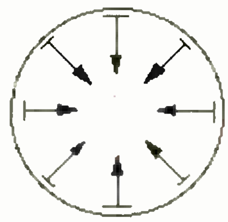
In the present model the inner surface of a negatively charged sphere is bombarded with electrons, and electrons have finite inertia, so we can reasonably suppose that this barrage will indeed exert an outward force at all points on the surface of the object which will tend to make it expand (and counteract surface tension). On the other hand a positively charged object has its inner surface constantly bombarded by holes. This bombardment by holes is equivalent in momentum terms to a constant withdrawal of electrons from the surface, and so we might conclude that there ought to be an inward force acting at the surface of positively charged objects. The force should, for example, increase surface tension in a fluid.

This postulate of an inward surface force on positively charged objects is fundamental to the present model, for it forms the basis of the explanation of the coulombic forces between charged objects.

The postulate is experimentally testable, and there is at least one piece of evidence which seems to support the present model. The capillary electrometer is an instrument, now rarely used, that can measure voltages by their effect on the position of a mercury-electrolyte interface in a capillary tube. The mercury meniscus at the interface can be made to move one way by one polarity of an applied voltage, and the other way by a reversal of this potential; thus one polarity of applied potential or field appears to increase the net surface tension at the meniscus while the other decreases it; according to standard theory the surface tension should be decreased by either polarity of applied field.



A. Electron reflections generate outward forces at the surface of negatively charged objects



B. Hole reflections generate inward forces at the surface of positively charged objects

Fig. 4. Surface forces on charged objects. A. Electron reflections generate outward forces at the surface of negatively charged objects. B. Hole reflections generate inward forces at the surface of positively charged objects.

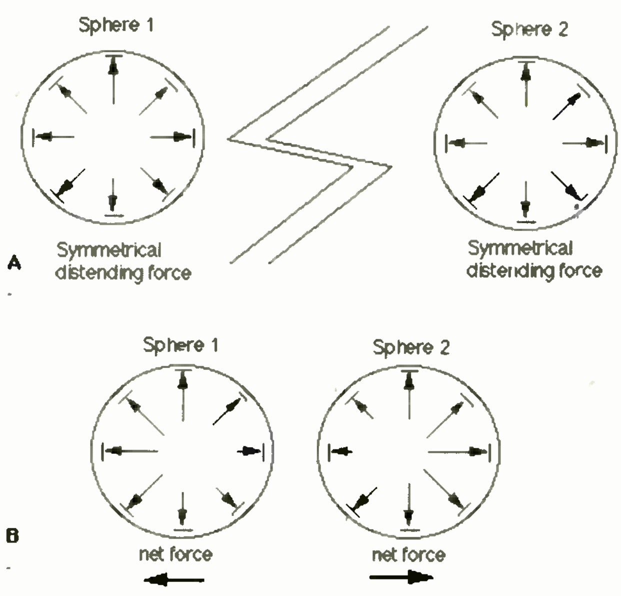


Fig. 5. Surface forces on two negatively charged spheres. A. If two negatively charged spheres are a long distance apart the surface forces are close to those of an isolated sphere. B. If the spheres are brought together the n-phaeon exchange alters the momentum changes of the electrons at the surface and hence the surface forces; the outward forces on the sides nearer the other sphere are diminished and those on the far sides are increased. The result is a mutual repulsive force between the spheres.

Interaction of charged objects

What happens when two charged objects are brought together? To simplify the argument, we shall deal solely with the effects of electrons and holes moving out to the surface of charged objects.

The effect of reflections at the surface will simply double-up the effects of the outward movement.

It becomes helpful at this point to think of thechange of momentum of the electron at the surface as an "event" with a time direction (electron acceleration or deceleration) as well as a spatial component. These events can be indicated by arrows with bars at the beginning or end. The force exerted on the surface is indicated by the length and direction of the arrow, and electron acceleration or deceleration by a bar at the beginning or end of the arrow.

To be consistent we must define a direction for positive acceleration. Positive acceleration will be defined as acceleration in the left-to-right direction in all the diagrams.

Figure 4 shows the surface forces of charged spheres using this convention. The direction and magnitude of the surface force is indicated by the arrows; Thus in Fig. 4A there are outward forces in a negatively charged sphere. The event arrows have a bar at the pointed end, to denote deceleration of the electron at the surface. Figure 4B shows the inward forces in a positively charged sphere. The bars at the beginning of the arrows indicate that the electrons accelerate inwards at the surface. (This is of course equivalent to holes decelerating outwards). Note that phaeons are always emitted from the "bar end" of the event.

Now we can consider the interactions between two spheres.

Figure 5 shows two negatively charged spheres initially at a distance (Fig 5A) which are brought together. N-phaeons emitted from sphere 1 in the figure will be absorbed by electrons in sphere 2 and vice-versa. Absorption of phaeons from sphere 1 will add to the initial momentum of electrons on the right-hand (far) side of sphere 2 and thus increase the outward surface force in this region, but subtract from the initial momentum of the electrons on the left-hand (near) side of sphere 2 and thus decrease the outward surface force here. The net effect will be an imbalance in the surface forces on the two

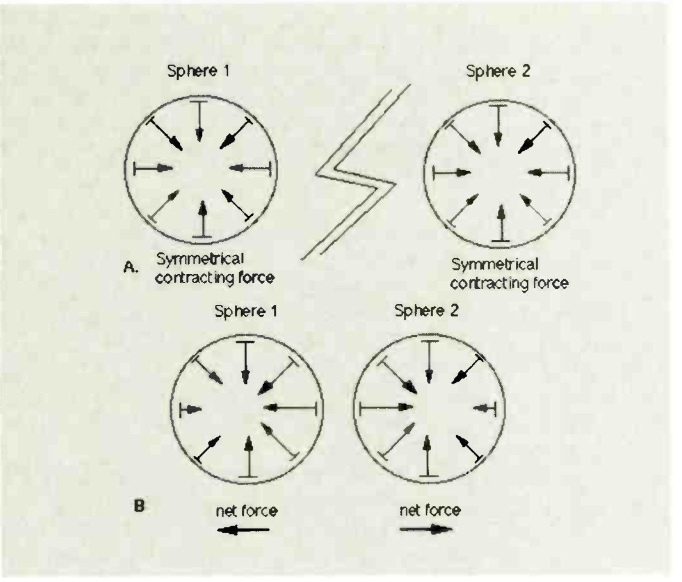


Fig. 6. Surface forces on two positively charged spheres.
A. When the spheres are a long distance apart the surface forces are close to those of an isolated sphere.
B. If the spheres are brought together p-phaeon exchange alters the momentum changes of the holes at the surface and hence the surface forces; the inward forces on the sides closer to the other sphere are increased and those on the far sides are decreased. The result is a mutual repulsive force similar to that between negatively charged spheres.

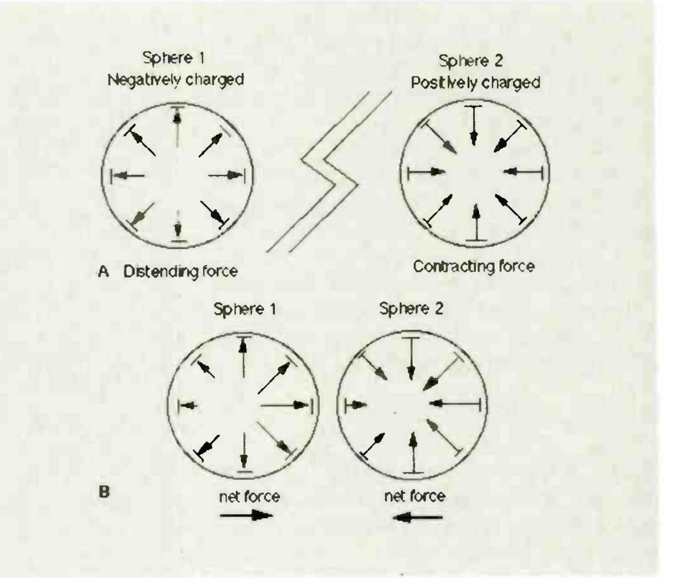


Fig. 7. Interaction of oppositely charged spheres.
A. With the spheres a long distance apart the surface forces are close to those on an isolated sphere.
B. If the spheres are brought together the phaeon fluxes interact as in Table 1. N-phaeons from the negatively charged sphere are absorbed by the holes reflecting in the positively charged sphere, and p-phaeons are absorbed by electrons reflecting in the negatively charged sphere. The result is a distortion of the surface forces on the two spheres which produces an attractive force between the two spheres.

sides of the sphere resulting in a net force tending to move the sphere to the right away from sphere 1.

A complementary process will occur in sphere 1, which will experience a net force to the left.

The total effect is thus one of mutual repulsion (Fig. 5B).

Figure 6 shows the situation when two positively charged spheres initially at a distance (Fig 6A) are brought together. P-phaeons emitted from sphere 1 will be absorbed by electrons on the left-hand side of sphere 2 and add to their momentum, and thus increase the inward surface force in this region. They will subtract from the inward momentum of electrons on the right-hand side of sphere 2, and so decrease the inward surface force here. Thus in sphere 2 there will be an imbalance of surface forces which will tend to make it move to the right away from sphere 1. A similar process will occur in sphere 1; net effect is again that the two spheres will tend to move apart (Fig 6B).

Table 1: Electron-phaeon interactions.

Emission event	Phaeon type	Absorbtion event Before	After	Comment
1. →│	n	→│	⟶│	Increase in left-to-right electron deceleration
2 →│	n	│←	│◂	Decrease in right-to-left deceleration
3 ←│	p	←│	◂│	Decrease in right-to-left acceleration
4 ←│	p	│→	│⟶	Increase in left-to-right acceleration
5 →│	n	│→	│▸	Decrease in left-to-right acceleration
6 ←│	p	│←	│⟵	Increase in right-to-left deceleration
7 →│	n	←│	⟵│	Increase in right-to-left acceleration
8 ←│	p	→│	▸│	Decrease in left-to-right deceleration

Finally, we can analyze the case when two spheres with opposite charge are brought together. To do this, consider what happens when an n-phaeon from a decelerating electron in a negatively charged sphere is absorbed by an accelerating electron in a positively charged sphere. To accelerate inwards from the surface of a sphere, a stationary electron would normally throw off an element (the p-phaeon) of anticlockwise momentum outwards. However, if it can absorb an element of clockwise momentum forwards it can start its forward motion without any reaction on to the surface, ie the surface force is eliminated.

Similarly, to decelerate at the surface, an electron would normally need to throw off forwards an element of clockwise momentum (an n-phaeon). However, if it can absorb an element of anticlockwise momentum travelling backwards, this "brakes" the electron without involvement of the surface, and hence the surface force is again eliminated. At this point it is helpful to draw up a table of the algebra of the event interactions.

Table 1 lines 1-4 shows the interactions described so far in figs 4 and 5. From the discussion above, we can add the interactions on lines 5 and 6, and from considerations of symmetry, we can add lines 7-8. Thus we can see that the n-phaeon electron emitted from the left-hand sphere (lines 1,2,5 and 7) always produces a net increase in right-to-left acceleration of the recipient electron. (This is sometimes seen as an increase in left-to-right deceleration, a decrease in right-to-left deceleration or a decrease in left-to-right acceleration but in all cases the overall momentum change is the same). In a similar way, absorption of p-phaeon from the left-hand sphere will always produce a net increase in left-to-right acceleration in the recipient electron.

Figure 7 shows what will happen when negatively and positively charged spheres are brought together.

The absorption of an n-phaeon by an electron accelerating inwards from the left-hand side of sphere 2 will reduce the inward force on this surface, and the absorption of another n-phaeon by an electron accelerating inwards from the right-hand side of the sphere will increase the inward force on this surface. The net result is a force tending to move the sphere to the left, ie towards the negatively charged sphere. The momentum changes in the negatively charged sphere create a complementary force which tends to move it to the right, towards the positively charged sphere. Thus the two spheres will be attracted together (fig 7B)

To sum up, according to my hypothesis, we can regard electrostatic (coulombic) forces as the result of the changes in surface forces on charged objects due to phaeon emission and absorption. These phaeon emissions are in turn due to electron momentum changes at the surface of the charged objects. Charged objects are attracted to or repelled from other charged objects because of an imbalance in the surface forces on the sides of them nearer to and further away from these other objects.

Fields of moving charges

In the Special Theory of Relativity, Einstein showed that magnetic forces arise as a necessary consequence of relativistic mechanics applied to the fields of moving charges. The necessary and sufficient condition for magnetic forces to appear is just that charge remains an invariant (a scalar) at all velocities (ie in all inertial frames of reference) whereas mass, length and time all change (via the Lorentz transformation) as the speed of the object relative to an observer approaches the speed of light, c.

In one sense any model of electrostatics which explains Coulomb's Law must predict magnetic fields from moving charges if the Coulombic forces in the model are relativistically invariant. We cannot prove that the phaeon fluxes are relativistically invariant, but we can develop some models of how the kinetic theory can generate electromagnetism via a relativistic mechanism.

Consider first the electromagnetic force that we know is produced between two parallel metal wires each carrying a steady (DC) current. If the current is in the same direction in both wires – for the sake of this example the z direction – the electromagnetic force is attractive between the wires. The relativistic explanation of this force in the classical model stems from the Lorentz transformation (dimensional compression) of moving inertial frames. So, for example, if we consider a stream of electrons moving through one conductor, we can place a frame of reference around one of these electrons and "look out" at the other wire (**Fig. 8a**).

From our electron-centred frame, the protons in the lattice of the other wire will be moving in the negative z direction at a higher velocity than the electrons in the other wire will be moving in the positive z direction. The difference in velocities will produce a relative compression of the observed distance between the protons, and so the apparent proton density in the other wire will be greater than the electron density. This is because each proton and electron keeps the same charge regardless of velocity; an attractive electrostatic force will be felt by the moving electron.

The situation is similar for an electron in the other wire; it will also observe a relative increase in proton density in the observed wire. Hence a mutually attractive force will be produced between the wires as the moving electrons in both wires see an apparent increase in proton density in the other wire (**Fig. 8b**).

We can use exactly the same kinds of argument to explain magnetic forces in the present model. Consider a metallic wire conductor carrying an electric current. The negative end of the wire has a relative excess of electrons and the positive end has a relative excess of holes.

Now we know that Ohm's Law is valid because the velocity of the mobile electrons in the direction of the current flow in a conductor is small relative to their random thermal motion. Thus we can think of each electron (or hole, for parallel arguments apply) as involved in random motion inside the wire with a small superimposed component of velocity in the direction of the current. In this situation the electrons and holes will be involved in frequent collisions with the atoms of the lattice including those on the surface. In other words, we can envisage a continuous emission of n- and p-phaeons from the surface of a wire carrying an electrical current (**Fig. 9a**).

As we have argued before, the net flux of the phaeons will be radially outwards from the surface. Because this emission contains equal amounts of both kinds of phaeons (viewed from a distance), there will be no net surface forces generated.

Now consider two parallel conductors both carrying a current in the same direction. We can use the same arguments about relativistic spatial compression that the classical model uses. Thus from the viewpoint of the inertial frame of an electron in conductor 2 the holes will be moving downwards in conductor 1 at a higher speed than the electrons will be moving upwards. The Lorentz transformation of distance will increase the apparent density of holes over electrons in conductor 1 as seen from this electron. Thus the number of collisions of holes with the surface and therefore p-phaeons emitted will also be increased. In other words, from the viewpoint of the moving electrons in conductor 2, there will be an excess of p-phaeons over n-phaeons emitted towards them. (**Fig. 9b**).

This net flux of p-phaeons will change the surface forces exerted by these electrons in the same way that a positively charged object affects a negatively charged object; an attractive force towards conductor 2 will be generated. Exactly the same process will occur for the inertial frame of any moving (current carrying) electron in conductor 1. Thus a mutually attractive force is generated between the two wires.

If the current flow is in opposite directions in the two conductors, an electron in conductor 1 would see an excess of electrons in conductor 2, and therefore experience an

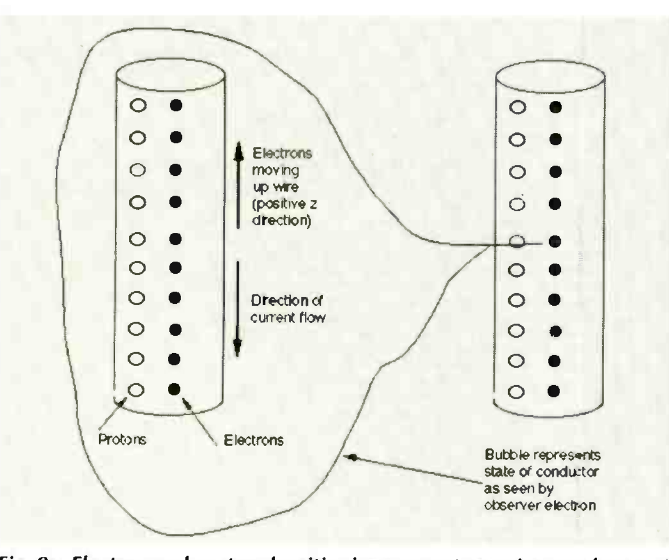


Fig. 8a. Electron and proton densities in a current-carrying conductor. A stationary electron on this conductor observes an equal density of protons and electrons in the left-hand conductor. Although the electrons in the other conductor are moving past the protons they have the same linear density as the protons.

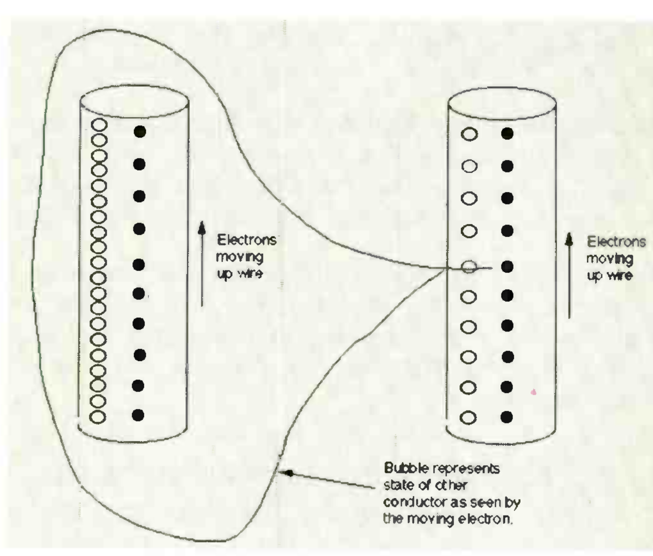


Fig. 8b. Relativistic effects of moving charges in two conductors. The electron which is moving in this conductor sees an increase in the density (in the z axis) of the protons in the other wire relative to the electrons. Thus it experiences an attractive electrostatic force.

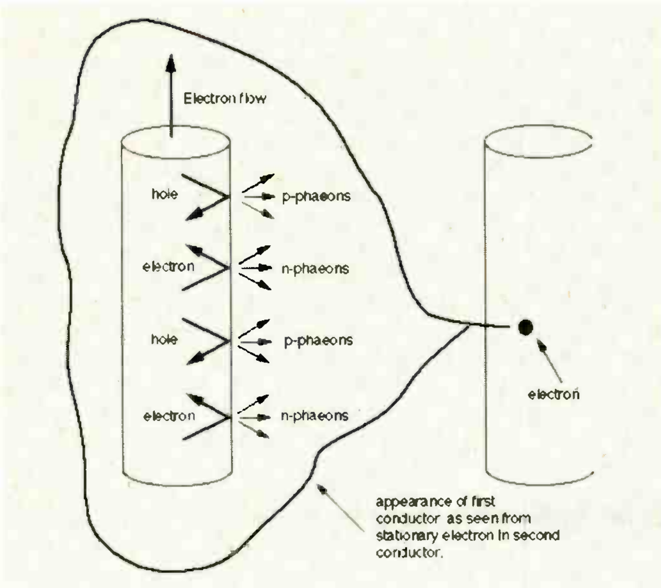


Fig. 9a. Phaeon flux from a conductor carrying a current as seen by a stationary electron in another conductor.

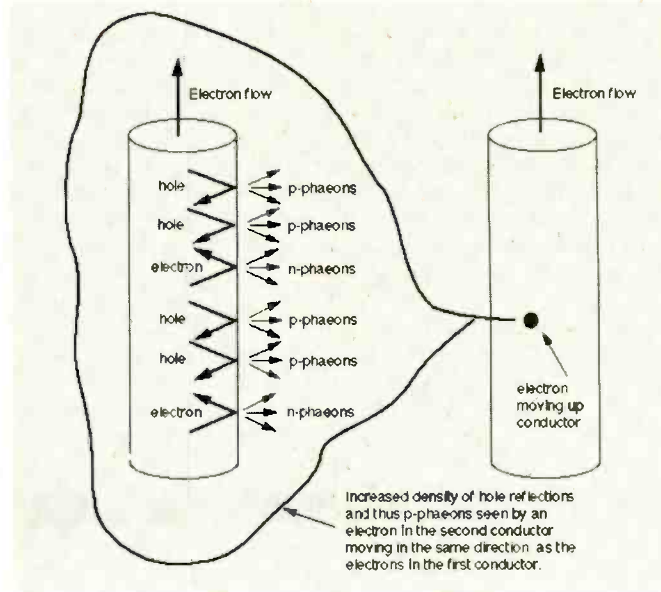


Fig. 9b. Phaeon flux from a conductor carrying a current as seen by a moving electron in another conductor.

excess n-phaeon over p-phaeon flux. The same thing would happen to an electron in conductor 2, so in this case there would be a repulsive force between theconductors. Exactly parallel argument will hold true from the frame of holes moving through the two conductors; a similar direction of current will produce attractive forces and an opposite direction will produce repulsive forces.

Thus, in summary, we can argue that the forces that we know that are generated between two parallel current-carrying conductors can be explained in our model by a relativistic compression of the motion of electrons and holes that carry the current.

Dr Julian Millar is senior lecturer, Department of Physiology, Basic Medical Sciences, Queen Mary and Westfield College, London.

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US teletext falls on deaf ears

In spite of some 50 million teletext TV receivers operating in over 40 countries, the US market has shown no interest in what is now known as World System Teletext. "We have failed dismally in the USA", admits Dick Bugg of Philips Semiconductors. "But it's not for want of trying. The last big opportunity to open new markets in is in China."

Since the first text service began in1976 the company has supplied 42 million chip sets. Early decoders needed over 200 IC's. Now one chip does it all.

Having given up hope of turning the US market onto teletext, Philips is pitching for a share of the market for closed caption decoders. TV programmes in the US have subtitling for the deaf buried in line 21. The data rate is much lower than for teletext, around 0.5 MBit/s. Congress has decreed that from 1993 every TV set with a 13in or larger screen must have a built-in decoder.

Posed for success. The Chinese have adopted euro-teletext but will the US follow suit? Dick Bugg of Philips bemoansAmerican apathy towards teletext.

The aim is to force down the price of decoders from around $200 for an add-on box, to around $10 on the price of a TV set.

Philips has eyed the potential market of 20 million TV sets a year and designed a single chip decoder for manufacturers to build into TV sets. The chip ("Litod", short for Line 21 decoder) will be ready in the first quarter of 1992. It will connect in a daisy chain with the RGB colour circuits, to give colour titles with the option of scrolling, rolling and underlining. Chips cost is put at $5 in volume. Makers of budget TV sets can make only hardware connections, without any software control of the Litod chip.

Why should all this interest us in Britain, when we already have teletext for subtitles? Because the US Litod system has one very special advantage over teletext. The data rate of the signal in line 21 is so slow that it can easily be recorded by any VCR. British teletext can only be recorded by professional video decks or tweaked Super VHS. This is why prerecorded video tapes in NTSC format can boast subtitles for the deaf.

Chinese whisper

The teletext signal is a stream of digital code, running at just under 7MHz, which is transmitted in the unused lines of the TV picture which define the black borders at top and bottom of the screen. This code triggers the generation of alphanumeric characters permanent stored in rom. Early decoders stored 96 characters. The latest can store 192, which covers all languages in Western Europe. But this is still nowhere near enough to cope with the Chinese langauge, which uses at least 20,000 ideograms or picture symbols. Each requires six times as much digital code as a Western character to describe.

It is far too expensive to store the code for all the necessary ideograms in rom. Japan's *Captain* system uses facsimile technology to transmit ideograms as ready-made characters. This takes up far more transmission capacity than the teletext method of sending only short codes which trigger the generation of characters stored in rom. Also the code is easily corrupted by transmission errors, for instance caused by reflections of the broadcast signal from buildings or hills. Small code errors cause large changes in the ideogram.

Japan has been trying to sell *Captain* to China, but with no success. The Chinese Ministry of Radio, Film and Television wanted a more robust system than Captain. The Ministry also said the system was cheap enough for the masses and compatible with World System Teletext so that the TV station can broadcast pages of either Western text or Chinese ideograms, or pages containing both, to all TV sets.

Philips Semiconductors at Southampton has come up with a solution. The transmitted signal is a mixture of conventional teletext trigger codes and ready-made patterns. The decoder in the TV set has a read only memory which stores a library of the most commonly used ideograms. It also has a random access memory. When the text page contains an ideogram which is not available from rom, the transmitter converts the character into a string of dots, like facsimile code. The receiver stores these dots in ram which reconstructs them into a "soft character". What appears on screen is thus a mix of ideograms sourced from rom and ram. The rom also contains Western characters, so the system can mix and match languages.

The more characters the rom stores, the less time the system must waste reconstituting soft characters from ram. But large rom storage increases component cost. After analysing text likely to be transmitted, Philips chose 4Mbits of rom, to store 3000 hard characters and 16Kbits of ram to buffer the soft characters.

The system was tested during the Asian games, held in Beijing. Philips installed 150 prototype receivers in public places to check compatibility of dual language information services. The Chinese Ministry is now recommending that the system be adopted as a broadcasting standard.

Barry Fox

Medium-wave/VHF frequency synthesiser

All necessary logic for a MF/VHF phase-locked loop synthesiser is on board the Plessey NJ88C31 cmos chip: reference oscillator, divider, two-modulus prescaler, control register, programmable divider, phase comparator and interface logic.

A Pierce oscillator uses parallel-resonant fundamental crystals in the two bands, although an external sinewave or logic-level reference oscillator may be connected if necessary. Oscillator output is divided to give a number of comparison frequencies which are selected by the first three bits of the input data, one of them being available as a band-switch bit. The chip provides a 4.5MHz microprocessor clock output.

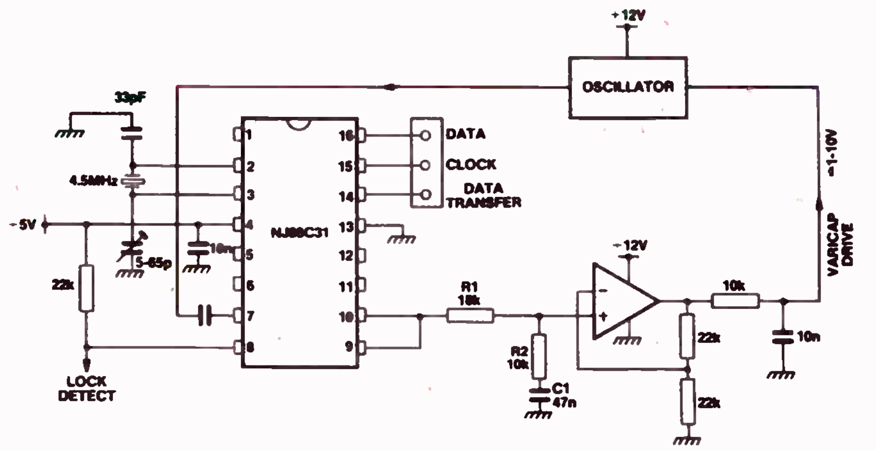
On FM, the oscillator frequency is divided by 15/16 in a two-modulus divider.

Phase comparison results in three open-drain outputs. The charge pump receives its drive from ϕUP and ϕDN\ and LOCK DETECT generates a mute signal. Phase comparison is linear over $\pm 2\pi$; if the phase shifts by more than 2, one cycle is lost or added and the comparator retries with the new difference.

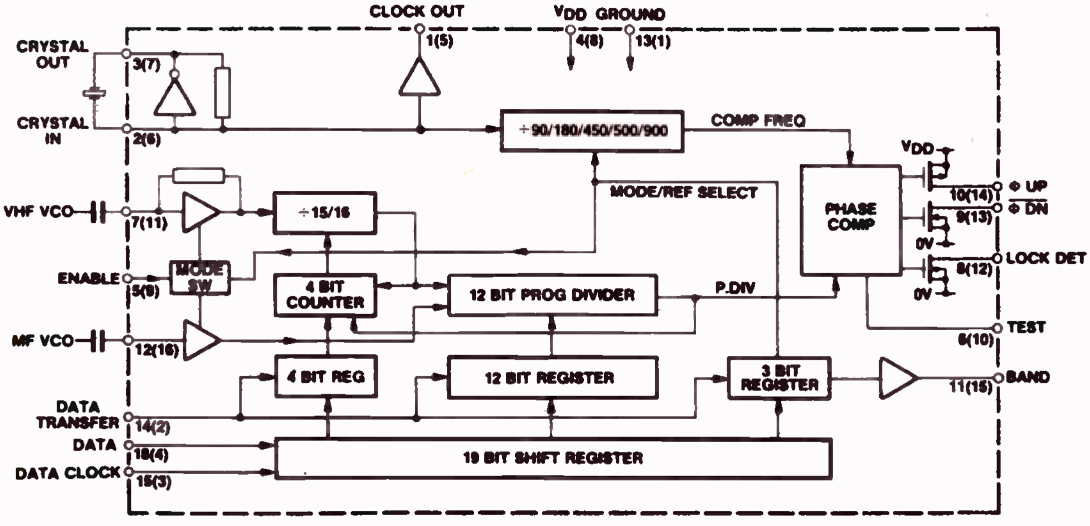
Three lines only are needed to control the synthesiser: data, clock and data transfer. There are 19 bits, the first three being concerned with the reference divider and the rest with the prescaler and programmable divider.

Data transfer instructs the device to accept new data, until which point the old frequency is output.

In this circuit for a VHF synthesiser, the Varicap drive voltage may need to be higher than the 5V provided by the chip. For this reason, the single-supply op-amp gives a 1-10V range. The filter R_1, R_2, C_1 removes the pulses from the phase comparator, values being given in the application note from Plessey contained in the data book on frequency dividers and synthesisers.



One application of the Plessey chip, in this case for a VHF-only receiver. Control is by means of the three lines on pins 14-16.



NJ88C31 VHF/Medium-wave frequency synthesiser. The chip is in either a plastic DIL package or a miniature DIL, for which the pin numbers are in brackets.

Plessey Semiconductors Ltd, Cheney Manor, Swindon, Wiltshire SN2 2QW. Telephone 0793 36251.

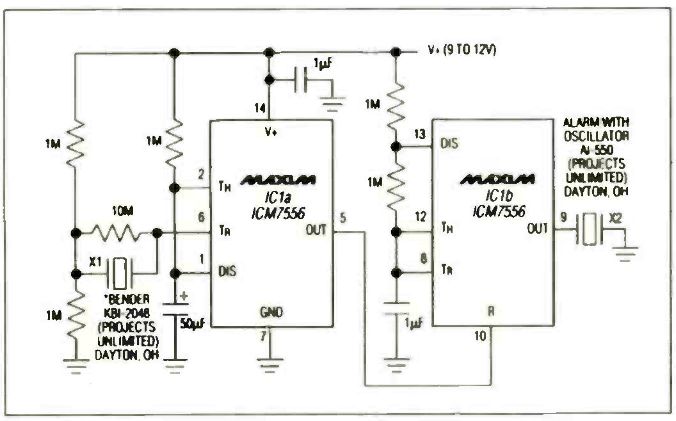
Shock alarm

One IC, two piezoelectric devices and a few passive components make a mechanical shock alarm that emits a loud, modulated tone for a minute.

In the circuit shown in **Fig.1**, which is taken from the Maxim Applications Handbook, any flexure of the piezoelectric plate on pin 6 of the IC1a gives a voltage across the 10M resistor, which triggers the 556 timer and sounds the piezoelectric horn X2 during the time constant of IC1a (the horn shown is complete with its own oscillator to drive it at its resonant frequency). The second timer IC1b modulates the sound by gating the horn at around 5Hz.

In the application note, the sensor takes the form of a brass disc with the sensitive element bonded to its centre and is mounted according to whether the sensitive direction is in one plane or all round, as seen in **Figs. 2** and **3** respectively. The weight shown in Fig. 3 amplifies the movement and provides a greater voltage for a given shock. It consists of a 1/4in bolt with a couple of nuts at one end, the position of which on the bolt can be adjusted to obtain the correct sensitivity.

Maxim Integrated Products UK Ltd, *21C Horseshoe Park, Pangbourne, Reading RG8 7JW*



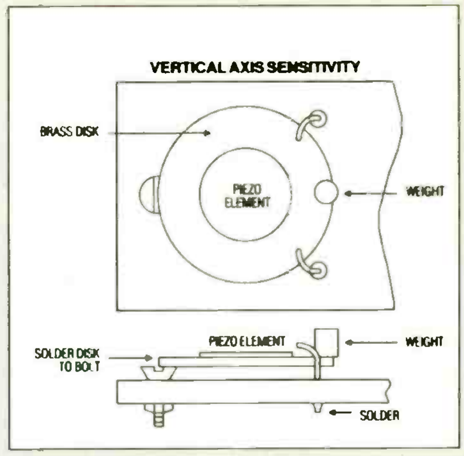


Fig. 2. Mounting of sensor for sensitivity in the vertical direction. Weight increases sensitivity.

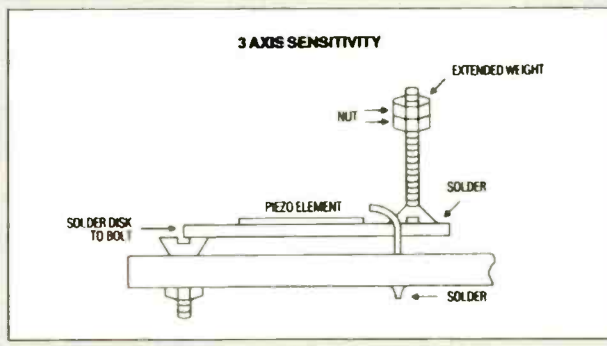


Fig. 3. Sensitivity in all directions is given by this layout, nuts on the 1/4in bolt being adjusted for sensitivity.

Fig.1. (left) Two halves of a 7556 generate timing and modulation for the shock alarm, which sounds for a minute.

Low-cost speech synthesis

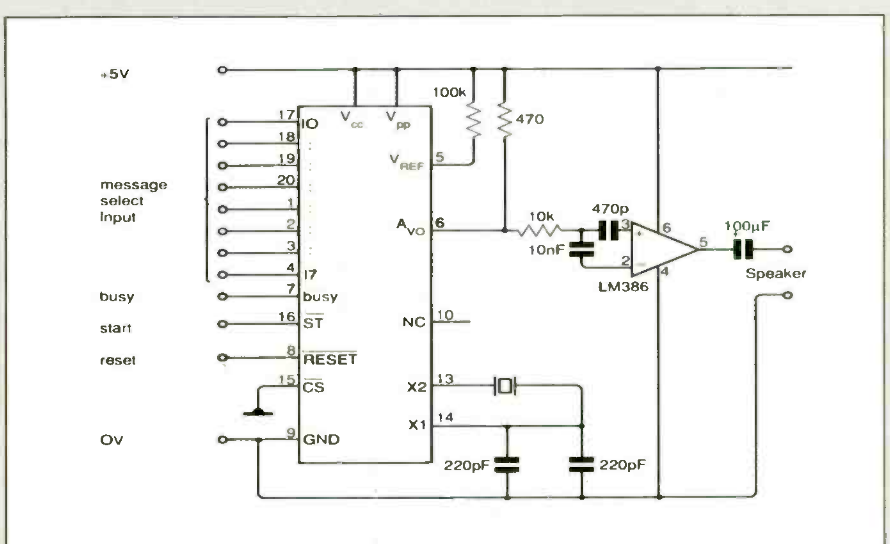
Using the NEC µPD775X speech synthesiser family and a few peripherals, a simple, fixed-vocabulary module can be added to existing equipment such as telephones, alarms, toys and the kind of car equipment that drives you mad with its air of superiority.

Up to 45 words are generated by the minimum configuration shown in the diagram, which uses the µPD77P56 one-time programmable version to allow quick realisation of the initial idea.

It will store selectable single words, phrases or sentences and possesses a tone generator which will play melody or produce DTMF tones. Words and phrases are recorded and then digitally compressed on a PC before being blown into the synthesiser's prom.

Messages are selected by applying a binary value to inputs 0 to 7, whereupon the message is produced when the start line goes low. The Busy line provides an indication to the rest of the equipment that a message is in progress.

NEC Electronics (UK) Ltd, *Cygnus House, Linford Wood Business Centre, Sunrise Parkway, Linford Wood, Milton Keynes MK14 6NP. Telephone 0908 691133.*



NEC's simple voice synthesiser using one of the µPD775X family of synthesiser devices. The resonator is a CSB640P ceramic type from Murata.

Wide-range waveform generator

A low-cost audio signal generator can be made using the Analog Devices AD639 universal trig. function converter. Such a circuit in no way extends the chip, but does illustrate its capabilities and versatility.

The AD639 provides all standard trigonometric functions and their inverses, which are obtained by pin straps. Accuracy of law exceeds that given by diode shapers and speed is higher than is produced by rom look-up tables with a D-to-A converter on the output. For example, a triangular-to-sine conversion is carried out with -74dB distortion at up to 1.5MHz. **Figure 1** is its internal block diagram.

Figure 2 shows the application referred to above: a general-purpose function generator providing sine, square and triangular wave outputs from 20Hz to 20kHz, which can be gated and modulated.

The AD654 generates the triangular wave across C_f, the two AD611s A_1 and A_2 buffering, amplifying and level-shifting the signal; P_3 and P_4 are used, while viewing the output on a spectrum analyser, to reduce harmonic distortion to a minimum. Although this triangle is not accurate enough to make the AD639 exert itself, THD is nevertheless around -55dB. Amplifier A_3 provides more gain for a 10V triangular wave output. Sine output is fixed at 2V RMS from the AD639 and squares are taken direct from the AD654 at 15V and are not buffered. The square becomes 30V pk-pk if pins 2 and 5 of the AD654 go to -15V.

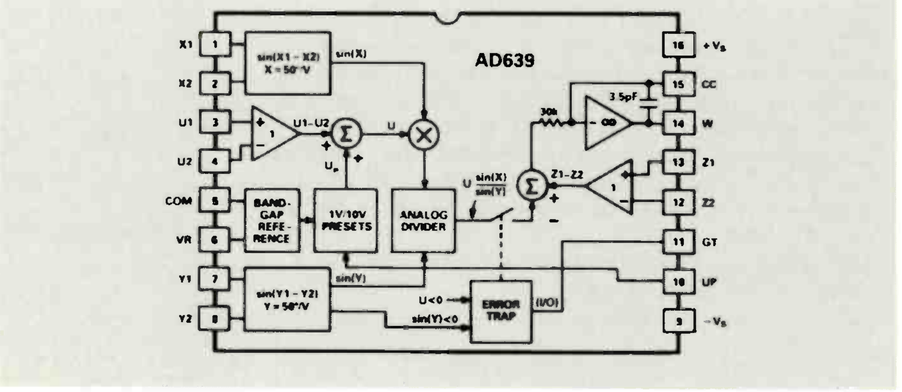


Fig.1. Block diagram of AD639 trig. function converter which, among its other roles in life, makes a good function generator.

Alternative frequency-adjustment methods are shown in Fig. 2. The circuit using P_1 shown connected to the AD654 gives about 10kHz/V, 2V being used to give 20kHz. The other method gives a log sweep response with a scaling of 10^V kHz (V in volts), the range being from 10Hz to 100kHz.

The AD639 will also multiply the frequency of the triangular wave to give sines at two, three, four or five times the frequency using cosine for even multiples or sine for odd ones. In this mode, harmonic distortion stays less than -50dB. ■

Analog Devices Ltd, *Station Avenue, Walton-on-Thames, Surrey KT12 1PF. Telephone 932 252320.*

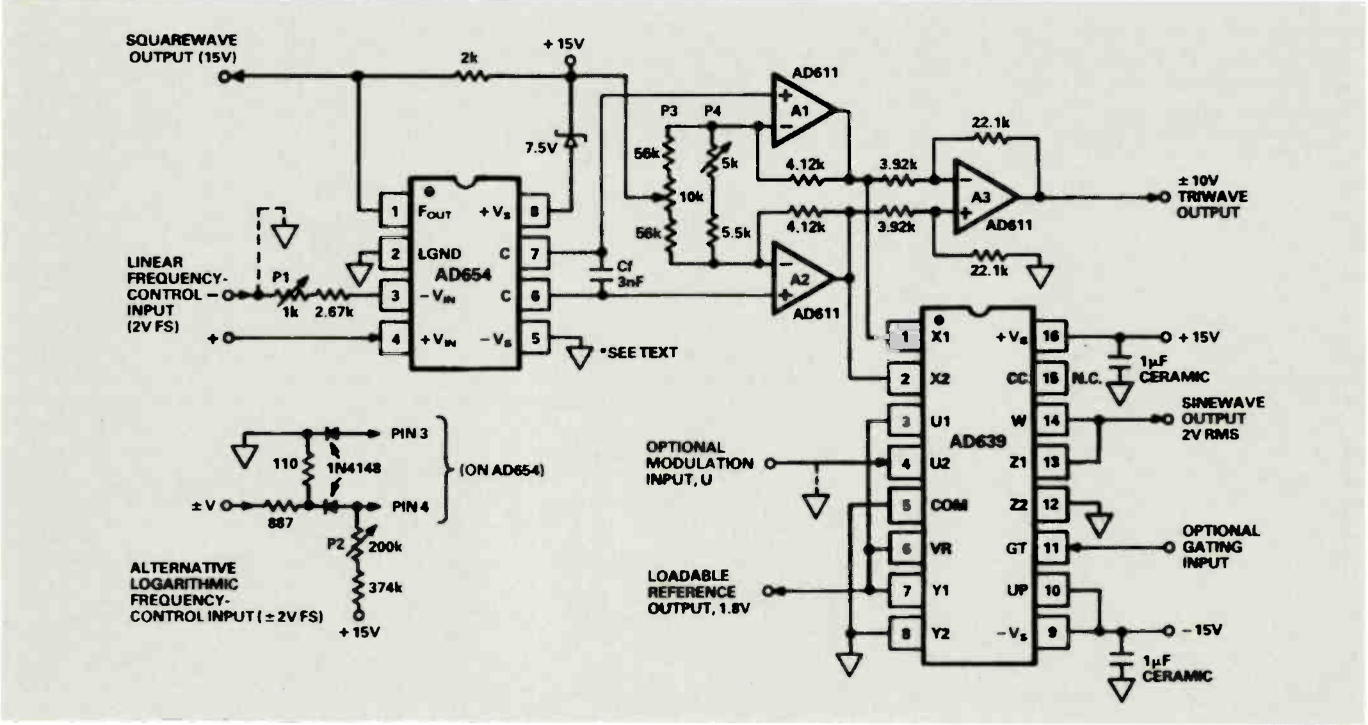


Fig.2. Analog Devices's AD639 used with an AD654 to make a general-purpose audio function generator to give sine, square and triangular waves from 20Hz to 20kHz.

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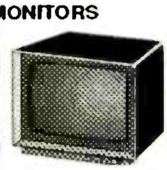

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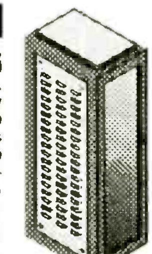

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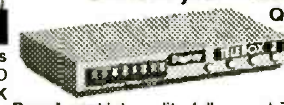

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Rugged receiver with an edge

Tim Stanley tests Lowe's HF receiver and finds it not only good value for money, but also a cut above the average

Lowe Electronics seems to have made a worthwhile contribution here in the professional receiver market. The HF235 is a general coverage HF communications and broadcast receiver, to Lowe's design, in the lower price range for the professional user. Advertised as a "professional monitor receiver", the equipment is interesting to those looking for good performance but not wanting to pay significantly more for equipment over-engineered for their requirements. The unit is a development of the HF225 consumer/amateur receiver (the main signal handling board is essentially the same). Since introduction early this year it has apparently been selling well world-wide.

Features highlighted by Lowe are: four IF filters fitted as standard, low-noise synthesiser, 8Hz tuning steps and a synchronous AM detector. The receiver supplied is also fitted with the high stability oscillator option. (See **Table 1** for handbook specification of significant parameters).

Appearance is smart and simple, and the uncluttered front panel is less daunting than the banks of knobs and switches often found on receivers of this class!

Standard bodywork is for 1in rack mounting but desk-top use is possible using an optional stand-alone case. The rear panel

Frequency configuration

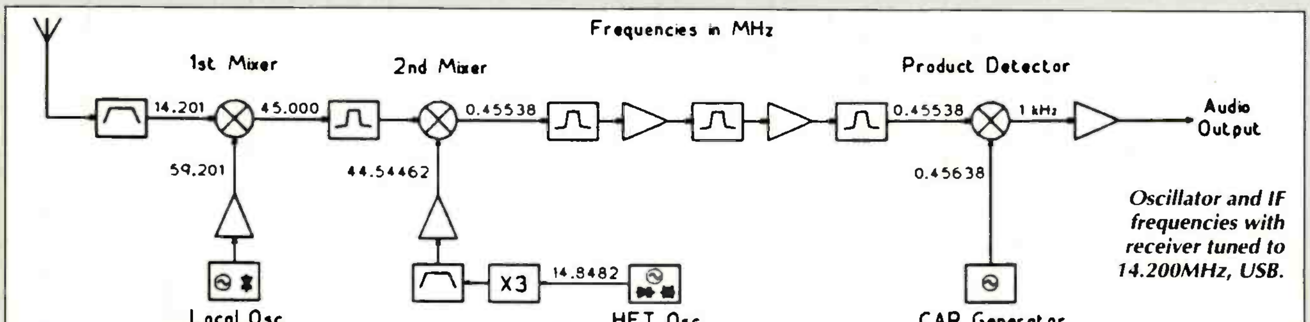
The HF-235 is a dual-conversion superheterodyne receiver, using intermediate frequencies of 45MHz and 455kHz in its two IF stages. RF signals are converted to 45MHz by the local oscillator signal (LO) which is tuned from 45.030MHz to 79.999MHz to give 30kHz to 30MHz receiver coverage. The local oscillator is tuned in 1kHz steps. A set of switched filters in the RF signal path provide primary control of image rejection. They switch automatically via the microcontroller.

Conversion between the two IFs is by the heterodyne oscillator signal (HET) which is tuned over a 1kHz range between 44.544 and 44.545MHz in 128 steps of 8Hz. The frequencies of LO and HET are varied together by the microcontroller to give continuous receiver tuning.The filters in the 2nd IF are centred on 455kHz. This frequency corresponds to the tuned frequency in AM and FM modes, but the IF is offset by 1.4kHz above or below 455kHz in SSB mode so that only the correct sideband signals pass through the filters.

The offset is provided numerically within the microcontroller program.

SSB mode audio is derived by mixing the final IF with a carrier reinsertion signal (CAR). The frequency of this reflects the IF offset, ie 456.4kHz in USB mode and 453.6kHz in LSB mode. In CW mode the IF is offset by 200Hz towards the upper sideband and the CAR frequency is 456.0kHz to give an 800Hz audio tone at the tuned frequency.

Because the local oscillator frequency is higher than the 1st IF, the RF frequency spectrum is reversed in both IF stages, so an increase in signal frequency produces a corresponding decrease in intermediate frequency.



Oscillator and IF frequencies with receiver tuned to 14.200MHz, USB.

carries the usual mains power (IEC) and aerial (BNC) sockets and a 25-way D-type socket with connections including mute control, external gain control/indication and various audio o/p, power supply and earthing configurations.

Simple design

Familiarisation with the basic controls takes only a few minutes. But the apparent simplicity of the front panel is at the cost of operating convenience - the design of the plastic-membrane-type push buttons leaves something to be desired. These buttons are used extensively in control of the receiver, and the "scrolling" technique of selection is cumbersome – particularly noticeable when selecting filter bandwidth.

To go from, say, 10kHz to 7kHz requires three keystrokes as the receiver scrolls through, and executes, the other settings (2.2 and 4kHz) to finally arrive at 7kHz. This is an operation which may have to be tried a few times to decide on the best setting for a particular transmission.

Memory programming and reading, selection between the two VFOs and attenuator (20dB) in/out are also controlled via these push-buttons, with the LCD display giving three or so seconds annunciation of the current selection, on pressing the appropriate button, before reverting to receive frequency readout.

Presumably the use of button type controls is a cost saving, but I would much prefer the more conventional rotary/toggle switches, particularly if I need to drive the receiver in a dynamic hands-on way rather than leaving it in a monitoring role with only occasional operator intervention.

A minor niggle is that the main tuning control jumps to its higher speed mode a little too early for my liking and I sometimes missed weak signals. The internal speaker gives surprisingly nice sounding audio, but quality is, of course, improved with a larger external speaker.

Full marks to Lowe for an excellent handbook. This is conscisely written and includes clear circuit diagrams, an in-depth specification and extensive explanatory text, including a technical description and alignment instructions.

Bench tests

Results are good. One or two intermodulation and reciprocal mixing results for 10kHz spacing were very slightly out of specification, but in general performance is similar to receivers in this class.

Selectivity is impressive, with a measured shape factor of better than 1.6 (the 60dB bandwidth measurement accuracy is limited by the noise floor of the test system, but is better than 3.5kHz). Image rejection is particularly good and greatly exceeds the handbook's spec.

One significant area which might need improvement in some applications is sensitivity. While adequate for most of the frequency range, weak-signal reception towards the top end of the range could be enhanced - sky noise from a properly matched aerial is detectable at 28MHz but sensitivity is still limited largely by the receiver noise floor. A switchable pre-amplifier is often included even in modern receivers without significantly compromising the dynamic range.

There is a surprisingly high level of high frequency noise from the audio stages. The hiss is much less than the "RF" noise, wideband audio hiss (up to about 15 kHz?) but is noticeable using headphones or a high quality external speaker. This should be easy to improve in the design with a little more IF gain and audio filtering.

Table 1: Abbreviated specification with measurement results

PERFORMANCE	Specification	Measured
Sensitivity: PD across aerial I/p for 10dB signal/noise at o/p:		
	2 MHz to 30 MHz: 0.5 uV	At 29MHz: 0.39µV At 10MHz: 0.35µV
Selectivity: 2.2 kHz I.F. filter bandwidth:		
At -6dB:	2.3kHz	2.2kHz
At -60dB:	3.4 kHz	<3.5kHz
Shape factor:	1.5	<1.6
Pass-band ripple at receiver o/p:		
	(Not specified)	<0.2dB
200Hz CW filter bandwidth: at -6dB:		
	170Hz	190Hz
Dynamic range: with 2.2kHz filter, 10kHz spacing:		
	85dB	80dB
50kHz spacing:	>93dB	96dB
Reciprocal mixing with 2.2kHz filter,3kHz spacing:		
	(Not specified)	76dB
5kHz spacing:		
	80dB	82dB
10kHz spacing:		
	90dB	86dB
Image rejection: wanted frequency +90MHz:		
	>75dB	99dB at 29.999MHz
IF. rejection: wanted frequency +45MHz:		
	>85dB	83dB at 29.999MHz
At +22.5MHz:	>75dB	85dB
Frequency stability: (Not measured)		
	<±30Hz in one hour at constant 20°C	
Frequency error	<±200Hz, -15°C to +50°C ambient	

Field trials

The receiver was "field" tested – literally! – at the end of a rhombic aerial totalling 280m of wire at a height of about 30ft.

Design frequency was 14MHz, but an aerial of this type is not particularly frequency conscious and it performed very well from below 7MHz to at least 24MHz.

Orientation was for maximum response from the ENE and WSW directions but directivity was also not critical and good all-round high-angle reception was obtained, particularly in the 7.2MHz broadcast band where signals were extremely strong. The set-up should be reasonably representative of a professional system for "serious" work, although professional installations may often be somewhat higher above ground.

However, the lower height of the aerial is likely to give a stringent trial as the most critical test of the receiver is thought to be the handling of relatively high-angle strong signals from European broadcast stations.

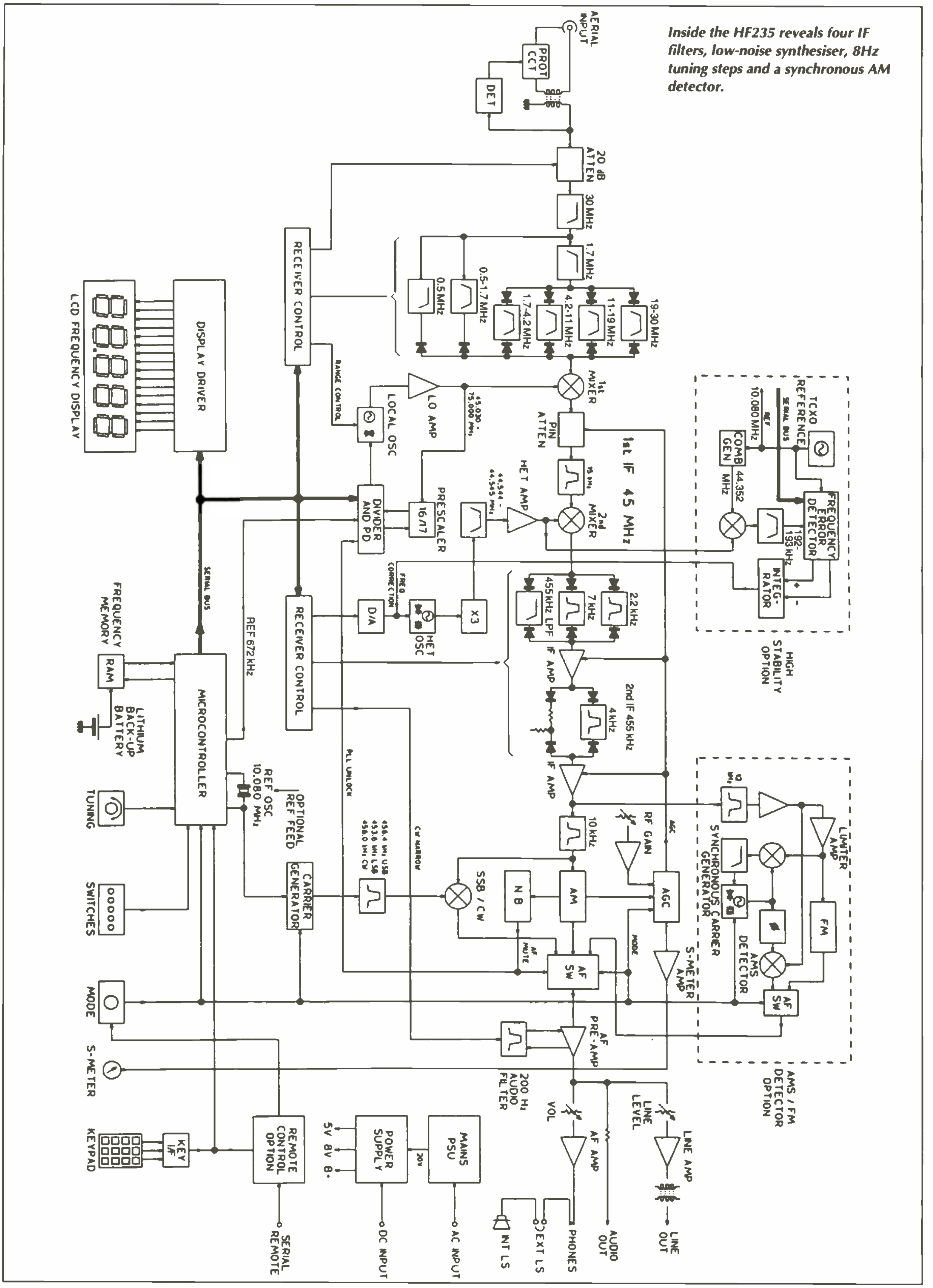
This test was carried out soon after dark when such signals are at their strongest, usually occurring between about 5 and 10MHz. Weak-signal reception was tested, in-between the broadcast bands, by switching between the rhombic and a check aerial - an inverted "V" dipole 80m in length, with the apex at 35ft above ground.

While tuning through the non-broadcast bands, any suspicion of an intermodulation

GENERAL FEATURES

Frequency range:	30kHz to 30MHz continuous
Modes:	AM, LSB (or FAX), USB, CW, narrow band FM, synchronous AM.
Memories:	30 (Lithium battery back-up for > 5 years).
Filters:	2.2, 4, 7 and 10kHz (12kHz for FM).
Noise blanker:	Permanently enabled, threshold level12dB above nominal carrier.
Remote control:	Optional RS232 interface.

Inside the HF235 reveals four IF filters, low-noise synthesiser, 8Hz tuning steps and a synchronous AM detector.



or spurious product appearing was checked by switching to the dipole as the signal levels from the smaller aerial were much less than from the rhombic. No spurious responses or products were apparent - a very pleasing result, especially as rejection of the band-pass filters was probably compromised by the (deliberate) omission of an aerial matching network.

A comparison was also made with my Yaesu FT-1 general coverage HF transceiver (quoted simply as having "90 dB dynamic range"). Any discrepancy between the two receivers would lead to suspicion of a spurious response. However, this was encountered on only one frequency -about 21.4MHz - where a rogue response was discovered on the HF235 at fairly low level (about S3).

A further test was made soon after daylight; authenticity of signals was tested by switching in filtering (admittedly fairly broad) ahead of the receiver in the form of an aerial tuning unit tuned to the wanted frequency. Again, no spurious responses were revealed during this test (although signals were not as strong as during the evening test). These results are very good and lead me to a high degree of confidence that the receiver should cope with most normal applications in a professional role.

Tests were done using mains power and the good dynamic range was sacrificed when using a 12V DC supply. The handbook concedes that using such a supply results in a slightly reduced RF performance. In fact this rendered the receiver unable to cope below about 10MHz. For example, at around 5MHz, signals were swamped by wideband intermodulation registering about S5 on the signal strength meter. The effect occurred even using the dipole aerial. A 24V DC used for the daylight tests confirmed the handbook recommendation for supplies of 20 to 40V when not using mains. Close-in dynamic range seemed adequate with reception not compromised by reciprocal mixing.

Critical receiver design

Perhaps the most exacting task for the receiver designer is optimising the trade-off between sensitivity and the requirement for the receiver to handle the barrage of strong signals appearing in the HF spectrum, i.e. the test of its's "dynamic range".

Signals from the aerial outside the receiver passband appear at it's input and are passed through the early stages along with the wanted signal until the I.F. filters which define the passband for the wanted signal. The sum of the unwanted signals may be enough to push the early stages of the receiver (the front-end) into non-linearity. Hence mixing of the signals occurs - intermodulation - which can result in unwanted products falling within the receiver passband.

Obviously, a narrow RF filter before any active stages would help to eliminate the unwanted signals, but would of course need to be tunable in sympathy with the main tuning of the receiver. This would not be a cost-effective solution.

The best technique is to arrive at a compromise between input filtering and designing the front-end stages for high signal level handling. This normally results in fixed-tuned bandpass filters in the front-end, each covering a portion of the HF spectrum, and minimising the amount of amplification before the main I.F. filters - see the HF 235 block diagram.

A further factor sometimes limiting the dynamic range in modern receivers is noise from the local oscillator. Frequency synthesizers offer high accuracy, stability and control agility, but a phase locked loop will always exhibit some phase jitter, resulting in noise sidebands on the local oscillator signal. These can be significant up to a few tens of kHz away from the nominal L.O. frequency, and, in the normal mixing process in the receiver, will again cause strong unwanted signals outside, but fairly close to, the nominal receiver passband to appear as noise within the passband. This is known as "reciprocal mixing".

Further comments

The receiver is supplied with the high-stability option fitted. A frequency standard is not available and so the frequency stability could not be measured. However, in practice the receiver seemed rock-steady; commercial SSB could be monitored for at least tens of minutes with no discernible pitch change

I suggest that the high stability would allow long periods of "hands-off" FAX reception (an option in place of the LSB mode setting), although a suitable terminal was not available to check this mode.

Synchronous AM detector certainly gives a significant improvement in audio quality when listening to MF broadcasts subject to selective fading (which includes domestic services). The high frequency response is noticeably extended also. (An audio derived AGC would be useful to overcome the increase in loudness of the audio during a carrier fade, caused presumably, in part, by a sympathetic increase in gain by the receiver's IF derived AGC).

Improvement in reception of shortwave broadcasts seems surprisingly moderate, but again a truer frequency response is sustained, particularly noticeable when listening to the pulses of a standard time transmission on 10MHz. Fairly careful tuning is required to make sure the detector PLL is properly centred to minimise the amplitude threshold at which it could loose lock.

Quantitative evaluation of the permanently enabled noise blanker was not carried out but it seemed to do at least as well as the one on my FT-1 with which I have been very pleased. The squelch (the threshold level adjustment is on the back panel) works only in FM mode – an all-mode squelch may be worthwhile for long-term monitoring of quiet channels. A faster (switchable) AGC time constant could make copy of CW signals easier during more rapid fading. The remote control option was not fitted in the review model, but its evaluation would have been limited as at the time of this review no control software packages were known to be available and customers have developed routines to their own requirements.

Conclusion

Reservations about design should be seen in perspective, as for many monitoring applications more elegant controls would be an unnecessary expense. I have suggested some other small additions and improvements but this should not undermine the overall impression which is good.

I sense that a lot of thought and genuine effort have gone into developing this receiver which is a cut above the average, though aimed at the lower end of the professional market. It should be very competitive in the price range. Electrical performance is good, and the receiver should serve admirably in many professional applications. ■

HF235, basic set, is £1116 (inc VAT). Lowe Electronics Ltd, Chesterfield Road, Matlock, Derbyshire DE4 5LE. Tel: 0629 580800

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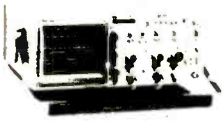

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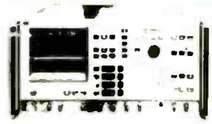

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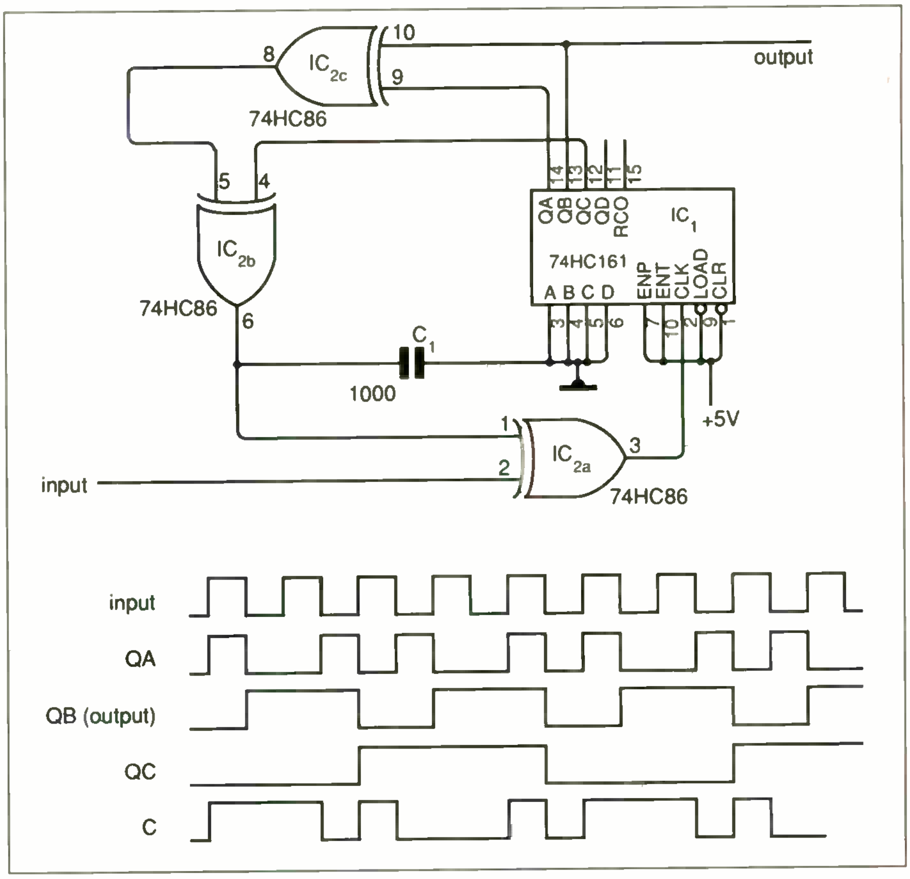
CIRCLE NO. 138 ON REPLY CARD

Divide by 2.5

Division by 2.5 is performed by two ICs, one of them being a 74HC161 positive-edge-triggered 4-bit binary counter.

A logic level at point C determines whether the counter triggers on a positive-going or negative-going edge at the trigger input terminal, since trigger input is fed via an X-Or gate IC_2, C=1 giving triggering on a negative-going edge. Level at C is controlled by the counter outputs and the circuit output from QB is a clean, though asymmetric waveform.

Yongping Xia
West Virginia University
Morgantown, WV
USA



Circuit by Xia to divide input frequency by 2.5. Circuit can be made to trigger from either edge.

FRESH IDEAS

While we are not short of Circuit Ideas to publish, it would be agreeable to see some fresh input from the vast, untapped bank of talent that our thousands of readers represent. We pay a moderate fee for all ideas published. So send them to Circuit Ideas, *EW+WW*, Quadrant House, The Quadrant, Sutton, Surrey, SM2 5AS. We will be happy to consider them.

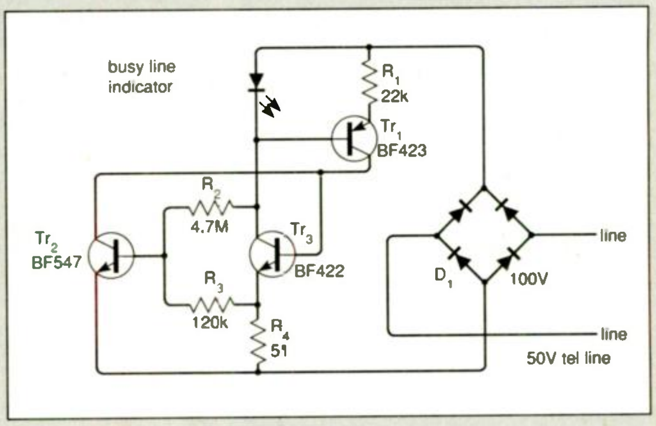
Busy line indicator

Telephone line-activity indicator shown is simply connected in parallel with the line. It is line-powered and takes a stand-by current of less than 50μA, active current being about 8mA.

Line voltage is rectified for ease of installation and is needed anyway if outgoing calls are inverted. Transistor Tr_2 senses the 50V line voltage and turns Tr_3 off in standby mode, sensing voltage across R_4 to limit active-mode current to avoid latching. Base current to Tr3 comes from Tr_1, current being limited by R_1. A 120V V_{CEO} rating is needed by Tr_1 and Tr_3 to avoid breakdown to ringing voltage.

If an opto-coupler is used instead of the led, it will control recording equipment and transmitters etc; a small amount of modulation is visible in the light output, which indicates voice traffic.

Ron Weinstein
Centralab
Tel Aviv
Israel



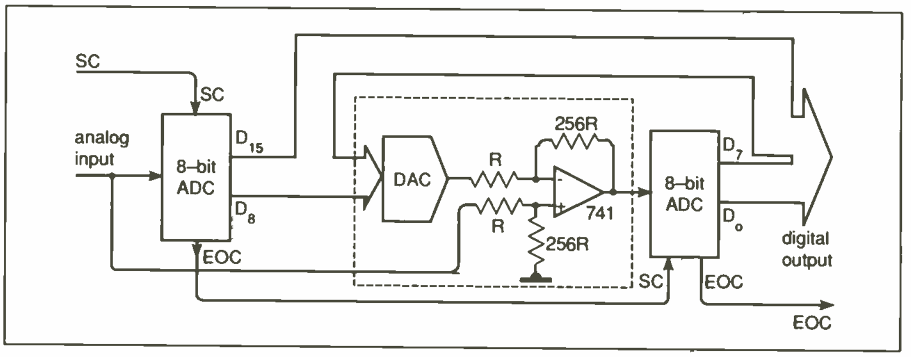
Telephone line activity indicator uses a mere 50μA in standby mode and may be modified for use in control.

High-res A-to-D using low-res converters

Using n low-resolution A-to-D converters, increase the final resolution of a converter by n-fold by means of the circuit shown here.

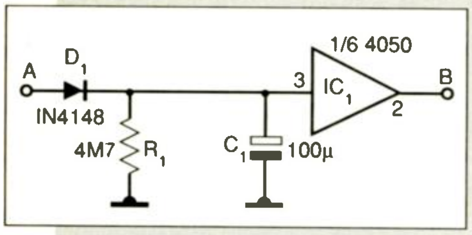
Converter 1 gives the most significant byte of the conversion, of which the analogue equivalent is at the output of the A-to-D converter and is subtracted from the analogue input by the 741 difference amplifier, providing a gain of 256. This voltage goes to the second A-to-D, which produces the least significant byte of the conversion, the end-of-conversion signal from the first serving as the start-conversion input for the second, whose EOC signals the end of the whole conversion. So two 8-bit A-to-D converters function as one 16-bit device.

In principle, resolution of an A-to-D converter increases by n times for n low-resolution A-to-Ds of most kinds, including flash and successive-approximation types.



Two low-resolution A-to-D converters perform the function of one high-resolution type, the principle being capable of extension to an increase of n times.

K Balasubramanian
Cukurova University
Adana, Turkey



Simple timer for long time intervals, which could be made variable.

Simple, but versatile timer

One non-inverting cmos buffer and three passives compose this simple timer.

Point A is normally low, whereupon the output B is also low. When A goes momentarily high, C_1 charges through D_1 and the output goes high, where it stays for a period of up to about five minutes when A is taken low again, the exact time being determined by the CR.

You could make the circuit a little more flexible by replacing R_1 by a 2.7MΩ potentiometer having a 10kΩ fixed resistor in series to give variable times.

K R Kirwan
Aldersley
Wolverhampton

Continuous on/off timer switch

On and off times of this continually operating switch are settable from seconds to hours independently of each other.

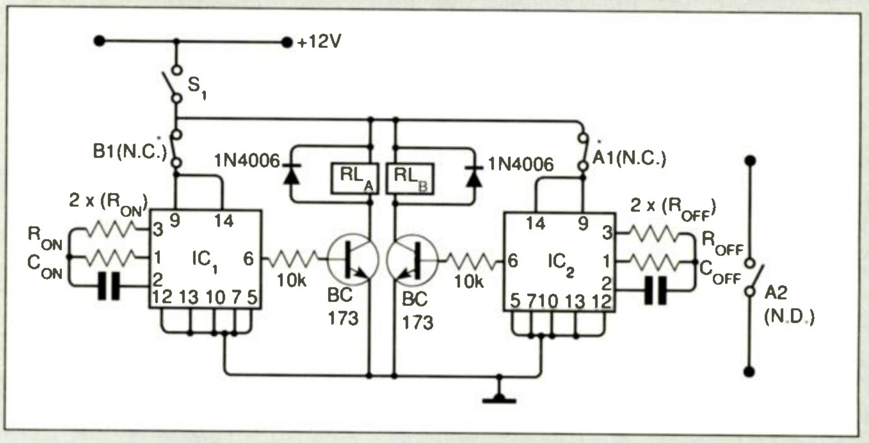
Closing S_1 applies power to IC_1, an MC14541B oscillator/timer, making the associated BC173 conduct and energise RL_A. Contact A_1 opens to de-energise IC_2 and close contact A_2 – the load switch. After IC_1 timesout, A_2 opens to isolate the load and A_1 closes, applying power to IC_2. Relay RL_B is now energised and contact B_1 opens, disconnecting IC_1. When IC_2 times out, IC_1 is once again under way and the whole thing starts again. Values of R_{on}, C_{on}, R_{off}, C_{off} are given by $T = 1.15R_C \times 8192$.

John Karageorgakis
Thessaloniki
Greece

Reference

Motorola data sheet on MC14541B programmable timer

Timer produces on and off periods, independently adjustable from a few seconds to hours.



Adjusting differential amplifier gain

Figure 1 shows the common-or-garden differential amplifier, which is known to be simple and reliable – unless its gain is to be made variable. In that case, ganged potentiometers or another gain stage might be needed, which neatly remove the advantages of simplicity and reliability.

Figure 2 is one way out; if R_g is large compared with R_1, gain is $\approx R_2/R_1$, whereas a small R_g gives a gain approaching zero. In the case of o, the reverse applies; a small R_g gives a high gain, a large value confers a gain of R_2/R_1. You cannot carry this too far, however, since if you make R_g too small, negative feedback is no longer effective.

B D Runagle
Swadlincote Derbyshire

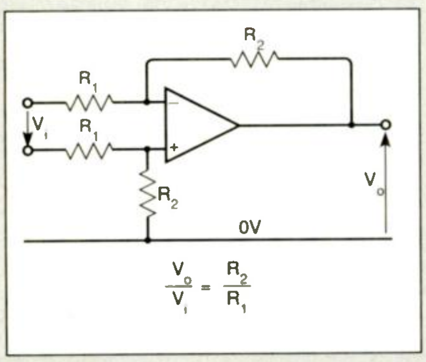


Fig. 1. Ordinary differential amp for fixed-gain operation.

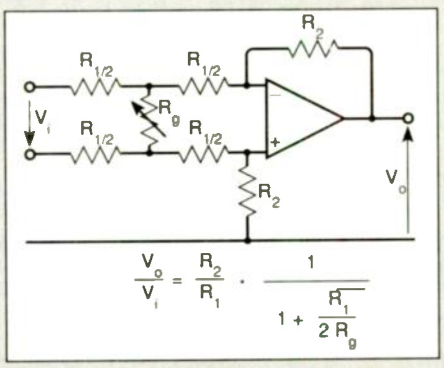


Fig. 2. One way of providing gain adjustment without losing benefits of simplicity and accuracy. Gain is from zero to R_2/R_1.

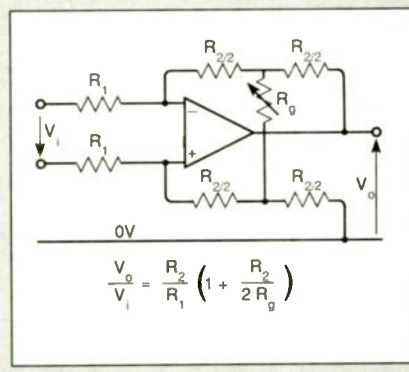


Fig. 3. Another way, giving adjustment from R_2/R_1 to a high value.

Dual-speed DC motor controller

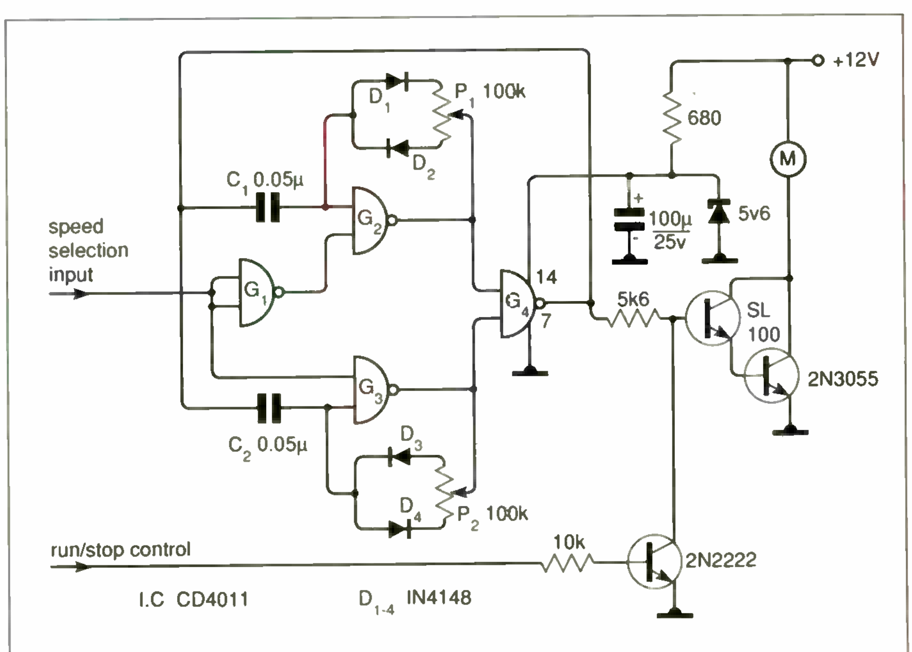
A cmos NAND IC, the CD4011, is the core of a pulse-width controller for DC motors, providing logic selection of two preset speeds.

Gate G_4 forms one half of two separate astable multivibrators activated by a logic signal to G_1. One of the astables is formed by G_4 and the components C_1, preset P_1 and diodes D_1 and D_2, the operative NAND being G_2; preset P_1 sets the mark:space ratio for this astable.

When the speed selection input is low, this astable oscillates under the control of P_1 and drives the output transistor; when high, the otherastable takes over at a M:S ratio set by P_2. Run and Stop control is a separate input.

M S Nagaraj
ISRO Satellite Centre
Bangalore
India

■



Two-speed pulse-width control of a DC motor with logic input; the two speeds are independently set.

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12bit DAC. The DAC667 is a microprocessor compatible 12bit d-to-a converter with a precision voltage reference and double-buffered latching. Power consumption is 390mW maximum. Feedback resistors used are specified to a tolerance of 10%. The double buffered latching scheme has four independently addressable latches letting the chip interface with 4, 8, 12 or 16bit data buses while eliminating spurious analogue outputs. Settling time to ±0.01% of FSR is 2µs typical, 3µs maximum. Burr-Brown International, 0923 33837.

Discrete active devices

Transistor array. The SL2366 is an array of transistors internally connected to form a dual long-tail pair with current mirrors. They are made on a high speed 6GHz bipolar process and they are suitable for battery powered radio applications such as CT2. It comes in a 14-pin SO14 package. GEC Plessey Semiconductors, 0793 518000.

P-channel mosfet. The ZVP4105 is a p-channel mosfet with a 4.8 by 2.4mm footprint. It can switch currents up to 520mA with turn on and off times at this current lower than 20ns. The device operates from supplies up to 50V and dissipates a maximum of 625mW. On-state resistance is typically 6Ω given a 5V gate-source voltage and 100mA drain current. Zetex, 061-627 4963.

Linear integrated circuits

Op amp. The MAX406 is a cmos operational amplifier for battery operated applications. It has a 1µA quiescent current that is relatively constant over the entire supply range in unity gain stable and high-speed modes of operation. The output can source 2mA when powered by a 9V battery and smaller loads down to 2.5V. The common-mode input voltage range extends from the negative rail to within 1.1V of the positive supply, and the output stage swings from rail to rail. 2001 Electronic Components, 0438 742001.

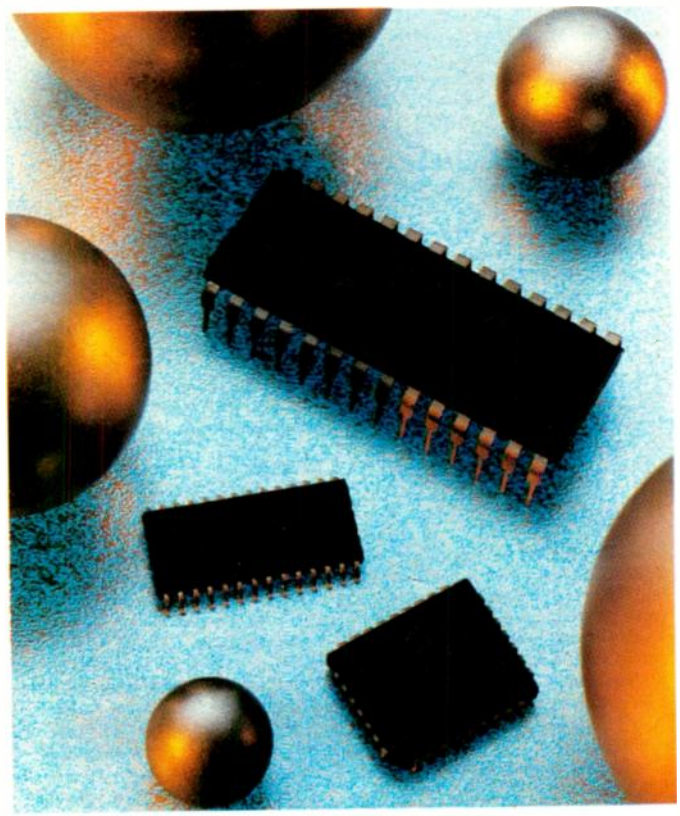
Driver IC. A dual driver IC, the UDN2962W, is for use with solenoids and DC stepper motors. It consists of two source/sink driver pairs for continuous operation up to ±3A and uses PWM techniques to minimise power dissipation and maximise load efficiency. It can be connected to drive two independent loads or a single load in the full bridge configuration. Allegro Microsystems, 0932 253355.

Wave generators. The Sierra SC11313 and 14 are programmable sine and square wave generators. The frequency range is from DC to 3.5kHz with an accuracy of ±0.1dB in amplitude, and of ±1.0dB from 3.5 to 8kHz. No external components are needed to do this. Square waves are generated by a programmable 16bit counter and sine waves by attenuating the harmonics of the square wave tones through a fifth order bandpass filter. They can be powered from a 5 or 10V supply. Amega Electronics, 0256 843166.

Single-chip modem. The Yamaha YM7109C is a single-chip modem for use in Group 3 fax machines or for PC telecommunications. It operates from a single 5V supply and has a typical power consumption of 200mW, 300mW maximum. Half duplex synchronous data transfer is supported at 9600, 7200, 4800, 2400 and 300baud and the device includes programmable functions for dual-tone origination and tone detection. Barlec-Richfield, 0403 50111.

Delay line. The Bt630 is a monolithic cmos high-bandwidth delay line with a programmable range of 25 to 400ns and full TTL compatibility. It is adjustable in full-scale delay over this range and handles 15ns pulses over the entire delay range. It comes in a 14-pin plastic DIP. There are five buffered taps at 20, 40, 60, 80 and 100% of full-scale delay with output delay accuracies of ±5% or 2ns. Power dissipation is 50mW. Brooktree, 0844 261989.

Vertical deflection. The TA8427K is a monolithic vertical deflection output circuit for use in colour televisions. It runs from a 27V supply and uses a charge-pump topology to produce the 60V needed to drive the vertical deflection of the current generation of CRTs with a peak-to-peak output current of up to 2.2A. It dissipates up to 20W which reduces by 4W/°C above 25°C subject to the use of a suitable heatsink. It comes in a 7-pin single-in-line package. Toshiba Electronics, 0276 694600.



Golden balls: the fastest 3V eproms in the West, from Arizona Microchip.

Video amp. The EL2073 is a precision voltage-feedback amplifier with 200MHz gain-bandwidth product, settling time of 13ns (0.1% for a 2V step), and 50mA output current. It is unity gain stable with a -3dB bandwidth of 400MHz. Input offset voltage is 200µV and bias current 2µA. The feedback loop may be configured for reactive components letting the unit be used in active filters, integrators, sample-and-holds and log amps. Elantec, 071 482 4596.

Video amplifier. A dielectric isolation process has been used to improve the performance and reduce the cost of high-speed video amplifiers such as the HA5020 which is a direct replacement for the EL2020/30 and OP160 devices. It has a slew rate of 800V/µs and 90ns settling time making it suitable for high speed communication and data acquisition system designs. Offset voltage is 2mV, offset drift 20µV/°C, bias current 3mA, input resistance 20MΩ, minimum common mode rejection ratio 50dB, and unity gain bandwidth 100MHz. Harris Semiconductor, 0276 686886.

QPSK modulator. A monolithic quadrature phase shift keyed modulator from Hewlett-Packard replaces several discrete components with a single 16-pin SO-16 IC. It is aimed at digital cellular and digital cordless telephones. Called the HPMX2001, it comprises twin double-balanced modulators which are cross-coupled into a summing amplifier. It is for wide or narrow band applications and has a typical LO operating frequency range of DC to 2000MHz and I/Q bandwidth of DC to 700MHz. Jermyn Distribution, 0732 740100.

Op amps. Three high speed op amps have 450V/µs slew rates, 50 to 100MHz true bandwidths, and more than 50mA of output drive current. Units in the LTC LT1190 family are specified driving 100Ω loads while operating from a single 5V supply as well as ±5 to ±8V supplies. Low offset voltage is 1mV, input bias current 500nA and gain 45,000V/V. They come in 8-pin plastic DIL or ceramic packages and in 8-pin small outline packages. Micro Call, 0844 261939.

Load switch IC. A load switch IC can extend battery life in portable equipment by up to 100% by shutting down functions that are not in use. The Si9405DY is a p-channel device in a low profile SO-8 package. Its on resistance is 200mΩ when driven from 5V logic. This translates into a negligible voltage drop across the switch which means more power is available to the load. Maximum power dissipation is 2W at 25°C and 0.8W at 100°C. Siliconix, 0635 30905.

Temperature IC. Based on the period group switching principle, the U2800B bipolar IC is for use in temperature control applications. Offering three preadjustable temperature set points, it enables the configuration of a two-position control with adjustable hysteresis, as well as proportional control with programmable proportional range. The 16-step ramp is generated internally with selectable cycle times of either 31 or 5s. It can be used for controlling either relays or triacs. Telefunken Electronic, 0635 30905.

Memory chips

64Kbit sram. The DS2064 is a byte wide 64Kbit sram for battery operated and battery backed applications. This cmos memory can operate at TTL levels from a supply voltage of 2.7V and retains its data down to 2V. Access time is 150ns maximum from a 5V supply or 250ns from a 3V supply. At 25°C, standby current from a 5.5V supply is 100nA and from a 3V supply 50nA. Dallas Semiconductor, 0221 7822959.

72Kbit fifo. The IDT7205 fifo operates at 25ns and is organised as 8K by 9bit. It combines a predictive look-ahead architecture with a submicron cmos process. Housing is a 300mil thick DIP. It is suitable for inter-board communications, data communications and video graphics. It is available in commercial and military versions. Integrated Device Technology, 0372 377375.

3V eproms. The 27LVX 3V cmos eproms have a 200ns access time. The first two products in the range are organised as 32K x 8bit (27LV256) and 64K by 8bit (27LV512). They are claimed to draw four times less power at 3V than similar 5V eproms. Both are available in plastic DIP, PLCC and SOIC packages.

4Mbit sram. The uPD434000 4Mbit sram has a 55ns access time and is made with a 0.5μm cmos process and thin-film transistor memory cell technology. Data retention under power-down conditions is helped by the 0.4μA standby current requirement and a 3V supply potential. The chip measures 17.8 by 7.9mm and packages include 600mil 32-pin DIP, 525mil 32-pin SOP and 400mil 32-pin TSOP. NEC Electronics, 0908 691133.

Microprocessors and controllers

Single chip PC. Processor, graphics, communications and power management are all integrated on the single 160-pin PC/Chip using ChipSystem architecture. The chip implements a 3MIPS 8086-compatible microprocessor running up to 14MHz, IBM XT equivalent logic, colour graphics array compatible flat panel or CRT controller, serial port, and built-in power management. The Dos processor combines an iAPX86 compatible instruction set processor with a 16bit four-stage pipeline. Chips & Technologies SA, +41 38 338490.

Optical devices

LED lamp. A deep-red high light output H-P LED lamp uses double heterojunction AlGaAs technology to improve flux efficiency, thermal management and power capabilities. The HPWR-A200 lies 3.58mm above board height and emits at a wavelength of 637nm. DC forward current is 120mA, power dissipation 375mW, and reverse voltage 5V. Celdis, 0734 585171.

Laser diodes. Compact visible (660 to 685nm) laser diode modules in the Imatronic range have been given an added modulation option. These versions offer 1 to 100kHz modulation with a 1μs rise time and can be driven from any TTL compatible source. They are a suitable replacement for He:Ne lasers. There is also an infra-red version at 820nm that comes in the same 49 by 16mm housing. All units include focusing optics and need a 4 to 5.25V DC supply. Outputs are from 1 to 3mW for infra red and 0.5 to 3mW visible. Lambda Photometrics, 0582 764334.

Dual red LED. The TLRA179 is a two-chip LED lamp for message board applications. It has two LED chips connected in series and produces a high intensity red light from a forward current of 15 to 20mA. It comes in a two-pin plastic moulded package with a lens that gives a viewing angle of ±30°. Luminous intensity is 1000mcd from a 20mA drive. Peak emission wavelength is 660nm. Toshiba Electronics, 0276 694600.

Oscillators

Clock oscillator. Units in the 1600 series of surface mount crystal clock oscillators come in a 4.7mm high 1.5g weight packages that are suitable for reflow and vapour phase automatic mounting processes. They have stand-by functions for output (tri-state). The crystal unit is hermetically sealed in a metal housing and the available frequency range is 1 to 55MHz. The units come in static proof packages using tape and reel. NDK Europe, 081 390 8344.

Programmable logic arrays

Cmos PLD. The 85C224-7 is a 24-pin cmos microcomputer programmable logic device that runs at 7.5ns input-to-output delay. It exceeds all performance parameters of E-speed PALs and is a plug-in replacement for them. Internal clock speed is 100MHz. Intel, 0793 696000.

Gate array family. A submicron gate array family offers 250ps speed and 0.7μm triple-metal cmos technology. Called ISB24000, it has a usable gate count range from 3000 to more than 200,000 and features such as JTAG support and direct drive of industry standard buses. Flip-flop toggle rate is 200MHz and there is a 24mA per pad sink and source capability. The family is compatible with the emerging 3.3V standard supply voltage. SGS-Thomson Microelectronics, 0454 773095.

Power semiconductors

Hybrid couplers. A series of 90° hybrid couplers with a power rating of 200 or 400W comprises 20 models in 10 frequency bands from 100 to 1450MHz. Insertion loss is less than 0.3dB and isolation 20dB. The quadrature phase shift characteristic allows for integration into high power amplifier subsystems where low interstage VSWR must be maintained. Atlantic Microwave, 0376 550220.

Avalanche diodes. Avalanche diodes are available rated from 1 to 2000A with peak inverse voltage ratings from 1.2 to 3.2kV. The smallest devices are supplied in wire-ended form, those rated between 15 and 600A in conventional stud type packages, and the largest sizes in metal or ceramic capsules. Complete assemblies to customers' requirements can include heatsinks and ancillary components. GD Rectifiers, 0444 243452.

Quad power switches. Quad power drivers in the CA32 family are for driving loads such as motors, solenoids, lamps, and heaters, especially in automotive electronic systems. Four versions are available. The CA3242 is a quad gated inverting power driver that can switch 600mA. The CA3252 is a noninverting version without built-in current or temperature protection. The CA3262 has a 700mA rating. And the CA3272 is similar with a fault-mode diagnostic flag. Harris Semiconductor, 0276 686886.

PASSIVE

Passive components

Chip coils. The LQH1C miniature chip coils measure 3.2 by 1.6 by 1.8mm, making them 40% smaller than the LQH3C range. Inductances range from 0.12 to 100μH, current ratings up to 970mA, and DC resistances down to 0.08Ω. Nominal self resonant frequencies are from 12 to 900MHz. The devices are supplied taped and reeled and their nickel electrodes allow flow soldering at 270°C for up to 10s. Murata Electronics, 0252 811666.

Polyester capacitors. The Type 6124 metallised polyester capacitors are encapsulated in plastic cases and sealed with epoxy resin, complying with UL 94V-0. A dipped version is available. They also come with a bleeder resistor of 2.2MΩ nominal to safely discharge the unit to less than 50V within one minute. Range is from 1 to 30μF. They are for motor run and applications where power factor correction of retrofit compact fluorescent lights is required. They.are suitable for exit and ceiling lights. Tecate Industries, 0101 619 448 4811.

SM inductors. The IMC1210 surface mount inductor has a PCB mounting height of 2.2mm, is protected by moulded construction, and has a mounting footprint of 3.2 (long) by 2.49mm (wide). It is compatible with vapour phase and infra-red reflow solderingtechniques and has solder coated terminals of phosphor bronze to eliminate leaching problems. Inductance ranges from 0.1 to 100μH with tolerances from ±10 to ±20%. Vishay Components, 091-514 4155.

Crystals

Thin crystal. The CP21B advanced crystal unit is 1.3mm thick and offers stable operation from -10 to +50°C. Frequency tolerance is ±5 x 10-6 and the frequency range is 16 to 110MHz. It can be surface mounted and is suitable for hand-held telephones, video cameras, portable laptops, electronic notebooks, pocket pagers and computer terminals. NDK Europe, 081 390 8344.

Displays

Digital indicators. A range of loop-powered digital indicators has been extended with the DM421 - a panel mounting instrument that lets less than 3V be drawn from the host loop. It can provide a panel reading for any 4 to 20mA signal and gives a 3.5 digit 12mm character display. It is packaged in a 96 x 48m Din case with sealing to IP65. Status Instruments, 0684 296818.

Leader 3100D: scope for production?

Filters

Variable filter. The latest model in the VBF8 series of variable two channel filters offers a switchable high/low pass response with rejection equivalent to 132dB/octave. The VBF806 is fitted with elliptic filters which have a flat response up to the cut-off frequency and offer a typical rejection of 77dB at 1.5 times cutoff. This is achieved without sacrificing the ability to switch between low and high pass responses on both channels. It comes in rackmount or bench configurations. Kemo, 081-658 3838.

Isolation transformer. A line isolation transformer, the TRO1335, meets the barrier requirements between a carrier's network lines and the subscriber's equipment. Its performance has been optimised for speech and data communications in the audio transmission band. Nominal matching impedance is 600Ω, but it can also be used with the complex impedances seen on most transmission lines. Kenton Research, 03224 41933.

Two-channel filters. The VBF3 and VBF4 are two-channel variable filter instruments with cut-off frequencies continuously variable from 0.1Hz to 10kHz for the VBF3 and 1Hz to 100kHz for the VBF4. Each of the two channels may be set to high or low pass response and the filter slope may be switched between 6 and 24dB/octave with Butterworth characteristics. Kemo, 081-658 3838.

Hardware

Enclosed subrack. Ratiopac is a successor to the long-running Europac case range. It is designed to be versatile and to meet electromagnetic compatibility requirements. It can be used either as a standard subrack in a 19in equipment cabinet or as a desk-top case. Supplied in kit form, it is available in 13 models with heights of 3 or 6U, widths of 42, 63 or 84HP, and depths of 266, 326, 386, 446 or 506mm. There are also various front trims, handle styles and mounting rails. Schroff, 0442 40471.

Instrumentation

Clamp meter. A combined tester and clamp meter comes with various test leads and probes for direct voltage, current and resistance measurement. Using an optional thermocouple sensor it can measure temperature from -20 to +200°C. Called the CM8000, it can handle induced AC current measurement on 6, 60 and 300A ranges with cables of 25mm maximum diameter. Probes for direct voltage measurement work up to 300 or 600V AC. Resistance can be measured from 0 to 10kΩ. Di-Log Instruments, 0942 222657.

Dataprinter. There are two versions of the SP25 series four-channel dataprinters. The SP25K has a temperature range from -100 to +1199.9°C and an accuracy of ±1.7°C ±0.1% of reading. And the SP25T has a -50 to +399.9°C with an accuracy from ±0.5 to 0.8°C. Both monitor voltage over the range ±99.9mV with an accuracy of ±0.1mV ±0.02 of reading. They can be programmed for unsupervised monitoring. Digitron Instrumentation, 0992 587441.

Video analyser. The Panasonic VP8450A video analyser covers Pal and NTSC systems and has an LCD information panel for setup and results information. Up to 32 regular tests can be saved in memory. As well as video level and phase, it also measures peak values on video and AC from 100kHz to 5MHz. Luminance level, chrominance level or phase, sync/burst level, and peaks at specified points are possible on a composite signal or with Y/C separated signal as output. Farnell Instruments, 0937 581961.

100MHz scope. Panasonic has introduced a 100MHz four-channel ten-trace analogue oscilloscope, the VP5020A, with a maximum sensitivity of 1mV/div, and maximum sweep rate of 2ns/div. It has a brighter CRT than the firm's previous models and the vertical amplifier has a monolithic IC to improve stability and reduce drift. The trigger and sync functions cover video and TV applications. A vertical trigger mode helps with multichannel signal observations. Farnell Instruments, 0937 581961.

Four-channel scopes. Covering the bandwidth DC to 100MHz (V1085 and V1100A) and DC to 150MHz (V1150), these three real-time oscilloscopes each have four independent channels, eight traces, and delayed sweep. Features include auto trigger level, CRT and cursor readout, built-in frequency counter, and selectable signal output. The V1085 also has sweep time autoranging and trigger lock, and the V1100A and V1150 has ground reference and DVM. Hitachi Denshi, 081-202 4311.

D/A converters. IOTech has introduced two high resolution IEEE488.2 compatible d-to-a converters - the DAC488HR2 and HR4. These data acquisition instruments provide the capabilities of a precision voltage source, function generator and arbitrary waveform generator. The architecture consists of a motherboard and up to four independent daughter board modules each of which has a microprocessor and isolated analogue circuitry. Keithley Instruments, 0734 575666.

Spectrum analyser. The PSA-65A spectrum analyser provides 200kHz to 1GHz frequency coverage in a single sweep. Key uses include the alignment and testing of RF systems, cellular radio, cable TV equipment, and electronic countermeasures. Sensitivity is better than -95dBm. It operates from 220V AC, 12V DC or its own internal battery. Marconi Instruments, 0727 59292.

Field detector. Magnetic fields and voltages can be shown by the Type 200 non-contact test pen. The shirt-pocket unit measures 22 by 32 by 140mm, gives visual and audible warnings, and displays the polarity of magnetic fields. It is for conductors energised at voltages in the 100 to 600V range and for inductors, relays, solenoids and transformers operating from low-voltage AC/DC and above. A self-check facility uses a 50Hz signal transmitted to either the voltage or magnetic sensor. Selectronix, 0442 874973.

Multimeter. The Testmate is a multimeter for service and maintenance engineers, laboratories and education. It costs £29 and has ranges for AC/DC current from 200μA to 10A, AC/DC voltage from 200mV to 100V (750V AC), and resistance from 200Ω to 200MΩ. Other facilities include continuity, diode, transistor and battery testing. Accuracy on voltage ranges is 0.5% of reading ±1 digit. Solexpress, 0455 283486.

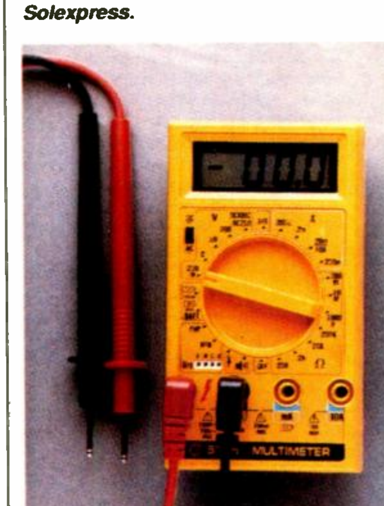
RMS multimeter. The 1504 multimeter is a bench instrument with a scale length of 32,000 counts. It provides AC and DC voltage, AC and DC current, resistance, diode test, amd frequency measurements. All AC measurements are true RMS and the frequency response extends to 20kHz. Basic accuracy is 0.05% and input impedance is either 10 or 1000MΩ user selectable. Maximum sensitivity is 10μV, 10MΩ or 1nA. Currents up to 25A can be measured. Thurlby-Thandar, 0480 412451.

Pulse generator. The TG105 is a full-function portable pulse generator that provides a frequency range of 5Hz to 5MHz and fully variable period and pulse width with a variable output level of 0.1V to 10V from 50Ω. Free run, single shot, gated and triggered modes are standard as is a TTL and synchronous output. It is housed in a rugged case measuring 255 by 150 by 50mm and weighs 1.2kg. Thurlby-Thandar, 0480 412451.

Literature

EMC wallchart. A wallchart is available that provides at a glance the most commonly used EMC data for conducted and radiated emission measurements. It is in full colour and measures 1000 by 700mm. Detailed information is provided on the decibel

Cheap and cheerful: the £29 Testmate multimeter from Solexpress.



with conversion tablesand example calculations. Data is also provided for electromagnetic fields, open area test sites, antennas, standards, CISPR-16 instrumentation characteristics, and CISPR/FCC measurement layouts. Chase EMC, 081 878 7747.

Image sensors. A 458-page databook describes Toshiba's range of CCD linear image sensors. Full data is included on 32 image sensors with peripheral circuitry and modular subassemblies. There are also more than 60 pages of application notes and technical articles on the principles, characteristics and application of these sensors. Toshiba Electronics, 0276 694600.

Navigation systems

Weather forecasting. Fax-2 combines weather facsimile reception with Navtex, RTTY, FEC, Marine Page and computer data printing. It comes in a rugged extruded aluminium case which can be hung from a shelf or mounted through a panel. It will plug into the loudspeaker extension socket of most HF SSB receivers. It picks up Navtex broadcasts that give printed navigation warnings, weather forecasts, gale warnings, and search and rescue information. ICS Electronics, 0903 731101.

Power supplies

Alkaline batteries. A range of alkaline batteries has been introduced for medical and communications applications. They are made to military standards, meet ISO approval, are guaranteed against leakage, and have a four year shelf life. There are six sizes: LR20 1.5V 18,000mAh capacity; LR14 1.5V 7750mAh; LR6 1.5V 2700mAh; 6LR61 9V 550mAh; LR03 1.5V 1175mAh; and LR1 1.5V 825mAh. Activair Europe, 0978 661984.

325W supply. Measuring 63 by 127 by 216mm, the Lightning ALS304 unit is claimed to have the smallest footprint of any 325W multiple output power supply available. This has been achieved because of its 200kHz switching frequency, implemented by two mosfet forward converters, and a thermally efficient external heatsink. It can be powered from any source from 90 to 264V AC and comes with three or four fully floating outputs. The post regulation on the secondary outputs is achieved by MagAmp regulators designed to allow up to 200% peak loading capability on two outputs. It has 20ms full load holdover storage. Astec Standard Power, 0246 455946.

Production test equipment

100MHz scope. The 3100D is a 100MHz bandwidth digital storage oscilloscope which can automate the measurement task by presetting up to 100 different sets of conditions through a low-cost dedicated controller. This makes it suitable for the electronics production market where accurate or repetitive measurements need to be made with the minimum of operator interaction. In a production environment, the preset scope parameters can be set to mirror a test procedure, coordinated by on-screen messaging for operator instructions, so non-technical users can make circuit adjustments without knowing how to select ranges or timebases. Leader Instruments, 0753 538022.

Radio communications products

IF synthesiser. The Sciteq VDS1306 satcom and radio IF synthesiser combines PLL with a patented DDS to improve resolution and spectral purity. Operating range is 55 to 85MHz with 100Hz steps and the potential for 0.1Hz steps. It has BCD parallel control and non-harmonic spurious is better than -60dBc typical. Power is less than 5W and it measures 3 by 7.5 by 0.72in. The phase noise floor is better than -115dBc/Hz. Custom versions can provide other frequency bands to 300Hz. Lyons Instruments, 0992 467161.

Test set. The CMS50 radio communication test set has all the features of the CMS52 but costs 20% less. These features include an autorun facility, built-in self test and field replaceable RF attenuator. The spectrum monitor has 150Hz selectivity. It can test all parameters of AM, FM, phase modulation and SSB radio systems as well as cellular radio and networks including trunking MPT 1327/1343. Rohde &Schwarz, 0252 811377.

Switches and relays

PCB relays. Capable of switching low power signal loads up to a rated current of 16A, the RP series of PCB relays comply with VDE0110. Four of the models have 4kV dielectric strength and 8mm creepage and clearance. Included are relays with bifurcated contacts and a choice of contact materials for switching low level loads. Sterling Components, 0753 820753.

Transducers and sensors

NTC thermistors. The Curve 17 negative temperature coefficient (NTC) thermistors have an NTC of -4.5%/°C at 25°C with a value range from 2 to 50kΩ. They come in standard conformal coated styles with radial leads or in various custom models and assemblies. Point matched models are available with tolerances of ±1, ±2, ±3, ±5 and ±10%. Standard curve tracking models are available from 0 to 70°C and from 25 to 125°C in ±1 and ±0.5°C versions. Vishay Components, 091-514 4155.

COMPUTER

Computer-aided design

Electronics design. EE System is a version of the EE Designer package that gives a no-frills design system without some of the more advanced features. It can, however, be upgraded to a full EE Designer system. Options are Schematic, Designer (which combines schematic design with PCB layout), and Engineer which includes schematic design, PCB layout and mixed mode circuit simulation. Features include front and back annotation, autoplace, autoroute, unlimited pad sizes and shapes, design rule checking, and SMD support. Betronex, 0920 469131.

Thermal analysis. An enhanced version of the Flotherm thermal-analysis CAD package is available which uses computational fluid dynamics techniques to predict the 3D air flow and heat transfer within electronic systems. Known as version 1.3, this package lets design engineers examine the effects of air viscosity, turbulence and buoyancy forces. Special functions include the automatic calculation of fan power ratings and the analysis of air flow through tilted equipment such as VDU monitors. It is available in Fortran and will run on all major Unix hardware platforms. Flomerics, 081 547 3373.

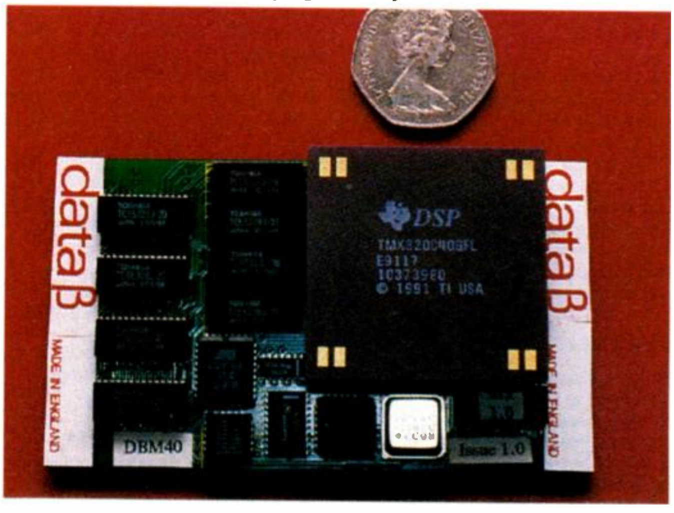
Computer board level products

SCSI adapter. An EISA addition to the Rimfire 5000 series of SCSI adapters has been announced. The RF5600 adapter is based on thirdgeneration SCSI technology incorporating Fast SCSI-2 features. The device can transfer data at up to 10Mb/s and has separate data paths for simultaneous transfer of SCSI data and commands into an on-board queue reducing SCSI command overhead. Drivers can be NetWare 3.11, SCO Unix, or SCO Xenix. MS-Dos is supported by the on-board bios eprom. Ciprico, 0635 73666.

Motherboards. Two motherboards have been introduced that are compatible with the TIM-40 standard for modular flexible multiprocessor systems. The DBI40 and DBV40 are for the PC-ATbus and VMEbus, respectively. Also available is the DBM40 TIM-40 plug-in module which includes a 50MHz TMS320C40 to give a performance up to 275Mops, 50MFlops. The module has 1Mbyte of zero wait state sram and 32Kbyte eeprom. Data Beta, 0734 303631.

A/D interface. A 12bit a-to-d interface is available for data acquisition applications in transputer based parallel systems. The Parsytec TPM-ADC1 is an intelligent 16 channel module with multiplexed sample-hold circuitry and four RS422 buffered serial links. It operates at 200Ksample/s and comes in a single Eurocard format. DC-DC transformers and optocouplers are used and the analogue front end is separated galvanically from an on-board control

Size, not price. The DBM40 plug-in subsystem from Data Beta.



and communications transputer section. As well as a 16bit T222 processor, this section has 64Kbit of sram and 32Kbit of rom to store user code. Dean Microsystems, 0734 845155.

Multibus II board. A 33MHz 68030-based Multibus II CPU board has a buffered Ethernet controller, SCSI interface, two buffered 32bit DMA controllers, and an optional MC68882 floating point coprocessor. The HK68/M230 has 4 to 16Mbyte of static column dram which supports burst transfers. It implements the full Multibus II interface including the 32bit parallel system bus, the 32bit iLBX bus, and the 8bit iSBX bus. Diamond Point International, 0634 722390.

386SL chipset. The Intel 386SL chipset consists of two VLSI circuits with on-board main memory controller, cache memory controllers and ISA bus interface controller and buffers. It supports sram and dram arrays, including expanded memory configurations to the LIM/EMS standard. Jermyn Distribution, 0732 740100.

VME board. The MPV955 provides eight independent single-ended 16bit analogue output channels on a 6U VMEbus card. The board design avoids VMEbus bottlenecks by using 16Kwords of on-board sram to eliminatethe need for continual data transfers. Outputs are 14bit accurate providing a total error at 25°C of ±0.006% of full scale range. Gain drift is typically 20ppm/°C and offset drift 10ppm/°C. Eight d-to-a converters are controlled by an on-board rate generator which gives output data rates of up to 600Ksample/s. Pentland Systems, 0506 464666.

Signal processing board. The Spirit 30 is a signal processing board based around the 33MFlop TMS320C30 floating point DSP. It is available in versions for the AT bus (ISA/EISA), PS/2 (MSA), VME bus and Sbus (Sparc). Each can be configured with up to 64Mbyte of sram and dram. Standard I/O interfaces include two 8Mbyte/s ASM-Serial ports, one 66Mbyte/s ASM-Main port, and one 32Mbyte/s ASM-Peripheral port. SSE Marketing, 071-387 1262.

Software

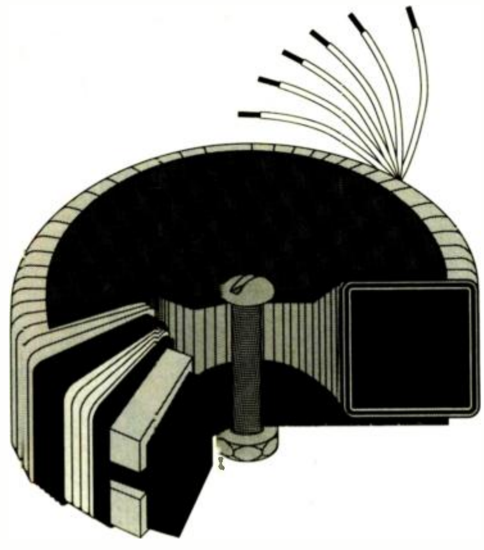
Analogue/digital design. DesignStar is a graphical design environment that has been integrated with the Saber simulator to provide a complete turnkey solution for analogue and mixed analogue and digital design and modelling. It lets designers quickly create schematics and simulation models. At its heart is a design capture package supported by a graphical model generator. This provides and tailors all the menus, drawing commands and output formats. It can be run on various workstations including Sun, HP/Apollo, Solbourne and DEC. Analogy Europe, 0793 432286.

Two-way interface. The RFD Schematic Interface is a two-way software interface between RFDesigner and DesignWorks running on Macintosh computers. It lets the user enter analysis and optimisation circuit data, edit it and tune the circuit through the schematic environment, as well as update schematic component parameters with the data modified or optimised in RFDesigner. Also, a circuit synthesised in RFSynthesist can automatically appear in the sublaunched DesignWorks with calculated values annotated to component fields. Ingsoft, 010 1 416 730 9611.

Semiconductor testing. The Model 251 I-V test software package has been improved with the addition of automatic semiconductor device test procedures. The software can automate the operation from one tosix source-measure units, plus voltage sources and switching matrices to characterise semiconductor devices quickly and display test data graphically. It can be used to control other IEEE488 programmable equipment such as probers, handlers, power supplies and hot chucks. It will run on IBM PCs and compatibles using Dos. Keithley Instruments, 0734 575666.

Linear circuit analysis. Analyser III is a linear circuit analyser program that makes full use of graphics facilities offered by EGA and VGA screens with a full colour display showing a smooth interpolated frequency response graph. Axes are automatically scaled and labeled in engineering units. The scaling can be altered by hand and two sets of results can be overlayed on the same graph. As many component models can be created as needed and there is a maximum capacity of more than 130 nodes or 2000 components. There is an easy upgrade path from previous versions of Analyser. Number One Systems, 0480 61778.

Maths editor. Version 1.1 of MathType for the IBM PC is a mathematical equation editor which runs in the Microsoft Windows environment. It lets users build complex mathematical equations using point-and-click techniques, and then place them into word processing and page-layout documents. This version includes new fonts, improved printer and display support, and enhancements to the user interface. It needs 640K of ram, hard disk, mouse, and Windows 3.0. Text Formatting, 081 802 447 ■



Circuits, Systems & Standards

First published in the US magazine EDN and edited here by Ian Hickman.

IF chip forms audio decibel-level detector

The NE604 is a low-power IF chip that includes a logarithmic signal-strength output. **Fig. 1**'s circuit draws less than 5mA from a 6V supply and offers a signal sensitivity of 10.5μV. Although the chip is intended for cellular-radio and other RF applications the log output provides an 80dB range of response and ±1.5dB accuracy in the 100-10kHz audio range (**Fig. 2**).

Capacitively couple the audio signal to pin 16. The log circuit generates approximately 10μA per 20dB of input signal at pin 5; convert this current to voltage by connecting 100kΩ (R_2) from pin 5 to ground. You can then measure this voltage directly with a voltmeter, or buffer and filter the voltage as shown using op amps IC_{2A} and IC_{2B}. A standard 0 to 5V meter with a linear decibel scale serves to display 80dB of signal level. To measure higher audio levels, add a resistive attenuator at the chip's audio input.

R_1 and C1 form a lowpass filter. Specifying 2kΩ for R_1 provides maximum linearity. C_1 should be adjusted to change the filter's cut-off frequency. A higher value for C_1 lowers the circuit's output to about 0.6V when no audio signal is present (Fig. 2). Lowering C_1 increases the frequency response, but raises the circuit's output when no audio signal is present. Filter R_3/C_3 provides a trade-off between meter damping and ripple attenuation. If both a quick response and low ripple are required, substitute a more complex, active lowpass filter.
Robert J Zavrel, Signetics Inc, Sunnyvale, CA.

AF levelmeter from RF chip

Here is another example of ingenuity in pressing devices into service in ways other than the original application. There are other ways of obtaining a log level response at AF, but if accuracy requirements are not too stringent, this one is quite neat. **IH.**

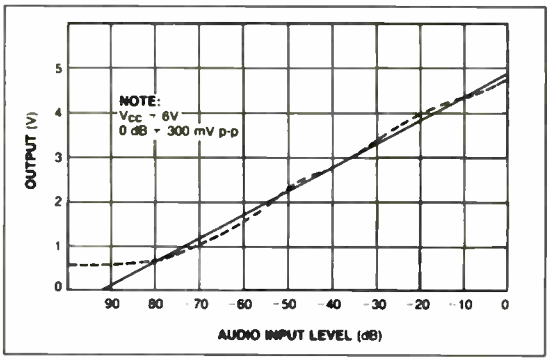


Fig. 2. The dotted line indicates the response of Fig. 1's circuit for the 100Hz to 10kHz audio range; solid line indicates an ideal response. Full scale (0dB) equals 300mV pk-pk.

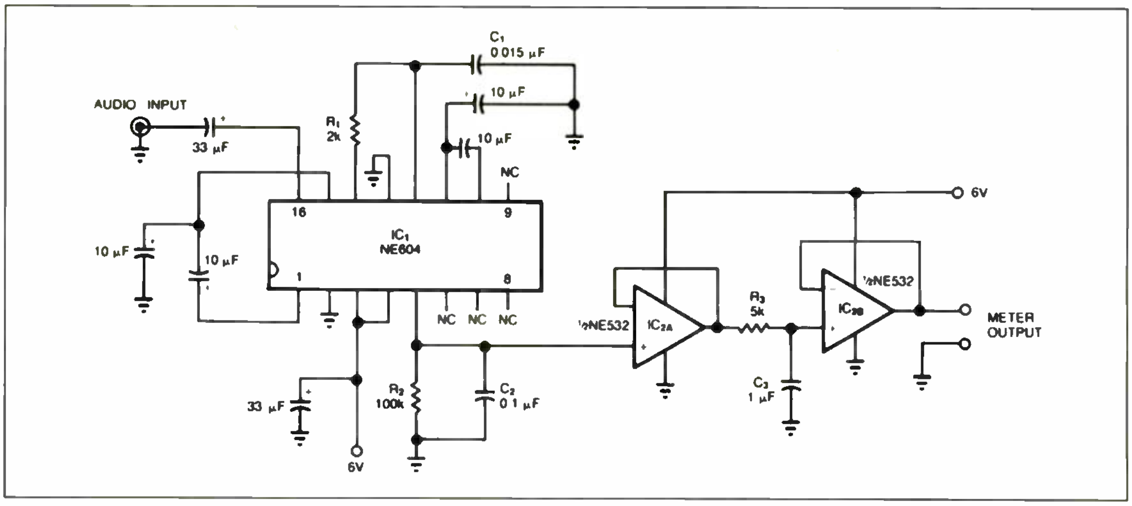


Fig. 1. Audio signal levels to ±1.5dB accuracy can be measured using a dual op amp and an FM IF chip (normally used for cellular-radio and other applications). Sensitivity is 10.5μV; power consumption is 30mW.

Three-rail power supply uses four diodes

The circuit shown in **Fig. 1** generates three supply voltages using a minimum of components. Diodes D_2 and D_3 perform full-wave rectification, alternately charging capacitor C_2 on both halves of the AC cycle. On the other hand, diode D_1 with capacitor C_1 and diode D_4 with capacitor C_3 each perform half-wave rectification. The full- and half-wave rectification arrangement is satisfactory for modest supply currents drawn from the -5 and +12V regulators (IC_3 and IC_2).

You can use this circuit as an auxiliary supply in a µP-based instrument, for example, and avoid the less attractive alternatives of buying a custom-wound transformer, building a more complex supply, or using a secondary winding (say 18VAC) and wasting power in the 5V regulators.

Economy and elegance

Of all the readers' *Design Ideas* which have appeared over the years in EDN, this is one of my favourites. A three-rail supply is powered by a two-winding transforner using only four diodes. The -5V and +12V regulators which are usually comparatively lightly loaded, are driven by a half wave circuit and a voltage doubler respectively. The main +5V regulator on the other hand is supplied by a full wave rectifier circuit. **IH**

Robert J Zavrel, Signetics Inc, Sunnyvale, CA.

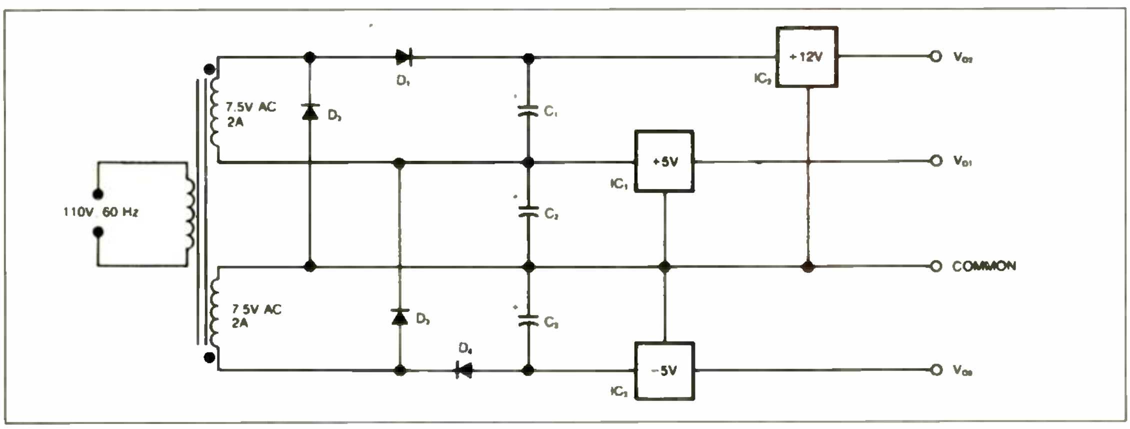


Fig. 1. Simple power supply generating three regulated voltages using a minimum of components.

Cmos circuit always oscillates

The common clock oscillator in **Fig. 1a** has two small problems: it may not oscillate if the transition regions of its two gates differ; and, if it does oscillate, it may sometimes oscillate at a slightly lower frequency than its equation predicts because of the finite gain of the first gate. If the circuit does work, oscillation occurs usually because both gates are in the same package and, therefore, have logic thresholds only a few millivolts apart.

Circuit **Fig. lb** resolves both problems by adding a resistor and a capacitor. The R_2-C_2 network provides hysteresis, thus delaying the onset of Gate 1's transition until C_1 has enough voltage to move Gate 1 securely through its transition region. When Gate 1 is finally in its transition region, C_2 provides positive feedback, thus rapidly moving Gate 1 out of its transition region.

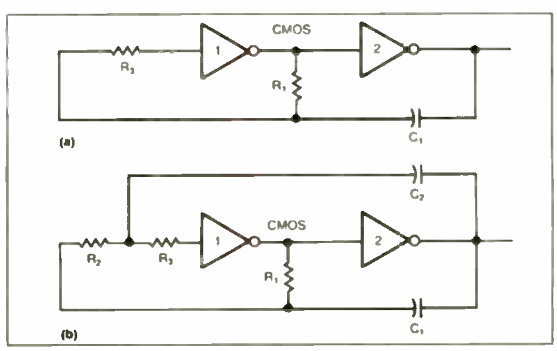


Fig. 1. The conventional cmos oscillator, 1a, sometimes does not oscillate. Or if it does oscillate it can oscillate at a lower frequency than calculated. Circuit 1b adds hysteresis to overcome these problems.

Surefire oscillator

I have never known the circuit of Fig. 1a fail to oscillate, but then I have never made up the circuit using gates from different packages. If you have to do so, be warned. **IH**

The equations for the oscillator in Fig lb are:

$R_2 = 10R_1$

$R_3 = 10R_2$

$C_1 = 100C_2$

$f \approx 1/(1.2R_1C_1)$

WF McClelland, Electronic Resources, Stamford, CT.

Variable-Q bandpass filter fixes gain

A major problem with standard variable bandpass filters is that their gain also varies, as shown by

$$G(S) = \frac{\omega_0 S}{S^2 + \frac{\omega_0}{Q} S + \omega_0^2}$$

where ω_0 is the centre frequency and Q equals the selectivity at the 3dB points. This Q-dependent gain becomes especially troublesome in swept (ie variable selectivity) applications, where you must compensate for such gain changes.

You can, however, realise a constant-gain, variable-bandwidth transfer function by using

$$F(S) = 1 - \frac{S^2 + \omega_0^2}{S^2 + \frac{\omega_0}{Q} S + \omega_0^2} = \frac{\frac{\omega_0 S}{Q}}{S^2 + \frac{\omega_0}{Q} S + \omega_0^2}$$

Here, the transfer function of the second term of the middle expression duplicates that of an active notch filter with variable Q.

You can achieve an excellent realisation of this form by employing the design depicted in the figure. Here, you combine the individual highpass and lowpass outputs of a four-op-amp state-variable filter. The four-stage version, unlike standard stage filters, has a Q-independent gain. By superimposing these two filter characteristics, you get a fixed-gain notch filter. This circuit implements a fixed-gain, variable Q bandpass characteristic by summing the original input signal with the high/low signal emerging from the notch filter.

You can continuously vary the filter's centre frequency by synchronously changing resistor R_0 or step-wise change it by switching capacitors C_0. Varying R_Q, will modify the filter Q – without changing gain.

As with any active filter, the op amps' gain-bandwidth products must accommodate the filter's $\omega_0 Q$ product. When you have satisfied this requirement, your design can supply stable Qs with values of several hundred. But note that because the filter's internal nodes operate at high gains under high-Q conditions, you must ensure that the input signal's level stays low enough to preclude saturating the amplifier.

Yishay Netzer, Honeywell Inc, Lexington, MA. ■

Vary Q at constant gain

The state-variable filter provides lowpass, bandpass and highpass outputs, and centre frequency and Q are separately adjustable. However, adjusting the Q alters the centre-frequency gain at the bandpass output, as well as the Q. In this circuit, the bandpass characteristic is produced by summing the lowpass and highpass outputs to form a notch (of width adjustable by changing Q) and then summing this with the input, which is in antiphase. At the notch (centre) frequency, the output simply equals the input, whereas at other frequencies the notch output cancels out the original input. Note, however, that the roll-off either side of the pass band does not continue indefinitely, but reaches an attenuation floor set by the exactness of the cancellation – in turn set by resistor tolerances, etc. **IH.**

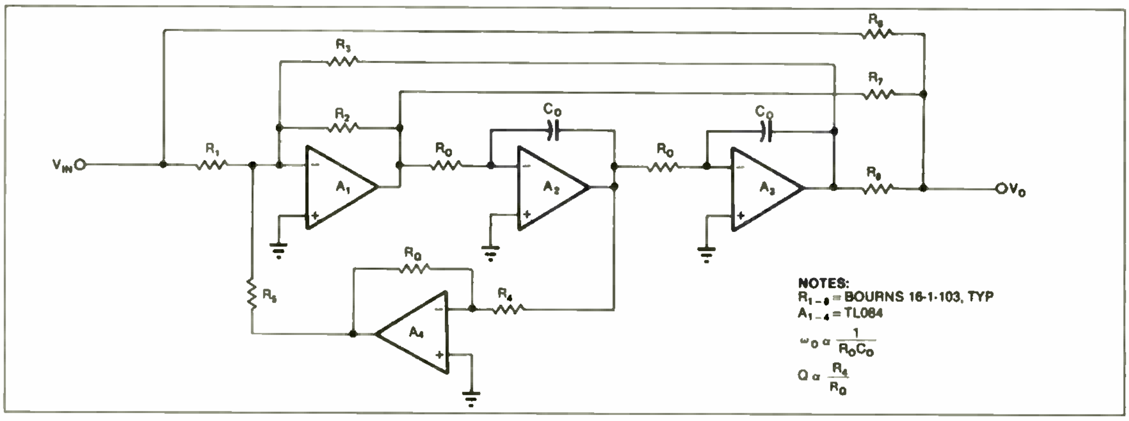
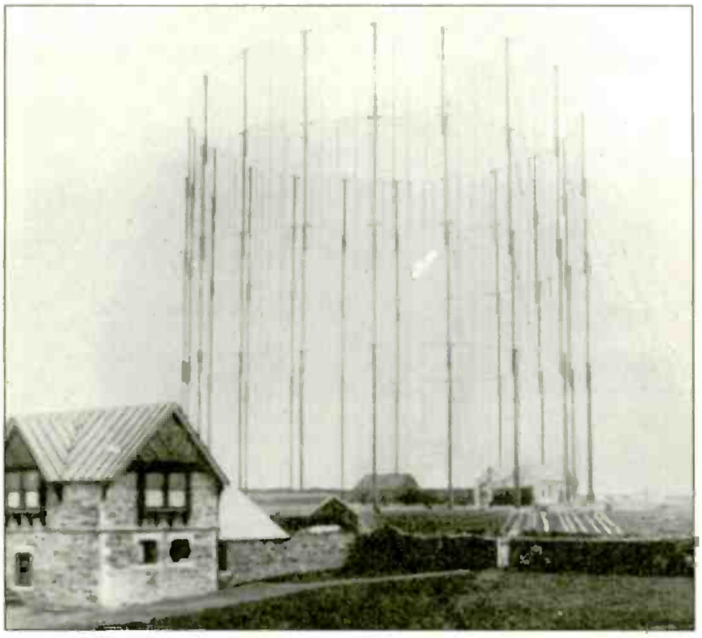
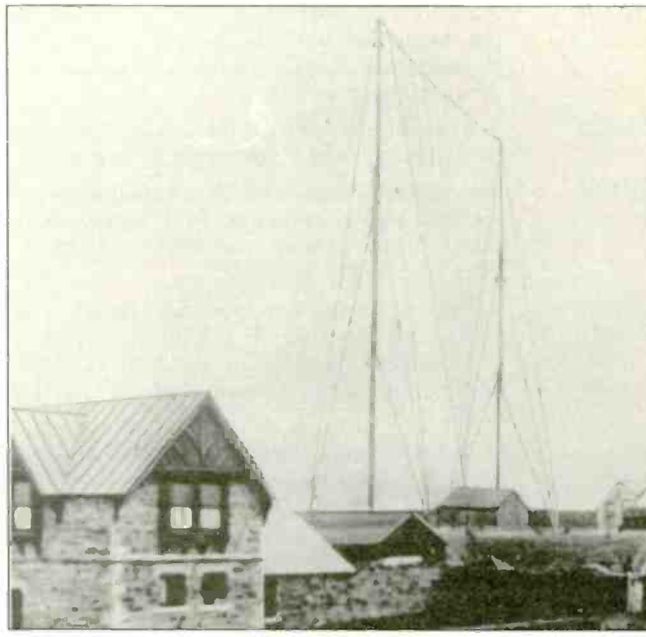


Fig. 1. A fixed-gain variable-Q bandpass filter results when a state-variable filter's highpass and lowpass respones are summed with the input signal. The filter centre frequency changes with R_0 and/or C_0 and Q varies with R_0.





Top left: Inverted cone suspended in a ring of unstayed 200ft masts at Poldhu.

Top right: Poldhu's new, more robust and simple fan shape, aerial after a storm destroyed the original.

Below left: Interior at Poldhu showing risky beginnings.

Below right:The wireless operator's table at Poldhu from which the first transatlantic signals were sent. On the left is the knife switch. Connected by a cord to a change-over switch, it was used to make and break the circuit to form the Morse transmission. To its right are regulating instruments for the power supply.

BRIDGING THE ATLANTIC

When *The Marconigraph* – soon to change its name to *Wireless World* – began publication in 1911, the wireless industry was already 11 years old. Its prehistory of discovery and invention stretched back at least into the latter years of the previous century.

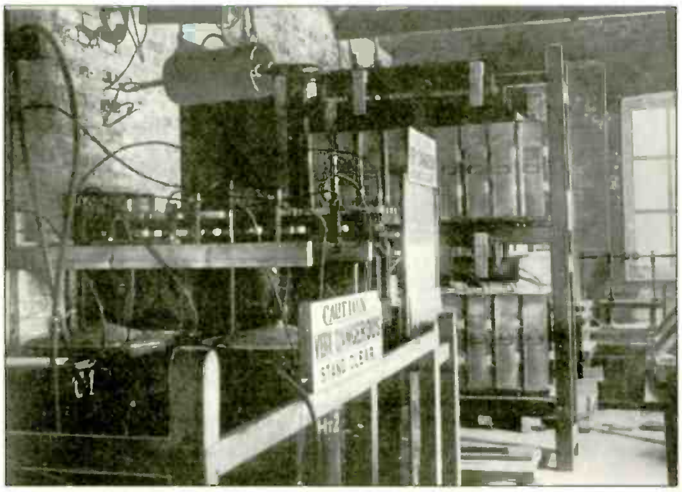
The moment of birth of a scientific discovery is often difficult to determine amid the many learned contributions which lead up to it. But its coming-of-age is relatively obvious: the start of a commercial service or product based on the technology.

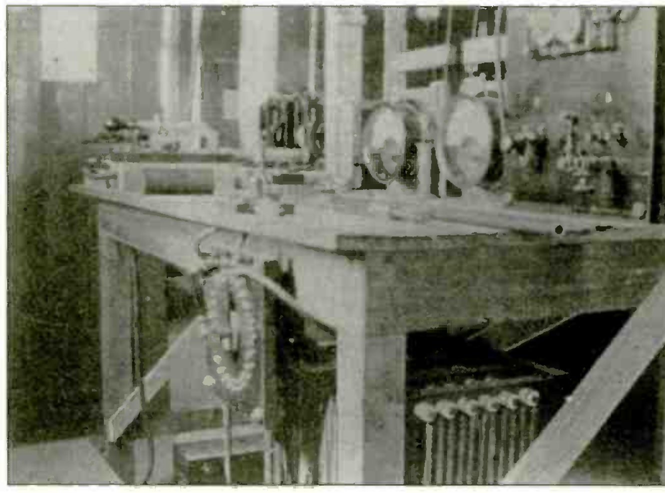
In the case of wireless, this was the founding of the Marconi International Marine Communication Company, to provide communication to and between ships, in 1900.

For Marconi himself, and the companies which bear, and have borne, his name, it was one of a long string of firsts. Its significance is that it provided a service which existing cable telegraphy could not. It ended the isolation of ships at sea, but also marked the end, for civilisation as a whole, of reliance on a fixed link for long distance communications.

1900 also saw Marconi take out a patent (No 7777) on a "syntonic" system which enabled transmissions to be tuned to a specific frequency. Prior to this, signals had been untuned, which led to interference and interception, and would have prevented any sizeable commercial development. So successful was the system that it was virtually impossible for competitors to avoid infringing the patent.

Marconi's early experiments with radio transmission had begun in 1894, when he was 20. The possibilities of electromagnetic wave propagation through the "ether" (a substance presumed to exist between the particles of air, and in a vacuum) were first proposed by James Clerk Maxwell in 1864, and demonstrated by Heinrich Hertz in 1888. Others followed-on from Hertz, notably Oliver Lodge who first discovered, but failed to recognise the significance of, syntonic tuning and Professor Popoff,





who achieved reception over 5km in 1895, while tracking electric storms.

However, it was Guglielmo Marconi who persevered in using the Hertzian waves for signalling. In 1895, while using slabs of sheet-iron to increase the transmitter spark's wavelength, he placed one on the ground, and held the other in the air. This – the first aerial, in effect – produced a large increase in the signal strength, and in the range - from about 100m to one kilometre.

He took out his first wireless patent in 1896. Transmission distances increased steadily and by 1899 the English Channel was bridged, with the signal picked up at Marconi's HQ in Chelmsford, 130km away.

This month sees the 90th anniversary of the first transatlantic wireless transmission.

Base for trans-Atlantic transmission

By 1901, Marconi had already established a wireless-based commercial service for shipping, and had had taken out his patent (No 7777) on a "syntonic" system which enabled transmissions to be tuned to a specific frequency. Now he turned his attention again to extending their range, and decided to attempt to transmit a signal across the Atlantic - over 20 times the distance so far achieved. Sites were selected at Poldhu in Cornwall, and Cape Cod, Massachusetts, and aerials erected.

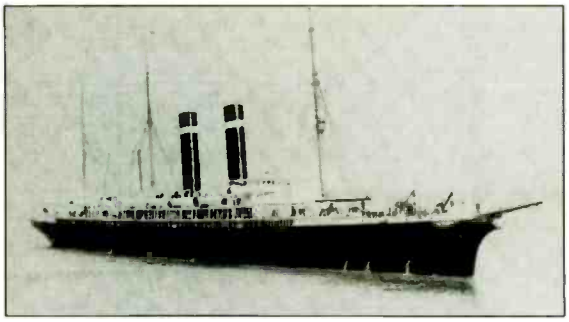
The design at Poldhu was an inverted cone, suspended in a ring of unstayed 200ft masts. The Poldhu aerial was destroyed on 17 September 1901 in the worst gale in living memory. But within eight days a new aerial, this time a more robust and simple fan shape, had been erected and tested.

The Poldhu transmitting station, operating at 20kW equivalent DC input power, was 100 times more powerful than anything previously seen. Cautionary notices had to be placed in front of the transformers to remind visitors. The picture shows the racks containing banks of capacitors, and in the background, the spark gap.

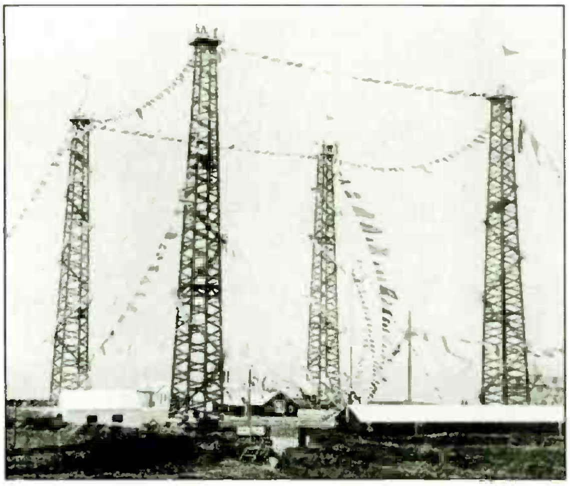
***Top:* Marconi (centre) with assistants Kemp (left) and Paget arrive St John's, Newfoundland with a hamper full of balloon equipment to raise a temporary receiver aerial.**

***Below:* Marconi (far left) using a kite to raise his aerial after an earlier balloon attempt failed.**

In 1902, sailing westward on the SS Philadelphia, with wireless apparatus on its main mast Marconi succeeded in picking up signals over 2000 miles from Poldhu.



Right: Poldhu's inverted pyramid suspended from four towers, was a more robust version than previously (seen here dressed for the visit of the Prince and Princess of Wales in 1903).



No equipment existed at the time which could measure accurately the efficiency of conversion from DC to RF power.

Measurements on similar equipment made over a decade later suggested that conversion efficiency was around 20 per cent for simple spark transmitters.

Wind of change

Shortly before the planned start of the tests, the Cape Cod aerial was also blown down. The idea of two-way transmission was abandoned and the North American site was shifted to St John's, Newfoundland, the nearest landfall, where Marconi with his assistants Kemp and Paget arrived on December 6 with a hamper full of balloon equipment and a large kite with which to raise a temporary receiver aerial.

Reception was eventually achieved on December 12, in the midst of another gale After the first, balloon-hoisted aerial was carried away, another was held aloft on a kite. The test signal from Poldhu – the Morse S, three dots – was heard through appalling static by Marconi and his assistant George Kemp on a telephone headset, but was too weak to activate an inking machine.

Despite public scepticism over this lack of proof, the American Institute of Electrical Engineers feted Marconi at its annual dinner on January 13, 1902 to mark his arrival in New York. Lamps flashing the Morse S adorned the Waldorf Hotel.

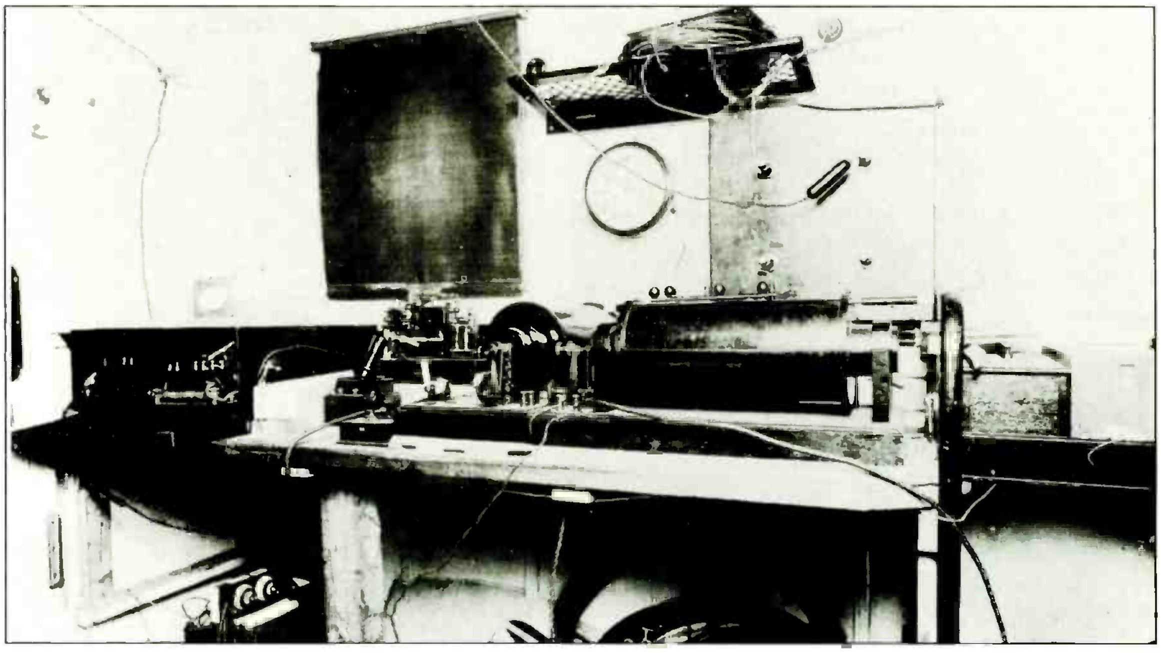
SS Philadelphia

No evidence having survived of the first transatlantic transmission, Marconi decided to repeat the experiment in 1902, sailing westward on the SS Philadelphia (with wireless apparatus on its main mast).

He succeeded in picking up signals over 2000 miles from Poldhu (and messages at 1500 miles). This time the results were recorded and witnessed. It was proved that radio waves followed the curvature of the Earth, also that the signals were stronger after dark.

The eventual aerial design at Poldhu, an inverted pyramid suspended from four towers, was a more robust version of the original, ill-fated cone. Within a couple of years, directional aerials were evolved, for which the Poldhu site proved too small. Transatlantic operations were transferred to a new station at Clifden in the west of Ireland. ■

Below: Marconi's wireless cabin on the SS Philadelphia. In the words of George Kemp: "Inside of the cabin on SS Philadelphia, which I fitted for Mr Marconi's wonderful achievement, proving to the world that it was quite possible to receive on a ship greater distances than Newfoundland, which many of the Professors had doubted." Equipment includes, from the left, two coherers (receivers) in screened boxes, morse key, and two cylindrical induction coils, for generating the spark, behind which is a jigger, or transformer, the square plate to which the lead from the aerial is attached.



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Input sensitivity	100mV-3V adjustable
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EEPROM 2816,2816A,2817,2817A,2864A	✓	✓
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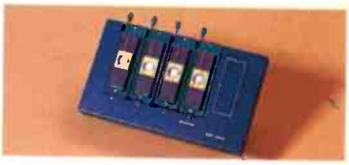

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