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FEBRUARY 1992

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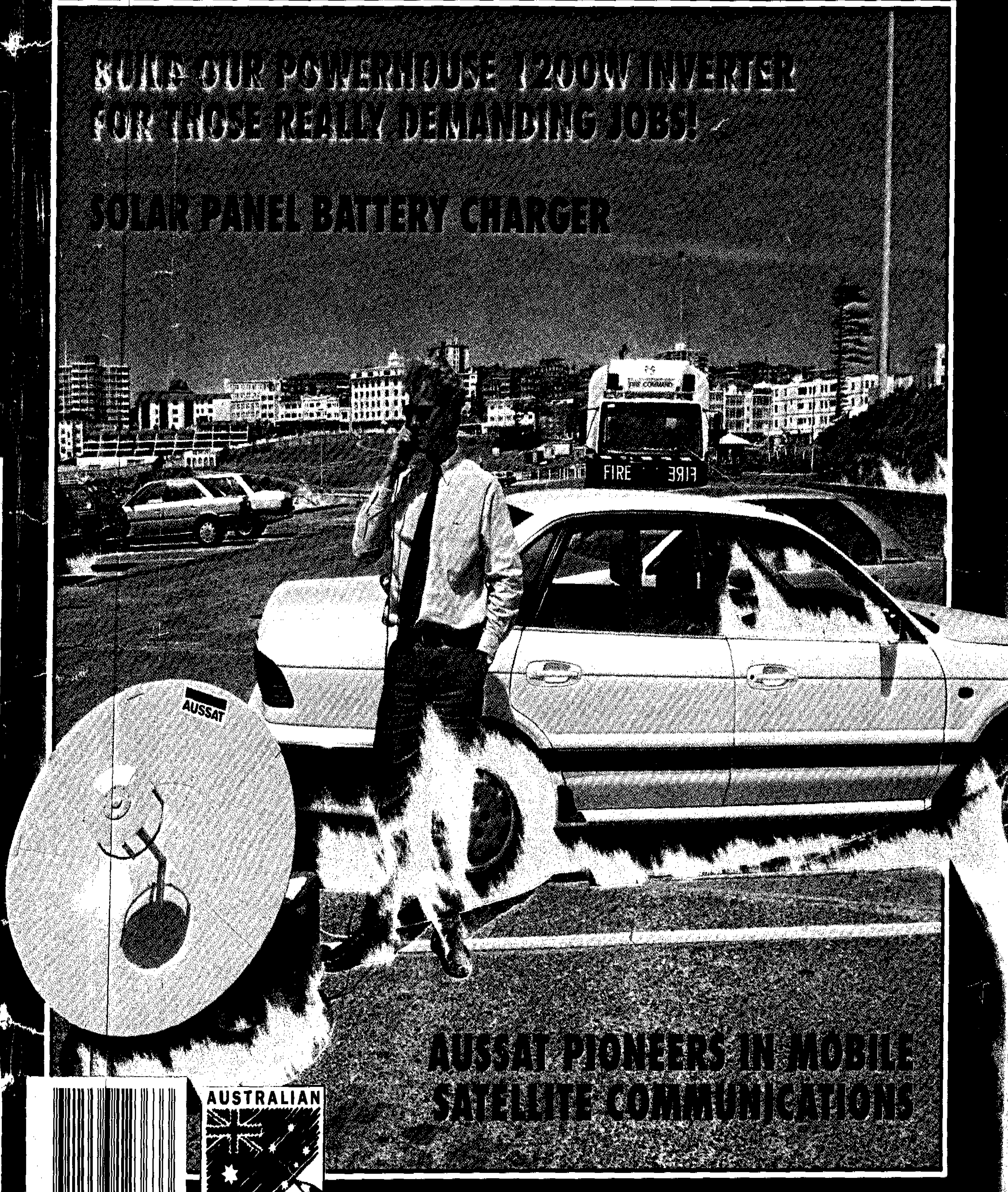

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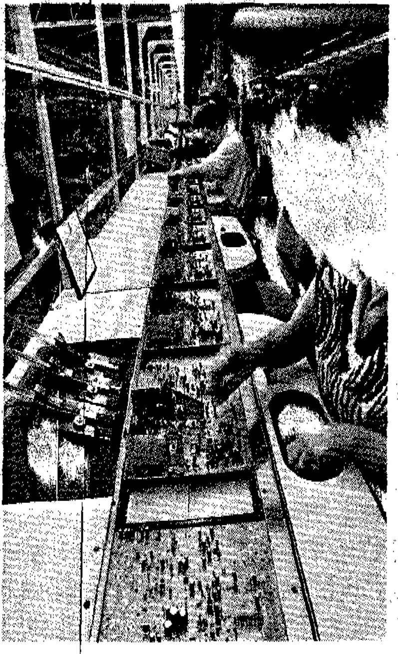
Electronics Australia with ETI

February 1992

AUSTRALIA'S LARGEST SELLING ELECTRONICS MAGAZINE — ESTABLISHED IN 1922

New Panasonic CTV is being made here



Promoted in ads as 'THE ONE', Matsushita/Panasonic's new big-screen CTV is being assembled at the firm's plant in Penrith, NSW. As Barrie Smith explains in his story starting on page 8, the set is also known unofficially as the 'Trinitron cracker'.

A 12V/240V inverter for those really *big* jobs

Our new Powerhouse 1200 inverter design can deliver 1200 watts continuously, or 2400W surge, to power 240V appliances from either a 12V or a 24V battery (two versions). It's also crystal locked, for frequency stability. The description starts on page 52.

On the cover

Brian Woodward came upon Aussat's engineers at Sydney's famous Bondi Beach, demonstrating a prototype mobile satellite communications set for emergency services representatives. Brian's feature story about Mobilesat begins on page 18. (Picture by Brian Woodward)

Video and Audio

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Projects and Technical

Professional Electronics

Columns and Comments

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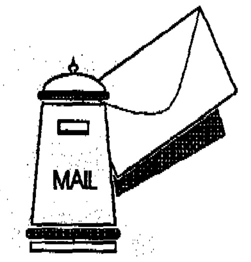
LETTERS TO THE EDITOR



Schematic wanted

I would appreciate the publishing of this letter in your magazine because I need help from your readers. I have a two band clock radio — AM and FM — model RD-918 Copal. This set does not work. It's a mains operated set.

Could I request any of your readers to send me a circuit diagram of this model or a circuit for a two band (AM/FM) clock radio designed for AC mains and battery operation.

I am a member of the Oakleigh Public Library, Clayton branch, where I am able to have access to this magazine.

Looking forward to your publication of this letter and the hopeful response from one of your readers.

R.A. Hendricks,
4/183 Carinish Road,
Clayton, Vic. 3168

80m SSB receiver

I wish to point out the following errors that have appeared in the 80m SSB receiver article of September and December 1991 *EA*.

1. In the parts list C13 should be 82pF not 47pF as shown. The schematic diagram is correct.
2. In Fig.3 the PC overlay, black dots indicating connection to the groundplane, are missing from:
   (a) R4, the end connected to VR3.
   (b) C8, the end nearest the end of the PC.
3. The second last paragraph of the December article referring to polystyrene capacitors around the VFO should have been deleted.

I initially designed the VFO with ceramics but changed my mind in favour of polystyrenes after a couple of prototype oscillators using ceramics exhibited excessive drift. Although the supplied floppy disk Word 5 file contained the paragraph referred to above, I did send a covering letter, indicating that it should be deleted.

This now unfortunately creates an embarrassing situation where polystyrene capacitors are specified in the parts list, and the second last paragraph recommends that they not be used. Perhaps you may find an easy way out of this problem!

It has come to my attention that the CA3028 has become difficult to obtain in the 8-pin round package. VSI in Sydney can supply the device in a standard 8-pin DIP plastic package, having the same pin for pin functionality. If constructors can't obtain the round package, it is possible to use the DIP device with the original PC layout. Carefully solder small lengths of wire (cutoff pigtails) to each pin. Then form the extended pins into a circle and place into the PC holes. Push the IC down as far as possible without shorting to the groundplane. Double check the orientation of the pins, solder in place and trim off the excess leads.

I have tried this method and it worked with no problems evident.

Leon Williams, VK2DOB,
Bungendore, NSW.

Balun for HF receivers

I commend the construction project in your *EA* May 1991 issue, Variable-tapped Balun for HF receivers, by Tom Moffat, VK7TM. I built one, after straining my bifocals to the limit and trying not to shake whilst soldering the fine tapping points to the coil.

I've replaced the co-ax from the straight dipole with twin-lead and now feed through the balun into my main receiver, Kenwood R5000. Manmade noise has never worried me very much in my area, or so I thought, until I tuned across the range from 150kHz to 30MHz.

With some occasional ratio shifts on the balun, I am clear of noise and my S-meter seems to be peaking higher.

In fact I've had to back off on both RF gain and RF attenuator to avoid front end overload on internationals, and with some of the faint distant signals, I can wind up the audio volume without sharing it with manmade 'mush'.

I think this was a remarkable project for the end result. I am an SWL only, but I would like to read more articles of this nature related to my hobby — particularly with the pre-amble explanation and clear logic that Tom Moffat uses to explain his point. I've learned a lot from his articles. That variable balun is a good project, I'm waiting for more.

I've been a reader of *R&H* since before 1941.

Bruce Grant,
North Balwyn, Vic. 3104

Comment: It's great to hear that you're *still a reader after 41 years. Tom has his own column now and your comments have been passed on.*

Carburettor parts

I read with interest Tony Mercer's article on electronic engine management systems (November 1991) on modern cars and I would like to point out an item of interest.

The vacuum advance method Tony describes was certainly adopted on the early British car for which he went shopping for SU carburettor parts. And it really did operate the way he says.

However, by the early 1970's vacuum advance had pretty much dropped that method (known as Vacuum Ported Advance) and had adopted Spark Ported Advance. The fundamental difference is that Spark Ported Vacuum Advance is fed from ABOVE the throttle and not BELOW it, and Spark Ported Advance increases with throttle opening.

Also it provides no advance at all at idle or on the overrun. However, like Vacuum Ported Advance, it remains dynamic, i.e., take the case of a vehicle travelling along a flat road with the driver holding a constant throttle setting.

If the car then encounters a hill and the throttle is held at that setting, the increase in engine load will cause a drop in vacuum. This drop in vacuum will cause the vacuum advance to 'fall back' onto the current level of centrifugal advance. When the car regains speed on the next level section of road, the increase in vacuum will pull the diaghram back into the advanced position.

My motor manuals for various cars claim Spark Porting to provide better fuel economy, better performance, and seeing how my car conforms to ADR27A, superior emission control. Pre-ADR27a models of my car were vacuum ported in the automatic version. My ADR27A auto model is Spark Ported.

A great magazine. Keep up the good work. Also thanks to Peter Philips for his article on power amplifiers.

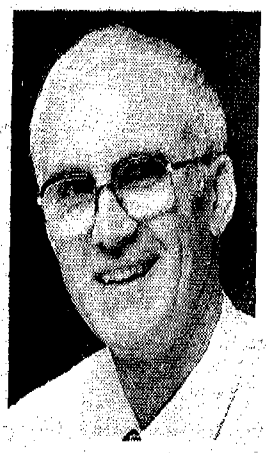
Tim Gard,
Waverton, NSW.

Radio and TV services

With reference to the list of Radio and TV broadcasting services on page 111 of your November 1991 issue, please be advised that our call letters are PMFM not 6PMFM.

Ray Holman,
Chief Engineer,
PMFM,
Subiaco, WA.

EDITORIAL VIEWPOINT



More musings on science and technology education...

Here we are again at the start of a new academic year. The annual holidays are behind us, and large numbers of young people are preparing to start another year of their formal education — whether it be at school, TAFE college, CAE or university. It's a time for hope and optimism, and I for one am hopeful that there'll be no further decline in the number of people choosing subjects or courses directed towards science and engineering. I know I've written about this before, but I firmly believe that Australia is going to need all the scientists and engineers we can get, if we're not to sink into the status of a 'banana republic' — or worse.

When I wrote about this subject in last October's and November's editorials, one or two readers thought I was endorsing the idea that science and engineering in general, and electronics in particular, are somehow 'boring' subjects which have little intrinsic appeal for for young people. Far from it — in fact I believe that they're basically *extremely* interesting (although I'm perhaps just a tiny bit biased). No, what I meant was that somehow these disciplines are often still very badly presented and 'sold' to young people, so often they don't get the opportunity to *see* how interesting and satisfying these activities can be.

Perhaps this is due to the fact that many scientists and engineers tend to be rather shy, retiring people, who are often not very comfortable 'selling' or 'marketing' the value of their work. Of course there have been and still are notable exceptions, like Michael Faraday, Julius Sumner Miller, Harry Messell, Stephen Jay Gould and Paul Davies; but on the whole they tend to be few and far between.

How then to get more young people interested in science and technology? I'm sure TV programmes like *Quantum* and *Towards 2000* play an important role, because we're now undoubtedly in the 'audio-visual' era where young people in particular tend to be more receptive to information presented to them in this form. But understandably as a magazine editor I'm still convinced that printed media like *Electronics Australia* have a worthwhile role to play as well.

It seems to me that there are still many aspects of electronics in particular that can benefit from the detailed, systematic and in-depth treatment that can best be provided by a magazine. We can be much more cost-effective than video, more accessible and of course much more *permanent* as an information reference.

What then are we at *EA* doing, to help interest young people in electronics and science? Well, we run many articles on educational projects, like Peter Murtagh's series on 'Experimenting with Electronics', and also others on basic theory — like the ongoing 'Basic Electronics' series by Peter Phillips and the 'Basics of Radio Transmission and Reception' by Bryan Maher (all three of these writers are experienced teachers of science or electronics, by the way). We also run articles on scientific discoveries and achievements, whenever the opportunity arises.

No doubt we could do more, and I'd be happy to receive your suggestions. I'd also like suggestions on how we can do more to encourage young people to pick up magazines like *EA* in the first place — because unless they do this, they never will find out what's inside...

Jim Rowe

Matsushita's latest hi-tech, Australian made CTV:

MAKING IT BETTER, AND MAKING IT HERE

The latest high quality colour TV set from Matsushita/Panasonic is known officially as 'THE ONE', but unofficially as the 'Trinitron cracker' — revealing the Company's aim of using it to break Sony's grip on the large-screen end of the market. The 68cm version is being made in Australia, in a plant which has adapted Japanese manufacturing know-how to local conditions...

by BARRIE SMITH

In 1968, the Australian Government invited Matsushita to open a TV set factory in Australia — just 12 years after local TV transmission had begun. The initial production run consisted of sets no larger than 48cm.

Colour arrived in 1974 and the Penrith, NSW plant began manufacturing the sets to receive the broadcasts. The total industry production figure in that year was 67,000 — with no imports.

By 1976 the number sold in this country reached 1,172,000, with only 42% locally made.

This total sales figure has never been equalled — a measure of colour as a sales incentive.

Today, there are three TV set manufacturing plants in Australia: Matsushita, Sharp and NEC.

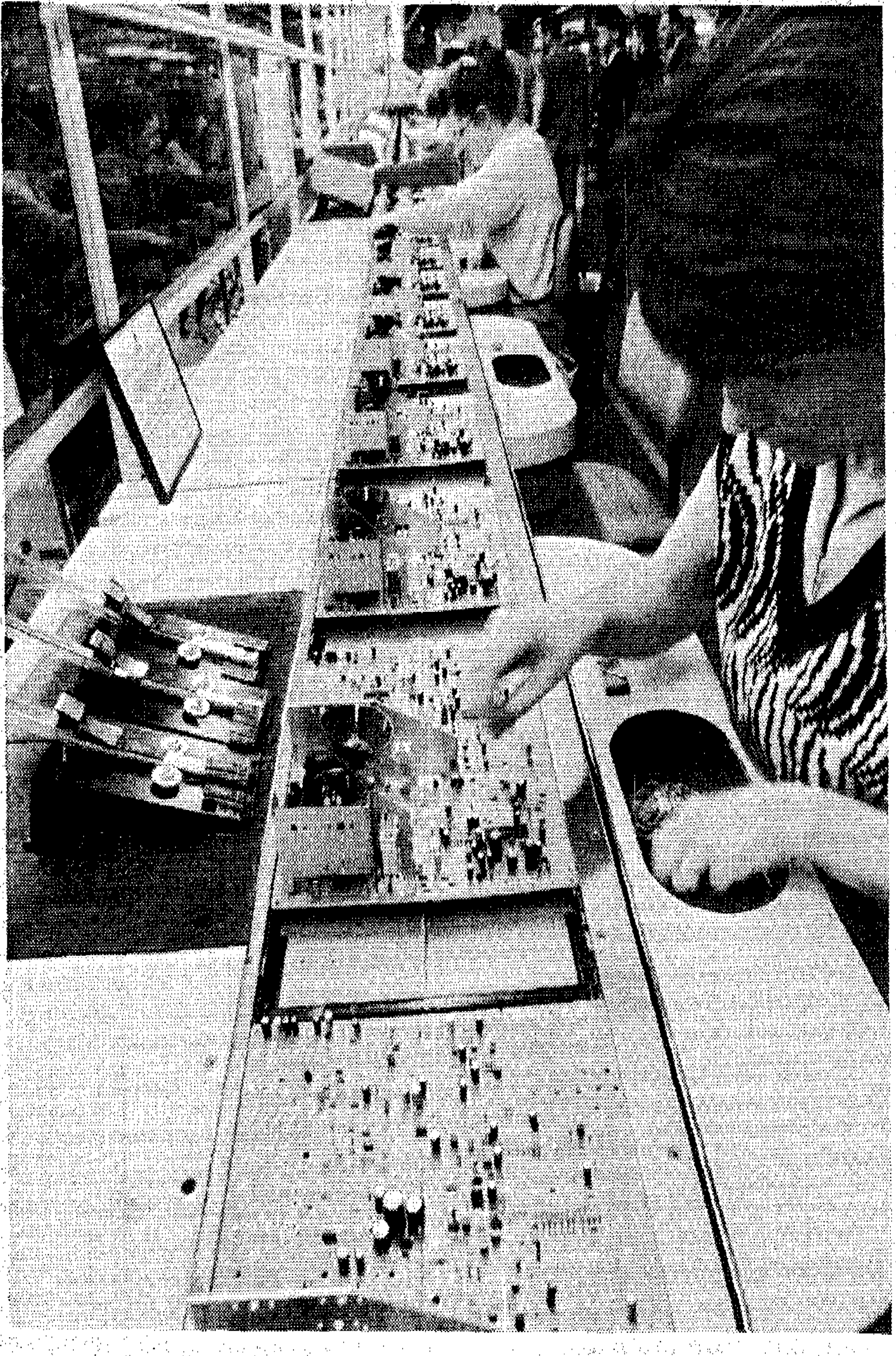
In 1990 sales reached 724,000 sets — of which 22% were locally produced. Of the former figure, Matsushita — or Panasonic as the company's brand is known — was responsible for 61%.

1991 was expected to see the total rise to 740,000 — projected to be the third biggest figure on record.

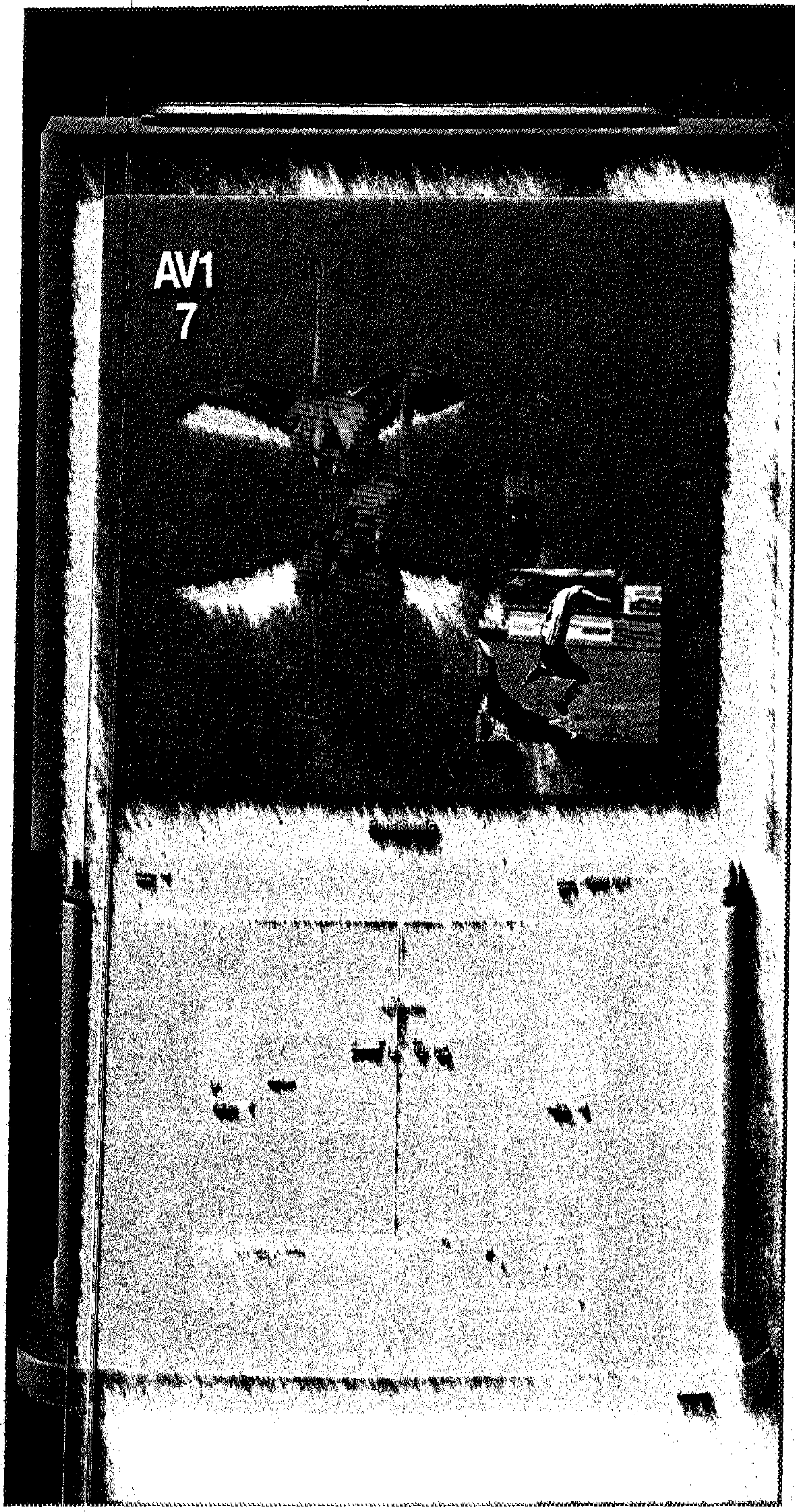
The interesting component of the figures in 1990 and 1991 is that the driving force in the total are the larger screen sizes. So it appears we're going to see more locally produced sets from the Australian plants — and those sets will be the larger ones.

Matsushita's Pana-sonic plant in Penrith is far from large, by Japanese standards. It also differs from most in that the production lines are spread wider apart.

This is because Australian workers prefer more 'personal space' than their Japanese counterparts, according to



A shot looking along the production line, showing the careful hand assembly of the main printed circuit board used in the sets.



the Company's GM/Manufacturing Ross Henderson.

Undoubtedly, the racial mix in the Penrith plant would raise eyebrows in Osaka also: the 156 employees come from 14 different national origins. The average age is 37 years.

The factory is notable also for being the first outside Japan to engage in production of the company's new, high quality colour set — modestly labelled 'THE ONE'.

THE ONE is Panasonic's 'Trinitron cracker' — the one the company hopes will crack Sony's dominance of the high quality TV set market.

The Trinitron design has been around for a long time, and has been arguably the best approach to colour displays not only for domestic TV sets, but computer monitors as well.

But now the opposition is claiming the blue ribbon, with advanced tube shape, new phosphors and glass pigments.

The Panasonic set has been three years in development, and is currently being produced in two screen sizes: 68cm and 78cm. The former is the only one made at the Penrith plant — leaving the doors at the rate of 7,000 a month.

The set differs from the company's previous models in a number of respects: a flatter, squarer picture tube; reproduction of black areas has been improved; brightness and focus of the picture has been improved; screen phosphors have lifted overall colour rendition; definition has been raised by use of Invar metal in the shadow mask; and a new sound system using domed ports has been installed. (See sidebar for detail).

Plant tour

Recently I was able to tour the Penrith plant with other journalists, to see for myself how the new sets are made. We were shown around by Ross Henderson and Scott Yamaguchi (GM — Engineering).

The product of the plant is made in an essentially fuss-free and clean procedure: no fumes or gases.

The more you come in contact with Japanese industrial complexes the more you appreciate what appears to be a national proficiency in organising the manufacturing process.

The aisles between machine tools are tidy, with no boxes of parts littering the floors, no piles of waste — and, most important of all — a definable flow of the manufacturing process from small component to larger assembled sub-assemblies to final, fully manufactured product. In this case, a 68cm TV set. A large chart is fixed to the wall at the factory's entry, outlining the whole process.

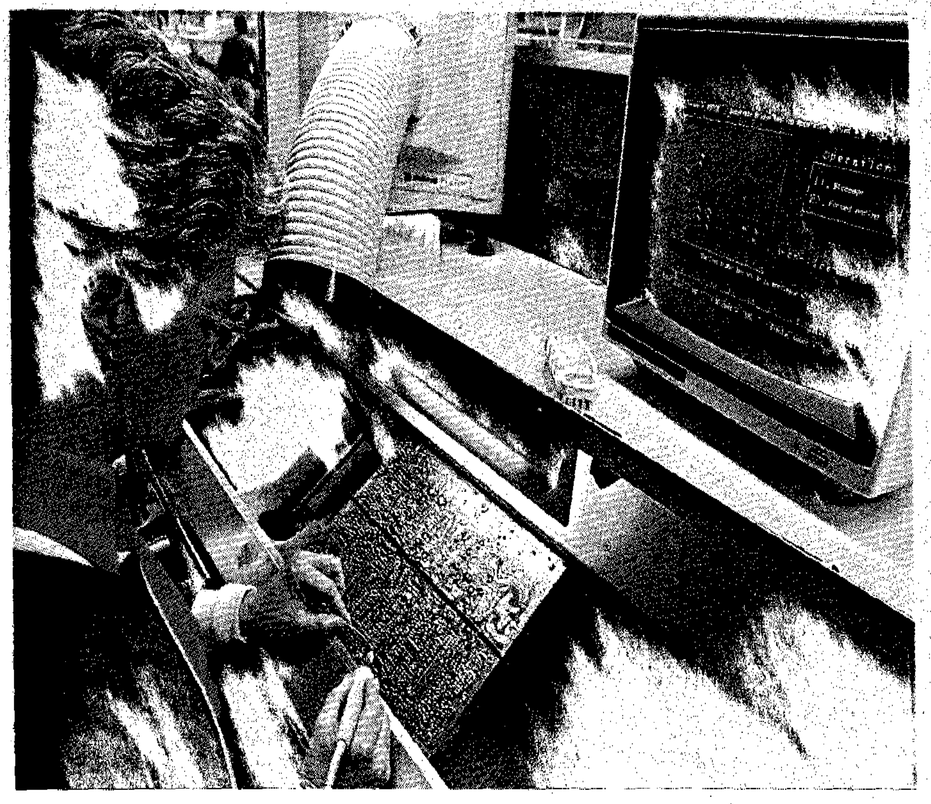
The production flow was carefully explained to us, but when a number of us began to raise our cameras to the eye, there came a polite admonition from our hosts to the effect that 'We would prefer you don't photograph that — for intelligence reasons'.

You began to realise how important, and individual, the structure of a production line is to a Japanese company. A row of robot machine tools — made by another branch of Matsushita itself — performs the initial auto insertion of parts into the PCB.

Some 84% of the components are inserted by machine. The ubiquitous TV monitors display the immensely complex work of the robots as they insert parts to an accuracy of 1 micron. Many finished parts measure as small as 5mm.

Insertion is completed manually on two sub-PCB lines. Wave soldering is used on each PCB line, and a board tester automatically searches for missing

Matsushita's hi-tech CTV



Most of the soldering on the PC boards is done by machine, but the finishing touches are done by skilled hands, as shown above.

or faulty components. At this point a 'local memory writer' loads the tuning frequencies into the TV's circuitry. An alignment and testing process then sets up the RF sections, adjusting video signal levels and functionally testing the chassis. Then assembly of main and sub PCBs, cabinet assembly, picture tube, chassis and speaker follows on a manual production line. Inspection follows, involving operational checks and the setting of some parameters for ageing characteristics. Then the sets go through a series of display alignment checks:

Purity — where the CRT's beam landing is set to achieve colour uniformity.

White Balance — where RGB levels are set to produce the correct colour temperature.

Convergence — where the R,G, and B beams are adjusted to ensure they strike at the same point, over the full screen.

Sub Brightness — where the black level is set.

Final inspection tests cover the areas of electrical interference, mode functions, picture and sound quality, concluding with cabinet integrity itself. Completed sets are selected for testing and assurance that operation follows specs.

Impressive performer

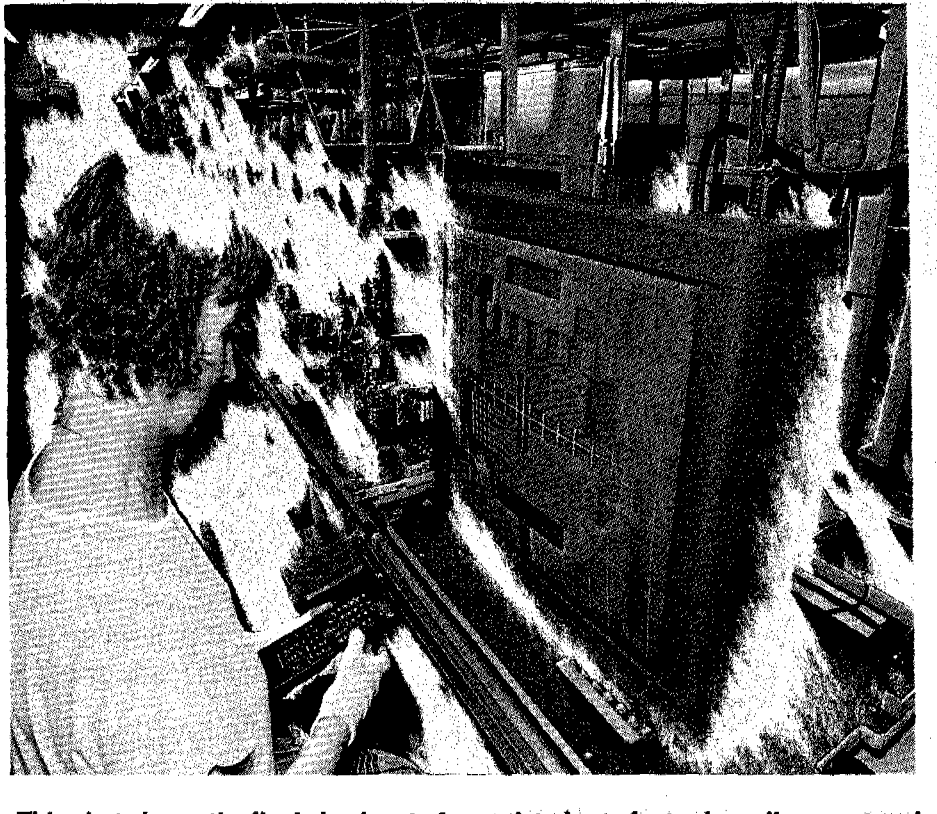
I have used one of the sets as a display monitor to photograph colour stills for press reproduction, and have become fairly familiar with its characteristics.

From the start I was impressed by the quality of vision and audio. Perhaps I should have been, with the sets' prices beginning at $2,000 and heading to near $5,000 for the larger screen version. Both can be bought with Teletext — for roughly $500 more. The 'superflat' picture tube is 30% flatter than previous models. During the Penrith visit I saw cutaway 'before and after' comparisons, with quite obvious physical differences to previous designs. The benefit is a screen surface which can be viewed from a wider viewing angle, with fewer reflections. The tube's MPF (multi-prefocus) electron gun uses a six electrode, three lens construction, which is said to improve spot focus by 15% at the edges and 20% at picture centre.

The Invar metal shadow mask is considered a vast improvement over conventional masks. It resists the heat of the electron beam bombardment, so eliminating 'doming' or colour blurr. The glass itself lifts contrast by 46%, giving sharper, brighter images. Higher contrast naturally improves the colour rendition as well.

The sound side uses a Dome speaker layout, giving a higher output from a relatively small area. Treble and bass response is noticeably superior to your average TV set. Sound output is up from 7W per channel with the previous model, to 12W per channel. The speakers are concealed in the cabinet's edges, reducing the overall size of the unit. The cabinet itself is charcoal-black, the colour and its method of moulding being the product of special technology. All you see is a narrow frame around the bright picture.

To my eye, black areas of the picture were blacker than the cabinet itself. Viewing with the room lights on I found the extra luminance of the screen (plus the flatter surface) cancelled out room reflections, increasing sharpness and creating a picture of almost



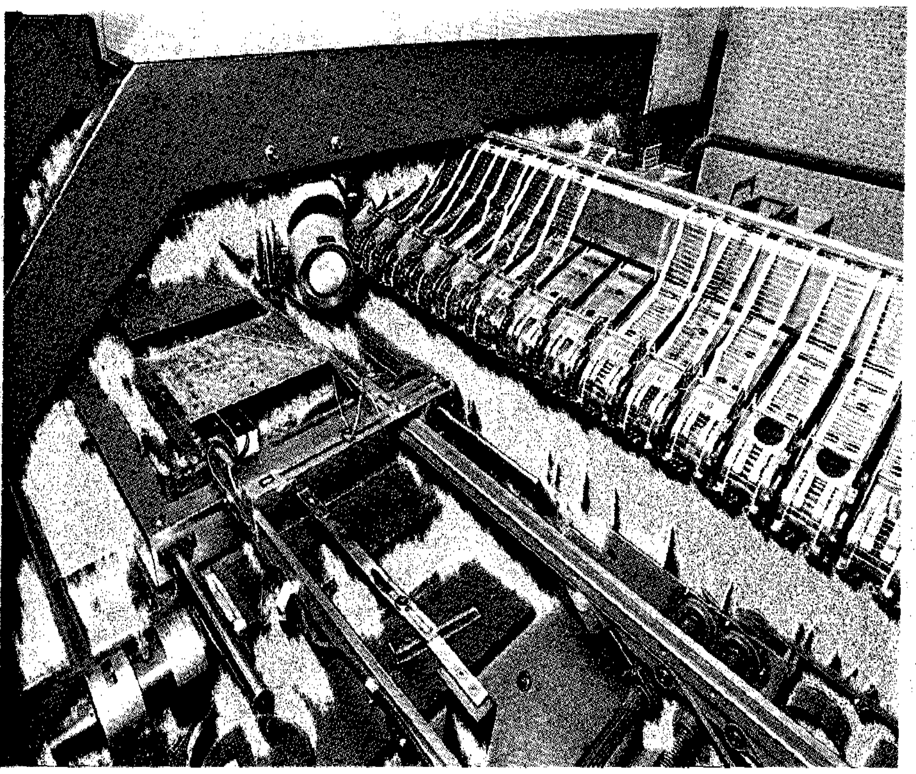
This shot shows the final check out of completed sets for tuning adjustment and operation of the remote control functions.

photographic quality. In terms of picture quality, the set produces brilliant whites and natural greens, while reds — difficult for video — lost their stridency due to the use of Europium in the tube's red phosphor. Colours like pink and mauve were pleasingly subtle.

Footnote

Walking away from the plant and the impressive demonstration of the new set, I could find little fault with its picture — except for one. The bane of every television set on the market is reflection, no matter what maker or price level. I suppose I'm especially aware of this, spending most of my days in front of a computer which never gives trouble from room reflections due to the anti-glare coating on its surface.

I asked Ross Henderson when we are likely to see the same techniques applied to TV set screens. He answered me enigmatically by saying: "We're working on it". ❖



A close up of the PCB auto insertion machine. The boards being loaded are visible at centre left while the bandoliers of resistors and other components to be inserted are visible at upper right.

Matsushita/Panasonic's TV set history:

1935	Company began research on television.
1938	First set, a 12" model, completed production.
1952	First post-WW2 sets manufactured.
1961	World's first 14" TV using a 110° deflection tube.
1963	First colour set, using 90° deflection.
1968	Company completes manufacture of 10 millionth TV set.
1974	30 million sets — cumulative total. Quintrix tube marketed. Tube used 5 poles, 3 lenses.
1981	World's smallest colour set: 3".
1983	1.5" colour set introduced — smallest, lightest.
1985	First model with 500-line horizontal resolution. 100 million sets — cumulative total.
1987	Largest direct-viewing type set — 43".

THE ONE: main features:

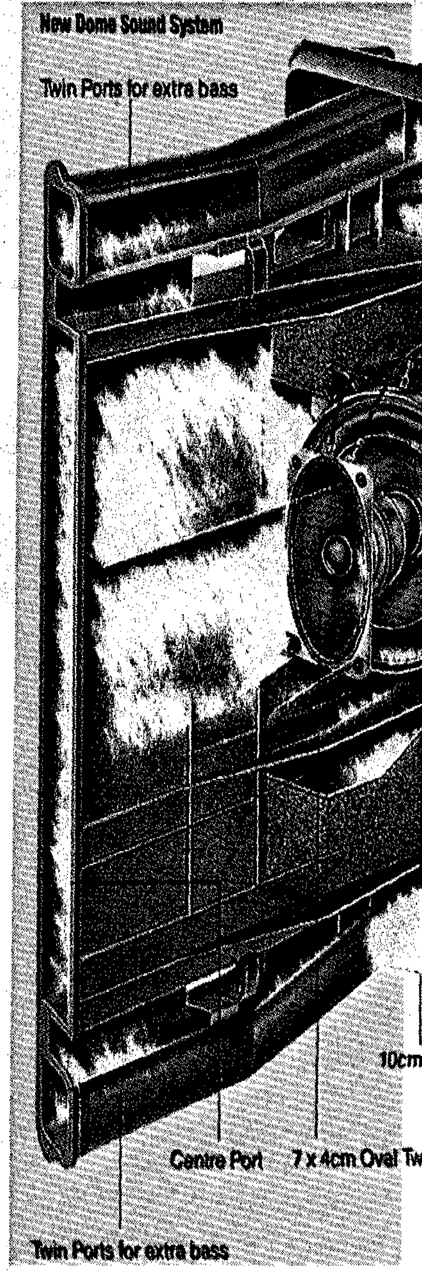
Super Flat picture tube — 30% flatter screen than the company's previous sets.

Super Black picture tube — black pigment used in screen glass produces 46% greater contrast than conventional sets.

Dome Sound stereo system — dual upper and lower ports reduce bass distortion. 10cm round woofer, 7x4cm oval tweeter. 12W output per stereo channel.

World 21 system reception — compatible with virtually all major broadcasting and playback systems. PAL/NTSC compatible tape playback.

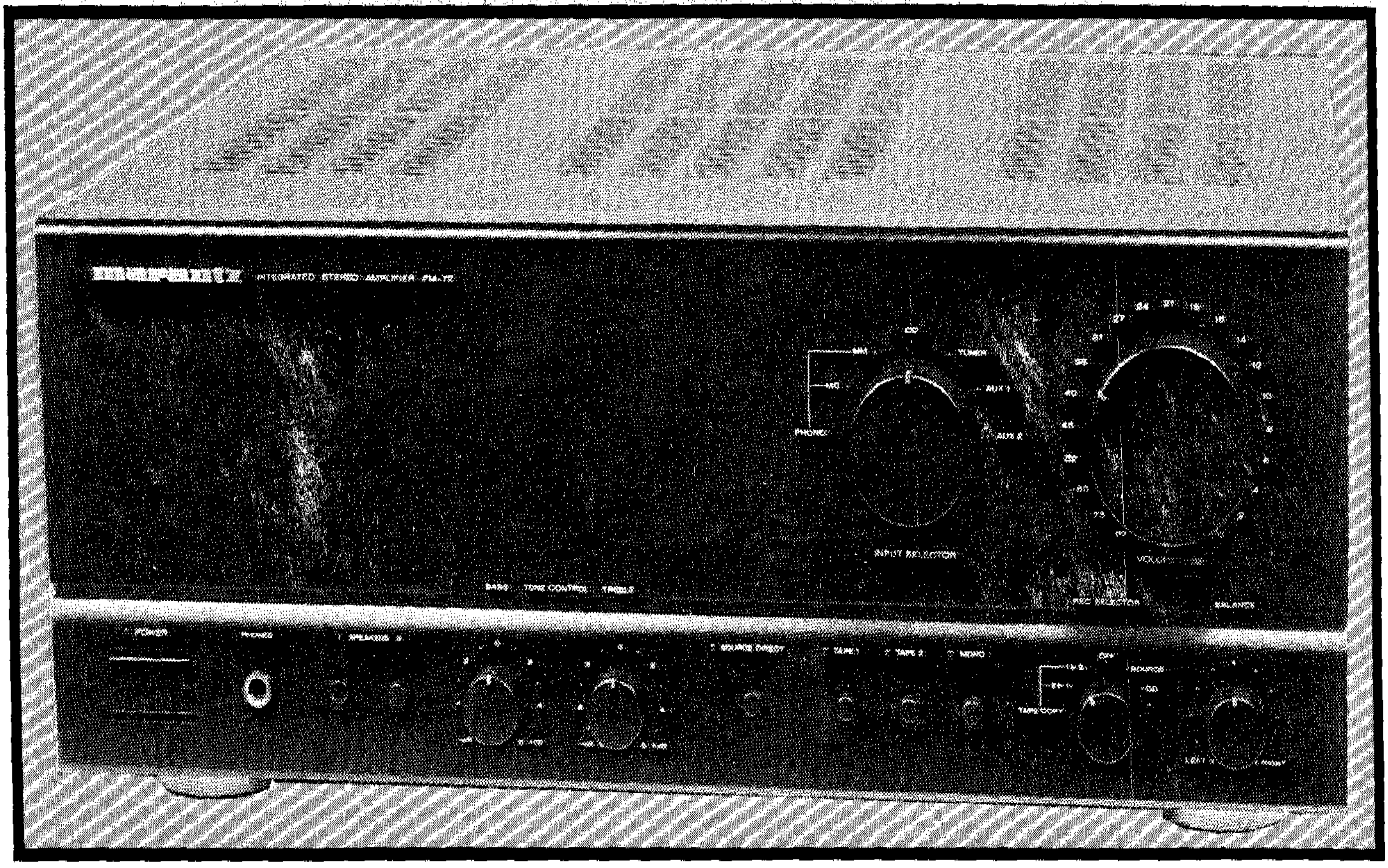
Picture in Picture, horizontal resolution 750 lines (in S-video), surround sound level control, three pairs of S-video and audio/video inputs, AV memory operation, pincushion correction circuit, noise reduction and vertical sharpness circuits, NTSC comb filter.



Taken from Matsushita's brochure, this illustration shows the construction of the new Dome Sound System used in the receivers. Note the very narrow frontal area.

Video & Audio: The Challis Report

As something of a break from esoteric loudspeaker systems, CD players and audio recorders, Louis Challis has spent this month checking out a pre-release sample of one of the latest breed of integrated hifi amplifiers from Marantz. He found it a worthy example of the Marantz tradition of providing 'a better product at a better price'...



THE NEW MARANTZ PM-72 INTEGRATED AMPLIFIER

When Sol Marantz founded his famous Marantz Company some four decades ago in the USA, he started a company which became a legend in his own lifetime.

Marantz products were innovative, and the market accepted them as being attractive.

Their gaudy gold fronts were squarely aimed at the new generation of American Yuppies, who were buying up 'hifi' and were apparently turned on by flashing lights and 'bells and whistles'.

Sol's philosophy was to give his clients a better product at a better price, and he did so well that some of his competitors (like the famous Frank McIntosh) complained about their lost markets and 'the upstarts who had purloined them'.

In the early 1970's I reviewed many of the more outstanding and gaudy Marantz products, and as I recall, they were all very good products. More important their critical performance parameters were with few exceptions, at the top of their class. All of his amplifiers had lower distortion and higher power output figures, and even his big receivers were in a class of their own — which started yet another trend.

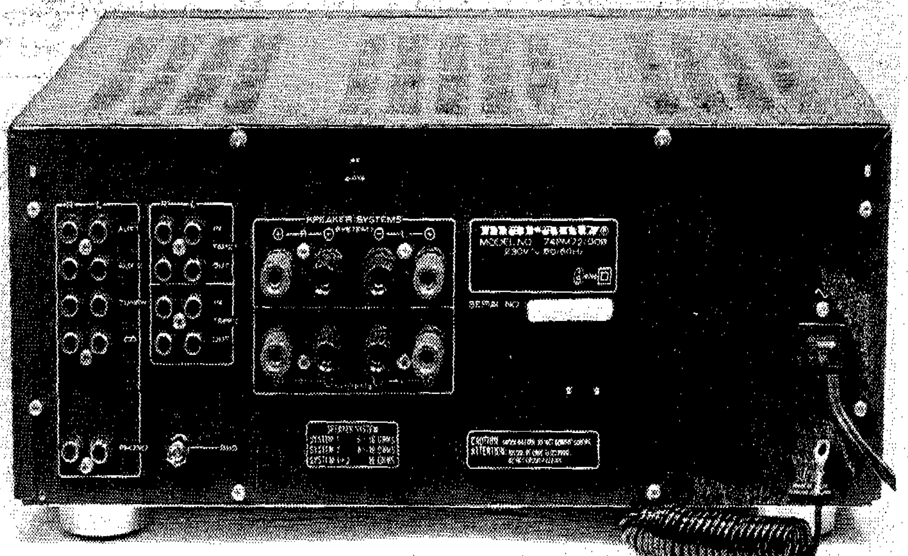
Although Sol Marantz sold out his controlling interest in the company more than a decade ago, it wasn't just his name that stayed on; the new owners respected both the name and what it stood for. They chose to follow the same ethos, to sell a better product at a better price. However gold panels are *passe* now, and so the one feature that I disliked in the old Marantz amplifiers is gone — at least in Australia.

Like Henry Ford, the design team at Marantz now believes that *black is beautiful*; and so all the Marantz amplifiers, receivers, CD players, VCRs and TV's are black — with, of course (you guessed it), gold lettering. I guess Sol's still leaving his mark on the company.

Now the very latest offering from Marantz is the PM-72 'Integrated' amplifier, which is another way of saying that it contains both a preamplifier section and a stereo power amplifier stage.

The latest generation of Marantz amplifiers have been developed to 'sound better and cleaner' than other amplifiers, with minimal colouration, minimal noise, maximum power output, low output impedance. In short, they're intended to behave like 'a piece of wire with amplification'. Which sounds just fine, but as many of us now know, that's easier said than done!

The block circuit diagram of the PM-72 looks very much like that of the earlier PM-80, which it appears has not been replaced by the PM-72. There are obviously many other similarities between the two, but it's the differences which are the most telling.



The rear end of the PM-72 looks rather like that of many other amplifiers. However there are two sets of loudspeaker outputs, selected by front panel pushbuttons, and also a coiled lead to earth other components such as a CD player.

Enhancements

The first notable difference is the *current conversion noise elimination circuit,* which is an unbelievably simple circuit addition. This takes the form of non-inductive high voltage capacitor, and a carefully selected series resistor which are sealed in an epoxy moulding. This assembly is part of the power supply and is placed directly across the secondary winding of the DC power supply circuit.

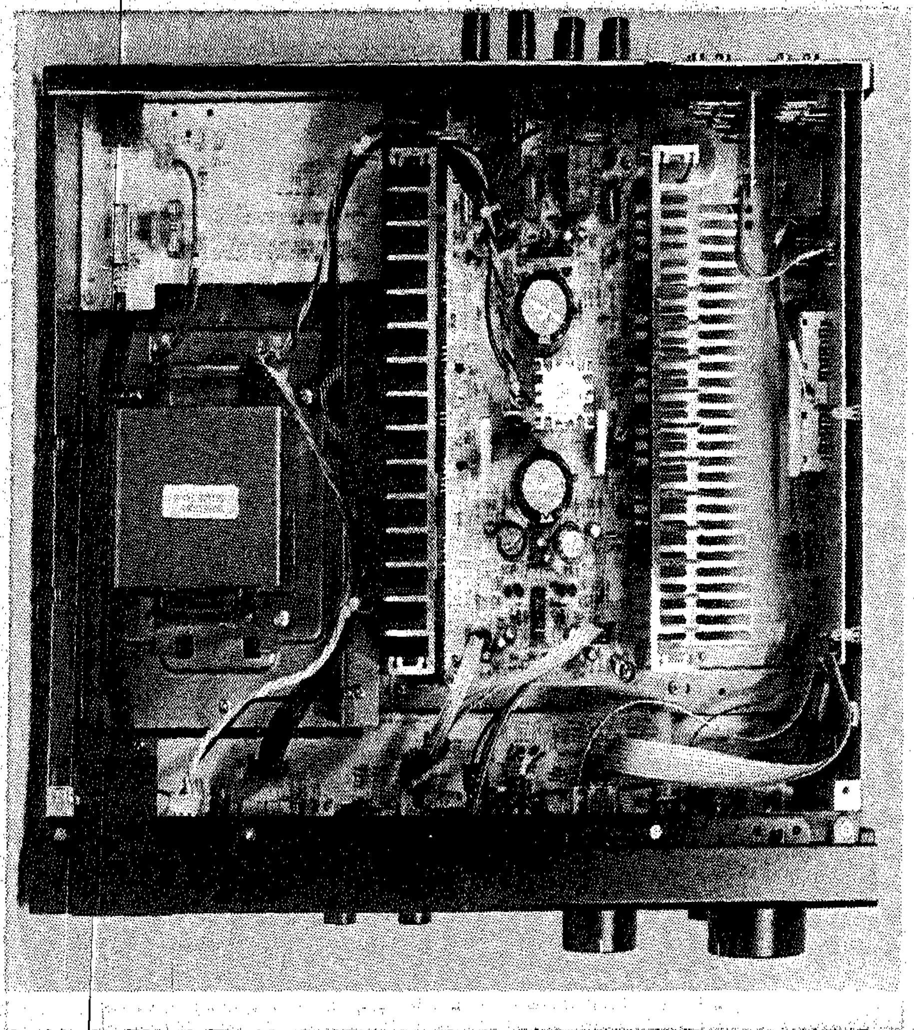
The beauty of this addition is that it virtually eliminates the sharp switch-off knee of the rectified half wave current. This sharp transient is neatly modified or 'softened' by the resonant circuit formed by the transformer winding and the capacitor, so that the high frequency harmonics generated by the diode switch-off transient are effectively 'down converted' to energy at much lower frequencies. The series resistor decreases the 'Q' of the resonant circuit, and optimises the decay characteristics of what the circuit diagram neatly describes as a 'Noise Killer' circuit. This is not as effective as a full regulation circuit, but then it costs much less, and works nearly as well.

The preamplifier stages are however fed from a full regulating power supply, providing regulated 24-volt and 5-volt rails to maintain low noise and stable operating parameters.

There are other design innovations and circuit refinements, the majority of which are not described in the manufacturer's blurb, all of which have been directed at achieving improved electronic performance. Some of the refinements are directed at reducing costs, but not too many are visible.

Of course, even a straight piece of wire with amplification needs protection, and consequently the PM-72 incorporates a sophisticated protection circuit. This separately detects power on/off, over current, DC voltage level, and substrate temperature.

The outputs are each connected to an OR circuit, which in turn is followed by a Schmidt trigger and relay driver circuit —to provide rapid disconnection of both output circuits in the event of any detection or sign of anomalous behaviour.



Inside the PM-72. The low level signal circuitry is on a vertically mounted PCB on the right, with tone control circuitry on the board just behind the front panel and power amplifier and power supply circuitry in the centre.

Front panel

The front panel of the PM-72 would most probably make Sol Marantz cry if he saw it, because the only part that looks like anodised aluminium is the name 'Marantz' emblazoned on the top left hand corner of the front panel. Of course there is also the tip of the gold-plated headphone socket at the bottom left hand corner of the same panel, but then that doesn't really count!

The front panel's major controls are sensibly arranged in two rows. At the upper right hand end of the panel is a large volume control, directly calibrated in dB relative to maximum output. Next to this is a somewhat smaller rotary input selector for moving cartridge (MC) and moving magnet (MM) phono inputs, CD input at the top (where it rightly belongs), followed by TUNER, AUX 1 and AUX 2 to the right.

On the left-hand end in the bottom row is the mains power ON switch, with a small discrete LED connected directly above. Next to this is the headphone socket, pushbuttons for Speaker 1 and Speaker 2, and bass and treble tone controls.

The tone controls provide a nominal +10dB of boost and cut at 50Hz and +10dB boost or cut at 20kHz, respectively.

In the middle of the lower section of the curved and shaped front panel, are four selectors with matching LEDs. The first of these is labelled SOURCE DIRECT, which disconnects all superfluous electronic circuitry to provide the purest possible sound with maximum dynamic range and of course minimal possible noise.

Next to this is TAPE 1, TAPE 2 and MONO. To the right of these again is the TAPE COPY switch, with five positions: TAPE 2 TO TAPE 1, TAPE 1 TO TAPE 2, OFF, SOURCE and CD.

These switch settings provide the degree of flexibility that most serious audiophiles would need for tape copying, or for tape copying while listening to another program.

At the extreme right hand end of the panel is the balance control, which sensibly has a central indent.

Although the front panel is neat, the lettering is small, and with a black background under poor lighting conditions may well prove to be difficult to read — particularly if you are myopic or short sighted, as I am.

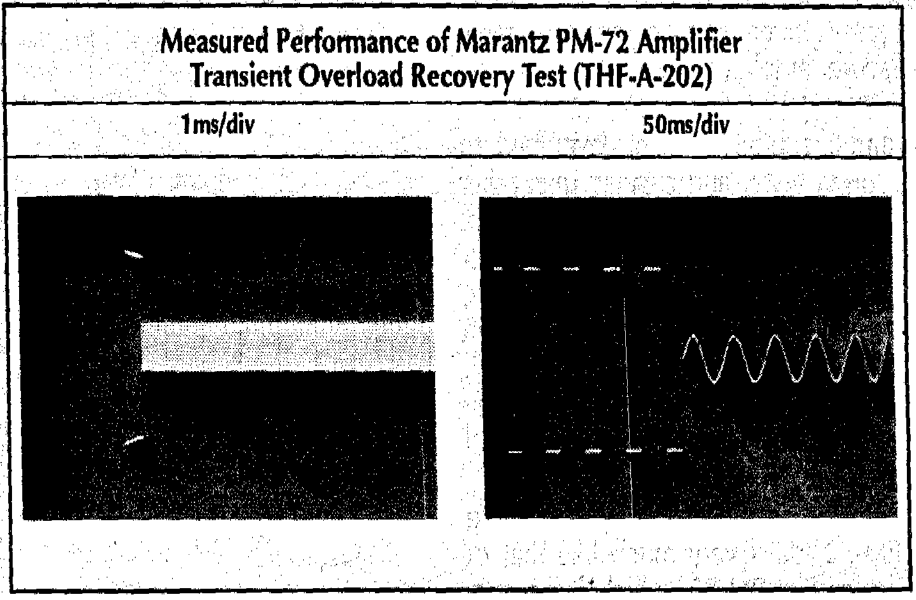
The rear panel has all the input connections neatly laid out with better labelling than the front panel, and is clearly a very sensible ergonomic design.

At the extreme left-hand end of the panel are a block of RCA type phono sockets, with gold-plated PHONO and CD sockets and conventional chrome-plated sockets for tuner AUX 1 and AUX 2.

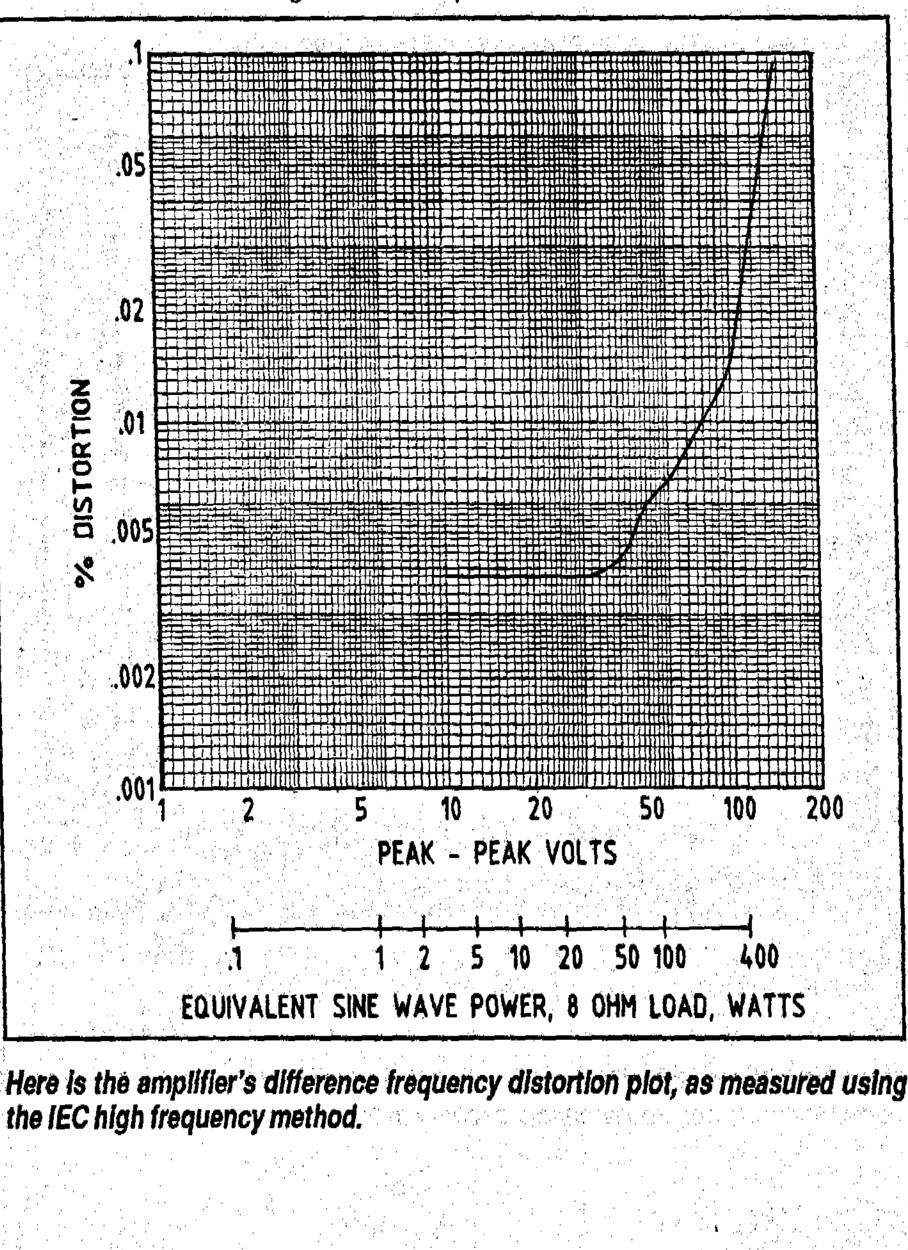
Adjacent to these are two pairs of sockets for TAPE 1 and TAPE 2, also with conventional chrome plated RCA type phono sockets.

Below this is a screwed ground terminal, which may well prove essential in some situations as the internal circuitry is not separately grounded via the mains lead. In the middle of the panel are four large pairs of colour-coded speaker sockets, for left and right channels and for SYSTEM 1 as well as for SYSTEM 2. These use large three-way universal terminals, which will accept bare wires and banana plugs, but not spade lugs.

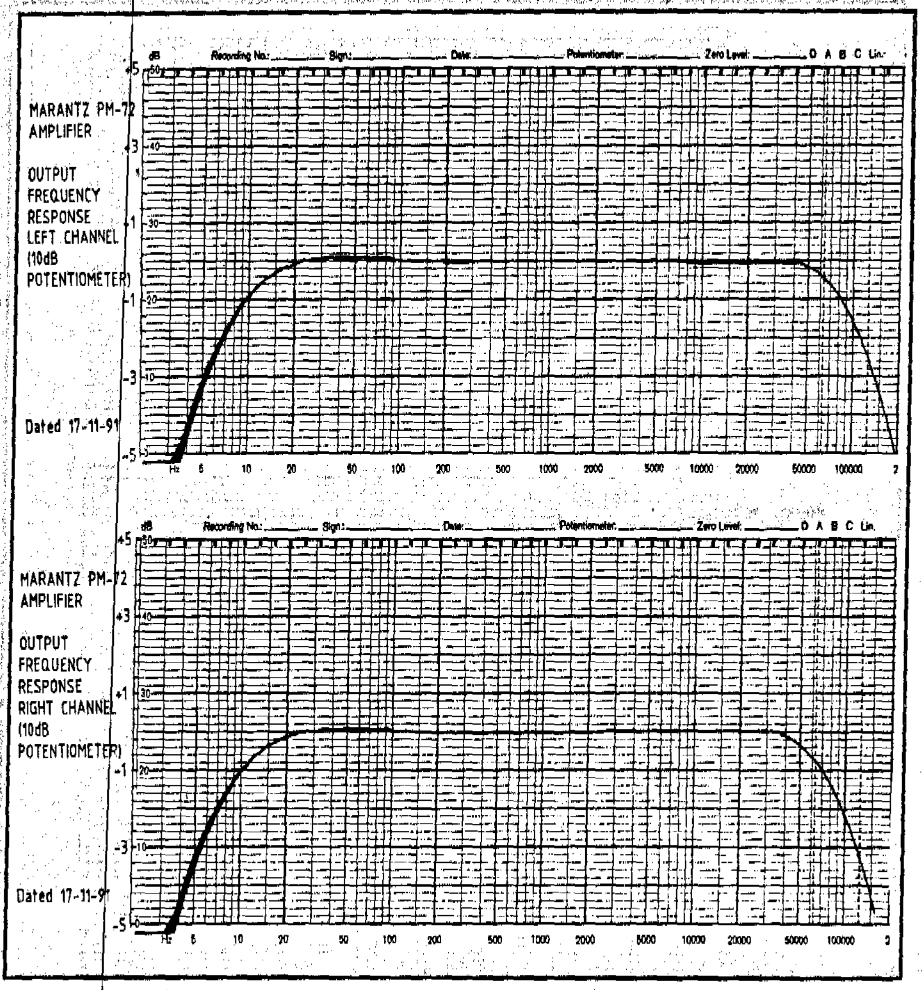
One intriguing aspect of the back panel was its annotation in relation to



Here are the results of the overload recovery tests on the Marantz PM-72. The overload conditions are with both channels driven and output 10dB above rated power into eight ohms. Overload duration is 20ms with a 512ms repetition rate.



Here is the amplifier's difference frequency distortion plot, as measured using the IEC high frequency method.



The frequency response plots for left and right channels are slightly different, as you can see. This is a little surprising, and may well be a characteristic of the pre-release sample tested.

the speaker loadings. This advises that the minimum impedance when connecting two systems in parallel is 16 ohms — whereas the handbook crows about the ability of the amplifier to handle 2-ohm loads (i.e., SYSTEM 1 and SYSTEM 2 impedances of four ohms each). One of the sets of information is obviously wrong, and based on my measurements it is the handbook that is right.

Another neat feature on the back panel is a small coiled earth lead, which has a half-metre reach when extended. This facilitates the interconnection of the amplifier earthing to other pieces of equipment, such as the record player chassis, when called for.

The inside of the amplifier is neatly constructed, with clearly labelled quality printed circuit boards and quality components, but surprisingly I could not identify the esoteric capacitors and resistors which were only recently lauded by Marantz's PR people in previous generations of Marantz amplifiers.

Evaluation

The evaluation of an amplifier's specifications is generally regarded as a simple and straightforward task. The first parameter normally quoted by manufacturers and sought by purchasers is a good power output, which is the maximum continuous undistorted power that the amplifier can deliver into a specified load impedance.

The second parameter, which is closely aligned with the first, is the *dynamic headroom*, which is the margin in decibels by which the amplifier can exceed its maximum continuous output in short bursts.

The third parameter is the magnitude of the output distortion, which is the magnitude of spurious output generated by the passage of a signal through the amplifier, and which is normally determined by the harmonically related output components, and most particularly the third harmonic in the output.

The fourth parameter is the *signal to noise* or 'S/N' ratio, which is the ratio in decibels between a rated signal output level and the output of the amplifier in the presence of no input signal.

The electronic noise generated under the latter condition is normally hiss and hum, and the lower those components are below -75dB(A), the better. A good amplifier should be able to achieve a signal to noise ratio of -90dB(A) or better.

Last but not least is the *frequency response* of the amplifier, which surprisingly many manufacturers no longer quote — as by and large, the poorest amplifiers of today exceed the best performance achieved by the valve amplifiers of yesteryear, where it all started.

However, don't be *fooled:* an amplifier's frequency response is still of some importance, and a well designed amplifier should have a flat frequency response from 20Hz to 20kHz. Beyond those limits the response should ideally roll over fairly smoothly and reasonably sharply below 20Hz, as well as just above 30 or 40kHz.

With those thoughts in mind, I proceeded to evaluate the objective performance characteristics of the PM-72. When evaluating an amplifier, for convenience and as much as from habit, I generally start my evaluation with a measurement of the output frequency response. This normally gives me some feel for how an amplifier is going to perform.

I was pleased to see that the PM-72 amplifier's frequency response is almost 'ruler flat', and within +0.1dB from 20Hz to 35kHz. The response rolls over smoothly at the bottom end and is -3dB down at 10Hz.

At the top end, there was a perceptible difference in the frequency response between the left channel and the right channel. I was surprised to find that the left channel has a marginally broader frequency response than the right, although that difference is not of any major significance.

The smooth rolloff at high frequencies augers well for the amplifier's stability, and this parameter is tightly controlled by the negative feedback loop, over which the designers have taken considerable trouble.

The next parameter to be evaluated was the output power, and not surprisingly the amplifier delivers a genuine 120 watts into eight ohms, although Marantz claims an output power of 100 watts into eight ohms.

The output power into four ohms is also impressive, with a genuine output of 180 watts, while the output into two ohms is even more impressive — with short term continuous outputs of 260 watts, and IHF outputs of well in

Challis Report

excess of 300 watts. The question of two ohm output capability has me intrigued, for although the manufacturer publishes data on its two ohm capability, the caution on the back panel will undoubtedly dissuade many purchasers from applying such difficult loads.

I was gratified to find that the signal to noise figure of the amplifier when using its auxiliary input was -94dB(A) relative to 1 watt output, or conversely -114dB(A) relative to the rated 100 watt output into eight ohms.

This level of performance is particularly good, and it would appear is attributable in part to the current conversion noise elimination circuit. The hum and noise at the MM phono input, is still -80dB(A) relative to one watt (which is still pretty good), but with the moving coil input, the level of 50Hz hum reduces that figure to a measly -55dB(A) figure, which is not quite as impressive as the other signal to noise figures which I have measured for moving coil cartridge inputs.

The measured crosstalk between the two channels is exceptionally good: better than -90dB at mid-band frequencies, and still in the order of -80dB at the outer band edges relative to a one watt signal.

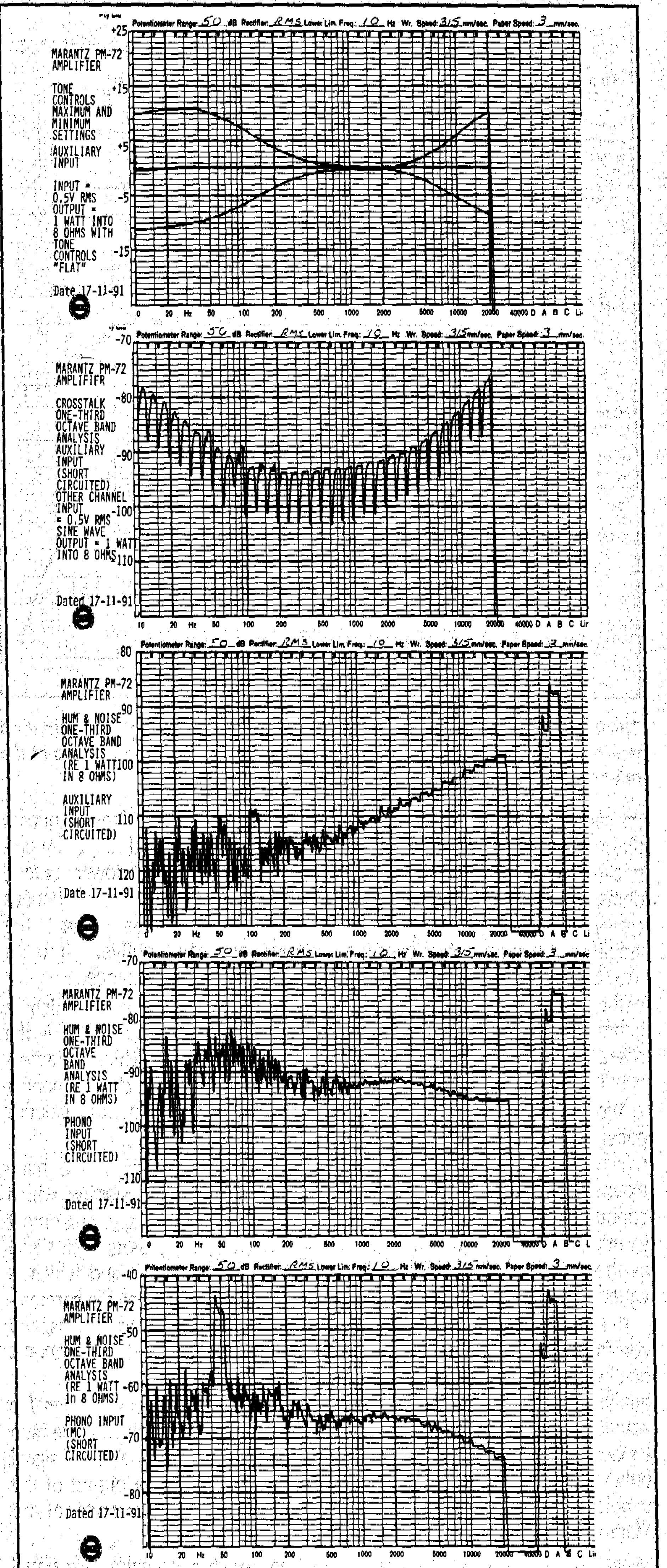
The transient overload recovery test was also exemplary, and the PM-72 is clearly inherently stable under virtually any operating condition.

The last test and one of the most important, was the IEC High Frequency Total Difference Frequency Distortion measurement.

This reveals that the Marantz PM-72 Amplifier produces a total difference frequency distortion of less than 0.01% at all output power levels of up to 100 watts into eight ohms, and only at powers above 100 watts does the distortion start to rapidly rise.

From an objective test standpoint, if one ignores the hum and noise figures for the moving coil phono input, this amplifier is truly exemplary.

(Editor's Note: The S/N result for the MC inputs of the sample PM-72 strongly suggest that this section of the unit was in fact faulty. However it was a pre-release sample, and no other samples were available for testing at the time of preparing this review. From the measured perfor-



These plots show the tone control range, channel cross talk and noise performance of the PM-72. Note the hum peak in the moving oil phono noise plot, which appears to be due to a fault in the sample amplifier available for review.

Measured performance of Marantaz PM-72 Amplifier
Serial No. MZ 00912 0000021

Frequency Response (-3dB re 1 watt. Input to Aux = 0.5V)	Left Channel	5.2Hz	to	120kHz
	Right Channel	5.3Hz	to	130kHz
Sensitivity (for 1 watt in 8 ohm)			LEFT	RIGHT
		Auxiliary	13.2mV	14.3mV
		Tuner	13.2mV	14.3mV
		Tape	12.6mV	14.0mV
		CD	13.2mV	14.3mV
		Phono M/M	220uV	240uV
		Phono M/C	22uV	24uV
		Overload M/M	180mV	178mV
		Overload M/C	440mV	420mV
Input Impedance (@1kHz)			LEFT	RIGHT
		Auxiliary	34k ohms	35k ohms
		Tuner	34k ohms	35k ohms
		CD	34k ohms	35k ohms
		Tape	34k ohms	35k ohms
		Phono M/M	200k ohms	200k ohms
		Phono M/C	5.3k ohms	5.4k ohms
Output Impedance		36milliohms		
Noise & Hum Levels (re 1 watt in 8 ohms)				
	Input 0.5V	Auxiliary	78dB (Lin)	84dB (A)
	Input 5mV	Phono M/M	66dB (Lin)	71dB (A)
	Input 0.5mV	Phono M/C	35dB (Lin)	45dB (A)
Harmonic Distortion		100Hz	1kHz	6.3kHz
At a power of 1 watt into 8.0 ohms	2nd			
	3rd			
	4th	**All below noise threshold**		
	5th			
	THD	**All less than 0.0002%**		
At a power of 120 watts into 8.0 ohms	2nd	94.8	100.6	95.5
	3rd	92.6	87.5	81.9
	4th	105.6	104.9	105.4
	5th	100.8	104.2	-
	THD	0.0071%	0086%	0.016%
IEC High Frequency Total Difference Frequency Distortion				
		8kHz and 11.95kHz mixed 1.1		
		Load		8.0 ohms
		At a power of 120W		0.02%
		At 1 watt		0.0038%
Maximum Output Power at Clipping Point (IHF-A-202)				
20ms burst repeated at 500ms intervals			4.0 ohms	8.00 ohms
			98V p-p	112V p-p
			300 Watts	225 Watts
Therefore Dynamic Headroom (re 170/100 watts)			2.5dB	3.5dB

mance of the rest of the sample unit, we believe it is likely that production PM-72 amplifiers will give a much better S/N performance for the MC inputs.)

Subjective testing

On the basis of its output power capabilities, which will provide power outputs of up to 100 watts, I installed the PM-72 in my living room, where its output characteristics suitably match the power requirements of my monitor speakers and my preferred peak power listening level.

With a new CD player connected, I enjoyed the PM-72's output — primarily because I couldn't really hear it.

I conducted numerous subjective evaluations with some delightful new discs including, *Agnes Baltsa Sings Rossini* with the Vienna Symphony Orchestra (Sony SK45964). This is a wonderful new disc, with some of Rossini's most outstanding operatic arias for a soprano.

It includes extracts from The Barber of Seville, La Cenerentola, and a number of other less well known Rossini Operas. Agnes Baltsa has a vibrant and warm style, matching her powerful voice.

This is an exceptional recording, which typifies the latest generation of CD's — with improved use of microphones and cleaner recording techniques which are revolutionising operatic recording. With my eyes shut, I had no difficulty believing that I was back in the famed Vienna Opera House.

The second set of discs I auditioned were *Mozart's Symphonies 34-41*, from the Philips Complete Mozart Edition (Philips 422611- 2), featuring Neville Marriner with the Academy of St. Martin in the Field playing Mozart's Symphony No 41 — the 'Jupiter'.

This offers outstanding classical musical content, with which I was able to evaluate the dynamic characteristics of the amplifier with plenty of *fortissimo* and *pianissimo* as well as some particularly quiet portions, of which there are many. Happily, I could not detect any trace of the amplifier's noise, even with my ears up close to the loudspeakers.

The third disc which I used in my main evaluation was a demonstration disc in which John Williams conducts *John Williams — The Star Wars Trilogy*, (Sony Classical SK45947).

Now this is not really the sort of music I normally listen to, but it is nonetheless an outstanding disc with loads of *staccato* and transient material suitable for evaluating or showing off the prowess and potential of your hifi system.

Track 9, 'The Cantina Band' was my favourite on this disc and it provided all the proof that I needed that the PM-72 is an outstanding amplifier — one which offers a performance that would clearly satisfy either my needs or those of the most critical purchaser.

The Marantz PM-72 is a well conceived, well designed and a well constructed amplifier. It provides proven performance characteristics which would be hard to beat.

However if I have to sum it up, its real attributes are undoubtedly its low noise and low distortion. In these respects it provides a performance which is only ever so slightly removed from the mythical 'straight piece of wire with amplification'.

The physical dimensions of the Marantz PM-72 are 420 x 132 x 334mm (W x H x D), and it weighs 10kg. The quoted recommended retail price is $999.

Further information is available from Marantz dealers, or from Marantz Australia, 3 Figtree Drive, Homebush 2140. ❖

MOBILESAT REVEALED

The technical wizardry of Australia's mobile satellite phone link was revealed for the first time recently to Emergency Service Chiefs at Sydney's Bondi beach. The demonstration was a blow for credibility in a field where Australia is a world leader in this vital technology, due for release in 1993.

by BRIAN WOODWARD

Voice and data communication using satellites makes good sense in a country like Australia. The rapid reduction in the price of satellite links is making it a close cost contest when comparing satellite and land line in remote areas.

Dramatic improvements in quality and reliability now make a satellite telephone system a practical alternative to existing wire or optical cable systems.

The real benefits of satellite communications become huge when the land station is compact enough to be operated while on the move. Just as Australia has embraced the cellular phone, so too will Australians flock to Mobilesat when it starts in 1993.

Mobilesat will be a world first in consumer satellite communications, and Australia is leading the rest of the world by about 18 months.

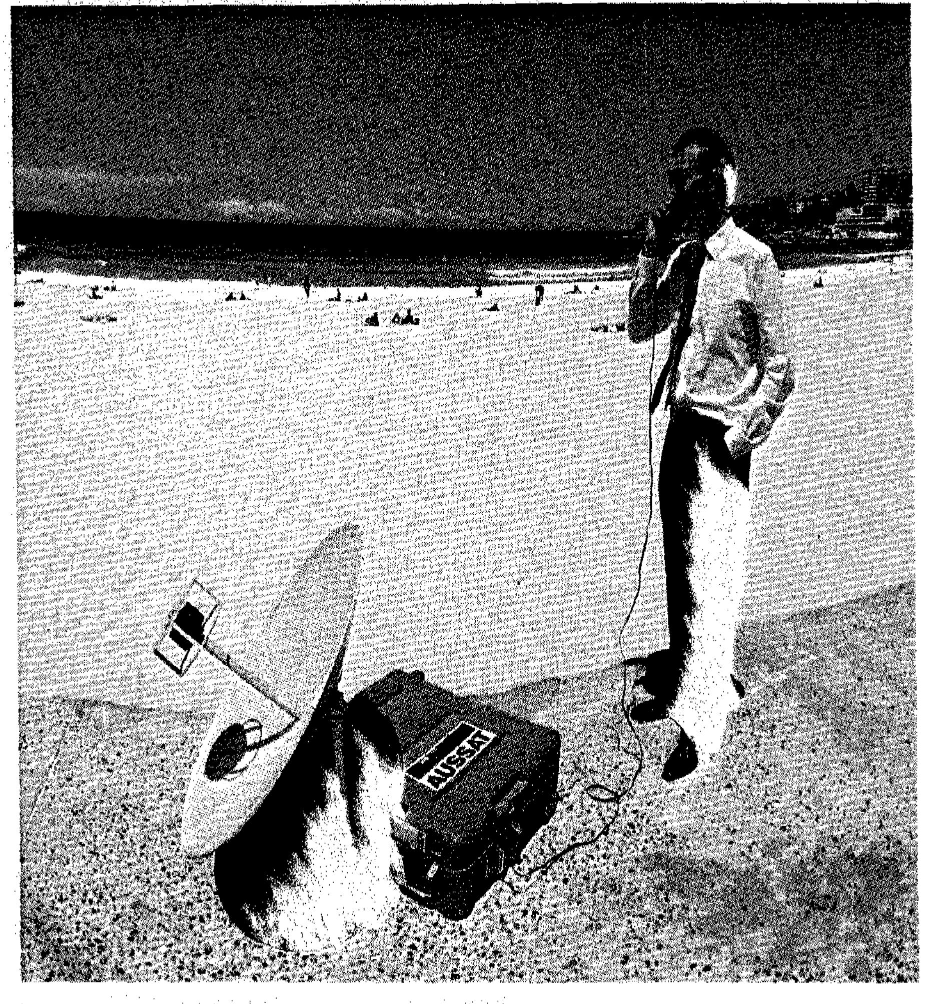
Existing systems

Mobile satellite communications systems have been available for several years. The most widely known is the Inmarsat-A and C systems — with C for text only, and A for voice, text and even slow scan television. Hardware and operating costs have limited the acceptance of the Inmarsat systems to those companies or organisations with no alternative but to pay, whatever the system costs.

At present an Inmarsat C text and data system is compact enough to fit in a briefcase, and will operate on mains or battery power. The case contains operating circuitry, keyboard, screen and printer as well as the very compact 'dish'. Actually 'upturned jelly mould' would be a better term for the C system's antenna.

Inmarsat C's rate of data transfer is impressive for the size of the equipment, at 600 bits/second. Once an up-downlink has been established with the Inmarsat, the C system patches into a local public switched telephone network to complete the data transfer circuit. At present, Aussat offers the Inmarsat C system for sale at around $10,000.

More comprehensive is the Inmarsat-A system. Its case is larger (and much heavier), and from it folds a conventional satellite dish.



Testing satellite phone communications using the Inmarsat-A system from Bondi Beach in Sydney. The new Mobilesat phones should be much more compact.

The Inmarsat-A system is also sold by Aussat in Australia, and a base station similar to the one shown here costs about $50,000. Portable it is, but mobile it certainly is not. For true mobility we must turn to the exciting prototype system caught in action recently at Bondi beach.

Better, cheaper

Mobilesat is designed to operate as a mobile voice and data communications network, starting in 1993 when Australia's second generation B-series satellites are launched. Its major aim is to offer mobile telephone communications to those people who are presently outside existing wire or cellular phone systems. Where Mobilesat beats almost every other communications system presently operating, or planned, is its price. The hardware will be around $5000 (remember when cellular phones were $3500?) — and that includes the clever little plastic covered dish-tenna. Operating costs are planned to be equally impressive, at $1.20 to $1.50 per minute.

Mobilesat's primary targets are those people and companies currently using radio for remote area communications — outside the existing phone system. Some people say that these users will not be influenced by Mobilesat, because they operate on 'free time' — once the hardware has been bought, it costs nothing to send a message using radio.

But the cost of establishing and maintaining a private radio network, plus the staffing cost necessary to patch it into the existing international telephone network, can give Mobilesat a clear head start when the bottom line is reached.

Mobilesat will be available as an adjunct to the cellular mobile phone service, but it will also be marketed as a closed system for those who demand the greatest privacy. Research has shown that Mobilesat is likely to have a 20% Government use, with Trades following a close second at 16%. After this, people in Sales are estimated to become around 13% of Mobilesat's traffic.

One of the major potential uses, and that being demonstrated when *EA* happened upon Mobilesat's prototype, is the nation's emergency services.

Emergency services

Although every branch of Australia's emergency services are presently connected by dedicated radio networks or even cellular phones, there can be no doubt that the ability to have instant global access by telephone offers huge potential.

Imagine if the skipper of an emergency craft near the sinking supertanker *Valdiz* could have had telephone contact by phone with a chemical (or marine) engineer in Dallas.

It doesn't take much to create the scenario where global satellite communications fall into place as logical. Imagine an ambulance officer in the remote outback being able to talk, directly, with the head of an anti-venom research laboratory who is on holidays aboard a cruiser somewhere up the Hawkesbury River — one on Mobilesat, the other on his trusty cellular phone.

At present Mobilesat is estimating its Australian market as a total of 100,000 subscribers, with 50,000 operating in the field by the year 2000. If the estimate has not taken into account Australians' love of new communications technology, then these figures could be under by as much as 50%. Australia has already reached a stage where more than eight million phone services are connected, and even the cellular phone system has finally reached 300,000.

Mobilesat's specification was announced in September 1989. By April 1990 the basic specification for the Mobilesat terminals had been announced and in June that year, Minor Base Station Specifications were announced. Now, after some public argy-bargy with the ownership of Aussat being finalised, the countdown to 1993 introduction is underway.

When introduced, Mobilesat's coverage will be all of mainland Australia (including, of course, Tasmania) and 200 kilometres out to sea. The specifications call for mobile transmitters to achieve a radiated power of 15dBW. How this is done is left to the hardware manufacturer, but uncovers some fascinating research into microwave technology.

Fire, police, ambulance and emergency service representatives being shown the benefits of satellite communications at Bondi Beach. Note the tiny satellite antenna dish on the roof of the Toyota LandCruiser.

The prototype unit uses an L-band up and downlink from both the Toyota LandCruiser mobile and to the base station. As Australia's new satellites are not yet in space, the prototype is using Japan's ETS-V (Engineering Test Satellite 5) owned by the Radio Research Laboratory of Japan's Ministry of Post and Telecommunications. In production, Mobilesat Aussat connection will be via Ku-band between base stations and satellites, and L-band between mobiles and satellites.

Although there will be only 7.5kHz separation between channels, the basic frequencies are 1.6GHz from the mobile up to the satellite, 12GHz from the satellite down to the earth base station, 14GHz back up to the satellite and 1.5GHz back down to the mobile. The prototype's white radome cover on the roof of the LandCruiser is only 300mm diameter and 80mm tall. This has been fitted to show the approximate size of the 'dish-tenna' that will most likely be used on final hardware. However under the test car's radome is a drooping crossed dipole (the outer ends of the elements are bent down at 45°, to match the elevation of the ETS-V) that is a tiny 60mm across!

Antenna crucial

Naturally, much of the success of Mobilesat will depend on antenna design. Mitsubishi has already demon-strated a costly, but very effective electronically steerable patch antenna. Resonant copper patches are 'steered' by controlling cir-

Inside a Toyota LandCruiser fitted with the prototype Mobilesat system. This used L-band up and downlinks to the Japanese ETS-V satellite, as Australia's B-series satellites won't be operational until the end of this year.

Mobilesat revealed

Another shot taken during the Bondi Beach tests, showing the Intelsat-A system being used. As you can see, even this system is reasonably compact and portable.

A compact Inmarsat-C satellite terminal system, packed in its transport case. Suitable for data transmission only, it costs twice as much as the projected new Mobilesat terminal.

cuitry to keep gain at its maximum. Experiments are also continuing with a helically wound whip antenna (at 1.5/1.6GHz!) which would be much cheaper, but less efficient.

As the specifications call for 15dBW, the efficiency of the antenna chosen by a manufacturer will also determine the RF output power required from the transmitter. In 'advertising' terms, a Mobilesat phone will most likely be called 'five watt' — or two more than the larger models of cellular phone currently on sale. Also, the prototype circuitry shown in the photos will be condensed into a package about the same size as one of the current three-watt cellular phones. Apart from the antenna, the prototype mobile unit consists of a codec (a digital coder-decoder) made by Digital Voice Systems Inc (the commercial arm of the Massachusetts Institute of Technology), a modem developed by the University of South Australia and an RF section by MITEC of Queensland.

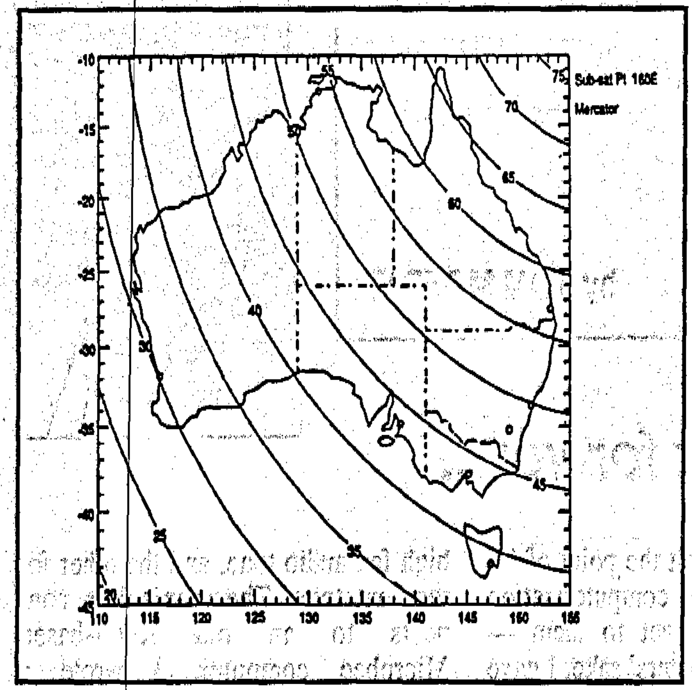
Australia's lead in mobile satellite SDVC (switched digital voice telephony) has caused some problems. Australia is too small to justify the development of a stand-alone system. Technical progress is being monitored (and co-developed) in conjunction with companies in the US, working towards the 1995 introduction there. Hardware must be suitable for Australia's service needs and yet still be compatible with the system which will go on line in the USA and Canada, 18 months after Australia.

One fascinating development has been inclusion of an RS-232C port in Mobilesat hardware. With a cheap GPS (Global Positioning System) receiver connected to the Mobilesat telephone, a unit's location can be determined to within 100 metres.

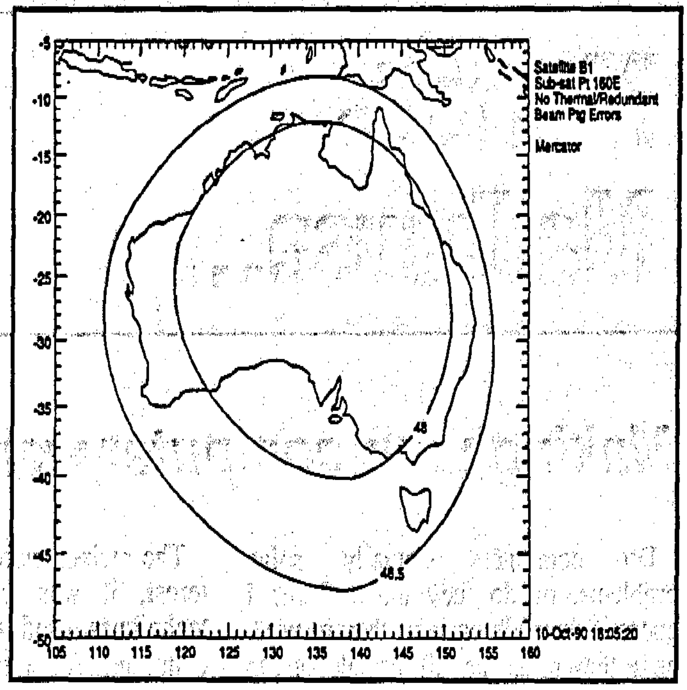
The importance of this was demonstrated recently when a prototype Mobilesat system was tested by the Royal

One of the Aussat engineers shown using his cellular phone during demonstrations of the Intelsat-C system.

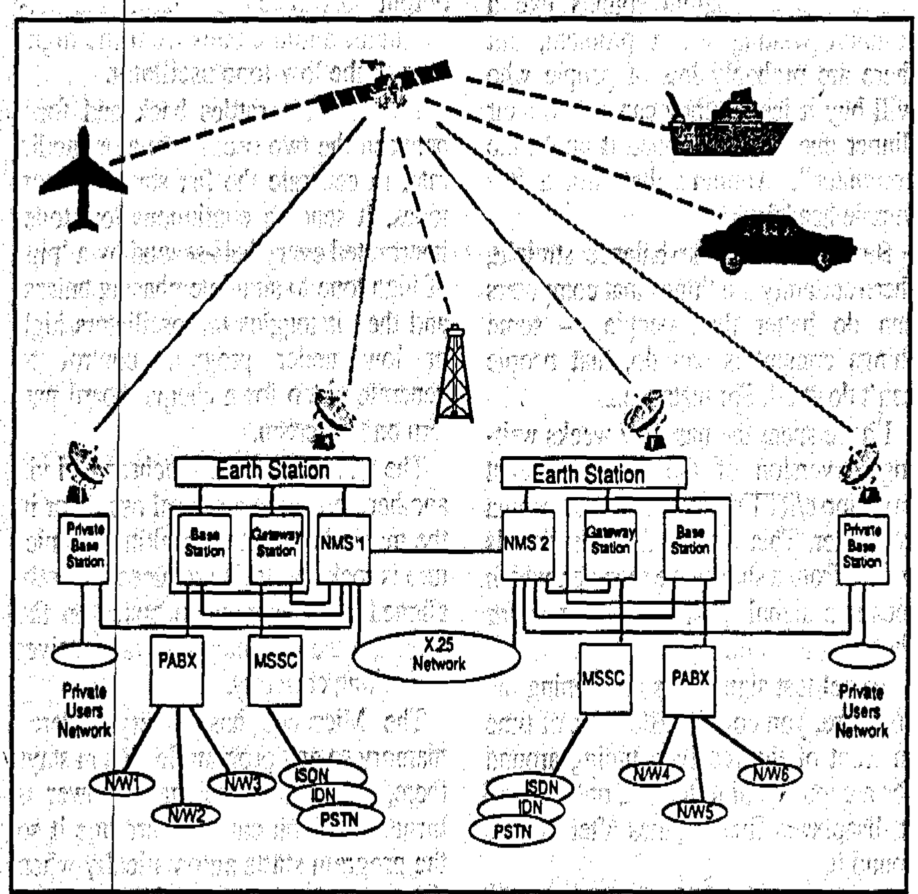
Emergency Services representatives inspecting the prototype Mobilesat terminal, in the back of the LandCruiser.



An Aussat graph showing Mobilesat elevation angles for locations throughout Australia.



The projected L band beam footprint for the new B1 satellite. EIRP over most of the country is at least 48dBW.



A basic diagram of the overall Mobilesat system, as supplied by Aussat.

Flying Doctor Service. With little difficulty, a Mobilesat phone fitted with the GPS receiver would be able to give its location to a caller, remotely.

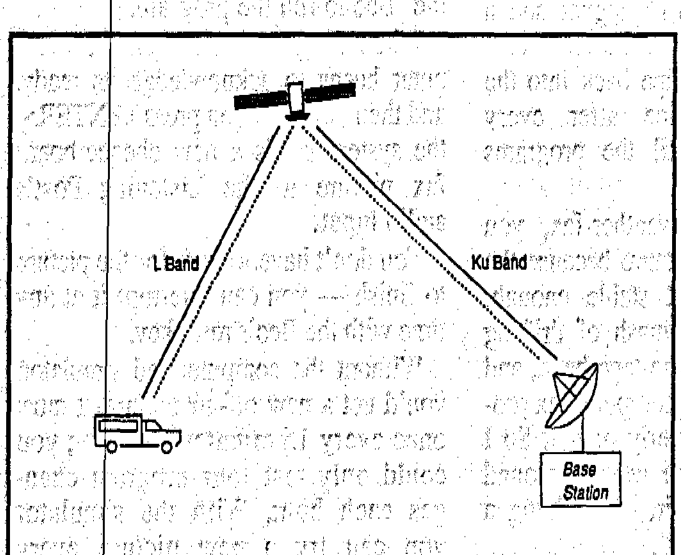
If a person had wandered off, or was injured, they could still be found. In this vast country, such technology saves lives.

Tests impressive

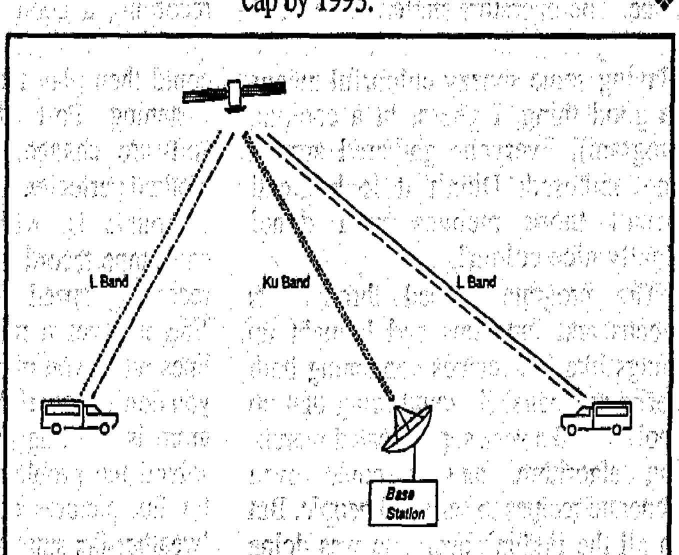
How does one test a satellite phone? The prototype mounted in the Land-Cruiser worked perfectly as Mobilesat Engineer Ian Jorgensen drove back and forth along the sea front at Bondi beach.

The link was from the mobile to ETS-V, back to Aussat's office, through Aussat's PABX switchboard to the domestic cellular phone network, and then to a 300mW handheld being used by a Mobilesat staffer.

It worked clearly, with no trace of excess noise. What more can be said? If Mobilesat works this well in its prototype stage (almost two years away from public launch), then it looks set to be an international feather in Australia's technology cap by 1993. ❖



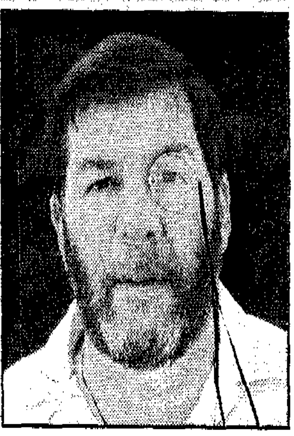
The Mobilesat system will use both L and Ku bands.



Mobiles can be linked, but only via the base station.

Moffat's Madhouse...

by TOM MOFFAT



Making your computer work for you...

Do computers actually solve problems, or do they make them? I guess it depends on how they're used, or IF they're used at all. I think back to the Madhouse column of last October, when I discussed all the hassles that developed when electronic 'parts houses' got computerized. It all came out right in the end, but these establishments faced some trying times to get there.

Is the computer the solution to every problem? Not always, I suspect. At a computer group meeting the other night, the star attraction was a new program that stored and retrieved cooking recipes. This was an enhancement on the original excuse for buying a home computer when they first appeared: 'Buy this computer and your wife can use it to store her recipes!'.

Ten years after I got my first home computer, I have never yet seen anybody use one to store recipes. My own wife would quite happily throw my computer (or all 11 of them, as it is now!) out the door. Her recipes are stored in loose-leaf notebooks, a direct and most efficient method.

At the computer group meeting, four big IBM-PC clones were all lined up in a row, running *Windows* with their icons and menus and clicking mice. The operators started up the new cooking program, and up it came displaying some snazzy colourful menus (a good thing, I guess, in a cooking program). Everyone gathered around and enthused: *Didn't it look great! Aren't those menues well done! Really nice colour!*

The program zipped through its menus and functions and brought up things like 'all recipes containing both garlic and eggs' (I would bring that up too!). It had a very sophisticated searching algorithm, and it could even generate recipes to serve 40 people. But in all the fiddling everyone was doing with that program, I never once heard anyone say "What a yummy recipe!".

The recipes weren't the point of interest, it was the computerization techniques used to get to them — computers for computers' sake. I gave up watching after a while, and retired to the pinball machine.

The recipe program sounds like a solution waiting for a problem, but there are probably lots of people who will buy it just so they can say to their dinner guests, "I whipped it up on the computer". Wouldn't that turn a few yuppie heads!

But just to set the balance straight, there certainly are things that computers can do better than people — some things computers can do, that people can't do at all. For instance...

I have spent the past few weeks writing a version of the Listening Post fax/Morse/RTTY project for the Amiga computer. This project decodes signals off-air from a shortwave receiver, which means a signal must be coming in for the thing to work.

To get test signals for developing the software, you could waste a lot of time in front of the receiver, tuning around for a good signal to try out, only to find it disappears five minutes after you've found it.

For the Morse Code and RTTY programs, I solved the problem by tape-recording a good RTTY signal and a good Morse signal from the receiver. I could then play the tape back into the Listening Post device after every software change, until the programs worked perfectly.

Trouble is, with weather-fax, you can't tape record a picture because the recording speed isn't stable enough. You just get a mish-mash of drifting lines when you play the tape back, and you don't know if the computer fax program is working properly or not. So I solved the problem of waiting around for fax pictures off-air, by building a 'weather-fax simulator'.

This gadget has a couple of 555 IC's hooked up as oscillators — one for the high fax audio tone, and the other for the low tone. The magic box connects to an old ROM-based Microbee computer. I wrote a machine-language program which controls one bit on the computer's output port to select whether the fax-simulator audio comes from the high-tone or the low-tone oscillator.

The program rattles back and forth between the two oscillators at an audio rate, to generate the fax start and stop tones. It sends a continuous low tone, interrupted every half-second by a 'pip' of high tone to simulate phasing pulses, and then it toggles the oscillators high or low under program control to generate video for a chequerboard pattern on the screen.

The whole works is synchronized via another port bit to a crystal oscillator in the magic box so the resulting fax picture is rock-stable. It produces perfectly aligned black and white boxes on the screen, if the Listening Post fax receiver is working correctly.

The Microbee has battery-powered memory so any program loaded in stays there, even when the mains power is turned off. You can also arrange it so the program starts automatically when the computer is powered up, so you don't even need a video monitor on the 'Bee to run the program.

When the power turns on the computer beeps to acknowledge its ready, and then any time you press <ENTER> the system sends a new chequerboard fax picture to the Listening Post's audio input.

You don't have to wait for the picture to finish — you can interrupt it at any time with the Bee's reset key.

Without the computerized simulator, you'd get a new off-air picture at most once every 15 minutes, meaning you could only test four program changes each hour. With the simulator you can try a new picture every minute or so if necessary.

So there's a hardware solution, computer controlled; but what about pure software problems? An application that comes to mind is the installation of an antenna mast, a job that every radio amateur faces sooner or later.

There is a rule of thumb that your guy wires should not rise toward the tower at an angle greater than 60°.. Otherwise the tower has too much mechanical advantage over the guys, and the tower would come down in a windstorm.

Amateurs usually don't install guy anchors at the 'perfect' places; instead they look for existing points that would do the job and satisfy the 60° rule.

The first time I did this I proposed a possible configuration and then went over every guy wire with a calculator, working out its angle with the tower. This was a time-consuming business, so I wrote a computer program in BASIC to calculate angles for each of nine guy wires in turn. If I changed one anchor spot I had to edit the program to allow for it, and then run the program again. It was effective, but not the best way.

Most readers would know of computer spreadsheet programs, originally designed for financial calculations. The beauty of spreadsheets is that you can use them for 'what-if' type operations. Financial people might plug in a different rate of taxation for a particular activity, and then let the spreadsheet work out all financial results related to that one change.

With something like our antenna tower example, you can plug in a new value, and ask the spreadsheet 'what-if I moved this guy point lower down this fence post', or further along that wall. As soon as you type in a new figure, perhaps as a distance and height from the bottom of the tower, the spreadsheet automatically works out the new angles, along with required length of wires for all the guys affected. Now that's what you call doing it in style.

I won't go into the details about how to use spreadsheets here; we ran an article back in November 1989 on using spreadsheets in electronic calculations, and the general ideas set out there would also apply to things like designing antenna tower systems.

Or anything else, for that matter. You can use a spreadsheet for any design job where you can lay data out in tables, to see how changing one table entry affects all others under the rules you specify.

In that earlier article we used a spreadsheet called *SuperCalc*, Version 3. This program certainly did the job, and I've also used it many times to produce graphs and charts of data such as the filter response of a receiver. But good ol' *SuperCalc* is a program which I've been using continuously since the CP/M computer days, and was starting to show its age. Graphics capabilities were pretty minimal, designed for the Hercules and CGA screens that came with the very first IBM-PC computers.

A few months ago *SuperCalc* came on the market with a new version for more modern computers, but it carried a whacking big price tag — $600.

A short time later, perhaps after re-examining their opposition, *SuperCalc*'s distributors re-priced it at one-third the original, $199. Now that's more like it. I snapped up a copy and found that, unlike so much of today's new software, *SuperCalc 5* operates just like my old mate from my CP/M Microbee; none of these trendy pull-down menus and other such frills. If you want to load a file you type '/L', to save a file, '/S'.

Unfortunately the new *SuperCalc* has grown to the extent that it can only be used on a hard disk, so it's banned from my faithful laptop. But it can also read and write files in the *SuperCalc 3* format, so I can use Version 3 on the laptop to cook up some spreadsheet project, and then transfer it to Version 5 in my big computer to do the final touches on things like graphics. And the graphics — wow!

Version 3 was all chunky and black-and-white and generally yucky, but *SuperCalc 5* produces good sharp stuff in the VGA mode, with multiple colours against a neutral gray background. All in all, the new *SuperCalc* would certainly be worth looking at for a problem-solving tool for your computer.

Just getting back to financial 'what-ifs' for a moment, I should mention one other program that I acquired from an ad in the Green Guide supplement in the Melbourne *Age*, where all the good cheap computers are advertised.

This program has absolutely no use in electronics, or anything else other than saving Australia from total financial ruin. The program is called the *Keating Game*, and it's adorned with a clever cartoon on the front of the box showing the World's Greatest Treasurer sweating profusely and holding a computer which is going 'Kapow!'.

Sadly for the program's makers, said World's Greatest Treasurer got the flick about a month after the program came out, so it could now be called the Kerin Game. Too bad about the lovely cartoon. But as for the program — it lets YOU play Treasurer.

You can enter what you think should be the interest rate or taxation levels, and the program will come back with its estimate of things like inflation for the year and the balance of payments deficit.

The interesting thing about this program is that it didn't start off as a game. It is in fact an implementation of an economic model called the Keynesian Demand System, and it assesses over 300 behavioral equations and identities to produce a result.

This produces much internal gyration within the computer, a frenzy of number-crunching that makes an XT-type computer run at a crawl. But it seems to work.

When I tried the *Keating Game*, I had Australia firmly locked into Third World poverty within two years. I told my kids they wouldn't enjoy the *Keating Game* — no action, no graphics, no sound — but try it they did, and would you believe even my 12-year-old son had Australia back onto the world's leading nation list on his first try.

Maybe that's what we need in real life — some young hands steering the ship, some original thinking. And a little help from computer programs, which can replace a whole bevy of top economists using one little box with a picture of Keating on it! ❖

NEW KITS FOR EA PROJECTS

Dick Smith Electronics has advised us of the release of new kits for the following EA projects:

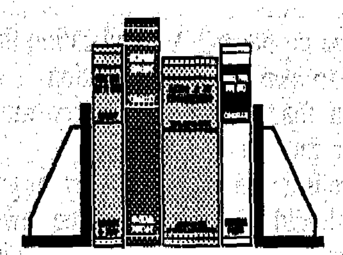
ANTENNA TUNER & RF PREAMP (November 1991): The DSE kit is complete (except for matching plug pack supply), and includes pre-punched front and rear panels with the front panel also silk-screened. The kit has the catalog number K-6100 and is priced at $109.00.

KARAOKE ADAPTOR (November 1991): The DSE kit is complete with pre-punched and silk-screened front panel. It has the catalog number K-5300 and is priced at $39.95.

LOW VOLTAGE BATTERY CUT-OUT (January 1992): The DSE kit is complete with case and front panel label. It has the catalog number K-3124 and is priced at $24.95.

NOTE: This information is published in good faith, from information supplied by the firm or firms concerned, as a service to our readers. Electronics Australia cannot accept responsibility for errors or omissions.

NEW BOOKS



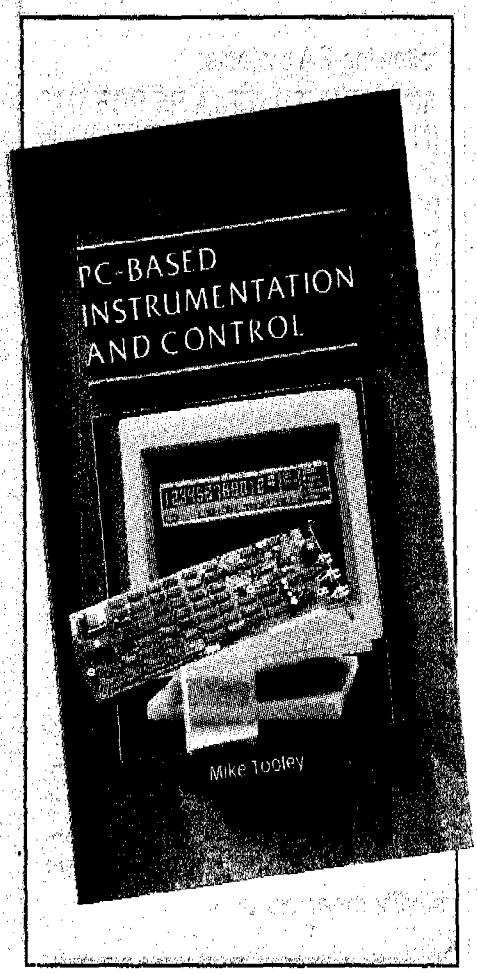
PC instrumentation

PC-BASED INSTRUMENTATION AND CONTROL, by Mike Tooley. Published by Newnes (Butterworth-Heinemann), 1991. Hard cover, 240 x 160mm, 348 pages. ISBN 0-7506-0038-1. Recommended retail price $32.95.

The author's aim for this book is to provide readers with sufficient information to be able to select the necessary hardware and software to implement a wide range of practical PC-based instrumentation and control systems. While the book is written primarily for the professional control and instrumentation specialist, it would still be a useful reference for anyone — professional or hobbyist — who wishes to use their PC to log data or to control external circuitry.

The first three chapters describe PC hardware: IBM PCs and compatibles, PC expansion systems, and the operating system. Chapters 4-7 then cover programming, assembly language programming, BASIC programming and programming in C.

Next comes interfacing itself, in chapters 8-9: the IEEE-488 bus (this bus is ideally suited to the implementation of automatic test equipment), and the general principles of interfacing sensors and transducers to PC bus I/O cards.



Finally, chapters 10-11 cover software packages (how to select these, with some examples), applications (areas covered by the range of PC expansion boards currently available), and reliability and fault-finding.

The appendix contains a glossary of terms, SI units with multiples and submultiples, decimal/binary/hexadecimal and ASCII table, a bibliography, and a list of UK suppliers.

I found the book to be well set out and explained, and very thorough in its treatment of each area. Clear examples and applications are used to illustrate the theory. Highly recommended for anyone wishing to understand how to link their PC to instruments and other equipment.

The review copy came from Butterworths, of PO Box 345, North Ryde 2113. It is available from major bookshops, or by mail order from this address. (P.M.)

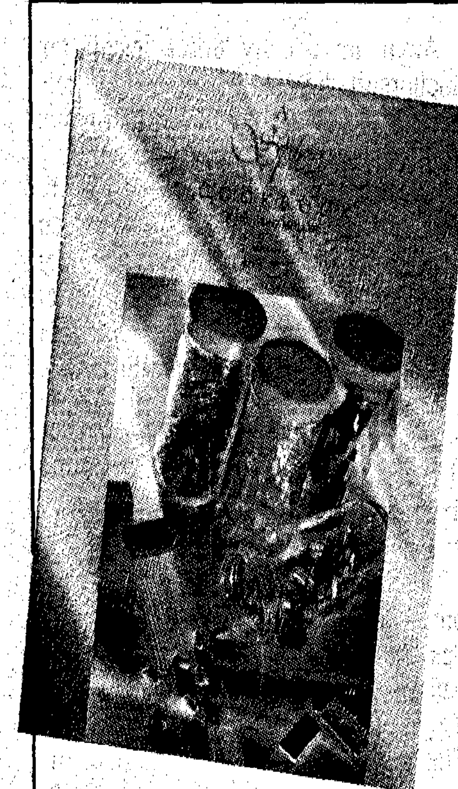
SPICE reference

A SPICE COOKBOOK, by Karl Heinz Muller. Published by Intusoft Inc., 1991. Soft cover, 218 x 161mm, 256 pages. ISBN 0-923345-02-7. Recommended retail price $68, including floppy disk (PC or Mac versions available).

If you're interested in circuit simulation and read our recent articles on the subject, you'll no doubt be aware that Intusoft is the developer/marketer of *IsSPICE*, one of the leading implementations of SPICE for personal computers. You may also recall that in the last of the articles, we noted that the company was shortly to release this new reference book.

Well, it's now arrived, and it certainly contains a lot of very worthwhile information. The author is a German engineer and author, with extensive experience in high-frequency transistors, communications, microwave electronics and the design of radar systems.

In this book he has provided a good practical handbook on using a PC-based



SPICE simulator such as *IsSPICE*. There are plenty of down-to-earth circuit examples, each with their netlist/SPICE input files and generally a discussion of interesting and/or tricky aspects of their simulation — plus, in many cases, examples of the output plots. Not only that, but the book comes with a floppy disk (or disks), with complete input files for each example — ready to load into your computer, to save you the time and hassle of entering them manually.

The material is divided into six main sections, headed 1 - Introduction; 2 - Analog Techniques; 3 - Digital Techniques; 4 - Analog Computing Circuits; 5 - Continuous and Discontinuous Systems; and 6 - High Frequency and Microwave Circuits. Model listings are in an appendix.

Although the style is rather brief and concise, there's still a lot of useful information on the practical techniques and applications of SPICE simulation. So on the whole, it should make a valuable addition to the reference library of anyone working with this important design tool.

The review copy came from Intusoft's Australian distributor ME Technologies, of PO Box 50, Dyers Crossing 2429, which can supply copies by mail for the price quoted. (J.R.) ❖

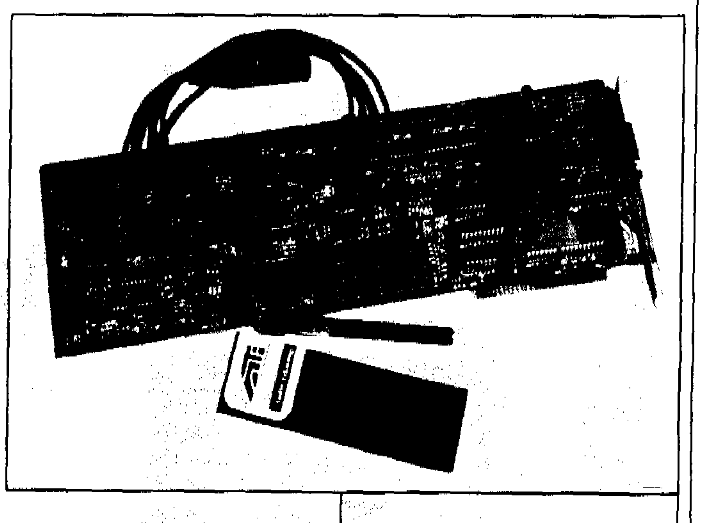
©

LMS

Loudspeaker Measurement System

$1490*

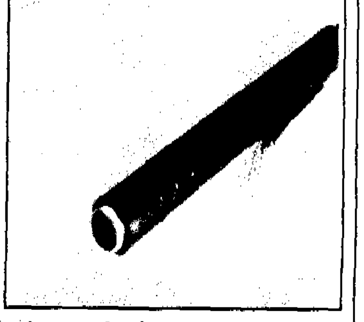
Breakthrough Technology



The LMS can perform an extensive variety of acoustic and electrical tests including SPL response, Gated SPL curves, Distortion modes, Voltage in dBm (gated or non-gated), Direct Impedance, Transfer Functions in dB, and many more. The on board oscillator covers a frequency range of 10Hz - 100kHz.

*Plus tax & freight

LMS is a PC based, software driven acoustic/electrical measurement and analysis tool, which includes a calibrated microphone for a fraction of the cost of a competitive microphone alone ! Don't let the price fool you, this is not a "toy". The LMS is a laboratory quality test/analysis tool.



LMS requires an 8 bit full length card slot in your IBM PC or compatible. The calibrated microphone assembly includes a precision built in pre-amplifier and connects to the LMS card via a standard DB15 connector which fans out to three XLR-type connectors, OSC line out, Line Input, & Mic Input.

LMS is controlled via the LMS System Controller software, a simple menu driven program, and some of its functions are:

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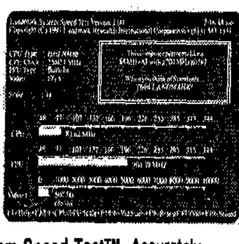
READER INFO NO. 2

PC DIAGNOSTICS

SPEED TEST YOUR PC



You've seen the *Landmark Speed Rating* advertised by major PC manufacturers, now you can have your copy of the **Landmark System Speed Test™**. Accurately measure CPU, math, and video speeds to *make an informed purchasing decision*, determine the best PC whose PC is *really* faster! Includes the Landmark AT CMOS RAM Setup program to update your system configuration *on-the-fly*.

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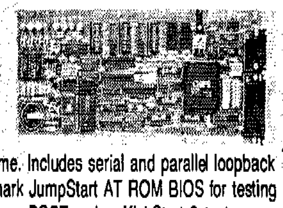
Alignit is *ideal for corporate users with* 2 or more PCs because it includes a **"GOLD STANDARD"** feature so you can align all your PCs to the same in-house standard, *guaranteeing that all your floppies are perfectly interchangeable* between PCs.

80% of all floppy drive failures can be fixed with Alignit so don't replace your drive, save time and money instead. Includes dual size floppies, (both high and low density) and no-mess pre-lubricated cleaning diskettes (both sizes) good for 180 uses. Replacements and single drive size versions available. For al PCs and compatibles.

PC WON'T BOOT? THEN JUST KICKSTART IT!

Don't replace your motherboard, don't call service, use **KickStart 2™**. When serious hardware problems occur, nothing gets you up and running as fast. KickStart 2 *measures power within 2.5%* on all four voltages, *shows Power-On Self-Test* (POST) failure codes, and features *on-board ROM-based diagnostics* allowing you to *determine and remedy the problem quickly, easily, and inexpensively!*

Built-in serial and parallel I/O *allows for testing via modem*, or simply logging results to a remote terminal, printer or laptop. You can configure your own test routines and store them in KickStart 2's battery backed-up CMOS RAM saving valuable setup time. Includes serial and parallel loopback plugs and Landmark JumpStart AT ROM BIOS for testing PCs that don't issue POST codes. KickStart 2 *tests your system regardless of O/S (even UNIX)*.



On-board switches, LEDs, and digital displays allow complete control over testing in systems lacking video or disk (ideal for motherboard or system burn-in).

Kick Start 2 is the *ultimate SECURITY CARD* tool With both supervisor and user levels of password protection, you can prevent unauthorised use of your PC and accidental running of destructive tests.

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Landmark/SuperSoft **Service Diagnostics™** is ideal for professionals requiring the *most exhaustive diagnostic* test capabilities. Each module is CPU specific, including PC, XT, AT, 386/486, and PS/2. Since 1981 major manufacturers like Wang, Xerox, Prime, Sony, DEC, NEC, and NCR have relied on Service Diagnostics to tackle their tougest operating problems.

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Ideal for UNIX and other operating systems, the *self-booting version* doesn't require DOS. The manual offers troubleshooting tips to the component level. Also available in a complete Kit including; all CPU specific software, dual size floppy alignment software (see Alignit), and PC/XT & AT ROM POSTs. ***Winner of the PC Magazine Editor's Choice Award in August 1990.***

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READER INFO NO. 3

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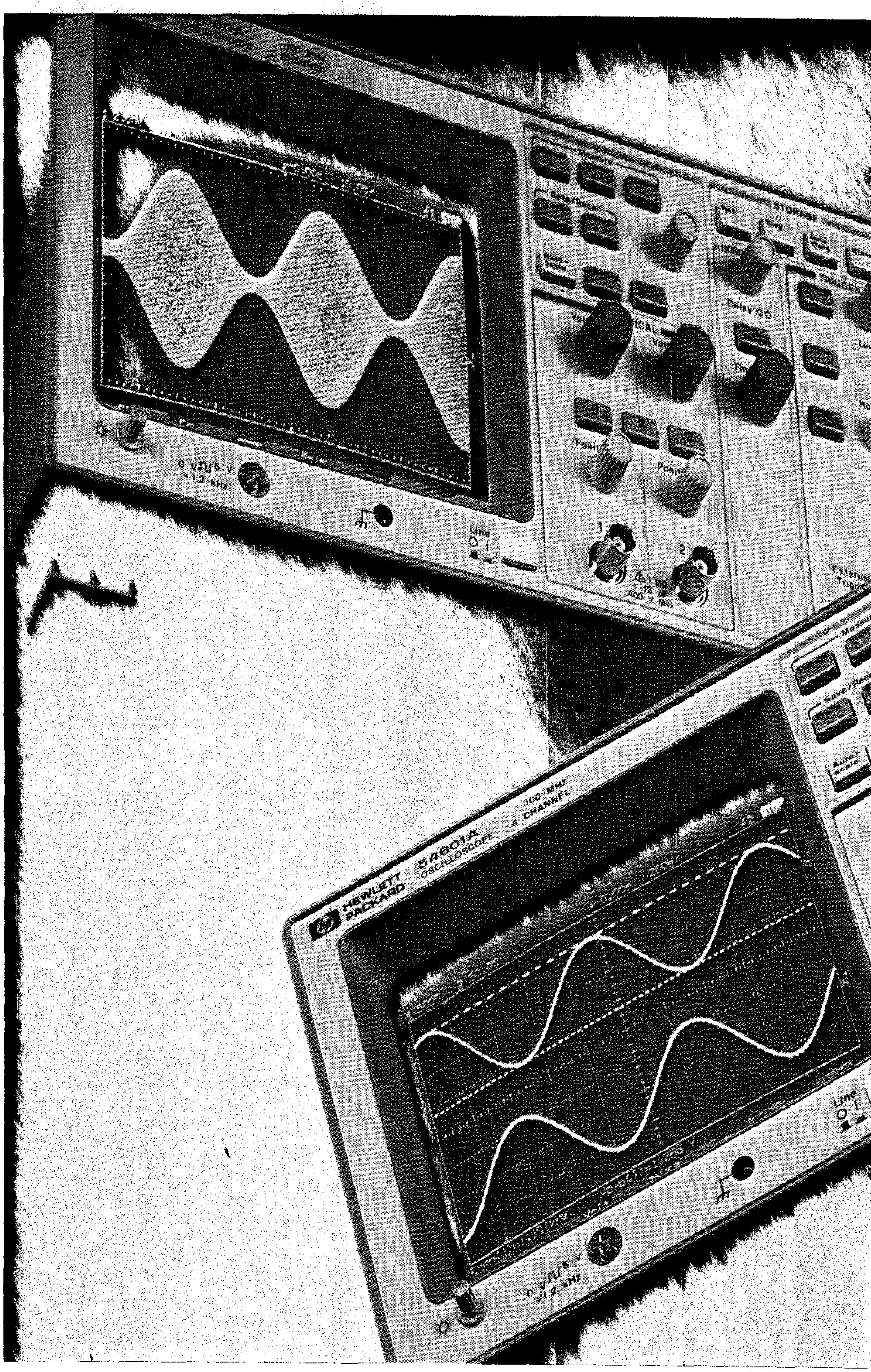
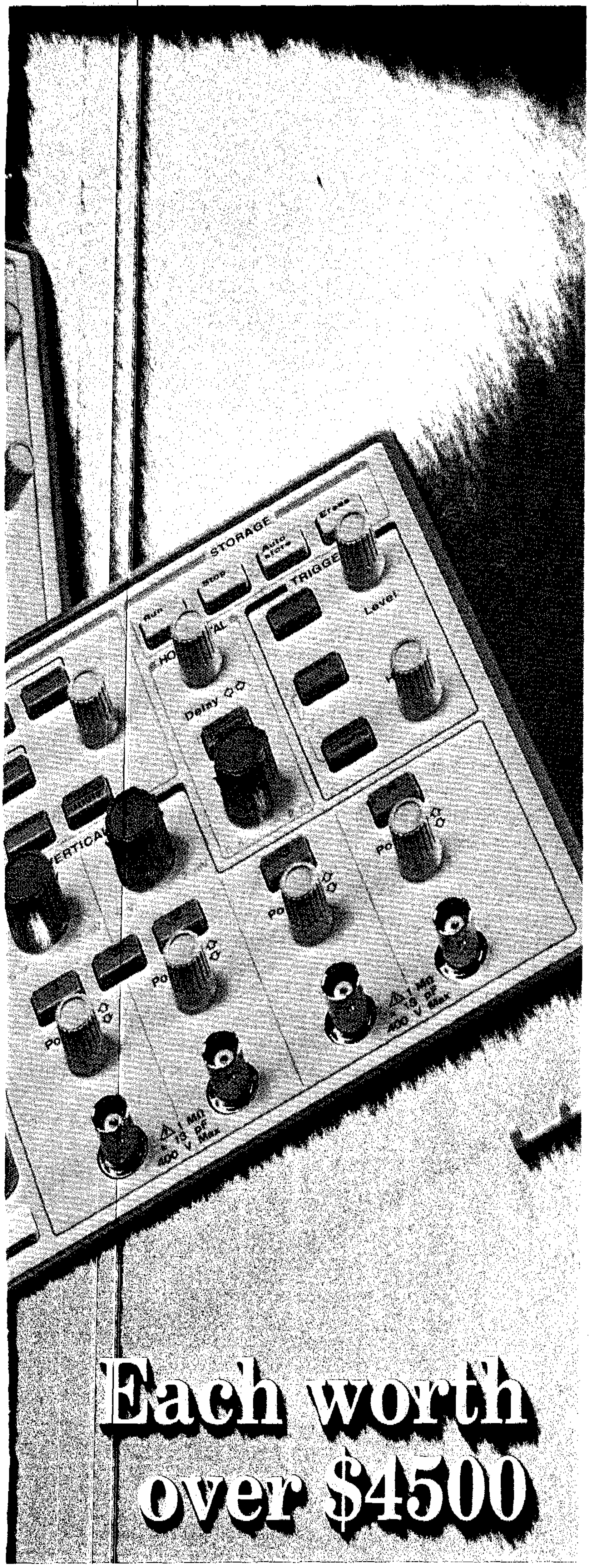


Packard Digital Scopes



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The new **Hewlett-Packard** HP 54600A and 54601A are very compact and light in weight, for fully-featured oscilloscopes with 100MHz bandwidth. Not only that, but they've been getting rave reviews around the world for the way they combine the use, display update speed and 'display confidence' of traditional analog' scopes with the high performance of a modern digitising instrument.

The 54600A offers two channels, while the 54601A offers four channels. Both instruments feature a sampling rate of 20 megasamples/ second, with 'random equivalent time sampling' to give a guaranteed bandwith of 100MHz for all repetitive signals, and 2MHz for single-shot measurements. Needless to say they have an inbuilt microprocessor, and can automatically measure most waveform parameters of interest: voltage (peak-to-peak, average or RMS), frequency, period, pulse width, rise and fall times, duty cycle — all to better than 0.4%. Any screen display can be stored in memory, sent to a printer or passed to a personal computer for further analysis, via optional RS-232C or IEEE 488 communications interfaces.

Other features include a one-touch 'Autoscale' button to give clear, locked waveform for virtually any signal; a wide range of trigger modes; and the ability to capture both fast and slow signals.

For further information about these products please call HP's Customer Information Centre on 008 033 821 or Melbourne on 272 2555. **Hurry subscribe today, the offer ends 26.02.92.**

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HEWLETT PACKARD

When I Think Back...

by Neville Williams

Vintage radio receiver design — 7
Enhanced audio, dualwave tuners & frequency changers

During the latter half of the 1930's, the audio systems in Australian radio receivers were upgraded by the adoption of negative feedback — offering better sound for both radio and record reproduction. Up front, dual- or triple-band tuners extended their coverage to the international shortwave bands. Ornate edge-lit glass dials became routine, perhaps in anticipation of the day when they would give place to a video screen.

While these and other developments can be identified with the late 1930's, the sequence in which they appeared is ambiguous. In the pursuit of market share, manufacturers tended to major on different features at different times, with the advantage accruing to those that managed to get it right in terms of sales appeal.

In this present article, it will be more realistic simply to discuss aspects of receiver design which characterised the period from around 1936 to the outbreak of war — an event which was to put domestic radio on hold 'for the duration'.

Fig.5 in the last article typified the design of domestic 4/5-valve mains powered superhets of around 1935/6. Fitted with AGC and magic-eye tuning, and offering acceptable audio quality, they gave their owners little cause for complaint. In a laboratory situation, however, limitations were still evident — which posed an ongoing challenge to design engineers.

So it was that while the 2A6/75/6B6 series of hi-mu diode-triodes appeared to meet the immediate need, engineers knew that they were lacking in treble response because of the so-called *Miller effect*. Incoming signals were being 'shunted' by the valves' intrinsic grid-anode capacitance, rendered the more serious by the fact that the anode was not simply an inert electrode but one that carried an amplified version of the signal — in opposite phase to the grid input.

The end effect, according to J.M. Miller of the US Bureau of Standards, was as if the grid-anode capacitance was (M+1) times its actual value, where M represented the voltage gain of the stage. The *Radiotron Designer's Handbook* (1940) quotes the 75 as having an inherent grid-anode capacitance of 1.7pF so that, allowing for a gain of 60, this translated into a dynamic (Miller effect) input capacitance of 105pF.

Duo-diode pentodes

While it could be argued that this was less of a liability than the audio bypass capacitors included elsewhere in the circuitry, engineers saw it as a needless treble loss of original signal that should be avoided, even if only on principle.

Valve manufacturers responded to their dilemma with the 2B7/6B7/6B8 series of duo-diode general purpose pentodes. As an R-C coupled audio amplifier, these offered a potential stage gain of 100 but, with a static grid-anode capacitance of only 0.007pF, the Miller effect capacitance amounted to less than 1pF — compared to 105!

Not surprisingly, for the cost of a screen feed resistor and bypass capacitors, many engineers opted for the diode-pentode rather than the diode-triode.

Alert to a still further design option, Australia's Amalgamated Wireless Valve Co (AWV) devised a special variant of the 6B7, the 6B7S, followed by its octal-based equivalent the 6G8-G. Whereas the original 6B7/6B8 had been classified as 'remote cut-off' pentodes, the 6B7S and 6G8-G were redesigned with a full variable-mu characteristic, cutting off at -43V — about twice the figure for the original types.

AWV engineers reckoned that the 6B7S/6G8-G could still serve as plug-in alternatives for the original types in most audio applications.

However, the full variable-mu characteristic should enable them to be used with variable bias and the valve(s) did, in fact, find limited use as gain-controlled audio amplifiers, supplementing normal front-end AGC systems.

In practice, however, they found their widest application as IF amplifiers in place of the traditional variable-mu 78/5D6/6K7 pentodes — the difference being that the IF output could be fed to the 6B7S/6G8-G's own diodes for detection and AGC voltage. By so doing, the entire tuner could be standardised around two valves, with an antenna feeding into one end and an audio lead coming out the other (see Fig.2).

The audio system could then likewise be self-contained, ranging from a single high-gain valve for an 'el cheapo' mantel set, to something more pretentious for standard or up-market models.

It may seem like a small point, but it fitted in with the emerging philosophy of regarding the audio system as an audio amplifier in its own right, rather than extra stages stuck on the rear end of a radio set!

Power pentodes

Back in 1936, the greatest single limitation on audio quality in 4/5-valve receivers had to do with the power output pentode.

With their high output impedance, these exhibited an exaggerated treble response and exaggerated harmonic distortion, when operating into the highly reactive load presented by a loudspeaker. They also imposed very little electrical damping on the cone, resulting in an unnaturally resonant or 'boomy' kind of bass.

As noted in earlier articles, designers sought to counteract these effects by wiring a tubular capacitor (e.g., 10nF or 0.01uF) across the loudspeaker transformer primary, and/or resorting to treble-cut elsewhere. It sufficed as an interim measure, but the need to find a more fundamental solution to the problem was hastened by the release of the high-power 6L6 beam tetrode, which could generate high frequency transients across a loudspeaker load of quite startling — and destructive — proportions.

In *Radiotronics* No.71 (December 1936), AWV published a circuit which proposed the most radical approach of all to the overall problem, namely to replace the output pentode with a 2A3 filament type power triode.

Adequate drive to the 2A3 involved the use of a 6C6 resistance-coupled pentode, preceded in the tuner by a 6A7 and a 6B7S. In this so-called 'fidelity' design, the highest level of overall distortion at any signal level, any modulation percentage and/or any condition of loudspeaker load was said to be 7%.

If this seems high by present standards, similar tests on a contemporary receiver using an output pentode yielded a figure of 30%!

Despite this evidence, and to the best of my knowledge, the idea was taken up only by a few hobbyists. Manufacturers presumably looked with disfavour on the marginally larger and more awkward power transformer that would be required, and the potentially less rugged output valve. In addition, a new scaled-down beam power tetrode was on the horizon (the 6V6), which would make for good sales promotion — even if it didn't amount to much in practice!

Negative feedback

As it happened, the same issue of *Radiotronics* was cautiously optimistic about the idea of using *negative feedback* with pentode (or tetrode) output valves — for the reason that, while preserving their efficiency in terms of current drain, it could artifically reduce their output impedance to approach that of a power triode. As a result, frequency response would be flatter, distortion drastically reduced and loudspeaker damping greatly improved.

Negative feedback involved diverting a small proportion of the output voltage from the power stage back to an earlier point in the audio signal chain, such that it would be out of phase with the input signal at that point.

Inevitably, in counteracting or partially cancelling the original signal — hence the description 'negative' or 'inverse' feedback — it would reduce the apparent

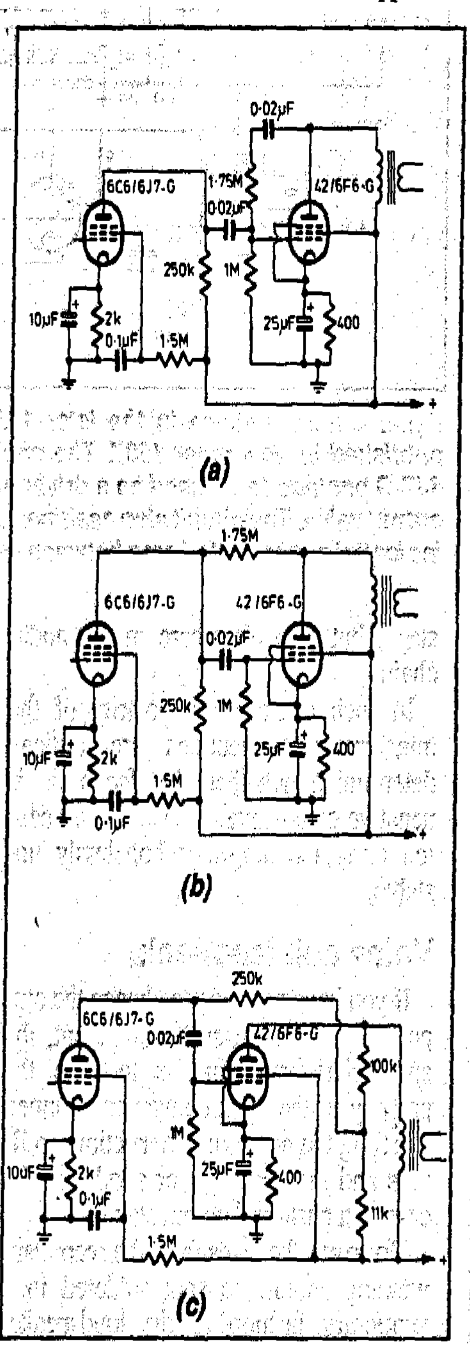


Fig.1: Typical circuit configurations for applying negative feedback around the output stage of ordinary receivers. Such circuits normally remain valid after replacement of the output transformer or even the complete loudspeaker.

gain of the system and necessitate a larger input signal. It offered a vital bonus, however.

If the amplifier gain within the feedback loop tended to rise for any reason, over any part of the frequency spectrum, the output signal would increase accordingly. But so also would the sample fed back via the feedback path — thereby increasing the degree of cancellation and further reducing the system gain.

By such means, negative feedback would tend to counteract variations in stage gain, either up or down, so that the overall frequency response would be made smoother.

Similarly, if the stage(s) within the feedback loop generated spurious harmonics, they would be fed back to the input along with the legitimate signal. Being then amplified in reverse phase, internally generated harmonics would tend to cancel themselves, effectively reducing the level of distortion.

Again, if the loudspeaker cone tended to prolong sonic vibrations of its own accord, the mechanically generated wave trains would be fed back to the input of the amplifier in reverse phase, and serve ultimately to counteract the spurious cone movements which gave rise to them in the first place.

Research in Australia and elsewhere established that a voltage gain reduction of around 3:1 or 4:1 (10 to 12dB of negative voltage feedback) was sufficient to impart triode-like characteristics to a power pentode output stage, in respect to the vital parameters mentioned above. In particular, the new and more economical 6V6-G could be expected to behave like a 2A3!

Simple circuits

Since the deficiences in the audio end of a typical 4/5-valve receiver related to the disparate characteristics of a power output pentode (or tetrode) and the complex anode load presented by a loudspeaker, an effective negative feedback path could most simply be provided between the anode and grid of the output valve.

Fig.1 shows a number of possible configurations, which appeared in literature of the period. Diagram (a), from *Radiotronics* 71, is probably the most obvious way of placing a feedback loop around the output valve, with a DC blocking capacitor and a series resistor simply strung from the anode back to the grid. With the grid shunted to virtual earth through its own 1M resistor and by the 250k anode supply resistor and the anode resistance of the 6C6/6J7-G, slightly less than 10% of the anode signal swing would be effective in the grid circuit.

At full output, on the basis of 3.1W into a 7000-ohm load, the signal voltage at the anode would be about 150V RMS or 212V peak.

Of this, about 10% or 21V peak would be fed back to the grid — so that instead of the rated figure of 16.5V peak, the required drive with feedback would become (16.5 + 21), or 37.5V peak. This would be equivalent to a gain reduction of just under 2.3 times or 7dB — a rather cautious figure in terms of audio feedback design.

The figures indicate, however, why AWV encouraged engineers to provide a capable audio driver ahead of a feedback output stage — to ensure that adequate gain would still be available, along with a distortion-free drive voltage.

Fig.1(b) is/was very similar to (a), except that the blocking capacitor was omitted, with the resistor connecting to the anode of the voltage amplifier.

With the values shown, the gain reduction would be identical to that of 1(a) — although in practice, the values could conceivably have been juggled slightly to maintain the effective DC anode feed resistance to the 6C6/6J7-G at the then-recommended level of 250k.

Fig.1(c) emerged as the most popular configuration of the day, probably because the feedback percentage was determined by a resistive divider wired directly across the output transformer primary.

With the constants shown, the basic divider was set for 10% — although only four-fifths of this, or 8%, would be effective at the grid because of the secondary divider formed by the feedback/load and grid resistors.

Again, some juggling of the divider could well have been justified to get the gain reduction closer to the desirable 3:1 or 10dB.

Such details aside, most 4/5-valve receivers employing negative feedback used a simple configuration along the general lines indicated in Fig.1 — and for this we can be duly thankful. Such circuits are inherently stable, and failed components can be replaced with equivalent values without apprehension.

This applies even to a faulty output transformer and, provided the replacement is a functional approximation of the original, the negative feedback will continue to ameliorate possible problems with frequency response, distortion and damping.

The same cannot be said of the more complex audio systems found in contemporary up-market receivers or stand-alone audio amplifiers. In such equipment it was common practice to mount the output transformer on the chassis, rather than on the loudspeaker, running the feedback loop from the secondary of the output transformer to a point relatively early in the audio chain. The design objective was to combat possible aberrations not just in the output

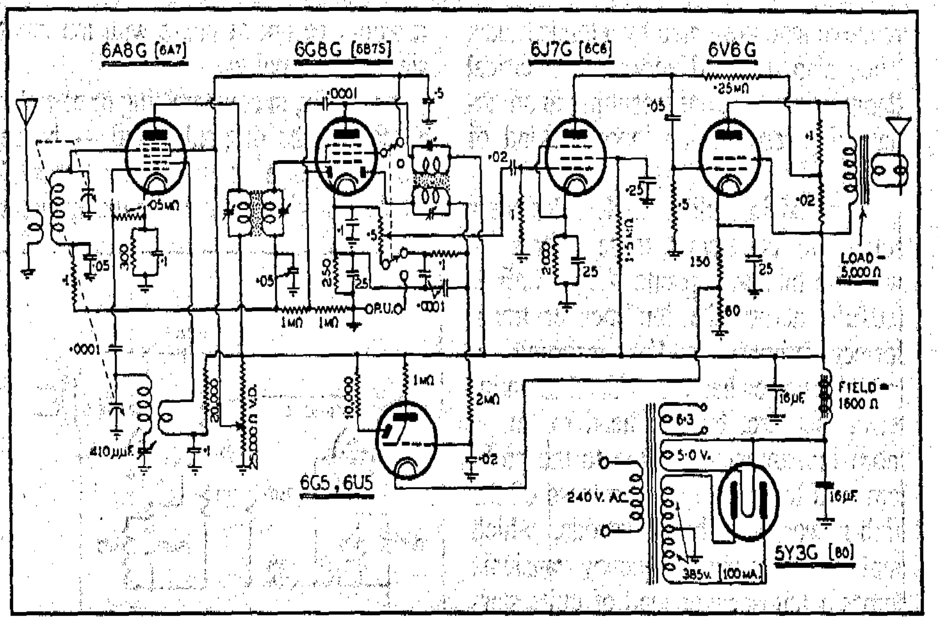


Fig.2: Circuit practice in the later 1930's, as exemplified in Radiotronics 81, published in November 1937. The choice of a 6G8-G in the IF stage allowed a 6J7-G pentode to be used as a driver ahead of the then-new 6V6G beam tetrode output valve. The circuit also assumes the use of ferrite-cored IF transformers, as indicated by the dotted area between windings.

stage, but also elsewhere in the audio chain.

In such circuits, the polarity of the transformer connections are critical, determining whether the feedback is negative or positive — in the latter case rendering the amplifier hopelessly unstable.

Voice coil feedback

If you have occasion to change the output transformer in such equipment, the appropriate procedure is to wire the primary in the most convenient manner, effecting the necessary connections to B-plus and the anode — or anodes in the case of a push-pull output stage.

However, the leads from the secondary winding should be spot soldered in a temporary fashion to the loudspeaker socket, one lead being usually earthed while the other feeds the other end of the

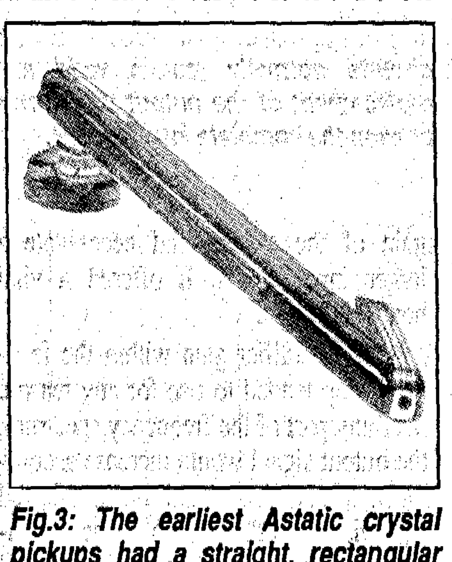


Fig.3: The earliest Astatic crystal pickups had a straight, rectangular metal arm. This then-new O-7 model, featured in our December 1939 issue, had a more ornate moulded arm with offset head to counteract tracing error.

voice coil and the negative feedback circuitry.

Unsolder this feedback lead and leave it disconnected for the next step. Connect the loudspeaker, switch the amplifier on and feed any available signal through it at a low volume setting.

Now, keeping your hands clear of high voltage leads, touch the feedback wire on to the point from which it had been removed. If the volume level increases or, more likely, if the amplifier emits a loud shriek or begins to 'motorboat', it is a pretty sure sign that the feedback is now positive.

In this case switch off, reverse the connections from the transformer secondary winding and try again. This time, reconnecting the feedback lead should reduce the sound level from the loudspeaker, indicating that the feedback is now negative, as it should be.

A problem with multi-stage feedback loops is that the phase of the feedback can still rotate at supersonic frequencies, to produce a degree of instability which may or may not compromise the behaviour of the system in the audible range.

Ideally, this should be checked after an output transformer has been changed — a procedure which calls for a high-performance AF/RF signal generator, square-wave generator and a wide-band oscilloscope.

But this assumes another level of expertise and is really outside the scope of this present article. Domestic 4/5-valve receivers rarely used voice coil feedback, if only because the output transformer was conventionally treated as part of the loudspeaker, rather than of the chassis.

Typical circuit

It fell to my lot to draft the circuit shown in Fig.2, which was devised by AWV Applications Engineer R.H. (Dick) Errey. Published in *Radiotronics* 81 (November 1937), it was intended to epitomise appropriate circuit practices for contemporary 4/5-valve superhets.

The tuner was concentrated around a 6A8-G and 6G8-G — in the latter case for reasons outlined earlier. (A separate article in the same issue of *Radiotronics* explains why a high performance pentode should be provided for in feedback circuits such as those illustrated in Fig.1).

The circuitry to do with detection and AGC broadly follows recommendations discussed in the last article, as also does that involving the 6G5/6U5 remote cut-off 'magic eye' tuning indicator.

Series resistors in the HT supply to G2 of the 6A8-G and 6G5/6U5 target are intended to provide a self-compensating effect, particularly if the HT supply voltage should rise above 250V as a result of mains fluctuations.

By way of further explanation, the article says that investigation of early complaints about unduly short life of tuning indicators reveals that it had commonly been due to excessive target current — leading, in some cases, to the target structure becoming red hot!

It is also noteworthy that the circuit provides for Radio-Phono switching, with one switch pole to select the desired input and the other to silence the tuner by interrupting the supply to the 6G8-G screen grid. The latter provision was to prevent possible break-through of noise interference or powerful radio signals when playing records.

It was about this time, as I remember, that crystal pickups (Fig.3) were making an initial impact on the market. While the early Astatic piezo models were rather clumsy compared with their postwar lightweight counterparts, they had more output and a much fuller sound than typical 1930-style magnetics. They contributed significantly to the mid-1930's swing to combination 'radiograms'.

The beam tetrode output valve is referred to in *Radiotronics* as 'the new 6V6-G' — of potential interest to set makers because it represented new technology, offered a marginal increase in sensitivity and an extra watt of power output, albeit at about 10 milliamps extra current drain.

Note that the feedback circuit follows Fig.1(c), but with an increased ratio of 20% — which according to *Radiotronics* ends up as an effective 10% at the 6V6-G grid.

Emphasis on feedback

In effect, AWV chose to divert the extra sensitivity of the 6J7/6V6 combination to the negative feedback, to provide a further contribution to quality rather than to gain — an indication of the emerging design philosophy of the day.

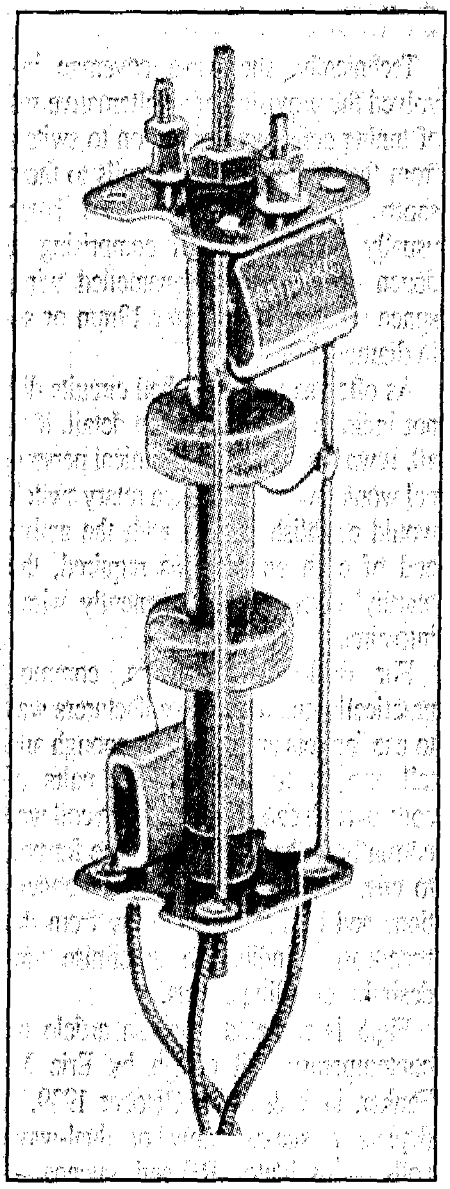


Fig.4: From the April 1941 issue of R&H, this Britannic IF transformer, minus its shield can, uses litz pie-wound coils, fixed tuning capacitors and adjustable ferrite slugs for alignment.

So too, perhaps, was the tacit acceptance of a 100mA power transformer and the specification of 16uF filter capacitors, presumably to ensure adequate filtering with the somewhat reduced value of field coil impedance.

On the subject of gain, AWV suggests that the sensitivity should still be adequate for the reception of interstate broadcast stations or for use on the shortwave bands.

The addition of an RF stage, they say, would result in a high performance receiver with ample gain and good quality reproduction from both radio and records. As such, the design would become the 1937 counterpart of the high-performance 175kHz circuit featured earlier in this series.

A point of note is that a pattern of dots between the windings of the IF transformers seeks to convey the idea that each of the relevant coils has a central ferromagnetic core — normally slugs of powdered iron or oxide, moulded with an insulating binder and cemented inside the former on which the coils were wound.

As pointed out in the last chapter, the merit or Q-factor of IF transformers had already been boosted by winding the coils with litz wire, which offered a significant reduction in their RF resistance. It transpired that insertion of a suitably formulated ferrite core through the centre of each winding could provide the required inductance with fewer turns, therefore with less wire and a still further reduction in RF resistance.

This, plus the use of low-loss moulded formers (e.g., Trolitul) and Trolitul-based varnish pushed the Q-factor of 465kHz IF transformers to the point where designers, once again, had to balance selectivity against loss of treble due to sideband cutting.

(The emergence of Trolitul was featured in the very first issue of our predecessor *Radio & Hobbies* — April 1939 — in a feature article and in an RCS advertisement.

The same issue contained a contemporary discussion of selectivity by R.H. Errey, mentioned earlier. Further articles on selectivity and coil design appeared in the June, July and October 1939 issues, written by Eric M. Fanker — chief engineer of Thom & Smith, makers of 'Tasma' receivers).

The use of litz wire and ferrite cores became so routine from then on that they were taken for granted, and not necessarily designated in circuit diagrams.

It also became routine to mould cores and formers with a matching thread, so that IF transformers and tuning coils could be aligned by positioning cores in the formers, thereby reducing reliance on trimmer capacitors (Fig.4).

This subject will be discussed in detail in a later article, to do with receiver alignment.

Shortwave coverage

What triggered consumer interest in shortwave listening in the 1930's is open to speculation, although *EA*'s shortwave listening columnist Arthur Cushen may have offered an inadvertent clue in his recent mention of the commencement of the BBC's World Service from Daventry, UK, in 1932.

Perhaps it was also due in part to diminishing interest in ordinary long distance reception. With 'me too' programming and the increasing use of transcription discs, distant Australian stations no longer sounded all that different from the locals.

By contrast, periodic re-broadcasts of overseas stations often highlighted news, sport and events from countries that were still weeks away by steamship, and equally remote in terms of culture. With more and more overseas broadcasts penetrating Australian airwaves, it was intriguing to discover that they could be accessed with an otherwise normal receiver equipped to cover the shortwave bands.

For listeners in rural areas, shortwave reception offered a further bonus in that shortwave transmissions, both overseas and local, could often be heard at times when atmospheric conditions had obliterated broadcast band reception.

Appearing on the market from about the mid-1930's, shortwave coverage began almost as a fad, but attracted attention as the overseas political situation edged towards war.

Most of the resulting receivers were D/W (dual wave) types, with coverage from about 16-51 metres (19-6MHz) in addition to the normal broadcast band. More pretentious receivers often boasted two shortwave bands in addition to the broadcast band, covering 13-39 metres (23-7.7MHz) and 35-105 metres (8.6-2.9MHz) — the latter taking in both the 40m and 80m amateur bands.

Because shortwave signals were commonly weaker than local broadcasters, adequate receiver sensitivity was essential. But a normal 4/5-valve D/W superhet, with the ability to log interstate stations, was usually capable of a useful performance on short waves. The 5/6-valve circuits with an RF stage were invariably better, in terms both of sensitivity and signal/noise ratio. Even a few 3/4-valve mantel sets boasted shortwave coverage, although with strictly limited performance.

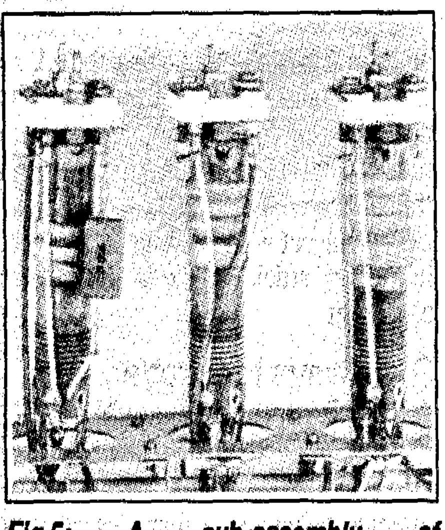


Fig.5: A sub-assembly of (presumably) Tasma coils from the late 1930's, ready to be bolted into a chassis and fitted with cans. Alignment trimmers are at the top, normally accessable through holes in their respective cans.

Coils and switches

Technically, shortwave coverage involved the provision of an alternative set of tuning coils, with provision to switch from the normal broadcast coils to their shortwave counterparts — the latter usually being solenoids comprising a dozen or so turns of enamelled wire, space wound on a former 19mm or so in diameter.

As often as not, published circuits did not indicate the switching in detail, if at all. It was assumed that technical personnel would understand that a rotary switch would establish contact with the active end of each winding, as required, the 'earthy' ends being permanently wired into circuit.

For dual-wave receivers, common practice by the major manufacturers was to use formers and cans long enough and tall enough to accommodate pairs of coils in each can. The shortwave coil was normally at the lower end of the former, to ensure the shortest possible connections and be far enough away from the broadcast winding to minimise undesirable coupling effects.

Fig.5 is repeated from an article on contemporary coil design by Eric M. Fanker, in *R & H* for October 1939. It depicts a sub-assembly of dual-wave coils — oscillator, RF and antenna — presumably as used in an up-market Tasma receiver.

Alignment trimmers, one for each winding, are so positioned as to be accessible through the top of the individual cans. In the accompanying article, Eric Fanker explains the role of ferrite cores in the broadcast coils but says that, at higher signal frequencies, core losses would tend to overtake anticipated benefits, rendering them of little value.

Normal layout practice was to mount the coils alongside the tuning gang, with the decks of a rotary bandswitch immediately below and the relevant frequency changer — and possibly RF amplifier — valves nearby.

For each model, bench wirers were required to adhere strictly to a predetermined wiring pattern, to ensure the shortest possible signal paths on the high frequency band(s) and to minimise possible stray coupling between them.

The first rotary bandchange switch that

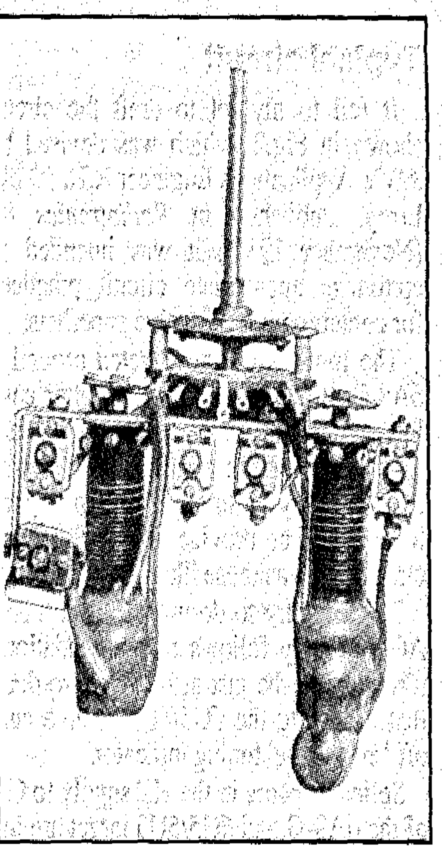


Fig.6: A Britannic pre-assembled dual-wave coil unit advertised in the April 1941 issue of R&H. Mounted on a bracket attached to a Yaxley switch, it is typical of units often used in home-built or small production-run 4/5-valve superhets.

I can recall was a dubious device with a separate, rather cumbersome wafer mechanism for each pole, supported by side-rods and spacers. The common contact on each wafer was a plated semi-circular strip, the other half-sector accommodating an arc of rounded brass rivets, each provided with a solder tag.

Contact between strip and rivets on each wafer depended on a springy wiper blade, supported on a central rotatable shaft by moulded spacers.

One end of each wiper rested on the relevant contact strip; the other end was so shaped, with a hole or dimple, that it would mount and drop over the selected stud, establishing the desired circuit connection.

At best, the mechanism had a rather stiff and imprecise action, rendered so by the need to disengage and re-locate each wiper on a new stud in the somewhat flexible assembly. At worst, it was necessary to 'wiggle' the knob each time it was moved to ensure adequate contact.

If a collector should come across a vintage receiver with a switch answering this description, you will be looking at an historical relic — but a potentially troublesome one!

Fortunately, before many such receivers were produced, 'Yaxley' brand switches appeared on the market — followed, some years later, by a look-alike which was marketed locally under the

AWA/Oak banner. Both used a front clicker plate to provide positive indexing, and wafers able to accommodate multiple poles. These employed small, low-drag, silver-plated contacts.

Notably trouble-free, YaxleyOak inspired rotary switches are still with us decades later, and used for a variety of purposes.

Prefab coil units

In the major factories, it was possible to use separate coils, switches, capacitors and valves because the optimum placement for every component and every lead could be determined in factory prototypes and duplicated, as a mandatory requirement, by production line assemblers and wirers.

But in the realm of hobbyists and kit suppliers, cottage industry assemblers and even small factories, rigid control of wiring was less practical and shortwave performance could suffer as a consequence.

Reacting to the situation, component suppliers made available a variety of pre-wired sub-assemblies which could be mounted in otherwise complete chassis, and installed by connecting up a few external leads.

The least pretentious of such sub-assemblies comprised a Yaxley or Oak switch on a bracket, on which was mounted two antenna coils and two oscillator coils, as for a 4/5-valve superhet.

The assembly was often held in place by the lock-nut on the switch shaft and wired up according to the maker's instructions. (See Fig.6).

At the other extreme were complete and much more expensive tuner sub-assemblies carrying the tuning gang and even the sockets for the frequency changer — and possibly RF — valves, all pre-wired and pre-tested.

Bolted into a suitable space in the host chassis, such units largely obviated any uncertainty about 'will it work?' Any number of variants between these two extremes may turn up in reclaimed valve receivers.

Frequency changers

At this point it had been planned to include a few paragraphs about the associated dial mechanisms and the problem of locating and tuning shortwave stations, but for space reasons, this has had to be held over until the next article.

It is appropriate, however, to round off this present discussion with a few relevant observations about frequency changer valves.

Throughout the mid-1930's, most mains powered receivers had used a pentagrid converter in the 2A7/6A7/6A8-G series. These had done a useful job on both the broadcast and shortwave bands, although limitations had become apparent in the 20MHz region when changing conditions heightened interest in the 13-metre (22MHz) band.

At this frequency, the somewhat makeshift triode oscillator in the pentagrid series tended to become unreliable with ageing valves or reduced supply voltages, as well as exhibiting frequency shift with fluctuating AGC or other voltages affecting the mixer section. The resultant detuning tended to exaggerate the effect of signal fading.

In *Radiotronics* 84 (March 1936), AWV announced the pending release of two new frequency changer valves to replace the 6A8 series: the 6K8-G and 6J8-G. These would use the same base and socket connections but could offer improved performance, given minor changes in the associated circuitry.

As I recall, the 6K8-G was the first to become available in quantity, possibly because it had greater support on the American market.

Described as a triode-hexode, the triode was a separate structure, with a transconductance of 3mS (3mA/V) — being a very willing oscillator as a result!

In the mixer section, G1 was the remote cut-off signal input grid, and G2 a screen grid; G3 was tied internally to the triode grid for oscillator injection, with G4 tied to G2 to provide further screening.

The input and output impedances of the mixer were higher than those of the 6A8-G, offering the designer improved performance by increasing the dynamic resistance of the input and output tuned circuits and optimising the oscillator grid current.

Compared to the pentagrid series, oscillator frequency shift due to applied voltages was said to be reduced by about 10:1.

The 6J8-G, described as a triode heptode, also featured a separate triode but differed from the 6K8-G in having a suppressor grid, G5, in the mixer. This was tied internally to the cathode.

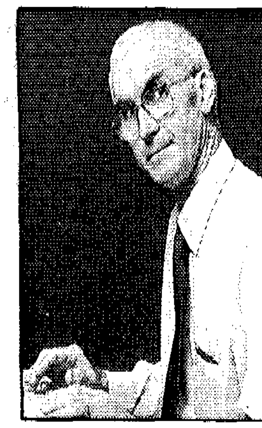
It had slightly lower oscillator and conversion conductance than the 6K8-G but, as I recall, was credited with higher output impedance, even better oscillator stability and a better signal/noise ratio. In Australia, at least, it ultimately became the more popular of the two types.

Other frequency changers appeared in Australian receivers in the 1930's, such as the Philips/Mullard octodes. But while they had their supporters, they were very much in the commercial minority.

(To be continued) ❖

FORUM

Conducted by Jim Rowe



A minor milestone, more on project safety, and a young reader asks about the volt...

There's been a few interesting letters in response to the comments published in last November's column, taking us to task about safety aspects of our projects. We have a look at these this month, and also try to help a young reader who's having difficulty trying to understand *exactly* what we mean by a 'volt'. It's a concept that has given many of us trouble, and I'm sure he's not alone.

Before we jump once more into the fray, though, dear friends, I've just noticed that last month's *Forum* column was actually the 50th that I have 'conducted' since taking over the column in December 1987. It may not mean all that much to most readers, I guess, but to me the realisation came as something of a surprise.

Actually the term 'conducting' sounds a bit odd, as a description of the humble activities one performs in keeping this venerable column going. It also sounds a bit grandiose, for a task that superficially involves little more than selecting letters from the bulging Forum correspondence file each month, and then typing them tediously and painstakingly into my word processor...

The term 'conductor' conjures up a much more impressive image of a majestic figure in a dress suit, waving a baton imperiously in front of a group of performers. Or a stout copper rod with spikes on the top, pointing towards the heavens in a fierce electrical storm, to attract all manner of impressive lightning discharges...

Come to think of it, with all the heated discussions that we get at times, I suppose there *are* a few similarities!

Still, whether it's a baton or a copper rod, or whatever, I do seem to have kept it metaphorically aloft for no less than 50 episodes now, and hopefully in a reasonably entertaining fashion.

Mind you, I still have a long way to go before I would make any sort of impression on the previous record. Our former Editor-in-Chief (and current 'When I Think Back' columnist) Neville Williams started the column off in September 1950, under its former heading 'Let's Buy An Argument', and kept it going for over 37 years — no less than 440 episodes. Quite an achievement!

A mere 50 episodes sounds pretty trifling in comparison, doesn't it? But I think I'm getting the hang of it, now, at least...

Let battle commence!

So let's press on, and get cracking with episode 51 of the present series. You'll recall, I trust, that in the November issue we quoted fairly substantially from a couple of letters sent by Ian McGrath of Moulden in the Northern Territory. Mr McGrath was quite critical of some of the recent projects we've described, in terms of their safety aspects. His criticisms were constructive and carefully explained, and on the whole I believe they were fairly justified — so much so that we've resolved to pay much greater attention to this area in the future.

In the column concerned I also noted the suggestion made by Ken Laird, of Melbourne kit firm Kalex, that we swing over to using the IEC mains connector system for our projects. This too was a very constructive suggestion, and we're putting it into practice too.

Traditional wisdom has it that only a fool hangs out their dirty linen in public, and I suppose many magazine editors would have reacted to criticisms like those from Mr McGrath by replying in private, and then publishing a few unobtrusive 'Notes and Errata' to solve the problem. But I guess I'm getting a bit too old now to worry much about looking foolish, or to try pretending that I/we never make mistakes. Nowadays I'm well aware of having made mistakes, and by the truckload — my only consolation being in the old saying that 'He who has never made a mistake has never done anything'.

In any case, when I read Mr McGrath's criticisms myself, it struck me that the points he raised made very interesting reading, and really needed to be published on that score alone. Judging from the letters that have arrived since the November column was published, it looks as if I was right in that decision at least. Apparently quite a few people found the comments of Mr McGrath and Mr Laird of interest, and have been motivated to offer some of their own. That's the whole idea of 'Forum', after all...

But enough preambulising (yes, I know it isn't in the dictionary, but you know what I mean). Let's see what some of the readers concerned actually had to say.

One of them, Mr I.W. Cowan of Hawker in the ACT, actually wanted to take Ian McGrath to task over his quotation from a particular Australian safety standard:

I think you surrendered a little too meekly to your correspondent Mr Ian McGrath. His statements are not as correct as you give him credit for.

He cites AS3000 as his authority for taking you to task over the earthing practices apparently recommended in an earlier issue, in relation to a power supply construction project. This specification is not relevant to the case in point — it relates to buildings, structures and premises, but not to equipment which may be operated therein.

The relevant specification is AS3100, which sets out the general requirements for electrical materials and equipment. It has a reasonably detailed section on earthing, and I note with interest that the use of a constructional bolt, stud or screw for the attachment of an earthing conductor is acceptable, providing some commonsense requirements are satisfied.

Well — it looks as if we may not have been alone in making a blue, according to Mr Cowan. I must confess that I didn't check Mr McGrath's reference to

AS3000 myself, because as I explained at the tail end of the November column we don't actually have a full set of the standards.

Whether or not I 'surrendered a little too meekly' to the original criticisms is a matter of opinion, I guess. I did point out that even if using a transformer mounting bolt to attach the earthing connection was strictly wrong, in at least a proportion of cases (like Peter Phillips' power supply), it seemed to make little difference in practical terms.

Although I didn't actually say so at the time, I couldn't really see why it *was* supposedly so dangerous to use one of the transformer mounting bolts to attach the earth connection lug to the transformer frame and case. And where the case is metal, and we use the correct assembly of spring washers, etc., I still can't see anything wrong with this approach. So assuming Mr Cowan is right, it's a relief to discover that the relevant standard actually allows this to be done. Thanks for pointing this out, Mr Cowan — now at least we won't have to drill extra holes in transformer mounting flanges...

(Mind you, many of Mr McGrath's other points were much more valid; for example we'll definitely have to avoid using bolts that tighten up through a layer of plastic, so they'd become loose and prejudice the earthing when everything became overheated.)

Toroidal transformers

Moving on, the next letter came from Mr S. Calder, who runs the firm Hycal Electronics in Parramatta, NSW. As regular readers will be no doubt be aware, Hycal advertises regularly as a specialist in the repair of kits; so Mr Calder's comments are of particular relevance.

We don't have the space to reproduce the whole of his letter here, because of its length. However I've selected the most interesting sections. As you'll see, one of the points he raises is the safety aspects of toroidal power transformers, which are currently in vogue for things like amplifiers and power inverters:

It is good to see the safety of kits and projects being discussed. At Hycal we service a fair range of products and kits.

On average we have usually at least one, sometimes two transformers per month that have failed with the primaries burnt out, or shorted turns either on the primary or secondary windings.

I have not seen a failure where the primary or secondary has actually melted the bobbin to a stage where the chassis of the transformer has come into contact with any part of either winding.

If a transformer which is manufactured to the Australian Standard is supplied/fitted to kits, then the chances of the primary becoming shorted to either secondary or chassis is extremely remote. I know Jaycar Electronics have these approved transformers, but if their kits are supplied with them or not I do not know.

Most of the transformer failures I have seen are caused by operating a transformer designed for 220V AC or 60Hz from 240V AC 50Hz. The difference between 60Hz and 50Hz causes the magnetising current and often the temperature to rise dramatically.

Toroidal transformers are fairly dangerous. They have basically no protection against failure. With the approved E-core type transformers the primary and secondary windings are separated, with the primary on one bobbin and the secondary on the other and with insulation in between. When the transformer fails, there is no danger of the primary contacting the secondary. However with a toroidal transformer the secondary is wound directly over the primary. What's more, there is often pressure added from the mounting plates and mounting bolt.

If the transformer is subject to abuse, over voltage, incorrect frequency, high secondary current etc., and the temperature of the transformer exceeds its ratings, there is a distinct possibility of the insulation melting and allowing contact between the primary and secondary.

In a power amplifier situation where the zero volt rail is not earthed, the amplifier could be quite lethal, or damage other equipment connected to it.

I have seen only three toroidal failures. One was in a disco mixing console made by Cashmore Sound. The toroidal sits on the heatsink for the power amplifiers — a big no-no in my opinion. The transformer's primary had failed, probably with a shorted turn at first, which caused much more heat and had finally melted the tubing on the primary connection to a terminal block. The unit is not fused, and the transformer's primary winding wires going to the terminal block had melted.

The second toroidal was one used in an Altronics inverter. The unit was not producing the full 240V output, and when loaded with a 100W lamp the voltage would drop further. The inverter was about 18 months old, and according to the customer had very little use. I eventually found a breakdown in insulation between the 240V winding and the 12V winding used for the feedback circuit. This feedback circuit draws only a very small sampling current from this winding, and so it could not have been overloaded unless something in this area had failed. I checked, and this circuit was working correctly. I sent the transformer back to Altronics and they replaced it, as it seemed that the transformer was defective from manufacture. It had no signs of overheating, etc.

The third transformer was in a power amplifier that a constructor had built in a wooden box. The transformer was charcoal black when the unit was brought to me, and the customer said that during the night the amplifier stopped working. He had a spare amplifier, and disconnected the inputs — which used plastic shrouded RCA connectors. He then went to remove the speaker connections, which used metal 6.5mm phone plugs, and when he touched one of these he had received a huge electric shock.

I had a look at the toroidal transformer, and sure enough there was a low resistance from primary to secondary winding. The zero volt rail in the amplifier was not earthed.

With regard to earthing, any control, switch, transformer or metal chassis with mains power cabling should be earthed. In most projects with a metal toggle switch used as the mains power switch and where the front panel is plastic, the switch body should be earthed. If the front panel is metal then the earth for the power switch is made via the front panel being earthed. This does not seem to happen too often in kit projects. The technicians at Hycal check the earthing of kits when they are being repaired and constructed, and change the wiring as required for proper earthing.

Thanks for your comments, Mr Calder, and also for your suggestions about ways of improving the safety of our projects. I haven't reproduced them here, but we've taken careful note of them and will try to put them into effect.

I guess Mr Calder is also right in his suggestion that many toroidal power transformers are essentially less safe than traditional E-I types. I don't know about you, but I hadn't quite noticed this before. Certainly the common technique of apparently putting one winding over the other, with a layer of plastic insulation tape between the two, seems likely to be less safe than the modern approach of two separate high-temperature rating bobbins side by side, with a 'washer' of fire-proof insulation between them.

But perhaps there's more safety built into a modern toroidal transformer than we think, and if this is so I hope one of their designers or manufacturers will let us know and set the record straight.

Actually in principle I don't see why a toroidal transformer can't have fully separate bobbins, like an E-I type or one of those 'C-core' transformers that were used in some of the last last valve-type TV receivers. It should also be possible to mount them in a way which doesn't subject the windings and insulation to pressure, too.

Now let's look at one more letter on the subject of safety, which came from Mr John Wark of Carlingford in NSW. Mr Wark picks up on the topic of plugpacks and connectors:

Plugpacks may well have their place, however they can be inconvenient inasmuch as if you have a number of them running from a power board, the 'Law of Tangling Leads' will inevitably prevail. The problem of failure of leads can also arise. This is particularly irritating when the open circuit happens to occur at or near where the lead enters the case.

Might I therefore offer the following solution to the problem. A little elegant maybe, and probably more expensive.

What is needed is an encapsulated transformer/power pack with a back plane, incorporating an IED socket — perhaps also a mains fuse and switch. Emanating from the other end of the case, facing into the project, would be the low voltage AC or DC leads, depending on the model, together with a lead connected to the mains earth pin on the IED connector. Such a unit could then be mounted on the rear panel of a project, hopefully overcoming the issues which have been raised.

I might add that I have been using IED sockets in projects for some years, as they provide a convenient method of being able to vary the length of mains leads on equipment, on the occasions that you may wish to take it out of the workshop. I tend to have leads on shelf-mounted gear only as long as they need to be, to reach their assigned mains outlet.

Thanks for your suggestion too, Mr Wark. It sounds as if it would indeed be an elegant solution to the problem of ensuring the safety of mains-powered projects, combining the safety of a plug pack with the convenience of a built-in supply — and adding a few extra benefits as well. Now all we have to do is persuade one of the power transformer/power supply makers to produce some bolt-in power packs of the type you've described!

By the way I note that you use the term 'IED socket' all the way through your letter. You've thrown me a bit with that one, I'm afraid. In picturing the unit you describe, I'd imagine it to have what I would describe as an 'IEC captive plug' fitted to the rear panel, to mate with the usual appliance cord ending in what I would again call a 'cord-type IEC socket'. Is your description an alternative accepted in some countries or branches of engineering?

Rightly or wrongly, I have the impression that the connector system concerned conforms to International Electrotechnical Commission specification IEC320, and also to another standard known as CEE22. But perhaps it goes by another monicker as well...

By the way I have passed your comments about Peter Phillips' Basic Electronics article over to Peter, who will no doubt get back to you himself.

And now let's leave the topic of project safety, at least for a while, and turn to something much more fundamental.

What *is* a volt?

As I mentioned in the introduction, I've had a letter from a young reader struggling with the exact meaning of the term 'voltage'. It's good to see young people not only getting involved in electronics, but also trying to dive in below the superficial level of 'I dunno how it works, but when I do this the right things happen'. The only problem is that when you *do* try to look more closely at fundamental concepts, things can often get rather hard to explain!

But I'm jumping the gun. The young reader concerned is Sam Benson, of Highgate Hill in Queensland, and he's 15. Here's what he asks:

Would you, or someone else, please clarify what voltage really is. We know that it is a potential difference or electromotive force between two points, but that still does not explain fully what voltage is. If you have, as an example, 1000 positively charged atoms separated from 1000 negatively charged atoms, can the number of volts as a figure be established, like it can be done with current — where one amp equals 6.25×10^{18} electrons flowing past a given point per second? Or is it a case of knowing our total resistance and wanted current, and then using Ohm's law to calculate the required voltage?

Please reply, otherwise I will be totally lost in trying to understand the Basic Electronics series of articles.

Thanks for having the interest to write in, Sam, and I'm sorry it's taken me a while to work through other things and get to the point of trying to give you an answer. I hope you haven't lost heart or interest yet, because your desire to understand the basic concepts better is very commendable. All the great developments in science and technology have come from people like yourself, who weren't happy with the explanations they were given, and wanted to find out MORE — so keep it up. We need more people just like you!

Now to try providing an answer to Sam Benson's question, which I confess sent me searching back through a variety of basic textbooks, old and new...

Since Mr Benson is obviously aware that an amp of current is equal to 6.242×10^{18} electrons flowing past a given point in a circuit each second, let's start more or less from there. The significance of that particular number of electrons is that they carry a certain amount of electrical *charge*, which in this case is regarded by convention as being of *negative* polarity. An equivalent amount of *positive* charge is carried by the same number of protons, or of ionised atoms that have lost one electron.

The actual quantity of charge carried by 6.242×10^{18} electrons, protons or ions is known as one *coulomb* — in honour of Charles Coulomb, who is credited with discovering in 1785 the 'inverse square law' of magnetic and electric attraction/repulsion. So a current of one amp corresponds to one coulomb of charge flowing past a given point each second.

But what is electric *charge*, exactly? Well, it's essentially a manifestation of electrical energy itself. So if you like, one coulomb is the amount of negative electrical energy carried by 6.242×10^{18} electrons, or the amount of positive electrical energy carried by the same number of protons or singly-charged positive ions.

And how do we get positive and negative electrical energy? Basically, by 'persuading' electrons to part company from their atoms and move away. This creates an imbalance — a 'tension' — between the two, because we're disturbing the 'rest' condition of the atoms, where everything is in balance: equal numbers of electrons and protons, etc.

So when we somehow persuade an electron to leave its atom, there's a natural tendency for it to be attracted back again, in order to restore the *status quo*. In other words there's a 'pull' or force field linking the two, which we describe as an *electric field*. And in doing all this we've in effect established a unit of electrical energy, consisting of a negative charge (the electron), a positive charge (the ionised atom) and the field between them.

But note that in order to separate the electron from the atom, *work* had to be done. In effect, what we've really done is transform *energy* from one form into another.

In a battery, the energy comes from chemical interaction between the materials that make up the battery. In a generator, it comes in the form of mechanical energy from the steam turbine, petrol engine or diesel engine used to turn the generator's drive shaft. Similarly in a solar cell, the energy comes from the photons of light radiation.

Energy conversion

In each case, the incoming energy is basically being converted from its existing form into electrical energy, in the form of our separated electrical charges.

Now as we've seen, once our electrons have been separated from their atoms, there's a natural tendency for them to be attracted back again — although not necessarily to their original atom, of course. All electrons are much the same, as are ionised atoms, so what we really see is that any negatively charged electron is attracted to any positively charged atom. Hence the maxim '*opposite charges attract*'.

Conversely, the negatively charged electrons tend to repel each other, as do the positively charged atoms — '*like charges repel*'. So if we try to assemble a collection of electrons in one place — say 6.242 x 10^{18} of them, to make up a coulomb — we find that we have to expend additional energy in doing this.

The nett result of all this is that electrical charge is essentially stored-up or *potential* energy. The energy we use to assemble the charge is stored up. And because of the 'strain' involved, there is a built-in tendency for the assembled like charges to separate, and seek out their opposite numbers so that the original balance is restored. This provides the opportunity for the stored electrical potential energy to be returned, in some form or other.

People often use an analogy here, to help understand the situation. It's as if resting atoms in a material are like a big pool of water. When we separate electrons from their atoms, it's a bit like pumping some of the water up into a tank, at the top of a tower. We have to do work — expend energy — in pumping the water up there; but when it's up there, it represents stored or potential energy. Because the water has a natural tendency to return to the pool (in this case due to gravity), there's the opportunity for getting the water in the tank to return most of the stored energy — for example by getting it to turn a water wheel or turbine, on its way down again.

Note that we have to use a pump to exert *pressure* on the water, to overcome its natural tendency to remain in the pool and force it up into the tank. And when the water is up in the tank, it in turn exerts a pressure on the tank (and any pipes or valves), in an attempt to return again.

In the same way, we really have to exert an *electrical* 'pressure' on our electrons, to separate them from their atoms and collect them together in one place. And once they're separated and collected, *they* in turn also exert a 'pressure', in *their* attempt to separate and return to the original situation.

By now, you've probably guessed what we call that electrical pressure: when it's stored up in potential form we tend to call it *electromotive force* or EMF; and when it's being exerted by the charges in their attempt to return to the original situation, we tend to call it *potential difference* or *potential drop*. Actually the distinction here is a bit artificial, just as it is in the water analogy.

At last: the volt

Whether we're talking about EMF or potential difference or potential drop, though, we use the same unit to measure this electrical pressure: the **volt**, named after Alessandro Volta.

Traditionally one volt is defined as the electrical pressure required when one joule of *work* is done, to move a coulomb of charge. Conversely, it's also the pressure that exists when each coulomb of stored charge is able to release a joule of *energy*, in moving back again.

At this stage you may well be wondering how all this relates back to electrical and electronic circuits, and to Ohm's law. Well, think back to our water analogy for a moment. In general the way we recover the energy stored in our tank of water is by letting it return to the pool, but arranging for it to 'do work' on the way down — say by turning a turbine. And we'll probably want to control how fast the stored energy is recovered, by regulating how fast the water returns. We do this by means of valves, and by adjusting the diameter of the pipes — a wide pipe will let the water flow quickly, while a narrow pipe will slow it down.

It's much the same in an electrical circuit. If we have a battery, which uses chemical energy to produce a pressure of 12 volts, this means that it's capable of making each coulomb of stored charge release 12 joules. How quickly that stored energy is released depends upon our circuit, and how rapidly it allows the charge to 'flow back'.

Now the basic quality of our electrical circuit that regulates how fast the charge is allowed to flow is its *resistance*. A low resistance allows the charge to flow quickly (like large diameter pipes), for a given pressure, while a high resistance only allows it to flow slowly (like a narrow pipe).

Unit of resistance

As you probably know already, the unit of resistance is the *ohm*, and Ohm's law defines one ohm as the resistance which requires one volt of pressure to produce a current flow of one ampere ('amp').

Now remember that one amp is basically one coulomb of charge moving past a given point in a circuit per second. So if we have a circuit with a resistance of one ohm, our 12 volt battery will be able to produce a flow of 12 amps — or 12 coulombs per second. But if we increase our circuit's resistance to 12 ohms, the battery will only be able to produce a current of one amp — or one coulomb per second.

Get the idea? The higher the resistance of a circuit, the higher the voltage (i.e., electrical pressure) that must be applied in order to produce a given current (i.e., flow of charge). Conversely the lower the resistance, the higher the current that will flow in response to a given voltage.

In other words the voltage, the resistance and the current flowing are related, as Mr Ohm's law tells us:

$E = I \times R$, or
$I = E/R$, or
$R = E/I$

where E is the voltage, I is the current and R is the resistance.

So if we know the current and the resistance it's flowing through, we can work out the voltage. Or if we know the voltage and the resistance of the circuit, we can work out the current that will flow. Or if we know the voltage and the current that it produces, we can work out the circuit's resistance.

Now how about that energy that can be released, when a charge 'moves back' — how do we work that out?

This bit's fairly easy. Remember that a pressure of one volt means that one joule

(Continued on page 95)

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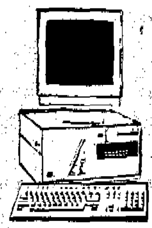

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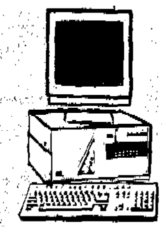

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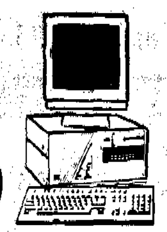

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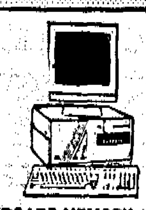

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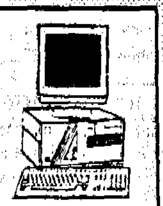

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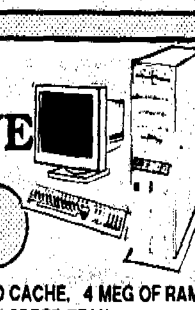

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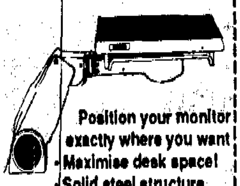
Errors & ommissons excepted. Prices & specifications subject to change. *IBM, PC, XT, AT, are registered trademarks of International Business Machines.

★★★GREAT RANGE! GREAT PRICE!★★★

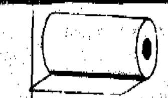
MONITOR MOVER ARM



- Position your monitor exactly where you want!
- Maximise desk space!
- Solid steel structure
- Span 33cm
- Tray 30cm (tilting +/- 15)
- Desk clamp range 3cm -7.5cm
- Maximum load 50 kg

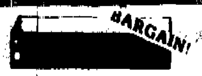
C21079.......................$199

FAX ROLLS



	1-9	10+
C20092	$9.95	$9.50
Size: 210 x 11.5 x 30m		
C20094	$9.95	$9.50
Size: 210 x 25.4 x 50m		
C20096	$19.95	$17.95
Size: 210 x 25.4 x 100m		
C20098	$9.95	$9.50
Size: 216 x 25.4 x 30m		
C20100	$11.95	$11.50
Size: 216 x 24.4 x50m		
C20102	$9.95	$9.50

RIBBONS



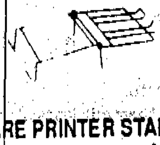
PRINTER RIBBONS TO SUIT:

	1-9	10+
CP80, SX80, DP80, BX100, BX100, MB100,		
C22036	$19.95	$17.95
MX80, FX80, RX80, FX800, MX70, MX80, LX800.		
C22031	$16.95	$15.25
MX100, FX100, RX100, LQ1000		
C22002	$19.95	$17.95
LX80		
C22003	$12.95	$11.95
CITOH 8510 - 1550		
C22051	$13.95	$12.50

NATIONAL PANASONIC KXM110 PRINTER RIBBON
C22034.......................$19.95

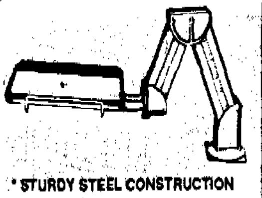
PRINTER STANDS

DELUX PRINTER STAND
C21058.......................$89.00



WIRE PRINTER STAND
C21054..80 column.......$29.95
C21056..132 Column....$34.95

NEW MONITOR MOVER



- STURDY STEEL CONSTRUCTION
- MONITOR MOVER CAN ROTATE 360°
- LIFTS MONITOR WEIGHTS UP TO 22KG
- PLATFORM TRAY 13 3/4" X 12 1/4"
- PLATFORM CAN SWIVEL 360° & TILT 25°
- 80MM DESK CLAMP OPENING
- SCREW CLAMP CAN BE MOVER 90°
- UNIQUE CONSTRUCTION, LOCKS IN PLACE WITH MONITOR ON TRAY.

C21082.......................$199

CPF CONTINUOUS POWER FILTER SPIKE ARRESTOR

The Fortron CPF Filtered Electronic Spike Protector provides a protective electronic barrier for microcomputers, printers, telephone systems and modems electronic typewriters, audio and stereo systems and other sensitive electronic equipment

The CPF provides protection from dangerous electrical spikes that can cause anything from obvious damage (like immediate equipment failure) to less obvious harm that can drastically shorten a system's life

CPF's superior circuitry design and semi conductor technology responds instantly to any potentially damaging over-voltage, ensuring safe trouble free operation

Additionally, CPF's filtering capability helps eliminate troublesome and annoying interference, general hash created by small motors, fluorescent lamps, and the like that threaten the performance and shorten equipment life of unprotected electronic components

SPECIFICATIONS:
Electrical rating: 220-260 volts (AC) 50Hz 10 Amp
Spike/RFI Protection: 4 500 amps for 20m second pulses
Maximum clamping voltage: 275V differential mode
Cat.X10088 .... $69.95

RS232 BREAK OUT BOX

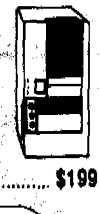
A simple way of monitoring RS232 interface lead activity. Interface powered, pocket size for circuit testing, monitoring and patching 10 signal powered LED's and 2 spares. 24 switches enables you to break out circuits or reconfigure and patch any or all the 24 active positions

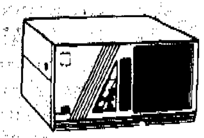
SPECIFICATIONS:
Connectors: DB25 plug on 80mm ribbon cable and DB25 socket
Indicators: Tricolour LED's for TD RD RTS CTS DSR CD TC RC DTR (E)TC
Jumper Wires: 20 tinned end pieces
Power: Interface power
Enclosure: Black high impact plastic
Dimensions: 85 x 95 x 30mm
X15700 ....$99.95

COMPUTER CASES

NEW TOWER CASE!
Give your computer that professional look.
X11105.......................$199
Power supply to suit (220W)
X11102.......................$199

TOP OF THE RANGE MINI TOWER CASE
200 x 415 x 330mm
with 200w power supply
X11100.......................$199





RITRON EXECUTIIVE CASE
X11089.
Includes power supply.....$119

NEW STYLE MINI TOWER CASE WITH POWER SUPPLY
X11103.......................$149

SAVE ON ECLIPSE DISK BOXES!

5 1/4" x 100 DISK CAPACITY ONLY..$6.95

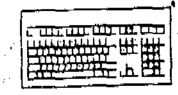
3 1/2" x 40 DISK CAPACITY ONLY...$6.95

UV EPROM ERASER

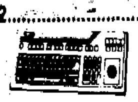
It will erase up to 9 x 24 pin devices in complete safety, in about 40 minutes (less time for less chips)
- Chip drawer has conductive foam pad
- Mains powered
- High UV intensity at chip surface ensures EPROMs are thoroughly erased

Without timer
X14950.......................$99
WITH TIMER......$169

KEYBOARDS

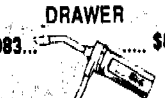


IBM COMPATIBLE EXTENDED KEYBOARD (101 KEYS)
X12022....................... $69



101 KEY TRACKBALL KEYBOARD
Keyboard & mouse in one
X12030.......................$199.95

KEYBOARD STORAGE DRAWER
C21083.......................$84.95



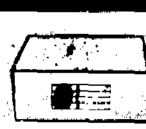
MINI VACUUM CLEANER
C21087.......................$14.95

KEYBOARD COVERS
C21089 84 KEY..........$4.50
C21088 101 KEY.........$5.95

DISK BOXES

100 x 5 1/4" ECLIPSE
C16042.......................$11.95
40 x 3 1/2" ECLIPSE
C16040.......................$8.99
120 x 3 1/2" LOCKABLE
C16039.......................$21.95
100 x 5 1/4" LOCKABLE
C16020.......................$13.95
50 x 5 1/4" LOCKABLE
C16025.......................$11.95
120 x 5 1/4" LOCKABLE
C16028.......................$19.95

PRINTER SWITCHES



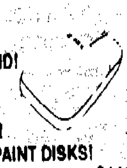
RS232-2 WAY $39
RS232-4 WAY.......................$69
RS232-X OVER.......................$69
RS232-2 WAY AUTO.................$89
CENTRONICS 2 WAY...............$49
CENTRONICS X OVER..............$69
CENTRONICS 2way auto..........$79
CENTRONICS 4 WAY...............$69

MICE

QUICK MOUSE

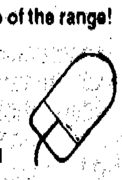
Microsoft Compatible
FREE mouse house & mouse mat Plus FREE pop up menu software
X19955.......................$69.95

SUPER BUS MOUSE 2



DESIGNED TO FIT THE PALM OF YOUR HAND!
GREAT FOR SAVING A SERIAL PORT!
2 FREE TELEPAINT DISKS!
X19951.......................$119

MICROSOFT MOUSE



The top of the range!
Supports hunderds of applications.
FREE MICROSOFT PAINTBRUSH SOFTWARE BRINGS YOUR COMPUTER TO LIFE.
X19958.......................$179

IBM* CARDS

XT HD CONTROLLER....... $129
AT HD CONTROLLER....... $149
RS232/SERIAL CLOCK..... $49
MONO COLOUR CARD......$76
MULTI I/O CARD..............$99
PRINTER CARD...............$29
EGA CARD.....................$179
DIAGNOSTIC CARD..........$795
TTL PRINTER..................$89
6M AT EX/EXP.................$325
FAX CARD......................$595
4 PORT SERIAL CARD...... $199
2 WAY FDD CONT (360).....$39
RS/232 SERIAL CARD........$39
GAMES CARD..................$29
AT S/P/G 2 S/P/G..............$49
4 WAY FDD CONTROLLER (360-1.44M)...................... $129
2 WAY FDD CONTROLLER (360-1.44M)...................... $89
CLOCK CARD...................$39
SMART DRIVE ADAPTOR IDE/FDC...........................$49
SMART DRIVE ADAPTOR IDE I/O FDC.......................$89
512K/576K RAM CARD.......$99
VGA CARD 16 BIT 250K.... $89
VGA CARD 16 BIT 512K.... $129
VGA CARD 16 BIT (1 MEG).$199

JUST ARRIVED NEW COMPUTER CABLES!

PC MONITOR EXTENTION CABLE 9 WIRE STRAIGHT THROUGH
DB9 M/M 1.8 M....$14.95
DB9 M/M 3.0 M....$19.95
DB9 M/M 5.0 M....$29.95
DB9 M/F 1.8 M....$14.95
DB9 M/F 3.0 M....$19.95
DB9 M/F 5.0 M....$29.95

RS232 EXTENION CABLE 25 WIRE STRAIGHT THROUGH
DB25 M/M 1.8 M....$14.95
DB25 M/M 3.0 M....$19.95
DB25 M/M 5.0 M....$24.95
DB25 M/M 10 M....$39.95
DB25 M/F 1.8 M....$14.95
DB25 M/F 3.0 M....$19.95
DB25 M/F 5.0 M....$24.95
DB25 F/F 10 M....$39.95
DB25 F/F 1.8 M....$14.95
DB25 F/F 3.0 M....$19.95
DB25 F/F 5.0 M....$24.95

IBM PRINTER CABLE, 25 WIRE STRAIGHT
DB25/CN36 M/M 1.8 M...$14.95
DB25/CN36 M/M 3.0 M...$19.95
DB25/CN36 M/M 5.0 M...$24.95
DB25/CN36 M/M 10 M...$39.95

IBM PRINTER CABLE, 25 WIRE RIGHT ANGLE
DB25/CN36 M/M 1.8 M...$19.95
DB25/CN36 M/M 3.0 M...$24.95
DB25/CN36 M/M 5.0 M...$29.95
DB25/CN36 M/M 10 M...$44.95

RS232 EXTENION CABLE 25 WIRE STRAIGHT THROUGH
DB25 M/M 1.8 M....$14.95
DB25 M/M 3.0 M....$19.95
DB25 M/M 5.0 M....$24.95
DB25 M/M 10 M....$39.95
DB25 M/F 1.8 M....$14.95
DB25 M/F 3.0 M....$19.95
DB25 M/F 5.0 M....$24.95
DB25 F/F 10 M....$39.95

NEW BUDGET MOUSE
Microsoft compatible streamline design an amazing $29.95.

The famous QUICK MOUSE
Mouse & Image72 software only $39.95

BUDGET IBM JOY STICK

Compatible with IBM, PC, XT, AT Elegant appearance & durable mechanism
Auto return centering
An incredible....................$24.95

ROD IRVING ELECTRONICS
MAILORDER HOTLINE: 008 33 5757

ROD IRVING ELECTRONICS MAILORDER HOTLINE: 008 33 5757

TEST US ON PRICE WITH THESE MULTI METER SPECIALS!

DIGITAL MULTI METER HC -4510

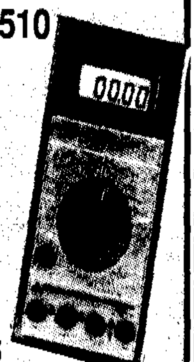
DISPLAY:4 1/2 DIGIT

BASIC ACCURACY: 0.5% DC V

DC VOLTAGE: 0-1000V
DC CURRENT: 0-10A
AC VOLTAGE: 0-750V
AC CURRENT: 0-10A
RESISTANCE: 0-20M OHMS
CONTINUITY TEST, DIODE TEST
DATA HOLD

SAVE $20

Q13030..........RRP $149.95 NOW $129.95



DIGITAL MULTI METER HC-5010EC

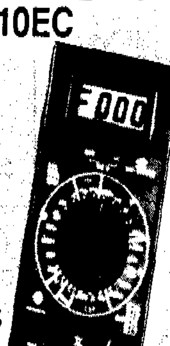
DISPLAY: 3 1/2 DIGIT

BASIC ACCURACY: 0.5% DC

DC VOLTAGE: 0-1000V
DC CURRENT: 0-10A
AC VOLTAGE: 0-750V
AC CURRENT: 0-10A
RESISTANCE: 0-20M OHMS
CONTINUITY TEST, DIODE TEST

SAVE $10

Q13010..................RRP $119.95 NOW $99.95



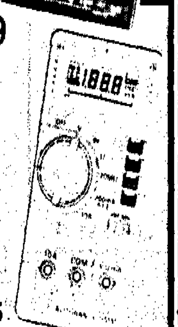
DIGITAL MULTI METER HC-889

DISPLAY: 3 1/2 DIGIT

DC VOLTAGE: 0-1000V
DC CURRENT: 0-10A
AC VOLTAGE: 0-750V
RESISTANCE: 0-20M OHMS
CONTINUITY TEST, DIODE TEST,
DATA HOLD, TR HFE GAIN,
AUTO RANGE DMM WITH BAR GRAPH

SAVE $10

Q13040..................RRP $99.95 NOW $89.95



DIGITAL MULTI METER HC-3500T

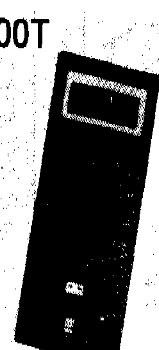
DISPLAY:3/12 DIGIT

BASIC ACCURACY: 0.5% DC

DC VOLTAGE: 0-1000V
DC CURRENT: 0-20A
AC VOLTAGE0-750V
AC CURRENT 0-20A
RESISTANCE: 0-20M OHMS
TEMPERATURE:-20C -1200C
CONTINUITY TEST, DIODE TEST
TEMPERATURE CAPACITANCE
FREQUENCY, hfe TEST, DATA HOLD.

SAVE $20

Q13000..................RRP $169.95 NOW $149.95



ANALOGUE/DIGITAL MULTIMETER

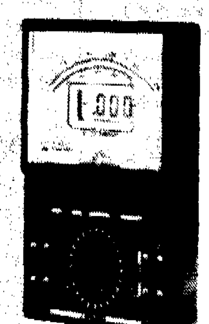
HC-5050DB 3 1/2 DIGIT

BASIC ACCURACY: 0.5% DC

DC VOLTAGE: 0-1000V
DC CURRENT: 0-10A
AC VOLTAGE: 0-750V
AC CURRENT: 0-10A
RESISTANCE: 0-20M OHMS
DC AC RMS:-45dB -+50dB
TEMPERATURE: -20C-1200C
AC FREQ SPREAD: 50Hz-2KHz
CONTINUITY TEST, DIODE TEST

SAVE $20

Q13020.................RRP $169.95 NOW $149.95



LOGIC PROBE (LP-2800)

USEFUL FOR TTL AND CMOS.
HIGH & LOW INDICATORS
PULSE MEMORY.
FOR THE HOBBIEST OR SERIOUS TECHNIICIAN
FOR TRACING THOSE HARD TO FIND FAULTS
ON LOGIC BOARDS.

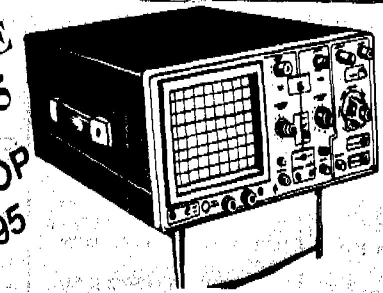
SAVE $10

Q11272..........................RRP$29.95 NOW $19.95

NEW YEAR SPECIALS

SAVE $55

SCOOP $695



20 MHz DUAL TRACE OSCILLOSCOPE

CTR DISPLAY: • 150 mm rectangular

VERTIACAL DEFLECTION:
- Deflection Factor: 5mV to 20V / Div on 12 ranges in 1-2-5 step with fine control
- Bandwidth DC: DC to 20 MHz (-3dB) AC: 10Hz to 20 MHz (-3dB)
- Operating modes CH-A, CH-B, DUAL and ADD (ALT/CHOP L202 only)
- Chop Frequency: 200 KHz Approx.
- Channel separation: Better than 60dB at 1KHz

TIME BASE
- Type: Automatic & normal triggered in automatic mode, sweep is obtained without input signal
- Sweep Time: 0.2m Sec to 0.5 Sec/ Div on ranges in 1-2-5 step with fine control and X-Y.
- Magnifier: X5 at all times.

CRO Probe to suit $39.50 each - Cat. Q12201.

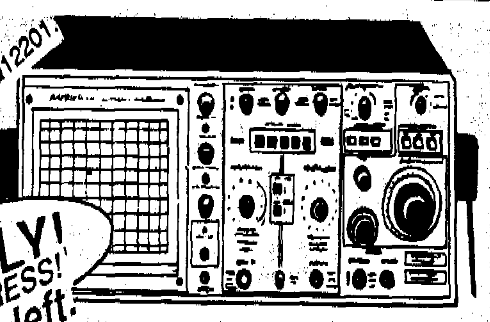
TRIGGERING
- Sensitivity Int: 1 Div or more Ext: 1Vp-p or more.
- Source: INT, CH-B, LINE or EXT
- Triggering Level: Positive and Negative, continuously variable level; Pull for Auto.
- Sync: AC, HF Rej, TV (each + or-) at TV Sync. TV-H (line) and (frame) sync are switched automatically by SWEEP TIME/Div switch.

HORIZONTAL DEFLECTION
- Deflection factor: 5mV to 20V/ Div on 12 ranges in 1-2-5 step with fine control
- Frequency response: DC to MHz (-3dB)
- Max Input Voltage: 300V DC + AC Peak of 600V p-p
- X-Y operation: X-Y mode is selected by SWEEP TIME/ Div switch.
- Intensity Modulation Z Axis: TTL Level (3Vp-p-50V) + bright, - dark

OTHER SPECS: • Weight: 7Kg Approx • Dimensions: 162 (H) x 294(W) x 352(D)mm.

Q12105........................RRP $750 NOW $695

CRO Probe to suit $39.50 each - Cat. Q12201.



4 ONLY! STOP PRESS! Only 1 left.

100 MHz 3 CHANNEL 8 TRACE MODEL 5510

This instrument meets the customers needs in quality of performance, efficiency, function, design, and cost! Being rugged, highly reliable and a multi-purpose 3 - channel, 8 trace oscilloscope with a 6 inch domed mesh type 14kV post deflection acceleration cathode-ray tube and with a fine red internal graticule.

FEATURES:
- Compactness, lightweight, ruggedness and simple design.
- The diecast frame provides compactness lightweight and ruggedness.
- Easy Operation
Light torque lever switches and pushbutton switches are used.
- High Brightness CTR, high acceleration voltage and high beam efficiency of the 150mm rectangular CTR ensures a bright high speedsweep observation
- Multi mode display system
CH1, CH2, CH3, Add any combination or all the channels may be viewed simultaniously. Maximum 8 trace displaying is possible with the ALT sweep function.
- High sensitivity and wide frequency bandwidth.
The maximum vertical sensitivity is 1mV/DIV (when x 5 MAG)at 20 MHz or greater 3dB and mV/DIV at 100 MHz or greater -3dB.
- High input impendance
The input impendance of CH1, CH2, CH3, is 1MΩ±2%, 25pF ±3pF

Q12109.........RRP $2995.00 NOW $1,995

SCHOOLS & COLLEGES TAKE NOTE! ONLY $1,695 tax exempt.

ROD IRVING ELECTRONICS - No.1 FOR COMPONENTS

BNC PLUGS AND SOCKETS

BNC MALE PLUG

	1-9	10-99	100+
P10514	$2.50	$2.25	$1.50

BNC PANEL SOCKET

	1-9	10+	100+
P10516	$2.50	$2.25	$1.50

BNC CRIMP PLUG

	1-9	10-99	100+
P10530	$3.95	$3.75	$3.00

BNC SOLDERLESS TWIST ON PLUG

	1-9	10-99	100+
P10531	$3.50	$3.25	$3.00

CANNON PLUGS AND SOCKETS

CANNON TYPE 3 PIN CHASSIS MALE

	1-9	10-99	100+
P10962	$3.50	$2.95	$2.50

CANNON TYPE 3 PIN LINE FEMALE

	1-9	10-99	100+
P10964	$3 [illegible]5	$3.50	$2.90

CANNON TYPE 3 PIN CHASSIS FEMALE

	1-9	10-99	100+
P10966	$4.95	$4.50	$3.50

CANNON TYPE 3 PIN LINE MALE

	1-9	10-99	100+
P10960	$4.50	$3.50	$2.50

COMPUTER CABLES

• Six conductor shielded computer interface cable.

	1-9M	10M+	100M+
W12670 • CIC6 6 con.	$1.30M	$1.10M	$1.00M
W12672 • CIC9 9 con.	$1.60M	$1.50M	$1.20M
W12674 • CIC12 12 con.	$2.50M	$2.20M	$1.90M
W12676 • CIC16 16 con.	$3.50M	$3.20M	$2.50M
W12678 • CIC25 25 con.	$3.90M	$3.40M	$3.00M

LEDS

QUALITY 3mm LEDS

	1-9	10-99	100+
Z10140(R)	$0.15	$0.12	$0.10
Z10141(G)..	$0.20	$0.18	$0.15
Z10143(Y)..	$0.20	$0.18	$0.15
Z10145(O)..	$0.20	$0.18	$0.15

QUALITY 5mm LEDS

Z10150(R).	$0.15	$0.12	$0.10
Z10151(G).	$0.25	$0.20	$0.18
Z10152(Y)..	$0.25	$0.20	$0.18

FLASHING LEDS

RED 5mm	1-9	10+
Z10159	$1.10	$1.00

RECTANGULAR LEDS

	1-9	10+	100+
RED	20¢	15¢	12¢
GREEN	20¢	15¢	12¢
YELLOW	20¢	15¢	12¢
ORANGE	20¢	15¢	12¢

IC SOCKETS

LOW PROFILE IC SOCKETS

Save a small fortune on these "Direct import" low profile IC sockets! PCB mounting solder tail. All tin plated phosphor bronze or berryllium and dual wipe for reliability.

	1-9	10+	100+
P10550 8 pin	15¢	12¢	10¢
P10560 14pin	20¢	18¢	15¢
P10565 16pin	20¢	18¢	16¢
P10567 18pin	30¢	25¢	22¢
P10568 20pin	35¢	30¢	25¢
P10569 22pin	35¢	30¢	26¢
P10570 24pin	35¢	30¢	26¢
P10572 28pin	45¢	35¢	30¢
P10575 40pin	45¢	40¢	35¢

WIRE WRAP IC SOCKETS

These quality 3 level wire wrap sockets are tin plated phosphor bronze.

P10579 8pin	$1.50	$1.40
P10580 14pin	$1.85	$1.70
P10585 16pin	$1.95	$1.80
P10587 18pin	$1.95	$1.80
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THE SERVICEMAN

This time the service van died, and it was a TV set that 'bit' people!

I have another mixed bag for you again this month — a couple of stories from colleagues far and near, and a tale of my own about many hours spent dallying with a wayward Princess. A Princess 14CT8 colour TV, I hasten to add, with a picture that simply *wouldn't* lock vertically no matter what I tried...

We'll give pride of place this month to our old friend L.K., of Daintree in North Queensland. If you remember, L.K. recently gave us a couple of amusing stories about electric fences and the tricks they can get up to. Now he tells us about the finale to one of those stories. It goes like this...

In a recent story, I described how an electric fence had become the round-about cause of a door knob at a rural residence becoming too 'hot' to handle. Well, that episode had a sort of sequel, which occurred during my drive home the same evening.

With some 40km still to go, the service van stopped dead — without so much as a cough. We were stuck on a lonely country road, in the dark, and no 'phone or two-way. (Mrs L.K. usually mans (womans?) the other end of the radio, but on this occasion she was with me in the van!) It was to be a self-help affair...

Some time previously I had fitted a couple of 20W globes under the bonnet for just such an emergency, hoping of course that they would never be needed. But now I was grateful.

A bit of probing soon revealed that the capacitor housed inside the distributor had developed a short. Although I didn't have an automotive spare in the glove-box, there was a full complement of capacitors in the parts box on board.

These auto capacitors are usually around the half-microfarad, so I hunted out a 0.47uF/200VW greencap which was duly attached by means of jumper leads between the low tension side of the ignition coil and earth. Then, I cut the offending capacitor lead before replacing the distributor cap.

The engine fired at the first try, and we were soon on our way once more. Feeling somewhat smug as well as grateful that the the ignition system wasn't one of these new "all electronic" designs, we were 10 kilometres down the track when the same thing happened — dead again, in a district of dense darkness.

Delving under the hood for a second time revealed that the substitute part had suffered a similar fate. Two failures in 20 minutes was definitely a cause for suspicion. I wondered if I could have grabbed a faulty component. Or was there something more sinister to be uncovered? This time I used a 400V replacement and set off anew.

We had only travelled around six kilometres when the vehicle staged a repeat performance — convincing enough that the problem was more than just faulty capacitors.

Looking back over the events, I reasoned that the only way a 400V capacitor could short so quickly was from excessive voltage. And the only source of such voltage must be the coil itself, developing some sort of arc-over to the primary winding.

Also, noting the distances travelled between each breakown suggested that the failures were coinciding with the temperature rise in the engine compartment. I've never before heard of such a

thing happening though I saw no reason why it couldn't, especially to me!

So after fitting yet another capacitor to the jumper leads, I slowly cooled the coil with the remains of a can of 'freezer'. Then I left the bonnet on the second catch, hopefully to allow more air to reach the engine. This time we made it all the way home, which seemed to suggest that the diagnosis was not very wide of the mark.

Now, I'll admit that this story has little direct relevance to the serviceman column, other than to highlight the coincidences of life. I had been out to trace a problem with an electric fence (which is a form of HT coil) and on the return journey was con-

fronted with an HT coil fault of my own. How often in service work do we all, from time to time, experience a run of similar repairs, devoid of any contributing influence other than pure chance?

For the record, a new coil and capacitor cured the trouble for good — I hope!

Thanks for that anecdote, L.K. I, for one, found it most interesting. I hope our readers did, too.

I also share your feelings about electronic ignition systems in cars. I have yet to be convinced that cars and electronics belong together. Particularly so while manufacturers charge such exorbitant prices for replacement parts. (One owner recently wept when I told him his $1200 engine management computer contained about $50 worth of parts!)

The TV that 'bit'

Now we come to another short item from a contributor who is a fellow service tech in my own area. Actually, he didn't write this story, but gave me the details during a kerbside encounter. I think you'll agree that it's one of the most outstanding tales of TV butchery I've ever told in this column.

The chap concerned stopped me in the street recently and called me over to his car. He handed me a piece of fencing wire about a foot long, bent into a ring about two inches across at one end. The other end was twisted up, in the manner of an office paper spike.

He asked me if I had ever seen anything like it, and if I had any idea of what it might be. I had to admit ignorance — I couldn't imagine what it was or what it could be used for. So he went on to tell me all about it.

It seems that one of his customers complained that his TV 'bit' him every time he tried to insert the antenna plug. More accurately, the antenna socket was 'alive', and caused a big spark whenever he tried to attach the antenna with the set turned on. The set eventually arrived on my colleague's bench, and he set it up much as it was in the customer's home. He tried attaching the antenna with the set on, but nothing happened. No sparks, no bites.

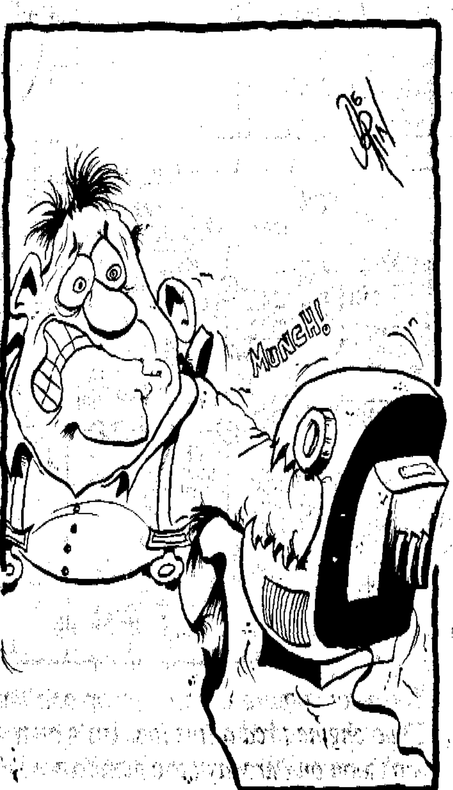
He tried this several times with similar results. He pushed and prodded at the antenna socket with more and more vigour, until the set began to wobble and threatened to topple off the bench.

To guard against this, he put one hand on top of the cabinet to steady it, while he attached the antenna with the other. Then he got it. A blue flash at the socket and a nasty belt right across his chest.

When his heart and nerves had settled down again, he thought about what might be causing the problem. Certainly, there had been no reaction until he started to rock the set, so perhaps there might be something loose around the EHT section which was making contact with the antenna socket.

When he got the cabinet back off, he could not see immediately what was wrong. The tripler and EHT cabling seemed to be in good order. Indeed, the only thing he could see out of the ordinary was a liberal dose of cured silicone sealant around the CRT's ultor cap.

It was when he examined this deposit more closely that the answer to the riddle became apparent. Firmly sealed into the silicone, right around the ultor cap, was a ring of steel wire, about the thickness of fencing wire. Standing up from this ring



was a straight piece of wire that went up as far as the cabinet. Indeed, it was wedged in tightly under the cabinet top, as if to stop the ultor cap from moving.

That was the whole answer. At some time the ultor cap had become loose, and someone had tried to fix it by wedging it in place with the wire loop between the cap and the cabinet top, then locking the wire on the cap with the silicone sealant. Unfortunately, the pressure of the loop on the cap, both physical and electrical, had perished the plastic and allowed the wire to become charged to the EHT voltage.

The cabinet top was only 10mm particle board and was obviously not a very good insulator. When the owner (and later my colleague) put his hand on top of the cabinet to steady it, there was considerable leakage through the wood.

When the other hand approached the antenna socket, there was a nice path to earth and the EHT took it. Admittedly, it was fairly high impedance, but enough to frighten the wits out of both owner and serviceman.

Nobody knows who was responsible for this butchery, as the set was second hand when the owner bought it. But whoever it was, is a leading contender for the 'Order of the Striped Apron'! (Although not many butchers wear them nowadays, do they?)

Vertically unsyncable

Now it's back to my own bench. This time I have a story about a job that plagued me for months.

I've said before that if a job can't be solved in a couple of hours, it should be given to someone else to look at. One can get too close to the woods and not see the trees. This story is a perfect example of the one-track mind at work.

The story is about a Princess portable TV, a model 14CT8 to be exact. It came to me, in a roundabout sort of way, from a friend who had run out of time and space in his own workshop. His decision to pass it over to me was helped by the fact that he didn't have a copy of the service manual, and I did.

The problem with the set was that it had no trace of vertical hold. The hold control worked to adjust the vertical oscillator, but there was no sign of locking. The horizontal hold was locked solid, but the vertical was just floating. The picture might hold still for minutes at a time, but would then drift slowly up or down the screen. The owner had put up with it for some weeks, but finally it all became too much and they sent the set in for service.

The fact that the picture was perfect and the horizontal hold locked firmly suggested to me that all was well up to the sync separator. It seemed that the vertical integrator, that part of the circuit that extracts the vertical sync pulses, was the most likely culprit.

The integrator in most sets consists of nothing more than a resistor and capacitor, and there's not a lot that can go wrong with it. In other sets with a similar fault, I've sometimes found the capacitor leaky. Trouble with the resistor is far more rare, but I have known it to happen. So I pulled out the circuit diagram and began a search for the relevant components.

In this set the sync separator and both sweep oscillators are in a single chip, IC301, an HA11423. The vertical integrator comprises R305 and C303, connected between pins 7 and 8. Two other components, R304 and an unmarked capacitor are also in this loop, but play no part in the integrator function.

My first task was to check these components, even going so far as to take them out of circuit to measure them exactly. As you might expect, this story would go no further if either of them had been faulty. Just to make sure I replaced both parts with new ones, but it made no difference at all.

A check of the waveforms around the circuit showed no anomalies. The video input appeared to be exactly as shown on the diagram, and the integrated vertical sync, at the junction of R305 and C303 was to all intents and purposes identical with the diagram.

At this point I was becoming a bit worried. Circuits that contain no faulty parts, yet will not work properly are the bane of my life. I much prefer shorted or open components, even if they are hard to find.

In this case, I had two options — neither very inviting. I had either to find a faulty component remote from the sync separator, or replace IC301 which was in all other respects faultless.

When I checked my parts catalogue, I learned that the HA11423 was not a particularly expensive chip, at about $11 including tax. So I ordered two, one for this set and one for spare. In the meantime, I went on trying to find trouble among other components around the vertical stage.

There are several low value electrolytics around IC301, and readers will know by now that I do not trust these items. In particular, C323 is a 1uF tantalum capacitor and these can cause all kinds of trouble. I replaced it as a matter of course; but the picture still floated. The unmarked capacitor on pin 7 of IC301 was also a low value electrolytic, but changing this for a new, low leakage type did nothing to solve the problem.

C302 was another low value electro that was changed, but without any effect on the problem. Even though they had no apparent link to the vertical section, I began changing caps around the horizontal oscillator, in the hope that there might be some internal link, inside IC301, that could upset the vertical sync.

But all this was to no avail. Although the foregoing might give the impression that I concentrated on capacitors to the exclusion of all else, this was not the case. I checked every resistor that remotely concerned the vertical stage, but they all checked out perfectly.

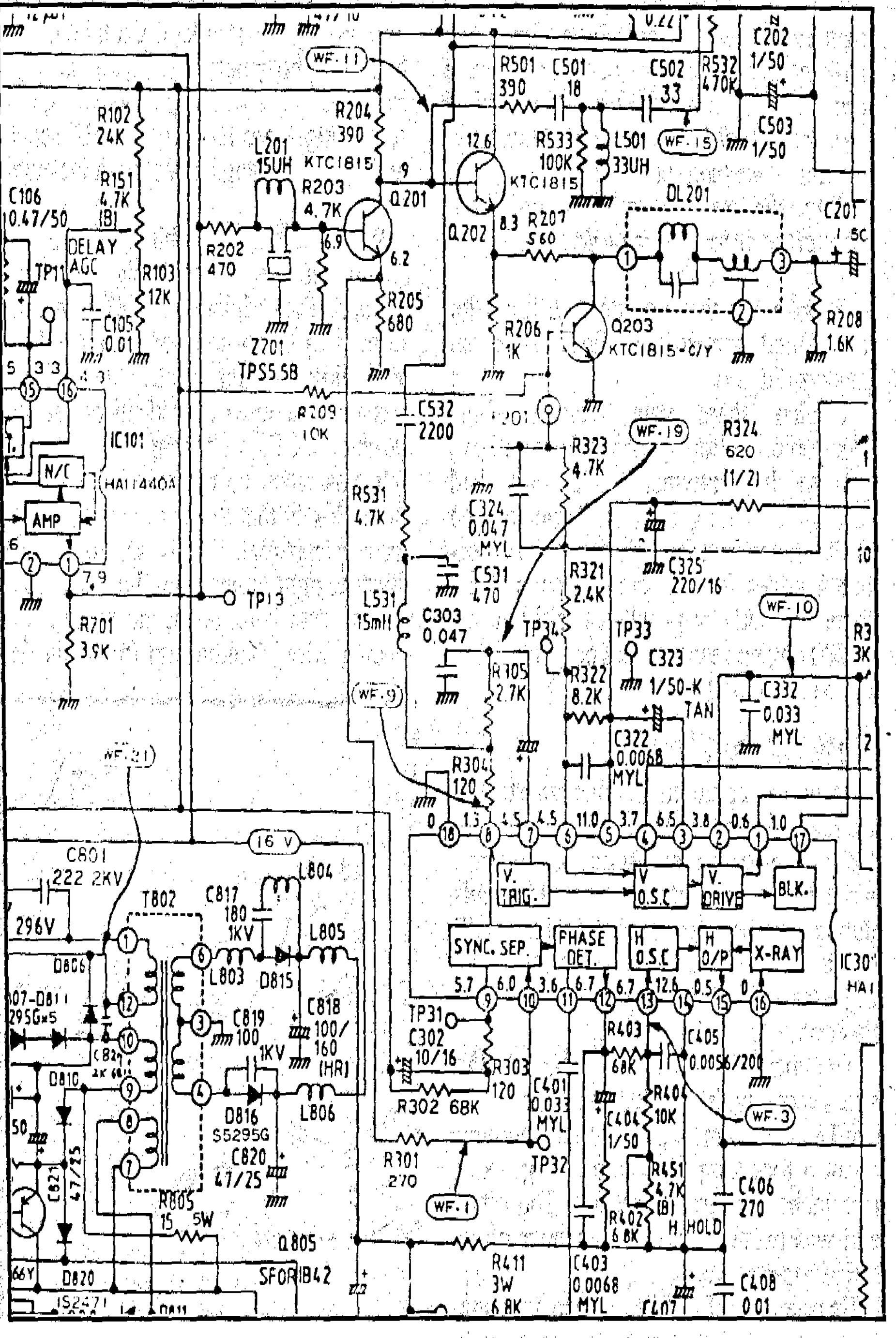
So after several hours of this, I was left with the only conclusion possible — it *had* to be the chip, and that meant a wait until the two chips I had ordered were delivered. Astute readers are probably way ahead of me. When it arrived, the new chip did absolutely nothing for the problem. If anything, it was worse — with the hold control now so sensitive that the picture could not be held still even for a second. It was constantly floating up or down the screen.

I don't have a lot of hair and it's this sort of job that explains why. I tore out a few more strands, then stamped my foot in anger. As far as I could see, I had checked and/or replaced everything that could possibly have an effect on the vertical sync, yet nothing seemed to help.

At this point I began to wonder if the trouble might not come from a quite different source. If you have ever seen a TV set with a faulty filter in the power supply, the most obvious symptom is a 'hum bar', a dark bar that floats up or down the screen. A secondary symptom, and sometimes the only symptom, is that as the bar reaches the top of the screen, the vertical sync becomes unstable. Although in this set the symptom was continuous and not cyclical, I was so desperate for a 'fix' that I grabbed this idea and worried it to death. I went through the power supply very thoroughly and checked its output with both a voltmeter and a CRO. The output voltage was spot on, and the waveform showed not the slightest sign of 50Hz ripple. There was a small degree of line frequency ripple, but not more that I would have expected. Nothing in the power supply could explain the trouble in the vertical circuits.

At about this time I put the set aside and went on with other work. I had spent more than enough hours on this job, and I needed a break. Unfortunately, the break went on for several weeks, until the owner started to become a bit stroppy. Whether I liked it or not, I had to return to the Princess and solve the problem.

I quickly reviewed all that I had done previously, but found that I had no new ideas. I wondered about the new chip that I had fitted, and whether it was really 100% — seeing that it had less control than the original. So I decided to fit the second chip



The sync separator and sweep oscillator section of the Princess 14CT8 portable TV, subject of our Serviceman's own story this month. The set simply would not lock vertically, and it took quite a while to find the source of the trouble.

Fault of the Month

AWA video recorder Model AV61

SYMPTOM: Machine will not accept cassette. It will eject a cassette if the failure occurs during play, but the next cassette offered seems to meet a solid obstruction in the cassette carrier.

CURE: A small lug securing one end of the tension spring between the two halves of the worm gear has broken off. A proper repair calls for the replacement of the worm gear, but an emergency repair can be made by bending the end of the spring outwards, to hook through a convenient hole in the gear.

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that I had ordered. It was here that I knew that the job had me spooked. When the chips had arrived some weeks earlier, I had used one and filed the other on the bench, preparatory to putting it away in the parts drawer. When I came to look for it, it wasn't there.

I could find the original one from the set, but of the second new one there was no sign. I threw another tantrum, then set about replacing the original chip into the chassis. And would you believe, the set was now almost fixed!

I say almost because although the vertical hold range was very limited, the picture did snap into lock and stay there. I must admit that changing channels was enough to upset the hold, and it took some time for the picture to drift up close enough for the hold to catch. But compared to the way it had been, this was almost a cure! There was no explanation as to why the old chip seemed to work better after it was re-installed, other than that perhaps there had been an obscure dry joint somewhere. It wouldn't be the first time that disturbing a component had cured an invisible fault.

About this time the owner called to find out when his set would be ready and I explained the position to him. He suggested that he should take the set on trial, and if it gave no great trouble he would consider it fixed. If there were still problems, he would bring it back and take one of my 'lenders' until I could solve the problem once and for all.

Back again

The set was back again in less than a week. It seems that it was OK most of the time, but any interference would make it roll. It took off every time the refrigerator started up. It would roll whenever a light was switched on or off. Although it would then be quite stable until the next burst of interference, the waiting was getting on the owner's nerves and he decided that the set was more a worry than it was worth. It certainly wasn't entertainment. So he went off with my 'lender', and I settled down yet again to try to solve the riddle. I'm a bit embarrassed to say that the final answer came about through no effort on my part.

A friend of mine (not the original friend who brought in the set — by this time that friend was a bit on the outer) called in to borrow a circuit diagram for another set, and I took the opportunity to ask what he thought about the problem Princess. He spent several minutes musing over the circuit diagram, then asked me what I had done so far. I listed all the caps that I had changed, and the resistors I had checked, and the chip(s) I had changed. Then he asked the question that I should have asked myself weeks ago. He said "Have you checked the voltages around the chip?"

Now, I had checked some voltages, notably the Vcc supply which comes from two sources. Pin 14 takes 12.6V from the power supply to fire up the horizontal oscillator. After the line output is running, an 11V supply is delivered to pin 5 from a 16.5V rail off the line output transformer. I had checked both of these rails as all present and correct. My colleague wasn't so much interested in *those* rail voltages as in the secondary voltages on other pins — particularly those associated with the sync separator and vertical oscillator.

I had to admit that I hadn't checked these other voltages, an omission that I can't explain. But even so, I wonder if I would have twigged to the problem, even if I had measured them. He suggested that if any of the voltages were wrong, and particularly if the voltage at the input to the sync separator was wrong, then it would explain why the sync appeared to be weak.

It took very little time to find that the voltage on pin 10, the video input to the sync separator, was indeed low at only 4.5V, rather than the 6V called for on the circuit diagram. I was getting close. The 6V might have been supplied from inside the chip, but it was just as likely that it was supplied from outside.

And so it appeared to be. There is a 270

Continued on page 82

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Provides a number of useful but reasonably simple projects for the model railway enthusiast to build. The projects covered include such things as controllers, signal and sound effects units, and to help simplify construction, stripboard layouts are provided for each project.

ELECTRONIC PROJECTS FOR CARS AND BOATS
BP94 **$9.50**
Describes fifteen fairly simple projects for use with a car and/or boat. Each project has an explanation of how the circuit works as well as constructional details including a stripboard layout.

POWER SUPPLY PROJECTS
BP 76 **$7.50**
Mains power supplies are an essential part of many electronic projects. This book gives a number of power supply designs, including simple unstabilised types, fixed voltage regulated types, and variable-voltage stabilised designs, the latter being primarily intended for use as bench supplies for the electronics workshop. The designs provided are all low-voltage types for semiconductor circuits.

ELECTRONIC SECURITY DEVICES
BP56 **$9.50**
This book, besides including both simple and more sophisticated burglar alarm circuits using light, infra-red and ultra-sonics, also includes many other types of circuit as well, such as gas and smoke detectors, flood alarms, doorphone and baby alarms, etc.

PRACTICAL ELECTRONIC BUILDING BLOCKS-Book 1
BP117 **$8.50**

PRACTICAL ELECTRONIC BUILDING BLOCKS-Book 2
BP118 **$8.50**
These books are designed to aid electronic enthusiasts who like to experiment with circuits and produce their own projects. The circuits for a number of building blocks are included in each book, and component values and type numbers are provided in each case. Where relevant, details of how to change the parameters of each circuit (voltage gain of amplifiers, cut-off frequencies of filters, etc.) are given so that they can be easily modified to suit individual requirements. No difficult mathematics is involved.

HOW TO DESIGN ELECTRONIC PROJECTS
BP127 **$9.00**
The aim of this book is to help the reader to put together projects from standard building blocks with a minimum of trial and error, but without resorting to any advanced mathematics. Hints on designing circuit blocks to meet your special requirements where no "stock" design is available are also provided.

HOW TO DESIGN AND MAKE YOUR OWN PCBs
BP121 **$6.50**
Chapter 1 deals with the simple methods of copying printed circuit board designs from magazines and books and covers all aspects of simple PCB construction as comprehensively as possible.
Chapter 2 covers photographic methods of producing PCB's and Chapter 3 deals with most aspects of designing your own printed circuit board layouts.

S.W., AMATEUR RADIO & COMMUNICATIONS

COMMUNICATION (Elements of Electronics-Book 5)
BP89 **$11.00**
A look at the electronic fundamentals over the whole of the communication scene. This book aims to teach the important elements of each branch of the subject in a style as interesting and practical as possible.

AN INTRODUCTION TO AMATEUR RADIO
BP257 **$11.00**
Gets you started with the fascinating hobby that enthrals so many people the world over.

INTERNATIONAL RADIO STATIONS GUIDE
BP255 **$16.00**
Totally revised and rewritten to replace the previous edition (BP155), this book contains considerably more information which is now divided into thirteen sections including: Listening to SW Radio, ITU Country Codes, Worldwide SW Stations, European, Middle East & N. African LW Stations, European, Near East & N. African MW Stations, Canadian MW Stations, USA MW Stations, Broadcasts in English, Programmes for DXer's & SW Listener, UK FM Station, Time Differences from GMT, Abbreviations, Wavelength/Frequency Conversion

AERIALS

AERIAL PROJECTS
BP105 **$8.50**
The subject of aerials is vast but in this book the author has considered practical aerial designs, including active, loop and ferrite aerials which give good performance and are relatively simple and inexpensive to build.

25 SIMPLE SHORTWAVE BROADCAST BAND AERIALS
BP132 **$6.50**
Fortunately good aerials can be erected at low cost, and for a small fractional part of the cost of your receiving equipment.
This book tells the story. A series of 25 aerials of many different types are covered, ranging from a simple dipole through helical designs to the multi-band umbrella.

25 SIMPLE INDOOR AND WINDOW AERIALS
BP136 **$6.00**
Written for those people who live in flats or have no gardens or other space-limiting restrictions which prevent them from constructing a conventional aerial system.
The 25 aerials included in this book have been especially designed, built and tested by Mr. Noll to be sure performers and give surprisingly good results considering their limited dimensions.

25 SIMPLE TROPICAL AND MW BAND AERIALS
BP145 **$6.00**
Shows you how to build 25 simple and inexpensive aerials for operation on the medium wave broadcast band and on the 60, 75, 90 and 120 metre tropical bands. Designs for the 49 metre band are included as well.

AUDIO & HI-FI

DIGITAL AUDIO PROJECTS
BP245 **$11.00**
Contains practical details of how to construct a number of projects which fall into the "Digital Audio" category. They should be of interest to most audio and electronic music enthusiasts.

AN INTRODUCTION TO LOUDSPEAKERS AND ENCLOSURE DESIGN
BP256 **$11.00**
All you need to know about the theory and operation of loudspeakers and the various types of boxes they may be fitted into.
Also includes the complete design and constructional details of how to make an inexpensive but high quality enclosure called the "Kapellmeister".

AUDIO PROJECTS
BP90 **$8.50**
This book covers in detail the construction of a wide range of audio projects. The text has been divided into the following main sections: Pre-amplifiers and Mixers, Power Amplifiers, Tone Controls and Matching, Miscellaneous Projects.
All the projects are fairly simple to build and designed to assist the newcomer to the hobby.

AUDIO (Elements of Electronics-Book 6)
BP111 **$13.00**
Analysis of the sound wave and an explanation of acoustical quantities prepare the way. These are followed by a study of the mechanism of hearing and examination of the various sounds we hear. A look at room acoustics with a subsequent chapter on microphones and loudspeakers then sets the scene for the main chapter on audio systems, amplifiers, oscillators, disc and magnetic recording and electronic music.

AUDIO AMPLIFIER CONSTRUCTION
BP122 **$9.00**
The following practical designs are featured and include circuit diagram and description, Veroboard or PCB layout and any necessary constructional or setting-up notes.
Chapter 1 - Preamplifiers: versatile microphone type based on the NE5534; tape type using the LM3802; RIAA pre amp; simple guitar pre amp; ceramic or crystal pick-up type; active tone controls using a LF351; general purpose pre amp.
Chapter 2 - Power amplifiers: simple low power battery type using a 2283 IC; 2 watt using the TBA820; 8 watt using the TDA2030; 16 watt 12 volt P.A. amplifiers; 20 watt using a MOSFET output stage; 100 watt DC coupled amplifier using four MOSFETs in the output stage.

CHOOSING AND USING YOUR HI-FI
BP68 **$6.00**
Provides the fundamental information necessary to make a satisfactory choice from the extensive range of hi-fi equipment now on the market.
Help is given to the reader in understanding the technical specifications of the equipment he is interested in buying.

THEORY & CALCULATIONS

FROM ATOMS TO AMPERES
BP254 **$12.00**
Explains in crystal clear terms the absolute fundamentals behind the whole of Electricity and Electronics. Really helps you to understand the basis of the subject, perhaps for the first time.

FURTHER PRACTICAL ELECTRONICS CALCULATIONS AND FORMULAE
BP144 **$16.00**
Written in the same style as the first book (BP53) and with the same objectives in mind, this book is divided into the following fourteen sections: Electricity, Electrostatics, Electromagnetism, Complex numbers, Amplifiers, Signal Generation and Processing, Communication, Statistics, Reliability, Audio, Radio, Transmission Lines, Digital Logic and Power Supplies.

THE SIMPLE ELECTRONIC CIRCUIT AND COMPONENTS
BP62 **$12.00**

ALTERNATING CURRENT THEORY
BP63 **$12.00**

SEMICONDUCTOR TECHNOLOGY
BP64 **$12.00**
The aim of this series of books is to provide an inexpensive introduction to modern electronics so that the reader will start on the right road by thoroughly understanding the fundamental principles involved.
BOOK 1: This book contains all the fundamental theory necessary to lead to a full understanding of the simple electronic circuit and its main components.
BOOK 2: This book continues with alternating current theory without which there can be no comprehension of speech, music, radio, television or even the electricity mains.
BOOK 3: Follows on semiconductor technology, leading up to transistors and integrated circuits.

ELECT. & COMPUTER MUSIC

ELECTRONIC MUSIC PROJECTS
BP74 **$9.50**
Provides the constructor with a number of practical circuits for the less complex items of electronic music equipment, including such things as fuzz box, waa-waa pedal, sustain unit, reverberation and phaser units, tremelo generator, etc.

MUSICAL APPLICATIONS OF THE ATARI ST's
BP246 **$12.95**
The Atari ST's are fast becoming the first choice in computers for the electronic music enthusiast due to their relatively low cost and MIDI interface. The Penfolds show you how to make the most of these machines musically, with simple add-on circuits and program routines.

COMPUTER MUSIC PROJECTS
SOLD OUT
BP173 **$11.00**
Shows some of the ways a home computer can be used to good effect in the production of electronic music. Topics covered include sequencing and control via analogue and MIDI interfaces, computers, digital delay lines and sound generators for computer control.

MORE ADVANCED MIDI PROJECTS
BP247 **$11.00**
Carries on where book BP182 left off by providing constructional details of some more advanced and sophisticated projects such as a mixer, merge unit and harmoniser etc.

ELECTRONIC SYTHESISER CONSTRUCTION
BP185 **$11.00**
This book will enable a relative beginner to build, with the minimum of difficulty and at reasonably low cost a worthwhile mono-phonic synthesiser, and also learn a great deal about electronic music synthesis in the process.

TV, VIDEO & SATELLITES

AN INTRODUCTION TO SATELLITE TV.
BP195 **$12.95**
As a definitive introduction to the subject this book is presented on two levels. For the absolute beginner with no previous knowledge, the story is told as simply as it can be in the main text.
For the professional engineer, electronics enthusiast, student or others with technical backgrounds, there are numerous appendices backing up the main text with additional technical and scientific details, formulae, calculations and tables etc.

FAULT-FINDING

HOW TO GET YOUR ELECTRONIC PROJECTS WORKING
BP110 **$8.50**
We have all built circuits from magazines and books only to find that they did not work correctly, or at all, when first switched on. The aim of this book is to help the reader overcome just these problems by indicating how and where to start looking for many of the common faults that can occur when building up projects.

AUDIO AMPLIFIER FAULT-FINDING CHART
BP120 **$4.00**
This chart will help the reader to trace most common faults that might occur in audio amplifiers. Across the top of the chart are two "starting" rectangles, vis Low/Distorted Sound Reproduction and No Sound Reproduction; after selecting the most appropriate one of these, the reader simply follows the arrows and carries out the suggested checks until the fault in located and rectified.

GETTING THE MOST FROM YOUR MULTIMETER
BP239 **$11.00**
It is amazing just what you can check and test with a simple multimeter if you know what you are doing. This book tells the story, covering the basics and relative merits of analogue and digital instruments,component checking and dealing with circuit testing.

MORE ADV. USES OF THE MULTIMETER
BP265 **$12.00**
A sequel to book BP239 showing the reader some more advanced and unusual applications of that humble test instrument - the simple multimeter.

HOW TO USE OSCILLOSCOPES AND OTHER TEST EQUIPMENT
BP267 **$12.00**
Just as the title says, this book shows the hobbyist how to effectively use a number of pieces of electronic test equipment including the oscilloscope.

To order, simply fill in the coupon, remembering to included the code numbers and $5.00 postage and handling. If the coupon is missing, write down the names, code numbers and prices of the books you require. Include your name, address, ph number, plus cheque, money order or credit card details (card type, card number, expiry date and signature) and send it all to Federal Publishing, Freepost No.3, P.O.Box 199 Alexandria, NSW 2015. Don't forget to sign all orders.

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.

10-channel RS232 Device selector

This project was designed to allow a single PC with a serial interface card to communicate with several devices, by selecting one device at a time.

This 3-wire configured interface is commonly used with 'Crosstalk' software to communicate with numerous CPU boards on an auto insertion machine. It allows long communication cables between the interface and the machine.

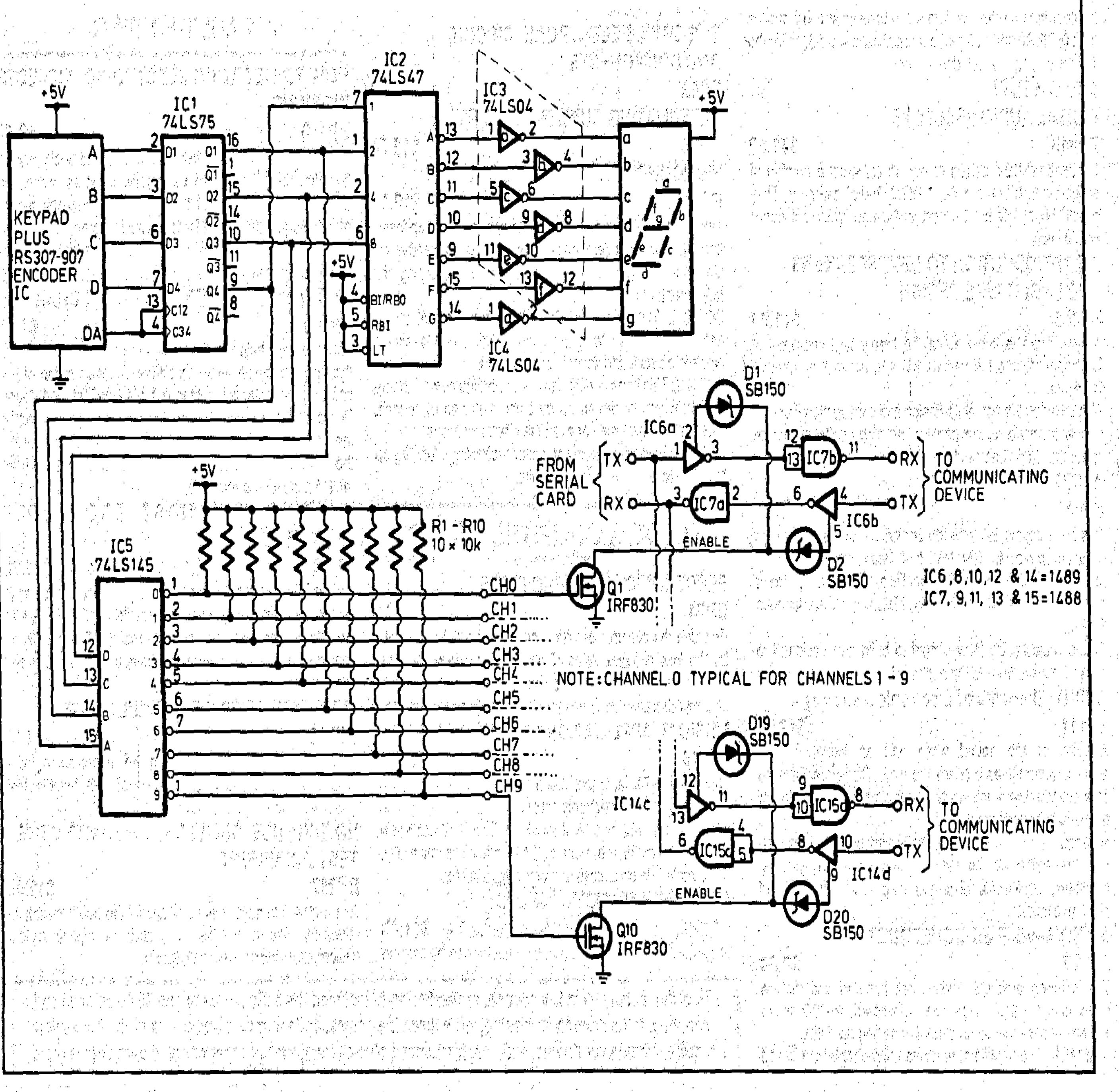
Selection is made by a 16-key hexadecimal encoded keypad, which converts the keypress into BCD.

This data is fed to IC1 (74LS75) which is a bistable latch — so the key does not need to held depressed for the period of communication e required channel via MOSFETs Q1-Q10. R1-R10 are pull-up resistors added to the output of IC5 to drive the MOSFETs.

These in turn enable the desired RS232 links, each of which comprises two gates from the quad line receiver IC6 (1489) and two gates from the quad line driver IC7 (1488). The two Schottky diodes, D1 and D2, isolate the enable pins of the two chips. For the full 10 RS232 lines, three 1488s and three 1489s are needed to build the 10 links.

The output from IC1 is also fed to a 7-segment LED display to indicate which channel is selected. The signal passes through the 7-segment decoder IC2 (74LS47) and hex drivers IC3 and decoder IC5 (74LS145), which switches th IC4 (74LS504).

Ranjit Singh,
Kuala Lumpur, Malaysia $50



LED display board

A friend built a model railway and used a small computer to control the signals, etc. This circuit extends that idea by providing an electronic 'billboard'. It can be run by any computer with an available 7-bit output.

Clock pulses are fed to the 4017 IC1 by ulsing the output line D5 from the computer. The pulses advance the counter, turning on each transistor Q1-Q10 in turn, provided that Q21 is switched on via IC2.

After a count of '10' is reached, the 'CO' output of IC1 goes high and clocks IC2, making the Q output high and Q-bar low. The clock pulses then turn on the second bank of transistors Q11-Q20 in turn. After this second count of '10', IC2 is reset, and the cycle repeats.

Before IC1 is clocked each time, the LEDs which have to be turned on for the display are briefly pulsed via data lines D0-D4, being turned on with logic 1 and off with logic 0.

The corresponding LED columns are enabled via Q23-Q27. The length of this pulse will determine the brightness of the display. BASIC is a bit too slow for all this, so machine code must be used.

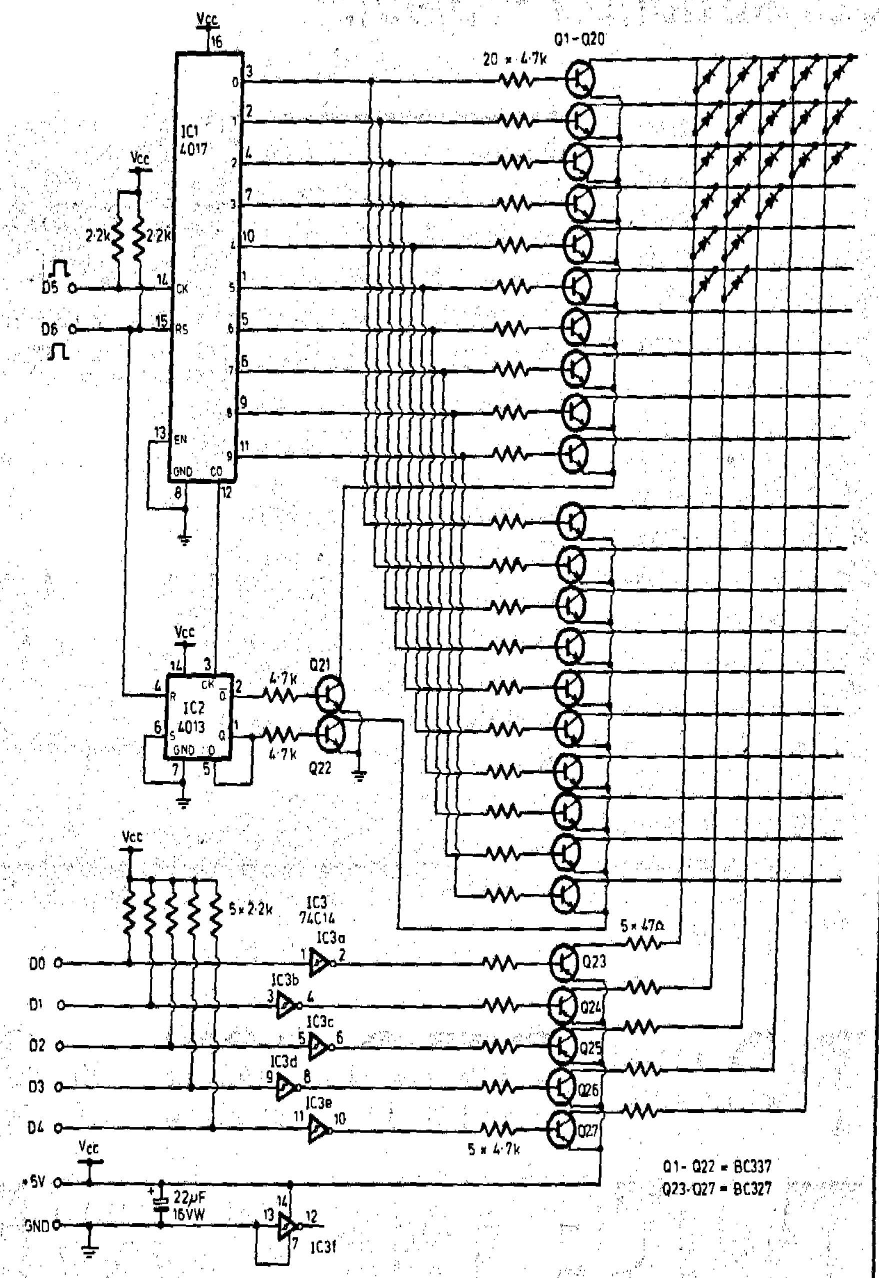
The 74C14 Schemitt trigger inverters (IC3) clean up any display flicker. The diagram shows how an 'A' is displayed. The display will be enabled as long as the 20 bytes of data are sent continuously along with the clock pulses.

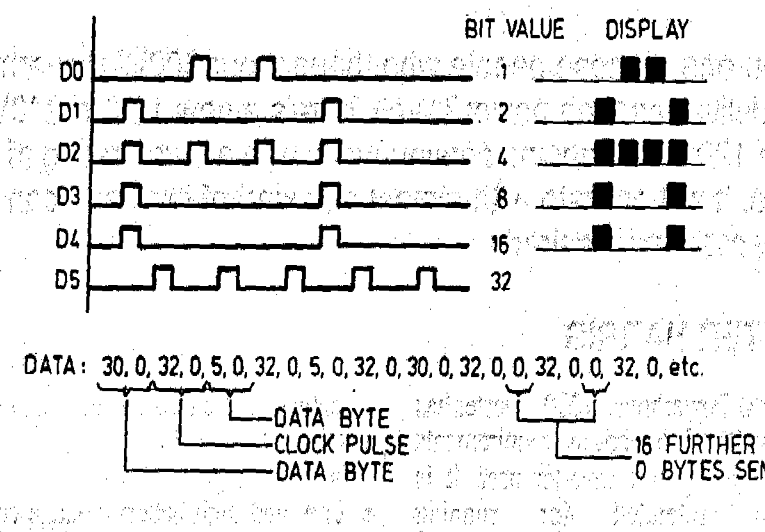
A brief pause is needed in between the data and clock pulses and the next data pulse, otherwise the display blurs. To stop the display, simply stop sending data. Pulsing D6 briefly will reset the display so that it begins at the first row the next time it is enabled.

With different programming techniques, the display can be made to scroll up, down left, right even merge letters or small pictures. Other uses for the circuit might include shop counter displays, front door messages or the like.

My display measured 75 x 25mm and cost about $23.

Anthony Nixon,
Hastings, Vic. $40.

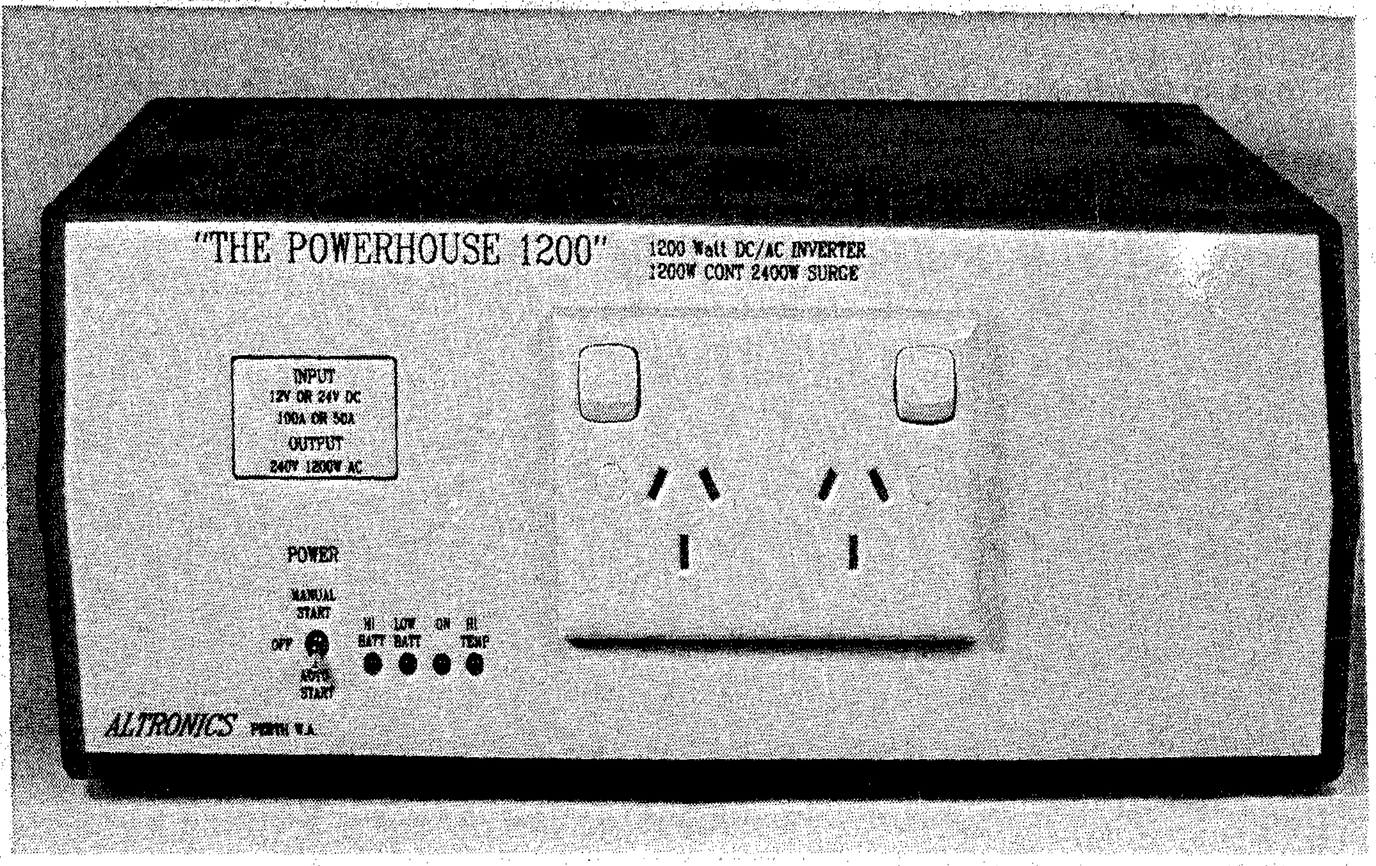




DREAMED UP A GREAT IDEA?

If you have developed an interesting circuit or design idea, like those we publish in this column, why not send us in the details? As you can see, we pay for those we publish — not a fortune, but surely enough to pay for the effort of drawing out your circuit, jotting down some brief notes and popping the lot in the post (together with your name and address) and send them to Jim Rowe at -

Electronics Australia,
PO Box 199,
Alexandria, NSW 2015



POWERHOUSE 1200: TWICE THE POWER! - 1

Are you one of those people who thought our 600W Powerhouse inverter of December 1987 *still* didn't deliver enough power? Well, here's a new 12V-to-240V inverter with some *real* grunt: it can handle 1200W of loading continuously, with a surge rating of 2400W. Crystal locked, compact and reliable, it will operate with almost any kind of load and can also be wired to operate from a 24V battery system if desired.

by PETER HARRIS

Our new Powerhouse 1200 inverter has been developed to meet the requirements of the higher power inverter user. It is primarily intended for running refrigerators, freezers, high power drills, saws, emergency lighting and general purpose household equipment.

The new design has enough surge power capacity to run just about any type of load — from 500L fridges to 3/4hp drill presses. It can also run a microwave oven with a cavity power rating of up to 600W (1000W drain).

But note that the microwave will NOT produce as much heating power as usual with this kind of inverter, due to its square wave output.

Features of the new Powerhouse design include:

- Auto starting
- Low and high battery voltage cut-out (cannot run on the wrong battery voltage)
- Protection via a high quality circuit breaker — no fuses to replace
- An over temperature cut-out
- Crystal locked master oscillator to ensure that the output frequency is a very stable 50Hz
- Very high surge power capability (2400W) to cope with appliance starting surges
- Protected against reverse battery connection (trips circuit breaker)

In designing the new inverter, we decided that it needed to meet some reasonably tough specifications. These were:

1. It needed to have a large power output, large enough to run just about anything. A figure of 1200 watts seemed reasonable.
   In addition to the continuous power rating, its surge rating needed to be approximately double this figure — i.e., 2400 watts.
2. It needed to work under virtually any load conditions and be highly reliable.
3. It needed to be completely 'bullet proof', and protected against any likely 'accidents'.

4. It had to offer as much as possible, for a reasonable price (not easy!)

We believe the Powerhouse 1200 design meets these requirements comfortably, and should therefore meet the needs of almost anyone wanting a high power inverter.

Incidentally the Powerhouse 1200 inverter has been developed for Altronics, of Perth, and copyright to the PCB patterns and front panel design, etc., is held by Altronics — which will be marketing kits for the project. This means that other firms will generally not be able to supply kits or PCB's, etc., unless they enter into agreements with Altronics.

However private individuals would presumably still be able to build up the design for their own use. Note, though, that the power transformer used in the project is a specially designed unit, and may be very difficult to get except from Altronics and its dealers.

The Altronics kit for the project will have the catalog number K- 6790, and we're told that it will be priced at $799.Fully built up and tested versions, for both 12V (K-6792) and 24V (K6793) operation, will also be available for $999. In both cases the prices quoted do not include packing, freight or insurance if required.

How it works

The overall design is best considered as comprising two separate sections: the power board and the control board. In explaining its operation, we'll look at the power section first.

The starting point for any high-power inverter like this is inevitably the power transformer, because this must handle the required power. In this case the transformer had to be specially wound for the job. The transformer was to be rated at 1200 watts continuous power, with 240V AC output from a battery voltage input. Assuming push- pull drive, the effective input voltage to the transformer primary was chosen to be 10.5-0-10.5V.

This voltage allows for 1V drop across the input leads and the switching FETs. One volt of drop may sound a lot, but because we're talking about a primary current of 100 amps (1200W/12V), the resistance to produce 1V of drop is actually 1/100, or only 0.01 ohms — not very much!

It is clear that even very small resistances can cause significant power loss with this sort of current drain, so the transformer primary obviously needs to be wound from very heavy wire. The core also needs to be able to handle the flux levels involved in transforming 1200W, with minimum losses. And finally the transformer must have a 12V feedback winding in addition to the main 240V secondary, for regulation purposes.

Once we had sorted out the transformer, a suitable power switching circuit was needed. This is basically used to 'chop up' the battery voltage, and feed it into the transformer primary in 'push-pull' mode — i.e., each half of the primary is connected across the 12V supply alternately, at 50Hz.

Now to get maximum voltage across the transformer primary, the switching devices need to have a resistance that is pretty low — so that minimal voltage is lost across the switch. Allowing for 0.4V drop across the input leads and circuit breaker, this leaves 0.6V drop for the power switches. This calculates out to be 0.6/100, or 0.006ohms (6mΩ.

To achieve this figure, it was decided to use parallel arrays of TO-220 style TMOS power FETs. These are extremely rugged devices as far as current rating and temperature is concerned.

They also have the advantage of a *positive* temperature coefficient, which means that they can share current (among other things). This comes about by the fact that as the device heats up it will conduct less current, so then it will cool down.

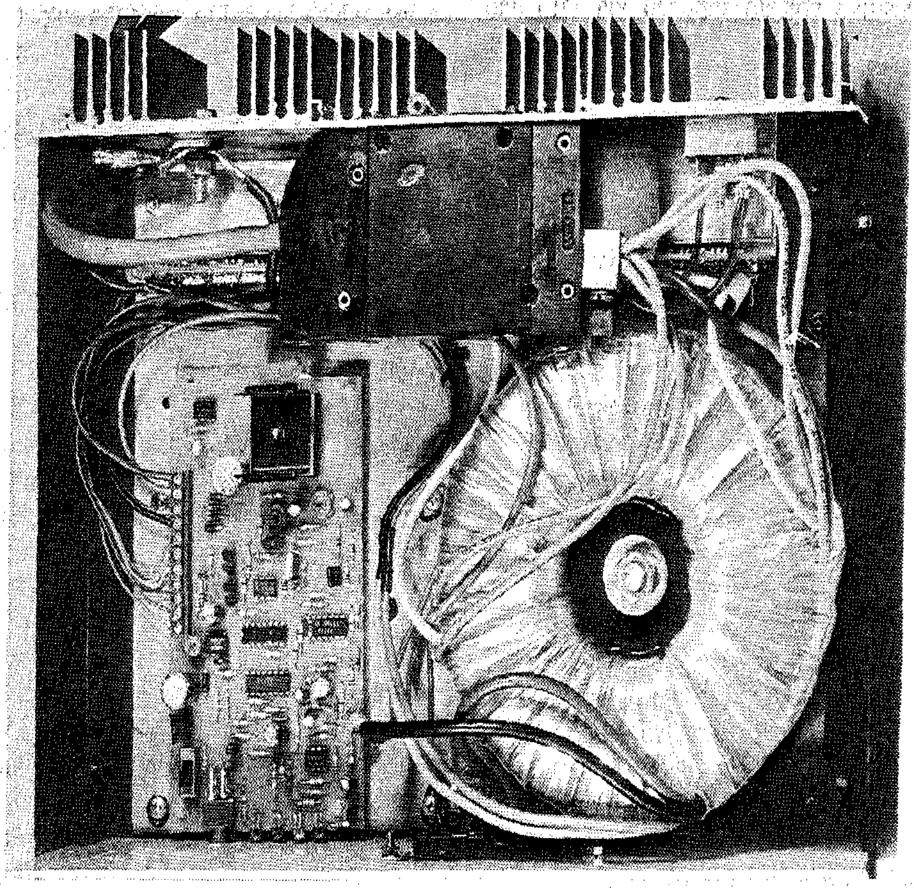
This sets up a balance not only between all the devices connected in parallel, but also within the individual chips themselves. This makes the devices immune not only to the 'secondary breakdown' effect characteristic of bipolar transistors, but also to the same devices' thermal runaway problems. The other advantage with TMOS FETs is that they are *voltage driven* rather than current driven. They require only a gate voltage above 10V to turn fully on, meaning that only low power driver stages are required.

The only problem with this type of input is that they also have a high input capacitance. This requires the driving circuit to deliver high pulse currents, to charge and discharge this capacitance.

Having established that TMOS FETs were the go, the question was which device to use and how many would be needed. The voltage rating needed to be higher than 60V (2 x 30V for a fully charged 24V battery), so 100V devices have been used.

The highest current rating in 100V devices is 25A, provided by the type MTP25N10 or IRF540. These devices are quoted at having an ON resistance of 0.085 ohms. As we need 0.006 ohms, this meant that 14 of the devices were needed for each 'side' — i.e., the switch for each side of the transformer's push- pull primary. The circuit diagram shows how they are all connected.

Quite separately from the basic switching, the other thing that is needed with a high power inverter is some form of *back EMF suppression*. This is necessary because large voltages can be reflected back into the transformer primary windings from inductive type loads. These can either make the inverter run very ineffi-



Inside the inverter. As you can see most of the space is taken up by the large toroidal step-up transformer. To its left is the control PC board, while at the rear and underneath the circuit breaker is the power switching board.

ciently, or overheat the switching devices and/or the load — not desirable.

The inductive voltages basically occur only *during* the brief periods in each cycle when *neither* side of the transformer primary is being driven (the inverter uses pulse-width modulation, for regulating the output). When either side of the primary *is* connected to the battery, via its conducting switch array, the total primary voltage is effectively clamped to twice the battery voltage by the conducting switch and battery.

The suppression technique used here actually *shorts out* the primary of the transformer when neither side is being driven. This involves the bridge BR2, used here as a pair of high-current diodes, and the four extra power FETs Q35-Q38. These are switched on, shorting both ends of the primary directly to the battery, when both of the main switch arrays are off — i.e., during the switching 'dead time'.

Drive for the suppression transistors comes from the same push- pull signals (G1 and G2) used to drive the main switch arrays, fed into the power PCB at pins 5 and 6. Diodes D13 and D14 hold Q39 and Q40 on during drive pulses, clamping the gates of Q35-Q38 to their sources and preventing them from conducting. However in between the drive pulses, Q39 and Q40 turn off, and the suppressor FETs turn on as a result of the positive voltage supplied via D15 and R78 (from the switch-mode regulator on the control PCB).

That about covers the basic operation of the power board. Now let's look at the control board circuitry.

Control PCB operation

It is easiest to explain the operation of the control circuit stage by stage. There are four basic sections: the oscillator and drive section, the voltage control section, the protective cut-out circuitry and the power supply and auto start section.

1. **Oscillator and drive circuit:** The master clock signal is derived from a timebase oscillator/divider chip, IC1, a MM5369-EST. This chip provides a 100Hz pulsed square wave from a 3.579545MHz crystal (X1). The 100Hz pulses are fed into a flipflop (IC2a), which divides it by two to produce two precise 50Hz outputs which are 180° out of phase. These appear on pins 1 and 2.

The output from IC1 is also fed into a triangle wave shaper (IC4a). We'll return to this shortly.

WARNING!

The output voltage and current capability of this inverter are such that accidental contact with both output lines — or the active output line and the battery terminals — could easily prove FATAL. It is important therefore to take just as much care, when using the inverter, as you would when using any appliance or equipment connected to the 240V AC power mains.

Equipment to be operated from the inverter should also be in a safe condition. Frayed cords, exposed but unearthed metal parts (unless double insulated) and broken or wet unsulators should be repaired before the equipment is used.

It is also important to keep the electrolyte level of the battery above its plates. This not only prolongs battery life, but also reduces the risk of explosion. When charging the battery, do so in a well ventilated area — the hydrogen given off from a charging battery is highly explosive.

When connecting or disconnecting the inverter to the battery, make sure that the appliance is not plugged in and the inverter's control switch is in the 'Off' position. This will prevent sparks as the battery connections are made or broken, and again minimise the risk of explosion.

The two outputs from IC2a are fed into two NAND gates, IC3a and IC3b. The other input of each NAND gate comes from the voltage regulation comparator IC4b — more about this later, too.

The outputs of IC3a and IC3b are fed into two further NANDs (IC3d and IC3c respectively), each configured as inverting buffers. The outputs of these in turn are then fed into the driver stage transistors.

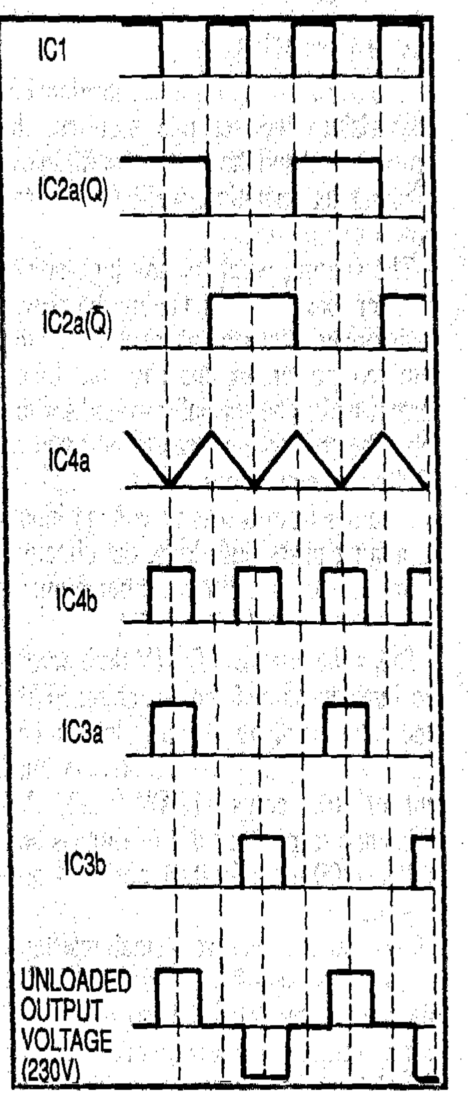
The driver stages use transistors Q4, Q5, Q6, and Q2, configured as two 'complementary emitter followers'. These provide high current pulses to the TMOS power FETs, while providing good isolation from the low power circuit.

2. **Voltage control circuitry:** The transformer T1 has a 12V feedback winding, which is used to sense the output voltage. The voltage developed across this winding is rectified by D1-D4, producing a DC feedback voltage which is then fed to RV2, a 10k trimpot which provides adjustment of the feedback and hence a limited control over the inverter's output voltage.

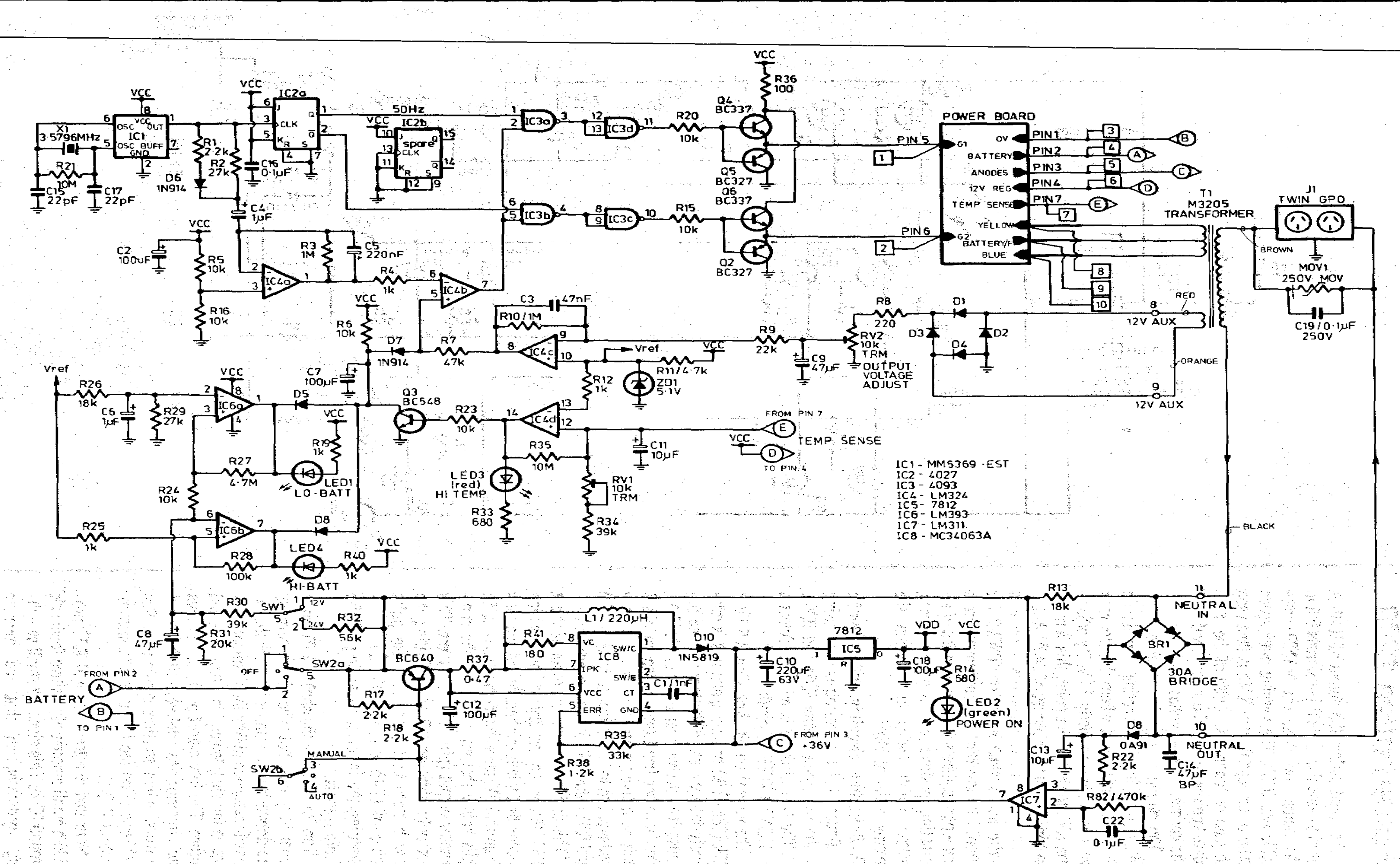
The wiper of the trimpot is connected to capacitor C9, which smooths any ripple on the feedback voltage, and then via R9 to the input of IC4c, an LM324 op amp connected as a comparator. IC4c effectively compares the feedback voltage on its pin 9 with the 5.1V reference voltage applied to its positive input (pin 10), and established by zener diode ZD1.

If the feedback voltage rises above 5.1V then the output of IC4c will go low. Alternatively if the feedback voltage falls below 5.1V, the output of IC4c rises to Vcc (12V). So the output from IC4c switches between 0V and +12V, depending upon whether the feedback voltage is higher or lower than 5.1V.

This low/high error voltage is then fed to a second comparator IC4b, where it is compared with the 100Hz triangle wave produced by IC4a. The output from IC4b thus becomes a rectangular wave — still at 100Hz, but whose mark/space ratio depends upon the level of feedback voltage. If the output of IC4c is low (corresponding to a feedback voltage of more than 5.1V), the 'high' sections of the 100Hz waveform from IC4b will be much narrower than the 'low' sections; conversely if the output of IC4c is high (because the feedback voltage is less than 5.1V), the 'high' sections will be much wider than the 'low' sections.



Here are the key waveforms inside the inverter, which help to understand how it all works.



This schematic shows the circuitry on the control board of the inverter. The remaining circuitry is on the power switching board, shown overleaf.

Powerhouse 1200

As noted earlier, the output of IC4b is used to gate the 50Hz drive signals fed to the output switches, via NAND gates IC3a and IC3b. The varying mark/space ratio of the signal from IC4b is thus used to gate or 'chop' the width of the drive signal pulses, to vary the average value of the inverter's output voltage.

The output voltage is therefore regulated, with the circuit acting to maintain the output at a level where the feedback voltage is almost exactly 5.1V. By adjusting RV2 to the correct point, this is made to correcpond to an output of 240V AC.

This type of regulation is known as *pulse width modulation*, or 'PWM' for short. The inverter's output waveform is not a pure square wave, but a series of alternating positive and negative pulses, whose width varies to maintain the average value at 240V.

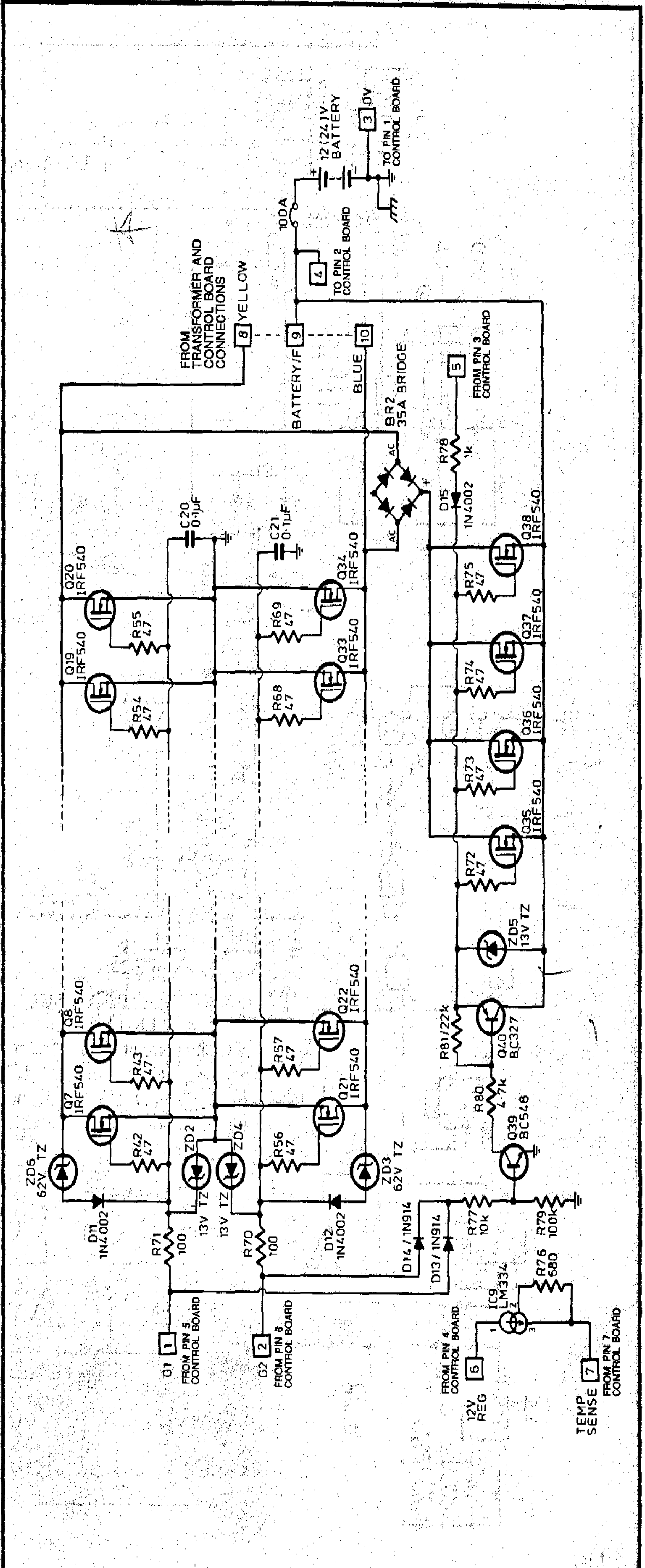
3. Protection circuitry and cut-outs: Battery voltage sensing is done using the two comparators IC6a and IC6b. The first of these is wired to detect a LOW BATTERY condition.

The voltage on pin 2 of IC6a is 5.1V * 27k/(18k+27k) or 3.06V, and this is relatively independent of battery voltage because it is derived via zener diode ZD1. On the other hand the voltage on pin 3 will be a fixed proportion of the battery voltage, due to the divider formed by R30 and R31 (plus R32 for 24V operation).

This divider provides an input of about 0.34 times the battery voltage, which means that when the battery voltage falls to around 9V, the voltage on pin 3 of IC6a falls below that on pin 2, and the comparator output (pin 1) switches low. This not only turns on LED1, indicating the low battery condition, but also pulls pin 5 of IC4b low, via D5 and D7 — stopping the inverter by gating off the drive signals.

The low battery threshold of 9V may seem very low, but when large currents are drawn from a standard battery the internal resistance makes the terminal voltage somewhat lower than the unloaded figure. The low cutoff point also allows the inverter to deliver high surge powers, when starting appliances. For 24V operation the low cutoff voltage is around 17.5V.

Note that resistors R24 and R27 provide a small amount of positive feedback around IC6a. This gives it a small switching hysteresis, so that the inverter switches off cleanly when the low battery point is reached. There's no 'hunting' or rapid switching on and off. The 12V and 24V comparator levels are



And here's the schematic for the power switching board section of the inverter. Two sets of 14 paralleled power FETs are used to switch the battery current alternately to each side of the transformer primary winding.

selected via SW1, a mini slide switch on the PC board.

The 'HIGH BATTERY' cutout circuit works in a very similar way, except that the inputs to its comparator IC6b are reversed in terms of sensing polarity — so that its output will go low when the input fed to pin 6 is higher than the reference voltage on pin 5. Here the reference voltage is also the full 5.1V from ZD1, with a small addition due to the effect of feedback resistor R28. As a result the cutoff point occurs at around 15V for a 12V battery, and 29V for a 24V battery.

As before, when the output of IC6b switches low it both turns on LED4, to indicate the problem, and cuts off the inverter by pulling down pin 5 of IC4b via D9 and D7. The positive feedback provided by R25 and R28 again introduces hysteresis to ensure clean switching.

By the way, the main purpose of the 'HIGH BATTERY' cutout is to protect the inverter from damage, if it is connected to a 24V battery when SW1 and the output transformer connections are still set for 12V.

The 'OVER TEMPERATURE' cutout again uses a comparator (IC4d) to do voltage sensing. The reference voltage is again the 5.1V from ZD1, fed to pin 13, but this time the input voltage is derived from an IC temperature-controlled 'current source'. This device, an LM334Z (IC9), is located on the main power heatsink.

The resistor (R76) connected between the Rset and V- terminals of the LM334Z sets the rate that its current changes with temperature. The chosen value of 680 ohms gives a rate of 333.8nA/K (Kelvin). Therefore, at 343K, corresponding to 70°C, the current will be 114.4uA. This current is then converted to a voltage level by R34 and trimpot RV1.

RV1 is adjusted to give 5.1V at pin 12 of IC4d, when the heatsink temperature reaches 343K/70°C. So when this level is reached, IC4d switches and pin 14 goes high. This turns on LED3 and Q3, which pulls pin 5 of IC4b low as before (via D7), gating off the inverter's drive signals.

4. Power supply and auto start: This section proved to be more difficult than first thought. Easy, you may say — just use a regulator (say 5V), straight from the battery! But it isn't that easy.

Firstly the power FETs require more than 10V and less than 20V of gate drive, to switch them correctly; 12V is ideal. This means that a 12V regulator is required, calling for an input voltage of more than 15V.

A further requirement is that for correct operation of the back- EMF suppression circuitry, the gate circuits of power FETs Q35- Q38 must be powered from a DC source that is at least 8V higher than the highest battery voltage. This means that we need a supply of about 36V, to cope with operation from a 24V battery. There are several ways to get 36V from a 10V supply. One is to use a voltage doubler, driven from the inverter transformer itself. This works OK at 12V, but at 24V the output could be as high as 60V — a little too high for the regulator!

Another solution is to use a diode from each side of the transformer. This also works fine, but not when the transformer is shorted out! This can happen when the inverter is powering a load with a high starting current, or loads that are highly inductive. In any case this scheme will work fine at 24V, but not at 12V. So another solution is required.

The final design uses a small DC-DC converter to produce the required voltage. This can produce enough voltage for the 12V regulator from a battery voltage as low as 6V (in fact the DC-DC converter itself will work down to 2.5V!). This means that no matter what the battery voltage, the inverter will run correctly.

The DC-DC converter is based around IC8, a type MC34063A, in conjunction with inductor L1 and diode D10. The 36V output of the MC34063A appears across C10, and is used both for the gate supply for the back-EMF suppression FETs, and to drive the 12V regulator IC5. The 12V regulator provides the +12V rail for most of the low-power inverter circuitry, and also runs the 'POWER' LED.

The **auto start circuitry** comprises rectifier bridge BR1, comparator IC7, transistor Q1, switch SW2b and their associated components. It works as follows.

Transistor Q1 is essentially used here as a switch, controlling the DC input from the battery to the DC-DC inverter IC8. As the 12V supply rail used by most of the inverter's circuitry is derived from the 36V supply produced by IC8, Q1 therefore controls whether the inverter is operating or not (without drive, the main power FET arrays used for output switching are effectively open circuit).

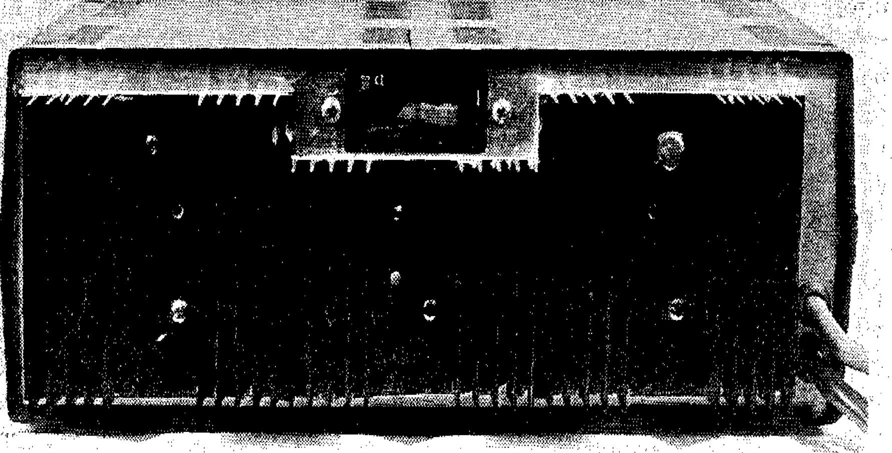
Basically Q1 is turned on by providing it with base current, and this is achieved by connecting its base resistor R16 to ground. This is done directly by SW2b, when the inverter is used in its 'MANUAL' mode. However in the 'AUTO START' position of SW2, the control of Q1 is performed by IC7 instead.

IC7 is connected as a high-gain inverter, with its positive input (pin 2) connected to ground via a bypassed 470k resistor. The comparator's input bias current thus causes the input to float at around 50-100mV positive, with respect to ground. IC7's negative input (pin 3) is also connected to ground via R22, and with no current flowing through R22 this input will at virtually ground potential because R22 is much smaller (2.2k). Under these conditions the output of IC7 (pin 7) is high, and Q1 and the inverter are held off.

Note, though, that a small current can be made to flow in R22, to change this situation. This current can flow only when an appliance is plugged into one of the inverter's 240V outlets, and is also turned 'on'. It flows from the battery, through R13 and the secondary of the transformer, through the appliance itself and then through D8. And the effect of the current is to make pin 3 of IC7 more positive than pin 2, causing it to switch its output to the low state and turn on Q1.

The idea is that when SW2 is in the 'AUTO START' position, the inverter turns on automatically if an appliance is plugged into one of the inverter's output

Continued on page 91

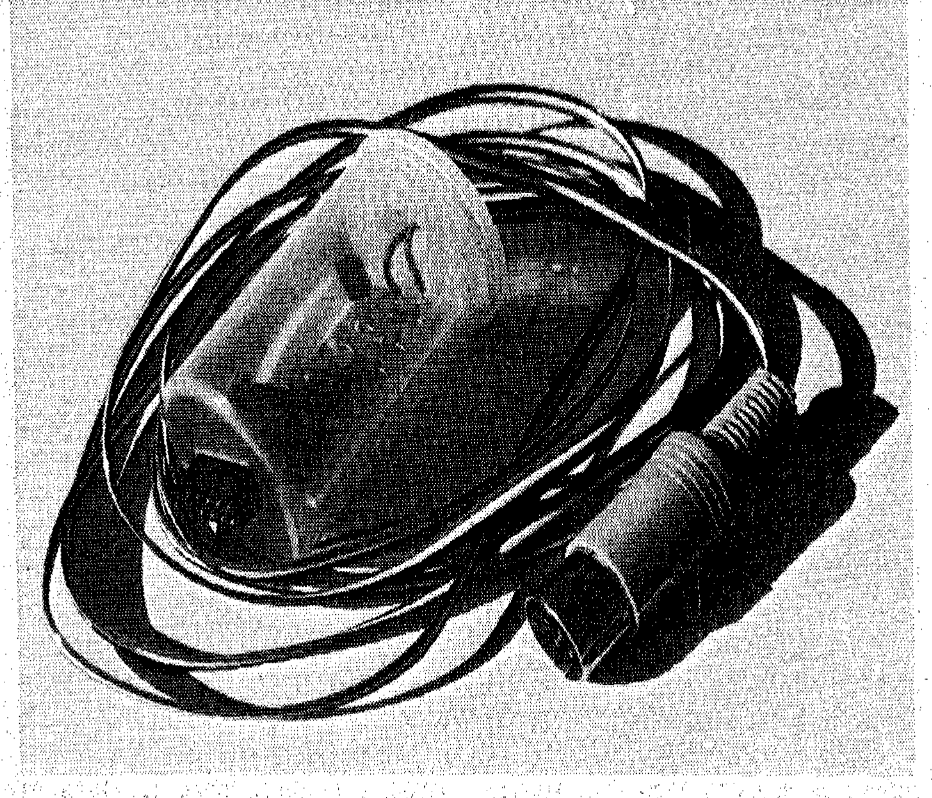


The rear end of the inverter is mainly comprised of the heat sink radiators, with the battery circuit breaker mounted at upper centre and the heavy duty battery leads entering at lower right.

Using your PC to control radio gear - 3

Here is the third and final part of our series on controlling radio equipment with a personal computer. The first part demonstrated the BASIC language, using the AOR AR-3000 scanner receiver as an example. Part two covered Icom gear, using the C language. This month it's Yaesu's turn, with programming examples in both BASIC and Turbo Pascal, and also brief information on using an Amiga computer instead of an IBM compatible.

by TOM MOFFAT, VK7TM



You might recall that the AOR scanner connects directly to the computer via its RS-232 serial interface. Both Icom and Yaesu need special interfaces to convert the +12V/-12V RS-232C signal levels into 0/+5V TTL levels used by the radios. Each manufacturer supplies its own interface. The Icom unit costs about $180; Yaesu's device is around $125.

This month's construction project is a tiny interface circuit the size of a postage stamp that can take the place of either the Icom or Yaesu 'official' interface. Note that this differs from the advice given in the second of these articles; then we thought we would need a special interface for each brand of radio. Now we have come up with a design that suits either.

Differences

The Icom computer control system described last month uses a single wire working against ground, to connect the interface with the radio. Signals can travel FROM the computer TO the radio, and FROM the radio TO the computer, along the same wire. Obviously this cannot happen simultaneously; it's strictly one end talking while the other end listens. This type of communication is known as 'half-duplex'.

Yaesu, on the other hand, still use 0/+5V logic levels but use two separate wires each working against ground — one for transmission from the computer to the radio, and the other from the radio to the computer.

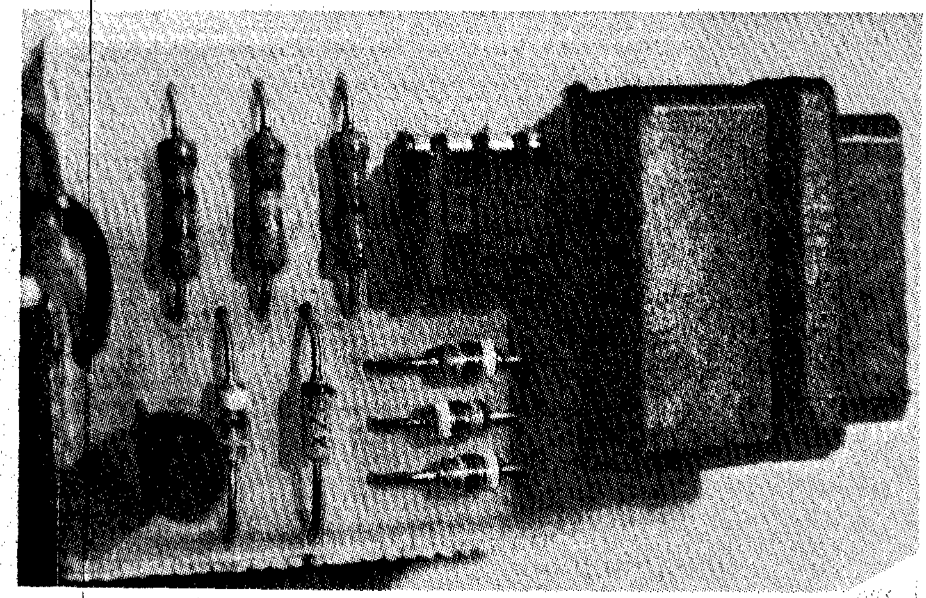
With this 'full duplex' type of communication it is quite feasible for data to pass simultaneously from the computer to the radio and from the radio to the computer — although Yaesu don't actually do this, at least with radios I've worked with.

Regardless of whether half or full duplex is used, separate inward and outward paths connect with the computer.

For Yaesu operation with our interface kit, signals to and from the radio are simply converted between RS-232 and TTL levels and fed straight through to their respective send and receive lines. For use with Icom gear, a jumper is required on the interface board which connects the send and receive lines together on the radio end. This, of course, means that anything the computer sends to the radio is also looped back to the com-puter's receive side. This data is quite useless to the computer and must either be ignored or got rid of to avoid scrambling the data coming from the radio. We achieved this in last month's Icom scheme by using custom RS-232 communications software that completely disabled the computer's data receiver while the data transmitter was operating.

With the Yaesu system, we can be assured that anything arriving on the computer's receive line originated in the radio, so the handling of incoming data is somewhat easier.

Yaesu equipment communicates with the computer at 4800bps (bits per second), four times faster than Icom. But most Yaesu radios are incapable of accepting a continuous stream of data bytes at 4800bps. There must be a small time delay between bytes, or the radio will choke up.



Here's a close up of the author's prototype interface board, which can now be used with either Icom or Yaesu equipment. When this shot was taken he had not drilled the holes for the link JP.

Icom's data format for computer commands is pretty well standard right across their whole range of products. But Yaesu seem to design each radio with its own command structure. ALL Yaesu commands are five bytes long, but the arrangement of data within those five bytes varies enormously.

For instance to set the frequency on an FRG-9600 VHF receiver, you must first send a command code meaning 'set frequency', followed by four bytes containing eight digits of frequency information. But on the FRG-8800 HF receiver, the four frequency bytes are sent first and the 'set frequency' code last.

On the '9600 the highest order digits come first, while on the '8800 the lowest come first. And the order of digits within bytes differs between radios. They couldn't have made it any harder!

This means you can't write a 'universal' Yaesu computer control program. Each model will require its own program, but luckily Yaesu provide all the programming information you'll need, right in the owner's handbook for the radio in question.

The interface

This month's interface project is very similar to the Icom version described previously, although the new one can work with either Icom or Yaesu radios. When analyzing the Yaesu communications system for this month's article I found that both radios require the same kind of voltage levels and the same data polarity.

Icom radios want to be fed signal current via an external pull-up resistor, whereas Yaesu gear prefers an open-collector interface with the collector resistor inside the radio.

So it was a simple matter to cut the 'send' transistor Q1 loose from its collector resistor on the previous Icom interface and feed the collector straight into the Yaesu radio. Data coming FROM the Yaesu radio then connects to the interface where Q1's collector was formerly attached. Voila! Instant full-duplex communication.

A small jumper (JP on the overlay) restores the connection between the collector of Q1 and its on-board resistor, enabling half-duplex operation for use with Icom equipment.

The new interface circuit now has three connections for the radio. For Yaesu use, the pad marked A receives data from the radio, B sends data to the radio, and C is ground. For Icom operation, jumper JP must be installed. Then either A or B is the signal line to/from the radio, and C is ground.

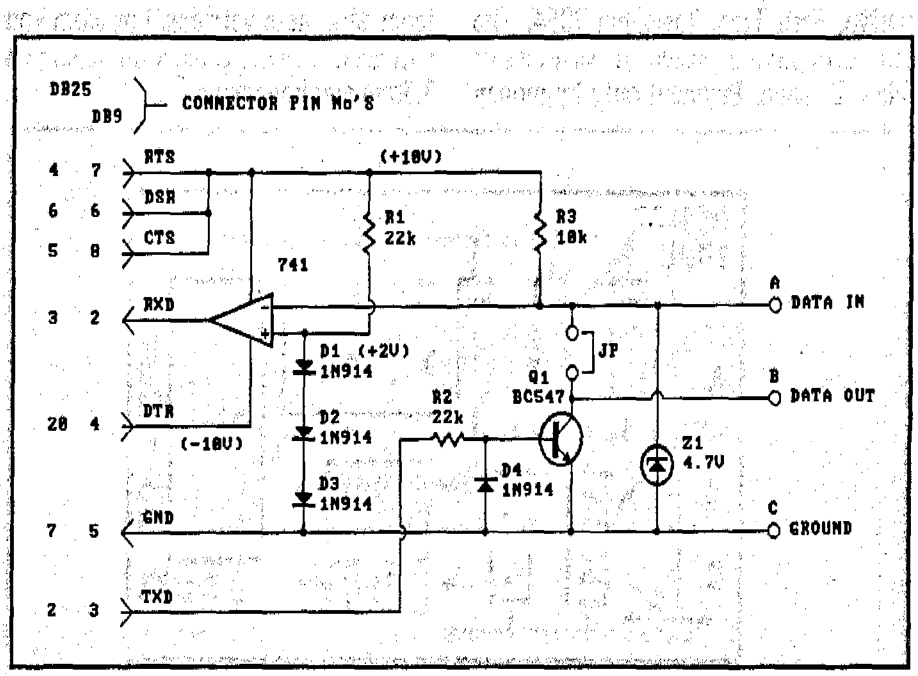
If you're lucky enough to own both, Icom and Yaesu radios can use the same interface by setting it up for Yaesu operation. Then you can make a simple Icom adaptor cord with a 6-pin DIN plug on one end and a 3.5 mm earphone plug on the other. Connect ground to pin 1 of the DIN plug and the hot side to pins 2 and 3 strapped together.

The 'official' interfaces for Icom and Yaesu radios are powered from the mains. Our interface draws its operating power from the computer's own control lines, present on the RS-232 serial port connector. These are designed to operate over long distances, so they are of fairly low impedance; that is, they can supply small, but useful, amounts of current.

With one simple computer software instruction we can arrange for the RTS (Request To Send) line to have a nominal +12 volts on it, and the DTR (Data Terminal Ready) line to have -12 volts. These are used to supply the tiny amount of operating power needed by the interface's 741 IC.

The computer's RS-232 port expects to see incoming data swinging between a nominal +12 and -12 volts at its RXD (Receive Data) input. The 741 is used as a simple comparator/switch so its output is always close to one of the power supply rail voltages, +12 or -12 volts. The non-inverting input is set at about 2 volts positive to ground by the string of three diodes, pulled up by the 22k resistor.

When the data signal from the radio (swinging between 0 and +5 volts) goes higher than the reference voltage on the



The schematic for the modified version is very similar to that given in the second article for the Icom interface. The main difference is that with the link JP not fitted, the data in and data out lines are separated — as required for Yaesu sets.

Using your PC to control radio gear - 3

741's non-inverting input, the 741 output swings to -12 volts. When the radio data goes below the reference voltage, the 741 flips to +12. The three diodes were used instead of a zener, by the way, because zener diodes at such low voltages are notoriously unreliable.

We do use one proper zener of 4.7 volts to ensure that the voltage fed to an Icom radio can never go beyond the normal 5 volt TTL level. Should this happen the innards of the Icom would not be very impressed.

As with the Icom-only interface, the new Icom/Yaesu version is designed to mount within a 35mm film canister. The production version of the circuit board has turned out to be a perfect fit inside the clear plastic canisters you get with Fuji film.

These have a strong molded lid that snaps up into the canister, securely holding the circuit board in place. Any photo-processing shop should give you a handful of these canisters just for the asking. Or you could even lash out and buy a roll of Fuji film (or K-Mart *Focal* — it's the same stuff).

The completed interface plugs straight into the 9-pin serial port on the back of your computer. Should your computer use the older 25-pin connector, you can easily buy, or make, a 9-pin to 25-pin adaptor. You'll find it useful for other purposes as well.

A kit to build the Icom/Yaesu radio interface can be purchased only by mail order, and only from High-Tech Tasmania (home of Listening Post II).

The postal address is 39 Pillinger Drive, Fern Tree, Tasmania 7054. The kit costs $39.00 posted in Australia or New Zealand. Payment only by money order or cheque please, High-Tech don't yet have credit card facilities.

This kit has been specifically designed with the first-time constructor in mind. Despite its tiny size the parts are well spread out, the circuit board soldering pads are of good size, and the tracks are nice and fat.

The board is of very high quality fibreglass and it's solder plated, so construction should be foolproof. Even if you are a shortwave listener who'se never touched a soldering iron before, you should be able to construct the kit without trouble.

The kit consists of the circuit board and all the parts required to build it, including the DB-9 connector, and full assembly instructions.

What you don't get is the film canister and the cable and connector for the radio, since these are different for Icom and Yaesu versions. For Icom you will need a 2-wire cable terminated in a 3.5mm earphone plug.

For Yaesu you need a 3-wire cable and (usually) a 6-pin DIN plug. The connectors are normally supplied when you buy the radio.

```
10 REM Test for response from Yaesu radio
20 REM
30 DATA 65,66,67,68,69,70,71,72,73,74
40 OPEN "COM1:4800,N,8,1,RS,CS,DS,CD" AS #2
50 OUT &H3FC,10: REM Power for interface, RTS (+) and DTR (-) (000010
60 REM
70 REM Send to radio
80 REM
90 FOR I=1 TO 10
100 READ X: PRINT#2, CHR$(X);
110 FOR J=1 TO 100: NEXT J: REM Time delay between bytes if needed
120 NEXT I
130 REM
140 REM Receive from radio
150 REM
160 FOR I=1 TO 10
170 PRINT HEX$(ASC(INPUT$(1,#2))); " ";
180 NEXT I
```

Called 'RESPONSE.BAS', this little BASIC program allows you to check that your computer and Yaesu radio are communicating with each other.

Experimenting

The best way to write a computer control program for your Yaesu radio is to establish simple communications with it and then build from there. The small BASIC program 'RESPONSE.BAS' should help you. You can pre-arrange a known string of data bytes and send it to the radio, and then look to see if anything comes back.

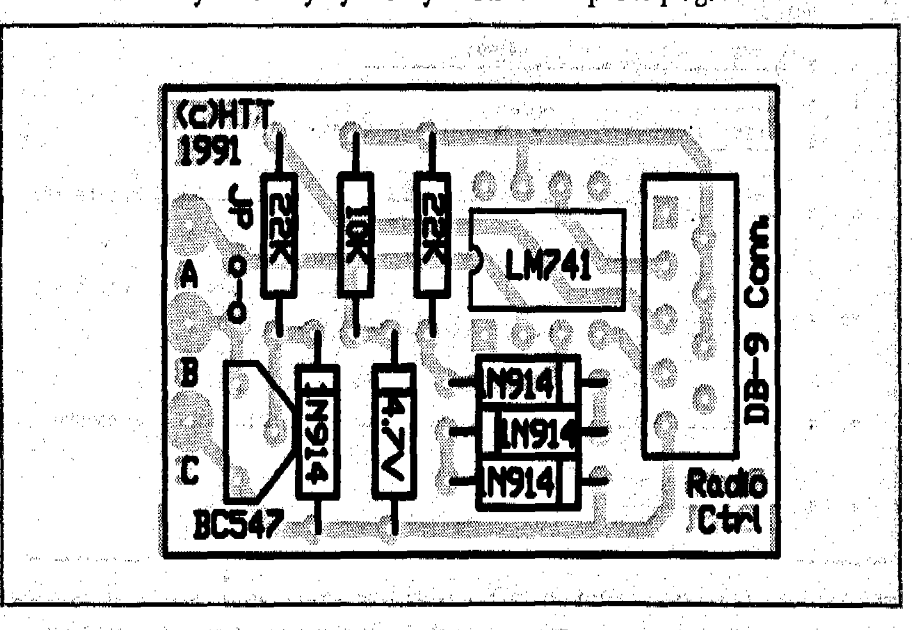
First test the interface. Short together the transmit and receive lines on the radio side by temporarily installing jumper 'JP'. If you run the program exactly as shown in the listing, it should print the same string of numbers shown in the DATA statement in line 30.

This proves that 10 data bytes have gone out through the computer's RS-232 port, been converted to TTL levels, crossed over to the radio's receive line, been converted back to RS-232 levels, and gone back into the computer.

With the interface operation confirmed, it's the radio's turn. For the first test select a command that will make itself readily apparent, such as changing the radio's frequency.

You know this has succeeded when the new frequency appears on the dial display. Most radios do not send a response back to the computer for this operation, so you can forget the part of the program related to receiving data from the radio.

Using the FRG-9600 receiver as an example, the operating manual says you can set it to 65.4321MHz by sending the five bytes '0A-06-54-32-10'.



As you can see from this PCB overlay diagram, the interface has very few parts and is easily wired up. Link JP is only fitted for use with Icom equipment.

```
10 REM ==============================================================
20 REM ||   Demo control program for Yaesu FRG-9600 VHF receiver.
30 REM ||   Written in GWBASIC for the IBM-PC
40 REM ||   Asks for frequency, then mode, then exits.
50 REM ==============================================================
60 REM
70 DEFINT N,B,C,X: DIM M$(5), N(5)
80 FOR I=0 TO 5: READ M$(I),N(I): NEXT I
90 REM
100 REM [This is the data for FRG-9600 functions and codes.]
110 DATA "AM-W",21,"AM-N",20,"LSB",16,"USB",17
120 DATA "FM-W",23,"FM-N",22
130 REM
140 OPEN "COM1:4800,N,8,1" AS #2
150 OUT &H3FC,10: REM Power for interface, RTS (+) and DTR (-) (00001
160 INPUT "Frequency"; FREQ
170 CMD=10: GOSUB 270
180 INPUT "Mode"; MODE$
190 FOR I=0 TO 5: IF MODE$<>M$(I) THEN 210
200 FREQ=0: CMD=N(I): GOSUB 270: END
210 NEXT I: PRINT "Mode not found!": END
220 REM
230 REM ==============================================================
240 REM |       Subroutine to send five-byte command, (CMD, FREQ)
250 REM ==============================================================
260 REM
270 FREQ=FREQ/1000
280 PRINT#2, CHR$(CMD);
290 FOR I=3 TO 10
300 GOSUB 340: BYTE=X*16: I=I+1: GOSUB 340: BYTE=BYTE+X
310 PRINT#2, CHR$(BYTE);
320 NEXT I
330 RETURN
340 X=VAL(MID$(STR$(FREQ),I,1)): RETURN
```

After confirming that your computer and Yaesu radio are communicating, you're ready for the next step. Here's the author's program 'SEND9600.BAS', which shows how to control an FRG-9600 from GWBASIC.

Note that these are in hexadecimal. To try them on the radio, replace the DATA numbers in line 30 with the five bytes, using hexadecimal notation: &h0A, &h06, &h54, &h32, &h10.

Since we are sending five bytes, line 90 must be changed to 'FOR I=1 to 5'. You can then delete lines 130-180, the receiving part of the program. When you run the program the radio's display should jump to '65.4321'.

Note the time delay between bytes in line 110. You can try shortening it by changing the '100' to something smaller.

When you get down to 5 or 3 or some small number, the radio may ignore the command. A time delay for reliable operation would then be about double the delay you were using just before it failed.

You may find you don't need any time delay at all. This means your computer has a pretty slow clock speed. But if you're running a 33MHz '386 machine, you're definitely going to need that time delay.

You might want to use the 'response' program to set a new operating mode, just to prove that works too, and to get your confidence up.

Then, having proved to yourself that computer control of your radio is possible, and having established what time delay you need, you can use your owner's manual information on codes and formats to build a full program.

Software schemes

Sending serial data out of a computer is usually a straightforward process. You feed the data byte you wish to send to the RS-232 serial routine, and then wait for whatever number of milliseconds it takes to send the byte at the baud rate in question. The computer remains 'tied up' within the transmission routine until the byte is finished.

If you send 100 bytes, the software feeds them into the sending routine as quickly as it can. But it still spends most of its time waiting as each byte is sent.

Receiving isn't so easy, because the computer isn't in control of how fast the data is being sent — the radio, or other external device, sends for all its worth while the computer tries to keep up.

The computer can use one of its control lines to tell the sending end to hold each byte until the computer is ready to handle it, but radio receivers don't respond to such niceties. They only have data lines, not control lines.

The most elegant way for the computer to handle the problem of unstoppable data is to allow each incoming byte to 'interrupt' whatever else is going on. The computer then uses a small routine to store the received byte in memory, before resuming what it was doing before the interrupt occurred.

If the radio unleashes a string of 100 bytes, the computer will soon have a whole string of them (a 'queue') awaiting attention from the software. It gets to them as quickly as it can, but if bytes keep coming, the queue may become full before the bytes can be attended to. Data will then be lost.

The IBM-PC in its standard form has no interrupt-driven serial receiving capabilities. Your program can try to be ready to catch bytes as they arrive, but this is a dicey business at best. At the 4800bps Yaesu gear sends at, it's hopeless. But all is not lost. IBM's BASIC language GWBASIC has its own built-in interrupt-driven RS-232 routines that work like a dream.

You'll remember in our first interface test above, we sent 10 bytes out and then collected 10 bytes back to display them on the screen. They looped back through the interface, but where did they go after that, before we began 'receiving' them? Into a queue in memory, that's where.

This is a very important concept to keep in mind while doing serial things in GWBASIC. If you don't 'read' the expected number of bytes, they'll sit in the queue forever, unnoticed. If you try to read more than are sent, the computer will 'hang', waiting for more bytes.

The RS-232 data standard was born back in the early days when the only thing people attached to serial ports was a modem — or even earlier, a 'Data Set'. The Data Set was a contraption supplied by the Bell Telephone Company of America to allow data to be sent over long lines. Instead of civilized audio tones, these things used DC voltages and they were awful to work with.

The Data Set has left its terrible legacy with the RS-232 signal line called DSR (Data Set Ready). And the IBM-PC with its MS-DOS operating system still demands to see Data Set Ready as well as another signal called CTS (Clear To Send), before it will allow ANY serial communication to take place.

If your programming bypasses the IBM's built-in routines and uses the serial hardware chip directly, you can ignore its protestations about no Data Set being connected. But if you try to use the MS-DOS RS-232 routines, they insist that a Data Set be present. No Data Set Ready, no DOS service.

GWBASIC lets you bypass the Data

Using your PC to control radio gear - 3

Set Ready hurdle when you configure the RS-232 feature at the start of the program. In line 30 of the Response program, the OPEN statement includes the parameters 'RS,CS,DS,CD'. This means "ignore Request To Send, Clear To Send, Data Set Ready, and Carrier Detect". Request To Send is actually an output which we turn on in the following line to power up the interface.

Carrier Detect is for modem use and is not essential for communication. But CTS and DSR must be got rid of, or we simply can't use the RS-232 facilities.

Yet another feature in our interface that the others don't have: we have 'hot-wired' the CTS and DSR lines to the Request To Send line, so when we turn RTS on to power up the interface, these two lines send their correct signals back to the computer.

The computer sits there in blessed ignorance thinking there's a Data Set connected and it's ready to go. Silly old computer! RS-232 communication is now possible, even without GWBASIC.

You'll notice in the SEND9600.BAS program we've OPENed the RS-232 feature without mentioning the control lines. With them hot-wired, BASIC also thinks there's a Data Set connected.

Now let's look at some sample programs to see how we can put this information to use.

SEND9600.BAS

This is a program in BASIC to send a new frequency, and then a new mode, to an FRG-9600 receiver. Since this is a VHF receiver, frequency input is expected in MHz, as in '123.4567'. Modes must be entered in upper case, exactly as shown on the radio's display.

Bear in mind that this isn't the ultimate in 'user friendly' programs; it's presented only to show ways to convert keyboard input into results in the receiver, in the easiest possible way.

Since this isn't really a textbook on computer programming, we won't discuss every detail of the BASIC language, just the general ideas used. The start of the program sets up various variables and arrays, and then establishes a lookup table for mode setting. With each mode designator is its code number to be sent to the radio.

Next we set up the RS-232 port as discussed above, and turn on the interface power by setting the correct bits of the computer's modem control register. This command also turns on the interrupts. Next we collect the desired frequency from the keyboard (in MHz), set the variable CMD to '10' which is the code for set-frequency, and then enter a subroutine which sends five bytes to the radio (remember, always five bytes for Yaesu).

Here we first divide the frequency by 1000; the idea being to get the decimal point to the front of the number. We then start the command sequence going by sending the command code for set-frequency.

Now look at line 340. Here we take the variable FREQ (which is going to

```
program Send9600; {Written in Turbo Pascal version 3.01A}

const
   ALPHA: array[1..6] of string[4] =
      ('AM-W','AM-N','LSB','USB','FM-W','FM-N');  {The mode names...}
   NUMER: array[1..6] of integer =
      (21,20,16,17,23,22);                          {and their numbers}

var
   FREQ: real;
   I,CMD: integer;
   MODE: string[4];


procedure Init_RS232; {Set for 4800,n,8, and power up interface}

begin
     port[$3FB] := $80; {access baud-rate divisor}
     port[$3F8] := $18; {4800 baud, LSB}
     port[$3F9] := $00; {4800 baud, MSB}
     port[$3FB] := $03; {8 bits, no parity}
     port[$3FC] := $02; {Power for interface, RTS (+), DTR (-)}
end;


procedure Send_Five;     {Sends five-byte command, (CMD, FREQ)}

var
   X,Y,BYTE: integer;
   NUMBUF: string[10];  {For the ASCII version of the frequency}

begin
     FREQ := FREQ/1000;
     WRITE(AUX,chr(CMD));   {The first byte...}
     str(FREQ:1:8,NUMBUF);
     for I := 3 to 6 do     {and four more.}
     begin
         delay(10);          {MUST have this delay or radio ignores co
         val(copy(NUMBUF,I,1),X,Y); I := I+1; BYTE := X*16;
         val(copy(NUMBUF,I,1),X,Y); BYTE := BYTE+X;
         write(AUX,chr(BYTE));
     end;
end;


begin              {main}
   Init_RS232;
   if not (port[$3FE] and $30 = 0) then {Check for DSR and CTS}
     begin
     write('Frequency? '); readln(FREQ);
     CMD := 10;   {The command number to set a frequency}
     Send_Five;
     write('Mode? '); readln(MODE);
     FREQ := 0; CMD := 0; {CMD is changed only if mode search is suc
     for I := 1 to 6 do   {Scan ALPHA array for mode match}
     begin
         if MODE = ALPHA[I] then CMD := NUMER[I]; {If mode is found
     end;
     if CMD = 0 then writeln('Mode not found!') else Send_Five;
   end
   else
     writeln('No response from interface. Is it connected?');
end.
```

For those who prefer to program in Pascal rather than BASIC, here's the Pascal version of the previous FRG-9600 program. It performs exactly the same job as SEND9600.BAS.

be zero-point-something) and convert it to an ASCII string of digits. We can then pick off each digit one by one and convert it back to a number. Note that this is being done with ASCII characters for the numbers. It could have been done with numbers only — mathematically — but I found the maths routines caused small errors resulting in occasional incorrect digits.

It is quite inefficient to do the full string conversion for each digit, but the idea is to keep the computer busy between sending its bytes, avoiding the need for an artificial time delay. A dirty trick, but it works.

At line 290 we see that the characters between positions 3 and 10 are going to be plucked from the string. Positions 0, 1, and 2 are ignored because they contain space or a minus sign, a zero, and the decimal point. After that comes the stuff we want — seven digits of frequency data, including leading zeros. There are no trailing zeros, but the conversion back to a number yields a zero even if there is nothing in the string.

Back to line 300: subroutine 340 has produced a digit as an integer X which is now mathematically merged into another variable called BYTE. BYTE has two goes at subroutine 340 and carries two digits by the time it is sent to the radio.

For a frequency of 65.4321 MHz, the final result of all these gyrations is five bytes, in hexadecimal notation: '0A-06-54-32-10'. The last zero cannot be used by the radio, and is ignored.

Now to send a mode: We enter a mode name from the keyboard into string variable MODE$. The program then searches the lookup table for a match for MODE$. It either copies the mode's code number into the variable CMD, or it complains if you've typed in the wrong mode designator.

If the mode is OK, the program then goes into the five-byte subroutine with the mode code in CMD and the FREQ set to zero. The subroutine sends the mode code, and then makes up the other four bytes by converting the zero frequency into bytes of zeros.

Remember there MUST be five bytes, even though the last four are dummies for a mode command. All the dummy string processing makes up the required time delay.

When you're developing a program like this, it is convenient to bypass the RS-232 stuff in the early stages and make the bytes go to the screen instead so you can see what's going on. You can redirect output to the screen by changing PRINT#2 (lines 280 and 310) to a simple PRINT, and use the HEX$ statement to make it display as hexadecimal.

Once everything is working you can get rid of the HEX$ statements, re-establish the PRINT#2's, and try your program with the radio. If it doesn't work, the most likely reason is that your computer is faster than mine and you'll need an artificial time delay. You can bung one in as line 305, just before the PRINT#2. Try 'FOR J=1 to 10: NEXT J'.

SEND9600.PAS

Here we have an FRG-9600 control program in Turbo Pascal, in case you'd prefer to work with this fine language. SEND9600.PAS was written in Turbo Version 3, which must be one of the most elegant languages ever released.

The language is sensible, easy, structured, and comes in a package about 40K long including a built-in WordStar type editor. There are later versions of Turbo Pascal available, but like so much other new software they have become bloated and harder to use. Version 3 will do me.

9-PIN TO 25-PIN RS-232 ADAPTER

LINE	DB-9 Male	DB-25 Female
DCD	1	8
RXD	2	3
TXD	3	2
DTR	4	20
GND	5	7
DSR	6	6
RTS	7	4
CTS	8	5
RI	9	22

If your computer has a 25-pin connector for its RS232 port, here are the connections for a 9-pin adaptor.

The Pascal program is designed to copy its BASIC cousin as much as possible, and it produces the same results using much the same techniques. Unfortunately Turbo Pascal doesn't have the nice interrupt-driven RS-232 capabilities of GWBASIC; instead it uses those nasty old MS-DOS routines.

You would normally initialise the RS-232 using the DOS MODE command before entering Pascal, but I have chosen to attack the serial hardware directly from within the Pascal program. The procedure Init_RS232 sends data to port registers to set the baud rate, data bits, parity, and finally set RTS and DTR to supply power for the interface.

Note that these port addresses apply only to COM1. They will be different for COM2.

If you study the procedure Send_Five, you will see it is a direct Pascal copy of the five-byte subroutine in the BASIC program. We enter the procedure with the command code in CMD and the frequency in FREQ. The procedure does all the conversions and sends the five bytes.

Note, however, that we have had to slip in an artificial time delay, because Turbo Pascal is a lot faster than BASIC. There is a nice Turbo command 'DELAY' just for this purpose. The number after it is the approximate delay length in milliseconds.

Finally we get to the main part of the program, which works just like the BASIC version. But there is one difference — we have included some code to check the 'modem status port' ($3FE) to see if a Data Set (or our hot-wired interface) is connected, before the program is allowed to continue. If the interface isn't there the DOS RS-232 routines hang, and the only way out of it is to re-boot the computer. With BASIC you can exit gracefully with the control-break key combination.

I tried to use Turbo Pascal and its MS-DOS routines to receive serial data, but I couldn't get any sense out of them at all. Most attempts produced either a DOS error message and an immediate exit from Turbo Pascal, or a complete lockup of the computer. After fiddling about with data bits and parity and the like, the routines finally started delivering characters to Pascal when nothing was being sent!

Now the good news: I have stumbled upon a public domain interrupt-driven serial communications package for Turbo Pascal which I have modified to work with the Icom/Yaesu interface.

This package ignores the DOS serial routines and substitutes its own commands for send-character, receive-character, etc. I got a Turbo Pascal program talking back to itself through the looped- back interface, just like in the BASIC interface test above. The package works perfectly under Turbo 3 and I can see no reason why it shouldn't work for versions 4 and 5 as well. The package along with a couple of communications test programs will be included on the disk offered at the end of this article.

FT747.BAS

Here we have a talking/listening program for the popular FT-747 amateur transceiver. This radio is the baby of the Yaesu line, but it's a fairly new design and its computer control capabilities ex-

Using your PC to control radio gear - 3

Using Amiga computers

The radio interfaces described in these articles can be used with Amiga computers in the same way as with IBM compatibles. The Amiga uses a more-or-less standard 25-pin RS-232 port, although the connector also carries sound channel and power connections.

To use the Icom interface with its nine-pin connector, it will be necessary to build a standard 9-to-25 pin adaptor. The Amiga 500 and Amiga 2000 (and older IBM-PC) require a female 25 pin connector; the Amiga 1000 needs a male connector.

Interface power can be drawn from the Amiga's RS-232 port in two ways. To use the RTS and DTR lines for +12 and -12 volts, you must write hexadecimal number '80h' to memory location 'BFD000h' (12570624 decimal).

This sets DTR (bit 7) high and RTS (bit 6) low. These signals are inverted in the hardware so that RTS carries +12 and DTR -12 volts, as required by the interface.

The Amiga 500 and 2000 RS-232 connectors also carry proper power supply lines, fed through 47-ohm resistors so shorts don't cause explosions. Pin 9 is +12 volts and pin 10 is -12 volts.

(The 1000 model offers +12V only.) An adaptor made up in this way is no longer a 'standard' RS-232 9-to-25 pin adaptor, so it should only be used for the radio interface.

RS-232 communication on the Amiga is handled by a UART (universal asynchronous receiver-transmitter) contained within the 8364 custom IC, known as 'Paula' in the Amiga scheme of things.

Data in and out of Paula travels on the microprocessor's normal data bus, so serial communication is totally under software control.

Amiga BASIC, unlike IBM BASIC, seems to ignore the state of the handshaking lines, so it is not necessary to disable them when opening a serial communications channel. BASIC uses a device driver called 'serial.device' for RS-232 communications.

```
REM ============================================================
REM |   Demo control program for Yaesu FRG-9600 VHF Receiver.
REM |   Written in AMIGA BASIC
REM |   Asks for frequency, then mode, then exits.
REM ============================================================

DEFINT n,b,c,x: DIM M$(5), n(5)
FOR i=0 TO 5: READ M$(i), n(i): NEXT i

REM [This is the data for FRG-9600 functions and codes.]
DATA "AM-W",21,"AM-N",20,"LSB",16,"USB",17
DATA "FM-W",23,"FM-N",22

OPEN "COM1:4800,N,8,1" AS #2
POKE 12570624&,&H80: REM Power for interface, RTS (+) and DTR (-)

INPUT "Frequency"; FREQ
CMD=10: GOSUB SendFive
INPUT "Mode"; MODE$
FOR i=0 TO 5: IF MODE$<>M$(i) THEN Again
FREQ=0: CMD=n(i): GOSUB SendFive: END
Again:
  NEXT i: PRINT "Mode not found!": END

REM ============================================================
REM |      Subroutine to send five-byte command, (CMD, FREQ)
REM ============================================================
SendFive:
  FREQ=FREQ/1000
  PRINT#2, CHR$(CMD);
  FOR i=3 TO 10
  GOSUB Digit: BYTE=x*16: i=i+1: GOSUB Digit: BYTE=BYTE+x
  PRINT#2, CHR$(BYTE);
  NEXT i
RETURN

Digit:
  x=VAL(MID$(STR$(FREQ),i,1))
RETURN
```

ceed some of its older (and more expensive) brothers. This is an actual working program, more than just a demonstration, but it's still written for simplicity and ease of understanding.

We will not go through a detailed explanation of FT747.BAS. If you know BASIC programming at all you should be able to follow it through. The program lets you use a menu to exercise the radio's functions, and you can create a disk file of up to 100 channels which can be sent to the radio in any order desired, or sequentially.

(Editor's Note: The FT747.BAS program is unfortunately too long to be included in this article — it would take too much space. We can supply readers with photocopies of the listing Tom supplied via the Reader Information Service, for $5.00, but we understand that in any case he will be providing it on the disk offered below.)

The FT747 data format is as usual different from other Yaesu gear. In the case of function setting there is a 'parameter' byte in addition to the mode code. This is needed so you can send something like the 'clarifier' command, with additional information as to whether the clarifier is to be turned on or off. The data is sent backwards from the previous examples; for a mode command there are three dummy bytes, then the parameter byte, and finally the command code.

The most interesting part of the program begins at line 1820. If you first issue a command known as UPDATE, the FT747 responds with a burst of 345 bytes containing every conceivable piece of information about the radio — including the contents of all its memory channels and VFO's, and the states of its toggles.

The radio has also thoughtfully provided a PACING command that lets you insert time delays between the bytes it sends to you, to avoid outrunning your computer.

In this case we read all 345 bytes into a big array, from where we can retrieve them as we need them. The program displays all this information on the screen in an order different from the order the bytes were received, so we must be able to get at them randomly.

Disk offer

Right, you're on your own now. The only other help I can offer is a disk containing every radio computer control program I have written, or collected from somewhere else.

These include all the examples from this series of articles, as well as programs from other articles I've written for computers such as the IBM-PC, the Microbee, and other CP/M machines. Languages include BASIC, Turbo Pascal, C, and assembler.

The disk is going to cost you $25 posted for 5-1/4" or $23 for 3-1/2" — MS-DOS format only. Please send money order or cheque (no credit cards please) to: High-Tech Tasmania, 39 Pillinger Drive, Fern Tree Tasmania 7054. And don't forget to order your interface kit at the same time! ■

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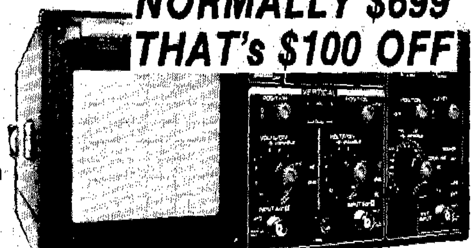

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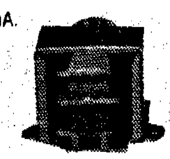

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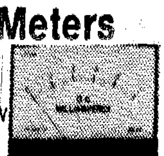

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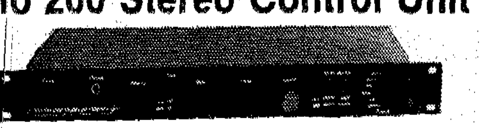

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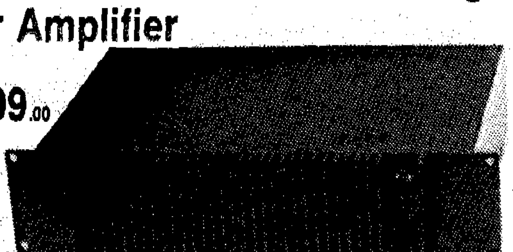

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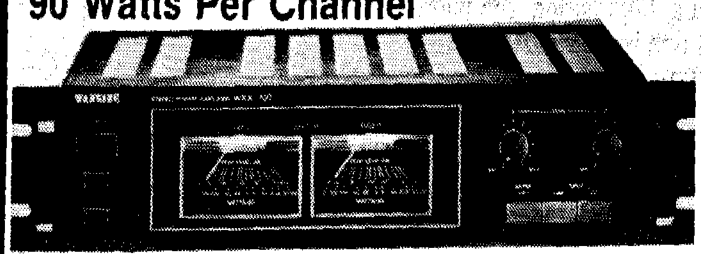

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Construction Project:

The ROMloader, an EPROM Emulator - 2

In this second article describing his EPROM emulator, the author covers making the interconnection cables, setting the emulator up correctly, connecting everything up, software considerations and using the emulator in practice.

by PETER BAXTER

The ROMloader's female DB25 socket J3 allows direct connection to the RS232 communication port of most host computers, such as IBM PCs and their clones. You may need a 1-metre long DB25 female to DB25 male extension cable to connect the two together.

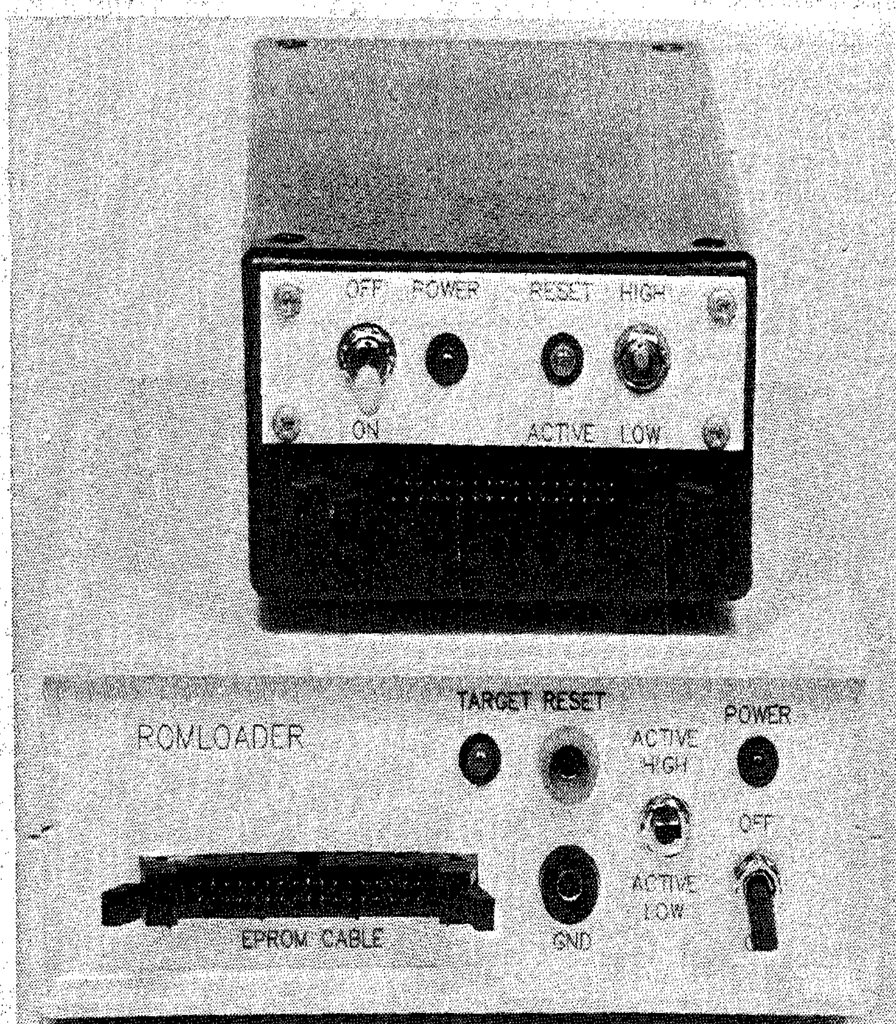
I suggest making this a 25-way flat IDC cable, as it allows easy interconnection of printers, plotters and other serial devices such as the ROMloader, without requiring you to reach around the back of your computer every time.

The ROMloader requires TXD (Transmit Data), RXD (Receive Data), CTS (Clear To Send) and the GND (Ground) connections to be made for proper operation. If you don't have access to a CTS signal, J3/pin 4 should be connected to U4/pin 2 via a 47k resistor. The purpose of the CTS line is discussed further shortly.

While the ROMloader doesn't need to output an RTS signal (Ready To Send), the RTS line may still be tested by the host computer, therefore it is tied low. Some computers may also require other pins to be connected. Consult your computer's technical manual.

Power to the ROMloader is provided by a standard DC plug pack supply, connected to the DC power input socket of the unit (J6). The current consumption using 74HC devices is 250mA, and 350mA using 74LS devices. Therefore a plug pack with a 7.5 volt or 9 volt setting, rated at 300mA for 74HC or 500mA for 74LS is ideal. The less power dissipated in the LM7805 regulator the better.

The header at the other end of the ROMloader's box (J4) takes an IDC socket, for a cable and DIL plug to connect into the target system under development. The board has been designed to accept header connectors of different pin counts for J4. If the system will only be emulating 24-pin EPROMs, a 26-pin header can be used.



If 28-pin EPROMs are being emulated, a 30-pin header can be used. The maximum size is 34 pins. Try to get one with eject levers, if possible (Altronics sells one).

The cable associated with this header, the 'EPROM' cable, should be made by crimping the appropriate mating IDC socket onto the ROM-loader end. Using a strain relief bracket is also highly recommended. The cable should be no longer than 300mm. The appropriate 24-pin or 28-pin DIL IDC 'EPROM' plug is crimped onto the other end.

Note that the EPROM cable is 'bottom justified' at the ROMloader socket end. That is, the cable is always 'pushed' towards the pin 34 end, with any blank pins at the pin 1 end. So with a 24-pin EPROM plug, pins 1-10 of the 34-way socket will be left unconnected, while for a 28-pin EPROM plug it will be pins 1-6 of the socket that are unconnected.

Note too that the connectors are attached to the cable so that the 'pin 1' end of the EPROM plug is on the *other* side of the cable from the 'pin 34' end of the ROMloader socket. These points should be clear from the photo given in the first article.

The ROMloader has been designed to emulate standard Intel 2716, 2732 and 2764 devices. Should you need to work with an EPROM that is not pin compatible with these types, simply modify the 'EPROM' cable to suit the special device. To protect the pins of the 'EPROM' IDC plug and to allow easier insertion and removal, I suggest that you stack three machined-pin 24- or 28-pin IC sockets onto this plug as shown in the photo. Not only do the machined pins plug into EPROM sockets more easily, but the three-high stacking makes it easier to get into tight spaces.

By the way if you fit your cable with a 28-pin EPROM plug, this can also be plugged into 24-pin EPROM sockets, if you use three stacked 24-pin sockets as an adaptor. A second cable with a 24-pin plug isn't really necessary.

To connect the ROMloader to the target system, remove that system's EPROM from its socket. Plug the 'EPROM' cable from the ROMloader into this socket, ensuring that pin 1 is orientated correctly.

The 'Target Reset' cable from J7 on the ROMloader should also be connected to the target system's micro-processor reset line. If your target microprocessor needs an active low reset, set the 'Target Reset' polarity switch (SW3) to active low — vice-versa for active high. To use the ROMloader with an 8032 microcomputer, the reset line would need to be set 'active high'; for a Z80, 'active low'.

A ground cable (J8) is also provided should you need it. It is best to connect it to a good ground point on the target system such as the main power supply ground, or the EPROM socket's ground pin (pin 12 or 14).

Host computer software

The host computer that is used to assemble the source code must be able to communicate serially with the ROMloader.

Apart from it requiring a serial communications port, you will need a serial communications software program. Programs that work with modems, such as Procomm, Procomm Plus, Telix, Crosstalk and Mirror to name a few, are ideal for the task.

Many of these are shareware, which means that after you obtain the program, use it and decide you like it, you are requested to pay a registration fee to the program's writer. I can supply you with Procomm, but it is up to you to pay the registration fee to Procomm as discussed in its registration file.

The communication program used with the ROMloader needs to be set up for optimum performance. This is obtained at 19200bps, 8 bits, no parity with RTS/CTS or XON/XOFF handshaking enabled and no alterations to any ASCII characters (i.e., CR is CR only, not CR/LF).

It is also desirable to reduce any timeout delays to zero, to speed up screen operations. These delays are for modem telephone operations, such as waiting for dial tone and hanging up delays.

ROMloader setup

Start by setting the baud rate DIP switches SW1-1 and SW1-2, to the fastest possible speed. When one computer sends data to another, a situation can occur whereby the one sending is too fast for the one that is receiving.

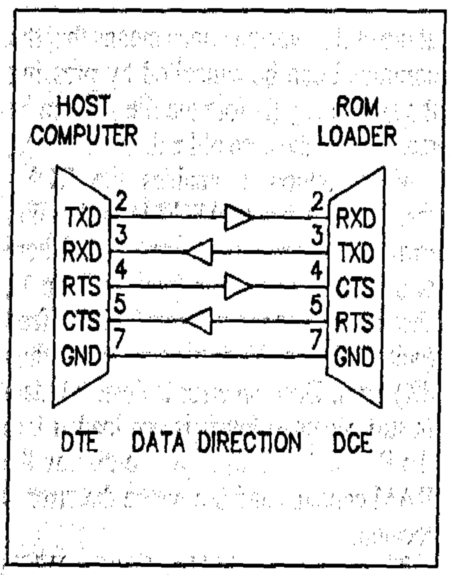


Fig.1: The connections for the cable used to connect the ROMloader to the RS232 serial port of a host computer.

The computer receiving the data needs to send a signal back to the one sending to tell it to slow down. This exchange is called handshaking. There are two types of handshaking. Hardware and software.

Hardware handshaking requires another set of wires in addition to TXD and RXD. In the RS232 environment, the RTS and CTS wires are usually used. Data is transmitted out of one computer on its TXD pin and received by the other on its RXD pin.

When the receiving computer can't process the received data fast enough, it de-activates its RTS output pin. The transmitting computer receives this signal on its CTS input pin, and stops transmitting. When the receiving computer is ready to receive data again, it re-activates its RTS output which starts transmission again.

The ROMloader has this type of hardware handshaking available. In this application, it is preferable over software handshaking because it is fast and efficient. The appropriate connections for the host computer (as DTE) and the ROM-loader (as DCE) are shown in Fig.1.

Software handshaking only requires the TXD and RXD wires. When data is being received too fast, the receiving computer sends an special ASCII character back to the transmitting computer on the other wire. Then when it is able to accept data again, it sends another special character.

This kind of handshaking is called XON/XOFF. You have probably used it without knowing it. When data is being displayed on the screen too fast for you to read, typing 'control-S' freezes the display. When control-S (actually it should be control-Q) is typed again, the screen starts scrolling.

The ROMloader also works with XON/XOFF. In fact most people will be forced to use XON/XOFF instead of CTS/RTS, as most communications software programs working with modems treat RTS/CTS differently. RS232 can be very tricky!

What happens if *no* handshaking is available? One of the ROMloader's commands (option 7), displays the RAM's contents on the screen in the usual 'hex dump' format. At 19200bps and possibly 9600bps, the screen may break up and characters may be lost.

This happens as the computer monitor retraces its beam from the right hand side of the screen to the left hand side, after a carriage return/line feed. When this happens, either the baud rate will need to be reduced, which is undesirable, or the ROMloader will have to add 'padding' characters.

Pad characters are a set number of ASCII 'null' codes (00Hex), sent immediately after carriage return/line feeds, to allow the CRT beam time to fully retrace before the next line of text is sent. Obviously sending this padding data is inefficient, but sometimes you have no choice.

The ROMloader is set to provide padding characters using DIP switches SW1-3 and SW1-4. These should be set for the minimum number of pad characters required for satisfactory operation. Start at 0, then try 50, 100 and finally 150 pad characters.

Finally, switch SW1-5 sets up the default EPROM type. If this switch is open, the ROMloader will initialise to 2716 mode and if closed, 2732/2764 mode. Most users will set the mode according to the EPROM type they use most of the time.

ROMloader - 2

A software option is also available (press '0'), that changes the mode without requiring access to the PCB DIP switch. Some people may also choose to install a switch on the outside of the box for this option.

```
ROMLOADER
===========          (2716 MODE)
1) SEND TO ROMLOADER - ASCII - INTEL HEX FORMAT (ESC)
2) SEND TO ROMLOADER - ASCII - MOTOROLA HEX FORMAT (ESC)
3) SEND TO ROMLOADER - XMODEM - BINARY FILE (ESC)
4) RECEIVE FROM ROMLOADER - XMODEM - BINARY FILE (ESC)
5) STOP (HOLD - RESET) EXTERNAL COMPUTER
6) START EXTERNAL COMPUTER
7) DISPLAY RAM CONTENTS (XON-^Q/XOFF-^S ESC)
8) FILL RAM WITH FF-HEX
9) FILL RAM WITH 00-HEX
0) CHANGE MODE - 2716 MODE OR 2732-2764 MODE

ENTER OPTION:-
```

Fig.2: The ROMloader's main menu, which is displayed on the host computer's screen when the unit first powers up and finishes its internal RAM test. As you can see, there are a number of available options.

Operation

When using the ROMloader, there are two modes of host computer operation. The first is Terminal mode, whereby any character received from the ROMloader is displayed on the host computer screen and any key pressed on the host computer is sent directly to the ROMloader.

This is the standard 'menu' mode. When in menu mode, once a file transfer is selected, we go into the second mode, which is 'file transfer' mode. There are three types of file transfer within this mode.

The first type is ASCII file transfer, using *Intel* Hex format. Most assemblers provide output in Intel Hex format, which is a text file. File transfer is the same as for any text file. Most people will use this format.

The second type of file transfer is ASCII file transfer using *Motorola* Hex format, which is also a text file. Motorola Hex is not compatible with Intel Hex, but their formats are close.

The third type of file transfer is Xmodem format. Xmodem was the most popular transfer protocol in the early days of CP/M personal computers. It is definitely not the best, but its simplicity and popularity have kept it supported by virtually all communication programs.

Xmodem is for binary files, which means that any type of file can be sent — such as programs, text and straight data. File transfers in ASCII can only handle text, as communication programs respond to hidden control codes such as XON/XOFF, and also like to put a CR/LF combination on lines longer than 80 or 144 characters.

An excellent book that I can recommend is *C Programmers Guide to Serial Communications*, by Joe Campbell (Howard W Sams 22584).

Once the ROMloader has been connected and the serial communications program is running, operation can begin.

Immediately after power up, the first message on the screen indicates whether the ROMloader's internal RAM test was good or bad. This test checks for both address and data line problems. If there is an error, it must be solved first for proper operation.

Next, the ROMloader will display its main menu (see Fig.2). The '(ESC)' at the end of various lines means that the command can be cancelled by pressing the escape key (before the file starts to be received, in the case of load commands).

Menu option 1 enables the ROMloader to receive an ASCII Intel Hex file. Error messages will be displayed if there is a record type error (neither 0 or 1), checksum, carriage return/line feed (neither CR or LF) or file size (larger than 8K) error. Once an error is detected, data is still accepted but it is not loaded into the RAM. This allows you to display the RAM contents and see where the error is located.

There is also a hidden feature. While waiting at the 'ENTER OPTION:' prompt, should a colon ':' be received, option 1 will automatically be activated — reducing the number of keystrokes required. This colon ':', indicates the start of an Intel Hex file.

Option 2 is very similar to option 1, but loads Motorola Hex files. The error messages are the same, except that the record type error message will be displayed if anything other than S1 or S9 is received. That specific text line will not be loaded.

Again an automatic load feature is available, when the ROMloader receives an 'S'. This 'S' indicates the start of a Motorola Hex file.

Option 3 enables reception of an Xmodem binary file. There is no checksum error message, as Xmodem will resend any data frame if there is an error. There is however a file size error message. There is no automatic load function as the Xmodem process is different. The escape option is also available.

Option 4 allows the ROMloader's RAM contents to be transferred back to the host computer in Xmodem format, where it can be saved to disk.

To keep the file size small, the RAM at power up (and after function 8 or 9 has been selected) is filled with FF-hex or 00-hex and a software subroutine searches downwards to find the last modified (non FF-hex or 00-hex) address. Therefore the transferred file is only as large as need be. Again, the escape option is available.

The option to retrieve the file in Intel Hex or Motorola Hex is not available, as it would need pointless reprocessing before it is readable. Except when option 6 is selected, option 5 is always active. The target system's microprocessor is held in a reset state and the 8032 has access to the ROMloader's RAM. The ROMloader's LED will be on when reset is active.

Option 6 is used to start the target processor once a file has been loaded. This also switches RAM access from the 8032 to the external target system. The reset line is de-activated, which allows the target microprocessor to execute instructions. The ROMloader's LED will now go off.

Option 7 displays the ROMloader's RAM contents in the standard memory dump format. In 2716 mode, only 2K of RAM will be displayed. Typing 'Control-S' freezes the display. Typing 'Control-S' again or 'Control-Q' starts the display scrolling again. As most host computers will have a serial input buffer, there will be a delay between typing 'Control-S' and the display freezing.

Pressing escape will return you to the main menu. Option 8 fills all locations in the ROMloader's RAM with FF-hex, while option 9 fills all locations with 00-hex.

Finally option 0 changes the mode from 2716 to 2732/2764 mode. The current active mode is displayed next to the menu heading.

Continued on page 98

Construction Project:

SOLAR CHARGER

Free power! Use the sun, even on cloudy days to keep a 12V battery charged. Or use it to charge NiCad battery packs, perhaps the one in your camping light — charge it all day, ready for the night time. And all this for around $20.

by PETER PHILLIPS

This project comes from the people at Oatley Electronics, who originally designed it as a solar charger for the fluorescent light wand published in November 1991. But as it turns out, the solar charger can also be used with a wide range of batteries, including a 12V lead-acid battery.

Boat owners are likely to be specially interested, as the unit can be used to maintain the charge on a boat battery. This may help reduce the number of times a flat battery has to be lugged home for charging, particularly if the bilge pump has been running for more than the usual period.

But perhaps you're wondering why all the electronics. Why not simply connect a solar panel directly to the battery? The answer can be obtained from the graphs of Fig.1, which show the power delivered by the 6V solar panel specified for this project to different voltage batteries.

There are three possible connections: solar panel direct to the battery, battery connected to the B+ and B- terminals of the DC-DC converter, or to the B+ and ground terminals of the converter. These graphs were derived from measurements taken in winter at 9 o'clock in the morning, and similar measurements taken in October around midday give nearly twice the power input. Therefore these graphs can be taken as worst-case figures.

As you can see from the curves, if the 6V solar panel is connected directly to a pack of four NiCad cells (nominal 4.8V), nearly 500mW of power is transferred to the battery. This drops to around 450mW for a 6V lead-acid battery and 400mW for a pack of three NiCad cells. A set of six NiCads will receive around 300mW of charge power, and higher voltage batteries receive very little charge.

When the DC-DC converter is used and the battery connected to the B+ and B- terminals, the power transfer is more constant, averaging over 350mW. But the significant feature is that virtually any battery from 5V to 12V can be charged — all from a 6V solar panel.

If a 12V battery is connected from the B+ and earth terminals of the converter, the power transfer is increased to about 400mW. In other words, by using the most appropriate connection, batteries with voltages ranging from 3.6V to over 12V can be charged using a 6V solar panel.

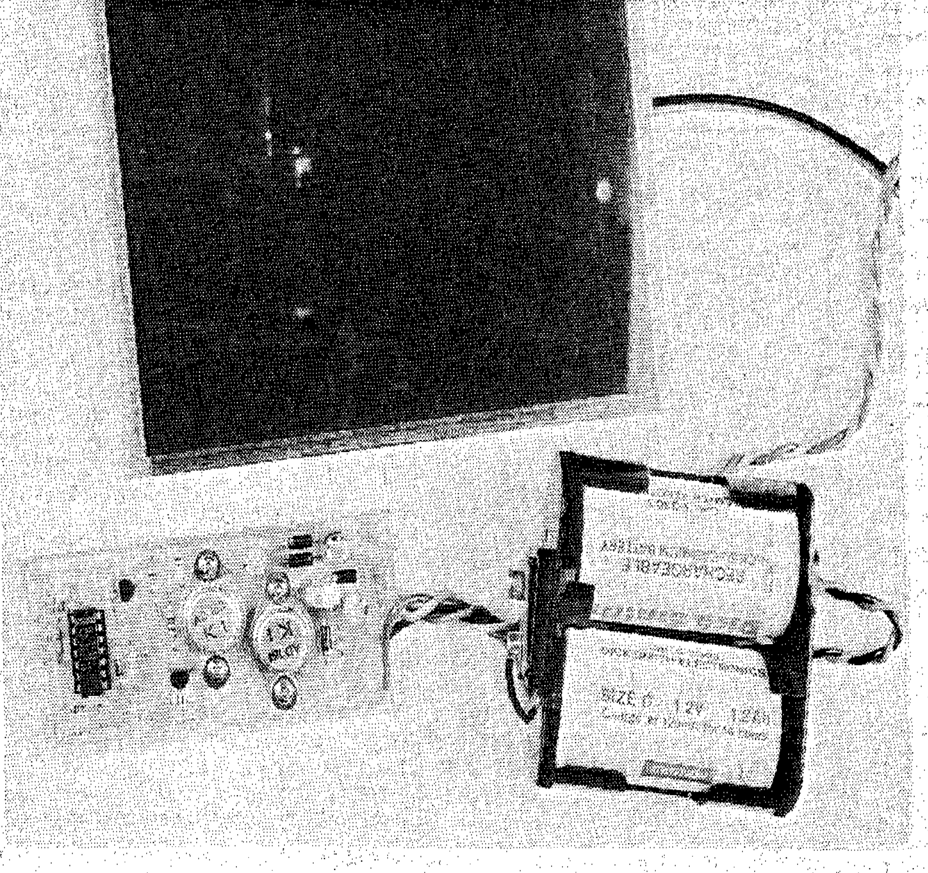
Although the graphs don't show it, the converter unit also ensures that charging is maintained all day, even under cloudy conditions. As already mentioned, these graphs are for a cloudy morning in the middle of winter, and given a warm spring day, nearly double the power transfer is obtained. So while the charge current will fall as the sunlight becomes weaker, the percentage change will be less than for a direct connection.

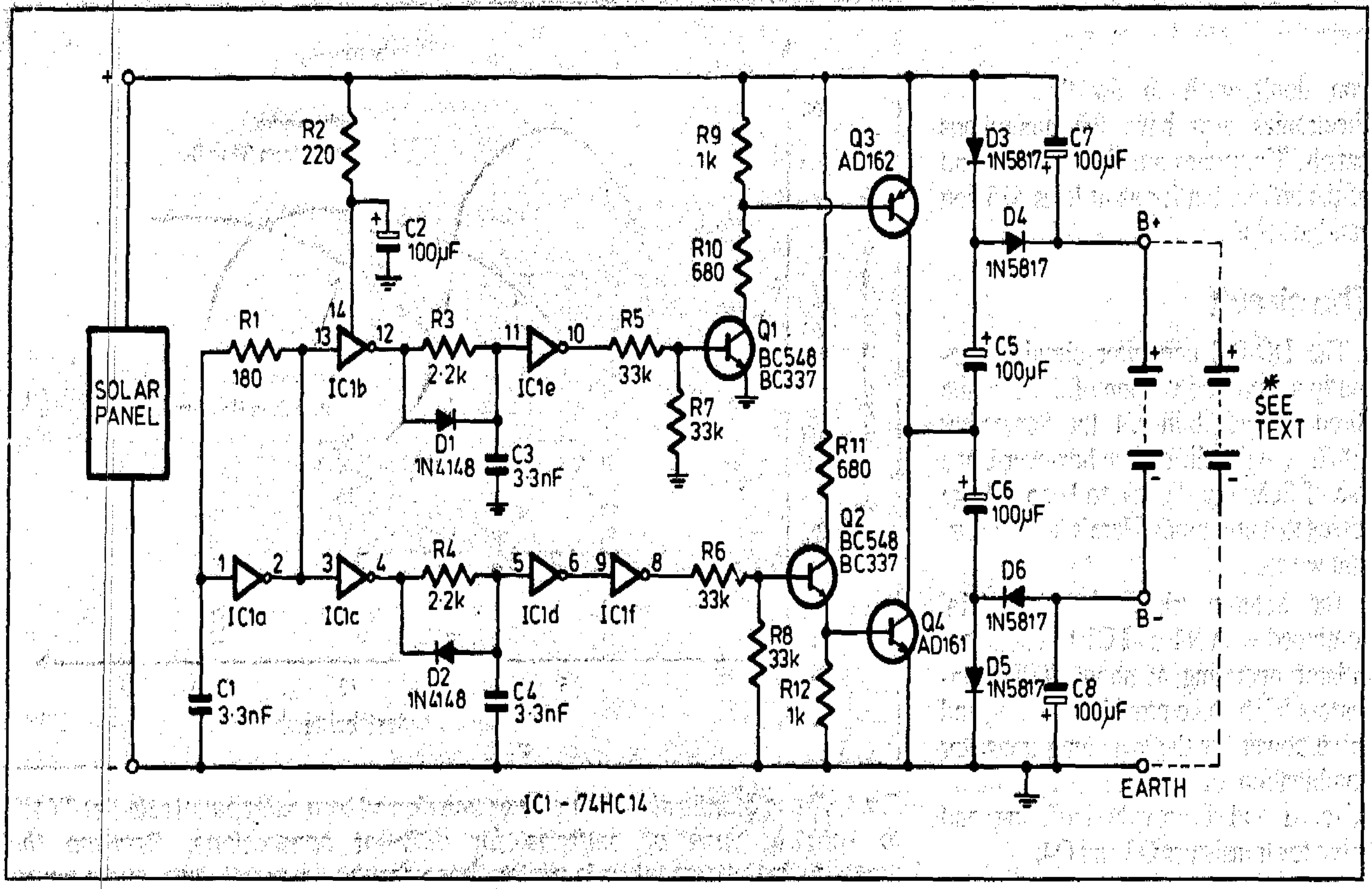
Of course, a 12V solar panel can also be used to directly charge a 12V battery, but the cost of the solar panel becomes substantial. As well, charging will only occur under good sunlight conditions, so on average the efficiency will be less compared to using the inverter.

So from all this, you can see that the DC-DC converter part of this project ensures the best overall efficiency, allows virtually any battery (up to 12V) to be charged, and keeps the cost to an absolute minimum.

Solar cells

Before we describe the project, first a few lines about solar cells, in particular their rating. Solar cells and panels are produced by a range of manufacturers and the standards used to rate them are rather loose. One method is to rate the





The circuit consists of a 400Hz oscillator around IC1a which switches the germanium output transistors Q3 and Q4. These transistors supply two charge pumps, which together give an output up to four times the input voltage. A 12V battery is best connected as shown by the dotted connection.

power using the open circuit voltage and the short circuit current. Obviously, this is a mathematical impossibility, because the two can't occur at the same time. Fortunately most manufacturers give more useful values.

As the graph of Fig.2 shows, for measurements taken in winter, the solar panel used in this project delivers about 500mW at a load current of 100mA. Under brighter conditions, this power will rise to over 1W. The manufacturer of the panel takes the better figure and rates the panel at 1W. Therefore the sunlight conditions have a lot to do with the power rating, and obviously the manufacturer's rating is the best possible.

The open circuit voltage of the solar panel is a nominal 9V, but maximum power is obtained at a voltage around 5V to 6V. The short circuit current (during winter) is 130mA, but maximum power is transferred for a load current of 100mA. Therefore, the values of the open circuit voltage and the short circuit current give a guide, but cannot be used directly.

An individual solar cell has an open circuit voltage of 0.44V, regardless of its surface area. The area determines the current capability and higher voltages are obtained by connecting cells in series. Using an approximation, if you assume a loaded voltage output of 0.4V per cell, the operating voltage of the solar panel under maximum power transfer conditions can be determined more accurately.

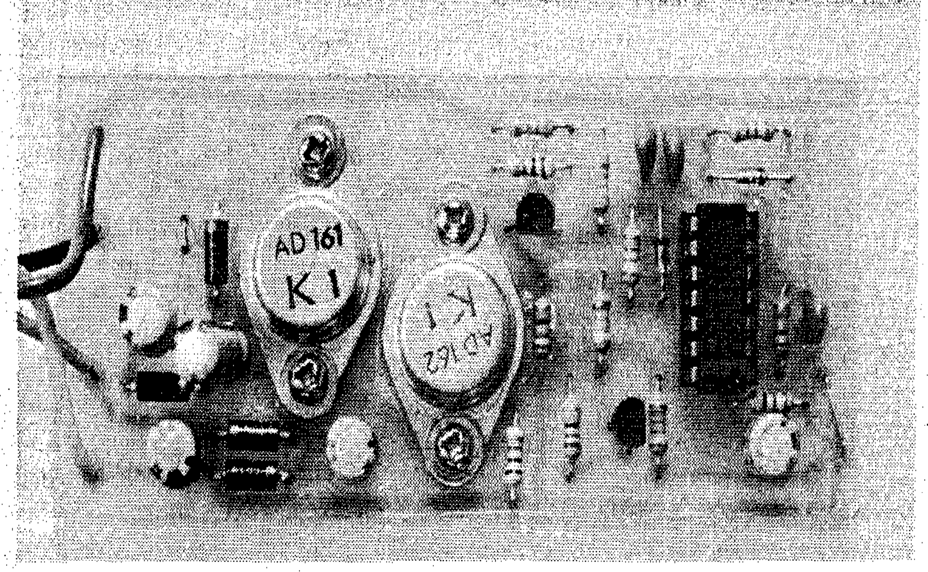
In Fig.2, the panel has 14 series connected sections and using the figure of 0.4V per section, an operating voltage of 5.6V is obtained. This represents an average value for a range of sunlight conditions, and is less in winter, higher in summer. Obviously the output voltage will drop to zero as the load approaches a short circuit, but this calculated value is reasonably accurate for best power transfer conditions.

Solar cells are readily available in two forms, the *amorphous* type and the so-called 'photovoltaic' type. Actually, the term photovoltaic applies to both, as this refers to the family of devices, but it seems to have stuck to one type of solar cell. Solar cells are made from silicon and the amorphous type has the silicon layer coated onto glass, with the rear of the cell protected with a clear laminate.

The 'photovoltaic' solar cell is a monocrystalline silicon wafer and needs to be protected by placing it behind glass as it is fairly brittle. The amorphous type is more expensive, but has the advantage of being 'ready to go'.

However, if you can obtain offcuts of the solid silicon type, it's possible to construct your own solar panel to suit your needs.

Oatley Electronics have suitable offcuts and we'll explain later how to make up your own solar panel using these. If



This shot shows the printed circuit board. The output transistors should be fixed to the PCB with machine screws, nuts and shakeproof washers.

Solar charger

you don't wish to do this, Oatley Electronics also have the amorphous panels. The prices are shown at the end of the article, but for as little as $16 you can 'go solar'.

The circuit

The DC-DC converter circuit is actually a modified version of the Satellite Siren published in *EA* for September 1987. A major difference however is the use of Schottky diodes, to keep voltage losses to a minimum. Here's how the circuit works.

The Schmitt trigger inverter IC1a, combined with R1 and C1 forms an oscillator operating at about 400Hz. Inverters IC1b and e provide buffering and drive power for the switching transistor combination of Q1 and Q3. Similarly IC1c, d and f provide buffering and drive for transistors Q2 and Q4.

The network consisting of D1, R3 and C3 delays the turn-on time of Q1 (and Q3) and D2, R4 and C4 delay the turn-off time of Q2 and Q4. This ensures that output transistors Q3 and Q4 are never on together, giving minimum power dissipation and the best operating efficiency. It also eliminates the possibility of thermal runaway of these transistors.

Germanium transistors have been used for the output devices, as these have a very low saturation voltage and their current gain remains relatively constant over the full operating cycle. Silicon transistors are *not* suitable as replacements.

The AC output voltage developed by the circuit is applied to two individual 'charge pump' rectifier circuits. The pump consisting of D3, D4, C5 and C7 raises the voltage at the positive output terminal (B+) above that of the positive input from the solar cell. The charge pump of D5, D6, C6 and C8 lowers the voltage at the negative output terminal (B-) by a similar amount. The combined effect is an output voltage between the B+ and B- terminals that is up to four times higher than the input voltage from the solar panel.

Power for the circuit is derived from the solar panel itself, and by using a 74HC14 for IC1 the power consumption is kept to a minimum. As already mentioned, Schottky diodes are used in the charge pump sections to reduce the voltage drop. Schottky diodes have a voltage drop of about 0.25V compared to the higher 0.6V for a silicon diode, and this together with the use of germanium transistors for Q3 and Q4 gives a considerable reduction in losses.

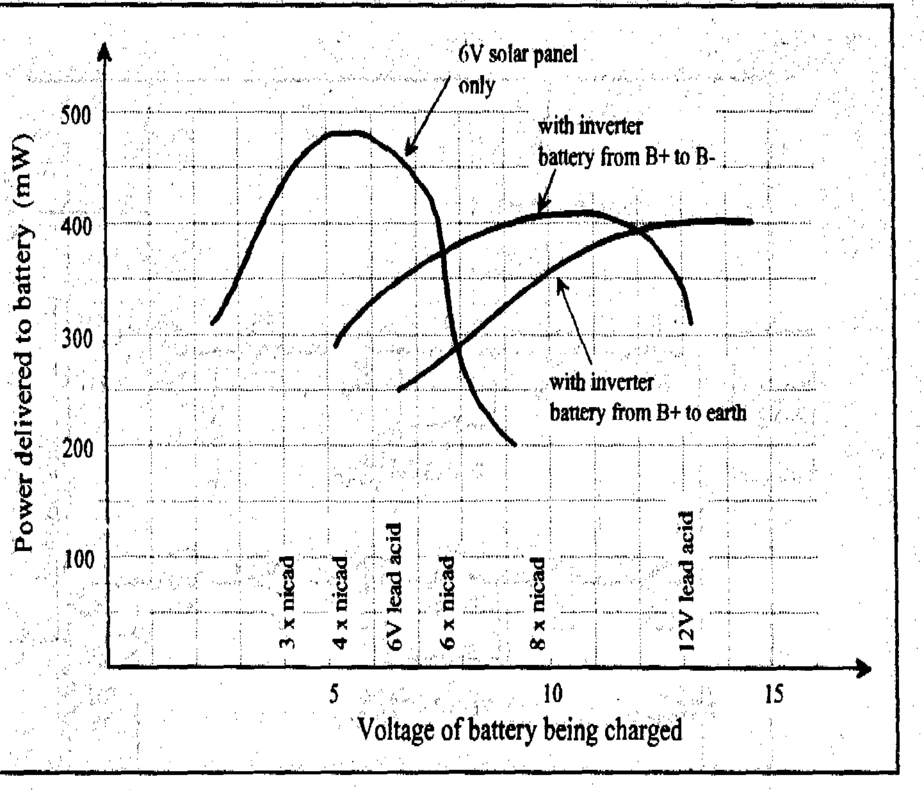
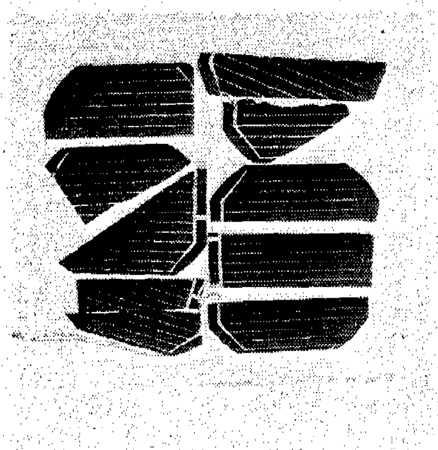


Fig.1: These graphs show the power transferred by a solar panel rated at 6V 1W to various types of batteries for different connections. Because the measurements were taken in winter, these graphs are worst case, and a power of over 1W can be expected in summer.



The amorphous type solar panel for the project is shown in this photo. The panel is rated at 6V, with a maximum power output of 1W.

Construction

A kit of parts for this project is available from Oatley Electronics (see end of article). Everything is contained on the PCB, and construction is simply a matter of fitting and soldering all the components as shown in the layout diagram.

As usual, watch the orientation of the diodes, transistors and the electrolytic capacitors. Also secure the two output transistors with machine screws, nuts and shakeproof washers before soldering their base and emitter terminals.

In some cases, the PCB supplied by Oatley Electronics may be slightly different to that shown in the layout diagram. Details will be supplied by Oatley Electronics.

You may want to fit the board inside a box, depending on your intended use of the project. In most cases, the enclosure should be weatherproof as the project is intended for outdoor use unless you place it behind a window. Alternatively, the solar cell panel can be connected with long leads and the converter section located indoors.

When the board is assembled it can be checked by applying a DC input of around 6V. The current consumption should be around 20mA and the unloaded output voltage about 21V or so. If you connect a 1k resistor as a load to the circuit, the voltage will drop (to 20V on the prototype, giving a load current of 20mA).

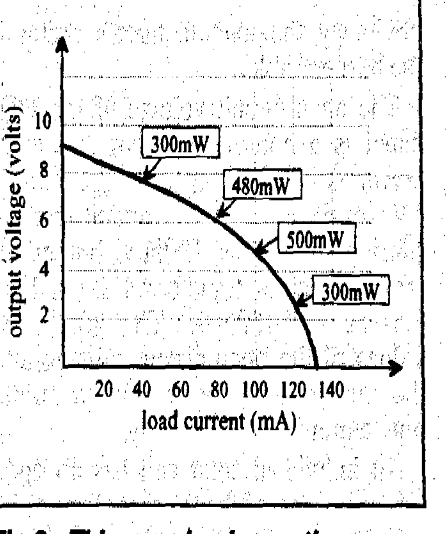


Fig.2: This graph shows the power transfer of a 6V 1W solar cell varies for different load currents. Notice how the test power transfer occurs at a load current of 100mA. As for Fig.11, the measurements were taken in winter, so expect twice the power in summer.

PARTS LIST

Resistors

All 1/4W, 5% unless otherwise stated:

R1	180 ohm
R2	22 ohm
R3,4	2.2k
R5-8	33k
R9,12	1k
R10,11	680 ohm

Capacitors

C1,3,4	3.3nF ceramic
C2,5-8	100uF electrolytic

Semiconductors

D1,2	1N4148 signal diode
D3-6	1N5817 Shottky diode
IC1	74HC14 Schmitt inverter
Q1,2	1N4148 or BC337 NPN transistor
Q3	AD162 germanium PNP
Q4	AD161 germanium NPN

Miscellaneous

6V, 1W solar panel or to suit;
PCB 102mm x 50mm;
hook up wire.

Kits of parts for this project are available from:

Oatley Electronics
5 Lansdowne Parade,
Oatley West, NSW 2223.
Phone (02) 579 4985
Postal address (mail orders);
PO Box 89, Oatley West NSW 2223.

6V, 1W amorphous solar panel	$14.00
Photovoltaic solar cell offcuts, enough to make a 6V/1.5W panel	$7.00
PCB and all components for converter (limited stocks)	$8.00
All semiconductors for converter	$4.50
Post and pack charges	$3.00

The input current under this condition will increase to about 140mA.

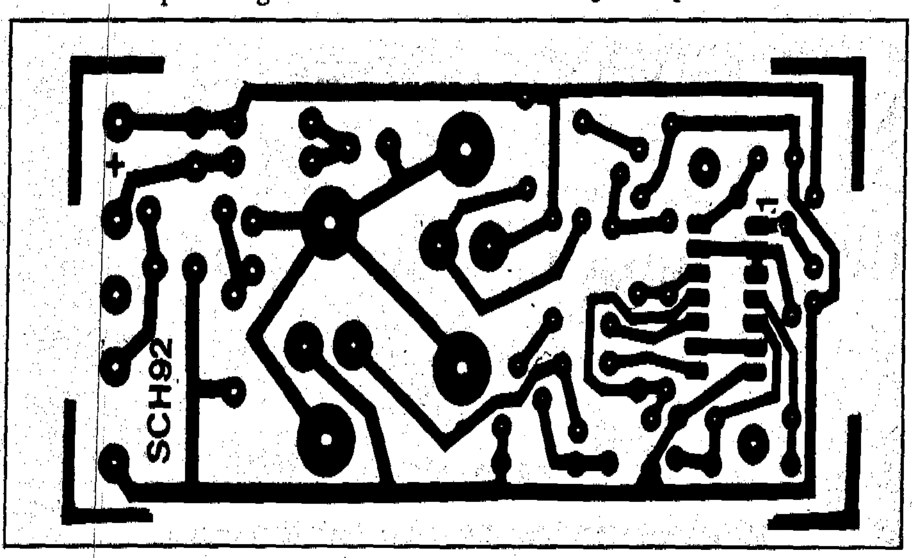
The solar panel

As already mentioned, Oatley Electronics have offcuts of the 'solid silicon' type of solar cell (photovoltaic type), which can be interconnected to give a complete solar 'battery'.

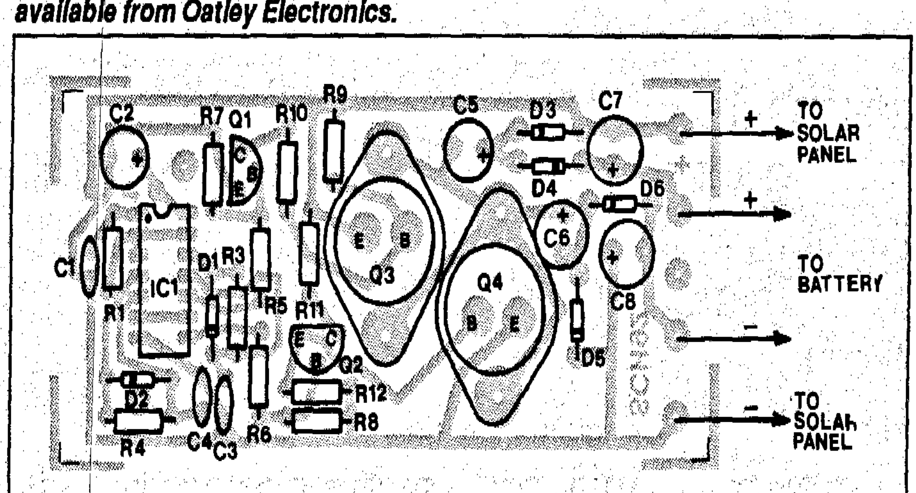
Cells are connected in series to increase the output voltage and connected in parallel to increase the output current. Ideally, all cells should have much the same area — as the smallest cell will determine the maximum output current. To connect the cells, one wire is soldered to the common track on the top of the cell and another to the already tinned reverse side. A series connection is obtained by joining the top of one cell to the bottom of the next, and so on. Connecting the tops and the bottoms of two cells will give the parallel connection.

To solder the wires, first tin the wire then place it in contact with a suitable track on the cell front or anywhere on the reverse side. Apply the soldering iron quickly to complete the connection. Because they are already tinned, you don't need to tin the solder points on the solar cell before soldering. Naturally you should perform the soldering task as quickly as possible, to avoid cell damage.

When you've connected the desired number of cells, the complete unit should be housed under glass. In the prototype, the interconnected cells were sandwiched between two plates of glass and the glass plates glued together (and sealed) with silicone glue. The resulting panel will be quite strong and ready for work. The amorphous panel won't require any additional construction and can be connected directly to the converter.



The PCB layout, if you want to make your own. Ready-made boards are also available from Oatley Electronics.



The layout for the converter PCB. Boards supplied by Oatley Electronics may be slightly different, requiring two links to be fitted.

Using the charger

To use the solar charger, simply connect it to the battery being charged using Fig.1 as a guide to determine the best connection. If you intend charging a 12V battery, connect the battery between the B+ terminal and the earth terminal (solar panel negative terminal) of the converter.

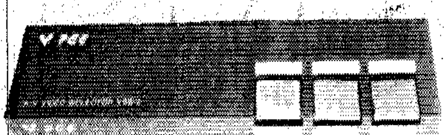
The charge power to a 12V battery will vary between 400mW and 1W, giving a charge current ranging from 30mA to over 80mA. This current will at least maintain the charge of the battery or slowly charge it, depending on the sunlight conditions. This will be particularly useful if the battery is left unattended for long periods, as all batteries lose charge over a period of time.

Typical applications are for boat owners, campers or anywhere requiring a 12V battery to at least be kept fresh and ready for action. If you want to take the unit with you on your next bush hike, we recommend making some type of timber enclosure for the amorphous solar panel, as it is relatively fragile.

The unit can also be used to charge NiCad cells, and a set of six NiCads will be charged at between 50mA to 100mA. At this rate, a set of AA cells will be fully charged after 12 to 14 hours. Use the graphs of Fig.1 to determine the charge current for other battery voltages, where current equals power/voltage.

So there it is, probably the cheapest solar charger project ever published. The power itself comes free of charge, and is available whenever and wherever the sun shines. ❖

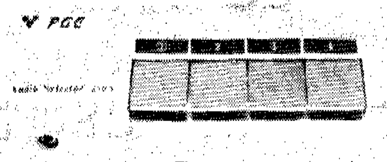
VIDEO SWITCH BOX NEW



If your TV has not got enough inputs, then this switch will solve your problems. Most TVs have only one set of inputs. It becomes difficult when you purchase a second VCR or a TV game or a laser disc, etc. How do you connect 2 or more components into one socket? This switch will solve that problem. It has 3 inputs and one output to the TV. All connections are via RCA plugs and each input has 3, one for video and two for audio (L and R). Once wired, all components can be left wired in permanently. The switch requires no power lead for connection from the video switch box and TV is supplied (3RCA - 3 RCA). Size 193(L) x 46(D) x 28(H)mm.

Cat AC-1662 **$49.95**

AUDIO SWITCH BOX NEW



If your amplifier has not got enough inputs, then this switch will solve your problems. There are many components available now for HiFi systems including tuner, cassette deck or 2, VCR, CD player Stereo TV, DAT, laser disk etc.. Most amplifiers don't have enough inputs. This audio switch box has 3 sets of RCA sockets on the rear for any three of the above, and one set for the output to the amp. This output lead is supplied with the switch (2 RCA to 2RCA plugs). There is more input on the switch and its for a walkman. So, now you can play your walkman through your Hi Fi stereo with a minimum of fuss. The connection lead for this is also supplied (3.5m plug to 3.5m plug - stereo). The selector switch has push buttons and once the unit is wired up, all components can be left connected. Requires no power. Size 138(L) x 29(H) x 39 (D)mm.

Cat AC-1660 **$49.95**

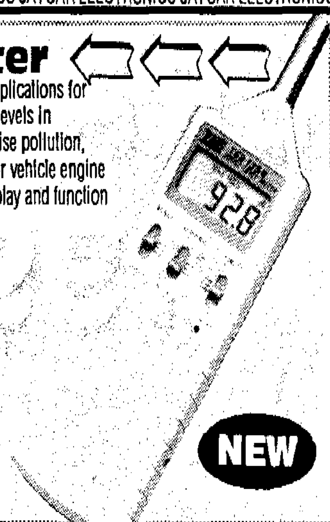
Digital Sound Level Meter

This quality sound level meter is made by TES and has many practical applications for professional an home use. These applications include measuring noise levels in factories, schools, auditoriums and home HiFi applications as well as noise pollution, soundmakers including car alarm sirens, home burglar alarm bells, motor vehicle engine noise levels etc. The precisely calibrated meter features a large LCD display and function sign and unit indicator for instant measurements anywhere.

FEATURES: • Maximum level hold • Over and under range indicator • Pocket size and lightweight • AC and DC signal output for data analysis and recording • Internal oscillation system for calibration • A and C weightings for checking in compliance with safety regulations as well as acoustic analysis • Fast and slow dynamic response settings to check peak and average noise levels • Includes quality case

See 1992 catalogue for full specifications or call into any Jaycar store.

Cat QM-1850 **$239.50**



NEW

'METEX' END OF MODEL RUN OUT SALE

Model 3650

3.5 Digit display frequency capacitance transistor test, 20 amp current, carry case. Cat QM-1555

Normally $129.50
Now $109.50
Less 15% **$93.08**

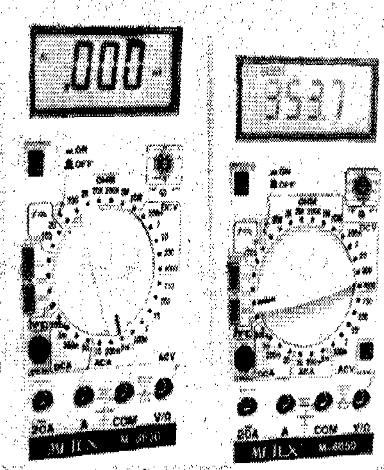
SAVE $36.42

Model 4650

4.5 Digit, frequency, transistor test, capacitance, data hold, 20 amp current, carry case.
Cat QM-1560

Normally $189.00
Now $169.00
Less 15% **$143.65**

SAVE $45.35



15% OFF EVERYTHING

CELLULAR PHONE BATTERIES & BATTERY ELIMINATORS

Battery Eliminators When you are in your car, use your cars power and save your telephones batteries. Simply slide the battery pack out of the phone and replace it with the Eliminator. It has a curly cord attached with a cigarette lighter plug.

Batteries Why not keep a 2nd battery charged up for your cellular phone. You just don't know when you may need it.

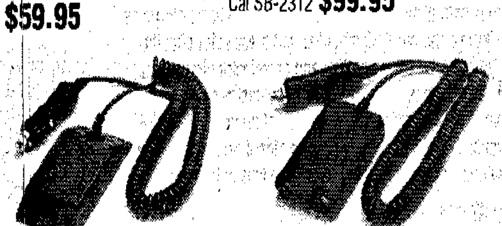
NEC P300 SERIES
Battery Eliminator
Cat MP-3116 **$59.95**
Battery Pack (6V 700mA)
Cat SB-2316 **$79.95**

MOTOROLA 9800/9500 XL
Battery Eliminator Cat MP-3114 **$59.95**
Battery Pack Cat SB-2314 **$89.95**

NEW

NOVATEL PTR-800 SERIES
Battery Eliminator
Cat MP-3112 **$59.95**
Battery Pack
Cat SB-2312 **$99.95**

MOTOROLA MICRO TAC PT 500 FLIP
Battery Eliminator
Cat MP-3110 **$59.95**
Battery Pack
(6V 200mA)
Cat SB-2310
$79.95



DMM WITH FREQUENCY

- Capacitance • Transistor test
- Logic • One hand operation
- 3½ Digit

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Cat QM-1520 **$109.50**
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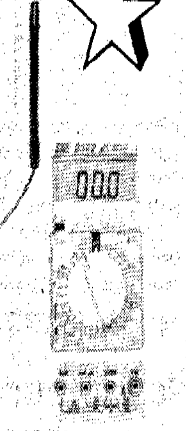

NEW

NEW KIT - 4 CHANNEL GUITAR MIXER/ PREAMP KIT

Ref Silicon Chip Jan 1992

This kit replaces our very popular ETI 467 mixer preAmp released way back in 1980. This project takes advantage of the new low noise, low cost op amps available. This kit features separate bass, midrange and treble controls, very low noise and distortion, separate input level controls plus an output level control. Ideal for use with most musical instruments from keyboards to guitars to tape decks. In fact, you can feed it with just about any audio signal. It's not just limited to guitar outputs. Kit includes PC Board, potentiometers, input socket and all specified components. The kit does not include optional ground phone nor the 15V supply board (Cat KC-5038 $12.95)

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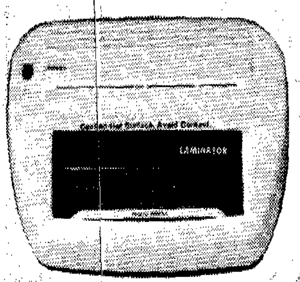

Cat XL-2500 **Only $99.95**

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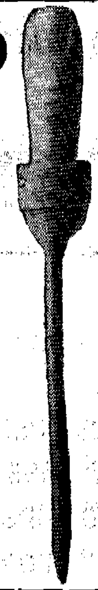

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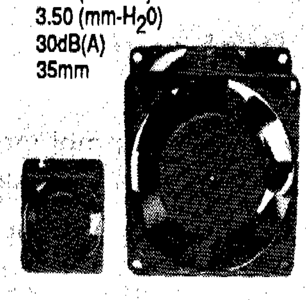

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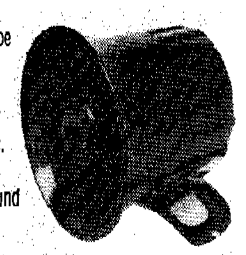
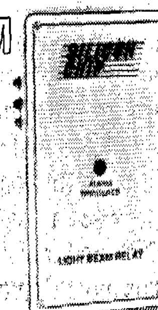


Cat. LA-5705 **$34.95** *Less 15%* **$29.70**

LIGHT BEAM RELAY KIT

Ref: Silicon Chip December 1991

This simple project allows you to monitor a doorway or a path using an infra red light beam. When someone walks through the beam, it triggers an alarm for a 1 second period. Kit includes PC board, case, panel and all specified parts. Plugpack and optional relay are not supplied. Plugpack Cat. MP-3006 $15.95. Cat. KC-5106



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ICs tested	CMOS & TTL digital, 16-pin DIP maximum
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Input impedance	1MΩ (approximate)
Display	High LED on
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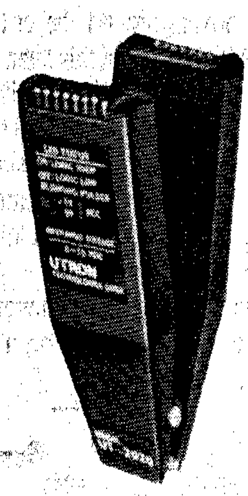
	Pulses LED blinking
Operational frequency	DC to 20MHz
Latch mode	Latches first pulse detected until manually reset
Operational voltage	4 to 15 volts DC
Overvoltage protection	20 volts absolute maximum
Temperature range	-10° to+70°C
Dimensions	8.6 x 3.4 x 3cm (H x W x D)

NEW



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CRO Cat. QC-1900

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Cat. QC-1902

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(2 required)

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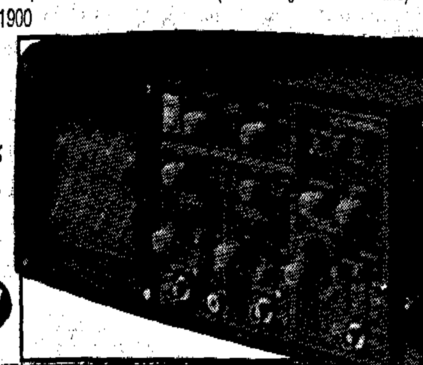

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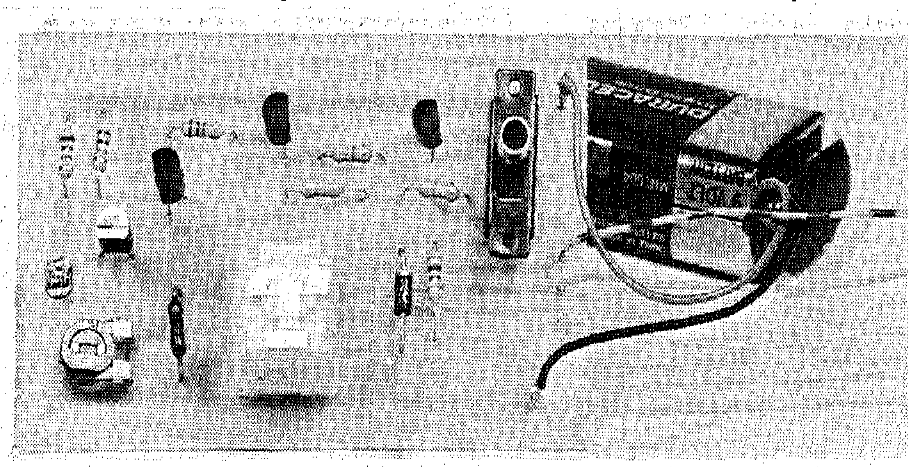
Experimenting with Electronics

by PETER MURTAGH

Light switch

Here's another method which you can use to switch a circuit on or off — light. You can adjust the sensitivity of this circuit so that it switches with ordinary background lighting, or with more intense light such as a torch beam. In addition, the design gives you two switching choices — you can use the light falling on the detector to switch *on* a normally-off circuit, or to switch *off* a normally-on one.



In our previous circuits, we have looked at various ways of switching a circuit — a touch pad, a time-delay, even automatic switching on and off at a controlled rate by an astable flipflop. Another common way is to use a Light Dependent Resistor (LDR), and an LDR is the control feature of this month's project.

LDRs change their resistance quite dramatically when exposed to light, and this changing resistance can be used to bias a transistor on and off. The LDR resistance can vary from very high (often megohms) in the dark, to quite low (even just hundreds of ohms) in the light.

Sitting on the bench, under a fluorescent light, our LDR had a resistance a little less than 10k ohms, so we designed our circuit to switch somewhere around this value. However, this 10k value is not critical.

Sometimes you need a light-activated circuit to turn on when it goes dark, e.g. security lighting around your home; and sometimes you want it to turn on in the light, either bright or dull, e.g. a timer-controlled automatic watering system which only works in bright sunlight, but not at night or when it's overcast or raining!

This circuit is capable of doing all this — switching on (or off) in the dark, switching on (or off) in the light, or only in bright light. Of course, for safety reasons, we don't suggest that you use the relay to switch 240V mains power — this project is definitely designed for a low, 9V supply.

As well as learning how to use a LDR, another new feature in this month's circuit is using two transistors to form a Schmitt trigger. Such a trigger lets us turn a circuit hard-on and hard-off, even if the turn-on voltage hovers around the critical on-off value. But more about this later.

Again, (as in our touch-switch circuit), we have used a relay to control the circuit's output. By separating the sensing circuitry from whatever is switched means that there is no chance of the switched load interfering with the sensor.

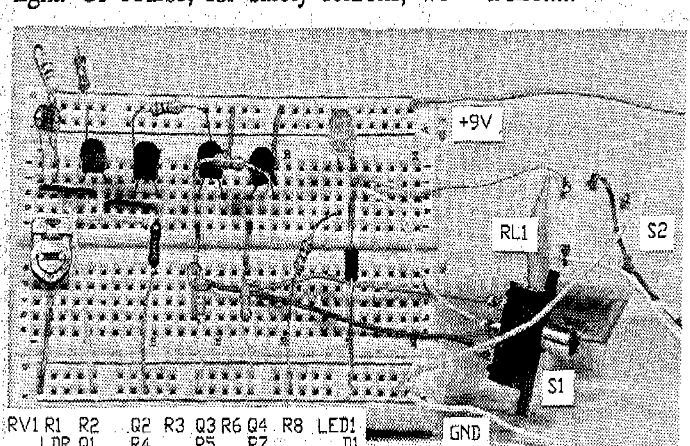
So switch on or off whatever you like: a light, a flashing indicator, a buzzer or a siren...

We have included a LED to indicate whether the relay is switched on or off. If you don't plan to actually switch another circuit with your light-switch, then you may wish to save the cost of the relay.

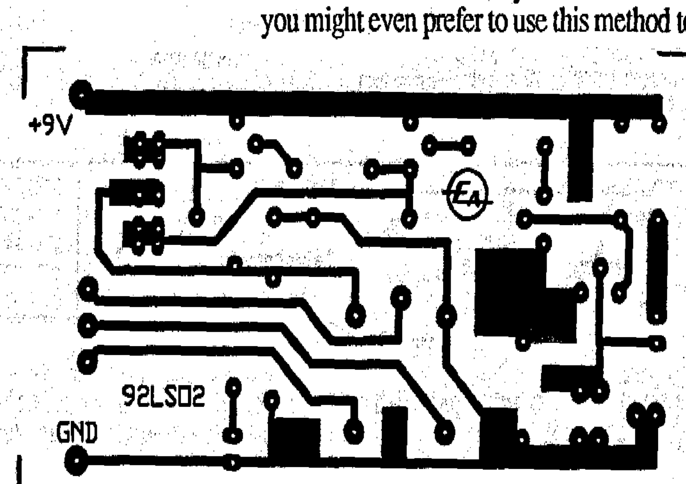
Just omit it, along with its protection diode D1 — the circuit will work fine without them.

Construction

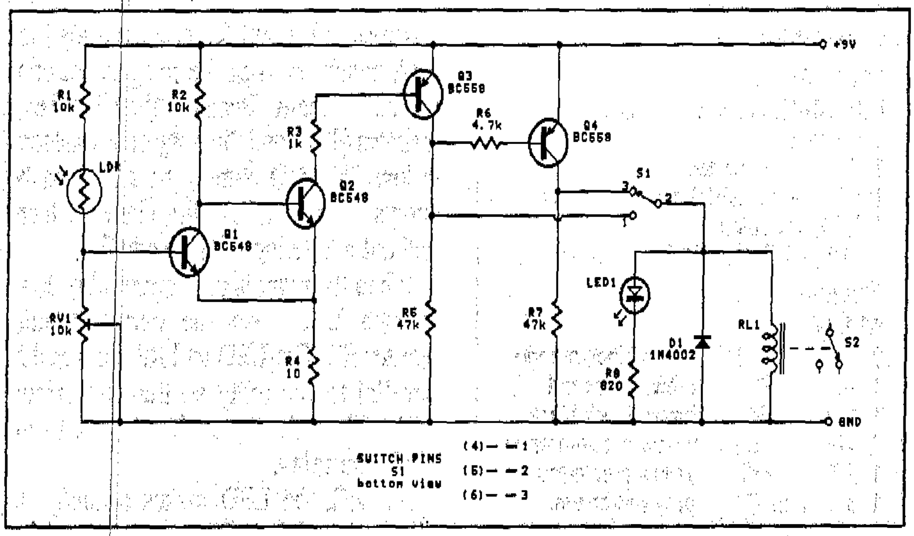
Construction of this circuit is quite straightforward. If you don't use the PCB design, then you will have to solder wires to the relay and switch (S1) contacts. This will be necessary if you are using strip-board or a breadboard — the relay and switch lugs are too large to fit into the holes on such boards. Even if you make a PCB, you might even prefer to use this method to



Here's how to lay out the components on a breadboard. The slider switch and relay lugs will not fit into the holes on the board, so must be connected by lengths of hookup wire.



If you wish to etch your own PCB, here is the full size master for the circuit. To simplify this process, why not buy the etching negative from our Reader Services Division for $2.



The schematic diagram shows the Schmitt trigger (based on transistors Q1 and Q2), followed by the two relay drivers (Q3 and Q4).

connect the switch to the board, because it takes a fair bit of work to cut slots large enough to take the switch lugs.

Start your soldering with the more rugged components like the switch, resistors and trimpot. With the other components (diode, LED and transistors), take care that they are connected the right way around.

Remember that transistors Q1 and Q2 are NPN types (BC548), while Q3 and Q4 are PNP (BC558). It is quite easy to accidentally interchange them, especially as their E-B-C layout is the same. Check Fig.3 to see which pin is which on these components.

We need a single-pole, double-throw (SPDT) switch to vary the circuit from being normally-off to normally-on. For convenience, we selected the cheaper slider-type switch and (as mentioned above), for neatness, soldered it directly onto the PCB.

In fact, we used a double-pole one as it was available — hence the extra set of switch pads on the PCB. The two sets of pads are connected in parallel, so you can solder to either side. We found the side closer to the edge easier to access. Of course you could use a toggle switch instead of a slider (easier to use, but more costly), or even dispense with a switch altogether and just swap the wires over.

If you do use a switch, and use stripboard or a breadboard, take care with the wiring connections. The centre terminal (pin 2) is the 'common', which is soldered to the relay. Switch S1 connects pin 2 to pin 3 ('NC' — normally closed) or to pin 1 ('NO' — normally open). 'NO' is connected to the collector of transistor Q4, while 'NC' is connected to that of Q3. With these connections, the 'off' (up) position of the switch means that the relay is normally-off and needs the light to turn it on.

Changes

Trimpot RV1 is included so that you can vary the sensitivity of the circuit. This is required because different LDRs have different resistances. And it also allows you to vary the light intensity required to activate the switch. You might like your circuit to react to normal background light, or sunlight, or a direct beam of light from a torch. Just adjust the sensitivity until it switches at the light level you require.

For example, with the slider switch in its 'up' position, turn the trimpot clockwise until the LED switches off. Then slowly turn the trimpot anticlockwise until it just switches back on. Move your hand over the sensor and it should block enough light to turn the circuit off. You have adjusted the sensor to distinguish between bright and dull background light. The same process can be followed with any desired switching light level.

How it works

Resistor R1, the LDR and the trimpot RV1 form a potential divider which is used to apply bias to the base of transistor Q1. The darker the surroundings, the higher the resistance value of the LDR. While the LDR resistance is high, the voltage drop across it is also high. Hence the voltage applied across Q1's base-emitter junction is insufficient to turn the transistor on. But as the light intensity increases, the resistance of the LDR drops, so that the voltage applied to the base gradually increases and eventually switches on transistor Q1.

Transistors Q1 and Q2 (both NPN type) are not connected in our normal Darlington pair configuration, but as a Schmitt trigger. Our need this time is not so much for a *high-impedance* amplifier, but for a *definite switching* one. Once the circuit turns on (or off), we want it to stay that way, even if there are slight alterations to the bias voltage. With an ordinary amplifier, it is very easy for the input voltage to vary slightly up and down. This is caused by a slight drop in the supply voltage when the relay switches on and loads the circuit. So, if the voltage applied to the base-emitter junction of Q1 is only just sufficient to turn it on, then this slight drop will immediately turn it off. But with the relay load removed, the supply voltage rises, so Q1 will now turn back on — then off and on, off and on.. The relay contacts will start 'chattering' as it rapidly turns on and off!

To avoid this happening, the Schmitt trigger uses *positive feedback*. When transistor Q1 turns on, Q2 ensures that Q1's base-emitter voltage becomes more positive. Q1 turning-on turns Q2 off — and the more Q2 turns off, the more Q1 turns on.

The key to the Schmitt trigger is the

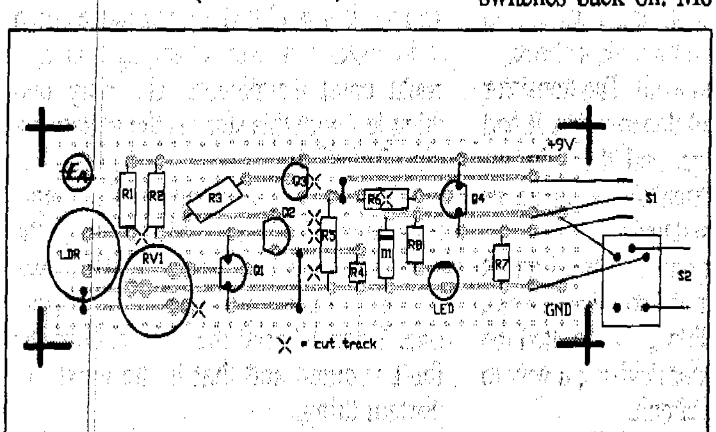


Fig.1 shows the component layout for breadboard construction. Note that the side leads of Q1 and Q4 do not go straight into the board but are bent to make contact with the next track out on each side.

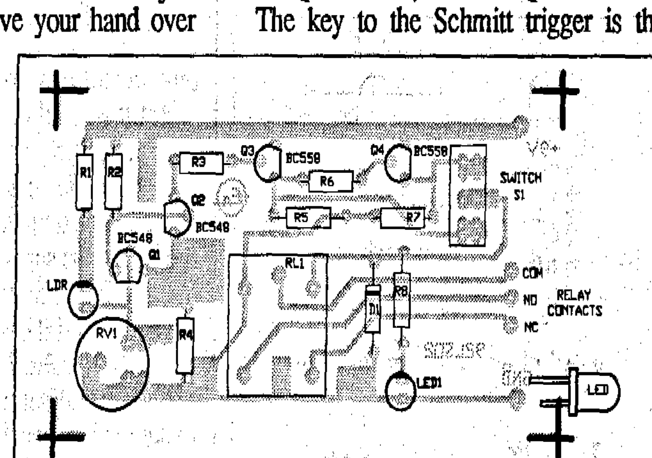


Fig.2: On the PCB you can see the double set of pads for the slider switch S1, which allows the use of either a DPDT or a SPDT switch. Fairly large holes are needed to solder the slider direct to the board.

Experimenting

common emitter resistor R4. The emitter currents from both transistors flow through this resistor, and so affect each other. The current flowing through the resistor causes a voltage drop, which reduces the voltage applied across the base-emitter junction of each transistor.

Let's suppose that we are in the dark, and the LDR resistance is high. So transistor Q1 is off and Q2 is on. Current will flow through the 1k resistor R3, then Q2, and cause a voltage drop across the 10 ohm resistor R4. (But if Q1 was on, and Q2 off, because R2 is ten times the size of R3, the current and voltage drop in R4 would be ten times smaller.)

So, as the light intensity on the LDR increases, transistor Q1 begins to turn on, transistor Q2 begins to turn off, and the voltage drop across R4 becomes less — the larger current from Q2 is being replaced by the smaller current from Q1. Since the voltage drop across R4 is becoming smaller, this means that the voltage across the base-emitter of Q1 increases. This is our positive feedback' — as soon as Q1 starts to turn on and turns Q2 off, this turns Q1 on harder. Very quickly, Q1 is fully-on and Q2 fully-off.

The same applies in reverse. As soon as transistor Q1 starts to turn off, it is rapidly turned fully off. Rather than risk interfering with the operation of the Schmitt trigger, transistors Q3 and Q4 (PNP type) have been added to do the actual switching of the relay. This approach also ensures more reliable operation, since we are using a 12V relay (cheaper and easier to find), running off a 9V battery supply.

Transistors Q2 and Q3 operate together — with Q1 off, both are switched on. If the relay was connected in the place of R5, it would be switched on in the dark, and off in the light (normally-on).

Hence we also need transistor Q4, which acts as an inverting switch, to have the opposite choice — having the relay off in the dark, i.e. normally-off.

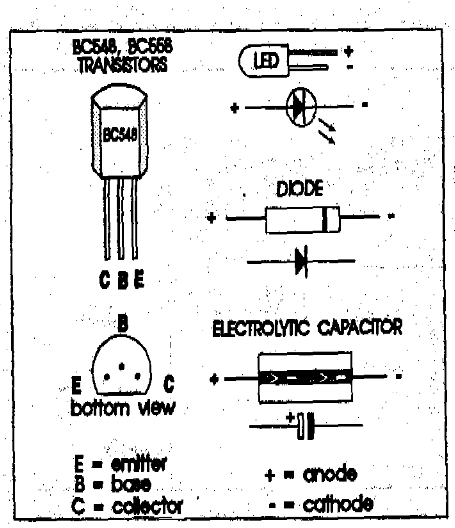


Fig.3 identifies the leads for those common components which must be inserted with the correct orientation.

PARTS LIST

Miscellaneous

PCB 90x48mm, coded 92LS02
1 9V battery
1 SPDT slider switch
1 PCB mount, SPDT 12V Mini Relay
1 LED, any colour
1 LDR, ORP12 or similar

Resistors

All 1/4W, 5%:

2	10k	R1,R2	brown-black-orange
1	1k	R3	brown-black-red
1	10 ohms	R4	brown-black-black
2	47k	R5,R7	yellow-purple-orange
1	4.7k	R6	yellow-purple-red
1	820 ohms	R8	grey-red-brown
1	10k trimpot horizontal-mount		

Semiconductors

1 1N4002 power diode
2 BC548 NPN transistors
2 BC558 PNP transistors

We achieve the inverting effect by connecting the base of Q4 to the collector of Q3. With Q3 turned on, the base of Q4 goes high and Q4 turns off (because, like Q3, Q4 is also a PNP transistor).

Now, we can connect our relay to the collector of either Q3 or Q4, and have the choice of having it normally-on or normally-off before the light shines on the LDR.

Resistors R5 and R7 provide a load for each transistor when the relay is not connected to them. Because they are large resistors (47k), and the relay coil resistance is low (200-400 ohms), the relay can be connected in parallel with either of them without interfering with the circuit.

When the relay is on, current also flows through LED1 via the current-limiting resistor R8. The LED and R8 are wired in parallel to the relay so that the circuit will still work if you decide not to include the relay.

As well, the LED makes a handy indicator light. Diode D1 provides protection for the transistors against voltage spikes from the collapsing magnetic field of the relay coil. (See last December's circuit for a full explanation.)

Transparencies

A high contrast, actual size transparency (negative) is available for only $2 for anyone wishing to make their own printed circuit board. This special price applies for transparencies for projects in this series only. Write to *EA*'s reader services division. Happy experimenting — and don't forget to send us your ideas for future circuits. ❖

THE SERVICEMAN

Continued from page 47

ohm resistor (R301) off pin 10, and then a direct connection to the emitter of the first video amplifier Q201 where the voltage was shown as 6.2V. In fact, at this point it was only 4.7V. I hunted about for the source of the bias on the base of this transistor, and eventually found it at the video detector output on pin 1 of IC101.

Here the voltage was 7.5V, rather that the 7.9V called for on the diagram. This was down, but nowhere near as 'down' as that on the base of the transistor. There now seemed to be a strong possibility that I had a leaky transistor, and I wasted no time in pulling it out for a critical check.

But it was all to no avail. The transistor checked perfect in all departments. It had no detectable leakage, and the gain appeared to be quite normal and adequate for the job it was supposed to do.

If I'd had a direct replacement, I might have changed it over and so saved the rest of this story. But I didn't, so I refitted the transistor and set about devising a way to make further tests in circuit.

The easiest way to check for leakage was to remove the base bias, by lifting one end of L201 across the ceramic filter Z201. By rights, under these conditions there should have been no voltage on the emitter of the transistor. In fact, there was a steady 4.7V, the same as when the transistor was turned on and operating normally.

So that was the answer to the whole problem. A leaky transistor. But it was leaky in a most unusual way. I might have expected that the leakage would have reduced the gain of the transistor and thereby degraded both the picture and the sync. But this didn't happen.

The gain continued quite normally and if the sync separator had not been DC coupled, there may never have been any symptoms to show there was a problem. I replaced the transistor with a BC337 and that removed the symptoms altogether. The vertical hold had a good range and a solid lock. Not even changing channels could upset the picture. The only odd thing left with this story is the voltage on pin 10 of IC301.

After fitting the new transistor, the input became just 5V, not the 6V shown on the diagram. In fact, the new voltage was closer to the faulty one than the correct one. I don't know the answer, but the fault is cured and that is the most important thing.

One last thing. I never did find that other chip. There's a perfectly good, brand new HA11423 lying around in my workshop, but I don't know where it is. You're welcome to keep it, if you can find it! ❖

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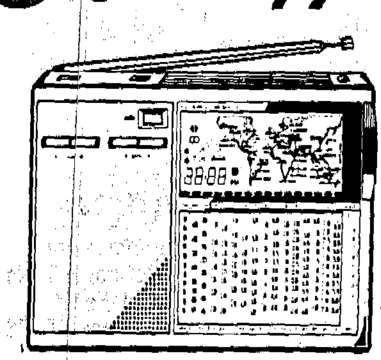

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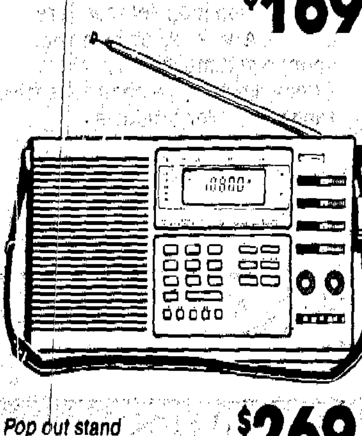

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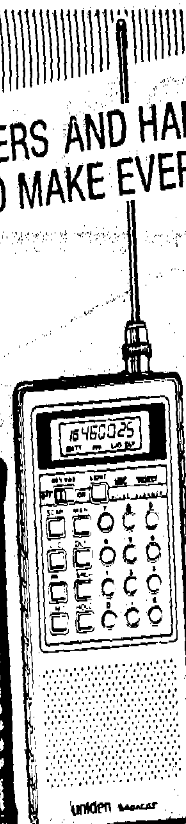

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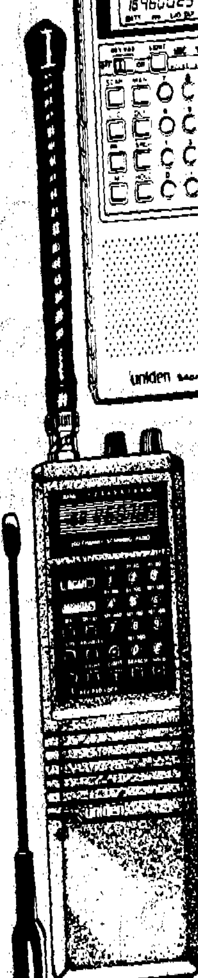

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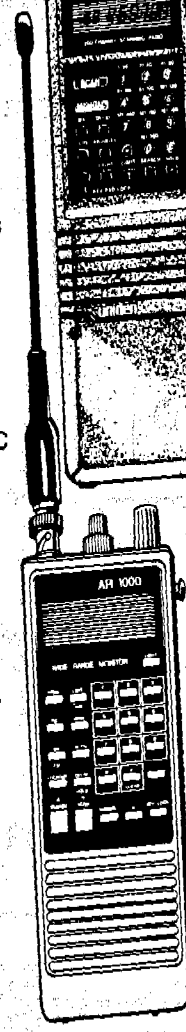

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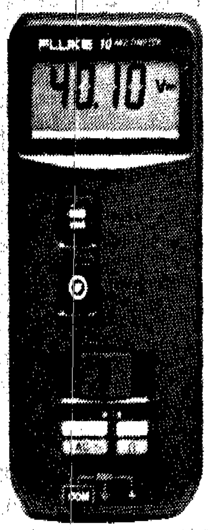

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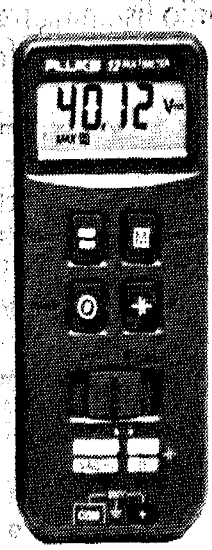

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VOLTAGE

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4000mV, 4.000V	1.5% + 2	0.9% + 2
40.00V, 400.0V, 600V	1.5% + 1	0.9% + 1

ac V - Range	Accuracy Fluke 10	Accuracy Fluke 12
4000mV, 4.000V, 40.000V 400.0V, 600V	2.9% + 3	1.9% + 3

OHMS & DIODE TEST

Ohms - range	Accuracy Fluke 10	Accuracy Fluke 12
400.0ohm	1.5% + 2	0.9% + 2
4.000kohm, 40.00kohm, 400.0kohm, 4.000Mohm	1.5% + 1	0.9% + 1
40.00Mohm	1.9% + 3	1.5% + 3

DIODE TEST: Displays voltage drops to 2.4V

CONTINUITY: Beeper comes on at <25ohms and turns off at >250ohms. The meter detects opens or shorts of 250us or longer.

CAPACITANCE (Model 12)

Capacitance - Range	Accuracy
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SHORTWAVE LISTENING

by Arthur Cushen, MBE

Publications to help the new listener

For the new listener starting the radio listening pastime, it's important to have not only a receiver and aerial, but accurate and up-to-date information from books and magazines as well.

Over many years there have been annual editions of publications which list all the world's radio, television and satellite stations both by country and frequency. Another popular version has the material listed in computer printout, with the time across the top of the page, the frequency down the side and indicating on a line the length of transmission and associated information.

Radio Nederlands English Section is one of the few international stations which promote many aspects of radio listening, and offers free wide variety of pamphlets and booklets. The latest booklist, which is the 13th edition, covers a wide field. It's chapters include: Listening Guides, Mass Market Periodicals, Books and Pamphlets for the MW/SWL, Broadcast Related Books for the SWL, Tape Recordings, Amateur Radio, Vintage Wireless and Specialist Addresses.

When the writer started listening in 1935, there was little in printed form to assist in the hobby. The first major help was the *World Radio & Television Handbook*, first published in 1946 in Denmark.

After World War 2 had ended, O. Lund Johansen wrote a newspaper column in a Copenhagen Daily about listening to the world. He was surprised at the interest in shortwave listening, so with Jens Frost, he formed the World Radio Handbook Company. From a mere 76-page publication, this has extended to the 1992 edition covering almost 600 pages.

Jens Frost took over editing the *Handbook* in 1968, and in 1986 the office was moved to Amsterdam, where Andrew Semmitt became the new editor. The early issues were printed in Denmark, but in recent years, as the *World Radio Handbook* is now associated with Billboard Publications, printing has been done in the United States.

The major competitor to the *World Radio Handbook* is *Passport to World Band Radio* which was first published in the early 1980's. This uses a different approach with its information — a graphic system to show international broadcaster occupancy of shortwave bands. Frequency and country order are useful for people who scan the bands, but not so handy if you simply want to know what is on at a particular time.

AROUND THE WORLD

AUSTRIA: Vienna broadcasts in English to Australia at 0830-0900 on 15450 and 21490kHz, and to the Far East at 1130-1200 on 11780 and 15450kHz. The service to North America also provides reception in this area at 0130-0200 on 9870 and 13730kHz.

BELGIUM: BRT International Brussels presents 'Brussels Calling' in English, in one transmission to Australia at 0730 daily on 11695kHz and to Europe on 5910 and 13675kHz.

CANADA: RCI Montreal, though having suffered a budget cut, has extended its frequencies in several transmissions. The broadcasts in English at 0400-0430 were formerly only carried through the Austrian Radio, but are now on 6150, 9505, 9670 and 11925kHz which originate from Vienna. The other transmitters are from Daventry and Sackville. The popular Monday-Friday English programme at 0615-0700 continues on many frequencies, including 6050, 6150, 7155, 9740, 9760 and 11905kHz. The transmission to Europe at 2200-2300 is audible on 9760 and 11945kHz.

COLOMBIA: Radio Nacional Bogota on 17865kHz is heard as early as 2100 with popular Spanish music. It identifies itself five minutes after the hour, and complete details are given in sign-off at 0455, when the station closes with the Colombian national anthem.

ESTONIA: Radio Tallinn confirms reception reports with a verification card and schedule. The station broadcasts in English every Monday with 'Estonia Today' at 2130-2200 on 5925kHz. Its address is: Estonian Radio International, English Service, Lomonossov St. 21, Tallinn 200100, Republic of Estonia.

ISRAEL: The broadcasts from KOL Israel in English have been reduced, due to a budget cut. The two transmissions audible in this area are at 2000-2030 on 11587 (Sunday-Thursday only), 11605, 11675, 15640, 17575 and 17603kHz; and at 2230-2300 on 9435, 11587 (Sunday-Thursday only), 11605, 15100, 15640 and 17575kHz.

LEBANON: The 'King of Hope' has been broadcasting from Lebanon with gospel programmes for some years, and has joined the powerful transmitter 'Wings of Hope' on 11530kHz. The station announcement indicates 'King of Hope' is on 6280kHz, and requests reception reports on the new 'Wings of Hope' transmitter to PO Box 3379, Limassol, Cyprus. At 1900 there is a full identification in English after a Russian programme, and English programmes have been noted at 1930 on some occasions. The station is operated by High Adventure Ministries, which also broadcasts in California and plans a new station on Guam.

NEW ZEALAND: Radio New Zealand International has always stayed with Daylight Time in NZ during our summer months, which meant that overseas listeners had to tune in one hour earlier. However, its 1991-92 broadcasts from Wellington are now tied to UTC; therefore, overseas listeners do not have to adjust their listening time. For instance Mailbox every second Monday is heard at 0430UTC on 17770kHz, and the transmission schedule is at 1800-2200 on 15120kHz, 2200-0630 on 17770kHz, and 0630-1210 on 9700kHz.

Passport does not cater for mediumwave listening. It does have a comprehensive list of station addresses, while its buyer's guide enables the listener to read all about the new portable and communication receivers on the world market. Its frank and unbiased criticism helps listeners to know what receiver is best value for money.

There are many other publications in this field. For example, *Confidential Frequency List* is a popular book, which features stations outside the international broadcast band. It lists worldwide information of FAX, INTERPOL, VOLMET, coastal, RTTY, military stations and the like. The book contains over 3000 entries and the stations are listed by frequency and callsign, along with their power, schedules and other details.

Specialist books

The new listener can draw on the experience of the world's experts in radio listening, as there is a wide variety of publications available.

There are specialist books on Listening to Latin America, the Pacific and titles like *Secrets of Successful QSLing, Radio Receiver Chance or Choice,* and *More Radio Receivers Chance or Choice,* which cover over 100 radios available worldwide.

Others like The *World Address Book* and *Pirate Radio Stations* are a few more of the dozens of titles which take a specialised look at radio listening.

Radio Nederlands booklist is available free from: The English Section, Radio Nederland, PO Box 222, Hilversum JC 1200, Holland.

ZLXA on 7290kHz

Radio New Zealand International is widely heard on shortwave, but our second shortwave service is the low powered Print Disabled Radio, broadcasting from its studioes in Levin. In the past, its broadcasts have been on 3935kHz, with the same transmission also available on mediumwave 1602kHz.

Due to a falling off of reception during the early evenings in summer, this second frequency of 7290kHz is temporary — until the WARC Conference in 1992. Print Disabled Radio, PO Box 360, Levin is a radio reading service for the blind and those who have sight problems in New Zealand.

Though its power is only 1000W, the signal has been heard in Australia and North America. The present schedule is Sunday 0500-0900UTC and Monday-Friday 0530-0900.

Japanese audience

When Radio Australia discontinued its broadcasts in Japanese some two years ago, it must have been aware of losing its largest potential audience in Asia.

Japan, with its tremendous manufacturing capabilities in portable and communication receivers, reflects this interest in its own radio listeners — and it has millions who listen to shortwave.

Radio New Zealand International last year carried out a series of one hour tests to Japan on Saturday and Sunday evening 1100-1200UTC on 9700kHz. In the first week, it received 500 letters from Japanese listeners, tuning to New Zealand for the first time in their own language.

The Far East Broadcasting Company in Manila also recently carried out an unannounced survey of trends in listening in Japan.

For five days it broadcast for ten minutes in Japanese from Manila and FEBC received over 1200 letters from right across Japan. The survey indicates that there would be at least 1.2 million Japanese listeners tuning up and down the dial on shortwave every evening. It is obvious that there is a huge potential audience in Japan for broadcasters in the Pacific, who wish to carry transmissions in the Japanese language.

Radio Japan itself broadcasts to Australia and New Zealand in English at 0900-1000 on 15270 and 17890kHz. At the same time, the General Service in English is available on 11840 and 21610kHz, while on Sunday at 0930 there is Radio Japan's 'DX Corner'.

Radio Japan itself has been operating for almost 57 years, having commenced broadcasting on 1 June 1935. It is part of the Japanese Broadcasting Corporation, NHK, and in its earlier days used the slogan 'Radio Tokyo'.

In recent years, Radio Japan has expanded by upgrading its transmitters at Yamata, and by building a relay base at Ekala, Sri Lanka. It also uses the facilities of Africa No.1 in Gabon, Radio Canada at Sackville and Montsinery in French Guiana. ❖

This item was contributed by Arthur Cushen, 212 Earn St. 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 10 hours behind Australian Eastern Standard Time.

Vintage Radio

by PETER LANKSHEAR

Something 'different' from the UK

By the late 1930's receiver design was generally standardised and predictable, with a host of locally-made radios dominating the Australasian scene. But during the short period from 1937 to 1940, New Zealand was fortunate in having the Ekco brand receivers imported from England, and one of their 1938 pushbutton models, the PB289, is worth studying as an example of 'up market' British design.

Founded in 1922, the E.K. Cole Company of Southend-on-Sea soon became a major British manufacturer, with extensive facilities including a plastic moulding plant. At one stage they even made their own valves, which, although given their own type numbers, were equivalent to the standard Mullard range.

Having in 1931 pioneered the use of plastic, Ekco's Bakelite cabinets became a major specialty and in 1933 they employed leading industrial designers to create innovative and imaginative styles. Although concentrating on distinctive moulded cabinets, they did use wood for some of their top line receivers, including the model we're going to look at here.

The PB289 has a nicely proportioned cabinet with a very large square dial covering three bands — the European 'long wave' band from 150 to 300kHz, the standard medium wave or broadcast band, and short waves from 6 to 18MHz. To the right of the dial is a row of 12 pushbuttons.

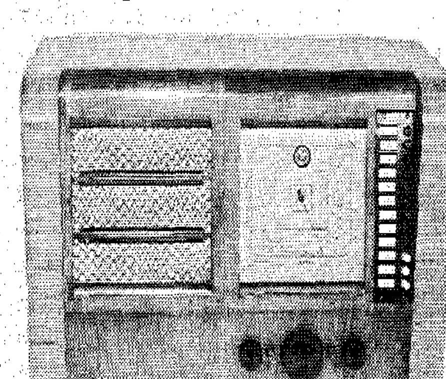
Pushbutton tuning, originally used in car radios, was the fashion feature for 1938 domestic receivers. According to one authority, of the 665 new British models for that year, no fewer than 231 had pushbutton tuning.

Three major systems were used. Most common were switched preset semi fixed-tuning capacitors or inductors, and telephone-type dials with finger stops linked to the tuning capacitor. More complex and expensive was the motor-driven tuning capacitor used in the PB289.

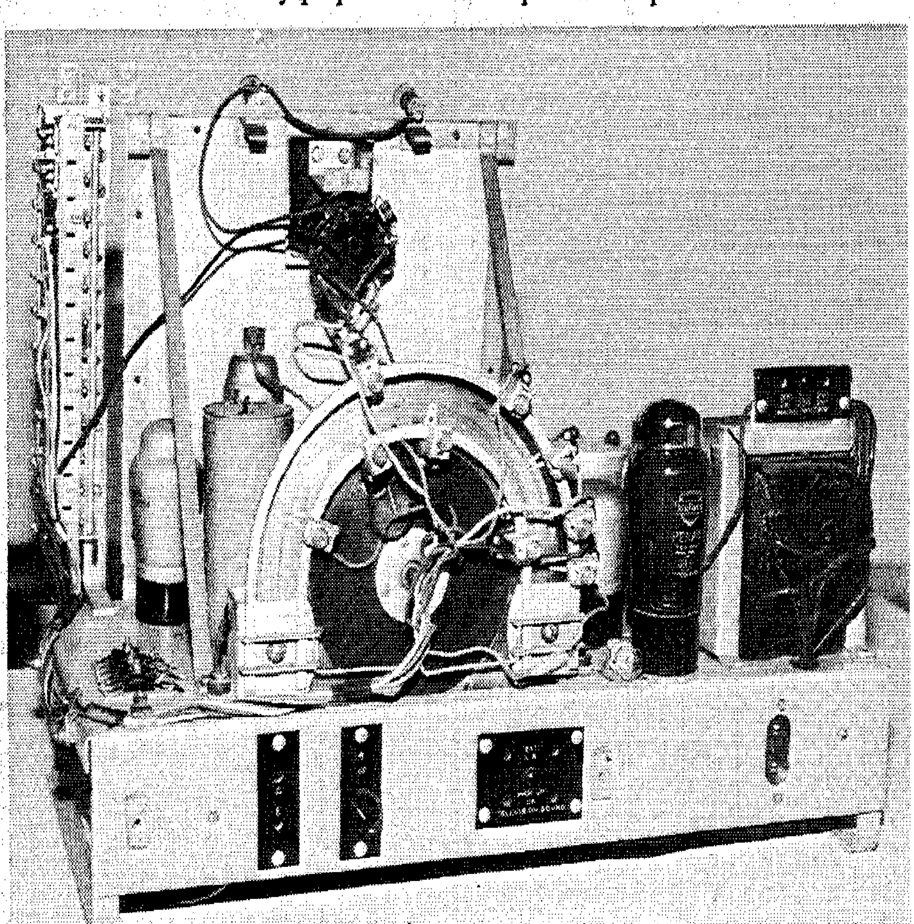
The PB289 motor can be used in the pushbutton mode to select broadcast band stations, and also to assist manual tuning. As it also controls bandswitching, there is no bandswitching knob! Instead, the three lower white pushbuttons are used to select the manually tuned long and shortwave bands as well as broadcast band manual operation.

Enclosed back

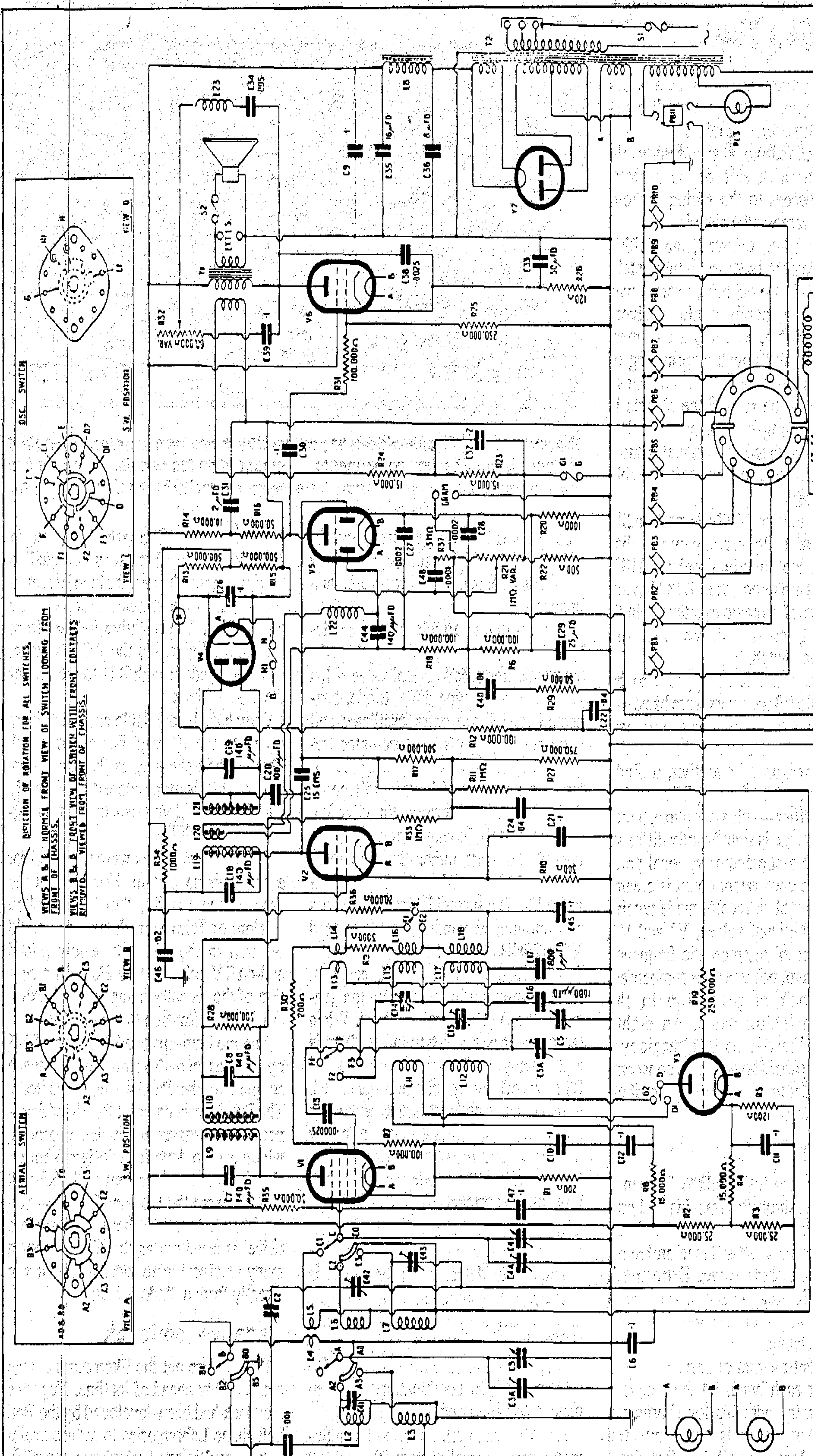
The PB289 incorporates two good features frequently found in European receivers. One was to protect the rear of cabinets with fibre panels, which although of questionable acoustic value, served to prevent contact with live termi-



Most of their receivers had distinctive plastic cabinets, but Ekco chose wood for the 1938 model PB289. At the top centre of the dial is the magic eye tuning indicator. Note the row of tuning selector buttons down the right.



Left: Dominating the rear of the chassis is the motor tuning assembly. Two semicircular rails carry the fingers which contact the commutating segments on the large 'Paxoline' disc.



This circuit is for the Ekco PB189. The PB289 has minor differences, with the addition of a magic eye tuning indicator and a motor drive for the wavechange switch.

nals — and which now provide a bonus for the collector by their having discouraged meddlers, dirt and mice!

The other feature was a removable panel on the underside of the cabinet, providing access to the wiring without the need to remove the chassis.

With the back removed, the British metal-sprayed valves are immediately apparent. This 4-volt heater series was rarely seen in locally made receivers which, at the time, generally used American pattern valves, with a sprinkling of the Philips side-contact 'P' based series.

Dominating the rear of the chassis is the motor tuning control system disc, with its silver-coated contact plates and a frame fitted with two rows of adjustable contact fingers.

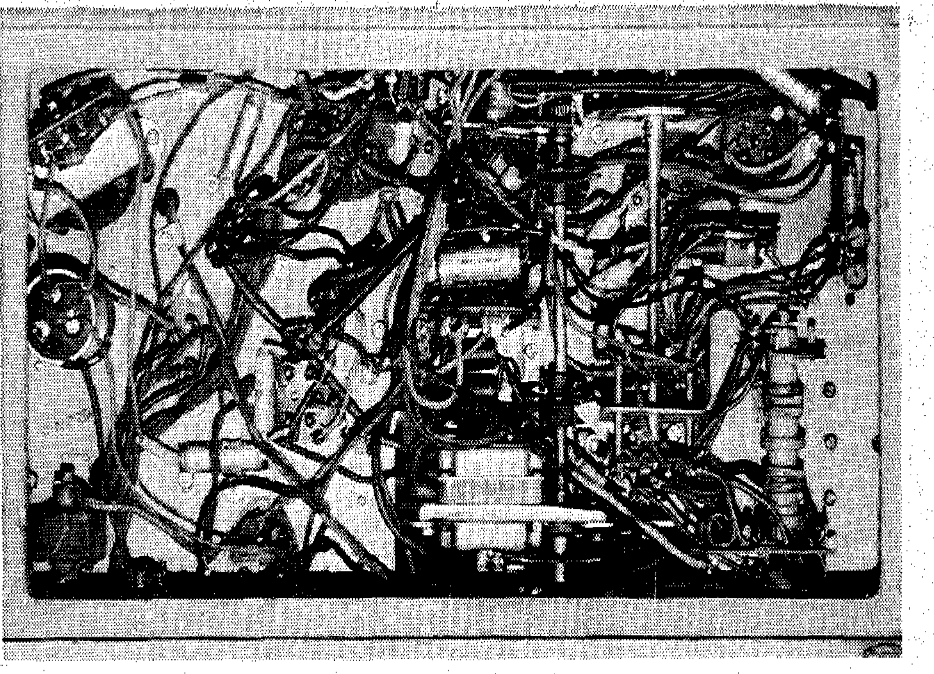
A circuit of the PB289 is not readily available, and the accompanying diagram is of the slightly simpler PB189. Differences are minor, the PB289 having the addition of a magic eye tuning indicator and motor drive for the wavechange switch.

Although the circuit appears to be complex, the PB receivers were basically conventional band-switched superheterodyne receivers comprising a triode-hexode mixer, an IF amplifier, a diode triode detector-audio amplifier and a power amplifier — plus of course, a rectifier. Each stage is significantly different in detail from contemporary local practice, and the component count is greater than for equivalent locally made receivers. Two additional valves, V3 and V4, are the heart of an automatic frequency control system, necessary to compensate for any lack of precision in the pushbutton tuning mode. An eighth valve is a 'P' based type TV1 'magic eye' tuning indicator. The design is conservative, with plenty of bypassing contributing to stability.

Image problem

The very low intermediate frequency of 126.5kHz simplifies tracking and provides considerable gain and selectivity, but also creates serious image problems, especially on short wave. Extra tuned circuits, following the aerial, are used to minimise images on the long and medium wave bands.

A different method of aerial coupling is used for each band. L4 is a conventional primary winding for shortwave, and longwave signals are connected through a loading coil L1. Broadcast band coupling is to a tap on L2, an efficient method commonly used for car radios, but ideally must be tuned for individual aerials. C2 is a phasing capacitor for further reduction of broadcast band images.



The underside of the chassis can be accessed by removing a panel on the cabinet bottom. Although many components are mounted on tag panels, the wiring has the familiar 'rats nest' appearance. Note the motor and drive shaft in the centre.

The oscillator circuit of the triode-hexode mixer V1 is complicated by the automatic frequency control valve V3, a general purpose type 354V triode, connected to HT via extra oscillator coil windings. V3 'pulls' the oscillator frequency, to an extent governed by the polarity and amount of its grid voltage — derived from the discriminator valve V4.

A type VP4B, having a screen grid rating of 250 volts rather than the more familiar 100, is used as the IF amplifier valve V2. The second IF transformer has a centre-tapped winding (L21) to feed V4, a 2D4B double diode discriminator. Similar to those used in FM receivers, the discriminator in this application generates the AFC control voltages. When the receiver is accurately tuned, there is zero voltage at the junction of R13 and R15, but off tune a voltage is generated, with a polarity and magnitude depending on whether the signal is above or below resonance, and the degree of mistuning. By controlling the anode current of V3, this voltage corrects any tuning errors.

Effective AGC

The diode detector configuration is slightly unconventional. Instead of the usual IF secondary winding, a small coil (L20) closely coupled to the primary of the second IF transformer is connected to L22 and C44, the combination being resonant at the intermediate frequency.

As AFC requires an effective automatic gain control system, the PB289 has an effective system with a delay of 2.5 volts, the voltage of the cathode of V5 above earth. C25 (which is rated in centimetres, an obsolete unit equal to 0.9pF) couples the anode of the IF amplifier anode to the second diode of V5, a type TDD4. The negative voltage from the rectified signal is the AGC voltage, and is applied through R11 to the grid of the TH4A mixer.

Only half the available control voltage is fed to the IF amplifier control grid. This is good practice, as the anode current of V2 is not reduced sufficiently with large AGC voltages to limit its signal handling ability.

The usual terminals were provided for a gramophone pickup. However, in the case of the PB289, they are labelled 'Pickup or Television Sound' and could be used in the UK with a low priced add-on TV unit made by Ekco for reception of the recently inaugurated Alexandra Palace television transmissions.

The medium-mu triode section of V5 operates as an audio amplifier resistance coupled to the PenA4 output pentode. The PenA4 was one of a family of European high transconductance pentodes, which had no American designed equivalent. Similar valves, but with 6.3-volt heaters, were the EL3 and EL33 — better known locally. These valves were twice as sensitive as the 6V6G, and in many receivers were successfully driven directly from a diode detector.

Negative feedback

One feature put the Ekco output stage considerably ahead of its time. Negative feedback had been developed by the Bell Telephone Laboratories to reduce crosstalk in multiplexed telephone amplifiers. By 1938, primitive negative feedback was being used around the output valve in some receivers, but usually this was simply a sample from the anode coupled back to the control grid. Although design becomes critical, feedback is more effective if it includes the output transformer, and also is around more than one stage.

Some contemporary Australian HMV receivers did use feedback from the voice coil winding over two stages. Around 1936, the BBC had patented the use of a separate feedback or tertiary output transformer winding for improved stability. Ekco used this method in the PB289, the feedback signal being applied through R24 to the bottom end of the volume control.

It is surprising that the system of connecting the feedback to the volume control was not used more, as it has some good features — the chief being that, due to the shunting of the detector diode, the amount of feedback decreases as the volume control is advanced and consequently, maximum gain is not limited by feedback.

A further uncommon feature is the combination of L25 and C34, connected across the output transformer primary and used as a series-tuned 9kHz whistle filter.

Permag speaker

The power supply is conventional, using choke L8 instead of a speaker field for filtering. Unlike contemporary local and American loudspeakers, which still used electromagnetic field magnets, Ekco loudspeakers had permanent magnet fields. British manufacturers had adopted Alnico alloy in 1936, and were well ahead in permanent magnet development.

Rather than the usual 8" speaker generally found in larger mantel receivers of the period, Ekco managed to fit in a 10" unit, with an improvement in bass response.

Rugged, reliable

The motor-driven tuning mechanism of the PB289 is rugged, simple and well built — reasons for the unit in the receiver illustrated still working flawlessly after more than 50 years.

At the heart of the system are a twin field motor and a fibre disk about 15cm in diameter. Attached to the rear face of the disc are silver-plated commutating segments, in the form of two half circles with a 1mm gap between them.

Surrounding the disk is a frame carrying adjustable clips carrying fingers in contact with the commutating segments, each one being connected to the return of a motor field winding.

Each finger is in turn connected to its own pushbutton, which when depressed, completes the circuit between a segment and earth, energising the motor which rotates the tuning capacitor and disc towards the gap between the segments. As the finger concerned encounters the gap, the motor is open circuited, and the rotation of the tuning capacitor stops at the position of the desired station. As a clutch ensures that the stopping is instantaneous, location accuracy is quite good, with any minor tuning errors corrected by the AFC.

Instead of a wavechange knob, the PB289 has a pushbutton for each of the three bands. Connected to the wavechange switch is a small disc, also with motor control segments. When a wavechange button is depressed, an electromagnetically activated dog clutch couples the motor drive to the wavechange switch, which is rotated to the required position. If the medium wave change pushbutton is left depressed, tuning becomes manual — but with motor assistance if required, controlled by buttons either side of the main tuning knob.

How does the PB289 perform? The pushbutton tuning works well, and there is good sensitivity. Tonal quality is above average. Used as intended, primarily for listening to local stations, it is an excellent receiver. The only real criticism is the image reception, which is apparent to a degree on the broadcast band and is very bad on the 6 to 18MHz band.

Motor tuning was a short lived fashion, but for the historian, is a significant development. The wartime austerity of the 1940's discouraged such non-essential frills, and after the War, switched capacitors or inductors and cam-driven mechanical pushbutton tuning methods proved to be adequate. Motor tuning is unlikely ever to be resurrected, for today non-mechanical remote controls provide pushbutton features that were once only possible in the dreams of science fiction writers. ❖

Powerhouse

Continued from page 57

sockets and turned on. When the appliance is turned off again or unplugged, the current through R22 stops and IC7 switches Q1 and the inverter off again.

The purpose of diode bridge BR1 is to protect the auto-start circuitry from damage, once the inverter starts up and 240V AC appears across the transformer secondary. While allowing many amps of AC to flow between the transformer secondary and the load appliances, the diode bridge ensures that the voltage at the secondary end of R13, and also that across C14 and D8/R22, never exceeds 0.7V respectively with respect to the inverter's 'earth' — i.e., battery negative.

Diode D8 and capacitor C13 are used to rectify and filter the AC voltage component developed across the C14 side of the bridge, during inverter operation, to prevent IC7 from being switched on and off at the 50Hz rate.

Note that if there is no initial DC path through the load (as with fluorescent lights, etc.), then the inverter will not switch on in auto-start mode. This can be overcome by turning on a resistive load (e.g., a standard incandescent lamp) to start the inverter, and then turning it off again if not needed — once the inverter is going and the fluorescent lamps are conducting. In 90% of applications this is not likely to be a problem. The inverter can, of course, be run all the time in the 'MANUAL START' position, bypassing the auto-start section completely.

When in the 'AUTO START' position but not actually running, the inverter draws approximately 3mA. Conversely when in the 'MANUAL START' mode and running, but with no 240V load connected, it draws approximately 600-700mA from the battery.

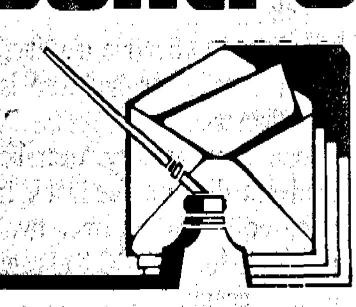
Finally, it's worth pointing out that because of the way the auto-start sensing circuitry links the low voltage and high voltage sides of the inverter, the neutral side of the 240V output sockets is effectively tied back to battery negative. (Although if the two are actually shorted together, this will disable the auto-start circuitry.)

This means that if the negative side of the battery is connected to true earth, the 'active' side of the inverter's output will be just as dangerous as that from a normal 240V mains power outlet (see warning box).

In the second of these articles, we'll look at assembling the testing the new inverter. A full parts list will also be given.

(To be continued) ❖

Information centre



Conducted by Peter Phillips

What? Were we all conned?

We delve into some abstruse areas of electronics this month. The 'Dirac' function comes in for a caning, readers disagree on the drift velocity of electrons, and the well-known topic of 'oxometry' is raised. There! I've warned you...

Electronics, if nothing else, is an area that seems to know no bounds; an impression I continually get from reading the amazing range of letters I receive. Letters from you are the life source of this column, and I'm continually surprised (and pleased) by the range of opinions and interest in some of the topics that get raised in this column.

A topic that I thought might have run its course is the 'capacitor discharging into another' problem. I presented this as a What?? question in October 1991 and ran quite a few letters about it in January 1992.

Well, here's a letter that challenges all the previous letters on this topic. In short, here's the definitive answer...

October What??

Some half century ago there was a program called 'Frank Legg's Weekend Magazine' on ABC radio. One evening he interviewed the president of the Oxometric Society of NSW. It was beautifully done, and the president expounded at great length on the many aspects of his complex and obscure specialty.

Legg reported later that the interview had met with a saddening degree of success, as several listeners had complained, saying that air time should not be devoted to abstruse scientific matters like oxo-metry and that in any case the president of the society obviously did not know what he was talking about.

Anyway...

I was amused by the apparently serious answer in the November 1991 issue to the October What?? question.

The whole question of course is based on the fallacious 'snuck-in' assumption that the voltage on the two capacitors is halved when they are connected. It ain't! That indestructible quantity we call energy is what is equally divided between the two capacitors, each therefore holding 2500J.

The resulting voltage across each 1F capacitor can be calculated using your published formula. That is:

$E = 1/2CV^2$ (note that the voltage is squared)

$2500 = 1/2 \times 1 \times V^2$ (values substituted)

$V^2 = 2 \times 2500$ (transposed)

or V = the square root of 2500, which gives about 70.7V.

To look at the situation another way: Take two parallel connected 1F capacitors, which form a 2F capacitor. Ensure it has no voltage. Into this 2F capacitor we pour our 5000J bucketful of energy from somewhere — whether from an external or internal source matters not. What voltage will we get? Not 50, but 70.7V. Try it out experimentally if you must, I don't need to!

Your question could have been framed by a politician, even a Treasurer; it is a matter of conning the unwary by surreptitiously swapping a square root relationship for a linear one.

I had assumed the item in the October issue to be a tongue-in-cheek joke on either your own, or Mr Madigan's part. Perhaps it was and you are now bent on perpetuating it. 'Fourier transform of a Dirac function' and 'radiation of white noise' indeed — ye canna get away with that on a 73 year old without a guffaw. But you really shouldn't do such naughty things to the more gullible of your readers; some may believe you!

Incidentally, you might like to add something derived from the following to your 'explanation': if your so-called theoretical case of instantaneous or even sub-microsecond discharge could be attained, I for one don't want to be anywhere near a source of 'white noise radiation' measurable in thousands of megawatts. It sounds suspiciously like a cheap and nasty alternative to a nuclear bomb.

Keep up the lighter vein! (R.V., St Georges Basin NSW).

Somehow, R.V., I get the impression you aren't convinced by Mr Madigan's solution! Being totally honest, I have to say I have never heard of a Dirac function, something I made clear last month. But then I haven't heard of many things, including oxometry, let alone the Oxometric Society. (But then, neither has the Oxford English dictionary!)

As one who is not averse to invention (remember the toidi, the Wollings tube and all the nonsense of the April 1991 article about the direction of an electric current?) it would not surprise me if a Dirac function is a figment of Mr Madigan's imagination. But somehow it rings true, and hopefully a reader or two can support this. (Hope you're reading this Mr Madigan!)

Still, I have to agree with your mathematics concerning the voltage across the capacitors. In other words, there is no lost energy!

So, it's all a big con, but one that got me, as well as 99% of the readership. As I said in the lead-up, I get a lot of letters, including many I don't publish.

No one saw the 'mistake' in the question — the red herring in a classic question that has probably fooled generations. What can I say, except to quote Pascal who, in 1670 declared "It is not certain that everything is uncertain."

Thanks R.V. for an entertaining letter, and for putting us all straight. And while we're on the abstruse, here's some more thoughts on the drift speed of electrons.

Speed of electrons

This question has been lingering for a while in these columns, and the general opinion is that the speed of an electric current is much faster than the drift speed of the electrons that comprise the current.

The question is, what is the drift speed? Recapping briefly, in December 1991 D.L. (Tumblong, NSW) suggested a value of around 36 metres per hour and J.D. (Waarncort, Vic) gave 1mm/sec (or 3.6 metres/hour). Both rather different, but both very low values of speed.

I'll abbreviate the next two letters on this topic, which include one from a physicist and one from a lecturer in Agricultural Engineering. I've also received other letters, which I'm not including as they either repeat what has already been said, or in one case, I can't even read the handwriting. (Hint hint!)

I read with interest the letters concerning the flow of ions and electrons in solutions. I'd like to toss in my two-bob's worth — from the point of view of a physicist — mainly on the subject of electron velocities in a solution.

In an electrolyte with no current flowing at all, the innermost (K shell) electrons have velocities of about Z x 0.007c, where Z is the atomic number of the ion (29 for copper) and c is the speed of light. The outer electrons, which are very loosely bound to the ion, are shielded from the nuclear charge by the inner electrons and have velocities of about 0.007c at most.

Now, what about current flow? It is important to realise that individual electrons don't flow at the speed of the current pulse. Rather, the current pulse is carried through the solution on the 'sea' of relatively free charges.

If we assume that individual electrons do flow through the solution with a speed of c/2, we are led to absurd conclusions. Using Einstein's theory of special relativity, it can be shown that electrons with velocities of half the speed of light have a kinetic energy equivalent to that obtained by acceleration through a potential difference of about 80kV — enough to cause the emission of K-shell X-rays from the atoms of the solution. This cannot happen when lower voltages are applied as it would violate the conservation of energy. (Dr A.S., Latham ACT).

So, from your letter A.S., I conclude that the outer (current carrying) electrons are buzzing around at 2100 metres per second, while current flows at c/2.

While this doesn't give a drift speed, it illustrates there are really three speeds to think about: orbiting speed, drift speed and propagation speed.

The next letter gives a value of drift speed...

Your correspondent D.L. of Tumblong may even be a bit optimistic with his estimate of 1cm/sec for ion velocity, but he is certainly close to the mark.

Sears and Zemansky write in 'University Physics' Vol 2 that the drift speed of electrons in a copper conductor is about 0.015cm/sec. They continue saying 'this should not be confused with the velocity of propagation of an electromagnetic wave along the conductor, which if the conductor is in a vacuum is the same as the velocity of light'.

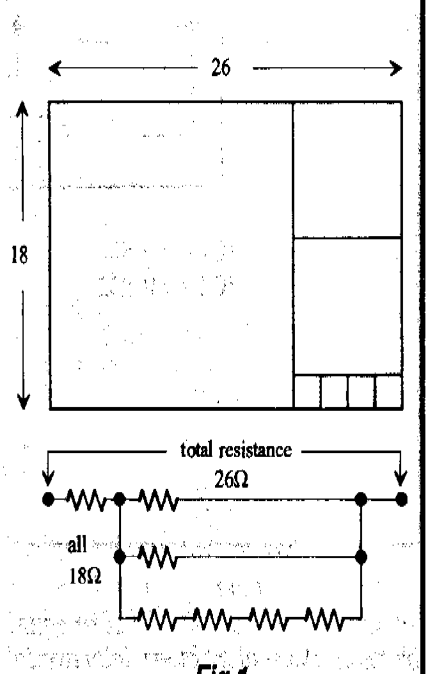


Fig.1

Since there are about 3.5×10^9 atoms of copper per lineal metre, each electron has to negotiate around 0.5 million atoms per second. It's hardly surprising that current flow experiences resistance and produces heat. (N.E., Lecturer in Agricultural Engineering, Geelong Vic).

This value for drift speed is certainly much slower than any value so far suggested, but given the source, it's probably the value generally accepted. So, in summary, the drift speed is around 0.02cm/-sec, the orbiting speed of outer electrons is 2100 m/s and the propagation speed anywhere from c/2 to c.

My thanks to these writers, and to all those who have contributed to this rather academic discussion. It may not help a student learning Ohm's law, but it clarifies a few issues that bug us from time to time.

And having mentioned Ohm's law, here's an interesting way to calculate a resistance value...

Precision resistor value

A question that occasionally arises is, given an unlimited number of resistors of X ohms, calculate the minimum number of resistors required to obtain a desired resistance value — then draw the resistor network required.

I was recently shown an interesting way of solving this problem. To do this, draw a rectangle with the total resistance represented by the length of the top and the given resistance value represented by the sides.

You then divide the rectangle into squares of the largest possible size until the rectangle is fully divided. The input and output of the resistor network is along the sides of the rectangle.

If X number of parallel blocks of resistors are placed in series X times, the total resistance equals the value of the single resistor. Therefore, each square in the diagram can be replaced by a single resistor.

The diagram (Fig.1) shows how to connect 18 ohm resistors to give a total resistance of 26 ohms. (T.R and G.S., Mitcham Vic).

A most elegant and simple method indeed. The diagram is shown in Fig.1, which as you can see is simplicity itself. I drew this one on a computer, which makes the process very quick and accurate.

Some quick checking on a calculator proves the point as the total resistance of the network of resistors is exactly 26 ohms. Just as the writers predicted. I like it!

Amiga computers

We get quite a few letters asking for computer projects. We also get quite a lot of letters saying 'computer projects are too complex, how about a ...' And there are many readers who claim the IBM computer gets all the projects — 'what about the Amiga, Commodore etc'. It's difficult to please everyone when it comes to computers, so I'll say no more and let the next correspondent take up the argument.

I am a great reader of your magazine. I think an improvement could be made on construction projects however, for example PCB designs could be smaller. Also, computer projects could be designed to suit various types of computers, such as the Amiga. I say this because I own an Amiga 500.

INFORMATION CENTRE

I've noticed your Improved Serial I/O Interface for PC's and I wonder if it can also work on an Amiga computer. If not, perhaps the Real World Interface published February 1989 might suit.

I recently picked up a circuit diagram for using IBM drives on an Amiga. It came on a public domain disk and I want to know if this circuit is suitable for using 1.44Mbyte IBM drives on the Amiga. Incidentally, you might want to use this circuit as a project. (L.L., Warradale SA).

Thanks for these comments L.L. Both projects you mention will work on the Amiga (a point actually made in the articles). However, the BASIC programs may not be compatible, particularly the references to ports and other hardware items.

I've included the interface circuit (Fig.2) you sent me, as this could be of interest to other Amiga users. I'm not sure if a 1.4M drive is compatible, as although (to the best of my knowledge) the hardware requirements are the same as for a 720K drive, there are some subtle differences in these drives.

A 1.4M drive knows if the floppy disk is a 1.4M type by the presence of the extra hole in the disk case. An IBM computer knows if the drive is a 1.4M type through the BIOS, which is updated by the user.

It may be that a 1.4M drive will only operate as a 720K drive on the Amiga, or at worst, not work at all. Unfortunately, I can't be more definite about this as there are quite a lot of issues involved. My advice would be try it, as I can see no electrical reasons that could cause damage to either the drive or the computer.

On the subject of suggested project areas, here's an interesting idea...

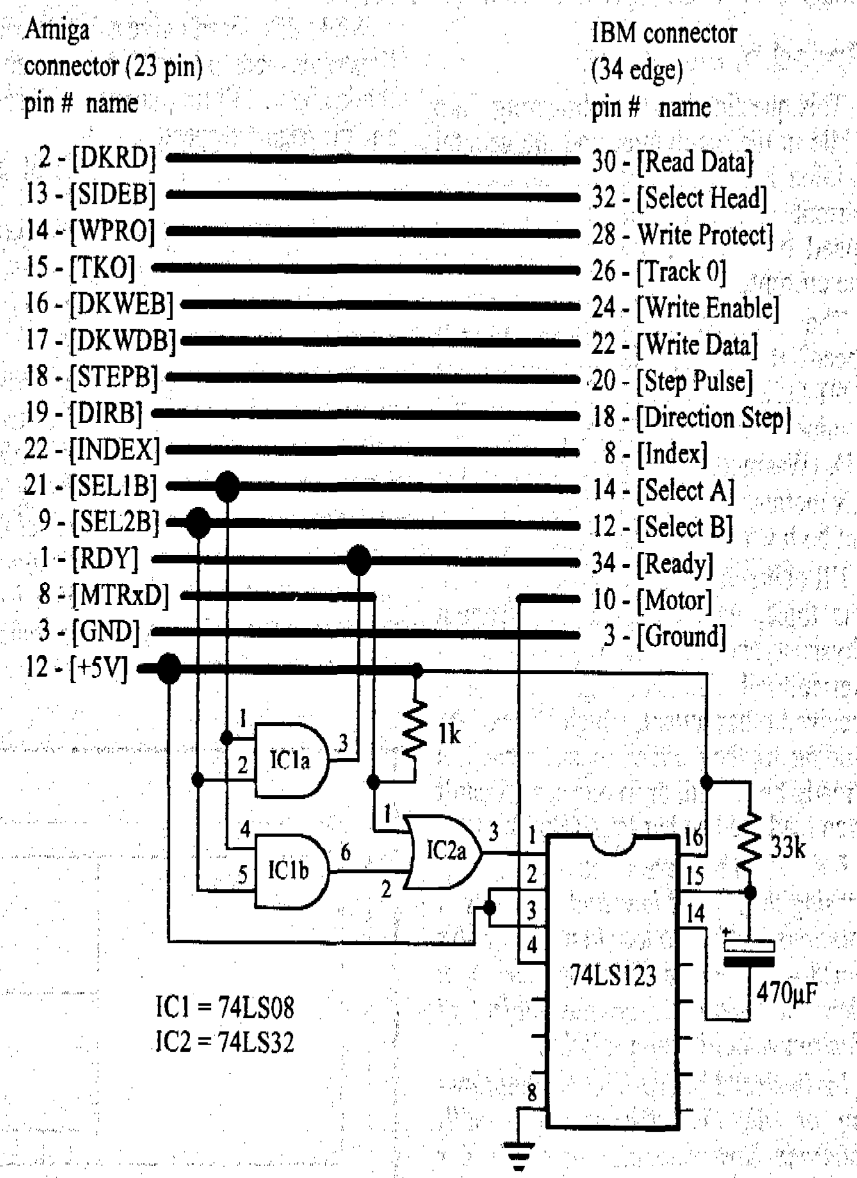


Fig.2

Lawn mowers

I recently had the situation of being unable to start my lawn mower. It's bad enough having to mow the lawns when one has interesting projects in hand, but worse when the mower won't start. Some systematic fault finding eventually showed that the ignition module in the mower was defective. A new one cost $40 and the mower is now back in service.

Since an electronic ignition module can replace the ignition points on older mowers, it occurred to me that an electronic ignition circuit might be a very good project for those EA readers who prefer to maintain their own mowers.

Certainly, the circuit would be equal to or better than the commercially available modules. And also much cheaper.

Thanks for a fine magazine. (B.G., Wingham NSW).

And thanks to you B.G., for the nice comments about the magazine. This is an interesting idea, although I'm wondering how many of today's mowers could use such a module.

All the mowers I've been unfortunate enough to own have used a magnet on the fly-wheel to generate the spark, and the timing of the spark as well. In fact, I must say that the electrics has always been the most reliable part of these mowers.

My experiences have been more to do with the mechanics: wheels falling off, handles collapsing, gummed up carburettors, broken rings and that sort of thing. In fact, about five years ago I bought an electric mower, and apart from having to replace a motor bearing, I've had no further problems. However, as this indicates, my experience with petrol mowers is therefore rather out of touch and an electronic module may be a good project. At this stage, it's not being planned, but is one we will keep in mind.

To end this month's offerings on a fairly basic level, here's another word about:

Hand dryers

Harking back to October, the next letter has more to say about hand dryers — in response to the suggestion of recirculating the hot air.

On the subject of hand dryers, the elements are up to temperature in seconds and the coolness is due to the evaporation of the water.

As the water evaporates, so the heat is sensed by the hand, making the user think that the heater is just coming up to temperature.

If the air is recirculated, all that will happen will be an increase in the humidity of the air and a decrease of evaporation, leading to a longer

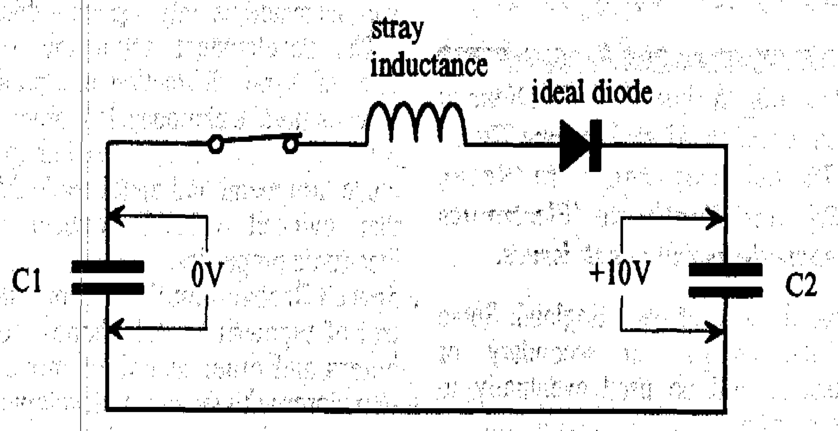


Fig.3

drying time. It would even be possible to end up with badly steamed WET hands. (R.H., Croydon Vic).

Fair enough, although it seemed a good idea at the time. What you say makes sense, R.H., and probably explains why hand dryer manufacturers don't incorporate air recirculation.

What??

This is more a Why?? than a What??. The question comes from Vic Ciscato (Kenthurst NSW) who asks: Why does the VA rating of a centre-tapped transformer connected to a full-wave rectifier circuit need to be higher than a conventional transformer connected to a bridge rectifier?

This assumes the same load current and output voltage for both circuits.

Answer to January What??

In any circuit there is a finite stray inductance, as shown in Fig.3. With the switch open, the c urrent through the inductor is zero. When the switch is closed, the current through the inductor increases with time, and reaches a maximum when the capacitor voltages are equal (both +5V).

At this point the current in the inductor begins to decrease, due to the reversal of the voltage. When the current falls to zero, C1 is uncharged and C2 has 10V across it. This is a stable state as the diode prevents C2 discharging back into C1.

Note that the exact value of the stray inductance is unimportant and that any resistance in the circuit has been neglected. ❖

NOTES & ERRATA

ALL-PURPOSE WIDEBAND AMPLIFIER (November 1991):

In the circuit diagram, the 7.5V rail is shown as being 5.5V. This annotation should be on the other side of R4 (i.e., the collectors of Q7 and Q8). Also, the voltage rating of C3 should be 25V, and Q1 should be fitted with a heatsink.

The cost of the amplifier may be reduced considerably and the assembly simplified by replacing the discrete 7.5V regulator circuit with an LM7808CT 8V regulator, which is now widely available at a good price.

Some circuit voltages will be slightly higher, but this is acceptable. The LM7808CT will require a minimal amount of heatsinking.

The reason that a 'jacked-up' 5V regulator was not used originally is that the required programming resistors would have increased the regulator output current by about 50%.

Note that differences between various brands of potentiometers used for RV2 (the gain control) and the way they are mounted may have an effect on HF response. The leads to RV2 should be very short, and kept clear from earth and any other wiring.

Varying construction techniques may increase the shunt capacitances associated with the collectors of Q5 and Q6, making it necessary to recompensate the amplifier. This can be achieved by feeding to the input a 1Vp-p good quality square wave with a frequency between 100kHz and 1MHz.

The output is then terminated in 75 ohms and viewed with a CRO having at least 20MHz bandwidth. The output amplitude is adjusted to be 1Vp-p by means of RV2, and the values of both C13 and C14 are then increased proportionately by small increments until overshoot is just visible on the output waveform.

If necessary, trimmer capacitors may be fitted to facilitate this adjustment.

FORUM

(Continued from page 38)

of energy has been expended in collecting together one coulomb of charge, and that the same joule of energy can be released again when the coulomb of charge returns again.

Now just as the rate of flow of charge (coulombs per second) corresponds to current (amps), it turns out that the rate at which the stored energy is released — in *joules per second* — corresponds to power dissipation, which is measured in *watts*. If a circuit is dissipating one watt of power, this means that one joule of energy is being released every second.

Not surprisingly, it's basically both the current flow and the voltage that together determine the rate at which energy is released. This is because the current corresponds to the amount of charge that is flowing (amps = coulombs per second), while the voltage determines the amount of energy stored in the charge by virtue of its pressure (voltage = joules per coulomb).

So if we simply multiply together the current and the voltage, we get a figure that corresponds to the power, or the rate at which electrical energy is being released — in joules per second, or watts.

In other words:

$$P = I \times E$$

where P is the power dissipation, and I and E are the current and voltage as before.

Did I lose you?

At this stage I seem to have covered rather more than simply explaining the concept of voltage. Perhaps that also means I've digressed too far, and not answered the original question well enough. Alternatively, it could be that my explanation has become so long, that I've managed to lose everyone — including perhaps Sam Benson himself.

It's hard for me to tell, of course; I guess I'm too close to it. So I'll leave the discussion here for the moment, in the hope that either Sam Benson or someone else will 'come back for more' if the concept still isn't clear enough.

Don't be shy, now. If there's still something about voltage that I haven't explained properly, let me know. These fundamental concepts are not easy to either explain or to grasp, and the only way to do either properly is for us to keep working at it.

Either way, I hope you'll join us here again, next month. ❖

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 Au:tralia' 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.

February 1942

Power Alcohol: Distilleries designed to produce 3,000,000 gallons of power alcohol a year from wheat may soon be open in several states. One of the main plants will be in NSW.

Chief factors governing the selection of the sites are availability of power, adequacy of water supply and sewerage capacity to dispose of waste.

Hydro Power: After final tests, the first of three identical 108,000kW Westinghouse generators, each driven by a 150,000 horse power waterwheel, will go to work at Grand Coulee Dam. Each generator is nearly one third more powerful than any waterwheel previously built in the United States.

Power from the big machines will fill many defence requirements and peace time industrial needs in an area about twice the size of New England. Some of the energy, all secondary or seasonal, will be used eventually to pump water into the vast semi-arid Big Bend area, 50 miles away, to restore productivity to about 1,200,000 acres of land.

February 1967

Thin Films: Delicate layers of electronically active material are making possible a new generation of solid state devices. Less than one micron (one millionth of a metre) thick, the thin films which constitute the latest micro circuits, are revolutionising the design of television equipment, computer, communication systems, missile and spacecraft controls and a host of other electronic devices.

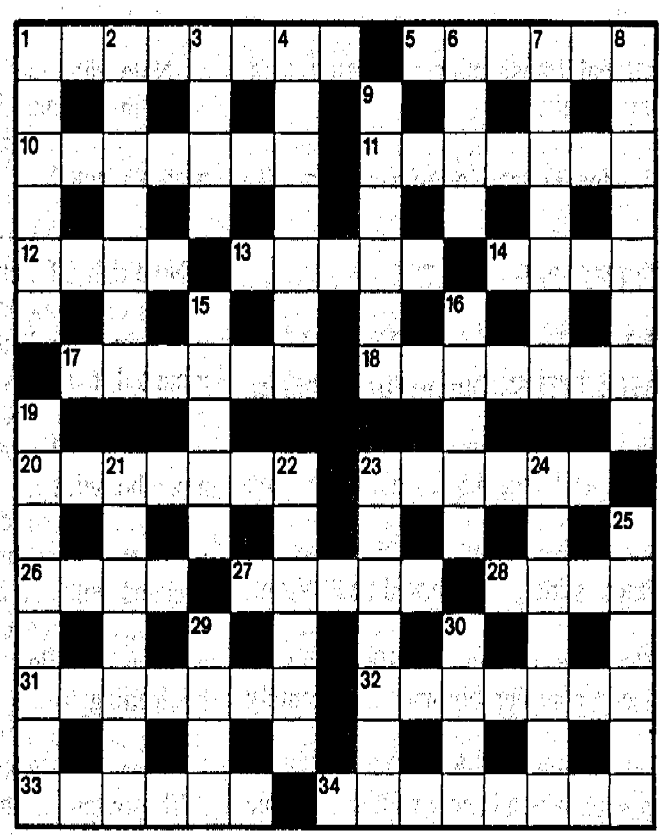
Interest in 'electronic' films arose in the early 1920's following investigations into the nature and dynamics of atomic monolayers — thin layers of various materials only one atom thick.

The development about the same time of X-ray diffraction and similar investigative techniques led other researchers to extend these studies to include thin metal and metal oxide films that evinced valuable optical and electronic properties.

Speech Recognition: Direct voice control of typewriters, telephones, computers and other machines moved a step closer with the recent development of an experimental speech recognition system. It was built by RCA and employs electronic circuits that function like living nerve cells.

The system identifies the smallest units of speech, called 'phonemes', by abstracting their more salient features. Of the 40 phonemes in the English language, the machine can recognise 28. In its present form, the equipment recognises the initial consonant and the following vowel in a consonant-vowel-consonant word. Further experiments will try to produce circuitry that will determine the influence on the consonant of a preceding vowel. The system will then be able to identify all phonemes in complete words. ❖

EA CROSSWORD



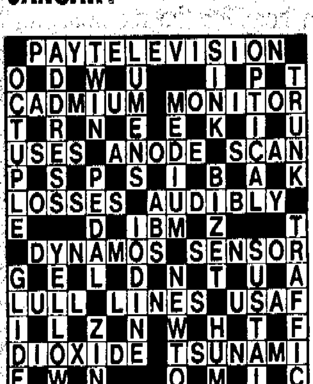
ACROSS

1. Make self-operating. (8)
5. Relative position or condition. (6)
10. Transmitting a blocking signal. (7)
11. Said of reasoning based on reliable inference. (7)
12. Unaccompanied flight. (4)
13. Electrical appliance. (5)
14. Unit of force. (4)
17. Sub-atomic particle. (6)
18. A systematic study. (7)
20. Said of telephone circuit in use. (7)
23. Protects from external interference. (6)
26. Division of the Zodiac. (4)
27. Pertaining to base 8 numbering. (5)
28. Cease to be functioning. (4)
31. Mixed metals. (7)
32. Famous firm in electronics. (7)
33. Checked operation of device. (6)
34. Said of data that was not recorded. (8)

DOWN

1. Change setting. (6)
2. Type of switch. (7)
3. Quick communication, electronic——. (4)
4. Possibly put under high tension. (7)
6. Radioactive tracers act as these. (4)
7. Name of particle exceeding the speed of light. (7)
8. Fused a connection. (8)
9. Clean-room gear. (6)
15. Significant part of a complex circuit. (5)
16. Mathematical figure. (5)
19. Transmission of information via TV. (8)
21. Safety wear. (7)
22. Group of ten. (6)
23. Improve focussing. (7)
24. Inserting cassette or disc. (7)
25. Operated a switch. (6)
29. Use word processor. (4)
30. Metric prefix greater than pico. (4)

SOLUTION FOR JANUARY



EA with ETI marketplace

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ROMloader - 2

Continued from page 70

An example

To make things clearer, I will go through an example using Procomm. Procomm would be running on the host computer and the ROMloader turned on. The menu will be displayed.

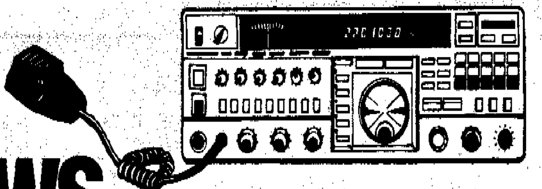
Type '1' at the option prompt and the ROMloader will be awaiting an ASCII file in Intel Hex format. Now inside Procomm, the upload command (page-up) is pressed and the protocol type selected (7 for ASCII). Procomm will ask for the 'filename.ext'.

After entering the filename and return, the file will be 'uploaded' into the ROMloader. When uploading is complete, the ROMloader will re-display the menu. Type '7' if you want to check that the data is correct and finally if all seems well, type '6' to start the target system. The target system will now be running. If we want to restart the program again, type '5' and then '6'. All very simple!

One feature that may be of benefit to some people is the ability for the target system to write back into the ROMloader's RAM, as if it were a 'real' EPROM. While microprocessor emulators let you read the registers, using the write to RAM ability, you might be able to modify your program to write the microprocessor's registers into the ROMloader's RAM.

Finally, when you have finished developing the software, the software can be burnt into a genuine EPROM and installed in the target system permanently. ❖

Amateur Radio News



Morse practice sessions for MWRS

The latest issue of Manly-Warringah Radio Society's Newsletter advises that Morse practice sessions for the Society's members are being held each Tuesday evening from approx. 7.45 to 9.00pm by Vic VK2EVJ at his home QTH in Dee Why. As Vic himself has a code capability of better than 60wpm, he is in a position to offer considerable help to those struggling to master the code for their full call.

Update on Waitakere by-law

You may recall that in the September 1991 issue we published a report from New Zealand amateur Ian Andrews ZL4MB, on a new by-law announced by the Waitakere City Council — imposing what seemed like draconian regulations on all transmitters and other devices that radiate RF. All such equipment was to be tested, and a special additional licence paid — all with the idea of ensuring that they posed no health risks.

Well, there's been an update to this story, sent to us from Mr K. McLean of Papakura in South Auckland. Apparently the version of the Waitakere C.C. by-law reported by ZL4MB was only the 'first draft', which was subsequently modified after a further public meeting and submissions from various bodies — including both the NZ Amateur Radio Association and the Citizen Band Radio Association of NZ.

The upshot is that the final draft of the by-law, which came into force on November 1, now appears to apply only to equipment with 'a transmitter power output level greater than 1kW'.

Hopefully this means that most amateur radio gear, CB rigs, cordless telephones and other low-power transmitters will be exempt, and able to continue as before.

Satellite demos at Gosford's Field Day

Further to the Central Coast Amateur Radio Club's latest Gosford Field Day, coming up this month on Sunday the 23rd, Julie Kentwell VK2XBR has sent this item on what's planned for one of the WIA displays:

Visitors to last year's Gosford Field Day would have noticed a small WIA home-brew Aussat receiver demonstration, in Wally VK2AXW's VideoSat bus. The overwhelming response caught us all flat-footed. There are many stories about how many amateurs tried several times over a period of hours, to get into the bus, but they couldn't get near it.

Well, the NSW Division of the WIA will be better prepared this time! We will have several displays, and a team of Aussat home-receiver enthusiasts — including a hands-on 'as you buy it' display — as well as more and bigger satellite dishes, better pictures, more facilities and more fascinating gadgets.

Last Gosford Field Day people came from as far as Wagga to see our little display, so if you come again we will make you glad you did. On display will be receivers for different types of radio and TV, controllers and accessories. Some cannot be bought and must be made by you — but information enabling radio amateurs to 'roll their own' will be available, perhaps with ready-made circuit boards which are being developed by the WIA NSW Division, along with custom integrated circuits to make the job easy.

More information will be broadcast by the WIA NSW Division on our regular Sunday broadcasts, as the big event draws close. Listen on 7146kHz AM at 11am and 7.30pm each Sunday in February, for more details. See you at Gosford in the big blue bus! ❖

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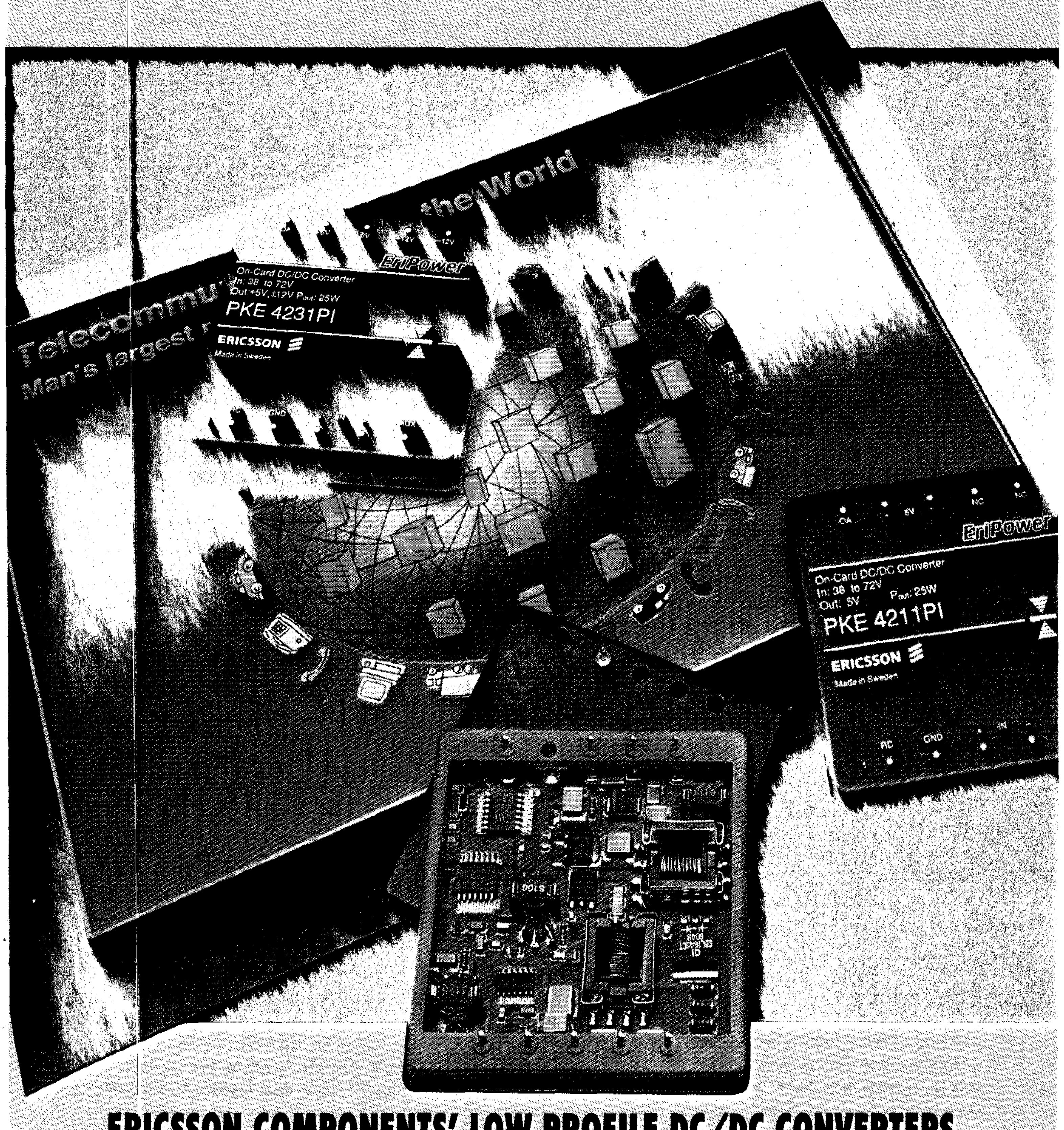


ERICSSON COMPONENTS' LOW PROFILE DC/DC CONVERTERS FOR DISTRIBUTED POWER SUPPLIES IN DATA, TELECOMMS

NEWS HIGHLIGHTS

NEW MICROWAVE TEST SET FROM MARCONI

UK-based test equipment maker Marconi Instruments has developed a new portable microwave test set, which integrates the facilities to perform a comprehensive range of tests on both equipment and components used for RF and microwave communications. The unit was demonstrated in Sydney recently by MI's Australian subsidiary.

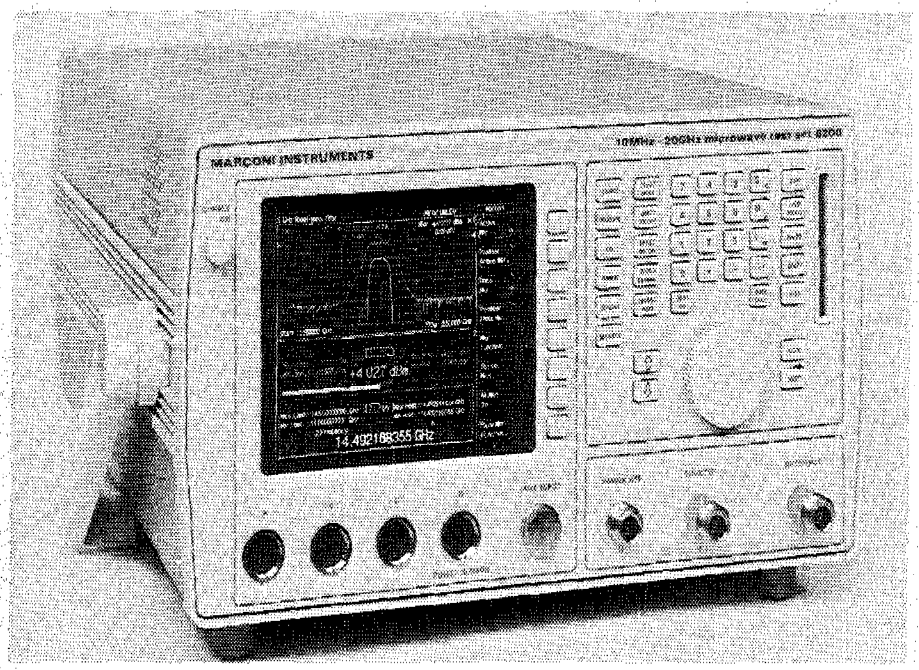
Designed for both field testing and laboratory use, the new Marconi 6200 Microwave Test Set (MTS) covers the frequency range from 10MHz to 26.5GHz, and offers a standard of performance comparable with testing systems costing between twice and three times its cost.

The new 6200 MTS integrates what is claimed to be the fastest synthesised wideband sweep generator currently available (resolution 1Hz) with a four-input scalar analyser, power meter, frequency counter and programmable voltage/current source. These facilities allow it to perform fast and efficient measurements of the performance and characteristics of both systems and components. It also offers the ability to perform *real-time* fault analysis and location on microwave cables and waveguides, using 'synthetic pulse' frequency-domain reflectometry (FDR).

Much of the new test set's impressive performance stems from the use of two 32-bit 'Transputer' microprocessors, one for system housekeeping and the other for signal analysis and processing, which give it exceptionally powerful 20MIPS processing. It also features a high resolution colour display, with an intuitive graphical user interface (GUI) for easy and efficient use.

The fast synthesiser used in the MTS uses patented technology to achieve true synthesised sweeping — over the full 26GHz, if required. Every point in the sweep is synthesised, which enables the testing of even the narrowest of filters — including devices with Q's as high as 10,000. A typical 400-point fully synthesised sweep can be made in less than 200ms, allowing interactive tuning without compromising accuracy. Levelled accuracy is typically within +/-0.5dB, and patented source matching system eliminates the need for a second live reference detector for many measurements.

Thanks to its fast synthesiser, the FDR facility of the 6200 allows real-time location of discontinuities and faults in microwave antenna feeders and transmission lines, with a resolution and accuracy typically 10 times that of non- synthesised FDR systems. Faults can be located over distances of many kilometres, and pinpointed to within a few millimetres — typically in less than 600ms, and all without the need for external processing. Marconi claims this is the only scalar system to offer this performance, currently available.



NEW HEADQUARTERS FOR JAYCAR

Jaycar Electronics has moved into a new 15,000ft^2 warehouse and operations centre in the Sydney suburb of Rhodes — centrally located to the major interstate road links.

The new facility houses all of the firm's administration, warehousing and distribution operations.

A new computerised distribution management computer system has also been installed.

Jaycar Managing Director Gary Johnston says that the new facility will enable the company to provide even faster service, to its 10 fully-owned stores.

Mr Johnston said the facility will also enable Jaycar to expand its store base, which was impossible with its head quarters at the previous premises.

OPTUS TO 'FAST TRACK' INFRASTRUCTURE

Australia's new second telecommunications carrier Optus Communications is planning to invest over $4 billion over the next five years, to 'fast track' the establishment of its infrastructure, according to the consortium's chairman Sir Brian Inglis. This is expected to be the largest privately-funded project in Australia for the 1990's.

Sir Brian explained that deployment of the Optus network will involve establishing a fibre-optic backbone network from Cairns, through the eastern states and Adelaide to Perth. This network will be complemented by highly advanced digital switching and transmission systems.

Optus Communications is 51% owned by Mayne Nickless, the AMP, National Mutual and other institutional investors (whose interests are managed by the AIDC Telecommunications Fund Management), and 49% owned by US-based Bell South and UK-based Cable and Wireless. It plans to introduce domestic long distance and international services by the end of the year, and digital cellular services for mobile and personal communications early next year, based on the European Global System for Mobile Communications (GSM) standard.

The consortium apparently plans to use Aussat's facilities for those services for which satellite delivery is best suited, such as TV distribution, pay TV, remote TV and radio broadcasting, data and VSAT services, and mobile satellite communications. It apparently has no plans to vary Aussat's existing contractual committments relative to the new B-series satellites.

AUSTEL CRACKS DOWN ON NON-PERMITTED PRODUCTS

The Investigations Inspectorate of Australian Telecommunications Authority (Austel) has begun cracking down on suppliers of telephones, answering machines, fax machines and other telecommunications equipment which is not authorised for connection to the Australian network. This is because some suppliers are still selling such 'non-permitted' equipment to users, even though a penalty of $12,000 applies for both selling or supplying such equipment, and/or connecting it to the network.

Austel has also launched an education program, to raise consumer awareness regarding the need to ensure that all equipment is permitted. Called the Permitted Products Program, this is emphasising the need for users to only purchase and connect equipment carrying a distinctive logo, indicating that it has passed Austel's tests and requirements to become a Permitted Product. Suppliers of permitted products are being encouraged to use the logo in the promotion and marketing of their products.

AUSTEL
AUSTRALIAN TELECOMMUNICATIONS AUTHORITY
Only products that carry an AUSTEL Permit have been tested to meet AUSTEL's safety and technical standards.

FAST GROWTH OF MOBILE PHONES

Despite the recession, Australia's mobile phone network is currently expanding at the rate of nearly 50% per year, according to Arthur Wood — Telecom's national sales and marketing manager for MobileNet. This makes it one of the fastest growing in the world.

"Our current projections indicate that by the year 2000, more than 60% of all calls will have a mobile component", Mr Wood added.

"The usage of mobile phones in the central business districts of Sydney and Melbourne means that base stations are being erected as closely as 500 metres, to make sure the network's capacity can cope with the demand. Only in some sections of New York are base stations spaced so closely." Mr Wood said that 80% of Australia's population was now covered by Telecom's MobileNet network, while geographically the network covered more than 25 million hectares. The next largest coverage area is the UK, with 13 million hectares.

To date Telecom has invested $600 million in the mobile network, and plans to continue investing at $50 million annually. "Australians have shown they want mobile phones, and that they want to use them just about anywhere", said Mr Wood.

INMARSAT-C NOW GLOBAL

Inmarsat-C, the new mobile satellite communications system that features terminals small enough to be hand-portable, is now available worldwide with the opening of COMSAT's land earth station at Southbury, Connecticut, in the US.

The Southbury station provides Inmarsat-C service to the Atlantic Ocean-West coverage region, an area which includes most of North and South America, western Africa and western Europe.

COMSAT has also inaugurated its Santa Paula, California, station for service to the Pacific Ocean region, bringing to 10 the number of land earth stations around the world offering the Inmarsat-C service. A further 11 stations are in the process of being commissioned and at least 16 more are planned.

Introduced early in 1991, the Inmarsat-C system allows two-way text or data messages of up to several pages in length to be sent and received between fixed telecommunications networks and mobile terminals anywhere in the world. The system currently handles between 4000 and 4500 calls every day.

Inmarsat-C is rapidly becoming the basis for a wide variety of land mobile services including fleet management and information systems for the road transport industry. Portable Inmarsat-C terminals are also increasingly being used by journalists in the field and by companies for remote monitoring and control applications.

POWER SUPPLY VIA OPTICAL FIBRES

A power supply module has been fabricated at Siemens Central Research Laboratories in Erlangen, Germany, with a high power laser diode array as transmitter and GaAs photoelement arrays as receivers. It can transmit 120mW of electric power through a 10 metre long optical fibre.

The transmitter used is a high powered laser diode array developed by the Siemens Semiconductor Group, with 40 strips and a maximum optical output power of one watt. It is connected to a pigtail approximately one metre in length, from which the light is injected into a 400um step-index quartz glass fibre.

A multi-photoelement array based on GaAs with an approximate 2mm card length, also developed by the Semiconductor Group, reconverts the light into electric current at approximately 7V. The array consists of 4 x 8 discrete elements, some of them switched in series to increase the output voltage. With optimal matching of the cone of illumination to the multi-photoelement array, an efficiency of more than 30% was attained for the optical-to-electrical conversion. The efficien-

NEWS HIGHLIGHTS

cy of the overall system was about 2% at maximum electrical power and a transmission length of 10m. The overall efficiency declines with increasing length of the glass fibres. Despite this, a power supply of over 100mW can be realised over several hundred metres with a 6dB/km attenuation of the light in the glass fibre.

Such power supplies can be used for sensors in the high-voltage range, for example. Apart from the power supply, signals can also be transmitted along the optical fibre: all electrical connections to the test instruments are thus eliminated.

THREE MORE AIRLINES CHOOSE AIRCOM

China Airlines, Finnair and Swissair are to fit their new McDonnell Douglas MD-11s with Inmarsat satellite communications equipment. In the biggest single satellite avionics deal to date, the three airlines have selected Inmarsat type-approved manufacturers, Honeywell-Racal, to supply up to 60 sets of satcoms avionics equipment. This equipment will be integrated into the aircraft systems by McDonnell Douglas on and delivered to the airlines from 1993. The airlines are yet to make a decision on which antenna they will use.

Each installation will offer a total of six voice and data channels, capable of being used in any combination to support passenger telephony, facsimile and data communications services as well as all flight deck voice and data links with ground control facilities, wherever in the world the aircraft may be flying.

Calls from aboard aircraft are routed via Inmarsat satellites and through ground earth stations (ESs) which deliver them into national and international telecom networks. GESs are owned and operated by signatories of a number of Inmarsat member countries.

Several GES operators have teamed together to provide global aeronautical communications using the Inmarsat system. China Airlines, Finnair and Swissair have contracted with the Satellite Aircom consortium that comprises France Telecom, OTC Ltd. of Australia and Teleglobe Canada, for the provision of Inmarsat satcoms services. This consortium uses GESs at Pleumeur Boudou (France), Perth (Australia), Weir (Canada), and Niles Canyon (USA).

In September last year, commercial airline passenger telephony was inaugurated on a Singapore International Airlines Boeing 747-400. The airline is scheduled to fit 20 more Boeing 747s with Inmarsat terminals between now and 1994. Other passenger airlines committed to Inmarsat satcoms are Air Canada, Air France, Canadian Airlines International, Cathay Pacific, Northwest Airlines, Qantas, Saudia and United Airlines.

CCIR VOTES FOR HD-MAC

The working parties and task groups of the CCIR (Consultative Committee for International Radio), meeting in Geneva in November adapted a breakthrough recommendation on the HD-MAC transmission standard.

This proposes that 50Hz countries starting with MAC transmissions, and which wish to continue with a compatible high definition service, should use the HD-MAC system as given in the annex of the recommendation. This decision is an important advance for the European HD-MAC transmission standard, which is being developed within the Eureka 95 HDTV project.

The primary objective of the Eureka 95 project has always been downwards compatibility with the MAC/Packet system to allow for easy introduction of high definition television. The HD-MAC draft recommendation has also been unanimously adopted by the European administrations.

During this CCIR meeting, it was agreed that the existing studio standard using 1250 lines and 50Hz field frequency, developed within the Eureka 95 project, should be incorporated in the annex of the already existing CCIR recommendation 709, which describes some parameters. However, no equipment could be designed according to this recommendation, because the most important parameters, such as field-rate and number of lines, were still missing.

The CCIR has now recognised the necessity to specify the two existing systems (the European 1250/50 for 50Hz countries, and the Japanese 1125/60 for 60 Hz countries), so that further implementation of HDTV studios can continue at full speed.

SMALLEST E-M MOTOR DEVELOPED

Toshiba Corporation claims to have developed a prototype ultra-small electromagentic motor with the smallest outside diameter ever achieved. The new motor, including bearings, coils and a magnet, is housed in a 5mm long cylindrical casing which has an outside diameter of only 3mm. This is 40% small than cur-

NEWS BRIEFS

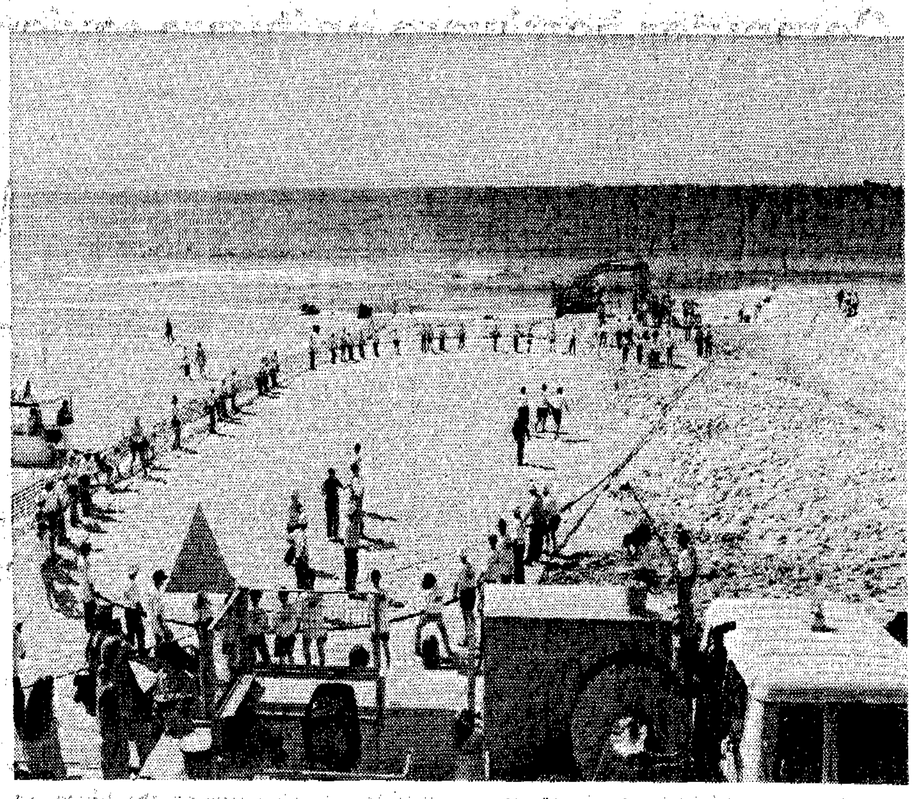
- Mr. John Dougall, with 26 years' experience in business development and administration in high technology industries, has been appointed managing director of ***AWA Limited.*** He took up the position in January, following three years in which Mr John Iliffe has performed the dual role of chairman and chieve executive officer.
- ***Electronic Development Sales*** has appointed its Queensland distributor ***ECQ Electronics*** to be its Victorian distributor also. (ECQ is the distributor for EDS — not EDS the distributor for ECQ, as we accidentally stated in the December issue of *EA*.
- Mr Dean Vaughan has been appointed as Melbourne Sales Engineer for ***Thomas Electronics***. The company has relocated its Melbourne office and service facility to larger premises at 19 Stewart Street, Mount Waverley. Its new phone number is (03) 887 8900.
- ***Siemens*** has appointed Darren Powierski as Applications Engineer in its electronics components department.
- Brian McGoldrick has been appointed General Manager of Sydney-based audio distributor, ***Ross Electronics***.
- Paul Cummings is the new Managing Director of ***Hanimex Australasia***, replacing Jonathan Pinshaw who has been appointed Chief Executive Office for the Hanimex Corporation in both Australasia and the United Kingdom.
- Quality Technologies Corporation has completed its purchase of Harris Corporation's optoelectronics operation. All such products previously supplied by Harris will be be supplied by QTC (represented in Australia by ***KC Electronics***).
- Darling Harbour, Sydney will host several exhibitions next month. ***Optical & Image Processing*** is on 3-5 March, with ***PC92*** and ***Communications and Office Technology 92*** being held concurrently on 10-13 March.
- ***CADEX'92*** (Computer Aided Design EXpos) will be held in March and April, with three shows in NSW, Victoria and Queensland. Exhibitors can register by phoning 008 077 622.

rent prototypes, which have been reported as having an outside diameter of 5mm.

Researchers around the world are now engaged in a number of major projects to develop 'micromachines' — minute hardware systems expected to have wide application in the inspection of small diameter tubes and piping in industrial plants. Another potential area of application is medicine, where it is anticipated that a future generation of much smaller machines may be directly introduced into the human body to carry out inspection of the digestive tract and the bloodstream.

The compact size of the motor is achieved through the use of Toshiba's expertise in precision machining technology to fabricate miniaturised components. The motor's three coils are wound from fine wire, and have a diameter of only0.2mm. The magnet is manufactured by using EDM (electrical discharge machining), and the size of the motor is further reduced by the incorporation of a dedicated IC to control the direction of the drive — removing the need for the position detecting sensors and brushes found in conventional ultra small motors.

Toshiba's prototype requires only 2 - 3V of power, to achieve a driving power of 1 x 10^{-5} Newton metre. The design also offers flexibility, in that the driving power can be enhanced by increasing the length of the motor, including the length of its coils and magnet, while maintaining the current outside diameter.



This photo was taken when the Sydney end of the new Tasman 2 Australia/NZ fibre optic cable was being brought ashore and laid at Bondi Beach. The cable ship Vercors is visible offshore at upper right, with the cable path identified by a row of spherical floats.

'ANYTHING GOES' PRIZE WINNERS

The response to our Oatley Electronics/EA 'Anything Goes' Competition (which closed on November 30, 1991) was most gratifying — our thanks to the many, many readers who sent in imaginative applications for the Helium-Neon Gas Laser (September 1991) and Night Viewer (October 1991) projects.

After much reading through the veritable mound of entries, and then debating amongst our judges, we were finally able to select the winners. And here they are:

FIRST PRIZE: Winner of the 'Sub Starlight' Night Viewer (value $1595) was Mr Lawson James, of Jindalee in Queensland, for his Veterinary Laser Acupuncture Unit.

SECOND PRIZE: Winner of the 7mW Helium-Neon Gas Laser System (value $520) was Mr Ian Richie, of Turner in the ACT, for his Night Ranging Viewfinder.

THIRD PRIZE: Winner of the Night Viewer Kit (value $299) was Mr Robert Marcussen, of Paradise in South Australia, for his Nocturnal Wildlife Photographic System.

FOURTH PRIZE: Winner of the 1mW Laser Head and Power Supply (value over $259) was Mr Jeff Fell, of Windsor NSW, for his Smoke Imager.

FIFTH PRIZE: Winner of the 2mW Laser Head and Power Supply (value $210) was Mr Simon Jansen, of Avondale, Auckland NZ, for his system to measure the wavelength of light.

PRIZES 6-25: The following entrants each won a kit of parts for the PIR Alarm Module, as described in the May 1989 issue (value $47.85 each):

Mr Brett Sandercock, Colonel Light Gardens, SA (Simple Laser Ruler)
Mr Andrew Helgeson, Devon Park, SA (Laser Image Scanner)
Mr Simon Hildebrandt, Mona Vale, NSW (Laser Oscilloscope)
Mr Otto Priboj, Carramar NSW (Laser Scanning System)
Mr Denis Krslovic, Roselands NSW (Laser Dance Pattern Projector)
Mr Alex Hasker, Beaumaris, Vic (Self-levelling Laser Dumpy Level)
Mr John Eastoff, Valley View, SA (Electronic Fault Finding using IR)
Mr Erik Isokangas, of Kenmore, Qld (IR Fault Finding Viewer)
Mr Carl Moser, of Glebe Point, NSW (Ultra-Low Cost Laser)
Mr Robert Hatvani, of Glen Iris, Vic (Laser Level)
Mr Owen Makinson, of Wattle Park, SA (Monitoring Darkroom Equipment)
Mr Paul Marson, of Royal Oak, Auckland NZ (Darkroom Viewer)
Mr Wilp Booth, of Lake Eacham, Qld (Studying Native Animals)
Mr Doug Sinclair, of Rozelle, NSW (Studying Wild Animals)
Mr D. McLean, of Keilor, Vic (IR Detection of Geological Vents/Fissures)
Mr Jeff Nocker, of Hurstbridge, Vic (Laser Sightline/Fall Guide)
Mr J. McLeod, of Scarness, Qld (Night Sextant)
Mr Antony Hendro, Baulkham Hills, NSW (Head-Mounted IR Imager)
Mr David Timmins, of Kingsford, NSW (Model Rocket Tracker)
Mr Goran Panjkovic, Wallsend, NSW (PWM Motor Speed Controller for Laser Engine)

PRIZES 26-45: The winners of the Stereo VU Meter Kits as described in the June 1987 issue (each valued at $14.90) were:

Mr Ross Geraghty, New Farm, Qld
Mr Goran Panjkovic, Wallsend, NSW
Mr Graham Cooper, St Lucia Qld
Mr Richard Rowe, Browns Bay, Auckland NZ
Mr Mark O'Doherty, Broadford, Vic
D. Rigg, Parkdale, Vic
Mr Ben Sprey, Sheldon, Qld
Mr Daniel Doyle, West Pennant Hills, NSW
Dale Dikker, Middle Park, Vic
P. Samootin, Berowra, NSW
M.V. Attwood, N. Rockhampton, Qld
Mr Michael King, Lindfield NSW
Mr Ben Gilmour, Port Macquarie, NSW
Mr Steven Horne, Altona, Vic
Mr George Cratchley, Elizabeth North, SA
B. Falleen, Wallangra, NSW
Mr Andrew Trickett, West Pennant Hills, NSW
A. Lavaring, Gin Gin, Qld
Mr Brian Plummer, Hastings NZ
Mr Simon White, Blackburn, Vic

Our congratulations to these winners, who have been sent their prizes by Oatley Electronics. We would also like to give a special commendation to Mr Otto Priboj of Carramar, NSW, whose second entry of a Laser Pointer was very well executed — but could not be included in the judging because it didn't use either the He-Ne Laser or the Night Viewer. We hope that Mr Priboj might allow us to describe this unit in the magazine, as a mini project.

TEKTRONIX WINNER

Tektronix Australia has advised the winner of the free DMM, offered in its recent promotion to *EA* subscribers:

Mr V.S. Venkatesan, Director of Biomedical Engineering, R.G.H. Hollywood, Nedlands WA. ❖

Computer hardware/software review:

MICROKEY AUDIOCARD: DIGITAL AUDIO FOR YOUR PC

Add the power of voice, music or sound effects to your favourite graphics program with this package from Video Associates. It allows the user to record sound onto the computer's hard disk, then 'play back' the audio file as a matching graphics file is displayed.

by ROB EVANS

Those who are involved in public or corporate presentations will be well aware of the persuasive power offered by a relatively standard personal computer (PC), when running one of the popular slide show/presentation software packages. These programs allow the PC to display a pre-determined sequence of graphic or text images, either under the automatic command of a programmable 'timetable', or in response to simple keyboard instructions. To make the most use of your existing software, the presentation program can generally import the images from a wide range of spreadsheet, graphics or wordprocessing programs — or in some cases, use a screen capturing utility to create its own image files by sampling the display's video memory.

As effective as these programs are in creating a striking and animated visual presentation, they tend to offer little in the way of matching sound effects other than perhaps a few plaintive beeps and squawks from the PC's internal speaker. To correct this imbalance and exploit a PC's full potential for sophisticated presentations, Video Associates have developed the Microkey AudioCard system — which in effect, offers all of the hardware and software needed to produce a corresponding *audio* show.

In contemporary buzz-word terms: welcome to 'multimedia'...

The Microkey AudioCard system

Since IBM-compatible PC's are arguably the most popular machines in the business world (where presentation software is generally used), it's not surprising to find that the Microkey AudioCard system has been designed for this type of machine. While there's an enormous range of presentation/graphics software available for the IBM-compatible (MS-DOS) range, the Video Associates people seem to have taken a great deal of effort to ensure that the Microkey AudioCard system is compatible with virtually all graphics programs (more about this later).

The computer's hardware requirements are quite straightforward, since the Microkey AudioCard system is based on its own dedicated card which is designed to fit into the 16-bit expansion socket of an AT-compatible machine, and uses the standard hard disk to store the audio files.

Although the supplied manual strongly recommends a machine equipped with the 16-bit AT-style bus, the card will apparently operate successfully when installed in the single connector 8-bit expansion slot of more modest PC/XT machines. In this case, however, we suspect that the restricted processing speed of these PCs *could* produce some timing bottlenecks with the Microkey AudioCard system. The full 640K complement of system memory is also recommended, by the way.

The card itself is a highly populated full-length device, with the various audio input and output connectors installed on its end mounting plate. There are four 3.5mm sockets in total for external connections, with two assigned to line and microphone inputs, and the remaining couple for line and headphone outputs. The latter connection is driven by the card's own 1.5W amplifier, at a level determined by a headphone volume control — which is also mounted in the end plate.

According to the information supplied by Video Associates, the card uses 12-bit sampling, and encodes and decodes the information using 'Adaptive Differential Pulse Code Modulation' or ADPCM. In practice, this apparently means that data compression ratios of roughly 3:1 are achieved as the audio files are stored on your machine's hard disk — so at a 16kHz sample rate, one minute of audio needs only 480K of disk space. Full points go to the designers for this feature, since without such compression techniques sampled audio files can easily grow to quite an alarming size, particularly at the higher sampling rates.

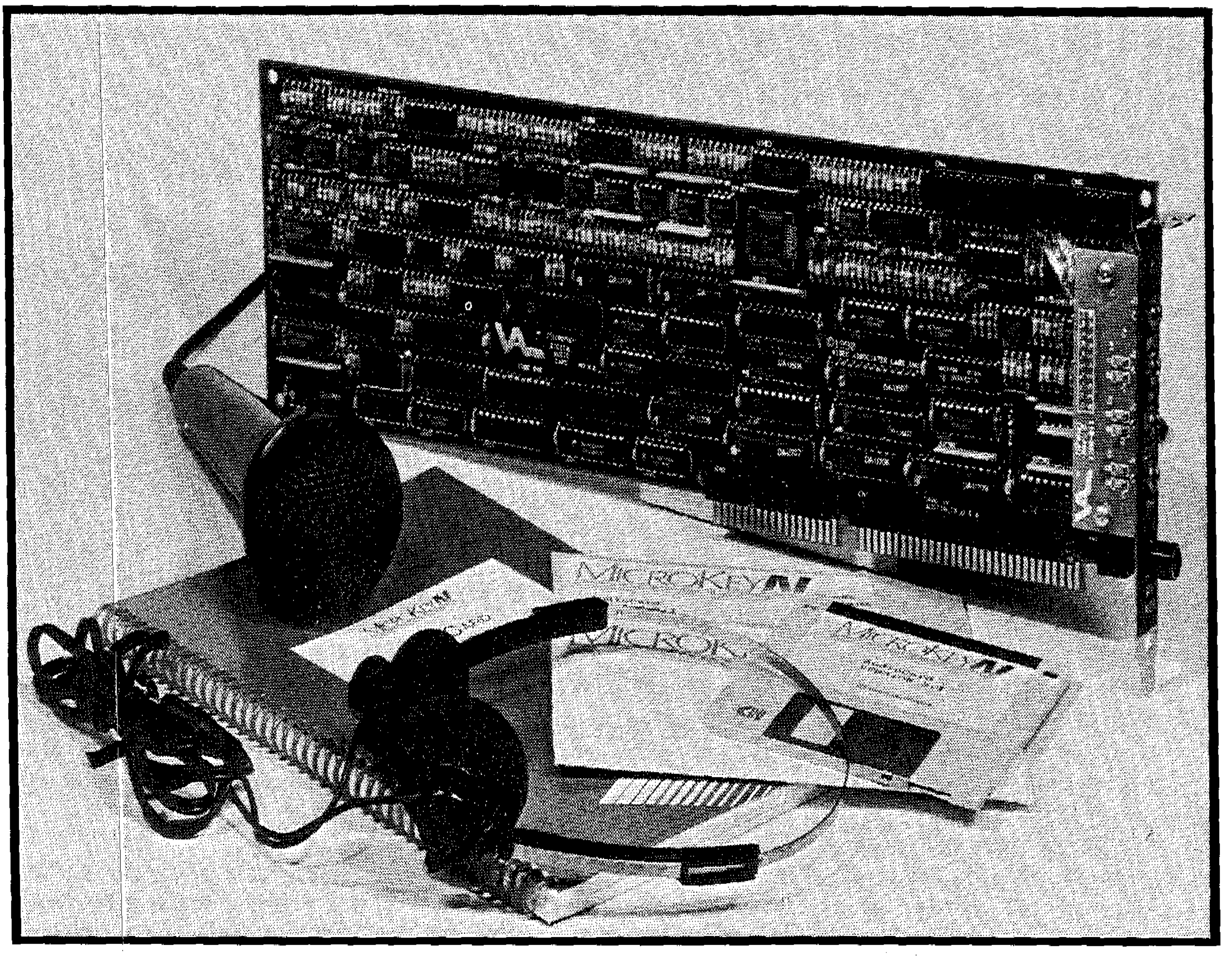
In this respect, the card's matching software can select between sample rates of 8kHz, 16kHz and 32kHz — which in general suit speech, music and hifi recordings respectively. Virtually all the card's functions are in fact under the control of the Microkey AudioCard software, which is a suite of programs under the command of a versatile menu-driven system called Mkmenu.

Software

The Microkey AudioCard's kernel program (Mkmenu) is a fully programmable system of pull-down menus, which calls the various routines (record, playback, configure, etc) under the control of the PC's mouse or keyboard. If the Record/Playback option is selected for example, Mkmenu loads the card's TSR (terminate and stay resident) driver *mkdriver.exe*, then runs the actual recorder software *mkrecord.exe*.

When your recording session is finished (you have selected EXIT from *mkrecord*'s pull-down menu), the card's TSR driver is 'unloaded' and you are returned to Mkmenu. This is all done under the command of standard MS-DOS batch files, which as it happens, are initially generated by Mkmenu itself.

This operation is really quite clever. When an option is selected in Mkmenu, the program immediately terminates and



delivers a DOS error code which is specific for that selection.

This in turn is processed by a master batch file (*menu.bat*) which re-directs proceedings to the appropriate operating batch file. For example, selecting Record/Playback in Mkmenu might force a DOS error level of 8 as the program terminates. The main menu batch file will then find the line 'if errorlevel 8 goto l__8.bat', which re-directs command to *l__8.bat*, where this in turn loads the mkdriver and mkrecord executable files as mentioned above. Talk about creative batch file processing!

While all of the above may sound a little convoluted, it's quite easy to come to grips with once you are using the system. As it turns out, this is also quite a versatile and ingenious software arrangement, which offers a virtually unlimited range of programming possibilities, and is guaranteed to run on almost any system configuration. In fact the batch file system is so open-ended it could be used to control almost any software, including normal DOS commands such as DIR, CHKDSK, etc. Very handy indeed...

By the way, when you wish to change any of Mkmenu's titles or operations, you just select 'Edit List File' from the main window, and simply change or add batch commands to a list file (*mkmenu.lst*) as required. Mkmenu will then delete the current operating batch files (*l__8.bat* and so on), and generate a new series of batch files which incorporate your changes (as recorded in *mkmenu.lst*). Also, a number of list files can be stored under different filenames, and recalled with the 'Load New Menu File' option, allowing Mkmenu to be totally reconfigured as the new operating batch files are generated.

The Microkey AudioCard system's other main executable files can also be incorporated into the menu system as required; these are Mktest, Mkconfig and Mkslide. Mktest allows the user to type commands directly into the card TSR (Mkdriver) itself, for testing purposes. Mkconfig is a menu driven configuration program which sets the card's relationship to the computer itself in terms of interrupt (IRQ) and DMA channels, the use of LIM expanded memory, and so on. Mkslide is the key to the system's ability to link graphics files to audio files, which ultimately produces the desired audio/visual effect.

The linking system provided by Mkslide (another TSR program) is delightfully simple; it just monitors calls to the PC's hard disk, and when your nominated *graphics* file is read from the disk, it instructs the audio card to replay the nominated *audio* file. Such a low-level and simple system means that this linking process is quite independent from the software which is running at the time (say, a graphics or presentation program), since it avoids any complications by just monitoring the appropriate DOS function calls.

The program itself (*mkslide.exe*) has a large number of command line options, which can be used to configure the linking process for each particular application. For example, programming a batch file to run *mkslide /e pcx /p c:\mkav* would instruct the TSR to link the sound files to any file called with the extension*.pcx*, and look for the actual sound files in the MKAV directory on the machine's C drive. So if a file *test.pcx* was called by a graphics (or whatever) program, Mkslide would instruct the audio card (via Mkdriver) to play the *test* sound file.

With such a versatile software arrangement, the Microkey AudioCard system could be put to many other uses besides audio/visual presentations. You could even arrange to have continuous audio feedback for just about all of your computer operations — provided the action calls a file from the hard disk. As you might expect by the way, files with extensions *.com, .exe, and .ovl* (overlay files) are ignored by Mkslide.

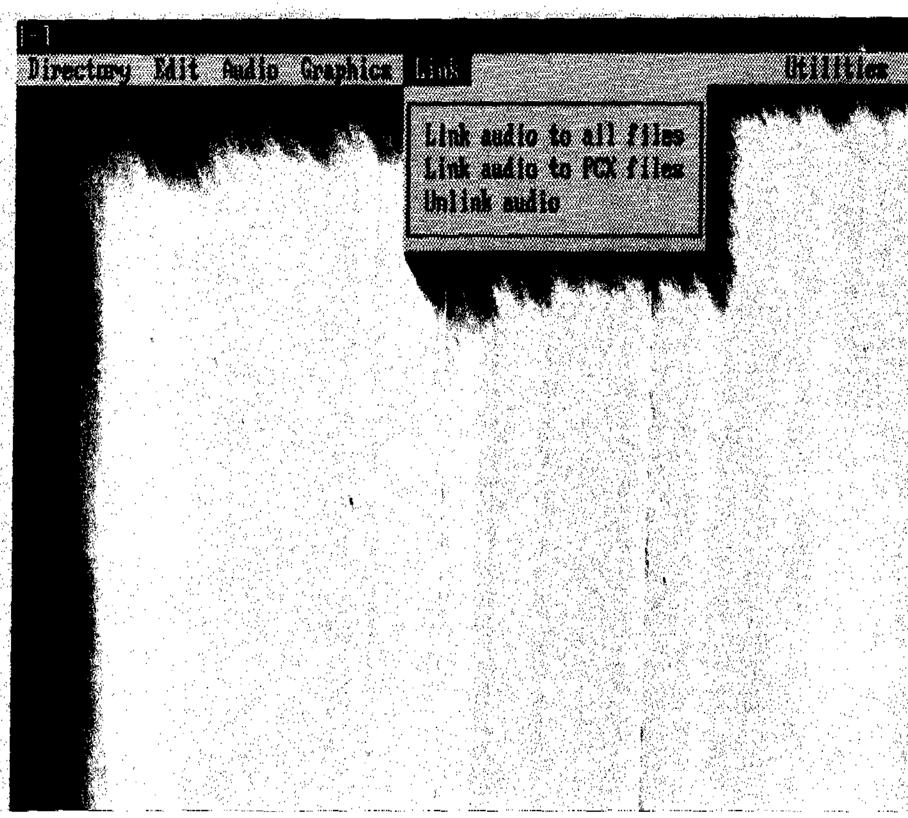
On test

Once the Microkey/AudioCard system is installed (happily, quite a simple procedure), and an amplifier/speaker arrangement has been connected to the card's audio output socket, then you're ready for business. The quickest way to get a feel for the system, and to have some fun, is to play back a few of the sample audio files via Mkrecord; these range from a screeching car crash to a trumpeting blast of reveille, which are both guaranteed to wake up the most slumberousofficestaff.

Despite the fact that the sample files have all been recorded at the 16kHz sampling rate (as indicated by their *.s16* filename extension), the resulting sound is very clear and quite free from any obvious quantising noise or other digital artifacts. When it comes to recording your own sounds via the card's line input or through the supplied microphone, the sound quality is equally as gratifying, once you have mastered the best recording technique for the job at hand.

To help you through this process, Mkrecord offers an additional 'mixer' screen as well as its normal tape recorder style of RECORD/STOP/PLAY mouse-activated buttons. The mixer is also totally mouse-driven and offers 'slide' controls for all input and output levels, 'push-buttons' for channel assignments and muting, and a peak- or VU-reading level meter. Again, this is a very versatile system, and even allows the user to mix the microphone signal with the audio from the sound files, as they are being played back.

Using the Microkey AudioCard system for a full audio complement to a graphics presentation was also quite a straightforward task, once we became familiar with Mkmenu's unusual batch file scheme. The system's TSR programs remain quite transparent to any graphics software that we tried, and presumably if you do come up against a configuration clash, this can be easily rectified with the Mkconfig utility. All in all, the system easily lives up to the designer's claims of a powerful yet versatile multimedia package that's simple to operate.

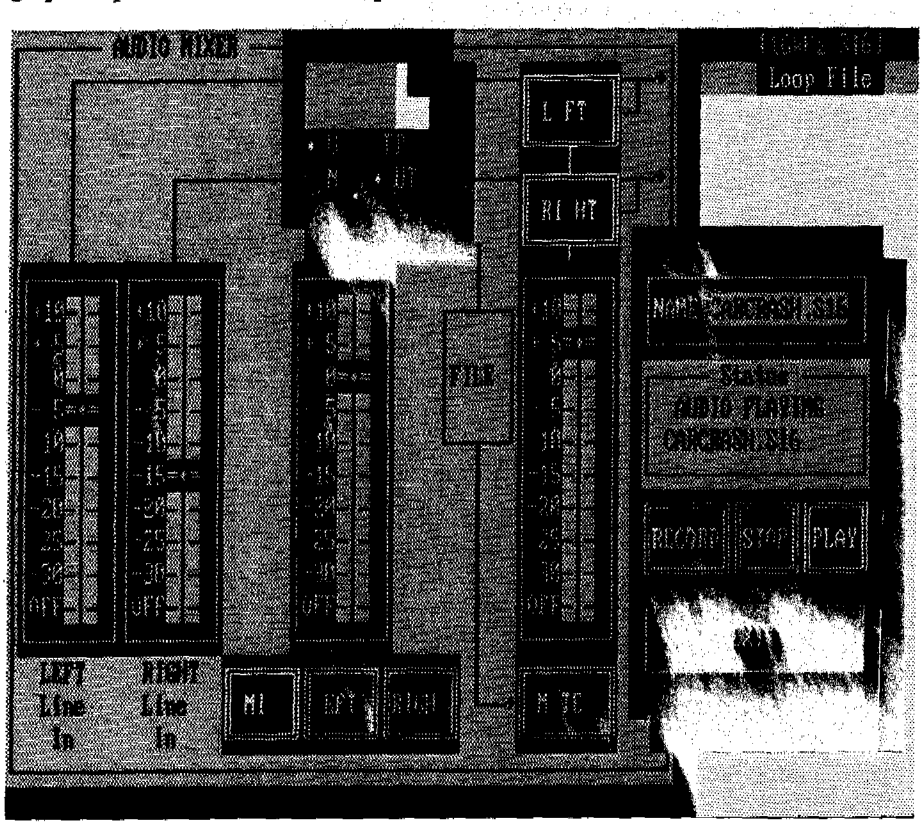


Mkmenu acts as a control centre for the Microkey AudioCard software, and offers a series of mouse-driven pull-down menus which can be programmed to suit individual requirements. The above menu system was produced during this review.

The only disappointing, if not downright frustrating aspect of the Microkey AudioCard package was the operating manual's disagreement with the system software, in a couple of areas. It seems that the manual revisions (ours was dated July 1990) have not quite kept up with the software updates, where a number of new or changed features caused some confusion — particularly in *mkmenu.exe*, which is a 2.01 revision dated 1991. While such updates are usually covered by the text of a 'read.me' file on the installation disk, this was not included on our evaluation copy.

On the positive side, we were most impressed with the versatility of Mkmenu, the sound quality from the audio card itself, and the generous range of additional hardware supplied with the package. This included a dynamic microphone with a matching clip, a set of lightweight headphones (including spare foam covers), and a extensive supply of connecting leads and adaptor plugs. The Video Associates people have been very thorough in this regard, with the Microkey AudioCard package including all of the components and accessories needed for almost any multimedia installation. So if this is your need, or you just want to add the power of digital audio to your computer system, this package from Video Associates can fulfill your needs in a very elegant manner.

The complete Microkey AudioCard system has a recommended retail price of $940, and is distributed by Lako Vision who can be contacted at Suite 1, 45 Wellington Street, Windsor Victoria 3181; phone (03) 525 2788. ❖



Mkrecord shown with its mouse-driven 'mixer' activated. Note the various slider-type volume controls, and its peak or VU-reading level meter.

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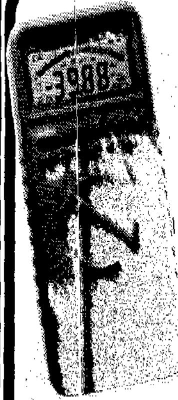

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Vac 200mV, 2V, 20V, 200V, 750V
Adc 200µA, 2mA, 20mA, 200mA, 2A, 20A
Aac 200µA, 2mA, 20mA, 200mA, 2A, 20A
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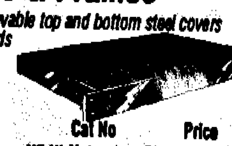

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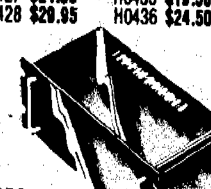

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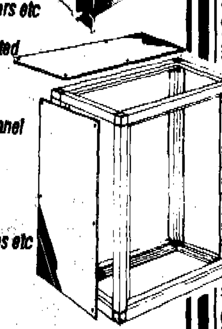

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Cheap software fools AI judges

Supporters of artificial intelligence development got a lot more than they bargained for recently, when a US$160, 100K program running on a PC was able to fool half a team of 10 judges into believing they were having a conversation with a human.

And several more judges were also fooled by some of the other five computer contestants during the first annual running of the 'Loebner Price Competition', in which computers are teamed up aginst humans in a dual of conversational skills.

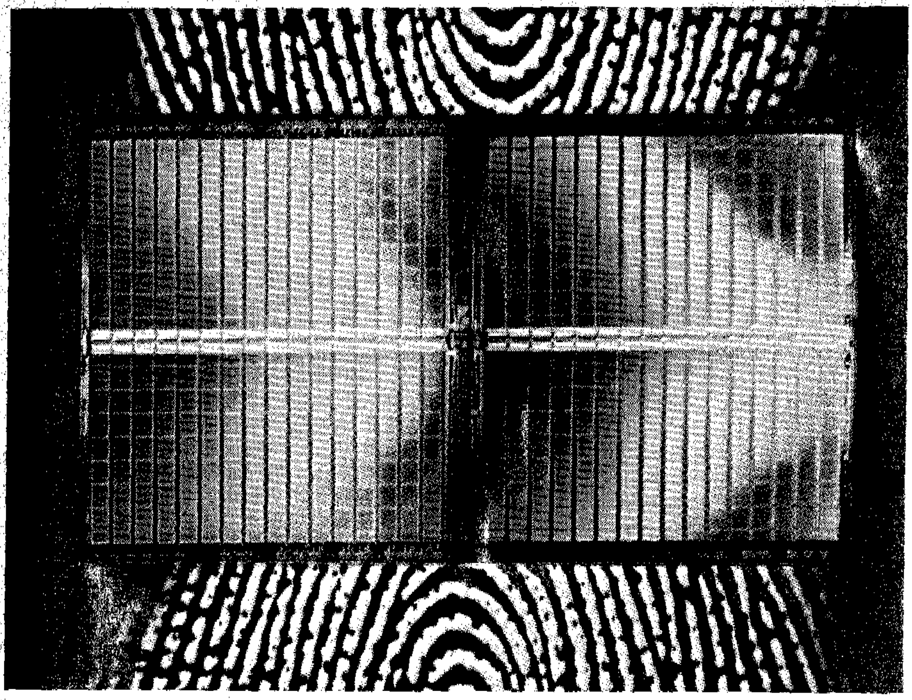
AI supporters who set up the contest, with a prize of US$100,000 for the computer which fools all of the judges into believing they're talking with a human, were disappointed. Some were even angry at the results of the first contest. As part of the event, 10 judges conducted 15 minute typed conversations with 10 computer terminals, four of which had human operators on the other side, while the other six were connected to computers.

The contest was intended to raise public awareness about the state-of-the-art in artificial intelligence, and help generate more public support for AI research. Instead of showing vocational skills that are impressive and still obviously non-human, the contest showed how even simple programs are able to trick human judges.

The organisers were shocked to see five of the 10 judges get fooled by 'The Therapist', a program that is able to keep up a 'whimsical' conversation and even inject humour.

"I felt very comfortable talking to it — it was making me laugh. It had a sense of humour that wasn't like a computer", said Nelson Reynert, one of the judges and a Harvard University Government Studies student, "I was fooled".

Joseph Weintraub, creator of 'The Therapist' program will receive US$1500, the annual prize for the program that is 'most human' by fooling the most judges. The program comes with just 100,000 bytes of programming and is designed to pick up and respond to key words in a line of conversation. Before the event, most A1 experts had predicted that chances were small at best for any of the judges to be fooled by the six first-year entrants...



It's not made in Silicon Valley, but Siemen's new 16Mbit dynamic RAM chip is nevertheless state-of-the-art. The smallest elements on the chip have dimensions of around half a micron. A human hair is approx. 100 times thicker.

Manufacturing back to Silicon Valley?

The perceived trend in Silicon Valley is one away from manufacturing and towards corporate administration and research and development. But that apparently is a false perception, as Silicon Valley was rated in a new study as the second fastest growing centre for manufacturing in the United States for the 1990's.

The study, released recently by the Washington DC-based Woods & Poole Economics company, said manufacturing growth in Silicon Valley during the 1990's will be second only to Orange County in the Los Angeles area.

Silicon Valley's manufacturing sector will grow some 23% by the end of the decade, with manufacturing-related jobs increasing from the current 274,600 to 339,000. The survey's results were so surprising, most industry and government officials in the valley were startled and at a loss to explain the prediction.

"This is astounding," said Bill Glaggett, director of the San Jose Office of Economic Development. "I just hope to God they're right," added Gary Burke, president of the powerful Santa Clara County Manufacturing Group which lobbies on behalf of the area's electronics industry. He added that he viewed the study results with considerable skepticism.

Since the late seventies, Silicon Valley companies, after producing their products almost exclusively in Silicon Valley during their startup phase, have traditionally shifted production elsewhere in the US and offshore, when their business became high-volume oriented and subject to intense competition. The Woods & Poole survey however, found that California will have four of the top 10 centres for manufacturing growth.

Industry observers said that if manufacturing is to expand as rapidly as predicted in Silicon Valley, a new boom in high-tech startups will have to occur. The last such boom occurred in the early 1980's, when billions of new venture capital dollars, freed up by the lowering of capital gains taxes, fuelled the formation of hundreds of new personal computer and semiconductor companies.

Any new upsurge in startups will

depend on whether the US implements a cut in the capital gains tax, an issue President Bush has been lobbying hard for. And with a new generation of personal computers just around the corner, a new wave of startups may indeed become a reality.

Parallel system runs at 130BIPS

Thinking Machines, the Massachusetts based maker of massively parallel processing computers, has built an RISC-based supercomputer capable of processing data at 130 billion calculations per second — smashing the recently set record of 32BIPS by an Intel machine.

The CM-5 from Thinking Machines is built around 1024 SPARC chips. Previously Thinking Machines used as many as 64,000 low-end Intel processors to generate the kind of speed its system is said to possess.

The company said it could technically string as many as 64,000 SPARC chips together, to create the first supercomputer to break the one trillion instructions per second barrier. But such a system would have cost more than US$100 million to build.

The new SPARC-based machine was ordered by the Los Alamos National Laboratory and will cost about US$25 million. At the low end of the line, a 32 processor system will sell for US$1.4 million. Thinking Machines emphasised that the switch to SPARC processors will not make previous software obsolete.

Customers switching to the CM-5 line will still be able to use their older software while taking advantage of new SPARC-based applications as well.

Philips signs licensing deal with Hyatt

Gilbert Hyatt has scored a major victory in his bid to get the semiconductor industry to pay royalties on the microprocessor patent that was awarded to him last year by the US Patent Office.

Holland-based electronics giant N.V. Philips said its North American Philips subsidiary had signed a license for 23 of Hyatt's semiconductor-related patents, including the microprocessor patent.

Rather than money, Philips will provide Hyatt with legal protection with 'predator' companies that may take advantage of him, as well as help him in licencing his patents to electronics companies throughout the world.

"I now have a large mentor to take care of me. Large companies often misperceive that an individual inventor is alone and vulnerable. But now I have a major friend who can help me," Hyatt said from his Southern California home.

Hyatt said that prior to the actual signing of the agreement, Philips had already assisted him in the legal battle with Texas Instruments, which is challenging the validity of Hyatt's patent at the US Patent Office. Hyatt said he is confident the Patent Office will uphold his patent. A preliminary ruling may be issued in the next several months.

As part of the deal with Philips, the Dutch giant has licenced two portfolios of Hyatt's patents, covering such technologies as microprocessors, microcomputers and certain liquid crystal computer displays.

In addition to the legal assistance, Philips will pay him a certain amount in cash as well. Hyatt declined to specify the size of the payment, saying only that it was sufficient to fund his research "for many years to come," and even to hire a small staff to help him in his research.

Philips, he said, is only the first of a number of companies who are currently negotiating with him for licences to his microprocessors and other patents.

Akers: Repeal flat panel tariff or else

IBM has fired a shot across the bow of the US government, threatening to help boost Japan's trade surplus with the US by moving production of a new line of notebook PC's to Japan if the US government doesn't reverse the 63% anti-dumping duty it imposed last July on active-matrix and other advanced flat panel displays made in Japan.

In unusually critical language, IBM chairman John Akers said IBM would have little choice but to move hundreds of US jobs to Japan in order to bypass the tariffs — because finished products incorporating the controversial displays are not subject to the import tax.

IBM's move came less than a week after Apple Computer filed an appeal to the tariff decision, which was aimed at protecting a handful of US flat panel startup companies from their huge Japanese competitors.

Apple has already moved production of its new PowerBook 170 to plants in Ireland, a decision that cost the US more than 300 jobs. With other US computer makers, as well as Japanese notebook vendors moving production offshore, the US may lose as many as 30,000 manfacturing jobs because of the active matrix tariffs.

Currently IBM is engaged in a joint venture with Toshiba to make and sell active-matrix displays. Saying IBM has not made a final decision on where it will produce a forthcoming notebook PC, Akers said, "Of course we can assemble complete computer systems in Japan and avoid the tariff. From an American point of view, that is an export of jobs that exacerbates the balance of trade."

IBM, Apple and others are arguing that none of the US active matrix display companies are able to deliver products commercially in high volume and at competitive prices. Only the Japanese have developed such capability.

Bush wants to curb encryption exports

Regardless of the ease of being able to smuggle a floppy disk or send software code electronically out of the country, the US government — under pressure from the Pentagon — is preparing tough new rules on the export of software that incorporates data encryption features.

Reports of a new Bush Administration plan to restrict export of data encryption software have sent a shockwave throughout the software industry. Currently, software is a major industry where the US still holds a commanding lead over foreign competitors. But that position may deteriorate quickly if US firms cannot deliver data protection features to their foreign customers.

Data protection is rapidly becoming a major concern in the industry worldwide, and many companies are expected to demand data encryption features on their application software. If US firms cannot deliver such features, international buyers may look elsewhere for programs that satisfy their data security requirements.

While the new plans have not been formally introduced, Washington sources have been quoted saying the Bush Administration has been persuaded by concerns over national security interests to propose strict curbs on the export of data encryption technology. In particular, the National Security Agency, the most secretive of US intelligence agencies, and one that routinely scans foreign computer data transmissions, has been known to oppose the spread of leading edge data encryption technology, even in the US market.

The US recently overlooked a superior public key data encryption technology from RSA Technology in Menlo Park in favour of a much less sophisticated standard. ❖

NEW PRODUCTS

High quality CCTV camera

Philips is expanding its range of CCTV video cameras with the LDH 0701/10, a high performance CCD observation camera which is ideal for remote surveillance and process control, where a high quality image is required.

Based on the modular design of the high performance LDH 0702/20 camera, the LDH 0701/10 is a high sensitivity, high resolution camera, producing exceptionally good image quality. The camera has a 1/2" solid state interline CCD sensor with microlens, and its characteristics provide optimal picture quality of indoor scenes. With a wide dynamic range, the camera can be used with a fixed iris lens for many indoor applications.

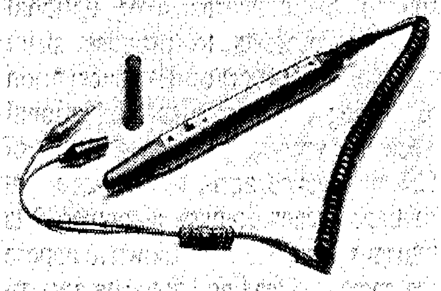
Designed on a system concept basis, the LDH 0701/10 is fitted with a mains lock feature. This locks the camera frame frequency to the mains frequency, thus avoiding picture roll in a multi-camera system.

Applications areas include arrival and departure lounges, transport stations, museums and banks. It is particularly suitable for a wide range of outdoor applications.

For more information circle 241 on the reader service coupon or contact Philips Scientific & Industrial, 25 Paul Street North, North Ryde 2113; phone (02) 888 8222.

Logic pulser probe

OK Industries has released the PLS-500 Logic Pulser for IC troubleshooting. The pulser is switchable from 0.5Hz to 500Hz pulse frequency with a 2us pulse width. Other features include a Sync out, Sync in and Ground for triggering.



The maximum output current (tip) is 1000mA, and the input frequency is from DC-100kHz. The operating power supply is between +3.5 and +18V.

For more information, circle 242 on the reader service coupon or contact ElectronicDevelopment Sales, PO Box 822, Lane Cove 2066; phone (02) 418 6999.

New case for projects

Jaycar Electronics has released a new project case, the 'Jaybox' — especially designed for instruments, power supplies and similar projects.

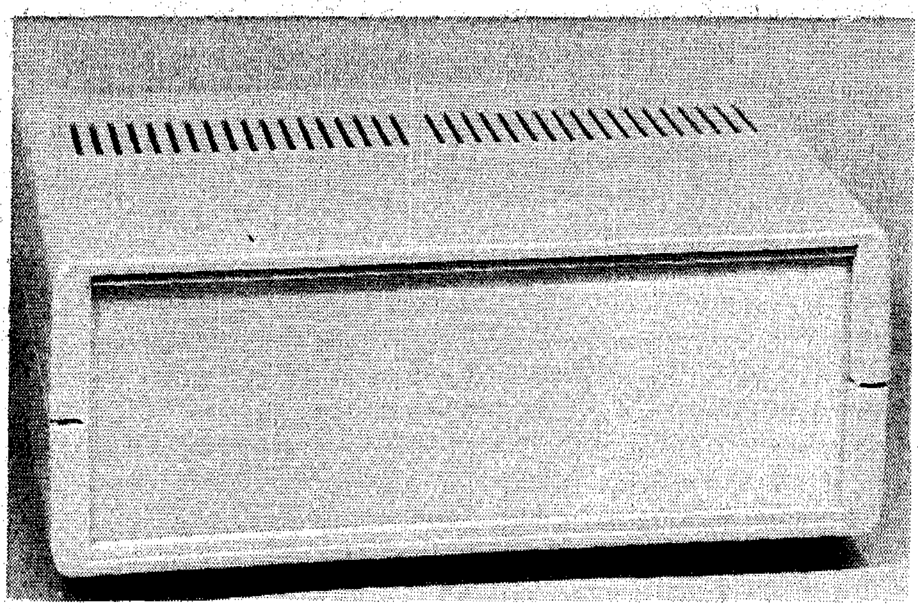
The new case measures 250 x 170 x 75mm (W x D x H), and uses the convenient system of moulded top and bottom halves, with removeable front and rear panels.

Both top and bottom case halves are provided with a set of ventilation slots, which align when the case is assembled to provide efficient ventilation for equipment such as power supplies.

An advantage over similar cases is that the front and rear panels are cut from 1.2mm aluminium sheet, which not only provides a rigid and readily earthed support for front-panel controls and rear-panel connectors, but can also serve as an efficient heatsink for semiconductor devices.

Other features of the Jaybox include built-in moulded support pillars for PC boards (inside both case halves) and metal-thread assembly screws which mate with moulded-in threaded bushes, for greater reliability than 'self-tapping' screws cutting into plastic. The case also comes complete with four plastic feet.

The Jaybox has the catalog number HB-5930, and is priced at a very reasonable $19.95. It is available from all Jaycar stores, or by mail order from PO Box 185, Concord 2137; phone (008) 022 888 (orders only).



Programmable dialler

The Australian-made Nidac TE3 'DialSafe' user-programmable dialler uses an existing telephone line to send a beeping sound to convey such conditions as security, medical or industrial plant monitoring to three different phone numbers.

Its main features include: three memories which hold up to 16 digits each; two trigger inputs for alarm/emergency (with different sounds for each); remote shutdown from a called number; and keyboard disable mode for security.

It dials each number three times, and can also dial pagers or mobile phones. The dialler is incorporated in the TKI 'DialGuard'.

This unit includes a battery backup, power supply and charger. Its output can operate a siren, strobe relay or any 12V device, for up to four minutes after the dialler is trigger.

Another similar system is the 'DialCare' medical dialler. This personal wireless transmitter can be worn or carried around the house at all times, and is simply pressed to call for help. Up to three phone numbers can be contacted, including pagers and mobile phones.

For more information circle 245 on the reader service coupon or contact Nidac Security, 2 Cromwell Street, Burwood 3125; phone (03) 808 9335.

Multi-coloured LED panel meter

The DMS-30PC is a new digital voltmeter which combines the latest in surface mount technology with state-of-the-art thick film hybrid manufacturing techniques. The result is a fully encapsulated, low cost, 3.5 digit voltmeter, with a choice of nine different LED colours and power options.

At less than one cubic inch total volume, the DMS-30PC is a very small digital voltmeter but retains a full size (14.2mm/0.56") 3.5 digit display. Its wide variety of LED colours include red, green, orange, yellow, amber and blue; high intensityred and low power red, green and orange (less than 15mA drain). The 30PC is designed to fit virtually any monitoring and display application.

For more information circle 244 on the reader service coupon or contact Quiptek Australia, PO Box 129, Moorabbin 3189; phone (03) 532 1328.

Freon-free high voltage probe

Tektronix has introduced a new CFC-free version of its 75MHz P6015 high voltage probe. The redesigned probe uses a silicone compound as a dielectric instead of the CFC 114-based Freon. To stimulate replacement of the older version, Tektronix is offering a $200 discount trade-in program.

P6015A improvements include a smaller compensation box, wider compensation range, a larger, more durable ground lead and crocodile clip, flexible cable and an optional 1000X coding feature. The P6015A provides maximum input voltage of 20kV DC, and holds a 100 millisecond pulse at 40kV peak.

This high voltage capability makes it ideal for such heavy-duty applications as avionics and radar testing, as well as for designing and testing such devices as circuit breakers, surge protectors and transformers. The extended compensation range, 7-49pF, also allows the probe to be used with a wider range of oscilloscopes.

For more information circle 246 on the reader service coupon or contact Tektronix Australia, 80 Waterloo Road, North Ryde 2113; phone (02) 888 7066.

Copier for home or office

Xerox has launched a small compact copier, the 5009RE, ideally designed to meet the needs and budgets of a small business or the home office.

Taking only 20 seconds to warm up, and with a paper cassette capacity of 250 sheets, the 5009RE can efficiently tackle important larger jobs with up to 50 copies in a single run, and without constantly reloading. The copier has one enlargement and two reduction ratios, and has an automatic exposure feature to give good copies even from originals on coloured paper. By using interchangeable colour modules, the 5009RE can copy in read blue, green and brown. The running costs have been kept low: a single toner unit can last up to a year, and the copy cartridge gives 12,000 copies before requiring replacement.

CRT readout scopes

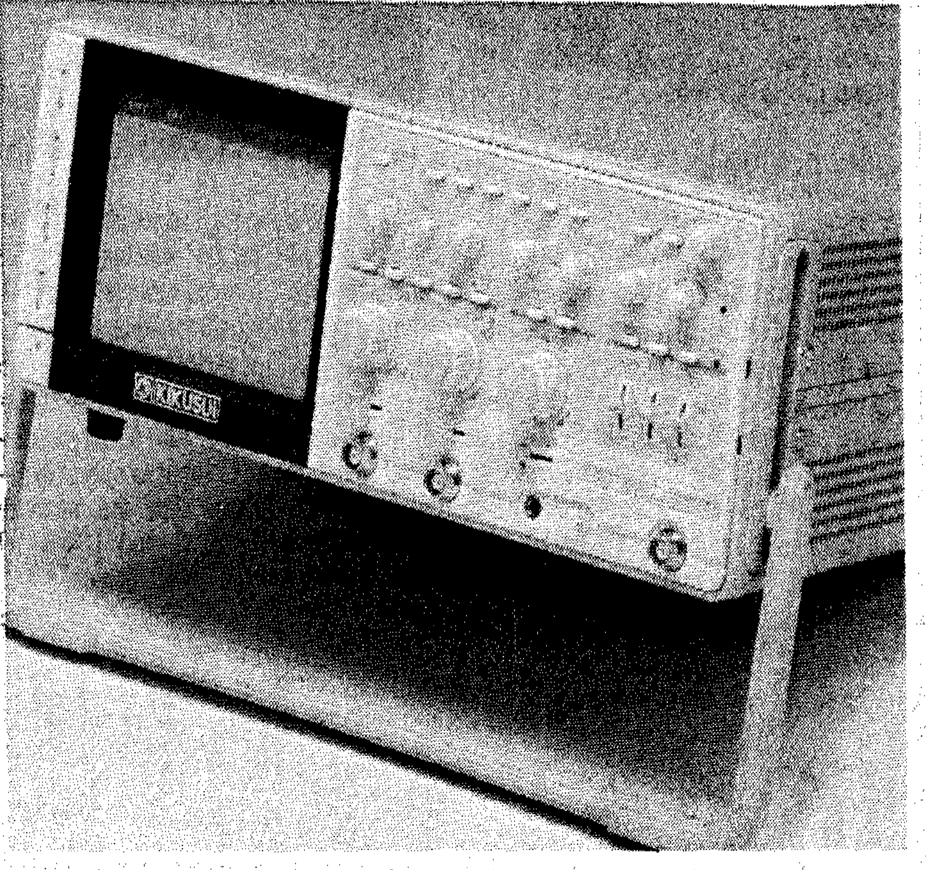
The COR-Series is Kikusui's new range of high-tech CRT readout scopes. There are eight models in the series, offering digital/analog and analog versions and bandwidths of 20, 40, 60 and 100MHz.

All models in the series offer CRT readout for displaying set values, along with cursor controlled measurement of voltage, time, frequency and waveform magnification.

Functions available include maximum two channel simultaneous sampling rate of 20MS/s, digitised 100MHz repetitive signal in the repetitive mode, four kilowords of memory capacity per channel, two save memories, one-touch switching between real and storage modes and direct copy of screen display using an HP-GL command with optional GPIB interface.

Bandwidths range from 100MHz to 20MHz, with analog models priced from $3500 to $2574 and digital/analog priced from $4537 to $2689 (excluding tax).

For more information circle 243 on the reader service coupon or contact Emona Instruments, PO Box K720, Haymarket 2000; phone (02) 519 3933.



Dissolved oxygen meter

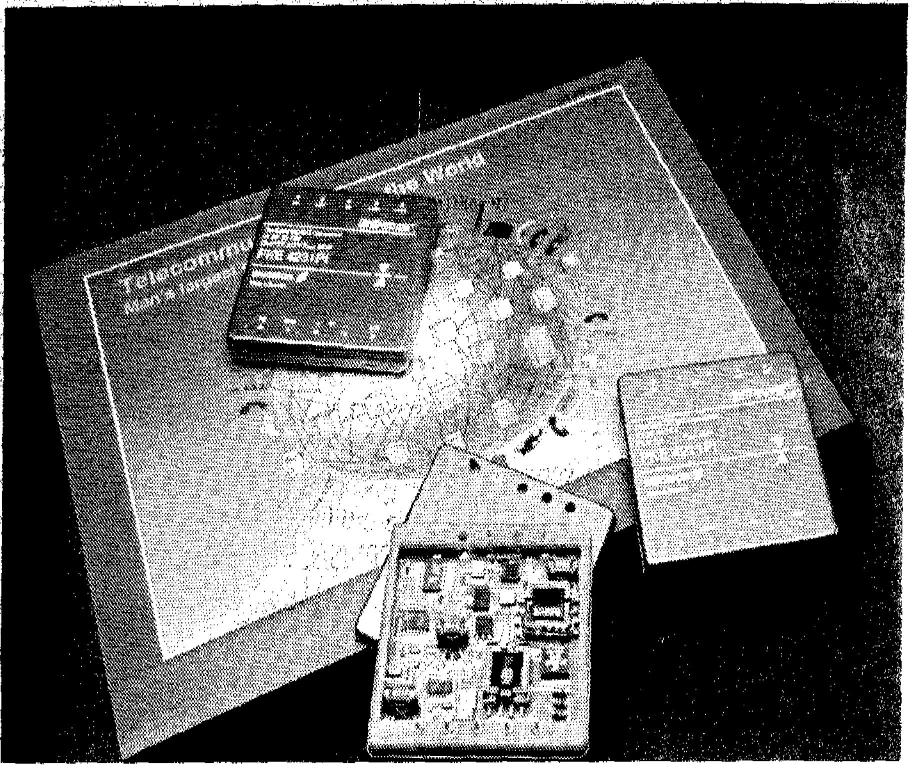
TPS has just released its new Australian-made model 90D Dissolved Oxygen Analyser. The 90D uses an 80 character LCD display to show all data, calibration information, and full online 'HELP' information.

All functions are accessed using the sealed membrane keypad. There are no knobs or dials to set and the input connectors are fully sealed, making the instrument extremely water resistant. All calibrations are performed quickly and easily at the touch of a button.

Many dissolved oxygen meters take several minutes to stabilise. The 90D however, is designed to maintain a small amount of voltage on the sensor, when switched off, allowing instant readings to be taken when the unit is switched on again. A standard feature incorporated in the 90D is the Notepad function. Up to 60 readings can be stored into memory while the user is out in the field. These can then be displayed and recorded back at the laboratory. The readings can also be downloaded directly into a computer, if the optional computer interface port is fitted. Another option is to extend the memory to 2200 readings with datalogger function.

For more information circle 249 on the reader service coupon or contact TPS, 4 Jamberoo Street, Springwood 4127; phone (07) 290 0400.

NEW PRODUCTS



Inert tweezer

Scope Laboratories has announced a 130mm ceramic tipped tweezer for the technician who wants 'non everything' hand tools. The tool is non magnetic, non conducting and not affected by heat at the tips. Zirconium oxide ceramic was chosen for its abrasion resistance, rigidity and extreme chemical inertness, while the handle is nmade from glass-fibre-reinforced polypropylene to provide the self opening springiness.

For more information circle 255 on the reader service coupon or contact Scope Laboratories, PO Box 63, Niddrie 3042; phone (03) 338 1566.

Low profile DC/DC converter

Ericsson Components has introduced a new series of highly reliable low profile DC/DC converters, intended to be used as onboard distributed power supplies in natural convection cooled decentralised power systems. The converters are primarily designed for use in telecommunications and data communications, but are also suitable for a variety of other demanding applications.

Designated the PKE series and designed for 48 and 60V battery systems, the series includes five different models of single, dual and triple output versions.

A low profile (10.7mm) standard 75 x 76mm footprint package allows as low as 18mm board spacing. The series also introduced 1500V DC input to output isolation in accordance with the recently established EN 41003 and UL 1459 standards.

The PKE series is designed using thick-film hybrid technology. Switching frequency is 300kHz, resulting in a ripple frequency of 600kHz and a power density of up to 8.0 watt per cu.inch.

Efficiency lies typically between 80-85% depending on output voltage version. Weight is 76grams.

For more information circle 250 on the reader service coupon or contact EC Capacitors; phone (03) 462 2855. ❖

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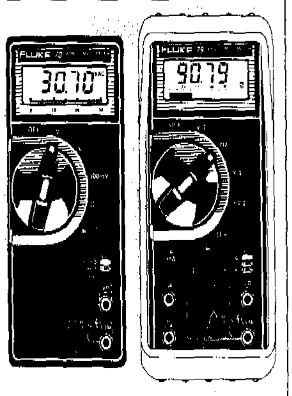
Fluke Upgrades 70 Series... Adds to Range... Lowers Some Prices!



It's hard to improve on a classic multimeter, but Fluke has risen to the challenge!

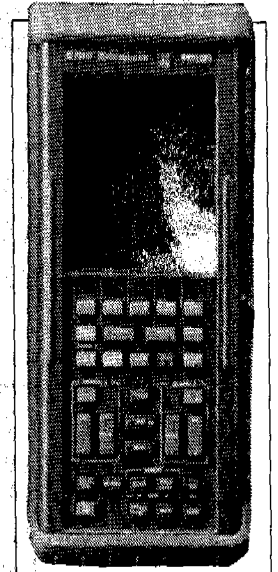
Three new multimeters - Top-of-the-line Fluke 79 and 29 offer capacitance, frequency, fast 63-segment bar graph and other features plus entry level Model 70 delivers unparalleled Fluke quality and safety.

Models 73, 75, 77, 21 and 23 are all upgraded - all now have Touch-Hold™

Accuracy Comparison

Range	70	73	75(21)	77(23)	79(29)
Vdc	0.5%+1	0.4%+1	0.4%+1	0.3%+1	0.3%+1
Vac	2.0%+2	2.0%+2	2.0%+2	2.0%+2	1.0%+2
Ohms	0.5%+1	0.5%+1	0.5%+1	0.5%+1	0.4%+1
Adc	NA	1.5%+2	1.5%+2	1.5%+2	0.5%+2
Aac	NA	2.5%+2	2.5%+2	2.5%+2	1.5%+2
Frequency	NA	NA	NA	NA	0.01%+1
Price (ex tax)	$125	$175	$260	$295	$350
Price (inc tax)	$146	$203	$302	$343	$406

Fluke 90 Series - 50MHz Bandwidth Digital Storage Scope plus...



- 25MS/s 2 channel digital storage
- 8-bit,25 levels/div vert. resolution
- 10ns/div to 5s/div timebase
- Store 8 waveforms (95 & 97) and 10 set-ups (97)
- Measuring cursors (95 & 97)

...Full 3000 count DMM

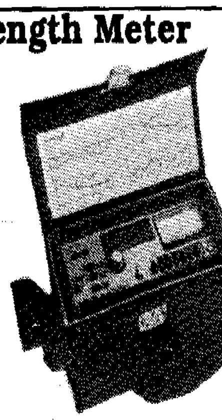
- Functions include Min/Max, Touch Hold™, Relative & %, Autoranging etc
- dBm, dBV and dBW (95 & 97)
- 5 Soft Keys/Pop-Up Menus
- 12cm 240x240pixel Super Twisted Nematic LCD screen
- Floating up to 600Vrms
- Optical RS-232 Port (97)
- Low Power (4 hr internal battery)
- Built-In component and baud rate testers and a sine, square and ramp signal generator (97)

Model 93 Basic instrument **$1460 ex tax $1752 inc tax**

Model 95 Adds measuring cursors and recording function **$1895 ex tax $2274 inc tax**

Model 97 Adds waveform and set-up memories, back-lit LCD, generator functions, RS-232 interface **$2350 ex tax $2796 inc tax**

Sadelta TC402C Field Strength Meter



● Digital LCD frequency display for tuning ● Covers all TV and FM frequencies 45 to 862MHz ● Seven ranges cover 26dB/μV to 100dB/μV ● Large level meter calibrated in dB/uV and Vrms ● Ohmmeter for passive continuity checks

$ 750.00 ex tax $895.00 inc tax

Sadelta TC400 Field Strength Meter

● Similar specs to TC402C but without digital frequency display (analog meter movement) ***$599.00 ex tax $715.00 inc tax***

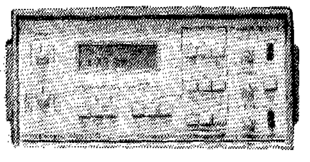
Sadelta MC11B Pattern Generator

● Generates colour bars, grey scale plus 7 other patterns ● Complete with internal battery and charger ● Tuneable VHF and UHF output on Bands III or IV ● Audio tone for sound checks ● Pocket sized ***$460.00 ex tax $550.00 inc tax***

Sadelta PAL VC11B Pattern Generator

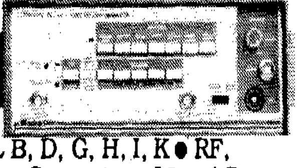
● Similar to MC11B but with composite output for PAL B, G or I ***$460.00 ex tax $550.00 inc tax***

Black✱Star Video Monitor Tester 1410



● Checks MDA, CGA, EGA, Hercules, PGA, VGA, SVGA, 8514A, XGA and TV formats ● Microprocessor controlled ● Intelligent alpha-numeric display ● Analog RGB, TTL-IRGB, Secondary RGB, Horizontal/Vertical/Composite syncs ● Colour Bars, Test Card, Crosshatch, Dots, Ramp, Focus, Horizontal Lines, Vertical Lines, Raster and Checkerboard ● Full control over output signals ● 15.625 to 48.5kHz Line Frequencies ● 49.9 to 87Hz Frame Frequencies ● Inverse Video ● Separate Analog and TTL Outputs ● 1V and 0.7V Video ● Easy Connection via 9-way and 15-way 'D' and BNC Connectors ***$1155.00 ex tax $1328.00 inc tax***

Orion PAL TV/Video Pattern Generator



● Tests TV, VCR, Monitors etc ● PAL B, D, G, H, I, K ● RF, Composite Video and IRGB Outputs ● Separate or Mixed Syncs ● Trigger Output ● Colour Bars, Greyscale, Crosshatch, Dots, Lines, Focus, Purity etc. ● Over 50 pattern combinations ● 1V or TTL IRGB ● 5.5, 6.0 and 6.5MHz Sound Carriers ● Internal/External Sound ● Mains Operated ***$755 (ex tax) $869 (inc tax)***

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CAD software feature:

Passive and active filter design

When designing passive and active filters, there are quite a lot of calculations needed to determine the values of the components. These two programs, *P-Filter* and *A-Filter* from 'Sitting Duck Software', are designed to do all these calculations. They also produce response curves, and in some cases also give the schematic diagram. Both programs run on MS-DOS machines.

P-Filter designs standard topology, 2- and 3-way, 1st-4th orders, all-pass (AP) and constant-power (CP) crossover networks. Only symmetrical networks are designed — if a 3rd order network is designed, all sections are 3rd order.

The program is based on, and refers directly to, Robert Bullock's *Cross-over Networks* books and the *The Loud-speaker Design Cookbook* by Vance Dickason.

The program does not attempt to compensate for the non-resistive nature of loudspeakers, but refers the user to the above books if such compensation is required. However, it does allow the insertion of a driver resistance to absorb the gain value associated with a bandpass network.

The program is simple to use, and the network designed with its component values can be viewed on the screen or sent to a printer. Frequency and phase response curves can also be viewed, but not printed. Once the data is entered, an AP or CP crossover solution can be obtained. In fact, you can toggle between the two, and note the component changes which occur.

A-Filter does the calculations for the most common op-amp based active filter configurations. The program assumes familiarity with op-amp filters and is based on configurations and formulae in *Active Filter Cookbook* by Don Lancaster, and *Rapid Practical Design of Active Filters* by Johnson and Hilburn. Each of the filters listed in the program manual are cross referenced to these books.

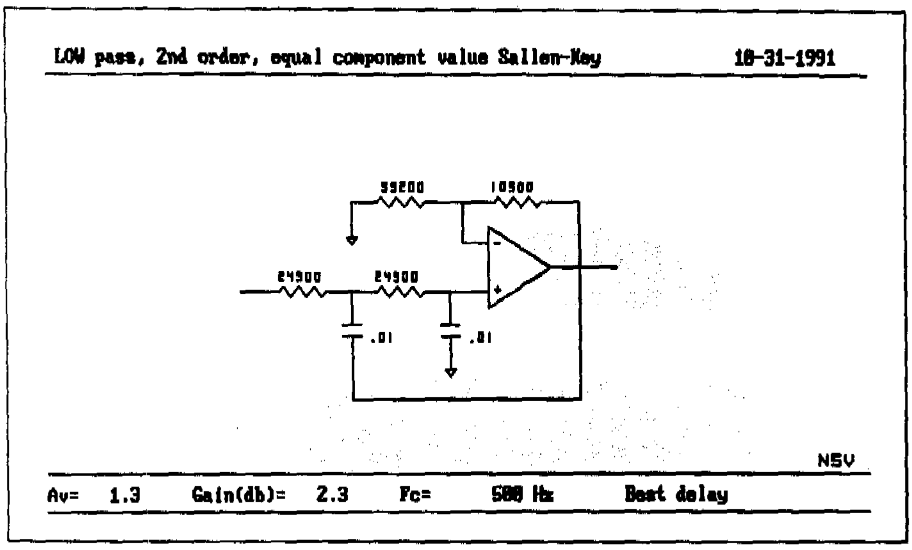
The manual lists the schematic diagrams for low and high pass, 1st to 8th order networks. The 2nd order designs include variations of the low and high pass, along with bandpass and notch filters.

```
+------------------- Schematic, APC parts list and details ------------------+
| <M>enu                     <T> Toggle T-C                          <P>rint |
|                                                                            |
|                 --- L13 --+--- L11 --------+       L11 =   1.68  mh       |
|                           |                |+      C12 =  66.41  mfd      |
|                  LP      C12               Rw      L13 =   4.52  mh       |
|                           |                |-      Rw  =   8.00  ohms     |
|                 ----------+----------------+                              |
|  400 Hz                                                                    |
|                 --- C33 --+--- C31 --------+       C31 =   7.54  mfd      |
|                           |                |+      L32 =   0.19  mh       |
|                  HP      L32               Rt      C33 =   2.80  mfd      |
|                           |                |-      Rt  =   8.00  ohms     |
|                 ----------+----------------+                              |
| 5000 Hz                                                                    |
|                                                    C21 = 104.38  mfd      |
|        --- L26 --+-- L24 --- C23 --+-- C21 ----+   L22 =   2.39  mh       |
|                  |                 |           Ra  C23 =  34.24  mfd      |
|         BP      C25               L22          |   L24 =   0.13  mh       |
|                  |                 |           Rm  C25 =   5.89  mfd      |
|        ----------+-----------------+-----------+   L26 =   0.32  mh       |
|                                                    Ra  =   0.00  ohms     |
|                              Gain =   0.72 db      Rm  =   8.00  ohms     |
|                                                                            |
+----- Dont forget to use Zobels and impedance correction where needed.-------+
```

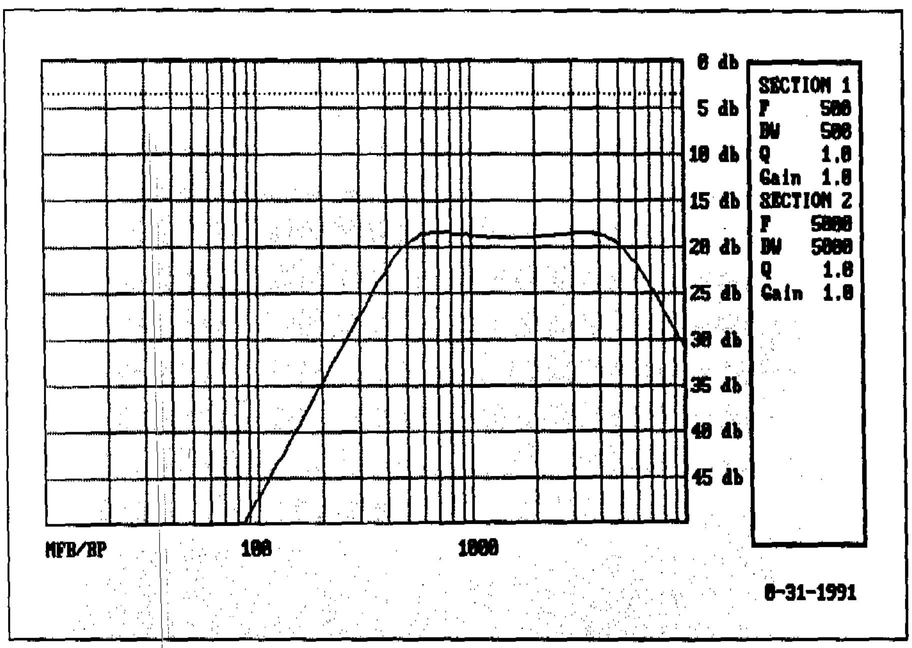
The schematic produced by the program for a two-driver, third order 18dB/o passive filter. The crossover frequencies were 400 and 5000Hz and all three speakers had eight ohms impedance.

The program does not produce a schematic for any first order filter, or any response curves except for bandpass filters — the author reasons that such curves are listed in the reference books mentioned. To speed up calculation time, there are no traps for entering or generating unreasonable values such as excessively large 99M resistors — again your design experience is presumed.

When the program does produce schematics and response curves, they can be sent to your printer. A 'printer setup' option allows the choice of either dot matrix, or 300, 150 or 75dpi resolution for a laser printer. But these three laser printer resolutions are all printed with the same number of dots — the higher resolutions are obtained by squashing up the image!



The program produced this schematic when asked for a low-pass, second order filter, of the equal-value Sallen-Key design. The 500Hz crossover frequency and the 0.01uF capacitor were specified — the program calculated the resistance values. These schematics are only produced for higher than first order designs.



Here's the response curve for a two-stage, multiple-feedback band-pass filter. Section 1 frequency and bandwidth were both 500Hz, while for section 2 they were both 5000Hz. A gain of 1.0 was specified for each section, as was a 0.01uF capacitor value. Only bandpass filter designs produce such response curves — for others you are referred to a reference text.

When we printed out a band-pass filter response curve, the 300dpi selection produced a postage-stamp size graph 4 x 2.5mm, the 150dpi a usable 8.5 x 5mm size, while the 75dpi gave a very 'dotty' image which was too large to fit across an A4 page. With the dot matrix selection, the program produced a slightly larger image, 180 x 120mm, but unlike the laser printout it was in portrait mode — so all the graph fitted neatly on the page.

About the manual: I would like to see it include a lot more detail. I feel that the program relies so heavily on the reference text that its use could easily be restricted without it.

Also the manual is really only an index to the types of filters, and gives no instructions for actually running the program. For the first-time user, instructions definitely would be useful.

Another limitation, this time in the program, is the number of filter designs that do not produce a schematic — and therefore no hard copy. A printout of the schematic, along with component values, is the simplest way of recording your design.

Despite these minor drawbacks, both programs are successful in achieving their main aim — to do the tedious calculations associated with filter design. For anyone involved in such design, and familiar with crossover networks, the programs are easy to use and would save a lot of time — very useful programs.

The review copies of *P-Filter* and *A-Filter* came from ME Sound, PO Box 50, Dyers Crossing 2429; phone (065) 50 2254. The programs are available from that address by direct mail order for $49.95 each. (P.M.) ❖

CAD software feature:

'Easy-PC' for both PCBs and schematics

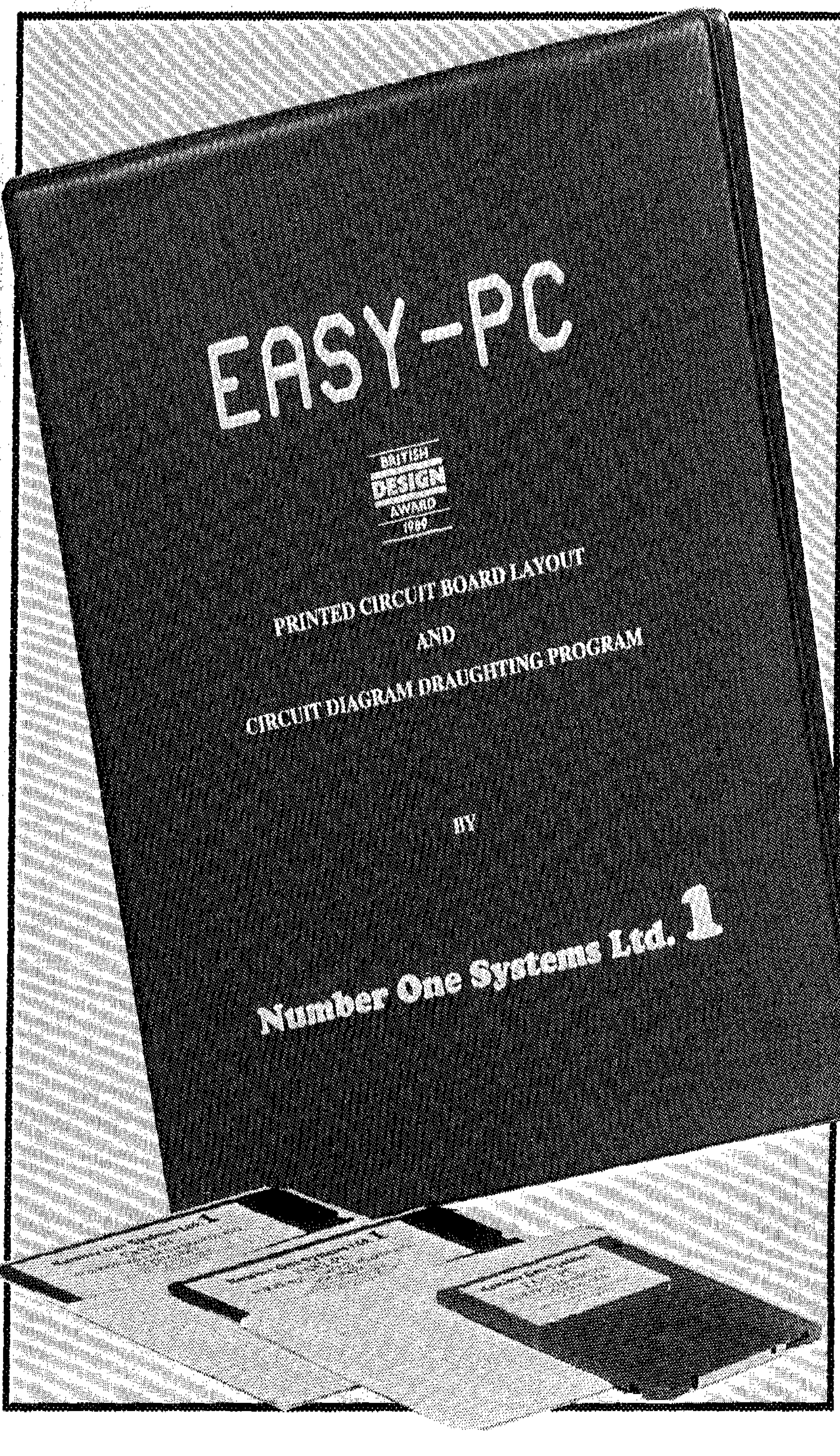
This low-cost CAD software from UK-based Number One Systems offers both circuit board design *and* schematic diagram drawing capabilities. It runs on IBM-compatible machines equipped with any of the common types of display, and can send the resulting artwork to a wide variety of output devices.

by ROB EVANS

There's no doubt about it, Computer Aided Draughting/Design (CAD) is one of the success stories of how computers can be used to great effect in the work environment. When it comes to printed circuit board (PCB) design for example, it's difficult to go back to older methods once you've experienced the convenience of using PCB CAD software, and appreciated the clean and ordered appearance of the final artwork. In the *EA* office, we're thoroughly hooked — we've been using Protel Technology's very effective 'Autotrax' software for a few years now.

Of course there was a time when only the largest companies, with equally impressive budgets, could justify the expense of a suitable computer/printer combination to run the CAD software of the era, which in itself was very costly. As a result, the benefits of such a system were only available to a chosen few. Nowadays however computers are relatively cheap and powerful, and PCB design software has followed suit by offering an ever-increasing range of features at a much more affordable price. It's now reached the stage where a small business owner, or even a hobbyist can run a full PCB CAD system without a serious impact on their finances.

It's from this point of view that we were particularly interested in seeing how Easy-PC performed, since is able to run on a very modestly equipped PC, offers both PCB *and* schematic drawing capabilities, and is currently available for only $275. With that sort of price and features, it's inevitably of great potential interest to those wanting to enjoy the benefits of electronics-orientated CAD software on a limited budget.



Hardware and features

Easy-PC is designed to run on an IBM PC/XT/AT/386/486 or compatible machine with more than 512k of main memory, and supports Hercules monochrome, CGA, EGA and VGA graphics cards/screens. It also supports the common types of mouse drivers (Microsoft, Mouse systems, etc), and although not recommended, the program can be controlled from the computer keyboard's arrow keys.

In the printer department, Easy-PC can send its drawing files to 9- and 24-pin dot matrix printers, HPGL-standard pen plotters, HP Laserjet (or Inkjet) compatible printers, Gerber photo-plotters, and NC-drill machines supporting the Excellon format. But there's currently no support for PostScript printers or photosetters...

The program itself offers all that you would expect of a comprehensive PCB package, with up to eight 'copper' layers and two 'overlay' or silk-screen levels, full control over pad and track sizes, the ability to edit existing track layouts, text capabilities, and so on. As with other CAD systems, a complete listing of the features would fill a number of these pages, and wouldn't provide much of an indication of what the system is like to actually *use*. Suffice to say, Easy-PC should offer enough facilities for virtually all practical situations.

It's interesting to note however, that the program appears to be essentially a *PCB* design package, with a number of its features simply restricted or modified when operating in the schematic drawing mode. For example, since you don't need up to 10 drawing 'layers' to produce a circuit diagram, these are automatically limited for schematic operation. This approach can work quite well (some people use a standard PCB package for schematics on a regular basis), and must be a large part of the reason why Easy-PC can offer both PCB *and* schematic capabilities at such a low purchase price. Mind you, if Easy-PC was only suitable for circuit board design, its $275 price tag would still be very competitive amongst other PCB CAD software.

Installation, operation

The Easy-PC package includes copies of the program on both 3.5" and 5.25" disk formats so as to suit all types of machines, and a large (A4-size) instruction manual featuring a number of tutorials and a comprehensive index. The program can be installed onto your machine's hard disk, or alternatively a couple of floppy disks, by simply invoking the *install* program on the Easy-PC distribution disk. This prompts you for information regarding the system configuration and which of Easy-PC's printer options are needed, then extracts (some of the program is in a compressed format) and copies the appropriate files from the master disk.

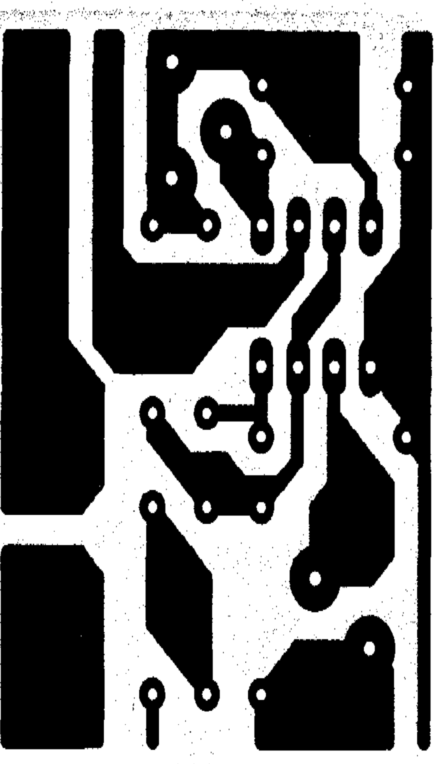


Fig.1: A small section of PCB designed in EasyPC, and sent to a HP Laserjet compatible printer via the program's 'easylase' utility.

After the installation is completed, your hard disk's new Easy-PC directory (or the floppies) will contain a number of executable files, depending upon which options have been chosen, a couple of demonstration drawings, and a few sample symbol library files. As it turns out, each of Easy-PCs main functions are invoked by their own dedicated program, where *easypc.exe* is the main drawing program, *easylase* is for sending files to a HP Laserjet-compatible printer, *easyplot* is for the HPGL plotter format, and so on.

The main drawing/editing program (*easypc.exe*) is 'switched' into its various modes at the initial options menu, which offers the choice of designing a PCB layout or schematic diagram, or creating a PCB or schematic symbol. Since all of these modes are in fact variations on the basic PCB design package (as mentioned above), each option looks and operates in a virtually identical manner. This in turn means that once you have mastered say the PCB design mode, you will have no trouble in operating the remaining three options.

Once the program is active, its operation is controlled by three pull-down menus; the first menu is used to select the current activity (drawing/editing tracks and pads, loading files, and so on), the second automatically changes its options in response to what has been chosen on the first menu, and the third sets the general screen options (zoom mode, snap grid, etc). By the way all of these operations can be directly accessed by the keyboard's function keys, which is quite a fast method once you learn the layout.

In practice, most aspects of Easy-PC's operation are quite straightforward. Placing tracks, pads and symbols is pretty much what you'd expect from a PCB CAD package, with the mouse movement used to drag shapes and track ends about the screen, and its buttons used to select objects or to escape from the current activity. In fact most of Easy-PC's functions behave in a similar manner to other PCB software, which instilled us with enough confidence to start drawing immediately.

After a little confusion over how a couple of the program's features worked

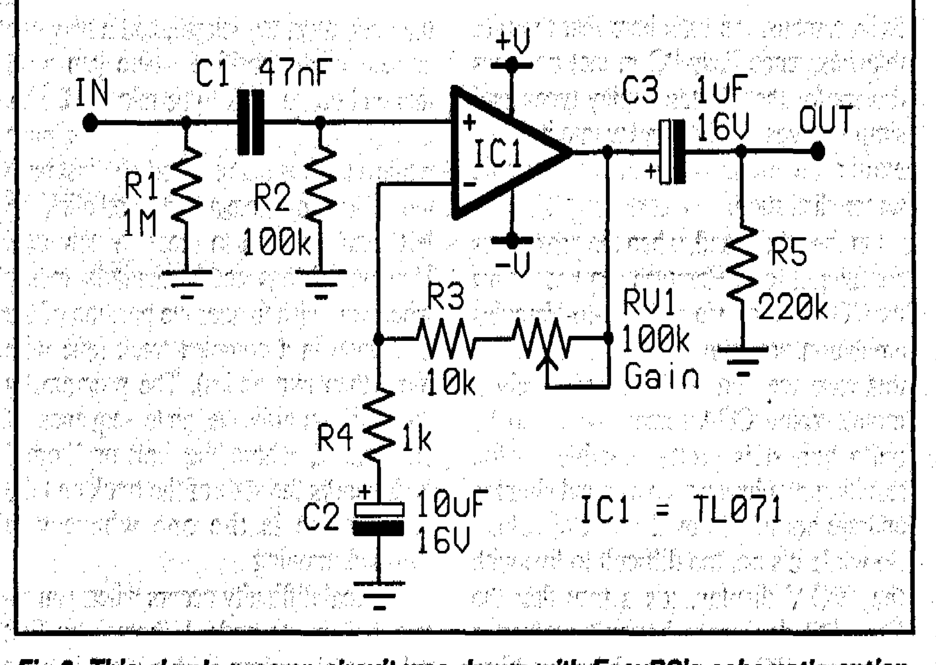
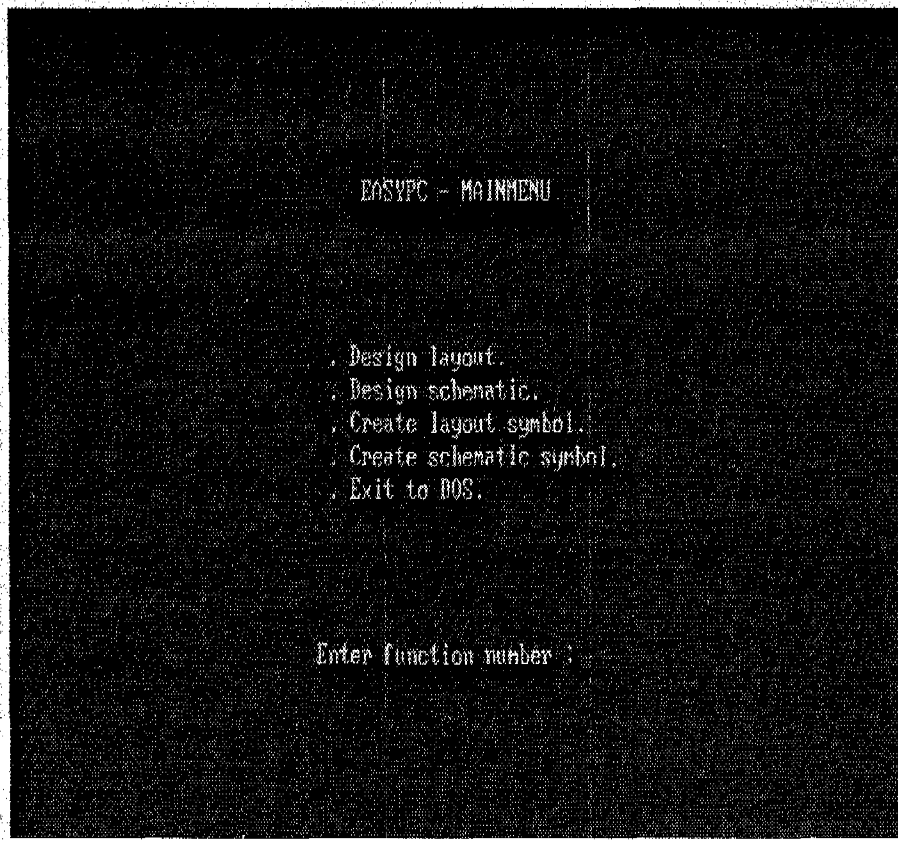


Fig.2: This simple preamp circuit was drawn with EasyPC's schematic option, and again reproduced on our resident laser printer.

'Easy-PC'

(when we first tried the package, a full manual wasn't available), we managed to complete both a small PCB layout and a simple schematic diagram in relatively short order. These drawings were dutifully saved, and the resulting files then sent to our office laser printer via the appropriate Easy-PC printing program (*easylase.exe*). Happily, the results were first class, and have been reproduced here as Figs.1 and 2 to give you an idea of the end product of a typical drawing job.



EasyPC operates in a virtually identical manner for each of its four main modes, which makes the overall program quite easy to learn.

Brickbats and bouquets

Unfortunately, there were a few aspects of Easy-PC that we found to be quite cumbersome, and in some cases rather annoying. For example, the actual screen image was quite non-linear on *all* types of displays (Hercules through to VGA), which can be very deceiving when drawing new symbols in particular. In this case, you can't simply draw a component that's in proportion to your eye, since it will ultimately be printed out with a rather squashed shape (elongated in the X-axis).

The answer of course is to set the shape of your drawing by noting the screen grid graduations, and ignore what appears to be a rather stretched image on the display. However you never really know what the drawing will look like, until it's finally printed out. Hardly a 'WYSIWYG' (what you see is what you get) screen display, as claimed in Number One System's promotional blurb...

It's interesting to note however, that a number of other PCB CAD packages also suffer from non-linear displays in their CGA and EGA modes, but not when the VGA screen drivers are used — presumably there is some inherent difficulty in programming for CGA and EGA screens. And it's here that the plot thickens, since Easy-PC in fact only has drivers for these latter display types, and simply forces a VGA display into its EGA emulation mode — with the intrinsic screen distortion.

On the other hand, when the program is configured for a Hercules display, it uses its CGA driver via a CGA-to-Hercules emulation program called Vastscreen. In this case the end result is effectively a monochrome CGA screen, which to be quite honest is pretty horrible — the resulting graphics are coarse and chunky, and are not helped by the lack of colour. So while it's not too difficult to live with the 'VGA' display, it's a pity that the Easy-PC designers haven't written a genuine VGA screen driver which delivers a truly proportional image. Particularly since nowadays, most new PCs are fitted with a VGA display as standard.

The other main grumble with Easy-PC was the way in which tracks must be edited, once they are laid down. The program deals with tracks on a 'node' basis, where a section or segment of track is terminated in a node at each end, and cannot be moved or altered in itself (except for setting its width and layer) — to move say, one end of a track, the appropriate *node* must be moved. While this basic concept works well, as in similar systems used with other CAD packages, it has been applied to Easy-PC in rather an awkward way.

The problem here is that you cannot literally *move* a node in Easy-PC. Rather, the node must be deleted, and a new one created in the position where you want that end of the track to be relocated. This is not quite as awkward as it sounds, since while a track is being edited you just push the 'd' key to delete a node, and click the left mouse button to create a new one. However things get particularly messy when you wish to alter the position of the *first* node in a complex track (one with more than two nodes). The program by the way, records the node sequence of each track, where the first or 'home' node marks the start of the track and the 'end' node is the one where you finished drawing.

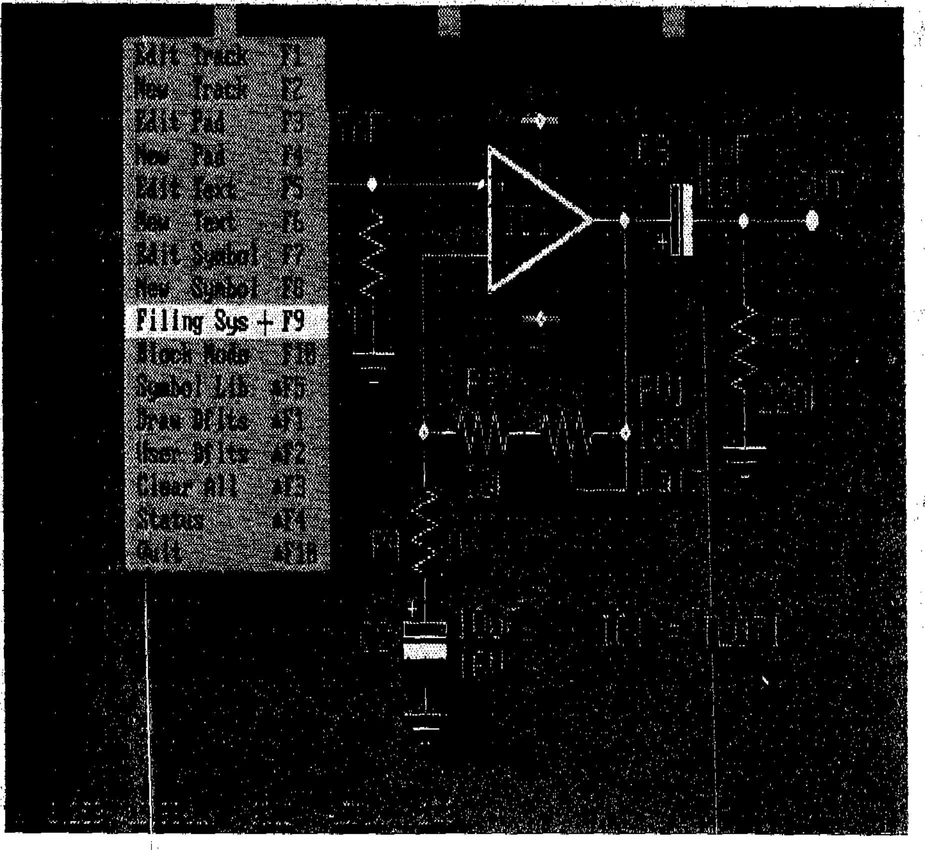
The real difficulty occurs when you attempt to move node 1 (home) by first deleting it — since in this case the next one along the track (node 2) automatically becomes the new node 1. Now as it turns out, the program can't create a node with a number less than one, and prepares to make a new node 2 further along the track. So you've now lost the first segment of your track, and can only form a new one *past* this point. And to compound the issue Easy-PC does not offer an un-delete function, which is a serious omission in our opinion.

However Easy-PC does offer a solution to the above problem with its 'invert node sequence' option, where the entire order of node numbers is swapped. So as soon as you realise that you are attempting to 'move' node 1, you activate this option (by hitting the SHIFT+I keys) which changes node 1 to node 5 (or whatever the end node is).

It can then be edited in the normal manner. Nevertheless it's still a rather clumsy system in our opinion, and could have been avoided with the addition of a simple 'shift node' option.

Other than the above complications, which you can adapt to without too much heartache by the way, Easy-PC was a few more minor quirks and omissions. One is a general lack of feedback or information about the program's status and filing system.

When opening a drawing file for example, the program simply prompts you for a filename — without automatically providing a list of possible files to choose from, as in most other programs. If you can't recall the exact name of the file that you want to load, you must then call the



An example of EasyPC's screen in the 'Design schematic' mode. The small squares at the top of the screen are used to activate the three menus.

'directory' menu for a list of viable files (which aren't sorted in alphabetical order by the way), memorise the filename of the desired drawing, go back to the 'load file' option and type in that name. Unfortunately the same system also applies to the symbol library.

Another aspect of Easy-PC which can be annoying is the lack of information regarding the program's current mode. If you have inadvertently selected the 'Create schematic symbol' mode at the opening menu instead of your intended 'Design schematic' option for example, things can become rather unstuck.

In this case the two operating modes have identical displays, and the program behaves in the same manner when loading drawing files, drawing tracks, and so on. All proceeds normally until you find that the components you have just loaded onto the screen cannot be moved in the normal manner (using the symbol edit option) for example, and must be shifted with a block operation.

Eventually the penny drops and you realise that you're in the wrong operating mode, and you have wasted your time loading files and laying tracks. Again, this scenario could be avoided by a small addition to Easy-PC's program, which in this case might add a line of text on the screen to indicate the current operating mode.

Easy-PC has yet a few more quirks, which are relatively minor but nonetheless still frustrating. For example, the software is quite intolerant of TSR (terminate and stay resident) programs which have been loaded beforehand, and tends to 'crash' at its opening menu unless these programs are removed. Also, the main screen offers short help messages (or hints) in its bottom left-hand corner, as each of the program's main functions are selected — but unfortunately these only appear for less than half a second, and are consequently unreadable!

Of course there are a number of points about Easy-PC that we really *did* like, such as the general speed of the program. In this respect, we were pleasantly surprised by the rate at which the screen is updated in response to a pan command, and how a new image is almost instantly redrawn when a different zoom level is selected. In practice this means that with Easy-PC, you can magnify and view sections of your drawing at will, without having to wait for protracted screen redraws, as is the case with many other CAD packages.

Also, while we found Easy-PC's track editing scheme to be awkward for moving track ends, it's a very efficient (and fast) system for adding new sections to existing tracks. Since the track editing mode will automatically create a new node in response to a click on the mouse button, you can form a 'detour' shape in an existing track with just a few clicks on the mouse.

Other than that, we found the supplied manual to be clearly written and quite helpful, were very pleased with quality of the printout from both the laser printer *and* the dot-matrix machine, and of course, we're most impressed with the $275 price tag.

Conclusions

All in all, Easy-PC is a very capable package, and has more than enough features to create PCB and schematic drawings for both amateur and semi-professional use.

However it does have a number of rather frustrating quirks in our opinion, which in practice means that you must be quite familiar with the package before you can smoothly produce a final drawing. The bottom line of course *is* the quality of the end result and how long it has taken to produce — in this respect Easy-PC can certainly deliver the goods.

The British certainly seem to think this is the case, since the Easy-PC PCB/schematic package won the 1989 British Design Award, in spite of its quirks. Mind you, Easy-PC *is* a British home-grown product...

It's interesting to compare Easy-PC with a similarly priced local package: Easytrax, from Protel Technology in Tasmania. While this is essentially a PCB-only system, it can be used to produce schematic diagrams in a similar way to Easy-PC, so a direct comparison is arguably quite valid.

While Easytrax is priced at $395 — around 40% higher than Easy-PC — and generally offers the same capabilities, it really is rather a more sophisticated package with a host of extra features. For the higher price of Easytrax you get a friendly filing system, a continuous display of status information, a full choice of colours for the screen and track layers, a wide range of snap grid settings, a versatile undelete function, programmable key macros, the choice of dragging tracks with moved components, basic auto-routing capabilities, a *Postscript* printing option, and so on.

Perhaps the general message here is that you get what you pay for. Both Easy-PC and Easytrax are 'entry-level' programs and offer excellent results, and a choice between the two may be governed by financial consideration alone. If pressed for a decision, we would have to opt for Easytrax on the grounds that it's rather more versatile and pleasant to use than Easy-PC, and would therefore be more productive in the long run.

However if you wish to take advantage of Easy-PC's very low price, and still enjoy the benefits of a powerful PCB/schematic CAD package, write to Breakthrough Computers at PO Box 432, Garbutt, Townsville, QLD 4814; or phone (077) 25 3189. ❖

CAD Software Feature:

Windows version of Protel's PCB package

As part of a planned changeover of its very popular PCB and schematic CAD software packages to the standardised Windows 3 platform, Tasmanian-based Protel Technology has recently released a bundled package of the Windows version of its *Advanced PCB*, *Advanced Place* and *Advanced Route* layout tools.

by RICHARD CHAPMAN and BRUCE EDWARDS

Protel Technology, the Tasmanian developer of the popular Protel PCB layout and schematic capture software, has recently released its all new Windows 3-based PCB design tools.

Called Protel for Windows, the family will ultimately include both entry-level and high-end schematic design, PCB layout, simulation, autoplacement and auto-routing options.

The first product, which began shipping in December 1991, is a special bundled release of Protel's three new premium PCB layout tools. Called the *Protel for Windows* Special PCB pack, it includes *Advanced PCB*, *Advanced Place* and *Advanced Route*. The package has been released at the introductory price of $990 for existing Protel users.

Protel for Windows brings the professionalism of Protel's well-proven PCB design system to the highly productive Windows 3 environment.The new system combines the natural advantages of Windows with the advanced capabilities of Protel, to yield a powerful yet flexible design system.

New users will find *Protel for Windows* easy to learn and use, says Protel, while experienced Protel users will be pleased by the extensive improvements and enhancements provided by the move into the Windows environment.

Because Windows is graphically based, learning any new application is a highly intuitive process.

Once you have mastered one Windows application, you already know a lot about other applications because of the standardized way that many tasks are performed under Windows, such as loading files or transferring information between applications.

In 386 Enhanced mode, Windows 3 also provides *virtual memory* capability, allowing users to design without restrictions on the total number of components, nets, tracks, etc.

Protel for Windows supports the multiple document interface (MDI) standard.

This allows any number of files to be loaded at the same time, the use of standard Windows routines like Cut and Paste to move information between files or even between applications, using Windows multi-tasking capabilitites.

Advanced capabilities

Protel for Windows' Advanced PCB is a complete PCB layout environment with many attractive features for productive design work.

You can use*Advanced PCB* as a stand-alone manual board layout tool, but when combined with the schematic capture package it becomes the backbone of a fully-automated, end-to-end design system that features a high degree of design automation and integration.

Advanced PCB accepts netlists not only from Protel *Schematic*, as did *Autotrax*, but also supports other popular netlist formats.

It is a 20-layer design system that features blind/buried vias, Gerber input and output, metric and imperial grid systems, true copper pour, 1° arcs and rotation, multi-level Undo and Redo, and multiple document windows with full implementation of standard Windows commands like Cut and Paste.

A key feature of the *Protel for Windows* system is the global editing options that are provided for each design primitive. Attributes can be edited simply by double-clicking directly on an item, to open a dialog box.

Changes can then be globally applied across an entire design, using specific conditions to define the targets.

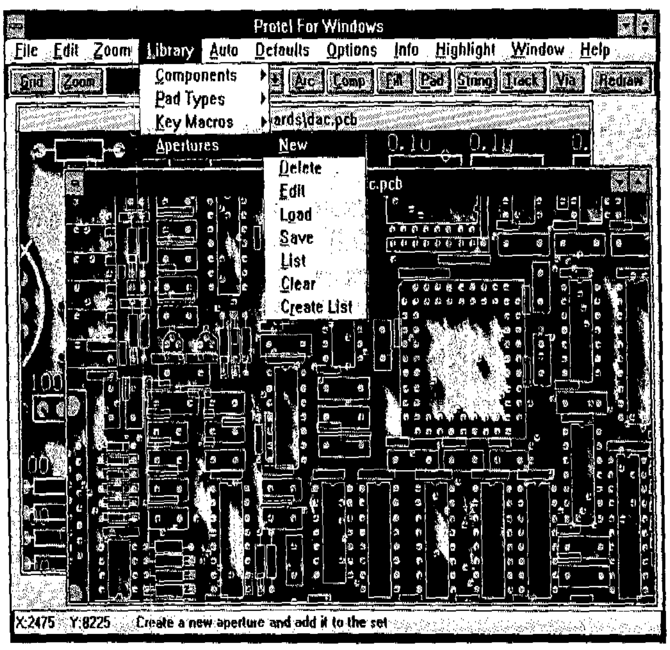
For example, when editing tracks you can change the track width, track layer or both the width and layer.

These changes can be globally applied to all tracks of the same width and/or layer; tracks which are *not* the same width or layer; all selected tracks; or all un-selected tracks. Similar global options are provided for components and other primitives.

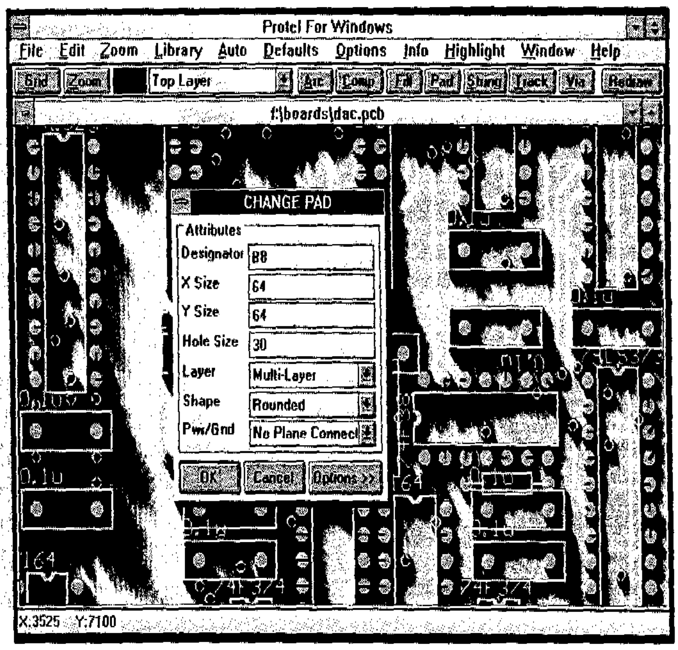
Other features of *Advanced PCB* include a facility to generate a non-linear density map, which accurately predicts routing difficulty for a placed board, and automatic generation of NC drill output without the need for user-defined tool files. A fast sorting algorithm processes the NC drill output file for efficient drilling.

Advanced Place is an automatic and interactive placement system that uses the AI technology of 'simulated annealing' to approach the placement problem from a global rather than a local perspective.

Protel claims dramatic improvements in autorouting performance when using this methodology. The system includes interactive placement tools, including a 'shove' feature that allows the designer to drop components into the layout — with the pre-



Operation of the new Protel for Windows package is fully integrated, and using the familiar Windows system of pull-down menus. New plotting apertures can be created at any time and added to the working library.



In the same way, items such as pads or component symbols can be edited at any time by double clicking on the item itself. This calls up a dialog box such as that shown here for changing pads.

viously placed components moving to accommodate the new item.

The *Advanced Route* module provides simultaneous 16-layer rip-up/retry routing, with blind and buried vias to user defined models. The user can also pre-define connection order for high-speed circuits and assign routing priorities for each net.

Familiar feel

The way *Protel for Windows* uses tools, menu commands and shortcuts will already be familiar to experienced Windows users — such as using combinations of ALT and other keys to execute menu commands. In short, *Protel for Windows* looks and runs like other Windows applications — and it's as flexible as you are. However you should be aware that *Protel for Windows* is different from other Windows 'drawing' applications, in some of its fundamentals.

A PCB design is a series of layers — layers which correspond to the individual 'tools' used to create the

Protel

board, such as the top and bottom signal layers or the silkscreen overlay layer. A PCB design package must display and manage these layers independently, and some operations such as track placement are layer dependent — you must first select the layer, then place the track. *Protel for Windows PCB*'s print/plot options also reflect this requirement for layered design.

PCB design differs from other drawing tasks in its requirement for extreme precision. As a result, *Protel for Windows PCB* is more of a placing environment than a freehand drawing environment.

Another fundamental difference is connectivity — *Protel for Windows PCB*'s ability to recognise connections between track segments, tracks component pads, etc.

For example *Advanced PCB* allows you to move a component without breaking its track-to-pad connections. You will be using connectivity on several levels as you design with *Protel for Windows Advanced PCB*.

Compared with Autotrax

While the graphics speed of some operations in *Protel for Windows* is slower than in Protel's previous DOS-based *Autotrax*, when comparing the two systems one should recognise the enormous productivity benefits that the new global editing, Undo, Redo and selection features in *Protel for Windows*, to name just a few, provide over those of *Autotrax*.

Protel anticipates the graphics speed difference to be a short term one, as Windows is further enhanced and other vendors release their own proprietary products (such as high speed graphics adaptor cards) to increase its performance.

Essentially every functional capability of *Autotrax* has been preserved in *Advanced PCB*, while at the same time advantages of Windows standardisation have been used to enhance many existing *Autotrax* features and make the system easier to use, more powerful and more productive.

Of course an important advantage of moving to the Windows environment is that it provides a standardised software 'platform', with matching software drivers supporting many different video graphics and hard-copy output hardware implementations — provided by both Microsoft and third-party hardware vendors. This provides a much greater range of display and output options for users.

For example *Protel for Windows* allows full use of all 24-bit colour graphics cards and monitors supported under Windows 3. On standard graphics adaptors such as VGA, dithering can be used to simulate colours beyond the standard 16.

Advanced PCB also supports a maximum magnification of 0.25 mils ('thou') per screen pixel, four times the maximum provided by *Autotrax*. Similarly any printer, plotter or photo-imaging device supported by Windows is now available for output of *Protel for Windows* files, from dot matrix printers to PostScript Linotrons.

Plots or prints can either be panellised or generated as a composite of multiple layers, with auto-centring on the sheet. All displayed items can be printed or plotted, making it easy for the designer to control the output.

For further information circle 201 on the reader service card, or contact Protel Technology, Technopark, Dowsings Point 7010; phone (002) 73 0100 or (008) 030 949. ❖

Solid State Update

KEEPING YOU INFORMED ON THE LATEST DEVELOPMENTS IN SEMICONDUCTOR TECHNOLOGY

Simple switcher

An extension of National's Simple Switcher product line, the LM2576 maximises system performance, while simplifying the design process. The new device requires only four external components: a diode, an inductor and two capacitors.

Specifying the inductor is very easy. Once the designer knows the circuit's input voltage and output current, he or she can use the inductor selection chart in the datasheet to determine the appropriate inductor for the circuit's design. The chart also lists three inductor manufacturers, along with specific inductor part numbers.

The key to using standard off-the-shelf inductors is the LM2576's fixed oscillator operating frequency of 52kHz. Competitive devices use variable frequencies, which require customer-designed inductors. The LM2576 is capable of driving a 3A load with impressive line and load characteristics. It is available in five versions: 5V fixed output, 12V, 15V and adjustable. Operating at 82% efficiency (compared with 40 to 50% for a linear regulator), the LM2576 helps to substantially reduce system power consumption, as well as heat generation. The LM2576 is a cost effective solution. Easier to design with than traditional switching regulators, the new device costs only about one fifth as much as a DC-to-DC converter.

For more information circle 272 on the reader service coupon or contact IRH Components, 32 Parramatta Road, Lidcombe 2141; phone (02) 748 4066.

Laser diode modules

A comprehensive range of laser diode modules is now available from Anritsu. A feature of the range is the high output power of the devices. The range includes FP-LDs, DFB-LDs and superluminescent laser diodes (SLDs) with operating wavelengths of 1300, 1480, 1535, 1550 and 1650mm. A device of particular interest in the range is the SD3F101F. It is a high power InGaAsP/InP laser diode operating at 1.48um, developed as a pumping light source for Er-doped fibre amplifiers.

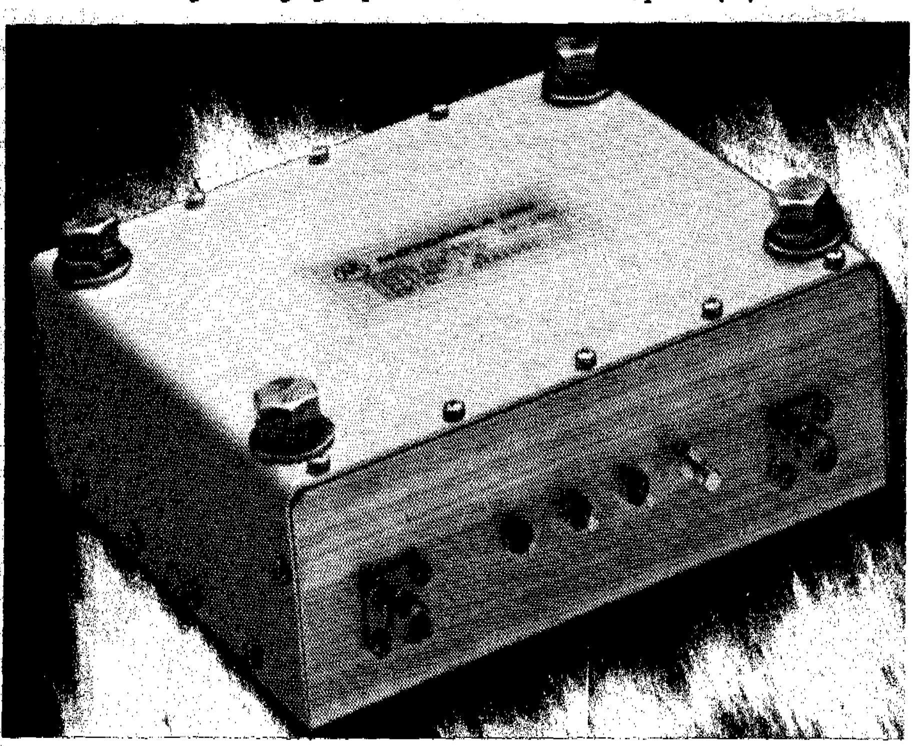
For more information circle 273 on the reader service coupon or contact Alcatel Australia, 58 Queensbridge Street, South Melbourne 3205; phone (03) 615 6666.

850-900MHz linear amp modules

Motorola has completed the development of three linear amplifier modules for operation in the cellular radio base station frequency bands of 850 to 900MHz.

The PA900 Series of complete broadband linear amplifiers operate from a supply voltage of 25 volts. Output power of up to 100 watts are included in the series which along with high gain provide the system designer with outstanding flexiblity. These solid state, Class AB linear amplifiers incorporate microsoft circuit technology and high performance, with gold metallised push-pull transistors. Amplifiers in the PA900 Series are intended for single or multi-channel digital technology base station applications.

For more information circle 271 on the reader service coupon or contact Motorola Australia, 673 Boronia Road, Wantirna 3152; phone (03) 887 0711.



AM/FM chip for car tuners

Toshiba has introduced a new LSI device 'TA8199F' for car-radio tuners, that integrates on one chip an AM tuner and an FM front-end for receiving FM signals and station selection. The AM/FM tuner is composed of several parts: front-end; amplifier; FM detector; noise canceller; and stereo decoder.

The new device improves the tuner's reception sensitivity to 1.5-2dB, allowing it to receive clearly, even if weak signals are buried in stronger signals. Adopting an unconversion method, the AM tuner is able to receive the low frequency wavebands mainly used in Europe, as well as medium wavebands commonly used.

In combination with Toshiba's FM processor LSI 'TA2027F', which integrates an amplifier, wave examination, noise canceller, and stereo sounding components, the new LSI configures a compact car audio tuner on only two chips.

Parallel-processing DSP chip

A new TI digital signal processor designed specifically for parallel-processing is now being used in a variety of high performance systems.

The chip is noteworthy, not only because of its next generation processing power, but also because development tools that support the chip make it easy to design sophisticated parallel-processing hardware and software. The architecture of the TMS320C40 reflects a design created specifically for parallel-processing applications.

Key features of the 32 bit device include six communication ports for direct, high speed interprocessor communication; a six-channel direct memory access (DMA) coprocessor, which unburdens the CPU and permits it to sustain maximum performance levels; a floating point processor which performs 275 million operations per second (MOPS) with 320Mbyte/second throughput; and dual external-bus architecture which links the 'C40' with global and local memory, reducing the bottlenecks designers experience when using single-bus processors in shared-memory systems.

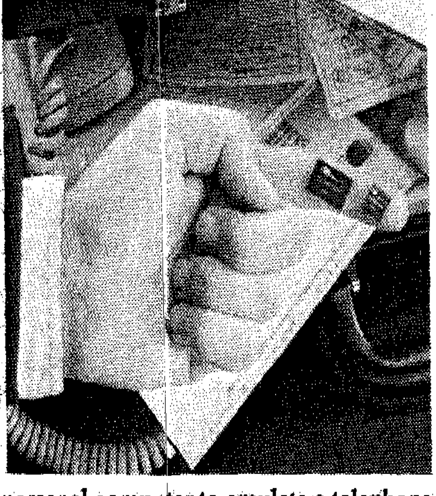
For more information circle 276 on the reader service coupon or contact Texas Instruments Australia, 6 Talavera Road, North Ryde 2113; phone (02) 878 9000.

Two chip modem for data, fax, voice

Cirrus Logic has introduced the CL-MD1424 'Communicator' Intelligent Data/Fax/Voice Modem device set. This is a communications product family that provides complete data, facsimile, and voice capabilities in only two integrated circuits — eliminating the external controller, host interface, memory and associated components required by other modem chips and chip sets.

With the CL-MD1424 Communicator, a complete data/fax/voice modem can be created in an area smaller than a business card, allowing this complete communications function to be a standard feature in next-generation portable computers.

The Communicator offers full-duplex data communication at up to 2400 bits per second, facsimile transmission and reception at a rate of up to 14,400 bits per second, and a voice mode that allows a



personal computer to emulate a telephone answering machine.

The initial two members of the new Communicator product family are the CL-MD1424AT and the CL-MD1424EC. The CL-MD1424AT is a two-chip intelligent data/fax/voice modem implementation, consisting of a 'digital signal microprocessor' (DSP) and a 'sigma-delta analog front end' (SAFE). The DSP performs all of the communications-related functions of both a microprocessor and a digital signal processor, and also has on-chip ROM in which is embedded extensive data/fax modem and voice command set firmware. The SAFE performs all of the communications conversion and filtering functions that have analog elements.

For further information, circle 277 on the reader service coupon or contact Cirrus Logic, 1463 Centre Pointe Drive, Milpitas CA 95035 USA; phone (408) 945 8300.

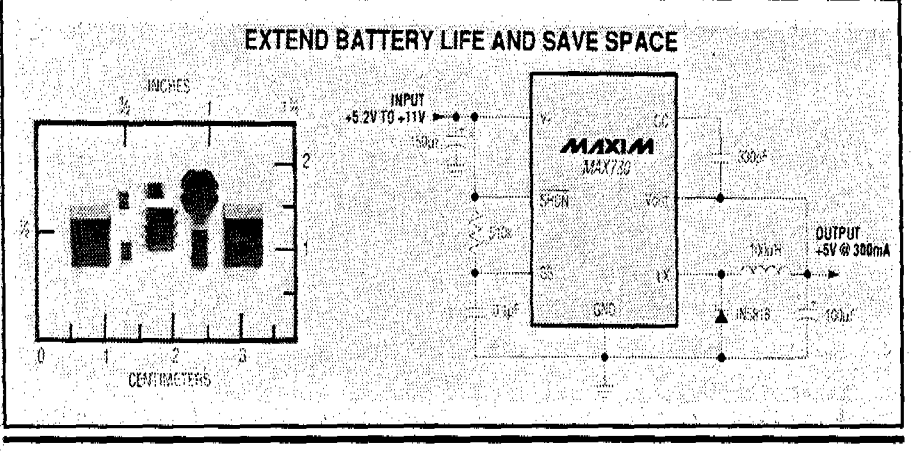
Small +5V step-down regulator

Maxim has released its new MAX730/MAX738, the first products of a new family of current-mode pulse width modulated (PWM) switching regulators. These +5V step-down converters extend battery life in portable applications by providing high-efficiency step-down regulation. The MAX730 has a 94% efficiency, and delivers currents up to 300mA. The MAX738 is guaranteed to deliver up to 750mA, and has efficiencies up to 90%.

The MAX730 and MAX738 are small and simple step-down solutions that feature built-in switches and require no designs or inductor selection. Using the single set of component values listed in the data sheet, the standard application circuit delivers the guaranteed power over all specified line, load and temperature conditions. The specified 100uH inductor is available off-the-shelf or directly from Maxim. Unlike previous step-down switching regulators, these new Maxim regulators operate effectively even at very low input voltages, extending useful battery life.

The MAX738 accepts inputs from -6V to +16V, and the MAX73 accepts input from +11V to as low as +5.2V. Other features include short-circuit protection to turn off the output during current overload, soft-start protection to ensure an orderly power-up and pincontrolled shutdown to turn off the regulator and cut quiescent supply current to 6uA. High frequency 160kHz pulse-width modulation (PWM) current-mode control provides low noise operation and reduces output voltage ripple to less than 50mVp-p.

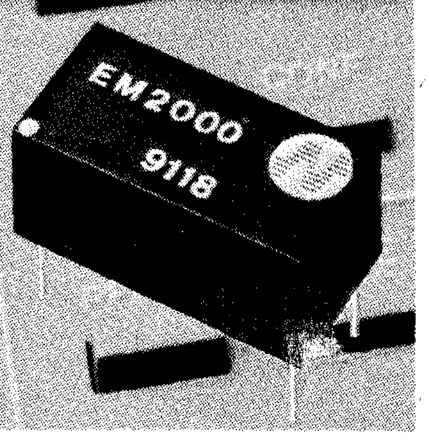
For more information 275 on the reader service coupon or contact Veltek, 22 Harker Street, Burwood 3125; phone (03) 808 7511.



Noise filter

Newport plans to produce a range of high performance common-mode filters for data and telephone lines. They also offer a custom design service, to produce filters tailored to achieve optimum EMC for special EMI performance in specific applications.

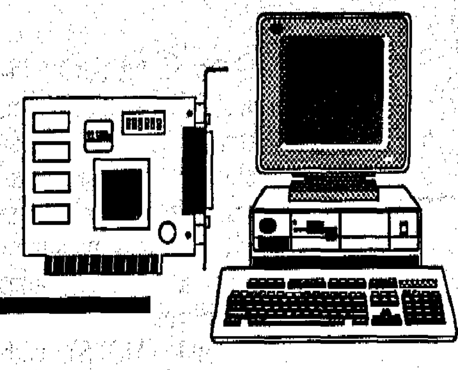
The first product in the filter range is the EM2000, which offers up to 40dB attenuation of common-mode noise over



the range of 100kHz to 30MHz, with useful performance extending to over 100MHz. The devices are housed in 14 pin, 0.3" pitch, dual-in-line packages and provide 1700V RMS isolation between lines. The performance and price of these filters are intended to make them the ideal choice for efficient and cost-effective EMI suppression. Costs vary according to the order volume, but the EM2000 will initially be priced at $3.53 (+250).

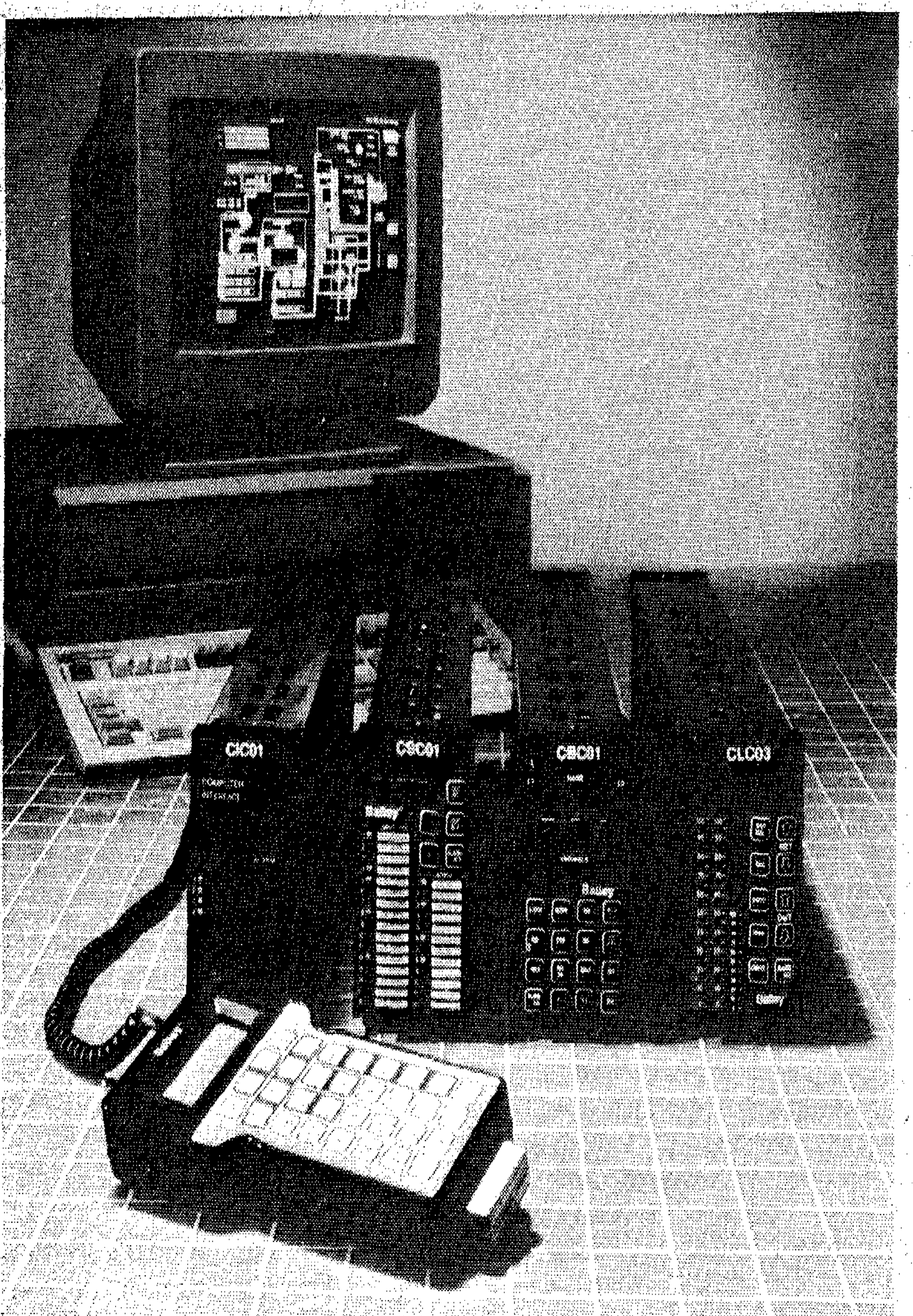
For more information circle 274 on the reader service coupon or contact Alpha Kilo Services, PO Box 180, Lane Cove 2066; phone (02) 428 3122. ❖

Computer News and New Products



Computer interface controller

The new Computer Interface Command (CIC) from Bailey Controls Australia provides a single 'window' interface into plant operations. The new CIC links a host device, such as a PC or large, multi-tasking computer, with up to 30 of the firm's standalone controllers. The device can monitor and control up to 500 points, allowing the host device to interface with any combination of command series loop, batch or sequence command controllers on a single module bus communication network. Interface takes place through a number of software packages, including PCView and CAD/TXT.



The CIC consists of communications hardware and firmware for transmitting information such as control station variables, analog and digital I/O, status information and controller configurations to and from the CIC.

For more information circle 161 on the reader services coupon or contact Bailey Controls, 26 Auburn Road, Regents Park 2143; phone (02) 645 3322.

PC diagnostics

LandMark/SuperSoft has released PC Probe V2.0, which combines advanced diagnostic and benchmarking testing, virus protection, utilities, and system information — to quickly and easily get a system back up and running.

PC Probe is menu driven (keyboard or mouse) with complete onscreen help facilities, and runs in harmony with drivers and resident programs. Diagnostic routines include tests for the CPU, math chip, real time clock, CMOS RAM, speaker, interrupts, DMA, RAM, video board and monitor, keyboard, serial and parallel ports, floppy and hard drive controller and disk drives, network controller, mouse and joystick.

As well, the utility functions allow reformatting of hard drive, parking of heads and locating bad RAM chips. The famous LandMark Speed Test 2.0 is also included. This version dynamically displays the CPU, FPU (math) and raw video speeds. Other benchmark tests include hard disk access times, disk-to-memory and disk-to-controller data transfer rates in total, over 50 vital system parameters.

Finally, PC Probe includes VirusCure Plus software, for fast, accurate scanning and removal of viruses. VirusCure Plus scans all drives, including network drives and lists over 500 known viruses.

For more information circle 162 on the reader service coupon or contact Interworld Electronics & Computer Industries, 1G Eskay Road, Oakleigh South 3167; phone (03) 563 7066.

HP laser printer

Hewlett-Packard has introduced the HP DeskJet 500C printer, which offers economical, laser quality colour printing for personal computers, for $1779 ex tax. The new printer joins the HP DeskWriter C printer for Macintosh computers, which was recently announced as HP's first laser quality printer with colour capability.

The HP DeskJet 500C printer produces black or colour output with 300dpi resolution. To change from monochrome to colour, the user simply swaps the black ink print cartridge with a new tri-chamber, colour ink print cartridge. The colour print cartridge holds cyan, magenta and yellow inks that are mixed to create virtually any colour, shade or hue. The DeskJet can print a monochrome page in approximately 20 seconds, and a colour page in about four minutes.

A new Microsoft Windows printer driver for the HP DeskJet 500C printer allows users to take advantage of all popular word processing, business graphics, spreadsheet presentation and other Windows based programs that have black as well as colour output options.

The driver offers one step matching between colours on the computer monitor and the printer ouput, eliminating the need for trial and error adjustments and a choice of dithering patterns from simple to complex, to produce various textures in the printed output.

Ten DOS-based drivers are included with the printer for programs such as Lotus 1-2-3, Harvard Graphics, Borland Quattro and HP Graphics Gallery.

For more information phone Hewlett-Packard on 008 033 821.

Windows driver for colour Canons

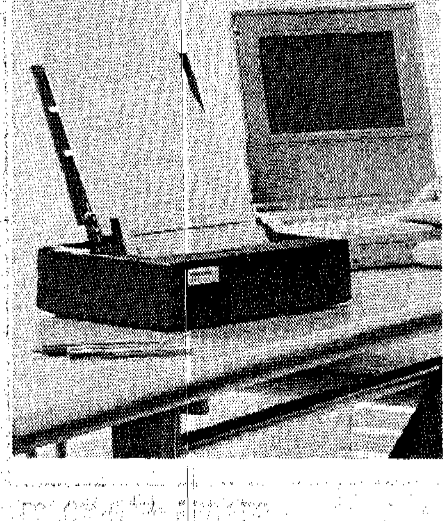
The Computer Support Corporation of Dallas, Texas has released a True Colour Printer (TCP), Windows 3.0 driver for the Canon Colour Imaging Systems.

The driver allows Windows 3.0 applications such as Arts & Letters, Corel-Draw, Aldus PageMaker, Venture for Windows, Word for Windows and Word-Perfect for Windows to print directly to the Canon CLC-500 or PS-300 colour imaging systems, the TCP allows text to be printed at 400dpi, even though the graphics memory may be limited, and so be printed at 200dpi. With a full complement of graphics memory — 48MB for

Portable 300dpi page printer

Siemens has launched a compact, portable page printer weighing 3.8kg and having a footprint of less than an A4 sheet of paper. The machine has a built-in power pack capable of printing 150 pages before recharging, and is based on silent thermal transfer technology — printing at six pages per minute on normal paper or transparencies.

Called the MT735 and priced at



$1500, the new machine has a print resolution of 300 x 300dpi — equivalent to normal laser printers — and has an integral sheet feeder holding 80 sheets of A4 paper.

Thirty six fonts are provided as standard, whilst the resident 1Mb memory allows for further downloaded fonts and forms overlays, for advanced word processing and DTP applications. Industry standard emulations include HP LaserJet Series II, HP DeskJet Plus, IBM Proprinter X24 and Epson LQ850. A copy button provides for the repeat pages of the document last loaded. The thermal print head block has 2560 heating elements across the width of the paper, divided into four blocks of 640. This provides the fast 6ppm output speed. The dimensions of the MT735 are 29 x 22 x 6cm, and the in-built rechargeable battery is designed to last the life of the unit.

For more information circle 163 on the reader service coupon or contact Siemens, 544 Church Street, Richmond 3121; phone (03) 420 7254.

an A4 page — the graphics could also be printed at 400dpi. In addition, the True Colour Printer driver includes a special 400dpi font generator that supports any Bitstream typeface from the Bitstream Facelift utility.

For more information circle 164 on the reader service coupon or contact Alkira, 11 Gertrude Street, Beacon Hill 2100; phone (02) 975 4423.

Mac 'meter display'

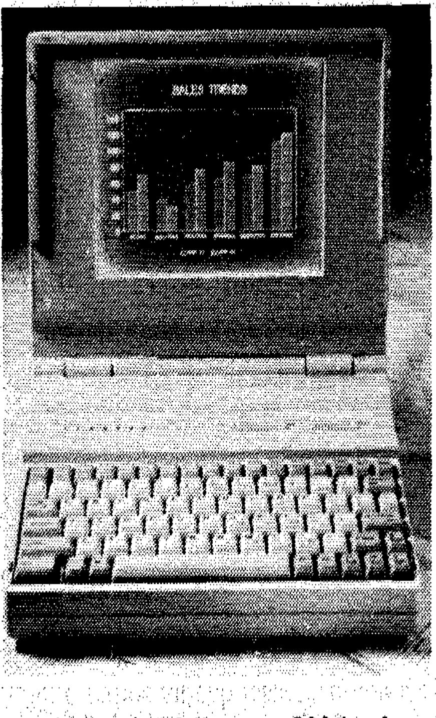
PanelMeter from Intelligent Instrumentation/Burr-Brown, displays on a Macintosh II series computer the signal values of one or more analog inputs as onscreen, digital panel meters. It is designed to be used with the PCI-701C NuCarrier Multifunction I/O board, and is ideal for engineers, researchers, students, technicians — anyone reading analog input data.

PanelMeter displays signal values from any or all of the I/O board's 16 single-ended channels. However, users are not limited to 16 meter displays. PanelMeter can support multiple NuCarrier boards and multiple meters can also be used to display values from the same channel.

When a new meter is opened, the user selects the NuCarrier slot location, the voltage range of the incoming signal, and the channel to be displayed. A pop-up dialog box provides display options that enable the user to customise meters and to scale the value displayed by each meter. A meter setup can be saved to disk, and reloaded later with screen position and all other parameters restored. A meter can also be 'zoomed down' to a size such that the slot, range, and channel controls do not clutter the screen.

For more information circle 166 on the reader service coupon or contact Kenelec, 48 Henderson Road, Clayton 3168; phone (03) 560 1011.

High performance 386SX notebook



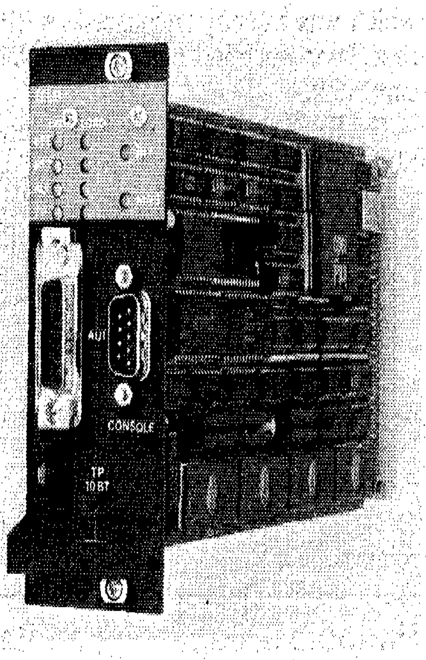
Total Peripherals has released a new notebook PC, the TP386SX-20, which has been configured for the corporate user, and has the full functionality normally sought in a desktop system.

The TP Notebook has an expansion chassis option, which enables the system to be plugged immediately into an office network.

The company is offering the Notebook both standalone, or bundled with external keyboard and VGA colour monitor. It is powered with a 386SX/20MHz CPU, a minium of two megabytes of RAM, 40 or 80MB hard disk, and has a three-hour battery.

For more information circle 165 on the reader service coupon or contact Total Peripherals, 178 Normanby Road, South Melbourne 3205; phone (03) 646 7011.

RISC-based Ethernet bridge



Integrated Networks has announced the release of an Integrated Ethernet Local Bridge (IELB) module for MultiNet, the popular multiLAN, multi-media modular active star enclosures. The IELB boasts a modern RISC CPU surrounded by state-of-the-art Ethernet controllers and a high speed memory.

To provide design flexibility and reliability, the IELB can be configured to bridge between the multiple MultiNet internal buses, or from the internal bus to an external LAN, through either an AUI or a 10BaseT interface, hence enabling the formulation of a modular multiport bridge. Bridging between the two external interfaces is also supported.

The bridge fully complies with the IEEE 802.1d Spanning Tree Algorithm, providing automatic backup data links in case of bridge or link malfunction. In conjunction with the synchronous Ethernet modules, a true fault-tolerant, multiple LAN solution can be provided.

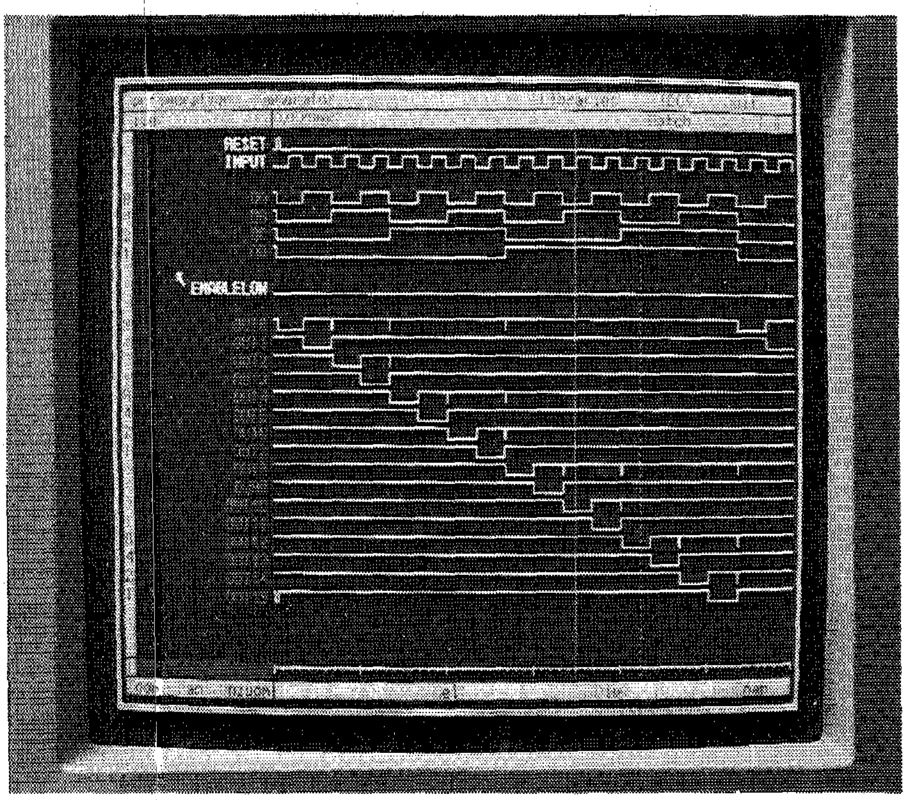
For more information circle 167 on the reader service coupon or contact Integrated Networks, 26 Tepko Road, Terrey Hills 2084; phone (02) 486 3066.

Digital circuit simulator

Pulsar is a PC-based digital logic circuit simulator program, that eliminates many of the hassles and time-consuming aspects of digital design. It allows you to go direct from design to concept on PCB, with no breadboarding.

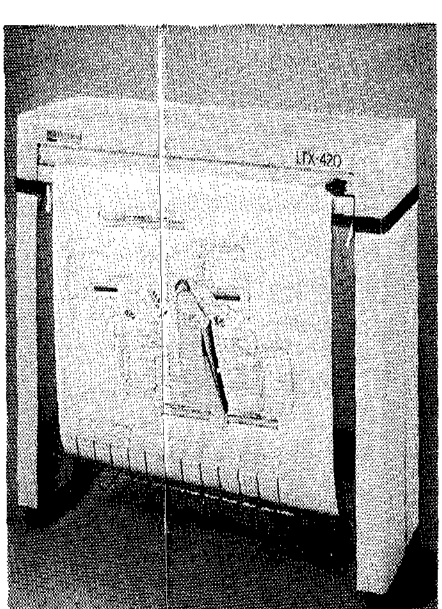
Pulsar outperforms physical test equipment because it has fully programmable signal sources, a printable logic analyser display that can catch glitches down to one picosecond, and adjustable component models. Its simulation speed on an AT is 1000 gates/sec, using 1500 connected signal generators.

For more information circle 168 on the reader service coupon or contact Break-Through Computers, PO Box 432, Garbutt 4814; phone (077) 25 3189.



Archiving and managing computerised drawings

Roland and Aarque have joined forces to provide a long awaited solution to computerised drawing management and archiving. With a Roland thermal plotter, and Aarque's large format scanner, existing hand drawn plans and designs can be transferred into 'electronic storage' for archival purposes, or merged with a CAD system for modification and fast output.



Plotters come in a variety of types, namely pen plotters, electrostatic and thermal. The advantages of thermal technology over others is its speed, cleanliness and near silent operation. No toners or messy consumables are necessary in thermal plotters which operate like everyday fax machines.

With the large format A1 and A0 Contex Scanner, the ability to take an existing A1 or A0 drawing and quickly scan the image ultimately provides for an efficient way of managing both a small and large number of drawings, without the traditional storage problems.

Although the speed of both the scanner (input device) and plotter (output device) can be very good individually, performance may be lost when the units are connected. This problem is overcome at the outset when devices used are completely compatible, as is the case with the Aarque Contex scanners and the Roland LTX range of thermal plotters. Using these, the data transmission time for an A0 drawing consisting of 122, 144, vectors, is 7min, 30sec.

For more information circle 169 on the reader service coupon or contact Roland Digital Group, 233 Burwood Road, Hawthorn 3122; phone (03) 818 0633. ❖

EA DIRECTORY OF SUPPLIERS

Which of our many advertisers are most likely to be able to sell you that special component, instrument, kit or tool? It's not always easy to decide, because they can't advertise all of their product lines each month. Also some are wholesalers and don't sell to the public. The table below is published as a special service to EA readers, as a guide to the main products sold by our retail advertisers. For address information see the advertisements in this or other recent issues.

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A Kits and modules
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'Electronics Australia' provides the following services:

SUBSCRIPTIONS: All subscription enquiries should be directed to: Subscriptions Department, Federal Publishing Co, PO Box 199, Alexandria 2015; phone (02) 6939517.

BACK ISSUES: Available only until stocks are exhausted. Price $5.00.

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PCB PATTERNS: High contrast, actual size transparencies for printed circuit boards and front panels are available. Price is $5 for boards up to 100sq.cm, $10 for larger boards. Please specify negatives or positives.

PROJECT QUERIES: Advice on projects is limited to postal correspondence only and to projects less than five years old. Price $5. Please note that we cannot undertake special research or advise on project modifications. Members of our technical staff are not available to discuss technical problems by telephone.

OTHER QUERIES: Technical queries outside the scope of 'Replies by Post', or submitted without fee, may be answered in the 'Information Centre' pages at the discretion of the Editor.

PAYMENT: Must be negotiable in Australia and payable to 'Electronics Australia'. Send cheque, money order or credit card number (American Express, Bankcard, Mastercard or Visa card), name and address (see form). All prices include postage within Australia and New Zealand.

ADDRESS: Send all correspondence to: The Secretary, Electronics Australia, P.O. Box 199, Alexandria, NSW 2015.

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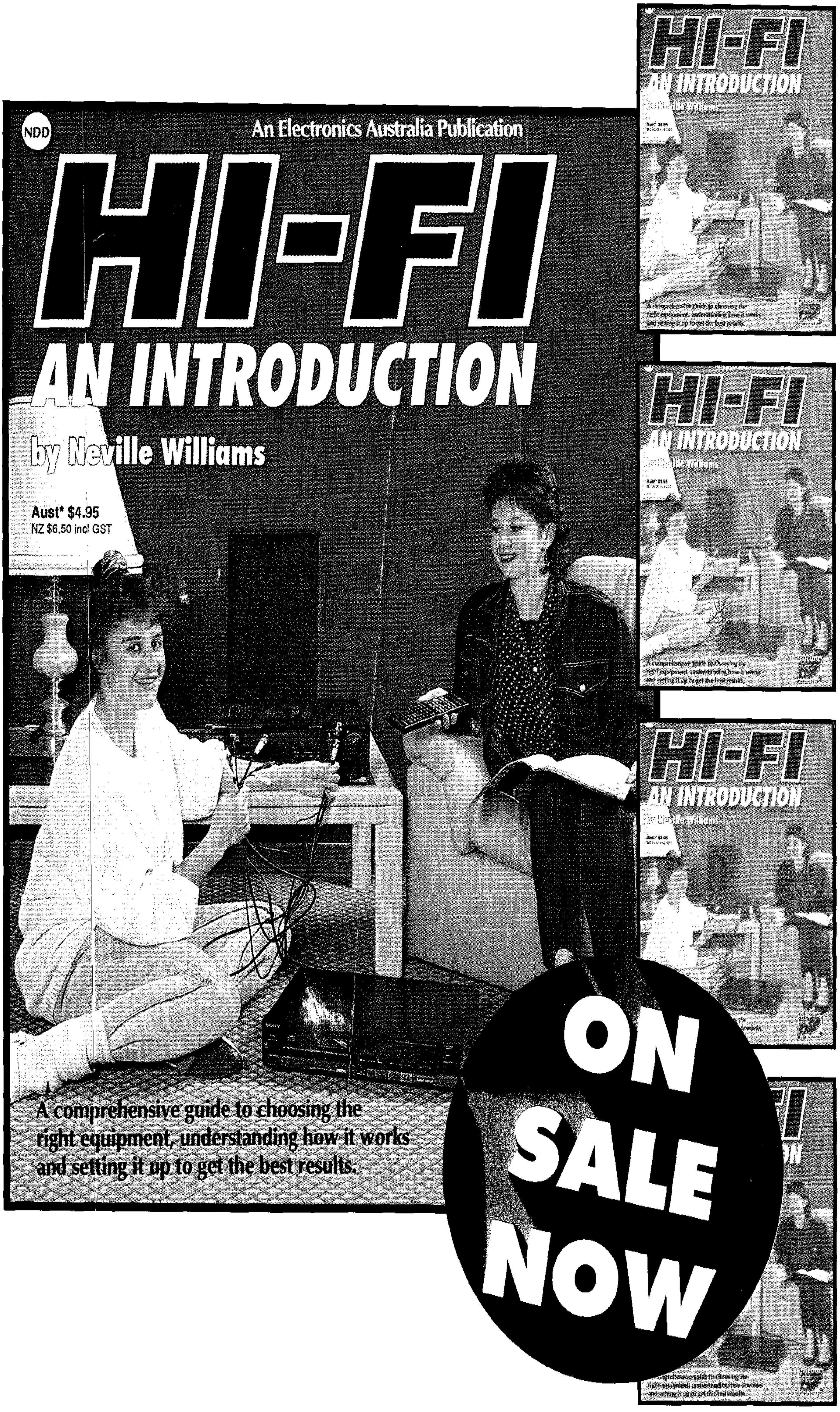

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still a reader after 41 years. Tom has his own column now and your comments have been passed on.

Carburettor parts

I read with interest Tony Mercer's article on electronic engine management systems (November 1991) on modern cars and I would like to point out an item of interest.

The vacuum advance method Tony describes was certainly adopted on the early British car for which he went shopping for SU carburettor parts. And it really did operate the way he says.

However, by the early 1970's vacuum advance had pretty much dropped that method (known as Vacuum Ported Advance) and had adopted Spark Ported Advance. The fundamental difference is that Spark Ported Vacuum Advance is fed from ABOVE the throttle and not BELOW it, and Spark Ported Advance increases with throttle opening.

Also it provides no advance at all at idle or on the overrun. However, like Vacuum Ported Advance, it remains dynamic, i.e., take the case of a vehicle travelling along a flat road with the driver holding a constant throttle setting.

If the car then encounters a hill and the throttle is held at that setting, the increase in engine load will cause a drop in vacuum. This drop in vacuum will cause the vacuum advance to 'fall back' onto the current level of centrifugal advance. When the car regains speed on the next level section of road, the increase in vacuum will pull the diaghram back into the advanced position.

My motor manuals for various cars claim Spark Porting to provide better fuel economy, better performance, and seeing how my car conforms to ADR27A, superior emission control. Pre-ADR27a models of my car were vacuum ported in the automatic version. My ADR27A auto model is Spark Ported.

A great magazine. Keep up the good work. Also thanks to Peter Philips for his article on power amplifiers.

Tim Gard,
Waverton, NSW.

Radio and TV services

With reference to the list of Radio and TV broadcasting services on page 111 of your November 1991 issue, please be advised that our call letters are PMFM not 6PMFM.

Ray Holman,
Chief Engineer,
PMFM,
Subiaco, WA.

EDITORIAL VIEWPOINT

More musings on science and technology education...

Here we are again at the start of a new academic year. The annual holidays are behind us, and large numbers of young people are preparing to start another year of their formal education — whether it be at school, TAFE college, CAE or university. It's a time for hope and optimism, and I for one am hopeful that there'll be no further decline in the number of people choosing subjects or courses directed towards science and engineering. I know I've written about this before, but I firmly believe that Australia is going to need all the scientists and engineers we can get, if we're not to sink into the status of a 'banana republic' — or worse.

When I wrote about this subject in last October's and November's editorials, one or two readers thought I was endorsing the idea that science and engineering in general, and electronics in particular, are somehow 'boring' subjects which have little intrinsic appeal for for young people. Far from it — in fact I believe that they're basically *extremely* interesting (although I'm perhaps just a tiny bit biased). No, what I meant was that somehow these disciplines are often still very badly presented and 'sold' to young people, so often they don't get the opportunity to *see* how interesting and satisfying these activities can be.

Perhaps this is due to the fact that many scientists and engineers tend to be rather shy, retiring people, who are often not very comfortable 'selling' or 'marketing' the value of their work. Of course there have been and still are notable exceptions, like Michael Faraday, Julius Sumner Miller, Harry Messell, Stephen Jay Gould and Paul Davies; but on the whole they tend to be few and far between.

How then to get more young people interested in science and technology? I'm sure TV programmes like *Quantum* and *Towards 2000* play an important role, because we're now undoubtedly in the 'audio-visual' era where young peonle in particular tend to be more receptive to information presented to them in this form. But understandably as a magazine editor I'm still convinced that printed media like *Electronics Australia* have a worthwhile role to play as well.

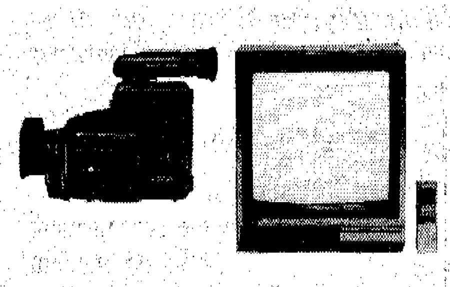
It seems to me that there are still many aspects of electronics in particular that can benefit from the detailed, systematic and in-depth treatment that can best be provided by a magazine. We can be much more cost-effective than video, more accessible and of course much more *permanent* as an information reference.

What then are we at *EA* doing, to help interest young people in electronics and science? Well, we run many articles on educational projects, like Peter Murtagh's series on 'Experimenting with Electronics', and also others on basic theory — like the ongoing 'Basic Electronics' series by Peter Phillips and the 'Basics of Radio Transmission and Reception' by Bryan Maher (all three of these writers are experienced teachers of science or electronics, by the way). We also run articles on scientific discoveries and achievements, whenever the opportunity arises.

No doubt we could do more, and I'd be happy to receive your suggestions. I'd also like suggestions on how we can do more to encourage young people to pick up magazines like *EA* in the first place — because unless they do this, they never will find out what's inside...

Jim Rowe

What's New in VIDEO and AUDIO



Video distribution system

The ASC Multiple Video Distribution System provides further enhancement of ASC's AS4 M Language Laboratory. designed for installation in the master console of the ASC AS4 M, the Multiple Video Distribution System enables up to four different video programs to be distributed throughout the laboratory.

The Video System is integrated with the student control switching system of the AS4 M, permitting single switch activation of the video routing.

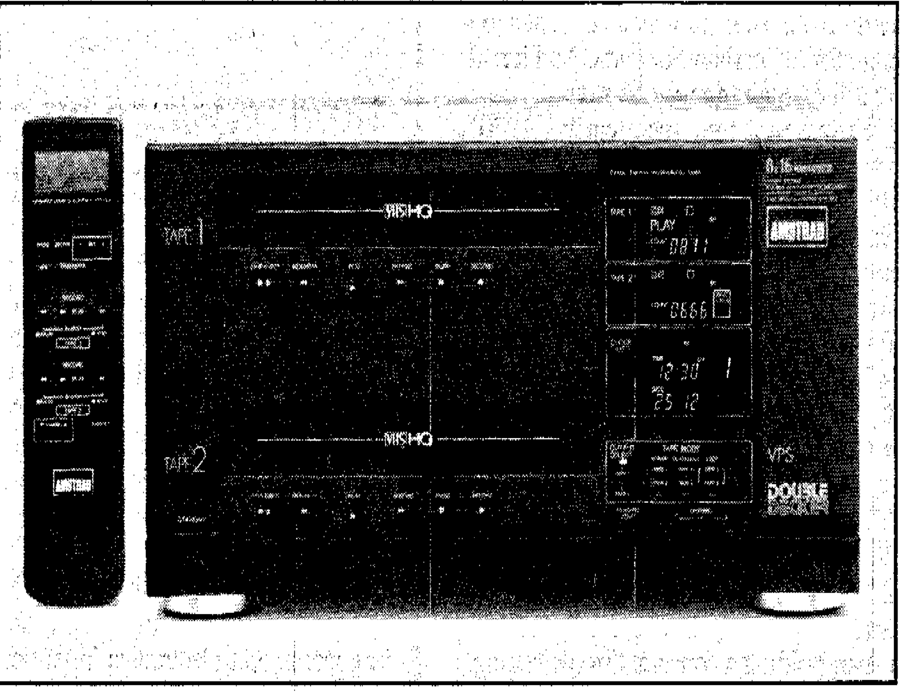
Four video programs may be routed simultaneously to four separate student groups. The video source may be a VCR, Videodisk, video camera, satellite, television or a personal computer.

Students may be grouped in any desired combination, with monitoring of audio and video at any student position available at the master console. The student monitor control is achieved through the existing student position cabling.

The ASC Multiple Video Distribution system may be installed in any existing AS4 M laboratories, or ordered fitted with a new system.

Central power supply switching for all student video equipment is provided, and the system can accommodate a second teacher monitor when used in the optional duo-teacher mode.

Amstrad launches 'Double Decker' VCR



Amstrad, well known as a supplier of IBM compatible personal computers, has released what is claimed to be Australia's first twin VCR.

With two fully functional tape decks, and a very keen recommended retail price tag of only $995, the Amstrad Double Decker allows users to

- copy from one video tape to another, using a single, easy 'synchro start' (copying of TV programs and pre-recorded video tapes is subject to copyright),
- watch a video on one deck while recording on the other dec,
- Record or play on one tape and then automatically switch to a second tape, giving a total continuous recording or playing time of up to 16 hours in long-play mode or eight hours in normal mode (with two E-240 tapes),
- Play back two tapes simultaneously to different TVs.

In addition to these twin-deck features, the Double Decker also offers all the 'conventional' features expected in top-range VCRs, like one-touch instant recording; an 'intelligent' infra-red remote control, allowing programming from the user's armchair; a long-play facility, doubling recording and playback times; HQ technology picture quality.

Amstrad's Managing Director, Mr Bordan Tkachuk, said Amstrad's decision to enter the consumer electronics market reflected the growing importances of new technologies in home entertainment in Australia, especially with the arrival of Pay TV in October. "In typical Amstrad style, we're out to shake up the marketplace," Mr Tkachuk said.

Mr Tkachuk said Amstrad expects to be a major player in consumer electronics with the arrival of Pay TV.

"We already have a very sound base and a high reputation in this field. Although we are best known in Australia for our computers, internationally half of Amstrad's revenue comes from consumer electronics."

"We are Europe's leading supplier of satellite TV equipment, with over two million sets sold since 1989, and we have been flooded with enquiries here since satellite-based Pay TV was announced for Australia."

New Yamaha AV receivers offer DSP, Dolby

The first two models of what the company considers a new generation of audio/video receivers has been introduced by Yamaha.

The flagship RX-V1050 and the RX-V850 receivers have been designed for the emerging segment of the market which wants a powerful and sophisticated receiver to control a multi-component audio/video system.

The two new models incorporate Yamaha's Digital Sound Field Processing with the company's proprietary Digital Dolby Pro Logic Enhanced and combine those features with a versatile, powerful, and high quality AM/FM stereo receiver.

The five channel receivers provide ample audio and video inputs, learning capable remote control and high power and high quality amplifier sections. The tuner sections feature Yamaha's direct PLL IF count synthesiser tuner circuitry and 40 station AM/FM random access preset tuning.

In addition, the two models incorporate a four mode Yamaha Digital

Sound Field Processor which recreates actual concert environments in the home, and Digital Dolby Pro Logic Enhanced, which provides a movie sound field similar to the best movie theatres.

The flagship RX-V1050 delivers 110 watts per channel RMS to eight ohm speakers for the main stereo channels and the centre.

Two pairs of main front channel speakers can be accommodated and the front panel provides A/B switching. An additional stereo amplifier section provides 30 watts per channel to the rear surround speakers, so that even the most dramatic surround effects can be cleanly reproduced.

The RX-V850 delivers 80 watts per channel to the main stereo speakers and centre speaker, and 25 watts each to the rear effects speakers.

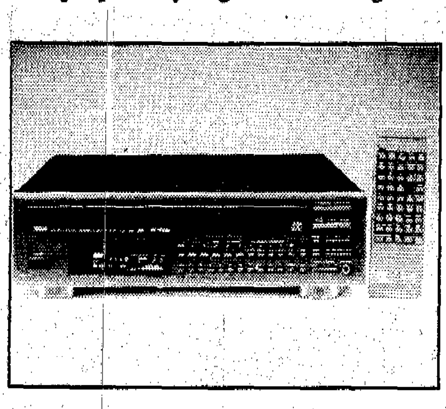
New CD changers

Yamaha has introduced two new five disc rotary tray CD changers, designated CDC-715 and CDC-815, incorporating the company's new S-bit plus technology and providing all the features of the models they replace.

The use of S-bit plus circuitry in the new changers improves the performance and gives them a more natural and musical sound than their predecessors, the CDC-705 and CDC-805.

In addition, the changers feature 'Play X Change', an exclusive Yamaha feature, which isolates the disc being played from the changer drawer to eliminate vibration and improve performance. Play X Change also permits up to four or five discs in the rotary tray to be removed and replaced while the fifth is playing.

The core of Yamaha's improved single-bit processing, called S-bit Plus, is a proprietary digital-to-analog con-



verter developed by the company's engineers.

The I-PDM, Independent Pulse Density Modulation, DAC reproduces pulse waveforms more precisely than previously available converters.

The I-PDM DAC yields greater accuracy by independently using two pulses as amplitude rather than attempting to reproduce the double-width pulse. This results in greater accuracy and waveform stability and ultimately, in sound which more fully reproduces the depth and complexity of the music.

In addition to the extraordinary fidelity achieved by the proprietary new I-PDM DACs, S-bit Plus also incorporates second order noise shaping and an eight times oversampling 20-bit digital filter. Second order noise shaping is used rather than third or fourth because it provides optimum tonality.

The eight times oversampling rate moves the sampling noise, inherent in any system, so far out of the audio spectrum that it is effectively eliminated.

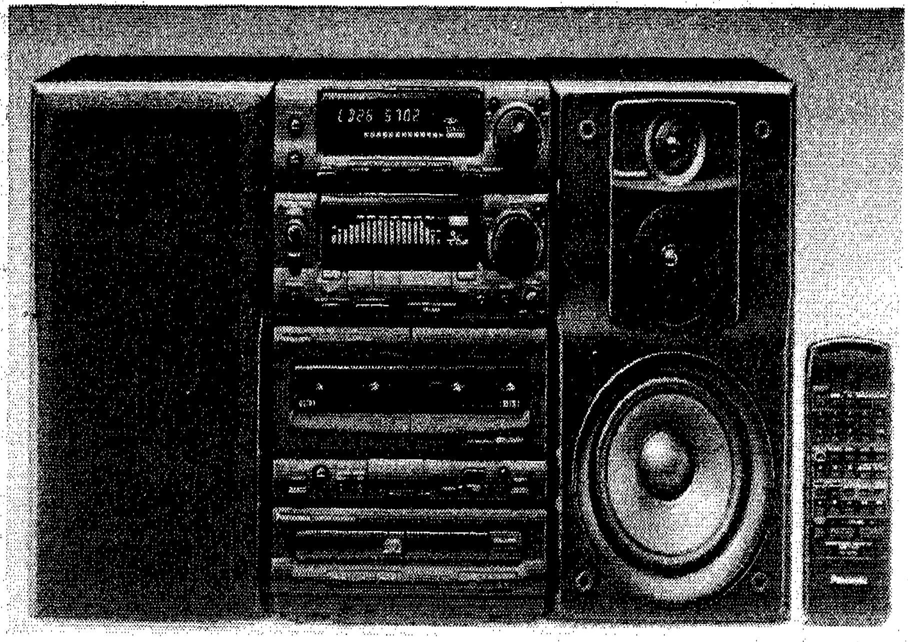
Mini component system from Technics

Technics' new SC-CH55 mini component system offers a compact entertainment centre with excellent hi-fi sound. Designed to be easy to use, the double cassette deck has a front-panel loading with auto reverse and Dolby B noise reduction.

The front loading compact disc player features an AI (Artificial Intelligence) edit function, to rearrange the CD song order in order to minimise leftover tape at the end of the cassette being recorded.

The automatic tape level setting also assures optimum recording levels are achieved. For convenience, the quartz synthesiser tuner (LW/MW/FM) provides 28-random access presets at the touch of a button, while the fully featured remote control gives the user instant access to the system. An added feature of the system is a Karaoke function. This enables 'sing alongs' with favourite CDs, tapes or tunes, by dropping the recorded voice by 50% to allow the live singing to take precedence.

Output is 30W per channel with a 19-channel spectrum analyser. The system has a recommended retail price of $1199.



Hexagonal speaker systems from Tannoy

Tannoy has broken away from traditional 'box' type speaker designs and employed a hexagonal design, in a new lineup, aptly named the Tannoy Six's.

By designing a cabinet in the form of an unequal sided hexagon, where all adjacent walls are at 120° instead of the conventional 90°, the company claims that standing waves have been minimised. The top and bottom of the cabinets are precision injected moulded and employ mineral filled polyolefinic to provide good stiffness and damping properties. A central brace runs internally down the height of the cabinet, to which the crowns and bases are bolted and bounded.

The line up consists of seven models; 615, 613, 611, 609, 607, 605, 603. The larger 615, 613 and 611 are floor standing models. The 615 employs an 8" dual concentric drive unit, a 6.5" bass unit and an 8" mass tuned passive cone. The 613, a 6.5" dual concentric drive unit, a 6.5" bass unit and a 6.5" massed tuned passive cone.

The 611, a 2-way system employing an 8" dual concentric drive unit and an 8" bass unit. The 609 is recommended to go with stands and employs an 8" dual concentric drive unit.

All concentric drive units employ Tannoy's 'Tulip' waveguide technoloy, using an acoustic waveguide at the throat of the bass unit.

The 607, 605 and 603 are 2-way discrete driver ducted port systems using an 8, 6.5 and 5" injected moulded cone-piston bass units respectively. ❖

Matsushita's latest hi-tech, Australian made CTV:

MAKING IT BETTER, AND MAKING IT HERE

The latest high quality colour TV set from Matsushita/Panasonic is known officially as 'THE ONE', but unofficially as the 'Trinitron cracker' — revealing the Company's aim of using it to break Sony's grip on the large-screen end of the market. The 68cm version is being made in Australia, in a plant which has adapted Japanese manufacturing know-how to local conditions...

by BARRIE SMITH

In 1968, the Australian Government invited Matsushita to open a TV set factory in Australia — just 12 years after local TV transmission had begun. The initial production run consisted of sets no larger than 48cm.

Colour arrived in 1974 and the Penrith, NSW plant began manufacturing the sets to receive the broadcasts. The total industry production figure in that year was 67,000 — with no imports.

By 1976 the number sold in this country reached 1,172,000, with only 42% locally made.

This total sales figure has never been equalled — a measure of colour as a sales incentive.

Today, there are three TV set manufacturing plants in Australia: Matsushita, Sharp and NEC.

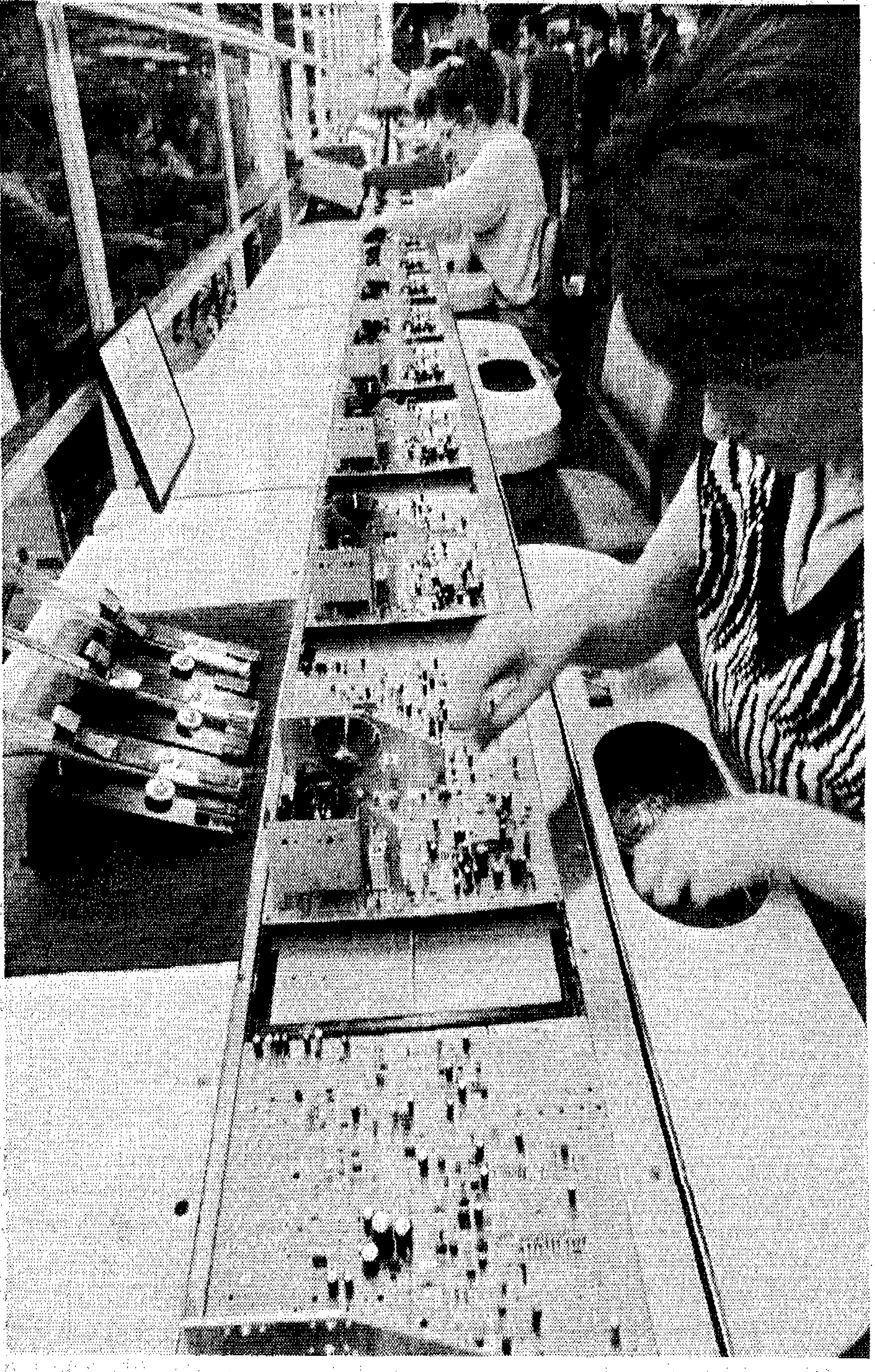
In 1990 sales reached 724,000 sets — of which 22% were locally produced. Of the former figure, Matsushita — or Panasonic as the company's brand is known — was responsible for 61%.

1991 was expected to see the total rise to 740,000 — projected to be the third biggest figure on record.

The interesting component of the figures in 1990 and 1991 is that the driving force in the total are the larger screen sizes. So it appears we're going to see more locally produced sets from the Australian plants — and those sets will be the larger ones.

Matsushita's Pana-sonic plant in Penrith is far from large, by Japanese standards. It also differs from most in that the production lines are spread wider apart.

This is because Australian workers prefer more 'personal space' than their Japanese counterparts, according to



A shot looking along the production line, showing the careful hand assembly of the main printed circuit board used in the sets.