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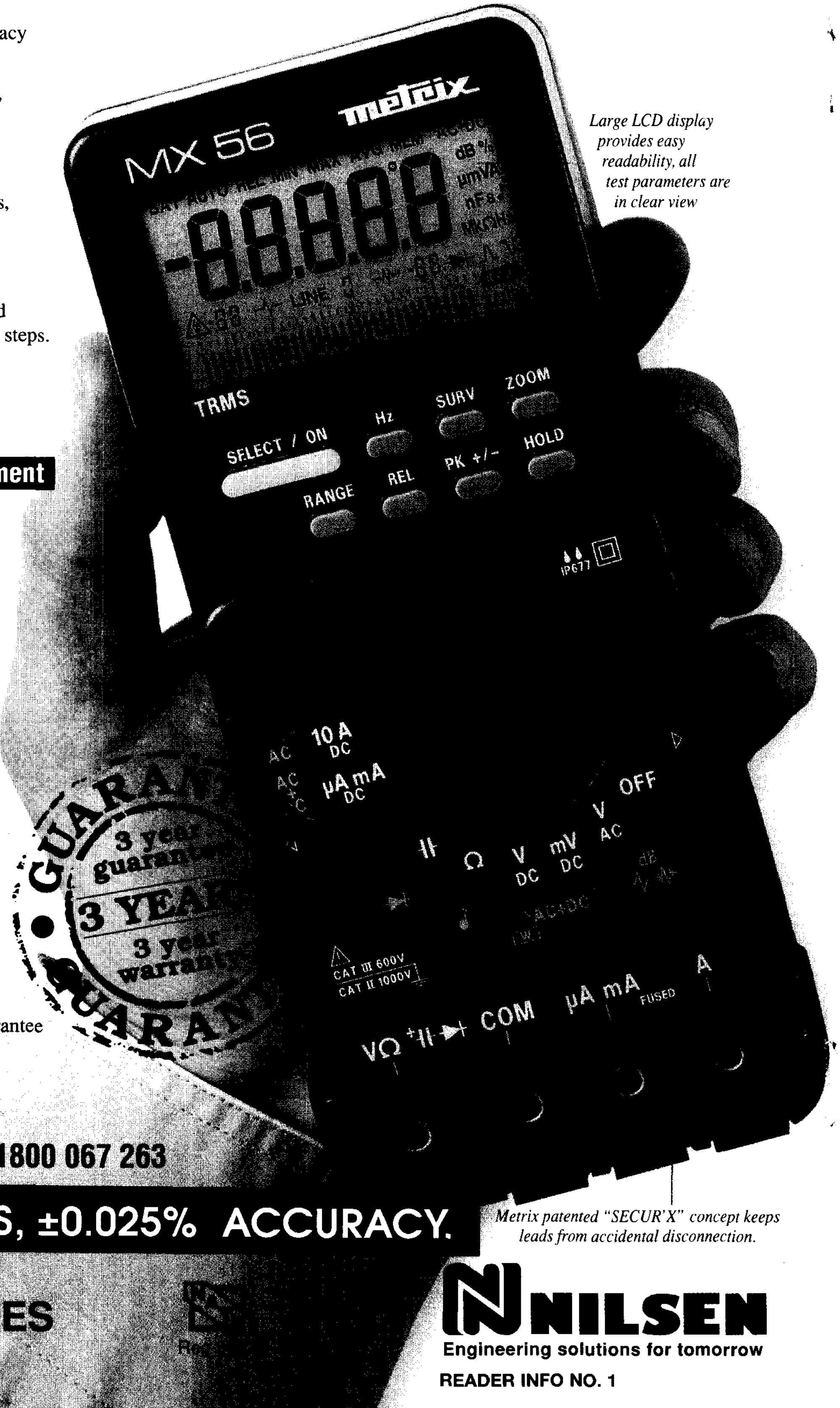

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Electronics

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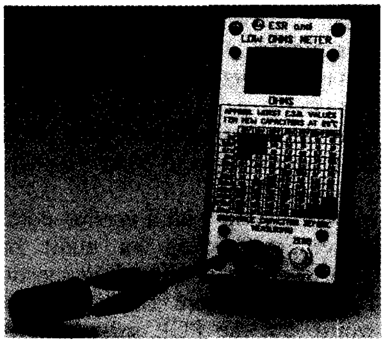
Volume 58, No.1
January 1996

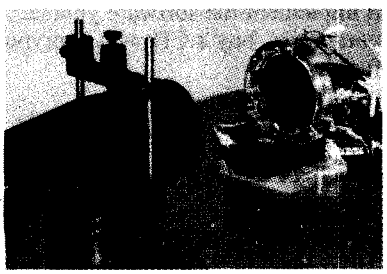
AUSTRALIA'S LARGEST SELLING ELECTRONICS MAGAZINE — ESTABLISHED IN 1922

Low cost ESR meter



Although electrolytic capacitors can cause a lot of trouble when they dry out and develop a high equivalent series resistance, you can't really check them with a DMM or capacitance meter. But Bob Parker's new ESR Meter design checks them easily —see his article starting on page 76.

Untwinkling the stars...



Scientists at the Anglo-Australian Telescope and Sydney Uni have developed new 'adaptive optics' systems, like this 'rubber mirror', to correct star images for distortion from the Earth's atmosphere. Geoff McNamara explains how it's done — see page 26.

On the cover

EA project designer Graham Cattley checks out his new PC-driven EGO Sensor Analyser on the oxygen sensor of a late-model Toyota Camry. As you can see, it provides a lot of very handy diagnostic information — at much lower cost than comparable commercial analysers. (See page 60.) Photo by Phil Aynsley.

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Features

Projects and Technical

Columns and Comments

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MANAGING EDITOR
Jamieson Rowe, B.A., B.Sc., SMIREE, VK2ZLO
PRODUCTION EDITOR
Milli Godden-Jones
TECHNICAL EDITOR
Rob Evans
PROJECT DESIGNER/WRITER
Graham Cattley
CONTRIBUTORS
Louis Challis
Arthur Cushen, MBE
Peter Lankshear
Jim Lawler, MTETIA
Tom Moffat, VK7TM
Peter Phillips, B.Ed., Dip Ed., ECC
Nick de Vries, MIAME, AMSAE
Neville Williams, FIREE, VK2XV
COVER DESIGNER
Clive Davis
ADVERTISING PRODUCTION
Anthony Macarounas; phone (02) 353 0740
PRODUCTION
Ray Eirth
CIRCULATION MANAGER
Michael Prior
PUBLISHER
Michael Hannan
ADVERTISING MANAGER
Selwyn Sayers. Phone (02) 353 0734:
fax (02) 353 0613
SECRETARY
Ana Maria Zamora
HEAD OFFICE - EDITORIAL
PO Box 199, Alexandria 2015.
180 Bourke Road, Alexandria 2015.
Phone (02) 353 0620; fax (02) 353 0513
Subscriptions Enquiries:
phone (02) 353 9992
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INTERSTATE ADVERTISING OFFICES
MELBOURNE: 504 Princes Highway, Noble Park, 3174. Phone (03) 9213 3222; fax (03) 9701 1534. Pilar Misa.
BRISBANE: 26 Chermside Street, Newstead 4006. Phone (07) 3854 1119; fax (07) 3252 3692. Graham Smith.
ADELAIDE: 98 Jervois Street, Torrensville, 5031. Phone (08) 3352 8666; fax (08) 352 6033. Kerryn Delaney.
PERTH: Allen & Associates, 54 Havelock Street, West Perth, 6005. Phone (09) 321 2998; fax (09) 321 2940. Tony Allen
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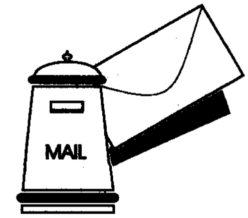
LETTERS TO THE EDITOR



LF field risk?

After the ABC-TV's Four Corners program, exploring the potential hazards associated with RF-electromagnetic fields, and following Editorial Viewpoint (September '95), I now dare to air a concern I've carried with me for some time, in regard to the low frequency electromagnetic exposures some hearing impaired persons and others are subjected to.

A very satisfying system for some deaf persons to hear the audio part from TV-programs, is the use of a 'loop system', consisting of an independent 20 watt amplifier which receives a signal from the audio output of a TV or video recorder. The output from this amplifier is fed to a multi-core wire, fixed around a room. An induction coil fitted in many types of hearing aids (T-switch), produces a perfect reception of TV/radio sound to the person with a hearing aid, which is not hindering other people. The room however, is now subject to an electromagnetic field.

My concern is the fact that this kind of radiation has, as far as I know, never been investigated and my question is, if you, or any of our readers can throw a light on this subject, in particular about ways to measure and establish acceptable levels of electromagnetic radiation.

Pieter Engelsman,
Calliope, Qld.

Encryption, PGP

I wish to make some comments regarding PGP and encryption technology as mentioned in Moffat's Madhouse (October 1995 issue). Firstly, the instructions given for getting PGP over the Internet are illegal — Australian users must obtain the international version of PGP, not the version meant for people inside the US.

The US government classifies encryption technology as a munition, and therefore subjects it to export restriction which PGP (in addition to many other software packages) has to live with. The history of encryption technology (PGP is no exception) is a very political and legal one.

Secondly, there are many uses for encryption technology which are often overlooked:

- Detecting tampering of documents when they are thrown around the 'net;
- Restricting document access to a group of people who the sender wants;
- Providing additional security even if a hacker manages to break into one of your computers;
- In conjunction with a version control system, providing an audit trail whose validity is difficult to question;
- Data compression! This might seem weird, but the PGP software has a compression algorithm built into it, to make it difficult to guess what the original text is. If the person trying to crack the document knew that the document begins with 'Once upon a time' it makes it much quicker to 'crack' a document.

Finally, if you wanted to hide your tracks just buy an encryption book (paying cash and wearing your best disguise) and implement the software yourself, or if you prefer, buy a CD with encryption software on it.

Andrew Cassin,
Newport, Vic.

Vic Harris story

Thank you for the articles by Neville Williams on my late father, Vic Harris, of High Fidelity Products.

Since my father ran a business, some of his clientele can be described as simply being his customers, but many became personal friends like members of a club. He had an impeccable sense of business ethics and treated his clientele with great respect and caring.

Not many would know of some of our future plans. His wife, my mother was expected by many not to survive the past four years. Being nine years older than my father, even she expected that the long term, future plans would not include her. Proposed accommodation projects, and goals were being assembled over the past 15 years. My husband, Ray Tierney, is an industrial designer. Vic and he were working jointly on two development projects. Ray hopes to be able to complete them, but admits that he will have a difficult time without him.

Vic's client list to some degree became part of his reason for existence. To the best of his ability, he told me, he would endeavour to survive, and outlive his equipment. The old turntable that he helped my husband install in an antique cabinet for me 20 years ago, has had almost daily use. Over this time, a new stylus, a clean and oil, and a new belt, is all that it needed. I am told that excluding catastrophic failure such as lightning, car accidents, floods and fire, his equipment rarely needs repair so I can't blame him for not being able to outlast it.

I now would very much like to find someone to make use of the stock of spare parts he has left, to provide a repair service for as long as possible. A side benefit to this person would be the absolute assured sale of any equipment which could be assembled out of some of the spare parts.

Mrs Julia Tierney,
Leura, Blue Mountains, NSW.

Interesting error

The item by Manfred Schmidt in CDI November 1995 entitled '24V - 12V converter for trailers' contains an interesting technical error. Mr Schmidt has determined that a 50% duty cycle for the switching MOSFET is appropriate for half voltage output, where the correct ratio should be only 25%. A doubling of supply voltage from 12 to 24 leads to four times power into a resistive load, requiring a 25% duty cycle to correct.

At 50% duty cycle a normal DC meter will show 12 volts from a 24 volt supply which no doubt Mr Schmidt has found. This is misleading as the RMS value is much higher at 17 volts. The RMS value of voltages or currents must be used wherever the heating effect is of interest, as is the case with lamps.

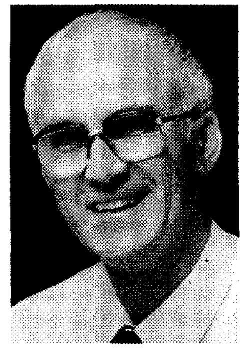
At 25% duty cycle, the RMS value is 12V and the average only 6V, which is what a normal DC meter will show.

A change in R1 from 47k to 18k will bring the ratio to 25%.

Philip Allison,
Summer Hill, NSW.

Letters published in this column express the opinions of the correspondents concerned, and do not necessarily reflect the opinions or policies of the staff or publisher of Electronics Australia. We reserve the right to edit letters which are very long or potentially defamatory.

EDITORIAL VIEWPOINT



Reactions to our story on the L2 cache RAM scam...

Judging by the response from readers, our article in the October issue on the 'Cache RAM Scam' really hit the spot. A surprising number of readers have written in, faxed or left a message on the BBS to thank us for uncovering this nasty scam — and unfortunately many have also reported that when they'd checked their own computer, the tests revealed they too had been caught. I gather that quite a few dealers around the country (and also in New Zealand) have been hit with claims for a replacement or refund, and the relevant State and Federal authorities have also been alerted.

What really amazed me, though, was some of the reponses that people have reported getting from their dealers. A common reaction, when confronted about a faulty machine, was to pour scorn on the *EA* article and deny that the scam was possible — even when the user had done the tests, and these clearly showed that the machine *they'd* supplied had the fake RAMs and doctored BIOS!

Another common response, from other dealers, was even more incredible. This was to say "That's nothing new — everyone in the industry knows it's been going on for quite a while!"

I don't know about you, but I find this one even more disturbing than the first. If people 'in the industry' have indeed been well aware of the scam for quite a while, why on earth didn't they raise the alarm, and warn both the public and the authorities?

Goodness only knows how many unsuspecting customers have unknowingly bought computers fitted with these fake cache RAMs, because people 'in the industry' knew what some of their colleagues were doing, but kept quiet. By not raising the alarm, these people were virtually acting as accomplices to the crime — even if they've never knowingly sold a faulty machine themselves.

Every industry has its share of unscrupulous and dishonest operators, of course, but surely in any mature and reputable industry the honest people are keen to have the 'rotten apples' kicked out, so they don't ruin the reputation of everyone else. It's clear that the personal computer industry still has a long way to go in this direction, before it will be able to inspire much customer confidence.

By the way, thanks to Tom Moffat and the Internet we've been able to track down a shareware program called CACHECHK.EXE, written by a gentleman from Illinois called Ray Van Tassle. Like AMIDiag it too seems to be able to tell if there's really any L2 cache RAM present, and can also check memory accessing speed with and without the cache operating. It's now available on our BBS complete with documentation file, in the compressed file **CACHCHK2.ZIP**.

So if you suspect your machine, this program can provide another testing tool. For the best results, though, boot your machine straight from a DOS 'system' floppy disk (i.e., with no memory manager or network driver enabled) before checking — otherwise you can get some strange results.

Jim Rowe

TECHNOLOGY LEAP IN NEW VAF SPEAKERS

Although its 'DC Series' of locally designed and manufactured kit loudspeaker systems has been very well received by the hifi industry, South Australian firm VAF Research has now gone one better again. Its new Ultra-DC range achieves even more impressive performance, largely by taking advantage of an innovative new 'physical low pass filtering' technology developed by VAF's founder and chief designer Philip Vafiadis.

by JIM ROWE and ROB EVANS

There's no holding back SA loudspeaker system designer Philip Vafiadis and his firm VAF Research, it seems. Not content with the considerable success achieved by their 'DC Series II' kit hifi speaker systems, they've now come up with a range of 'Ultra DC Series' models, delivering even more impressive performance for only a small premium in cost. And although they aren't intended to replace the existing DC Series II systems (which remain current), the performance/cost ratio delivered by the new models must inevitably have an impact on these — as well as the systems from quite a few other makers.

VAF's DC Series II models were released early last year, you may recall. Louis Challis gave the DC-7 MkII a very favourable review in our April 1995 issue, while we gave an overview of the series as a whole in the May issue. Basically we found them most impressive, with a performance that compared very well with commercial systems costing considerably more. This made them of great potential interest to anyone wanting to achieve 'audiophile' performance on a restricted budget.

It's therefore not surprising that since their release, the DC Series II models have apparently been very popular — not only in the Australian market, but overseas as well. Significant numbers have now been sold to Singapore, while a large US distributor is launching them into the North American market this month. VAF's reputation and success, as a designer and manufacturer of high quality but affordable hifi speaker systems is steadily growing.

But Philip Vafiadis is not one to rest on his laurels. In fact like all of the best speaker designers he admits (somewhat reluctantly) that his work is driven more by an ongoing 'passion' for improved sound reproduction, rather than a desire to be a successful business entrepreneur. He has been pursuing the goal of 'an even better speaker system' ever since he was back in his teens, and his success to date doesn't seem to have changed that quest.

Even before the DC Series II went into full production, it seems, he was working on another idea — a way to achieve a much smoother overall performance from any speaker system, by using what he describes as 'physical low pass filtering'. After a lot of testing and analysis this has now been achieved, and the results turned out to be so impressive that VAF has patents pending on the technology involved.

Although the new physical low pass filtering technology can actually be applied to sound sources other than loudspeakers, and also to speakers other than the popular moving-coil/cone variety, it's mainly in this area that it has been tested to date. And it was because the technology allowed such a significant improvement to be achieved in the performance of their existing bass/ midrange drivers that VAF decided to come out with the new Ultra system models, based on it.

Although Mr Vafiadis is understandably somewhat cautious about revealing much detail of the technology, until they have full patent protection, he has explained the basic concept to us in general terms and as applied to a loudspeaker. Essentially it involves a special tapered cylindrical structure extending from the front of the centre magnet polepiece, on the axis of the voice coil and cone. The protrusion is currently machined from acetal plastic, selected for its acoustic properties.

At the far end of the protrusion is attached a larger-diameter cap of the same (or a different) material, with a carefully designed shape and profile. Typically it may be a disc with a diameter around 50% of the effective cone piston diameter. The rear surface of the cap is also covered with acoustically absorbent felt.

By careful design of this structure, VAF has been able to make it act as a selective low-pass acoustic filter, acting upon the sound energy generated by the speaker. It has virtually no effect at lower frequencies, but begins

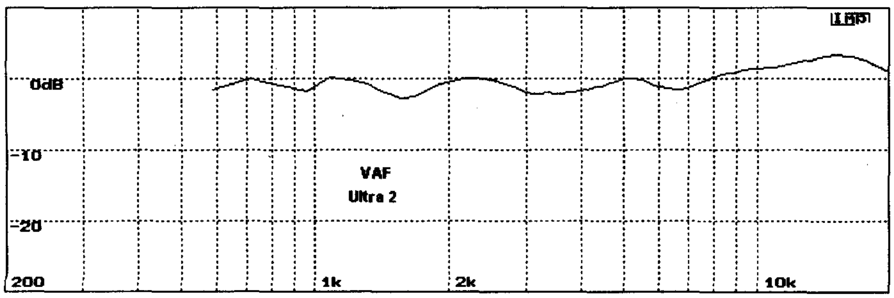
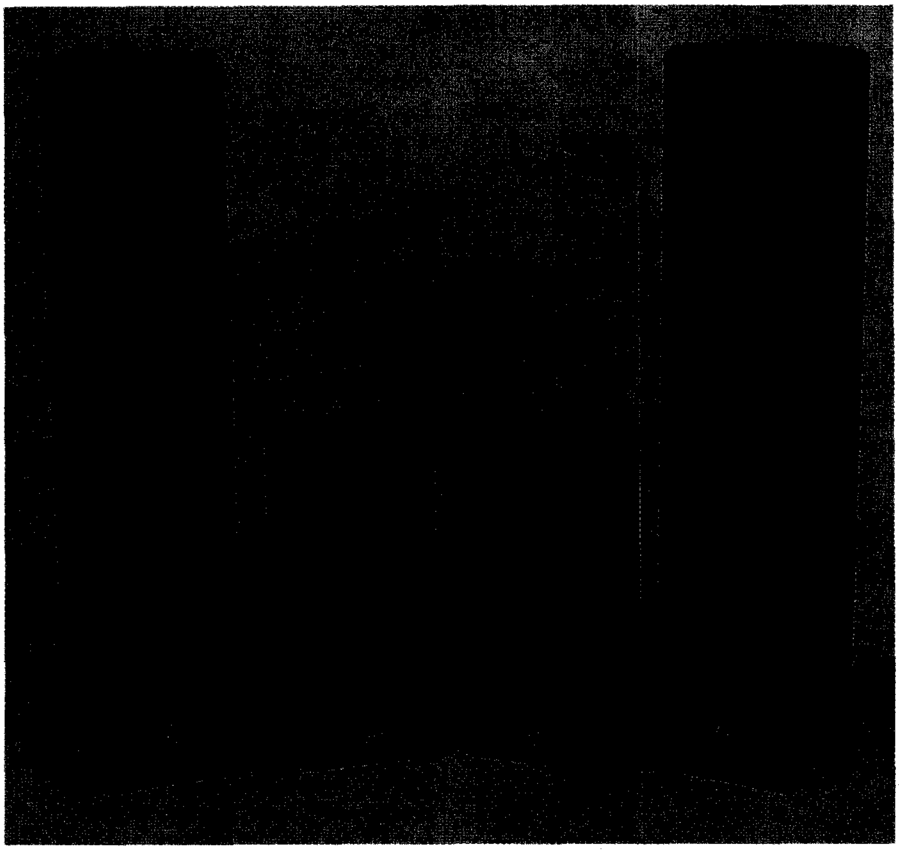


Fig.1: Our measured frequency response for the Ultra 2, above 600Hz. Although there are a few minor variations, it is much smoother than the DC-2 model.



to absorb more and more of the energy once the system's acoustic 'corner frequency' is reached.

But how can this be used to improve the overall performance of a speaker system? Well, all loudspeaker cones — even those in the most elaborate and expensive drivers — tend to 'break up' and develop high-order resonant modes of vibration at higher frequencies. This introduces all manner of peaks and dips in a driver's high-end response, along with various kinds of distortion. That's why, for the best results, it's necessary to use two or more drivers to cover the complete audio spectrum. In theory at least this allows each driver to handle only the frequencies where it operates correctly as a 'piston' — with an electrical filter or 'crossover' network dividing the bands of signal frequencies among them.

The problem is that the design of a crossover network always tends to involve fairly significant compromises. Separating the bands of frequencies effectively can require a complex circuit, and the more complex the circuit the harder it is to stop it from introducing distortion, phase shifts and spurious responses of its own.

A 'two-way' system with only two drivers (woofer and tweeter) tends to involve fewer of these compromises than one with three drivers, but still isn't easy. Very careful selection of drivers, together with a lot of skill and experience is needed to achieve a smooth overall response, combined with low distortion.

The 'crossover' region is particularly critical, because for best results the output of the woofer needs to be reduced rapidly as soon as its cone begins to depart from correct 'piston' operation. At the same time, the output from the tweeter must be increased at the same rate, and with as little relative phase shift as possible, if the overall response is to remain smooth and 'clean'. With many woofer and tweeter combinations this can be almost impossible to achieve.

VAF's physical low pass filter technology can help in this situation, in a number of ways. Its effect is fairly complex, but one function is to achieve some of the necessary roll-off of the woofer output at high frequencies *acoustically*, which allows the electrical crossover network to be simplified. It provides an additional means of controlling not only crossover frequency, but also the driver's Q in the crossover region.

By providing additional damping and suppression of higher-order resonances in the woofer cone, it can also extend the useful range of the woofer and bring it 'closer' to the optimum range of the tweeter — reducing the demands on the crossover network and also making it less of a compromise. The nett result is a simpler network, fewer phase shift problems, a smoother response in the transition region and lower distortion.

Now let's look at two of the new Ultra DC Series systems, to see how VAF has been able to take advantage of this new technology.

The Ultra 2

The Ultra 2 is a compact two-way system intended for use in high quality audio systems where accuracy and realism are required at comfortable listening levels, on a limited budget. It is also very suitable for use in the 'surround' channels of very high quality home cinema systems.

Measuring only 400 x 268 x 180mm overall, each Ultra 2 enclosure uses a VAF proprietary 130mm woofer fitted with the new physical low pass filter technology, teamed with a proprietary 'double chamber' 25mm precision ground metal dome tweeter fitted with VAF's Hypersoft damping. The enclosures themselves are filled with what VAF describes as 'second generation Special Hypersoft' damping foam, claimed to offer improved control of internal reflections and further optimise low-end response.

The simplified electrical crossover network in the Ultra 2 features resin-bound air cored 1% tolerance inductors wound from very heavy gauge wire, and close tolerance capacitors and resistors. It is claimed to provide sophisticated

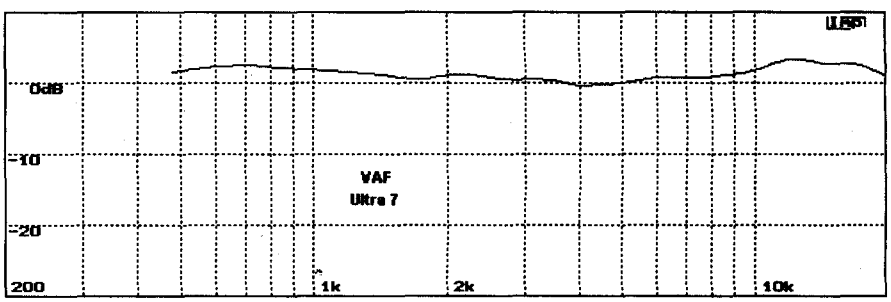


Fig.2: The measured frequency response for the Ultra 7, above 500Hz. As you can see, it is remarkably smooth and well balanced.

Technology Leaps in New VAF Speakers

shaping of frequency, phase and impedance characteristics.

The rated frequency response of the Ultra 2 system is 45Hz - 20kHz +/-2dB, with a phase response +/-35° above 200Hz. Nominal impedance is 8Ω, with a sensitivity of 87dB/W/m. Recommended amplifier power is 20 - 75W per channel.

Note that although the overall dimensions of the Ultra 2 enclosures are roughly the same as those for the corresponding DC-2 Series II, the aspect ratios have been adjusted to make them less 'narrow looking'. They also have a different finish and trim, with moulded top caps and bases (available in a range of colours and finishes), and full wrap-around 'socks' of acoustically transparent cloth. The trim can apparently be changed quite easily at any time, if desired.

The quoted introductory price of the Ultra 2 system (two enclosures) is $599 for the kit version, and $699 for the fully assembled and tested version.

The Ultra 7

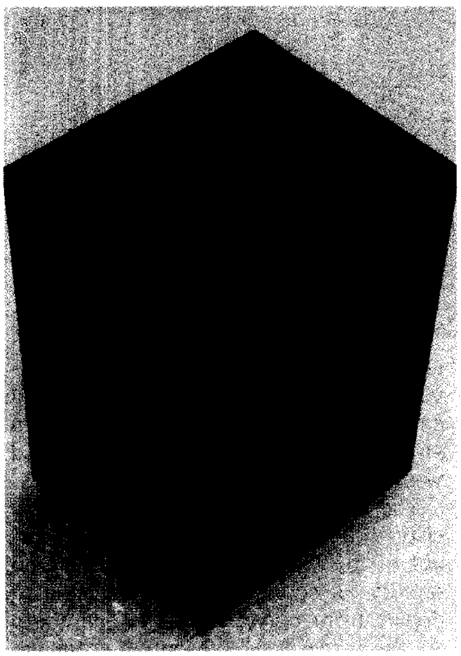
Like the existing DC-7 MkII, the Ultra 7 system consists of two floor-standing enclosures, each a two-way system which teams two of VAF's proprietary 130mm woofers (in this case fitted with the new physical LP filter technology) with a single 25mm precision ground metal dome tweeter. The Ultra 7 is intended for use in high quality audio and home cinema systems, and offers easy loading for compatibility with a wide range of amplifiers.

The Ultra 7 system enclosures are again broadly similar in overall size to the corresponding DC-7 Series II system, although the proportions have again been adjusted to make the new enclosures less narrow looking and more stable — they measure 900 x 268 x 180mm (H x D x W). They also use the new trim system.

The enclosures of the Ultra 7 system are again filled with improved Special Hypersoft damping foam, but feature an angled internal bracing system which combines with the damping foam to function as a tapered, closed-end lossy transmission line for better control of internal reflections. The electrical crossover network again uses 1% tolerance resin-bound air cored inductors wound from heavy gauge wire, and close tolerance resistors and capacitors.

Rated frequency response of the Ultra 7 system is 40Hz - 20kHz +/-2dB, with a phase response of +/-35° above 200Hz. The nominal electrical impedance is again 8Ω, while the sensitivity has been increased (compared with the DC-7 MkII) to 91.5dB/W/m. Recommended amplifier power rating is 20 - 100W per channel.

The quoted introductory price for the Ultra 7 system (two enclosures) is $799 for the kit version, or $999 fully assembled and tested. These prices are only $50 above those for the existing DC-7 MkII system, although Philip Vafiadis stresses that they probably won't be able to hold them at this level for long.



A close up view of one of VAF's new models, showing the 'physical low pass filter' device in the centre of the woofer driver. It simplifies crossover network design, and also extends the woofer's effective frequency range.

What we found

When VAF very kindly provided sample Ultra 2 and Ultra 7 systems for our evaluation, the first thing we were interested in testing was the frequency response in the critical middle and higher frequency region — the area where any benefits from the physical LP filter technology would be most apparent. And we certainly weren't disappointed.

Tested with our IMP system, the smaller Ultra 2 system turned out to have a very smooth and balanced response. As you can see from the plot (Fig.1), it was within +/-3dB from 600Hz to above 20kHz, with no worrying anomalies at all. A very nice response, in fact.

When it came to measuring the response of the Ultra 7 system, though, the results were even more impressive. In fact it proved to be remarkably smooth, as you can see (Fig.2), with only gentle deviations and well within +/-2dB from below 500Hz to above 20kHz. Frankly this is the smoothest mid/high end response from a speaker system that we've ever measured, and it shows a very clear improvement over the DC-7 MkII, which does exhibit a small but noticeable 6dB dip at 3kHz in the crossover region.

The other thing we noticed straight away with the Ultra 7 system was its increased sensitivity over the DC-7 MkII. Over the middle frequency range in particular, it's at least 2dB more sensitive than the DC-7 — presumably another benefit of the physical LP filter technology. As well as making the system more suitable for use with modest-power amplifiers, it also tends to give the Ultra 7 better overall balance (the DC-7 MkII is slightly 'top heavy').

We also tried measuring the low-end response of both systems, using both IMP and LMS. This isn't nearly as easy as measuring the middle and high-end response, of course, and like many other 'indoor' measuring setups ours isn't capable of giving truly clear-cut and unambiguous results. However both systems gave a very good account of themselves, with the Ultra 2 quite consistently showing a gentle sag of about 4.5dB around 200-300Hz, a small peak around 90Hz and a slow rolloff below that — with very useful output down to about 45Hz, which is impressive for a system of this size. The Ultra 7 seemed to have much the same performance, although with a more pronounced dip (about 6dB) around 150-200Hz, again a small peak at 90Hz and a slower low end rolloff — with useful output down to about 40Hz.

We can't be positive that the apparent 'dip and peak' were not at least partly due to measuring artifacts, though, especially with the Ultra 7. Getting a reliable measure of the bass performance of this kind of bass reflex system, with two drivers, is not easy.

We also measured the electrical impedance of the two systems, as you can see from Fig.3. Both appear to have less variation than the corresponding DC Series MkII models, with the Ultra 2 (solid line) remaining in the range 8 -

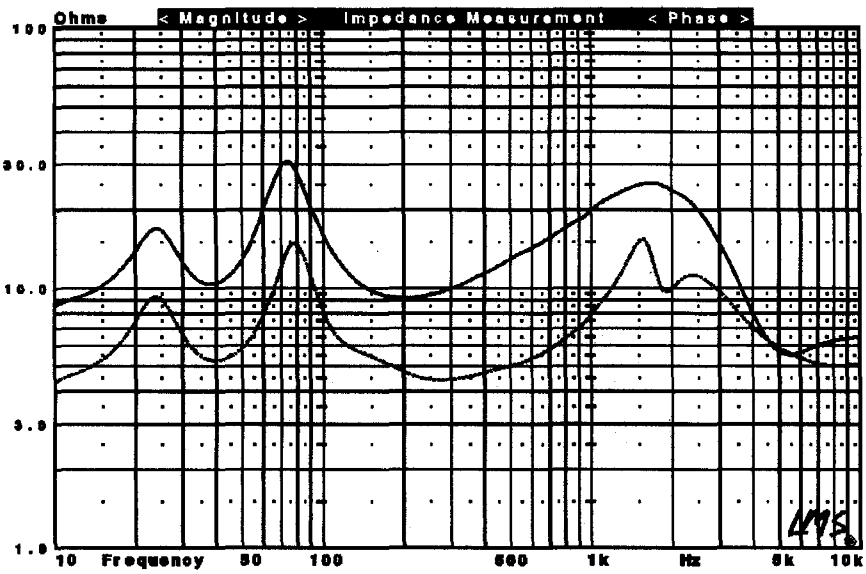


Fig.3: The measured impedance plots for the Ultra 2 (solid, top curve) and Ultra 7 (dotted, lower curve). Both vary less than the corresponding DC models.

30Ω over most of the spectrum and only dipping to about 5.5Ω briefly at about 5.5kHz.

The Ultra 7 has a minimum of 4.5Ω at about 300Hz and maxima of around 15Ω at 80Hz and 1500Hz. Although the curve looks a little odd in the crossover area, there's nothing there that should cause any concern. In fact both systems should be remarkably 'amplifier friendly'.

Listening tests

For our listening tests, in a typical 'domestic lounge room' environment, we first tried the smaller Ultra 2 system. This gave a very nice account of itself, with a particularly smooth and balanced sound on virtually every kind of programme material. Its bass response was most impressive, for such a small system, and the improved middle register now mates well with the quite exceptional high-end performance of VAF's dome tweeter. The transient response was very clean, and we couldn't really detect any audible distortion.

Not surprisingly, though, the Ultra 7 system was even more impressive, with an exceptionally smooth and 'transparent' sound on every kind of material we tried — solo vocal and full choral works, string/brass/wind instrumental, full orchestral and so on. We were particularly impressed with the stability of its stereo imaging — a good indicator of the absence of 'funnies' in the dispersion and/or phase response, especially in the mid range. The sound was also very well balanced, with no real evidence of that dip-and-peak that seemed to be present in the measured bass response...

The transient response also seemed to be exceptionally clean and accurate, and again we couldn't detect any audible distortion.

The existing DC-7 MkII system is already an excellent performer, so the new Ultra 7 with its much smoother mid range and better overall balance can now only be described as *exceptional*.

By the way, we also liked the new styling of the Ultra models, with their more balanced aspect ratio and tidy wrap-around grille cloth trim. However some hifi enthusiasts may find them a little frustrating, as you can no longer 'unclip' the grilles to display the drivers.

In short, then, and judging from these two sample systems, VAF seems to have achieved quite a significant breakthrough with its new physical LP filter technology and the Ultra Series it has made possible. Both the Ultra 2 and Ultra 7 systems show significant advances over the corresponding models in the DC Series MkII range, and are now very nice loudspeaker systems indeed.

Even more than before, they surely represent an excellent choice for anyone seeking to achieve 'audiophile' performance on a restricted budget. In fact from our experience, you'd have to spend considerably more to achieve even comparable performance.

Further information on any of the VAF Ultra Series models is available from VAF Research at 291 Churchill Road, Prospect 5082 (or PO Box 380, Greenacres 5086); phone (08) 269 4446, or fax (08) 269 4460. ❖

The Bose 'Auditioner', and 100 Years of Applied Acoustics

This month, Louis Challis had the opportunity to attend a demonstration of Bose Corporation's new Auditioner, a computer modelling and simulation system for auditoria and other acoustical environments. Acoustical engineering is his primary area of expertise, of course, and he was struck by the significance of this development — which comes almost exactly 100 years after the 'birth' of the modern science of applied acoustics...

Imagine a scene a century ago, in which a young, brilliant and resourceful university lecturer stood inside a newly completed lecture theatre which had proved to be virtually unusable, because of the persistence of the sound whenever a lecturer attempted to address his classes. The lecturer was Wallace Clement Sabine. The year was 1895, and the time at which this scene occurred was typically between 2.00am *and 4.00am*, five nights per week.

Sabine, with one assistant, would stand in the lecture theatre and perform strange measurements involving a series of organ pipes, a stop watch, and with just his ears as the instrumental detector to assist him during those ungodly hours. The location of the measurements was the Fogg Art Museum's lecture theatre, at Harvard University.

When I first read Sabine's collected papers on acoustics in 1966, I too had been performing somewhat similar measurements at 2.00am. Whilst Sabine was forced to perform his measurements to avoid the noise of tramcars, my unwanted source of noise was overflying aircraft at Rockdale, in southern Sydney.

When I read about Sabine's work, I experienced a feeling of *'deja vu'*. Thereafter, apart from both of us being involved in acoustical measurements, all similarity ends.

Sabine's intrepid research work resulted in a new and exciting technology. Sabine was the father of modern acoustics, and the theories and principles which he developed impinge on each of us, and our lives, on a daily basis.

Sabine accepted the challenge of the task he was given with zeal. Whilst a lesser man might have been satisfied with 'partial correction of the problem', Sabine broadened the task to include two other lecture theatres which displayed similar problems.

More significantly, realising the need for additional data, Sabine also chose to include a constant temperature room located at the Jefferson Physical Laboratory and another lecture room which displayed 'tolerable acoustics', into the array of rooms whose performance characteristics he measured.

It is only when one compares Sabine's equipment with that which almost any acoustician would use today to analyse similar problems, that one begins to understand the paucity of the resources that Sabine brought to bear at that time.

Sabine used four organ pipes (with solenoid activated switches), a constant pressure air supply, a stop watch, and his ears. Yes, he used his ears as the detector to identify when the reverberant sound energy in each of the rooms decayed to the point of 'inaudibility'.

It is only when you read what Sabine wrote about his studies, and extend that reading to encompass what other contemporaries wrote about his work, that you realise how great and rare an ability he displayed.

His greatest strength lay in that, having examined a complicated situation in which he correctly identified the problems, he was able to develop practical solutions. Those solutions in turn ultimately opened the door to both his, and subsequently our understanding of the fundamental principles involved.

Sabine immediately recognised the importance of good hearing, as well as the need to be able to both identify, and preserve the frequency balance in such environments. His understanding of the need to exclude extraneous noise from the rooms in which he performed his evaluations was extremely perceptive. His understanding of the importance of maintaining an appropriate signal to noise ratio for his test signals ultimately proved to be the most critical factor in his studies. In the absence of all of those elements, he would never have been able to perform valid measurements.

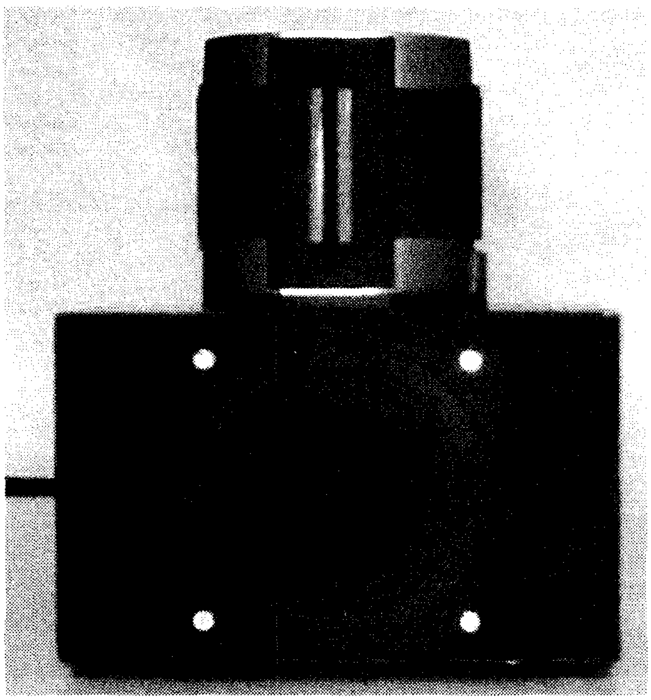
Now Sabine was not just a good physicist — more significantly, he was the first architectural acoustician who was able to logically apply scientific principles to his design studies. His pioneering work was immediately recognised in Boston.

In 1900, he was commissioned to assist the architects in the design of the new Boston Music Hall. For those of you who have not been to Boston, or have not read books like Beranek's *Music, Acoustics and Architecture*, you would be unaware that the Boston Music Hall is acclaimed as being one of the best concert halls in the world.

In the first half of this century, between 1900 and 1950, architectural acoustics came of age. We not only saw the development of sound level meters with A, B and C-weighting networks, but also saw the development of octave band analysers, level recorders, amplifiers, loudspeakers, electronic oscillators, and even cathode-ray oscilloscopes.

During that 50 year period were founded the three major companies which dominated the field during the next 50 years.

Those companies were in order of creation and importance, General Radio and Hewlett-Packard in the USA, and Bruel & Kjaer in Denmark.



When Louis Challis himself was modelling the acoustics of the new Parliament House in Canberra, he used this 'scaled down' speaker system to generate sounds at 10 times normal frequencies. It covered 1-80kHz, +/-6dB.

If one excludes Sabine's momentous work between 1895 and 1900, the second world war, nearly 50 years later, provided more impetus for applied acoustical research than any other single factor during that 100 year period. The war (and the subsequent creation of the United Nations) resulted in the creation of many illustrious firms, the most notable of which was Bolt Beranek & Newman, who were also located in Boston.

During the second half of the century, from 1950 to the present, the study of acoustics came of age. More significantly, the commercial, educational and environmental facets of acoustics suddenly assumed a prominence that would have even staggered Wallace Clement Sabine. During the first half of this century, Sabine pioneered the technique for carrying out two dimensional acoustical modelling.

During the second half of this century, *three* dimensional modelling using carefully scaled models of auditoria and important buildings, gained technical prominence — particularly in the period 1950 to 1980. Important auditoria like the Concert Hall and Opera Hall at Sydney's Opera House, made use of scale model testing. The evaluation procedures were both slow and tedious. More significantly, they were fraught with innumerable technical problems.

The underlying principle was based on scaling the test frequencies used (as well as the absorption coefficients), to match the scaling factor of the model constructed. Thus by way of example, if you chose a model whose dimensions were 1/10th of those of the proposed chamber, your test frequencies would be scaled up by a factor of 10:1. Even though there were innumerable problems and frequent pitfalls involved in performing an analysis of a future building with an acoustical scale model, it offered the only effective and analytical procedure available at the time.

Relatively few acoustical engineers ever get the chance to undertake a scale modelling program for a major auditorium. I guess I am one of the more fortunate ones, as I was given the opportunity when I was appointed as the acoustical engineer for the New Parliament House, Canberra.

Titles are fine, however when a monumental project is dished up with unrealistic deadlines, the pleasure and the excitement soon turns into a monumental headache. The client insisted that the architectural studies and the refinements of the acoustical design had to be completed within three months.

New approach

Faced with what appeared to be an insuperable problem, I set aside the then 'current practice' and its related measurement technology, and in effect invented a new way of performing acoustical modelling. I described it as 'computer controlled acoustical scale modelling'. Whilst other acousticians and engineers used tape loops and multi-speed tape recorders to laboriously re-analyse their scaled acoustical data, I decided that approach was 'strictly for the birds'. The time required to extract the critical data by that approach, was anywhere from one to five days for each different variant of the model.

The approach that I adopted would probably now be described as being close to the 'cutting edge' of new technology, circa 1981. I decided to build a 576KB digital memory, which provided

392K of 12-bit resolution data storage. With a 400kHz sampling frequency I could store approximately one second of acoustical data.

I could then expand that data to 1/10th of the original sampling speed, and still achieve a commendable frequency resolution — i.e., a nominal 18kHz bandwidth in the reduced speed mode.

I set out to use the digital memory with a new Hewlett-Packard computer. That computer was already capable of controlling a new digital one-third-octave band real time analyser. With the addition of a spark source which was modified to accept computer control, I believed I would be able to use the real time analyser's proprietary software to analyse the characteristics of the 1/10th scale acoustical model.

Minutes, rather than days

What this system offered us was the ability to analyse the characteristics of the model in a few minutes, rather than in a few days. More importantly, it provided us with the mechanism for processing the data, and simultaneously printing the graphed 'report ready' output onto a matching HP digital plotter.

Whilst I can now afford to gloss over the myriad of problems which we experienced in commissioning the system, it is still noteworthy that all the modelling studies were completed within the restrictive three-month period, and the 'fast track' design process was neither impeded nor prejudiced by our efforts at that time.

Relatively few people realised that I was neither satisfied, nor content to just perform testing and present the client with the results. I realised that the multitude of graphs and tables would have no real significance or meaning to most of those who would read it.

I felt that further refinements in the testing procedure were essential. I believed that those refinements should provide the client with an appropriate impression of the quality of sound for each model variant evaluated.

The approach I adopted was to record the voice of a staff member whilst he read the text of an act of parliament. That signal was then scaled up in speed/frequency by a factor of 10 using a Kudelski Nagra IVSJ instrumentation recorder, and replayed into the model.

In order to reproduce the re-scaled sound, I constructed an unusual two-way loudspeaker, using a Philips mid-range driver and a Technics Leaf tweeter (Type 10TH 1000).

With an appropriate crossover network, the miniature speaker system was capable of faithfully reproducing the scaled frequencies to cover the range from 1kHz to 80kHz, +/-6dB.

The sound produced in the model was then recorded with a miniature Bruel & Kjaer 1/4" microphone, type 4136, and its signal was then recorded by the digital memory.

The final step involved replaying the sound at 1/10th the recorded speed onto a cassette recorder, for the client's subsequent audition.

During each stage of the modelling program the reproduced speech from the modelled loudspeaker was recorded at various critical points within the model. When the client and the architects ultimately heard the tape recordings, they were able to assess the quality of the sound, and give their approval for the design concept.

At the time, I considered this approach to be a technical break-through. In the ensuing period, I would now describe it as just another milestone in the development of acoustical philosophy and technology.

Gives perspective

You may wonder why I bother to account my distant past, in the midst of what started out to be a conventional technical review. Well frankly, it provides a historical perspective for the main subject of this article.

In 1989, following the successful completion of New Parliament House in Canberra, I decided to visit the Yamaha Acoustics Laboratory in Hamamatsu, Japan. To my surprise, I discovered that a team of dedicated acoustical engineers had recently developed a computer modelling procedure for large auditoria. That program could analyse auditoria without the need to construct a scale model and generate either the cost or the complexity of the tasks which I had successfully completed during that decade. The Yamaha acoustical analysis programs displayed an exciting innovative perception of the technical issues involved, and gave that company a decided advantage when offering their proprietary hardware for evaluating the performance characteristics of various new auditoria in Japan.

Yamaha decided not to market their software, and the advantage was strictly 'in-house'. Around about the same time I learnt that a Norwegian group had developed a software package which achieved similar results, which anybody with enough money could purchase. The complete package proved to be far too expensive, and very few people were prepared to purchase it.

Danny Neuman, one of Louis Challis' associates, shown adjusting a microphone inside the 1/10th scale model for the Representatives Chamber of new Parliament House, during the acoustic modelling.

Enter Bose...

Enter centre stage Bose Corporation, who were aware of what Yamaha and the Norwegians had developed. More importantly, they learned through the 'grapevine' that at least two of their most prestigious competitors were developing similar programs. The year was 1986, and Bose decided to develop a program which they ended up calling the Bose 'Modeller Design Program' (MDP).

Unlike their competitors, who started out with the idea that their programs were marketable, Bose started out with the diametrically opposite viewpoint. The Bose concept was that the MDP should be available to assist any, or all prospective professional users.

Unlike the competing programs, its most important feature was its fundamental and straightforward ability to graphically model any room or space. Each surface of that space could be sub-divided into areas, with acoustical characteristics conforming to those from which it would be constructed, or which would be added to it after construction.

To further simplify that task, the program already contained a database with a wide range of conventional, reflective and absorptive materials.

Having drawn the plan and each of the elevations of walls or views of the ceiling of your modelled space, you would then select the materials. By nominating the sound absorption characteristics of each sub-surface on that wall, floor or ceiling, the program would then compute the following characteristics:

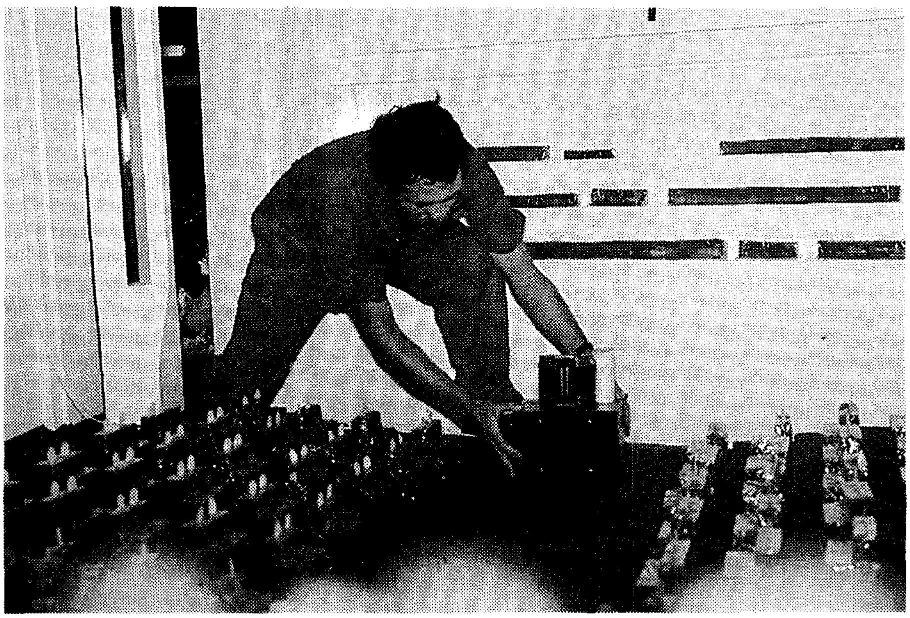
1. Reverberation time.
2. Speech transmission indices, including an array of different parameters.
3. The sound pressure level and point response for sound generated by a nominated single loudspeaker, or an array of specific loudspeakers positioned anywhere within that space, for any nominated listener position within that space.
4. The sound intensity plot for one or more arrays of loudspeakers positioned at any location or locations, within that space.

The only catch with the original MDP versions, and all subsequent versions up to 4.0, was the paucity of data on loudspeakers from competing manufacturers. Obviously, if one were to nominate one or more combinations of loudspeakers, and particularly if they were Electro-Voice, Altec Lansing or JBL speakers, you would need accurate, extensive and appropriate data for the computer modelling to be useful.

With the right data, you could rapidly determine (acoustically model) the frequency response of nominated loudspeakers at any point in any room.

The early version of the MDP proved to be extremely 'user friendly'. Bose chose to use an Apple MacIntosh computer in preference to a DOS based computer. That of course was no accident. At that time (and even now) the Apple MacIntosh based software and hardware, are generally superior for graphical analysis of this type, when compared with the competing DOS or Windows based software and hardware.

At the time of the initial release of its MDP, Bose had relatively few PA type loudspeakers which were 'fit for purpose'. As a result, Bose had qualms about incorporating design data for their competitor's products. By the same token, it's equally possible that the competitors may well have had similar qualms about providing all the relevant data on their loudspeakers, to an up and coming competitor.



Another view of Mr Neuman in the model, this time positioning the special scaled down speaker system used to generate test signals at 10 times normal frequencies. It used a Philips mid-range driver and Technics leaf tweeter.

In the ensuing period, it would appear that two issues wrought changes in Bose's original philosophy. The first appears to have been the result of their competitor's reticence in providing Bose with explicit and accurate performance data on their products. The second, and I suspect the equally compelling factor, was Bose's subsequent reluctance to provide data on products which were not of their manufacture.

Even when taking into account the inaccuracies that could devolve from inappropriate specification of absorptive materials, and misapplication of the data provided, the early MDP proved to be reasonably accurate and convenient. Subsequent versions proved to be substantially better, as user feedback resulted in the development of new features, and new or enhanced 'user-friendly' routines.

Anybody who used Version 4.1 or 4.2 would have to acknowledge that the speed with which a problem could be analysed, shamed any other conventional computational or computer based procedure available to them.

In the early 1990s, a number of Bose's competitors had also developed competing computer software intended for basically the same purpose. A number of those manufacturers started to aggressively market and/or distribute those programs. In 1991 and 1992, I evaluated two competing programs. I soon formed the view that the Bose MDP was considerably easier to master, as it provided both the graphical and tabular results in a format which was easier to digest.

Bose received copious feedback from a multitude of engineers and technicians who regularly used its MDP. They accepted the comments and criticism and proceeded to substantially improve and modify the program's format. Alas, during this period, they progressively dropped references and data on competing products as soon as comparable Bose products became available.

By mid 1989, Bose's top management reassessed their marketing strategy for professional loudspeakers. They decided to become a major player in the global supply of PA systems. They all agreed that the MDP gave them a distinct marketing edge with design engineers, during the critical phase when components were being selected for a system.

They also acknowledged that the MDP gave them no perceived advantage with the technically untrained architect or facility manager, let alone the developer who was frequently providing the cash. The key marketing issue foremost in their minds, was what could or should they do to convince the vacillating purchaser(s), that the system being proposed by Bose, was clearly the best.

New R&D project

At that point they set up a new research team of five senior engineers, and a number of peripheral engineers with the task of developing the 'Auditioner Audio Demonstration' system.

The key people in the group were Dr Beckman, who was responsible for developing the algorithms in the software; Chris Ickler, a senior physicist and project manager; and Ken Jacobs, who provided the conceptual vision and who ultimately developed the 'schematic block diagram' on which the system was ultimately based.

The Bose 'Auditioner R&D group' were a skilled group of electronic experts in audio-engineering who broadened their skills to encompass architectural acoustics, and related aspects of speech transmission. Ken Jacobs' proposals must have been viewed as being audacious, and even possibly speculative by the rest of the team's members.

The magnitude of the task must have been somewhat daunting, since what they were trying to do was model all the physical, directional and acoustical characteristics of PA systems, whilst simultaneously replicating all the relevant architectural features of spaces in which the speakers would be placed. The program had to be able to provide the flexibility to position the loudspeakers anywhere within that space. It also had to provide the flexibility to position a listener at any other point within that space, and then modify the resulting sound field at that point to conform to what the listener would actually hear.

During its development, the Auditioner system underwent a number of dramatic changes. The first developmental system was monstrous in size, encompassing racks of equipment, in much the same way that the original Yamaha DSP processor (which now only requires one LSI chip) required two full 19" racks of equipment.

Australian DSP

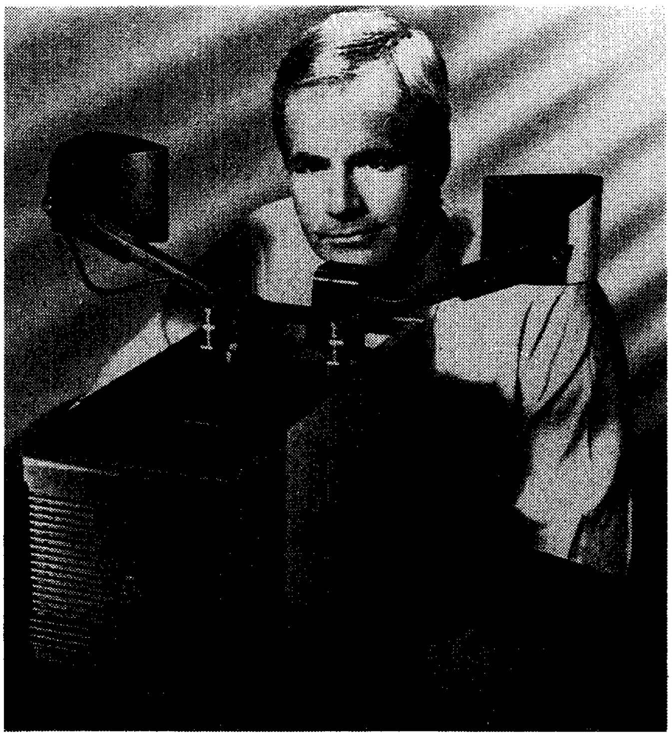
The refinements in the design were materially assisted by Bose's adoption of the Australian Lake DSP system, as a fundamental component. Bose are full of praise for the Lake DSP system. They acknowledge that without it, the Auditioner system would not be nearly as good. As I subsequently learned, the Lake DSP card and the associated special LSI chips perform a number of critical functions.

The DSP card provides special filters, and generates full bandwidth signals with a 'latency' of 1.5 seconds. The acoustical signal is provided from an external source which may be a CD player, tape or even a person speaking into a microphone. The Auditioner program and its DSP processor convert that signal into a two-dimensional signal which replicates a three-dimensional space.

Not just any three-dimensional space, mind you, but the space that has been modelled with a revised Bose 'Modeller' software routine which contains a number of critical refinements — which as yet, have not been incorporated into the basic Modeller program.

Bose were less than forthright in providing information as to what those changes might be. They were unwilling to describe the program in more detail, nor to give any clues which might end up assisting their competition.

They *were* prepared to describe in general terms how an engineer by the name of Morton Jorgenson was given the task of authenticating the accuracy and realism of the dynamic response of the Auditioner system. He apparently spent three or four months in assessing the dynamic response with impulse conversion tests, and inter-comparing with live A-B testing the Auditioner system in five different sized rooms, where he also evaluated the total system and room. The five rooms had reverberation times ranging from a low of one second to a high of 4.5 seconds.



The Bose Auditioner system uses this active speaker setup to create an accurate simulation of the sound which will be audible at any desired location inside the acoustic environment being modelled by the computer.

He also evaluated loudspeakers with 'Qs' or directional factors ranging between 4-27. These tests were conducted with central clusters and distributed speaker arrays, and made extensive use of the intelligibility tests of the American Standard ASA S.3.2:1989 — which is similar to AS2822-1985, 'Acoustics, Methods of Assessing and Predicting Speech Privacy and Speech Intelligibility'.

Those of you who are familiar with the speech transmission or speech intelligibility indices would be aware that for a PA system or speech communication system to be classified as 'good', normally requires an STI index of approximately 0.6 or better. The Auditioner allows you to compute that STI index, and to audibly assess its impact on speech or music transmission.

As the Auditioner system developed it became smaller, and with the availability of faster and (less expensive) Apple computers, the flexibility of the system improved immeasurably.

It became possible to rapidly change speaker selections, speakers positions, directional pointing angles, and equally importantly the acoustical characteristics of a room, to assess the quality of sound at any position of one's choice. As both a design and marketing tool, the Auditioner system has immense potential for Bose, as well as for its clients.

Sixty Bose Auditioner systems were constructed to satisfy the firm's current requirements, and 60 separate dedicated groups of operators were trained to use those systems. Obviously, if the wrong information were to be fed in, then the output would be simply a case of GIGO (garbage in, garbage out).

With so much at stake both professionally and financially, Bose were not willing to allocate Auditioner systems to any regional or marketing office, except where a competent operator had been trained to use it.

These systems were distributed world-wide for evaluation purposes, and Australia received two for local use, with two additional systems for use in the near east. In order to be able to optimally use the system, the operator needed to understand the electronic as well as acoustical and electro-acoustic theory, all of which are of fundamental importance.

The Auditioner

The Bose Auditioner Audio Demonstration unit consists of a modestly sized box in which amplifiers and a sub-woofer have been incorporated. At one end is a chin rest on which the listener places his chin. On both sides of the chin rest, a small tweeter extends on an arm pointing towards the listener's head.

The Auditioner box is connected to the computer which is normally positioned on the table where the demonstration is performed. The computer is capable of displaying a wide range of information, the most significant examples of which are plan or two-dimensional perspective views of what you would be able to see in the modelled space from the selected position at which you are listening.

The computer provides the ability to select a number of different positions at the

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touch of a button on the keyboard (or through the use of the mouse). It is able to alter any one of the significant dimensional, positional or acoustical parameters with prior preparation, so as to provide rapid A-B comparisons. Those comparisons frequently encompass changes of speaker configuration or directivity, or even the listener's position, at a single key stroke.

Bose Australia have recently used the Auditioner to model the quality of sound of various PA options for dozens of different auditoria and sporting venues. At the time of my visit to their office, they demonstrated pre-prepared data for St Andrews Cathedral in Canberra.

Now as it happens, I have visited St Andrews Cathedral on a number of occasions. I am familiar with its visual attributes, and sadly, with its acoustical liabilities. I was able to compare the modelled sound quality for a single centrally positioned speaker array, with my memories and clear recollections of the poor sound propagation within that worthy cathedral. The demonstration allowed me to position my ears at many locations within the cathedral.

I was impressed by what I would describe as the realism of the modelled sound. I was equally impressed by the convenience with which I could re-position myself in that acoustical model, to assess the reproduced sound quality as well as its speech intelligibility, with the similarity of sound that I had previously heard in the cathedral.

The Bose Auditioner is a bold and exciting milestone. It epitomises just how far acoustical theory and practical applied research and development have progressed, in a tad less than the 100 years since Wallace Clement Sabine initiated his exciting first steps in practical applied acoustics.

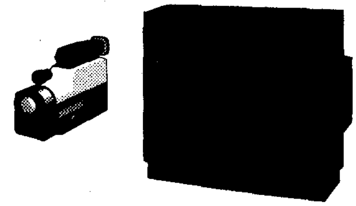
Bose Corporation are to be commended for what they have achieved in terms of a practical synthesis of wide ranging computer controlled DSP technology with fundamental psycho-acoustic principles. This development constitutes another impressive milestone in the continuous quest for superior technology which provides us with new and more effective design and evaluation tools.

Whilst neither you nor I will be here in the year 2095, it would be indeed a wonderful exercise in crystal ball gazing, to guess just how far or fast this technology will develop in the next century.

Suggested further reading:

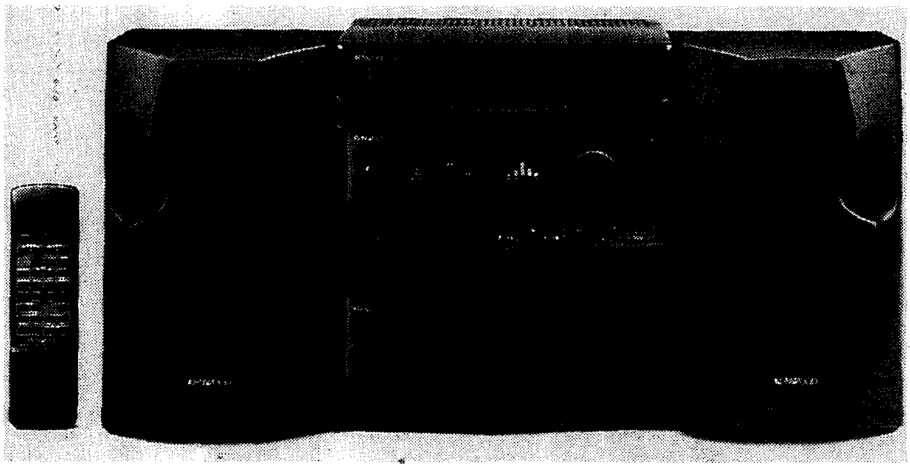
1. Sabine, Wallace C. *Collected Papers on Acoustics*. Dover Publications, New York 1964.
2. Beranek, L.L. *Music, Acoustics & Architecture*. John Wiley & Sons, New York 1962. ❖

What's New in VIDEO and AUDIO



Compact, well priced mini hifi system

Kenwood Electronics claims its new UD-213 mini system is 'big on entertainment', but conservatively priced with an RRP of $649. Finished in brilliant 'crystal cut' translucent black, the UD-213 mini offers the same quality finish as its higher priced stablemate minis. It provides a two channel (2 x 40W) stereo amplifier, five-band spectrum analyser, graphic equaliser, double cassette deck, CD player, AM/FM stereo tuner, two way speaker system and infra red remote controller. Also inbuilt is Kenwood's ASP or Acoustic Signal Processor, designed to recreate the ambience of an arena, jazz club or stadium.



The UD-213 employs a dual two way speaker system employing 130mm (5") woofer/mid drivers and 50mm (2") dome tweeters for extended high frequency response. The UD-213 is covered by a two year warranty and is available at selected Kenwood dealers.

For further information circle 271 on the reader service coupon or contact Kenwood on (02) 746 1888.

Smallest six disc car CD changer

Sony has come up with what is claimed as the world's smallest car CD changes — so small it will fit in the glove box. It says the CDX-T60 is set to revolutionise the car CD market, by abolishing the traditional boot mounted CD stackers and replacing them with a compact and convenient piece of car audio equipment.

Home THX audio system from Jamo

In the beginning of 1994, Danish loudspeaker manufacturer Jamo A/S obtained a Home THX Audio System licence from Lucasfilm Ltd. Now Jamo has announced its first Home THX Audio System.

The Home THX standard lays down a number of highly detailed and stringent specifications regarding frequency response, dynamic range and dispersion pattern to ensure that the sound from a Home THX Audio System comes as close as possible to the sound heard by the film makers in their studios.

Like most other manufacturers of Home THX certified left, centre and right front loudspeakers, Jamo has employed a vertical array design in order to meet the dispersion pattern criteria of Lucasfilm Ltd. But here the similarity ends.

For the vital front loudspeakers, Jamo has developed a special combination of two 5" woofers, two 3" midrange units with polypropylene cones, plus a 1" textile dome tweeter. These units and the computer optimised crossover network deliver a linear and extended frequency response that is also suitable for ordinary stereo sound reproduction.

The subwoofer features a 12" Peerless driver from Denmark with a front firing bass reflex port for easier room placement. To ensure optimum sound localisation, really thunderous bass, and meet the THX specifications, the use of two subwoofers is necessary.

Jamo's left and right surround loudspeakers for the Home THX Audio System are designed as dual two way dipoles, each featuring two 4" polypropylene cone woofers and two 1" textile dome tweeters. In spite of the compact dimensions of the enclosures, these surround loudspeakers deliver a linear sound pressure level all the way down to 125Hz. Retailing below $8000, the system is said to be very competitive in the market place.

Further information is available by circling 272 on the reader service card or by contacting Scan Audio, of 52 Crown Street, Richmond 3121; phone (03) 429 2199.

Meausring only 225mm by 158mm, the CDX-T60 is small enough to fit neatly under front car seats or in the consoles or glove boxes of most vehicles.

The system features a 110 Disc Custom File memory, which allows the user to apply an eight-digit character name to their CDs for easy identification. The appropriate name of the disc will then automatically appear on the head unit. This means less time fiddling with controls and more time spent concentrating on the road.

The CDX-T60 has been designed to interact with all other Sony car audio equipment with CD control capability. Other features include a 1-bit D/A converter and eight times oversampling digital filter. A five-step angle adjustment allows for vertical, horizontal, suspended and inclined installation.

The CDX-T60 has a suggested retail price of $849.

SlimVision camcorder has 10cm LCD monitor

Panasonic's New SlimVision NV-V10A camcorder has a 10cm (4") colour LCD monitor for video shooting and viewing recorded scenes with the recorded sound. The LCD is claimed to be 56% larger than any other camcorder model on the market.

The V10 also has a conventional black and white viewfinder for users who prefer this more conventional filming method but prefer to watch the scenes played back on the LCD colour screen.

Despite the inclusion of the colour screen, the V10 is a slim and compact unit which is easily held in one hand. The screen swings out from the left side for easy viewing during shooting and playback and folds neatly away when not required. It is also ideal for extreme low angle or overhead shots, because it can be turned upwards and downwards for a total of 180°. The LCD screen has a special non-glare, silica particle surface coating making it fingerprint resistant and stain proof. The surface coating also greatly reduces glare from strong light sources, making it simple to view in outdoor situations.

The V10 also comes equipped with a wide angle lens, combined with variable speed 10X power zoom. The wide angle setting corresponds to a 35mm wide angle lens of a standard SLR (Single Lens Reflex) photo camera.

Excellent indoor shooting is possible with the low light setting, which can film in lighting as low as 0.6 lux. The camera can also be set on full Auto, Manual, Sports or Portrat for special filming situations. The Panasonic NV-V10A video camera is available from leading electrical retailers for an RRP of $2399.

Samsung releases 'World Best' TV

Samsung Electronics has launched its 'World Best' colour TV, a 68cm model selling for arounf $2800. Featuring what is claimed to be the world's flattest screen, best reception and greatest built in surround sound system, World Best is the most advanced set Samsung has released into the Australian market. The ultra-flat CRT (2.5R) used in the set is claimed to produce a most realistic picture and to reduce picture distortion and eystrain. The set also offers a two tuner Picture in Picture feature, which allows watching two shows at once - one on the main screen and the other on a choice of four sub-screens.

Another feature of the set is described as a Low Noise Amplifier — 'the first in the world', which is said to ensure high quality pictures and sound, even in a weak signal area.

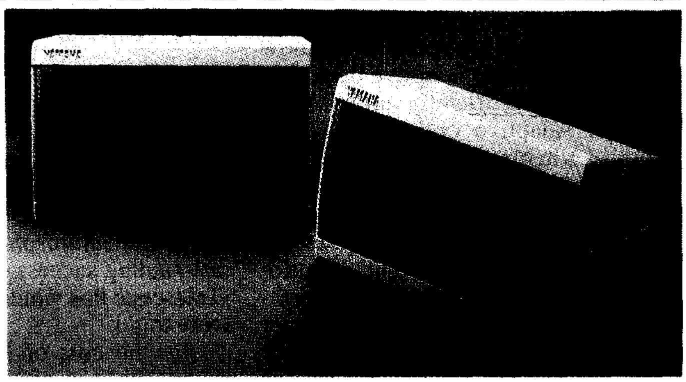
For spacious sound, Samsung has used a Twin Turbo Double Woofer speaker system with six speakers. And for sound to suit the occasion, the set's digital surround sound system provides a choice of concert, stadium or mono mode depending on the program and the atmosphere it creates.

World Best comes with a three year warranty, free installation to an existing aerial and person-to-person instruction with an optional television check-up in the last year of warranty.

Compact speakers from Yamaha

In the S15 and S55 Compact Speaker Systems, Yamaha claims to have combined the best in compact speaker performance, high power handling, design and affordability. The mount anywhere speakers are ideal for a wide range of around the home applications, as wll as commercial installations.

Both models feature a two way design for clean, accurate sound over a wide frequency range — up to 40kHz in the high end, where reproduction of upper harmonic components is critical to natural musical performance. Yamaha's original Waveguide Horn design further improves high frequency performance and dispersion by generating a virtually ideal spherical wavefront.



Although small, these advance speaker systems handle a surprising amount of power and possess a very efficient design. The S15, which is available in both black and white finishes, is comfortable with up to 80W continuous power output, and has a recommended retail price of $399. Its sensitivity is rated at 88dB/W/m. The S55, which comes in black finish, retails for $699 and will handle 140W.

Their efficiency is around 90dB/W/m, which means a big sound from a compact box. Additionally, with the escalating demand for home theatre, the S55 speakers feature full magnetic shielding, so they can be used in close proximity to TV sets without picture distortion.

Free angle wall or ceiling mount brackets let you set the speakers at any angle for optimum sound and coverage. Stand mounting is also possible, meaning that temporary or permanent installation can be easily accomplished in any listening environment.

For further information circle 273 on the reader service coupon or contact Consumer Electronics Division, Yamaha Music Australia, on (03) 9699 2388 or 1800 805 413. ❖

Adaptive optics at the Anglo-Australian Telescope:

UNTWINKLING THE STARS...

Scientists working at the Anglo-Australian Telescope at Siding Springs in northern NSW and at Sydney University have developed 'adaptive optics' systems capable of correcting for the optical distortion introduced by the Earth's atmosphere. Already in operation is a 'tip-tilt' mirror system to stabilise the image position, while a 'rubber mirror' system to sharpen the images is to follow

by GEOFF McNAMARA

Twinkle twinkle, little star
How I wonder what you are...

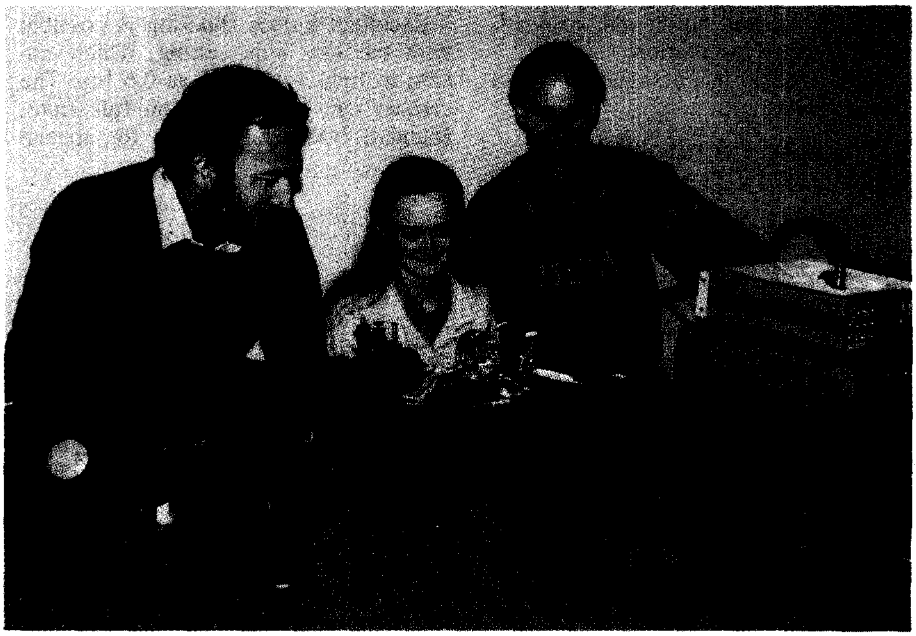
To most people, these famous lines are the beginning of a children's poem. To the astronomer, they're a lament of how difficult it is to study the Universe from Earth. While astronomers indeed wonder about the distant stars and galaxies, the twinkling mentioned in the poem blurs their view.

Stars twinkle in the night sky because their light is distorted, or blurred, by the Earth's atmosphere. While the stars look sharp and bright to the naked eye, to modern astronomers using state-of-the-art telescopes it's like standing on the edge of a swimming pool trying to read a copy of *Electronics Australia* at the bottom of the water. You can make out the big headline letters, but the really interesting stuff is just plain blurry.

After centuries of having to wait for those special nights when the air is really steady — or more realistically simply putting up with whatever clear night they get — astronomers are now experimenting with 'adaptive optics' in an attempt at artificially untwinkling the stars. Adaptive optics involves a system of tiltable and deformable mirrors that counteract the effects of the Earth's atmosphere.

One such adaptive optics system is being developed for the Anglo-Australian Telescope (AAT) in northern New South Wales, by a team of scientists and technicians from the Anglo-Australian Observatory and Sydney University.

As well as blurring a star's image, the atmosphere moves it around in an unpredictable manner. This random motion causes the image to dance around in the field of view of the telescope. Like a nervous bartender trying to fill a stationary glass, some of the light inevitably spills outside the aperture of any instrument attached to the telescope. With the incredible faintness of some of the objects astronomers observe, every photon counts!



Researchers John O'Byrne, Julia Bryant and Pal Fekete (left to right) examining an experimental adaptive optics set up at Sydney University.

The ideal solution is to send telescopes into space, well above Earth's turbulent atmosphere, and with the astounding success of the Hubble Space Telescope this would definitely seem the way to go.

But the cost of building a telescope like Hubble, putting it in orbit and maintaining it, are enormous. Even if the funds to build more of these orbiting observatories could be found, astronomers like to swap and change the instruments attached to their telescopes on a regular, sometimes nightly basis. This is something that just can't be done with space-based telescopes like Hubble, which have a set compliment of instruments that can only be changed during major servicing missions, timed years apart.

So, stranded on the ground, astronomers came up with adaptive optics. The idea was first proposed over 40 years ago, but the technology to realise the idea has only recently become available. While the new generation of large telescopes is being fitted with adaptive optics systems to maximise their performance, several existing instruments are being retro-fitted. Such is the case with the 3.9 metre Anglo-Australian Telescope.

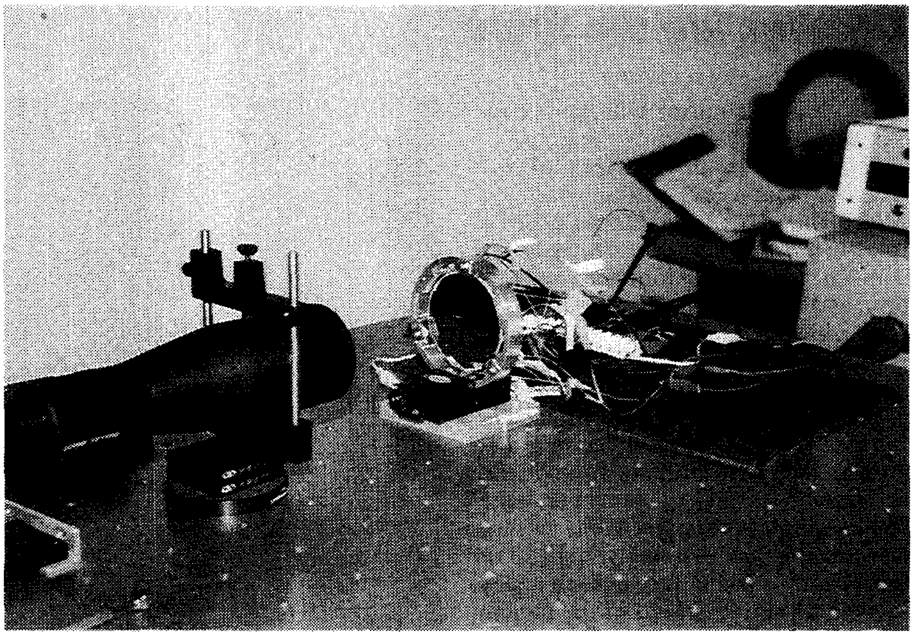
By today's standards, the AAT is in an odd place. The largest telescope in Australia, and arguably one of the finest and most efficient in the world, the AAT sits on what passes for a high peak in Australia: the 1200-metre Siding Spring Mountain in northern New South Wales.

Modern telescopes of the AAT's calibre are built on much higher mountains, well above most of the Earth's atmosphere. For example, the telescopes on Mauna Kea in Hawaii peer at the Universe from a height of 4205 metres above the surrounding ocean. So, while Siding Spring is one of the darkest sites in the world, it's blanketed by much of the Earth's atmosphere. The result is that on some nights the atmospheric stability, or 'seeing' as astronomers call it, is less than ideal.

Despite this handicap, the AAT is famous for the high accuracy of its optics, and the efficiency and cleverness of the staff and visiting astronomers who work there. Continuing in this tradition, the AAO and Sydney University scientists have developed an adaptive optics system for the AAT that will further increase its already world-renowned capabilities.

Leading the project is John O'Byrne, a physics lecturer at Sydney University, who became interested in adaptive optics four years ago. At first, he says, he simply had "an interest in playing the game". But an Australian Research Council grant of $170,000 in 1994, and a second grant of $330,000 a year later, enabled O'Byrne to assemble both the equipment and the people to do some serious work in the field.

He had two objectives in mind: "Produce a system that would enhance the observing efficiency of the AAT, and explore how effective adaptive optics was going to be at the AAT site."



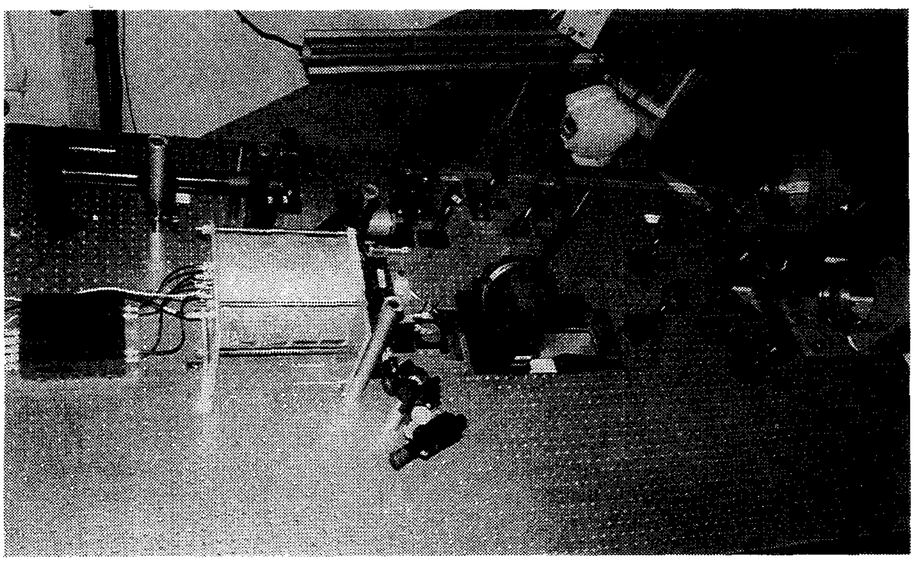
A close up view of the 'rubber mirror' set up, on the optical test bench at Sydney University.

How it's done

So how *do* you untwinkle the stars? The principle behind adaptive optics is straightforward, even if the actual techniques aren't.

A special mirror called a beam splitter intersects the beam of light produced by the telescope. Some of the light is sent to sensors that measure the location and amount of distortion in the image, while the remainder goes on to the science instrument. Before the light encounters the sensors, it's manipulated by special mirrors that correct for the effects of the atmosphere.

One of these special mirrors is called a 'tip-tilt' mirror. Its purpose is to re-centre an image which has been shifted by the atmosphere. As the image 'zigs', the mirror 'zags' and keeps the image in the middle of the field of view — ensuring all of the light makes it into the instrument. The shifting of the image is by far the more important factor to be corrected by adaptive optics.



The 'tip/tilt' image centring setup on the test bench at the Anglo-Australian Telescope Facility at Siding Springs. The large silver object at left is the quad sensor assembly.

In order to detect the location of the image in the field of view, the beam from the telescope is divided into four by a series of prisms called a 'pyramid'. The light from each of the four quadrants is focussed onto one of four photomultiplier tubes, which count the number of photons in each of the quadrants.

If the image isn't perfectly centred on the field of view, more light will be detected by one or more of the photomultiplier tubes. A computer measures this discrepancy and commands the tip-tilt mirror to redirect the light more evenly onto each tube.

"Essentially what the computer wants to do is even up the number of photon counts in each quadrant", said Julia Bryant, a post-graduate student who joined O'Byrne's project two years ago. "The mirror is mounted on four piezoelectric 'pistons'. By varying the voltage to the pistons, the mirror is tilted to redirect the beam."

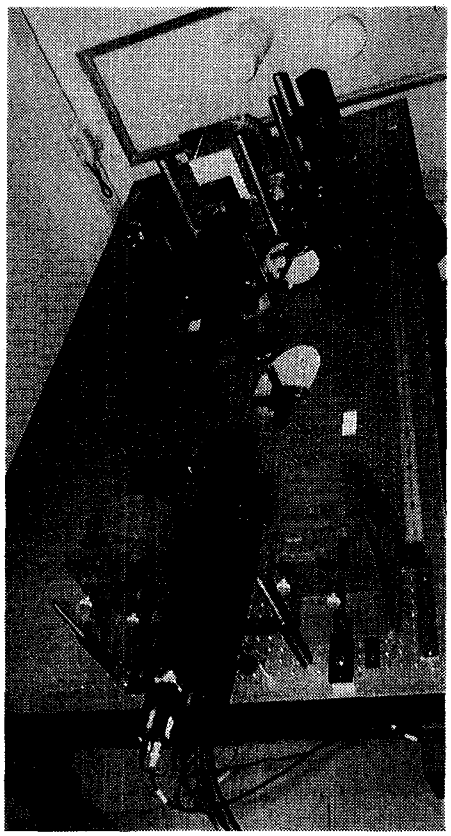
The use of a tip-tilt mirror offers astronomers an added bonus. "The tip-tilt mirror nominally corrects for seeing, but it also corrects for telescope pointing", according to Bryant. "Even though we're using a telescope like the AAT (which is renowned for its pointing accuracy), there are minute drifts in positioning throughout an observing run. The tip-tilt mirror will correct for that as well."

To counteract the blurring of the image, adaptive optics uses a deformable mirror, sometimes called a 'rubber mirror'. Unlike ordinary astronomical mirrors, deformable mirrors flex and bend in discrete places on their surfaces.

You can make a crude deformable mirror from any shiny, flexible material such as aluminium foil. By gently bending the foil, you can create a distorted image of everything around you. In adaptive optics, however, the demands on the accuracy of the surface deformation are extremely high. The rubber mirror has to flex in such a way that the distorting effects of the atmosphere are counteracted precisely, so a sharply focussed and distortion-free image is produced.

The rubber mirror is made from two wafers of piezoelectric material, that sandwich a layer of electrodes. The computer varies the voltage applied to each electrode, which in turn flexes the segment of piezoelectric mirror directly above it. The end result is that whatever the atmosphere does to the image, the rubber mirror does the reverse.

The computer decides which segment of the mirror is to be distorted, and by how much, based on the amount of distortion of the image. This distortion is once again measured by counting the number of photons in each segment. The light from the telescope is subdivided by an array of tiny lenses that focus the light from discrete segments onto optical fibres.



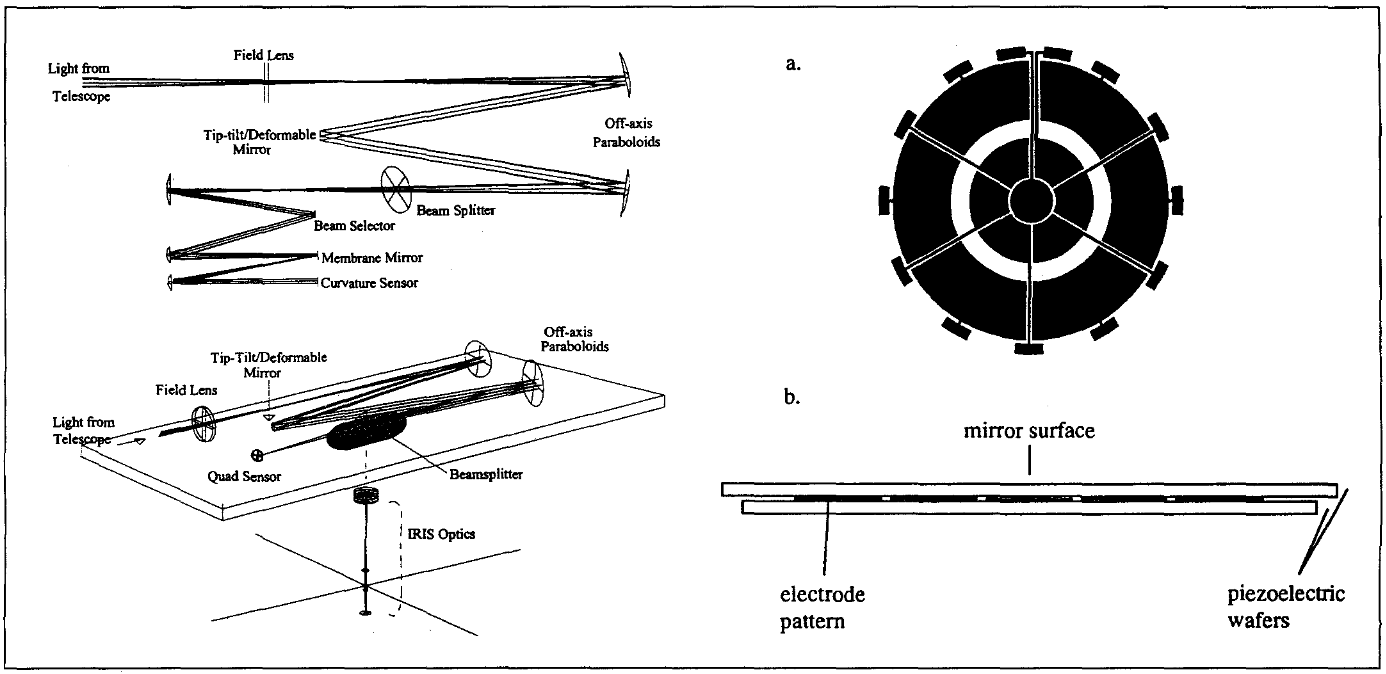
Another view of the 'tip/tilt' optical assembly at Siding Springs. The two blue objects are the off-axis paraboloid mirrors.

The fibres carry the light to a collection of avalanche photodiodes, that once more play the photon-counting game. The computer analyses the intensity of the light coming from each segment and determines the distribution of photons. Once again, it's the computer's job to even up the score — something Bryant describes as a "computing nightmare, but it can be done."

The astonishing thing about adaptive optics, however, is the speed with which all this occurs. Even a casual glance at the night sky reveals just how quickly stars twinkle.

To keep up with the atmosphere, an adaptive optics system has to perform the necessary measurements, calculations and mirror adjustments a thousand times every second.

To be able to do all this, however, an adaptive optics system needs a bright enough guide star in the field of view, to feed the sensor. "The problem with most systems is that they're attempting to produce a very high level of correction by using a sensor that's divided



The diagram at left shows the 'tip/tilt' adaptive optics assembly used for image centring, with the plan view at top and a perspective view below it. At right is shown the construction of the piezo-actuated 'rubber mirror' used to clean up the images themselves.

into a whole lot of little bits", explained O'Byrne. "But each little bit needs to be supplied with light. You've got a finite amount of light coming through the telescope (from the reference star), so the more ways you sub-divide it the fewer photons each segment ends up with. The result is that the sensitivity tends to be awful."

For a sensor on a 4-metre telescope you can achieve tremendous results by having hundreds of segments — if you can find a comparison star in the field of view that's bright enough to feed the sensor enough photons. Each segment in the sensor receives only a small portion of the total amount of light, "...about as much as you'd get out of a 10cm telescope", explained O'Byrne. "The rest of your telescope is feeding other bits of the sensor." On top of that, the system is making corrections a thousand times a second. "You rapidly run out of photons!" said O'Byrne.

The problem is worsened by a shortage of suitable reference stars. Even a casual glance at the night sky will show you there are fewer bright stars than faint ones. The same is true for telescopes like the AAT, which peer deeper into the night but have correspondingly smaller fields of view. The result is it's rare to have a bright enough reference star in the same field of view as the object you want to study.

Make your own reference?

One solution to the problem is to make your own reference 'star'. By sending a laser down the business end of a telescope, the optics of the instrument work in reverse and project a beam of light into the sky.

The laser light reacts with the atmosphere to create an artificial star image, that the telescope can then monitor. Since the beam is travelling through the very stuff the system is designed to correct for — air — it's distorted in exactly the same way as the incoming light from the distant stars. By using this method, the adaptive optics system basically has a reference star wherever it looks.

There are problems with this, however, such as the fact that such a laser can have serious detrimental effects on anyone looking out of a plane window, should it cross over the beam of the telescope. Then there are other astronomers using telescopes nearby — your artificial reference star is fine for you, but it's basically just another form of light pollution for your colleagues.

Faced with a shortage of bright guide stars, O'Byrne has decided to follow a different path to other adaptive optics projects. "We keep the number of segments low," he said. By using a rubber mirror with fewer segments, 13 in this case, more light can be analysed by the sensor.

While this means the correction for the blurring of the atmosphere may be less effective than a system with hundreds of segments, it leaves more light for each segment's sensor — allowing astronomers to use fainter reference stars. "That gives us much better coverage of the sky, simply because there are more faint stars to look at", said O'Byrne.

Eventually, the tip-tilt and deformable mirror requirements will be combined. By mounting the deformable mirror onto the four piezoelectric 'pistons', the scientists hope both processes can be handled at once — which cuts out one of the mirrors and so reduces loss of light.

So far, all adaptive optics systems, including the AAT's, are working in the infrared rather than the optical. The reason is simple: the demands placed on the system by infrared are much lower. "It would be great to be able to do good adaptive optics in the optical, but nobody is really claiming very much success in that respect at the moment", said O'Byrne. "We're all going for the infrared."

The beam splitter used by the system therefore has to be highly reflective at infrared wavelengths, but transparent to visible light. This means that most of the infrared collected by the telescope can be passed on to the tip-tilt/deformable mirror and then on to the science instrument, while the optical is siphoned off and sent to the sensors.

"For a long time, the AAT has been one of the largest telescopes in the world. That's now changing, with the new generation of 10 metre class telescopes", says O'Byrne. "If the AAT is going to survive as a front-line facility, it will have to carve itself an appropriate niche. One of the things it should be doing is improving efficiency by the use of adaptive optics."

The tip-tilt mirror phase of the adaptive optics system became operational in October 1995, while the deformable mirror will follow in 1996. When the system is operating it will sharpen the vision of an already superb optical instrument.

In closing, I would like to extend special thanks to John O'Byrne and Julia Bryant, for their assistance in preparing this article.

(Geoff McNamara is a freelance astronomy writer and Associate Editor for Sky & Space magazine.) ❖

Australian achievements in optical communications:

IMPRESSIVE RESULTS BY UNSW OPTO RESEARCHERS

Researchers at the University of NSW's School of Electrical Engineering, led by Professor Pak Chu (Head of Optical Communications), have achieved impressive results in three key areas of relevance to the future of optical communications direct to the home and office. The developments include a low-cost optical waveguide on a glass wafer, an on-chip mirror to swing a light stream 90° into a photodiode, and a low cost optical demultiplexer.

Professor Pak Chu (in front) with Ruo Fei Peng, a Laboratory Assistant working for UNSW's Optical Communication Group, shown keeping an eye on the production of a twin core optical fibre. (Photo courtesy Uniken.)

Researchers in NSW's School of Electrical Engineering have devised a simple method of making an optical waveguide on a glass wafer.

An optical waveguide is a device which guides a beam of light along a defined path, similar to the way a wire guides an electrical current, Inexpensive optical waveguides will be essential to the economics of delivering communications carried by optical fibre to the home.

Michael Bazylenko, a PhD student working with Professor Pak Chu, and Dr Mark Gross, a postdoctoral researcher in the school, have shown that they can make an optical waveguide by focusing an ultraviolet laser beam onto a wafer of silica (pure glass) that had been doped with a small amount of germanium, a semiconductor element similar to silicon.

The new waveguide thus becomes another device by which photons are steadily supplanting electrons as the means for transmitting and processing information.

It also becomes the latest of several potentially valuable devices that have been developed by electrical engineers at UNSW working with the Optical Fibre Technology centre at the University of Sydney, the Optical Sciences Centres at the Australian National University and Siemens Ltd.

All are members of the Australian Photonics Cooperative Research Centre.

Professor Chu said that the new process was less expensive than previous methods that required the silica wafers to be impregnated with hydrogen for up to two weeks, before they could be treated with a process that was less accurate than the new method.

"With our process," said Professor Chu, "we can construct a waveguide that is only eight microns (millionths of a metre) wide, and about 12 microns deep. This means a beam of light or a stream of photons, whatever you wish to call it, can be directed very accurately into optical or electronic devices."

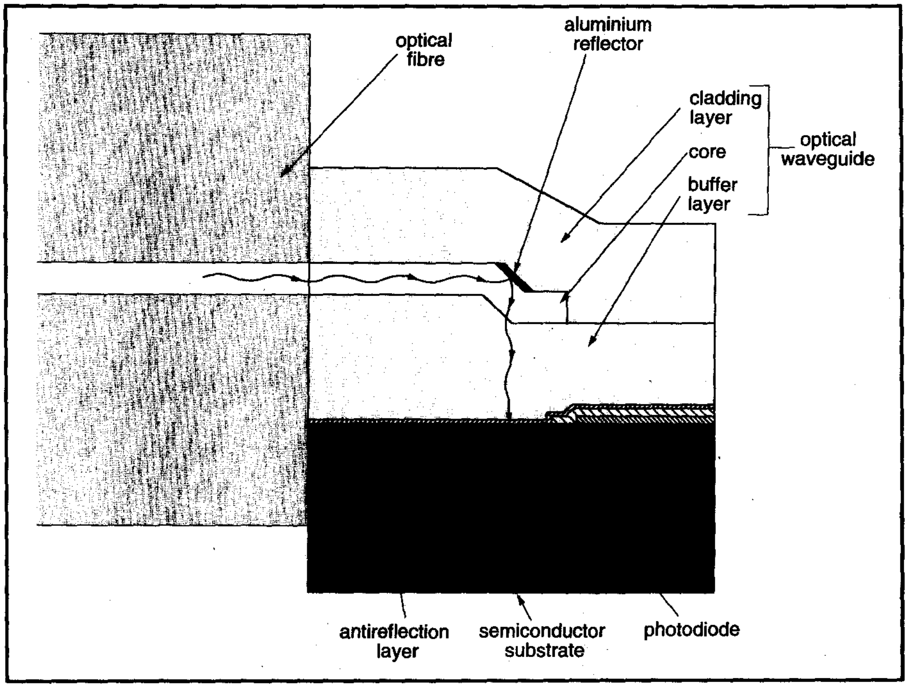
Another advantage of the new process is that parts of the waveguide can be erased by running the laser over the parts of the wafer that need to be altered.

Among the many possible applications of the new waveguide could be a simple-to-record device, similar to a CD-ROM but able to be rewritten.

Professor Chu said that his group was not yet certain why their process achieved the results it did. Part of the process had to do with placing the 5cm doped silica wafers under a compressive stress while they were illuminated with the UV laser.

'Doping' is a term for implanting small amounts of a foreign material into a host material, to alter its behaviour. The host material is usually a semiconductor, often silicon, and doping induces changes in the semiconductor that can be exploited by makers of computer chips and photovoltaic cells.

Researchers are now using doping techniques to create changes in silica and other materials that influence the behaviour of light in the materials. In this case, a process known as plasma enhanced chemical vapour deposition (PECVD) is used to dope the silica.

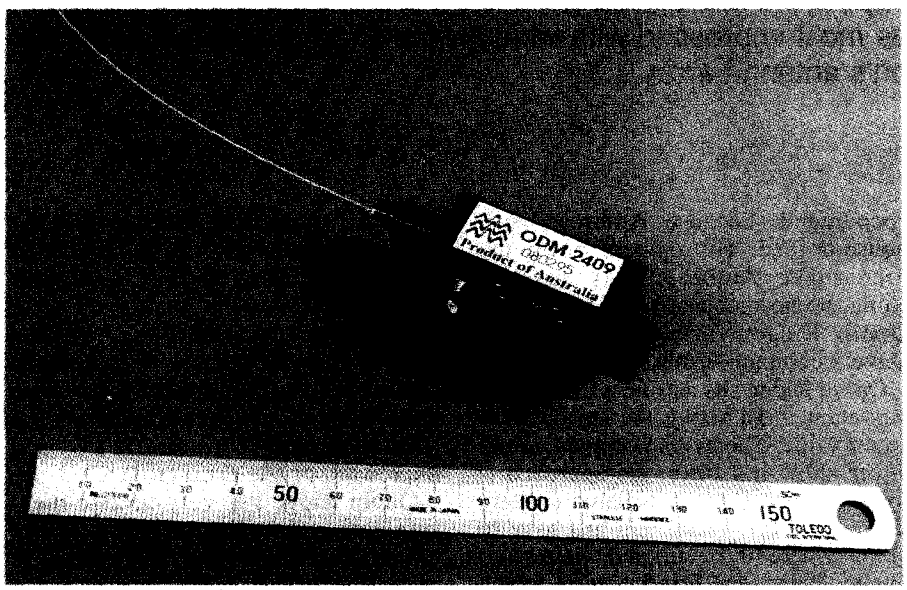


A diagram of the on-chip mirror developed by the UNSW researchers, to reflect light through 90° for coupling into a photodiode. (Courtesy Optical Communications Group, UNSW.)

Professor Chu said that two advantages of the new process were that it induced a change in the refractive index of the silica almost three times as large as had been achieved by other processes, and that the change was negative whereas other processes produced a positive charge. The negative change — reduction of the speed of light in the waveguide — could be expected to lead to other novel approaches, he said.

A built-in mirror

A device to reflect light signals from an optical fibre through 90°, so they can enter a photodiode, has also been developed by the above researchers and Erik Gauja, a professional officer in the School of Electrical Engineering.



This demultiplexer, pictured with optical fibre attached, could become the link between the home and the optical communications highway. Inside the 5cm package only about 1cm of twin core optical fibre is needed to separate two streams of light signals. (Photo courtesy Optical Communications Group, NSW).

The advantage of the UNSW device is that it can be made economically at the relatively low temperature of 300°C. Optical devices have been made at temperatures of 1000 - 1200°C and these prevented the integration of electronic components into the optical chip. The low temperature technique developed by the UNSW group is a crucial step for the manufacture of a monolithic opto-electronic chip required in future communication systems.

Again, a PECVD technique is used to deposit a highly reflective layer of aluminium at 45° to the light carrying core of the optical fibre, after a special technique has been used to produce a flat reflecting surface at the required 45° angle.

The device has been tested and as it can be made using only standard semiconductor fabrication techniques, it is amenable to low cost mass production.

The projection was supported by the ARC and ATERB, the Australian Telecommunications and Electronics Research Board.

Inexpensive demultiplexer

The third device produced in UNSW's School of Electrical Engineering could become an essential item in every home or office linked to optical fibre for phone, TV and other data services coming down the information superhighway.

The device is a demultiplexer, that will be necessary to separate the two optical signals that have been selected to bring all the above information to consumers.

Professor Chu explained that the device, which is only one centimetre long containing two identical cores, was attached to the optical fibre carrying different signals at 1.3 and 1.55 micron wavelengths. By a quirk of physics and much hard labour by the research group, one of the incoming signals has been persuaded to jump across from one core to the other. From this point, both optical fibres unload their now separated signals into two photodetectors, which convert the optical signal into an electrical signal that is then processed in the usual way by the telephone, television or other receiver.

"The optical isolation between these two channels is larger than 30 decibels optical, or 60dB electrical. No other demultiplexer can achieve such good separation but, more importantly, the cost of this device is very low because of the unique qualities of the twin core

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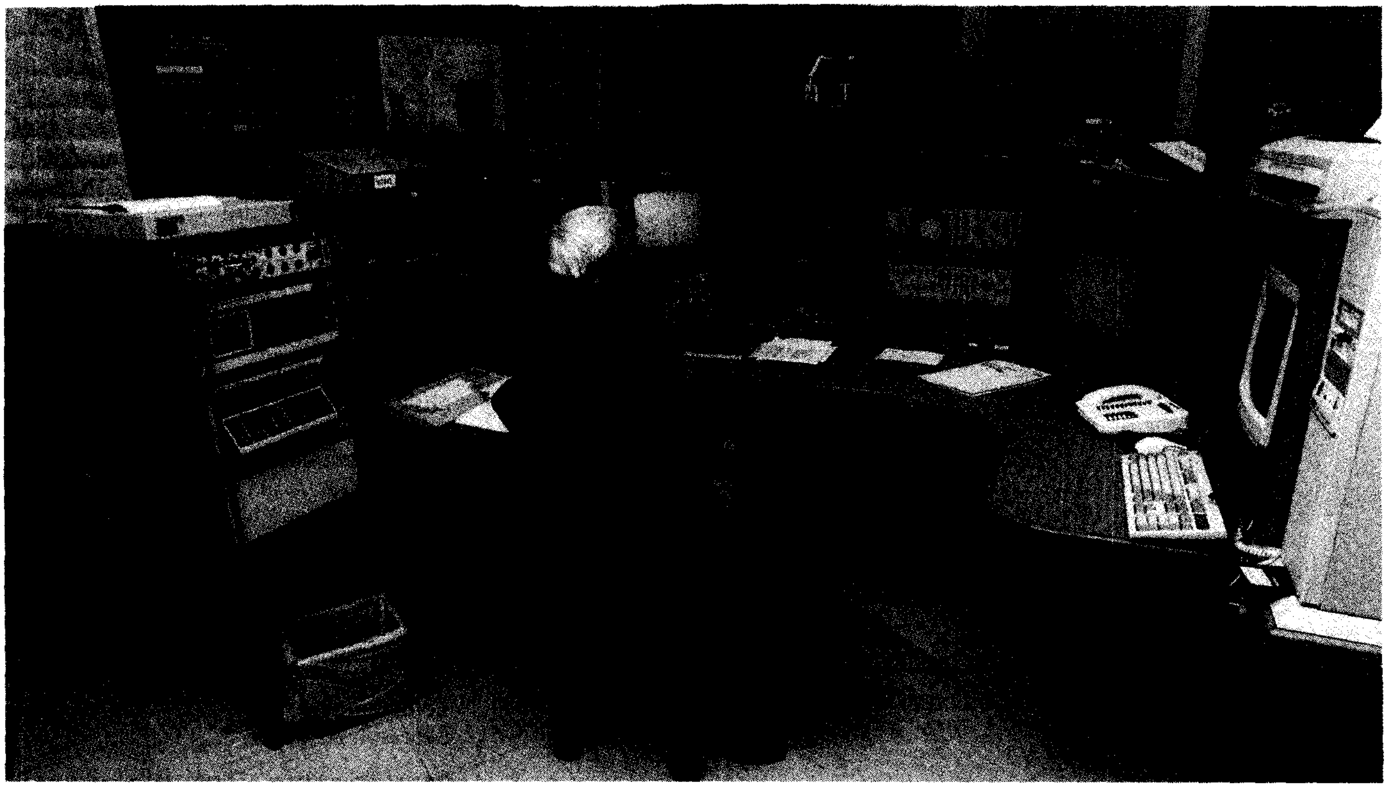


QUOIN RIDGE: SMA'S BIG EARS IN TASMANIA

Just before he left for the USA, Tom Moffat paid a visit to a part of Tasmania that few people have had the opportunity to visit — the Spectrum Management Authority's very important HF monitoring station at Quoin Ridge. He was most impressed with what he found, and especially with the reception possible using the station's antenna array...

by TOM MOFFAT

How would you like to have a radio receiving site so quiet that the only allowable approach to it would be on horseback — cars would be banned. Well, that's the first impression you get when you arrive at Quoin Ridge, the Spectrum Management Authority's super-quiet monitoring station near Hobart. Standing there in the parking bay is a horse. But he's not really for transport; a small jeep is parked nearby for that purpose.

The horse's name is Ambrose, and he's pretty good mates with Dave Thorne, Officer in Charge at Quoin Ridge. Ambrose doesn't just stop at the door; given half a chance he kicks the screen door open and steps inside. This behaviour isn't really encouraged, because Ambrose isn't house-trained. His owners down the road make Ambrose stay outside, alone. So he spends a lot of his time at Quoin Ridge, for warmth and for Dave's companionship.

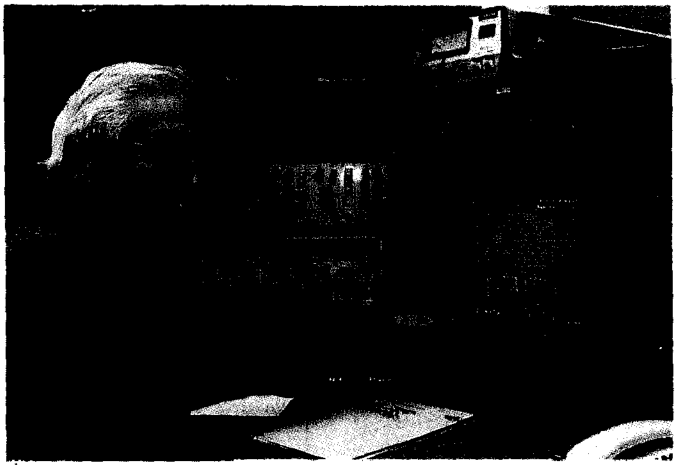
Quoin Ridge sits astride a flat-topped mountain, high above the surrounding countryside. The average person would never know it's there; the approach is by a dirt track off an isolated country lane. There's no sign; you just have to know where it is. Invited visitors to Quoin Ridge are faxed a map which reveals all, but for someone to just stumble upon the station would be very unlikely. Should that happen there are gates and early warning systems all along the road.

Given reasonable conditions, the receiving equipment at Quoin Ridge can hear just about any HF signal radiated anywhere in the world, and get a pretty good idea where it is coming from and how strong it is. The site radio noise level is -120dBm, so it can hear signals that would only be a dream in a suburban setting. (-120dBm is .001 of a microwatt, or one nanowatt!)

Quoin Ridge has very precise measurement capability, making it the only monitoring station in Australia to meet the strict ITU (International Telecommunications Union) standards. The number of similar stations in the world can be counted on the fingers on one hand.

Quoin Ridge has two primary purposes: tracking down interfering signals, and making very precise frequency and strength measurements on selected signals. Although it's mainly concerned with HF signals, the station can receive on any frequency between 3kHz and 1.5GHz. All modes are covered, from AM and FM right down to decoding individual channels on a multi-channel radioteletype system. So *nothing* can escape its attention...

Its radio-quiet status is what makes Quoin Ridge so important. Being high on a mountain (442 metres), the station is well isolated from ignition noise. The nearest above-ground power line is over 1km away; power is brought to the station via a shielded underground conduit. Since the site is flat, there is plenty of space — over 40 hectares — to install the gigantic antenna systems.



Quoin Ridge OIC Dave Thorne shows a spectrum analyser display of a 16 channel radio teletype signal. All channels are idle except for the one in the middle, which looks 'furry' with modulation.

Two main antennas

For HF receiving there are two main antennas. The biggest is centred on a 32 metre tower. Eighteen wires radiate out 150 metres in all directions, to three-metre towers at their far ends. Each pair of these wires forms a vee antenna, making nine in all spaced 40° apart. Each wire is terminated at the far end with a 470 ohm resistor, and thence to an underground return wire back to the main tower.

Each pair of vee-wires connects to a 470 ohm balanced winding of a ferrite transformer. The other winding, 50 ohms unbalanced, goes to a piece of low-loss 50 ohm coax running back to the station. So the output of the whole antenna system is nine runs of coax, each representing a different direction of reception.

Back at the station, each of the nine vees feeds into a wideband distribution amplifier with 10 outputs, so each 'direction' can be sent off to 10 different receivers, simultaneously if need be, with total isolation between the receivers. The distribution amps are made of VHF power transistors of the type used in mobile radio transceivers; the idea is to provide extreme dynamic range, so a received signal can produce as much as 20 volts at the antenna terminals without causing intermodulation with other signals.

Each receiving location thus has a feed from each of the nine vee antennas, and the operator can select which direction to receive from by turning a large 10-position switch marked in degrees — 10, 50, 90, etc. The array of vee's has a frequency range of 100kHz to 30MHz.

The other HF receiving antenna is basically a large upside-down discone, supported by four telephone poles and a network of wires broken apart with strain insulators. This antenna has been built to a very stringent ITU standard, so its sensitivity is known and carefully calibrated.

The cone can thus be used for direct field-strength measurements; if a spectrum analyser, for instance, shows something at a level of -130dB, then that's what the true incoming level is.

The output of the cone antenna goes to another wideband distribution amplifier, and it's distributed throughout the Quoin Ridge station just like the nine HF vee's. The cone comes up as position 10 on each antenna selector switch.

HF transmitters

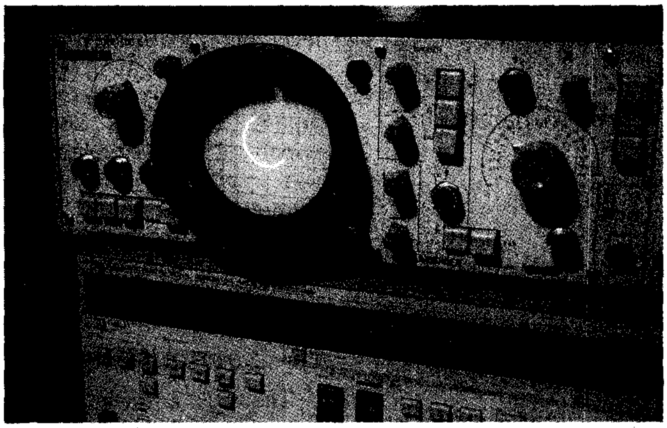
There is a further cone-type antenna, a Collins Low Angle multi-cone array, which is used primarily for transmitting in the range of 2-25MHz. The station has two all-mode HF transmitters of 200 and 1000 watts, which can be used for regulatory purposes such as asking a suspected unlicensed station to identify itself. The transmitters are also useful in distress or disaster situations.

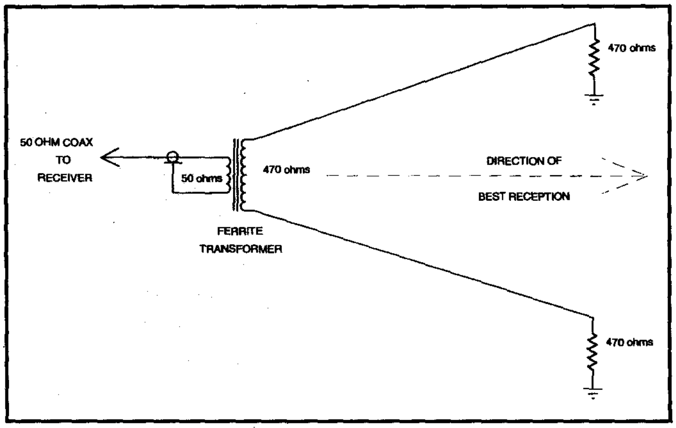
Although officially an HF station, Quoin Ridge also has VHF/UHF capabilities covering such services as marine, police, CB radio, and small boating. This is for southern Tasmanian use only, extending out to 100km or so.

The receivers within the Quoin Ridge station are enough to make any short-wave listener drool with envy. The one most used at the moment is an Icom R-9000, considered the king of all communications receivers. It, however, is

Left: The 'far end' of one leg of the vee array. The central tower is 150m away. Right: The 'upside down' discone, which forms the ITU FSI array.

Quoin Ridge: SMA's Big Ears in Tasmania





Above: Frequency measurement display of the VNG 2500kHz transmitter. The half circle display on the CRO is stationary, so VNG is on frequency. Right: How the 'Vee' antennas are used.

'under evaluation' and will probably be replaced with something else equally flash at a later date. The SMA is swapping them around, to try to find the 'best' communications receiver available in Australia.

Just above the R-9000 sits an Icom R-71A, the same one I use for my own development work. They're joined in the main console by a rather yummy-looking Racal model. There is a secondary operating position in another room, also serviced with the 10 antenna feeds, and still more antennas go into a lab area.

Tracking 'em down

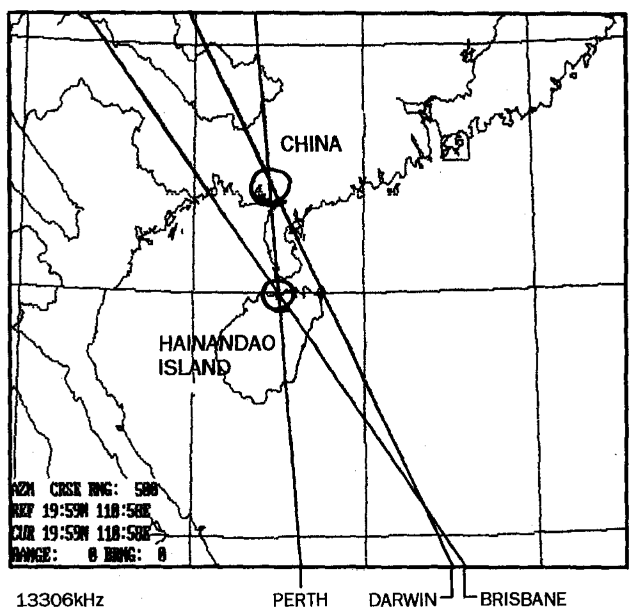
The day I visited Quoin Ridge there was a big Australia-wide operation under way to find the source of some interference affecting a world-wide aviation channel on 13.306MHz. This channel is used extensively by air traffic controllers in Perth, to communicate with aircraft flying to Singapore, Cocos Island and other parts of Asia. The channel was getting so messed up that the air traffic controllers finally issued a 'Critical Service Failure Notification' and the SMA swung into action.

Every hour on the hour, a woman's voice came up on 13.306MHz SSB and said, in Mandarin, "THIS IS JUHAI. THIS IS JUHAI". And a few moments later, again in Mandarin, "NOTHING, GOODBYE". This occurred like clockwork, and later increased to every half-hour. The response was always "nothing", never "something", and it sounded very much like a test of some service that might later expand its operation to obliterate 13.306MHz completely.

Australia operates an interesting direction-finding network called Jackal. This consists of three 'blockhouse' stations at Perth, Brisbane and Darwin, in addition to Quoin Ridge. The blockhouses are simple concrete huts containing remotely-controlled direction finding equipment, working from 1-30MHz. Because of their three-point wide physical separation, the stations can do triangulation fixes near Australia with deadly accuracy (watch out drug runners!) and with excellent accuracy further afield.

The blockhouses are normally operated by SMA staff in their home cities, but is also possible to telephone the huts directly from Quoin Ridge to take control of them. Although Quoin Ridge coordinates interference searches, in the case of JUHAI, most of the work was done by SMA staff in Perth. It was they who organised bearings to the

Left: Dave and Ambrose — best mates at Quoin Ridge. Right: Computer printout of the direction finding 'fix' on the 'Juhai' signals.



JUHAI transmitters from all three stations and then faxed the results to Quoin Ridge, where a computer system is set up to use observed headings to pinpoint the interfering signal.

The JUHAI transmitter worked out at two locations. One was at the city of Haikou on the Chinese island of Hainandao. The other was on the Chinese mainland, about 200km north of Hainandao, near the city of Zhanjiang. Two location indications could have been due to several causes; perhaps there were actually two transmitters, or the one transmitter could be moving from one location to the other, or maybe there was just some screwy propagation.

Still, China was proved to be the culprit one way or the other. Once all the evidence is finalised, the SMA will write up a 'harmful interference complaint' and give it to the Chinese authorities. Dave Thorne says it's entirely possible the authorities themselves don't know about the JUHAI transmitter. They are members of the ITU, so he is confident China will cooperate to have the offending station removed.

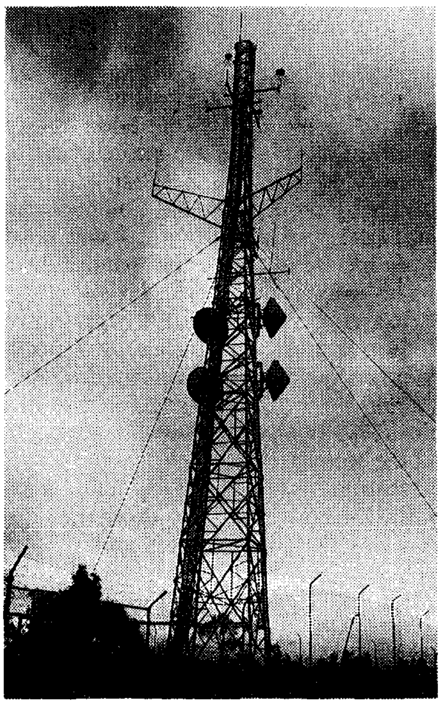
Frequency measurement

Quoin Ridge can measure the frequency of any signal it can hear, with the result based on a Rubidium frequency standard with an accuracy of 1 part in 10^{12}. Frequency measurement over an HF path is difficult, however, because of the fading and phase changes that cause the observed frequency to jump around.

So digital methods are out, and analog methods are in. Quoin Ridge uses a simple oscilloscope coupled to the human eyeball to determine the frequency. The CRO is nothing more than an X-Y display, with a 1kHz sine wave applied to both the vertical and horizontal plates with a 90° phase shift between them. The result is a circle displayed on the screen, caused by the electron beam going round and round 1000 times a second.

To make a frequency measurement, an HF receiver is first tuned to the station in question. Then a signal generator, tuned 1kHz higher or lower, is mixed with the incoming signal to produce a 1kHz beat note. The audio thus developed is used to *intensity modulate* the oscilloscope's electron beam, such that peaks on the audio intensify the display and valleys on the audio cut the beam off. With the beam going round and round 1000 times a second, the display becomes a half-circle, with one half intensified and the other half cut off.

Should there be some difference other than 1kHz between the incoming signal and the local signal generator, the whole oscilloscope display will rotate one way or another. The operator then adjusts the signal generator frequency to make the display stop spinning, and notes the signal generator's frequency less the 1kHz offset. Both the 1kHz tone going to the oscilloscope's deflection plates, and the signal generator output frequency, are locked



VHF and UHF antennas at Quoin Ridge. The dishes are part of an Army microwave relay link.

to the station's Rubidium frequency standard. So the measurement result is traceable to that standard as well.

This all sounds easy in theory, but in practice most HF signals are knocked around by phase delays and multipath propagation and their own modulation. The result is an oscilloscope display that gyrates wildly, and a certain amount of human interpretation is required to establish when the display actually stops spinning. That's why they have *people*, instead of machines, as frequency monitors.

The photo shows a frequency measurement being made on the Australian time and frequency station VNG on 2.5MHz. It was chosen because during the day its signal is solid as a rock in Hobart — almost ground-wave performance with no fading or phase changes at all. This was the only station that would hold still long enough to get a good photograph. VNG staff will be pleased to know that they are correctly on frequency — 2500.00000kHz plus the 1.00000kHz offset.

Valves rule!

That made you sit up and take notice, didn't it? But my visit to Quoin Ridge showed me something in practice that many of us old-timers have suspected for a long time. Maybe we're about to start some more squabbling in the Forum column...

After our 'official' business was finished, Dave Thorne took me into the lab — where sitting on the workbench was an elderly GEC receiver type BTR400K, a 1970 model built on a REAL chassis with REAL valves poking out all over it.

"Listen to this!", Dave said, and he twisted the tuning dial. Up popped a low frequency air navigation beacon identifying in morse code FLI — Flinders Island. "But you ain't seen nothing yet!", he said, and tuned it again. This time we got an airport at Sale in Victoria, and then Essendon, and then — Sydney! In the middle of the day, no less, on frequencies around 200kHz, and just about noise-free.

Admittedly that thumping big directional vee antenna had a lot to do with it. But then we went back to the main operating console and fired up the R-9000 receiver on the same frequencies. Yes, we heard the stations, but this time they were accompanied by various shrieks and whistles and buzzes, obviously caused by local broadcast stations.

In short, that old GEC boat-anchor KILLED the latest Icom in the intermod stakes...

That little demonstration led to a discussion of what Dave Thorne would really like to see as the main station receiver. A brand-new valve design, with tracked tuning in the front end, would be ideal. But if valves are a no-no, then perhaps something based on VHF power FET's as used in the antenna distribution amplifiers, as the front-end amplifier at least.

But is a 'modern' valve receiver impossible? They used to say that about hi-fi, didn't they. But now valve-based amplifiers are the latest thing, highly sought after by the audio elite.

Maybe, just maybe, someone like Icom or Yaesu or Kenwood could drag an old valve-receiver engineer and give him one more moment of glory. It would make a lot of people extremely happy, especially Dave Thorne! ❖

ONLINE, BUT NOT ON YOUR OWN...

All of the media hype on the Internet has tended to distract attention away from commercial online information services, like the long-established CompuServe and Apple's new eWorld service. Here's a look at what's available on these services — which nowadays also provide links to both the Net and its GUI domain, the World Wide Web.

by BARRIE SMITH

If you're close to the point of screaming at the sight of another story on — wait for it — the Internet, relax. This one is about other online services.

Like many, I jumped into online communication with little more than a modem, a service provider account and a disk of comms shareware — most of which was useless.

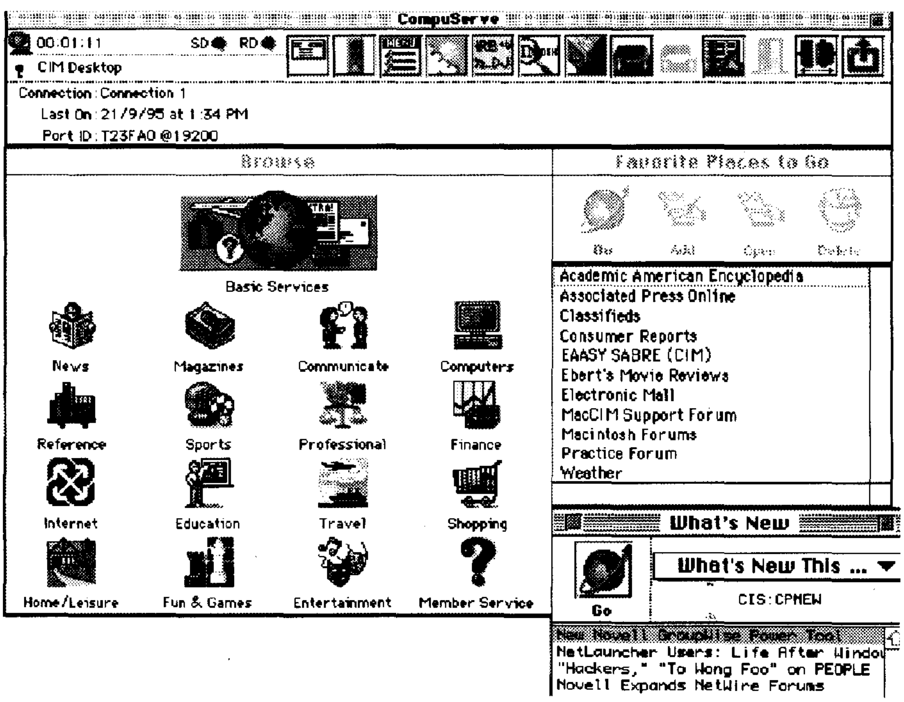
Getting my Net connection up and running, I began to see what all the fuss was about. But, sook that I am, after getting my fingers wet with the UNIX commands, I soon developed a deep and brooding aversion to any form of command line instruction — DOS included. But that comes from many years of GUI (graphical user interface) navigation on the Mac.

Then I tried CompuServe, now a veteran of some 25 years. Soon after, Apple's eWorld service appeared, which I embraced with gusto. What with my Ozemail provider account, CompuServe and Apple's slice of online, I was now triply literate in online communication!

The weight of services now truly across my aching back, it was fortuitous that a sudden influx of writing commissions appeared on my desktop; I could now not only pay for the services, but finally use them for research on the stories.

Getting myself in deep with both, I soon found two things: there was much of use to me; and it was easily accessible.

But with CompuServe I discovered it can be costly, unless you know where you are going. However, compared to swamping around on the Internet, digging into the commercial services for information turned out to be relatively quick, accurate and satisfying.



CompuServe's main window which appears at log on. The service claims to have 29,000 Australian subscribers.

CompuServe

This service is well developed and comprehensive. It is also very American in attitude and content — aside from a useful European slant, with some sites in French and German plus a UK component.

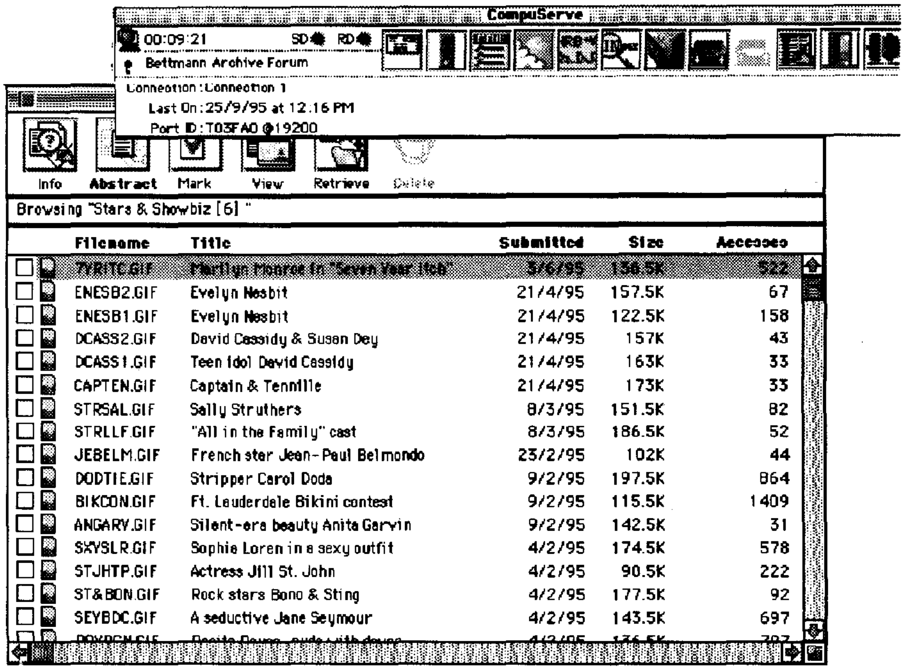
Here's an overview:

News, sports and weather are served well, from such press agencies as Australian Associated Press, Reuters and UPI as well as the main English newspapers (excluding Murdoch's), plus German and French press agencies. Editable text from these sites can be downloaded with little fuss — provided you follow through with each service's proclaimed copyright policy.

An interesting site is the Bettmann photo archives, with an amazingly wide catalog of images, begun in 1933 and now totalling 17 million images — from cave paintings to current news shots. Small (roughly 100-200KB) files that will print to A5 size on a 300dpi printer, they are available for personal use only.

Another is Archive Photos, holding 20 million images of all varieties. Again, downloading of small image representations is allowed 'for personal use'. Like a shot of Claudia Schiffer in a black tee shirt?

Magazines in all forms get a heavy run: naturally computer titles feature (*PC Week*, *PC World*, etc), as well as *Fortune*, *Rolling Stone*, *New Yorker*, etc. Unless you keep exhaustive files of major world titles going back many years you will find, as I have, access to these publications useful in tracking



One of the strengths of CompuServe is a wide choice of photo files. But copyright latitude is a moot point...

down specific articles and their publication dates. The interactivity is an attractive feature, allowing subscribers to make direct input to a publication.

Computer vendors operate major support and information sites: Lotus, Novell, Microsoft, IBM and Apple are all there, as well as dozens of others. With the current cost of telephone help to sort out hardware and software problems, you can expect to see this area grow. Major US publisher Ziff-Davis operate six sites; one is in French, another in German, while still another can be accessed to download shareware for both PC and Mac enthusiasts.

If you really want to move around, an unusual location on the CompuServe 'network' is operated by Magellan Geographix. Here maps can be selected and downloaded. Your basic online charge covers you for downloads of 'Basic Maps' of any area on any of the seven continents. Fire up the mouse and you can download limited resolution GIF images — with the usual copyright restrictions.

If you feel the need for a higher quality, vector-based (in Postscript) graphic map, you may find what you want in the site's MGDigital Atlas. The cost can be anywhere between US$50 - 400. Cheap they are not, but the advantage is that the map image files are editable and in layers.

Movies feature heavily on CompuServe. Less than four hours after the 1995 Oscar awards night concluded, some 38 stories were filed in the Reuters Variety news area — along with 40 GIF and JPEG graphics and clips from the winning movies. Enough to keep any Hollywood buff buoyant for a few months! Naturally, downloading megabyte-heavy movie files could lead to long hours at the PC — and a hefty CompuServe charge on your credit card.

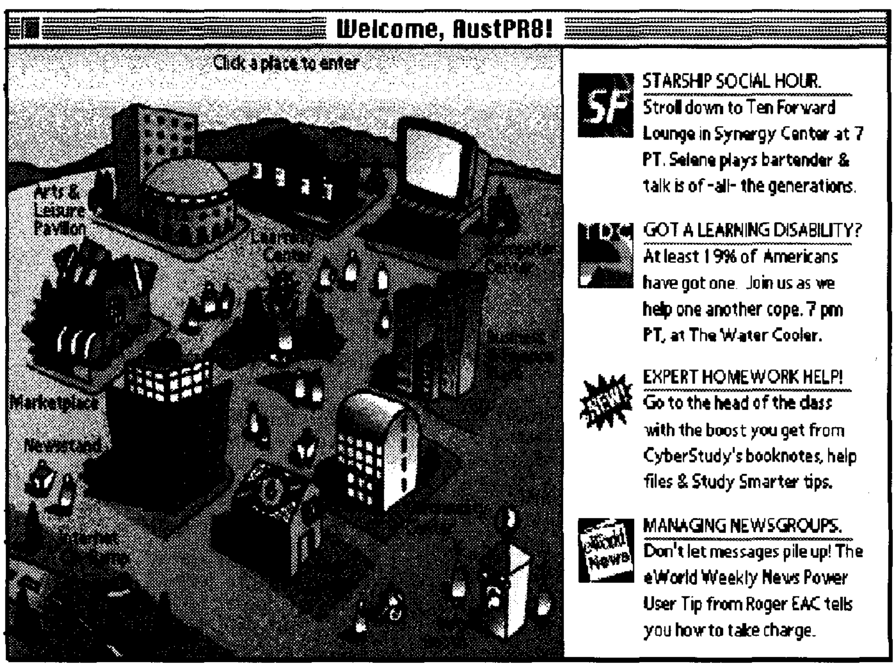
Online reference is becoming a useful tool for those with a pauper's library, or a slothful approach to dropping in at the local library. The main encyclopaedia on CompuServe (and eWorld) is Grolier's — adequate, but certainly no Brittanica in depth!

Professional forums are CompuServe's strength. I have had many happy hours poking around in my area of interest — broadcasting — and was mischievously delighted to pick up a thread of messages about excessive head wear in SP Betacam recorders.

Apparently, Sony changed the head formulation without telling anyone (except its own tape manufacturing facility); the result was that other tape companies were caught flat footed — and Betacam owners with worn heads — until 3M entered the fray and marketed a new tape!

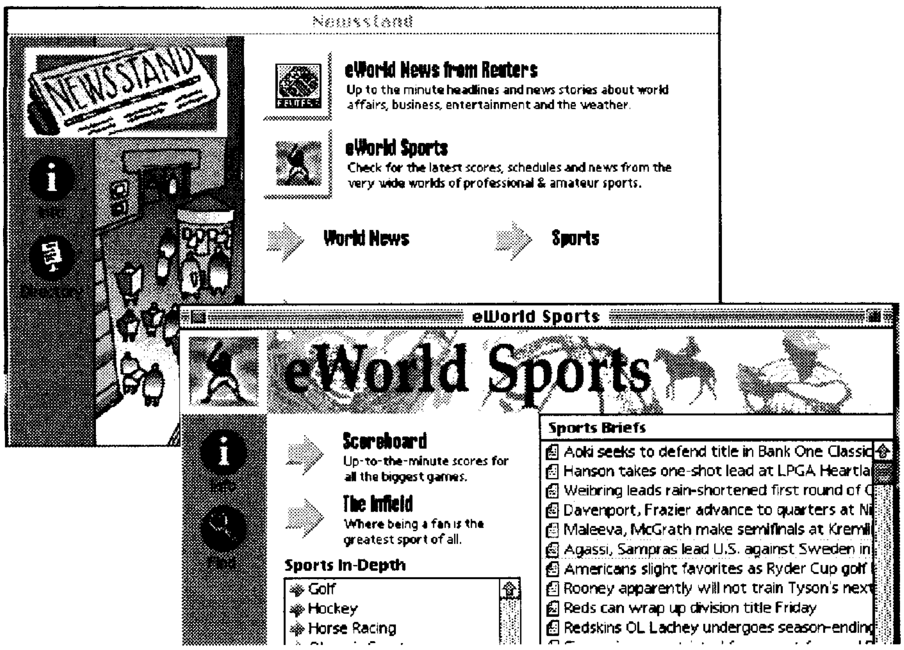
Online navigation

Navigation around the CompuServe service is fuss free. The initial graphic menu window is the starting point. Double clicking on any icon will move you into the area you want. But once past the pretty picture facade it's text driven all the way. The contents listings are depicted in long menus, supported by textual explanations. Moving to a site directly is very simple; a typed command GO BETTMANN will take you directly to the Bettmann Archive; GO UK PAPERS moves you into an area where you can peruse recent editions of *The Daily Telegraph*, *The Guardian*, etc.



Apple eWorld's main window. The graphics facade goes three menus deep, then text takes over.

Online, But Not on Your Own...



The eWorld 'Newsstand' graphics window. The penalty for such visuals is download time.

In this GUI facade, backed up by textual navigation, CompuServe differs considerably from eWorld, which carries graphics for three or four layers more until text begins. As a result, the former is considerably faster...

Member support is another strength. Once you're connected, and if you still feel out of your depth, you can tap into customer service in a quest for help in getting around. Or you can make billing enquiries, send a message back to base, etc, etc — all at no charge. CompuServe still sees the need to stuff subscribers' letterboxes with all sorts of paper publications in support — as well as a magazine, mailed each month.

CompuServe now also offers gateways to the World Wide Web and the rest of the Internet.

Despite a tip of the mouse towards kids in a few forums, CompuServe is a business/professional service that will fill many needs. But mind those extras!

Apple's eWorld

A cow of a name to type, with its initial lower case character, this service is the one to watch — until Microsoft's Network can display its strengths.

In many ways eWorld is complementary to CompuServe. Unfortunately, it may be a little too late on scene to garner any more substantial and attractive content.

The situation of various companies soaking up content to make a commercial online service viable and appealing has great similarities to the plight of local Pay TV operators, scrambling to sign up programme providers.

Apple have targetted their core market as 'consumer/home' and SOHO (small or home office) users. For some, eWorld will be a little too 'Mum and Dad', but the promise of Australian content will surely attract many subscribers.

The access software I tried before writing this story was in version 1.1, a little slicker, definitely more 'graphicy' than the launch version.

I have been a subscriber twice over the last six months or so, and each time found much of interest to me. But then my interests are fairly catholic; what eWorld does lack is information rich, professional content.

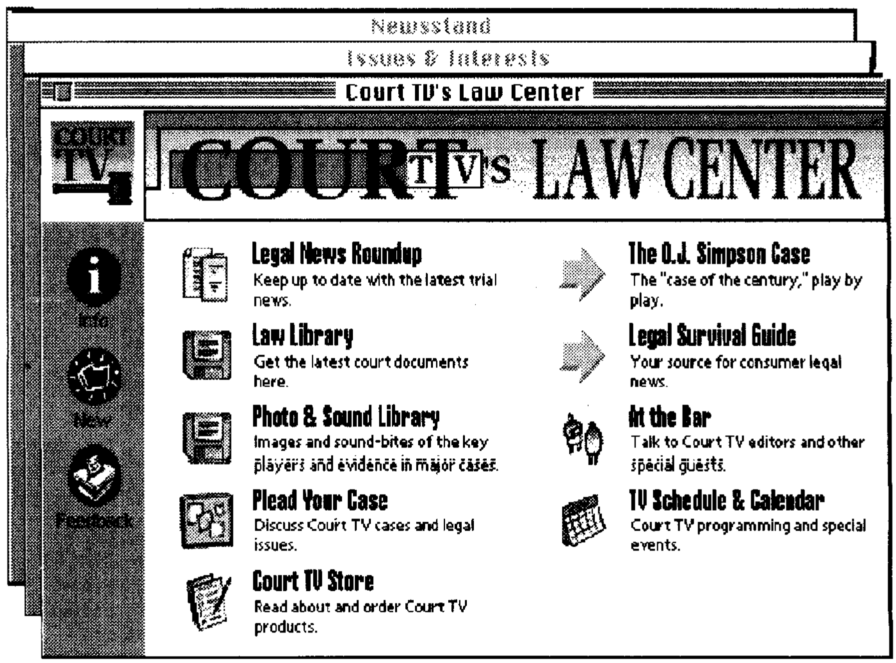
The much described eWorld 'town square' greets you on connection, complete with muted traffic sounds.

The current version features 10 sites, to lead you into its byways: News Stands, Marketplace, Arts & Leisure Pavilion, Learning Centre, Computer Centre, Business & Finance Plaza, Community Centre, Info Booth, eMail Centre — and the Internet ramp.

Concerning the latter, I was happy to find a special World Wide Web browser can be downloaded — with no connect charge.

I'm afraid you will find one or two of the eWorld sites a little too US-orientated, particularly the Learning Centre, complete with US college admissions info. But imagine its usefulness with a fully loaded Australian educational content!

There are some highly interesting projects for student level browsers. Some niceties on this spot relate to historical dates and images of personalities, all of which text and graphics you can down-



The eWorld 'Court TV Law Center' site, which was especially popular during the O.J. Simpson trial.

load; these don't appear to carry copyright burdens.

Another site that caught my eye was the Arts Pavilion, appealing for the movie or arts buff — but not the place where you can find handy tips on SP Betacam!

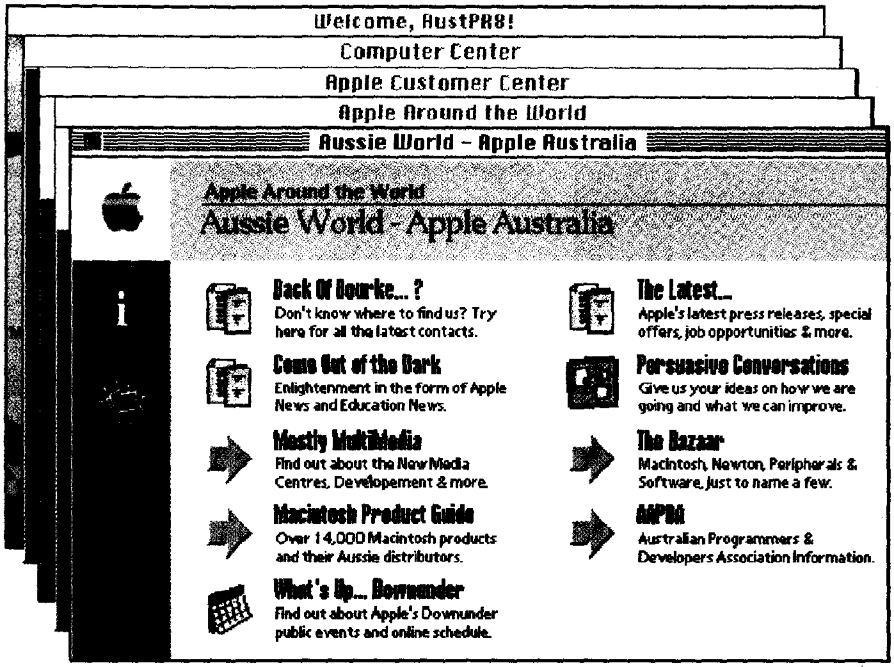
If you have children, eWorld (and possibly CompuServe to a degree) could be 'ultra safe' services to leave the kids to roam freely; the company claims the service is 'G' rated.

No porn — maybe the occasional nude, but little that will frighten the average parent. Just make sure the kids can't get your credit card details — or watch out for them scavenging around the beguiling shopping malls sprinkled around the service.

However, if you are researching a book on an arcane scientific subject, perhaps eWorld is a little too prosaic.

One irritating facet of eWorld is the highly polished graphic interface. While it is, admittedly, pleasing to click on dialog buttons on ultra decorative windows, the pain in the behind comes from the time the system takes to download each graphic — anything up to 30 seconds per window. But, once loaded, the graphics headers are stored in your eWorld folder.

I have to admit I'm a sucker for eWorld; it reminds me of those 500-page US magazines we used to get (before paper costs soared), replete with long articles and an advertising content of somewhere near 70%. Great to roam



The Australian sites currently available on eWorld. The company hopes to expand this area.

around in — and, in truth, eWorld is a delight to roam around in, with return visits repaying you with new delights at every mouse button click.

Conclusion

I am faced with the choice: CompuServe, eWorld, or my basic Internet service provider (which happens to be Ozemail). I like both of the commercial services very much; eWorld has much appeal and, if it grows in content over the next few months, it may well be my ultimate choice. But then I'm a Mac user — and there is much for devotees of the Apple Corp product.

Now that both commercial services offer a ramp onto the Internet, it means I could well do without my original service provider!

In closing, I would like thank Peter Sandys and Mike Fuller of eWorld and Subra Venkat of CompuServe for their help in compiling this story. ❖

CompuServe

CompuServe began as a computer time sharing service, in an effort to make an insurance office computer available for the use of down-at-heel programmers in out of hours 'downtime'.

Now the world's largest commercial online service, CompuServe has 3.2 million members — around 29,000 of which are in Australia.

The service is believed to be the market leader in terms of breadth of content. Its traditional users have been from the business sector, but now being discovered by SOHO and individual members.

In CompuServe's formative years no hardware or software was found capable of allowing it to do what it desired so it built its own. Using host machines based on VAX, it created its own operating system and also built its own network equipment.

Several dozen mainframe computers are used, plus a myriad of other host machines for special purposes, like a dedicated WinCIM (Windows CompuServe Information Manager) download machine.

Regarding censorship: it is against company operating rules to post any obscene material on the service. Forum operators will generally remove obscene material and warn the offending person not to do it again. Repeat occurrences will result in forum lockouts or loss of membership.

Australian content: aside from AAP, there are a number of other local content providers, and the company encourages people with ideas for their content to contact them.

eWorld

Currently 115,000 subscribers (as this article closed) are on eWorld globally. The base in the US uses Stratus servers with HP UNIX systems as mail servers.

Occasionally I had trouble logging on, due to traffic. I did find the slow download times at 9600b/s a bit annoying — how about 20 minutes for a megabyte! But Apple say they will soon lift this to a higher speed.

By the end of 1995, a Windows/DOS version of the comms software was scheduled to be available — which will be of some delight to the PC crowd.

One big advantage of Apple Australia being on eWorld is that you can hit them with questions and download system software without needing to overload the Pacific carrier.

Comparisons

Both services have a useful 'intelligent agent' feature, which can make daily downloads from the world's press on any subject of your choice.

In the US, there are over half a dozen commercial services. CompuServe is the leader. eWorld is now global and soon will be PC compatible. The question is, will either survive the arrival of an all-singing, all-dancing Microsoft Network?

When I Think Back...

by Neville Williams

Dr Ernest Benson: A brilliant career in electronics, academic and practical - 1

Such is the history of electronics that most of its pioneers became involved at an elementary level and gained expertise mainly by practical experience. But a few, like the late Dr Ernest Benson, concentrated first on gaining an initial foundation in physics, maths and electrical engineering — resulting in an exceptional appreciation of both the theory and the practice of electronic equipment design.

Having known 'Ern' or 'Ernie' Benson as a personal friend over many years, it was a shock to hear of his death and to read the notice in the *SMH* a couple of days later:

BENSON, John Ernest — August 2, 1989 (suddenly) at home (D.Sc.ENG) loved husband of Mavis ....

Ern had been an esteemed member of the Institution of Radio & Electronics Engineers (Aust), and an obituary was published in the *IREE Monitor* for March 1990, contributed by his fellow engineer, Neville Thiele. It was reprinted, with due acknowledgement, in the July 1990 issue of this magazine.

Then why this belated instalment of 'When I Think Back', in January 1996? Mainly because the memory of Ern Benson lives on, and embraces far more than could be conveyed in a one-page obituary. There were episodes in his career that I can personally recall and, with the passage of time, it is now possible to merge them with the published obituary, without embarrassment or conflict with the personal recollections of his family.

So here is the story of the Ernest Benson who will be remembered by many old-timers in the electronics industry, and by another quite separate group affiliated with the Anglican Church of Australia. Much of the information, and most of the illustrations have been made available by his wife Mavis and with the cooperation of his sons, both of whom are medical practitioners.

John Ernest Benson was born in Ryde, Sydney, on March 7, 1911, the only son of John Ernest and Lilian Benson. His father was an orchardist and property owner, as were his grandfather and great-grandfather. So it was that Ernest junior spent his boyhood ln a farming environment, with cows to be milked, a horse and sulky, fuel stove and grate, and kerosene lamps. The family had to wait patiently for the gas to be connected — and even longer for electricity!

Come Sunday and the Benson family would put on their 'Sunday best' and head off to St John's Anglican Church at North Ryde, where his father was Sunday School Superintendant. Young Ernest attended St John's until the age of 12, when he linked up with the larger Anglican church of St Anne at Ryde.

At a personal level, this provided a link when we met in later life. My parents also attended church each week in their Sunday best; my father too was Superintendant of the 'bush' Sunday School in Bargo, and I had been one of

Fig.1: A young John Ernest Benson poses on the family pony with his 'kid' sister Ruth Lilian, his junior by 15 months. They grew up in the 'bush' that once encompassed Sydney.

the kids. To the 'sceptics', we were both accepted as incurable 'wowsers'!

The 'bushie' fringe

If Ern's rural background seems inconsistent with his suburban address, one must allow for the fact that Ryde at the time was very much on the city fringe. Beyond it lay what what was then Sydney's 'food bowl' — a pattern of rolling hills, orchards, market gardens, dairies, poultry farms, family farms and timber mills, punctuated by tracts of native bushland as yet uncleared.

Fig.2: An old 'Box Brownie' photo of a live steam scale model of the 'Flying Scotsman' loco — An early indication that Ernie Benson had an aptitude for practical work as well as 'book learning'. Ern Benson is at right.

Ern's years at the Ryde public school would appear to have been a mixed bag, with a teacher problem costing him an extra year. However, when he finally sat for what we then called the 'QC' (Qualifying Certificate), he gained admission to the Sydney Technical High School in Albion St, Paddington. This was in 1925.

It was a tedious return journey from his home each day by foot, train and tram, but it was obviously the right kind of school for his temperament. He appears to have skipped second year and sat for his Leaving Certificate in 1928, earning a Teachers' College Scholarship deferrable over five years. For extra measure, a University Exhibition entitled him to be enrolled in the Faculty of Engineering, commencing in 1929.

This he took up, but after two years of Engineering, he transferred to Science and graduated with a B.Sc. in 1932, continuing his studies to completion in November 1933.

From December 1933 to February 1934 he did Honours Research under Dr Geoffrey Builder and Dr David Martin, in the Radio Research Board in the Electrical Engineering School. His Honours Thesis was titled 'The Cathode Ray Oscilloscope in Radio Research'.

Ern Benson graduated Bachelor of Engineering in Electrical Engineering (B.E.) with First Class Honours, in 1934. Ironically, all this study in Ern's home was done under gaslight, presumably from one of the original coal gas conversion plants that supplied Sydney. The electricity mains did not reach the Benson home in Arthur St, Ryde until 1939!

Professional hobbyist?

To this point, one might be excused for assuming that the former 'farm lad' had gravitated into the compleat academic — preoccupied by 'why so' rather than 'how to'. But in fact, while pursuing his very successful studies at 'Tech High' he had joined a school hobbies club and built a small slide-valve steam engine.

(I can relate to that because at one stage in my own rural boyhood, my ultimate acquisition had been a miniature steam engine, fired by methylated spirits. It would spin the flywheel like a top but, unlike Ernie's home made slide-valver, it lacked the power needed to drive separate models.)

This done, Ern joined forces with a school friend, Ken Nicholls and set about the construction of a 'Flying Scotsman' loco, live steam and scaled for a 2" track. It was completed during his early university years and necessitated the installation of a suitable track in the backyard of the family home 'Mascotte', in Arthur Street. The project culminated in a 'grand opening' attended by Ken Nicholls and C.A. ('Sammy') Coulson, their one-time metalwork teacher from Tech High.

I knew none of this until I read the notes supplied by Mrs Mavis Benson. But it helped explain why I had come to regard Ern as a very practical engineer, ready to come up with ideas but no less prepared to back them up with practical examples. More about this later.

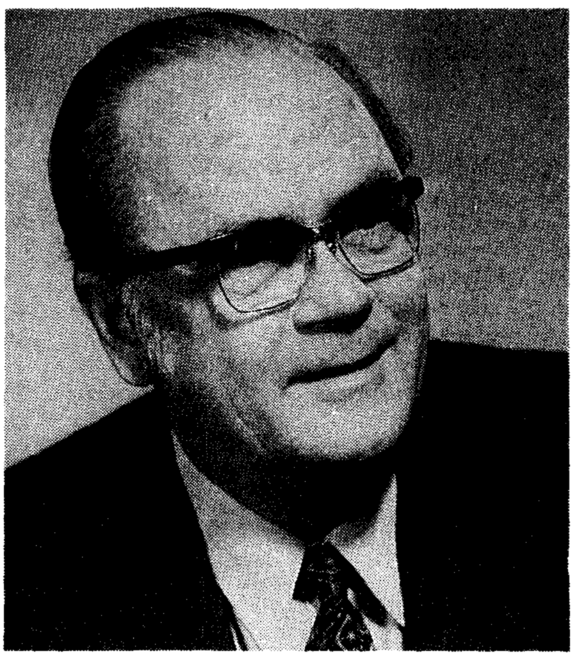


Fig.3: The Ern Benson that we knew at IREE meetings and other trade functions — and often plied with technical questions. Like fellow engineer Fritz Langford-Smith, he was also very active in Anglican Church affairs — from Sunday School teacher to a member of synod.

As it happened, 1934 — the year that Ern gained his honours degree — was a carry-over from the 'great depression' and appropriate vacancies were few and far between. He accordingly decided to take up the deferred teachers college scholarship, which was still valid — and emerged with a 2A Certificate from the Dept of Education, a Dip.Ed. from the University of Sydney and a letter from the Director of Education commending him for 'a meritorious college career'!

Classroom or lab?

Ernest did his practical teaching at Sydney Technical High, his old school, and duly received notice of his appointment to the High School at Lithgow, a mining town and rail centre on the western fringe of the NSW Blue Mountains.

However he apparently had mixed feelings about a teaching career and was still pondering the situation when he received a

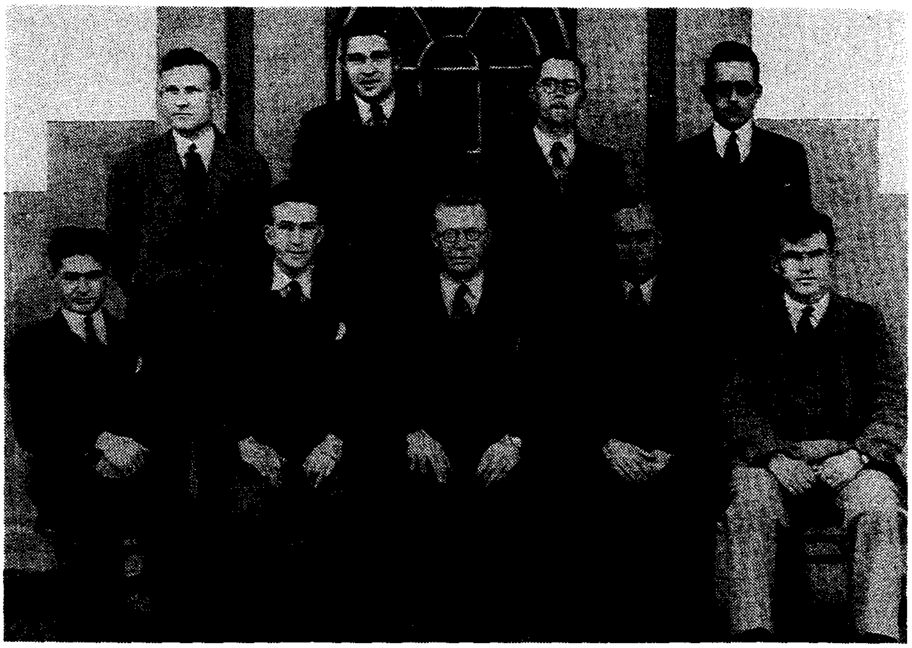


Fig.4: From EA files, AWA Research Lab staff in the 'good old days'. (L-R, standing): C.A. Saxby; G.R. Walters; J.E. Benson; H.A. Ross. (Seated): F. Maynard; R.M. Huey; Dr G.Builder; H.J. Brown; D.M. Sutherland.

call from his former mentor, Dr Builder. Dr B. himself had accepted a position with the Research Laboratory at AWA in Ashfield, and needing qualified support staff, had remembered young Ernest Benson. I gather that it didn't take young Ern long to make up his mind! This was in 1934.

At the time, there was considerable debate about the need for more accurate frequency control of AM broadcasting stations. In the early days of broadcasting, many transmitters used tuneable L/C master oscillators, adjusted to the best ability of 'techs' and inspectors — often without precision frequency meters! Listeners would notice aberrations and would protest *en masse* to the PMG Dept when ostensibly isolated stations appeared to edge too close to an adjacent channel.

The Government accordingly decided that all broadcasting stations should convert to crystal frequency control, thereby motivating AWA to document the problem and develop expertise in the production of precision crystals and crystal oscillators. This was at a time when crystalline quartz had to be sliced in certain planes, cut into rectangular wafers, then manually ground and/or etched to a critical thickness until each individual wafer exhibited a natural piezoelectric oscillation at a nominated frequency, when mounted in a suitably designed plug-in crystal holder.

It was a tedious task, with each crystal a one-off product, priced accordingly. How different from the present-day scene when tiny, precision crystals are used by the thousand in tuners and transceivers, and by the tens of thousands in accurate timepieces, ranging from ornate clocks to — almost literally — 'two bob' watches!

All about crystals

So it was that in December 1934, Ern Benson found himself in Dr Builder's Research Lab charged with the responsibility of clarifying the needs of broadcasters and the appropriate response of AWA in terms of advice and equipment. For several weeks, he spent long evenings in the lab listening to broadcast stations and tabulating the frequencies on which they were actually transmitting.

This led to ongoing work on crystals and their applications, culminating in a paper prepared for the IRE World Radio Convention (Sydney, 1938) entitled 'Precision Frequency Control Equipment using Quartz Crystals' by Dr Geoffrey Builder and J.E. Benson.

Unfortunately, although listed, the paper does not appear in my bound copy of the *Convention Proceedings* and I was denied a first-hand account of the work to that point. I gather, however, that Builder and Benson investigated various modes of vibration in quartz crystals and their further applications in remotely controlled receivers.

By 1945 Ern Benson had written some 10 further papers on these subjects, which were submitted to the Sydney University for an M.E. degree. This he gained with First Class Honours and the University Medal.

Ern was a natural writer and for the same reasons would no doubt have emerged as an outstanding teacher had he chosen that career. He had a natural ability to sense how best to introduce a given subject, and the sequence in which new and interdependent facts should be presented.

Almost as a matter of course he became the Editor of the *AWA Technical Review*, issued by the Research Laboratory and circulated to technical professionals in the local electronics industry and to contacts overseas. In a sense, it was a companion publication to *Radiotronics* and its related publications, devoted to valve applications under the guidance of Fritz Langford-Smith, a fellow professional engineer/author. Sourced from the same holding company, both publications did much to reinforce the image of AWA as a research organisation as well as being a manufacturer and a merchant!

A notable tribute

In his obituary (*EA* July 1990, p.16) Neville Thiele records that Ern Benson edited *AWA Technical Review* for 27 years, until he retired from AWA in 1975.

Referring to one of Ern's papers published in the IRE (Aust) *Proceedings* on the colorimetric principles of television (July-Aug, 1951) Neville Thiele modestly describes it as a 'lifelong model for at least one young author, for writing a technical paper'.

Meanwhile, at a personal level, I myself had joined AWA in 1936 and became a small cog in what was then a very large wheel. In the A.W. Valve Co. lab, I/we were only metres from where Ern Benson worked in the cottage-size 'Research' or 'Standards Lab' — call it what you will.

But we might as well have been in another world. We in the AWV lab reported for duty at the same time as most others in the Ashfield complex, arrived in the same buses or competed for parking places in the adjoining streets. We knocked off about the same time each evening and poured out through the same gates, scanned by the same uniformed security staff.

The research lab team, on the other hand, seemed to 'do their own thing', giving the impression that they were answerable to Head Office in the city rather than being an integral part of the organisation at Ashfield. Over the years, they came and went, as if by remote control.

Shortly after starting work at AWV, my attention was drawn to someone who had just pulled up in his car in the drive outside the Research Lab. "That's Ern Benson", I was told. "He's been specialising in quartz crystals".

Ern was conspicuous, not for his face or figure, but for the fact that the upper half of his torso was protruding from a 'Baby Austin' car. As I remember, it was classified officially as the 'Austin Seven', having a tiny seven horsepower motor. At the time it was the smallest — and lightest? — mass produced car on the road. Some called it the 'motorised pram'...

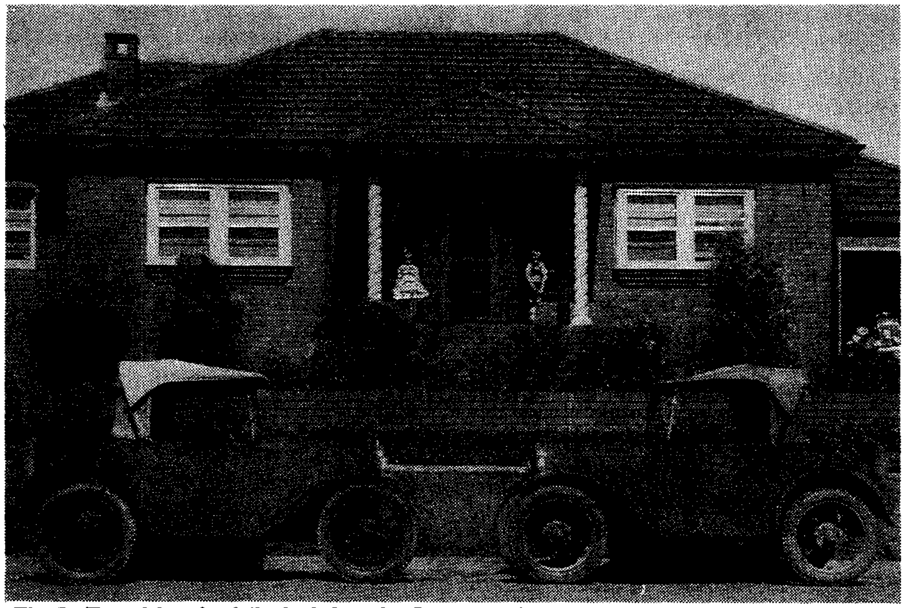


Fig.5: Two identical 'baby' Austin Sevens, the one on the right being the one which carried Ernest Benson to university and to work at Ashfield up to the mid 1950's. During the war years, they would make a little petrol go a long way!

Memorable vehicle

From then on, Ern Benson and/or his car became a familiar sight to me in the environs of the Ashfield complex. He seemed almost to relish the contrast between his tiny two-seater and the 'Gee Whiz' vehicles used by some of his peers. One, I remember, drove a French Delarge, weighing allegedly three tons! (Was my mind playing tricks when the name Don Connolly flashed before me?)

I mentioned Ernest and his Baby Austin to his wife Mavis, and suggested that he seemed almost to be making a statement of some kind. Said she: "I'm not sure about that, but he certainly continued to drive the Austin Seven until the mid-fifties. He reckoned he had the last laugh during the war with his Austin 'beetle', when motorists were rationed to a few gallons a month". She continued:

"Ernest used to drive his beetle to university, much to the good-natured amusement of this fellow students. On one occasion he came out of lectures, to find it on top of the steps of the P.N.R. building!" She didn't finish the story, but went one better by finding a picture of the original 'Ern-mobile', photographed outside their home with an exact duplicate owned by a friend.

Ernest's work with crystals led to a paper prepared in association with Ms Edna Dash entitled 'A Compact Piezoelectric Chronometer'. Despite the adjective 'compact' the finished clock used a standard 19" (48cm) wide panel, just on 1-metre high.

In its day it was a revolutionary concept, but such has been the progress with solid-state technology that I am wearing on my wrist an el-cheapo digital watch which my wife bought for me when I entered hospital over 12 months ago. It is waterproof, runs from an inbuilt cell, displays the year and date on demand, shows the time — which is still spot-on after 14 months — and it cost around 10 dollars. (Not worth pinching!)

Christmas chimes

That Ern Benson did not have a one-track mind became evident in 1940, when worshippers heading for the Christmas Morning service at St Anne's Anglican Church at Ryde were amazed to be greeted by the sound of a carillon, emanating from the normally mute stone tower.

It transpired that the Rector (Mr Stubbin) and Ernest Benson had 'got their heads together' and set up a public address system in the tower, fed from an amplifier, a phono pickup and a selection of records carrying chime music. To both rector and congregation, the sound brought just the right atmosphere to the occasion.

Then in 1943, the parishioners made a presentation to Mr Stubbins to commemorate the 21st anniversary of his induction as Rector of Ryde. He, in turn, handed the cheque back to the Church wardens to be used towards the purchase of a set of orchestral chimes.

It fell to the lot of Ern Benson to translate the gesture into a reality, beginning with the purchase of a set of tubular bell chimes from the Premier Drum Co (UK), suitable for keyboard operation. Ernest himself devised the mechanism and constructed the keyboard in memory of his mother, Ethel Benson. A fellow parishioner, Mr L. Vincent constructed the console.

Electronic pickup from the tubular bells and an amplifier feeding loudspeakers in the tower completed the installation. The loudspeakers were AWA public address flared horns, fitted with multiple drivers. The installation was dedicated on February 27, 1944 by Archbishop Howard Mowll.

AWA subsequently commercialised the design and installed an electronic chime carillon in about 25 churches, including Lithgow, Singleton, Scone, Hurstville, St Matthew's at Manly, and the Roman Catholic church at Darlinghurst. One was even shipped to Bombay in India. An AWA model was also installed in St Anne's, and the Benson original was presented by the Church to the Cathedral of the Holy Spirit at Todoma in the Diocese of Tanganyika — half a world away.

Special occasions

At a professional level, the Chime Carillon was played at the Melbourne Town Hall by Professor Bernard Heinze. Also by Professor D.R. Peart, Professor of Music at Sydney University, from an installation in the AWA tower atop their Head Office building at 45 York St, Sydney; the occasion was the birth of Prince Charles. How time passes!

Broadcast on short wave over Radio

Australia, the Melbourne performance was heard by Garth Major of the Antarctic Research Expedition on Macquarie Island. Reception was verified by cable to the AWA Melbourne office.

Commercial production of the carillon has since been terminated by AWA by reason of reorganisation and rising labour cost. The installation at St Anne's in Ryde is still functional. It was silent for a while for lack of an experienced player, but the role has since been filled — again — by Mavis Benson on Sunday mornings, in memory of her husband.

A practical advantage of the electronic carillon, she says, is that, unlike their traditional counterpart, the loudness can be moderated — out of consideration for neighbours who may want to sleep in on Sunday mornings! The observation reminded me of an alleged conversation between two neighbours in an unspecified English village:

"Beautiful bells aren't they?"

"Sorry — I can't hear you!"

"I said: the bells are beautiful — so much a part of the English tradition."

"I'm afraid it's no use. I can't hear you for those (adjectival) bells!"

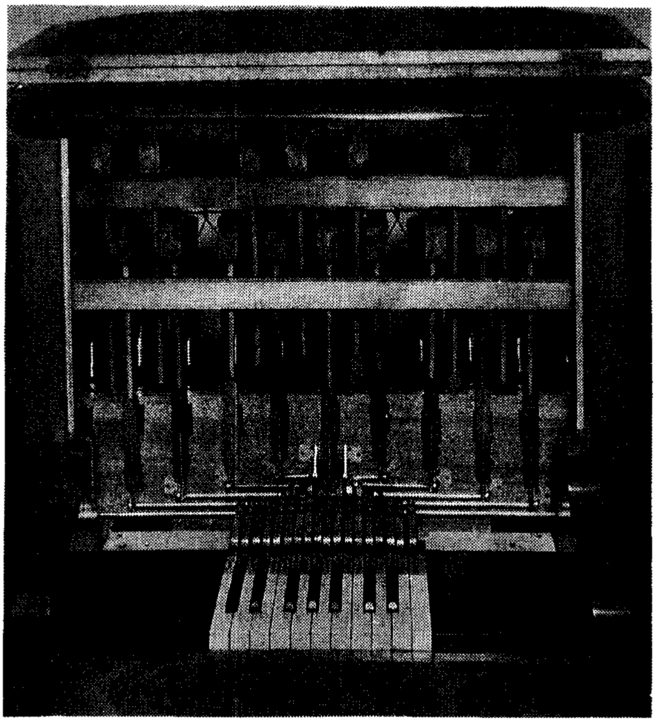


Fig.6: The 'works' of Ern Benson's keyboard carillon installed and still operating at St Anne's Anglican Church in Ryde, NSW — played by his widow, Mavis. The design was commercialised by AWA.

Taste of the future

I round off this first instalment with a reference to the first occasion on which I walked into the Epping Baptist Church, reportedly the largest Baptist church in Australia. It was full to the doors, but I was immediately impressed by the effectiveness of the PA system. It was crystal clear, with not a hint of feedback and with the voice appearing to come from the rostrum area.

A quick glance around revealed only one sound source — an oddly shaped enclosure bracketed into the area where the front wall merged with the ridge of the peaked ceiling. It was fairly large, but too far above the normal line of sight to be intrusive.

A tall narrow fret down the inner face of the enclosure betrayed the presence of (probably) four fairly large loudspeakers; it was clearly intended to project its wedge-shaped sound column towards the audience in the rear section of the auditorium.

Underneath, the sloping base of the enclosure carried a second, shorter column, focussed on the forward pews. Down below the enclosure was the platform carrying the pulpit and supplementary microphones, clear of the wedges of sound emitted by the columns above.

Textbooks tell us that human senses indicate to us the source of sound in the horizontal plane — left/right and front/back. We are much less sensitive in the vertical plane. The congregation at Epping Baptist simply accepted that the sound was coming from where the action was; they had no urge to quibble that the preacher was 'doing his thing' 50 feet in the air.

At the end of proceedings, I remarked to a church officer that "Whoever specified the PA system knew what he was doing!" His reply: "He's a local man from St Anne's at Ryde. You might know him — Ernest Benson."

Yes, Ernest Benson certainly *did* know what he was doing. He was to mastermind sound systems in some of the most important buildings in Sydney and Canberra!

(To be continued) ❖

Impressive Results by UNSW Opto Researchers

Continued from page 25

fibre we have developed. Also, integration of the demultiplexing and photodetection devices into a single package makes the unit very robust," Professor Chu said.

"If every home in Australia is going to be wired with optical fibre, it is not difficult to see the huge market for this device," he added.

As the principal investigator for the project, which received $1.28 million in GIRD funding, Professor Chu is looking for a commercial developer for the device, which, he estimates, could be manufactured for about $100.

Professor Chu said that the demultiplexer was robust enough for widespread application.

It is now ready for commercial production and Professor Chu welcomes inquiries.

Siemens has decided not to commercialise the product, due to the company's specialising in electronic (as opposed to photonic) technology and to a perceived bout concerning the speed with which 'fibre to the home' technology may be taken up by Australian markets.

In this project, Siemens paid for John Arkwright to work with the group. Professor Chu said that the link through Mr Arkwright to Siemens had been invaluable in defining Siemens' requirements and directing the focus of the research — which had produced numerous benefits for Siemens.

This project followed the highly successful project on twin core fibre optical switches supported financially by Siemens and led by Professor Chu and Professor Allan Snyder of the ANU.

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NEW BOOKS

Scope primer

FAST SERVICING WITH OSCILLOSCOPES, by M.C. Sharma. Published by BPB Publications, 1994. Soft covers, 234 x 180mm, 176 pages. ISBN 81-7029-409-6. RRP $19.95.

Another economy textbook from New Delhi (India) publisher BPB, this time an introductory book on the operation and use of modern scopes. The author says his aim has been to enable the scope user to use it more intelligently, and get the maximum out of it as a tool.

There are 17 main chapters, which start with scope basics and take the reader through the various sections of the instrument and how they work. Then follow chapters on probes, measurement techniques, troubleshooting, storage scopes, using a scope in conjunction with a counter, and choosing an instrument. A couple of appendices deal with scope performance parameters and measurement, and typical specifications.

Where particular instruments are discussed, there's a fairly strong emphasis on the particular instruments available in India. However apart from that, there's a great deal of general material that applies just as much over here. In fact on the whole, the book gives a very good basic introduction to the operation of scopes and how they're used.

I couldn't find any typo's, and there are plenty of neatly drawn diagrams — although only a few rather murky halftone pictures. If you're after a helpful but inexpensive introduction to scopes, though, it's well worth considering.

The review copy came from Jaycar Electronics, which stocks it as Cat No. BM-2488. (J.R.)

DIY monitoring

HOW TO BUILD EARTHQUAKE, WEATHER AND SOLAR FLARE MONITORS, by Gary G. Giusti. Published by Tab Books, 1995. Soft covers, 190 x 235mm, 290 pages. ISBN 0-07-025209-2. RRP $39.95.

This is a book about build-it-yourself equipment to monitor natural phenomena like lightning strikes, solar disturbances and earthquakes. The author is billed as a National Weather Service (US) spotter and longtime student of earthquakes and weather phenomena.

The book is divided into three parts, each with a number of chapters. The first part describes modular circuits and is a 'basics' section, aimed at beginners to electronics. Included are designs for a basic seismometer (with sensors), a seismic-flare receiver, a number of valve circuits (TRF radio, audio amplifier, geo-monitor) and some power supply circuits. At all times the author keeps the focus on monitoring natural phenomena, rather than just electronics.

The second, or advanced part includes details of a BFO seismic detector, a magnetic disturbance detector, a very simple ULF/VLF radio and an inductive energy field monitor. This part includes two chapters about earthquakes, mainly based around the United States.

The third part, called 'Maverick observations, theories and tools' details some case studies and theories, along with constructional details for some more equipment. It includes a Geiger counter, an interferometer and how to adapt a digital multimeter as the display for some of the projects in the book.

The appendices includes a list of basic electrical laws, US standard electrical symbols, component colour codes, very brief data on some popular ICs and components and a list of reference books.

In summary, there are over 40 projects to build. The most expensive project is costed at US$75, but most less than US$25. The book doesn't aim to teach electronics, but many of the projects are suitable for beginners.

The writing style is rather old fashioned, but is friendly and easy to read. The review copy came from McGraw-Hill Australia, of PO Box 239, Roseville 2069. (P.P.)

Caravan electrics

DAVE JEANES' COMPLETE GUIDE TO CARAVAN ELECTRICS, by Dave Jeanes. Published by Dave Jeanes, 1995. Plastic comb binding, 210 x 150mm, 88 pages. ISBN 0-646-21344-X. RRP $15 including P&P.

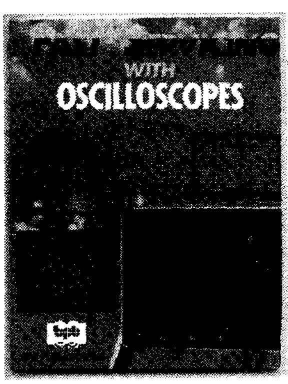
A handy little 'practical manual' from Australian author Dave Jeanes, whose earlier books *Marine Electronics Workshop Manual* and *Journey Around Australia* have been very popular. Mr Jeanes has also contributed various articles to *EA*, in the past.

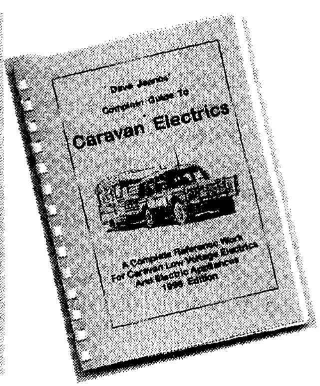
The idea of this new book is to give non-technical caravan owners enough practical knowledge of electricity, low voltage circuits and electrical appliances to be able to tackle mods, additions and of course emergency repairs, when trouble strikes in isolated locations.

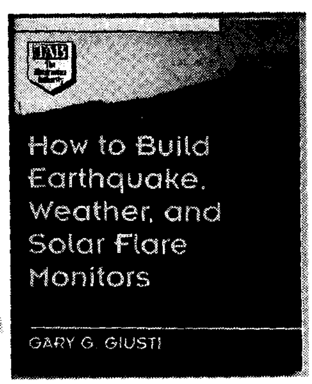
There are 12 chapters, which start off with basic electrical concepts and gradually progress through wiring, lighting and batteries to the various appliances — including fridges, TV and radio receivers, mobile radio and phones. There's lots of good practical information, which should make it of considerable value to those for whom it's written.

Mr Jeanes has written and published the whole thing on a PC using Microsoft Word and Publisher, and although some of the diagrams are a little basic, they're generally quite clear. Overall it seems good value for money.

Copies are available at the price given above directly from Dave Jeanes Books, PO Box 77, Tugun 4224; phone (075) 988 642. (J.R.) ◆

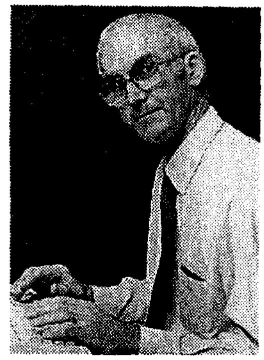






FORUM

Conducted by Jim Rowe



Why doesn't EA publish more micro-based projects — with full source code?

We're going to tackle a different, timely but also quite thorny subject this month: the question of whether or not magazines like *EA* should publish more construction project designs based on microcontrollers and similar chips containing 'firmware'. After all, say the pro-micro enthusiasts, this technology represents the real future of electronics. There's also the related question of whether we should always include the full source code listing for any firmware involved in such projects, to allow readers to learn more about its operation...

This is a subject that I've been concerned about myself for some time now, and I imagine that it's been exercising the minds of quite a few other electronics magazine editors as well. With microcontrollers and other programmable devices becoming more and more common in commercial electronics equipment, shouldn't we be publishing more construction projects using these same devices, so that our readers can learn more about them?

Unfortunately it's not quite as simple as that — I only wish it were. In fact it's one of those subjects that tends to open up all sorts of complex issues, as I'll try to explain.

Because these projects are based largely on firmware, or 'software in silicon', the conventional hardware side of the project often tends to become little more than a few unexciting-looking chips on a small board. The really 'interesting' part is the code buried inside the programmable chip — i.e., how the programmer managed to get the chip to 'perform the appropriate tricks'.

What this means, for a start, is that we're now talking about a different *kind* of electronics project from the traditional type. One where the interest and satisfaction (for readers and those who build the project) must come from understanding the code used to make the chip do the required job, rather than from understanding how the various components work together, to make a circuit which achieves a similar result.

Now I'm not saying that this makes such a firmware-based electronics project any less appropriate, or less worthy of publication than a traditional hardware-based one. Bearing in mind the directions in which electronics is moving — inexorably — that's clearly not the case. In fact you can easily argue that firmware-based projects are now more appropriate than the traditional type.

But they're clearly rather *different*. So different, in fact, that some readers and electronics DIY enthusiasts have indicated to us that they don't find them of much interest. They see them as exercises in programming rather than in building a piece of electronics, and they don't find this as satisfying. "Why don't you give us as many interesting little electronics projects as you used to?" they ask, "instead of these things based on yet-another-@#%$*@-programmed-micro?"

Another complicating aspect of the situation is that for magazines like *EA*, which still try to develop as many DIY projects as we can 'in house', these firmware-based projects always seem to take a lot longer to develop than the traditional variety. This means that essentially, they cost us more to develop...

Not only that, but when they are finished and we want to publish them, we then have to find ways to ensure that pre-programmed chips will be available, for the benefit of people who don't have their own programming equipment. As many people nowadays like to be able to buy a complete kit for any project they build, this often means talking at least one of the major kit suppliers into organising a chip-programming operation. This is something that understandably they're often not all that keen to do — it adds to the cost of producing kits, and if the kits don't sell, the programmed chips may not be easy to use for any other project.

What happens in a year or two's time, too — when the firm or firms who have originally agreed to do the programming may have decided not to program any more, because of reduced demand? Such a project can become 'too hard to build' much faster than one based purely on hardware...

Even publishing the firmware's source code listing in the magazine can be a problem, because it can take up a lot of space — often generating complaints that we're filling up our pages with 'boring computer programs'.

Other complications

On the other hand if we publish a project submitted by a contributor, using a programmed micro, there can be *other* complications. Because the firmware has often involved the author/designer in a great deal of work, they understandably want to get a reasonable return on this 'investment'. Often this means either that they want us to pay a lot more money than usual for the publishing rights (which would make them too expensive for us to pay), or that they want to retain the copyright for their firmware — and either sell the programmed micros themselves, as the sole supplier, or require a licence fee from any kit supplier who wants to make use of the firmware.

Needless to say, either of the latter options tend to make the projects less attractive to the main kit suppliers, who generally won't touch them. So both readers and advertisers tend to be rather less than enthusiastic, about such projects...

Starting to see what a complex subject this can be?

Actually the foregoing is all by way of a preamble, to two letters from readers

that turned up recently, dealing with different aspects of this subject. One is a complaint from a reader, asking why we don't publish more source code listings, while the other comes from an engineer/designer who had offered me a number of micro-based projects, and was understandably a little disappointed when I was only lukewarm in my response. When they both turned up in rapid succession, I decided that it was time we explored the subject here...

The first came from Mr Steven Pass, of Huntingdale in Victoria, who had this to say:

I have been reading various electronics periodicals for about 15 years, both local and international publications. In the last couple of years, I have noticed a disturbing trend, particularly in locally produced publications, from an educational to a profit driven content.

Many projects are now being based on microcontrollers, which is good to see. However virtually none of them include source listings, or the ability to download the listings, because the project writer has retained the copyright, etc. This forces the reader who is interested in building the project to purchase a pre-programmed device, and occasionally the PCB. Nothing is therefore learnt about microcontroller programming or its internal operations.

"The writer has put considerable time and effort into the project", I hear you say. True, however isn't that why you paid for the article in the first place? Didn't you pay for the rights to publish their work? Why should they, or even you, the publisher, monopolise the market for that project?

I used to see detailed listings and examples for all of the 'hi tech' projects. This is where electronics enthusiasts really learned their skills. Now we have to send off for a device where all of the hard work has been done, and we gain no new skills at all.

Why then, do other overseas publications continue to give their readers source listings, or at least the ability to download it from somewhere? They, obviously, are education driven. They actually want their readers to learn more from a project than just assembling projects onto a PCB and connecting switches and LEDs.

A few local attempts at educating the readers was made in the past, with microcontroller development kits, but these were never followed up. Why? With the increasing trend towards microcontroller based projects, why don't projects include the skills taught by the development kits?

I now find myself only purchasing your publication for 'The Serviceman', feature articles and the occasional non-microcontroller based projects. I sincerely hope this situation changes soon.

Thank you for taking the trouble to write about your concerns, Mr Pass. I can appreciate your general position, too — no-one can learn much from plugging in a pre-programmed 'black box' chip, if the code inside is kept secret. However some of your specific criticisms do seem a bit unfair, and perhaps based on either unrealistic or incorrect deductions.

For example you imply that magazines like *EA* have somehow changed from once being purely 'educational', to now being purely driven by profit. That's not true, of course — like all commercially published magazines, we've always had to make at least some profit in order to survive. What has changed, in recent years, is that nowadays we have a much harder battle in order to even survive.

All around the world, traditional electronics magazines like *EA* have been finding things tougher. Circulations seem to have been slowly falling, while at the same time advertising revenues have stagnated due to tightening economies in many of the developing countries like Australia. Paper costs have also been rising, quite dramatically. Nowadays we also have to compete on the news stands against an enormous range of other publications — including electronics magazines from overseas, and umpteen different computer magazines. All competing for the attention of our traditional readers, who seem to be fewer in number than they were. So survival isn't nearly as assured as it might once have been, and we simply can't afford to ignore this aspect.

Despite this increased pressure, though, we haven't forgotten or deliberately dropped our traditional role in helping readers learn about developing technology — after all, this is one of the reasons why people have wanted to read this type of magazine, and we wouldn't want to do anything that would make them lose interest in us. As I mentioned earlier, the problem has been that satisfying all of these requirements is simply not easy.

As you can see, Mr Pass also assumes that with contributed projects involving firmware, we should simply be prepared to pay the designer for all rights — so that we can publish and/or make available the complete source code, etc. Well, this might be feasible for overseas magazines with considerably larger paid circulations and better advertising support than we have here, but I can assure you that if we tried to do this, we'd need to charge rather more for *EA* than we do now...

I wonder if Mr Pass would be prepared to pay considerably more for the magazine, in order to make this possible? Even if he is, I'd doubt if many readers would be that generous. My guess is that we'd lose quite a few readers, and consequently we'd have even more 'challenges' than at present.

I'm sorry, Mr Pass, but I don't think there are any simple answers.

Designer's viewpoint

But let's look now at the second letter, which came by e-mail from Mr John Olsen of Whitireia in New Zealand. I gather that Mr Olsen is a lecturer in electronics at the local college, and he first sent me a letter asking about my possible interest in some microcontroller-based projects he had developed. Because of the complications with this kind of project, my reply was somewhat less than wildly enthusiastic, even though the projects themselves sounded quite interesting in themselves. I explained some of the drawbacks of publishing too many of these projects, and mentioned some of the criticisms we have received.

Mr Olsen was quite understanding, and sent back a letter with the following very interesting comments:

Thank you for your reply. It sounds to me from the fax you mention that you might at least have a possible topic for your forum pages. On that basis I thought you might be interested in some of my thoughts for and against programmable chips in general.

Firstly I believe that programmable chips, especially microcontrollers, are going to be more and more important in future. Suppliers tell me that they are selling these chips more and more. Many of them are going in instead of standard TTL and CMOS chips.

If this is the way that the industry is heading, then it follows that standard logic chips are going to get less common. This means that in the long run you are going to get more and more limited in the projects you can offer. I see this as part of the same trend that has taken us from octal valves, through the miniature tubes, into transistors, and on to integrated circuits. I haven't been around for the whole of this process, but I recall some of the arguments when changes were occurring. While I enjoy the odd bit of vintage radio etc, I'd hate to see the whole magazine drop into a time warp...

Remember back when integrated circuits were going to make home construction impossible? Well, we're still here.

On the other hand, I can understand a potential constructor being wary of a project which contains a chip which may be difficult to replace, and which he/she does not understand the contents of. However, this is not unique to programmable chips. I have been put off by projects containing special function chips which are not readily available in New Zealand, although they may be in Oz. Not all manufacturers are as well represented in both countries.

The point about publishing software and firmware is a pretty valid one. I have certainly been aided by the example software from application notes that I have been able to get hold of. Perhaps the article should contain a fully documented listing — or else it should be freely available, e.g., from your bulletin board.

The down side is that unless you are really interested, an assembly code listing is pretty deadly stuff. The computer magazines all breathed a sigh of relief when the march of technology rendered it unnecessary to publish listings.

Another aspect is that the writer of the software would have to surrender all rights, as once it is published there is no effective way of limiting its use, to say non-commercial use. This would mean that the payment to the writer would have to cover all rights, and would have to be a fair return for the effort put in.

I would not have any particular problem with selling rights in that way, but would point out that the designer does put in a larger effort with this type of design. The user reaps the benefit of a project which for a given outcome is easier to assemble. This would leave it to you to negotiate arrangements for kit manufacturers, who could program their own or arrange to have it done, and it would be just a part of whatever arrangements you already have with kit manufacturers.

It might in fact be easier for them to program a standard blank part which could feature in several projects, than to locate a brand XYZ special function chip which is only available from one place (and they just ceased production...). Electrically erasable chips are especially nice for this situation, as excess stocks can be erased and reused in another kit. But even one-time programmable chips should only be programmed at the latest time practical.

An advantage of publishing the listings would be that the adventurous reader could modify the design. (I sometimes wonder how many designs are built exactly as published. Going by some that I have been asked to help get going at times, not very many!)

Incidently one objection to programmable chips is the cost of the programmer and software. This is not as bad as it seems. There are two approaches. One is to buy a kit for a particular family of devices. The kit for the SGS-Thomson ST6 devices is around the NZ$250 mark, complete with software and sample devices. This is not an impossible sum for a keen enthusiast who wants to be able to do design work. The project for the 68705 chips described in your magazine seems to be good value too.

The other appproach is to splash out a *bit and buy a universal programmer. These are more expensive but will program a much wider variety of chips. I have a universal programmer myself at home. The difficulty is that you will still need software for the particular families of chips you want to program. There is some software available as shareware or public domain. It is also possible with PAL chips to do the equivalent of hand assembly. (Perhaps that would make a good article :-) Phillips used to provide a form in their databooks for doing just that. This means that you start with a logical design — e.g., symbolic diagram or equations, and figure out which fuses in the PAL need to be blown to create that design.*

Also not everyone needs a programmer. The ordinary constructor only needs access to programmed chips. Perhaps it could be like the printed circuit boards, where some manufacturers of boards can provide boards for any EA (or ETI) design for years back. I would actually program any chip for which I have the source code, for a half dozen tinnies for a one-off, and a very negotiable price around $1 each for large quantities. (Plus the price of the blank chip, of course!)

From your magazine's point of view, I suspect that microcontrollers are more practical than PALs, partly because programmer kits are more readily available. The software is also fairly available too.

My experience is that the chip manufacturers, or at least the agents, are only too happy for you to have the software, as the only possible reason to want it is to create a demand for their chips. They seem to think their mission is to sell chips, not disks. Some of the PAL software seems to be more commercial.

Fortunately microcontrollers are better suited for the kind of project you would mostly be interested in. PALs only come into their own where really high speed complex logic is needed.

It would be reasonable for you to limit the range of programmable parts you were prepared to consider to those that you know are readily available, and that the kit suppliers could cope with. This might include standard EPROMs and a few of the microcontrollers for which programming kits are available readily.

One thing that really appeals to me about the whole design process using programmable chips is its flexibility. If something isn't quite working right, just tweak the code a little. With simulators and emulators, you can try out the design before committing yourself too far. If the printed circuit layout proves difficult, you can change the pinout (to varying degrees depending on the type of chip). Also the printed circuit layout tends to be less complex, so you may get away with a single-sided board instead of double.

Thank you for those comments, Mr Olsen. I for one found them very interesting, and I imagine other readers will do so as well.

You may well be right, that the change from 'hard wired' chips to the programmable variety is merely another stage in the ongoing evolution of electronics, which began with thermionic valves. Perhaps that means we will find a way to adapt to this next stage, and one that will keep everybody happy...

Different implications

It's interesting, too, that you agree there's rather more effort in developing a microcontroller-based design than one based purely on hardware. As I read this part of your letter, it occurred to me that this is an aspect with different implications when you're designing equipment for commercial production, compared with designs for publication in a magazine like *EA*.

When you're designing something for commercial production, the additional effort involved in writing and debugging the firmware is of less importance, because it's a 'one time only' factor that can be balanced against the expected savings in production costs — or if you like, the additional profits from selling the end product. But when a design is to be published, that balancing can't be achieved as the magazine merely publishes the design and doesn't receive any revenue from the production and sale of the equipment concerned. The additional development cost simply makes the design a more expensive one, compared with one based purely on hardware.

It's true, of course, that the firmware-based design may be easier for the constructors to put together and get going. If we're able to publish the source code, they'd also be able to learn a lot about up-to-date technology. But that brings us back to one of those questions raised earlier: how many readers would be prepared to pay more for their magazine, in order to compensate the publisher for the additional investment?

Roughly about the same number of readers as those who'd be prepared to invest in their own programming setup for microcontroller chips, I suspect...

What it all means

Well then, let's see what can we conclude so far about this rather complex situation. I guess it's pretty clear that we're going to have to publish more of these firmware-based designs in the future, as that's the way electronics is headed. We've already published a number of them, of course — most of them from contributors.

At the same time, we're obviously going to have to try harder to obtain permission from the designers of these projects, to allow us to either publish their source code in the magazine, or at least make it available to interested readers via either the BBS or floppy disk. How many designers of these projects are going to allow this, without wanting additional money, I'm not sure; but we'll try.

Even if they do, I'm not sure how many source code listings we're going to be able to print in the magazine itself. As John Olsen points out himself, they can be pretty boring unless you're really interested — and they often tend to take a good deal of space. Perhaps readers like Steven Pass will be prepared to settle for them being available via the BBS, or by sending in a formatted floppy and having us run off a copy, for the usual 'nominal fee' to cover postage, etc.

I'm not sure exactly what we can do about the availability of pre-programmed chips, for those who can't program their own. We don't really have the staff or facilities to do this ourselves, and often the major kit suppliers don't want to be bothered. We might be forced to continue the arrangement that has been used with many of the designs published to date, whereby we ask the author/designer to make pre-programmed chips available for a reasonable fee.

But what do other readers think — is there a better way of handling this situation? What do the rest of you think about projects involving firmware? Please write, fax or leave a message on the BBS to let me know what you think. ❖

THE SERVICEMAN

The VCR with a mind of its own, and how long does it take to forget a fault?

Among the stories I have for you this month is the tale of a VCR which produced the most weird fault symptoms I've ever heard of — especially as they kept on changing. There's also yet another story of problems caused by dry joints on PC boards, and finally an embarrassing admission: I've just spent about 90 minutes rediscovering a fault I tracked down seven years ago, in the self-same set!

Most stories used in these pages have a distinct beginning, middle and end. That is, we open with a description of the symptoms, develop the story with the search for the cause of the trouble, then wrap it up with a discussion on why the fault caused the particular problem.

This is all very neat and satisfying as far as these 'finished' jobs are concerned. But there are a number of interesting tales that just peter out in the middle — no satisfactory answer is ever found. In these cases the appliance is either junked or used within the limitations imposed by whatever fault is still present.

The following story is one of these. It comes from contributor Gus Harvey, of Taringa in Queensland. I'll let Gus describe his problems first, then see if we can work out a likely end to his story:

I have a 1982 or 83 model National NV 777 VCR, which apart from replacement of some mechanical parts, has required no servicing and is still producing good recordings. However late last year it developed some strange electronic behaviour which I cannot explain, and I hope you may be able to throw some light on it.

With the machine in the normal 'standby' mode, when the On button is pressed the LCD counter remained blank but all other functions were operative. I assumed that this was due to the failure of the supply rail to the LCD.

I dismantled the machine, but by the time I had opened out all the boards to get to the power supply and do some checking, the LCD was again operating normally. Nevertheless, I traced out the 5V rail with a multimeter, paying particular attention to contacts in the inter-board plugs and sockets, wriggling and twisting circuit boards, and squirting freezer spray into strategic places. There was simply no way I could make the circuit misbehave.

I also checked with a CRO for adequate filtering, bearing in mind the possible condition of 12 year old electrolytics, and your article in the November 94 issue.

So I put the machine back into service, but after a couple of weeks the fault recurred. As it wasn't convenient to take the machine out of service at that time, I continued to use it. But several days later, while in the standby mode, I noticed some faint bits of other characters flickering on the LCD. Pressing the ON button brought the LCD to full display, but

now none of the control buttons would work!

So it was back to the workbench, and a repeat of the former performance. By the time I got the cover off and the set re-energised, everything was working normally. And it stayed that way — despite my attempts to bash it, freeze it or heat it into its failure mode, all of this over a period of several days.

In fact, it seemed that merely disconnecting it from the mains for a few minutes was enough to cure the fault.

Since then there has been another mutation of the fault. After the VCR has been in standby mode for a couple of weeks, with normal record and playback of about six hours per week, pressing cue or review buttons causes the machine to stop. However, it will respond to a subsequent press of the play button. This fault can also be *cured by disconnecting from the mains for a short time.*

I have adopted the practice of simply pulling out the mains plug whenever the VCR is not required, and in this manner it has been working perfectly for a couple of months. I realise that I am taking the easy way out, but I have only a superficial knowledge of VCRs and microprocessors, etc., and am not competent to probe any deeper. However, I tell the story so that others may find it of some academic interest.

Well, Gus, that is as strange a set of symptoms as any I have heard of. At first reading, I thought it sounded a bit like a faulty Mode Switch, then I changed my mind to a faulty microprocessor, then to something else and finally gave up. I really don't have any theory that would account for all the symptoms.

At one point the problem looked like a dry joint or loose connection. But that wouldn't be cured by simply turning the power off for a few moments. A bad mode switch would introduce mechanical problems — the machine would be unlikely to work normally for record and playback. A faulty display driver might account for the LCD problems, but not for the control lock-out.

I don't know, Gus. I can't answer your question — does any reader have a clue? Gus and I would both like to hear from you.

Happier ending

Now we turn to a New Zealand contributor, for a story with a happier ending. It comes from Graham Cheer of Tauranga. Graham tells a story about dry joints on early PCBs, and the long and frustrating search for one particular joint:

I have been in the electronics service business since the early 1960s, and have a collection of service stories from the non-TV/VCR bench that you may find of interest.

The first story dates back to about 1973, when I was working for the then NZ distributor of Canon cameras and calculators. I was servicing the calculators, which were using DTL (the forerunner of TTL) and diode/resistor logic.

As you can imagine, these desktop calculators were quite complex, especially as the logic chips were all NAND gates only and the more complex models had seven or eight plug-in PCBs with about 30 to 40 ICs per board.

One of the problems these PCBs suffered from was dry joints on the through pins, which connected the top and bottom tracks of the double-sided boards. Whenever one of these units came in with an intermittent fault, we would remove the offending board and resolder all the through pins at top and bottom. This would usually fix the problem.

I had one particular unit which came back for the same intermittent fault a number of times, and it was always proved to be the same board. So I had to get stuck into this one with the oscilloscope to try to find the cause, as resoldering had not solved the problem.

I found that the problem was still to do with a faulty connection, as one pin of an IC had an intermittent 'fuzzy' signal when it should have been a clean logic type of signal. To trace the source of the problem, I had to follow the track on the PCB to where I eventually came to a through pin.

On looking at the top side of the PCB, I found the pin came up underneath an IC. This we had never encountered before, and it was the only place where a pin appeared under an IC in all the models we serviced.

I removed the IC and found the pin barely protruding through the board and with an obvious dry joint on its surface. I pushed the pin further through and resoldered it, then reinstalled the IC, now sitting just a little higher than usual.

The calculator worked perfectly after that, and we didn't see it again. Needless to say, from then on whenever that model came in with intermittent problems, we made sure to resolder that hidden pin top and bottom!

I have found that working on these early model calculators has left me in a position of being able to get into microprocessors without too much difficulty. I have gained a good knowledge of adder circuits and how they function, and also the concept of subtracting, multiplying and dividing by doing addition only.

It is also interesting to think back just 20 years and how digital electronics has progressed. The old Canon calculators could easily fit into their own equivalent of 'Vintage Radio'.

Two things that come to mind are the complexity of the JK flip-flop, being made from two NAND gates with associated resistors, capacitors and diodes. The second item was a mechanical 'shift register' memory. It used an electro-mechanical delay line, like the reverb units used in guitar amps.

You may remember that these consisted of a piece of steel spring set into vibration at one end by a coil, the vibration travelling to the other end and being sensed by a pickup coil. As you can imagine, in digital memory service, any tap on the case would completely corrupt the data in the system!

Thanks for that little item, Graham. I can quite imagine the confusion that hidden through-pin must have caused. Come to think of it, I recall a number of early English colour TVs with double-sided boards and problems with dry joints. Who knows, maybe a number of those finished on the tip, due solely to hidden through-pins...

As far as the 'Spring Memory' is concerned, I've never heard of anything like it. I could imagine that it would work, but in a shaky island like New Zealand, I reckon the data would be corrupted more often than not! (All right — I'm sorry!)

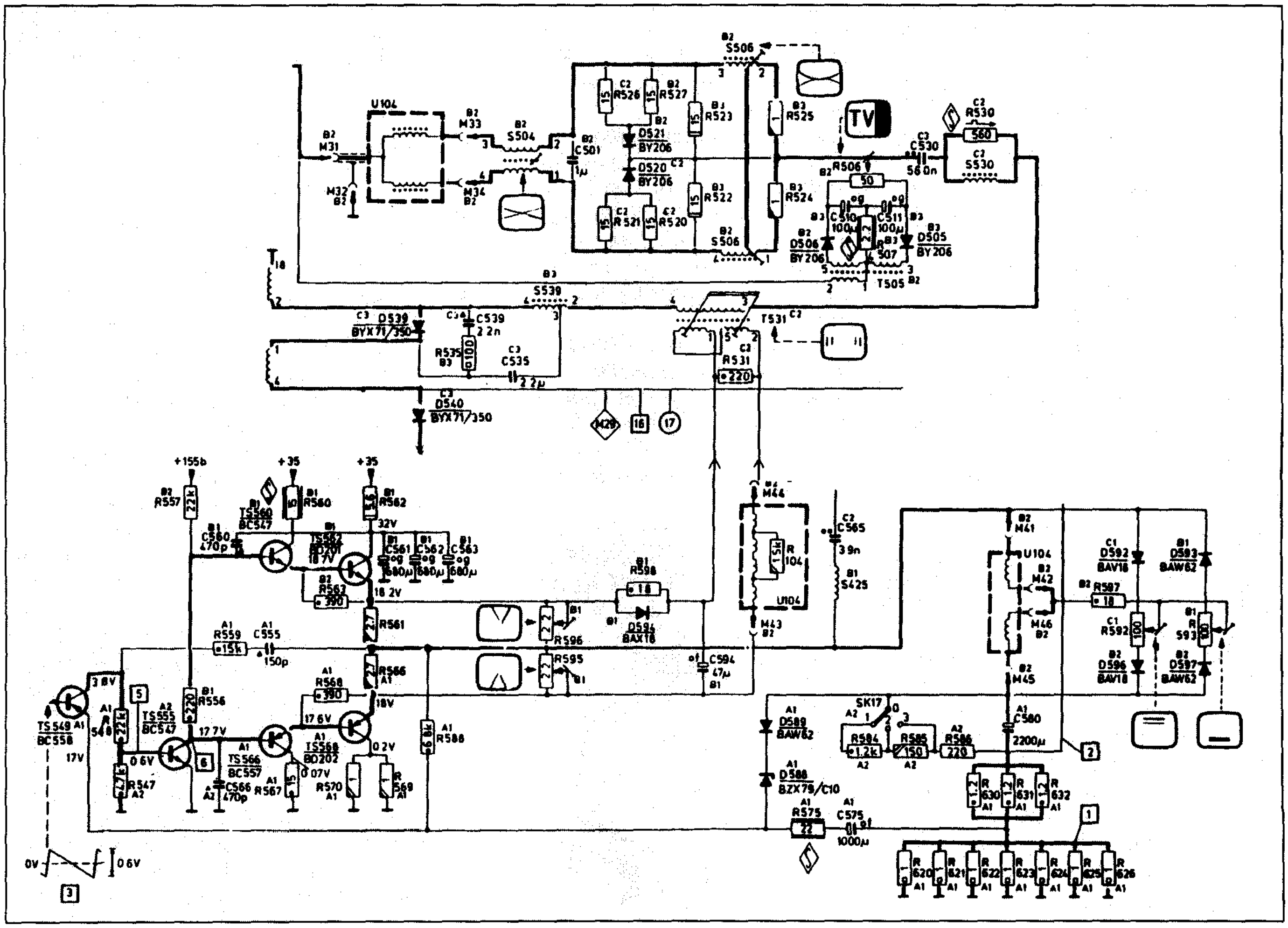
Graham mentioned that he was submitting several stories. I am holding the others until later — they are too good to splash out all at once. Thanks, Graham.

Lapse of memory

Now for a story from my own workshop.

How long does it take to forget a particular TV fault? I happen to know, because I have just looked it up on a customer record. It takes just seven years and twelve days!

I spent an hour and a half today rediscovering a fault that I first spent an hour and a half discovering just over seven years ago. And the frustrating thing about it is that the details were all there all the time on the customer record — I just didn't recognise it.



An extract from the circuit for a Philips K11 colour TV, showing the vertical sweep circuitry — the area in which our Serviceman finally found the cause of the set's poor height and width, in exactly the same place as it was the last time!

The set was a Philips model KL257, fitted with a K11A-1 chassis. It was a very early model, released soon after colour TV began in 1975. It was very similar to the K9 chassis, but was never that common in my neck of the woods. I'm much more familiar with the K9, but I've still seen enough of the K11A to be reasonably confident with the circuit.

It's just that these days, I seem to allow myself to get sidetracked by irrelevant symptoms.

The set came in with the complaint that it had a very narrow picture, about three centimetres wide across the centre of the screen. Now, by my interpretation of the word 'narrow', it means 'not wide' and I expected to see a narrow picture, up and down the screen. In turn, this suggests a limited range of causes, mostly centring around an open circuit yoke or dry jointed yoke connections.

When I got the set on the bench and switched on, I was immediately greeted by a blurred *horizontal* line, stretching about three quarters of the way across the screen. So the problem was really a form of vertical collapse, not horizontal as the client's description had first suggested!

Between the client's phone call and his presentation of the faulty set on my bench, I had had about 45 minutes to consider what might be the problem. In that time, I had more or less convinced myself that it was going to be a horizontal scan problem and had mentally listed all the components that I was going to test. So imagine my chagrin when the set finally arrived and presented a vertical scan problem!

Anyway, I swallowed my disappointment and accepted that the fault was not as the customer initially described it. It wasn't all that difficult to re-align my thinking, to accept the more accurate description provided by my eyes.

The only problem presented by the set in front of me was that *both* the height and width were less than normal. The blurred line that I was looking at was only three quarters of the width of the screen. And of course, the height was only seven eighths of the available screen height!

My previous experiences of 'low height' were usually accompanied by normal width, so the present symptoms were confusing to say the least. Then, they were coupled with a very fuzzy image to add yet another symptom to the list. It wasn't easy to decide which one to tackle first!

The easiest to check was the fuzzy pic, since it looked like a focus problem and the focus control was easily accessible. A quick twiddle on the focus pot shaft soon proved that the control wasn't working, and that usually means an open circuit focus resistor. A common fault, and easy to repair. Now I had a pin-sharp, but still narrow and low picture on screen. One down, two to go...

For some reason I decided that the narrow pic should be the next problem to tackle, on the basis that whatever was causing the lack of width might also be causing the lack of height. In retrospect, I know this was the wrong order of approach, but I had the feeling that I might be looking for a low supply voltage and this could affect both width and height.

So I spent well over half an hour looking for a low or missing voltage.

However, rather than low or missing voltages, all that I found were somewhat *high* voltages. Everywhere, the rails measured some 10% higher than they should have done.

Of course, when you think about it, this is not so unusual. Both the line output and vertical output stages were running at less than full power — so the current drain must have been low, and consequently the voltage was high.

As I said, I spent a lot of time looking for a fault that wasn't there. So I turned to the vertical circuits and began looking for a cause for the low height.

An oscilloscope check proved that there was a healthy sawtooth input at the base of TS549, the first vertical driver transistor. After that the waveform disappeared. With the scope's vertical gain turned right up, there were traces of vertical pulses on the other transistors, but nothing resembling a sawtooth.

All the transistors checked out OK, as did the voltages on bases and emitters; which implied that the transistors were turned on, and that all the relevant resistors were doing their jobs. That left only the capacitors to check, and since I have no faith in electros in vertical circuits, I attacked these items first off.

The vertical amplifier is direct coupled, so there are no electros in the signal path.

However, there are three important caps hanging off the collector of the top output transistor. They are C561, C562 and C563, each of 680uF. These have an important filtering duty on the supply to the output transistors and although it is unusual for all three to fail together, it is not unknown. So out they came and in with three new ones. But all to no avail...

Next, I turned my attention to the deflection yoke, its coupling capacitor C580, and the network of resistors R630/631/632 and R620 to 626 inclusive. The capacitor has been known to fail, so it was removed and thoroughly checked for capacity and leakage. It got a clean bill of health.

The resistors were not so easy to check since their purpose is to form a very low resistance (0.4 ohms in series with 0.142 ohms) voltage divider at the earthy end of the coupling capacitor. As far as I could tell, after allowing for the resistance of the meter leads, the network totalled about half an ohm which looked about right.

Then I realised that I had seen a similar fault in this part of another K11 some time ago. It was also a vertical collapse and was caused by the failure of the two diodes D588 and D589. As I recall, one went short circuit and the other open circuit. Could this be the cause here, I wondered?

The only difficulty in checking the theory was finding the diodes. They are tiny glass encapsulated items, in this case hidden under a thin layer of dust. I eventually found them, but the effort was a waste of time — they were both perfect. So where to now?

At this point I had the first bright idea I'd had all day. I decided to look at the equivalent part of a K9 circuit. If you remember, I said earlier that I have more experience with the K9 and my circuit diagrams are covered with notes about faults I have picked up over the years. And that's where I found the solution.

On the K9 diagram I had drawn a ring about C573 and noted 'No height'. C573 is a 1000uF electro that comes off the K9 equivalent of the resistor network mentioned above. Its purpose is to supply a feedback pulse, via an amplifier, to the input of the vertical stage.

In the K11, the same purpose is served by C575, although this one does not need an amplifier as in the K9. It took longer to find the capacitor (funny how Philips components are never where you'd expect them to be) than it did to remove and test it. But the effort was worthwhile, since its 1000uF had degenerated to something less than 10uF.

A new capacitor cured the 'low height' problem, and at the same time took the picture out to the full width of the screen. The lack of width was probably a result of interaction between horizontal and vertical signals in the pincushion correction circuits.

But now we come to the nub of this whole sorry story.

I keep a card index of all my customers, with brief details of each job I do for them. In this case, as I wrote 'no height, C575 o/c' on the card, my eye caught the figures C575 on the same card, about seven or eight lines higher.

On reading that entry in more detail, I found that I had done this very same job, on this very same set, just seven years and 12 days earlier! When I looked again at the dud capacitor, I saw that it was a different brand to all the others in the set — which seemed to confirm that it had, indeed, been changed sometime earlier.

My excuse for missing the vital clue on the card is that I only keep these records to cover myself during the warranty period. If a customer comes back next week and says "It's broken down again. You didn't fix it properly!", I can refer to exactly what the fault was and what I have done to repair it. After a month or two the information is more or less irrelevant.

So I had no reason to read the card before I tackled the set. It wasn't until I had finished the job that the opportunity arose to see the previous record. Perhaps I'll have to change my habits.

Anyway, my K11 circuit diagram now has a ring around C575 and a note similar to the one on the K9 sheet. Trouble is, I'll probably never again see another K11 in this particular condition!

I mentioned at the beginning that it takes seven years to forget a particular fault. It might also be noted that it takes seven years for an electro to drop dead!

That's all for this month. I have a good selection of stories for next month, so don't go away! ❖

Experimenting with Electronics

by DARREN YATES, B. Sc.

Too much experimenting is barely enough!

Experimentation is the basis of any advance in circuit design. It's also the basis of our initial understanding as well. This month we answer a reader's query, discuss pulse-width *modulation* (PWM) and continue on with our look at op amp circuits.

It's always good to hear from readers who are out there experimenting and actually building circuits, and when it comes to experimenting, I like to borrow a well-known phrase from H.G. Nelson: "too much is barely enough". This month, I received a letter from B.F. of Morphett Vale in South Australia, who posed an interesting design question.

Briefly, B.F. wanted to control some 6V globes so that when a switch was flicked on, the globes would brighten up over a period of three to five seconds and when it was flicked off, they'd dim over the same period. I've also had another point raised from a reader who wanted more explanation in the circuits, so I'll try my best to answer both.

B.F. had tried using some AC circuit theory, using zero crossing detectors and other circuits, but found that the project was becoming too complicated. A crude but practical answer to his problems is the circuit shown in Fig.1. It's a low voltage auto-dimmer using some of the switching theory we've covered in previous issues, and it should work quite well.

In answering B.F's question, I decided to use this DC-based switching circuit solution rather than trying to control an AC mains-frequency voltage.

While this circuit is primarily designed to control light globes, it could also be used as the basis of an auto-throttle for a model railway layout as well.

AC voltage control is a tricky area which would be difficult to handle in a short answer. While I hope to cover this topic at some stage, to cover it now would require a lot of new territory and topics we haven't covered yet.

Looking at the circuit in Fig.1, it's based around a common LM358 dual op-amp IC, with IC1a hooked up as a triangle wave oscillator and IC1b as a simple comparator.

Last month, we introduced the circuit of the squarewave oscillator and we're using that same circuit configuration here. What I didn't mention is that there is also a triangle waveform of sorts available from this circuit — provided you're careful. If you connected up a cathode ray oscilloscope — we'll call it a CRO (pronounced 'crow') from now on — across the capacitor, you'll see that you end up with a ramping voltage as the capacitor charges and discharges.

The signal across the capacitor can be used for other circuits, provided you only have a high impedance load connected to it. Using too low an impedance will cause the frequency of the circuit to change, and in extreme cases, stop the circuit from oscillating altogether.

Droopy, but OK

A perfect triangle waveform has linear or straight edges, but because of the way this particular circuit works, the peaks of the waveform droop a little. Now the reason for this lies in the way the capacitor is charged up. If we look just at the oscillator in Fig.1, the capacitor is charged and discharged through the output of IC1a via a resistor. Let's consider the capacitor's progress as it charges up.

With the output high, current flows through the 10kΩ resistor and 0.1uF capacitor and it begins to charge up. As it charges up, it develops a voltage across it. And as it develops this voltage, the voltage across the resistor reduces accordingly. Since the resistance is fixed, a drop in voltage causes a drop in current though the resistor and consequently, the capacitor as well. The drop now means that the capacitor doesn't charge up as quickly and the voltage across it rises more slowly, causing a droop in the ramp.

In order for the ramp to be straight or 'linear', the capacitor must charge and discharge with a constant current. As we've just seen, the current isn't con-

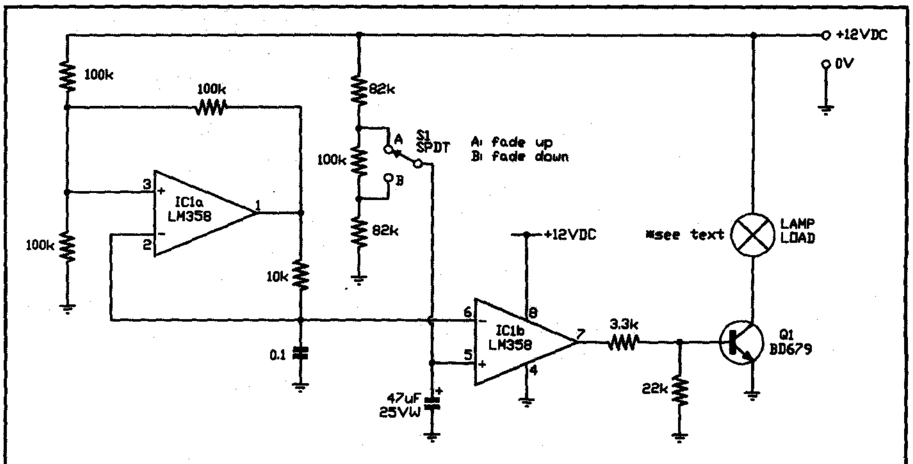


Fig.1

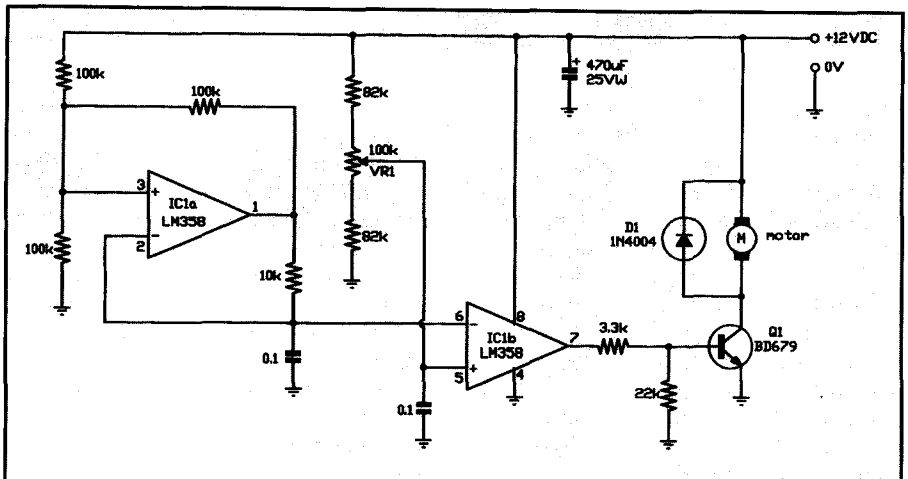


Fig.3

stant, and this happens when it's both charging and discharging, so the output is not linear. But for the purpose of this circuit, which is simply to fade and brighten some lights, it's more than adequate.

In some cases, this imperfect signal may well be 'perfect' for a particular application, so it's worth remembering because it's much cheaper to make than a proper linear ramp generator. However, it must be said that there are applications where linearity *is* important and we'll look at how to achieve this in a latter issue.

Looking back at Fig.1, the ramp signal from IC1a is connected to the inverting input of IC1b, and this is configured as a comparator. On the other input, we have a simple resistor/capacitor arrangement controlled by a switch. This is a single-pole double-throw (SPDT) switch, which will control the lights. With the switch in the 'A' position, the capacitor charges up and in the 'B' position, the capacitor discharges.

With the way the oscillator is biased, the absolute DC voltage level of the ramp signal is approximately 4V to 8V. The resistor network connected to the switch is designed to ensure that when we want the lamps to fade out, they go fully out and vice versa.

With the switch in position A, the maximum voltage on pin 3 of IC1b is around 8.5V and the minimum in position B is 3.5V. Because these voltages are just outside the range of the ramp signal, IC1b's output will remain fully high and low at these extremities and the lamps fully on or off. But because they're only just outside, you should still find that you get a fairly smooth fade in and out. The 47uF capacitor with the resistors selected gives a time constant of roughly the correct order of magnitude, producing a delay of around four seconds from lights on to lights off.

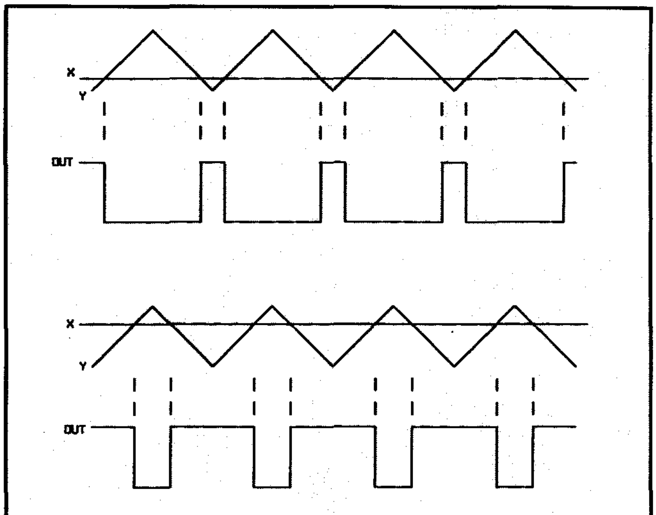


Fig.2

Again, we use the imperfect ramping voltage from this capacitor to control the output of the comparator. And the output we end up with is known as a *pulse-width modulated* or 'PWM' waveform. In practice, this means that if the switch is in position A, the output of IC1b will start from ground, then gradually progress from a narrow positive pulse waveform, move through to a squarewave, to a narrow negative-pulse waveform and finally to a high steady voltage. When the switch is turned off, the same thing will happen but in reverse order.

How PWM works

Fig.2 shows how this works a little more clearly. Pulse-width modulation is the process whereby a control voltage is used to vary the pulse width of a waveform. It can be a positive response — i.e., a low voltage produces a narrow positive-going pulse and a large voltage a wide positive-going pulse — or it can be negative, i.e. vice versa.

The method we're using, of a triangle waveform fed into a comparator, is one of the simplest and easiest methods to understand. There are other more complicated methods to produce signals with higher degrees of linearity, but they're not needed here.

Let's take a look at how the comparator produces the PWM signal, using the example of where the control signal X on the non-inverting input is a steady but low DC voltage, and the triangle waveform is applied to the other input Y. (Upper graphs in Fig.2.) As the triangle waveform starts out on its rise, the inverting input is lower than the non-inverting input, which forces the output high; but once the ramp output rises above the control input, the output falls low. Over time, the inverting input voltage is high-

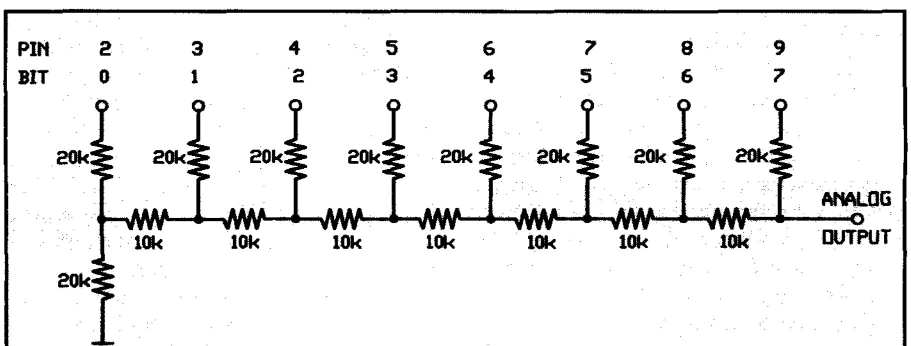


Fig.4

er in magnitude than the other and so the output remains low for a longer period of time.

If we now go to a higher DC voltage on the control input X (lower graphs), the output is now higher for longer than it is low, because the X input is higher in voltage than the Y input for a greater proportion of the time.

Now why use PWM in the first place? Well, it happens to lead in nicely to our current area of exploration; but more importantly, it can be done cheaply as well as wasting as little power as possible.

One important feature with PWM is that the frequency remains fixed — that is, the time of each high-and-low cycle adds up to the same total.

Back to the circuit, the output from IC1b is then fed into the power transistor Q1. Now while this transistor can switch on and off quickly, the light globes have a much slower response and more importantly, our eyes have an even slower response to switching light sources. So much so, that with a frequency of 2kHz our eyes can't see the difference. The globes will produce a dull glow with a low pulse width and a bright glow with a higher pulse width waveform.

The major benefit of using PWM here is that the transistor is simply used as a fast-acting switch. As a result it only has to dissipate relatively low amounts of power. This means that it produces less heat and requires only a small heatsink to keep it happy.

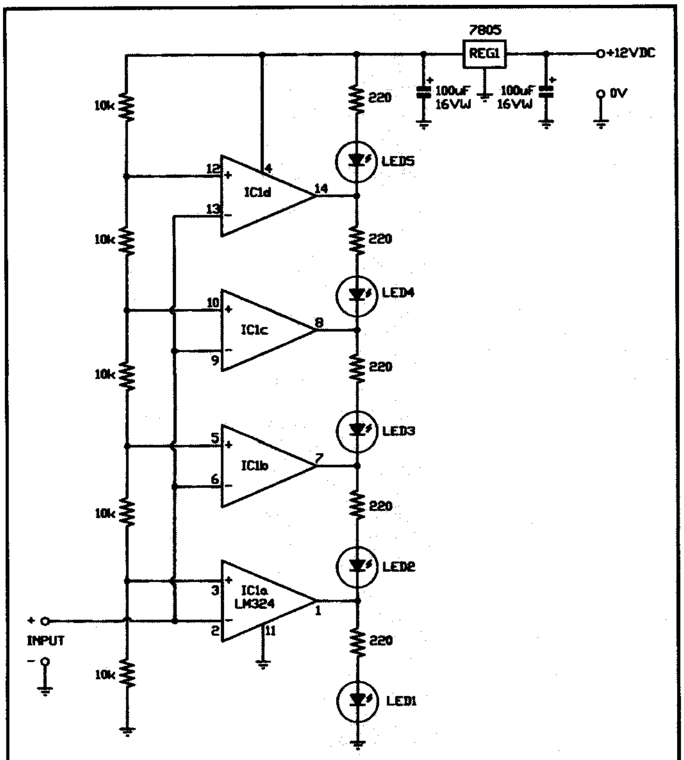


Fig.5

Drill controller

As I mentioned earlier, PWM is used to control motors as well, and one of the obvious uses is as a drill speed controller. In a previous column, we looked at a transistorised version which used a pot to vary the current ratio in a two-transistor oscillator. We can also use the same circuitry that answered B.F.'s problem to control a motor.

The updated circuit is shown in Fig.3. Note the addition of the protection diode across the motor. This is to protect the output transistor from the motor's inductive effects. Each time the transistor is switched off, the voltage at the collector can rise to several times higher than the supply voltage. The motor in reality is simply a large coil of wire, which tries to maintain the same energy level once the current though it has been stopped.

This causes the voltage to rise rapidly and without proper protection, this voltage could damage the output transistor. Once the voltage rises to 0.7V above the supply voltage, diode D1 conducts and shunts this voltage back to the supply rail, 'clamping' the collector to a maximum voltage of 12.7V.

Note also that the switch and 100kΩ resistor have been replaced with a 100kΩ pot which now acts as a speed control. The overall effect is the same as before, ensuring that we obtain both maximum and minimum speeds at the extremes of the control. The 47uF capacitor has also been replaced with a 0.1uF capacitor, which simply removes noise from the control signal.

The main difference between this circuit and the transistor equivalent we published a few issues back is that the control pot is not part of the active frequency control circuitry. Instead, it simply provides a voltage level to the circuit. This may not seem like a big deal, but it enables us to use anything that can generate a voltage to control the circuit. This can include a digital to analog converter driven from just about any computer. You could use, say, the printer port of an IBM PC, convert it to an analog DC voltage and get the computer to control the motor speed.

There are two interesting things to note about this. Firstly, you can use any IBM PC (so dust off that old XT) and secondly, you can use it to control your model railway or just about any motorised circuit.

Digital to analog conversion is a big topic, but by using the parallel printer port, most of the circuitry is already provided. All you need to do is to add a resistor array shown in Fig.4, to convert the 8-bit digital code into a DC voltage.

Later in this series we'll look more closely at the printer port, which provides a rich source of both outputs and inputs for our circuits. It's by far the easiest solution for interfacing circuits with the PC, without having to design special expansion slot boards or worry about blowing up expensive motherboards. We'll also show you some simple BASIC code to program the port.

But for the meantime, this circuit uses what's called an 'R-2R ladder' arrangement, since the resistors to each of the PC's port pins is twice that of the interconnecting resistors. Each bit provides twice as much voltage as the previous one, with bit 7 providing half the maximum possible DC voltage.

Multi-LED display

LEDs are great for giving visual indication of a voltage state, but what if you need to detect different levels? Op-amps, particularly the very-common LM324, make very good comparators and by stringing a few up together we can actually detect five different voltage levels using just four op-amps.

The circuit for the five-LED voltage monitor is shown in Fig.5. This circuit is quite convenient to build, since all of the op-amps required come from a single IC package. As you can see, all of the inverting inputs are wired together, giving each input the same look at the input voltage. Their non-inverting inputs are distributed along a resistor divider chain made up of five 10kΩ resistors, with the top of the chain connected to the output of a 5V regulator.

Using a bit of mathematics, you can deduce that each junction is 1V higher up the ladder i.e.,, IC1a sits at 1V, IC1b at 2V, IC1c 3V and IC1d at 4V. The outputs are each connected head-to-tail with a 220Ω current limiting resistor and a red LED. Let's run through it and see how it works.

With the input voltage less than 1V, the inverting input of IC1a is lower than the inverting input so the output is high. But it's also lower for the three remaining op-amps, so their outputs are high too. This means that only LED1 has a voltage across it, so it alone lights up.

As the input voltage rises to between 1 and 2 volts, the inverting input of IC1a is now higher than its non-inverting input so the output of IC1a falls low and LED1 turns off. The other three op-amps still have the non-inverting input higher than the input voltage so their outputs remain high.

But now we have a voltage difference between the output of IC1b and IC1a, which lights LED2. Note that the current flow is out from IC1b to the output of IC1a. Because the output voltage of IC1a is near ground, it's a low-impedance path to ground which can take the current from the LED.

Hopefully you can see that this process continues up the chain until finally the input voltage rises above 4V. At this point, all of the outputs are low since the input voltage is higher than all of the resistor tap-off points. But now the last LED switches on, because of the voltage difference between the supply rail and the low output of IC1d.

There are a couple of benefits to this circuit. Firstly, we can show five states with only four op-amps; secondly, only one LED is on at any one time and thirdly, because only one LED is on, the current consumption is lower than a parallel LED configuration, where all LED cathodes are connected to ground.

Note that since all resistors in the chain are equal in value, each LED represents a linear progression — i.e., equal steps of 1V. By changing the resistor values, you can also change the type of progression you get as well as determine at which voltage points the LEDs swap

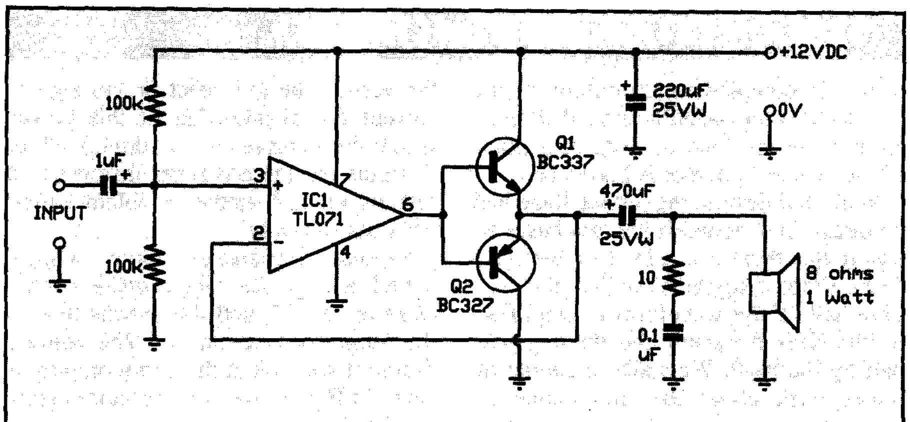


Fig.6

from one to the other. Too much experimenting...

Simple audio amp

Some op-amps also have the makings for some tiny but useful audio power amplifiers. Some — not all. While op-amps can be used as both comparators and op-amps, comparators can only be used for comparators. So don't connect up an LM339 or LM393 as an audio amplifier and expect it to work terribly well.

There are also some other op-amps that don't make very good amplifiers and a couple of these are the LM358 dual op-amp IC and its quad cousin, the LM324. These two devices suffer from crossover distortion unless you connect up a fairly heavy load to them. With such a load (around 600 ohms) the op-amp internally switches from Class B (which creates the distortion) to Class A, which has much less distortion but you use up quite a bit more current in the process.

Be that as it may, there are plenty of low cost op-amps which *are* suitable. Good examples are any of the TL07X range, and National Semiconductor's LF347/351/353 types.

Fig.6 shows a simple audio amplifier which uses the bare minimum of components but can still thump a watt into an 8Ω load at 12V. The most interesting thing about this amplifier is that both bases of the output transistors are tied together. Now normally this would result in enough crossover distortion to make anything sound like 'heavy metal' music(?) — but in this circuit the output transistors are connected up as part of the negative feedback loop.

By using this technique, the crossover distortion is reduced by a factor equal to the open loop gain of the op-amp. Since the open loop gain of most op-amps is in the order of 10,000 and up, the crossover distortion becomes tiny indeed.

Crossover distortion

For those who haven't come across this term before, crossover distortion

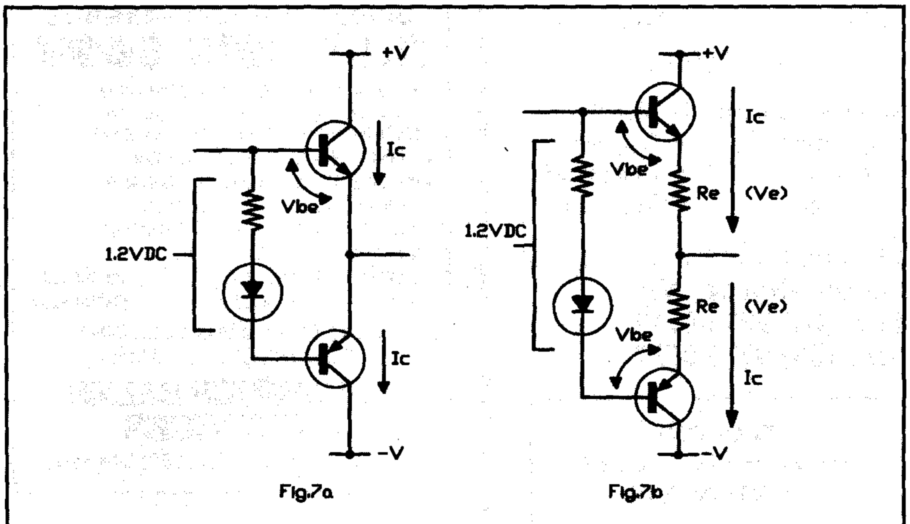


Fig.7

occurs in complementary output stages (i.e., those where an NPN and a PNP transistor drive the loudspeaker), at a point where neither transistor is biased on.

In normal design, the output stage has a voltage bias between the two bases to ensure that there is a 1.2V drop between them. When a signal is applied, the positive half of the waveform is amplified by the NPN transistor and the negative half by the PNP. We spoke a couple of issues back about the importance of remembering about the 0.6V drop between base and emitter of a transistor — and this is one of those times. You can almost think of it as an offset that we must overcome before we produce any output signal.

When the waveform is at its peaks, both positive and negative, we're alright — the transistors are switched on pretty hard and the signal is amplified. But in the grey area around the halfway-mark, we can run into crossover distortion.

This occurs when there is insufficient bias current to turn on either transistor, as the signal swings or 'crosses over' from one half of its waveform to the other. When you consider the 0.6V drop across both transistors, there is a region of 1.2V where we get no output signal regardless of what the input signal is doing.

In most amplifiers, this is taken care of by setting up a fixed 1.2V drop between the bases so that they're always just on the verge of conducting. (By 'on the verge', the quiescent or 'no signal' current for an amplifier of this power should be no more than 8-10mA.) While this cuts out the crossover distortion, it sets us up for another problem called 'thermal runaway'.

Bipolar transistors have what's called a *negative temperature coefficient* or 'NTC', and this means that as the transistor heats up, its Vbe voltage drops. If we look at the common output stage in Fig.7a, we can see more clearly what happens.

If we apply too much bias voltage at the bases, the transistors are conducting continuously. This causes the transistor to heat up.

The heat build-up causes the transistors to conduct a little more current, because of the way their Vbe's fall. This produces a little more heat and a little more current and then before you know it, wafts of smoke are gently climbing from the charred remains...

Fig.7b shows the simple remedy — two low value resistors 'Re'. By including these in the emitter legs of each side, we all but remove the problem. Here's how it works.

As the transistor heats up, the Vbe drops and it begins to conduct more current; but now we have the resistors in place, we now have an extra voltage drop across them. This pushes the emitter voltage up.

As the base voltage remains the same, the transistor shuts down slightly, cooling the transistor down and dropping the current. The drop in current also drops the voltage across the resistors. This allows the transistors to turn on a little more.

All this happens quite quickly, and the circuit reaches an equilibrium state where there is sufficient current flowing but not too much.

Now while all that is interesting and very important, if we go back to our amplifier of Fig.6 based on an op-amp, it's all done automatically. The op-amp sets up the biasing needs of the output stage so that the crossover distortion is reduced to just about nothing, as well as taking care of the thermal runaway problem. This makes this circuit one of the more difficult to blow up, and its tiny component count makes it nice and quick to build.

Hopefully some readers will remember that the four-transistor amplifier we presented some months back didn't use these protection resistors. That's because if you keep the base voltage drop between the two transistors to less than 1.2V, and you can ensure that the supply voltage doesn't rise above the stated level, you can get away without them. But it's a bit like walking a tight rope without the safety net below...

Next month, we'll continue with some more op-amp circuits. ❖

(Darren Yates is Chief Engineering Officer with R.A.T. Electronics, of PO Box 641, Penrith NSW 2750.)

SEMICONDUCTOR DEVICE DATA ON A CD-ROM

Hinton Information Services now has available the D.A.T.A Parametric Access Library, a CD-ROM version of D.A.T.A.'s comprehensive database of integrated and discrete semiconductor devices. It's designed to meet the needs of designers, purchasing officers, and repair and maintenance technicians.

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For discrete devices there are four database categories: diodes, transistors, thyristors and optoelectronics. According to the manufacturer there's data on over 380,000 diodes; 232,000 transistors; 145,000 thyristors and 92,000 optoelectronic devices.

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In addition to providing current device information, the system also covers discontinued devices dating back to 1956 — which should make it very useful for repair and upgrade operations. Over 1100 manufacturers are listed, both active and inactive.

The CD-ROM is accompanied by software on a 3.5" or 5.25" floppy disk, to provide fast and convenient searching of the database by generic type number, specific part number, device category, function, manufacturer or distributor. There's also a 'quick inquiry' mode, and searching can be refined by using up to 25 specific parameter values. Some search modes also allow 'wild card' or 'starts with' searching.

Although most of the information in the database appears to be in alphanumeric form, the device package outlines are in high resolution graphics images. Search results are displayed in 'browseable spreadsheet' format, and allow you to highlight devices meeting selected criteria.

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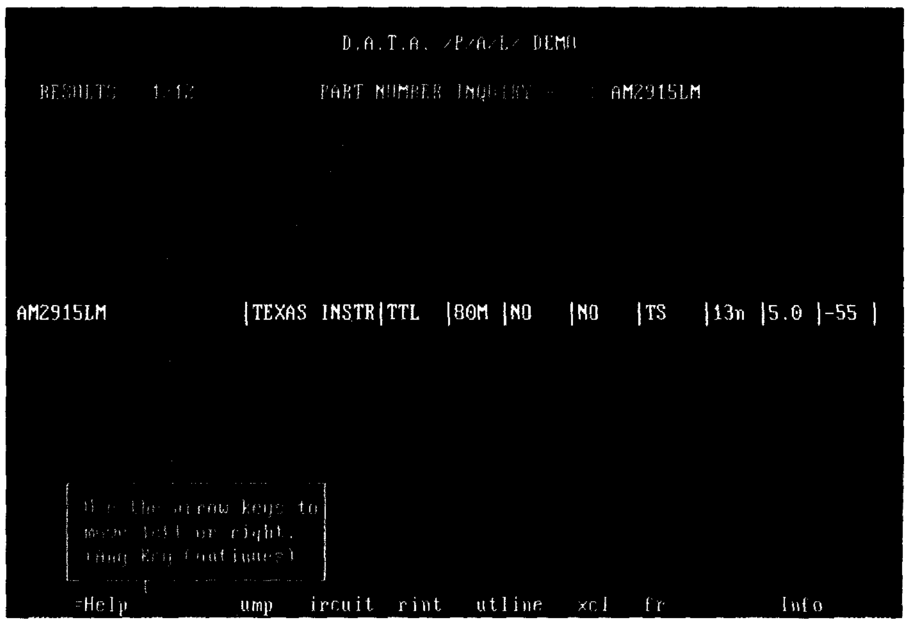
Hardware requirements are DOS 3.1 or higher, 2MB of RAM, 5MB of free hard disk space and a CD-ROM drive. A 486 or better processor is recommended. Although intended for use on a single PC, the software is optionally available in a form compatible with any PC LAN and the database can apparently be installed on a network server CD-ROM providing the network has CD-ROM management software.

The Parametric Access Library CD-ROM is sold as an annual subscription, where the annual subscription covers one disc and is currently priced at $1500. When your subscription has ended, the software apparently flashes a message on your screen to remind you that renewal is due.

According to the manufacturer, 'if you choose not to renew, your D.A.T.A. P/A/L will eventually discontinue itself'. It's unclear whether this means that superseded discs cannot be used for reference to data on discontinued devices, or that the database merely becomes obsolete with the passage of time.

Purchase of a subscription to the CD-ROM also entitles the user to order hard copies of manufacturers' data sheets, for a price of $12 per data sheet up to 10 pages, and $1 per page thereafter.

Further information on the D.A.T.A Parametric Access Library is available from Hinton Information Services, Locked Bag 7, Eastwood 2122; phone (02) 804 6022 or fax (02) 804 7434. ♦



This screen dump from a demonstration version of the D.A.T.A. Parametric Access Library gives a good idea of the 'browseable spread sheet' format used by the software to display device data.

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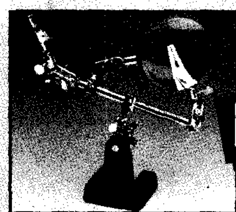

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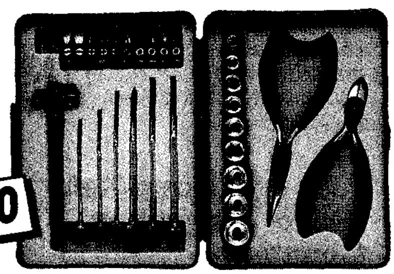

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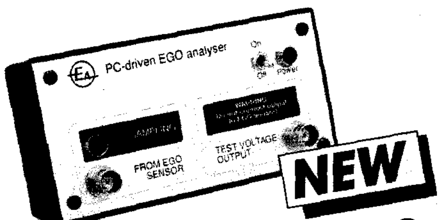

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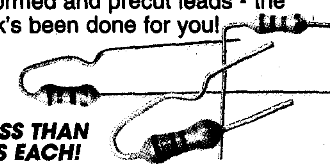

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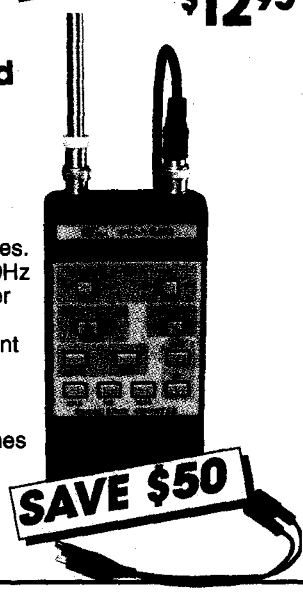

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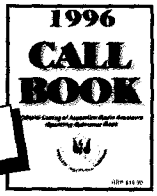

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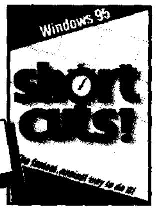

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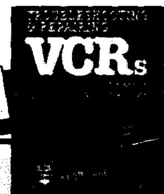

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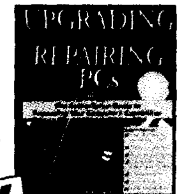

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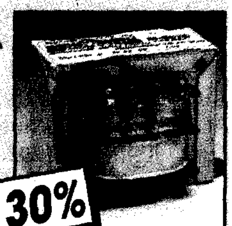

DICK SMITH ELECTRONICS

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B 2209

Circuit & Design Ideas

Interesting circuit ideas from readers and technical literature. While this material has been checked as far as possible for feasibility, the circuits have not been built and tested by us. We therefore cannot accept responsibility, enter into correspondence or provide further information.

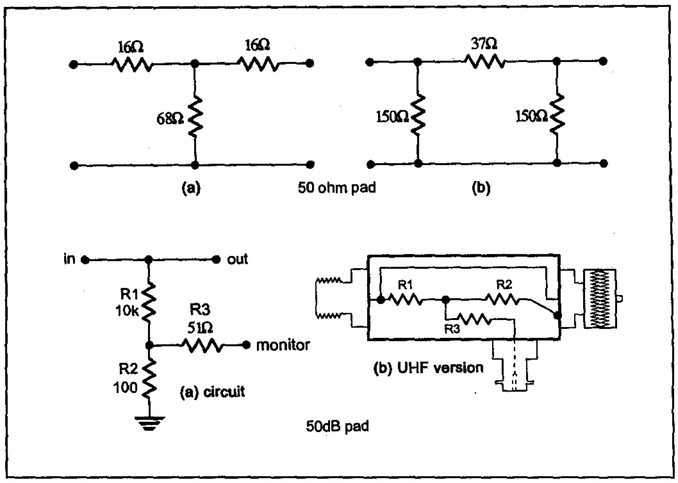
Protected 50Ω pad, 50dB pad

When working with communications transceivers, it's usual to connect a 6dB 50Ω pad between a signal generator and the receiver. This ensures both pieces of equipment see a termination of 50 ohms, which might not otherwise be the case.

There are a number of possible configurations for a 50Ω pad, but I've found those shown here to be the most useful. A special advantage of these circuits is that 100mA fuses come in two types, which happen to have a resistance of 16Ω or 36Ω. Using these in the circuits gives protection as well as the right resistance.

For HF transceivers it is sometimes convenient to use a 50dB pad to give an output point as a convenient means of monitoring — for instance, with an oscilloscope for a two-tone envelope check, or with a frequency counter to measure frequency. As well, it's possible to feed a signal from a signal generator into the receiver with no fear of damage should the transmitter be keyed.

The pad I use for this is shown in the circuit, along with a simple way to build it. The case is the smallest diecast box available, with a male and a female panel mount connector on the ends. Two 100Ω resistors in parallel will do if you can't get a 51Ω resistor.



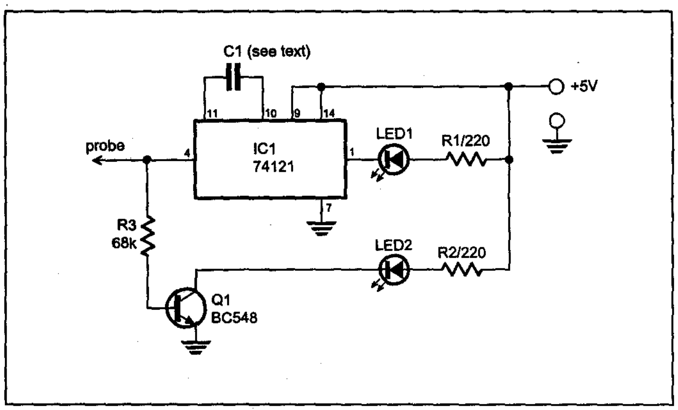
David Jackson
Papua, New Guinea. **$35**

Simple logic probe

This simple logic probe can detect low, high and floating logic levels, single short pulses and pulse trains. When the probe is connected to a logic 0, transistor Q1 is off and LED2 is also off. If the probe tip is connected to an open-circuit (floating), the small current from pin 4 of IC1 will keep the transistor on slightly, causing LED2 to glow dimly. A logic 1 at the probe will cause enough base current to make Q1 turn on fully, lighting LED2 to full brightness.

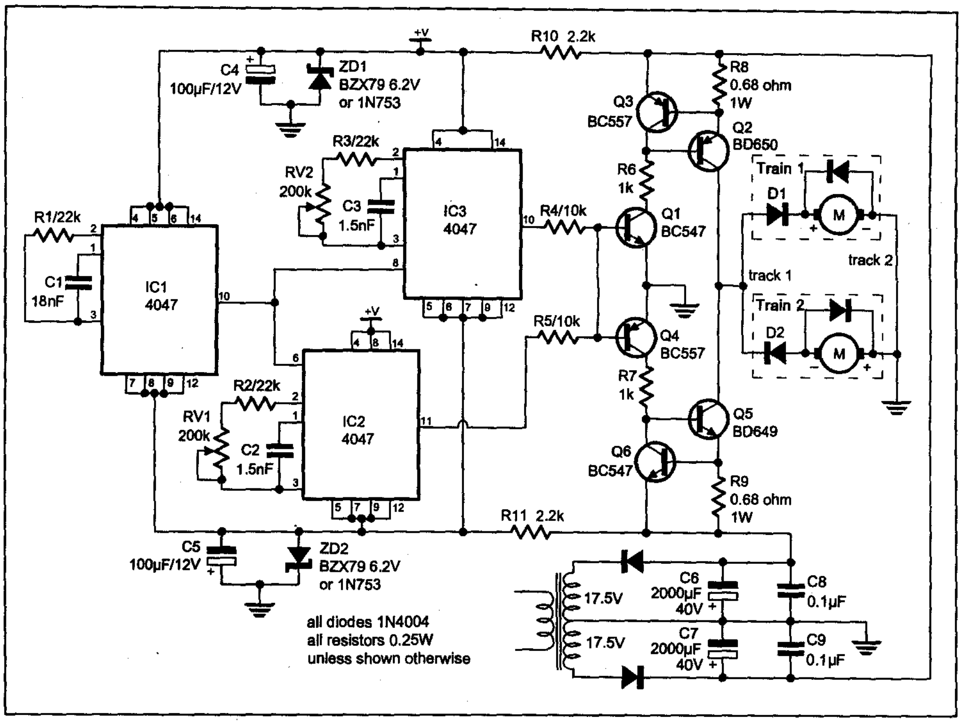
LED1 is on only when the monostable of IC1 is triggered, which occurs with a negative-going pulse (logic 1 to logic 0) at pin 4. For a single pulse, there is only one transition and therefore one flash from LED1. A pulse train will continually retrigger the monostable and the LED will keep flashing. The brightness of LED1 will increase with the frequency of the pulse train.

The value of R3 will probably need to be determined by trial, and should be such that LED2 glows dimly for an open-circuit at the probe tip. The value of C1 is determined by noting if a single pulse causes a suitable flash from LED1.



Andrew Chin,
Heidelberg, Vic. **$35**

Dual train controller



This circuit lets you independently vary the speed of two model trains on the one track. The only modification required to each engine is the addition of two diodes. The principle of the circuit is very simple — one train responds to positive going pulses, while the other responds to negative going pulses. To vary the speed, the mark-space ratio of each set of pulses is changed independently.

In the circuit, IC1 (multivibrator type 4047) is wired as an astable, with an operating frequency set by R1 and C1. Its output is coupled to two monostables, IC2 and IC3. Mono IC3 responds to the positive-going edge of the signal from IC1, causing its output to go high for a time set by RV2 in conjunction with R3 and C3. The larger the value of RV2 the longer the pulse width, and the faster train #1 runs.

The timing component values for IC3 have been chosen so the maximum duration of its output pulse is slightly less than half the period of oscillation of IC1. The output pulse at pin 10 of IC3 is coupled to the non-inverting amplifier and power stage formed by Q1 and Q2, and then by D1 to the motor of train #1.

Similarly the negative-going edge from IC1 causes the output of IC2 to go low, for a duration set by RV1, R2 and C2. The larger the value of RV1 the longer the pulse width, and the faster train #2 runs. The output pulse at pin 11 of IC2 is coupled to the non-inverting amplifier and power stage formed by Q4 and Q5, and then by D2 to the motor of train #2.

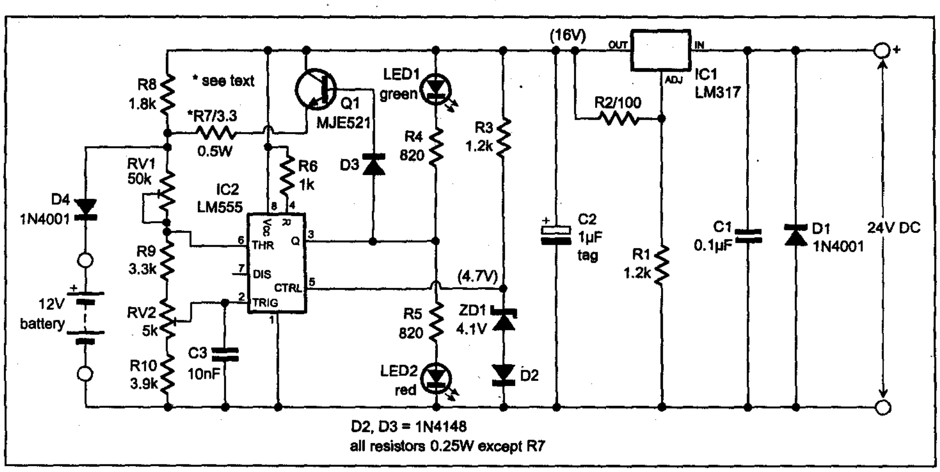
Output current limiting is provided by Q3 and Q6 and is set by R4 and R5 to about 900mA. The output transistors should be mounted on a heatsink. For 12V trains, you could use the suggested power supply or a centre-tapped power supply of 48V DC, with a suitable current capacity.

Les Kerr
Beacon Hill, NSW. **$45**

12V battery charger

This circuit is designed to charge a 12V lead-acid battery (gel etc). Charge current to the battery is via IC1, Q1, R7 and D4. The value of the charge current is set by R7, although in the circuit as shown, regulator IC1 has a practical limit of 1A or so.

IC1 is a 555 timer that drives LED1 and LED2 and also supplies base current to Q1 via D3. The battery voltage is sensed via RV2 and controls the operation of IC2. When the battery voltage is below a preset value, the output of IC2 is high. As a result, LED2 (red) is on and charge current flows to the battery. As the battery voltage increases, a point is reached when the output of IC2 switches low, turning on LED1 (green) and switching off charge current to the battery. The battery voltage now falls slightly, causing the output of IC2 to switch high, restoring charge current and turning on the red LED. This cycle continues while power is applied, giving pulses of charge current to the battery. The width of the charge pulses get smaller as the battery reaches full charge.Temperature compensation is provided by ZD1 and D2, which ideally should be mounted close the battery being charged to sense any increase in temperature of the battery. This circuit gives a voltage of around 4.7V to pin 5 of IC2.



To adjust the charger, first ensure the DC supply to the circuit is 16V. With the charger not connected to a battery, adjust RV1 to give 5.4V at pin 6 of IC2, and adjust RV2 for 2.8V at pin 2. The green LED should be on. Now connect a fully charged 12V battery (12.5 to 12.6V) to the charger. Readjust RV1 for 4.7V at pin 6 and RV2 for 2.4V at pin 2. The red and green LEDS should both be on, indicating the charger is regulating the current to the battery.

Allied Electronics,
Kingsford, NSW. **$45**

Construction project:

PC-DRIVEN EGO SENSOR ANALYSER - 1

With car engine management systems becoming more and more sophisticated (and complex), it is getting increasingly difficult to find out what's happening 'under the hood'. This low cost analyser, combined with any IBM PC and some special software can provide a large amount of information on your car's performance.

by GRAHAM CATTLEY

Look under the bonnet of almost any modern car, and you will find that a disturbingly large proportion of the engine's operation is controlled by a microcontroller — otherwise known as an Engine Control Unit (or ECU).

The ECU monitors, through a large number of sensors, almost every aspect of the engine's operation, and is responsible for keeping tabs on (and compensating for) the many different factors that affect the engine's overall performance.

If you don't have several thousand dollars to spend on specialised engine monitoring systems, you can find it difficult to analyse your car's performance — important, particularly when things like catalytic converters require the engine to be running within very narrow margins in order to operate effectively. To this end we have designed a simple, low cost device to monitor the engine and display the results on an ordinary IBM PC (or clone).

The PC driven EGO analyser monitors the output from the engine's Exhaust Gas Oxygen (EGO) sensor, and provides a scope-type graphical display of its output voltage. This is a great improvement on existing designs (which display the sensor's voltage using a row of LEDs), as the computer can not only display the sensor's output waveform, but also perform many complex calculations to give you such details as:

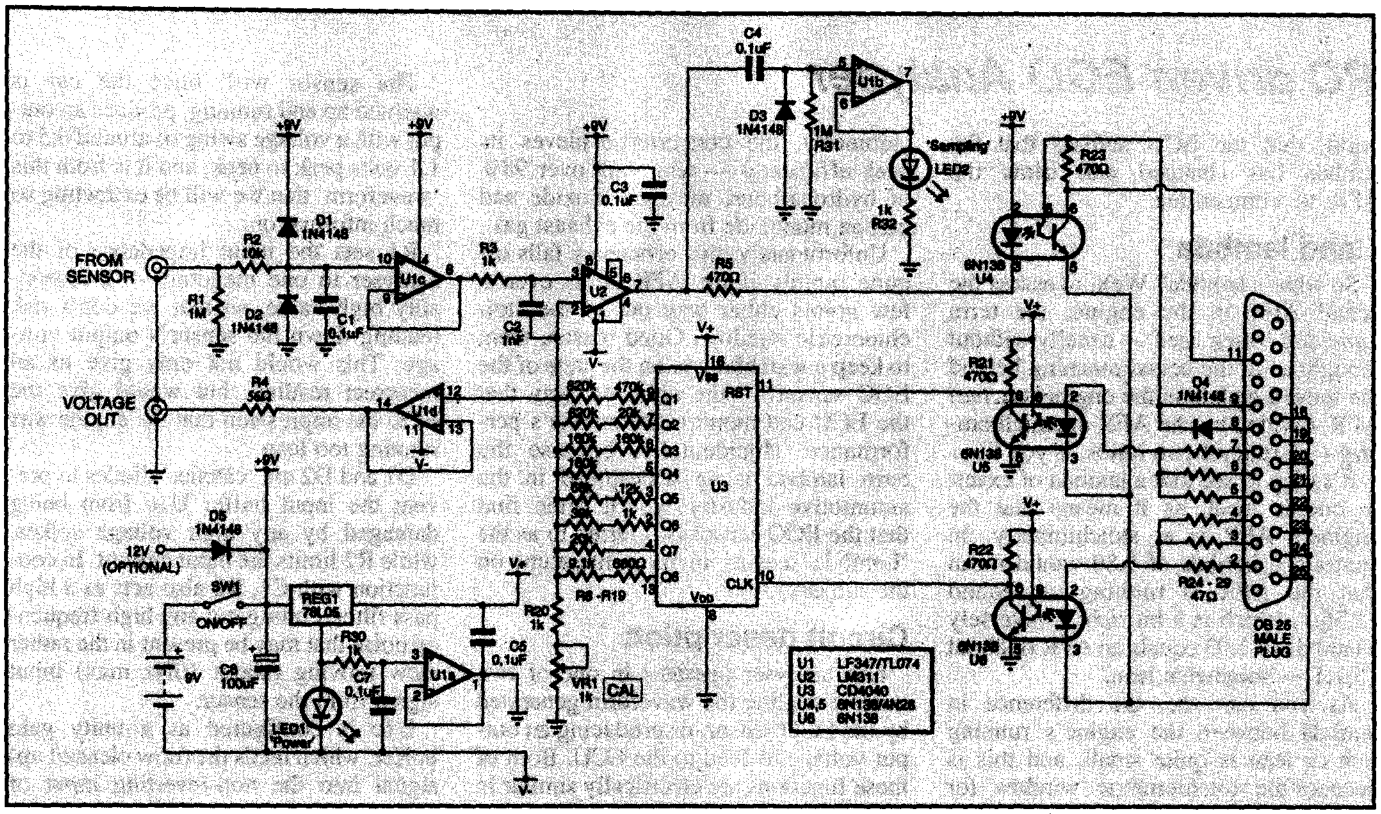
- The percentage of oxygen in the car's exhaust (indicating the amount of wasted or unburned fuel);
- Whether (or when) the engine is running too rich or too lean;
- The engine's Air/Fuel Ratio (AFR), and consequently its Lambda (more about this later).

By examining the waveform, you can even tell how 'tightly' the ECU is controlling the engine. Quite an impressive amount of data from one little sensor!

All of this information is updated in 'real time' — taking a lot of the guesswork out of tune-ups, as the results are immediately apparent.

Also, with a bit of extra work on the software side of things, we have managed to get the computer to drive the analyser in 'reverse' so that instead of reading a voltage coming in from the sensor, the analyser can produce a software selectable DC output voltage in the same range. This voltage can be fed in to the ECU *instead* of the EGO sensor's signal, allowing you to check the operation of the ECU and associated fuel injection systems with a 'simulated' EGO sensor.

The selection between reading in a voltage and outputting one is done under software control — in fact, the only hardware control on the device is the on/off switch! Also, much effort has been put into the software to make it as user-friendly as possible, as well as making it able to run on almost any system.



U3, a CMOS binary counter, the output of which is fed to high speed comparator U2, forms a simple digital to analog converter which is also fed with the EGO sensor's signal via U1c. Opto-isolators provide complete isolation between the analyser and the computer.

EGO sensor?

The ECU receives input from a multitude of sensors distributed throughout the car. Of these, perhaps one of the most important is the EGO, or Exhaust Gas Oxygen sensor, located as you might expect in the exhaust manifold of the engine. The correct functioning of this sensor is of paramount importance to the correct operation of the engine management system.

As its name would suggest, the EGO sensor produces a voltage that is inversely proportional to the percentage of oxygen remaining in the engine's exhaust gas. As this residual oxygen level is a direct indicator of the engine's efficiency in burning the fuel (petrol), the EGO sensor therefore plays a crucial part in the engine's AFR closed-loop feedback control system. It needs to be functioning properly in order for the engine both to give its best fuel economy, and to achieve the correct pollution control of exhaust gases.

One problem comes about when the EGO sensor becomes contaminated with carbon or other residues in the exhaust gas.

This causes the sensor to become slow or 'lazy' in responding to changes in the exhaust's oxygen content, and this is consequently reflected in the engine's performance.

Looking at the screen shot (Fig.1) you can see that the sensor's output voltage is not, as you might expect, maintained at a steady, constant level. This is because the sensor is part of a closed loop control system, whereby the ECU detects a change in the voltage coming from the sensor, and so changes the width of the pulses used to switch on the engine's fuel injectors.

In just a few hundred milliseconds or so (depending on the speed of the engine), the sensor detects the change in the AFR (or rather the change in the residual oxygen percentage, which amounts to the same thing), and consequently changes its output voltage accordingly.

Because of the inherent lag in this closed-loop system, due to the time taken for the exhaust gas to pass from the cylinders down to the sensor, as well as the distinctly non-linear AFR/voltage curve (see Fig.2), the sensor's output voltage swings fairly smartly between an upper and lower value. This means that the engine is running alternately rich and lean every second or so, which evens out to give the engine's average AFR.

By monitoring the sensor's varying output voltage, and by seeing how many times it crosses its own average voltage, we can see how fast the loop-response of the system is. The number of these crossings is averaged out over a 10-second period, with 20 to 40 'cross counts' every 10 seconds considered quite reasonable for high engine speeds.

Stoichiometry...

Of course the whole point of this feedback system is to maintain the AFR at some ideal level. And for petrol, this ideal air/fuel ratio is 14.7:1. A mixture of 14.7 parts air to one part fuel (by volume) is the best mixture to keep the engine running at its optimum level, in terms of maximum efficiency in converting the fuel into energy, and the lowest pollution.

This ideal ratio is known as the *stoichiometric* point, and the ECU strives to keep the engine running at stoichiometry. The way that it does this is to try and keep the sensor's average voltage at the magic value of 0.45 volts.

This is one nice thing about EGO sensors — when the AFR is exactly 14.7:1, the usual sensor will produce an output voltage of 0.45V, and it is when the voltage swings past this

PC driven EGO Analyser

point, that the ECU realises that the lambda has changed and trims the AFR to compensate.

...and lambda

So what's lambda? Well, to assess the actual AFR in the engine, the term *Lambda* is often used — usually without thought as to the actual meaning behind the term. Lambda is the engine's *actual* AFR, divided by the AFR at stoichiometry — a ratio of two ratios, if you like.

It's easy to see that a lambda of exactly one is ideal, as it means that the engine's AFR is at stoichiometry. In contrast, a lambda of 0.80 would mean that the AFR is running at around 11.76:1, which is a bit rich. Conversely a lambda of 1.03 equals an AFR of about 15.1:1 — somewhat lean.

As you can see, the difference in lambda between the engine's running rich or lean is quite small, and this is because the stoichiometric 'window' for optimum operation is itself quite narrow, ranging from 14.65:1 to 14.75:1.

Keeping the AFR within this range is not just for the engine's benefit, however, as the catalytic converter mounted in the exhaust system has a very narrow range over which it will operate. A quick look at Fig.3 will show you that at stoichiometry, the converter achieves its peak efficiency — removing over 98% of hydrocarbons, nitrogen dioxide and carbon monoxide from the exhaust gas.

Unfortunately, this efficiency falls off quite rapidly if the AFR shifts even a few points either way out of the stoichiometric window. Good reason, then, to keep a watchful eye on the state of the EGO sensor — the only real way that the ECU can monitor the engine's performance. (Incidentally, because the term lambda is so widespread in the automotive industry, you'll often find that the EGO sensor is referred to as the 'Lambda sensor' in most literature on the subject.)

Circuit description

Our analyser operates in one of two modes: reading the waveform generated by the EGO sensor, or producing an output voltage to feed to the ECU. Both of these functions are electrically similar in operation, the only real difference being in how the software 'drives' the circuit to perform each function.

To start with, we'll assume that we are reading in a waveform from a reasonably healthy EGO sensor, and that it is connected to the sensor input (labelled 'From Sensor' in the circuit diagram).

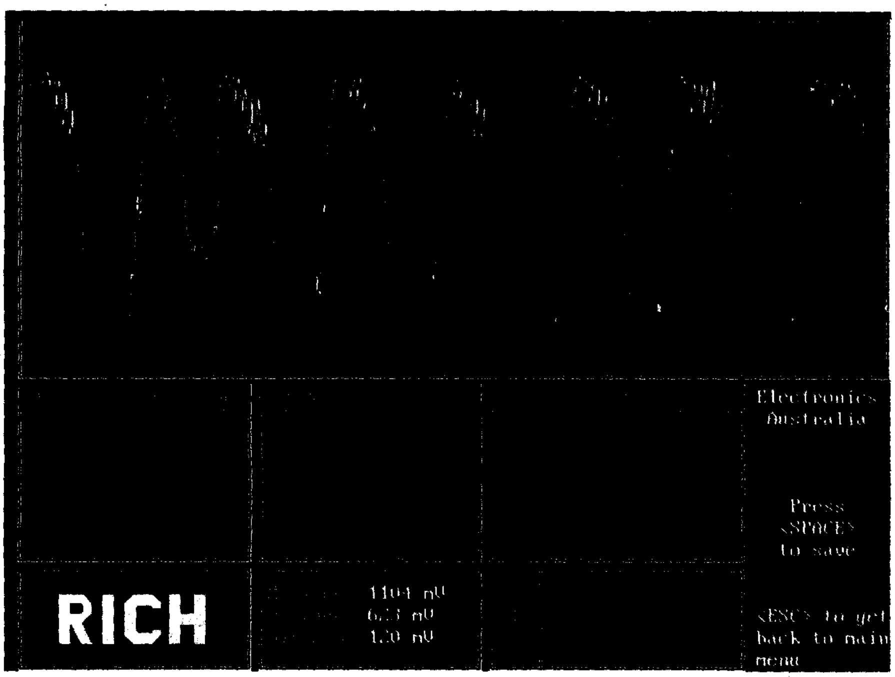


***Fig.1**: A screen shot from the analyser, clearly showing in the top half the waveform produced by the EGO sensor, while the bottom half displays all of the calculated readings. Note that this reading was taken while the car was accelerating, accounting for higher than normal lambda.*

The sensor will, once the car is warmed up and running, produce an output with a voltage swing of around 0.5 to 1.1 volts peak to peak, and it is from this 'waveform' that we will be extracting so much information.

R1 sets the input impedance of the analyser to one megohm — a reasonably high value, so that we don't risk loading down the sensor's output voltage. This would not only give us an incorrect reading, but would give the ECU the impression that the engine was running too lean.

D1 and D2 are 'catcher' diodes to prevent the input buffer U1c from being damaged by any high voltage spikes, while R2 limits the input current. In conjunction with C1, R2 also acts as a high pass filter, cutting out any high frequency noise that may be present in the rather slow moving (about 10Hz max) input signal from the sensor.

U1c is configured as a unity gain buffer, which feeds the (now cleaned up) signal into the non-inverting input of high speed comparator U2.

That's about it for the analog part of the circuit. The rest of the circuit is driven by the computer and is, as you might expect, digital. To explain this part of the circuit, we are best off starting with the signals generated by the computer on the parallel port, and to explain these properly, we will have to dig a bit deeper — into the operation of the software itself.

When configured to read in (or 'sample') the sensor's output voltage, the software starts off by writing the value C7 hex to the computer's parallel port address. This is converted into a reset pulse, synchronising the hardware with the software so that everybody starts off on the right foot.

After a few milliseconds (the exact time will depend upon the speed of your computer), the software writes the values FF and then F8 (hex) to the port in quick succession, and then has a quick look to see if the port's BUSY line has gone low. The software does this write-write-check routine a total of 255 times for each individual sample, which is why that particular part of the program was written in machine code — anything else would be too slow!

The real world

Okay, now that we know what the software is doing, we can get back to the 'real world' of electronics. Of course, each time a value is written to the port address in software, its binary equivalent is produced on pins 2 to 9 of the computer's parallel port, and consequently appears at the DB25 plug on the right hand side of the circuit diagram.

If you look at the binary equivalent of the reset value that appears on the port at the start of each sample, (11000111), you'll see that the three zeros match up with the current limiting resistors R24, R25 and R26. These three resistors tie together to drive the optocoupler U5, with the ground return connected to pins 18-25 on the parallel port.

We have decided to use optocouplers to interface between the computer and the analyser for a couple of reasons; one is so that you can plug and unplug the analyser from the computer at any time — even when the computer and analyser are turned on. The other (and more important) reason is to electrically protect the computer from any voltage surges that may occur in the car's electrical system. The optocouplers serve to provide complete electrical isolation between the computer and the rest of the world.

Getting back to our resistors though, as they have a logic low applied to them (through bits 4 to 6), the optocoupler will be turned off. As a result, the RESET line of the binary counter U3 is pulled high through R21, and counter chip U3 resets — bringing all of the Q outputs low.

A similar thing happens when the values FF and F8 are sent out from the computer, only this time it is U5 that gets switched. (The hex values FF and F8 are binary 11111111 and 11111000 respectively.) As you can see, bits 4, 5 and 6 remain high, preventing the counter from resetting, while bits 1, 2 and 3 toggle high/low, this time clocking the counter.

Resistors R6 to R19, along with R20 and VR1 comprise a resistor 'ladder' driven by the counter's outputs, and as a result of the counting action of U3, this simple 'digital to analog converter' (DAC) produces a rising staircase or ramp voltage on the inverting input of U2. This voltage is trimmed via VR1 so that after 255 counts, the voltage peak is at 1.28 volts. With the port toggling away at around 15 to 30kHz (again, depending on the speed of your computer), a few quick jabs at your calculator will tell you that the ramp's frequency is around 58 to 117Hz — quite fast compared with the rather slow moving signal coming from the sensor.

Looking back now at comparator U2, you can see that its output will flip high whenever the ramp voltage from the

PARTS LIST

Resistors

All 1% 1/4 watt:

R1,31	1M
R2	10k
R3,16,30,32	1k
R4	56 ohms
R5,21,22,23	470 ohms
R6	820k
R7	470k
R8	620k
R9,17	20k
R10,11,12	160k
R13	68k
R14	12k
R15	39k
R18	9.1k
R19	680 ohms
R20	1.5k
R24,25,26,27,28,29	47 ohms
VR1	10k horizontal mini trimpot

Capacitors

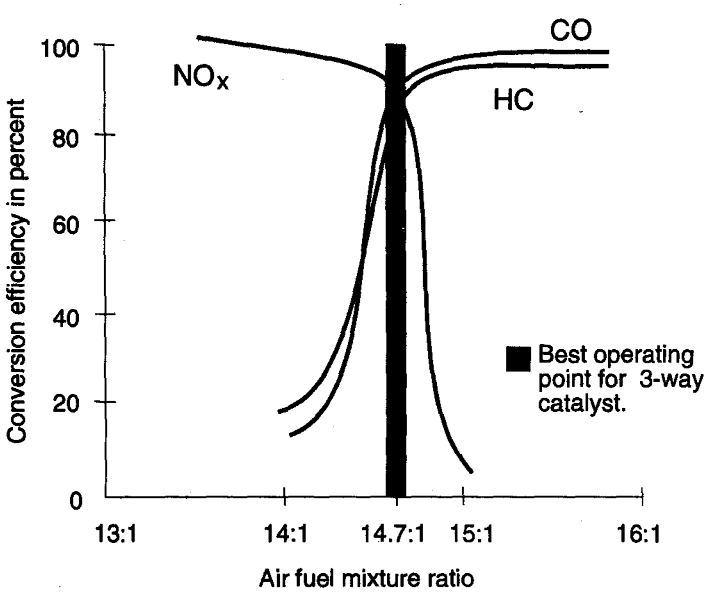
C1,3,4,5,7	0.1uF 100VW MKT
C2	10nF 100VW MKT
C6	100uF 16VW RB electrolytic

Semiconductors

U1	LF347/TL074 quad op-amp
U2	LM311 high speed comparator
U3	4040 14-stage binary counter
U6	6N138 high speed optocoupler
U4,5	6N138 or 4N28 optocoupler
D1,2,3,4	1N914/1N4148 small signal diode
REG1	78L05 low power 5V voltage regulator
LED1,2	5mm red LED with bezel

Miscellaneous

PCB 57 x 103mm, coded 96ego1; UB3 medium jiffy box, 130 x 77 x 40mm; 2 x BNC panel mount sockets; 2m x 12-way data cable; 30cm single core shielded cable; hookup wire; DB25 male plug; 9V battery clip; SPDT toggle switch; 19 x PC pins; nylon tie for cable clamp; 3 x 15mm 6BA bolts; 6 x 6BA nuts; 3 x 5mm spac-



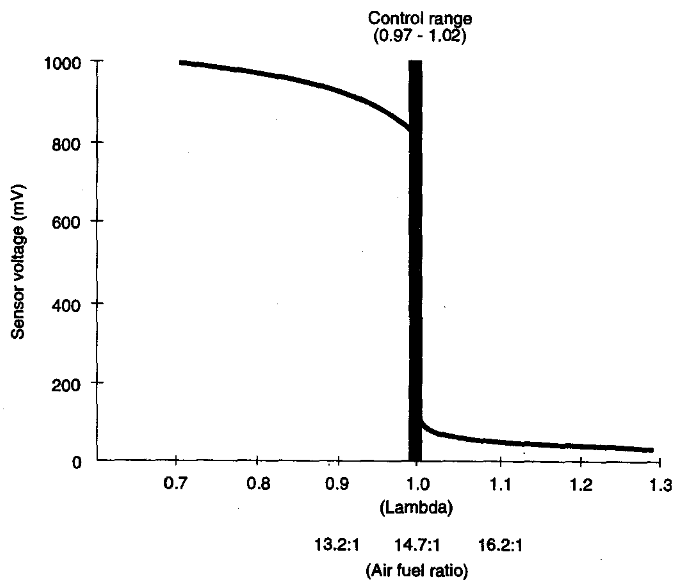


Fig.2 (left) This graph shows how the EGO sensor's output voltage swings severely as the air/fuel ratio moves through stoichiometry. Under normal conditions, the engine runs in the narrow range of .97 - 1.02 lambda, shown here in grey. Fig.3 (Right): Catalytic converers operate within a very narrow 'window' which is centred around the ideal AFR of 14.7:1. The ECU keeps tight control over the enginer in order for the converter to remove up to 98% of carbon monixide, hydrocarbons and oxides of nitrogen.

PC driven EGO Analyser

resistor ladder exceeds the voltage coming from the sensor. This high drives the optocoupler U4, which relays the signal through to the BUSY line (pin 11 on the parallel port). In this way the computer can determine the sensor's output voltage at any time, by counting the number of times it needs to toggle the port before a BUSY signal is generated by the analyser.

Power supplies

To be technical, there are two power supplies in this project — the more obvious one based around REG1, and another used to power optocoupler U4. This latter one is simply pins 8 and 9 of the parallel port, which are set through software so that they are permanently high.

Small signal diode D4 prevents any damage to the port, in case the analyser is plugged into the computer before the software has had time to set both of these bits high (if one were high and the other low, the two outputs would 'fight' each other, possibly overloading the outputs).

The power supply for the rest of the circuit is based around the low power three-terminal regulator REG1. This is a 5V device, but due to the 1.8V voltage drop from the 'Power' LED in its common line, the regulator puts out 6.8V relative to battery negative. Note that battery negative is not ground, as is usually the case, because here we are using U1a as a buffer to provide a ground that tracks exactly 5V below the regulator's output, giving a stable 5V supply for the binary counter U3 — necessary if we want to keep our ramp voltage stable.

The rest of the circuitry is somewhat less critical in its power requirements, and so is run straight off the battery, taking the load off the regulator.

As we are calling the output of U1a ground, battery negative by definition, becomes a minus voltage and is thus used to power the negative supplies of U1 and U2. Speaking of batteries, don't be tempted to power the circuit directly from the vehicle's own 12V battery, since this would effectively short out this 'induced' negative supply rail. However you could connect to some kind of huskier external battery via a flying lead and set of alligator clips — in which case we suggest that you include the diode D5 (not mounted on the PCB), to protect the analyser against accidental reverse polarity.

U1b, used to light the 'Sampling' LED, gets its input through C4 from the output of the comparator U2. This output will be toggling high/low with a mark-space ratio dependent on the input voltage to the analyser. C4 serves to block DC and pass only the 'AC' pulses as U2's output changes state. these pulses are then buffered by U1b, driving LED2 with a signal that is pulse-width modulated with the EGO sensor's output.

The other mode

As stated above, the analyser can operate in one of two modes, either reading in a voltage from the EGO sensor, or producing a voltage to feed into the Engine Control Unit instead of the EGO sensor's output. We've only covered the 'reading in' or sampling side of things so far, so we'll move on to the other mode — voltage production.

Surprisingly, this involves the addition of only two extra components, U1d and R4 (actually, that's one and a quarter components, but we aren't going to be picky, are we?).

The way it works is quite simple. All that happens is that the software (now in 'generate voltage' mode) produces a reset pulse, as it did before, and then proceeds to clock U3 a specific number of times, depending on the voltage to be generated.

As the maximum count of U3 is 255, and this corresponds to a voltage of 1.28 volts, it is a simple matter for the software to clock the counter 255/1.28V = 199 times per volt. this equates to 5.0mV per count, so that if an output of, say, 0.55 volts was required, the software would clock the counter a total of 110 times.

The required voltage appears as before on the end of the resistor ladder R6-19 and this is buffered by U1d which provides a relatively low output impedance, with the maximum output current limited to 20mA by R4.

Well, that's about all we have room for this month. Next month we will be covering the construction, testing and calibration of the analyser, along with some information on how to interpret its readings. If you're after more info on EGO sensors, our Automotive Electronics series makes very informative reading — particularly the January 1994 and last month's December 1995 issues, which cover the operation of the sensor in greater detail than can be afforded here.

(To be continued) ❖

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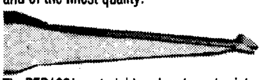

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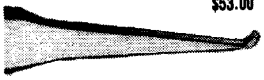
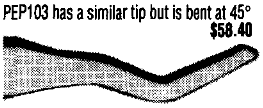


PEP103 has a similar tip but is bent at 45° **$58.40**



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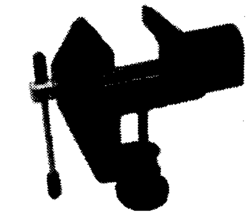

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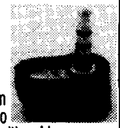

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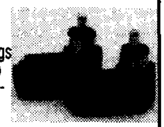

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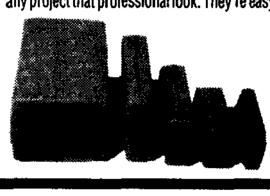

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READER INFO NO. 12

Construction project:

SMART DUAL 12V BATTERY CONTROLLER - 1

This auxiliary battery manager takes full advantage of a dual battery setup's capabilities, by controlling when and how the 'auxiliary' battery is connected to the electrical system. It's fully automatic, will cost you far less than an equivalent commercial unit, and is particularly suited to the new breed of deep-cycle auxiliary batteries.

by ROB EVANS

Those familiar with the way dual battery systems are used in (mainly) recreational vehicles will no doubt appreciate the added safety and convenience this arrangement has to offer. The main advantage is that with an auxiliary battery powering any 'non-essential' accessories such as a refrigerator during an overnight stop, the four wheel drive vehicle (4WD), boat or camper's main battery is preserved for starting the engine in the morning.

This certainly beats being stranded in the middle of the Simpson desert in your 4WD, because the ever-important beer fridge has exhausted the vehicle's main, and *only* battery during the night...

Since a dual setup's auxiliary battery needs to be isolated during stops, but connected to the main 12V system for charging while the engine is running, there needs to be some switching system involved — and preferably an automatic one. In practice, there are a number of ways this can done, and these vary substantially in cost and complexity.

The most common switching arrangements are based on a very heavy-duty relay — typically rated at between 20 and 100 amps — that has its contacts wired between the main and auxiliary battery terminals, and is energised via a switch on the vehicle's instrument panel or from an automatic control line. The relay itself is a fairly specialised and expensive device, with silver-coated contacts for longevity and very large bolt-type connectors, and is mostly sold through 4WD and marine accessory shops.

The manual switch method of engaging the relay has obvious pitfalls, as it relies on the correct action from the operator, but the various automatic arrangements can work well. Regardless of the control method though, the relay is often switching very high currents and will suffer from the associated contact arcing. This in turn tends to cause the contacts to burn and eventually fail (despite the use of silver), and in extreme cases, can induce large voltage spikes in the main electrical system — a cause for concern with today's sophisticated engine management systems...

In the light of this then, some form of semiconductor switching is clearly the way to go, and commercial manufacturers offer a number of solid state switching units, as well as those based on heavy-duty relays. These range from units that provide the required isolation by placing a high-powered *diode* in series with each battery — with the associated problems of forward voltage drop — to quite sophisticated management systems using switching MOSFETs, some of them quite costly.

As you've no doubt gathered, we have followed this latter path with the design of our own new auxiliary battery manager, which uses high-current switching MOSFETs and a relatively elaborate (but not expensive) control circuit. The MOSFETs have a rated drain-to-source current of around 50 amps, and an effective 'on' resistance of just 30 milliohms. To bolster the manager's current capability, we've elected to

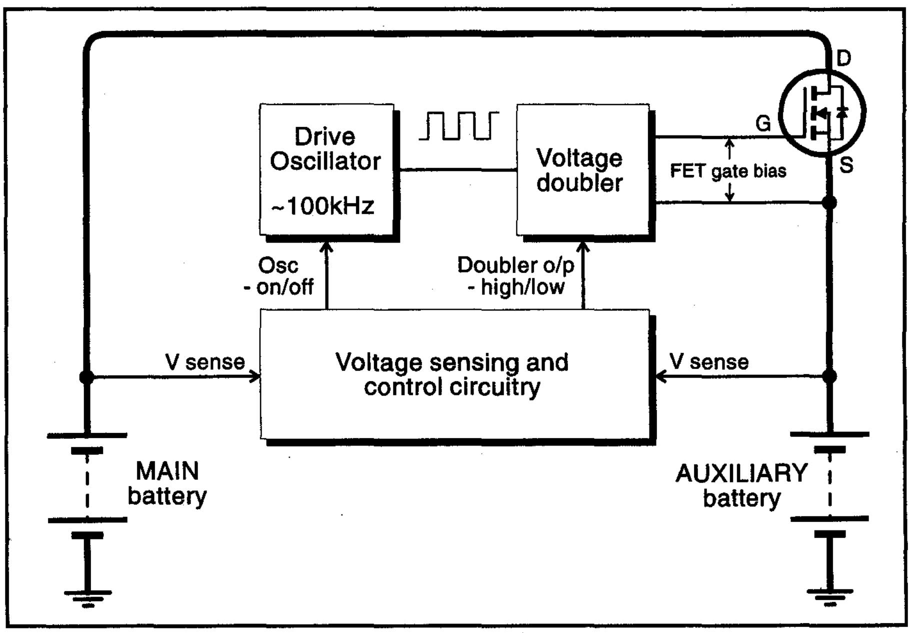
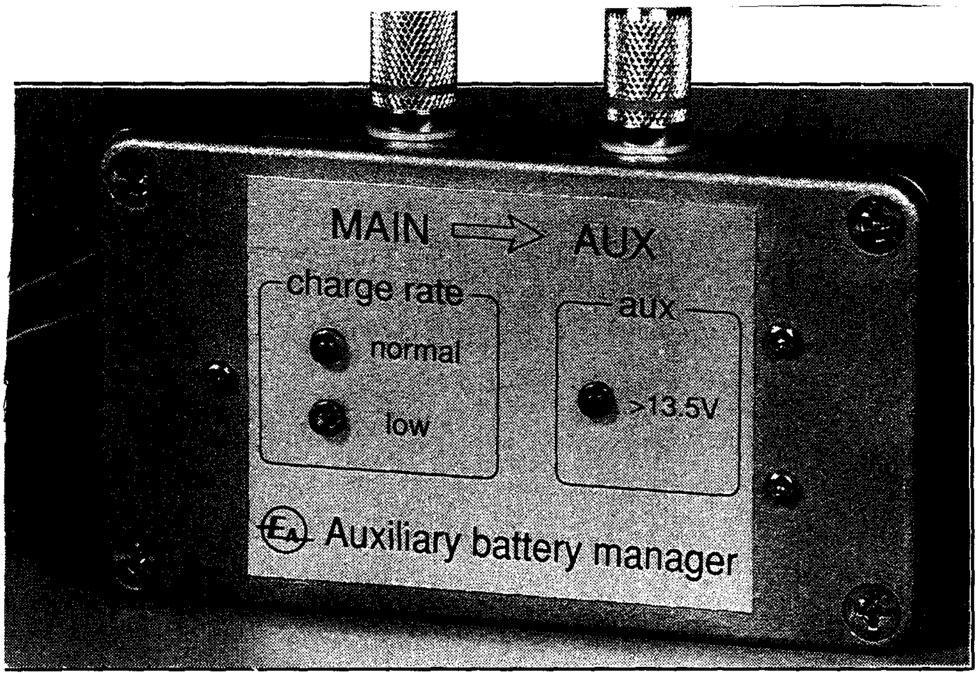


Fig.1: The basic block diagram of the battery manager. The control circuit only allows the MOSFET to pass charging current when both batteries are in a suitable state.



use two of these devices in parallel.

The circuitry used to control the MOSFETs senses the state of both the main and auxiliary batteries, and as a result will only connect the two directly together when conditions are appropriate. Namely, this is when the ignition system is active, the main battery has been fully charged, and the auxiliary battery has a reasonable terminal voltage.

This last condition has been included to protect the internals of a fully *discharged* auxiliary battery, because the new deep-cycle types in particular can be damaged by a large and sudden inrush of charging current. As this would be the case if the fully charged main battery is directly connected to a discharged auxiliary unit, the battery manager will not allow full current to pass until it senses that the auxiliary battery is at least partially charged.

In practice, the circuit allows an exhausted auxiliary battery to charge at two or three amps, then applies full charging current when its terminal voltage has reached about 10 volts. In this way the circuit helps to extend the working life of an auxiliary battery (which will often have a high replacement cost), and offers a degree of overload protection.

And to help you keep tabs on both the battery manager activity and the state of the electrical/charging system, we have also included a number of LED indicators on the front of the unit, as you can see from the associated photographs. Note that this includes an 'AUX>13.5V' LED, which will illuminate when the auxiliary battery has returned to a healthy state of charge.

So there we have our new auxiliary battery manager. It's relatively inexpensive to construct, thanks to the use of common, low-cost components; can be installed without interfering with the existing wiring, and automatically charges the auxiliary battery in a 'sympathetic' manner. Plus of course, it provides the basic isolation needed to preserve the main battery for starting purposes.

The overall design

The block diagram in Fig.1 shows the basic arrangement of the Battery Manager's circuit, where the high current charging path between the main and auxiliary batteries (via the MOSFET) is indicated by a heavy line, and the three low power control sections are shown in the centre area.

Here, the 'brains' of the circuit, the *voltage sensing and control* block, continuously monitors the voltage level of both the main and auxiliary batteries via their respective *V sense* lines, then uses this information to control the conduction of the MOSFETs (only one shown) via the remaining *Drive oscillator* and *Voltage doubler* blocks.

When enabled, the (nominally) 100kHz squarewave output from the oscillator drives the 'floating' voltage doubler circuit, which has its output connected between the MOSFET gate and source pins as shown in the diagram. The applied gate bias therefore has a DC level that's close to the peak-to-peak voltage of the incoming squarewave — around 12V — which comfortably exceeds the 8 - 10V bias level needed to switch the MOSFET into full conduction. In absolute terms then, the voltage at the MOSFET gate will be at the level produced by the voltage doubler stage *plus* the terminal voltage of the auxiliary battery (say, 12V and 13V respectively, or a total of 25V).

Note, however, that the MOSFET is only switched into full conduction when both the oscillator and voltage doubler are fully enabled by the control circuitry, and this will only occur when the unit has sensed that both batteries are in a suitable condition for full charge current to flow.

If the main battery has a terminal voltage of less than 13.5 volts on the other hand, the control circuit will shut off the drive oscillator via the 'Osc — on/off' line, thereby removing the MOSFET's gate bias and preventing any current flow to the auxiliary battery. Thus the battery manager will only attempt to charge the auxiliary battery when it has sensed that the main battery has reached an acceptable state of charge (above 13.5V), as mentioned earlier.

Once this condition is satisfied the enabled oscillator then supplies AC energy to the voltage multiplier, which will in turn apply either a *full* or *reduced* bias level to the MOSFET gate, as determined by the state of the 'Doubler o/p — high/low' control line from the voltage sensing circuit. If the circuit senses that the auxiliary battery's terminal voltage is above 10.5V — and is therefore ready to accept a full current charge — the voltage doubler is switched to a high output level, which will then apply full gate bias to the MOSFET to turn it hard on.

Conversely, if the auxiliary battery is in a relatively poor state of charge (less than 10.5V) and full charging current should not be applied, the control circuitry will switch the voltage doubler to its low output level, causing the MOSFET to only 'partially' conduct. In practice, this bias level will be around 3V DC, resulting in a charge current of about two amps. This is adjustable via a trimpot mounted inside the battery manager.

So there we have the broad outline of the auxiliary battery manager's operation, as shown in the block diagram of Fig.1. Note that there are actually two MOSFETs wired in parallel in the final circuit, so as to increase the unit's current capacity.

Also as depicted in Fig.1, these devices have an internal protection diode connected the drain and source pins. While this means that 'reverse' current *can* flow between the auxiliary and main batteries, this is not really a problem in practice — we'll discuss this aspect in more detail at a later point...

Smart Dual 12V Battery Controller - 1

Circuit description

Referring now to the battery manager's full schematic diagram, you can see that the layout roughly matches that of the block diagram in Fig.1. The drive oscillator is based on IC1a, the voltage doubler is formed around D2 and D3, while IC1b and IC1c perform the main voltage sensing and control functions as described above.

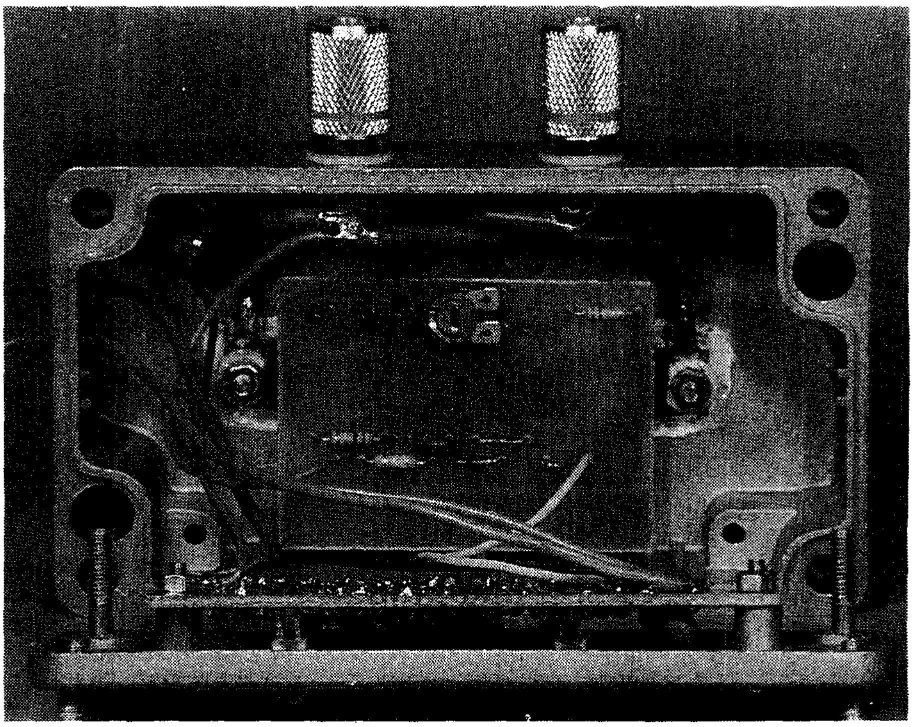
In detail, the main battery voltage is sensed by the comparator circuit based on IC1b, which monitors the terminal voltage via the divider chain formed by R9 to R11, then compares this to a 5V reference supplied by the 78L05 voltage regulator IC3. The values chosen for R9 to R11 (and R15) mean that when the source voltage rises to 13.5V, there is 5V present at IC1b's non-inverting input (pin 9) and the comparator will change state. This in turn allows the output at pin 14 to rise to a high level via pullup resistor R13.

At this point it's worth noting that the LM339 quad comparator used here for IC1 is of the *open-collector* type, and therefore needs a pullup resistor to achieve a high output level. In the above case R13 is connected to the 'IGN' supply rail. This rail is directly connected to the vehicle's ignition circuit and will therefore be at a 12V level (or close to that of the main battery voltage) when the engine is running. As this rail supplies virtually all of the battery manager's circuitry, the unit will therefore be disabled when the vehicle engine is shut down.

Thanks to the hysteresis effect produced by positive feedback resistor R12, the IC1b comparator will then remain in the above condition (output high) until the input voltage from the main battery drops to around 12.5V. At this point the voltage at IC1b's non-inverting input has fallen *below* the 5V reference at the inverting input, and the comparator's output will return to a low level.

In order to disable the drive oscillator when the main battery is at less than 13.5V, the comparator's output is connected directly to the oscillator circuit via diode D1, at IC1a's inverting input. A low level at the comparator's output will therefore forward bias D1 and hold IC1a's inverting input at near ground potential, which disables the oscillator and forces its output (pin 13) to a high level.

Conversely, a high level at the comparator output (pin 14) will reverse bias D1 and remove its loading effect on the RC network at pin 10, allowing the oscillator to run freely.



Two high current MOSFETs are used to control the current between the MAIN and AUX terminals — they provide support for the small 'drive' PCB, and use the bottom of the case as a heatsink.

The oscillator itself is it a fairly simple RC arrangement, where the biasing network composed of R1 to R3 provides both hysteresis and positive feedback for IC1a, and the values for R4 and C1 have been selected for an oscillator frequency of around 100kHz. Note that in this case the opamp's pullup resistor (R5) is tied to the main battery supply rather than the more usual IGN supply line, as this guarantees that the oscillator output swings between 0V and the main battery's terminal voltage.

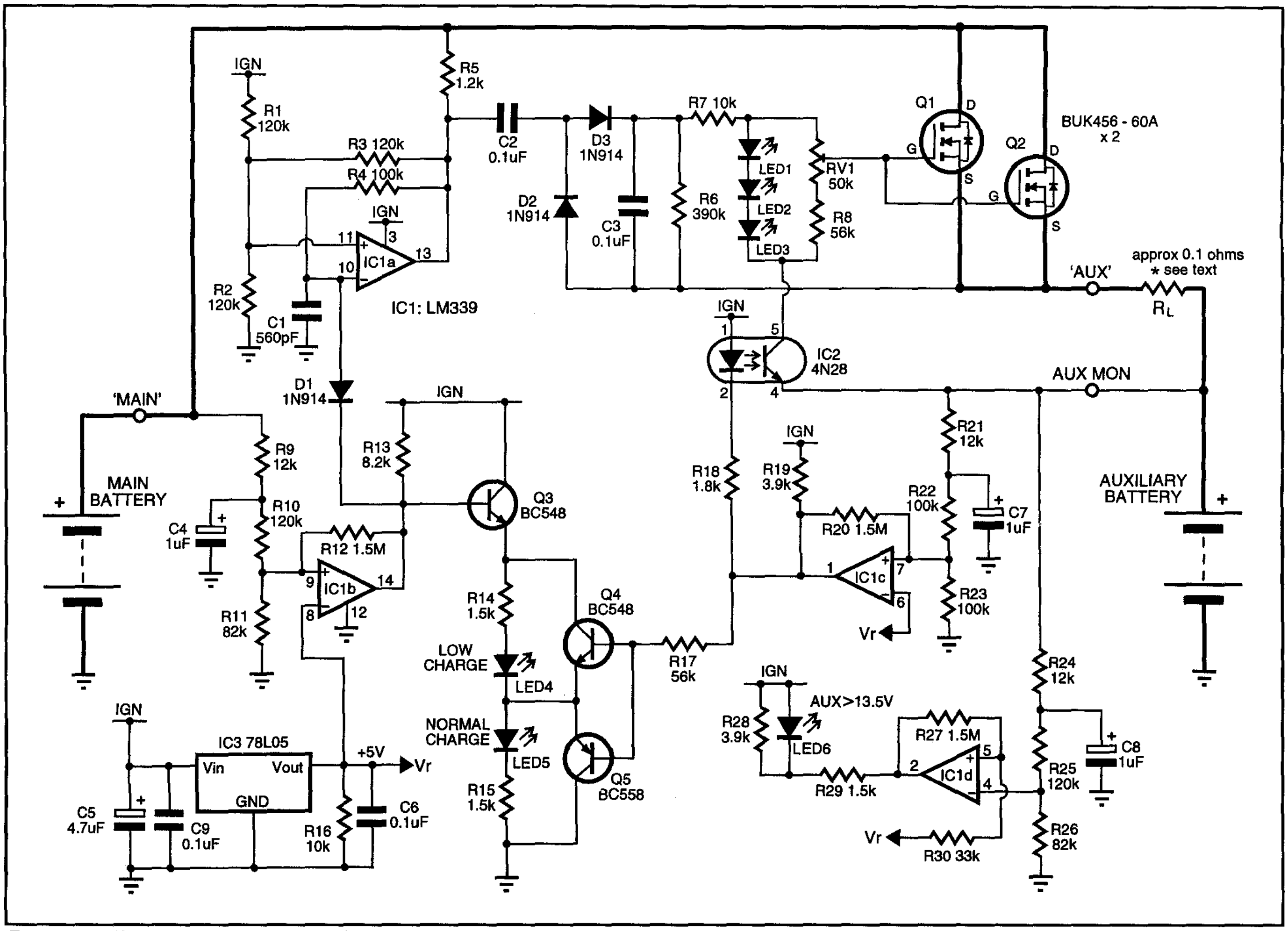
The aim here is to make sure that the input to the voltage doubler — and hence the drive voltage to the MOSFET gates — is at the highest possible level, and not at the mercy of the IGN supply line which can fall due to the loading of the vehicle's accessories. If the voltage on the ignition line drops by a significant degree, the proportional fall in the MOSFET gate drive voltage may cause their power dissipation to rise sharply, as they may no longer be *fully* biased on. In this situation, the MOSFETs could overheat or even self-destruct...

So while tying the oscillator's pullup resistor to the main battery rather than ignition line neatly solves this problem, it does increase the leakage current from the main battery when the battery manager is disabled — that is, when the vehicle is not in use.

However as the current path to ground via R5 is via high value resistors (R3, R4 and so on), the 'wasted' battery energy is extremely low. In fact, the bleed current will be less than 200uA, which is much less than the likely self-discharge current of a typical lead-acid automotive battery.

The squarewave energy from the oscillator output is next passed to the voltage doubler stage, which is composed of capacitors C2 and C3, and signal diodes D2 and D3. The resulting DC output developed across C3 and bleed resistor R6 is then applied between the MOSFET gate and source via R7 and RV1. Note that at this stage LED1 to LED3 and R8 are not influencing the circuit (optocoupler IC2 is 'off'), so full drive voltage (say 12VDC) is a applied to the MOSFETs, which will turn hard on and pass full charging current to the auxiliary battery via 'resistor' RL (which is actually the output lead). More about this component later on.

The terminal voltage of the auxiliary battery is monitored by the comparator



The overall schematic diagram for the manager. As you can see, the layout roughly matches that of Fig.1, so the various sections are easy to locate.

circuit based on IC1c, which is identical to the one used to sense the main battery voltage (IC1b), except for the value of the resistor at the bottom of the sensing divider chain, R23. With this arrangement, IC1c's output (pin 1) will at a high level when the auxiliary battery voltage has risen above 10.5V, and will then fall to 0V if the battery then drops below about 11.5V — as before, the circuit is essentially a non-inverting comparator with a hysteresis of about 1V.

When the auxiliary battery is below 10.5V and should not receive a full current charge, the resulting low level at the output of IC1c will energise the optocoupler's internal LED (pin 1 and 2 of IC2) via limiting resistor R18. This will in turn bias IC2's internal NPN transistor fully on (at pins 4 and 5), and connect both R8 and the cathode of LED3 directly to the auxiliary battery's positive terminal, via the 'AUX MON' connection.

Ignoring RL for the moment then, you can see that as R8 and the LED3's cathode are now connected to the MOSFET source pins, the level from the voltage doubler (across R6) is now applied to a voltage limiting circuit formed by dropping resistor R7 and the LED string (LED1 to LED3). The nominal 12V level from the voltage doubler is consequently reduced to about 4.5V across the LEDs (about 1.5V per LED), then 'trimmed' below this level by preset potentiometer RV1.

As the trimpot's wiper is connected to the MOSFET gates and therefore sets the final drive voltage when IC2 is activated, this adjustment is used to preset the 'low' charging current. In practice, about 3V of MOSFET gate bias will reduce the output current (into the auxiliary battery) to about two amps.

The story doesn't *quite* end there however, since the effect of the inline 'resistor' RL will slightly modify (in fact, improve) the behaviour of this part of the circuit, by acting as a source resistor for the MOSFETs.

As you would expect from a source or emitter resistor, RL provides a degree of DC negative feedback for Q1 and Q2, and therefore stabilises the output current for a given MOSFET gate bias voltage.

Note that the gate voltage generated across the LED string is referenced to the auxiliary battery side of RL, via IC2.

In effect then, the circuit behaves as a constant current source, when switched into the 'low' current mode.

Any increase in the nominal output current will cause a proportional rise in the voltage across RL, which in turn reduces the *actual* gate-to-source voltage applied to the MOSFETs. The MOSFETs will then shut down slightly, which compensates for the original increase in output current. However, note that since RL is a very low value and therefore provides only a *small* degree of negative feedback, the arrangement is somewhat less than a perfect constant current source. It's more than adequate for this application though, and the current varies by only a relatively small amount.

At this stage it's worth considering the other main effect of the output lead resistance (RL), which comes into play when the unit is in the 'normal' charge rate mode, where the MOSFETs are biased hard on (with IC2 inactive). Under these conditions RL simply limits the maximum current that can flow into the auxiliary battery, so as to protect the vehicle's electrical system, the battery manager's MOSFETs, and the auxiliary battery itself.

Note that in practice the battery manager only switches into the high (normal) current mode when the auxiliary battery has reached a terminal voltage of about 10.5V, so if we assume that the main battery is at say 14V, there will be around 3.5V across RL. If the lead has an inherent resistance of 0.1Ω then, the maximum charging current is restricted to about 35 amps.

Since the auxiliary battery is not fully charged at this point however, its own internal resistance will generally limit the charging current to a somewhat lower figure.

LED indicators

The remaining parts of the battery manager's circuit are mostly used to drive the front panel status LEDs, which indicate the current rate of charge (normal/low) and whether the auxiliary battery has reached a 'charged' condition (>13.5V).

As you can see from the schematic, the output of the main battery voltage monitor at pin 14 of IC1b also drives emitter follower Q3, which will provide a voltage source for the charge rate indicator circuit (LED4, LED5, Q4 and Q5) when the comparator output is at a high level — that is, when the main battery has risen above 13.5V and charging is enabled.

Then if the auxiliary battery is below 10.5V and a low charge current is flowing, the low level at the output of IC1c (pin 1) will be passed to the junction of LED4 and LED5 via emitter follower Q5 and isolating resistor R17. The 'low charge' indicator LED4 is therefore energised, via limiting resistor R14.

Conversely, when the auxiliary battery's terminal voltage has risen above 10.5V and the output of IC1c is high, emitter follower Q4 passes the high level to the junction of LED4 and LED5, thereby energising the 'normal charge' indicator LED5 via R15.

And as you would expect, when charging is *not* enabled (the main battery has not yet reached 13.5V) Q3's emitter will be low, which prevents either LED from illuminating regardless of the state of the auxiliary comparator IC1c.

The remaining comparator circuit based on IC1d monitors the state of the auxiliary battery in much the same way as IC1c, and drives the 'AUX >13.5V' indicator LED6 via limiting resistor R29.

In this case however, the circuit is set up as an inverting comparator, where the voltage reference Vr is applied to the non-inverting input (pin 5) via R30, and the sensing voltage divider (R24 to R26) feeds the inverting input at pin 4. Since the voltage divider values match those used with the main battery comparator (IC1b), IC1c's output will go low when the auxiliary battery has reached about 13.5V, therefore energising LED6.

Other minor parts of the circuit include the 78L05 low power voltage regulator IC3, which is used as a 5V reference for the comparator circuits, plus a number of passive 'housekeeping' components.

These include the IGN supply and regulator bypass capacitors C5, C6 and C9, and additional comparator pullup resistors R19 and R28 which ensure that IC2 and LED6 (respectively) are fully off when their matching comparator outputs are high.

Lastly, C4 is included to act as a low-pass filter in conjunction with R9, so that high frequency or transient interference from the main battery line *cannot* reach comparator IC1b. C7 performs the same function with R24, for the auxiliary comparator IC1c.

PARTS LIST

Resistors

(All 1/4W 5%)

R1-3,10,25	120k
R4,22,23	100k
R5	1.2k
R6	390k
R7,16	10k
R8,17	56k
R9,21,24	12k
R11,26	82k
R12,20,27	1.5M
R13	8.2k
R14,15,29	1.5k
R18	1.8k
R19,28	3.9k
R30	33k
RV1	50k miniature horizontal trimpot

Capacitors

C1	560p ceramic
C2,3,6,9	0.1uF monolithic
C4,7,8	1uF 25V tantalum
C5	4.7uF 25V tantalum

Semiconductors

IC1	LM339 quad comparator
IC2	4N28 opto-isolator
IC3	78L05 mini 5V regulator
Q1,2	BUK456-60A power MOSFET
Q3,4	BC548 NPN transistor
Q5	BC558 PNP transistor
LED1-3	3mm red LED
LED4	5mm red LED
LED5	5mm orange LED
LED6	5mm green LED

Miscellaneous

Diecast aluminium box (waterproof if possible) 115mm x 65mm x 35mm; 2 x heavy-duty terminal posts; 2 x medium-duty solder lugs; PCB, coded 96bm1a (85 x 40mm); PCB coded 96bm1b (55 x 40mm); 2 x BUK456-60A mounting kits; heavy and light duty hookup wire, tinned copper wire, nuts, bolts, etc.

Internal MOSFET diodes

As you can see from the heavy current path shown in the battery manager's schematic, the MOSFET internal protection diodes will allow a 'reverse' current to flow if the auxiliary battery's terminal voltage is significantly higher than that of the main battery. While this is obviously not the case during normal charging operations, there can be circumstances where the auxiliary battery is fully charged yet the main battery's voltage has fallen due a high current load — such as the vehicle's starter motor.

If the auxiliary battery can deliver a high current (most deep cycle batteries can't, by the way), then the MOSFET diode current is only really limited by the connecting lead resistance RL, and may rise to a high level — say 60 amps. This in turn means that the MOSFETs will dissipate around 30 watts each, thanks to the 1V drop across the diodes. If this current were present for an extended period, the MOSFETs would become rather hot and bothered due to the modest heatsinking capability of the diecast box.

Note that the MOSFETs dissipate less than 10W during normal charging operations.

While we were initially a little concerned about the above scenario, and considered a number of circuit configurations that would provide full two-way isolation between the batteries (by the use of a high-current relay), we found that the additional expense and circuit complexity of the alternatives was difficult to justify.

And as the condition would only occur if (a) the auxiliary battery was of the high current type, (b) the load was applied for an extended period (unlikely with a vehicle's starter motor), *and* (c) the main battery voltage dropped substantially under load (indicating a less than healthy battery), we reasoned that there was not too much cause for concern.

Of course, we'd have to add that it's extreme folly to set off in your 4WD, camper or car/caravan combination with an unhealthy main battery — or for that matter, a vehicle that's difficult to start and needs to be cranked for an extended period.

Under normal circumstances, the potential for reverse current flow could be considered as somewhat of an advantage in a dual battery system, since any excess charge in the auxiliary battery will be automatically passed to the main battery via the MOSFET diodes. This in turn ensures that the main battery is always in the best possible state of charge for the conditions at the time, and can therefore crank the engine into life.

That's all we have room for this month. In the second and final article, we'll cover the construction, testing and installation aspects of the battery manager. ❖

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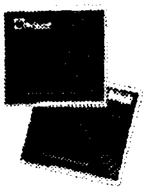

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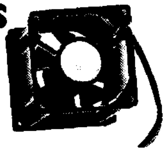

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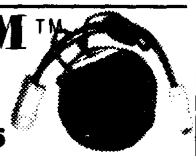

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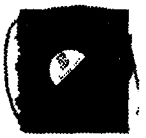

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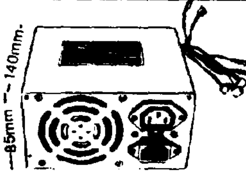

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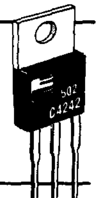

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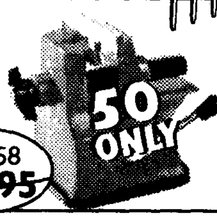

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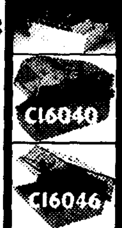

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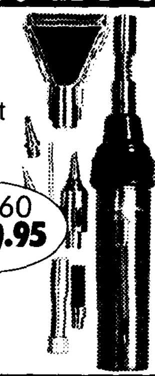

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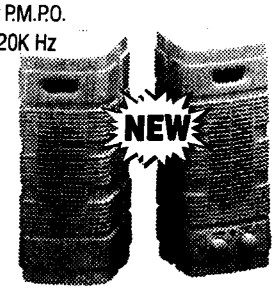

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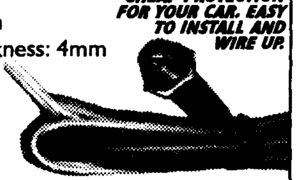

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Construction Project:

LOW COST MICRO-BASED ESR & LOW OHMS METER

If you repair switch-mode power supplies, TV receivers, computer monitors, vintage radios, or similar equipment, and/or if you need to measure very low values of resistance, this project can save you lots of time and aggravation — as it has for me. It measures an aspect of electrolytic capacitor performance which is very important, but normally very difficult to check: the equivalent series resistance, or 'ESR'.

by BOB PARKER

Some wise person once said, "The reliability of any piece of electronic equipment is inversely proportional to the number of electrolytic capacitors in it", and I doubt that many service technicians would disagree!

Especially now that switch-mode power supplies (SMPSs) have been commonly used in domestic VCRs and TVs, etc for a decade or so, one of the most likely components to fail is the humble electrolytic.

The symptoms can be as diverse as a VCR's playback picture swimming in tiny dots, up to SMPSs mysteriously self destructing.

As a service technician myself (though I'd prefer to be a full-time designer!), I was just about tearing my hair out because of the difficulty in determining which electros were faulty and which ones were still OK, in SMPSs and other equipment. I wanted to be able to check electros in circuit, with the power safely disconnected.

Why not use a readily available capacitance meter? Because when electros go faulty, they normally don't lose their capacitance significantly (as many technicians assume they do). Rather their equivalent series resistance (ESR) 'goes through the roof'. Capacitance meters don't tell you this; about the best they can do is give a low reading if the electro is nearly open circuit.

About ESR...

So what exactly is an electrolytic's equivalent series resistance?

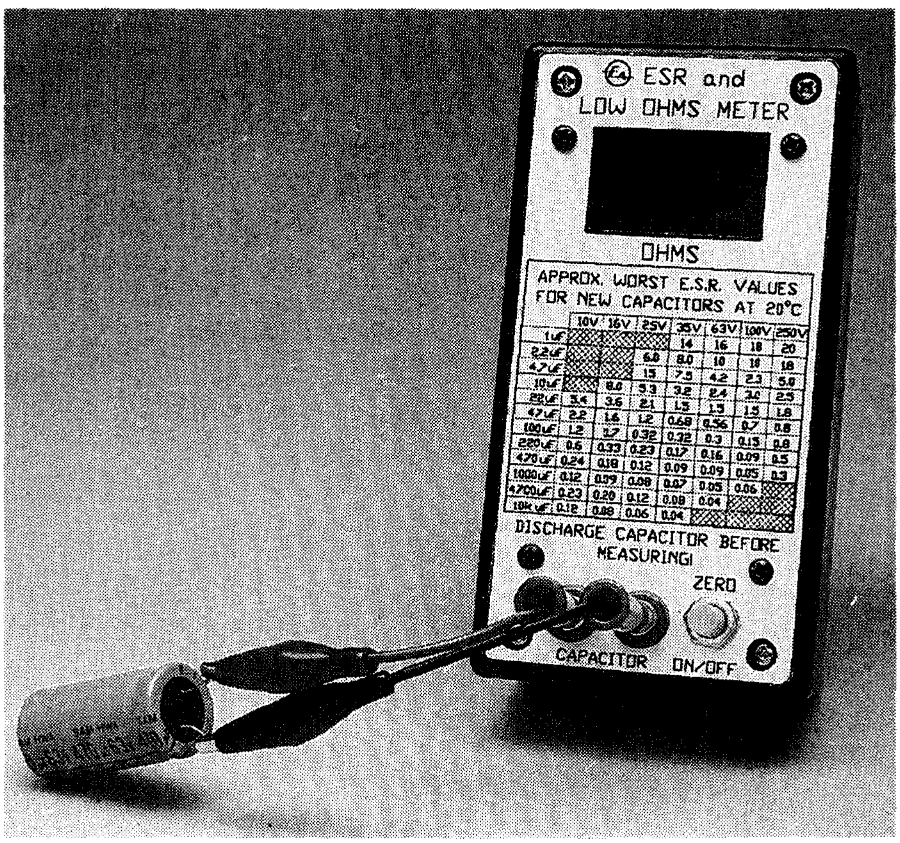
Electrolytics depend on a water based electrolyte, soaked into a strip of porous material between the aluminium foil plates, to complete the 'outer' electrical connection to the aluminium oxide dielectric coating on the anode foil.

The electrolyte has electrical resistance which, along with the (negligible) resistance of the connecting leads and aluminium foil plates, forms the capacitor's equivalent series resistance.

Normally the ESR has a very low value, which stays that way for many years unless the rubber seal is defective. Then the electrolyte's water component gradually dries out and the ESR creeps up with time. The electro gradually acts more and more like a capacitor with its own internal series resistor...

Heat makes it worse

If an electro is subjected to high temperatures, especially from heat generated internally as a result of large ripple currents, the electrolyte will start to decompose and the dielectric may deteriorate — and the ESR will increase far more rapidly.



To make things worse, as the ESR increases, so does the internal heating caused by ripple current. This can lead to an upward spiral in the capacitor's core temperature, followed by complete failure — sometimes even explosive!

The service life of electros is approximately halved for every 10°C increase in temperature and, surprisingly, many are designed for a reliable operating life of only a few thousand hours at their maximum rated temperature and ripple current. (A year is only 8766 hours!)

Switch-mode power supplies place quite severe stresses on filter capacitors. Because of their compact construction, temperatures are high (that's why your PC's power supply is equipped with a fan), and the capacitors have to endure large ripple currents.

Micro-based ESR meter

Necessity is supposed to be 'the mother of invention', but desperation works even better and I designed this ESR meter from scratch. It's based on a versatile Zilog Z86E0408 microcontroller — which already has two voltage comparators and two flexible counter/timers built in, greatly simplifying the rest of the circuit. A micro also allows the easy incorporation of some 'user friendly' features...

This instrument has three ESR ranges, with full scale readings to 0.99Ω, 9.9Ω and 99Ω respectively. The range is automatically selected by the micro, so your hands are free to hold the test leads. The accuracy of the prototypes was better than +/-5% of displayed reading, +/-1 digit. A single '-' on the left-hand display indicates a reading above 99Ω.

The readout is on two 0.5" (13mm) seven-segment LED displays, plus two 3mm decimal point LEDs which are needed because the display decimal points are on the wrong side for this application. If you forget to turn the power off, the micro will do it for you when the displayed reading has remained the same for two minutes. This feature can be disabled for uninterrupted operation from a 9V plugpack.

When the battery voltage is nearly too low for the circuit's 5V regulator to function correctly, the Z86 reduces the power to the LED displays and flashes a 'b' on the right-hand one in the 'off-scale' condition, to warn you to look for a new battery.

Meter operation

There's a single pushbutton, which has three functions: one press turns the power on, and another press will switch it off again if the measured resistance is 1Ω or more.

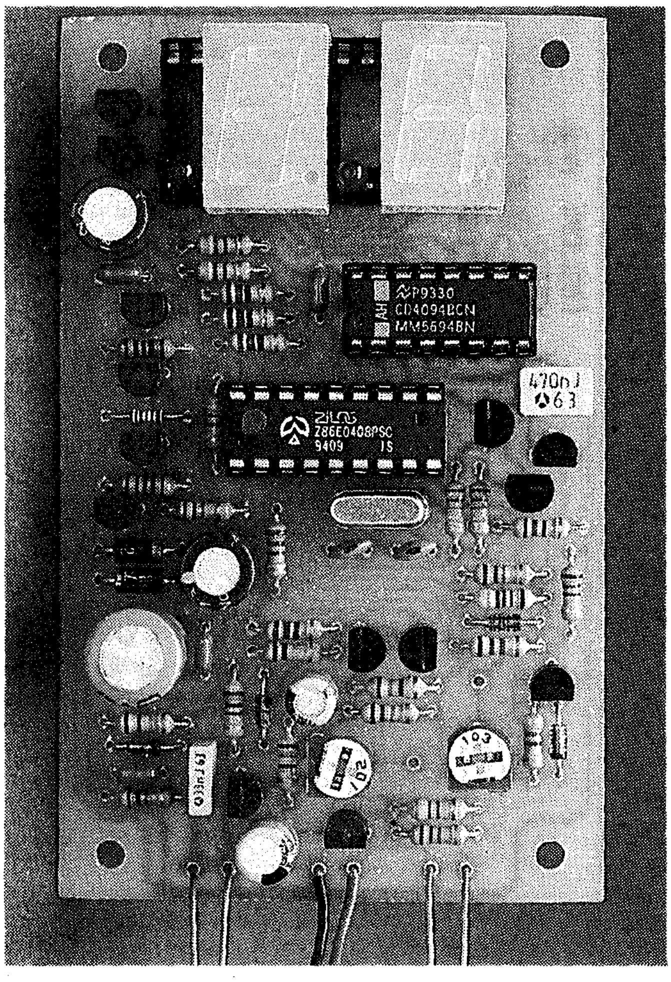
A push of the button with the leads shorted together will cause their resistance value to be subtracted from all subsequent readings, as long it's less than 1Ω.

Before making a measurement on an electrolytic, first discharge it. I find a 100Ω 5W resistor does this well. Then connect the test leads — either way around. If your capacitor is still in circuit (with the power OFF!), you're likely to get quite an accurate reading, because it should be the component with by far the lowest high-frequency impedance.

The circuit's test signal has a peak open-circuit voltage of 600mV (maximum 100mV peak at full-scale reading), so it won't make diodes or transistors conduct and cause measurement errors. Compare the reading you get with the front panel table, to get an idea of whether the electro's ESR is about normal or significantly above it.

The table's approximate 'worst ESR' figures were taken from the Nippon Chemi-Con Aluminum Electrolytic Capacitors Catalog Number 4, as 100kHz impedance figures for their 'SXE', 'SXG' and 'LXA' capacitor series. They agree pretty closely with my own measurements of many new electros of assorted brands, styles, sizes and ages.

From my actual faultfinding experience with the prototypes, an electro's ESR needs to be many times the table value before it's likely to cause trouble.



A close up view of the ESR meter PCB, showing the position and orientation of all the parts — except the test lead jacks, push button and battery. Note that the LED displays and decimal point LEDs are mounted via a 28-pin IC socket.

Low ohms uses

The instrument is very handy for measuring low values of resistance, too. But note that because it makes an AC measurement, it can't give a sensible indication of the DC resistance of inductive components, such as transformer windings or chokes.

I've used it to 'roll my own' low value resistors, by measuring off the required number of (milli) ohms of DSE catalog number W-3200 resistance wire, which I then formed into a spiral by wrapping it around a drill shank.

It can also locate short circuits on PC boards, by measuring actual track resistances. If the reading increases as you probe further along the track, you know you're going in the wrong direction!

You could also use it to confirm solid continuity of mains lead earth conductors, etc, etc...

What NOT to do

There are a few minor points to keep in mind, when using the meter. First, it can't identify leaky or

Micro-based ESR and Low Ohms Meter

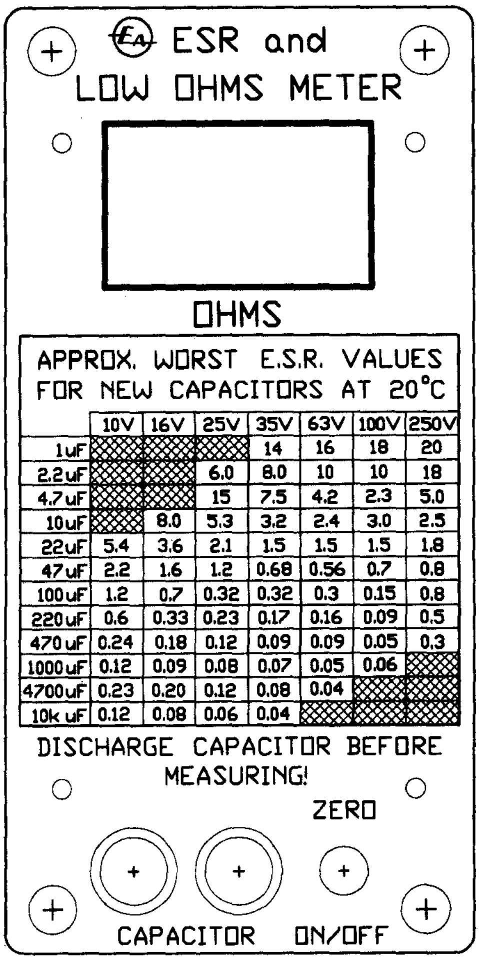
short-circuited capacitors — that's what the resistance ranges of normal multimeters are for! Also, avoid using self-retracting 'curly' test leads, because their inductance can cause small measurement errors.

Lastly, don't use the meter right next to an operating TV set or computer monitor — the high amplitude pulses radiated by the horizontal output stage can be picked up by the test leads and cause unstable readings.

The circuit

Now let's have a brief look at how it all works, by reference to the schematic.

A push of the button switches on Q1, supplying +9V to IC1, the 5V regulator. Once the Z86E0408 microcontroller ('Z86' for short) starts up, it forward biases Q2. This holds Q1 on, maintaining the 5V supply after you release the button.



	10V	16V	25V	35V	63V	100V	250V
1uF				14	16	18	20
2.2uF			6.0	8.0	10	10	18
4.7uF			15	7.5	4.2	2.3	5.0
10uF		8.0	5.3	3.2	2.4	3.0	2.5
22uF	5.4	3.6	2.1	1.5	1.5	1.5	1.8
47uF	2.2	1.6	1.2	0.68	0.56	0.7	0.8
100uF	1.2	0.7	0.32	0.32	0.3	0.15	0.8
220uF	0.6	0.33	0.23	0.17	0.16	0.09	0.5
470uF	0.24	0.18	0.12	0.09	0.09	0.05	0.3
1000uF	0.12	0.09	0.08	0.07	0.05	0.06	
4700uF	0.23	0.20	0.12	0.08	0.04		
10k uF	0.12	0.08	0.06	0.04			

Bob Parker's artwork for the front panel of his ESR Meter. There's only one control — the pushbutton, which doubles as both the ON/OFF switch and the control to get the inbuilt micro to compensate for test lead resistance. To make the meter easy to use, he has included a table of expected maximum ESR values for the most common values of electrolytic capacitor.

The displays are driven by IC3, an eight bit serial-in parallel-out shift register. IC3's outputs are connected to both seven segment displays and the decimal point LEDs in parallel. Cathode driver transistors Q12 and Q13 are configured so that only one display and its decimal point LED can illuminate at a time, under control of the Z86's pin 18.

Every 5ms the Z86 serially updates the segment and decimal point data in IC3, and swaps displays; at this speed it appears both displays are continuously illuminated.

The Z86 starts a measurement by grounding its pin 4, switching on current mirror transistors Q9 and Q10 and causing C10 to begin charging at a constant rate. Under control of its firmware, the Z86 drives Q3, 4 or 5 to apply short current pulses of 0.5, 5 or 50mA, via C5/6, to the capacitor being tested.

The resulting voltage pulses, proportional to the electro's ESR, are amplified by Q7 and Q8 (no relation to the one in the Persian Gulf!), and compared with C10's voltage. Q6 functions as a ground reference switch.

A simple time measurement allows the Z86 to determine the amplitude of the voltage pulses and so the capacitor's ESR. At the end of each measurement, Q11 is used to discharge C10.Then the Z86 subtracts the test lead resistance (if it's been zeroed), and displays the value.

Now for the 'frills'...

Battery voltage check: The Z86 regularly allows C10 to charge to 2V. If the battery voltage sample on VR1's wiper (fed in via pin 9) drops below this 2V level, the 'battery low' warning condition is triggered.

Protection: Sooner or later this meter will find itself connected to an unexpectedly charged capacitor (or worse), so some protection has been built in. D3, D4, D5 and D6 are strategically placed to prevent destructive voltages from finding their way back to the microcontroller; D4 also limits the test voltage to 0.6V peak.

The rest: When the Z86 detects the button is pushed while measuring a resistance of one ohm or more, it switches off Q2 and displays questions marks until your finger leaves the button. Then Q1 switches off the battery supply.

Crystal XTAL1, C11 and C12 complete the Z86's clock oscillator, which provides the timing for all the meter's operations.

Construction

As *EA*'s photos show, every component except the pushbutton is mounted on a 57 x 95mm (2.25" x 3.75") PC board, coded 96ESR1.

Before fitting any components to the PCB, first illuminate its component side with a bright light, and examine the copper side carefully for fine track breaks and especially whiskers or bridges — particularly where tracks pass between IC socket pads. If necessary, drill the corner mounting holes to accept 3mm screws, and enlarge the trimpot mounting holes if they're too small.

If you're planning to run the ESR & Low Ohms Meter from a 9V plugpack, leave R25 (47k) *off the* PCB. This will disable the two minute automatic switchoff function, and also the low battery warning...

When you're soldering the components to the PCB, using the overlay diagram as a guide, bear in mind that the PCB is tightly packed and the solder pads are small. The last thing this circuit needs is solder bridges and bad joints — so please use decent 0.71mm or similar *fine* diameter solder!

Begin installing the components, starting with the lowest-height ones (resistors and diodes), and working your way up to the tall ones. Note that the displays and LEDs are mounted on a 28-pin IC socket, not soldered directly to the PCB!

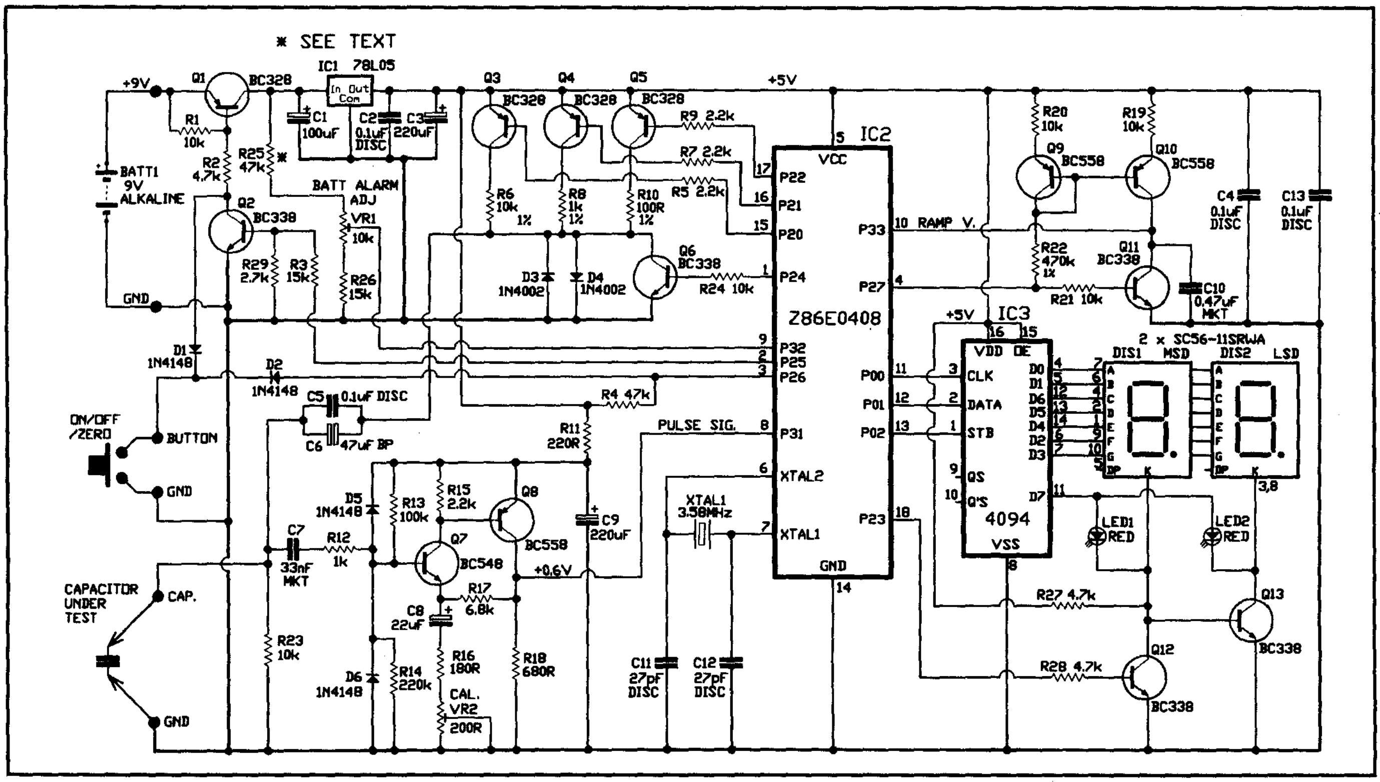
It's a good idea to double-check, especially at the beginning, that you're putting each component's leads into its correct holes. They're rather closely-spaced...

Take care with the orientation of the polarised components, and make sure the different transistor types and IC1 all go in their correct places. Don't install the socketed parts just yet, though.

When everything's on the PCB, once again illuminate it from the top, and check for and correct any solder bridges or other problems.

Making a display

Next study the display area in the photo of the PCB. Then, keeping the cathode (short) leads of the decimal point LEDs to the right, cut the leads down to about 9mm long. Use long-nose pliers to 'dog-leg' the leads about 3mm



The schematic may look a little complicated, but the circuit is actually quite elegant. Everything is under the control of IC2, a low cost microcontroller. As well as auto ranging, it also compensates for test lead resistance.

from the ends, so the LEDs will be about level with the bottom of the seven-segment displays when installed.

Push the LEDs into their places in the 28-pin socket, followed by the seven-segment displays themselves, ensuring their decimal points are at the bottom, and they are properly seated.

First test

Solder the battery snap leads to their pads, making certain their polarity is correct, and solder long component lead offcuts to the 'capacitor' and 'button' pads. Temporarily solder the pushbutton to the ends of its leads, then turn VR1 fully clockwise, and set VR2 to mid-range.

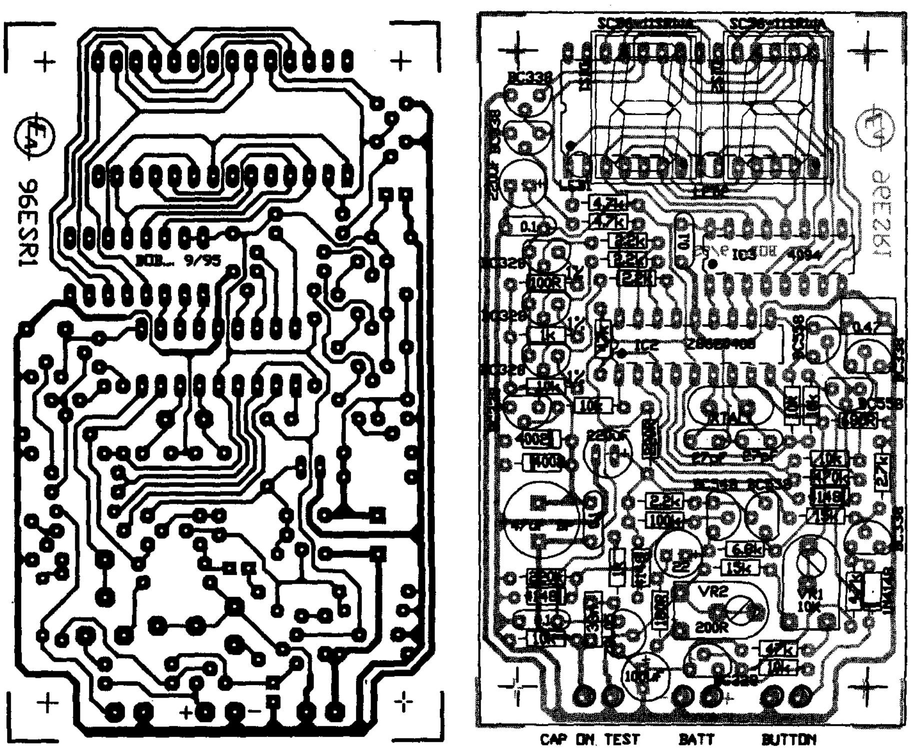
Using alligator clip leads or similar, connect a variable DC power supply set for 9V (and preferably with about 50mA current limiting) to the battery snap terminals.

Make sure the positive lead goes to the clip, and the negative to the stud. You can use another battery snap to make the connection, but remember that its black lead will be the positive one!

Hold the button down and check that pin 5 of IC2's socket and pin 16 of IC3's socket have +5V on them, relative to the power supply negative.

If they have, discharge any static electricity by touching something earthed, then install IC2 and IC3 in their sockets and double-check their orientation.

Push the button for a second or so, and you should see 'EA' flash on the displays for a moment, followed by a single '-' on the left-hand one. If not,



At left is the PCB pattern for the meter, reproduced actual size as usual for those who wish to etch their own boards. At right is the PCB overlay diagram, showing where everything goes. Use it in conjunction with the photo when you are assembling your own board, to ensure that you get everything in the right place.

carefully recheck the PCB and its soldering and component placement, until you find the problem.

Now short the 'capacitor' leads, and the display should indicate a resistance of around .03 ohms. Push the button again and this should change to '.00', possibly with the least significant digit hesitating between 0 and 1.

Calibration

Connect a resistor of known accuracy of around 68 to 82 ohms to the 'capacitor' leads, and adjust VR2 for a correct reading. Now try a resistor in the range of 1 to 9 ohms, and check that the meter reads close to the correct value.

Battery Warning: Skip this bit if you disabled the automatic switch-off function by leaving R25 off the PCB.

Leaving the 'capacitor' leads separated, turn the power supply voltage down to 7.0V, preferably confirmed by a digital voltmeter. Slowly turn VR1 *anticlockwise* until the display brightness suddenly drops noticeably, and a 'b' begins flashing on the right-hand display.

Push the button again and the displays should switch off. Wind the power supply back up to 9V, switch the ESR meter back on by pushing the button, and recheck that the battery warning triggers when you drop the supply to 7.0V.

General assembly

Now you only need to install the completed electronics in the box. If you're using a Dynamark front panel, get a photocopy of its pattern then use it as a template to mark out the holes you'll need to drill, ream and file in the lid.

Use an 'X-acto' or similar hobby knife to cut out the holes in the Dynamark panel, then after removing its backing, carefully align and stick it to the box's lid. Mount the button and banana sockets as shown in the photos, then position a suitably-sized piece of filter material under the display window — holding it in place with a drop of contact adhesive or similar on each side.

Now bolt the PCB to the lid, using 25mm x 3mm screws and 15mm tubular spacers (or a similar scheme). You might need some washers as extra spacers, if the display filter material is a bit thick...

Finally solder the 'capacitor' and 'pushbutton' leads in place and connect a 9V alkaline battery, which can be held snugly against the bottom of the box by a piece of thick foam plastic under the PCB. Alternately, you can bring the lead from a 9V plugpack into the box via a suitable grommetted hole.

Now screw the lid down, plug in some probe (or clip) leads, and prepare for a future of easy identification of faulty electrolytics, and low resistance measurements!

PARTS LIST

Resistors

All 0.25W 5% unless noted:

R1,19,20,21,23,24	10k
R2,27,28	4.7k
R3,26	15k
R4,25	47k
R5,7,9,15	2.2k
R6	10k 1% metal film
R8	1k 1% metal film
R10	100 ohms 1% metal film
R11	220 ohms
R12	1k
R13	100k
R14	220k
R16	180 ohms
R17	6.8k
R18	680 ohms
R22	470k 1% metal film
R29	2.7k
VR1	10k hor. trimpot
VR2	200 ohm hor. trimpot

Capacitors

C1	100uF 16VW RB electrolytic
C2,4,5,13	0.1uF 50VW disc/monolithic
C3,9	220uF 16VW RB electrolytic
C6	47uF 50VW bipolar RB electrolytic
C7	33nF 63VW MKT
C8	22uF 16VW RB electrolytic
C10	0.47uF 63VW MKT
C11,12	27pF 50V NPO disc ceramic

Semiconductors

D1,2,5,6	1N4148 etc signal diode
D3,4	1N4002 etc power diode
Q1,3,4,5	BC328 PNP transistor
Q2,6,11,12,13	BC338 NPN transistor
Q7	BC548 NPN transistor
Q8,9,10	BC558 PNP transistor
IC1	78L05 voltage regulator
IC2	Z86E0408 microcontroller (with custom firmware)
IC3	4094 CMOS shift register
DIS1,2	Seven-segment LED displays (see text)
LED1,2	3mm LEDs (see text)

Miscellaneous

XTAL1	3.58MHz crystal, HC-49/U case
BATT1	9V alkaline battery

One each 16,18, 28-pin IC sockets; '216' type battery snap lead; plastic utility box, type UB3; PC board, 95 x 57mm, code 96ESR1; push-on momentary pushbutton switch; two x 4mm banana sockets; Dynamark dress plate; 4 x 15mm tubular spacers; 4 x 3mm machine screws 25mm long, plus nuts; piece of foam plastic (see text); two non-curly test leads with 4mm banana plugs; display filter material (see text); 0.71mm solder, etc.

Uncommon parts

Nearly all the components in this project are common stock types, but it was unavoidable that a few special bits and pieces would be needed...

The Zilog Z86E0408 microcontrollers containing this project's firmware will be supplied with kits and will also be available separately, along with the PCBs and Dynamark front dress plates, from RCS Radio Pty Ltd, of 651 Forest Rd, Bexley NSW; phone (02) 587 3491). RCS will also have a detailed version of this article available on a 3.5" floppy, as 96ESR1.DOC.

Because of the need to conserve battery power, the 0.5" seven segment LED displays and 3mm LEDs stocked by most suppliers are too dim in this circuit to read easily under normal room lighting.

The orange 13.2mm displays and 3mm LEDs (catalog numbers Z-4151 and Z-4083 respectively from Dick Smith Electronics) are reasonable, if you can find a thin piece of orange-tinted plastic to use as a display window. (One side from a box of orange-flavoured 'Tic Tacs' is suitable!)

I recommend ultra high efficiency 'super red' Kingbright SC56-11SRWA 14.2mm displays and L-934HD 3mm LEDs, as shown in the photos. These perform brilliantly (pun intended!), and will also be available from RCS Radio.

Rockby Electronics, of 261 Huntingdale Rd, Huntingdale Victoria; phone (03) 9562 8559 stock pieces of excellent non-reflective red filter material (catalog number D1555), which can be cut down to make a display window for the Kingbright displays and LEDs.

Acknowledgements

In closing I'd like to thank Keith Anderson, Managing Director of Adilam Electronics Pty Ltd (who stock a wide range of high-grade electrolytic capacitors), for eagerly providing lots of technical information including the front-panel ESR figures. This has been of great help in preparing this article.

Thanks also to Wayne Scicluna for building, evaluating and thoroughly testing the prototype units shown in the photos! ❖

Construction Project:

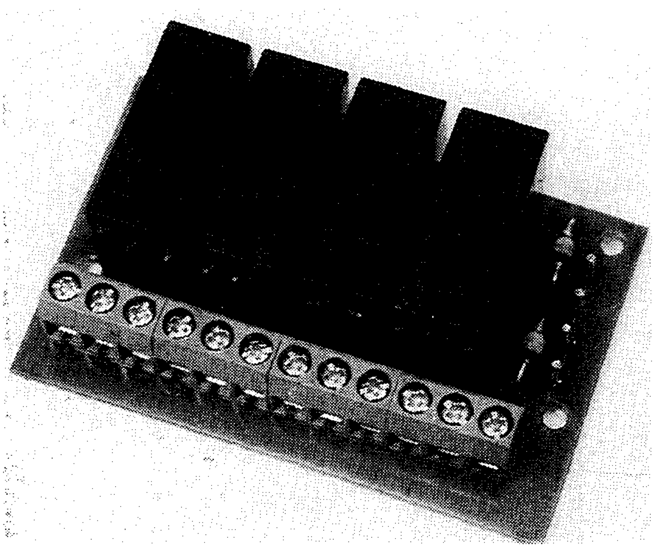
REMOTE VOLUME CONTROL - 2

In this second article describing the remote volume control project for hifi systems, etc., we present full details of how to build it, set it up and get it going. The PCB design is very flexible, allowing the project to be either built into an existing amplifier or as a separate self-contained unit linked in via the 'tape loop' connectors.

by PETER PHILLIPS

Last month we described the circuit details of this versatile project. As you've seen from Part 1, the project has two main applications: as a remote controlled volume system or a controller for relay operated loads. Therefore the circuit and the PCB design is in three sections, with the decoder section common to the other two.

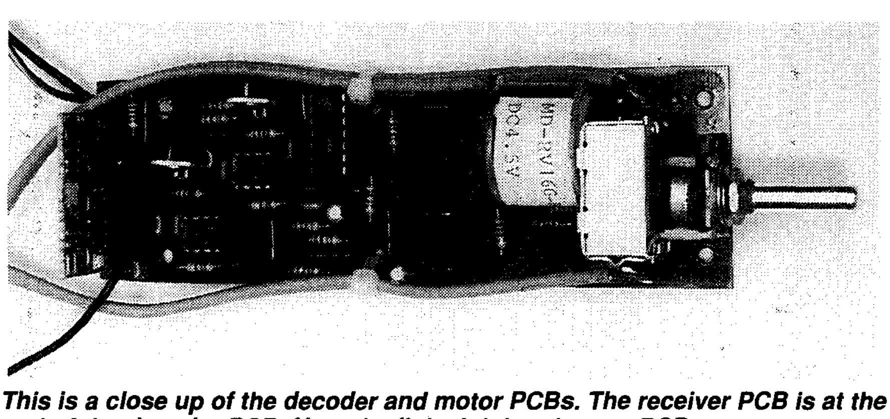
Recapping briefly, the decoder section has two output terminals, A and B. There are three possible output conditions, depending on whether a transmitter key is pressed — and if so, which of the two keys.



This photo shows the relay PCB. Connections to the relay contacts can be through a terminal block, or soldered directly to the PCB pads.

When there's no transmission, these terminals are effectively open circuit, or floating. If the UP key on the transmitter is pressed, the 12V DC supply is switched to terminal A, and terminal B is left floating. Pressing the DOWN key causes terminal B to be switched to ground potential, leaving terminal A floating.

In other words, the output of the decoder is rather like that of a three-state logic IC, in that it can source or sink current, or remain open circuit. When the motor PCB is connected to the decoder, terminals A and B are joined and the motor-ised potentiometer rotates according to the three possible states of the output.



This is a close up of the decoder and motor PCBs. The receiver PCB is at the end of the decoder PCB. Note the links joining the two PCBs.

When the relay PCB is connected, terminals A and B are separate. When terminal A is active (+12V), relays 1 and 2 operate. When terminal B is active (0V), relays 3 and 4 operate. As described last month, it's not possible for both terminals to be active at the same time (unless there's a fault).

Now here's how to build it all...

Construction

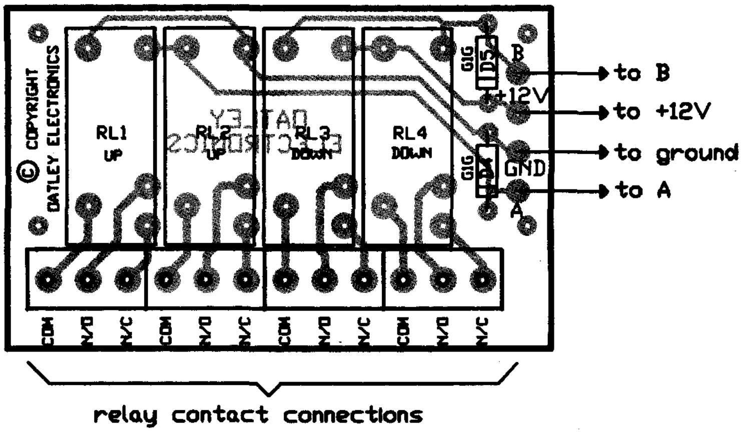
The first thing to decide is what to do with the PCB in regard to separating its sections. The only consideration is that the decoder section cannot drive *both* the motor and the relay sections, as the motor PCB joins terminals A and B, while the relay PCB requires these to be separate. The PCB artwork shows where to cut the board to either remove and discard an unwanted section, or to separate it as needed.

If you choose not to separate the motor section from the decoder section, remember to include the four links that interconnect them, as this is not done by the copper tracks, even though the sections are next to each other. The relay PCB must also be connected (with insulated wire) to the decoder PCB, whether they are separated or not.

Construction of the whole thing is relatively straightforward, and the supplied PCB is silk-screened with the component layout. Start by install-ing the links, or if you intend using them, by fitting IC sockets in place. Next solder the resistors, capacitors and diodes, checking for correct polarity of the latter two. Now fit the transistors, making sure not to accidentally mix them up. There are three different types of transistors that all look the same.

The motorised pot assembly solders directly to the PCB, and the motor wires connect either directly to the pads labelled R (for red wire) and B (for black wire) on the decoder PCB, or if the boards are separated, to the loop terminals on the motor PCB. This allows the motor wires to be terminated, with longer leads completing the connection back to the decoder PCB.

The audio connections are through shielded cable with RCA connectors. The prototype has leads fitted with RCA plugs to allow the volume control to be connected in the tape monitor loop of an amplifier. Anchor these leads with plastic ties.



This is the layout for the relay PCB. Because terminals A and B are joined on the motor PCB, don't include the motor PCB when using this one.

The relay PCB has four relays and two diodes, so its construction is very simple. A terminal strip like that in the prototype can be soldered to the PCB for connections to the relay contacts. This is really only necessary if the board is going to be used in a variety of applications. Otherwise just solder the connections directly to the PCB.

Finally, fit the UHF receiver module and the ICs. The UHF receiver module is mounted so its component side faces in. Before soldering it in place, fit a terminal post made from a piece of tinned copper wire to the test point for the receiver, to make things easier during adjustment. Also connect a 300mm length of insulated hookup wire as an antenna.

The power supply is specified at 12V, but can be 10V DC or so. The main thing is that the supply is DC and able to supply around 200mA. We used a plugpack, but any DC supply will do.

Transmitter mods

Before the system can be tested, there are four modifications to make to the supplied transmitter. Incidentally, although the transmitter comes with a 9V battery, it is most unlikely that the battery will be any good.

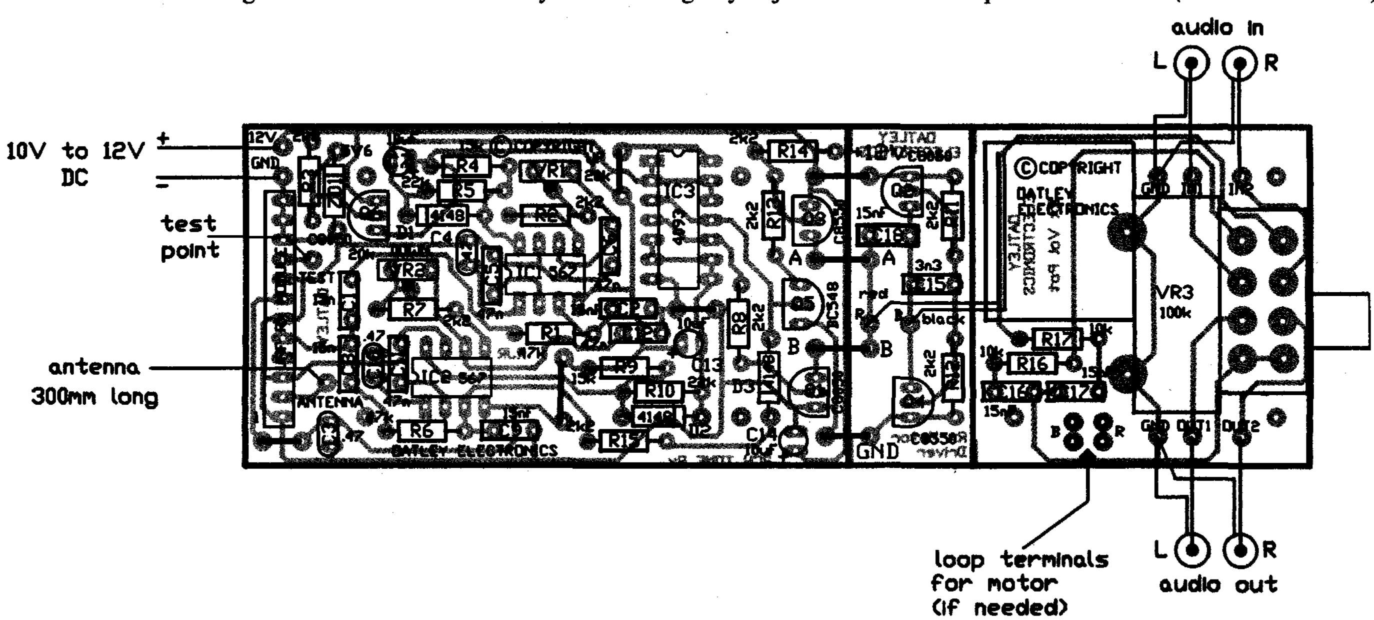
It will possibly read 9V when open circuit, but this will drop significantly under load. Using it with the transmitter will make adjustments almost impossible. So fit another known-good battery before doing any adjustments.

The modifications you have to make are marked on the circuit (Part 1 - Fig.1) and are:

1. Remove the coil former and its ferrite core from the inductor. This will leave two exposed loops of wire, which form the inductor. Try not to distort the position of the loops of wire when the former and core are removed.
2. Remove C5 and replace it with a trimmer capacitor. This capacitor is the one right next to the inductor, running parallel with the inductor.
3. Replace R8, a 220k resistor with a 10k resistor. This resistor is next to the UP pushbutton, parallel with three other resistors all fitted between the two pushbuttons.
4. Replace R7 with a 10uH inductor. The resistor is to the right of the UP pushbutton, almost in line with the two-turn inductor, and at the top-right edge of the PCB.

Adjustments

There are a number of adjustments to do to get the unit working over the best range. These are: the transmitting frequency of the handheld transmitter, the frequencies of the UP and DOWN tones in the transmitter, and the free running frequencies of IC1 (UP tone decoder)



This layout is for the decoder and the motor PCB. The boards can be separated and connected by lengths of wire to suit. In this case, connect the motor wires to the loop terminals, with extra leads from the terminals to the decoder PCB. Otherwise connect as shown here.

and IC2 (DOWN tone decoder). We'll describe two ways of doing these, one for those with an oscilloscope and one for those who have limited equipment.

The first adjustment is the transmitting frequency. If you have a 'scope, connect it to the test pin of the UHF receiver module. Otherwise, connect a voltmeter set to its low voltage AC range. The output voltage at this pin will be around 1V on a typical multimeter. If you don't have a voltmeter, connect a set of headphones or the input of an audio amplifier to the test terminal.

Hold the transmitter about one metre from the receiver, and press either button. Using a non-metallic screwdriver, adjust the trimmer capacitor to get the highest output at the test point. Trim the adjustment by moving the transmitter further away from the receiver and again peaking the adjustment.

For those with an oscilloscope or a frequency counter, monitor the frequency at the test point of the receiver and set the UP tone frequency to 2.2kHz by adjusting the transmitter trimpot nearest the battery. Then adjust the DOWN tone frequency to around 2.8kHz with the other trimpot. These frequencies don't have to be accurate, but you should get both frequencies so they are about 600Hz apart.

Then connect the oscilloscope to pin 5 of IC1 to monitor its free running frequency. Adjust this frequency with VR1 to about that of the UP tone frequency (2.2kHz). Fine tune it by pressing the transmitter UP button and setting VR1 so this tone remains the same when the incoming tone is received. You should also be able to confirm that the output of IC1 (pin 8) goes low when the two tones are within about 100Hz of each other.

Repeat this for IC2, this time for the DOWN tone frequency (2.8kHz). Again confirm that the output of IC2 goes low when the frequencies are about the same. Obviously the output of IC1 should not be affected by the DOWN frequency and the UP frequency should not affect the output of IC2.

If you don't have an oscilloscope, you can do all of this quite easily with an audio amplifier or even a set of high impedance headphones. Unfortunately, these days most headphones are low impedance, so unless you have the right sort, use an audio amplifier. The procedure is rather similar to that already described, except now you listen to, rather than watch, the signals.

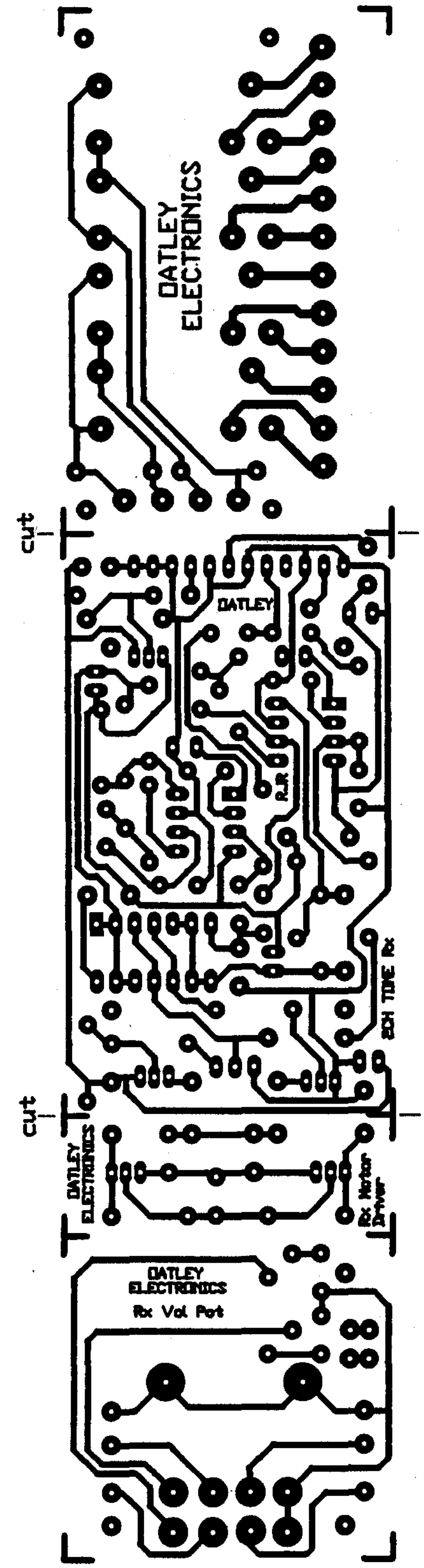
Start by connecting an audio amplifier to pin 5 of IC1 so you can listen to the free running frequency of IC1. Compare this frequency to that at pin 5 of IC2, and adjust VR1 and VR2 so the frequency from IC1 is markedly lower than that from IC2.

Now press the UP key of the transmitter and listen to the tone it produces by connecting the audio amplifier to the test terminal of the UHF receiver. Adjust the transmitter trimpot for this tone (the one nearest the battery) until the tone is about the same as that from pin 5 of IC1. Fine tune this setting by adjusting the trimpot so the frequency at pin 5 hardly changes when the UP key is pressed. When this setting is correct, the output of IC1 (pin 8) should go to zero volts when the UP key is pressed.

Repeat this for IC2. That is, compare the transmitted frequency (at the test terminal of the receiver) to the free running frequency of IC2 and adjust the transmitter trimpot for this tone (the one alongside the DOWN key) until the tone is about the same as that from pin 5 of IC2. Again confirm that the output of IC2 (pin 8) goes to zero volts when the DOWN key is pressed.

If you find IC1 responds to both the UP or DOWN keys, you haven't got the frequencies of the transmitter tones set so they are far enough apart. To fix this, adjust either trimpot in the transmitter to increase the difference in the frequencies, and repeat the adjustments already described.

If you have no equipment except a multimeter, you'll have to do the adjustments by trial and error. It really doesn't matter what the frequencies of the two transmitted tones are, providing they are sufficiently different. You could start by leaving the transmitter trimpots where they are set, and keep adjusting VR1 and VR2 until IC1 and IC2 respond properly. Remember you have to set the transmitting frequency (with the trimmer capacitor) first. This can be done as already described, or you can use a set of low impedance headphones connected to the test terminal of the receiver module. However you can't use these headphones to listen to the tones at IC1 and IC2, as the headphones will change the frequency.



This is the artwork of the complete PCB, showing where the board can be cut. It's reproduced full size for those who want to make their own. Commercially the design is copyright to Oatley Electronics.

Connecting it up

The volume control could be fitted in place of an existing control, providing there's room in the equipment. You might also be able to derive a suitable DC supply from the equipment. Otherwise, for an audio amplifier, connect the volume control in the tape mon-

PARTS LIST

Resistors

All 1/4W, 5% unless otherwise stated:

R1,R6	47k
R2,R3,R7,R8,R11-15	2.2k
R4,R9	15k
R5,R10	22k
R16,R17	10k
VR1,VR2	20k
VR3	100k log, motorised dual gang

Capacitors

C1,C2,C8,C9,C16-18	15nF ceramic
C3,C4,C10	0.47 monolithic
C15	3.3nF ceramic
C7,C13,C14	10uF electrolytic
C5,C6,C11,C12	47nF ceramic

Semiconductors

D1-3	1N4148 signal diodes
D4,D5	G1G, 400V 1A diode
ZD1	5.6V 400mW zener
Q1,Q2,Q6	C8050 NPN transistor
Q3,Q4	C8550 PNP transistor
Q5	BC548 NPN transistor
IC1,IC2	LM567 tone decoder
IC3	4093 quad Schmitt NAND

Miscellaneous

PCB, 205mm x 44mm; UHF receiver module; UHF transmitter with 2-5pF trimmer capacitor, 10k resistor and 2.2uH inductor as replacement parts; plastic case 50 x 90 x 160mm; 4 x SPDT 12V relays; 240V-12V DC/200mA plug pack, knob, stereo shielded lead with RCA connectors.

A kit of parts for this project is available from Oatley Electronics, phone (02) 579 4985. Postal address (mail orders): PO Box 89, Oatley West NSW 2223.

Complete volume control kit, includes everything in the parts list except plugpack (and relays)...................................$63
Complete relay control kit, includes everything in the parts list except plugpack (and motorised pot)....................................$55
Suitable plugpack...$12
Individual parts are also available, although there's a limit of two transmitters per kit. Phone for details.
Packing and postage charges $3 to $5 per order.
Please note that the PCB artwork for the project is copyright to Oatley Electronics, and cannot be sold by other companies.

itor loop of the amplifier. Because it has a value of 100k, the volume control won't significantly load the output from most audio equipment (like the output of a CD player, VCR or tape player). This means you could connect the volume control between the output of a piece of audio gear and the input of the amplifier. The disadvantage here is that the remote volume will only work for that piece of equipment.

As the photo in Part 1 shows, the prototype was mounted inside a black plastic case, with a hole drilled in the end for the potentiometer shaft. A large control knob is needed so you can see its position from a distance. You might even fit a 3mm LED to the knob, making its position even easier to see.

Relay operation

The relay section is for operating an external load, typically a motor. The relay contacts are rated at 8A 250V, although the PCB is not designed for 240V applications. Any load within the contact rating can be connected to the relays, but we advise that you only use low voltage equipment with the relays.

If you want to control mains equipment, use these relays to switch additional relays that in turn switch the mains. This keeps all mains wiring well away from the PCB.

There are lots of cheap and effective ways of building a simple motorised actuator. For example, a 12V DC windscreen wiper motor has incredible torque and might suit a simple panning mechanism for a security camera or antenna rotator.

An efficient, quiet, powerful and readily available example is a Volkswagen windscreen wiper motor. These have a permanent magnet field, and take around 2A under a reasonable load. There are 6V and 12V versions, but try for the 12V version. A typical price from a car wrecker is around $10.

Applications using this motor could include remote controlled curtains, an antenna or satellite dish rotator, a motorised flow valve and so on. When combined with a lead screw (available from most hardware shops as a threaded shaft), you could build a simple actuator arm.

To do this, run a threaded nut onto the shaft (make sure itruns smoothly along the shaft), and connect the shaft to the motor, so it's turned by the motor. Drill and tap a hole through the nut so a lever can be attached to the nut. The lever can be pivoted, or arranged to push or pull the load.

This type of actuator will have considerable power, and could be used to open a gate, door, flap and so on.

Other uses for the system will probably come to you, as this is really one of the most versatile remote control type projects we've presented for some time. ◆

JANUARY DEALS FROM JAYCAR

1 Amp AA NICADS!!!

NEW

Yes, thats correct. They do exist, and we've got them at very low prices.

AA 1.2V 1A/HR — $4.75ea
AA 1.2V 1A/HR with solder tags — $5.00ea
NICKEL METAL HYDRIDES ARE ALSO AVAILABLE
AA 1.2V 1.1A/HR — $5.95ea
AA 1.2V 1.1A/HR with solder tags — $6.25ea

JAYCAR ELECTRONICS IS NOW A QUALITY ENDORSED COMPANY!

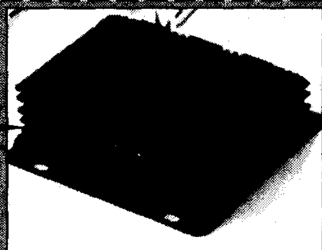
Our Purchasing Dept, Warehouse, Wholesale Sales and Kit Department are now Quality Assured to AS9002.

Quality System
Quality Endorsed Company AS9002

CAR AMPLIFIER 18WRMS X 2

OUTPUT POWER 18WRMS / CHANNEL

NEW



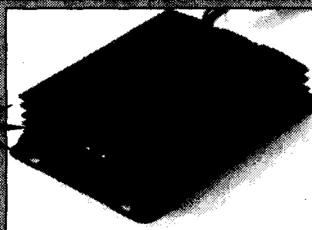
... This amplifier gives a genuine 18 watts RMS per channel into a 4 ohm load. Specifications: •Supply voltage: 13.8VDC (12V) ... •Output power: 18WRMS / channel 4 ohm ... •Frequency response: 25Hz to 20kHz ...

Cat. AA-0415 — $45.00

CAR AMPLIFIER 30WRMS X 2

OUTPUT POWER 30WRMS / CHANNEL

NEW



... Features include high input gold RCA sockets, as well as low inputs, an input gain control and power LED indicator. Outputs to speakers are by push terminals. Output power is a genuine 30 watts RMS per channel into 4 ohms. Specifications: •Supply voltage: 13.8VDC (12V) ... •Output power: 30WRMS / channel 4 ohm ... •Frequency response: 25Hz to 20kHz •Channel separation: 50dB ... •Weight: 1kg ...

Cat. AA-0420 — $75.00

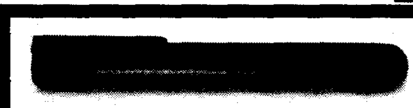
PROGRAMMABLE REMOTE CONTROL

NEW

This remote control will "learn" the functions of other remotes. If your TV / stereo coffee table has a row of remotes, you can actually retire them all and just use this one. Also ideal if one of your remotes is "on the way out". Before it dies, buy one of these and it will learn the functions. Brand name replacement remote controls cost a fortune. Specs: •Memory capacity: 150 commands •Memory hold without batteries: About 8 minutes •Suitable equipment: Most brands of infra red remote controllers for audio/video devices •Effective range: 8 metres •Power source: 4 x AAA batteries (not supplied) •187(L) x 64(W) x 15(D)mm

Cat. AR-1710 — $43.95

LASER POINTER



NEW

If you need to point out objects or details that are out of reach, then you need a laser pointer. Up until now you have had to pay around $140, but not at Jaycar. Laser Pointer is small and easy to hold, and has a push on switch for operation. Requires 2 x AAA batteries. Supplied in a plastic case for storage. Specifications: •wavelength - 670nM at 50 metres, 650nM at 150 metres, 630nM at 300 metres •size - 140 x 18 x 15mm. Class 2 laser product. Do not store into beam.

Cat. ST-3100 — $89.50

Jaycar 2.8 Amp 24 to 12 Volt Reducer

NEW

New smaller model for 1996. Ideal for cellular phones. This reducer will drop 24 volts to 12 volts with continuous loads of 2.8 amps. It is fully protected (see specs) and is ideal for trucking running a 12 volt cellular phone on the 24 volt truck power. And the price is lower than last year.

Cat. MP-3058 was $49.95 NOW $39.95

Planetary Gear Box Set

NEW

Automatic transmissions in cars use planetary gear clusters. They are simple, compact and strong. This gear set made in Japan by TAMIYA is sensational. Why? Firstly you can configure the gearbox to 8 different reduction rates 4:1, 5:1, 16:1, 20:1, 25:1, 80:1, 100:1 and 400:1. A genuine MABUCHI RC-260 3VDC motor is included! (at 400:1 the gearbox gives a massive 15kg/cm of torque)! Typically Japanese, it is thorough. Absolutely everything is supplied including tubes of lubricating grease, mounting feet, two drive attachment cranks and a beaut brass double female coupling to connect to other (drive) shafts. You will love this product! •Measures 100mm long x 28mm(dia of body), height including mounting feet 38mm. Steel output shaft 4mm dia •Can be ganged for up to (max) 160,000:1 •Moulded out of sturdy ABS plastic

Cat. YG-2720 — $39.95

Jaycar 7.5 Amp 24 to 12 Volt Reducer

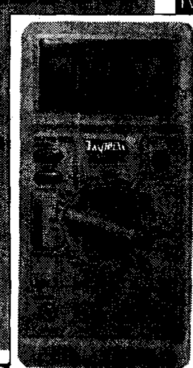
NEW

New model for 1996. This Switch Mode reducer will drop 24 volts to 12 volts with continuous loads of 7.5 amps. This unit offers very high efficiency - up to 90%. Its much smaller physically than the one it replaces, and it has internal current limiting.

Cat. MP-3060 was $92.50 NOW $69.95

JAYCAR NOW OPEN IN PERTH

4.5 DIGIT DMM SELLOUT



NOW ONLY $79.95

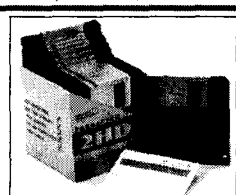
CHEAP DISKS!!!

NEW

Save even more on 3.5" HD IBM formatted disks. 100% error free and includes user labels. CAT XC-4740

Don't pay $19.95

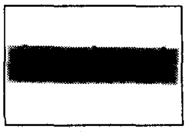
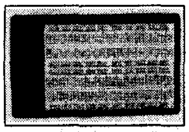
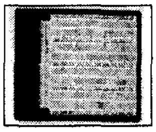
Pkt 25 Only $13.95



Save on Breadboard for January

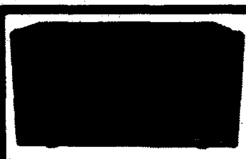
See catalogue page 130 for full details.

Cat	Description	Normally	Jan	Save
PB-8810	Distribution strip 100 hole	$4.25	$2.95	$1.30
PB-8812	Terminal strip 630 hole	$13.50	$9.95	$3.55
PB-8814	830 tie points	$18.95	$13.95	$5.00
PB-8816	1660 tie points on plate	$44.95	$34.95	$10.00
PB-8818	2420 tie points on plate	$56.95	$46.95	$10.00
PB-8820	3220 tie points on plate	$75.00	$62.00	$13.00

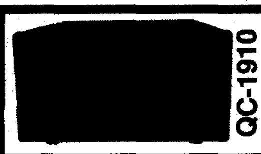




SAVE ON CROS

25MHZ
CRO $749
2 PROBES $79
$828
Jan Pay $699



50MHZ
CRO $1195
2 PROBES $79
$1274
Jan Pay $1095



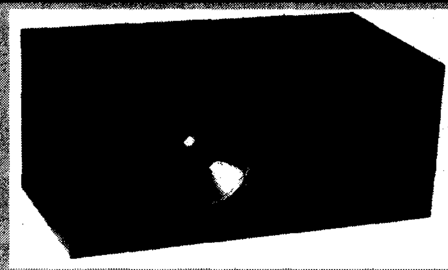
Cable For 2 Disk Drives

NEW

This lead has one 3.55" floppy disk drive plug to 2 x 3.5" drive power sockets.
Cat. PL-0753
$5.95

SAVE ON VIFA JV80 - SUBWOOFER

QUOTE FROM ROB EVANS IN ELECTRONICS AUSTRALIA MAGAZINE,
"The JV80 performed extremely well in both our subjective and objective tests, and really did demon-strate how a refined driver such as the Vifa M22WR can deliver the goods in a correctly tuned enclosure".



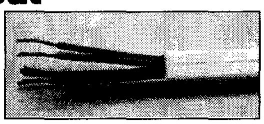
AS REVIEWED IN ELECTRONICS AUST. JUNE 95
The driver has an impedance of 6 ohms, so could also be used in a car situation. The power handling is very large, for such a small driver being 150 watts nominal (RMS) a long term max rating of 300 watts (on for one minute, pause for two minutes) and a short term max power of 500 watts (on for one second, pause for one minute). We also recommend you use a polyswitch RXE300 Cat RN3472 $10.95. To simplify, any amplifier between 30 and 200 watts can be used. Look at our new Subwoofer Amplifier Kit.
The enclosure is very small with a volume of 35 litres and only 600 x 270 x 300(D)mm. The cabinet is supplied prebuilt and is made from MDF in blackwood veneer. Grill is supplied with speaker cloth mounted.

SPEAKER ONLY
VIFA M22WR 8" **Cat. CW-2115**
Normally $199.50
Jan Price $179.50 ea
SAVE $20

SUBWOOFER KIT
INCLUDES. •VIFA M22WR DRIVER • PREBUILT CABINET •POLYSWITCH
Catalogue Price $349.45
Jan Price $299
SAVE ALMOST $50

ROAD FREIGHT ANYWHERE IN AUSTRALIA $14. INSURANCE $3

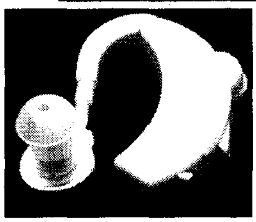
6 Core Phone Cable Sellout



SAVE A FORTUNE! Our new cable is Austel approved. This stuff isn't. Limited quantity only.Austel approved cable is 0.75¢ metre or $48 roll
This cable is **0.40¢** metre or **$28** roll
Cat. WB-1603

MAJIC EAR

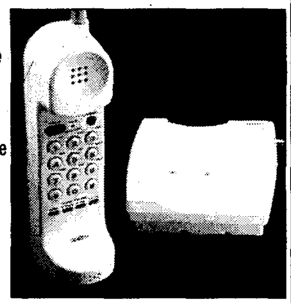
Majic Ear is an amazing aid to hearing that sits comfortably behind your ear and magnifies sound with superb clarity. If you have trouble hearing the TV, listening to the radio etc than Majic Ear will help. There is also 3 different earpieces so you can be assured of a perfect fit. There is an adjustable volume control and an on/off switch. Complete with battery and a spare. Don't put up with trouble hearing!!! Cat. QM-7230



Cat Price $29.50 ***NOW $19.50***

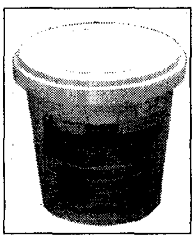
UNIDEN Cordless Phone Sellout!!!

We have a very small quantity of these phones left. See catalogue page 106 for full details.
CAT PRICE $229
Sellout Price $189
SAVE $40 Cat. YT-7040



Ammonium Persulphate Bucket

Save a fortune. 2.5kg bucket.
CAT PRICE $29.95
Now $22.95
SAVE $7
Cat. NC-4256



DOLBY PRO LOGIC CENTRE SPEAKER KIT BARGAIN

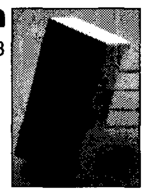
Kit includes:

- 2 x 5" shielded woofers Cat CW-2102 Value $79.90
- 1 x 1" shielded dome tweeter Cat CW-2006 $16.95
- 1 x crossover network Cat CX-2613 $8.50
- 1 x set box plans / wiring details $105.35

Only $89 **SAVE OVER $16** **Cat. CS-2500**

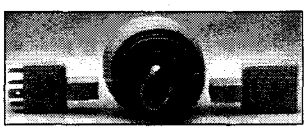
LED Display Bargain

LTS313AR /LT303 common cathode 0.3". Peak wavelength 700, IFMA10 .1V(VDC)650
Cat. ZD-1803



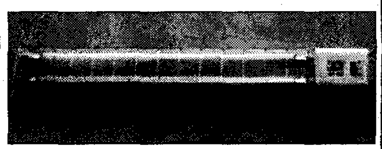
CAT PRICE $2 EACH
Jan 10 for $10

TELEPHONE EXTENSION LEAD



This lead has a 15 metre length of telephone cable with a U.S. 4 pin plug on each end. Also supplied are two adaptors. One accepts the U.S. plug and converts it to an Australian plug. The other adaptor is from the U.S. plug to and Australian socket. So you can have any combination of U.S. plug to Aust plug, U.S. plug to U.S. plug or U.S. plug to Aust socket all 15 metres long. Adaptors cost $6.50 each and the lead is $12.95. That's over $25 value. Austel approved.
Cat: YT-6050 **Cat Price $13.95** **JAN $9.95**

12V 16W TWIN TUBE FLURO LIGHT



This fluro light runs off your 12V car power and plugs into the cigarette lighter. It has a magnetic base, so its easily attached to a van, and you can have one or both tubes on. Also ideal for lighting sheds, or houses without 240 volts.

NEW

Cat. ST-3025 **only $24.95**

GIFT VOUCHERS AVAILABLE

JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS

STEREO INFRARED CORDLESS HEADPHONES

NEW

These are very similar to the mono ones shown above, but transmit in stereo. Use on your Hi Fi or stereo TV etc. To use, plug the transmitter into the headphones or output socket (lead supplied). Transmitter sits on top of your TV or stereo. Headphones have a separate volume control on each and require 2 x AAA batteries. Operating distance is up to 7 metres. Unit requires 12VDC mains adaptor. Use an existing one or purchase our cat MP-3006 $15.50.

Cat. AA-2004 **$79.95**

14,400 BPS DATA/FAX MODEM Internet Software Included!!! NEW

SPIRIT SWIFT

This is a fully featured modem on a circuit card ready to plug straight into the motherboard of your PC. Why clutter your workspace when your modem can be inside your PC!!!

The Swift will send and recieve faxes at the new V.17 standard of 14,400BPS as well as falling back to the slower speed of 9,600 BPS. This is a very clever modem which loses nothing to black box units.

SPIRIT SWIFT INCLUDES: •Spirit Swift fax modem •Winfax lite, DOSfax lite and Comit lite for DOS and Windows •2 metre phone cord •User manual •OzEmail Internet software

SPECIFICATIONS: •ITU-T V.32bis, V.32, V.22bis, V.22 and Bell 212A compliant •14,400/12,000/9,600/7,200/4,800/2,400/1,200/300bps •ITU-T Group III, Class 2 send and receive fax at up to 14,400bps •HARDWARE ITU-T V.42bis and MNP 5 data compression •HARDWARE ITU-T V.42 and MHP 2,3 and 4 error correction •57,600bps effective throughout •Auto speed negotiation •Adaptive line speed •Hardware and software flow control •Data communications, internet and fax software included.

Cat. XM-5100 **only $199!!!**

FREECALL FOR PHONE ORDERS

008 022 888

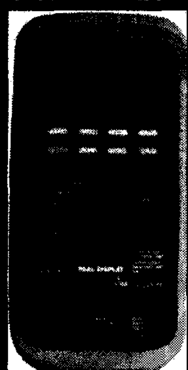
Mixed Semi Pack

Contains a minimum 100 mixed, semi conductors for $10. Includes ICs, transistors, diodes etc.

Cat. ZP-8990 **only $10**

SAVE $40 ON OUR TOP OF LINE AC + DC TRUE RMS DIGITAL MULTIMETER

FEATURES INCLUDE: •4000 COUNTS •40,000 COUNTS MODE •ANALOGUE BARGRAPH •DUAL DISPLAY •0.08% BASIC DCV ACC •BACKLIGHT DISPLAY •TRUE RMS •DC VOLTAGE •(DC + AC) VOLTAGE •DC CURRENT •AC CURRENT •RESISTANCE •CONDUCTANCE •FREQUENCY •DUTY CYCLE •CAPACITANCE •DC ADAPTOR •AC ADAPTOR •DBM & DB •DIODE •150US CONTINUITY •50MS RECORD •0.8MS CREST •SORT •DATA HOLD •STORE AND RECALL •RELATIVE ZERO •RELATIVE % CHANGE •RELATIVE PER UNIT •INPUT WARNING •SPLASH PROOF CASE •PROTECTIVE HOLSTER COMPLETE WITH TEST LEADS, BATTERY INSTALLED AND USERS MANUAL. SEE CATALOG FOR FULL DETAILS. CAT. QM-1460



was $399 JAN $359 save

1 Amp Regulated Switched Power Supply

Desktop type, with outputs of 6,9 and 12V DC. Includes 7 reversable plugs.

NEW

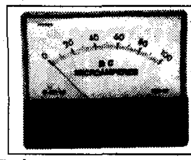
Cat. MP-3032 **only $39.95**

500mA Regulated 3/4.5/6/7.5/9/12VDC

Cat. MP-3030 **$29.95**

Panel Meter Sellout

MU65 style which is the largest available in the range. Overall size 100(W) x 82(H)



CAT PRICE $24.50 EA

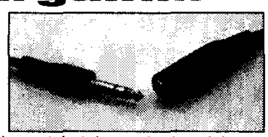
Now $14.95ea

0-1MA Cat. QP-5040

0-100UA Cat. QP-5042

Headphone Extension Lead Bargain!!!

Limited quantity. These leads should have been curly cord, but they arrived straight. 6.5mm stereo plug to stereo plug line socket. Length 2.8 metres. Curly cord ones sell for 411.95. These are only $4.95



Cat. WA-1004 **only $4.95**

Car Speaker Kit

These are a 2nd brand for famous name car speakers. Look at the name on the surround ring.

Consists of a 6.5" woofer and a Neodidyium Super Tweeter and a high power crossover. They handle high power so need a high power amplifier. They sound excellent and we can't understand why they won't sell. At this months birthday price they represent an absolute bargain. See cat page 64. Specs: •Power handling: 80WRMS, 240WPMPO •Freq resp: 50-22kHz •Sensitivity: 90dB/W/1m **Cat. CS-2275**

Catalogue Price $199.50pr

Jan $149.50pr

Multiturn Pot Sellout

Quality Japanese Sakae Brand

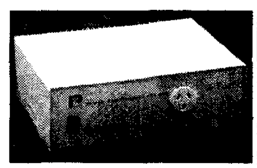
These are 10 turn glass filled with phenolic base. Stainless steel 1/4" shaft with screwdriver slot. Linear tracks rated at 3W @ 40°C. Some types have extremely limited quantities with stock only in our stores. Normally worth around $14, some values are in our catalogue at $5.95 and $7.95. Grab these while we have them.

Cat. RP-3810	100Ω		
Cat. RP-3812	200Ω	Cat. RP-3814	500Ω
Cat. RP-3818	2KΩ	Cat. RP-3830	100KΩ

ONLY $3.95 each

300 Watt Sinewave Inverter Sellout

See 1995 catalogue P109 for full details.



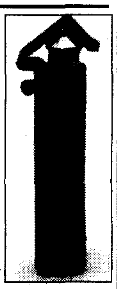
CAT PRICE $699

January $550

SAVE $149 Cat. MI-5030

PROFESSIONAL ADJUSTABLE WIRE STRIPPER SELLOUT

Quality tool ideal for stripping coaxial cables. Will either strip in a circular motion or slice the sheath side ways. Simple cutting depth adjustment. If you strip a lot of cables, this tool is a must for your toolbox.

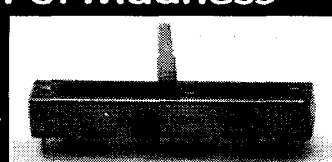


Cat. TH-1822 **WAS $24.95**

NOW $10 SAVE$14.95

Slide Pot Madness

50K LOG 45mm Slider Pot. Soanar brand. 3mm slot for knob. Worth $2-$3.

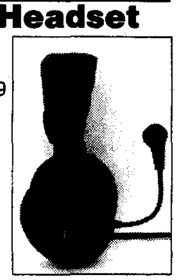


Cat. RP-3910 **Cat Price $1**

JAN 20 FOR $5

PRO Mic/Headset SALE!!!

See catalogue page 59 for full details.



CAT PRICE $89.95

Jan $69.95

SAVE $20

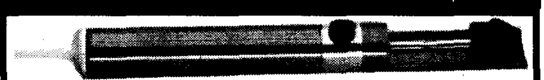
Cat. AA-2022

METAL DESOLDER TOOL

See cat page 88 for details.

NOW $12.95

WAS $16.95 SAVE $4 Cat. TH-1862



JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS

DSE 'Discovery Series' Construction Project:

A LOW COST STEREO PREAMP

The latest release in the Discovery Series of learning kit projects from Dick Smith Electronics is this low cost and compact stereo preamp module, which provides all four of the usual control facilities: volume, bass and treble tone controls, and channel balance. It can be combined with a suitable stereo power amp to make a complete hifi system, but can also be easily adapted for use as a simple stereo mixer for recording, etc. The kit for the module is available from DSE's stores as K-2811, priced at $34.50.

This compact high quality audio module makes it possible to upgrade your basic power amplifiers into a complete audio system, by adding volume, bass, treble and balance controls. The circuit is stereo, with an extra input to both channels that can be used for either multi channel mixing or gain control applications.

Suitable audio sources include CD players, tuners, VCR's, tape players or similar, but the gain can be easily increased to use low level sources like microphones or record players. Application circuits are provided to show how mixing, balanced inputs and other useful configurations can be implemented.

SPECIFICATIONS

Supply voltage:	
Single supply	9V to 36V
Dual supply	+/-4.5V to +/-18V
with optional regulators	+/-7V to +/-40V
Supply current:	18 to 25mA typical
Frequency response:	4Hz to 80kHz (controls centred)
Tone control range:	
Bass	+/-18dB at 20Hz
Treble	+/-18dB at 20kHz
Crosstalk:	-86dB at 1kHz, 1V RMS out
S/N ratio:	100dB A weighted (1kHz, 1kΩ source, 1V out)
Voltage gain:	3.5V/V (11dB)
Input impedance:	40kΩ (approx)
Output impedance:	100Ω (approx)

The module is small, measuring only 122 x 56mm, and has the four dual control pots mounted directly on the PC board. The complete assembly is light enough to allow it to be supported solely by the controls, although if you prefer mounting posts can be used.

Power for the module can be from single supplies within the range 9V to 36V, or from dual supplies within the range +/-4.5V to +/-18V. By adding two optional components to the PCB, dual supplies up to +/-40V can be used.

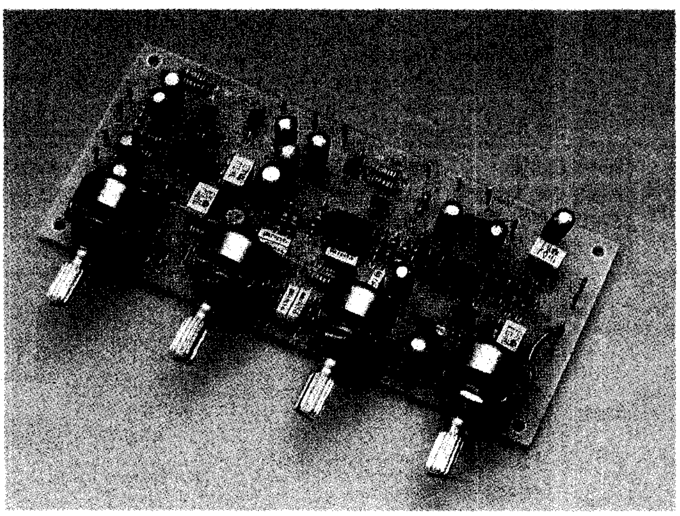
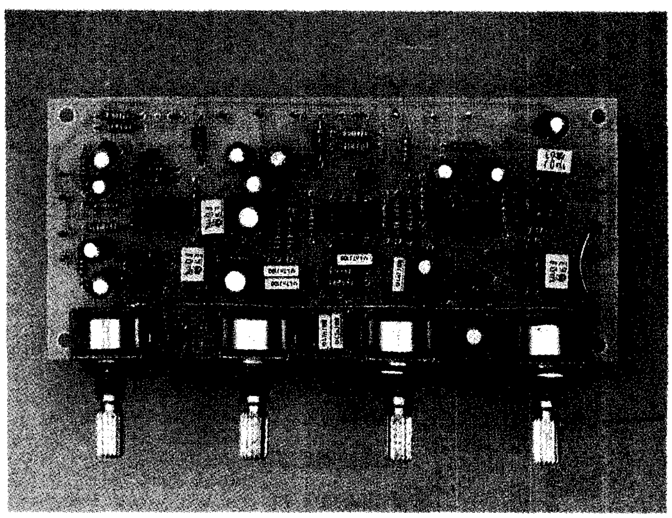
Circuit description

The stereo audio signal passes through three stages, each stage using one LM833 dual audio operational amplifier IC. For each of these IC's, one of its op-amps is used by the left channel and the other by the right channel. Despite the two channels sharing the same IC packages like this, the crosstalk within the IC is typically very low, at only -120dB.

Although the following description refers only to left channel components, it can be applied equally to the corresponding components in the right channel, since both channels are identical. Use of the extra inputs will be described later, and for the basic circuit are left disconnected.

Stage 1: The first stage uses op-amp IC1a. The main purpose of this stage is to act as a buffer, between the volume control and the stage two tone controls. Without this buffer the response of the tone controls would be effected by the impedance of the source and by the volume control setting.

The second function of this stage is to set the overall gain of the circuit, the last two stages having approximately unity gain. Putting most of the gain in the first stage gives a better overall signal to noise ratio than if the later stages provided the gain. The magnitude of the gain is determined by the values of resis-

Both of these views of the new module show it wired as a stereo preamp with volume, bass, treble and balance controls.

tors R2 and R3, according to the following formula:
stage 1 gain = (R2+R3)/R2
= 3.5V/V (11dB)

If the gain needs to be changed, the best way is to reduce the value of resistor R2 for more gain, or increase it for less gain.

The high end of the frequency response is rolled off by capacitor C3, to ensure the stability of IC1a and attenuate any unwanted ultrasonic frequencies.

Capacitor C1 prevents the op-amp's DC input current (which flows out of the inputs) from flowing through the sliding contact of volume control VR1, the bias path being provided instead by fixed resistor R1 to the bias supply rail. Capacitor C2 gives the stage unity DC gain, which is necessary with single supply operation, by blocking a DC path through R2.

Stage 2: This stage, using op-amp IC2a, is a version of the Baxandall active tone control. Active tone controls are those which have the control elements as part of the feedback loop of an amplifier, in this case the negative feedback loop. This type of tone control offers advantages over the passive variety: they are symmetrical about the axis in cut and boost operation, they have very low THD (total harmonic distortion), and the range of component values is small.

The gain of this stage at any frequency is equal to the ratio of the feedback impedance between pins 6 and 7, and the impedance between pin 6 and the input to the stage. So when the tone controls are both set to their middle positions, the gain of the stage at all frequencies is unity. This also tends to be its gain at mid frequencies (i.e., around 1kHz).

With the bass control VR3 set to maximum boost, the gain of the stage at low frequencies can be calculated by considering C5, C6 and C7 to be open circuit, and is equivalent to the maximum bass boost, given by the following formula:
maximum bass boost = (R8+VR3)/R7
= 10 (20dB)

Because of the symmetry of the feedback circuit, the maximum bass cut is simply equal to the reciprocal of this value, which is 0.1 or -20dB.

Conversely, with the treble control VR2 set to maximum boost, the gain of the stage at high frequencies is calculated by considering C5, C6 and C7 to be short circuits — as their reactance will be very low. The bass and treble networks are now in parallel, and the gain

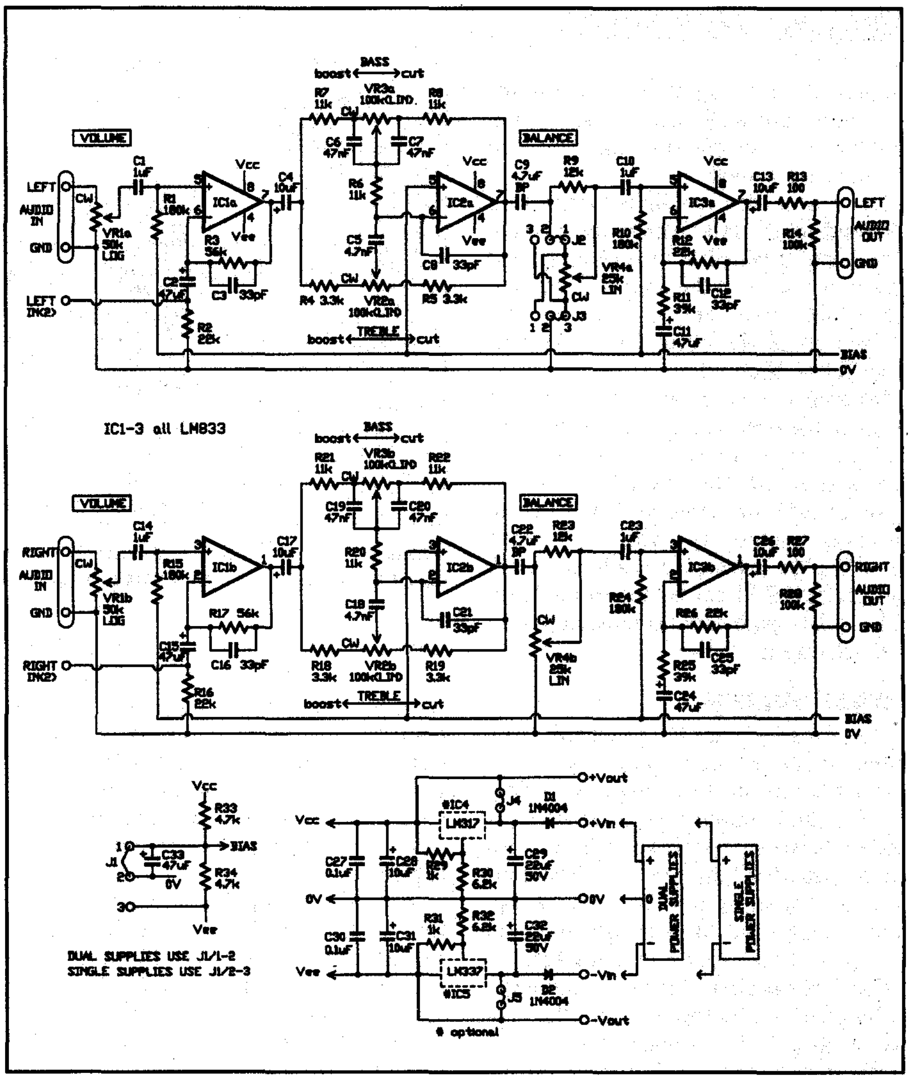


Fig.1: The schematic for the preamp module when connected as a standard stereo preamp with volume, bass, treble and balance controls. It's very flexible however, and can be wired in a variety of other configurations.

of the stage/maximum treble boost is given by the more complicated formula:
maximum treble boost =(R4+3R)(VR2+R5)/R4/(VR2+R5+3R)
which simplifies to = 8.3 (18dB)
where R = R6 = R7 = R8.

As before, the circuit is symmetrical and so the maximum treble cut is 0.12, or -18dB.

One component of the feedback loop that has been ignored until now is capacitor C8. This capacitor contributes to the desired rolloff at supersonic frequencies, without affecting the tone control action significantly. It also ensures that the stage remains stable under all conditions.

The signal input to this stage is coupled via capacitor C4, a DC blocking capacitor. The output coupling capacitor C9 is a bipolar type because the polarity of the voltage across it changes, depending on whether single or dual power supplies are used.

Stage 3: This stage, using IC3a, acts as a buffer between the balance control and the output load.

Balance control VR4 is simply a stereo volume control with the pot for the left channel connected in reverse. With the control centred, both pots give the same attenuation and so the two channels are balanced. With the control fully anticlockwise, the left channel has maximum gain and the right channel is off and vice-versa for the fully clockwise position.

Resistor R9 connected across the top end of both balance pots serves to decrease their attenuation and seems to enhance the 'feel' of the control. A more common type of balance control uses a single pot wired across both channels with the sliding contact earthed. This method, while being simpler, can introduce more crosstalk due to the sliding contact not completely earthing the potentiometer track.

The reason for the links connecting both ends of the left channel balance pot is to make it possible to reverse it, and hence to use it as the 'master' volume control in mixer applications. In that configuration, the normal volume control VR1 is disabled.

Op-amp IC3 is given a small amount of gain, determined by the values of R11 and R12, to compensate for the attenuation of the balance control. Resistor R13 in series with the output prevents instability from occurring when highly capacitive loads are used, and resistor R14 across the output provides a DC path around capacitor C13 to discharge it.

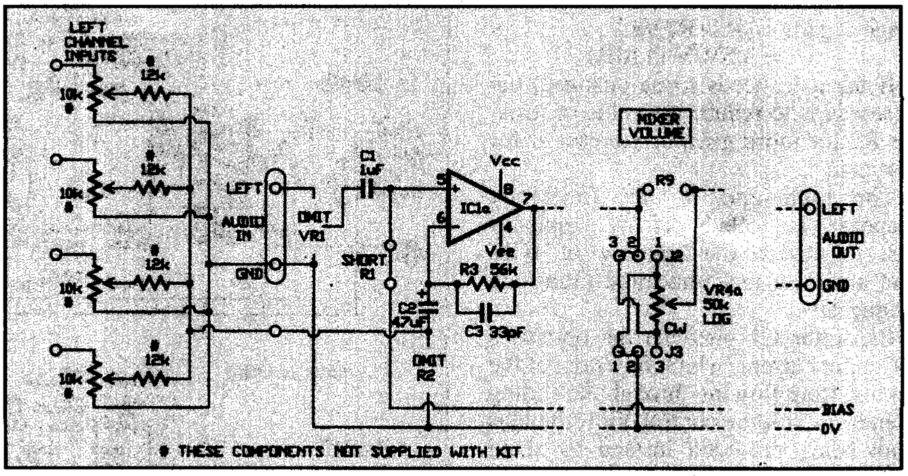


Fig.2: How the module is wired in order to turn it into a four channel mixer. IC1a becomes an active mixer stage, with VR4 becoming the volume control.

Power supply

The preamp can be powered from either single or dual power supplies, selected by means of a single wire strap J1. For dual supplies J1 must be connected between terminals 1-2 and for single supplies between 2-3. The purpose of this strap is to bias all the op-amp outputs at a voltage midway between the two supply rail voltages.

For dual supplies, this bias is automatically provided by the 0V from the supply, so strap J1/1-2 connects the bias rail to 0V. Single supplies however, do not have this half-rail potential available, so resistors R33 and R34 provide the bias. Also, with single supplies the Vee and 0V rails are now connected together by J1/2-3, to make the negative rail the common ground.

Diodes D1 and D2 protect against reversed polarity and capacitors C27-32 provide filtering. For dual supplies with voltages greater than +/-18V, PCB connections are available for inserting optional voltage regulators IC4 and IC5. These devices allow input voltages up to +/-40V to be used, and also offer the advantage of removing power supply noise.

With single supplies there is no use for negative regulator IC5, which can be replaced by wire strap J5. Similarly there is no need for diode D2, which can also be replaced by a wire strap.

When the regulators are used, voltages Vcc and Vee are determined by the values of resistors R29, R30 and R31, R32 respectively according to the following formula:

Vcc = 1.25 * (R29 + R30)/R29
= 9V (with values supplied)

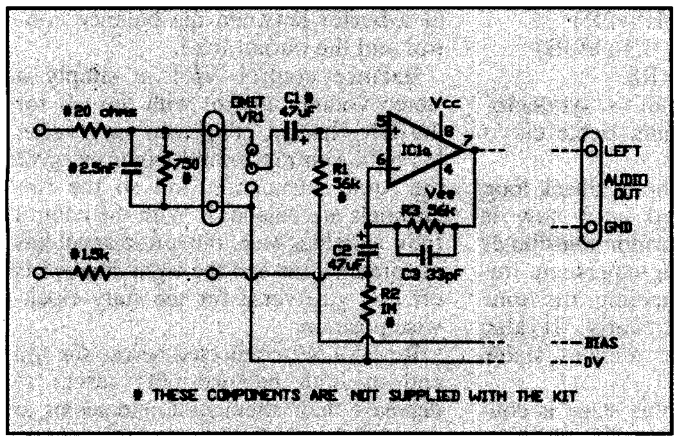
For the regulators to function properly, their input voltage must be at least 2.5V greater than their output voltage. So, with the regulated voltages set to +/-9V the supply voltages must be at least +/-12V.

If IC4 and IC5 are not used, then straps J4 and J5 must be inserted in their place, and resistors R29-32 can either be left in, or removed to reduce power consumption.

As well as the three power input terminals +Vin/0V/-Vin, three power output terminals +Vout/0V/-Vout have been provided. These can be used to provide a regulated supply to other PCB's (when IC4 and IC5 are used), instead of installing regulators on each board.

Creating a mixer

Fig.2 shows how the module can be configured as a stereo mixer. This example shows four channels, but more can be added if needed.



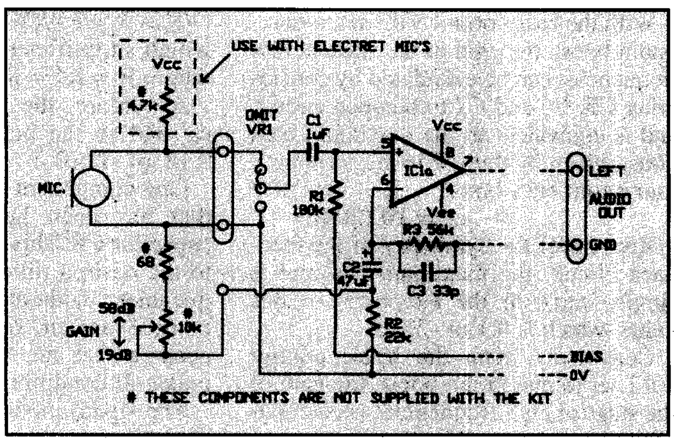


Fig.3 (left): How the module input stage is configured in order to provide a balanced microphone input. Note that VR1 is omitted. Fig.4 (right): For improved signal to noise ratio with microphones, the input stage can be configured to provide an active (negative feedback) volume control.

In this configuration the normal volume control VR1 is removed, the non-inverting (+) input of IC1 is connected directly to ground by replacing R1 with a strap, and R2 is left out. The extra input now becomes a 'virtual earth', which means that signal currents from a number of sources can flow into it without the sources interfering with one another.

The gain for each mixer input is given by the value of R3 (56k) divided by the value of the resistor in series with the input concerned (12k). With the values shown, the gain is 56k/12k, or 4.7. Potentiometer VR4 can be converted from a balance control to a master volume control by moving strap J2 to position 2-3 and strap J3 to 1-2. Also if desired, the 25k linear pot normally used for VR4 can be replaced by the 50k log pot that was VR1.

Balanced input

Fig.3 shows how the extra input can be used to create a balanced microphone preamplifier.

In this configuration the volume control is again removed and replaced by a strap. Capacitor C1 is replaced by a 47uF electrolytic capacitor (the same as C2), R1 is replaced by 56k and R2 is replaced by 1M. Four external components have to be added as shown, including a 2.5nF capacitor which can be made of a 1nF/MKT in parallel with a 1.5nF/MKT.

This circuit can be called a *subtracting* amplifier, because it only amplifies the difference between the two input signals. It does this by amplifying the individual inputs with the same gain but 180° out of phase. As well as the gain characteristics, it is important that both inputs have the same impedance to ground, so that noise tends to be picked up identically at both inputs and is therefore cancelled.

Ignoring component tolerances, the circuit in Fig.3 is balanced except at frequencies below about 10Hz. Capacitors C1 and C2 cause an imbalance at very low frequencies which is minimised, but not cancelled, by making them the same value. In any case, the gain rolloff at low frequencies compensates for the imbalance. To optimise the balance at low frequencies, the two inputs can be tied together and connected to a noise source while trimming the two series input resistors for minimum output.

For optimum balance at high frequencies, the 2.5nF capacitor across the non-inverting input should be an MKT type and may have to be trimmed in value due to wide capacitance tolerances. Also, capacitor C3 could be replaced with a more stable polystyrene type.

Active gain control

When using the kit as an unbalanced microphone or phono preamplifier, there are two methods that can be used to achieve the necessary increase in gain. Firstly, resistor R2 can simply be

PARTS LIST

Resistors

1/4W 1% metal film unless otherwise stated:

		Colour Code 4 band	5 band
R1,10,15,24	180k	brn-gry-yel-brn	brn-gry-blk-org-brn
R2,12,16,26	22k	red-red-org-brn	red-red-blk-red-brn
R3,17	56k	grn-blu-org-brn	grn-blu-blk-red-brn
R4,5,18,19	3.3k	org-org-red-brn	org-org-blk-brn-brn
R6-8,20-22	11k	brn-brn-org-brn	brn-brn-blk-red-brn
R9,23	12k	brn-red-org-brn	brn-red-blk-red-brn
R11,25	39k	org-wht-org-brn	org-wht-blk-red-brn
R13,27	100	brn-blk-brn-brn	brn-blk-blk-blk-brn
R14,28	100k	brn-blk-yel-brn	brn-blk-blk-org-brn
R29,31	1k	brn-blk-red-brn	brn-blk-blk-brn-brn
R30,32	6.2k	blu-red-red-brn	blu-red-blk-brn-brn
R33,34	4.7k	yel-vio-red-brn	yel-vio-blk-brn-brn

Potentiometers

VR1	50k	log dual gang 16mm PCB mtg
VR2,3	100k	lin dual gang 16mm PCB mtg
VR4	25k	lin dual gang 16mm PCB mtg

Capacitors

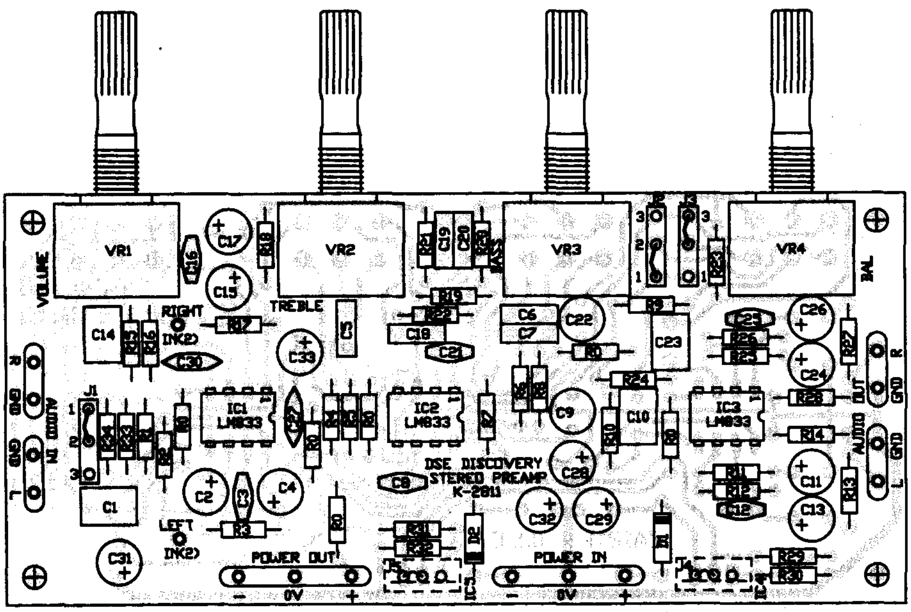
C1,10,14,23	1uF	63VW MKT
C2,11,15,24,33	47uF	25VW RB electrolytic
C3,8,12,16,21,25	33pF	50VW NPO ceramic
C4,13,17,2628,31	10uF	25VW RB electrolytic
C5,18	4.7nF	100VW MKT (.0047, 4700, 472)
C6,7,19,20	47nF	100VW MKT (.047, 473)
C9,22	4.7uF	50VW bipolar electrolytic
C29,32	22uF	50VW RB electrolytic
C27,30	0.1uF	50VW ceramic (100nF,104)

Semiconductors

IC1-3 LM833 dual op-amp
D1,2 1N4004 power diode

Miscellaneous

PCB, 122 x 56mm code ZA1211; PCB terminal pins.



Use this overlay diagram as a guide if you are wiring up the module in its basic stereo preamp configuration, together with the photos on page 90. Note that the metal frames of the potentiometers are connected to signal ground.

TABLE 1: Wire links

The function of the various wire links are described in the text, but the following table gives a summary:

Link Function	Insert Link	Omit Link
Dual power supplies	J1/1-2	J1/2-3
Single power supplies	J1/2-3	J1/1-2
Basic preamp (Fig.1)	J2/1-2 J3/2-3	J2/2-3 J3/1-2
Mixer (Fig.2)	J2/2-3 J3/1-2	J2/1-2 J3/2-3
IC4 option not installed	J4	
IC5 option not installed	J5	
IC4 installed		J4
IC5 installed		J5

replaced by a smaller value, typically in the order of 100 ohms depending on the input signal level, and use VR1 to control the signal level. Alternatively, the active gain control configuration shown in Fig.4 can be used.

In this configuration VR1 is removed and replaced with a strap, and the full signal level from the source appears at the non-inverting (+) input of the opamp. An external series resistor and potentiometer are then connected in parallel with R2 to control the gain of the opamp, rather than by attenuating the input signal level. This method typically results in a higher signal to noise ratio than with the passive volume control.

Construction

To mount the components on the PCB, start with the low profile components first and then work your way up to the taller components.

To place the components, look at the overlay diagram which shows how the components and wire links actually appear on the PCB. Read the label of the component, e.g. C5, from the overlay and then look up the description next to that label in the parts list. For example, C5 is an MKT type capacitor and has the value 4.7nF, so it may be marked either 4.7nF, .0047uF, 4700pF or 472 (i.e. 47×10^2pF).

Occasionally one of the supplied capacitors may be marked with a voltage rating greater than that shown in the parts list, which is acceptable as long as it fits on the PCB. If the voltage rating is *less* than that shown in the parts list, then advice should be sought unless the discrepancy is explained in the errata section at the end of the instructions.

Begin construction by installing the resistors. Resistors have their values marked on them as a colour code, which is given in the parts list. The last band of the colour code gives the tolerance value, and is the colour band furthest from the others. Resistors are non-polarised and can be mounted in either direction, but it is good practice to mount them with their colour codes all in the same direction so that it is easier to read the values later. Some of the resistors are labelled R0 on the overlay. These are actually wire links built like resistors and have a single black band in the centre. They are used in place of wire links wherever possible because they are easier to insert and look neater.

At this stage it is also probably a good idea to work out which wire links need to be inserted. Refer to Table 1 if you're not sure which to install or leave out.

The remaining components are installed as follows.

Diodes: These have a band on them close to one end and must be mounted in the direction shown on the overlay.

IC's 1-3: These have an eight pin DIL (dual in-line) package, with a dot or notch at the end near pin 1. The overlay shows at which end the notch should be. The IC pins count anticlockwise from this notch or dot, looking at the top of the package.

Ceramic and MKT capacitors: These two types of capacitors are non-polar, and can be mounted in either direction.

Electrolytic capacitors: All of these except for C9 and C22 are polarised types which will have a negative (-) or (+) sign printed on them — normally the (-) lead is marked. On the overlay the position of the positive lead is marked. C9 and C22 are bipolar and can be mounted in either direction.

Finally, the PCB pins can be inserted for making connections to the PCB. They are normally inserted through the top of the PCB with the short end passing through the PCB.

With the assembly of the board complete, carefully check all of your soldering. Look especially for dry solder joints, and solder bridges shorting tracks together.

Connecting it up

To connect sockets or switches to the inputs of the preamp, always use shielded cable if the connections are more than a few centimetres long. The output connections are not as sensitive to picking up noise, but should also be shielded.

The power wiring does not have to be shielded, but should be kept away from the signal wiring. The 0V power wiring should be run separately from the input/output ground wiring. ❖

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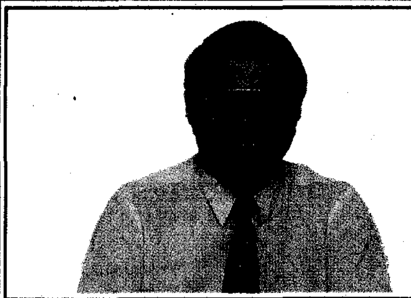

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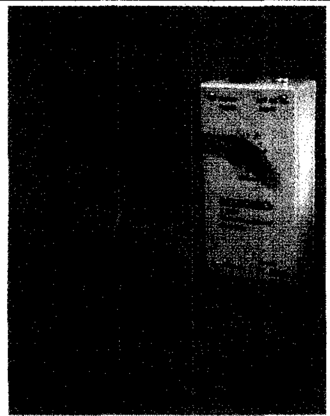

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(See EA Dec '95) This EPROM emulator allows you to do away with EPROM's whilst in the prototyping stage of product development. The emulator is connected to a spare parallel port on your computer and also the 'target' board. The EPROM file (that is normally downloaded into the EPROM), is then transferred into the emulator by copying the file to the parallel port. This process saves repetitively "blowing" new EPROM's with each modification to the program. Emulates 2764, 27128, 27256 and 27512 EPROM's.

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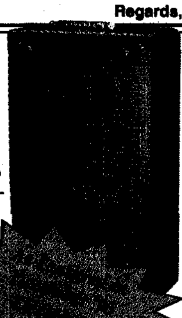

Signal Comparator Kit

(See EA Aug '93) If you have ever tried to fix a circuit without a circuit diagram you will know how frustrating it can be. If you have an operational unit this can ease the pain but still, difficulties can be incurred. This kit could help. It can compare two circuits point to point and will indicate any difference between them.

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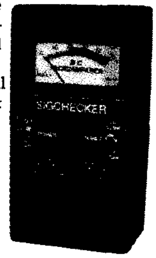

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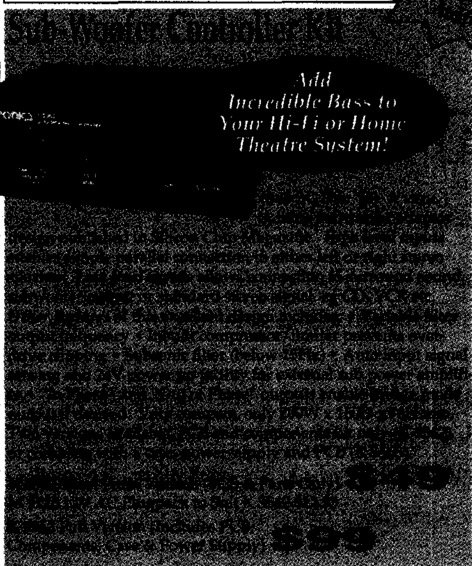

PC Based EPROM Programmer Kit

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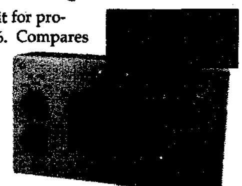

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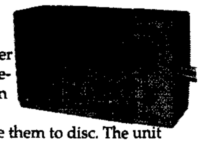

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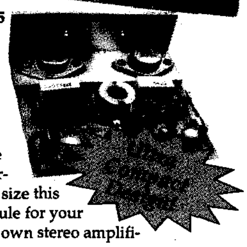

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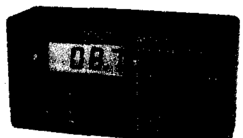

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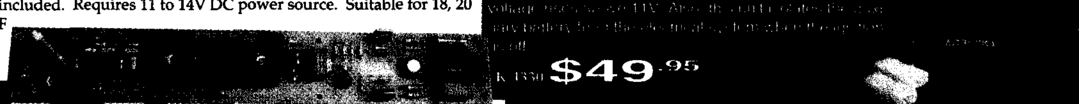

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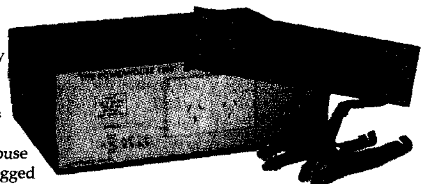

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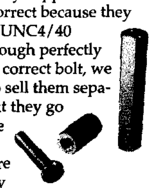

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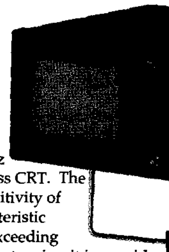

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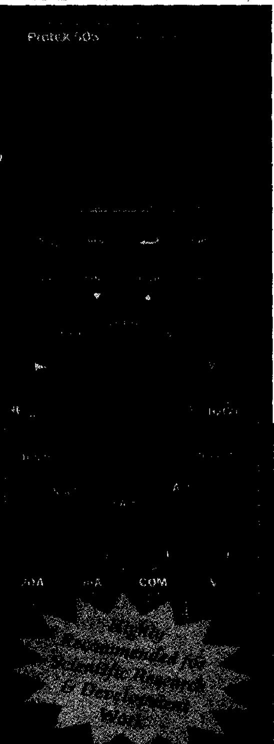

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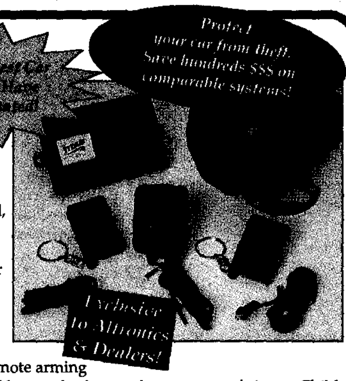

This amazing model features just about everything you could imagine. Multi-function key ring remote control will arm and disarm alarm (and activate central locking if fitted), panic and even open the boot (if actuator fitted). Other features include starter inhibitor, valet mode, central locking interface, flashes car indicators when tripped, auto reset, user programmable options plus much more. Also includes two spare electric outputs which are operated by the key ring remote control, these can be used to chirp the horn, turn on the car headlights or a myriad of other functions! Can be configured to automatically re-arm if a door is not opened within 22 seconds after disarming (avoids accidental disarming). Full battery backup siren includes built-in batteries, charging circuit, siren and key on/off switch.

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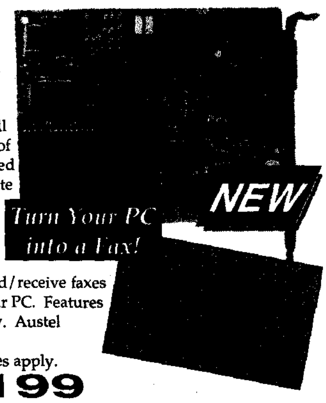

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SHORTWAVE LISTENING

with **Arthur Cushen, MBE**

Indonesia Radio's checkered history

Indonesia, with its population of 200 million, has many hundreds of radio stations. But when we look back at the history of broadcasting, we find that it was originally a Dutch colony, and the Dutch were the pioneers of radio in what was then the Dutch East Indies.

A company known as NIROM: Netherland Indies Broadcasting Company Ltd, was founded in the late 1930's and operated several stations in Batavia, Bandoeng and Surabaya. However the true pioneers were perhaps the various wireless societies set up by radio amateurs to broadcast to the local population. These were heard up to the Japanese occupation in 1942.

By June 1942, the Japanese had overrun the former Dutch East Indies and taken control of radio services. We then began to hear new voices on the band. Later Radio Batavia started to use the higher frequency bands and commenced broadcasts in English — full of propaganda with the Japanese war news, lists of prisoners of war and civilian internees. They also had a special lunchtime broadcast to Australia and New Zealand from Batavia, using 18,135kHz for this transmission at 0130GMT.

By 1946 two broadcasting systems were in operation: Radio Batavia, operated by the Dutch in Batavia and the Voice of Free Indonesia in Jogjakarta under the control of the emerging Indonesian Government. The latter was the founding of Radio Republik Indonesia.

The conflict dragged on, as a transfer of power from the Dutch to a new Indonesian Government was in discussion in 1947 and this took place in 1949 under Sukarno. In 1966, further radio activity was noted, with a student radio on the air and Radio Andir was heard.

According to a Radio Nederland programme looking at radio in Indonesia, there are now 647 private broadcasting stations as well as the network of the Radio Republik Indonesian RRI stations spread throughout Indonesia. All stations relay the news on the hour from Jakarta, and this is familiar to shortwave listeners for the preceding 'Song of the Coconut Island' before the news.

Reception of the Indonesian External Service with its high powered transmitters is noted with sign-on at 2300UTC on 9525 and 9680kHz and these frequencies are still in use at 1100UTC. Many RRI stations can also be received on the lower frequency bands with Tanjung, Karanga on 3395kHz and Jakarta on 4777kHz being well received around 1300UTC.

Media Network Milestone

This month Radio Nederland's Media Network programme will celebrate 30 years of my contribution to it — which when I first broadcast in January 1966, was called DX Jukebox. In those days it was a programme of some shortwave listener news and the hits of the moment, and was compered by Harry Van Gelder. The programme started in 1959 and it was designed to also help people build receivers and give more technical information, realising the difficulties of shortwave listeners worldwide in obtaining that type of information.

In 1966 in the broadcast on the first Thursday of the month, my contribution was carried. At that time, there were three other correspondents coming from South Africa, Holland and Sweden. In those days my broadcasts were recorded at Radio New Zealand studios in Invercargill, along with my programme for our own shortwave service which started in 1960. The two programmes were put together at the one sitting, using, of course, a braille script.

The Radio Nederland programme was recorded two weeks in advance as it was airmailed to the Hilversum studios, then put together and broadcast. In 1968, when the relay station in Bonaire was opened it was recorded a month in advance so that the material could be sent to Hilversum, the programme put together and airmailed down to the transmitter at Bonaire.

Harry Van Gelder carried the session into the 1970's and following his retirement there were several other comperes. Jonathan Marks joined the staff of Radio Nederland in 1980 and later the programme was re-titled Media Network, and in recent years, it has been voted the most popular communications programme on shortwave. Radio Nederland then pioneered the use of the telephone for reports and for the past few years, my contribution has been telephoned on a Tuesday morning to Hilversum for broadcast on a Thursday evening.

Media Network has now evolved into a communication type feature and there are only two overseas correspondents with regular input, Victor Goonetilleke and myself. The two sessions for reception in the South Pacific are at 0752UTC on 9720 and 11,895kHz; and 0952 and 7260, 9720 and 9810kHz. ❖

AROUND THE WORLD

BANGLADESH: Radio Bangladesh signs on in English at 1229UTC, with news broadcast at 1230 on 7185kHz.

BULGARIA: Sofia has been well received in English at 0500 - 0600UTC on 7480kHz and 9700. Both frequencies have been heard in the South Pacific.

GERMANY: Deutsche Welle transmits in English to Oceania at 0900 - 0950 on 6160kHz, 7380, 11,715, 17,780, 17,820 and 21,680kHz; 2100 - 2150 on 6185kHz, 9670, 9765 and 11,785kHz.

NETHERLANDS: Radio Netherland has English to the Pacific at 0730 - 0825 on 9720kHz and 11,895kHz; 0830 - 0925 on 9720kHz and 13,700kHz; 0930 - 1025 on 9720kHz, 7250 and 9810kHz; and 1030 - 1125 on 7250kHz and 9810kHz. The broadcasts on 9720kHz and 11,895kHz originate from Bonaire. All other transmissions are from the Commonwealth of Independent States.

Radio Netherland is using a transmitter in Russia for a broadcast in English noted at 1830 to 2030, on 4945kHz. Reception has been very good during this period and the transmission is beamed to Central and South Africa.

PALAU: KHBN, The Voice of Hope, 9965kHz after testing has been heard with an extended schedule, and English at 0730, Chinese at 0800 and still operating at 1800UTC. The station has two other frequencies, 9730kHz and 9985kHz, listed for use by new transmitters.

PHILIPPINES: FEBC, Manila has been heard on 11,635kHz opening at 0930 with news and feature programmes at 0940UTC. The address for reception reports is PO Box 1, Valenzuela 0560, Metro Manila, Philippines.

SAIPAN: KHBI, Christian Science to the South Pacific broadcasts from 0800 - 1000 on 13,615kHz; 1000 - 1100 on 13,625; 1100 - 1200 on 9425; 1200 - 1300 on 13,625; 1800 - 1900 on 9355; 2100 - 2200 on 13,840; and 2300 - 2400 on 13,625kHz.

SWEDEN: Stockholm broadcasts in English to Australia 1230 - 1300 on 9835kHz, 13,740 and 15,240kHz. Also heard 0130 - 0200 on 7120kHz to this area.

TURKEY: The Voice of Turkey has English broadcasts 0400 - 0500 on 7190kHz, 9560 and 9685kHz. The station uses five new 500kW transmitters for the Voice of Turkey broadcasts.

USA: WCTG, PO Box 1131, Copperhill, Tenn, 37517, USA heard on 9475 at 0400UTC with English and Spanish announcements. Signals are still heard at 0500 but at 0600 the station is blocked by HCJB. This is a new 50kW gospel station. ❖

This item was contributed by Arthur Cushen, 212 Earn Street, Invercargill, New Zealand who would be pleased to supply additional information on medium and shortwave listening. All times are quoted in UTC (GMT) which is 11 hours behind Australian Eastern Daylight Time and 13 hours behind New Zealand Daylight Time. ❖

INFORMATION CENTRE

by PETER PHILLIPS

Windows 95, new lifeforms and 'synchros'...

I'm devoting the column this month to two unrelated topics: computers and synchros. We haven't described synchros here at all before, and we've never devoted much of the column to computers and the problems people have with them. So I trust you'll find both topics interesting, even if you are not 'into' either. Incidentally, I'm out of What?? questions again. Can anyone help please?

You might not have seen a recent and rather remarkable SBS program in a series called the 'Seven Wonders of the World', which featured a man who was (I think) the director of a US company involved in the development of artificial thought. He talked about his work, about computers and the future, and threw in some quite profound beliefs.

Perhaps the most profound was his view that man and computer were destined to combine into a new, much higher order being — which would place today's man at about the relationship monkeys presently are to us. This new being, according to the program, would be God.

The segment featuring this man lasted about 10 minutes, and he went on to say that future computers and the supporting technology would be so sophisticated that no one person would be able to understand it. He further suggested that eventually parts of future computing systems (the computer itself perhaps) would be just a black box that no one would need to understand, like knowing why two plus two equals four.

It's hard to dismiss these opinions when you consider that computers are evolving at an ever increasing-rate and, unlike any previous technology, computers help in their own evolution. Furthermore, in the last few years we have seen millions of computers join together all over the world through a communications system (the Internet and so on) that is expanding as fast as the need arises. It only takes the right software to make these computers interact, perhaps like a large electronic brain.

Now consider the way computers have developed. Babbage is generally accredited with inventing the concept of the computer in 1831, and Boole in 1854 pioneered a new way of thinking, called digital logic. In the late 1940s the first generation of electronic computers appeared, followed some 10 years later by second generation, all solid state computers. Third generation computers were developed in the '60s, but until the '70s these computers were mainly the tools of large industry and government, because of their expense.

Then came the microprocessor during the '70s, followed by 8-bit personal computers towards the end of the '70s. In other words, it took from 1831 to the late 1970s to get computers into our homes. Now ponder the developments that have occurred with computers since say 1980 to 1996, a period of 16 years.

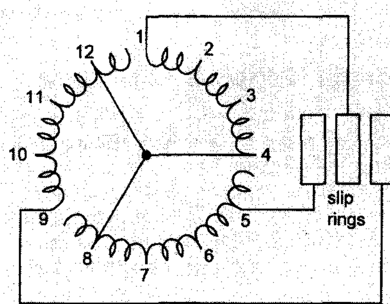

Fig.1

Even if the rate of change of computer development stays constant, where will computers have taken us in another 16 years? But given that the rate of change of computer development is itself increasing, then it seems we can look forward to huge technological improvements in half this time. So by 2020 or so, who knows where we will be. Perhaps the predicted computer-human creation will be a reality, with consequences we can only wonder at...

I'll leave you to think over that one, and in keeping with our computer theme for this month, we'll move to a discussion about the most publicised software ever written.

Windows 95

As an electronics magazine, we would be remiss if we failed to keep you abreast of the major happenings in the computer world. One of the more recent happenings is Windows 95, described by some as Microsoft's answer to the graphical interface of the Apple MacIntosh.

The story I'm going to relate about Windows 95 is not a reassuring one, but one that does have a happy ending. I'm describing it because it might give you some answers if you have problems installing Windows 95. It goes like this...

Last August, I described a computer crash I experienced at the time. Although traumatic, I learnt a lesson from the experience, including how important my computer is to me, and the need for backups. So when I decided to install Windows 95, I had tape backups of everything, and I'd even installed another hard disk, especially for the new program. This disk had no other software on it, and offered 'virgin territory' for Win 95.

Because of conflicting reports, I opted for a dual system, with Windows 3.1 on my old drive and the new system on the new drive. I installed from a CD ROM, choosing a custom installation and responding to the various questions during the installation. And after about 20 minutes, there it was — Windows 95. I was pleased that the installation had gone thus far with no problems, so I spent the next half an hour looking around the all-new graphical interface, that somehow reminded me of how my

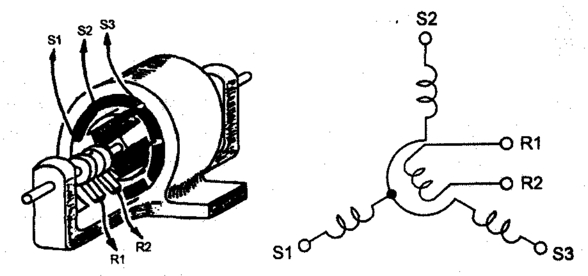

Fig.2

Apple IIGS (remember the IIGS?) looked in 1986.

I was soon to discover, however, that all was not as it should be. According to others, the program should have read my old WIN.INI file during installation and set itself up to run at least some of my existing Windows-based programs. I fiddled about for a while, finally concluding that I would need to re-install my programs to make them run under Win 95.

As this month's deadline was fast approaching, I decided to leave Windows 95 alone, and return to Windows 3.1. I then found to my horror that although Windows 3.1 ran — albeit very slowly — very few of my programs would now run under it, giving the message 'not enough memory'. I won't go into all the details; suffice it to say that my computer was now dysfunctional in a big way!

The first and most obvious thing was to use the 'uninstall' facility of Windows 95. Unfortunately, for some reason it had not made the necessary files to allow this, despite having made (at my request) a boot disk. I'm sure nothing I had done had prevented it making the required uninstall files.

I then tried finding what Windows 95 had done to my system. It seems the program is very intrusive, and gets into almost everything, even DOS. A few phone calls to other users confirmed that the simplest way out of the mess was to restore my hard disk from the tape backups.

So, after several more hours of restoring from tape, I felt confident all would be well. But no! In fact, things were now worse than before, as Windows 3.1 would not even boot. Instead the computer would hang, halfway during loading.

As you can imagine, I couldn't understand why my system wasn't working. I had even reformatted my drive to get rid of any possible remainders of Windows 95. It threw into doubt the whole principle of making backups.

I'll spare you my feelings and instead give you the happy ending, which came from Robert Priestly, a regular contributor to the magazine. Robert has had a lot of experience getting people out of trouble following a Windows 95 installation, and believes the best way is to start with a totally new computer system.

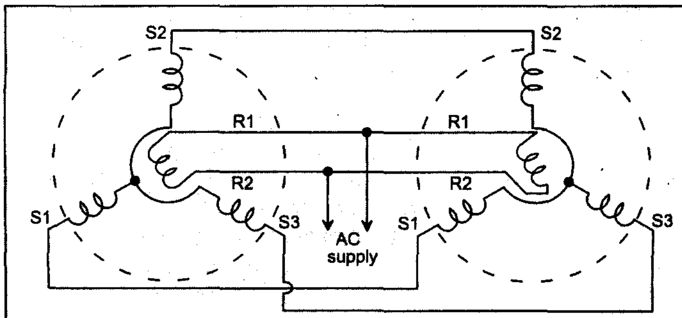

Fig.3

All I had to do was boot from a floppy, go to the C: prompt, and enter the command fdisk<space>/MBR (rewrite the master boot record). I had to do this twice and thereafter all was well. It seems the master boot record on my C drive had been altered (I have to assume by Windows 95), and this was stopping everything from working.

It's possible you've never heard of this DOS command, or even used it. But there it is, and one worth knowing. Incidentally, Robert and all the other people I spoke to agree that Windows 95 is excellent, but I guess it will be some time before I try it again.

And OS/2...

While we're on the subject of GUIs and computers, here's a letter from a reader who read my comments on the IBM Aptiva in November.

I read with interest about your adventure with the IBM Aptiva. A couple of years ago a friend and I decided (independently) to try out OS/2 — he got the full system and I chose OS/2 for Windows (claimed at the time to run Windows better than Windows itself).

Mine never did get installed, as it continually gave up at I think disk 5, out of a total of 20 3.5" disks. Although I could have had the disks replaced, I decided not to continue with the idea. So I was faced with removing what had been installed. That was when my troubles started, as some of the files were hidden and when found, refused to allow the attributes to be changed to delete them. And while they were there, all I could get was the maddening OS/2 logo.

My friend meanwhile completed his installation, but decided that OS/2 was not his cup of tea, and had similar experiences trying to remove the last of the files.

In the end we both had to re-partition and re-format our hard disks, and in my case I'm sure OS/2 had written to the scratch area of the CMOS BIOS to preempt some of the services to itself. I removed the on-board battery briefly, and then had to re-enter all the usual BIOS information. Finally I had to reinstall ALL my programs from scratch.

Incidentally, you describe the Aptiva as 'incompatible'. Can an IBM computer be other than compatible? I'm sure IBM would hold the view that since they engineered the original PC architecture, AND wrote the original code for the CMOS BIOS, they have a right to consider all 'clones' as interlopers, and completely incompatible with the IBM ethic. (Even if they use a BIOS licensed by IBM!)

Perhaps we should all say a prayer of thanks for Bill Gates? And hooray for Windows! (Bob Abel, Condobolin, NSW)

I know the feeling about having to start all over again, Bob, and I'm sure there's quite a few readers empathically nodding. You're right about it being unfair to call the IBM Aptiva incompatible, but it's certainly different from the so-called IBM compatibles. But as it happens there's more to say about this unfortunate computer, although it's probably nothing to do with it being an Aptiva.

Disk drive problem

Not long after I wrote about the Aptiva, its owner accidentally introduced a virus into it — called EXEBUG, I think. This virus could not be removed by the McAfee software recommended by the IBM help desk, so my friend decided to ask a computer-literate work colleague to help. This person was familiar with OS/2 and he was able to painlessly remove the virus, and OS/2 with it.

But later another problem

emerged. For unknown reasons, the single 3.5" floppy drive in the Aptiva now won't read the directory of anything other than the first disk it reads after power-up. That is, replacing the first disk with another gives a display of the same directory as the first. Trying to install software that comes on more than one disk is therefore impossible.

The solution? Who knows! At the time of writing, it seems all that can be done is to restore the Aptiva back to how it was shipped, so the IBM help desk can figure it out. This means my friend will get OS/2 back again, along with losing everything he has installed. Is it the remains of the virus, the complexity of OS/2 and the Aptiva causing the problem, or the well known gremlin? I'll keep you posted.

GPO problem

The next letter is computer related in a rather strange way. I'll let you read the letter first, then I'll make a few comments.

First, congratulations to EA for the great BBS you have set up. You may be interested in a strange problem I am having, and maybe a reader can help me a with solution.

The story needs a bit of background. I use quite a lot of computers, and also repair many for other people. This is the main way I earn my living, and it's all done at home. I usually have two or three computers set up at a time, doing a burn-in.

I therefore have a room set aside for this, and when the house was built this room was fitted with three double power points (GPOs), along with a telephone line (for a modem). The problem, which you may not believe possible, is with one of the power points.

With modern computers the power supply has a mains input which is connected to a GPO, and a fused mains output for a monitor. This allows a single switch to operate both the computer and the monitor.

So what's wrong? With one particular power point, when I turn the computer's power switch on the monitor comes on, but the computer doesn't! About three seconds later the LED display on the front of the computer flashes. However if I turn the computer on then off, wait for the flash, and turn it on when the display flashes, the system will come up beautifully!

One computer I was using on this power point had this problem on other GPOs as well, but after replacing its power supply it was fine on all other GPOs except the one in question.

I have used three computers (and four different computer power supplies) on this power point and each one has the same problem. The solution is fairly simple — run an extension lead from another GPO.

It seems strange that a GPO would sort of (?) work, is fine for using transformer type power supplies, but not switch mode designs. Any suggestions? (Conrad Smith, Berowra NSW.)

Thanks for your letter, Conrad, which came to me via the BBS. Anyone who likes to send their letters this way is most welcome.

I suggest you check the wiring to the offending GPO. It might be that the earth and neutral wires are reversed. This will usually make the GPO appear to work properly, but is really quite dangerous. I have no idea if this could cause the symptoms you describe, but I'm starting to give up on computer related problems. Other than that, I can only throw the question over to our readers.

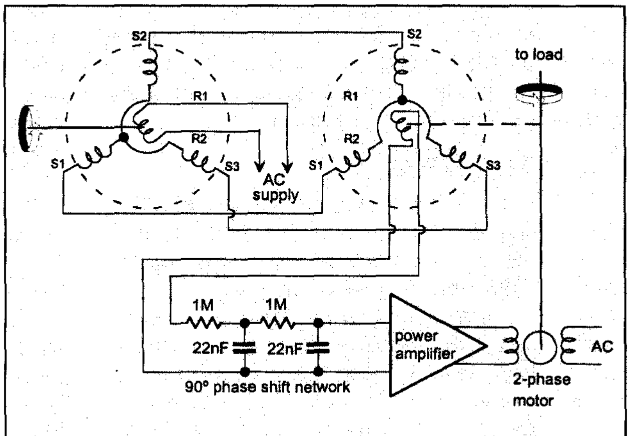

Fig.4

And now, I'm want to take you back to April 1964, when computers were almost unheard of, a hifi system cost around $400 and synchros were readily available through disposal stores.

Synchros

In October '95, I included a letter from a reader wanting a system that would allow the position of a remotely mounted weather vane to be indicated by a pointer on a compass face. He did not want a digital solution, just a simple analog method. I proposed a pair of synchros (also known as selsyns), but admitted to being hazy about these almost forgotten but simple devices.

Since then I've received a number of letters about them, and I have also found an article on the subject written by Jim Rowe in the April 1964 edition of this magazine (then called Radio & Hobbies). I'll present two letters first, as they both offer practical suggestions, then refer to Jim's article to give you a precis of how synchros work:

Your *inclusion of a letter from G. Kinnear in October's Information Centre reminded me that I've been collecting material for some years on the very devices you recommend as a solution to Mr Kinnear's problem. Unfortunately, suitable units may be hard to find or even recognise.*

The terms magslip, selsyn and synchro all refer to the same device, and yes, they do work over 360°. However while these devices have a three phase stator, they don't need an external three phase supply.

The way they work is quite elegant. The transmitter and receiver have a similar construction, and many were made in a standard housing of about 50mm diameter. Each unit has a three phase stationary winding and a two pole rotor.

When the rotors of both units are energised with the same AC supply, the induced voltage in the stator of the transmitter will cause currents to flow in the stator of the receiver. The rotor in the receiver will then align itself to agree with the position of the rotor in the transmitter.

So all we need are two synchros, a low voltage AC supply for the rotors, and five wires between the two units. A typical supply voltage is 30 to 50V AC, but the units I have are so nicely made they work at a much lower voltage. Old military units may have been designed for a 400Hz supply. The ARRL Antenna Handbook of a few years ago has useful information about how to get by with just four wires and a simple 400Hz supply.

The difficult part is finding a pair of suitable units. To my knowledge, they were used in meteorological instruments and radar heads. However suitable equipment may be closer at hand, in the form of a car alternator. Perhaps your magazine has the resources to try my idea.

First get a pair of alternators and remove the diode packs. Next connect the two stator networks together and apply a low voltage AC to the (paralleled) rotors. I think you'll find that moving the rotor of one causes the rotor *of the other to move in an identical way.*

My fear is that as the rotor has more than two poles, the two units will have more than one lock position. Maybe the extra pole pieces could be cut off with an angle grinder. Also the stator windings might have a field pattern differing from those of a standard synchro. (John Hill, Wellington, NZ.)

Thanks for your comments John, and in particular for suggesting a car alternator as a synchro. It's certainly worth a try, if you happen to have two (I assume identical) car alternators and a suitable AC supply.

Here's a few lines from another reader, who opens his letter in a rather unique way...

Damn you, you have disturbed my brain. I have had to resurrect KNOWLEDGE buried for at least 18 years and up to 50 years.

I suggest that any pair of universal motors can be modified to operate as repeater motors. These are in many household appliances like vacuum cleaners and blenders. Other possible sources are 12V car fans and windscreen wiper motors like those in Volkswagens.

The number of coils is not important provided the same coil segments are connected to each other. Only three segments need to be used as take-off points as shown in Fig.1. The idea is:

Open circuit the armature winding at three points and join segments 4, 8 and 12 (or equivalents on your motor). Fit slip rings to the shaft and connect segments 1, 5 and 9 (or equivalent). Do this with two motors and you have two synchros. (L.M. Cross, Newtown NSW.)

I think you've left out one step, Mr Cross: the field coils. In your idea, it seems the three phase stator normally found in a synchro is now the rotor, so the two pole rotor of a normal synchro must now be replaced with a two pole stator in your 'inverted' design. Most universal motors have a two pole stator anyway, so the design is complete.

My only other comment concerns the suggested Volkswagen windscreen wiper motor. As these usually have a permanent magnet field, it could not be used in this application.

Now let's look at what Jim Rowe had to say about synchros in 1964, when they were in much wider use:

About synchros

First is the name. Selsyn is a trade name from General Electric Company, and other names like Autosyn and magslip seemed to also be proprietary terms. The most general term is synchro, which I'll use here.

A basic synchro and its internal circuit is shown in Fig.2. The sketch of the synchro (from the April '64 article) is illustrative only, and commercial units look much more elegant. In a typical system, one synchro is called the transmitter and the other the receiver. It seems there is little difference between these and they can be used in either role.

If two such devices are connected as in Fig.3, turning the rotor of either machine will cause the rotor of the other to align itself to agree exactly with the first. However there is no power gain, so this simple system is only useful for low torque applications, such as that required by Mr Kinnear.

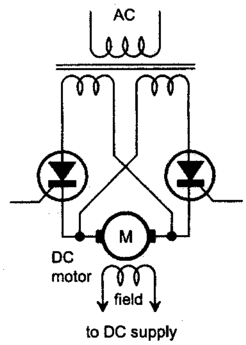

Fig.5

An arrangement that gives power gain is in Fig.4. As before, the stator windings of both synchros are joined, but the rotor winding of the receiver is now fed to a 90° phase shift network, which connects to a power amplifier. This amplifier feeds one winding of a two-phase AC motor, the other fed from an AC supply.

The receiver's rotor is mechanically coupled to the load, so it's turned with the load by the extra motor. When the position of this rotor agrees with that of the transmitter, there is no error voltage and the system is stable.

An interesting point is that a DC motor can be used as the load turning motor, as in Fig.5. The amplifier circuit shown is an adaptation of the original, which uses thyratrons (a gas-filled valve, rather like an SCR).

The trigger pulses to the SCRs are 180° out of phase, from a previous amplifying stage. The field winding of the DC motor is supplied by an external DC supply, perhaps from another winding on the transformer, via a rectifier bridge.

Jim's article goes on to say that synchros make an excellent alternator, perhaps to produce a signal source, or even a small amount of power. This gives support to John's suggestion of using an alternator as a synchro.

There's much more, including a description of differential synchros. I'll leave it there however, as this brief summary covers the main points of the article. Reprints of the full article are available through our Reader Service if you want more information.

What??

Here's a non-mathematical question. It comes from Bryan Maher, a regular contributor to our What?? segment. Bryan writes:

Electrons can exhibit positive or negative mass. In contrast, most physical objects like golf balls, people and cars have a positive mass, which means their inertia resists acceleration. Such objects tend to hold back when pushed. But if something has a negative mass, it would react to acceleration by instantly moving quickly ahead when pushed. The question is, what large size mechanical object that we are all familiar with exhibits an apparent negative mass?

Answer to December's What??

The answer is 75km. The mathematical solution is: on the first flight, the bird flies 50 x 60/80km, the trains go 50 x 20/80 km = 12.5km, and the trains are now 50 x (2 x 12.5) = 25km apart. For the second flight, the bird flies 25 x 60/80km, the trains go 25 x 20/80 = 6.25km and the trains are now 25 - (2 x 6.25) = 12.5km apart. For the third flight, the bird flies 12.5 x 60/80km, the trains go 12.5 x 20/80km = 3.125km and the trains are now 12.5 - (2 x 3.125) = 6.25km apart. For the fourth flight the bird flies 6.25 x 60/80km.

The total distance covered by the bird in four flights is: D (4) = (50 x 60/80) + (25 x 60/80) + (12.5 x 60/80) + (6.25 x 60/80). This equals (50 x 60/80)(1 + 0.5 + 0.25 + 0.125)km. The second set of brackets contains a geometric series, and the formula for the sum of the first n terms of the series is:

S (n) = a(1 - rn)/(1 - r), where a is the first term, in this case 1, and r is the common ratio, in this case 0.5. For an infinite series, n is infinity, so as a = 1 and 0.5 raised to infinity = 0, the formula reduces to S (infinity) = 1/(1 - 0.5) = 2. So, the total distance flow by the bird is D (infinity) = (50 x 60 x 2)/80 = 75km.

A more lateral way to approach the problem is: each train has moved 25km when they meet. At 20km/h this takes 1.25 hours. The bird flying at 60km/h for 1.25 hours travels 75km. ❖

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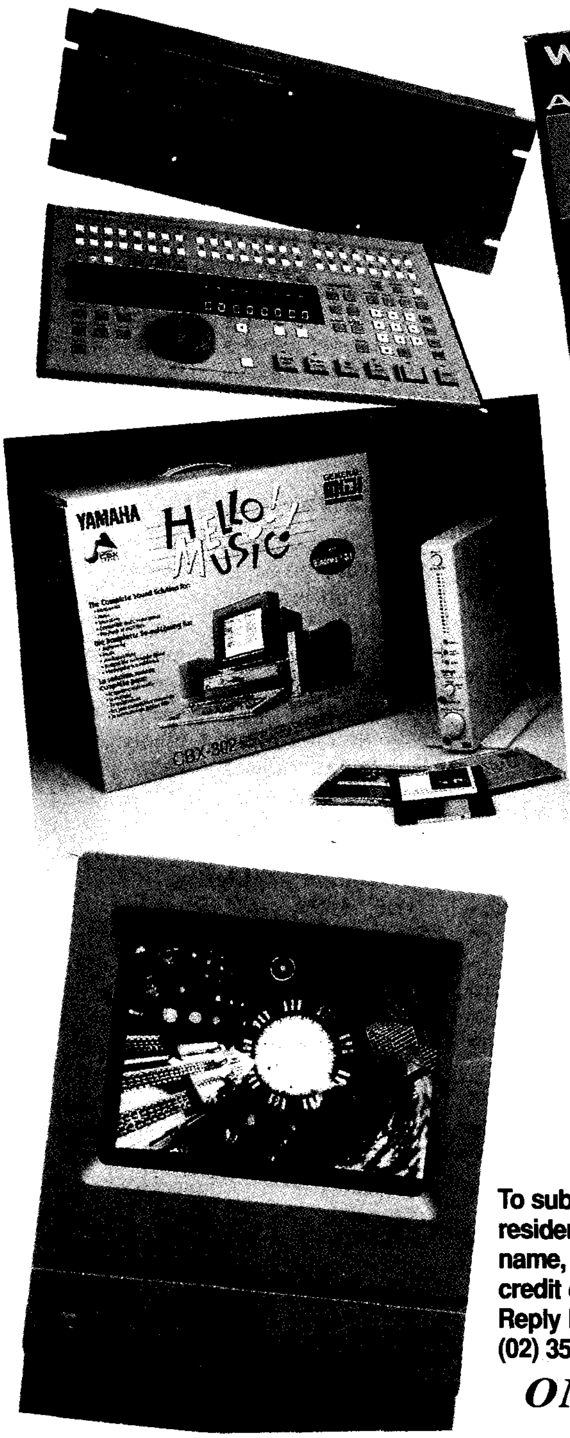

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Vintage Radio

by PETER LANKSHEAR

Ancestral Electronics — 1

1995 was a significant year in the history of electronics, as it was the centennial of the young Marconi's taking the generation and detection of Hertzian waves out of the laboratory to experiment in their practical use. But so far, there has been remarkably little commemoration of his achievements, from which grew one of the greatest engineering sciences. Here's a look at the existing technology that Marconi was able to build upon.

This coming year continues the Marconi anniversary, as it was during 1896 that he made his first application for a patent, and gave public demonstrations in Britain of transmission and reception of wireless telegraph signals.

I suspect that one reason for the lack of fanfare is that no exact date can be put on the occasion when Marconi was actually fired up with the idea of using electromagnetic radiation for communication. Nor on his experiments which made the transition from repeating the investigations of scientists such as Hertz and Lodge, to the realisation of a practical system of wireless telegraphy.

Marconi is generally credited as being the first to create a working system that evolved into a commercial operation, building on the findings of previous research. As Oliver Lodge is reported to have remarked, "We all knew about the egg; but Marconi showed us how to stand it on its end".

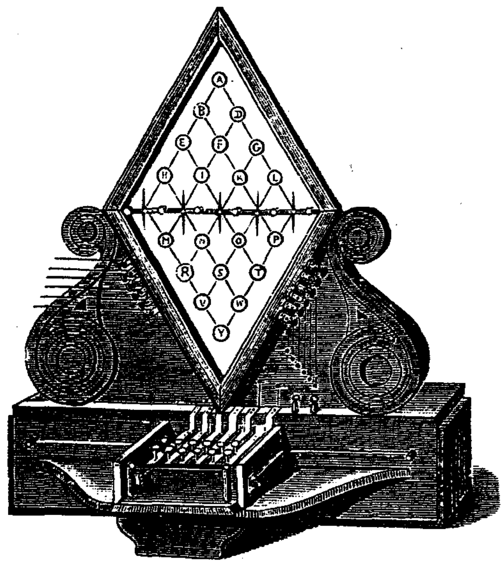


Fig.1: The first electric telegraph in commercial operation was the five needle Cooke and Wheatstone, of 1837. Any one letter of 20 could be selected by the deflection of two needles, controlled by the keys at the base of the instrument. Note the six line wires at the left of the face.

We know too that initially Tesla in America, and Popov in Russia were probably ahead of Marconi with their development work, but did not have the same business acumen or backing. Marconi had a head start by having the foresight to be born into an affluent family, with very influential connections in both Italy and Britain. In 19th-century society this provided invaluable advantages in achieving recognition.

Electronics engineering is sometimes thought of as having its birth in the wireless telegraph, but in reality its roots go back more than half a century previously to the invention of the electric telegraph — which by the middle of the 19th century was already well established world wide, with an advanced technology, and together with the railway had an enormous economic and social impact. In America especially, the study and collection of telegraph instruments is regarded as an important aspect of vintage electronics, all the more significant as the telegraph is now virtually extinct.

Although the value of Marconi's achievements should not be underestimated in any way, it is important to realise that he worked with an existing technology. In fact, his early equipment was essentially that of a basic electric telegraph, along with simple equipment to generate and respond to radio frequency radiations. His main object was to provide a wireless connection between conventional telegraph instruments. Had he first needed to have developed the telegraph instruments as well, his work would have been considerably more difficult.

Earlier origins

The origins of the electric telegraph go back a long way. In 1753, a correspondent in *The Scots Magazine* suggested electrifying wires to attract pieces of paper with letters or words printed on them or to ring bells. This was obviously not a practical system, but an indication of the early realisation that the ability of electricity to travel instantaneously through a long conductor could be used to convey intelligence.

In 1809 in Germany, Samuel Sommering demonstrated over a distance of 600 metres a telegraph which had an electrolyte filled glass vial for each letter of the alphabet. Bubbles of gas indicated the required letters. The system might have worked, but with a wire for each character, constructing connecting cables of any length would have provided a daunting obstacle. The signalling speed would also have been very slow.

Andre Ampere, whose name is immortalised in the unit of current, in

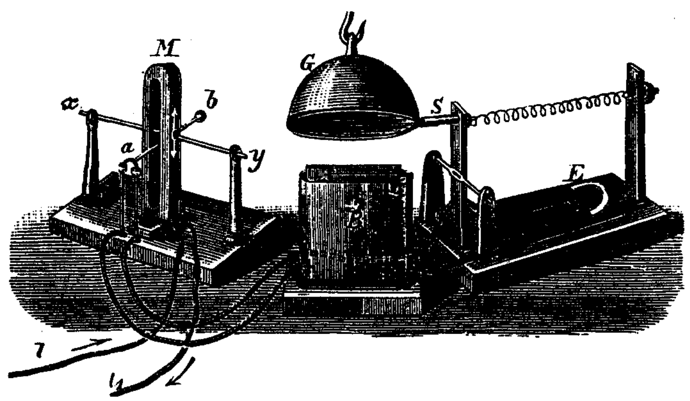


Fig.2: To obtain sufficient current to operate the needle telegraph alarm bell, Wheatstone invented the first relay. A galvanometer coil M surrounded a magnetised needle carrying a pair of contacts a. When the needle was deflected, the contacts touched the surface of some mercury in the two little cups, completing the circuit of the battery B and the electro magnet E. This activated the bell striker S.

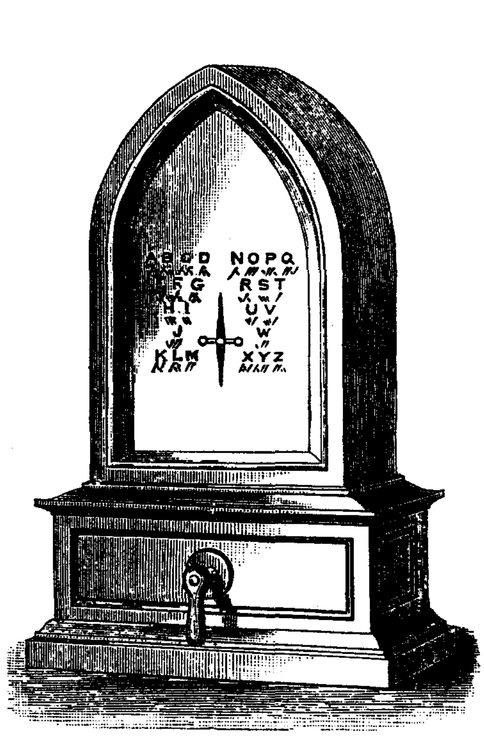


Fig.3: Cooke and Wheatstone's telegraph was ultimately simplified to a single needle, controlled by the handle in the base. It was often used with a form of the Morse code, with left deflections equalling dots and right deflections dashes.

1820 came up with a much more workable method by suggesting the use of galvanometers.

A galvanometer is essentially a compass needle deflected by currents flowing in a surrounding coil of wire, and is the ancestor of moving iron and moving coil meters. Ampere proposed using one instrument for each character, but again the logistics of constructing such a system ruled it out.

In one of those coincidences of the type that has happened several times in the history of electronics, in 1837 no fewer than three independent inventors announced workable systems. Carl Von Steinheil in Germany demonstrated a single galvanometer system which relied on a code using combinations of left and right deflections of the needle.

It is unclear as to what extent, if ever, that Steinheil's system was used, but he did make the invaluable discovery that the earth can be used as a conductor of virtually zero resistance. This useful property halved the amount of wire and battery power that would otherwise have been required for telegraph circuits.

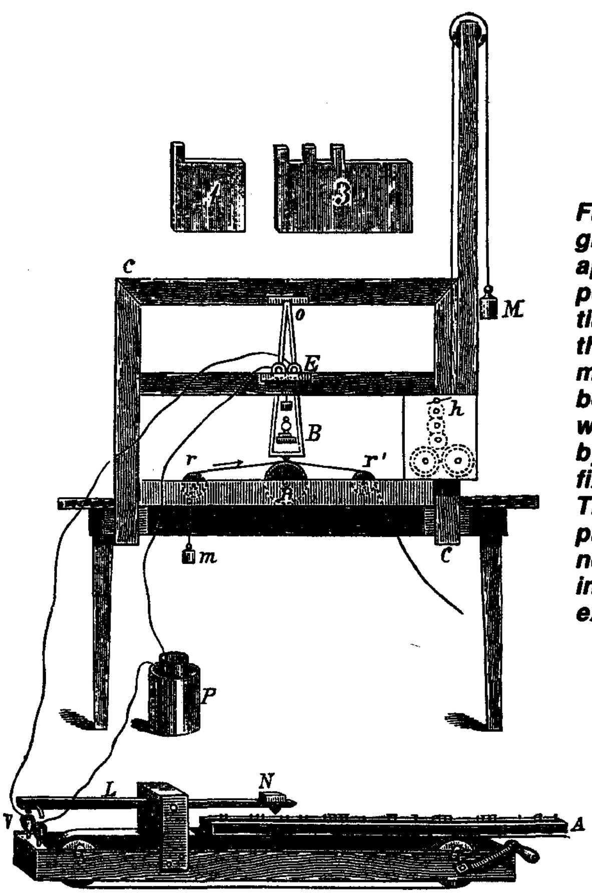


Fig.4:The first Morse telegraph. Although it bore no apparent resemblance, it possessed all the essentials of the practical system that remained in use for more than a century. At the bottom is the transmitter, in which level L was actuated by teeth on movable type fixed in the carrying strip A. There were nine different patterns, to provide the necessary number of teeth; in the drawing, 1 and 3 are examples.

In England Charles Wheatstone, (later knighted for his many engineering achievements) teamed up with William Cooke to construct the first successfully operational electric telegraph. Again, this was based on the galvanometer, and over the years it went through at least three developments. Wheatstone made several important contributions to the telegraph, and one of his greatest, the relay, came from his work with the needle telegraph. Another of major importance, the principle of which is still important today, was the introduction of the Christie Bridge, often called the Wheatstone Bridge.

Cooke and Wheatstone's first system of telegraphy used a row of four and then five needles. By deflecting two needles at a time, any one of 20 characters arranged in a diamond shaped grid could be selected. This system was installed over a distance of 2.5km between two London & Northwestern Railway stations and in 1840, the Great Western Railway installed a line 63km long. This

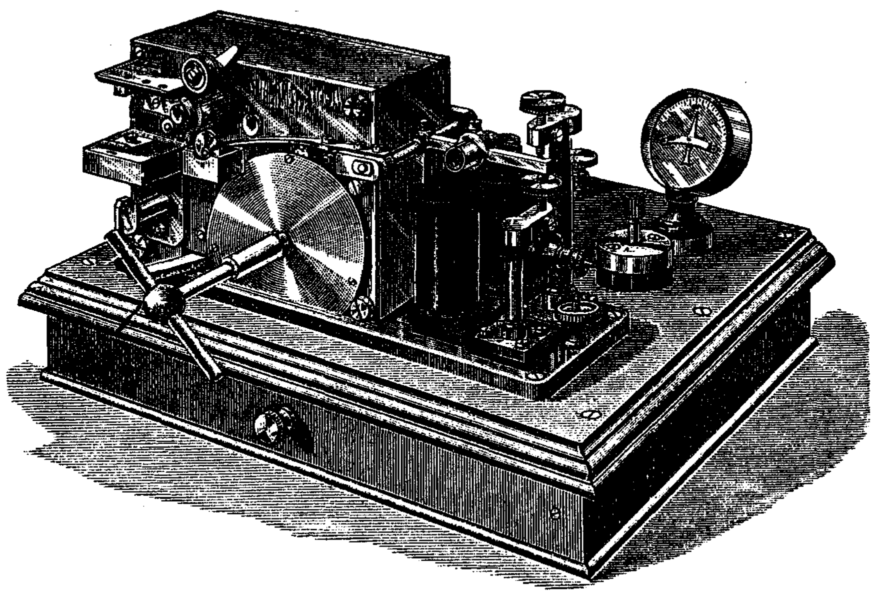
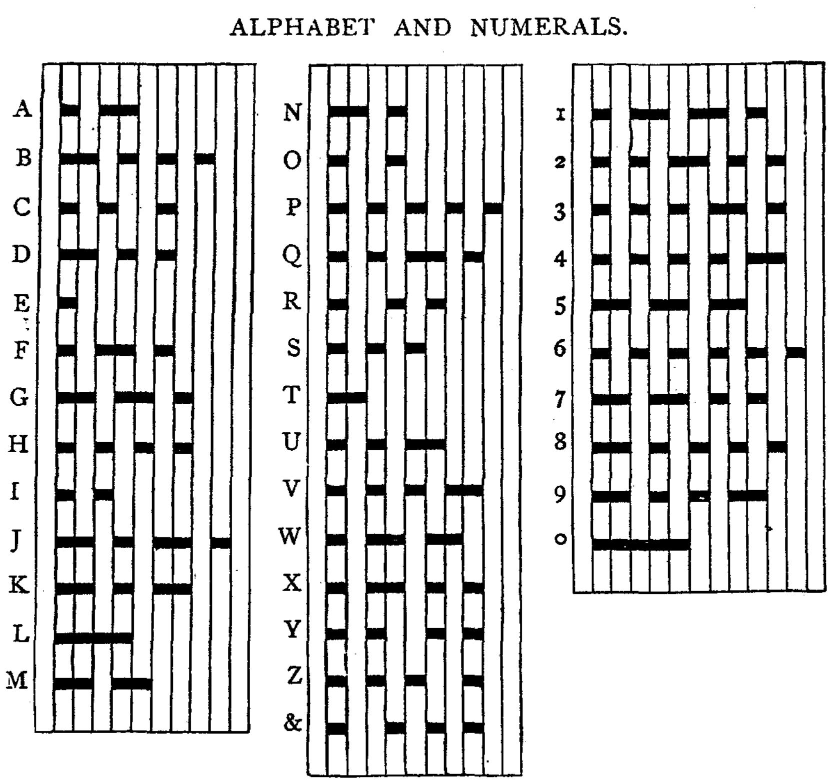


Fig.5: The Morse register, recorder or inker was developed directly by Alfred Vail, from Samuel Morse's picture frame receiver. Operators found that they could read the messages by listening to the sound of the armature hitting the limiting screws, and so the sounder was developed.



Vail's adaptation of the Morse code, which became known as Continental or American Morse. With two different lengths of dash and long spaces within some letters, it was a difficult code to master. American and Canadian landline operators refused to adopt the more familiar International Morse code, although it was used by their radio counterparts.

became quite a wonder, and the public was charged a shilling to watch it in operation.

This original Wheatstone and Cooke telegraph was successful, but it required five or six wires between stations, and needed two operators — one reading and the other writing down the messages. The restricted signalling speed also meant that it was soon superseded. Single-needle and double-needle adaptations were used quite extensively in England, and for communication between signal boxes, these instruments survived on some railway systems into the second half of this century.

Artist's obsession

The third system announced in 1837 was to revolutionise communications and dominate telegraphy well into the 20th century. This was of course the telegraph invented by portrait painter Samuel Morse, who although he knew little about electricity, was inspired to overcome enormous difficulties to do so. He received invaluable practical assistance from Alfred Vail, who has not always been given due credit, and the two eventually entered a partnership. Morse ran into problems in operating his receiver over long connecting wires, and enlisted the aid of Professor Henry, who explained the importance of sufficient ampere-turns on an electromagnet.

Previous systems had worked by some method of pointing to or indicating individual characters, but the genius of the Morse telegraph was that it used instead a binary code which could be used to represent an unlimited number of characters.

Initially, the Morse transmitter used nine different patterns of movable lead type, adapted from the printing industry. Instead of a typeface, each had a number of notches corresponding to the code pulses representing one of the numbers 0 to 9. For transmitting messages these 'types' were mounted on a bar, which was moved under a lever fitted with a set of contacts.

The prototype Morse receiver, which was built on a frame from a painter's canvas, consisted of an arm or pendulum actuated by an electromagnet. A pencil fastened to the end of the pendulum was in contact with a moving paper tape. Pulses from the transmitter caused lateral deflections of the pendulum, whose movements were registered on the tape as a serrated line from which the transmitted numbers could be read. These were then interpreted with the aid of a code book. For example, the sentence 'SUCCESSFUL ATTEMPTS WITH TELEGRAPH' was transmitted as 215, 36, 2 and 58.

Vail's Morse code

Alfred Vail now took over, and as a skilled and gifted technician, he refined the equipment to the stage where Congress could be persuaded to grant an appropriation for a line between Washington and Baltimore. The first message was sent on May 24, 1844 with the project hailed as a triumph.

For sending, Vail discarded the movable type and substituted the familiar manually operated key, while the ungainly receiver was transformed into the 'Register' which embossed or marked the paper tape by the vertical motion of a stylus or inked wheel. Of even greater significance was Vail's revision of the code, which now represented each character directly and did not need a code book.

There were seven elements in the new Morse code, with the basic unit of time the *dot*. The other elements were the short dash = two units; the long dash = four units; the space between elements of a letter = one unit; the letter space = two units; the word space = three units; and finally the sentence space was six units.

Readers familiar with the International Morse code will know that dashes are today three times the length of a dot, and may be puzzled by the reference to the long dash. The fact is that there were *two* Morse codes. Vail's original code, known generally as 'American Morse', was used exclusively on the extensive landline systems of the US and Canada. As can be seen from the table, it is more complex and demands greater skill than International Morse, and with some letters containing a double space, ambiguities were possible. For example, EE could be confused with O.

Within a few years, Morse himself campaigned for the adoption of a simpler code; but the operators refused to give up American Morse, which, according to some authorities, was faster than the International code. Eventually, the short dash was lengthened to three units, and, until teleprinters, computers and fax machines made the telegraph extinct, American Morse remained the standard code for North American landlines.

Elsewhere in the world, the International Morse code had become standard. This presented a problem as marine radio became established, requiring American radio operators, including amateurs, to use the International code. One outcome was that operators dealing with both line and radio telegraphy had to become 'bilingual'. It appears too that at one stage, the US Navy used yet another code.

Birth of the Sounder

The Morse register provided a permanent record on a paper tape, and for this reason was favoured by Marconi for his early equipment. But deciphering the marks on the paper was time consuming and operators soon learned to read the messages, as they were received, from the sound of the armature lever striking the limiting stops. A similar practice was developed by operators of the needle telegraphs, with the added advantage that a second person was not needed to transcribe the messages.

It was only a short step from this to the development of the most familiar of all telegraph instruments, the Morse sounder — but a fuller description of this will have to wait until next month. As well we will recount some of the story of Australia's own heroic enterprise, the Overland Telegraph, and look at some of the complex technology involved in Morse telegraphy.

As an example of this complexity, I will leave you with a question that could be a candidate for one of Peter Phillips' 'What?' puzzles: 100 years ago, how could four messages be sent simultaneously and independently over one wire, using DC technology only? Time sharing and diodes were not used. Look for the answer next month... ❖

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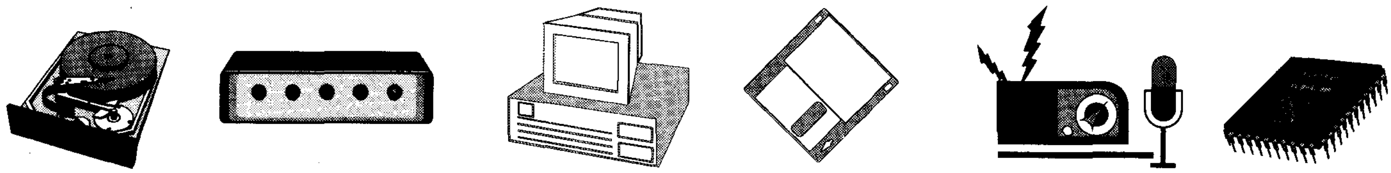

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Clearance Sale: PC-based Analog Interface unit kit. Parallel port powered. 8 bit ADC/DAC. C/Pascal/Basic drivers supplied. Complete kit now only $55. Short form kit, PCB & software only $25. Advanced R&D Solutions. 12 Copeland Road Lethbridge Park 2770. (02) 628 1223.

Eddystone 940 Communications Receiver: in very good working condition $250 ono (02) 331 3965.

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Satellite Dishes: International reception of Intelsat, Panamsat, Gorizont, Rimsat. Warehouse sale – 4.6m Dish & pole $1499, LNB $50, feed $75. All accessories available. Videosat, 2/28 Salibury Rd. Hornsby. (02) 482 3100 8.30-5.00 M-F.

WANTED

Any early valve hifi: Quad, Leak Garrard 301/401, SME, Ortofon, KT66, KT88, 300B or similar. Cash paid (074) 491 601.

Manual or circuit diagram: for Vinten base radio type BR20 (receiver/modulator section). Copy costs gladly paid. Call Brian, (03) 809 2079.

Experienced video-tv tech required: for the beautiful Atherton tablelands in North Qld. Above award for the right person, must have a sense of humour. Ph: Nick Chapman (070) 913 858 (W). (070) 965 546 (H).

Wanted: Circuit for Conway Masteranger model $639. (06) 299 3218.

50 and 25 years ago...

'Electronics Australia' is one of the longest running technical publications in the world. We started as 'Wireless Weekly' in August 1922 and became 'Radio and Hobbies in Australia' in April 1939. The title was changed to 'Radio, Television and Hobbies' in February 1955 and finally, to 'Electronics Australia' in April 1965. Below we feature some items from past issues.

January 1946

Television, sound on one channel: A radio development demonstrated at Cambridge seems likely to restore British television to the leadership it enjoyed until the war started, when the diversion of technicians to other work, enabled America to win ascendancy.

The Pye Radio Company has evolved a new system marking a major advance in transmission and reception. This makes possible the use of a single instead of a double transmitting unit as hitherto used, and similarly combines into one the vision and sound receivers.

Television pictures are broadcast in lines, picked up at the rate of 10,000 a second by a 'scanning point'.

At the end of each line there is a tiny pause before the 'scanning point' goes back to start a new line.

Pye technicians have discovered a means of broadcasting a sound 'snapshot' during that pause.

Guests who saw the system operating report that reproduction of both sound and vision is superior to the older system of dual transmission.

January 1971

Million volt electron microscope: The first commercial million volt electron microscope to be built in Europe is now installed at the UK Atomic Energy Authority at Harwell. It will be used in studies of neutron radiation damage in reactor materials and in their non-nuclear program.

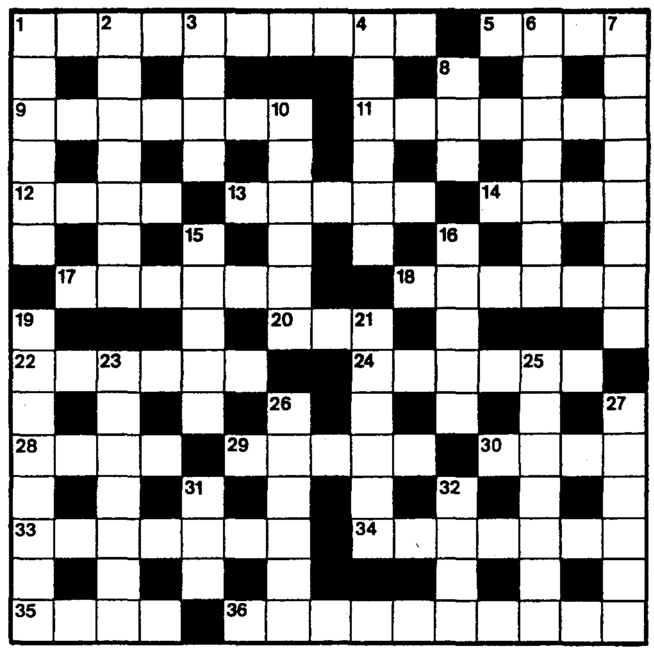
The high voltage makes it possible to obtain sharp images from thick specimens. This, combined with the large specimen space available, enables a wide variety of experiments such as heating and tensile testing to be performed within the microscope while the specimen is under observation.

High efficiency klystron: An electrostatic depressed collector developed by the General Electric Company in the USA has increased the efficiency of a high power broadcast klystron from 45% to 67% according to Dr Theodore G. Mihran, a physicist at the company's research and development centre.

Developed for space applications, the high efficiency klystron may help make possible communications satellites for direct and simultaneous nationwide television broadcasting, Dr Mihran said.

By virtue of its increased efficiency, the tube's heat rejection system and the satellite's solar cells can be reduced; the former by two to three times, and the latter by more than a third. The combination of increased efficiency and size reduction is expected to permit smaller communication satellites with less power needed for launching. ❖

EA CROSSWORD



ACROSS

1. Research facility. (10)
5. Collections of items for assembly. (4)
9. Flexible ring. (7)
11. Equipment carried on a mission. (7)
12. Items for bundling wires. (4)
13. Sound with vibrations. (5)
14. Laser guided weapon. (4)
17. Successful composer, ---- Lloyd Webber. (6)
18. Gradual introduction of a signal. (4-2)
20. Brand of mobile phone. (1,1,1)
22. Electronic system replacing cash. (6)
24. Manufacturer of CB radios. (6)
28. Section of a communication network. (4)
29. Gauge, in mm, of small videotape. (5)
30. Rock group with current choice? (1,1,1,1)
33. Purpose of most video games. (7)
34. Section of mains wiring. (7)
35. Telephone tone. (4)
36. Wave frequency generator. (10)

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1. Items activated in security systems. (6)
2. Type of logical system. (7)
3. Memories. (4)
4. Residual wave. (6)
6. Mineral located with magnetometer. (4,3)
7. Part of SSB transmission. (4,4)
8. Light-sensitive organ. (3)
10. Said of operated power switch. (6)
15. Inert gas. (5)
16. Australian Antarctic research station. (5)
19. Said of mobile phone network. (8)
21. EA's shortwave columnist, Arthur ----. (6)
23. Voltage. (7)
25. Passage taken from composition. (7)
26. Audible alarms. (6)
27. Directionless physical quantity. (6)
31. Unit of illumination. (3)
32. Type of scale used in balancing conditions. (4)

SOLUTION TO DECEMBER 1995

G	E	N	E	R	A	T	E		O	P	A	M	P	S
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PRODUCT REVIEWS:
HAMEG'S MODULAR SYSTEM 8000 TEST INSTRUMENTS, IMPROVED ACTIVE SPEAKERS FOR MULTIMEDIA PC'S, BASSBOX 5.1 CAD SOFTWARE

NEWS HIGHLIGHTS

CYBEC WINS VIC PREMIER'S AWARD

Melbourne based Cybec, which produces the highly regarded computer virus protection program VET, has been awarded the Victorian Premier's Award for outstanding technological development. The Award was presented by Premier Jeff Kennett to Cybec founder Roger Riordan, at the recent Telstra and Victorian Government Small Business Awards evening.

Founded six years ago, Cybec has also received independent acclaim for VET by the highly regarded virus publication *Virus Bulletin*, which gave it a 98% rating — ahead of McAfee's Viruscan, Virus Buster, Central Point Anti-Virus, F-Prot, IMB Anti-Virus, Microsoft Anti-Virus and Norton's Anti-Virus.

Major Australian users of VET include the Commonwealth Bank of Australia, Westpac Banking Corp, NSW and Victorian TAFEs, and BHP. (Smaller users include *Electronics Australia*!)

IREE LINKUP TO HONOUR MARCONI

On December 12, 1901, on Signal Hill in St John's Newfoundland, Guglielmo Marconi received a signal (the Morse letter 'S') transmitted from Poldhu in Cornwall (UK) — the first demonstration of long distance radio communications. To commemorate the centenary of his first transmission in December 1895, the IREE Society Hobart Local Area Committee has planned a 'multimedia' linkup between Hobart and St John's during its annual Radio Foundation Day Dinner, on December 12, 1995.

The main planned linkup is via HF radio, where Richard Rogers VK7RO will have attempted to make a Morse contact on 7018kHz with radio station VO1AA operated by the Society of Newfoundland Radio Amateurs, in Cabot Tower on Signal Hill — close to the longest possible transmission path on Earth. In addition it was planned to be on contact with St John's via the Internet, by email and also using the real time, interactive 'talk' Unix program. Links via normal and cellular phones were also planned.

Intel's new Pentium Pro processor chip itself measures around 13mm sq., but is packaged together with a 256K or 512K Level 2 cache memory chip measuring almost as much. Both are made using 0.6 micron technology, and operate from three volts. The power dissipation is around 30 watts!

Organiser of the event was IREE Vice President and Councillor David Edwards, a former *EA* staff member now working for the CSIRO Division of Oceanography. As this issue went to press before the event, we are unable to report on its success. However we'll try to give details next month.

JENSEN BOOK WINS AWARD

Australian author Peter Rolf Jensen's book *In Marconi's Footsteps: Early Radio*, published by Kangaroo Press, has won one of the 1995 Scientific American Young Readers Book Awards. The awards are newly established by the highly regarded US journal *Scientific American*, and are designed to recognise outstanding achievements in communicating scientific or technical topics to a youthful audience.

Peter Jensen VK2AQJ, who has contributed to *EA*, is an architect, town planner and long-time radio amateur with a deep interest in radio history. In his book he describes both the work carried out by Marconi and the more important places in which it was carried out, linking the narrative together with his own experiences in visiting them. A section at the rear explains how he made replicas of some of the more important early radio equipment, and gives sufficient information to allow the reader to make their own.

All books which received the Book Awards are apparently reviewed in the December 1995 issue of *Scientific American*.

COMPUTER SHOW SUB WINNER

Winner of the 12-month free subscription to *Electronics Australia* at the recent Brisbane Computer Show was Mr Phillip Kay, of Abstract Lighting in Deception Bay, Queensland. Our congratulations to Mr Kay, and we hope he finds the issues of interest and value.

CD-I PLAYBACK BOARD FOR PC'S

Philips is shortly planning to introduce a plug-in board for IBM-compatible PCs, which allows the playback of all CD-i, Video CD, CD Audio, Photo CD and Digital Video titles. The board effectively converts the PC into a fully functional and user friendly CD-i/Video CD player.

Since the board performs all of the necessary multimedia functions independently of the CPU, it can be used in machines with CPUs between a 386SX/16MHz and a Pentium with the same image quality and speed. All CD-i titles run directly from the CD and do not use hard disk space or system memory. MPEG quality Digital Video, Video CD and CD-i Digital Video titles are provided in theatre-quality images.

The CD-i/PC board also comes with an IDE CD-ROM drive interface.

Philips has also developed a CD-i based Internet access package, which allows users with a CD-i player and colour TV receiver to gain convenient access to the Internet and World Wide Web. The CD-Online package contains an CD-i disc and a 14.4kb/s modem, and the disc software allows automated login to the nearest Internet access provider. CD-Online also maintains a set of WWW home pages, offering user support information and hypertext links to other net sites.

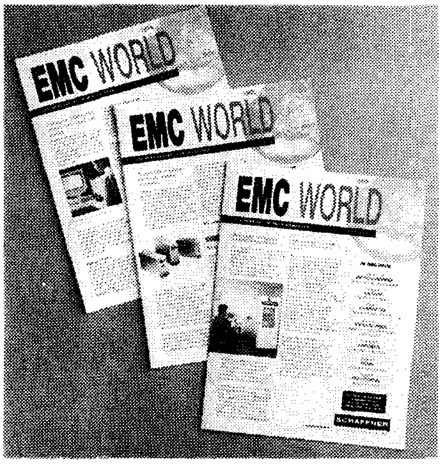
FREE EMC NEWSLETTER

Schaffner's free EMC world 12-page newsletter is distributed every three months and covers many important EMC issues that are relevant to the new mandatory standards being introduced by many countries around the globe.

A valuable feature is the centre lift out guide to Electromagnetic Immunity Standards — 'Standards UPDATE' which lists the types of EMC test, the relevant IEC test number and a brief description of the test parameters.

Other issues commonly covered are EMC instrument calibration/certification, new products, testing short cuts, world EMC news events and seminars, and application notes.

For further information circle 230 on the reader service coupon or contact



Westinghouse Industrial Products, Locked Bag 6, South Melbourne 3205; phone (03) 9676 8888.

CHURCHILL TRUST INVITES APPLICATIONS

Each year the Winston Churchill Memorial Trust awards a number of individual Australians with Churchill Fellowships, which fund approximately three months of overseas travel for study purposes. In 1996 the Trust will be financing the study trips of some 86 Australians in this way.

Applications are now invited for the 1997 Churchill Fellowships, which are open to all Australian residents. Most require no academic or other formal qualifications, as merit is the primary test.

For further information and applications forms, send a stamped and self-addressed 24 x 12cm envelope to:
Application Forms,
The Winston Churchill Memorial Trust,
218 Northbourne Avenue,
Braddon, ACT 2612.

Applications and references close on February 29, 1996.

US STUDY LINKS LF FIELDS & CANCER

A report prepared for the US National Council on Radiation Protection by a committee of leading experts in electromagnetic fields has recommended that safety limits for exposure to low frequency fields should be lowered to a level 5000 times smaller than the currently accepted international limits. The report was funded by the US Environmental Protection Agency.

Chairman of the committee was Professor Ross Adey, an Australian neurologist at the Veterans Affairs Medical Center in Loma Linda, California. Professor Adey is reported in *New Scientist* as saying that there is now "a powerful body of impressive evidence" to show that very low exposure to EMF's has subtle, long term effects on human health. "The sensitivity of the brain and its mechanisms to these fields is the key to understanding this issue", he added.

The safety limit recommended in the

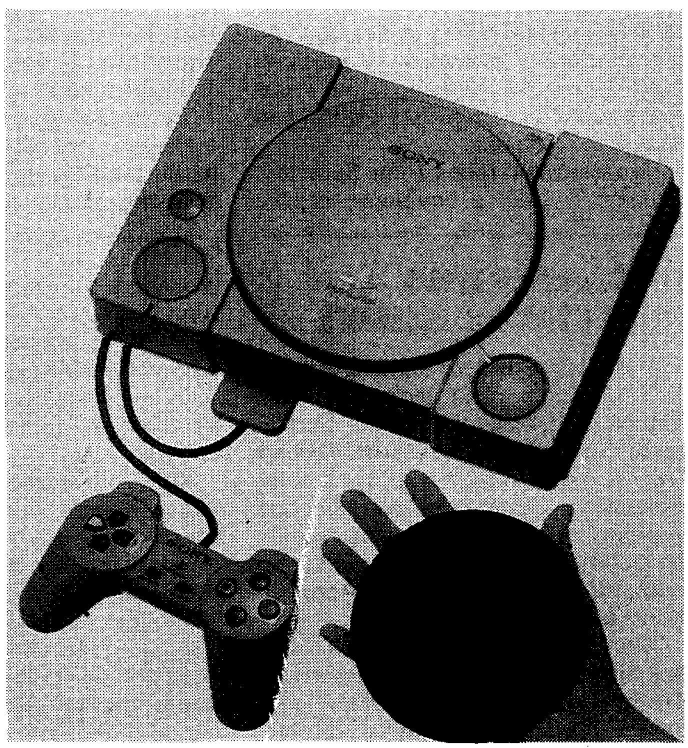
SONY RELEASES INTERACTIVE 'PLAYSTATION'

Sony Computer Entertainment has launched in Australia its long awaited 32-bit, CD based video games/entertainment system, the PlayStation. The company says PlayStation has the power to provide realtime action, 3D graphics and CD quality stereo sound, and is expected to emulate the huge success of Sony Walkman 24 years ago.

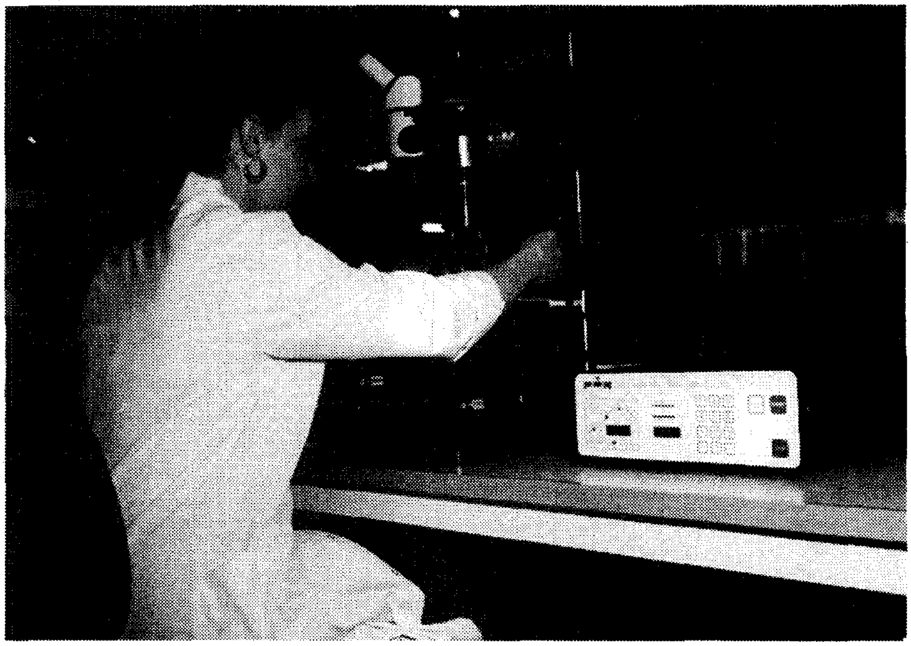
"Sony is widely recognised as a leader in entertainment technology, having invented CD-ROM, co-invented the audio CD and was the first with innovative products like the Walkman, Trinitron television, Camcorder and Discman. This trail of innovation now leads directly to PlayStation, which aims to shape the future of interactive home entertainment," said Michael Ephraim, General Manager of Sony Computer Entertainment in Australia.

"Hundreds of millions of dollars have been injected into the six year development of PlayStation, which makes it as important as the launch of the Sony Walkman in 1972. The investment in PlayStation demonstrates how serious Sony is to grow, and establish global leadership of the interactive home entertainment market."

Retailing for $695, the PlayStation is packaged with a sample disc of new game clips and playable demos. It employs a 32-bit RISC processor (the first time a RISC chip has been used in a games machine), runs at 500MIPS (millions of instructions per second), juggles 1.5 million polygons per second and is JPEG compatible for full motion video sequences.



report is 0.2 microteslas, whereas that currently recommended by the World Health Organisation is 1000uT. The field around many current domestic appliances exceeds 0.2uT at distances of less than 300mm, while the field beneath many high voltage transmission lines is typically between 8 and 40uT depending upon the voltage level.



UK company PDR Microelectronics has announced the sale of its one thousandth focused infra-red (FIR) SMT repair system, since it introduced this technology in 1986. The machine was purchased by Fujitsu Telecommunications Europe Ltd.

VIRTUAL ELECTRON MICROSCOPE LAB

For more than a decade, scientists have travelled to Berkeley in California to use the unique high voltage electron microscope at Ernest Orlando Lawrence Berkeley National Laboratory. Now the Berkeley Lab is taking the facility to the user.

No, the three-story-tall microscope (the most powerful in the USA) has not been put on wheels. Rather, the Laboratory has created a set of interactive, online computing tools that will allow scientists to manipulate the instrument, conduct experiments, and view images from their own offices, via the Internet.

In-situ electron microscopy — inducing and observing changes to a sample in the microscope — had never been done remotely until a demonstration by Berkeley Lab scientists last August.

The presentation, during the Microscopy Society of America's annual international meeting in Kansas City, caused a minor sensation, so much so that a repeat demonstration was demanded by scientists who had missed the first one.

Two thousand miles from Berkeley, researchers used a computer to take control of the microscope, heat an advanced alloy specimen, and observe the ensuing progression of structural changes on the computer monitor.

The team bringing the electron microscope online is led by computer scientist Bahram Parvin and Michael O'Keefe, the deputy head of the lab's National Center for Electron Microscopy. Other team members include John Taylor, Brian Crowley, Doug Owen, Ken Westmacott, Bill Johnston, and Uli Dahmen.

To make remote control of the microscope possible, Parvin's team is automating onsite the positioning and focusing of the microscope. This is being made possible through the development of advanced computer vision algorithms.

Experimenters at remote locations will be able to 'drive' the microscope. They will be able to change magnification, scan the sample, alter its orientation, and trigger a range of experimental conditions. Collaborators will do this through a computing environment that includes the necessary video-conferencing tools.

A short movie demonstrating computer vision tracking of DNA can be seen on the World Wide Web at the address of **http://www-itg.lbl.gov/ITG.hm. pg. docs/VISION/DNA_track.mpg**.

COCHLEAR-SIEMENS FORM HEARING ALLIANCE

Australia's Cochlear Limited, a leader in Cochlear implant technology, has formed a collaboration with German based Siemens Audiologische Technik GmbH, the world's leading hearing instruments company. Under the new agreement the companies will evaluate possibilities to cooperate in marketing, sales, distribution and R&D projects which have mutual benefit.

"Our global agreement demonstrates that Siemens is expanding its horizon, to better service hearing impaired customers", according to Brad Carlisle, Managing Director of Brisbane based Rexton, the Australian hearing technology arm of Siemens. "For example, Siemens has formed over 20 joint ventures in China alone, so we can help Cochlear into the world's biggest potential market."

"The collaboration with Siemens will help Cochlear re-enforce our preeminence in cochlear implant technology", says Albert Sorrell, general manager, Asia Pacific region, Cochlear Limited. "With the recent approval of cochlear implants for the severely hearing impaired, this collaboration can help us reach, and grow, this newest segment of our business".

Among specific areas in which Cochlear and Siemens will collaborate are the development and communication of a joint marketing positioning strategy and joint participation in congresses, workshops and presentations. In the R&D area, the companies plan to work on joint research projects leading to the development of new and improved products and technologies.

Cochlear Limited has offices located throughout the world which provide comprehensive service and support. It is the world leader in multi-channel cochlear implant technology and manufactures the Nucleus 22 Channel Cochlear Implant System.

FLUKE METER SAFETY RECALL

Philips Scientific & Industrial is advising owners of certain models of Fluke digital multimeters to return the meters for a safety modification. The Fluke meters concerned were manufactured after July 1994 and can be identified with the model numbers 70, 73, 75, 77, 21 and 23, with serial numbers in the range from 60990000 to 6375200.

A malfunction may arise in the affected units when used to measure 400V DC or greater. The meter may go into a lock-up state and indicate a reading of (or near) zero.

The safety modification involves the installation of a special capacitor, and Philips Scientific & Industrail is offering a free calibration for those affected meters which are returned for the modification. Multimeters that have the modification made will be marked with the letter 'R' near the serial number.

Telephone enquiries on this modification are being handled by Paul Tamone at Philips Scientific & Industrial on (02) 888 0491.

PHILIPS RELEASES CD-ERASABLE SPECS

Philips Electronics has distributed the proposed specifications for an erasable Compact Disc format, indicating significant progress in enabling companies to bring CD-Erasable products to market in 1996.

The release of the specifications came just five months after 10 major manufacturers — IBM, Ricoh, Hewlett-Packard, Mitsubishi Chemical Company (MCC), Mitsumi Electric Co., Matsushita Kotobuki Industries (MKE), Sony, 3M, Olympus and Philips announced their support for the development of an erasable CD format for data applications.

With a data capacity of up to 680MB per disc, CD-Erasable provides additional benefits to application environments currently served by CD-Recordable products.

CD-Recordable discs provide more permanent data storage, while CD-Erasable allows data to be updated and disc space to be reused. CD-E drives will be capable of reading all existing CD formats. They can also write and read CD-Recordable media and, of course, these products will be able to read, write and overwrite CD-Erasable discs.

FIRST COMMERCIAL SCALE POWER PLANT

What is claimed to be the first commercial scale solar power station in New South Wales has begun operation in Nimbin. Called the Sunpower Project, the 10 kilowatt facility is said to represent a significant milestone in the development of a new Australian industry which will allow customers to chose environmentally sensitive electricity for their power requirements.

Solar generated electricity from the Sunpower Project will be available for sale to North Coast residents from early in 1996. Mr Greg Don, the Retail Sales Manager with NorthPower said that as demand for solar generated electricity grew, the Sunpower Project would be expanded and other projects initiated. NorthPower distributes electricity from mid north coast and far north coast of New South Wales to the Queensland border and west to Bourke.

Opened by Mr Harry Woods, MP on behalf of Federal Industry Science and Technology Minister Senator Peter Cook, the Sunpower Project is the result of a two year research and development project undertaken by a consortium which includes Essex Electrical Pty Ltd, Hundell Corporation, NorthPower, the Department of Primary Industry and Energy and the Electricity Association of NSW.

TECH-RENTALS NOW ISO 9002 CERTIFIED

Tech-Rentals has implemented a quality management system certified by Lloyd's Register Quality Assurance (LRQA), meeting the ISO 9002:1994 standard.

The standard assures customers of an efficient and reliable management system, designed to ensure consistent levels of customer service.

A major goal of the company is to maintain a high level of flexibility and service in meeting customer needs, which in the rental market are often urgent.

At the same time the planning of the quality system has involved a complete review of Tech-Rentals' calibration procedures and facilities. This has been a major task given the rental inventory size of 900 different instrument models and over 7000 assets.

Managing Director Paul Jindra stated "Tech-Rentals had its foundations 20 years ago as a third party service company. The adoption of the ISO 9002 for our quality system is a logical step in continuing to meet our customers' needs for quality products both in the instrumentation and computer fields."

AUST. FIRE ALERT SYSTEM FOR TELSTRA

Telstra has installed a world recognised, Australian designed fire alert system to ensure the security of its telecommunications network.

"We need the earliest indication of a possible fire, particularly as new technology such as fibre optics and electronic switches have enabled us to concentrate more and more telephone traffic into a single cable and switching area", Telstra's National Fire Co-ordinator, Mr Rod Sinclair. "If a fire was to occur now, it would affect many more people and businesses than it would have just 10 years ago," he added.

Telstra has selected an Australian designed early system called VESDA. "By using VESDA technology we can detect a potential fire during the pre-combustion period and act on the threat before it progresses further," Mr Sinclair said.

With the telecommunications cable tunnels, some of which are located 30m beneath the roadway, the VESDA. "By using VESDA technology we can detect a potential fire during the pre-combustion period and act on the threat before it progresses further." Mr Sinclair added. ❖

NEWS BRIEFS

- ***TGE*** has been appointed as the Australian distributor for the Data Guard Electronics range of uninterruptable power supplies.
- Glenn Ward has been appointed product marketing manager of electronic test and measurement instruments for ***Nilsen Technologies***.
- The 12th international computer expo ***Computer '96*** will be held at the Hong Kong Convention and Exhibition Centre, May 15-18 1996. For details phone (852) 2865 2633.
- Kenwood Electronics has appointed ***Nilsen Technologies*** as the exclusive distributor for Kenwood test and measurement instruments in Australia.
- Mr Ron Spithill, managing director of ***Alcatel Australia,*** has been appointed to the Board of the worldwide Alcatel group's telecommunications operations. This is the first time an Australian has held such a position.
- ***Amber Broadcast*** has been appointed as the exclusive distributor for Pro-Bel signal switcher, routing and signal management products.

Product Review:

HAMEG'S MODULAR INSTRUMENT SYSTEM

Almost 10 years ago, European test instrument maker Hameg introduced its innovative and cost effective Modular System 8000, which has been very popular. Here we take a 'hands on' look at the system, which Hameg has steadily expanded...

by JIM ROWE

With its headquarters in Frankfurt, Germany, Hameg has been designing and manufacturing high quality, but 'down to earth' and competitively priced test equipment for over 30 years. Nowadays it has R&D and manufacturing facilities not only in Germany, but in France and the USA as well, and also sales offices in Spain, the UK and Hong Kong — together with distributors in other countries (like Kenelec in Australia), this has allowed the company to build up a substantial international business and reputation — albeit in a fairly low key fashion.

Currently its main range of instruments includes both analog and digital scopes, spectrum analysers, system multimeters and counters, function and RF generators, and a GPS-based time and frequency standard. There's also the Modular System 8000, an innovative range of relatively low cost instruments based on a compact two-slot 'mainframe' and a range of plug-in functional modules.

Since its introduction by Hameg about eight years ago, the Modular System 8000 has apparently been very well received — with over 100,000 units sold worldwide to date. And the range of modules has steadily expanded, to the point where there are now some 12 plug-in modules ranging from a 4.5-digit DMM to a semiconductor device curve tracer.

There's also a 'blank' module, for users who want to build their own custom module for use in the system.

The foundation of the system is the HM8001-2 mainframe unit, which is a sturdy case assembly measuring 285 x 365 x 75mm (W x D x H) — virtually the same external dimensions as Hameg's HM8100 series of system-level instruments. In contrast with the latter instruments, though, the front section of the HM8001-2 case is largely empty, with two 'full height/half width' cavities to accept a pair of the instrument modules.

At the rear of the case is a built-in dual power supply, with 22-way edge connectors in the rear wall of each cavity to supply power to the modules. Although the two power supplies share a common power transformer they are otherwise quite independent, delivering electrically isolated power for each of the two module 'slots'. Each supply provides 8V AC at up to 0.5A, regulated 5V DC at up to 1A, and two separate regulated DC sources capable of delivering up to 20V at 0.5A.

An ingenious linking system allows each 22-way connector to be set up for 'programming' that slot's two adjustable DC regulators for any of six supply voltages, from 5.2V to 20V — or even disabled, so that the basic AC voltage from that transformer winding is fed directly to the module. This means that any module can configure the power supply system to suit its particular needs.

The power supply is rated for a total loading of 36W, and since most of the plug-in modules draw no more than 11W, the supply has more than enough capacity. The only exception is the HM8040-2 Triple Power Supply module, which can draw up to 25W when fully loaded. Because of this, Hameg specifies that only one HM8040-2 module can be plugged into any particular mainframe module at a time, to prevent overloading. However a power supply module can be combined with any other module in the same mainframe, as the total loading will be no more than the rated 36W.

Another innovative aspect of the HM8001-2 mainframe is its power switch, which is located inside the rear power supply to avoid running mains wiring alongside the module slots. However to provide convenient front-panel control, the switch actuator is 'extended' forward via a 2mm rod inside the mainframe's centre partition, and provided with a narrow but easy to operate red 'pushbutton' — just visible in the photo, in the centre of the front-panel divider. An elegant solution!

The regulator chips for the mainframe power supplies are provided with husky finned heatsinks, mounted on the rear of the case along with the fused IEC mains plug and 230V/115V mains voltage selector. The case itself is provided with mounting feet, with the two front feet also fitted with tilting extensions for benchtop use.

The modules

As mentioned earlier, there are currently 12 different plug-in modules in the Modular System 8000 range. Here are brief details of each:

HM8011-3 Digital Multimeter: This is a 4.5-digit manual ranging instrument (maximum indication 19999), with a basic DC accuracy of 0.05%. It provides a total of 28 ranges, with a maximum resolution of 10uV, 10nA and 10mW. Other features include true RMS AC measurements (up to a crest factor of seven), and current measurements up to 20A DC or AC, short term (10A continuous). Indication is via LED readouts.

HM8014 Milliohm Meter: This is designed to measure low resistances accurately, from 0.1mW to 20kW. Four-wire measurements are possible using an plug-in Kelvin probe set (included). It has a 3.5-digit LED readout, five manual ranges, a diode test function and an audible continuity indicator.

HM8018 L-C Meter: This provides for accurate digital measurement of inductance and capacitance, via a 3.5-digit LED readout. There are 24 manually selected ranges, measuring inductance from 200uH to 200H, equivalent series resistance (inductors) from 20Ω to 200kΩ, capacitance from 200pF to 200uF and equivalent shunt conductance (capacitors) from 20uS to 200mS. Three test frequencies are used for the various measurement ranges (160Hz, 1.6kHz and 16kHz), and the maximum readout resolution is 0.1pF, 0.1uH, 10mW and 0.01uS. The basic rated accuracy is 0.5%.

HM8021-3 Universal Counter: This module provides a complete multi-mode counter with a frequency range from DC to 1.6GHz. Input channel A covers from DC to 150MHz with 1M/40pF input impedance, while channel C covers from 100MHz to 1.6GHz with nominal 50Ω input impedance. Input sensitivity is 20mV, and the LED readout provides eight digits plus exponent. The TXCO timebase has a rated stability of 5×10^7.

HM8026 Wow & Flutter Meter: This module was developed for the measurement of speed drift, wow and flutter in analog magnetic recorders and record turntables. It can use crystal-controlled test signals of either 3000Hz or 3150Hz, and provides a three-digit LED readout with a of 0.001% for wow and flutter, or 0.01% for speed drift. Results are calculated using the two-sigma technique.

HM8027 Distortion Meter: Measures total harmonic distortion in the audio range, between 20Hz and 20kHz in three bands. A three-digit LED readout provides a maximum resolution of 0.01%. The 'fine tuning' for fundamental nulling is automatic, and there is an output for monitoring the residual components on a scope.

HM8030-5 Function Generator: A versatile signal source for testing and experimentation, capable of generating sine, square or triangular waveforms over the frequency range 0.05Hz - 5MHz in eight decade ranges. Output frequency is displayed on a four-digit LED readout, and output voltage (maximum 10V into 50Ω) is adjustable over a 60dB range via switched and variable output attenuators. The module can also perform frequency sweeping over a 100:1 range.

HM8032 Sinewave Generator: Based on a Wein bridge RC oscillator, this module covers from 20Hz to 20MHz with a distortion of less than 0.2% below 500kHz and an output flatness of less than 0.2dB. Output frequency is displayed on a four-digit LED readout. Both 600Ω and 50Ω outputs, with a maximum output voltage of 1.5V RMS into 50Ω; output level is adjustable over a 60dB range via switched and variable output attenuators.

HM8035 Pulse Generator: This module produces pulses with less than 3ns rise/fall time, over a frequency range from 2Hz to 20MHz plus manual one-shot mode. Pulse width is continuously adjustable from 20ns to 200ms, with a LED indicator to warn when width exceeds repetition period. Two separate main outputs have independently adjustable polarity and amplitude (0.8 - 5Vp-p) into 50Ω, with a trigger output also provided (leading by 10ns).

HM8037 Low Distortion Generator: A high quality audio sinewave generator providing highly stable signals adjustable in frequency between 5Hz and 50kHz, with THD less than 0.01%. Output frequency is displayed on a three-digit LED readout, while output level (maximum over 1.5V RMS into 600Ω) is adjustable over a 60dB range via switched and variable attenuators.

HM8040-2 Triple Power Supply: A compact variable supply with digital metering, for laboratory testing and educational work. Three independent, fully floating DC supplies: one nominally fixed at 5V/1A (actually adjustable +/- 0.5V), while the other two are separately adjustable 0 - 20V at 0.5A, with adjustable current limiting. Each of the two variable supplies has a three-digit LED readout, switchable between output voltage and current. All outputs can be connected in series if required.

HM8042 Curve Tracer: This microprocessor-based module converts any oscilloscope with X-Y display capability into a system capable of displaying the characteristic curves of semiconductor devices such as diodes, transistors, FETs and thyristors. Provides on-screen display of up to five curves, with cursors for parameter value readout and auto calculation of dynamic parameters. Offers three collector/drain voltage ranges (2V, 10V and 40V); three collector/drain current ranges (2mA, 20mA and 200mA); and three power ranges (40mW, 400mW and 4W).

What we found

Thanks to Hameg's Australian distributor Kenelec, we were able to examine and try out an HM8001-2 mainframe unit with a total of four sample modules: an HM8018 L-C Meter, an HM8027 Distortion Meter, an HM8032 Sinewave Generator and an HM8035 Pulse Generator.

We were very impressed with the overall 'build quality' of both the mainframe unit and the modules. They were nicely made, and also revealed that a good deal of thought and planning had gone into both the electrical and mechanical aspects of their design. For example while both mainframe and

Continued on page 137

Construction Project:

A POST test card for IBM PCs

When you're trying to track down strange faults in a PC, you can save a lot of time and trouble by using a 'POST Card' to display the codes generated by the PC's own inbuilt Power-On Self Test routine. This article describes how to build your own low cost POST card using an Altera EPM7032 EPLD device.

by DAVID N. WARREN-SMITH, CPENG

Some readers of my article on the Altera system, published in the December 1994 issue of *Electronics Australia* may have acquired a free copy of Altera's First Step evaluation software. A neat project that is within the capabilities of this software is a POST test card for IBM compatible PCs, as presented here.

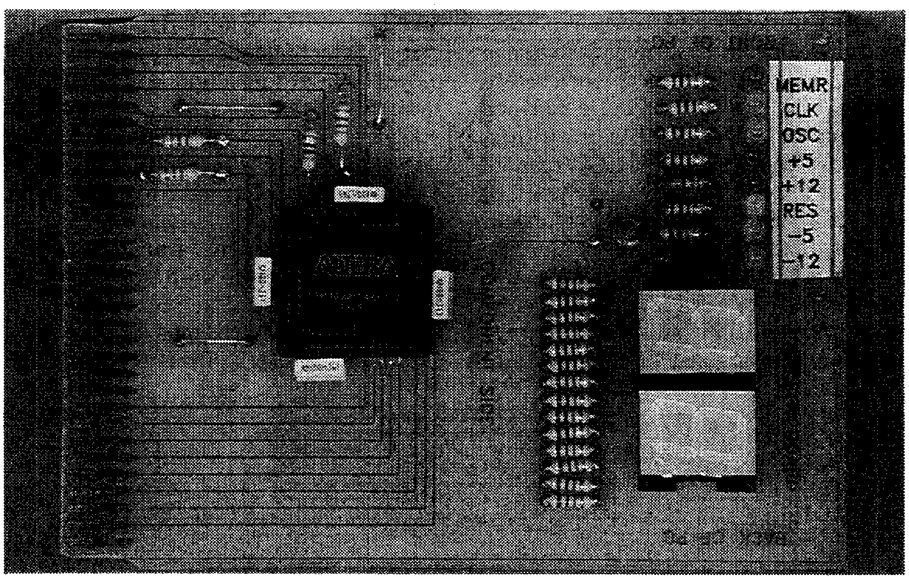
Similar cards have been described in overseas electronics magazines, as listed in the references at the end of this article. In this article I will give enough detail, including the complete source code, for the electronics enthusiast to construct their own POST test card, using Altera's low cost EPM7032 device.

This device can be compiled with Altera's First Step software and consequently any one with a copy of this software and a compatible programmer can start experimenting with this device.

The First Step software runs in MS Windows and provides an integrated environment consisting of a text editor, a compiler and a hierarchy manager.

To use the software you first enter the source code with First Step's text editor, then you set the project name to the name of the source code file, which generates a .ini file, and then you call up the compiler which generates a report file (.rpt) and a programmer (.pof) file amongst others. The .pof and .ini files are required by the programmer hardware to program the device.

If you don't have a copy of First Step you can get your own copy from the Bulletin Board Service operated by Veltek Australia, Altera's Australian distributor.



The numbers for Veltek's BBS are (03) 888 7776 in Melbourne and (02) 713 7278 in Sydney. Be prepared to download a fairly large file.

If you would like to construct the project but do not have access to a programmer, I am prepared to supply a programmed 7032 device at a nominal charge for the service. My phone number and address are given in the source code listing later in the article.

A computer club friend of mine, Eric Patching, and myself have built ourselves these test cards. Eric came across an article in one of the UK electronics magazines (see references) for a PC POST (Power On Self Test) test card.

The idea of the test card is that if you have an old AT type PC motherboard which may have stopped working, you plug the POST test card into the motherboard and power up. The test card has a two digit seven-segment LED display which displays a two digit hexadecimal number. As the PC goes through its POST testing routine it writes a number at a specified I/O address prior to each test — which is read, stored and displayed by the test card. The PC halts if a test fails.

If the POST test does not run through fully, the last number showing represents the last test run and hence the fault. You look up the number in a chart to find out the cause of the fault. The test card does not require a video or other card in the PC.

The test card in the original magazine article[1] required three PAL chips and Eric asked me where he could get them. I pointed out that I could program the whole requirement into a single EPM7032 device. Eric made up the printed circuit cards for us

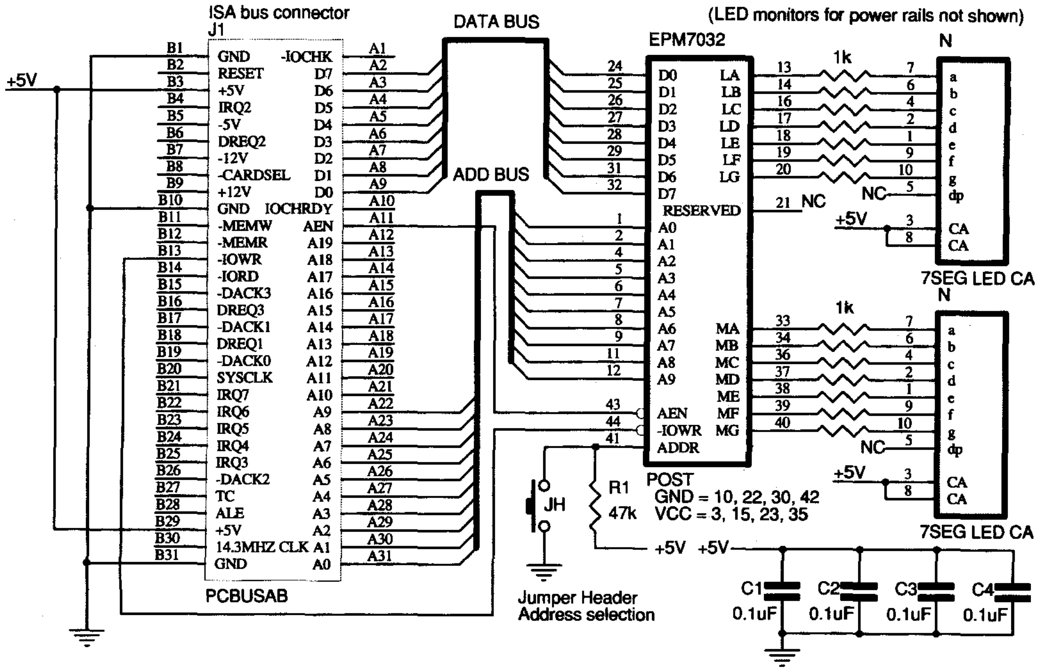


Fig.1: The schematic for the POST card. As you can see, it's surprisingly simple, thanks to the use of a pre-programmed EPLD device. The only other components needed are a pair of seven segment displays, some LEDs and a handful of resistors and capacitors.

and I provided the 7032 devices. We duly got together when a card was ready to test and we found it to be fully operational.

I think this is a plus for the Altera 7000 devices, considering the ease with which they provided a one-chip solution. The 7032 device directly interfaces with the ISA bus and directly drives the seven-segment common anode LED displays quite happily through current limiting resistors.

In another magazine article[2] describing a POST test card, the author has used eight discrete small-scale ICs to achieve the same result.

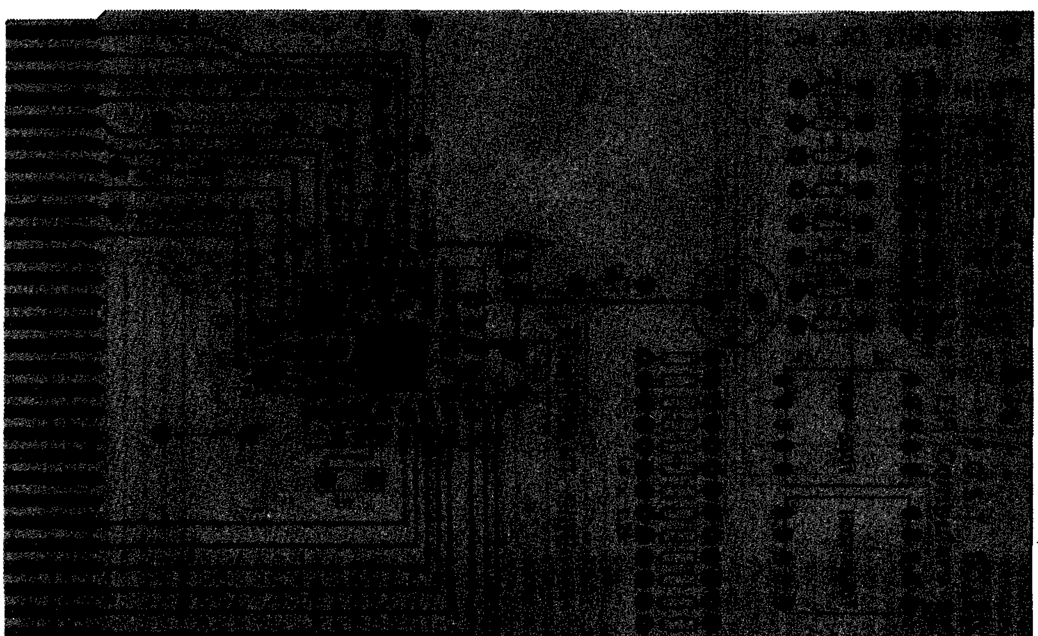
In yet another article[3] the author has used four ICs including two GAL chips, but this article has made provision for six possible addresses for the diagnostic address, for different BIOS versions.

This article is also the most comprehensive of the three articles and lists available commercial hardware and software for PC diagnostics.

The test card that Eric and I have constructed gives a selection of the two most common addresses. It could probably be modified to give all six addresses, but we haven't tried this.

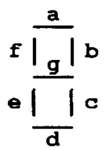
For deciphering the codes that come up in the POST test any of the articles listed give details.

There is a shareware program called Post Code Master (PCM) that provides quick look up for both POST codes and BEEP codes through a software program. It should be possible to get a copy of this program off a bulletin Board such as that operated by *Electronics Australia*. I found a copy on the 'SIM-



Use this overlay diagram when you are wiring up your own POST card. The small three pin jumper header with the A and X labels is used to configure the card for use in AT or XT machines respectively.

A POST test card for IBM PCs




```
0 = a,b,c,d,e,f          a = 1,4,B,D
1 = b,c                  b = 5,6,B,C,E,F
2 = a,b,d,e,g            c = 2,C,E,F
3 = a,b,c,d,g            d = 1,4,7,A,F
4 = b,c,f,g              e = 1,3,4,5,7,9,
5 = a,c,d,f,g            f = 1,2,3,7,D
6 = a,c,d,e,f,g          g = 0,1,7,C
7 = a,b,c
8 = a,b,c,d,e,f,g        Since active low outputs
9 = a,b,c,d,f,g          are required, the segments
A = a,b,c,e,f,g          consist of digits in which
B = c,d,e,f,g            the segments do not appear
C = a,d,e,f              in the table on the left.
D = b,c,d,e,g
E = a,d,e,f,g
F = a,e,f,g
```

Fig.4: How the decoding for the seven segment displays is derived. The actual decoding is performed in the author's program, of course.

TEL for DOS' CD-ROM, in the miscellaneous info section.

Circuit description

The schematic of Fig.1 shows the basic circuit, which as you can see is very straightforward. It consists mainly of the 7032 and the seven-segment display devices plus current limiting resistors and decoupling capacitors.

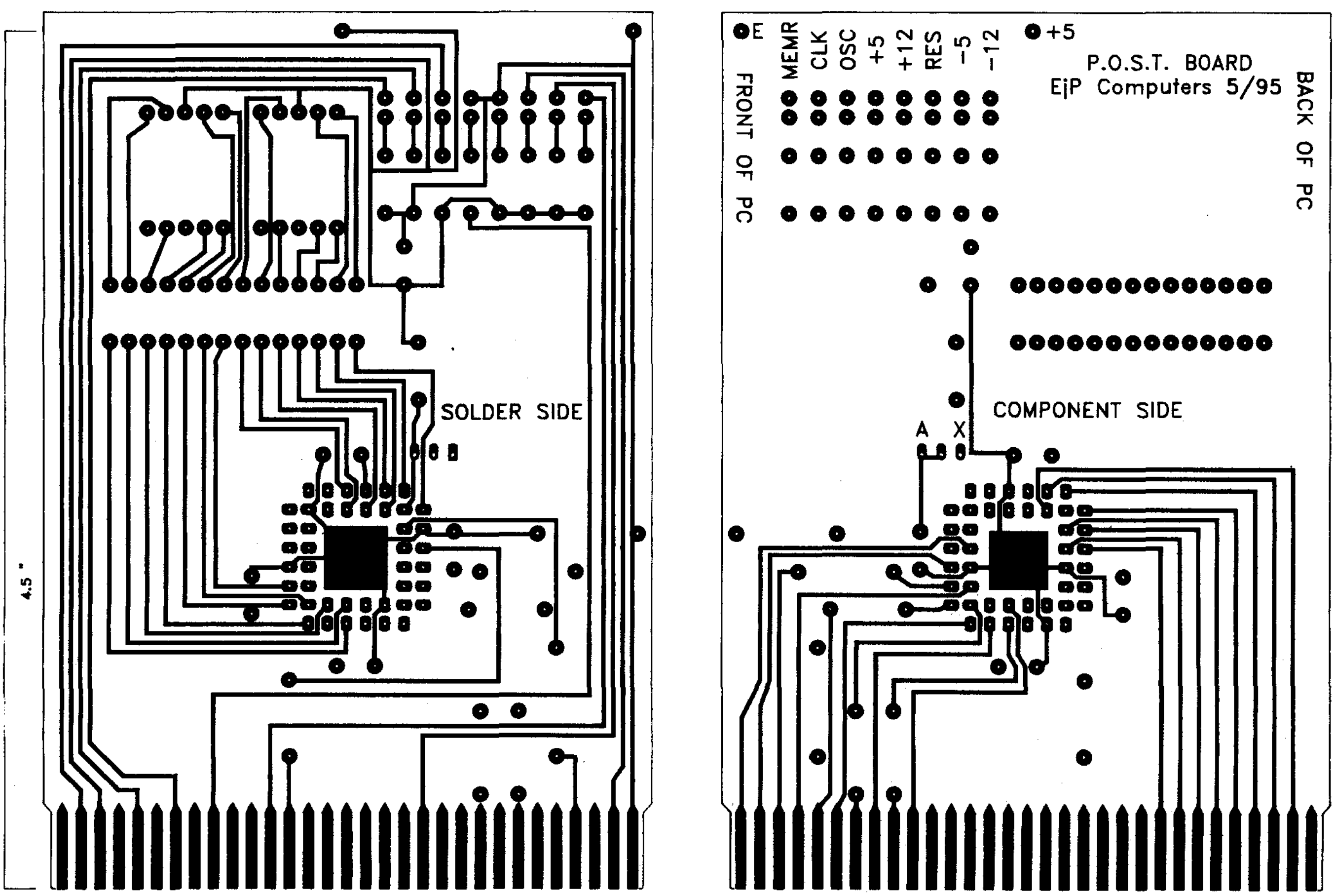
Usually provision is made on POST cards for LEDs to monitor the supply rails and other key signals. These are also provided here, although they have not been shown on the schematic. The LEDs monitor MEMR, CLK, OSC and RES, along with +5V, +12V, -5V and -12V.

Decoupling capacitors are placed near the four supply points on the PLCC socket. The jumper header makes provision for two addresses, one of which is 80H for the AT bus. The other is 60H, which according to reference 3 is for the XT bus.

The PCB design produced by Eric Patching is shown in Fig.2. As you can see, it is double sided, as cards have to be in order to connect to the contacts on both sides of the PC expansion bus sockets. The PCB wiring/overlay diagram is also shown (Fig.3), and using this along with the photograph should make assembly of the board very straightforward.

EPLD source code

For those who would like to program their own EPLD device, the source code I have developed is shown in the box. It is commented to help in understanding it.



Here are the etching patterns for the top and bottom of the POST card board, reproduced as usual actual size for those who like to etch their own boards. (Courtesy of Eric Patching.)

Source code for the POST EPM7032

```
Title "POST test card for PCs";
% File name: POST1.TDF
  Started: 6 December 1994
  Updated: 29 April 1995  (ADDR for selecting address added.)
  Concept from: Electronics Today International, October 1994 Page: 22 - 27.
  Coded by David N. Warren-Smith of Digital Logic Systems, South
  Australia. PO Box 647, Elizabeth, SA 5112, Phone: (08) 255 2953
%
FUNCTION LATCH (D, ENA) RETURNS (Q);
DESIGN IS POST1
BEGIN
  DEVICE IS EPM7032LC44-15T
    BEGIN % This section assigns signals to the pins on the socket %
      A0                  @  1    : INPUT ;
      A1                  @  2    : INPUT ;
      A2                  @  4    : INPUT ;
      A3                  @  5    : INPUT ;
      A4                  @  6    : INPUT ;
      A5                  @  7    : INPUT ;
      A6                  @  8    : INPUT ;
      A7                  @  9    : INPUT ;
      A8                  @  11   : INPUT ;
      A9                  @  12   : INPUT ;
      D0                  @  24   : INPUT ;
      D1                  @  25   : INPUT ;
      D2                  @  26   : INPUT ;
      D3                  @  27   : INPUT ;
      D4                  @  28   : INPUT ;
      D5                  @  29   : INPUT ;
      D6                  @  31   : INPUT ;
      D7                  @  32   : INPUT ;
      ADDR                @  41   : INPUT ;
      NALE  % or AEN %    @  43   : INPUT ;
      NIOW                @  44   : INPUT ;
      LA                  @  13   : OUTPUT;
      LB                  @  14   : OUTPUT;
      LC                  @  16   : OUTPUT;
      LD                  @  17   : OUTPUT;
      LE                  @  18   : OUTPUT;
      LF                  @  19   : OUTPUT;
      LG                  @  20   : OUTPUT;
      MA                  @  33   : OUTPUT;
      MB                  @  34   : OUTPUT;
      MC                  @  36   : OUTPUT;
      MD                  @  37   : OUTPUT;
      ME                  @  38   : OUTPUT;
      MF                  @  39   : OUTPUT;
      MG                  @  40   : OUTPUT;
    END;
END;
SUBDESIGN POST1
(     % This section is for declaration of inputs and outputs %
  A[9..0]              : INPUT;  % Address inputs %
  D[7..0]              : INPUT;  % Data bus inputs %
  ADDR,                          % Address select input %
  NALE, NIOW           : INPUT;  % Address latch enable, IO write signal %
  LA, LB, LC, LD, LE, LF, LG    : OUTPUT;   % 7 segment outputs for LS digit %
  MA, MB, MC, MD, ME, MF, MG  : OUTPUT;   % 7 segment outputs for MS digit %
)
VARIABLE  % This section is for declaration of internal variables %
  LL[6..0]    : LATCH;              % A=0, B=1 ... G=6 %
  LM[6..0]    : LATCH;              % Latches for POST data word %
  STROBE      : LCELL;              % Internal address select %
BEGIN     % This section is for logic equations %
  % With ADDR = High address is 80H for the AT bus,
     with ADDR = Low address is 60H for the XT bus %
  STROBE  = (A[9..0] == H"080") & !NALE & !NIOW &  ADDR   % Address 80H %
          # (A[9..0]  == H"060") & !NALE & !NIOW & !ADDR;  % Address 60H %
          % Insert the required second address in place of H"060" if different %
  LL[].ena = STROBE;
  LM[].ena = STROBE;

  % The code on the data bus is translated to 7 segment code and stored
     in 7 latches for each digit %
  LL0.d   = !D3&!D2&!D1&D0 # !D3&D2&!D1&!D0 # D3&!D2&D1&D0
                      # D3&D2&!D1&D0;
  LL1.d   = !D3&D2&!D1&D0  # !D3&D2&D1&!D0 # D3&!D2&D1&D0
                      # D3&D2&!D1&!D0 # D3&D2&D1;
  LL2.d   = !D3&!D2&D1&!D0 # D3&D2&!D1&!D0 # D3&D2&D1;
  LL3.d   = !D3&!D2&!D1&D0 # !D3&D2&!D1&!D0 # D3&!D2&D1&!D0
                      # D2&D1&D0;
  LL4.d   = !D3&!D2&D0 # !D3&D2&!D1 # !D3&D2&D1&D0 # D3&!D2&!D1&D0;
  LL5.d   = !D3&!D2&D1 # !D3&!D2&D0 # !D3&D2&D1&D0 # D3&D2&!D1&D0;
  LL6.d   = !D3&!D2&!D1 # !D3&D2&D1&D0 # D3&D2&!D1&!D0;

  LM0.d   = !D7&!D6&!D5&D4 # !D7&D6&!D5&!D4 # D7&!D6&D5&D4
                      # D7&D6&!D5&D4;
  LM1.d   = !D7&D6&!D5&D4  # !D7&D6&D5&!D4 # D7&!D6&D5&D4
                      # D7&D6&!D5&!D4 # D7&D6&D5;
  LM2.d   = !D7&!D6&D5&!D4 # D7&D6&!D5&!D4 # D7&D6&D5;
  LM3.d   = !D7&!D6&!D5&D4 # !D7&D6&!D5&!D4 # D7&!D6&D5&!D4
                      # D6&D5&D4;
  LM4.d   = !D7&!D6&D4 # !D7&D6&!D5 # !D7&D6&D5&D4 # D7&!D6&!D5&D4;
  LM5.d   = !D7&!D6&D5 # !D7&!D6&D4 # !D7&D6&D5&D4 # D7&D6&!D5&D4;
  LM6.d   = !D7&!D6&!D5 # !D7&D6&D5&D4 # D7&D6&!D5&!D4;

  % Output logic (active low) is driven directly from the latches%
  LA     = LL0.q;        % Least significant digit of POST code %
  LB     = LL1.q;
  LC     = LL2.q;
  LD     = LL3.q;
  LE     = LL4.q;
  LF     = LL5.q;
  LG     = LL6.q;

  MA     = LM0.q;        % Most significant digit of POST code %
  MB     = LM1.q;
  MC     = LM2.q;
  MD     = LM3.q;
  ME     = LM4.q;
  MF     = LM5.q;
  MG     = LM6.q;
END;
```

The author's source code listing for his program for the EPM7032 EPLD device in the POST card..

The logic consists of an address decoder, logic for decoding the seven segment display segments and two sets of latches for storing the segment data.

The segment outputs are driven directly from the latches. The decoding for the segments is derived in the diagram of Fig.4. Details of how to interpret the logic equations were given in the examples in my Pulse Generator article in the January 1995 issue of *EA*.

Using the card

When using the card, it should be noted that placing the card in the motherboard slot the wrong way around will result in +/-12 volts and -5 volts from the supply rails being applied directly to the address inputs on the 7032 device. This would very likely damage the 7032 device. Hence, warnings should be placed on the card and due care taken in inserting it.

A further debt is owed to the authors of the original *ETI* article for a BASIC program (POSTTEST.BAS) that will

Continued on page 127

Multimedia upgrade review:

High quality multimedia speakers

If you'd like more 'punch' in the sound from your PC's multimedia applications and games, this set of self-powered shielded speakers from Rod Irving Electronics may be just the shot. They offer volume, bass and treble controls, use vented enclosures to extend the low-end response, and are a genuine two-way speaker system featuring both bass and treble drivers.

by ROB EVANS

When it comes to reproducing the more demanding sound effects or musical passages from games and other PC applications, the typical set of low cost multimedia speakers really do fall rather short of the mark. More often than not they have a very small driver in an equally small enclosure, and as a result, tend to turn explosions into muted 'blurts' and segments of potentially emotive music into a series of lightweight tinkles — needless to say, the desired effect becomes somewhat lost...

While changing over to a larger set of speakers can relieve the situation to some degree, the sound card itself can then impose a further limitation on the sound quality though its very limited output power capability. With a typical figure of just a few hundred milliwatts, most cards have little hope of extracting the full potential from larger and better speakers.

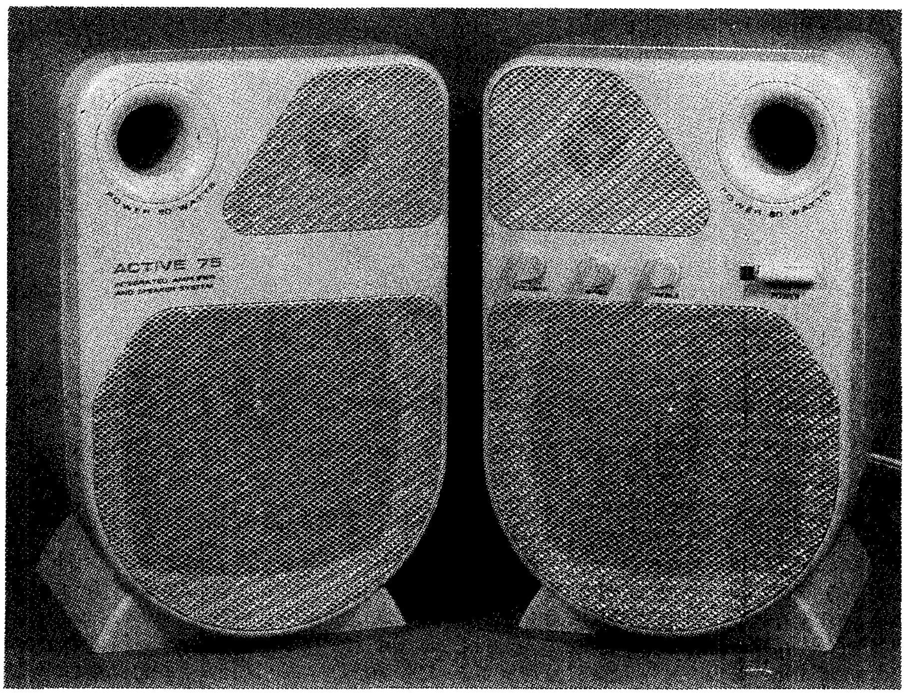
Perhaps the only real way to get the full impact from your PC sound then, is to upgrade both the amplifying system *and* speakers. While a retired hifi system can do the job at a pinch, the speakers would have to be placed some distance from the computer monitor due to their lack of magnetic shielding. You would also need to buy or construct an adaptor cable that can connect the output of PC's sound card to the hifi amp input. All in all it's a fairly bulky and inelegant way to beef up the sound from your PC, albeit a potentially low cost one.

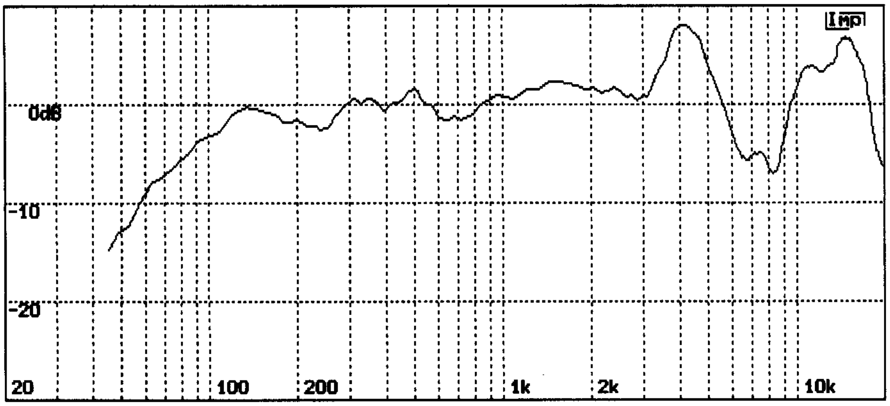
Of course the other approach to the problem is to purchase a set of higher-performance speakers that are specifically designed for multimedia applications, such as the 'Active 75' units featured here. With an integrated (that is, built-in) amplifier system, full magnetic shielding and relatively robust drivers, this system appears to address all of the above limitations in one hit.

The Active 75's are based on a set of molded high-impact plastic speaker enclosures that house what appears to be an 85mm woofer and 20mm tweeter, plus a 25mm port tube.

As you can see from the photo, the enclosures have a very neat and functional appearance thanks to the integrated speaker grills, rounded corners and a tapered vent tube, and would not look out of place alongside most contemporary PCs. For the record, the overall cabinet dimensions are approximately 225 x 140 x 185mm (H x W x D).

In order to have a just a single set of volume, bass and treble controls, the Active 75's stereo amplifier is held in one of the enclosures, while the other acts as a conventional (passive) speaker. The amplifier connections are accessed via a recess in the rear of the enclosure, where RCA-style connectors are used for the stereo input signal from the sound card and the single speaker output to the other enclosure — which in turn has just one RCA connector, as you would expect.





The frequency response plot for the Active 75's, as measured with our IMP loudspeaker testing system.

Sound check

The Active 75's are supplied with an RCA-to-RCA speaker lead to interconnect the two enclosures, plus a stereo input lead which is terminated in a 3.5mm stereo plug to suit most sound cards and portable music systems. Unfortunately though, while the connection process was very straightforward, we initially found that there was no response from the system at all, when power was first applied — even the power 'on' indicator next to the push-button power switch was dead.

Seizing the opportunity to take a look inside, we disassembled the 'amplifier' enclosure and soon found that the main PCB had been dislodged from its mountings (or perhaps installed incorrectly), and was badly cracked as a result. Fortunately, it was a fairly simple matter to repair the associated broken PCB tracks — which had effectively disconnected a couple of the unit's main power supply lines — and 'revive' the amplifier.

We're confident that this damage was an isolated case, and judging by the quality of construction inside the units we feel sure that other Active 75's will perform as expected.

By the way we also checked out the effectiveness of the driver's magnetic shielding, and found that unlike a number of other so-called multimedia or 'monitor friendly' speakers, these units caused no perceivable discolouration or distortion in our test monitor's screen.

When connected to a clean signal source such as an FM radio or CD player we found that the Active 75's delivered an impressive performance, and were able to produce surprisingly high volume levels without obvious stress. The bass response was pleasantly extended — implying that the vented enclosures are well matched to the woofers — and the treble response was similarly extended, but somewhat harsh (in hifi terms) in the upper midrange area.

Investigation with our IMP loudspeaker testing setup confirmed that the system exhibits a sizable peak in the response at around 4kHz, quickly followed by a broad dip in the 7kHz region, which would certainly account for the somewhat strident midrange performance (see Fig.1). This is probably a side effect of the enclosure's very simple crossover network (one capacitor), which appears to have introduced a degree of phase addition and cancellation between the acoustic output of the bass and treble drivers.

In practice though, we noted that when the Active 75's are operating in a typical setup (with a PC or portable CD player) the subjective performance is vastly superior to that of typical compact speakers — particularly if the treble control is slightly backed off. So if your PC has a 16-bit sound card and you have access to the latest generation of sound-orientated games, you should find that the Active 75's add a new dimension to your enjoyment.

And while really can't take the '80 watts PMPO' power figure offered by the manufacturer very seriously, we would guess that the unit's internal amps are rated somewhere between 5 and 10 watts *RMS*, which should be more than enough to disturb the entire household...

The Active 75's are currently priced at $129, and are available from Rod Irving Electronics stores around Australia — their mail order hotline is 1800 33 5757. ❖

A POST test card for IBM PCs

Continued from page 125

Software for this project

The POSTTEST.BAS program which can be used to test this project is available on the EA Computer BBS, in the EA Project Software area. Also available on the BBS in the Useful Utilities area is the PCM105.ZIP shareware utility, which provides a lot of information on the PC's Power-On Self Test routine and its diagnostic codes.
The phone number of the EA BBS is (02) 353 0627.

thoroughly test the card. That article should be referred to for details. Possibly a copy of the BASIC program may become available on *Electronics Australia*'s BBS.

To use POSTTEST, you simply run it using QB45 and note that all the correct numbers appear on the seven-segment display. You will need a floppy disk and video in the PC as well as the POST test card to run the test program. You will of course have to leave the lid off the PC in order to see the results.

You might want to test the card in a machine that is known to be working properly, before trying it on a faulty motherboard.

The information given here should be sufficient for anyone interested to make up one of these POST test cards using the 7032 device and so to experience the future of digital electronics. The libraries of Universities and TAFE colleges as well as public libraries are usually available to the public to look for the references.

References

1. The magazine articles which gave us the idea for the POST test card were in the October and November 1994 issues of *ETI* (Electronics Today International), written by Stephen Smith and A.R. Jardine.
2. Another POST test card was described in *Computer Craft* for November 1993, written by Paul E. Yost.
3. Yet another, but comprehensive article on POST test cards appeared in *Elektor Electronics* for January 1995, written by M. Rathjen.
4. An informative article on POST was published in *PC Magazine* for Feb 13, 1990, entitled 'Tutor — The First 30 Seconds' and written by Jeff Prosise. ❖

Solid State Update

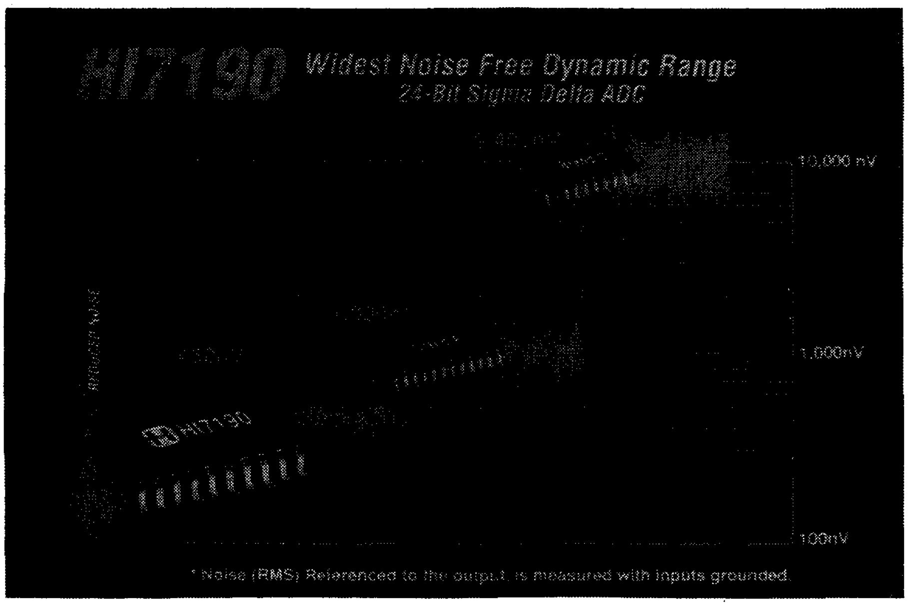
KEEPING YOU INFORMED ON THE LATEST DEVELOPMENTS IN SEMICONDUCTOR TECHNOLOGY

24-bit sigma delta ADC

Harris Semiconductor has announced the HI7190, a sigma-delta ADC.

Its 2.9uV peak-to-peak noise translates to 23.5-bit effective resolution. The device has 16-bit accuracy and is suited for process controls, commercial scales, instrumentation and medical applications. The serial interface is compatible with SPI, QSPI, MicroWire and Intel standards and supports three wire interface to most MPUs.

The converter features 0.0015% full scale integral non-linearity (INL) over the temperature range of -40°C to +85°C. Its differential analog inputs are programmable for unipolar (ground referenced) or bipolar (plus and minus) operation. Noise rejection at 50/60Hz is better than -120dB when the notch filter is programmed to a sub-harmonic of 50/60Hz.



A patent pending auto-calibrate function helps maintain 16-bit accuracy over temperature. This innovative function compensates for first and second order errors caused by differences in non-linearity between the negative and positive regions of the transfer function, differences that are typical of all switched capacitor charge-balanced modulators.

Conversion rates of 10 to 2000Hz (10MHz crystal) or one to 200Hz (1MHz crystal) and gains of 1, 2, 4, 8, 16, 32, 64 and 128 can be programmed. The on-board programmable-gain instrumentation amplifier has gain options of 1, 2, 4 and 8, and on-board processing provides further gain in the digital domain.

For further information circle 272 on the reader service coupon or contact Avnet VSI Electronics, 6-8 Lyon Park Road, North Ryde 2113; phone (02) 878 1299.

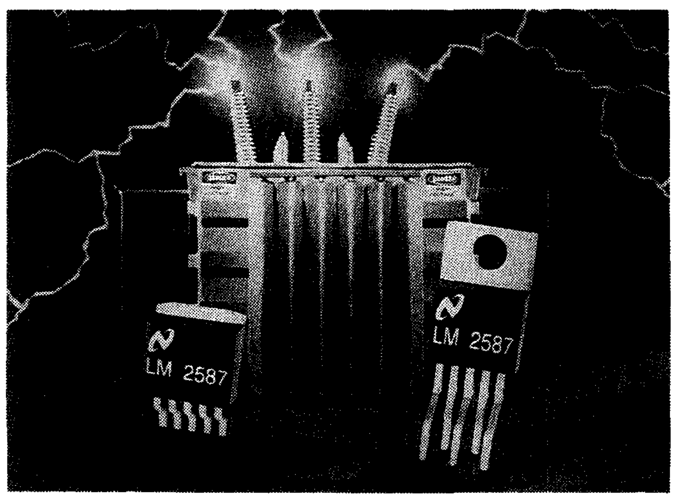
5A flyback power converter

National Semiconductor has expanded its Simple Switcher power converter family with the introduction of two new 5A flyback power converters, called the LM2587 and LM2588.

Both devices feature increased power (5A switch current versus 3A) over previous Simple Switcher power converters, and 65V switch voltage rating. New, higher frequency operation allows smaller external magnetic components and capacitors, reducing the required printed circuit board area. The LM2587 operates at 100kHz while the LM2588 allows frequency adjustment between 100kHz and 200kHz with one external resistor.

Other advantages of the LM2588 include synchronisation to a common frequency (so devices can be connected in parallel), and an on-off pin for external turn-off reduces quiescent current to 60uA.

Both ICs are designed for flyback, forward and step-up (boost) switching converter applications, and are available in 3.3V, 5V, 12V and adjustable output voltage versions. Both also offer current-mode operation for improved transient response, line regulation and current limit. Protecting the power switch are current and thermal limiting circuits and an under voltage lockout circuit for fail safe operation. A soft-start feature reduces in-rush current during start up.



The new flyback power converters are supported by 'Switchers made Simple' version 4.0 design software, which provides a complete design solution including schematics, components lists and vendor information. Both ICs are available in a TO-220 package or TO-263 surface mount package.

For further information circle 270 on the reader service coupon or contact National Semiconductor, Business Park Drive, Monash Business Park, Notting Hill; phone (03) 558 9999.

Combined photodiode-amp

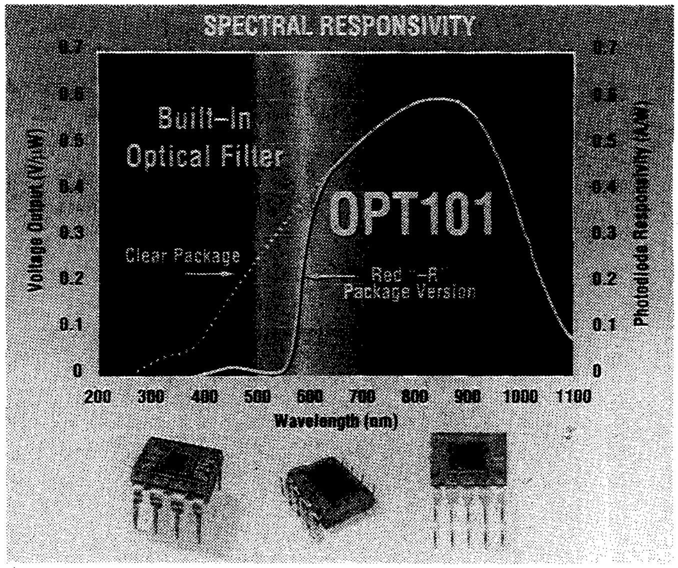
The new OPT101-R photodiode/amplifier IC from Burr Brown is packaged in red moulded plastic to provide optical filtering. The device combines a high performance photodiode, micro-power transimpedance amplifier and a 1MΩ feedback resistor on a single monolithic IC.

The Red plastic package provides selective response to wavelengths greater than 570nm, making it ideal for applications using red or infrared illumination. The device is suited to a wide range of light sensing applications including smoke detectors, position and proximity sensors, medical and laboratory instrumentation. Optical filtering improves performance by reducing response to ambient light sources. Clear plastic versions are also available for applications requiring wider spectral response.

The sensor's output voltage increases linearly with light intensity. Power supply current is 120uA and single supply operation extends from 2.7V to 36V. It can also operate from dual supplies. An internal 7.5mV output pedestal voltage assures linear operation down to zero light with a single supply. Other key specifications include bandwidth of 14kHz, and photodiode responsivity of 0.45A/W at 650nm.

The integrated combination of photodiode and amplifier eliminates the problems commonly encountered with discrete designs, such as leakage current errors, noise pickup and gain peaking. The 2.29 x 2.29mm photodiode is operated in photoconductive mode for best linearity and low dark current. It is available in 8-pin DIP, 5-pin vertically mounted SIP, and 8-lead surface mount packages.

For further information circle 273 on the reader service coupon or contact Kenelec, 2 Apollo Court, Blackburn 3130; phone (03) 878 2700.



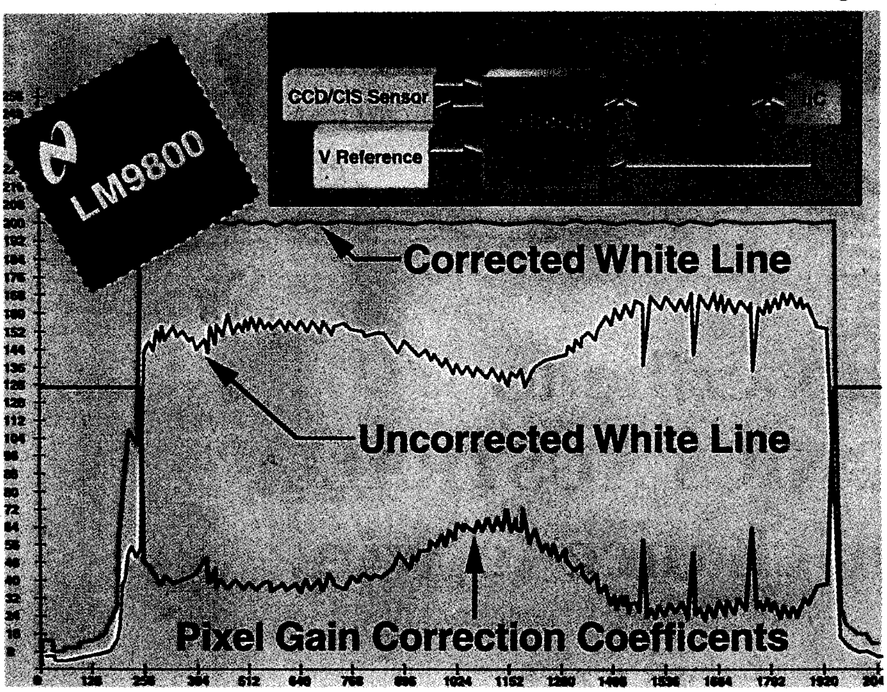
CCD image signal processor

A high integrated sensor processor that performs all the analog functions necessary for CCD sensor operation has been introduced by National Semiconductor. The device, called LM9800, is compatible with grey scale and colour CCD sensors used in sheet-fed and flatbed scanners.

The LM9800 features 8-bit resolution and operates at a 2.5 million pixel/second conversion rate. It removes errors from and digitises a linear CCD pixel stream, while generating all the necessary clock signals to drive the CCD. An internal configuration register sets CCD and sampling timing to maximise performance and simplify the design.

Functions include correlated double sampling for black level and offset compensation resulting in minimum noise and offset error; 8-bit analog-to-digital conversion; and pixel-by-pixel gain adjust that maximises the dynamic range and resolution, even on 'weak' pixels. The LM9800 is available in a 52-lead plastic leaded chip carrier (PLCC). A 52-pin thin quad flat pack (TQFP) package is also available.

For further information circle 275 on the reader service coupon or contact National Semiconductor, Business Park Drive Monash Business Park, Notting Hill; phone (03) 558 9999. ❖



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NEW PRODUCTS

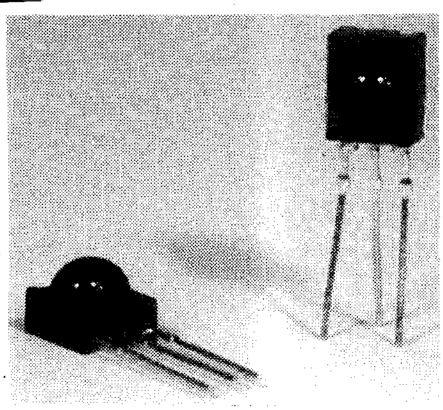
COMPONENTS

Infrared receiver IC

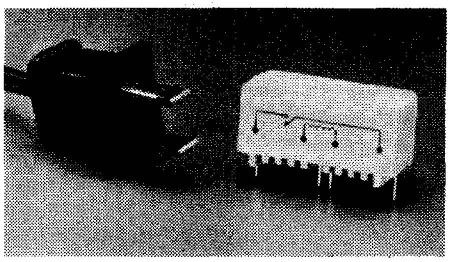
Dick Smith Electronics has added an integrated optical receiver 'subsystem' to its range of optoelectronic devices, as catalog number Z-1954. Housed in a compact three-pin plastic package incorporating a 'biradial' lens and filter, the device includes an IR receiver diode, amplifier, limiter, bandpass filter and demodulator.

As the output from the device is a demodulated digital signal that's identical to that transmitted, it provides a convenient and inexpensive alternative to traditional discrete receiver front ends in IR remote control systems. It has a high sensitivity and a nominal range of eight metres, operates from a 5V supply, and drives its output low in response to infrared energy modulated at 38kHz.

The Z-1954 infrared receiver IC is priced at $9.95 and is available at all Dick Smith Electronics stores.



Very small 8kV relay



Kilovac Corporation has added a new power switching relay to its line of vacuum sealed, high voltage and RF power reed relays. Kilovac's new S02JTA is claimed to be the smallest 8000 volt relay in the industry (35 x 12.7 x 19mm).

The in-line PC pin connections provide close side by side mounting. Power handling for the new relay is 2A continuously at up to 8kV and the relay can power switch over 200 watts. The S02JTA is available in form A, SPST-NO with a choice of 5V, 12V or 24V DC coils.

For further information contact Kilovac, PO Box 4422, Santa Barbara, CA, USA 93140.

Spring terminal pack

In response to suggestions from its customers, Dick Smith Electronics has released a low cost pack of 'spring terminals' for the highly successful Fun Way into Electronics Series 1 kits. The spring terminals are designed to augment the small screws originally used to mount components and perform connections in the Funway 1 kits, allowing the various circuits to be wired up faster and more easily, and ,with less damage to component leads. This results in longer component life, and less need to replace parts with continued use of the kits.

The terminal springs are made from stainless steel wire so that they will not corrode or oxidise. The quantity of 28 springs supplied is sufficient to make the connections for all circuits described in the Funway 1 manual. Each spring is formed at one end to allow easy attachment to the moulded plastic base, using the original terminal screws.

The K-2602 Spring Pack is priced at only $2.95 and is available from all Dick Smith Electronics retail outlets.

Switch caps

MEC has introduced a new series of 'Combi-Caps' for UNIMEC switches. The caps are available in round, rectangular, and square styles.

The three cap styles can be ordered in any of seven colours. The square cap is also available in a transparent clear which accepts interchangeable legends. A bezel can be ordered with the square cap to give a finished look to front panel cutouts and all caps can be printed with standard legends and graphics, or with custom markings.

Switch ratings are 250mA at 120V for

10.4" colour active matrix LCD

The LDH102T-20 is a new colour active matrix LCD from Flat Panel Display Co. It consists of an AM LCD, an integrated adjustable backlight and module electronics.

The module electronics enables simple interfacing with commercially available VGA chipsets such as those from Cirrus Logic, Western Digital and Chips & Technologies. It can display 4096, 256K or 16.7 million colours depending on user selection, has low power consumption, is thin, compact, light weight and has a fast response. The display has an integrated high efficiency, single tube CCFT backlight for a brighter display.

For further information circle 233 on the reader service coupon or contact Amtex Electronics, PO Box 285, Chatswood 2057; phone (02) 805 0844.

silver contact material (gold optional). Mechanical life is 1.5 million cycles for momentary and 500,000 cyles for maintained switches. The new caps are also available for high temperature UNIMEC switches which provide 10 million cycles for momentary and five million cycles for alternate action switches. All UNIMEC switches are sealed to IP54 standards, are splashproof and dust resistant.

For further information circle 231 on the reader service coupon or contact Associated Controls, 29 Smith Street, Hillsdale 2036; phone (02) 311 3255.

20A power relay

The Omron G4A relay is a miniature single pole relay capable of 80A surge current and 20A switching current, making it ideal for motor switching. The relay is available in 5V, 12V and 24V DC ratings, has highly noise resistive insulation materials and has the option of PCB terminals or #250 tab/PCB terminals.

For further information circle 232 on the reader service coupon or contact DGE Systems, 103 Broadmeadow Road, Broadmeadow 2292; phone (049) 61 3311.

CONSUMER/BUSINESS EQUIPMENT

Pocket sized fax machine and organiser

The Handifax 1000 is a 256K electronic personal organiser and fax machine in one.

Not much bigger than a family size block of chocolate, the product is used in conjunction with a standard touch tone telephone or analog mobile phone.

To use it, type the message you want to fax into the organiser, place the handset of the telephone (or mobile phone) on the acoustic coupler speaker and microphone, dial the fax machine you are calling and press SEND.

The Handifax 1000 can communicate with any standard fax machine at speeds up to 9600b/s. It can hold up to 120 faxable pages and its auto dialling facility overcomes the need to manually dial numbers or access codes. It includes built in fax cover pages and the ability to customise fax headers, standard orders, invoices and any kind of fax you regularly send.

Its 256K memory allows the device to double as a powerful personal organiser, capable of storing more than 3500 entries. It has a built in programmable alarm, and can store access codes, extensions, credit card numbers, daily schedules and appointment times.

Included is an integrated calculator in standard keypad format which doubles as a telephone pad for easy phone and fax number entry. An optional PC interface allows users to back up and store information on any standard IBM compatible PC.

The Handifax 1000 is available at all Dick Smith Electronics stores for $699.

Personal fax, TAM, phone and copier

The Panasonic SuperPhone is a dedicated personal fax machine designed for home use. It combines a telephone, facsimile, answering machine and copier all in one compact unit.

It is designed to replace an existing

telephone and answering machine. The UF-S1 can determine whether an incoming call is a fax or phone call and switches accordingly. By using digital memory instead of a tape for the answering machine, messages can be accessed instantly and the flash memory protects messages in the event of a power failure.

The unit includes a timer alarm as a useful reminder for deadlines, or appointments. It also has a help function which prints out a copy of the operation guide listing all the major functions.

When sending fax messages the SuperPhone has 64 level halftone output for sending photographs or drawings, and a built in 25 page memory for storing incoming documents when the machine is out of paper.

Included is a copy function with an enlarge ability. For telephone operation, up to 15 frequently called telephone numbers can be programmed into memory and the machine can be configured to recognise private calls, while others will automatically record on the answering machine.

The SuperPhone is available from electrical retailers and communication specialists for a recommended retail price of $799.

For further information contact Panasonic's Customer Care Centre on 132 600.

VHF/UHF FM handhelds

Kenwood has released two new handheld VHF/UHF FM portable transceivers, the TK-250 and TK-350. (West Australian Kenwood dealer Mobile Masters has won a large tender with the WA Police, involving a three year contract to supply TK-350 handhelds and provide service support.)

The TK-250 operates on frequencies from 150 - 174MHz and the TK-350 is available in four models covering 403MHz to 510MHz. Designed for the harshest environment, both units comply with selected criteria from MIL 810C/180D and 810E methods and procedures. Both units offer 150 channel capacity, four character LCD display, multiple scanning operation, and a selection of built in features including QT/DQT squelch, two tone decoding and DTMF decoding.

Other features of both models include 'busy channel lockout' that prevents transmit if another user or talk group is on the air, and a timer than can be programmed between three and 300 seconds to guard against misuse or accidental key presses. A tri-coloured LED gives four status indications for transmit, channel busy, selective call alert and low battery.

For further information circle 234 on the reader service coupon or contact Kenwood, 8 Figtree Drive, Homebush 2140; phone (02) 746 1888.

POWER SUPPLIES

Solar power for mobile phones

A new company called Southern Cross Solar has been formed to handle the Australian and New Zealand distribution rights to a new product called Solar Life solar batteries. The company is based in Hobart Tasmania.

Managing director Jon Grunseth believes the new batteries will revolutionise the mobile phone market. The nickel-metal hydride solar batteries have been specifically designed for mobile phones, and are a new technology developed by Bell Sound in the US.

The batteries can be charged by simply placing them in the sun, from a pocket size solar panel, from an AC power adaptor (two hours), or from a 12V car cigarette lighter. As an IC controller chip continually monitors charging and discharging to eliminate memory effect problems, the battery can be charged while in use, and automatic shut off circuitry prevents the battery overheating.

For further information phone Southern Cross Solar on 1800 636 758.

240V AC inverter for test equipment

A new accessory for use with the HP Basic Instruments range draws operating power from the cigarette lighter of a car, or from an external 12 volt battery. The HP 34397A DC-to-AC inverter makes it possible to use instruments on a portable calibration cart that travels throughout a plant, to make measurements at remote locations where no AC line is available, and to keep instruments powered and ready to use while in transit between sites.

Specifications include an input voltage range of 10.5 to 15 volts, output voltage of (standard) 115V AC 60Hz, +/-0.06Hz or (option 0E3) 230V AC 50Hz, +/-0.05Hz. The output range is 100 watts continuous or 200 watts for five minutes. The output waveform is a quasi-sine wave.

The inverter costs $260 and is supplied with a manual in English, French and German and a set of battery clip leads. The 230 volt option comes with an IEC-to-IEC power cord to connect the instrument to the inverter.

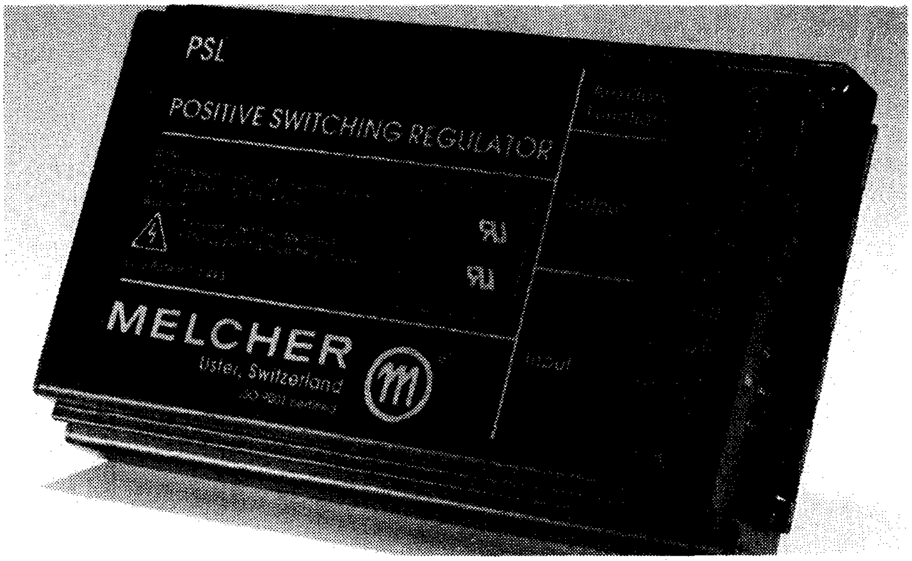
For further information contact Hewlett-Pacard's Customer Information Centre on 13 1347, extension 2902.

Switching regulators

Power supply manufacturer Melcher has announced the new PSL family of switching regulators. With outputs from 5V/12A to 36V/6A and wide input voltage ranges, the products are available in three grades to suit rugged, industrial and benign environments. Housed in a 19" Eurocassette format aluminium extruded case, the units can also be chassis mounted, with an overall profile of 36.5mm.

The three grades allow users to select input, temperature ranges and immunity to environmental conditions to suit specific applications. For example, 'rugged' units are fully rated to 71°C, with input voltage ranges up to 144V DC for powering directly from unregulated sources (e.g., traction batteries) and are well suited to portable/vehicle based systems. 'Benign' grade units are rated to 50°C and have input ranges up to 60V DC. Such units can be powered from a more stabilised source (e.g., 24/36V DC bus), and are suited to telecoms, and commercial grade applications.

For further information circle 239 on the reader service coupon or contact Scientific Devices, 2 Jacks Road, South Oakleigh 3167; phone (03) 9579 3622



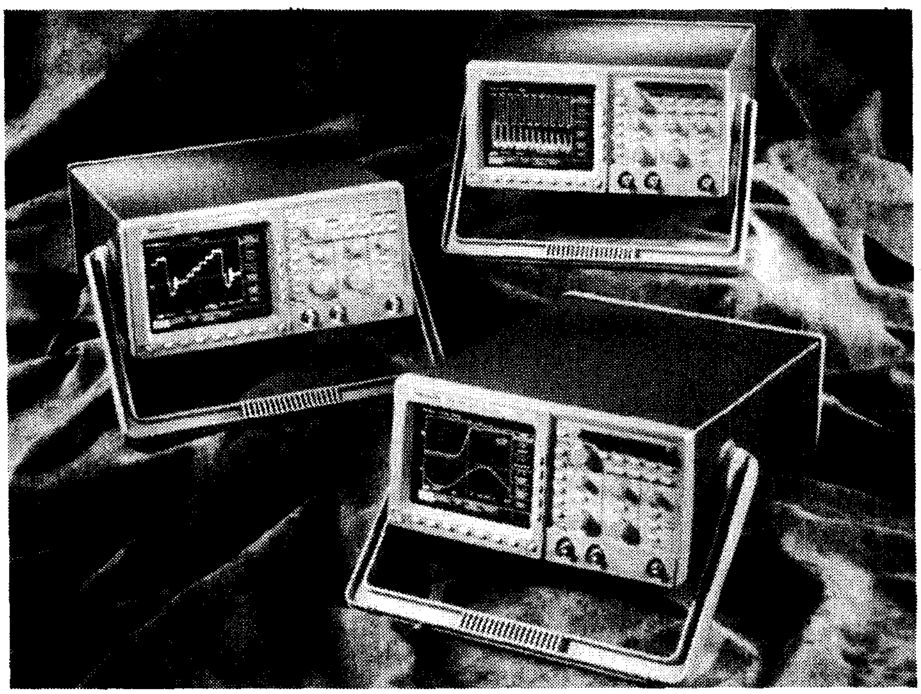
TEST EQUIPMENT

Tek DSOs double performance

Tektronix has doubled the performance of its TDS300 series digital oscilloscopes, with no increase in price. Announced are three new models: 100MHz (TDS340), 200MHz (TDS360) and 400MHz (TDS380).

The scopes are basic troubleshooting instruments targeted primarily for the eduction, design, service and repair markets. The digital capability of the series allows users to store set-ups and waveforms and perform 21 different automatic measurements.

The upgraded scopes now include fast



fourier transform (FFT) capability, which is useful for analysing harmonic content of signals.

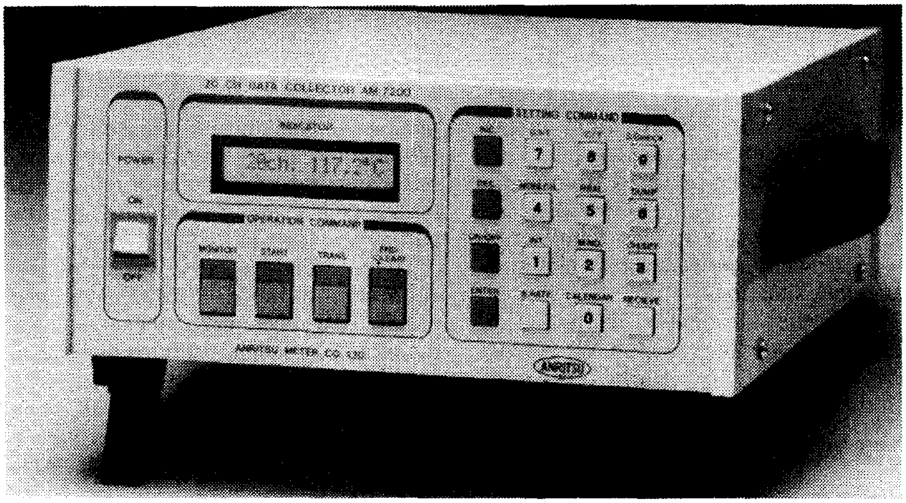
They also feature Tektronix' patented digital real-time (DRT) oversampling technology, claimed to dramatically reduce aliasing and allow single shot waveform capture at the instrument's full bandwidth.

The TDS340's two channels digitise at a rate of 500 megasamples per second, the TDS360 at one gigasample per second and the TDS380 at two gigasamples per second.

A 3.5" DOS compatible floppy disk drive is built into the TDS360 and 380 models, for storing reference waveforms, saving waveforms and setups, and importing and exporting waveform values into application programs.

The suggested retail price for the TDS340 is $3700; the TDS360 is $5200 and the TDS380 is $6800. Each comes with a three year warranty. A communication option is available for I/O to GPIB, RS-232 and Centronics type interfaces and VGA monitor output.

For further information circle 240 on the reader service coupon or contact Tektronix Australia, 80 Waterloo Road, North Ryde 2113; phone (02) 878 9000.



Fast 20 channel data collector

The AM-7200 high speed multi-channel data collection Anritsu incorporates a precision A/D converter, a CMOS microprocessor and a large capacity memory. Multi-purpose system upgrades are possible through communication with external devices through the RS-232C interface.

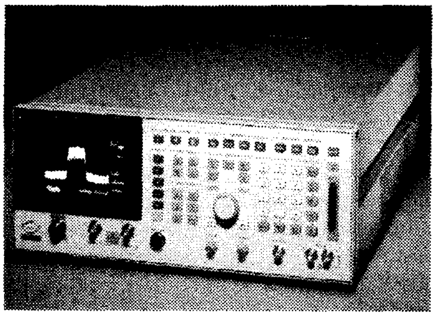
Many functions are concentrated in the compact unit and temperature ranges can be monitored from -200°C to +1200°C (type K or type E thermocouple).

The instrument features self-calibration for zero and full scale compensation. Linearisation and calculation of the temperature data over the 20 channels is achieved at intervals of 0.5 sec. Setting parameters include calendar (year, month, day, hour and minute), interval timer, machine number setting up to four digits, channel selection, real time RS-232C output, memory data output, baud rate, memory dump to display, 0.1° to 1° resolution, °C/°F selection, sensor check, parameter setting from instrument keypad or host computer.

The unit can be powered from mains AC, 12V DC or from battery. Cases can be supplied for use in high temperature ovens or warm showers for special measurement situations.

For further information circle 241 on the reader service coupon or contact Electromark, 36 Barry Avenue, Mortdale 2223; phone (02) 533 3322.

CDMA mobile phone tester



Hewlett-Packard has released a test set that uses one instrument to perform automated testing of the digital DMA and analog FM sections of dual-mode mobile phones.

The HP8924C test set simulates base-station operation to make an array of automated measurements in manufacturing or high level service environments. The instrument has two independent, intermediate frequency (IF) demodulators: one that recovers real time data bits for link maintenance and receiver measurements, and one that performs transmitter measurements. Manufacturers can perform simultaneous evaluation of frame error rate, transmitter power and modulation quality, cutting test time in half.

To test a CDMA phone, the technician connects it to the HP-8924C, enters the required RF channel number, waits for the mobile to acquire service and presses the instrument's call button. The tester makes a CDMA phone call, verifies receivers, the instrument displays a pass/fail indication based on the measured frame error rate.

A full complement of CDMA transmitter tests is performed automatically by the instrument, including high speed, digital signal processing based power measurement from 0.1mW to 6W and accurate channel power measurement from 0dBm to -50dBm. When making CDMA receiver measurements, the tester compares the received 9.6kb/s data to the transmitted 9.6kb/s pseudo-random data and performs a bit-by-bit comparison to calculate the true frame error rate.

For further information phone Hewlett-Packard's Customer Information Centre on 13 1347, extension 2902.

Troubleshooting workstation

Huntron Instruments of USA has announced the new ProTrack generation of programmable troubleshooting instruments, which link the company's analog signature analysis technique (ASA) with a number of new software and hardware tools.

The new product family, which introduces the concept of a personal troubleshooting workstation, is based on a modular approach. It allows users to put together customised systems, ranging from simple benchtop troubleshooting units to fully automated board testers using robotic probers.

Windows based software and programmable test ranges allow the system to handle complex boards, including through hole or surface mount assemblies incorporating mixed technology components.

The basic unit in the ProTrack family is the ProTrack 1 model 10; a benchtop unit for applications where a computer interface is not needed.

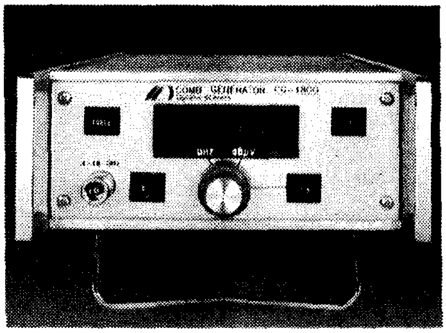
The interface is added in the model 20, which can be used in conjunction with the ProTrack Scanner 1 to scan up to 128 pins at a time, and make real-time comparisons between boards.

The model 20 can be interfaced with a personal computer running Huntron's Workstation for Windows automatic test software to form a troubleshooting workstation.

Test information can be transferred between computer or locations, and component databases can be stored or rearranged. Up to 10 individual models can be stored for each component. Test results can be viewed immediately and test data can be printed out or stored for archive purposes.

For further information circle 239 on the reader service coupon or contact Metromatics, PO Box 314, New Farm 4005; phone (07) 335 8155.

Comb generator, RF calibrator



The DSI-IG-1800 solid state RF comb generator from Dynamic Sciences covers the frequency range of 100MHz to 18GHz, and is suitable as a calibration source for RF measurement systems and receivers.

The instrument is claimed to be a precise, accurate and inexpensive signal source with the stability of a temperature stabilised crystal oscillator. It has a coherent comb line space of 100MHz, an output levelling function and is suitable for laboratory or field application. All controls can be remotely operated by the IEEE-488 bus allowing control over frequency, levelling and signal amplitude. The instrument features front panel indicators for repetition rate and amplitude. The impulse generator is supplied calibrated in dBuV (referenced to 50 ohms) with a maximum output of 70dBuV and an 81dB attenuator with 1dB steps.

For further information circle 216 on the reader service coupon or contact Dynamic Sciences Australia, 614 Hawthorne Road, East Brighton 3187; phone (03) 9596 0155.

'Pistol' screwdriver, olive picker

Scope Laboratories has announced a number of new hand tools for the electronics service industry. Included is an ergonomically designed pistol grip screwdriver that includes three slotted and two Phillips head bits, normally stored in the handle.

The drive has a reversible ratchet function and is a compact 120mm in length.

Another is the 'olive picker', a tool originally designed to lift olives from a narrow jar. This tool has been adapted to recover dropped parts from inside equipment. Its three spring loaded fingers expand to 15mm.

To help locate dropped parts, or to inspect impossible to see places, Scope has also available a 30mm inspection mirror that is adjustable to any angle. A 55mm mirror is also available, featuring a telescopic handle.

For further information circle 245 on the reader service coupon or contact Scope Laboratories, PO Box 63, Niddrie 3042; phone (03) 9338 1566. ❖

Hameg's Modular Instrument System

Continued from page 121

modules are light in weight and fabricated from fairly light gauge metal and plastic parts, they are carefully designed and structured to achieve a high order of strength and durability.

Incidentally although the mainframe unit appeared to have been made in Germany, all of the sample modules had been made at Hameg's factory in France.

Overall the operation of the various plug-in modules was very straightforward and intuitive, with the controls arranged logically and the LED readouts stable and unambiguous — leaving little need to refer to the user manuals.

The measured performance of the modules also compared very well with their rated specs, and were generally well inside them — suggesting that in most cases the specs are quite conservative.

By the way, the quoted prices of the Modular System 8000 components seem very reasonable. The mainframe unit is priced at $470, while the plug-in modules range from $480 for the HM8040-2 Triple Power Supply, up to $985 for the HM8042 Curve Tracer. The prices for the HM8027 Distortion Meter and HM8032 Sinewave Generator are both $590, for example, while the HM8018 LC Meter is $645 and the HM8035 $880.

These prices are all exclusive of sales tax, but include a two year warranty by the manufacturer.

On the whole, then, our impression of Hameg's Modular System 8000 is that it is a very well thought out and nicely executed family of medium level, cost-effective test instruments. Considering how infrequently some of the more specialised test instruments tend to be used, this approach should therefore have a lot of appeal for both individuals and smaller labs.

Further information on these and other instruments in the Hameg range is available from Kenelec at 2 Apollo Court, Blackburn 3130; phone (03) 9878 2700 or fax (03) 9878 0824. ❖

SPOTLIGHT ON SOFTWARE

BassBox 5.1

Using the Windows 3.1 environment, Harris Technologies' *BassBox* program helps you design a wide range of low-frequency loudspeaker enclosures, including the increasingly popular double- and triple-chamber bandpass configurations. It has a built-in database of around 1300 drivers, can plot up to six variables for each design, and offers a number of useful utilities such as an integrated port/vent calculator.

by ROB EVANS

Those interested in loudspeaker enclosure design are probably aware of how the related CAD (Computer Aided Design) software can make the job of developing a speaker system a much easier, and arguably less error prone process.

With the ability to quickly design, evaluate and then 'fine tune' a speaker system *before* building the enclosure, a comprehensive loudspeaker design program can save you a considerable amount of time and effort when developing a suitable cabinet for a given driver.

As it happens, we've been using the DOS-based LEAP (Loudspeaker Enclosure Analysis Program) system for several years now at *EA*, and have certainly been impressed with the accuracy of its design tools and performance simulations. With LEAP, the actual prototype enclosure tends to perform very close to the program's predictions, and usually just needs a little fine tuning.

While the current version of LEAP carries a fairly hefty price tag — as you would expect from what's now a very 'professional' CAD package — an array of quite competitively-priced loudspeaker design programs have surfaced since its inception back in 1988. These range from inexpensive 'shareware' packages written by speaker design enthusiasts, through to very comprehensive programs such as the Australian developed CALSOD system from Audiosoft in Melbourne (which is also the distributor of BassBox).

You can download a couple of examples of the low cost shareware alternatives from the EA Reader Services BBS, by the way — see SDES12.ZIP and BOXPLO.ZIP.

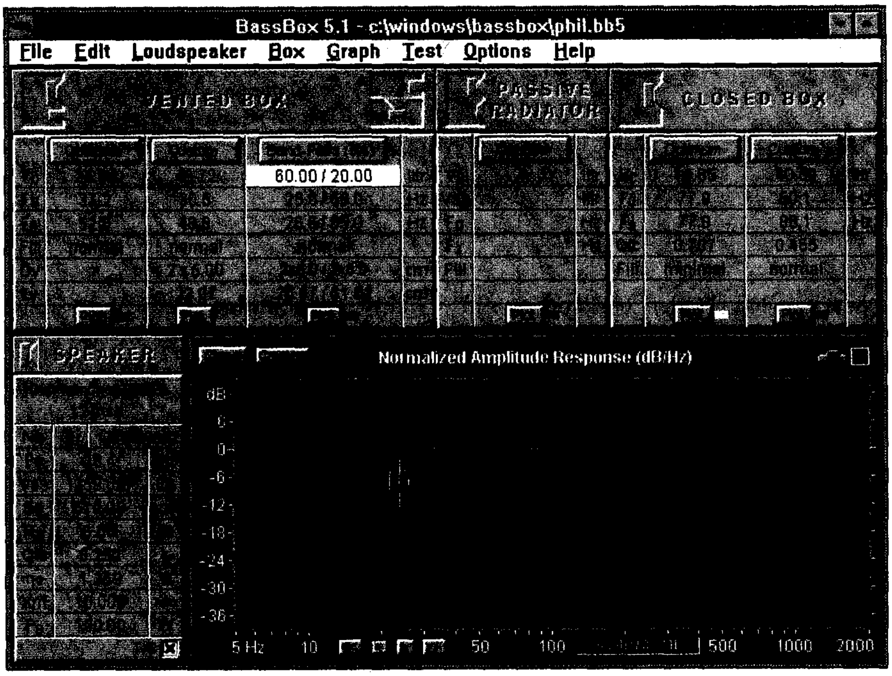
Harris Technologies' *BassBox* appears to take a quite effective middle path in the features/price balance, by concentrating on low-frequency (bass) enclosures only, and leaving the equally complex area of high-frequency driver and crossover network analysis to other dedicated programs — hence the *Bass*box tag.

Thanks to this somewhat more specialised approach, BassBox 5.1 is able to offer a very comprehensive set of analysis routines and utilities for bass cabinet/driver combinations. In practice this is of course the core of any loudspeaker design.

BassBox 5.1 requires a '386 or better machine with at least 4MB of system RAM, and Windows 3.1 (or later) installed. It is supplied on two 1.44MB 3.5" diskettes and requires approximately 7.5MB of free hard disk space — a fairly 'lean' program, by today's standards — and is quite reasonably priced at $189.

When it comes to features though, you could hardly summarise the program's capabilities as lightweight. They include:

- The ability to use drivers from the built-in database, or those entered from Thiele-Small or electromechanical ('BL' etc) data.
- Automatically derived 'optimum' enclosures for sealed and vented designs, which can also be used as a starting point for new designs.
- Definable degrees of box damping (Q) and acoustic fill material.
- Custom 'passive' radiator designs, plus 'extended bass' alignments for vented cabinets.
- Vented boxes can be designed with multiple ports, which can have almost any shape.
- Multiple woofer designs include 'standard', 'push-pull' and 'compound' (*isobaric*, or face-to-face) arrangements.
- Modelling for both fourth- and sixth-order bandpass (multi-chamber) box designs.
- Response plots for amplitude ('normalised' and at 2.83V), maximum acoustic power, voice coil impedance, phase change and group delay.
- An interior acoustic response plot (from a room or automobile interior) can be impressed on a design's amplitude response plot.
- Designs can be loaded and saved, plus all data and plots printed out under control of Windows — and therefore to any supported printer.
- A box dimension calculator which includes a range of predefined shapes, which can be applied to the overall box or internal sub-cabinets, or subtracted from the enclosure to allow for space occupied by speakers and braces.
- A vent dimension calculator for round, rectangular or undefined shape ports, which automatically derives the correct vent size for the selected cabinet's tuning.
- A speaker parameter calculator, that also guides you though the driver testing process (bench



BassBox's main analysis and plotting screen. The red curve shows the response for the program's suggested 'optimum' vented enclosure, while the blue plot is the projected response for a trial bandpass design featuring compound-mounted drivers. As you can see from the highlighted design near the top of the screen the bandpass enclosure has a 60 litre rear chamber and a 20 litre front chamber.

oscillator and multimeter required).

- Response plot data files can be imported from several popular loudspeaker measurement systems, including *IMP*.
- High resolution screen (1024 x 768 pixels) compatibility, which can simultaneously show four response plots along with the standard control panels.

As you can see BassBox offers a pretty impressive list of features and analysis 'tools', and all of these appear to be of practical use when designing bass enclosures, rather than just adding 'bells and whistles' to impress the user.

The impression of a well thought out and nicely 'focused' program is further reinforced by the 115-page manual supplied with the software, which is refreshingly lucid and uses a range of sample screen shots, response plots and diagrams at pertinent points through the text.

Trying it out

Our review copy of BassBox 5.1 included an additional version 5.15 update disk, which was duly installed after the main program was up and running.

There was no obvious change in the operation of BassBox after this was loaded, so we can only assume that version 5.15 is largely a 'bug fix' upgrade.

Thanks to the familiar nature of the Windows operating environment and the quite intuitive layout of the BassBox screens and labels, we had little difficulty in working our way through the program's features. It was interesting to note that despite the range of detailed analysis routines available in BassBox it could be used at a quite low level. After typing in just the basic parameters for a driver (Fo, Qts and Vas), we were were able to design a suitable vented cabinet in short order.

This sort of 'quick and dirty' design procedure appears to be quite practical in BassBox, due to the way it can interpolate a limited range of input data, and automatically offer the user an 'optimum' design for the current driver. This can then be fine-tuned to suit your needs, using the Box Designer and other BassBox tools. As you would expect of course, the final results will be more accurate if a complete set of driver parameters are used during this procedure.

When it comes to fine tuning an enclosure design we were particularly impressed with BassBox's Box Designer section, which automatically provides a quick 'preview' response plot when any parameter has been changed.

While the small preview screen makes no pretences as to its accuracy — there aren't any vertical or horizontal scales — it allows to user to immediately judge the results of a change, without the need for a full analysis and plotting cycle. With this arrangement, you can quickly 'home in' on the desired result, then return to the main screen and plotting routine to confirm your design's performance.

Virtually all other aspects of BassBox were similarly well thought out and easy to use. The program's screens and functions operate in a quite intuitive manner, so we had little need to consult the user manual or on-line help system while completing a number of test designs. In short, we were very impressed with BassBox's operation and user interface.

The only problem we *did* come across was the way BassBox responded when the computer had used almost all of its system resources — or in effect, had ran out of 'horsepower'. This came to light when using a fairly modest '386-based machine, where the program would labour for some time and then fatally crash as it attempted access the built-in speaker database, or print to a Postscript printer.

Since the above machine's configuration is the *minimum* recommended by the program's literature though, we can't really regard this as an overall criticism of BassBox, which rockets along smoothly on more potent machines. In practice, though, we would recommend that you run BassBox on a '486 (or better) computer that's equipped with at least 4MB of system RAM.

As a complete design package for bass enclosures then, we can highly recommend BassBox as a very 'user-friendly' but surprisingly powerful CAD system.

With the ability to deal with compound-mounted speakers in both double and triple-chamber bandpass enclosures, it's very much in tune with the latest trends in loudspeaker design. And with a $189 price tag, it may well be within the reach of many non-professional users.

BassBox 5.1 is available from Audiosoft at 128 Oriel Road, West Heidelberg, Melbourne 3081; fax (03) 9497 4441.

They are also offering both BassBox *and* CALSOD 1.30 in a bundle for $249, which sounds like a very interesting deal indeed... ❖

Silicon Valley NEWSLETTER

Chip market to grow 26% in 1996

The worldwide computer chip market is predicted to achieve a fifth year of better than 25% growth in 1996 and will continue to grow at an average of 21.3 percent through 1998, according to the Semiconductor Industry Association in a forecast presented at the group's 19th annual forecast dinner. Global semiconductor sales were predicted to have risen 43.7% to US$146.4 billion in 1995.

According to the World Semiconductor Trade Statistics (WSTS), the industry statistics organisation within the SIA, the global semiconductor market will grow by more than 26% in 1996 to US$185.1 billion. Chip sales will climb another 18.1% in 1997 to US$218.6 billion, and 19.6% in 1998 to US$261.5 billion.

The memory chip market will be leading the way in 1996 with an estimated 40% increase. Worldwide sales of microprocessors and other micro products will grow 22.4% in 1996 to US$41.2 billion.

Geographically, Japan will remain the second largest regional market at US$47.7 billion in 1996, with a 17.8% growth rate. The European market will rise 26.6% next year to US$36.2 billion, according to the trade group.

"Perhaps we are in fact entering the Golden Age of the electronics industry, where the products spawned by our industry are revolutionising society and the way we live, work and play — thus triggering a period of sustained high growth", said Ray Stata, Analog Devices chairman and chief executive officer, who delivered the forecast address at the SIA dinner.

Not surprisingly, the mood among the 1000 chip executives attending the SIA's annual forecast and awards dinner was festive. With four years of booming chip demand behind them and perhaps a decade or more of healthy growth ahead, there was little need to be overly serious at what the event's MC, Fred Hoar, called "one of Silicon Valley's great annual geek fests."

Few seemed bothered that the SIA appears to have fallen back on an old habit of miscalculating the growth of its own industry. Last year the SIA forecast growth of 15% for 1995, off a bit from the 44% real growth.

Ray Stata said "The forecasts were off, but the actual results were good and it looks like 1996 will be more of the same."

SIA honours IC inventor Jack Kilby

In an announcement laced with irony, 72-year-old Jack Kilby was honoured at the annual SIA dinner as recipient of the Robert N. Noyce award for pioneering the semiconductor industry — and, by extension, the information age.

In 1958, as an engineer for Texas Instruments, Kilby invented the integrated circuit. Almost simultaneously, Noyce made a similar discovery at Fairchild Camera & Instruments in Mountain View.

TI and Fairchild fought huge PR and legal battles in the 1960s, over whether Kilby or Noyce deserved the title of inventor of the integrated circuit. Noyce died in 1990 and the award was created in his name to honour excellence in the semiconductor industry. The integrated circuit, of course has become 'the plankton in the food chain of a trillion dollar electronics industry', said Pat Weber, vice chairman of TI, who called Kilby "a gentle giant who changed the world".

In accepting the award, Kilby said he is personally very pleased to see the impact his invention has had on the world and on the US$150 billion market its has created. "It's been exciting to watch", he said.

Korean DRAM exports booming

Meanwhile, in South Korea, the country's three largest chip makers announced that heavy demand for DRAM memories had sent their exports of semiconductors soaring during the first 10 months of 1995.

Officials for Samsung, LG Group, and Hyundai said the chip export boom was likely to continue throughout 1996, because of demand for memory-hungry multimedia software requiring powerful PCs. The top three Korean chip makers said their exports had risen about 60% to a combined US$10.7 billion in the first 10 months of the year, and could reach US$18 billion in 1996. The chip exports accounted for more than a tenth of South Korea's total exports of US$101.94 billion.

Two of Intel's rivals to merge

In a surprise move that could put some pressure on Intel in the microprocessor market, Advanced Micro Devices announced it has agreed to merge with competitor Nexgen, in an effort for the two companies to compete more effectively with Intel in the multi-billion dollar PC processor market. Under the terms of the all-stock deal, valued at US$865 million, AMD will buy Nexgen of Milpitas and produce Nexgen's Pentium and Pentium Pro-compatible 586 and 686 processors.

AMD and Nexgen executives said they have concluded that to be successful in their struggle against market-dominating Intel, they must combine their respective strengths in processor design and manufacturing.

AMD chief Jerry Sanders III said it was clear that his company could not compete on its own against the "vast resources of Intel", which he said spends seven times as much on chip factories and has a market value greater than that of General Motors.

"It is with tremendous pleasure that I make this announcement," said Atiq Raza, CEO of Nexgen since 1991. "The combination creates an opportunity as hasn't been seen before."

Following the merger, AMD will abandon its K6 processor development program and manufacture Nexgen's 686 chip at its state-of-the-art factory in Austin, Texas. However, Sanders said AMD will go forward with its much-delayed K5 chip, which is due out next summer. Once those projects are finished, AMD and Nexgen will combine their design resources to launch future generations of chips.

"Our goal is 30% of the market (about 30 million chips) by 1998", Sanders said. "We think this is a major event in the chronology of the PC industry."

Analysts said that while AMD has done a good job increasing manufacturing capacity to challenge Intel, it has been slow in bringing its new K-5 Pentium clone to market. Meanwhile, Nexgen has designs on par with Intel, but didn't have the manufacturing capability.

Sanders said AMD will operate Nexgen as a subsidiary and will keep all its employees. He said Raza will serve as chief technology officer of AMD and become a corporate vice president as well as retain his titles as top executive of Nexgen.

In addition, Vinod Dham, Nexgen's chief operating officer and former Intel Pentium designer, will serve as head of the combined company's processor design teams for the sixth and seventh-generation chips.

Cirrus to invest $2 billion in fab

Cirrus Logic, the world's first fabless semiconductor company with sales in excess of a billion dollars, has announced plans to invest some US$2 billion over the next five years in a variety of joint chip foundry projects that will ensure the Fremont-based company a steady supply of its popular multimedia and communications components. Cirrus also announced the financial results for its most recent quarter, showing a sales increase of 57% and profits surging 166%.

For the second quarter of its fiscal 1996, Cirrus said profits jumped to US$33.0 million, from $12.4 million in the same period a year earlier. Sales grew to US$317.8 million from $202.2 million.

Among the alliances announced by Cirrus is a joint venture with IBM to spend an additional US$195 million during the next 18 months for new production lines at an IBM facility in upstate New York.

Cirrus said it has also formed a new joint venture with AT&T's microelectronics group to start production in 1997 at an AT&T facility in Orlando, Florida. Cirrus will own 40% of the unnamed joint venture, while AT&T will hold 60%.

Cirrus will also invest US$90 million in the formation of a new company in Taiwan called United Silicon Inc., which will have the financial backing of both Cirrus, along with United Microelectronics Corp. of Taiwan and two other US chip companies whose names have not yet been made public.

Finally, Cirrus plans an expanded relationship with Taiwan Semiconductor Manufacturing Co., a foundry, calling for Cirrus to lend TSMC about US$120 million during the next three years.

At the recent Dataquest Semiconductor 1995 Conference, Sematech chip research consortium chief operating officer Jim Owens predicted that the world chip market could reach the magical trillion dollar mark as early as 2005, or 2008 at the latest. He also predicted that the industry may well achieve these huge increases in sales volume without any of the traditional 'boom or bust' cycles.

Motorola joins DRAM alliance

Motorola has moved to become a major player in the high-stakes DRAM memory chip business by joining the three-continent DRAM alliance of IBM, Siemens and Toshiba. The alliance has has successfully developed a production-ready 64Mb DRAM, a fully functional 256Mb DRAM and is hoping to bring an even more advanced 1Gb memory device to market.

"The existing alliance clearly is one of the most powerful and successful in the industry. It's a premier team of the world's best scientists and engineers", said Dr Michael Attardo, general manager of IBM's Microelectronics Division. "We are proud of our successes. We relish the future and all of its possibilities. We welcome Motorola as the newest member of the team."

"Motorola's enthusiastic participation in this alliance underscores our commitment to provide our customers with the most advanced memory technology," said Tommy George, president of Motorola's Semiconductor Product Sector.

National, Eveready to make new batteries

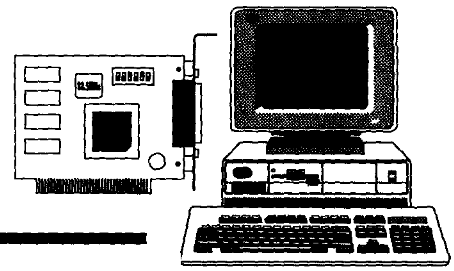
With the use of portable computers and communications devices in ever more critical business applications, National Semiconductor and the Energizer Power Systems division of Eveready Battery said they have agreed to respond to the demand for batteries that offer longer-lasting charges and require much less time to recharge. Together, the two companies said they hope to develop new intelligent battery solutions for rechargeable nickel-based battery chemistries.

The two companies have worked together on various battery projects since May 1994, particularly on charge-control and fuel gauge design. The new agreement expands the cooperative venture and sets the stage for integrating a wide range of battery chemistries from Energizer Power Systems with a series of new integrated circuits from National Semiconductor. The systems will encompass a variety of controls for intelligent battery-power packs including charge control, fuel gauging and protection circuits.

"The demand for longer battery life and shorter charge cycles has taken on a new urgency due to the increased use of portable equipment in critical business applications", said Mark Levi, National's vice president of analog marketing.

"Although battery types and their behaviour are changing rapidly to meet the needs of new portable product designs, the basic electronic solutions under joint development are adaptable across the board." ❖

Computer News and New Products



80C51XA development system

Ashling Microsystems, under an agreement with Philips Semiconductors, introduced the Ultra-51XA microprocessor development system for the new Philips 16-bit 80C51XA microcontroller.

The system provides a complete development environment for the Philips XA microcontroller family, hosted under Windows. It includes an in-circuit emulator operating at clock speeds up to 50MHz, 'Pathfinder for Windows', source level debugger and SEA-XA real time performance analysis system for XA applications.

A uniform user interface supports editing, C-compiling, assembling, linking, simulation, in-circuit emulation, performance analysis, code coverage measurement, software validation reporting and EPROM/EEPROM programming.

After debugging a 80C51XA microcontroller program with the Pathfinder for Windows debugger, the designer can immediately return to the WinIDEAS editor, at the appropriate line in the source file, to change the source program. With a single keystroke, WinIDEAS re-compiles and re-links the program, downloads it to the in-circuit emulator and resumes debugging at the same line in the source file.

For further information circle 161 on the reader service coupon or contact Metromatics, PO Box 315, New Farm 4005; phone (07) 3358 5155.

Smart sound card

The MA594 is an intelligent 16-bit sound card that combines recording and playback with control functions. It is compatible with Microsoft's WAV audio file format which has been adopted by virtually all PC-based sound cards, including Soundblaster. Fourteen sampling frequencies are available, including standard multimedia frequencies of 11, 22 and 44kHz. Five data formats are supported: 16-bit linear PCM, A-Law and u-Law PCM, 8-bit linear PCM and IMA ADPCM.

On-board sound memory supports EPROM and Flash devices. An optional MA502 adaptor enables playback from one or two PCMCIA memory cards. With two 40MB Flash cards, maximum playback time is over two hours with a 5kHz audio bandwidth. The I/O includes Line In/Out ports, microphone and speaker lines, serial port, 16 parallel lines and I^2C bus interface.

The on-board control software (VPM) includes routines to compress (2:1) 16-bit linear PCM files to an A-Law format and to program sound files from PC disk into Flash memory cards. The VPM software allows over 4000 audio segments or phrases to be linked, to provide complex announcements.

An optional embedded assembler (VPMASM) is available for custom control software development. User

'Multimedia' computer case

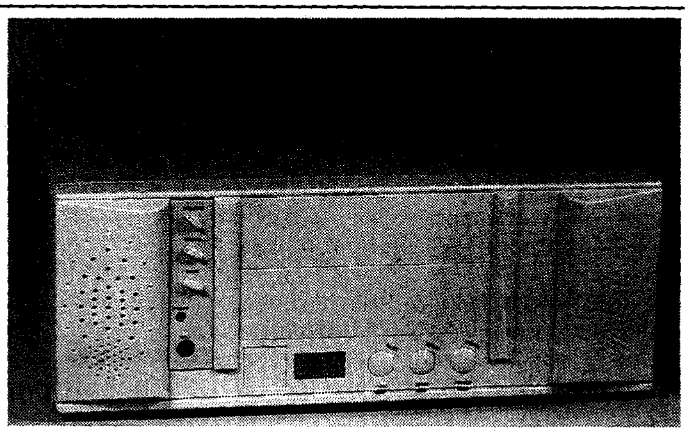
Rod Irving Electronics is now stocking a 'Multimedia' computer case, which has inbuilt stereo loudspeakers to save desk space and provide a tidier system than when the usual separate speaker boxes are used.

The case measures 360 x 400 x 135mm (W x D x H), and in addition to the inbuilt speakers also includes both a 200W switchmode power supply and a compact stereo amplifier with an output of 2 x 10W.

The amplifier provides both treble and bass tone controls as well as a volume control, all conveniently accessible from the front of the case. At the rear are mic and auxiliary audio inputs, and optional external speaker sockets.

Other features of the computer case include a three digit seven-segment LED speed/status display, three front control buttons (power, reset and turbo) and three status LEDs (HDD, turbo and power).

It also features eight push-out rear card slots, provision for mounting a 3.5" HDD and up to two 5.25" or CD-ROM drives, a slide-on top with five rear screws and all motherboard and expansion card mounting hardware.



Priced at only $149.65, the Multimedia Computer Case has the catalog number X11084 and available from all RIE sales outlets.

control software can also be written in an on-board proprietary programming language (Voice) which is optimised for applications needing simultaneous voice output and control functions.

For further information circle 162 on the reader service coupon or contact Microcontrol (Australia), PO Box 1020, Pymble 2073; phone (02) 449 1546.

486 CPU card has on-board VGA controller

Aaeon Technology's new SBC-450 is a half-size all-in-one single board 486 computer with an on-board VGA CRT/flat panel controller. The SBC-450 is fully PC/AT compatible.

The on-board VL-bus VGA CRT/flat panel controller uses the C&T 65545 chipset and supports resolutions up 1024 x 768 in 16 colours or 800 x 600 in 256 colours.

The on-board features include two high speed RS-232 serial ports with 16C550 UARTs, one bi-directional parallel port, and an IDE hard drive controller and a floppy controller. If program execution is halted by a program bug or EMI, the board's 15 stage watchdog timer can automatically reset the CPU or generate an interrupt.

The unit provides two 72-pin SIMM sockets for on-board DRAM, of up to 64MB. Industry standard PC/104 modules can be added to meet system requirements.

For further information circle 163 on the reader service coupon or contact Amtex Electronics, PO Box 285, Chatswood 2057; phone (02) 805 0844.

Power system management

Testing and Certification Australia has introduced Polylogger II — the successor to the Polylogger used by power authorities throughout Australasia.

Polylogger II provides simultaneous three phase voltage and current logging and computer analysis in a Windows environment. The new instrument offers measurement of real and apparent power, power factor and energy; quality of supply analysis features including logging of power surges and sags; increased memory; and multi-voltage capability.

The unit is designed to carry out load and voltage surveys, load balancing, voltage complaint investigations, and energy auditing.

Features of the software include

mouse operation, direct colour printing of graphs, zoom and compression of graphs, statistical analysis and comprehensive help.

For further information circle 164 on the reader service coupon or contact Testing and Certification Australia, 14 Nelson Street, Chatswood 2067; phone (02) 411 5180.

Data acquisition in Excel

Iotech has released DaqViewXL, a Windows 3.1 and Windows95 compatible data acquisition and display application that seamlessly integrates into Microsoft Excel spreadsheet software.

DaqViewXL is the first entry in Iotech's new series of products designed as 'software components' that can be launched and operated from inside a 'home' application such as Excel.

DaqViewXL enables users to set up data acquisition applications from within Microsoft Excel without programming, and provides graphical access to all the functions of Iotech's parallel port based DaqBook, plug-in DaqBoard or DaqPCMCIA card data acquisition products.

DaqViewXL permits hardware configuration for range, trigger condition, sampling rate and signal conditioning via a graphical interface that eliminates all programming.

It also provides a strip-chart recorder-like display that can be opened with Excel to view acquired data in real time. DaqViewXL's installation results in the addition of a new tool bar in Excel, providing access to all of DaqViewXL's features from within Excel.

For further information circle 165 on the reader service coupon or contact Scientific Devices Australia, 2 Jacks Road, South Oakleigh 3167; phone (03) 9579 3622.

Low cost version of Visual Designer

Intelligent Instrumentation has announced a low cost version of the Visual Designer Application Generator Software (PCI-20908S-1) for students, colleges, universities and other academic institutions.

Visual Designer is a Windows-based application generator for PC-based data acquisition and control. It allows users to develop custom applications by drawing block diagrams (FlowGrams) of their applications rather than coding the applications with a programming language. Customisable displays include plots, instrument panels and control panels. The software supports a variety of GPIB (IEEE-488) instruments and serial devices.

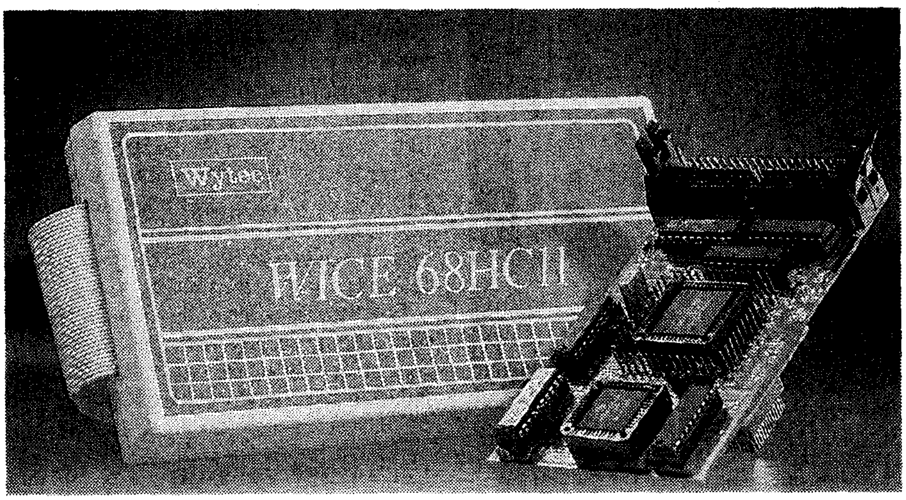
For further information circle 166 on the reader service coupon or contact Kenelec, 2 Apollo Court, Blackburn 3130; phone (008) 335 245.

68HC11 in-circuit emulator

Technology Affair has released the G5 probe for the WICE 68HC11 low cost in-circuit emulator, further extending the support to the 68HC11G5, 68HC711G5 and 68HC11G7 family of Motorola devices.

The system provides real time emulation for the Motorola 68HC11 family, in both expanded and single chip modes, at speeds up to 20MHz.

It supports symbolic debugging for a wide range of assemblers and C compilers, and incorporates hardware breakpoints with break on address, address range, memory read and memory write.



The emulator communicates with a host PC via a standard RS-232 COM port at 115.2Kb/s, allowing fast uploading and downloading of files in Motorola S-record, Intel hex and Tektronix hex formats.

The host PC software supplied with the emulator provides a windowed user interface that monitors user selectable memory locations, stack locations, CPU registers and breakpoint configurations.

It incorporates standard features like single stepping, breakpoints, on-line symbolic assembler and disassembler, fast file downloading, logic analyser trigger output, EEPROM erasing and programming, plus a range of commands for searching, displaying and modifying memory and CPU registers.

It also includes advanced features like peripheral simulation, which allows the target software to use the host PC as a peripheral device, for simulating target hardware in real time during software development.

For further information circle 167 on the reader service coupon or contact Technology Affair, 57 Wessex Street, Carine 6020; phone (09) 246 4810.

Solid state relay board

Procon Technology has released an externally mounted solid state relay output board. Manufactured in Australia, the PC-IO-LH2 board has been designed for operation in the most arduous conditions.

The boards are mounted externally and can be operated through any IBM-PC bi-directionally parallel printer adaptor interface (many PCs, notebooks and industrial PC/104 computers have compatible interfaces). The PC-BD-IO interface card is recommended for guaranteed operations and full expansion capability.

Three DIP switches select each board's address, allowing up to eight cards to be daisy chained with a single 25 way cable providing expansion up to 120 outputs. The 16 single pole single throw solid state relays are each rated at 120mA at 350V DC or peak AC.

The relay outputs can be used to control lamps, solenoids, motor contactors, and other high voltage equipment. They can also be used to switch low current analog or digital signals. EAch output provides 3750V RMS isolation from the other, and from the computer circuitry, providing maximum immunity to electrical noise and maximum flexibility in the system's design.

The relays have current limiting and over temperature circuitry, enabling them to pass FCC 86.302 and other regulator voltage surge requirements, when the over-voltage protection option is used. Ideal for telecom use, they employ a low current limit suited for ground fault applications.

For further information circle 168 on the reader service coupon or contact Procon Technology, PO Box 655, Mount Waverely 3149; phone (03) 9807 5660. ❖

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KEY TO CODING

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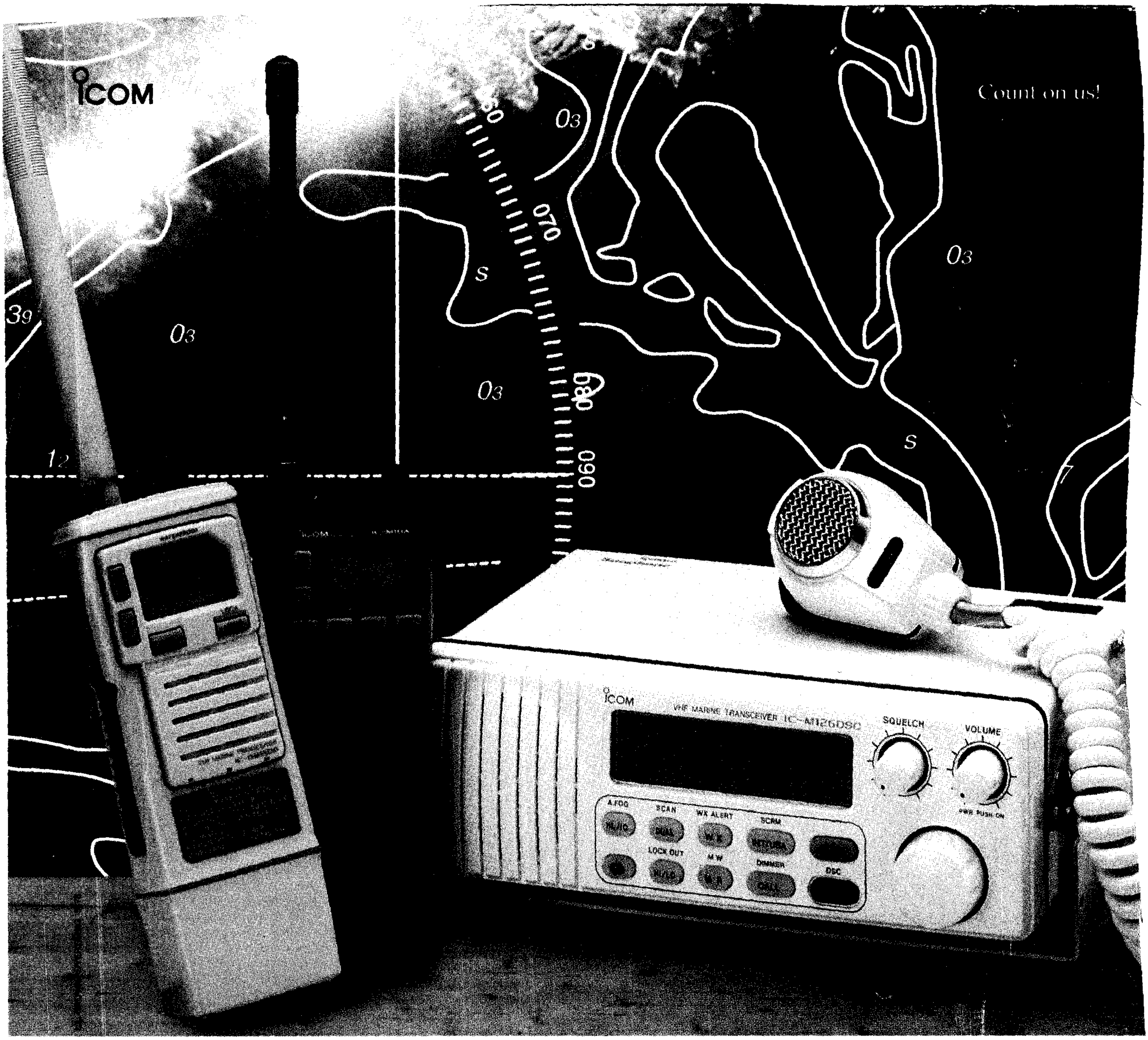
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