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DECEMBER 1987

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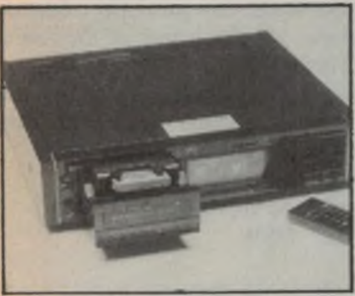
Sneak preview of DAT recorder



No news yet as to when you'll be able to buy one, but Pioneer let us check out one of its new D-1000 DAT recorders. Read what we found, in our story starting on page 10 . . .

3 great projects!

Our construction projects this month are a Jogger Logger, which counts your steps when you're jogging; a heavy-duty 600 watt power inverter; and a low cost AC/DC millivoltmeter.

Build your own "turbo" AT clone

A new kit just released lets you build your own PC/AT clone, without even picking up a soldering iron! Our review of the kit starts on page 116.

ON THE COVER

If you're into jogging, our new easy-to-build Jogger Logger project lets you count how far you've gone each time. Our main cover pic shows designer/author Henk Mulder, giving his prototype a thorough checkout in Sydney's Centennial Park. See our story starting page 62.

Features

Entertainment Electronics

Projects and Technical

News and Comment

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Letters to the editor

Bouquet?

Your magazine must be good. I have worked as a service technician for the past twelve years for a very large electronics company. Recently, I got involved in video recorders in my line of duty and came across a new principle, referred to as HQ. In my quest for technical knowledge, I discovered that one department of the company had the necessary information at one time, but had forgotten all about it. When I expressed my discontent to our national service support manager, saying that the information should have been passed on to the people doing the actual repair work, I received the reply: "Why don't you read Electronics Australia!"

My special thanks go to the service manager from JVC, a different company, who was kind enough and gave me the relevant technical information.

Manfred Walter VK2BZW,
Sydney, NSW.

Making PCBs

I have just finished reading the feature in the October edition named *Low Cost Techniques for Making Hobbyist PCB's*, and I am concerned about a few aspects of it.

In the section on cleaning the copper surface, the author suggests the use of methyl ethyl ketone (MEK) as a wash after water/Ajax wash up. MEK is a toxic solvent. (Schedule 5) and I believe that it is not a product for the hobbyist to have at home. It is a colourless liquid, slightly soluble in water and causes irritation to mucus membranes and eyes, it can cause lethargy and/or narcosis if absorbed in large amounts in air. In any case, after a thorough scrub clean with a detergent base powder cleaner using a nylon type pot scourer, washing under running water and drying with a lint free material (clean of course), a PCB really needs no further treatment.

I do not like the use of caustic soda as a developer or stripper either, for the same safety reasons as MEK. Even though it is a domestic type of product and is used quite casually more often as not, it is nasty.

On two different pages the catalogue number of the resist appears differently and in both cases incorrectly. The numbers have been CPR and CPD (resist and developer, with a two-digit suffix to indicate the quantity), for a few years now.

It must be remembered that whilst most of the chemicals we use for printed circuit boards are seemingly safe, they *are* chemicals and good workshop practice is most important to gain the best from the products concerned and above all, the safety of the individual involved.

Our company can supply information sheets which should help, but please send a S.A.E. for a quick response.

Doug Rees (VK2YMD)
Circuit Components (A'Asia)
Bexley, NSW.

Vintage radios: info available

I have quite a few service manuals on radios from 1920 to the last valve radios of the 1960s. For the cost of postage, I'm happy to photocopy any relevant information to help readers who are trying to restore early models.

Many of the manuals were handed down to me by my senior technician, still working at the age of 73 and refusing to retire. He now repairs colour TVs and computers — quite a change from the radios on which he started out!

Hans Vanderstelt,
Hans Radio & TV Service,
147 Magellan Street,
Lismore NSW 2480.

Comment: Many thanks indeed for your offer, Hans and for sending details of the Airzone set to P.W. We also received information on the Airzone set from Mr R. Brown of North Haven, NSW, Mr J. Emery of Bullcreek, WA, Mr E. Gill of Toormina, NSW, Mr A.F. Pain of Belrose, NSW, and Mr R.W. Pearce of Renmark, SA. Thank you, one and all, for being so helpful.

Thanks from "P.W."

Thank you for passing on the letters you received in response to my letter published in the October issue, concerning specs on a 1937 Airzone radio receiver.

I would agree with you that the readers were extremely generous in responding, making my job in restoring the radio much easier.

My thanks to all.

P. Waite,
New Town, Tas.

UHF converter

"Drop us a line" you say in your October issue. I did just this in 1986, pointing out an error in the UHF converter project of April 1986, but got nowhere except for letters from different EA staff members, telling me I was wrong.

The fact is that your article was wrong, and has always been wrong. If VR3, the gain control is wired up as shown, it works in the reverse manner to that described in your text. All that was necessary was to publish a line or two of correction in your Notes and Errata section.

On another subject, the Serviceman's comment in the October issue regarding the use of WD40 in servicing cassette recorders could do with a warning. If used in expensive and intricate cassette players, it can go anywhere (including up noses). If it gets on rubber belts and various other parts, it can cause chaos, as I know from personal experience.

When WD40 is used, I suggest covering with a suitable cloth any parts where it would cause trouble.

A.D. Fuller,
Pennant Hills, NSW.

Comment: Many thanks for taking the trouble to write again, Mr Fuller. We checked out the UHF Converter and sure enough you're right — the pot connections shown in the wiring diagram (p26) and the picture on page 27 are both wrong. Sorry about the earlier unwillingness to admit the error. Thanks too for your comments about the use of WD40.

Pyrometer nulling

With regard to your article on "Thermocouples Without Tears" in the October issue, I believe that the method you suggest for offset nulling is incorrect. It does not allow for the effects of input bias current and input resistance.

To offset null the amplifier correctly, it must be presented with a source resistance about equal to the resistance of the thermocouple — a short circuit would probably do. If this is not done, then the input bias current (approx 80nA) flowing in the 47k resistor (R2) will produce an offset of nearly 4mV. Compared to the maximum input (full scale input) of 50mV this represents an error of about 8%, which would swamp

Continued on page 141

Editorial Viewpoint

Excitement unlimited!

Well, here we are at the end of another year. Somehow this one seems to have been rather more hectic than most, at least in the electronics publishing business. It's been fairly hard work, but at the same time very satisfying.

One of the things that attracted me back to EA, after my break of a few years, was the excellent opportunity it provides to keep track of the latest developments in electronics. For all of us — not just ourselves as writers and editors, but hopefully (and more importantly) yourselves as readers, if we're doing our job right.

I don't know about you, but personally I find electronics very exciting. There's always something new happening — a new breakthrough in technology, or in bringing its benefits to people more cheaply. There's almost no other field where things get better and better, and steadily cheaper at the same time! It's great having the chance to see the latest things, on your behalf, and very challenging to try keeping up with it all, so we in turn can pass what we learn on to you.

This month we have an exceptional collection of goodies for you. There's our sneak preview of Pioneer's new digital audio tape recorder; a fascinating article on what's happening with microwave landing systems: a review of the new "build your own AT clone" computer kit from Dick Smith Electronics; some great construction projects, including the "Jogger Logger" and a heavy duty 600 watt power inverter; and of course all the latest news.

We've enjoyed putting it all together, and it comes to you with our best wishes for a very happy Christmas season.

By the way, make sure you don't miss our bumper 164-page *Electronics Digest 1988* issue next month. We're making an even bigger effort for that one, so it should really start off the new electronics year with a bang!

Jim Rowe

What's New In
Entertainment Electronics

First stereoscopic VHS camcorder

Toshiba Corporation has developed the world's first VHS-C format camcorder for easy shooting of stereoscopic (3D) pictures. The recorded 3D images can be reproduced on a TV screen in vivid colour using conventional video cassette recorders (VCRs), and viewers can see these images by just wearing special liquid crystal glasses.

The new "3D-CAM" camcorder, which incorporates two eye-like micro-camera heads using charge coupled devices (CCDs), shoots two pictures simultaneously — one for each "eye". In addition to reproduction of completed or prerecorded videotapes using a conventional VCR unit, images can also be relayed directly from the 3D-CAM to a TV screen using the new device's playback function.

The 3D-CAM serially records pictures shot by the two camera heads onto a VHS-C video cassette tape at 60 times per second. Viewers see these images through liquid crystal glasses synchronized with the images; the right and left views are occluded in quick succession, so that the respective images are seen by the appropriate eye. The right and left images are mixed in the brain to create a stereoscopic image in full colour.

An adaptor is needed between the VCR (or 3D-CAM) and the glasses to synchronise the images with the glasses. This method is the same one used with 3D-type video disc players, which means that the same liquid crystal glasses can be used with the new 3D-CAM unit.

Two video cameras and two VCRs have been needed in the past to produce quality 3D-images, and the method also required complex steps to adjust the interval between the two cameras and synchronise the cameras with the VCRs. Therefore, only professionals were producing quality 3D-images and they had to use all their skills to bring out the best in the various systems.

Toshiba's engineers have successfully combined these functions in a compact camcorder-size body and have eliminated the complex adjustments. This means that superb 3D colour videos can now be made and shown by non-professionals for recreational, business, medical, industrial and educational uses.

As part of the new development, Toshiba has also created a flickerless system for the 3D-CAM using digital image processing technology to solve the problem of flicker which previously plagued this 3D method.

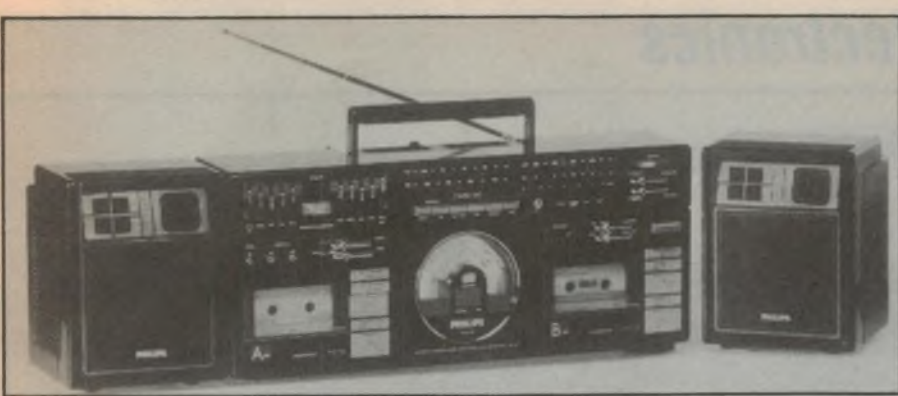
3-way tuned port speaker

Tandy's new Optimus 504 three-way tuned port enclosure is claimed to provide all the technological features of today's speakers without the high price.

Attractively styled and finished to complement any home, it features a power handling capacity of 120W to add punch to your favourite music at high volumes. Drivers include a 50mm cone tweeter and 380mm woofer.

Finished in an attractive easy care vinyl veneer with a removable cloth grille, the Optimus 504 measures 825 x 457 x 420mm overall. It has a sensitivity of 91dB (SPL at 1W/1metre) and an impedance of 8 ohms.

Priced at $479.95 each, the enclosures are available from Tandy stores and dealers Australia-wide (Cat. No. 40-9530).

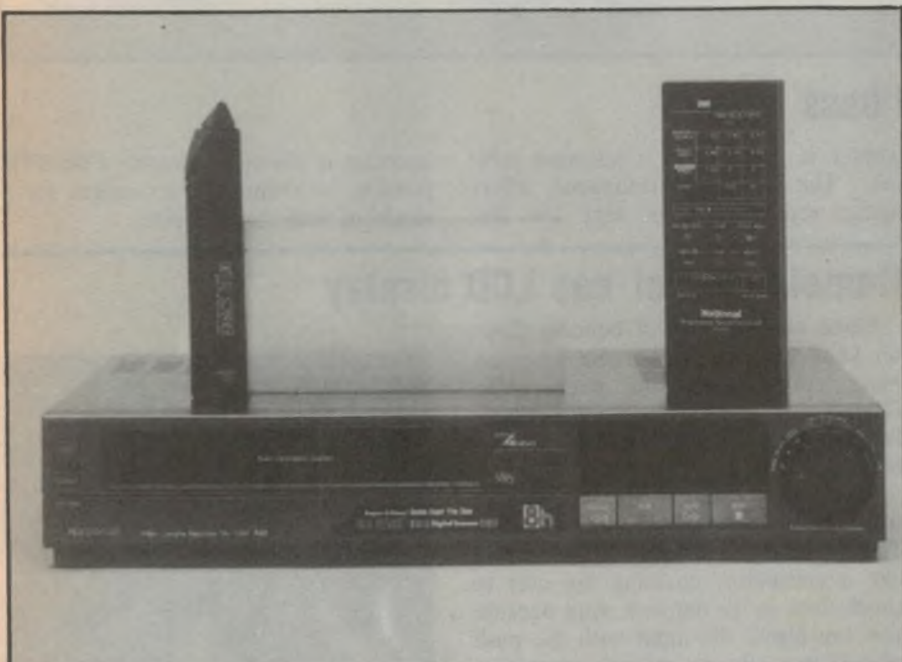


Compact combo with CD

With the new D8958 portable Sound Machine, Philips designers claim to have avoided the operator confusion usually associated with this type of portable system. In addition the amplifier circuitry and speakers are matched closely to support superior CD reproduction. The result is a high quality portable battery operated unit which can unashamedly double as a mains powered indoor shelf system.

With the two-way speakers detached, the D8958 is 540 x 230mm. Yet it houses dual tape cassette decks, FM stereo, AM/SW radio and a vertically mounted CD player with functions like cue and review, intro-scan (track sampling), next and previous.

Channel separation is continuously variable from mono to "Spatial Stereo" the power output is 50 watts PMPO, and the tonal output can be personalised with a ten band graphic equaliser.



VCR features "dial search"

National Panasonic's new NV-G25A video recorder offers Dial Search and long-play mode, in addition to features such as a barcode programming device, Double Super Fine Slow, programmable remote control, VHS search system, lap time counter (now to the second), HQ (High Quality) picture, title search and one calendar month 8-program timer (previously only 14 days).

The home enthusiast can now edit or dub more easily by using Dial Search, a rotary control dial previously found only on industrial models. This controls review, reverse playback, still, slow (1/30, 1/10, 1/5), normal playback, double speed playback and cueing. Consequently, operation is speeded up considerably with edit points being located immediately.

In LP mode, the G25A can record or play back for eight hours.

Entertainment Electronics

CD portable with enhanced bass

The new JVC PC-V2 is a portable sound machine with a built-in CD player and a new woofer system called the Hyper-Bass Sound system.

The CD player is capable of many convenient functions such as 16-track random access program play, repeat play, and intro scan (track sampling). An LCD display shows digital track information. Inside the CD player is incorporated a high-precision lightweight 3-beam pickup which is accurate, sensitive and resistant to vibration and shock.

For vibration and shock resistance, the PC-V2 incorporates a servo control which automatically increases the servo gain when a shock or vibration is applied. The pickup mechanism is also supported by a specially developed suspension system which employs both rubber and metal spring materials.

To effectively reproduce CD clarity, the PC-V2 is equipped with detachable speaker units housing 100mm acrylic resin composite cone speakers.

The newly developed bass-enhancement system (in the main unit case) is a super-woofer powered by a 16W output (10% THD) balanced transformerless amplifier handling only the lowest frequencies via a high-cut filter. The woofer is enclosed in a resonant cabinet. The resulting resonance effect makes reproduction of very low frequencies in the neighbourhood of 40Hz possible — claimed to be unique for a model of such compact size.

Remote control has LCD display

Gone are the days of bending down on your knees to tackle the programming compartment on your VCR. Sharp's 103 with "Command Control" lets you program from anywhere in your home.

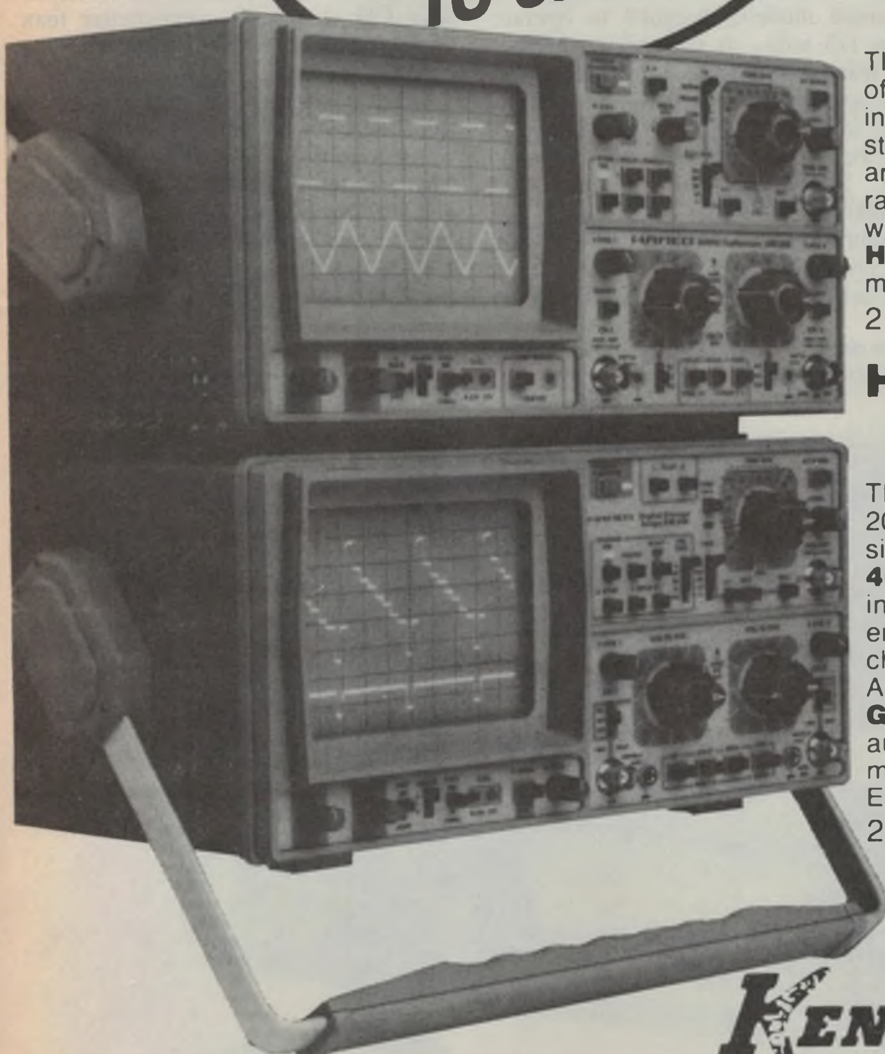
You simply take the Command Control and input the data by push-button. The liquid crystal display (LCD) works like a calculator, enabling the user to check data as it's entered. And because you can check the input with the push of a button, there's no risk of coming home to a re-run of "Gilligan's Island" instead of the Grand Final. Once satisfied you have programmed correctly, you simply push the transfer button and the VCR will pick up the program.

The 103 is the first of a range of three Command Control VCRs to be released by Sharp. Future models will include a digital and a four-head long-play version.

Available from retailers nationally, the Sharp 103 has a recommended retail price of $779.

Two of our best Performers

NOW TURBOCHARGED TO 5MHz



HM205

an outstanding Oscilloscope with digital storage

This new oscilloscope offers all the features of a state-of-the-art **20MHz** realtime instrument. In addition it provides digital storage capability for signals between **50s** and **0.3ms** duration, with a max. sampling rate of **5MHz.** Especially when working with comparatively slow phenomenae, the **HM205** can easily replace considerably more expensive digital storage scopes.

2 Probes × 1/ × 10 incl.

HM208

the high tech Storage Scope with 20MHz sampling rate

The **HM208**'s high sampling rate of max. 20MHz facilitates storing of relatively fast single shot events. Max. memory is **4096 × 8** bit, conveniently divided into two independent blocks. **XY-storage** capability enables easy viewing and recording of characteristic curves and Lissajous figures. An XY-recorder output and the optional **GPIB-Interface** allow full integration in automatic measurement systems. With more than **5000** units sold, this is one of Europe's best selling digital storage scopes.

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Sneak preview test report:

DAT's incredible!

We've finally been able to check out one of the new digital audio tape decks, even though they're still not being marketed here. Pioneer flew in a sample of its D-1000, and we were lucky enough to spend a couple of days putting it through its paces on your behalf. Here's what we found . . .

by JIM ROWE

When I wrote the piece in our August issue discussing the development of DAT (digital audio tape), I ended up with the hope that we'd soon be able to get hold of one for first-hand evaluation. Thanks to Pioneer Electronics, the opportunity to do so has come up even sooner than I hoped.

Apparently the release of Pioneer's new D-1000 DAT deck on the European market is now getting pretty close. I gather that in view of this, the company decided to fly a sample to Australia as well, to give its local people and dealers the opportunity to get familiar with it. Although it was kept pretty busy with a sales demonstrations, we managed to talk the Pioneer marketing people into letting us borrow it for a couple of days for evaluation.

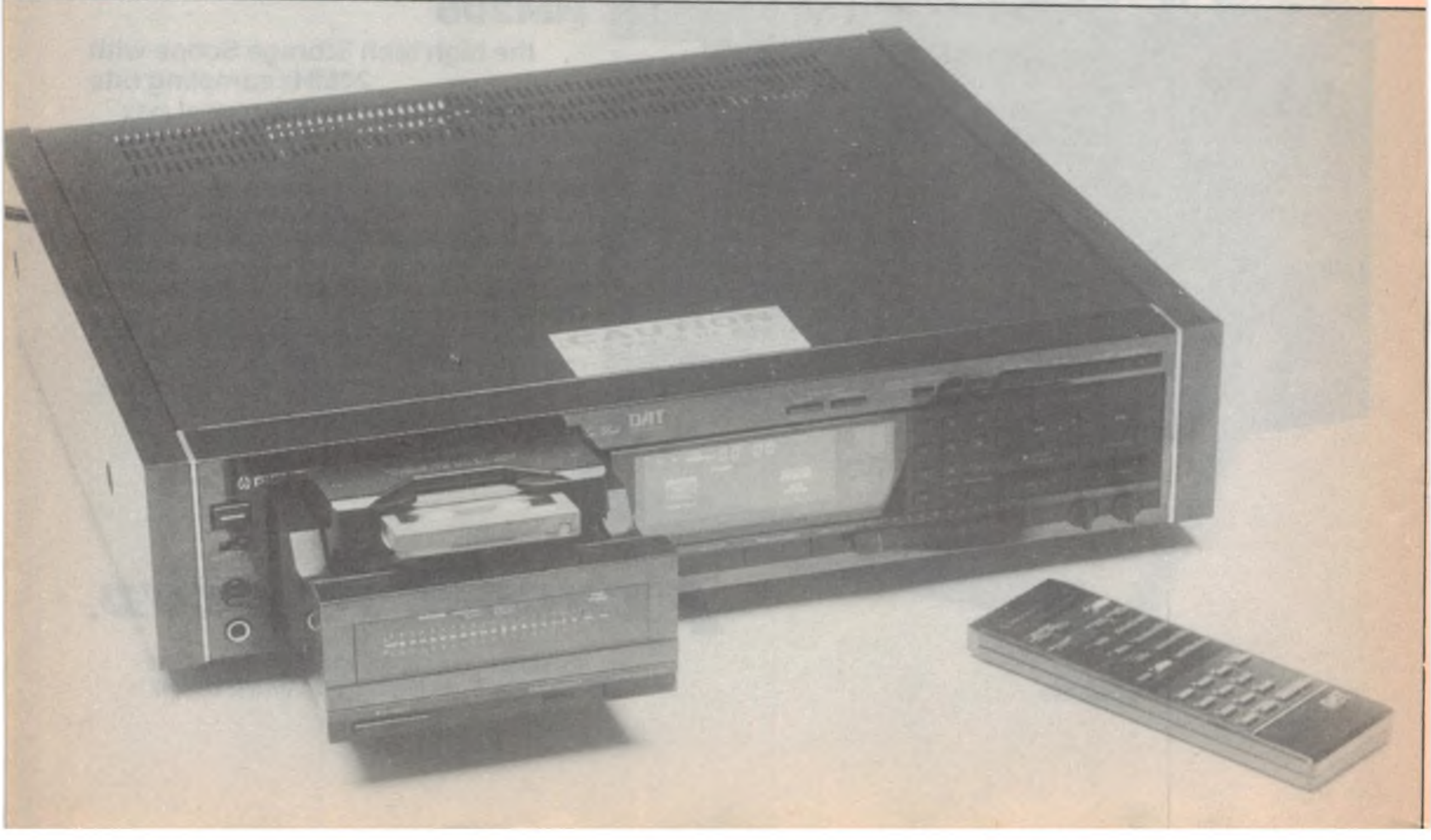
The sample was one of the domestic Japanese models, designed to operate from 115 volts, so we had to check it out using a stepdown transformer. The only operating manual available was entirely in Japanese, too, so to a large extent we had to "feel our way" by intuition. Luckily the operation of the D-1000 seems to be quite logical and straightforward, and there weren't any real problems.

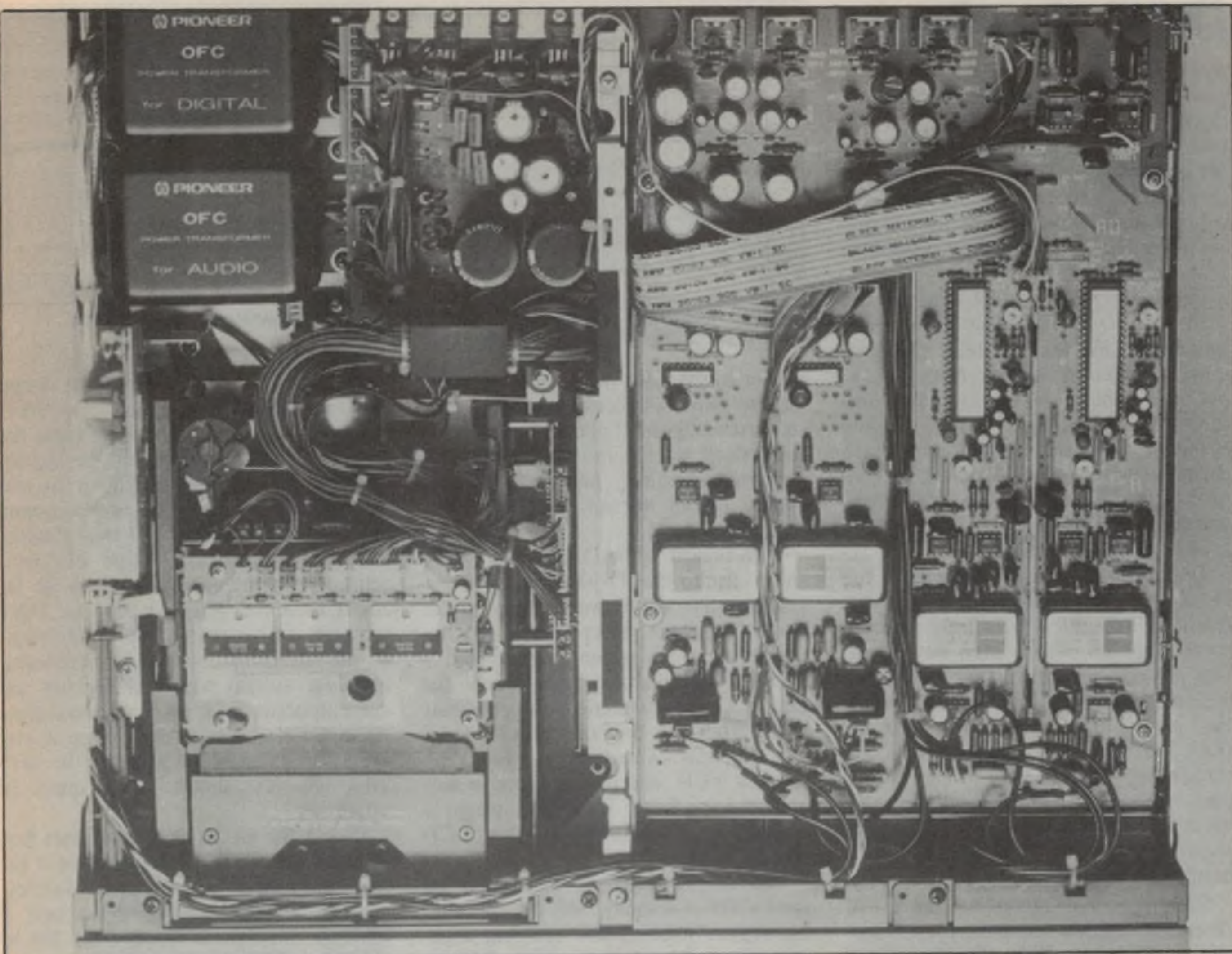
What did we find? Well, judging by the D-1000, DAT in the flesh is even more mind boggling than it looks on paper. The contrast with conventional analog cassette tape or even reel-to-reel is just so dramatic, my immediate reaction is that tape recording will never be the same again.

It's more than the contrast between CDs and vinyl records, because vinyls have always been better than domestic analog tape in terms of noise, distortion, wow and flutter. And CDs are already so much better than vinyl. So DAT, with a performance even better than CD, is just *so much* better than conventional tape that it really hits you between the ears.

Quite apart from the performance itself, there's the fact that it's all done using a tiny 3.81mm wide tape, in a weeny cassette 73 x 54 x 11mm — about half the size of a familiar "compact cassette". And the tape is moving at only 8.15mm per second — about a sixth of the speed of normal cassette tapes! Just

The Pioneer D-1000 DAT player with transport drawer open and cassette ejected.





Inside, the player is chock-full of electronics. Note the twin power transformers at top left, and the four oversampling filters (two for record, two for replay) just below centre right.

think about that for a moment . . .

But enough of generalities. The sample D-1000 was very impressive, to say the least. We were able to put it through its paces fairly thoroughly in the limited time available, recording both technical test material and various musical pieces from reference CDs, and in all cases the results were even better than we expected.

As quoted, the frequency response was within 0.5dB from 3Hz to 22kHz. There were a few minor "wiggles" near the top end, as shown in Fig.1, but these involve deviations of less than 0.25dB and are purely academic. These figures are even better than for CD, and reflect the higher sampling frequency used by DAT: 48kHz as opposed to 44.1kHz.

We couldn't measure the signal-to-noise ratio at full recording level, but tests at a level of –20dB confirmed that it was very close to the quoted figure of better than 95dB. Similarly we couldn't measure total harmonic distortion, because the distortion products were well down in the internal noise of our Sound Technology 1700B meter. So we have no reason to doubt the quoted figure of .003% here, either.

Just as an aside here, making THD measurements on tape decks or recorders is traditionally rather difficult, because of the significant wow and flutter content in the replay signal. You simply can't get a proper null, so the nominal THD reading is really a combined THD/W&F reading. But not so with the DAT machine — from a practical point of view there just isn't any wow or flutter, and it's just like measuring the THD of an amplifier: steady as a rock.

In fact Pioneer quotes the W&F figure for the D-1000 as below the .001% limit of measurement, and our comment on this can only be "amen". We don't have a W&F meter, but from the THD measurements and from simply observing the replay of test signals on the scope, it's just not there. Even a 20kHz signal might as well be coming straight from the generator (clean as a whistle, too — no steps or glitches visible).

Channel separation was excellent, and again virtually beyond the limits of measurement. Pioneer quotes better than 100dB at 1kHz, and 90dB at 10kHz. Only at 20kHz could we even pick up a smidgen of crosstalk on the Sound Technology, above its noise floor; of academic interest only.

Smooth frequency runs over the full 5Hz-22.05kHz range dubbed from track 65 of the Denon 38C39-7147 Technical CD showed up no trace of aliasing. Obviously the D-1000's digital filtering is good. We also did quick checks of linearity, using the 1dB/step runs from –60dB to 0dB on tracks 66-68 of the same CD (1001Hz, 100Hz and 9999Hz). These showed the D-1000 to be excellent.

On square-wave and tone-burst tests, from other tracks of the same CD (it

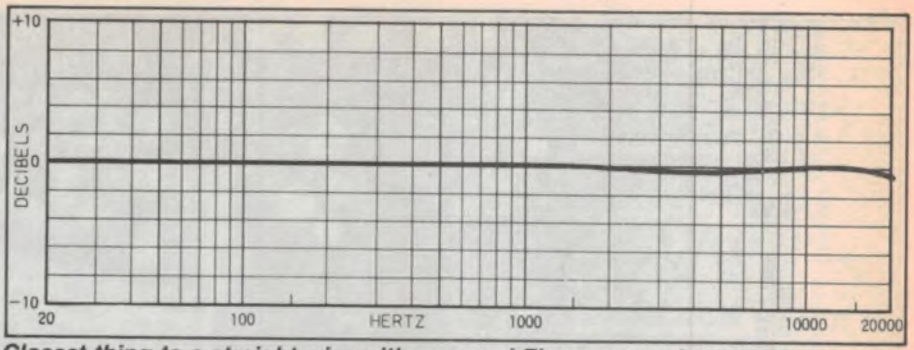
DAT Review

really is very useful!) the D-1000 also gave copybook results. Just a trace of ringing on the square wave, but the tone bursts were just as they came from the generator. In short, its performance is basically well beyond anything you could achieve from any traditional analog recorder, even the most expensive professional models.

How does the D-1000 achieve this performance? Well, it uses 16-bit linear sampling at the 48kHz rate, with digital low-pass filtering at both recording inputs and replay outputs to reduce distortion and phase shifts. These operate at 96kHz, twice the sampling rate. Each channel has separate A/D and D/A converters, to eliminate phase differences, and these are apparently of a new high speed "glitchless" design.

The audio and digital sections of the D-1000 are kept quite separate, on different PCBs, and with entirely separate power supplies. These even have separate power transformers, both of which are fully shielded. Pioneer also makes the point that oxygen-free copper (OFC) is used, not only in the power transformer windings, but in many other parts of the D-1000 as well. Exactly what this achieves is open to some conjecture, but in the D-1000 it obviously hasn't done any harm.

Other points of interest are the use of 70-micron copper laminate (twice normal) for the main PCB, plus 1mm-thick copper busbars for the earth and power lines to give lower common impedances; an earthed "ground plane" layer on the component side of the audio PCB, for improved shielding, plus heavy copper plating on all interior surfaces of the chassis and case.



Closest thing to a straight wire with memory! The measured record-play response of the D-1000 recorder.

With regard to the DAT player mechanism itself, the D-1000 has a front-loading slideout drawer system rather like a CD player, except that it also has a pop-up eject system rather like a VCR. This operates only when the drawer is fully extended. As you may recall from my previous article, DAT uses a helical scanning system very similar to a VCR, except that there is only one scanning head. So a DAT player is in many ways a kind of synthesis of CD and VCR technology.

The complete player mechanism of the D-1000 is actually built into the sliding drawer itself. There are four separate direct-drive motors: one for the tape capstan, one for the head drum, and one each for the two cassette "reel" spindles. As far as I could see, there are also two further motors for the drawer mechanism: one for moving it in and out, and the other for ejecting/accepting the cassette. With the D-1000 Pioneer has pursued the same kind of "anti-vibration" strategy evident with its latest CD decks. Arguing that the DAT cassette itself is susceptible to vibration, it has designed a special mechanical stabiliser system which sandwiches the cassette between layers of a special plastic material. If mechanical noise is any indicator, the system seems to be very effective; it's almost dead quiet in operation.

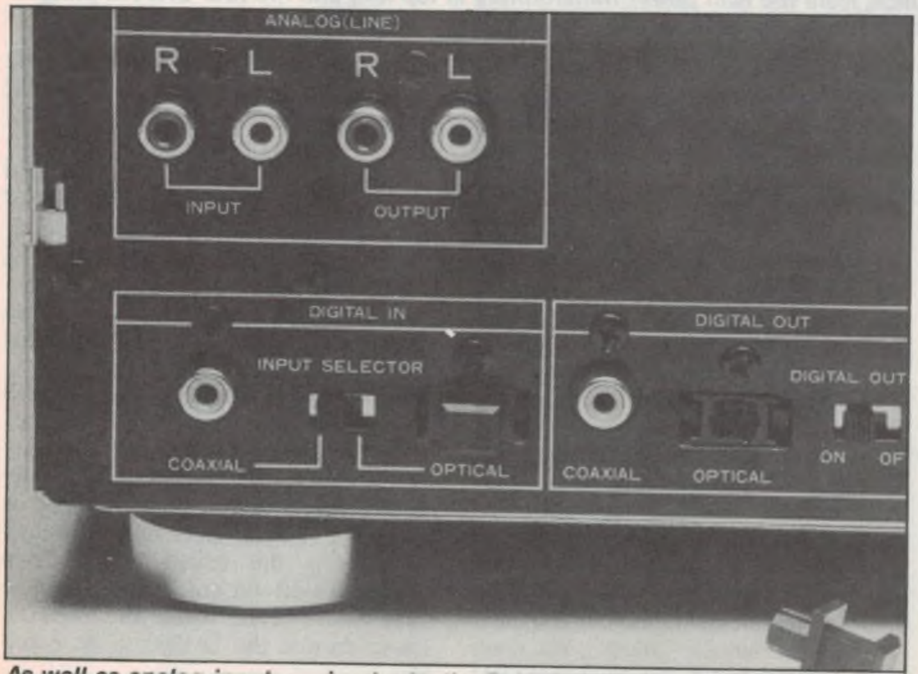
In fact the mechanism is so quiet that Pioneer has thoughtfully provided a little "light chaser" section of the fluorescent display, to show when the tape is moving. This moves slowly from left to right for normal play or record, and faster either way for rewind/fast forward.

A further anti-vibration feature stressed by Pioneer is the use of fairly large feet on the bottom of the D-1000 case. These are said to provide excellent vibrational damping, but Pioneer makes a big point about them being made from "pure solid brass", and attached to the chassis using pure copper screws and washers. The exact significance of all this escapes me, I must confess; from memory the Young's modulus of elasticity for brass is only about half that of steel, but still about 400 times that of rubber.

Still, I notice that the feet do have pads of soft rubber or similar material on their underside. Perhaps this helps a little as well . . .

Operationally, the D-1000 is a real pleasure to drive. It seems to provide virtually all of the track finding features of a modern microprocessor-controlled CD player, with a few extra niceties of its own on the tape recording side.

First of all, there's a full cordless (IR-



As well as analog inputs and outputs, the D-1000 has both electrical and fibre-optic inputs and outputs. The protective cap for the optical output is shown unplugged.

link) remote control, with 28 buttons which let you control just about all main deck functions from your chair. This includes track search and scanning, pause, track ID and renumbering, play order programming and even resetting the counter.

Then there's cassette auto loading. Slide a cassette into the top of the drawer, push it in lightly and the mechanism takes over — lowering it inside and retracting the drawer ready to roll. Very neat indeed.

When you press the record button, the D-1000 automatically enters "paused" mode, to give you the opportunity to set recording level. This is done with a professional-type slider, very smooth in operation, with two small controls nearby to allow fine control for balancing. These have indents in the centre "matched" position.

Adjustment of optimum recording level is made particularly easy by the fluorescent level "meters", which have a much wider range than usual. These have a bar-graph display driven by the digital version of the audio, and with the D-1000's maximum quantising level indicated as 0dB at full scale. To make it easy to set peak level, each channel has "peak hold" storage, which holds the peak reading automatically for 3 seconds and then resets.

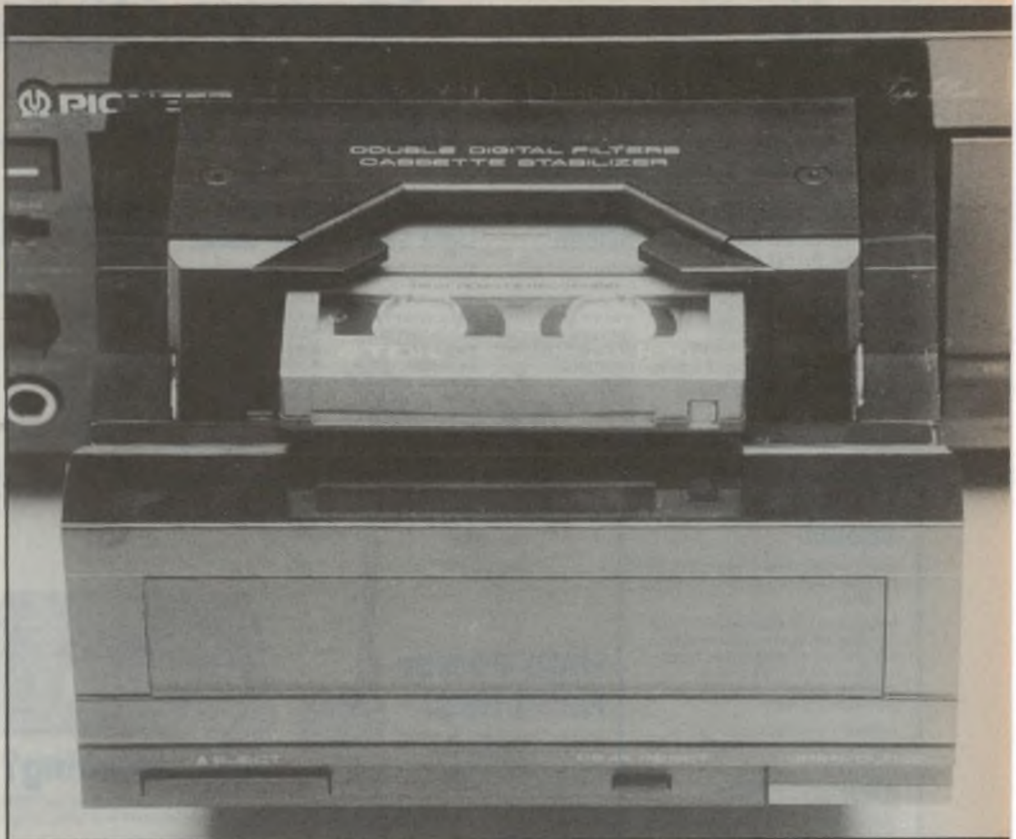
So you can always see the value of the highest peak occurring in the last 3 seconds, along with the current level. This is a very handy feature indeed, and one which makes the D-1000 exceptionally easy to set up for optimum recording. You almost can't go wrong!

By the way, when you're recording on the D-1000 it automatically provides its own track ID numbers, if you don't key in your own. Without a manual in English to check this, I can't be sure how it determines the start of each track — but I suspect that it senses when there's a gap in the program material of longer than about 5 or 6 seconds.

Other features include optional high frequency pre-emphasis and de-emphasis; an inbuilt timer, and a built-in driver for stereo headphones.

Oh, and I almost forgot: as well as the usual analog inputs and outputs at normal "line" level, there are also *digital* inputs and outputs. And not only that, but on the digital side you have a choice between electrical and optical interfacing. That's right — the D-1000 has inputs and outputs for optical fibre links, to both the amplifier and digital signal source.

Note, however, that it isn't capable of direct digital recording from a CD player with digital output, regardless of whether the output is electrical or optical. The sampling rates are not compatible, as the D-1000 can only record at 48kHz. But it could be used in straight-through mode as a high-quality D/A converter, from either the electrical or optical inputs.



A close-up view of the D-1000's cassette drawer in the open and ejected position. The complete deck transport is housed in the drawer, with the LED level meters in the front as well.

The electrical digital ports use RCA connectors, with both channels sharing common input and output connectors. The optical ports use snap-fit moulded connectors, with matching caps to prevent the ingress of dust when they're not in use.

The complete D-1000 package measures 457 x 390 x 108mm, and has a mass of 13.2kg — it's fairly solid. The case is nicely finished in jet black, with dress end pieces of flakeboard fished in stained and polished rosewood. Overall, it looks and feels pretty classy.

There it is, then. As a representative of the next generation of domestic and semi-professional audio tape decks, the Pioneer D-1000 gives an excellent insight to the undoubted benefits of DAT technology. It's the closest thing to perfection in sound recording that most of us are likely to meet, or want for that matter.

No doubt that's why the CD industry is desperately trying to delay the release of DAT outside Japan. It's almost *too good* in a commercial sense, even if that judgement seems irrational from the technical point of view. As someone who's basically an engineer I find this particularly ironic, a form of neo-Luddism.

Whatever, after checking out the D-1000, it seems to me it's the recorder makers that should be worried, not so much the CD player manufacturers. A DAT deck is considerably more complex than a CD player, and the DAT cartridge must surely cost more to manufacture and assemble than stamping out a CD. Surely DAT is never likely to challenge CD seriously as a cost-effective digital playback system for pre-recorded sound.

But for making your own recordings, DAT is obviously superb. After using the D-1000, I've been totally spoiled as far as conventional analog recorders are concerned. And we still don't even know when they're likely to be released here — it's all very frustrating!

Despite this, my thanks again to the good folks at Pioneer Electronics Australia, for letting us try out the D-1000 on your behalf.

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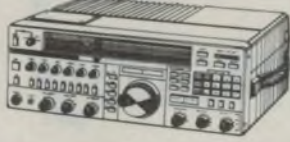

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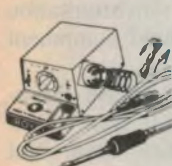

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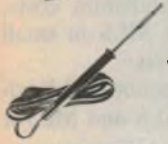

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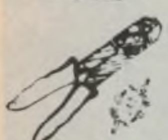

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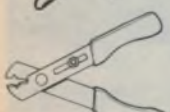

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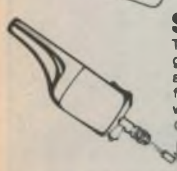

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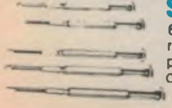

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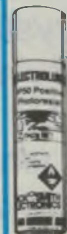

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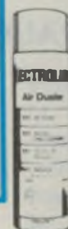

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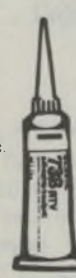

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Interscan: plenty of kudos, but as yet not many dollars

Australia scored another intellectual triumph when the Australian-invented Interscan microwave landing system was adopted by the International Civil Aviation Organisation (ICAO) as the basis for the next generation of navigational aids for aircraft landings. But the commercial benefits to Australia are still uncertain . . .

by PAUL GRAD

In the quest for ever safer and more economical aircraft operation and to permit a larger number of flight operations during adverse weather conditions, scientists and engineers have devised and developed a new generation of navigational aids.

Several such aids are currently in use, serving various stages of an aircraft's flight. Today the most widely used for guiding an aircraft during final approach and touchdown are the UHF/VHF Instrument Landing Systems (ILS). These are to be superseded, however, by Microwave Landing Systems (MLS), to be generally introduced by 1998. The Australian-invented Interscan is now seen throughout the world as the standard for any of the MLS to be adopted.

The ILS have been extremely valuable and reliable since they were introduced in the late 1940s, and there are now about 1600 ILS ground installations worldwide. Their limitations became increasingly apparent, however, and the aviation authorities became interested in alternative landing systems.

With the currently used ILS, only one predetermined, straight landing path can be followed, starting about 30km from the touchdown point.

The ILS are designed to use reflections from the ground on one side of the runway. They require a cleared area at the stop end of the runway to avoid spurious reflections. Any reflections from nearby buildings and terrain irregularities adversely affect the systems' accuracy.

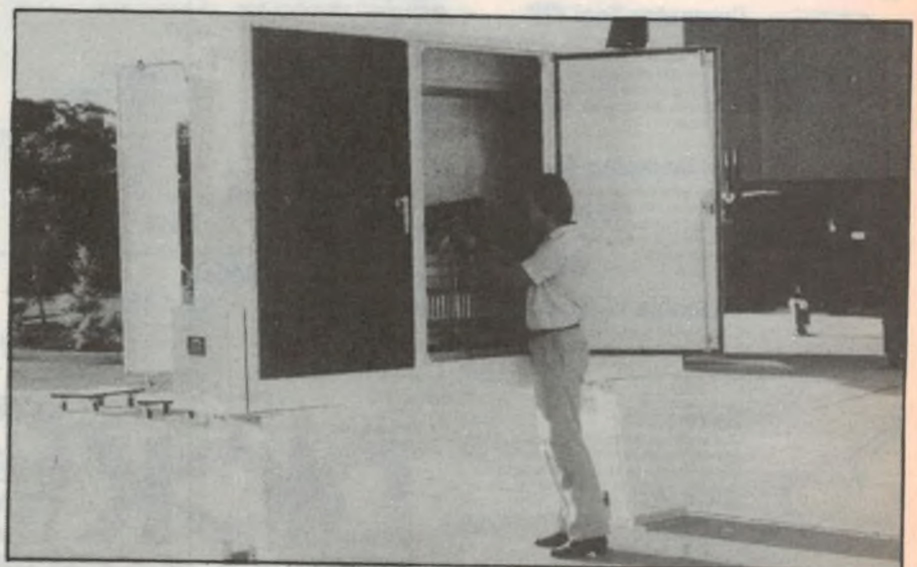
The new MLS cover a much wider area, making it possible for aircraft to approach for landing from any direction, possibly aligning with the runway only moments before touchdown. Thus airplanes can land in a shorter time after receiving permission, which allows the number of overall landings in a given time to be increased.

Also, the MLS allow aircraft to avoid overflying populated areas, reducing their noise exposure. It is doubtful, however, that much can be done regarding noise, since at most airports any approach path is over populated areas.

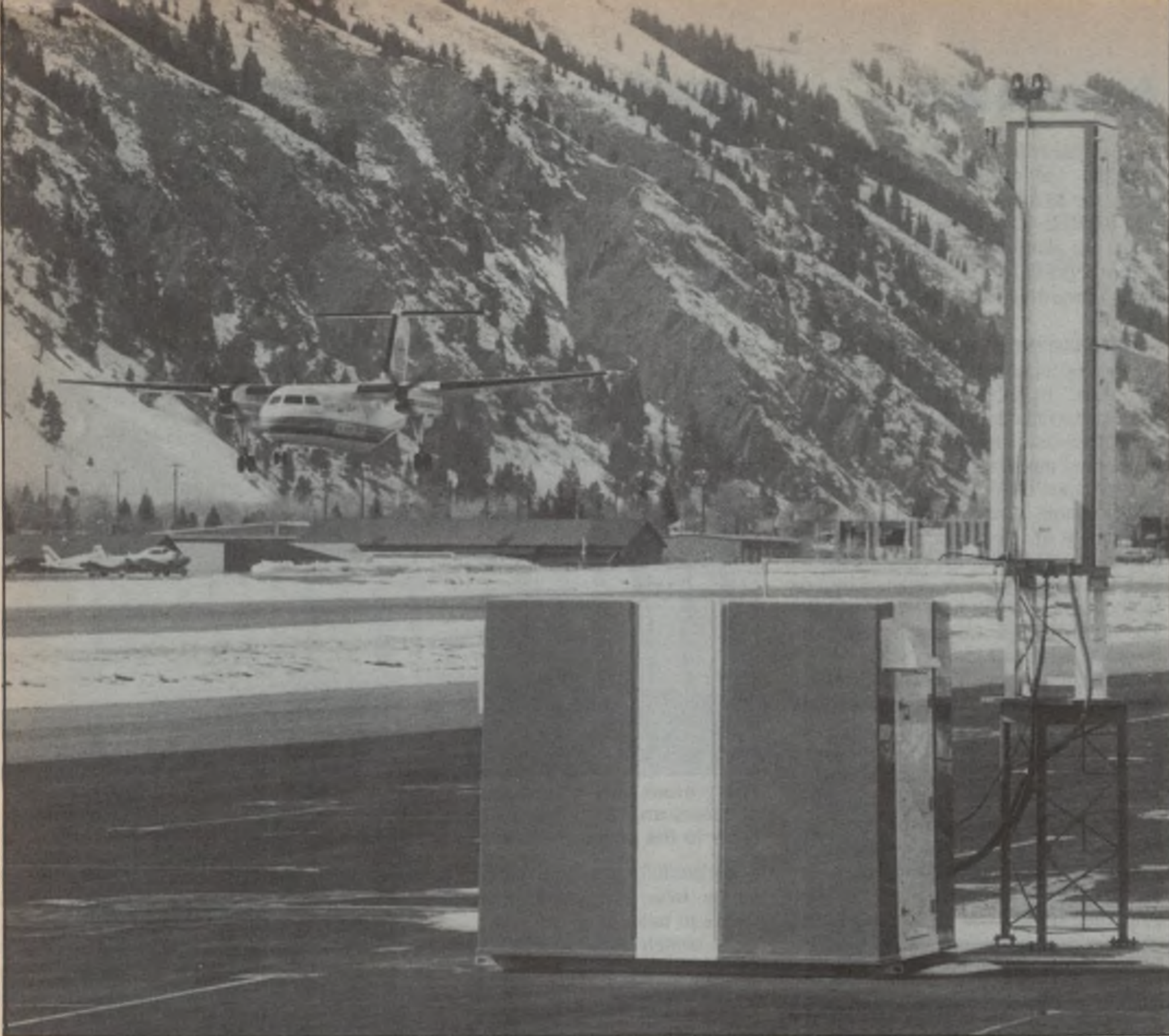
Another advantage of the MLS over the ILS is freedom from RF interference and a much larger number of available channels. This makes it possible to send messages to the aircraft via the MLS, such as weather data, identification of the beam which is intercepting the aircraft, receiver synchronisation and calibration, and ground equipment identification and status.

Since a MLS does not utilise reflections from the ground, it can be installed in any geographical area. Not only does this lower installation costs, but it also permits using MLS in small or remotely located airports.

To understand the functions of landing systems such as the ILS and MLS it



The azimuth antenna of the MLS designed by Interscan is easily accessible for maintenance.



The azimuth and elevation antennas of a newly-installed MLS can be seen in the foreground in this picture of the Friedman Memorial Airport in Hailey, Idaho. The MLS was supplied by Wilcox Electric, a subsidiary of the Northrop Corporation.

is necessary to know what's involved in landing an aircraft, specially a modern airliner.

When flying according to VFR (visual flight rules) with light aircraft, final approach and landing are done using only the most basic cockpit panel instruments such as the altimeter, air speed and engine rpm indicators. The pilot uses his "feel" and experience to decide when to turn, or when to increase or decrease engine rpm. He relies basically on the "eyemeter" to perform the "target shooting" leading to correct touchdown.

This presupposes good weather conditions with good visibility. It is made possible also because light aircraft fly at low speeds and respond almost instantly to the controls, specially to engine acceleration. It is possible to abort a landing when only a few metres from the ground.

An entirely different situation applies to large airliners, which start descending for final approach from an altitude of about 600m, where VFR weather conditions are often not found. Also, an airliner weighing about 50 tonnes, as in the case of a Douglas DC-9, or about 200 tonnes, as with a Boeing 747, is flying at a speed of about 250km/h just before touchdown.

Large jetliners cruise at speeds of 850km/h or 900km/h and are very sluggish at the comparatively low landing speeds. At low speeds it may take such an airplane 5 or 6 seconds to begin responding to engine acceleration, during which time the airplane will have travelled a horizontal distance of several hundred metres.

The "target shooting" leading to correct touchdown thus has to be performed much more accurately as there is much less scope for corrections. For safety, therefore, instrument-assisted approach and landing is essential for large aircraft.

The purpose of systems such as the ILS and MLS is to keep informing the pilots of the airplane's position relative to the glide path line to the touchdown point, enabling them to maintain a constant flight path during the approach. This is done either manually, or through the autopilot by coupling it to the incoming signal from the ILS or the MLS.

This narrows down the deviation of the various flight parameters such as airspeed, rate of descent and glide path angle from the range of values leading to a safe touchdown, until the last 50m or so before touchdown after which only minor corrections are possible.

The ILS radiate two narrow, fixed radio beams in line with the runway, from a system of antennas located at or near the end of the runway. One of them, the localiser beam, is on VHF in the 108MHz to 112MHz range. The other, the glide slope beam, is on UHF in the 329MHz to 335MHz range and is tilted upwards at an angle of 2.5 to 3 degrees.

When coming in to land the airplane flies along these beams and is kept "on the beam" by following instructions incorporated into the signals by means of a complex and ingenious system of antennas and modulation.

Two types of localiser are in current use, parabolic arrays and phased arrays with up to 48 elements. Each of these elements is fed with two types of signal. One is an RF carrier modulated by two sidebands, of 90Hz and 150Hz (CSB). The other consists only of the two sidebands of 90Hz and 150Hz (SBO).

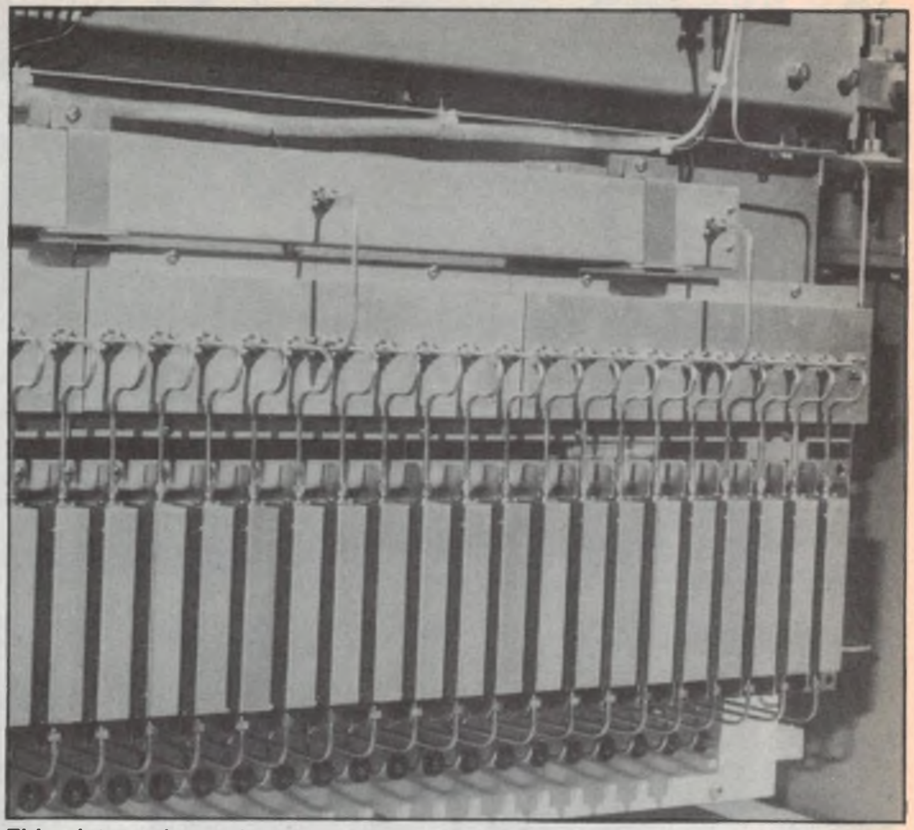
Some of earlier ILS were complex and cumbersome, requiring unusual and sophisticated receivers in the aircraft. In the centre element, in those systems, the sidebands in the CSB signal were in phase with the sidebands in the SBO signal. From the centre to the outer elements, these SBO were progressively shifted in phase relatively to the sidebands on the CSB signal. Thus a wave amplitude profile was created along the beam, which was a function of the angle the beam made with the axis of the runway.

This caused the 90Hz sidebands to predominate on the right side and the 150Hz sidebands to predominate on the left side of the centreline of the runway, along the incoming aircraft's flight path.

To the aircraft the localiser appeared as two beams, a left beam modulated with a 90Hz tone and a right beam modulated with a 150Hz tone. When flying along the centre of the beam the aircraft received both tones with equal amplitude. The signals were fed to an instrument in the cockpit and when the airplane was "on course" the instrument's vertical pointer stayed in its centre position.

When the aircraft drifted to the left the 90Hz tone predominated and the meter swung to the right, indicating "fly right", and conversely, when the airplane drifted to the right the 150Hz tone predominated and the meter swung to the left.

The glide slope system worked similarly with the 90Hz tone predominating above, and the 150Hz tone predominating below, the glide path. In the cockpit



This picture shows the power dividers of an MLS azimuth antenna designed by Interscan. The power dividers distribute RF power with suitable amplitude taper to the phase shifters, and then to the radiating aperture.

a horizontally-mounted needle, usually in the same instrument, indicated the course to take.

To complete the system there were two or three marker beacons beaming a 75MHz signal directly upwards at various distances from the runway, which indicated to the pilots what distance the aircraft was from the touchdown point.

Most ILS currently in use are simpler. In them the 90Hz sidebands in the CSB signal and the SBO signal are in phase, while the 150Hz sidebands in the two signals are in antiphase (180 degrees out of phase), in all points in space.

The CSB signal is radiated from a single aerial in the centre of the array, with a polar pattern. The depth of modulation (DDM) of each sideband of the SBO signal varies with azimuth angle. (The modulation depth is the ratio of the sideband and carrier amplitudes provided certain phase requirements are met). The SBO signal is radiated in a directional aerial system.

The loci of all points where the difference in DDM is zero constitutes a straight localiser course. Away from the course, the DDM rises in value with 90Hz predominating on one side and 150Hz on the other.

As with the earlier system, the aircraft receiver is adjusted so that the instrument panel indicator deflects to the right when the 90Hz signal predominates, and to the left when the 150Hz signal predominates. By keeping the indicator centered the pilot flies along the course defined by the localiser, i.e. the extended runway centreline.

It would usually be difficult to make an ILS approach using the ILS signals only, however. These signals are used to generate instructions for the pilot in a "flight director" display which combines the ILS signals with other information such as roll and pitch derived from the aircraft sensors.

As the limitations and high cost of these ILS became more evident, suggestions for alternatives began to appear. During the third meeting of ICAO's All-Weather Operations Panel in 1967, Brian O'Keeffe, now acting deputy secretary, airways division, Department of Transport and Communications, submitted a paper suggesting that a study for a new landing system should be initiated.

In 1972 the ICAO requested submissions on a better system from member organisations. There was concern among Australian transport authorities that a new system could be internationally agreed upon, to which Australia would have to adapt, which might prove disadvantageous to Australia. If the new system were developed to suit the prevailing weather conditions in the northern hemisphere, it could be less suitable to Australia. The Australian authorities therefore decided to contribute a submission to ICAO for a new landing system and to support it the Department began conducting studies on suitable antenna systems in conjunction with the CSIRO's division of radiophysics.

The CSIRO had developed antenna expertise through its work on radio astronomy.

Australia proposed Interscan's basic principles in March 1973 and a contract was later awarded to AWA for building the corresponding hardware. Interscan experimental hardware became first available in 1974, and testing started shortly thereafter, in Melbourne, using a Douglas DC-3 airplane.

The ICAO started studying the proposals in 1976 and accepted the Interscan principle at a meeting in 1978.

Although the proposals all referred to microwave landing systems, they were variants of two basic concepts.

The Australian-advanced concept, backed by the US Federal Aviation Administration (FAA), is based on the time-reference scanning beam (TRSB) principle as conceived by Dr Paul Wild, then head of the CSIRO's division of radiophysics.

The competing concept was proposed by the Europeans and was based on a fixed-beam, Doppler technique.

After the ICAO's selection of the TRSB principle as the basis for the next generation of MLS, the Australian Government set up Interscan Australia to co-ordinate the development of a MLS product.

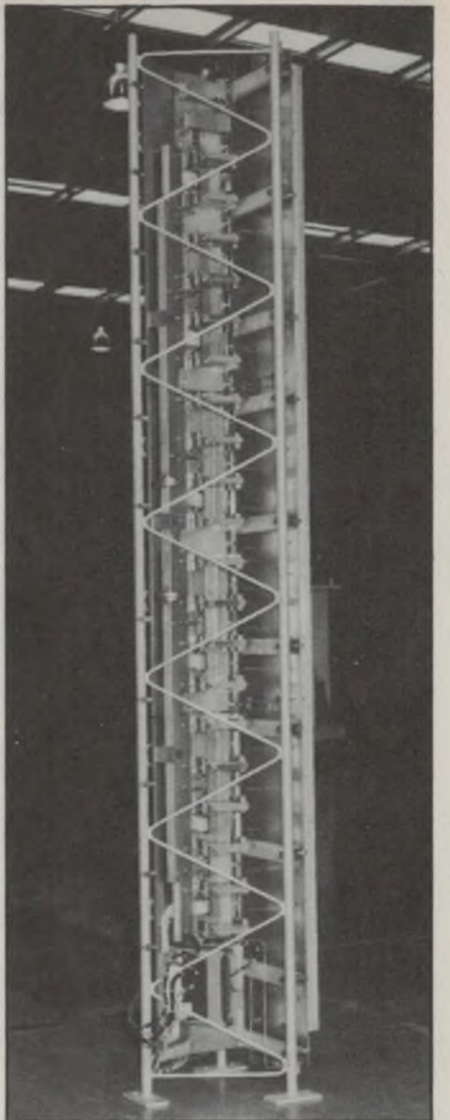
The development is targetted for the FAA, which is the only customer for landing systems in the world which can offer a large promising market before the general change to MLS in the late 1990s.

The system's initial development had been contracted to AWA and Hawker de Havilland, in Australia, and is now contracted to the Northrop Wilcox Corporation in the US.

From July 1st, 1984, funding for Interscan was undertaken by the Australian Industry Development Corporation. Renamed Interscan International, the company is now a wholly-owned subsidiary of the AIDC.

Interscan, as with all MLS, operates in the SHF band between 5.03GHz and 5.09GHz. It has a range of about 37km.

The operating concept of a MLS based on the TRSB principle is quite simple.



Interscan MLS elevation antenna, showing the tower and the microwave hardware.

Two scanning beams are used, one scanning in azimuth (horizontally) and one scanning in elevation (vertically). The azimuth beam scans 60 degrees either side of the runway centreline at a rate of 12 times per second. The elevation beam scans from the horizontal up to 20 degrees at a rate of 36 times per second.

The azimuth beam has a horizontal width of from 1 to 3 degrees, depending on the required accuracy, and a vertical width of 20 degrees, and forms a thin wall as it scans. The elevation beam is flat and fan-shaped, with a vertical beam width of 1 to 2 degrees and a horizontal width of 120 degrees.

A receiver on-board an aircraft approaching the runway intercepts the beam scanning in azimuth as it sweeps to and fro. The scan is preceded by a preamble which tells the aircraft receiver that an azimuth scan is to follow and from which side of the runway it is to start. The beam starts one half of the scan, the "to" scan. As the beam passes through the aircraft, the aircraft receiver detects it and an associated processor starts a timing cycle. The beam completes the "to" scan, then sweeps back on its "fro" scan. As the beam again passes through the aircraft, this time on the "fro" scan, the receiver again intercepts the signal and the processor terminates its timing cycle. Given the angle over which the scan sweeps and the time taken for the sweep, the processor uses the time between intercepts to calculate the angle the aircraft's path is making to the centreline of the runway.

Similarly, the elevation beam scans vertically, up and down, intercepting the aircraft twice each cycle. The time difference between the two intercepts allows determining the airplane's glide slope.

Finally, the third co-ordinate needed to precisely locate the aircraft is provided by a conventional DME (distance measuring equipment), which furnish the pilots with accurate information on their distance from the DME ground station.

The two scans are transmitted sequentially, permitting the use of the same frequency for both scans, saving spectrum space and simplifying the aircraft receiving equipment.

When the pilot receives the landing instructions from the air traffic controller, he feeds this instruction into his processor using a magnetic card or numeric keyboard. The processor then compares the aircraft's actual position with the nominated path and generates the appropriate correction signals.

The MLS signals are fed to the instrument display, to orientate the pilot, or are fed directly to the autopilot.

It will not yet be possible for a controller to decide which approach path an aircraft should follow. This will only be possible after the aircraft have been fitted with new, more advanced systems.

The Interscan antenna system design must be capable of producing a very narrow beam but must be able to sweep this beam to and fro (or up and down) at high speed and with a high order of accuracy.

Mechanical sweep systems would hardly be capable of achieving this. Texas Instruments had developed an antenna array system which vibrated me-

Interscan

chanically as a whole at a frequency of about 10 times per second. However, several problems, mainly of a practical nature, prevented the system from being adopted. Among those problems was the safety of any personnel approaching the antenna, and the fact that its vibrations created an air funnel which sucked down birds and insects causing them to crash on to the antenna.

After several design concepts were attempted, in which cost was always a major consideration, the phased array antenna was developed.

The phased array consists of a number of physically fixed radiating elements, connected to phase shifters. The sweep of the beam is caused by the controlled, sequential shifting of phase of the waves radiated by the antenna elements. While all elements radiate simultaneously, the differences in phase between neighbouring elements cause interference patterns in the radiated waves, with amplitude reinforcement in some regions and cancellation in others. This leads to a continuous change (or sweep) in the distribution of radiated energy.

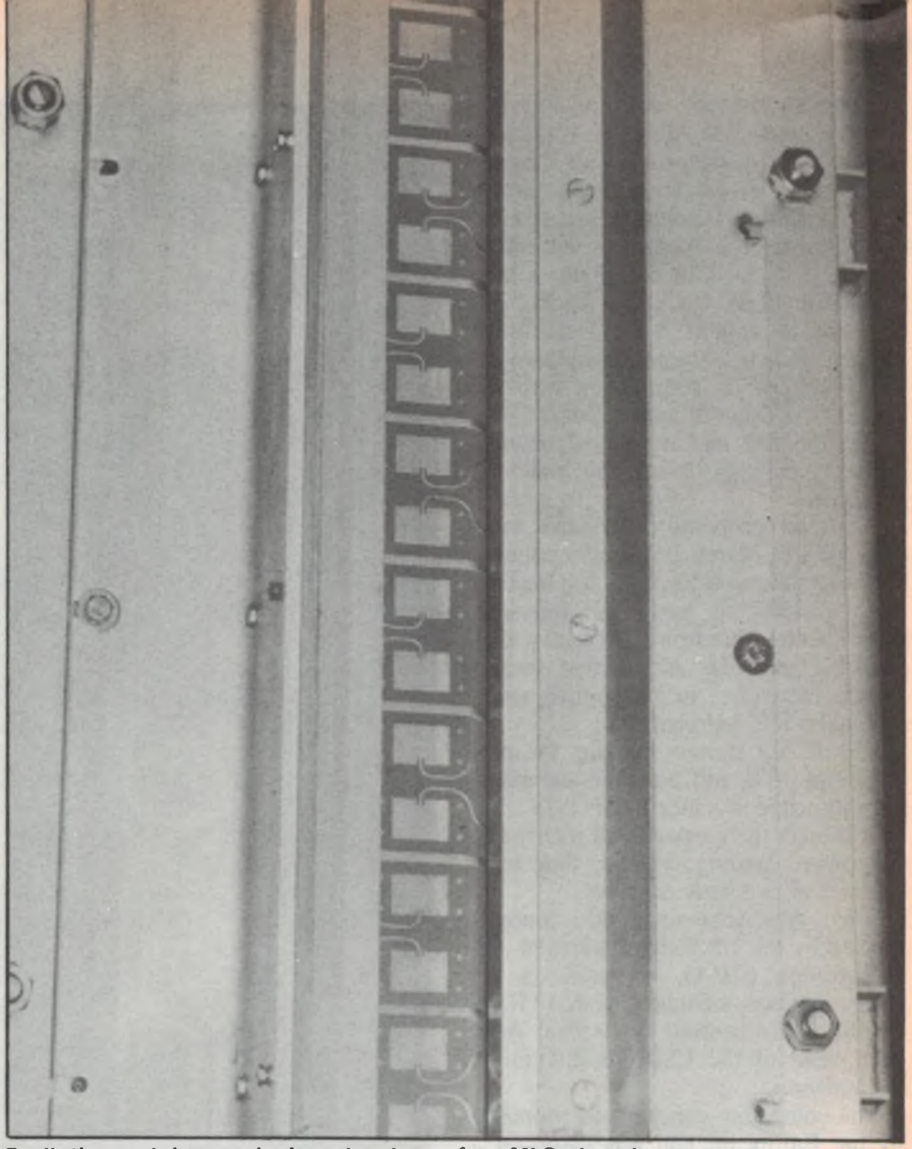
The number of antenna elements determines the beamwidth; the narrower the desired beamwidth, the larger the necessary number of radiating elements.

The azimuth antenna is a filled phased array antenna with 58 elements for a 2 degree beamwidth, and 58 phase shifters.

Each element (vertical column) of the azimuth antenna is a precision etching, in the style of a printed circuit board, on a PTFE microwave controlled dielectric substrate. The precision is needed to preserve sharp outlines, and the substrate quality is necessary to minimise losses, both critical factors at the frequencies used.

For the elevation antenna it was possible to use a thinned phased array because of its relatively small scan range of 0 to 20 degrees. The elevation antenna uses the principle of overlapping subarrays. It has about 78 elements for a 1.5 degree beamwidth. Because it is a carefully-designed thinned array it requires only 20 phase shifters, whereas a filled array would require the full 78.

The subarrays employ microstrip antenna technology and are combined with the thinning network and radiating patches on an etched single-sided microstrip substrate.



Radiating patches and wing structure of an MLS elevation antenna designed by Interscan.

Identical 4-bit PIN diode phase shifters are used for the scanning beam antennas, both azimuth and elevation. A power divider distributes RF power with a suitable amplitude taper to the phase shifters which are connected to the radiating aperture.

ICAO's choice of the Australian Interscan concept was an occasion of justifiable pride for the people involved in developing the concept and in the negotiations leading to its adoption.

O'Keeffe said "When I suggested to ICAO in 1967 that ILS had fundamental limitations and therefore studies be commenced on a new system, I was nearly asked to leave. It was thus with great satisfaction that, 11 years later, I was at the ICAO meeting that selected the MLS concept originally proposed by Australia."

However, the prospects for the system's commercial exploitation do not look too bright at the moment. The main reason for this is the difficulty in penetrating foreign markets.

The FAA plans to have commissioned 1250 MLS by the year 2000. In 1981 it released its equipment specifications for MLS and called for tenders for supplying and installing 208 systems.

There were three bidders: the joint venture of Interscan Australia and Wilcox, the Hazeltine Corporation and the Bendix Corporation. The contract's award to Hazeltine and the subsequent order, in 1983, for 208 systems was a disappointment to the Australians.

Interscan International did not lose out completely on the deal, however. It is supplying 208 precision DME antennas and 110 MLS test receivers as a subcontractor to Hazeltine.

The company also has seven of its systems installed in various small airports in the US. All seven are operating and some of them are certified.

Hopes are still high for the Interscan's ultimate commercial success and for a profitable use of the expertise and know-how acquired in building the system.

It all started 100 years ago with Heinrich Hertz

We take today's technological wizardry for granted and enjoy the benefits of satellites, radio, TV, and other marvels as if they all fell from Heaven. But they did not! Their story is often dramatic and awe-inspiring. Here is a brief homage to one of the great pioneers who made it all possible.

by PAUL GRAD

About 100 years ago, a series of experiments were conducted in the German city of Karlsruhe. They turned out to be among the truly epock-making experiments in history. The man who performed them was a 30-year-old, recently married physics professor named Heinrich Rudolf Hertz, and he caused a great international sensation at the time.

With the experiments, Hertz conclusively demonstrated the existence of electromagnetic waves and showed several of their main properties. Most sensational was his demonstration that electromagnetic waves exhibited many of the main properties of light, already well-known at the time.

He thus gave experimental confirmation to the theory of electromagnetic propagation, which had been published about 25 years earlier by the Scottish physicist James Clerk Maxwell.

Maxwell's theory had predicted that electromagnetic radiation propagates with the speed of light, suggesting that light is itself a form of electromagnetic propagation. This was seen as extraordinary by his contemporaries, because hitherto electromagnetism and optics were considered to be separate fields.

The scientific world had to wait almost a quarter of a century before Maxwell's predictions were proven correct.

It is difficult, today, to appreciate the dramatic impact Hertz made with the announcement of his experimental results he caused the international scientific community to be ablaze with excitment. He became famous and received many honours.

A lot of water has flowed under the bridge since those days, as we all know, and Hertz' name has lapsed into comparative obscurity. His importance and stature as a scientist do not seem to be fully appreciated today.

Heinrich Hertz

Who was Hertz, what was the measure of his achievements, and why is he now an only vaguely remembered figure?

Hertz was born in Hamburg in 1857 and studied initially to become an engineer at the Dresden Technical College. He interrupted his engineering studies, however, and volunteered for military service.

After about one year of military service he decided to abandon engineering. Instead, he studied physics and mathematics at the Technical College and at the University in Munich. In 1878 he went to the University of Berlin, attracted by Helmholtz and Kirchhoff, two of the greatest scientists of the time.

Both Helmholtz and Kirchhoff constituted a special attraction to students of mathematics and physics. Hertz thus did what all serious and ambitious students do, and followed the masters. He became Helmholtz' assistant in 1880.

His interest in electromagnetism seems to have been first aroused in a serious way during his times in Berlin. Here he started to perform both experimental and theoretical work on various problems of electromagnetism.

He received a doctor's degree from the University of Berlin in 1880, "magna cum laude", which was a rare accolade in Berlin those days. His thesis work departed from previous work by the French physicist Arago on the mutual effect between magnets and copper plates moving relatively to each other. It examined the case of a conducting sphere, rotating around one of its own diameters in a magnetic field. He calculated the patterns of propagation, on the sphere, of the currents induced by the magnetic field as well as the mutual effect between the magnetic field and the sphere. He performed investigations using both a solid and a hollow sphere.

From Berlin he went to Kiel, where he stayed about two years, during 1883-84. He was not happy there, however, and in 1885 he accepted an offer of a professorship in physics from the Technical College at Karlsruhe.

We don't know when he first thought of attempting to verify Maxwell's predictions, but it was here in Karlsruhe that he performed those great experiments, publishing his findings in a series of papers between 1887 and 1889.

He moved to Bonn in 1889, having bought the house in which Clausius, a scientist famous for his work on thermodynamics, had lived, and became Clausius' successor at the University there. In the same year, after moving to Bonn, he went to London at the invitation of the Royal Society.

Following his return from London, he

A demonstration, to the German Wehrmacht, of receiving equipment during World War I. (Courtesy of Photo Internationes)

was almost constantly plagued by ill-health. He felt tired and depressed, partly because after his great successes his work appeared to have stagnated, and interest in electromagnetic waves had diminished among scientists.

He performed little additional work of importance and died on New Year's day, 1894, just short of his 37th birthday.

So much on Hertz' short life. Let's now try to convey the magnitude and importance of his achievements.

Maxwell's theory predicted that an electrical disturbance could propagate and produce an effect at a distance from where the disturbance originated.

It incorporated the facts which had already been observed at the time, by Oersted, Faraday and others, that an electric current produces a magnetic field, and that a changing magnetic field (and therefore a changing current) produces an electric current.

However, Maxwell further assumed that those phenomena could propagate in space. He assumed that a changing electric field produces a changing magnetic field in the surrounding space, and this changing magnetic field produces itself a changing electric field, and so on indefinitely, these disturbances propagating in space with the speed of light.

The speed of light had already been accurately measured, but it was not yet known that light is a form of electromagnetic radiation.

Extraordinary as his theory was to his contemporaries, it could not be accepted, like all theory, until experimentally verified.

To understand Hertz' experiments we must look briefly at the special case of an electric current flowing around a closed loop such as a conducting ring.

According to the prevailing view at the time, a current flowing around a closed loop would exert a force on a magnet only at the centre of the loop, but not in the surrounding space. Maxwell, however, assumed that a force would be exerted on a magnet also outside the ring, since a change in the current flowing around the loop would induce an electric field in the space surrounding the loop. And since this electric field would itself be changing, it would induce a magnetic field in the space surrounding the loop.

Also, he assumed that the higher the speed with which the current around the loop changes, the higher will be the intensity (magnitude of the magnetic forces) of this induced magnetic field.

Further, he assumed that the type of material constituting the medium in which the electric field changes, and the medium's dielectric constant, affect the intensity of the induced magnetic field.

Why did it take so long to prove the existence of electromagnetic waves?

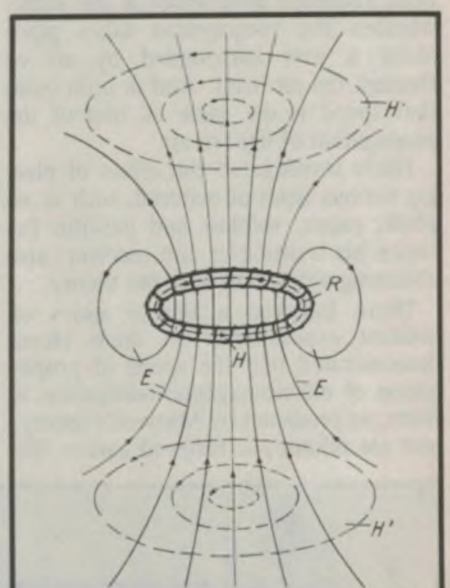
The main reason was that the fastest current oscillations (or alternating current) that could be produced in Maxwell's time — of about 1 million cycles per second — induced magnetic field intensities that were too weak to detect with the means then available.

It is difficult to appreciate, nowadays, how crude were the experimental resources available to scientists 100 years ago. Obviously there were no valves, no semiconductors, none of the paraphernalia of our time, which many of us take for granted. Great ingenuity and inventiveness were required from the researchers, who usually had to build their own experimental equipment from whatever they could find.

How different from today's attitude of many researchers, who keep hooting for more and more funds and better and faster computers!

Naturally, at the time of Maxwell's predictions it was not even known how to cause electromagnetic radiation to propagate or how to detect it in space.

Hertz' manner of solving all these problems revealed an experimental genius of the first order. He showed how frequencies of more than 100 mil-



Electromagnetic field generated by a current flowing around a closed loop.

Heinrich Hertz

lion cycles per second could be obtained.

He used a long straight wire, connected to a conducting sphere on each end, interrupted in the middle by a short air gap. Connecting each of the wire's halves to one of the poles of an induction coil caused sparks to jump across the air gap, and resulted in very rapid oscillations in the wire. Thus he built a crude type of oscillator, equivalent to a crude "transmitter", with a tuned circuit consisting of an inductance and capacitance.

He then built a "receiver" consisting of a circular loop of wire, completed by a short spark gap. The gap was adjustable down to a micrometre by means of a screw. There was also a telescopic viewer attached to the gap to check its exact size.

When this receiver was brought close to the operating transmitter, small sparks jumped across the loop's gap.

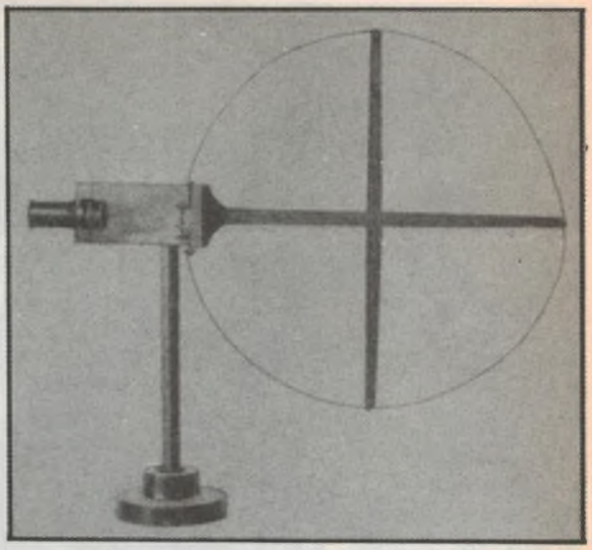
With this setup Hertz showed how one could determine the directions of the electrical and magnetic fields produced by the transmitter.

He then calculated the field forces on the basis of Maxwell's theory, obtaining results in full agreement with his measurements.

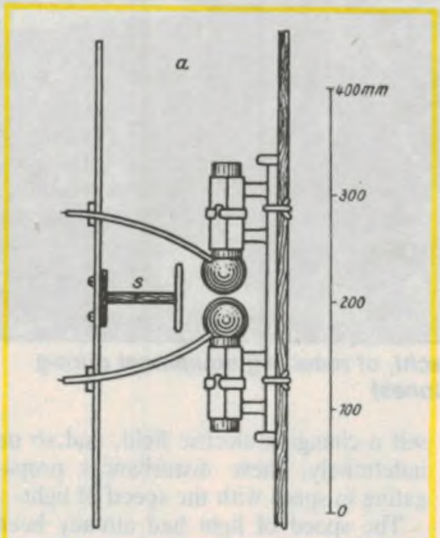
Hertz also provided another important confirmation of Maxwell's theory. As said earlier, the theory assumes that the induced magnetic field is affected by the medium. The theory also assumes that the speed with which electromagnetic radiation propagates is the same, whether the propagation takes place along a wire surrounded by air or through the air itself. And in both cases that speed is the same as that of the propagation of light in air.

Hertz investigated the effect of placing various types of material, such as asphalt, paper, sulphur and paraffin between his transmitter and receiver, also obtaining agreement with the theory.

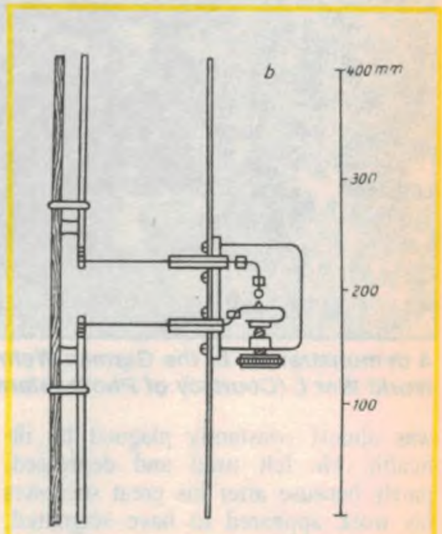
There followed a further series of brilliant experiments. In them Hertz demonstrated that the speed of propagation of electromagnetic oscillations is finite, as predicted by Maxwell's theory, and not infinite, as believed earlier. He



Hertz' first receiver. The loop had a spark gap inside the telescopic viewer on the left.



Hertz improved his transmitter to obtain higher frequencies.



Hertz' improved receiver.

showed that the electromagnetic radiation does in fact propagate with the speed of light. And he also showed that when reflected upon itself the electromagnetic radiation forms maxima and minima of electric and magnetic field intensity at regular intervals, analogously to the formation of standing sound waves. This was a striking demonstration of the wave nature of electromagnetic radiation.

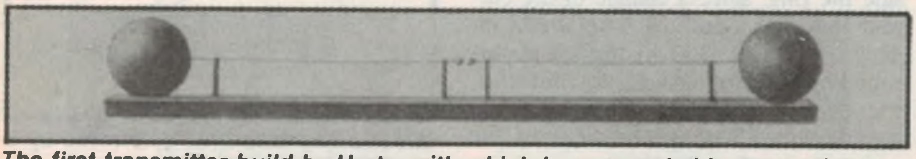
After working with the setup described earlier, Hertz employed a different kind of transmitter, dispensing with the spheres and using a much shorter but much thicker wire. This transmitter produced much more rapid oscillations, with much shorter wavelengths.

Having verified that the electromagnetic waves are reflected from metallic surfaces, he built two large cylindrical mirrors with parabolic cross sections, and placed a transmitter along the focal line of one of the mirrors, and a receiver along the focal line of the other.

Thus he obtained much higher efficiencies in both transmission and reception, since transmission proceeded in one direction only, and the receiver concentrated the incoming waves in one spot.

With these parabolic mirrors Hertz demonstrated that electromagnetic waves exhibited the, at the time, well-known properties of light, including straight-line propagation reflection, dispersion and polarisation.

Fancy somebody experimenting with



The first transmitter build by Hertz, with which he succeeded in generating 100MHz frequencies, the highest ever produced at the time.

parabolic transmitters and receivers 100 years ago and using them, not only to prove the very existence of electromagnetic waves but also to demonstrate many of their important properties!

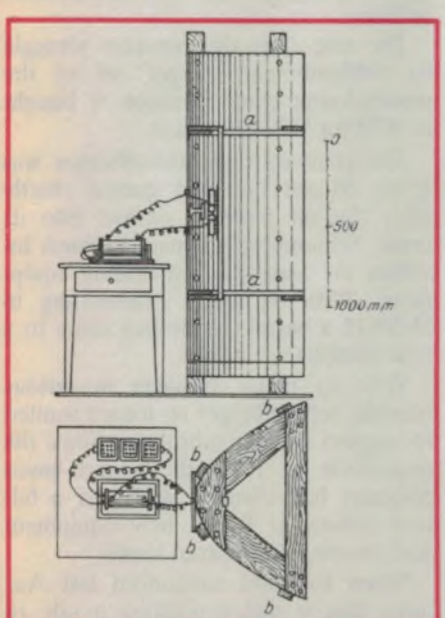
As we can see, Hertz did much more than demonstrate the existence of electromagnetic waves. He was also a pioneer in building and using equipment, and in applying techniques, which are, in principle, quite similar to those used today.

After working with the parabolic mirrors he built a large prism of pitch (the prism had to be large in view of the wavelengths with which he was working), and verified the analogy between the behaviour of the electromagnetic waves travelling through the prism and that of light going through a glass prism.

Hertz caused considerable sensation when he showed that the dispersion of the electromagnetic waves, and their corresponding refractive indexes, agreed very well with Maxwell's corresponding predictions on the basis of the dielectric constants of the media in which the waves propagate.

Always a theoretician as well as an experimenter, Hertz wrote a paper on Maxwell's theory with the intention of providing a simplified and clearer version of the theory. In the paper he extended the theory to the case of moving bodies.

By showing how high-frequency oscillations and electromagnetic waves could be produced, Hertz can be regarded as the founder of wireless communication, even though it was Marconi, as is well known, who first succeeded in transmitting messages telegraphically over large distances.



Hertz built two cylindrical mirrors with parabolic cross sections.

He also seems to have been the first to observe the photoelectric effect. In his experiments he saw that a spark gap released sparks much earlier when the gap was illuminated by ultraviolet light originating from another spark gap, which was a very surprising phenomenon at the time.

An interesting and little-known work of Hertz', and quite independent of his research on electricity, is a book called "Principles of Mechanics", in which he attempted to develop a theory of mechanics without using the concept of "force". His effort in this field is highly original and consistent, but has not proved directly fruitful.

His work on electromagnetism and his "Principles of Mechanics" were well-known to a later scientist named Albert Einstein. Before developing his relativity theories Einstein carefully studied the works of people like Helmholtz, Kirchhoff, Mach and Hertz. We don't know to what extent Hertz' work influenced Einstein or whether we can regard Hertz as one of the forerunners of relativity. We do know, however, that Einstein and other prominent scientists took Hertz' extension of Maxwell's theory and his book on mechanics very seriously.

It is not easy to tell why Hertz' work, so highly regarded in his days, is not well-remembered today. We know that, immediately following Hertz' brilliant successes, the subject of electromagnetic waves was almost shelved by most scientists.

It was only after Marconi's work that the subject of electromagnetic waves took off again, reawakening the scientists' interest.

This was similar to what happened after the discovery of X-rays by Roentgen. There was considerable enthusiasm immediately following their discovery, then they were somewhat forgotten until Bragg in Britain and von Laue in Germany developed the use of X-ray diffraction in crystals.

Maybe it was Marconi's spectacular success, closely following Hertz' early death, which caused Hertz' work to gradually lapse into comparative obscurity. We honour him by using his name as a unit of frequency (1 Hertz = 1 cycle/second), but how many know his importance in the history of science and technology, his stature as a scientist, and how dramatic was the effect of his experimental results on his contemporaries?

The real story behind

How National Semiconductor ended up with Fairchild

Fairchild Semiconductor formed the beginning of the semiconductor industry itself, when it began 30 years ago. Because most of the industry entrepreneurs trained there, it was often dubbed the "University of Fairchild". Here's the story behind the decline of this once-great company, and its recent acquisition by National Semiconductor, from EA's US correspondent.

by PAUL SWART

For most of the past decade, Fairchild Semiconductor has been on the corporate operating table in a painful struggle for survival. On Monday August 31, 1987 Schlumberger, its current parent finally turned off the life-support system and sold the corpse to National Semiconductor for $US122 million in stock.

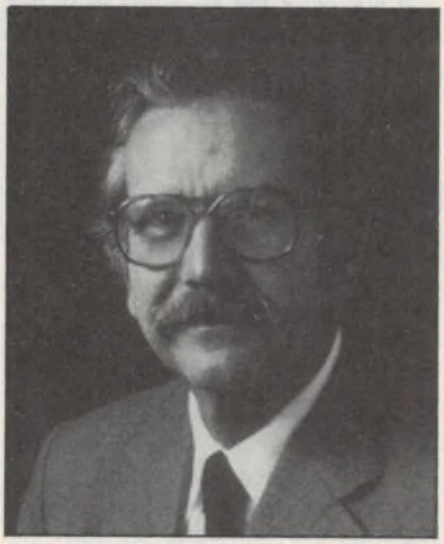
The deal ends the life of a company that founded the semiconductor industry 30 years ago when one of its founders, Robert Noyce, invented the integrated circuit.

Although Fairchild was Silicon Valley's leading chip manufacturer during the 1960s and early 1970s, the company also gained a reputation as the breeding ground for new semiconductor start-ups. Almost from its inception, Fairchild's management has been in a constant state of upheaval, causing many top managers to leave the company and form their own firms.

In 1979, at the annual forecast dinner of the Semiconductor Industry Association, keynote speaker Wilf Corrigan, a former Fairchild president himself, asked all those who had worked for Fairchild to stand up. Nearly three-quarters of the 700 chip executives present rose to their feet.

In time, the success of many of the spin-offs, including Intel and AMD, took its toll on Fairchild's performance as the company found itself playing catch-up with the innovations with which the spin-offs carved out niches for themselves. By 1978, Fairchild's growth came to a virtual complete halt, and even today's annual sales volume of some $US450 million is virtually the same as it was ten years ago. During the same period, the overall semiconductor market has grown at least eight-fold.

One of those Fairchild executives who left in disagreement was Charlie Sporck, who quit his job as general manager in



National Semiconductor's president Charles Sporck, who will now be deciding the destiny of the company he left in 1967.

1967 to become president of National Semiconductor, a $US7-million company, then heading for bankruptcy.

"I think Charlie made a hell of a deal," commented Corrigan, the LSI Logic chairman who was president of Fairchild when the company was sold to Schlumberger.

Even Schlumberger director Don Ackerman acknowledged that National got a great deal. "It is not a very substantial price. But then, the entity has been losing a substantial amount of money."

Surprisingly, most people reacted with relief when learning about the sale to National, a development that had seemed very unlikely just two weeks before. The relief compares to the outrage that erupted throughout the US when Japan's Fujitsu had agreed to purchase the company late last year for $US200 million.

The sale ends the two-year struggle by Schlumberger to get rid of the money-losing chip operation it bought in 1979 for $US456 million.

The rumours that Schlumberger was trying to sell Fairchild started shortly after the oil industry slipped into its crisis. Schlumberger's main business involves the leasing of oil drilling equipment. With oil prices plummeting to $US9-12 a barrel, oil drilling came to a near-complete standstill.

With its major business in serious trouble, Schlumberger no longer wanted to support its chip subsidiary. Since the acquisition in 1979, the French-based company had invested well over a billion dollars in R&D, new equipment and covering operational losses.

When Fairchild announced last Autumn that it had negotiated a sale to Fujitsu, US industry leaders, including Charlie Sporck expressed outrage.

Fairchild Semiconductor: the company from which most of Silicon Valley's chip entrepreneurs received their training then left to start up their own companies. In recent years it has been losing quite a lot of money — for example $US93 million in 1986.

Sporck told reporters he saw great danger in the sale to Fujitsu as it would give Fujitsu much easier access to the US market through Fairchild's marketing organisation. Because of the competitive nature of the Japanese industry, and the vulnerability of the US industry after two years of recession, he feared competitors of Fujitsu might try to match the move by buying a major American chip maker of their own.

In Washington, Defense Secretary Casper Weinberger also voiced his concern about the danger to the US supercomputer industry if Fairchild and its ECL business ended up in Japanese hands. Together with Commerce Secretary Baldridge, Weinberger called on the Reagan Administration to block the sale. Shortly afterwards, Schlumberger withdrew the offer to sell to Fujitsu.

At a crowded press conference at a Palo Alto hotel, Fairchild president Donald Brooks expressed his own outrage over what he saw as a ploy by his US competitors to sabotage the deal with Fujitsu. At the same time, Brooks said he would try to orchestrate a management-led leverage buy-out.

Early in 1987, it became known that Brooks had formed a consortium that included Fujitsu and Florida-based computer maker Integraph, as well as other outside investors. But early this summer, both Integraph and eventually Fujitsu pulled out of the deal. Industry observers said the continued huge losses generated by Fairchild scared off most of the investors.

During the next two months the efforts to sell Fairchild went into high-gear. On the one hand, Brooks desperately tried to put a new package together that would leave Fairchild's independence intact. On the other hand, a parade of semiconductor and other companies, expecting Schlumberger to start selling Fairchild in bits and pieces, began to arrive at Fairchild, window-shopping for bargains on parts of the organisation they could use.

As valley observers started to place bets on which way the battle for Fairchild would turn out, Brooks managed to put a new package together, largely supported by venture capital from Citicorp. Brooks, after submitting the proposal on August 14, and confident he had saved Fairchild, took off with some friends on a salmon fishing trip. But before the fishing trip was half over, the take-over battle had heated up considerably, and Brooks, contacted by radio, returned to Cupertino on August 19.

When he returned, Brooks learned that National Semiconductor, and one other — unidentified — company had also submitted bids.

In particular the National entry had come as a surprise. National hadn't even expressed any interest in Fairchild until late June or early July. And it wasn't until late-July that National sent over a team of specialists to take a closer look at the company's operations. Even then several National executives played down the company's intentions.

But just before the deadline for submitting bids, National reportedly offered to pay $US122 million for Fairchild's logic and linear divisions, which accounts for 60% of the company's business.

Schlumberger, however, was not interested in selling just part of the organisation. Reportedly, Schlumberger ended up giving the entire Fairchild organisation to National for essentially the same price.

Even more surprising is that in selling to National, Schlumberger by-passed the Brooks-Citicorp offer, which was actually considerably higher than National's offer.

But National's offer was in the form of about 12 million shares of stock,

Fairchild

while the Brooks deal was based mostly on cash and primisary notes. Schlumberger presumably felt the sale to National was less risky. And if National would turn the Fairchild operations around and its stock were to increase in price, it could conceivably increase the value of the sale price.

The decision undoubtedly dealt a hard blow to Brooks and his management team, who reportedly were stunned when they learned about the sale to National. It is unlikely Brooks and some of his closest allies will want to go to work for National. By the same token, it is unlikely National would accept a group of executives who may have bitter feelings about losing the opportunity to own their own company.

While National is nominally paying only $US122 million in stock, it will acquire assets, such as plants and equipment, that are valued at between $US600 million and $US1 billion.

One of the major acquisitions, for example is Fairchild's state-of-the-art research facility in Palo Alto and its many top semiconductor engineering staff. At the facility, engineers are involved in some of the most far-reaching applications of semiconductor technology. One group is reportedly involved in exotic speech recognition research, while another group focuses on advanced digital signal processing. Previously, the Palo Alto group built Fairchild's very fast 32-bit Clipper microprocessor.

Besides the technological know-how, the purchase will significantly strengthen National's position in a number of key product areas, including:

LOGIC DEVICES: Fairchild, with Fujitsu, is the leading supplier of super-fast ECL components used in high-performance mini, mainframe and supercomputers. One of the reasons the Reagan Administration blocked the sale to Fujitsu reportedly centered on Fairchild's role as a key supplier to the supercomputer industry and its development of advanced new ECL devices critical to "Star Wars" and other advanced military computer projects. National will inherit this growing business, at a time of rapid expansion of the high-performance and supercomputer markets.

MILITARY SEMICONDUCTORS: A key part of Fairchild's business (30% of sales) during the past several years, has been its sales to the defence industry. Combined with its own sizeable Phoenix-based defense operations, National will become the leading supplier of defence-related semiconductors.

ANALOG AND DIGITAL DEVICES: While Fairchild's analog and digital product groups may have been responsible for some of the colossal losses the company has suffered during the past couple of years, analysts consider the acquisition a plus for National. Fairchild's product lines will nicely complement National's own offerings, and the firm's production facilities will add additional muscle to National's output capacity.

National may soon return these operations to profitability if the market for these products continues to recover, and by streamlining operations through lay-offs and other cost-cutting measures.

CUSTOM ICs: Fairchild has invested heavily in its custom IC operations. Among other things, the state-of-the-art gate array facility uses an exotic DEC-VAX-based E-beam lithography system from Cambridge Systems, that takes gate-array design data directly from a Cray supercomputer to write the circuit patterns directly onto the wafer.

MICROPROCESSORS: Following the acquisition, National will be in a unique position of carrying two state-of-the-art 32-bit microprocessors product lines. In addition to its NS-3200 line of products, National will own Fairchild's Clipper processor line.

It is not known whether National wants to carry two lines of 32-bit processors. A company spokeswoman said it is still too early to tell what National will do with the Clipper. Some industry observers speculated National may sell it.

Earlier, National officials said National may indeed sell off one or more Fairchild groups which don't fit very well into the National organisation. But it will be some time before those decisions will be made.

DISTRIBUTION CHANNELS: Fairchild has one of the most extensive marketing and distribution organisations in the industry. The fear that Fujitsu would use these channels to further its presence in the US was another reason behind the opposition to the proposed sale to the Japanese giant.

While all of these advantages would make the $US122 million purchase price seem unbelievably low, National is also inheriting some big problems. For one, Fairchild has been losing money for years. Lots of money! In 1986, the company lost $US93 million on sales of $US488 million. This year, Schlumberger had set aside some $US70 million to cover the anticipated losses in its chip operation.

National, however, may have more luck with Fairchild than Schlumberger, which has lost close to $US2 billion on Fairchild, including investments in facilities, R&D, operational losses and the $US456 million it paid for the company in 1979.

On the bright side, National will not inherit several of the sources that accounted for a major portion of Fairchild's losses, including two under utilised plants in Japan and Germany. Also, Schlumberger will keep the idled MOS plant in South San Jose, where chemicals leaking from storage tanks polluted the drinking water of a nearby neighbourhood in 1981. Residents believe the pollutants were responsible for the unusual high rate of miscarriages, still-births and birth defects in the area. Fairchild recently settled a huge lawsuit with the residents.

National, in particular Sporck, has a reputation of running an efficient operation. National will try to cut Fairchild's operational expenses through consolidation. In areas such as administration and marketing, major lay-offs are expected as many positions duplicate those within the National organisation. National, however, will have the luxury of keeping the best of Fairchild's management, marketing and engineering staff and letting the rest of these often highly paid employees go.

This is not the first time National has acquired a severely distressed organisation and turned it around. In the late seventies, National acquired what was left of the ill-fated Itel company, which leased IBM-compatible mainframe computers supplied by National. Despite the historically poor record of semiconductor companies in trying to branch out into the systems business, National was able to return the Itel group, now known as National Advanced Systems, to profitability in two years. Since then, NAS has grown steadily and currently accounts for as much as half of National's annual sales — and virtually all of its profits since 1984, when the chip industry went into its recession.

Because Fairchild is a semiconductor firm, National's own bread-'n-butter business, analysts believe it may be even more successful putting the Fairchild assets to work.

Wall Street apparently thinks so too. On Tuesday, September 1, National's stock rose to $US16.50 on the same day the New York Stock Exchange suffered one of its largest one-day losses in history.

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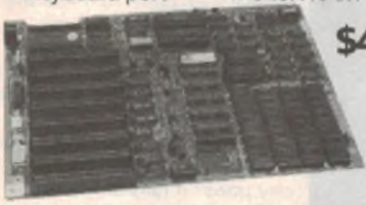

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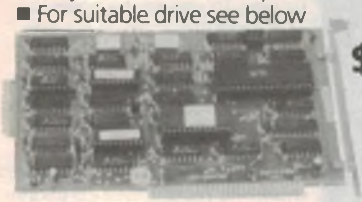

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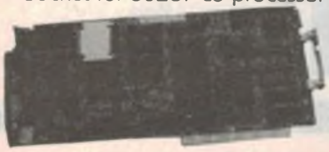

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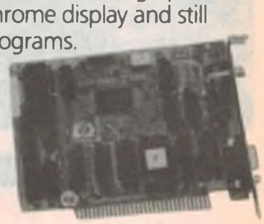

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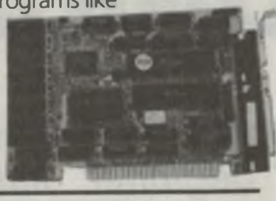

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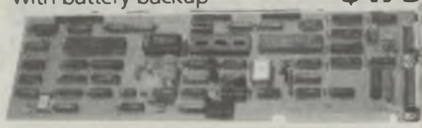

I/O Plus Card

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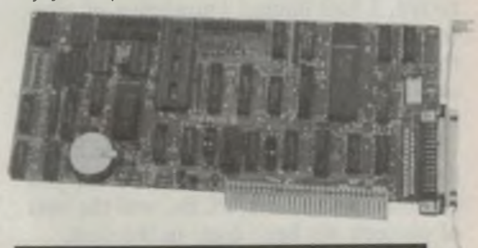

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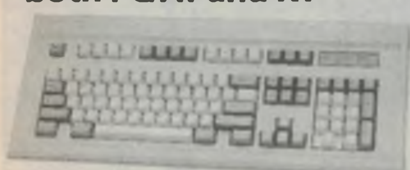

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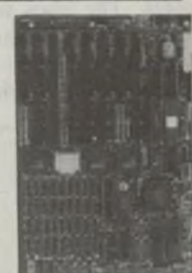

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A first-hand user's report on

FUNWAY INTO ELECTRONICS

How much can a newcomer to electronics learn from one of those "beginner" kits? EA's secretary decided she'd like to find out, and here's what she found . . .

by NAOMI LENTHEN

When I first started working in the offices of *Electronics Australia* as a secretary, I had limited knowledge of electronics. In fact, my only experience in this field was soldering together modules for an electronic organ kit that my father was building.

Since then, I have learnt a little bit to do with electronics. Mainly, where you can buy certain kits, PCBs, and the sort of projects we have done in the past.

When I was approached with the idea to try evaluating beginner electronics kits, I decided the best place to start would be with the Funway series by Dick Smith Electronics. DSE claims that the Funway kits would start anyone from the age of 8 to 80 on the road to becoming an electronics professional, so I decided to try them out.

Armed with the Funway Into Electronics Gift Box 1,2 & 3, a screwdriver and loads of enthusiasm, I embarked on a journey I would not forget.

Book 1 promises "Hours of fun and excitement", "No soldering required" and was apparently written by the man himself, Dick Smith. The book opens up with an introduction by the author and then a list of what you will need to get started. With the Gift Box, all of this is provided.

The next few pages are dedicated to what components you will use and what they actually do. This was quite informative, as I had no idea what capacitors or resistors actually did. This section is written in a friendly way and in a form that beginners should understand. There is no talking down to you. Some parts were a trifle hard to comprehend, but with a few forbidden questions to the engineers on hand, the new topic was soon clarified. (There have to be some advantages in working at EA!) A chart on component marking codes is also included.

Now I was ready to do some actual making of circuits. Project number one is a continuity tester. In the kit packs, you are provided with a baseboard with holes into which you screw down the screws which hold and connect components. The back of the book gives you paper grids to place on the baseboard, so that you know where to put what. I found that the grids are slightly out of line with the baseboard, which causes minor annoyance as you have to blind feel where the screws go.

A step-by-step guide to building the circuit is given, and it's quite easy to follow. Unfortunately, even though I followed the instructions to the letter, my first attempt at this project failed. After much laughter from the engineers, I spent a while trying to find out what went wrong. I screwed and unscrewed the components and checked them. Then I decided that the guys must have given me a flat battery (as a battery is not included), so I tried another. No joy! Eventually I found out that I had put the LED in the wrong way around. Success at last! It worked and my LED shone brightly.

The book then explains how the indicator works and for what uses it is designed. There are also several experiments you can do with it.

Buoyed on by my first success, I de-

At my desk — learning electronics the Funway!

cided that the next few projects — a transistor tester, a water indicator and things of the like — were too easy. Project six was for me: an Electronic Siren!

After carefully applying all the necessary components, it worked first go, much to the astonishment of everyone in the office. Although it was a sick sounding siren, I have to admit. (I think the battery was getting a little flat by this time . . .)

The process of building these kits is a little tedious. You end up with the screwdriver embedded in the palm of your hand, constantly screwing the little screws in and out. After winding transistor leads and wire links around the screws, when the time comes to take the project apart so you can build the next one, the ends of the components are twisted and in a sorry state. Just trying to unwind them is a skill in itself. I broke the end off a diode before long — this is one of the bits that is used in virtually all the projects.

Setting up for the Morse Code Communicator, I found that you are not provided with the Morse key. These can be bought from Dick Smith Electronics for an extra $2. A bit irritating — although you can make do by just touching the two wires together, if you wish.

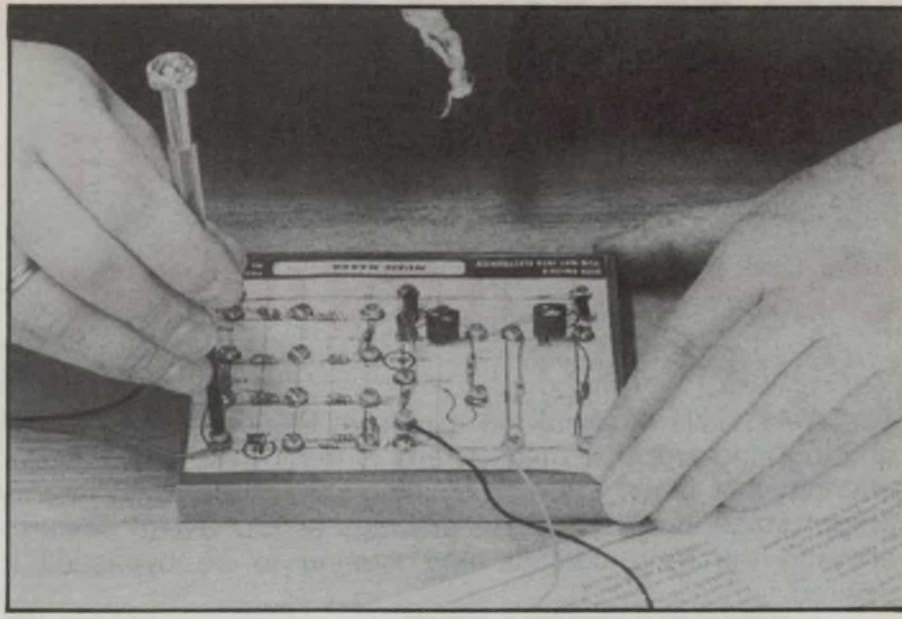
I decided to give that project a miss, and embarked instead on the Music Maker. Building this I found that two transistors that were said to be included actually weren't. I found the transistor I needed in our laboratory, and completed the project. Again, success on my first go. The strains of "Twinkle Twinkle Little Star" filled the air.

After just three projects, I find that I can read basic circuit diagrams, know what most components do and how they work. The engineers here had better watch out, their jobs are on the line!

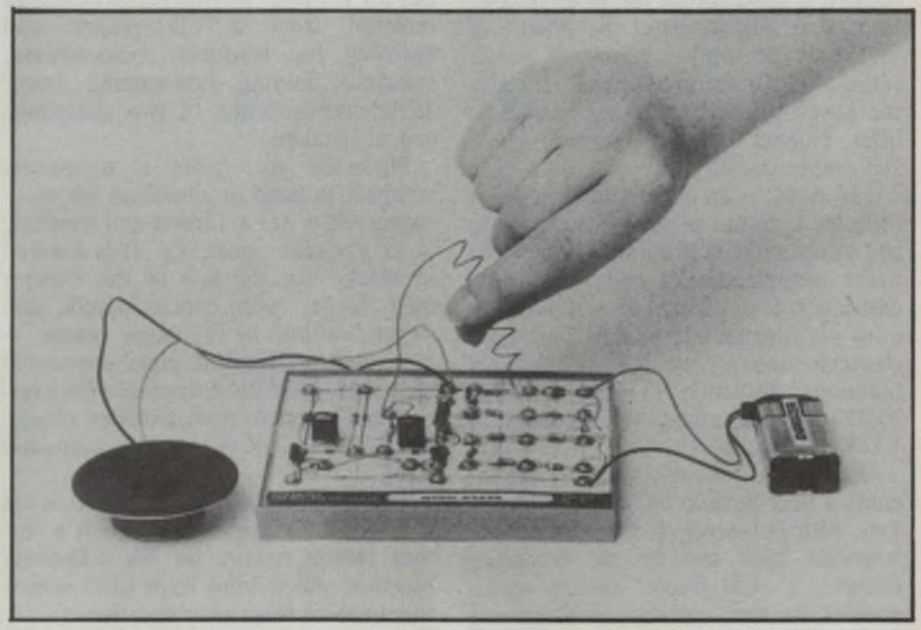
Projects 11-20 are a little more complex and I found that you need one or two more baseboards. The projects are radio receivers, CB receivers and transistor amplifiers. The book explains how a radio receiver works and how an amplifier works. It is written extremely well, and I now know the basics.

Overall I found the Funway Into Electronics Series 1 to be a very useful exercise. Despite minor annoyances with having to buy extra bits and pieces, the kits are very easy to follow, and a great aid in the learning of basic electronics.

Next month I shall attempt Funway 2 and 3. Soldering is my forte, but will my projects work?



Screwing the second last lead into the baseboard for the Music Maker project.



The finished Music Maker — music fills the air!

Funway kits: what, where & how much

There are several ways you can buy the Funway kit series. They are:
Books 1, 2 and 3 separately $4.95 — $6.95 Cat B-2600
Projects 1-10 of Funway One $8.95 Cat K-2600
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Projects for Funway Two and Three separately. Prices range from $3.85 to $18.65
Funway One Gift Box $24.50 Cat K-2605
Funway Two Gift Pack $26.95 Cat K-2620
Funway Three Bonus Pack $29.95 Cat K-2670
Funway 1,2&3 Gift Box $59.95 Cat K-2680
Jumbo Gift Box $99.95 Cat K-2690

All kits are available from Dick Smith Electronics stores and dealers throughout Australia and New Zealand.

HIFI PRODUCT REVIEW:

Pioneer's A-441 stereo amplifier

The A-441 falls in about the middle of Pioneer's latest range of integrated amplifier models, and is the lowest-priced model offering the firm's "non-switching" low distortion class-AB output stage circuitry. It also provides a "CD direct" feature, allowing the tone controls and filtering to be bypassed if desired.

In many ways the new Pioneer A-441 seemed a good choice for us to review, because it falls in about the middle of the range not only in terms of power rating, but for features as well. It's also the lowest-priced of the new models to offer Pioneer's lower distortion class-AB output circuitry.

The A-441 is an integrated amp which includes a phono preamp switchable to suit either moving magnet (MM) or the lower output moving coil (MC) type cartridges. It is rated at 58 watts continuous per channel into 8 ohms, with both channels driven and for .008% total harmonic distortion (THD). For 1% THD into 4-ohm loads this increases to 100W per channel.

Operational features of the A-441 include a very flexible input selection system, with independent selectors for the amplifier itself and for the recording outputs; a "CD direct" switch, which enables the tone controls, all filters and even the balance controls to be switched out for the most faithful reproduction of material from a CD player; and switches for loudness compensation, subsonic filtering (attenuating below 15Hz) and selection of two alternative sets of speakers.

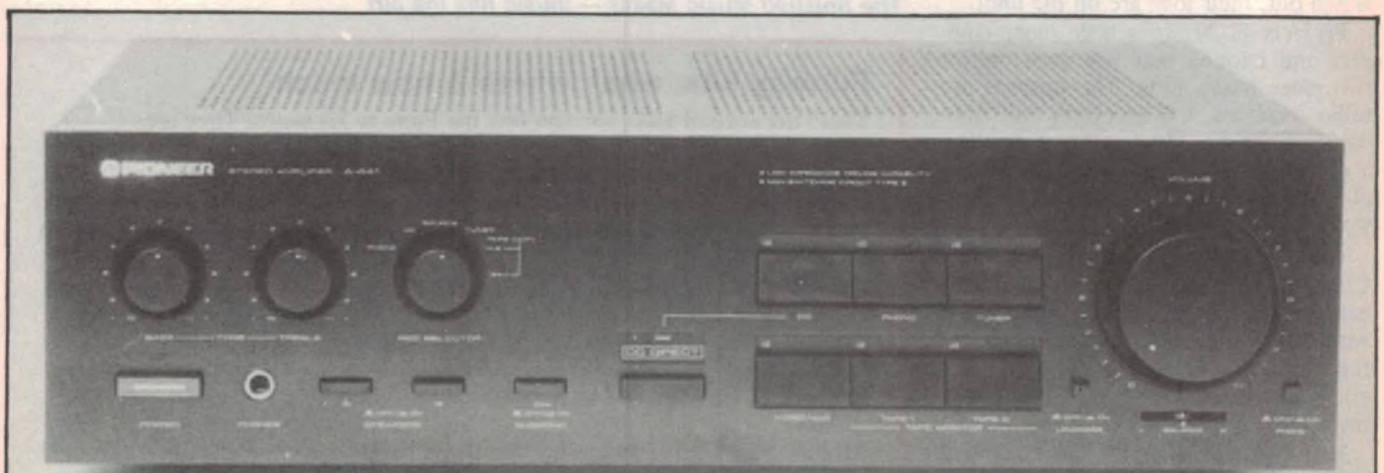
Physically the A-441 is reasonably compact as modern amplifiers go, measuring 420 x 317 x 122mm and weighing in at a whisker over 8kg. It is finished in black, like the rest of the Pioneer amp range, with control knobs and switch buttons in the same colour — quite stylish. The front panel appears to be a light anodised extrusion with internal reinforcement from moulded plastic, while the rest of the case is lacquered steel.

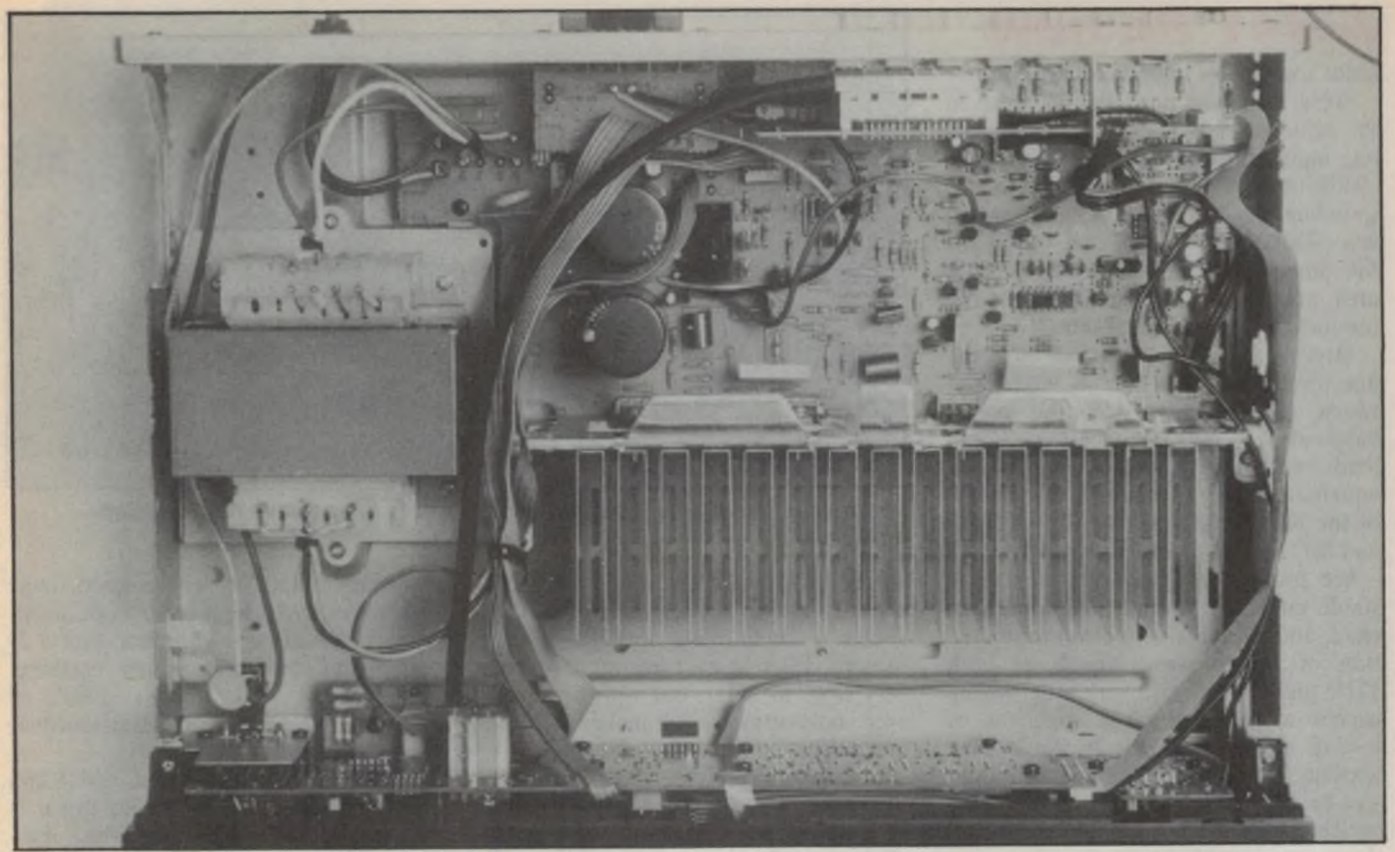
The main input signal selection is via a bank of six pushbuttons, with a further button nearby for the CD-direct function. All buttons have LED indicators to show when they're active.

Inside the case, Pioneer's traditional emphasis on manufacturing efficiency is still very much in evidence. Most of the active circuitry is laid out on the main horizontal PCB, which is rivetted at one end to the power transformer's mounting plate. The two thus form a drop-in module, which should also be relatively easy to remove for servicing (although a removeable plate in the bottom of the case should make that largely unnecessary). The power transformer is of a fairly generous size, and fitted with both a copper shorting strap around the windings and a steel strap around the laminations to minimise leakage flux. The main reservoir capacitors are quite modest in value, with a single 10,000uF for each rail.

The heatsink radiator for the output transistors is of the fabricated type, with a main plate from heavy gauge aluminium (about 3.5mm) to which are rivetted a series of long U-shaped fins. These appear to be of aluminium also, but as you can see from the picture, of rather thinner gauge (about 0.5mm). The complete assembly is mounted vertically across the centre of the case, with plenty of ventilation slots below and above in the case bottom and lid.

As usual, the input signals enter via a





Inside the A441. Note the low-leakage flux power transformer.

bank of RCA connectors on the rear panel. Most of these are taken immediately to a small vertical PCB immediately behind the connectors, and this board also handles the signal selection for the tape recording outputs. The sliding switch which performs the selection is driven via a neat mechanical "cable" from the mechanism behind the front-panel selector knob.

The input signals from the rear PCB are also taken via a ribbon cable and ID connectors to a further PCB mounted vertically behind the front panel, which caters for the main input selection, tone control and subsonic filter circuitry.

The only exceptions to this general signal flow are the magnetic phono inputs, whose input connectors are mounted directly on the rear of the main power amp PCB. These pass straight to their preamp, on this board, and with MM/MC switching controlled via a slider switch operated from the front panel via a long plastic button/-actuator rod. The preamp outputs then pass to the rear vertical PCB and then via the ribbon cable to the front board.

There are other small PCBs for the volume, balance controls and loudness switch; the speaker switching and headphone socket; and the speaker connectors proper at the rear. Overall a very neat and tidy arrangement, and one that should make servicing very easy when or if it is ever needed.

There were only two small surprises, one being the location of the phono preamp on the main power amp PCB. One would think this might make it a little harder to achieve the best possible hum and signal to noise performance.

The other thing that raised our eyebrows was the lack of mains earthing. The A-441 sent for review was fitted with only a 2-pin mains cord, which seems rather odd in view of the fact that good audio practice is to use the amplifier as the earth reference for the rest of the system. The amp is fitted with a screw terminal on the rear panel, to allow connection to its chassis, but in the absence of a mains earth connection inside this seems a little fatuous. We'd be much happier if the mains cord was changed to a 3-wire type, to earth the amp chassis properly.

In our tests the A-441 stood up very well. Power output easily exceeded the specs: for continuous rating with both channels driven it delivered just on 74 watts per channel into 8-ohm loads before clipping, and 122W per channel into 4-ohm loads.

For 60W per channel into 8-ohm loads the THD was only .006%, comfortably lower than the rated figure and very commendable. This was using the "CD direct" mode, by the way; we found the tone control circuitry tended to introduce a small amount of residual hum, which brought the same figure up to .012% (still very good, of course). The corresponding THD figure for 100W per channel into 4-ohm loads was .025%.

The EIA/IHF dynamic headroom test gave figures of 90W per channel into 8-ohm loads, and 145W per channel into 4-ohm loads — both figures again better than the specs, and showing that the A-441 has a good measure of extra "grunt" for music peaks.

Pioneer doesn't quote a figure for intermodulation distortion, but using the 7kHz/50Hz test with 4:1 ratio we found only .006% at 60W/channel into 8-ohm loads and .008% at 90W/channel into 4-ohm loads — very good indeed.

Input sensitivity for the line inputs was measured at 135mV for 60W output. Phono sensitivity at 1kHz in MM mode was 2mV for the same output, with 160mV allowable before preamp overload; the corresponding figures for MC mode being 180uV and 13mV respectively. These are again very good.

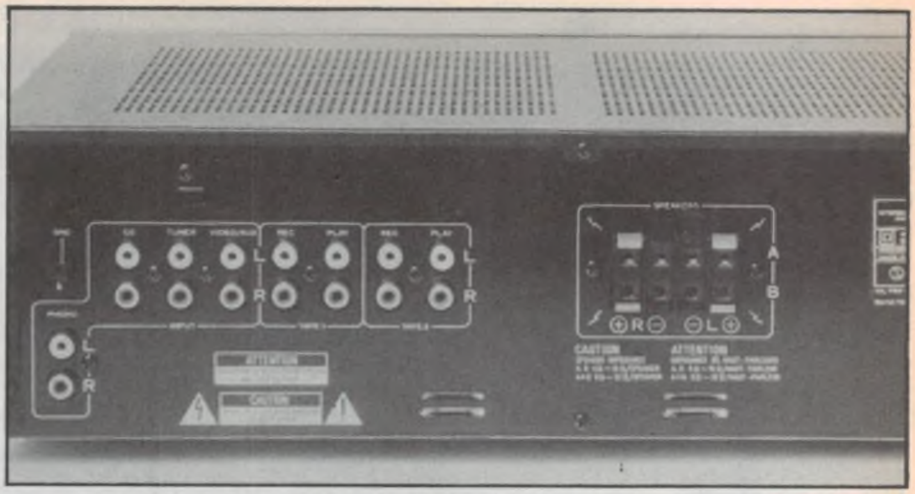
Crosstalk between channels was –67dB at 1kHz, –73dB at 100Hz and –48dB at 10kHz, all referred to 150mV line input for 60W output. These are quite acceptable, but not exceptional.

Signal to noise ratio figures were in the same category, with –85dB for the line inputs through the tone controls or –94dB in "CD direct" mode. The corresponding figures for the phono inputs was –75dB in MM mode and –64dB for MC mode. These are all unweighted figures, and apart from the CD direct figure include some residual hum.

Overall frequency response for the line level inputs was 5Hz — 90kHz between –3dB points, with the power bandwidth at 60W/channel into 8-ohm loads virtually identical. The phono equalisation was within less than 0.5dB of the RIAA characteristic in both MM and MC modes, again quite good.

We found the amplifier to be quite stable under all normal load conditions tried, and it gave a very clean reproduction of square wave signals at both 1kHz and 10kHz, with very little ringing except when we tried a capacitor of 0.47uF across the load. It would then oscillate, if you turned the treble control to full boost with the volume fully anticlockwise. This is really only of academic interest, of course.

The bass control had a range of



The rear of the A-441. It provides for two sets of speakers, and two tape decks.

+8dB/-11dB at 100Hz, while the treble control range was +12dB/-12dB at 10kHz — both quite reasonable. The subsonic filter had a turnover frequency very close to 15Hz, but with a slope of only –6dB/octave which makes it of limited value.

In listening tests, the A-441 gave very clean and uncoloured reproduction of all program material we tried — particularly in CD direct mode. All in all, then, we find it a very well designed and made amplifier, with a good range of features and a high order of performance. It would be even better with a 3-wire mains cord and proper earthing. Certainly at the quoted RRP of $569.00, it seems to us to offer excellent value for money.

Further information on the A-441 and other products in the Pioneer range is available from Pioneer Electronics Australia, which has offices in both Sydney and Melbourne. (J.R. and R.E.)

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7815KC	1.50	1.40	1.20
7818uC	.50	.48	.48
7818KC	1.50	1.40	1.20
78L05	0.39	0.35	0.33
78L12	0.39	0.35	0.33
7905uC	.70	.60	.55
7912uC	.70	.60	.55
uA323KC	4.50	3.90	3.75

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PN3563	0.18	0.16	PN3565	0.12	0.11
PN3566	0.15	0.13	PN3567	0.10	0.08
PN3569	0.18	0.16	PN3639	0.18	0.16
PN3640	0.18	0.16	PN3641	0.11	0.09
PN3642	0.11	0.09	PN3643	0.11	0.09
PN3644	0.15	0.13	PN3645	0.15	0.13
PN4250A	0.15	0.13	PN4355	0.18	0.16
PN4356	0.19	0.17	MPSA42	0.20	0.15
MPSA43	0.11	0.09	MPSA55	0.18	0.17
MPSA56	0.19	0.16	MPSA92	0.12	0.11
MPSA93	0.14	0.12	2SD350	3.90	3.75
BC327	0.11	0.10	BC328	0.11	0.10
BC337	0.11	0.10	BC338	0.11	0.10
BC547	0.10	0.09	BC548	0.10	0.09
BC549	0.10	0.09	BC557	0.10	0.09
BC558	0.10	0.09	BC559	0.10	0.09
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Plus 30% tax where applicable

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Cat.No.	Descript.	1-9	10+	100+
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Q10505	MU45 0-50uA	8.50	7.95	7.75
Q10510	MU45 0-5A	8.50	7.95	7.75
Q10518	MU45 0-1A	8.50	7.95	7.75
Q10520	MU45 0-20V	8.50	7.95	7.75
Q10535	MU45 VU	9.50	8.95	8.75
Q10530	MU52E 0-1mA	9.95	8.35	
Q10533	MU52E 0-5mA	9.95	8.35	
Q10538	MU65 0-50uA	12.50	11.35	10.90
Q10540	MU65 0-1mA	12.50	11.35	10.90
Q10550	MU65 0-100uA	12.50	11.35	10.90
Q10560	MU65 0-20v	12.50	11.35	10.90

Plus 20% tax where applicable

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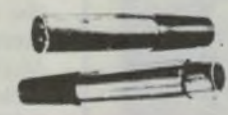
Cat.No. & Desc.	1-99	100+	1000+
M12851 2851 240V 12-6V CT 150mA	3.50	3.30	2.90
M12155 2155 240V 6-15V 1A tapped	6.00	5.75	5.50
M12156 2156 240V 6-15V 2A tapped	9.00	8.75	8.50
M12840 2840 240V to 9V C.T. at 150mA	3.50	3.30	3.10
M12860 2860 240V to 15V C.T. at 250mA	3.50	3.30	3.10
M16672 6672 240V 15-30V 1A tapped	8.95	8.75	8.40

Plus 20% tax where applicable



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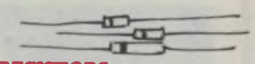

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2764	$6.60	$6.20	$6.50	$6.00
27128	$7.50	$7.00	$8.50	$8.00
27256	$9.50	$9.00	$15.00	$14.00
27512	$17.00	$16.00	$1.65	$1.60
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41256	$5.95	$5.50	$2.20	$2.00
6116P-3	$3.00	$2.90	$4.75	$4.50
6264	$5.50	$5.00	$1.20	$1.15
SM141D	$1.50	$1.30	$1.80	$1.75
LM3914	$2.00	$1.90	$1.80	$1.75
LM3912	$2.00	$1.90		

Plus 20% tax where applicable

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12 months warranty!

1-9	10+	100+
$145	$135	$125

Plus 20% tax where applicable
*(*IBM is a registered trademark)*

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- 20 M/Byte
- Tandon hard disk
- Hard disk controller by DTC

Cat. X20010 .... $600
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1-9	10-24	25+
$165	$150	$135

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*(*Apple is a registered trademark)*

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Cat. No.	10+ boxes	100+ boxes
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GREY FLAT RIBBON CABLE IN 100 FOOT ROLLS

Cat.No.	Desc	1-3	4-9	10-99	100+
W12614	14 Way	19.50	18.50	18.00	14.00
W12616	16 Way	21.50	19.50	19.00	16.00
W12620	20 Way	29.50	28.00	26.50	20.00
W12625	25 Way	32.50	29.00	28.50	25.00
W12626	26 Way	34.00	32.00	29.00	26.00
W12634	34 Way	44.00	42.00	39.00	34.00
W12636	36 Way	49.00	47.00	42.50	36.00
W12640	40 Way	55.00	52.50	49.50	40.00
W12650	50 Way	62.00	59.50	58.50	50.00

LARGER QUANTITIES NEGOTIABLE!
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1-9	10+	100+	300+
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Both 0.1 inch and 0.2 inch spacing available!

10+	100+	1000+
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Unbelievable Value!

Cat.No./Desc.	10-99	100+	1,000+
S11010 (SPDT)	0.85	0.78	0.65
S11020 (DPDT)	0.95	0.88	0.80
S11034 (4PDT)	2.95	2.85	2.75

Plus 20% Sales Tax where applicable

19" RACK MOUNT CASE

Tremendous value! Vented top panel.
Dimensions: 480(W) x 134(H) x 250(D)mm.

1-9	10+
$32.00	$29.50

Plus 20% tax where applicable

75 OHM COAX CABLE IN 100M ROLLS

Cat No.	Descript.	1-4	5+	10+
W11222	3C2V	25.00	24.00	23.00
W11224	5C2V	30.00	29.00	28.00

(5C2V WHITE OR BLACK)
LINE LOSS PER 100 FEET (33M 200MHz)
W11222 3C2V 6.2dB (Approx.)
W11224 5C2V 3.9dB (Approx.)
Plus 20% tax where applicable

TELEPHONE CABLE (200 METRE ROLLS)

Cat.No.	Description	1-9	10+
W11302	2 Pair	$24.00	$22.00
W11303	3 Pair	$29.00	$27.00
W11310	10 Pair	$120.00	$115.00

Per 200m Roll
20% Sales tax where applicable

DIODES

Cat No.	Descript.	10-	100+	1000+	10K
Z10135	IN4148	0.03	0.02	0.015	.015
Z10105	IN4002	0.04	0.03	0.03	.025
Z10107	IN4004	0.05	0.04	0.03	.025
Z10110	IN4007	0.10	0.06	0.05	0.04
Z10115	IN5404	0.18	0.14	0.09	0.08
Z10119	IN5408	0.20	0.16	0.10	0.09

Plus 20% tax where applicable

IDC SOCKETS

Cat.No.	Description	1-9	10+	100+
P12100	10 Pin	1.95	1.75	1.25
P12101	16 Pin	2.25	2.05	1.65
P12102	20 Pin	2.45	2.25	1.90
P12104	26 Pin	2.65	2.45	2.00
P12106	34 Pin	2.75	2.55	2.15
P12108	40 Pin	2.95	2.75	2.25
P12110	50 Pin	3.50	2.95	2.50

Plus 20% Sales Tax where applicable

LOW PROFILE IC SOCKETS

Desc.	10+	100+	1000+	10K
8 Pin	0.08	0.07	0.06	0.05
14 Pin	0.10	0.09	0.08	0.07
16 Pin	0.11	0.10	0.09	0.08
18 Pin	0.12	0.11	0.10	0.09
20 Pin	0.13	0.12	0.11	0.10
22 Pin	0.14	0.13	0.12	0.11
24 Pin	0.15	0.14	0.13	0.12
28 Pin	0.19	0.17	0.15	0.14
40 Pin	0.25	0.24	0.22	0.20

Plus 20% tax where applicable

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Cat.No.	Descript.	1-9	10+	100+
T12461	240V 4 1/2"	11.00	10.00	9.00
T12465	240V 3 1/2"	11.00	10.00	9.50
T12463	115V 4 1/2"	11.00	10.00	9.00
T12467	115V 3 1/2"	11.00	10.00	9.50

(Fan guards to suit also available)
Plus 20% tax where applicable

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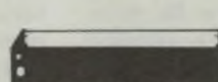
Description/Cat.No.		1-9	10+
1.2 AH	S15029	$13.50	$12.95
2.6 AH	S15031	$19.50	$18.00
4.5 AH	S15033	$29.50	$27.50

Plus 20% tax where applicable



PRINTER RIBBONS

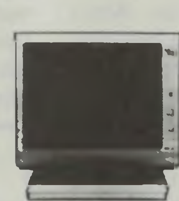
To suit CP80, BX80, DP80 etc

Cat.No.	3+	25+	100+
C22036	9.00	8.00	7.50

To suit MX80

Cat.No.	3+	25+	100+
C22031	7.60	7.10	7.00

Plus 20% tax where applicable



RITRON II MONITORS

Swivel base monitor in stylish case.

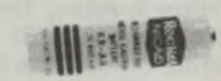
Desc/Cat.No.	1-9	10+	50+
Green Cat. X14506	$145	$135	$130
Amber Cat. X14508	$145	$135	$130

Plus 20% tax where applicable

SAMSUNG TTL MONITORS

Cat No.	Desc.	1-3	4+
X14500	Green	$130	$125
X14502	Amber	$135	$130

Plus 20% tax where applicable



NICADS

Cat No.	Description	1-99	100+	250+
S15020	AA .5AH	$2.20	$2.00	$1.95
S15021	C 1.2AH	$6.75	$6.50	$6.20
S15022	D 1.2AH	$7.55	$7.25	$6.90

Plus 20% tax where applicable

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Have a look at these prices!
These are 100% certified, prime spec. disks in labelled jackets.
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Description Cat.No.	1-9 boxes	10+ boxes	100+ boxes
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Attention schools, clubs, software houses etc! These are 100% certified, prime spec. D/S D/D disks with a 5 year warranty and made by a leading manufacturer, only without labels or brand names! But have a look at the price! Sensational value to say the least!

Descript	10+	100+	1,000+	10,000+
D/S D/D	$1.00	$0.90	$0.75	$0.70

Plus 20% tax where applicable

FREE sample disk available on request! (Please send $2 to cover postage)

FREE 58 PAGE WHOLESALE PRICE LIST!
Simply supply a Business Card!

Compact Disc Reviews

by RON COOPER

BRAHMS SYMPHONY No.4

Sir Georg Solti
Chicago Symphony Orchestra
Decca 414-563-2 AAD
Playing Time: 42 min 20 sec

PERFORMANCE
1 2 3 4 5 6 7 8 9 10

SOUND QUALITY
1 2 3 4 5 6 7 8 9 10

This very majestic fourth symphony of Brahms was composed over 1884-85 and is a more solemn work than its predecessors. Probably because of this it was initially not as popular as his previous ones — yet this work is certainly just as magnificent, but in a more austere way. So magnificent to me anyway, that during serious listening to the slow second movement on this recording it was apt to create watery eyes with its deep profundity.

Brahms is a composer who slowly grows on you and keeps growing; very complex, often slow but not boring. This work is the only one of his symphonies to have a scherzo and the only movement to use a triangle — and very tastefully done. Though for those just venturing into Brahms symphonies, I would suggest you start with No.1 or No.3 (see previous reviews).

As to this recording, I can say that like my previous reviews on Decca, it is the finest I have heard to date. It also just happens to be an analog one made in 1978, although this doesn't matter here as everything seems just right. The hiss level is so low that you have to listen carefully in the quiet passages to hear it. The most impressive effect though is on full orchestral crescendos where at natural room volume (loud) the strings are not overpowered by the recording hall acoustics. Obviously the Medinach Temple in Chicago where all these symphonies were recorded must have brilliant acoustics and they are certainly exemplified by this excellent team of Solti/Chicago S.O. and Decca. The only criticism is that it's a bit short as a CD with under 43 minutes of recording.

MOZART PIANO CONCERTOS

No.23 and 27
Vladimir Ashkenazy
Philharmonia Orchestra
Decca 400 087-2 DDD
Playing Time: 59 min 38 sec

PERFORMANCE
1 2 3 4 5 6 7 8 9 10

SOUND QUALITY
1 2 3 4 5 6 7 8 9 10

Mozart's concerto No.23 in A major was written during 1786 when he also "brushed off" the opera "The Marriage of Figaro". With most of the concertos since the large 1784 group, Mozart had broken with the procedures of that group by devising an opening theme unsuitable, as it stood, for the soloist to present on his own entry, here he reverts to the earlier scheme.

The No.27, K595 work was completed around the beginning of 1791, three years after the preceding one and both the works presented here are well-known with the 3rd movement of the number 27 — Rondo, being a particular favourite of mine. I would recommend these works for anyone wanting to add Mozart concertos to their collection, if they are a little hesitant as to which ones.

This all-digital recording by Ashkenazy as pianist and director is just magnificent. Here again, Decca have got it right with a perfect balance between soloist and orchestra. Acoustics are bright and do true justice to the music. I was aware of a slight hardness to the string sound on soft passages, but it is easily forgiven and for nearly a full hour of Mozart represents excellent value.

A FESTIVAL OF CAROLS

The Choir of Westminister Cathedral
The Alexandra Choir
The Cantorum Choir
Fanfare Trumpeters of the Royal Military School of Music
IMP PCD 843
Playing Time: 67 min 20 sec

PERFORMANCE
1 2 3 4 5 6 7 8 9 10

SOUND QUALITY
1 2 3 4 5 6 7 8 9 10

Here is a delightful disc of traditional carols played traditionally and recorded in Westminster Cathedral — which all makes for a near perfect sound for this music.

All the arrangements are of celebrated and popular Christmas hymns and carols, beginning with the grand fanfare into John Wade's "O Come All Ye Faithful". Like John Neale, the Rev. George Woodward translated many early carols and the famous "Ding, Dong Merrily on High" is a setting by Charles Wood (1866 — 1926) of a joyful 16th-century French dance tune. After the traditional "I Saw Three

MEDIEVAL CHRISTMAS

Pro Cantione Antiqua & Medieval Wind Ensemble
IMP PCD 844
Playing Time: 55 min 40 sec

PERFORMANCE
1 2 3 4 5 6 7 8 9 10

SOUND QUALITY
1 2 3 4 5 6 7 8 9 10

Here is another excellent disc on this $19.99 price label, brilliantly performed and recorded with perfect balance. If you are unfamiliar with medieval Christmas music you may not find the music as familiar as the previous IMP disc, because the works are obviously not in the same well-known category.

The Christmas music heard here is drawn from one of the most interesting periods in Western musical history, the development of polyphony to the edge of the Renaissance. The oral monophonic tradition that persisted in Eastern cultures, was revolutionised in Europe by the invention of notation, so that hitherto accidental harmonies and rhythms could be reproduced again and again.

Organum, the earliest type of polyphony, was a liturgical plainsong tenor

(from tenere to hold out) with one or more contrapuntal parts added, at the 4th 5th or octave. These intervals were regarded as consonant, not only to medieval taste but to medieval acoustic order, and always came on strong beats; the so-called dissonances 3rd, 6th, 2nd and 7th falling between where they might. A hangover from the apparent harshness of free organum can be heard here in the jovial Verbum Patris and Orientis Partiubs. The robust cheerfulness of the latter is further enlivened by the singers' portamento, imitating the ass's bray in its refrain.

If you are interested in this music this disc is certainly for you as it is a first class performance with top sound. EA

Ships" comes the specially evocative "Silent Night". Written by parish priest, Mohr and local organist Franz Gruber, in the Austrian Village of Hallein for Christmas of 1818 when the organ was unavailable, it is a simple and touching portrayal of a still, starlit night. It has survived much sentimentalising.

The composer of the Victorian hymn "Once in Royal David's City" was a London lawyer and organist, John Gauntlett (1805-76), and the arranger of "In Dulci Jubilo", Robert de Pearsall (1795 — 1856) was also a lawyer and composer.

The balance and overall sound of this disc played on good equipment does what I believe it should. It transforms you aurally to a 10th-row seat in this magnificent cathedral, with its naturally very long reverberation time (4-5 seconds) and with a near perfect balance of choir, organ and soloists.

Regardless of price this disc would be a must for all year as well as this time. At $19.99 and with over 67 numbers, it has to be superb value.

FORUM

Conducted by Jim Rowe

NiCad batteries: the universal panacea?

When a reader complained in the September issue about an advertisement for Nickel-Cadmium rechargeable cells, we suggested in fairness that the advertiser concerned might care to comment. We also asked for an impartial opinion from Union Carbide Australia. In some ways, we got more than we bargained for . . .

But first, a few words of explanation. As you've no doubt noticed already, there's a different picture and by-line now at the head of the Forum column. Sadly for us my long-time colleague and former boss Neville Williams, who has conducted the column ever since it started, has advised that he can no longer continue with it due to other demands on his time. Although he officially retired about five years ago, he seems to be getting busier rather than easing off . . .

The column is a popular one, no doubt because it provides a place where controversial topics can be aired and reader opinions discussed at greater length than in the Letters to the Editor section. Obviously it should continue, so I've decided to conduct it myself, at least for the time being. I hope you'll find me an acceptable substitute.

Before I do start, I'd like to pay a tribute to the very able and enthusiastic way that Neville has conducted the column up until now. He started it just over 37 years ago, in the September 1950 issue, and apart from the odd month or two has done it every issue since then — over 440 episodes. That's a pretty tough act to follow, and quite a tradition to maintain, but I'll be doing my best.

By the way, Neville will still be writing frequent articles for us. It's just that he feels he can't keep them coming at quite the same rate.

Incidentally younger readers may be interested to know that the column was originally called "Let's Buy An Argument", and this was only changed to the current "Forum" in April 1965 — a mere 22 years ago — when the magazine itself changed to its current title. At the time the earlier title seemed a bit too much of a mouthful, and perhaps unnecessarily provocative.

Actually I had a letter from a long-time reader in South Australia the other day, saying that "Let's Buy An Argument" was one of the things that he sorely missed from the old days. Neville and I both found this a little puzzling, as apart from the name itself, the column is still basically much the same as when it first started. Understandably the topics discussed herein have changed, but I can't see how it could be otherwise — probably not too many readers nowadays could get excited about the comparative merits of different kinds of DC coupling in valve amplifiers, or whether or not amplifiers should have tone controls. But perhaps I'm wrong; if so, sock it to me.

Whatever, it does seem that the superficially rather mundane and by-no-means new subject of nickel-cadmium rechargeable cells *can* still generate its fair share of controversy. When Dick Smith Electronics began a NiCad marketing drive a few months ago in its ads and mailers, this immediately stirred up one of our regular Sydney readers Mr Phil Allison, who sent us a fairly long letter decrying many of the ad's claims — which he described as "at variance with well-known facts about these cells." We published his letter in the Letters column of our September issue.

Now I have to confess that somehow over the years I've never been able to generate a great deal of interest in NiCads. And I suspect I'm not alone. Although they've always had a loyal band of enthusiastic supporters, I think it's true to say that they've never really "taken off" in the battery world.

I suspect that's because they have something of a reputation for being finicky; for needing special charging and discharging procedures, and even then for doing strange things like going into reverse polarity, or becoming "moody" and refusing to take a charge.

Despite this, in recent years they've become moderately popular for use in electrical toys and other things which tend to consume batteries fairly quickly. As a result firms like DSE have been motivated to put a range of them into stock, and then plug them in ads to help move them along. Fair enough; it's what they said in their ads that stirred up Mr Allison.

Essentially, he seemed to question four aspects of NiCads, based on DSE's claims:

1. The number of charge-discharge cycles one could expect from NiCads in practice (DSE claimed up to 400), and therefore whether or not it would really be worth changing to them, taking the cost of doing so into account;
2. The suitability of NiCads for some applications, in view of their lower terminal voltage of 1.2V;
3. Whether the very low internal resistance of NiCads might pose a possible risk of damage to some kinds of equipment; and

4. Whether the energy capacity of NiCads (in milliamp-hours) is better, or worse than typical dry cells.

As you can see from the first part of Ross Tester's response written on behalf of DSE, the company firmly stands by its claim of up to 400 charge-discharge cycles. In fact it claims to have been very conservative, when one of its NiCad manufacturers claims up to 1000 cycles. Furthermore, Ross's calculations suggest that for AA cells at least, NiCads break even at a little over 10 cycles — well below even the fairly pessimistic figure of 50-100 cycles quoted by Phil Allison himself. So who's right?

To try and resolve this and the other matters raised, I contacted that fountain of battery wisdom, Union Carbide Australia (the "Eveready" people). After considering Phil Allison's criticisms, UC battery marketing/sales engineer Bill Johnson sent me his evaluation, which is also reproduced.

Unfortunately Bill seems to have sidestepped the question of just how many cycles you can expect from a NiCad, and confined himself to general comments. But if I read him right, he seems to be coming down more in favour of Phil Allison than Ross Tester. In short, that for at least some appliances, NiCads are unlikely to offer "enormous" savings. Although for other high drain equipment, the savings would at least be very significant and certainly worthwhile.

So round 1 seems to have ended in a draw. What about the second point, that of possible problems due to a NiCad's lower terminal voltage?

Here Ross Tester does seem to be on fairly secure ground, because lack of complaints from customers would seem

ENERGIZER and EVEREADY Battery Service Comparisons

	Type No.	Description	Typical Service # Capacities (mAh)
SIZE AA	CH15	EVEREADY Ni-Cad. Rechargeable	500
		other brands available rated up to -	600
	915	EVEREADY General Purpose	300 - 600
	1015	EVEREADY Heavy Duty	600 - 850
	1215	EVEREADY Super Heavy Duty	700 - 950
	E91	ENERGIZER Alkaline	1500 - 2000
SIZE C	CH35	EVEREADY Ni-Cad. Rechargeable	1200
		other brands available rated up to -	2000
	935	EVEREADY General Purpose	1500 - 2000
	1035	EVEREADY Heavy Duty	2000 - 2500
	1235	EVEREADY Super Heavy Duty	2500 - 3000
	E93	ENERGIZER Alkaline	5000 - 6000
SIZE D	CH50	EVEREADY Ni-Cad. Rechargeable	1200
		other brands available rated up to -	4000
	950	EVEREADY General Purpose	3000 - 4500
	1050	EVEREADY Heavy Duty	4000 - 5500
	1250	EVEREADY Super Heavy Duty	5500 - 6500
	E95	ENERGIZER Alkaline	11000 - 13000
'9 volt' SIZE	CH22	EVEREADY Ni-Cad. Rechargeable	80
		other brands available rated up to -	100
	216	EVEREADY Heavy Duty	250 - 300
	1222	EVEREADY Super Heavy Duty	300 - 350
	522	ENERGIZER Alkaline	400 - 450

- Primary Battery Capacities based on simulated equipment service to 0.9 volts/cell & typical average voltage of 1.2 volts/cell.

DSE's response:

We refer to the letter from Phil Allison regarding NiCad Batteries in your September issue, and the serious claims made against our company's advertising of NiCads.

We not only reject the notion that this advertisement is misleading, we believe that the letter itself is misleading in the extreme.

Without getting bogged down in the "well known facts" he talks about but doesn't explain, please allow me to answer his four specific objections in turn.

1. "Four hundred plus charges might be obtained, but only under laboratory controlled test conditions." (His emphasis).

I have on my desk a telex from one of the manufacturers of our NiCad batteries, which arrived completely coincidentally and without the matter being raised by us. They noted a previous publication of ours which stated NiCads, from a different manufacturer, offered at least 200 cycles. (This manufacturer, incidentally, specifies at least 1000 cycles. We erred on the extreme conservative side in specifying 400).

This telex says, and I quote, "Please look at rechargeable cycles . . . when DSE quotes 200 cycles. Are not up to date but for 15 years ago NiCad quality."

Not only that, but Mr Allison quotes various figures and costs to changeover: "This high cost of changeover to NiCads ($50 to $300 including charger/s) means a break-even point of 50 to 100 cycles . . . " Let's examine the facts:

"AA" NiCad Battery — by far the most sold –

8 NiCads (2 packs x 4 of Cat S-3150):	$33.00
Charger (Cat M-9517)	$17.50
Total	$50.50
8 standard batteries (i.e., the cheapest!)	$ 4.80

My mathematics says that the break-even point is just 10.52 cycles. Not 50 to 100, but 10.52. And that's first time only, because you won't throw the charger out. Incidentally, a second set of NiCads brings the break-even point down to 6.8 cycles!

If you want to look at "C" cells, it's not too much

DSE's response: *(continued)*

different:

6 NiCad C cells (the most common number sold in one lot) with charger: $61.00

6 cells $4.80

Again, my working out suggests a figure a little less than 50 to 100 cycles — 12.70 to be precise. Take out the charger, and this drops to just over 9!

2. The constant discharge voltage is not something that can be quantified easily (Mr Allison has merely claimed "some equipment will barely work . . . ").

However, based on experience (which now involves DSE selling close to half a million NiCad batteries), we would have to dismiss the claim that "some equipment will barely work at the reduced voltage offered by NiCads" as such an insignificant amount as not to be arguable.

To my knowledge (involving nearly 12 years at DSE), *not one* customer has returned NiCad cells claiming they won't work because the voltage is too low. Sure, we get customers returning them because they haven't charged them (NiCads are sold "flat", deliberately), and, as one would expect, a very, very tiny percentage of faulty cells are returned for exchange. But I have never heard of anyone returning cells for the reason quoted.

And just in case the manufacturers have missed this vitally important point, why do many (not all, but many) specifically make provision for NiCads by allowing extra room (e.g., two extra spaces for 12V items) and supply two dummy cells if the user wants to use Carbon Zinc cells? (e.g., virtually every hand held two-way radio etc.).

What we are saying is that if a manufacturer recognises that use of NiCads might be a problem because of voltage, they make allowances for it.

3. We agree that there could be very rare instances where high discharge current *could* cause problems — but even Mr Allison has hit the nail on the head here: if manufacturers (such as National with their flash unit) believe there is, or could be, a problem, they warn against using NiCads. Clever, aren't they?

As far as motors in toys, etc are concerned, why do virtually all radio-controlled cars, etc, use NiCads?

4. This is the cruncher. Mr Allison states that "arguing from a single example is logically erroneous" then goes on to make two textbook classics:

(a) "The figures in the Plessey brochure . . . were obtained by comparing a NiCad with a light duty cell, in a heavy duty situation." and

(b) "The specifications for Eveready "Black" and Alkaline cells indicate 10 hours or more is to be expected.."

(a) They were? Plessey don't know that. The tests weren't even made locally. How can Mr Allison claim this when he was not in the "laboratory", and does not know what the test conditions were!

(b) Eveready "Black" and Alkaline batteries are more expensive — making the NiCad argument ($ or $) even better! Alkaline batteries give a break-even point of just 4 cycles.

Finally, there is a slight error: the constant voltage of a NiCad does not indeed make nonsense of measuring the battery under load (except that the load might push the battery past the end point and give a quicker indication). The simplest way of measuring charge? A good, old fashioned voltmeter. Easy, isn't it!

Ross Tester,
Dick Smith Electronics.

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to suggest that most gear must be capable of working fairly happily from the roughly 20% lower nominal terminal voltage of NiCads (1.2V compared with

Phil Allison's response:

Mr Tester,

I now must take you to task over your letter as well as the DSE Ni-Cad advertisement you wrote. Again you make errors of fact, false assumptions and draw erroneous conclusions from misunderstood information.

Firstly, the business of number of cycles is a vexing one –manufacturers quote figures that users cannot obtain (ref 3). This is mainly the result of the many differences between lab tests based on a single cell and real world applications involving series connected batteries. NO manufacturer claims that a battery of randomly selected cells, cycled fully without any special precautions, will DEFINITELY last 400 or 1000 cycles as you assume. Typical figures quoted for MATCHED sets of cells with custom designed chargers and auto cut-off systems are 200 to 300 complete cycles. Without such precautions the expected figure would be much lower (ref 3). This puts your advertised claim of "enormous savings" in great doubt.

The break even point: Your maths are fine — the assumptions are not mentioned. You specify the M9517 plug-pack charger (not shown in the ad) which is only suitable for the two examples given and in the first case (at 80mA) exceeds the normal charge rate. Also you assume that dry cells and NiCads always have equal capacity; not so. The IEC standard (ref 1) for typical dry cell applications is for a small radio, four hours per day at 20mA. Used like this the recovery

Union Carbide's view:

We refer to your recent invitation to us to comment on correspondence between one of your readers Mr Phil Allison, and Dick Smith Electronics, in relation to an advertisement on rechargeable nickel-cadmium batteries.

In line with the advertisement's highly promotional emphasis, we would agree that its general impact is accurately summed up by the reader as "replace the dry batteries in your portable electronic equipment with NiCads and enjoy large savings in cost, improvements in performance and longer running time than before."

We would also accept that there are difficulties in sustaining this simple proposition in practice, without some important qualifications. By way of explanation we offer comment on each of the points raised as follows:

1. It is clear that rechargeability is the principal feature of these batteries, offering potentially low operating cost where the battery usage rate is high. Hence, the claim of enormous savings by reference to a working life of "at least 400 recharges".

Whether this level of usage is actually realised in practice, is subject mainly to equipment power consumption, usage and frequency of recharge. Other considerations would include "abuse" factors such as tolerance to repeated or prolonged overcharge, deep discharge (i.e., polarity reversal), accidental shorting, extremes of temperature and so on.

There is no doubt that regular use of high drain appliances such as some motorised toys, tape players, lighting devices

1.5V). Assuming, of course, that if customers struck trouble from this they would actually realise what the problem was, and would then bother to return to the store to complain. And then that the complaints would necessarily trickle back to Ross Tester at head office (sorry — but I did work there for a while!).

I imagine Phil Allison would find this just a little hard to swallow. But Bill Johnson seems to be supporting Ross here, by stating that the average "working voltage" of zinc-carbon cells is normally regarded as 1.2V — the same as for NiCads. He quotes end-point voltages of less than 1V for typical applications, suggesting that prudent equipment makers probably design their gear to operate down to at least 1V or so. Round 2 to DSE, I fancy.

Point 3 was about possible damage due to the low internal resistance of NiCads, allowing them to deliver very

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effect (absent in NiCads) of "Red" AA cells allows them to deliver 2 to 2.5 times the capacity of NiCads. If one also allows for the extra cost of a box type charger (as mentioned in your ad) then break-even occurs after 35 cycles. If the number of cells were 4 instead of 8 then the answer is 53.

In your second example there must be an error. DSE sells two types of C size NiCad cell, 6 of which including M9517 charger cost $65, and $92 respectively. As no holder is available for 6 C cells, a problem exists where there is no charging socket on the device. If one does then the break-even occurs after about 40 cycles in each case. If two box chargers were purchased then the figure increases to 60 or more.

The voltage problem (ref 1,2) is not deniable; equipment intended for dry cell is not usually designed for NiCads as well, (a few hand held transceivers not withstanding) neither in terms of voltage nor anything else. Note that any damage caused by NiCads is not likely to be covered by warranty unless their use is specifically recommended. What Mr Tester's unique ad promotes is not common practice and many manufacturers (e.g. Sony) advise against this substitution.

As for toy cars employing NiCads, I am assured by one leading Sydney retailer (Sheridan Hobbies) that " . . . we do a roaring trade in replacement motors because burnt out ones are so common."

Now, as to my whereabouts during the great dry cell test! The Plessey components brochure has a graph showing the discharge curve for a "typical" dry cell at 90mA load. The graph tapers to 1.1 volts after 2.5 hours. This is consistent with a light duty dry cell. As stated in my original letter an Eveready "Red" lasts 5.5 hours under these conditions and is classed as heavy duty. This seems perfectly straightforward to me Mr Tester?

Yes, alkaline cells are more expensive than Red or Black but as Eveready would no doubt point out they are worth it. They last longer! In a typical dry cell application they deliver 3 to 4 times more capacity than a NiCad (ref 2) as well as providing many other benefits.

The last paragraph really had me puzzled for a while — first you agree with me and then disagree with me, it must be a joke — isn't it?

Sorry, Mr Tester, but your ad and letter don't strike me as funny at all. Many DSE customers are being misled into buying NiCads with false promises. They would be well advised to keep using dry cells.

A retraction is definitely still necessary.

Phil Allison.

References:

1. Henderson *Wireless World* March 1982. (Used as a source for the Dick Smith Reference guide to NiCads)

2. Philip Clark, *Electronics Today International* December 1982.

3. Rod Cooper, *Wireless World* May — June 1985.

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etc., and therefore the resulting frequency replacement of primary batteries, makes the use of rechargeable batteries an attractive option in reducing operating costs significantly.

There are many battery appliances however, whose consumption levels and rates of battery replacement are not particularly high, and given the relatively high cost of rechargeable batteries plus a charger, the expected "enormous" savings in costs would not be realised.

2. The working voltage of primary dry batteries (i.e., popular "carbon zinc" and "alkaline" types drops progressively through discharge, from initially approx. 1.5V to less than 0.75V. The effective end of discharge and hence useful service life is determined in practice by the minimum acceptable operating voltage of the appliance, which generally falls within the range of 0.5 to 1.0V per cell. For the purpose of assessing battery service levels, reference "cut-off" voltages commonly used are 0.65, 0.75 and 0.9V.

The actual average working voltage for primary batteries and therefore ampere-hours service, is highest under light to medium drains and/or intermittent usage. Heavy drain/continuous use reduces operating efficiency, more so in carbon-zinc types than with alkaline.

By comparison, rechargeable NiCad batteries provide a relatively stable voltage of approximately 1.2V through discharge, with a sharp decline below 1.1V. Ampere-hours service also remains relatively stable under increased drain and usage schedules.

It follows that most appliances designed to operate effectively with primary dry batteries will also operate successfully with rechargeable NiCad batteries. Rare exceptions to this would be where the equipment cut-off voltage is unusually high (i.e., 1.2V per cell or higher).

While the effective end of discharge of primary dry batteries is usually determined by the performance characteristic ("cut-off") of the appliance, with NiCad batteries, it is essentially determined by the battery characteristic, as the battery end point is higher than the equipment cut-off.

3. The lower internal resistance of NiCad batteries can provide higher peak current in appliances whose load impedance is significantly low in relation to the battery's internal resistance. In some appliances such as photoflash or high torque motorised appliances, this can result in improved performance, provided that component maximum power ratings are suitably adequate, and this generally is the case. In some cases however, this may not be so, and the appliance manufacturer may accordingly caution against using NiCad batteries.

Of course any possibilities of accidental short circuits or other forms of electrical abuse, raise more general questions of appliance design and safe practices which should broadly apply to all battery types. Nevertheless, NiCad batteries are capable of higher short circuit amperage than primary batteries and therefore due care should be exercised to avoid the possibility of damage to equipment or the batteries through accidental misuse.

4. The ampere-hour capacity of NiCads is generally less than the service available from primary batteries in typical use. This

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high currents. Here Ross Tester does concede that there are instances where the potential for high discharge currents could be a problem, but stresses that these are in DSE's experience very rare. Also that like National with its photoflash units, the manufacturer will usually be aware of the potential danger and recommend against the use of NiCads.

Bill Johnson seems to go along with this, pointing out that the higher current capability of NiCads is undoubtedly an advantage in a lot of cases. And where there is a risk of damage due to excessive current, Bill seems to suggest that this is the responsibility of the equipment designer. So Phil Allison seems to have won round 3 in principle, although Ross Tester's point about the heavy use of NiCads in radio-controlled cars and other toys does seem to take a lot of the sting away, from a practical point of view.

That leaves point 4, the one about the energy capacity of NiCads compared with zinc-carbon and alkaline cells of the same size. Here things seem to degenerate into a bit of a slanging match on both sides, with both Ross Tester/DSE and Phil Allison making useful points but mixing them with generous helpings of rhetoric.

Frankly I'm inclined to go along with Bill Johnson here. As you can see from the table he sent with his letter, it certainly does seem that NiCads on the whole tend to have lower milliamp-hour capacities than the equivalent zinc-carbon cells, and very much less than the corresponding alkalines.

So I think we must give round 4 to Phil Allison too, although this whole point seems a bit academic. We're comparing apples with oranges, to a large extent; although the heavy-duty zinc-carbon and alkaline cells store significantly more energy than NiCads, they can't be recharged whereas the Nicads can.

Undoubtedly there will be applications, like operating an emergency radio on a hike through the Simpson Desert, where it's going to be most important to have batteries that cram the most energy into the smallest volume, and last as long as possible before dropping their bundle. NiCads won't be too useful here, with a shortage of power points to operate a charger.

But in many other applications, the fact that NiCads mightn't store as much energy as others won't really be a problem. All you'll need to do is recharge them when they need it — something you can't do with the others.

Where does all this lead us? As I see it, it mainly points to the predictable conclusion that NiCads, like every other kind of battery have their strengths and weaknesses; they're certainly not the "universal panacea" of the battery world. I think Phil Allison was right to make sure we were all reminded of this.

Mind you, at the same time it's fairly clear that NiCads are very attractive for powering most things that tend to chew up a lot of batteries — providing you have a convenient means of recharging them. In this kind of situation, it does seem clear that they should pay for themselves and the charger pretty quickly. So the basic thrust of DSE's original ad doesn't seem all that far off the mark. Perhaps it was a little over-enthusiastic, but that's almost traditional with DSE's ads.

I think that's about it for this month. Reminds me — the batteries in my tape recorder are flat. Which ones should I buy for it? I'm blessed if I know, it's all so confusing. Now where did I put Bill Johnson's phone number . . .

Union Carbide's view: *(continued)*

depends upon the progressive reduction in operating efficiency of primary types in high drain/continuous use. Lower performance primary batteries are of course, affected to a greater degree than the higher performance types.

The reference to the Plessey components data based on a five hour rate of continuous discharge is unfortunate insofar as it appears to unconditionally represent the typical service difference between dry cells and NiCad cells. This does not take into account the typical service levels of the higher performance primary types and does not recognise the normally lower appliance cut-off voltage levels as already discussed.

A guide to typical service levels of the popular size Eveready and Energizer batteries is shown in the separate attached list.

5. As is the practice in testing primary batteries, provision is made for voltage testing NiCads "properly" under load (as opposed to no load). This will simply indicate whether the battery is at a useful operating level.

In the case of Nicads, it will show either complete discharge or some unspecified state of charge. The only means of fully testing NiCads for capacity involves at least one full charge and discharge.

If batteries are in regular use, some idea of the state of charge will be known (i.e. time and period of last charge, amount of use etc.). If not used regularly, and the state of charge is unknown, it is acceptable to give them either a partial or full charge as is required. To obtain best operating life however, it is preferable to normally discharge them before recharging.

There is no doubt that rechargeable NiCad batteries provide a useful extension to the range of non-rechargeable batteries where the level of use is great enough to justify the relatively high outlay on batteries and charger.

While there are other practical considerations which could be discussed at length, we hope these comments will be useful in relation to the particular points raised.

Bill Johnson,
Union Carbide Australia.

STOP PRESS:

It seemed only fair to send copies of the letters from Ross Tester and Bill Johnston to Phil Allison, to give him the opportunity to reply. Although he responded quite rapidly, we were virtually going to press by the time his letter arrived. I have managed to squeeze it in, but there hasn't been time to modify my commentary in the light of the new points he makes. So I'll have to leave you to decide who finally wins on points.

At this stage, with everyone having had their say and the subject of NiCads well and truly aired, I wish to exercise my editorial discretion and declare the discussion closed!

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PRIMER ON

Semiconductor Devices

by JIM ROWE

2 — The Junction Diode

The simplest semiconductor device most of us are likely to meet is the junction diode. Here's a quick look at how it works, and the kinds of jobs it can be used for in practical circuits.

A junction diode is produced by forming a P-type region and an N-type region directly alongside one another inside a semiconductor crystal. This can be done by either growing a layer of one type epitaxially on the top of a wafer formed from the opposite type, or by reversing the nett doping of a selected region on the top of the wafer by diffusing or ion implanting it with atoms of the opposite kind of dopant. The resulting kinds of structure are shown in Fig.1.

Either way, you end up with P-type and N-type regions inside the crystal, directly alongside one another. And when you do this, interesting things happen at the "junction" area which separates the two.

As you may recall, N-type material has a surplus of electrons in its conduction band, and conducts a current using these as its *carriers*. At normal temperatures these surplus electrons move around the crystal in a random fashion due to thermal (heat) energy.

On the other hand P-type material has a shortage of electrons in its valence band, and the resulting electron "holes" act as this material's current carriers. At normal temperatures these also tend to move around randomly.

What happens at the P-N junction is that electrons tend to wander over from the N-type region into the P side, and holes tend to wander the other way from the P-type region into the N side. When this happens the electrons tend to fill the holes, cancelling each other out as far as nett charge is concerned. So a kind of "no-carrier's land" tends to develop in the vicinity of the junction, with neither kind of current carrier able to survive there for more than a very short time before meeting its opposite number and being neutralised.

Because this region around the junction becomes depleted of free carriers, it is known as the *depletion layer*. And the effect of the depletion layer is to set up a potential barrier between the P-type and N-type regions, because of the lack of carriers. In effect, the N-type region has lost some of its electrons and becomes positively charged, while the P-type region has lost some of its holes (i.e., gained electrons), and becomes negatively charged — see Fig.2.

The wider the depletion layer spreads away from the actual junction, the larger this potential barrier grows. Eventually it stops growing, because the potential barrier repels carriers back into their own regions. So for a given temperature, the depletion layer width remains fairly constant — providing no external voltage is applied. At normal room temperatures it produces a potential barrier of about 300mV for a junction in germanium, and about 600mV for a junction in silicon.

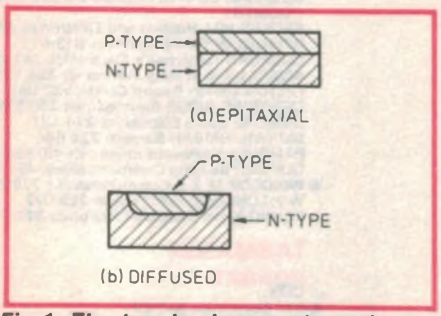


Fig.1: The two basic ways to make a P-N junction diode, epitaxy and diffusion.

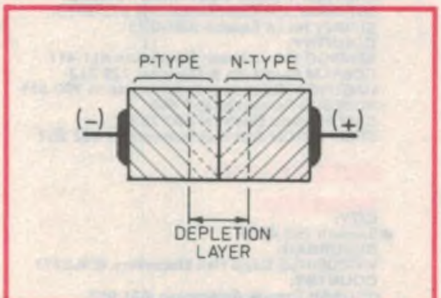


Fig.2: The region around the junction becomes depleted of carriers, setting up a potential barrier.

What happens when we apply an external voltage? It depends on the polarity. If we connect it "in reverse", so that the N-type region is made more positive than the P-type region, all we do is boost the depletion layer's own potential barrier. The layer simply widens, and the number of carriers able to "scale its wall" becomes even smaller.

So *reverse biasing* the junction doesn't achieve a great deal. Very little current flows at all — a few microamps or less (until the reverse voltage is increased to a point where the depletion layer can widen no further, as we discuss later).

On the other hand if we apply an external voltage in the "forward" direction, with the P-type region made more positive than the N-type region, things are rather different. Here the external voltage is opposite in polarity to the depletion layer's potential barrier, so as soon as the two become comparable, the effect of the barrier disappears.

So in this case the current increases rapidly, as soon as the external forward bias exceeds the barrier potential of 300mV (germanium) or 600mV (silicon).

In other words, a semiconductor P-N junction tends to behave in a very similar fashion to one of the old thermionic valve *diodes*: it conducts very easily in one direction (with forward bias), but very poorly in the other (with reverse bias).

This makes the semiconductor P-N junction diode generally quite suitable for most of the circuit functions that previously called for valve diodes: rectifying AC, detecting AM signals, preventing circuit voltages from rising or falling below specified levels, and so on. In fact they're often rather better at these jobs than the older valve diodes, because they generally have a much lower resistance when conducting in the forward direction. This makes them closer to a perfect "one-way" diode.

Of course they're also much more compact than valve diodes — another point in their favour. Even a diode capable of conducting 6 amps typically has a body size of less than 10mm in diameter and say 15mm long. Small-signal detector diodes can be very much smaller, say 2.5mm in diameter and 4mm long.

Apart from rectification and detection, P-N junction diodes have other uses as well. For example while the internal depletion layer prevents the junction from conducting any significant DC when reverse biased, at the same time it has significant *capacitance*. And because the width of the depletion layer varies according to the applied reverse bias, the capacitance varies as well. In fact it varies inversely with voltage, in a parabolic fashion; for high reverse bias it is small, and for low reverse bias it can become quite large. So a P-N junction diode can be used as a voltage-controlled variable capacitor.

Although virtually all silicon junction diodes can be used for this (germanium diodes have rather too much reverse bias leakage current), diodes made specifically for rectification/detection are generally not ideal. Instead special diodes are made to exploit the effect, and these are known as *varicaps* or *varactors*. They are used for tuning radio and TV receivers, for control of oscillator frequency in AFC (automatic frequency control) circuits, and for more esoteric things like frequency multiplication.

Another circuit application for P-N diodes makes use of the fact that when the reverse bias applied to a diode is increased beyond a certain point, its current suddenly increases from the normal very low figure. This is due to it "breaking down" in one way or another (a number of different mechanisms can occur).

When it does enter this "breakdown" mode, the diode's voltage drop tends to remain almost constant, despite the rapid rise in current. In other words, its *dynamic resistance* becomes quite low. At the same time, the diode need not be damaged, providing the current flow and power dissipation are prevented from rising to damaging levels. So in this reverse voltage breakdown mode, the P-N junction can be used to stabilise or *regulate* circuit voltages.

Although most silicon diodes can be used in this way, again it is usually better to use diodes that are specially made to exploit the effect. These *zener* or regulator diodes are designed to have rather lower dynamic resistance in the breakdown mode, and are also designed to conduct more current in this mode without damage. They are also made to break down at a range of convenient voltages, so that you can select a diode to suit the voltage you want to regulate: 6V, 15V, 27V or whatever.

Yet another use for what is still essentially a simple P-N junction diode is to detect light and/or convert it into an EMF to provide power. This relies on the fact that when photons of light energy fall on the P-N junction, they "knock" electrons out of the crystal structure and create a free electron and a hole. The extra carriers produced cause the junction's depletion layer to widen, increasing the potential difference between the P-type and the N-type regions. So in effect, the light energy is converted into electrical energy — which can be used to power circuit if desired.

Again most P-N diodes can be used for this, providing they are in a package which allows light to reach the actual diode "chip". But *solar cells* are even better, with very thin junctions spread over a large area to allow lots of light to enter the depletion layer and be converted.

Silicon is generally used for solar cells, because it generates 600mV per diode cell instead of 300mV. The larger the cell area, the higher the current (and hence power) it can deliver. EA

News Highlights

Australian-developed digital audio system to debut first in WA

A Perth radio station will be the first in the world to install an innovative new sound storage system developed by WA firm Southern Broadcasting Systems.

The system stores sound on a computer hard disk as digital signals, solving many of the problems radio stations have with cartridges and cartridge machines. It has done for radio station advertisements and announcements what the compact disc did for on-air music.

D.A.M.S. which stands for Digital Audio Mass Storage, improves the way the station sounds, reduces mechanical and administrative problems, is easy to use and flexible, allowing it to be tailored to the needs of specific radio clients. Its detailed printouts provide improved record-keeping and can make an important difference to station profitability.

SBS, a wholly-owned subsidiary of the Perth second board company Ampersand International launched D.A.M.S. at an international trade fair in Dallas in the USA at the end of March, where it was well received. It is currently being marketed in Australia and in the USA where interest in the system is growing.

The company is also negotiating to have the system manufactured in the USA and is considering granting worldwide licensing rights to major broadcasting groups.

"The potential of the D.A.M.S. system is tremendous," said SBS managing director, Eddie Jurkiewicz. "It saves time and running costs and will revolutionise the operation of radio stations.

"We are very excited about the unit and it has generated considerable interest in the industry."

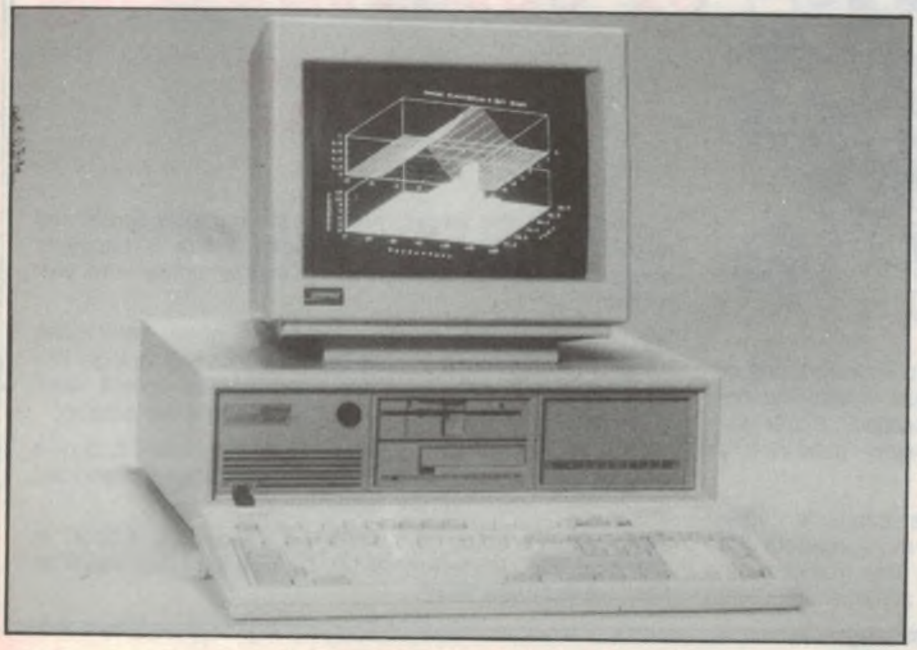
Mr Jurkiewicz said the company had received a considerable number of enquiries both nationally and internationally.

Compaq launches "world's fastest PC", advanced portable

While other manufacturers have yet to deliver their first 80386-based personal computers in any volume, Compaq has launched a 20 megahertz, second generation version of its Deskpro 386 and announed the first 80386-based portable.

The Compaq Deskpro 386/20 combines the Intel 20MHz 80386 microprocessor with advanced system architecture, utilising the new Intel 82385 Cache Memory Controller, to make it the fastest and most powerful personal computer available.

The system's performance is said to be up to 50% better than most 16MHz 386-based PCs.



The Deskpro 386/20 provides up to 300Mb of high performance shock-mounted fixed disk storage, and up to 16Mb of high speed 32-bit RAM. It will run all popular software, hardware add-ons and peripheral devices designed for today's industry-standard 286 and 386 personal computers.

"The Deskpro 386/20 offers a practical solution for advanced user applications such as network file servers, computer aided design and engineering, multi-user systems, scientific processing and artificial intelligence," said managing director of Compaq in Australia (CCA Systems), Mr Ian Penman.

"It will also take full advantage of the features of the MS OS/2 operating system when it becomes available early next year," he said.

The Compaq Portable 386 is claimed to be the world's first portable utilising the new generation of 80386 microprocessor running at 20MHz. It provides up to 10Mb of high performance 32-bit RAM and up to a staggering 100Mb of fixed disk storage. According to Ian Penman it is up to 25% faster than high performance 16MHz 386 desktop PC's.

IBM donates $2.5 million computer to UNSW for CAD/CAM centre

The opening of the University of NSW's new centre for Manufacturing and Automation was made possible by the donation by IBM Australia of the an IBM4381 computer system, valued at $2.5 million. This is the largest national contribution yet made by the company to an Australian university.

"Additional support from Dassault Systems (France), CADAM Inc (USA), AutoDesk Australia, Roland Corporation Australia, Hewlett-Packard Australia, NC Microproducts Inc and Pongrass Industries has enabled the Centre to be the best-equipped computer-aided engineering centre in Australia," according to Centre Director, Dr Grier Lin.

He says these facilities will enable the Centre to expand considerably its teaching and research activities in computer-aided design and computer-aided manufacture. The Centre is part of UNSW's School of Mechanical and Industrial Engineering.

HP donates to RMIT

A recent donation of much-needed equipment by Hewlett Packard Australia has given practical support to the students of the Royal Melbourne Institute of Technology's electrical trade school.

"We had a project for automating our swinging arm photometer measurements on the drawing board for two years but there was no way we could afford to buy anything", said Neville Darragh, acting head of RMIT's electrical trade school. "A swinging arm photometer is an instrument for plotting light output, and looks like a big arm with a mirror on it", he added.

"As soon as HP donated this equipment, we were able to get our project up and running straight away. We are certainly very grateful to HP", he said.

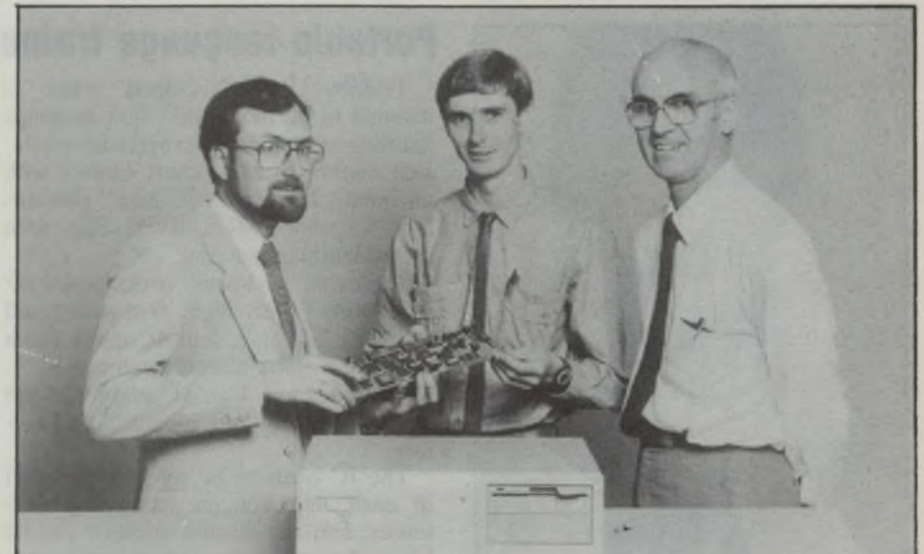
Before the arrival of eight Hewlett Packard instrument modules and the necessary hardware and software for computer interfacing, all measurements were made manually. This involved twenty to thirty pages of readings, which then had to be entered into the computer.

"But with this donation from HP, we now have a program that takes all those measurements," Mr Darragh said.

NSW Premier visits new Philips complex

After officiating at the opening of the new Business and Technology Park at Homebush, in Sydney's western suburbs, NSW Premier Barrie Unsworth inspected the Philips complex — the first building completed and occupied within the Park. The tour allowed the Premier to catch up on Philips' latest developments in Compact Disc technology, like CD-ROM and CD-V (audio plus video disc).

In the photo above, Philips press officer George Sprague uses a mouse to demonstrate the rapid interaction with a CD-ROM player connected to a Philips P3200 colour graphic PC. Accompanying the premier are (left) Mr Lindsay Thomas, chief executive officer of Lend Lease Developments and (right) Mr Willem MacLaine Pont, chairman and managing director of Philips Australia.



TI LAN Development System Winner

The winner of the Texas Instruments/EA LAN Development System Contest was Mr Sebastian Hutten, a cadet engineer with Illawarra Electricity and a senior student in electrical engineering at Wollongong University. His entry described a proposed use for the system in developing a SCADA interface for high-voltage circuit breakers, using a DSP (digital signal processor). The picture above shows Mr Hutten (centre) receiving part of his prize from TI representative David Cartwright (left), with EA's Jim Rowe.

News Highlights

Local doctor pioneers use of optical fibres in medicine

Dr Helen Ward, a physician practising in Sydney, has been awarded a PhD in electrical engineering by the University of NSW for her pioneering work in designing a laser fibre optic system for heart and skin treatment.

As far as she knows, Dr Ward is the only person in Australia investigating medical applications for such laser systems.

She moved into electrical engineering to get the high technology her project demanded. "We were very glad to help her", says her supervisor, Associate Professor Pak Chu of the Department of Communications in the School of Electrical Engineering and Computer Science.

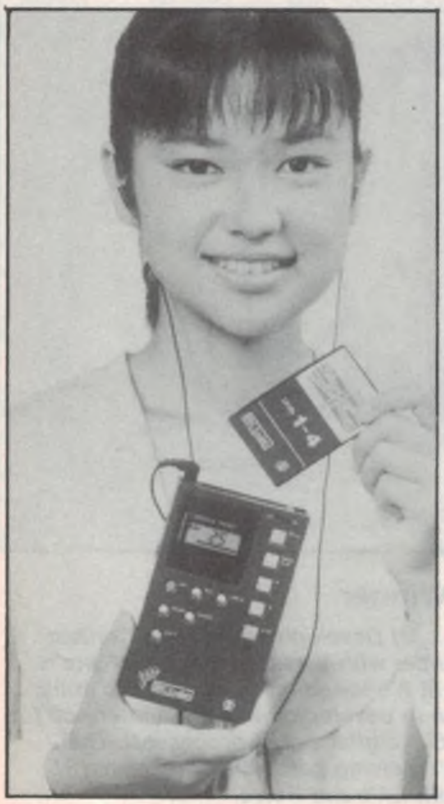
"I wanted to find out if these systems could be modified to apply to most, if not all skin disorders, and then be extended to treat disorders of internal organs," Dr Ward said.

The work involved experimenting with different kinds of lasers — argon, ruby, neodymium and carbon dioxide — to find one that could align directly down the centre of the optic fibre without overloading and melting the fibre. It also had to be simple enough for Dr Ward to adjust and maintain herself, and be realistically affordable.

Lengthy experiments with optical fibres also had to be conducted to find the one best able to transmit very powerful coherent beams of light. Dr Ward settled on an argon laser and a plastic-clad, glass-cored fibre.

Once she started testing her optical fibre laser on cadaverous tissue in 1982, she realised she had to find a way to disperse rapidly the heat used to "shoot" plaques off the artery wall before the walls themselves began to contract.

The solution lay in altering the normally flat ends of the fibre to an arc or bulb shape, both of which allowed the laser to burn the plaque off faster and disperse the heat so quickly as to minimise contraction of the arterial walls.



Portable language trainer uses "smart cards"

Toshiba has developed what is claimed to be the world's first language learning system for the personal education market to use "smart cards", with an inbuilt IC. Each "IC card" contains a 4 megabit CMOS ROM chip with stored learning material.

The new "IC-Voice" is composed of: 1. a body (13cm high, 8cm wide, and weighing 200g); 2. four IC cards (each containing 80 master sentences); 3. headphones; and 4. an AC adaptor, which can also recharge the inbuilt NiCad battery.

The IC cards to be sold for insertion in each unit contain many key sentences, and any desired selection can be heard through the headphones on a random access basis. For effective learning, the unit makes it possible to hear and repeat key phrases (up to 10 times); to rearrange sentences freely; and to record the learner's voice (8 seconds) for comparison with the pre-recorded voice of the teacher.

The portable equipment and series of IC cards will be supplied on an OEM (original equipment manufacturing) basis to International Learning Systems Japan (ILS), the exclusive distributor in Japan for English language educational materials produced by the British Broadcasting Corporation's Radio and TV Educational Bureau.

A contract was signed in Tokyo recently with ILS Chairman and CEO Sir Robert Maxwell, who is also Chairman of British Printing & Communication Corporation (BPCC) and the Daily Mirror Group. Under the contract, Toshiba Corporation will supply ILS with 50,000 sets of IC-Voice within 3 years. ILS plans to sell about 2.5 billion yen (approximately $US17.2 million) worth of the sets during the period.

The first software to be marketed will be targeted at beginners, but its range will be widened to intermediate or upper levels in the future. ILS also plans to sell IC-Voice in other countries — including China, where foreign language learning is reaching new heights of popularity.

Above: An aerial view of the Expo 88 site in Brisbane. Right: A close-up of the monorail.

Heyden-Spike wins Expo 88 comms contract

Australian electronics company Heyden-Spike has won the total radio communications network contract for World Expo 88, to be staged in Brisbane from April to October next year.

The company will supply communications equipment valued at over $600,000, providing a series of two-way radio talk-through repeater stations for on-site and off-site communications, back-up power supplies, antennae and other ancillary equipment.

The sophisticated Expo 88 radio communications system will comprise a total of 11 base stations, 32 mobile radio units and 165 hand-held two-way radio portable transceivers.

There will be 10 radio channels operating to service the world fair. These will be located at the Riverside Building in Brisbane; the Westpac Bank Building at the Expo site; and at Expo House, the central management complex.

The network is the communications nerve centre for World Expo 88, where more than 30 nations and 20 corporations will showcase their achievements under the theme "Leisure in the Age of Technology". It is expected to attract an attendance of over 8 million people.

News Briefs

- The 1987 Nobel Prize in physics has been awarded to Georg Bednorz and Alex Mueller, for their work on higher-temperature superconduction at the ***IBM*** research laboratories in Zurich, Switzerland.
- ***Goldring Audio Industries*** has promoted Ken Tait, formerly national sales manager to general manager.
- Helmut Gunt, formerly of Philips Austria, has been appointed to the managing board of ***AKG*** in Austria.
- ***Hy-Phon Distribution*** has appointed ***Warehouse Sound Systems*** as Victorian distributor for its Tannoy and Drawmer products, and dealer for JBL professional studio products and Fostex multitrack recording equipment.
- Queensland regional city Ipswich is to receive its own local commercial FM radio service. Licences for the service are to be called in early 1988, for commencement in 1989.
- Alistair Campion, formerly national education sales manager for Microbee, has been appointed national business and education manager for ***Atari Computers*** based in North Ryde NSW.
- ***GEC Australia*** has appointed Geoffrey Scott as chief executive of its electronic products and systems division.
- Peter Stephenson has been appointed systems manager at ***Amber Technology*** responsible for the development, installation and commissioning of turnkey systems for radio stations, recording studios and public works.
- Dr Walter Brattain, who shared the 1956 Nobel prize in Physics, for the invention of the transistor, died on October 14 in Seattle, aged 85. With Drs. John Bardeen and William Shockley, he announced the invention of the transistor in December 1947.
- Bill Newcombe has been appointed deputy general manager of the measurement and control division of ***AWA Technology Group***, in North Ryde NSW. Bill joined the division in 1982 when it was still part of Electrical Equipment.

"Silicon Village" developing in China

In China they like to refer to it as "Silicon Village". While there are some similarities to California's Silicon Valley, the area around Zhongguancun in Northern Beijing still has a long way to go before Porches and Mercedes SLs replace the current means of transportation, donkey carts and bicycles.

One of the key similarities are the Beijing and Qinghua Universities which, like the Stanford and Berkeley schools in Silicon Valley, are feeding the area's growing high-tech industry with a steady supply of engineers.

Already some 100 electronics companies have sprung up in the area, some with names like Three Star Electronics and Stone Electronics Accessories. Besides electronic instruments and computer-related products, some of the companies are involved in biotechnology, chemical and other high-tech product areas.

Unlike Silicon Valley, two-thirds of the companies are under control of the universities. The others are privately owned.

The development of the high-tech industry around Zhongguancun is being encouraged by the government as part of its modernisation program.

Currently most of the technology used by the companies in the area lag quite far behind the West. Still, expectations for export opportunities are said to be high and partly based on the fact that manufacturing costs are about as low as you can get. Even Tu Yan, president of Keli High Technology, which makes computer products, earns just $US40 a month. (Apple chairman John Sculley makes that much about every 30 seconds . . .)

News Highlights

Photo archive transferred to laserdisc

The future of an historic photographic collection dating back to 1869 has been assured by its transfer to laserdisc — the first time an Australian collection has been catalogued, conserved, and presented in this way.

The archive project, the largest of its kind in Australia to date, covers more than 40,000 fragile, glass plate negatives belonging to the New South Wales Government Printing Office, and is just part of more than 200,000 historical and contemporary photographs, drawings and paintings in its care. The company selected for the preparation of a laserdisc master is Digital Imaging Australia (DIA), a Melbourne-based video facility house specialising in the transfer of still images.

DIA laid down the laserdisc master from 35mm archive film positives of the original negatives prepared by the Laser Picture Studio.

From the edit master, a first pressing of 50 laserdiscs will be made for sale to professional photographers, researchers, libraries, etc., around Australia and overseas.

Each disc will be accessed by image-retrieval and indexing software, specially developed by Queensland software and systems house, QCOM, to allow easy searching and accessing by professionals and laymen alike. Proprietary rights to the software is owned by the NSW Government Printing Office.

Although somewhere in the order of 60 different laserdiscs have been produced in Australia, until now these had been confined mainly to training discs, particularly for the larger vehicle manufacturers.

Rowe disappears

No, not EA's managing editor! The name Rowe has gone from the company originally known as H. Rowe & Co, which in recent years became Nilsen Rowe Australia. In October it became Nilsen Instruments, finally dropping the name of Melbourne electrician Henry Rowe who founded the company in 1901.

The new name was chosen to reflect more accurately the company's current ownership and activities.

Novel keyboard has inbuilt LCD display

Australian company Keycorp has announced an innovative technique to make personal computers and terminals easier to use. Each function key on Keycorp's "Keymaster" keyboard has an 8-character LCD display, built into the top surface of the keytop.

The character strings displayed by the keys are controlled by a Z80 micro built into the keyboard, together with 2K of ROM and 16K of RAM. This makes it easy for the key legends to be changed as often as required, directly from applications software, using a novel Manchester encoding scheme for computer-keyboard communication. In fact a complete "key table" can be loaded into the keyboard's RAM, and different sets of legends automatically displayed on the keys as the user progresses from menu to menu to the applications software.

In addition to the main Keymaster keyboard, intended to replace existing PC keyboards, Keycorp has also produced a separate keypad which can be used to add the facility to existing keyboards. Currently the full Keymaster keyboard retails for $1500, and the add-on keypad for $1200.

The idea for the product came from John Wood, one of Keycorp's founders. Patents have been either applied for or granted in 23 countries. According to Keycorp managing director David Ballantine, the new technique offers many advantages over conventional screen legends, touch screens and help files. The company is confident of the export earning potential of the new technology.

Amateur radio link via Aussat

Radio amateurs using the 2 metre VHF band in Sydney and Perth were able to communicate directly in mid-October, thanks to a special satellite link generously provided by Aussat as its contribution to the annual Jamboree of the Air (JOTA). The link effectively connected Sydney's Terrey Hills repeater, near the Belrose earth station, to the corresponding 6800 Group repeater in Perth.

The idea for the satellite link came from two Sydney amateurs, Laurence Adney VK2ZLA and Bruce Boardman VK2ZZM, who are also Aussat staff members. After Aussat agreed to donate one of the channels on Aussat 1's transponder 13, the two then approached the authorities and the radio clubs concerned, and organised the actual linkup using transceivers set up temporarily at the earth stations.

The complete exercise went off very well, and allowed JOTA to give participating Scouts a really up-to-date idea of amateur radio.

AWA wins excellence award

For the second year running, Amalgamated Wireless (Australasia) — AWA — has taken out the prestigious Engineering Product Excellence Award, from the Institution of Engineers, Australia.

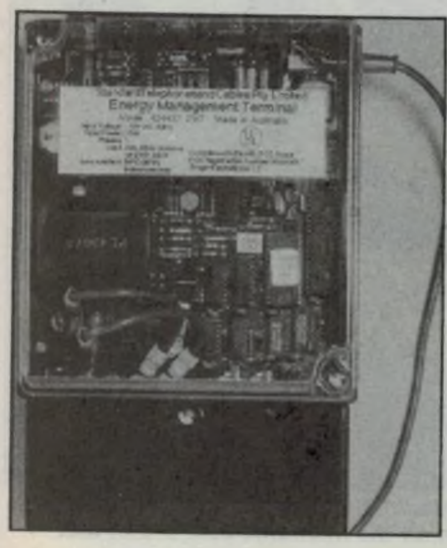
AWA's winning entry this year was AWANET, an advanced local area network (LAN) system designed to service the current and future local communications needs for major government, commercial and military organisations. An all-Australian initiative, AWANET took five years and some $2.8 million to develop. It uses a mix of multipair copper cable and optical fibre cable to interconnect computers, peripherals, telephones, intercoms, radios and sensors.

AWANET is already in use as the communications backbone for the Sydney Police Centre Radio Control system, and it will also be incorporated into the air traffic control system to be installed at the RAAF's F/A-18 fighter base at Tindal in the Northern Territory.

US power utility to test STC's energy management system

The first commercial test application of STC's new Australian-developed Energy Management System (EMS) is to be conducted in the USA, by the Baltimore Gas and Electric Company in co-operation with the C&P Telephone Company of Maryland.

"This will lead to a multimillion dollar export order for STC, " said Ron Spithill, STC's marketing director. "It will also provide us with an important entre into the international energy management market — a new market that has significant export potential for Australia."



EMS is a real-time multiservice network for energy authorities distributing electricity, gas or water to millions of residential, commercial and industrial customers. The concept centres around STC's Australian-design and manufactured Energy Management Terminal (EMT).

A small and relatively inexpensive device, the EMT makes use of existing telephone lines to communicate with customer locations. It is installed at a customer's premises and is in constant, two-way communication with a central computer located in the offices of the electricity, gas or water authority. The telephone service is unaffected. The EMT reads the customer's meter automatically and feeds the information directly into the company's billing system.

Although the system is capable of handling literally millions of customers, the Baltimore Gas and Electric Company will restrict its field test to a carefully selected mix of 250 residential users in metropolitan Baltimore, with a primary focus on remote meter reading applications. The system will be installed early in the new year and the test will run for approximately one year.

If you don't have a replacement, improvise!

There is a technician around my area who is either a humorist *Par Excellence*, or else one of the most irresponsible characters ever bred. I don't know who he is, but I'm sure that if I met him I'd be tempted to touch him for luck. You'd need a lot of luck to get away with what he's done.

A customer brought in a Korting colour TV for service. He said that somebody else had fixed it some time ago, but he wouldn't take it back there because he didn't trust the "so-and-so".

The set had worked OK since the last repair, but when he had moved it the previous night there had been a bright flash from inside the cabinet and "the set don't go no more!"

To shorten an otherwise long story, when I got inside I found that the previous fixer had been fiddling around with the power supply, the degaussing coils and the aquadag return to the picture tube socket.

There were wires going everywhere, and none of them seemed to be originals. One in particular was a foreigner; a length of white figure 8 mains flex leading from the back of the main circuit board to a strange contraption lying loose in the bottom of the cabinet. Look at the photo accompanying this story and see if you can work out what it is.

Quite obviously this device did not belong in the set, so I pulled it out with no further ceremony. It didn't help though, the set was still as dead as ever.

As I probed further into the works, I came to the conclusion that the power supply had shut down because of excess current. So the first thing was to check the excess current trip and the resistor which generates the trip voltage. In this set it is R606, a 15 ohm 10 watt wire wound unit near the regulator board.

However, when I looked for R606 it wasn't there. Then I recalled that the white flex had come from that area on the back of the circuit board. In fact, the strange contraption mentioned earlier was somebody's substitute for the original R606.

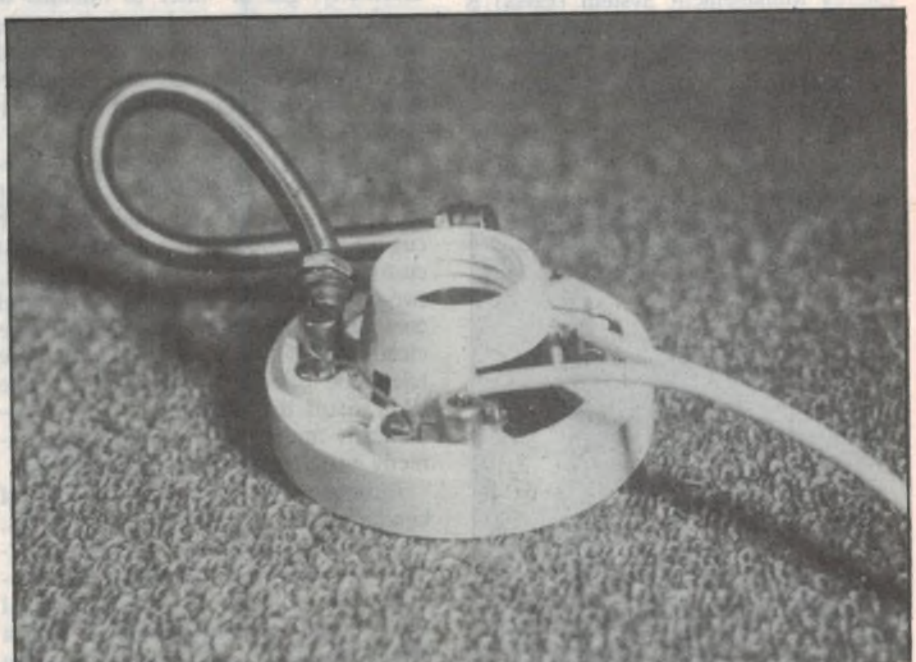
It was a 4" length of coiled nichrome resistance wire, mounted on a white plastic ceiling rose with no attempt at insulation.

It was spot on for resistance, so he had obviously gone to some trouble to select his material. He had also taken much trouble to give it a solid mounting. Only thing was, he had tossed the assembly into the bottom of the cabinet and made no attempt to secure it there.

This crazy bit of bush technology had worked for some six months, and might have gone on for years if the customer had not moved the set. When this happened, the loose resistance coil (which carries the main 315V DC rail) had touched something on the main circuit board and brought the set to a shuddering halt.

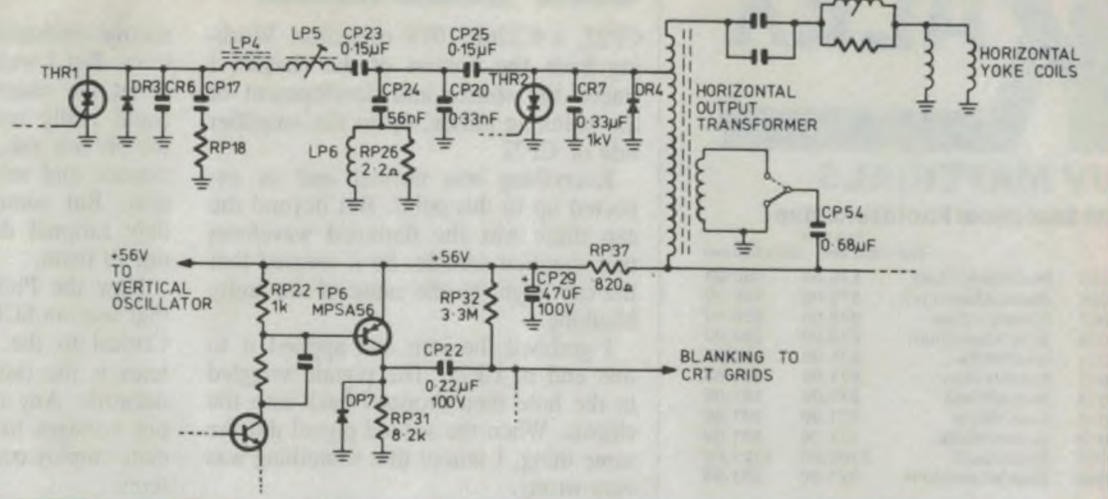
The short seemed to have blown every fuse and quite a few of the semiconductors in the set. It set me up for a long, tedious repair and to be honest I felt like writing the whole job off. In fact I had to put it aside for a while to get on with other, more profitable work. If I had known who the joker was I would have gladly given him back the job to do properly.

Finally, a week later, the job was done. I found the main bridge rectifier was shorted, two faulty transistors (one



This strange device is the "Bush Carpenter's" attempt to mock up a 15 ohm 10 watt resistor. There was no insulation on the nichrome coil, which was carrying the set's main B+ rail at 315 volts.

Here is a simplified circuit for the relevant part of the Philco 1A47 26" colour set, as discussed below. Finding the cause of the trouble proved quite tricky!



on the chroma board and one on the vertical board), a shorted 12-volt regulator, several shorted tantalum caps, a shorted zener diode, a faulty demodulator chip and several open circuit resistors.

The customer accepted my charge, so all was not as bad as it looked when I first opened the set. But I would still like to find the joker responsible and give him a piece of my mind.

My next story concerns an electrolytic capacitor. Anyone who has ever grasped one of these when charged with a high voltage will know that they can be powerful beasts. This story shows that they can be powerful in other ways as well . . .

It concerns a Philco 26-inch set, model 1A47, and once its owner's pride and joy. Nowadays, it's a bit long in the tooth and will have to be pensioned off one day soon. But in the meantime, the owner is prepared to keep it going for a bit longer.

It belongs to a customer of long standing, and my records show that I last saw this set around 1980. When the owner rang to ask if he could bring the set in, he commented that I must have done a good job last time, because it was six and a half years since he last saw me.

He brought the set into the workshop this time because the vertical scan had collapsed. My instruction was that he was prepared to spend "fifty dollars or so" on the job. If the repair was to be much more than that I was to ring him to discuss the matter.

Once inside the cabinet, I quickly found that the cost would be less than his limit. The faulty component was a half-watt resistor, RP37 (820 ohm 1/2 watt) that feeds 56 volts from the line output stage to the vertical oscillator.

The resistor had failed for some reason and had stopped the oscillator, but all other rails remained normal. In an attempt to find and eliminate any cause of future resistor failure, I tried to trace out the source of this 56 volt rail.

Now somebody else might be a better tracer than me, but try as I might I couldn't find the source of that rail. The manual says that it is "obtained over CP54 in the line output amplifier stage"; CP54 is a 0.68uF ceramic cap connected to a small secondary winding on the line output transformer. There is no diode in this line, and no other apparent source of 56V DC. So apart from checking CP54, there was not much else I could do.

After replacing the resistor, the set was delivering quite a good picture so I let it run for the rest of the day. Then I called the customer to tell him to come and collect it.

He was quite happy with the repair and with my charge and took the set off home, ready to enjoy some relaxing TV viewing.

As he left, I wished him "Good Luck" and hoped that it would be another six years before the set came back to me for further attention. My parting comment was to wish him "Good Viewing". But his viewing was to be short-lived.

It was a few minutes after seven that same night when he was back on the phone, to tell me that the set had just exploded. He said there had been a terrific bang and a cloud of smoke from the back of the set, and now there was no picture any more.

He brought the set back the next morning and I wasted no time getting the back off. I wanted to see what had made the Big Bang.

It was painfully obvious! There was a small aluminium cylinder standing upright on a wire stem, and the inside of the TV was covered in little pieces of shredded aluminium foil. It had been a 47uF 100V electro (CP29) and tracing its circuit led me back to resistor RP37 which had burnt out, again.

So, whatever was going on had close associations with the 56 volt rail. But what?

Fortunately, there are really only two ways that electrolytic caps fail. Excess voltage, or internal breakdown usually results in a short circuit. The other failure follows application of reverse voltage or raw AC, and this almost always finishes as a violent explosion.

The AC theory led me to wonder if there was an intermittent open circuit in CP54. This could put excess line frequency current on the rail and overstress the decoupling cap. It was quite easy to replace both caps, and the resistor, and the set was soon working again.

Only it wasn't working very well. There was a dark band down each side of the screen. The picture information was OK right across the screen but for about three inches in from each edge the picture was darker that it was in the middle.

An oscilloscope check showed that the video information on the tube cathodes was perfectly normal, but the blanking signal on the grids had a flat spot each side of the central blanking pulse and almost certainly this was the cause of the trouble. But where was it coming from?

In this chassis the blanking is developed in a small two transistor amplifier and fed to the tube grids through

Serviceman

CP22, a 0.22uF 100V capacitor. Working from the bottom of the chassis, I traced the source and development of the blanking pulses, up to the amplifier side of CP22.

Everything was normal and as expected up to this point. But beyond the cap there was the flattened waveform that signified trouble. So it seemed that the cap might be the cause of the faulty blanking.

I grabbed the iron and applied it to one end of CP22. The pigtail wriggled in the hole then dropped back into the chassis. When the second pigtail did the same thing, I sensed that something was very wrong.

I turned the set over and found the pigtails hanging on the edges of the holes. But that is all that I found. there was no trace of the capacitor. It'd gone — completely. Vapourised. Pouff! Only the pigtails left standing in the board.

The significant point is, though, that the cap had been about an inch away from the exploding electro. The only explanation for the missing component is that the explosion literally blew it to pieces. Pieces so small that they were unrecognisable in the dusty interior of the set.

All the other components in that part of the set are low profile parts, resistors and diodes, and the blast had had little effect on them. The missing cap stood upright above the board and took the full force of the Big Bang.

Replacing CP22 restored the set to normal operation, at least in the short term. But I was still a bit apprehensive about the cause of the Big Bang. If I could really understand the source of the 56 volt rail, I might be able to anticipate and so prevent another explosion. But some circuits just seem to defy rational description and this was one of them.

Now the Philco is one of those sets that uses an SCR type line output stage. Critical to the operation of these systems is the timing in the commutation network. Any mistiming allows dangerous voltages to build up and most circuits employ complicated protection systems.

One common cause of mistiming is failure of the commutation capacitors between the two SCR's. These generally fail in a way that shuts down the set, but they can become intermittent and cause high voltage spikes to appear on the secondary rails. This might have been the cause of my present trouble, so I resolved to replace the suspect caps.

The commutation capacitors are critical as to value, and are usually high voltage high current types which are only available from specialist suppliers. There were none available locally, so I placed an order with a Melbourne company. While waiting for new caps to arrive, I chanced to mention the problem to a colleague who is familiar with most European sets. I did not know then that the Philco is one of his specialities. He responded even before I had finished describing the fault.

He told me that replacing THR2 (the second line output SCR) would cure the problem, once and for all. The exact mechanism is not known but the SCR presumably fails to switch on during retrace and the flyback current tries to go to ground through the 56 volt rail. No wonder RP37 went open circuit and the electro exploded!

My friend was also able to explain the source of the 56 volt rail. It is developed by rectification in the SCR that is now suspect. This lifts the line output transformer windings above ground and the 56 volt rail is tapped off the bottom of the winding, with CP54 acting as a filter on the rail.

This story goes to show that what looks simple at the start can develop into a most complicated, time consuming and frustrating exercise. Yet if you know the right person to ask, the problem can be reduced to nothing at all.

TETIA Fault of the Month

Sanyo 2750 (European model)

Symptom: Owner gets an electric shock from silver knob on power switch, but only since external antenna has been fitted.

Cure: Check volume control/power switch shaft. Replace with plastic type if metal shaft fitted. Set uses live chassis and metal plated knob allows contact with chassis through control shaft. This was a dramatic example of shoddy servicing which could have proved fatal if contact had been made with a more efficient earth.

This information is supplied by courtesy of the Tasmanian branch of The Electronic Technicians' Institute of Australia. Contributions should be sent to J. Lawler, 16 Adina St, Geilston Bay, Tas 7015.

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Data Format	Asychronous
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Silicon Valley NEWSLETTER . . .

DSP Technique cleans up old recordings

Thanks to the invention of a tiny San Francisco electronics company, you may soon enjoy watching old movies or recordings without the irritating hisses, clicks, cracks and pops in the background.

Sonic Solutions recently introduced its NoNoise process, which is capable of cleaning up even the worst of recordings.

The NoNoise system feeds a digital copy of an old recording into the memory banks of a Sun Microsystems workstation. The computer, with the help of the NoNoise program, analyses the sound just before and after a click, hiss, or pop at the rate of 58 million calculations per second. Using various digital signal processing (DSP) techniques, the system then replaces the disturbances with what should have been heard.

In one instance, the NoNoise system was able to rescue a rare 1968 15-minute filmed performance of Jim Morrison with his rock band The Doors. While the sound in the Hollywood Bowl was perfect, Morrison ruined the soundtrack when he stepped up to the microphone and accidently ripped one of the wires to the recorder. As a result the tape is full of loud clicks.

But the NoNoise system replaced the clicks with recreated bits of Morrison's voice to create a "perfect" recording and revived a precious piece of rock history.

Already, several Hollywood studios have begun using the NoNoise system to clean up old recordings. "Stuff from the 1930s that sounded like it was coming from a tin can now sounds like it's coming from one of our recording studios," said producer Ed Mitchell, who is working on cleaning up some classic Louis Armstrong recordings which RCA is planning to rerelease on compact discs.

National sells Clipper group

In the first of a series of moves to cut back, close, or sell parts of the Fairchild organisation it has acquired, National Semiconductor announced it has reached an agreement to sell Fairchild's 32-bit "Clipper" microprocessor group to computer workstation manufacturer Intergraph in Huntsville, Alabama.

While details of the transaction were not disclosed, industry analysts estimate that National will receive a little under $US10 million for group.

Analysts were not surprised at either National's decision to sell the Clipper group, or the decision by Intergraph to buy it. National already has a well established 32-bit microprocessor family. Supporting two competing product microprocessor lines would be both costly, unprecedented, and cause confusion among National's customers and potential customers. Some had expected National to even discontinue the entire Clipper group in order to eliminate a potentially powerful competition from the 32-bit field. Particularly in Japan, the Clipper may have a promising future, as Fujitsu, which manufactures most of them, has the Far East marketing rights for the product.

Intergraph, on the other hand, has a vital interest in keeping the Clipper alive. It has designed its most advanced family of workstations around the Clipper. For that reason, Intergraph was part of a consortium that tried to help Fairchild president Donald Brooks earlier this year, in his failed attempts at a management leverage buy-out.

Intergraph said it will retain all 115 employees of the Clipper group. "We put a lot of blood, sweat and tears into this product. We want to be around to make it a success," commented Howard Sachs, general manager of the Clipper group.

Wyse Technology has just shipped the one millionth computer terminal from its factory in San Jose. Pictured are Charles Comiso, VP international sales (left), and chairman Bernard Tse.

Japanese now charging too much, SIA claims

In an ironic, and almost comical, reversal, the Semiconductor Industry Association has adopted a resolution accusing the Japanese of violating the US-Japanese chip trade agreement by charging too much for their chips. Only a year ago, the SIA was about ready to cancel the same agreement amidst complaints of dumping practices.

In drawing up the resolution, the SIA was the first to admit that its complaint would seem to discredit the validity of its earlier position. SIA vice president Warren Davis conceded that many in the outside world would ask: "Wait a minute — aren't you ever satisfied?"

In recent months, many US computer

and other electronic manufacturers have complained about the difficulties in obtaining Japanese-made memory and other critical components and the high prices charged for the ones they are able to get their hands on.

In its resolution, the SIA charges Japan's Ministry of International Trade & Industry (MITI) of creating an artificial shortage of chips by ordering companies to hold down production levels. This, the SIA says violates the spirit of the chip trade agreement as much as the dumping practices did in 1986. The trade agreement sought to ensure that Japanese producers would not charge customers below the fair market value of their product in a market where supply outstrips demand. But it was never the intent of the agreement to restrict supply as a means to prevent predatory pricing policies.

To eliminate the oversupply problem, MITI last year put pressure on Japanese firms to curtail production. But when the conditions in the semiconductor market improved earlier this year, MITI has not allowed Japanese producers to increase production to meet demand. As a result, an artificial shortage has developed in critical memory markets and prices have soared as a result.

Wozniak's remote controller hits snafu

In another set-back for Apple cofounder Steve Wozniak's new CL9 company, president Sam Bernstein has resigned following a bitter argument with Wozniak over the solution to a problem in the manufacturing of the company's new "CORE" remote control device.

Bernstein said he left the company when Wozniak refused to compromise on his wish to hire business consultant Marty Spergel to iron out the manufacturing problem. "It was either him or me," Bernstein said. Wozniak chose Spergel, causing Bernstein to hand in his resignation.

Wozniak's CORE controller finally went into production at a contract factory in Silicon Valley in early August. But a serious problem caused shipments to fall far behind schedule.

Spergel said he was able to resolve the problem in only a couple of days by moving some of the sub-component production to a different contractor. Shipments are now on target, Spergel said, and the first of a number of electronic and computer retail chains are now carrying the CORE on their shelves.

The $US199 device took Wozniak, inventor of the original Apple computer, two years to develop. It is driven by two microprocessors and is able to control any remote-controlled piece of electronic gear or appliance. Wozniak invented the device, which offers advanced programming features, after he got fed up with the dozen or so remote controllers crowding the table in his living room.

High-tech camera fails

A futuristic video tape camera developed by the US Pentagon apparently failed to live up to its expectations.

Before attacking an Iranian ship suspected to be laying mines in the Persian Gulf, US helicopters tried to film the operation with a special camera that uses the faint light of stars in combination with advanced infra-red sensors to illuminate images.

The Pentagon had hoped a videotape of the operation would have provided undisputable evidence the ship was involved in mining the Gulf. But the tape reportedly failed to show anything. "It happens all the time. You can go to a photo shop and have the same problem with your own film," said disappointed White House spokesman, Marlin Fitzwater.

Ready for the BIG ones in 88?

What a year on TV! The Bicentenary — think of the coverage that'll have. And the Olympics — sensational!

Is your TV antenna system up to it?

If it's typical of most, it's not (up to it, that is!). Probably put up when TV started (that's over thirty years ago!): the antenna's probably broken, corroded or bent, the lead-in's probably pretty suspect too.

Fix them — before '88. And get ready for the Big Events of '88!

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(Note: Many areas do not yet have local area translators. In that case the L-4025 antenna will normally suffice).

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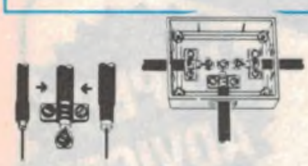

More than one TV?

Don't just connect them together: it doesn't work! Use a splitter for optimum performance — sets won't interfere with each other.
Cat L-4472

$5.45

Two Antennas?

UHF & VHF Antennas don't need two lead-ins. Save money by using a diplexer — one lead in is much more convenient (saves madly swapping leads!) Cat L-4470

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Cable:

DSE stocks top quality TV cable in both 75 ohm coax and 300 ohm twin lead.

75 Ohm — Air dielectric, low loss cable for external/internal installations. Dual shielded (foil/braid) with UV stabilised outer cover.
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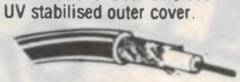
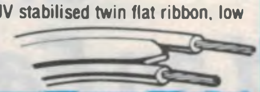


300 Ohm — UV stabilised twin flat ribbon, low loss. Cat W-2070



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For country viewing (deep fringe area) or where signal levels are very low (shielded, etc) you'll probably need one of the "big guns": the phased array. High gain, high performance on all high VHF channels. Suitable for horizontal or vertical mounting.
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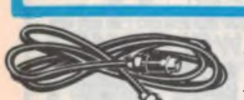

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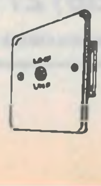

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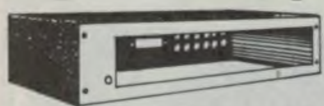

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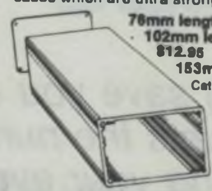

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This portable radio kit puts the life back into AM reception! Using a cunning TRF circuitry system the original audio bandwidth transmitted by the station is largely maintained — AM comes alive!
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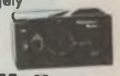

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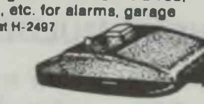

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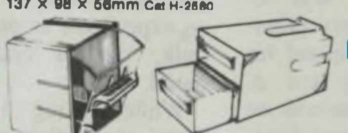

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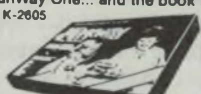

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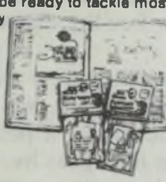

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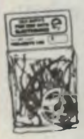

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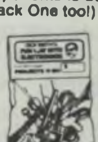

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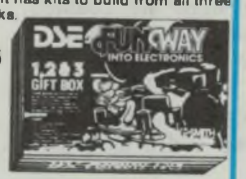

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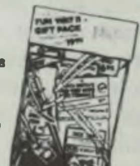

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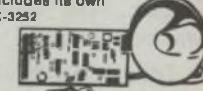
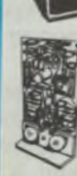


50W Module



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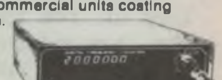

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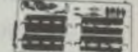

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Jogger Logger counts your steps

Here's a project that can save you a lot of doubtful guessing. It counts the number of steps you run while having your evening jog, and lets you work out how far you've gone.

by HENK MULDER

Ten, perhaps fifteen years ago, our society was struck by this new sport, jogging. Until then running was a branch of athletics and was based on speed. Running was also an additional training to other sports.

Suddenly however, running was renamed jogging and became very popular. Anybody who cared a bit about his (her) health jogged. Jogging was it. Politicians looking for votes would be interviewed while jogging around Capital Hill.

Jogging was also promoted by commerce. The fashion industry took the initiative and launched a whole new line of clothing. The electronics industry saw a hole in the market and strapped wild coloured walkman-type radios to the joggers. The stereotype of the jogger was born.

Today, in 1987, the novelty has worn off a bit. Only the real joggers have survived. Still, joggers are a familiar sight in our streets and parks.

Jogging is a cheap and simple way to keep fit. You can do it wherever you like. Any moment of the day is good enough, and it takes as long as you like. But just as in most sports, joggers like to compare their jogging talents to those other people, or to their own previous achievements.

The easiest way to make such comparisons is to run a known distance and to time oneself. The timing is generally not a problem, as nowadays we seem to be born with quartz watches strapped around our wrists!

It is the other parameter, distance, which seems to be more difficult. Estimating distances is for many people an impossibility. Those people who manage guessing a distance probably base their estimation on the time it took them to cover the distance, and the speed they had while doing it. The latter is based on experience as one person will mostly walk, run or cycle with a constant speed.

While having a tiresome jog one night, the author wondered whether it would be possible to measure the jog distance using electronics. A couple of miles later the Jogger Logger was conceived, in spirit at least. The actual prototype took another few miles, which just shows how healthy electronics can be!

We made just one assumption when conceiving the Jogger Logger: we assumed that the step length of a person does not vary much as time goes by.

The Jogger Logger basically counts all the steps a person takes when jogging about.

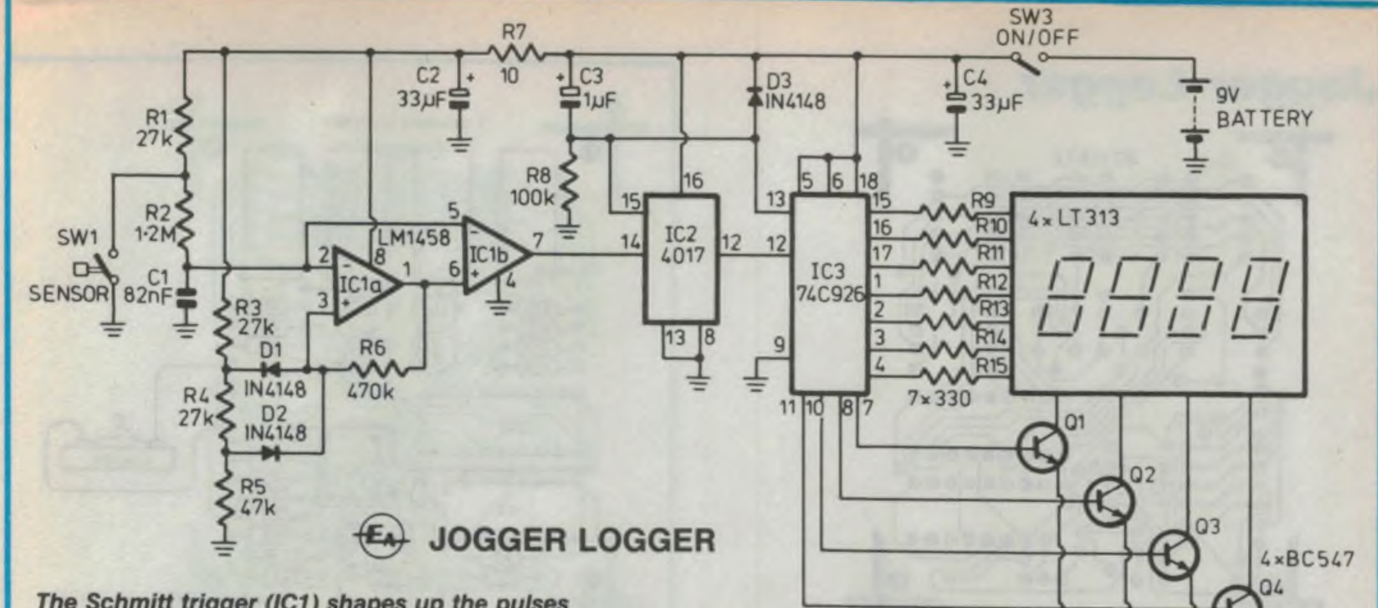
Although all the steps are counted, not all are displayed. The resolution of the Jogger Logger is ten steps. The maximum count is 9999. This covers a running range from roughly crossing the street to running two and a half marathons.

The Jogger Logger runs from a 9V battery. As the LED display is only activated when a button is pushed, it doesn't consume very much battery power at all. As a result, the Jogger Logger should run quite a few miles. Electrically speaking that is; physically we can't predict too much . . .

The circuit

Although the name wouldn't suggest it, the Jogger Logger is a typical example of a piece of measurement equipment. The circuitry of such equipment can generally be divided into five blocks. There is the transducer, interface, signal processor, output device and the power supply.

Our transducer here is a vibration sensor. When a person moves in a horizontal direction with a constant speed (also called jogging), the body of the person tends to shake and vibrate. The set of shakes in the body with all their related vibrations are doubtlessly infinitely complex. But without going too much into the physics of the human body, one might agree that every time a foot lands on the running surface, a major shake is given to the body. It is this shake we aim to measure with the Jogger Logger, hence the vibration sensor as transducer.



The Schmitt trigger (IC1) shapes up the pulses from the vibration sensor. These pulses are then counted and read-out by IC2 and IC3.

Ignoring the details for the moment, the signal conditioner consists of a low pass filter and a Schmitt-trigger amplifier (IC1). This block converts the switch signal from the vibration sensor into a digital signal; every step should result in a pulse at this stage. All other vibrations or noise are eliminated in this section.

The digital signal from IC1 is processed by IC2 and part of IC3. The only processing to be done is counting the steps taken by the jogger. IC2 is a decade counter and divides the number of steps taken by 10. The resulting pulses are counted by the four digit counter in IC3.

The display device consists of the multiplexer in IC3, the 7-segment displays and the transistors. This is where the number of steps are being read out.

The remaining block is the power supply. Ours consists of a battery and a two stage RC filter. This to supply a smooth voltage to the conditioner and processing blocks.

Right, now for the details. Fig.1 shows the relation between the various signals in the first stage.

The signal from the vibration sensor is filtered by R1, R2 and C1. The contacts of the switch are normally open and C1 is therefore normally charged to the 9V supply voltage. When the contacts of the switch close, this capacitor is discharged. As the contacts open again, the capacitor recharges again.

This process results in a signal as shown in the diagram. Other short vibrations (such as contact "bounce") appear as noise on the output signal of the filter.

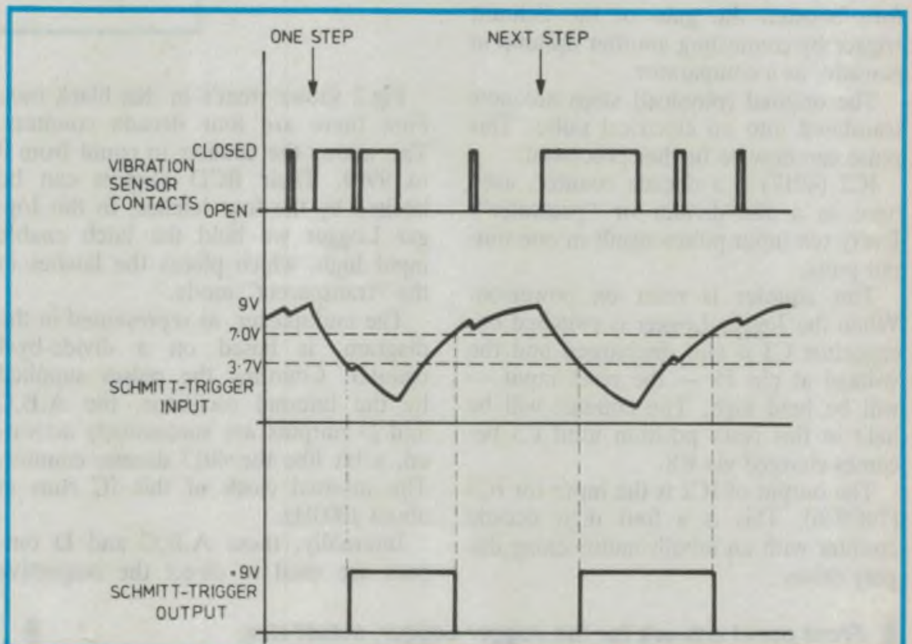


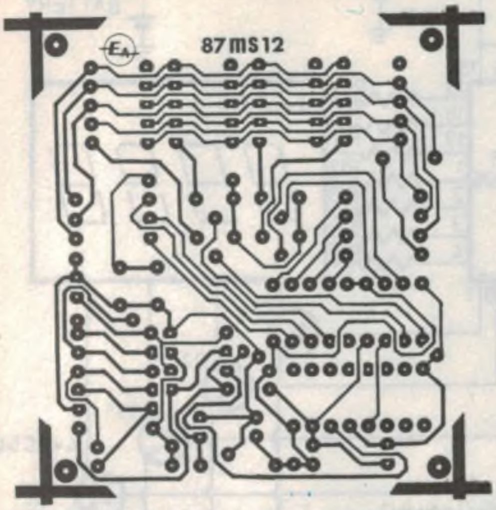
Fig.1: The vibration sensor converts the steps into a digital signal. The contact noise is filtered off and the step pulses are retrieved by the Schmitt trigger.

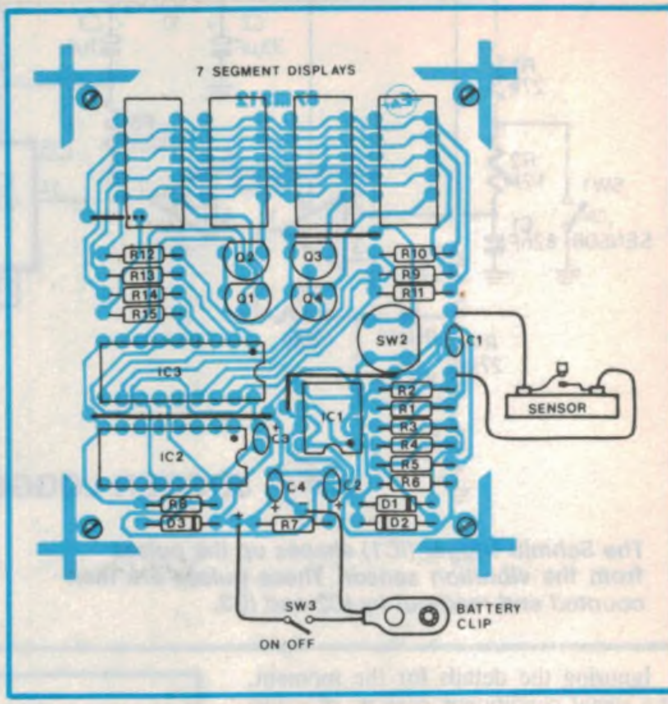
The Schmitt trigger amplifier cancels out this noise. How does it work? Have a look at the amplifier first. Suppose that the input voltage at the inverting input is low and the output is high. The voltage at the non-inverting input is equal to that of the voltage at the upper branch of the voltage divider R3, R4 and R5. Increased with the 0.6V of diode forward voltage drop, this is about 7.0V.

When the voltage at the inverting input exceeds this 7.0V, the output of the op amp will toggle to low. The voltage at the non-inverting input is now supplied by the lower branch of the voltage divider, minus the 0.6V diode voltage, this being 3.7V. In order to toggle the output voltage of the op amp back to high, the voltage at the inverting input has to go under the 3.7V threshold level.

The great advantage of this type of Schmitt trigger amplifier is that the trigger levels can be given any desirable value without having to fiddle with voltage biasing at either the inverting or non-inverting input.

Our prototype still showed some noise around the transitions. We there-





Here's a full size reproduction of the PCB artwork (above). At right are the PCB overlay and wiring diagram.

fore boosted the gain of the Schmitt trigger by connecting another op amp in cascade, as a comparator.

The original (physical) steps are now translated into an electrical pulse. This pulse can now be further processed.

IC2 (4017) is a decade counter, used here as a 10x divider or "prescaler". Every ten input pulses result in one output pulse.

This counter is reset on power-on. When the Jogger Logger is switched on, capacitor C3 is still discharged and the voltage at pin 15 — the reset input — will be held high. The counter will be held in this reset position until C3 becomes charged via R8.

The output of IC2 is the input for IC3 (74C926). This is a four digit decade counter with an inbuilt multiplexing display driver.

Fig.2 shows what's in this black box. First there are four decade counters. This allows the counter to count from 0 to 9999. Their BCD outputs can be latched by the four latches. In the Jogger Logger we hold the latch enable input high, which places the latches in the "transparent" mode.

The multiplexer, as represented in the diagram, is based on a divide-by-4 counter. Counting the pulses supplied by the internal oscillator, the A,B,C and D outputs are successively activated, a bit like the 4017 decade counter. The internal clock of this IC runs at about 1000Hz.

Internally, these A,B,C and D outputs are used to direct the respective contents of the latches to the BCD to 7-segment converter.

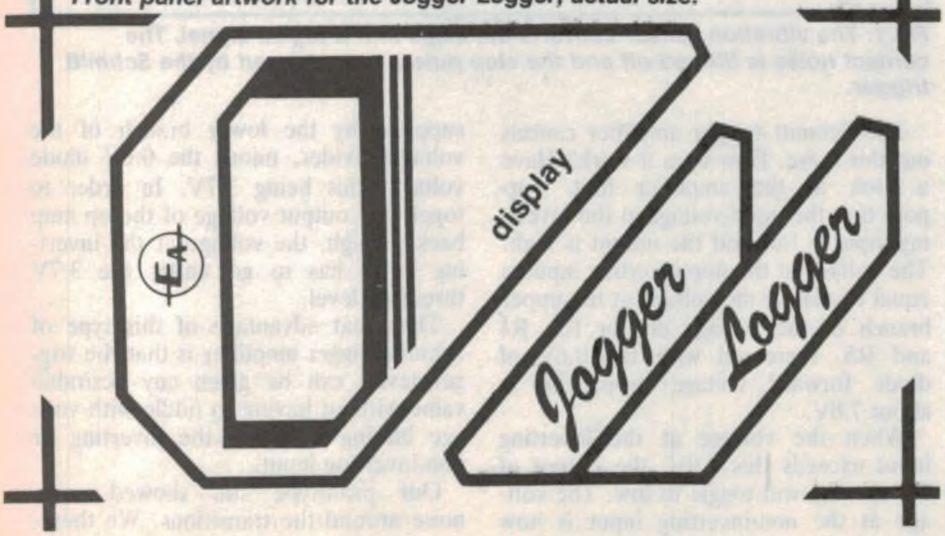
Back to the Jogger Logger, the 7-segment information is fed to all four displays. Using the A,B,C and D outputs of the multiplexer, the cathodes of the displays are only switched on by transistors Q1-Q4 when the 7-segment information applies to that particular display.

As you may know, this is called multiplexing: sending parallel information (4 digits) via a serial link (7-segment control lines) to retrieve the original parallel information (4 digits displayed). The advantage of course is that we only need 11 lines to control the 4 displays, rather than 32 (4 times 8).

When pushed, the display button (SW2) switches the emitters of the transistors to earth. This means that the displays can only be read when this button is pushed, saving us precious battery power as displays tend to consume a lot.

IC3 is reset by the same power-on signal as is used for IC2.

Front panel artwork for the Jogger Logger, actual size.



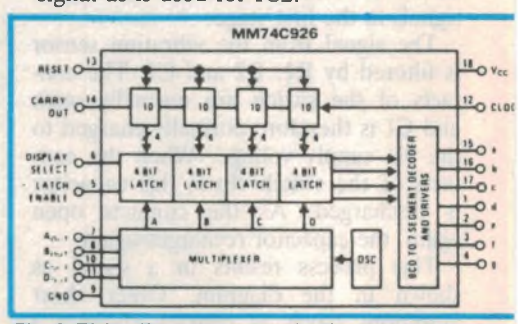


Fig.2 This diagram reveals the secrets of the 74C926, a 4-digit counter and display driver.

Capacitor C4 compensates for the increasing output resistance of an aging battery. The low pass filter R7/C2 filters off the ripples caused by the display multiplexer and supplies a smooth voltage to the signal conditioner stage.

Constructional details

The "brains" of the Jogger Logger are fitted on a printed circuit board (PCB) coded 87ms12. It measures 54 x 62mm. The PCB, battery and vibration sensor are mounted together in a small zippy box.

We managed to keep the Jogger Logger relatively small. As it has to be carried along when jogging, it can't really be small enough. You might have a case which is ideal for the job. You might even consider making a pouch of material, like a money belt. As said, we used a small zippy box, which didn't seem such a bad compromise.

Whichever case you decide to use, the electronics of Jogger Logger need to be constructed first. Looking at the PCB you will notice that there is a lot to be mounted on a small surface. Although the assembly is far from difficult, you should take a bit of extra care when soldering the components to the PCB. There are a lot of tiny tracks close to the component pads and it would fairly easy to bridge certain tracks with a drop of solder. Needless to say, this isn't a good idea.

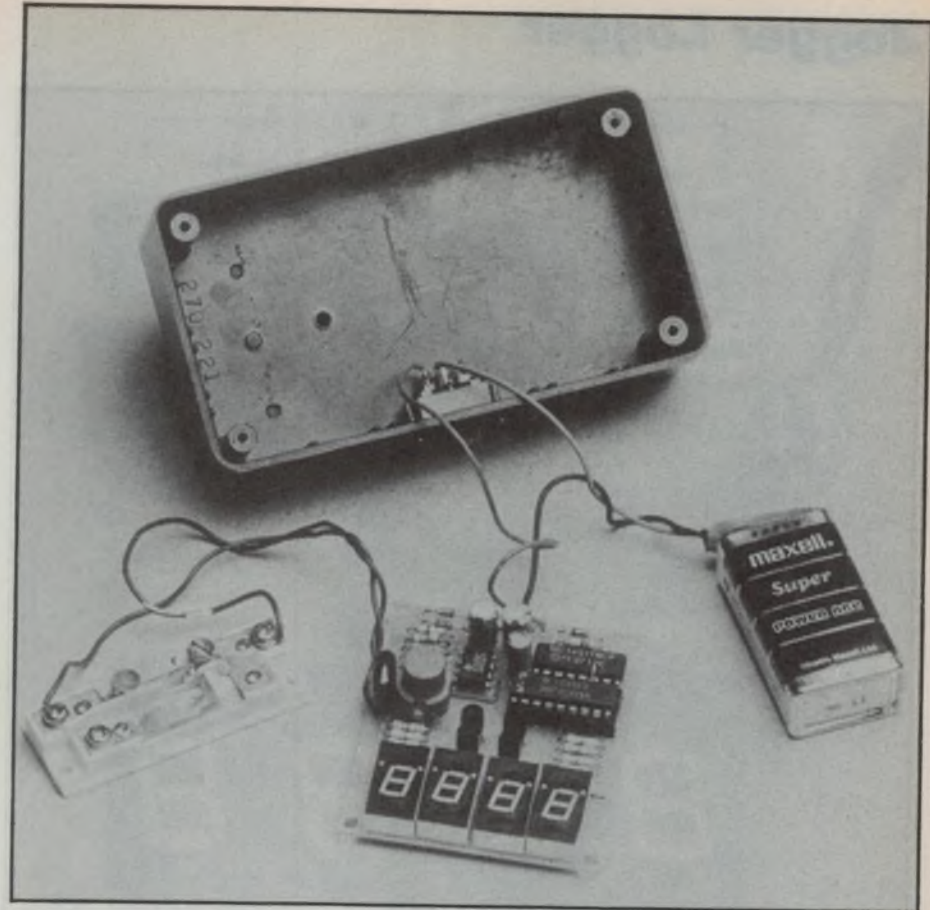
Following the established logic you should start the construction by mounting the wire links. Note that one link "goes around the corner". Next come the resistors, the diodes, and ICs. We mounted IC3 — the dearest of the lot — in an 18 pin socket, rather than solder it in.

After the ICs you should mount the four displays, the transistors and the capacitors. Note the orientation of the ICs, transistors, diodes and the electrolytic capacitors.

The last to mount on the PCB is the push button switch. This switch should be mounted a bit off the PCB, so that it can be pushed down without it touching the resistors nearby.

Having finished the PCB assembly, you should test it before actually mounting in the project case. To do so you'll need to wire the battery clip, on/-off switch and the vibration sensor to the board. The wiring diagram will provide the details.

Looking at the vibration switch, you will see that there are three connections. You should use the two connections at either side of the actual contacts. The third contact is for a tamper switch, but this we did not use.



The Jogger Logger taken to pieces. Note the adjustment screw on the vibration sensor. The PCB is normally mounted to the lid with screws and spacers. The vibration switch is mounted at the upper end of the case, while the battery fits at the lower end.

Before switching on, you should inspect the PCB for accidental shorts or cut tracks. Also recheck the orientation of the components, just to make sure.

Having visually checked the Jogger Logger, you can flip the on/off switch. Push the push button on the PCB and the display should read "0000". If not, switch the unit off and check for errors.

The Jogger Logger can be checked by pushing the contacts of the vibration sensor several times. After ten times, the display should read "0001". Tiring as it may seem, it is worth tapping the sensor at least a thousand times in order to check that all the digits count properly.

Switching the Jogger Logger off and on again should reset the counter.

Having made sure that the electronics function properly, you should now build the PCB into the case. We did not use the plastic cap provided with the vibration sensor; instead we trimmed the sides, to make it fit into the case. Having cut away the last of the plastic ribs inside the case, the sensor fitted tightly between the remaining ribs and the plastic uprights (which connect to the lid).

You should drill a hole (about 5mm diameter) in the case, to provide access to the adjustment screw of the vibration sensor.

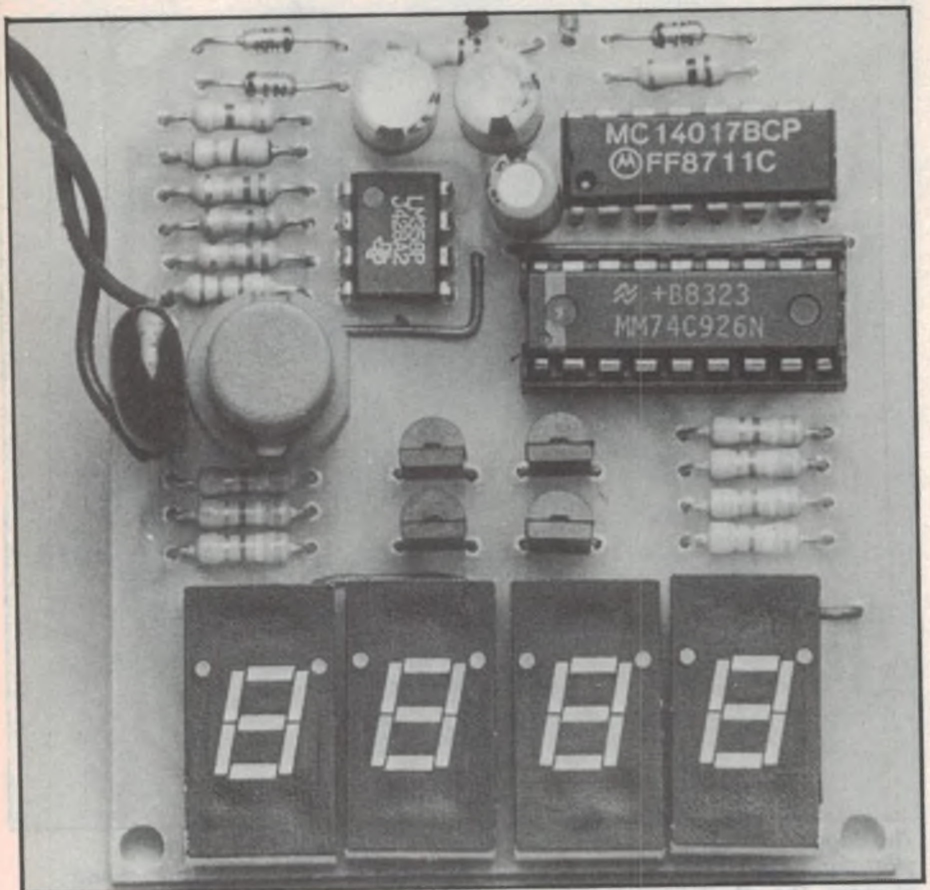
The PCB is connected to the lid using four screws, spacers and appropriate nuts. You'll need to drill holes for the push button and the four mounting screws. The latter should be counter sunk.

The hole for the display we worked out slightly larger than strictly necessary. The panel artwork as shown will then cover all the 'rough' edges. This open space should be filled with red perspex.

The panel artwork also covers the four mounting screws, so make sure that these screws are well tightened before you stick the panel artwork to the lid. We made this artwork out of aluminium Scotchcal.

Finally mount the on/off switch. Put in a battery and firmly screw the lid to the case. The Jogger Logger should now be ready for adjustment.

Jogger Logger



A close up shot of the PCB. In reality it's only half as large.

Preparing the test run

The only adjustable part of the Jogger Logger is the vibration sensor. The adjustment is entirely mechanical and does not involve any high-tech test equipment. The only tool needed is a screwdriver.

Initially, the adjustment screw should be set so that the gap between the sensor contacts is very small. The gap should be a bit less than 0.1mm, which is about the thickness of this page.

Before telling you how to improve this adjustment, we'll discuss the tests we have done with the Jogger Logger. This should give you a clear picture of what the Jogger Logger does, or doesn't.

Performance

Quite a few kilometres have been run with the prototype, with very satisfying results. While testing, we noted the number of step counted by the Jogger Logger and the actual number. Some of the typical results are shown in Table 1 — remember that the Jogger Logger counts in units of 10 steps.

We tested both running and walking with the Jogger Logger, as you can see. The results for running are fairly good. Only on two occasions, the number of counted steps was wrong. The reason for both is the same. When the Jogger Logger shakes more than the body does, it can either count more or less steps. This excessive shaking can occur when the Jogger Logger is carried too loosely in the pocket. As it happened, the side pocket was fairly large.

When walking with the Jogger Logger, the results are all quite different. The Jogger Logger could be used for walking but you might have to experiment a bit, both with the adjustment and the position on the body.

From the test results we can conclude, that the Jogger Logger works well, provided that it is carried the right way. We found that carrying it in the back pocket gave satisfying results. For walking, you might care to try strapping it to the ankle.

Continued on page 137

Actual Steps	Jogger Logger	Comment
300	30	Jogger Logger in back pocket, running on level surface
300	30	Still in back pocket, running uphill.
300	32	Same pocket but running downhill.
200	17	Jogger Logger in side pocket running on level surface.
200	20	Jogger Logger between shorts and stomach, running.
200	20	In back pocket again, running on a rough surface.
300	27	In back pocket but walking (not strolling).
200	11	In side pocket now, and still walking.
200	19	Jogger Logger between shorts and stomach, walking.
200	1	Strolling . . .

PARTS LIST

1 PCB coded 87ms12
1 plastic utility box 30 x 62 x 112
1 vibration sensor (as used in car burglar alarms)
1 PCB mount push button switch
1 miniature SPST switch, or similar
1 aluminium Scotchcal front panel
1 9V battery clip
1 9V battery 216 or similar

Semiconductors

4 LT313 (Z-4103) 7-segment displays 8mm
1 74C926 4-digit counter display driver
1 4017 decade counter
1 LM1458 dual opamp
4 BC547, NPN transistors
3 1N4148 diodes

Capacitors

1 1uF 16VW electrolytic (PC mount)
2 33uF 16VW electrolytic (PC mount)
1 82nF metallised polyester

Resistors (0.25W,5%)

1 x 10, 7 x 330, 3 x 27k, 1 x 47k, 1 x 100k, 1 x 470k, 1 x 1.2M

Miscellaneous

scrap piece of red perspex, glue, hookup wire, solder, screws, nuts, spacers etc.

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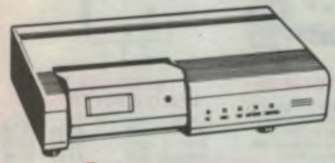

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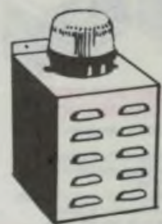

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Dimensions: 135 x 150mm
Flashing Light:
DC 12V
100 flashes per minute
Dimensions: 82 x 100mm

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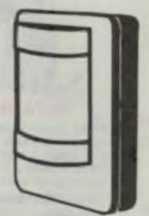

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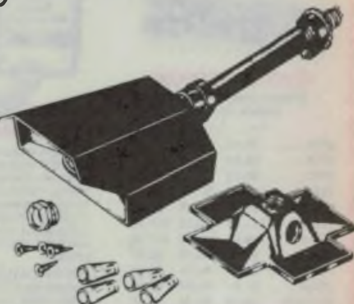

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- Easy installation
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Dimensions: 139 x 165 x 136mm
Exit Delay: 60 seconds approximately
Entry Delay: 12 seconds approximately
Auto reset: 90 Seconds approximately

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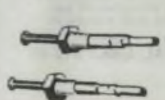

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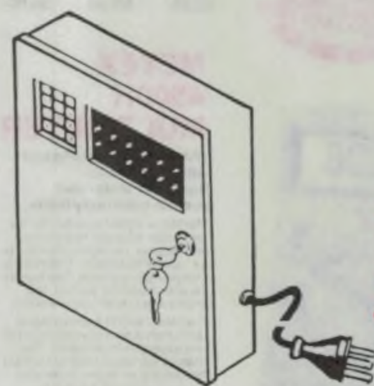

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- ACP3 compatible

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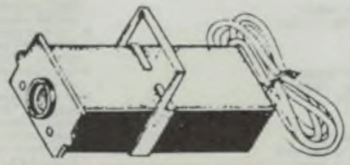

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Always check our prices before you buy!

	1-9	10+	100+
2114	$2.95	$2.75	$2.50
2716	$9.95	$9.50	$8.95
2732	$8.95	$8.50	$7.95
2764	$7.95	$7.50	$6.95
27128	$9.95	$8.95	$7.95
27256	$11.50	$10.50	$10.00
27512	$19.50	$18.50	$17.50
4116	$3.95	$3.50	$2.95
4164	$3.95	$2.95	$2.75
41256	$7.95	$6.95	$5.95
555 8 pin	$0.50	$0.40	$0.35
6116	$3.95	$3.75	$3.50
6264	$7.95	$6.95	$6.50
6802	$5.00	$4.00	$3.75
6821	$2.00	$1.80	$1.70
6845	$5.00	$4.00	$3.75
7406	$0.40	$0.30	$0.25
INS8250	$29.95	$27.95	
NE5534AN	$1.95	$1.85	$1.75
AM/EF7910	$19.95	$18.95	
MEL9501	$29.95	$27.95	
SC141D	$1.75	$1.50	
SC151D	$2.50	$2.25	
555	$0.40	$0.38	
741	$0.50	$0.45	

8087

Genuine Intel chips with manual and data sheets packed in boxes!

8087-3 (4.77MHz)	$269
8087-2 (8MHz)	$385
8087-1 (10MHz)	$585
80287-6 (6MHz)	$475
80287-7 (8MHz)	$679

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 .... **$94.95**

ROTATING LIGHT

Motor driven rotating reflecting mirror with a flash rate of about 150 per minute. Large lens fit right to base, making unit weatherproof. Spare globe included.

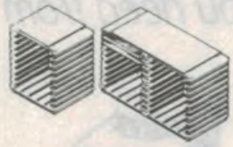
SPECIFICATIONS:
- Available in Blue or Orange
- 150 Revolutions per minute (approximately)
- Shock absorbing rubber mounting legs
- Connecting wire fitted through base
- 12V DC 750mA
- Base diameter: 102mm Height: 140mm

A15042 Blue **$42.95**
A15043 Orange .. **$42.95**

CENTRONICS PLUG SPECIAL!

36 WAY MALE (P12200)

1-9	10+	100+
$3.95	$3.50	$3.00



COMPACT DISC STORAGE UNITS

- Holds 10/20 compact discs in their cases
- Interlocking modular design allows vertical and horizontal interlocking
- Discs slide into place horizontally making titles easy to read
- Wall mount or free standing

A10031 (10 discs) **$12.95**
A10032 (20 discs) **$19.95**

FREE STANDING, FOLD UP MAGNIFIER

An economically priced "hands free" magnifier, lets you take care of all those tricky fine detailed jobs so often encountered in electronics, or any of many other practical uses such as home, work, hobbies etc.

Cat. T10020 **Normally $14.95**
SPECIAL, ONLY $12.95

RS232 FAST CABLER

Makes RS232 interface configurating fast and simple. 3 slide switches enable line swapping functions, positive and negative voltages are displayed on 6 tricolour LED's.

SPECIFICATIONS:
Connector: DB25 plug on 100mm cable and DB25 socket on 100mm cable.
Indicators: Tricolour LED's for pins 2(TD), 3(RD), 4(RTS), 5(CTS), 6(DSR), 20(DTR).
Switches: 3 Slide switches to swap leads.
Power: Interface power.
Enclosure: Black, high impact plastic.
Dimensions: 85 x 95 x 30mm.
X15710 .... **$145**

CORDLESS RECHARGEABLE SOLDERING IRON

- Built in solder point illumination
- Easy replacement of solder tip
- Protective stand which also functions as charging unit
- Sponge pad attach to stand
- Plug pack power adaptor
- Includes Nicad battery
- Instruction manual
- 12 months warranty

Cat. T12480 Normally $79.95
SPECIAL, $69.95

SPECTROL 64Y MULTI TURN TRIMPOTS

Cat No	Description	1-9	10+
R14700	10R	$3.50	$3.20
R14710	20R	$3.50	$3.20
R14720	50R	$3.50	$3.20
R14730	100R	$3.50	$3.20
R14740	200R	$3.50	$3.20
R14750	500R	$3.50	$3.20
R14760	1K	$3.50	$3.20
R14770	2K	$3.50	$3.20
R14780	5K	$3.50	$3.20
R14790	10K	$3.50	$3.20
R14800	20K	$3.50	$3.20
R14810	50K	$3.50	$3.20
R14820	100K	$3.50	$3.20
R14830	200K	$3.50	$3.20
R14840	500K	$3.50	$3.20
R14850	1M	$3.50	$3.20

UV EPROM ERASER

Erase your EPROMs quickly and safely. This unit is the cost effective solution to your problems. It will erase up to 9 x 24 pin devices in complete safety, in about 40 minutes (less for less chips).
Features include:
- Chip drawer has conductive foam pad
- Mains powered
- High UV intensity at chip surface ensures EPROMs are thoroughly erased
- Engineered to prevent UV exposure
- Dimensions 217 x 80 x 68mm

WITHOUT TIMER
Cat. X14950 Normally $119
Special, $99

WITH BUILT-IN TIMER
Cat. X14955 $139
Special, $119

METEX M-3650 MULTIMETER

20A, 3½ digit frequency counter multimeter with capacitance meter and transistor tester.

This spectacular rugged and compact DMM has a bright yellow high impact plastic case. It features a frequency counter (to 200kHz), diode and transistor test, continuity (with buzzer), capacitance meter, up to 20 amp current measurement and comprehensive AC/DC voltage current and resistance ranges.

CHECK THESE FEATURES...
- Push-button ON/OFF switch
- Audible continuity test
- Single function, 30 position easy to use rotary switch for FUNCTION and RANGE selection
- Transistor test
- Diode test
- Quality probes
- ½" High contrast LCD
- Full overload protection
- 20 Amp
- Built in tilting bail
- Capacitance meter
- Instruction manual

SPECIFICATIONS:
DC VOLTAGE:
Range: 200mV, 2V, 20V, 1000V
Resolution: 100uV, 1mV, 10mV, 100mV, 1V
Accuracy: 200mV - 1000V ± 0.3% ± 1 digit
AC VOLTAGE:
Range: 200mV, 2V, 20V, 200V, 750V
Resolution: 100uV, 1mV, 10mV, 100mV, 1V
Accuracy: 200mV - 200V ± 0.8% rdg +3 digits
750V ± 1.2% rdg +3 digits
Input Impedance: 10M ohm
DC CURRENT:
Range: 200uA, 2mA, 20mA, 200mA, 20A
Resolution: 100nA, 1nA, 10uA, 100uA, 10mA
Accuracy: 200uA - 20mA ± 0.5% rdg +1 digit
200mA ± 1.2% rdg +gt
10A ± 2% rdg +5 digits (10A range unfused)
Max. I/P Amps: 10A (20A up to 60 seconds)
AC CURRENT:
Range: 2mA, 20mA, 200mA, 10A
Resolution: 1uA, 10uA, 100uA, 10mA
Accuracy: 2mA - 20mA ± 1% rdg +3 digits
200mA ± 1.8% rdg +3 digits
10A ± 3% rdg +7 digits (10A range unfused)
RESISTANCE:
Range: 200, 2k, 20k, 200k, 2M, 20M ohms
Resolution: 0.1, 1, 10, 100, 1k, 10k ohms
Accuracy: 200 ohm ± 0.5% rdg +3 digits
2k ohm - 2M ohm ± 0.5% rdg +1 digit
20M ohm ± 0.5% rdg +2 digits
Overload: 200 ohm 250V DC/AC rms, 2k-20M ohm 500V
Protection: DC/AC rms
CAPACITANCE:
Range: 200nF, 2uF, 20uF
Resolution: 100pF, 1nF, 10nF
Accuracy: 200nF-uF ± 3% +5 digits
FREQUENCY RANGE: 0-20kHz, 0-200kHz
Cat. Q91550 .... SAVE $16, **Special $149**

METEX 4500H MULTIMETER

10A, 4½ digit multimeter with digital hold, transistor tester and audible continuity tester.

The Metex 4500H is perfect for the technician, engineer or enthusiast who requires the higher accuracy of a 4½ digit multimeter. This meter is exceptionally accurate, (just look at the specifications), and yet, still retains an exceptionally low price!

The Metex 4500H features digital hold which is normally only found on very expensive multimeters. This enables you take a reading and hold that reading on display even after you have removed the probes, simply by pressing the hold button.

CHECK THESE FEATURES
- Readout hold
- Transistor Tester
- 4½ digit x ½"(H) LCD
- Audible continuity tester
- Push-button ON/OFF switch
- Quality set of probes
- Single function, 30 position easy to use rotary switch for FUNCTION and RANGE selection
- Built in tilting bail
- Instruction manual
- Full overload protection
- hFE test
- Battery and Spare fuse
- Diode Tester
- Vinyl case

SPECIFICATIONS:
DC VOLTAGE:
Range: 200mV, 2V, 20V, 1000V
Resolution: 10uV, 100uV, 1mV, 10mV, 100mV
Accuracy: 200mV - 1000V ± 0.05% rdg +3 digits
Input Impedance: 10M ohms
AC VOLTAGE:
Range: 200mV, 2V, 20V, 200V, 750V
Resolution: 10uV, 100uV, 1mV, 10mV, 100mV
Accuracy: 200mV - 200V ± 0.5% rdg +10 digits
750V ± 0.8% rdg +15 digits
Input Impedance: 10M ohm
DC CURRENT:
Range: 200uA, 2mA, 20mA, 200mA, 2A, 10A
Resolution: 10nA, 100nA, 1uA, 10uA, 100uA, 1mA
Accuracy: 200uA - 20mA ± 0.3% rdg +3 digits
200mA - 2A ± 0.5% rdg +3 digits
10A ± 1% rdg +5 digits (10A range unfused)
Max. I/P Amps: 10A (20A up to 60 seconds)
AC CURRENT:
Range: 200uA, 2mA, 20mA, 200mA, 2A, 10A
Resolution: 1nA, 10nA, 1uA, 10uA, 100uA, 1mA
Accuracy: 200uA - 20mA ± 0.8% rdg +10 digits
200mA - 2A ± 1% rdg +10 digits
10A ± 1.5% +5 digits (10A range unfused)
Max I/P Amp: 10A (20A up to 60 seconds)
RESISTANCE:
Range: 200, 2k, 20k, 2M, 20M ohms
Resolution: 10m ohm, 100m ohm, 1, 10, 100, 1k ohms
Accuracy: 200 ohm ± 0.2% rdg +5 digits
2k ohm - 2M ohm ± 0.1% rdg +3 digits
20M ohm ± 0.5% rdg +5 digits
OVERLOAD PROTECTION: 200 ohm 250V DC/AC rms, 2k-20M ohm 500V DC/AC rms
Cat. Q91560 .... Save $16, **Special $159**

METEX 3800 MULTIMETER

This instrument is a compact, rugged, battery operated, hand held 3½ digit multimeter for measuring DC and AC voltage, DC and AC current, Resistance and Diode, for testing Audible continuity and transistor hFE. The Dual-slope A-D Converter uses C-MOS technology for auto-zeroing, polarity selection and over-range indication. Full overload is provided. It is an ideal instrument for use in the field, laboratory, workshop, hobby and home applications.

Features:
- Push-button ON/OFF power switch
- Single 30 position easy to use rotary switch for FUNCTION and RANGE selection
- ½" high contrast LCD
- Automatic over-range indication with the "1" displayed
- Automatic polarity indication on DC ranges
- All ranges fully protected plus Automatic "ZERO" of all ranges without short circuit except 200 ohm Range which shows "000 or 001"
- High Surge Voltage protection 1.5 KV-3 KV
- Diode testing with 1 mA fixed current
- Audible Continuity Test
- Transistor hFE Test

SPECIFICATIONS
Maximum Display: 1999 counts 3½ digit type with automatic polarity indication.
Indication Method: LCD display
Measuring Method: Dual-slope in A-D converter system
Over-range Indication: "1" Figure only in the display
Temperature Ranges: Operating 0-C to +40-C
Power Supply: one 9 volt battery (006P or FC-1 type of equivalent)
Cat. Q91530 **Normally $109**
SPECIAL $79

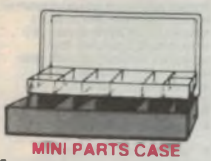
METEX 3530 MULTIMETER

This instrument is a compact, rugged, battery operated, hand held 3½ digit multimeter for measuring DC and AC voltage, DC and AC current, Resistance and Diode, Capacitance, Transistor hFE and Continuity Test. The Dual-slope A-D Converter uses C-MOS technology for auto-zeroing, polarity selection and over-range indication. Full overload is provided. It is an ideal instrument for use in the field, laboratory, workshop, hobby and home applications.

Features
- Push-button ON/OFF power switch
- Single 30 position easy to use rotary switch for FUNCTION and RANGE selection
- ½" high contrast LCD
- Automatic over-range indication with the "1" displayed
- Automatic polarity indication on DC ranges
- All ranges fully protected plus Automatic "ZERO" of all ranges without short circuit except 200 ohm Range which shows "000 or 001"
- High Surge Voltage protection 1.5 KV-3 KV
- Capacitance measurements to 1pF
- Diode testing with 1 mA fixed current
- Audible Continuity Test
- Transistor hFE Test

SPECIFICATIONS
Maximum Display: 1999 counts 3½ digit type with automatic polarity indication.
Indication Method: LCD display
Measuring Method: Dual-slope in A-D converter system
Over-range Indication: "1" Figure only in the display
Temperature Ranges: Operating 0-C to +40-C
Power Supply: one 9 volt battery (006P or FC-1 type of equivalent)
Cat. Q91540 **Normally $139**
SPECIAL $109

ROD IRVING ELECTRONICS!!



MINI PARTS CASE

Features a clear plastic lid for easy identification of contents. Up to five, adjustable lower compartments plus a self elevating upper tray for smaller items.
Dimensions: 110 x 210 x 43mm
Cat. H10087 .... $9.95

COMMODORE EDGE CONNECTOR

.156" spacing, 12/24 contacts

Cat.No.	1-9	10+
P10973	$5.95	$4.95

2¼" MINI SPEAKERS (57mm)

Cat.No.	1-9	10+
C10610	$1.95	$1.75

KEY SWITCHES

Cat. S12500 Normally $7.95

1-9	10+	25+
$4.95ea	$4.25ea	$3.95ea

CANNON TYPE CONNECTORS SPECIALS

Cat. No. Description	Price
P10960 3 pin line male	
Was $3.90	NOW $2.90
P10962 3 pin chasis male	
Was $3.00	NOW $2.40
P10964 3 pin line female	
Was $4.50	NOW $3.25
P10966 3 pin chasis female	
Was $4.95	NOW $3.45

COMPUTER CABLE

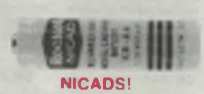
CIC6 6 conductor computer interface cable. Colour coded with braided shield (to IE422 specifications). Copper conductor 6 x 7/0.16mm
1-9 metres **$1.90/m** — 10+ metres **$1.70/m**

CIC9 100 9 conductor computer interface cable. Colour coded with mylar shielding. 9 x 7/0.16mm
1-9 metres **$2.50/m** — 10+ metres **$1.95/m**

CIC12 12 conductor computer interface cable. Colour coded with mylar shielding. 12 x 7/0.16mm
1-9 metres **$2.70/m** — 10+ metres **$2.50/m**

CIC16 16 conductor computer interface cable. Colour coded with mylar shielding. 16 x 7/0.16mm
1-9 metres **$3.90/m** — 10+ metres **$3.40/m**

CIC25 25 conductor computer interface cable. Colour coded with mylar shielding. 25 x 7/0.16mm
1-9 metres **$4.90/m** — 10+ metres **$4.40/m**



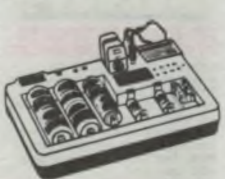
NICADS!

Save a fortune on expensive throw away batteries with these quality Nicads and Rechargers!

Size	Desc.	1-9	10+	100+
AA	450 mA.H.	$2.95	$2.75	$2.50
C	1.2 A.H.	$9.95	$9.50	$8.95
D	1.2 A.H.	$9.95	$9.50	$8.95

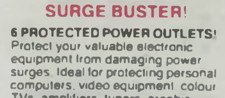
UNIVERSAL BATTERY CHARGER AND TESTER

Save money on expensive batteries with this universal battery charger. Features include meter tester, and provisions for D, C, AA, AAA, N, button and cell batteries, 9V and 6V (square types). Comes complete with detailed instructions.
Cat. M23533 .... $29.95



DELUXE UNIVERSAL BATTERY CHARGER AND TESTER

Save money on expensive batteries with this universal battery charger. Features include meter tester, and provisions for up to 8 pieces of any size, (D, C, AA or AAA type batteries) at once, plus positions for a button and cell battery. Two times 9V and one times N type batteries. Recharging lead with alligator clips, 9V clip and 4-way universal. Select currents from 2.5-3V 150mA 1.2-1.5V 80mA 1.2-1.5V 25mA 6-9V 14mA, 12V 50mA. Includes detailed instructions.
Cat. M23535 .... $49.95



SURGE BUSTER!

6 PROTECTED POWER OUTLETS!
Protect your valuable electronic equipment from damaging power surges. Ideal for protecting personal computers, video equipment, colour TVs, amplifiers, tuners, graphic equalisers, CD players etc.

SPECIFICATIONS:
Electrical rating: 240V AC, 50Hz, 10A
Complies with Australian Standards Approval number N10084
3 x Metal Oxide Varistors (MOV)
Surge/Spike Rating (each MOV) 4,500 amps (8x 20us)
Energy Absorbtion Factor each MOV 75 joules (10 x 1000us)
Maximum Clamping Voltage each MOV 710 volts at 50 amps
Response time: Less than 25 Nanoseconds
X10086
Normally $69.95
Introductory price $47.95

HIGH EFFICIENCY RADIAL FIN HEATSINK

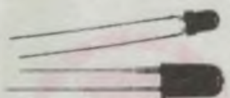
Black anodised with a thick base plate, this radial fin heatsink can dissipate large amounts of heat for maximum efficiency.
Designed by Rod Irving.

H10520	105 x 30mm	$ 3.50
H10525	105 x 75mm	$ 4.95
H10529	105 x 100mm	$ 5.50
H10534	105 x 140mm	$ 7.90
H10535	105 x 150mm	$ 8.90
H10538	105 x 170mm	$ 9.95
H10542	105 x 195mm	$10.95
H10543	105 x 200mm	$10.95
H10546	105 x 225mm	$11.95
H10549	105 x 300mm	$12.95
H10560	105 x 600mm	$26.95

WELLER WTCPN SOLDERING STATION

The WTCPN Features:
- Power Unit 240 V AC
- Temperature controlled iron, 24 V AC
- Flexible silicon lead for ease of use
- Can be left on without fear of damaged tips!

The best is always worth having.
Cat. T12500 R.R.P. $149
SPECIAL, ONLY $129



QUALITY 3mm LEDS

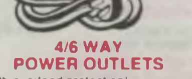
Cat. No.	Col.	1-9	10+	100+
Z10140	Red	$0.15	$0.12	$0.10
Z10141	Grn	$0.20	$0.15	$0.12
Z10143	Ylw	$0.20	$0.15	$0.12
Z10145	Ora	$0.20	$0.15	$0.12

QUALITY 5mm LEDS

Cat. No.	Col.	1-9	10+	100+
Z10150	Red	$0.10	$0.09	$0.08
Z10151	Grn	$0.15	$0.12	$0.10
Z10152	Ylw	$0.15	$0.12	$0.10

CLICK AUTOMATIC NIGHTLIGHT

For safety and security around the home and at work, this clever little Australian made nightlight can't be beaten. The light sensitive sensor cell automatically switches on at dusk and off at dawn (or whenever the the ambient light level is very low). And Click's nightlight costs less than 1 cent per day to operate!
A15058 .... $19.95



4/6 WAY POWER OUTLETS

With overload protection!
4 Way (P18040) ~~$14.95~~ $7.95
6 Way (P18042) ~~$19.95~~ $12.95

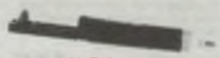
ARLEC SUPER TOOL

A versatile 12V electric tool for:
- Sanding
- Engraving
- Grinding
- Polishing
- Cutting
- Drilling
- Milling
- Erasing, etc

Features:
Operates on safe, low 12 volts from mains electricity via AC adaptor (supplied). Light and easy to handle with touch switch and lock for continuous running. High torque motor: 10,000 R.P.M. Can drill 2mm holes in steel. 2 year guarantee.

Contents:
- 12V Super Tool
- Plugpack AC adaptor
- 1 spherical milling cutter
- 1 wire brush
- 1 grinding wheel
- 4 drill bits, 0.6, 0.8, 1.0, 1.2mm
- Set of 5 chuck collets
- 6 eraser sticks
- Instruction sheets

Cat. T12300 .... $59.95



ANTISTATIC SOLDER SUCKER

- Light weight
- Sturdy construction
- Easy to remove tip
- Excellent value for money!

Cat. T11281 .... $13.95

DB25 CONNECTOR SPECIALS!

We have just imported 50,000. So you get to save a small fortune!

DB25 MALE (P10900)

1-9	10+	100+
$1.00	$0.90	$0.80

DB25 FEMALE (P10901)

1-9	10+	100+
$1.20	$1.00	$0.90

VOLTAGE REGULATORS BARGAINS

Description	1-9	10+
7805UC	$0.50	$0.45
7812UC	$0.50	$0.45
7815UC	$0.50	$0.45
7905UC	$0.60	$0.55
7912UC	$0.60	$0.55
7915UC	$0.60	$0.55
78L05	$0.45	$0.40
78L12	$0.45	$0.40
LM324	$1.00	$0.90
555	$0.40	$0.38
741	$0.50	$0.45

PHILIPS SPEAKERS

"Unfortunately we cannot always guarantee Philips speakers to be in stock due to availability problems nor can we guarantee the exact models listed. However, Philips equivalent or better will be supplied."
-Rod

Description	Cat.No.	Price
AD01610T8	(C12030)	$24.95
AD02160SQ8	(C12040)	$69.95
AD80652W8	(C12042)	$69.95
AD070620M8	(C12045)	$69.95
AD12250W8	(C12050)	$129.00

20% OFF THE PRICE OF SPECTROL MULTIDIALS

MODEL 15-1-11

Number of turns: 10
Minor Scale Division: 1/500 turn
Shaft Bore: 6.35mm (¼")
Finish: Satin Chrome
Body Size: 25.4 x 44.45mm (1 x 1¾")
Depth: 25.4mm (1")
Weight: 45.4g (1.6oz.)
Cat. R14405 .... $45.95
SPECIAL, $35.95

MODEL 16-1-11

Number of turns: 15
Minor Scale Division: 1/50 turn
Shaft Bore: 6.35mm (¼")
Finish: Clear Anodize
Body Size: 22.2mm diameter (.875")
Depth: 22.2mm (.875")
Weight: 19.8g (0.7oz.)
Cat. R14400 .... $26.95
SPECIAL, $21.50

MODEL 21-1-11

Number of turns: 15
Minor Scale Division: 1/100 turn
Shaft Bore: 6.35mm (¼")
Finish: Satin Chrome
Body Size: 46.04mm diameter (1.812")
Depth: 25.4mm (1")
Weight: 85.g (3oz.)
Cat. R14410 .... $46.95
SPECIAL, $37.50

10 TURN WIRE WOUND POTENTIOMETER
Spectrol Model 534
¼" shaft.

Equiv (Bourns 3540S, Beckman 7256)
Dials to suit 16-1-11, 18-1-11, 21-1-11

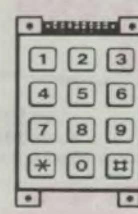
R14050	50R	R14100	5K
R14055	100R	R14110	10K
R14060	200R	R14120	20K
R14070	500R	R14130	50K
R14080	1K	R14140	100K
R14090	2K		

1-9	10+
$9.95	$9.50

10 AMP RELAY

S.P.D.T. 12V Coil, 240V (S14114)

1-9	10+	100+
$4.95	$3.95	$3.75



NUMERIC KEYPAD

Unencoded keypad, 10 digit keys plus two utility keys. Light grey in colour.

OUTPUT ARRANGEMENT:

Output Pin N°	Symbol
1	N.A
2	Shieldplate
3	Column 2
4	Row 4
5	Column 3
6	Row 1
7	Column 1
8	Row 2
9	Row 3
10	N.A

Cat. C19030

1-9	10+	100+
$2.95	$2.50	$1.95

TOGGLE SWITCHES

Cat.No.	Descript.	1-9	10+
S11010	S.P.D.T.	$0.90	$0.80
S11020	D.P.D.T.	$1.10	$1.00

3M DYNAMARK PHOTOSENSITIVE
(EX SCOTCHCAL)

All prices per box and include tax

8007 REVERSAL FILM
250 x 300mm (10 sheets) ... $39.95
300 x 600mm (5 sheets) ... $54.95

8005 BLACK ALUMINIUM
250 x 300mm (10 sheets) ... $69.95
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250 x 300mm (10 sheets) ... $69.95
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250 x 300mm (10 sheets) ... $64.95
300 x 600mm (5 sheets) ... $74.95

8015 BLACK/WHITE
250 x 300mm (10 sheets) ... $64.95
300 x 600mm (5 sheets) ... $74.95

8016 BLUE/WHITE
250 x 300mm (10 sheets) ... $64.95
300 x 600mm (5 sheets) ... $74.95

8018 GREEN/WHITE
250 x 300mm (10 sheets) ... $64.95
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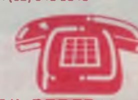

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(TOLL FREE)
(STRICTLY ORDERS ONLY)

LOCAL ORDERS & INQUIRIES
(03) 543 7877

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$1	$9.99	$2.00
$10	$24.99	$3.00
$25	$49.99	$4.00
$50	$99.99	$5.00
$100	$199	$7.50
$200	$499	$10.00
$500 plus		$12.50

The above postage rates are for basic postage only. Road Freight, bulky and fragile items will be charged at different rates.

All sales tax exempt orders and wholesale inquiries to:
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Ph. (03) 543 2166 (3 lines)

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SERIES 5000

INDIVIDUAL COMPONENTS TO MAKE UP A SUPERB HIFI SYSTEM!

By directly importing and a more technically orientated organisation, ROD IRVING ELECTRONICS can bring you these products at lower prices than their competitors. Enjoy the many other advantages of RIE Series 5000 kits such as "Superb Finish" front panels at no extra cost, top quality components supplied throughout. Over 1,500 sold!

For those who haven't the time and want a quality hi-fi, we also sell the Series 5000 kits assembled and tested.

POWER AMPLIFIER

WHY YOU SHOULD BUY A "ROD IRVING ELECTRONICS" SERIES 5000 POWER AMPLIFIER

- 1% Metal Film resistors

SPECIAL, ONLY $399 SAVE $50

...and developed by ROD IRVING ELECTRONICS and is being supplied to other kit suppliers.

SPECIFICATIONS: 150 W RMS into 4 ohms (per channel)
POWER AMPLIFIER: 100W RMS into 8 ohms (+ − 55V Supply)
FREQUENCY RESPONSE: 8Hz to 20Hz +0= 0.4 dB 2.8Hz to 65KHz, +0=3 dB. NOTE: These figures are determined solely by passive filters
INPUT SENSITIVITY: 1 V RMS for 100W ouput
HUM: 100 dB below full output (flat)
NOISE: 116 dB below full output (flat, 20KHz bandwidth)
2nd HARMONIC DISTORTION: 0.001% at 1 KHz (0.0007% on Prototypes) at 100W ouput using a + = 56V SUPPLY rated at 4A continues 0.0003% for all frequencies less than 10KHz and all powers below clipping
TOTAL HARMONIC DISTORTION: Determined by 2nd Harmonic Distortion (see above)
INTERMODULATION DISTORTION: 0.003% at 100W (50Hz and 7KHz mixed 4:1)
STABILITY: Unconditional

Cat. K44771 .... **$449**
Assembled and tested $599
packing and post $10

PREAMPLIFIER

THE ADVANTAGES OF BUYING A "ROD IRVING ELECTRONICS" SERIES 5000 PREAMPLIFIER

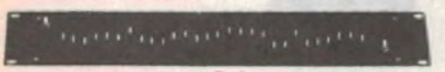
- 1% Metal Film

SPECIAL, ONLY $359 SAVE $40

...believe that dollar for ...commercial unit available that sounds as

SPECIFICATIONS:
FREQUENCY RESPONSE: High-level input: 15Hz = 130KHz, +0 = 1dB. Low-Level input-conforms to RIAA equalisation + = 0.2dB
DISTORTION: 1KHz 0.003% on all inputs (limit of resolution on measuring equipment due to noise limitation)
S/N NOISE: High-Level input, master full, with respect to 300mV input signal at full output (1.2V) 92dB flat 100dB A-weighted. MM input, master full, with respect to full output (1.2V) at 5 mV input 50ohms source resistance connected 86dB flat/92dB A-weighted MC input master full, with respect to full output (1.2V) and 200uV input signal: 71dB flat 75dB A-weighted

Cat. K44791 .... **$399**
Assembled and tested $699
packing and postage $10



THIRD OCTAVE GRAPHIC EQUALIZER

SPECIFICATIONS:
BANDS: 28 Bands

SPECIAL, ONLY $209 SAVE $30

Cat. K44590 .... 1 unit: **$239**
.... 2 units: **$429**
packing and postage $10

SERIES 4000 SPEAKERS

8 Speakers .... only **$549**
8 Speakers with Crossovers **$795**
Speaker Cabinet Kit (complete) **$395**
(Please specify cabinet to suit 7" or 8" mid range woofer)
Crossover Kits **$295**
Complete kit of parts (speakers, crossovers, screws, innerband boxes) **$1,095**
Assembled, tested and ready to hook up to your system **$1,295**
(Approximately 4 weeks delivery)

Errors and Ommissions Excepted

PARABOLIC MICROPHONE

Build a low cost parabola, along with a high gain headphone amplifier to help when listening to those natural activities such as babbling brooks, singing birds or perhaps even more sinister noises. The current cost of componenets for this project is around $15 including sales tax, but not the cost of batteries or headphones (EA Nov 83) 83MA11
Cat. K83110 .... **$14.95**

1W AUDIO AMPLIFIER

A low-cost general-purpose 1 watt audio amplifier, suitable for increasing your computers audio level, etc. (EA Nov. 84)
Cat. **$9.95**

EA AM STEREO DECODER

AM stereo is now broadcast in Australia on an experimental basis. This add-on decoder works with the Motorola C-QUAM system. (EA Oct. 84) 84MS10
Cat. K84100 .... **$26.95**

PLAYMASTER 300 WATT AMPLIFIER

This module will deliver up to 200 watts into an 8 ohm load and up to 300 watts into a 4 ohm load. Comprehensive protection is included and a printer circuit board brings it all together in a rugged easy-to-build module. It can be built in either fully-complementary or quasi-complementary versions, so output transistor shortages should be no problem at all.
(80PA6) (EA July 80)
Cat. K80060 .... Normally $109
SPECIAL, ONLY $99
(Heatsink not included)

SERIES 4000 STEREO PREAMP

This high performance project is designed to complement ETI's 60 watt low distortion amplifier module and forms part of a complete stereo system the "Series 4000" project. (ETI 471)
(Top Projects Vol. 6)
Cat. K44710 .... **$59.95**

GENERAL PURPOSE PREAMPLIFIER

A general purpose stereo preamplifier using a single LM382 IC which can be tailored for use with magnetic pickups, tape recorders or microphones by changing a few components. (ETI445) (ETI July '76)
Cat. K44490 .... **$9.95**

OP AMP TESTER

The Op Amp Tester which could save you hours in agonising whether that old op amp thats been sitting in the draw for the last year.
(ETI April 85, ETI 183)
Cat. K41830 .... Normally $26.50
SPECIAL, $21.50

150W MOSFET POWER AMPLIFIER

Here's a high power, general purpose 150W Mosfet Power Amp Module! Suitable for guitar and P.A. applications and employing rugged, reliable Mosfets in the output stage. (ETI 499) (ETI March '82)
Cat. K44990 .... **$97.50**
(Heatsink not included)
plus transformer **$49.50**

SUPERB VIFA/EA 60 + 60 SPEAKER KIT!

The Vifa/EA 60 + 60 loudspeaker kit has been designed to completely out perform any similarly priced speakers. This is a 2-way design incorporating drivers which give a deeper, more natural bass response and 19mm soft-dome ferro fluid cooled tweeters which provide clear, uncoloured sound reproduction.

These Vifa drivers are identical to the ones used in such fine speakers as Mission, Rogers, Bang & Olufsen, Monitor Audio and Haybrook just to name a few. Some of which cost well over $1,000 a pair!

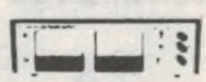
The dividing network is of the highest quality and produce no inherent sound characteristics of their own: they simply act as passive devices which accurately distribute the frequency range between both drivers in each speaker.

The fully enclosed acoustic suspension cabinets are easily assembled. All you need are normal household tools and a couple of hours and you've built yourself the finest pair of speakers in their class!

D19 TWEETER SPECIFICATIONS:
Nominal Impedance: 8 ohms
Frequency Range: 2.5 - 20KHz
Free Air Resonance: 1,700Hz
Sensitivity 1W at 1m: 89dB
Nominal Power: 80 Watts (to 5,000Hz, 12dB/oct)
Voice Coil Diameter: 19mm
Voice Coil Resistance: 6.2 ohms
Moving Mass: 0.2 grams
Weight: 0.28kg
Cat. C10301 .... **$38**

C20 WOOFER SPECIFICATIONS:
Nominal Impedance: 8 ohms
Frequency Range: 35 - 6,000Hz
Resonance Frequency: 39Hz
Sensitivity 1W at 1m: 90dB
Nominal Power: 50 Watts (12dB/oct)
Voice Coil Diameter: 25mm
Voice Coil Resistance: 5.5 ohms
Moving Mass: 15 grams
Cat. C10322 .... **$89**

Cat. K86092 (speakers only) **$379**
Cat. K86091 (complete kit) **$449**



50V 5A LABORATORY POWER SUPPLY

New switchmode supply can deliver anywhere from three to 50V DC and currents of 5A at 35V or lower. Highly efficient design.
(Ea May June 83) 83PS5
Cat. K83050 .... **$199**

50 W AMPLIFIER MODULE (ETI 480)

Cat. K44880 .... **$31.80**
(Heatsink optional extra)

100 W AMPLIFIER MODULE (ETI 480)

Cat. K44801 .... **$34.80**
(Heatsink optional extra)

LOW BATTERY VOLTAGE INDICATOR

Knowing your batteries are about to give up on you could save many an embarrassing situation. This simple low cost project will give your early warning of power failure, and makes a handy beginner's project.
(ETI 280 March '85)
Cat. K42800 .... **$9.95**

MICROBEE SERIAL-TO-PARALLEL INTERFACE

Most microcomputers worth owning have an 'RS232' connector, or port, through which serial communications (input/output) is conducted. It is a convention that, for listing on a printer, the BASIC LLIST or LPRINT command assumes a printer is connected to the RS232 port. Problem is, serial interface printers are more expensive than parallel 'Centronics' interface printers. Save money by building this interface. (ETI Jan. 84) ETI 675
Cat. K46750 .... **$49.50**

CRYSTAL CONTROLLED TV PATTERN GENERATOR

Anyone wishing to obtain the maximum performance from a colour TV reciever needs a pattern generator. Why not build this superb unit which provides five separate patterns: dot, crosshatch, checker board, grey scale and white raster?
Note: The RIE kit includes a large ABS type case!
(80pg6, EA June 80)
Cat. K80033 .... **$99.95**

ELECTRONIC MOUSETRAP

This clever electronic mousetrap disposes of mice instantly and mercifully, without fail, and resets itself automatically. They'll never get away with the cheese again!
(ETI Aug. 84) ETI 1524
Cat. K55240 .... **$39.95**

RADIOTELETYPE CONVERTER FOR THE MICROBEE

Have your computer print the latest news from the international shortwave news service. Just hook up this project between your short wave receivers audio output and the MicroBee parallel port. A simple bit of software does the decoding. Can be hooked up to other computers too. (ETI Apr. 83)
Cat. K47330 .... **$19.95**

MUSICOLOR IV

Add excitement to parties, card nights and discos with EAs Musicolor IV light show. This is the latest in the famous line of musicolors and it offers features such as four channel "color organ" plus four channel light chaser, front panel LED display, internal microphone, single sensitivity control plus opto-coupled switching for increased safety.
(EA Aug. 81) 81MC8
Cat. K81080 .... **$114.95**

MULTI SECTOR ALARM STATION

Protect your home and possessions from burglars with this up to the minute burglar alarm system. It's easy to build, costs less than equivalent commercial units, and features eight seperate inputs, individual sector control, battery back up and self-test facility.

Specifications:

- Eight sectors with LED status indication
- Two delayed entry sectors
- Variable exit, entry and alarm time settings: entry delay variable between 10 and 75 seconds; exit delay variable between 5 and 45 seconds; alarm time variable between 1 and 15 minutes.
- Resistive loop sensing: suits both normally open and normally closed alarm sensors.
- Battery back-up with in-built charger circuit
- Built-in siren driver

The RIE kit includes a superb printed and prepunched metal case and inside metal work, plus a gell battery! Unbeatable VALUE!

K85900 complete kit .... only **$159**
K85901 without battery backup **$134**

TRANSISTOR TESTER

Have you ever desoldered a suspect transistor, only to find that it checks OK? Trouble-shooting exercises are often hindered by this type of false alarm, but many of them could be avoided with an "in-circuit" component tester, such as the EA Handy Tester. (EA Sept. 83) 83TT8
Cat. K83080 .... **$18.95**

ELECTRIC FENCE CONTROLLER

Restore discipline to the farm or allotment with this new electric fence controller. It features higher output power and lower current drain than the previous design for use in rural areas.
(EA Dec. 85, 85ef11)
Cat. K85110 .... **$49.95**

30 V/1 A FULLY PROTECTED POWER SUPPLY

The last power supply we did was the phenomenally popular ETI-131. This low cost supply features full protection, output variation from 0V to 30V and selectable current limit. Both volatage and current metering is provided. (ETI Dec. 83) ETI 162
Cat. K41620 .... Normally $73.50
SPECIAL, $63.50

COMPUTER DRIVEN RADIO-TELETYPE TRANSCEIVER KIT

Here's what you've been asking for, a full trasmit-receive system for computer driven radio teletype station. The software provides all the latest "whizz-bangs" like split-screen operation, automatically repeating test message, printer output and more. The hardware uses tried and proven techniques. While designed to team with the popular Microbee, tips are available on interfacing the unit to other computers. (ETI Nov. 84) ETI 755)
Cat. K47550 .... **$135**

Rod Irving Electronics
No.1 for semiconductors!

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4052	1.20
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4054	3.90
4055	3.90
4056	4.20
4060	2.50
4063	2.00
4066	0.80
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4094	3.35
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4097	6.50
4098	2.90
4099	3.90
4194	1.70
4510	1.40
4511	1.45
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4514	2.60
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74C925	9.90
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74HC7266	1.20
74LS	
74LS00	.75
74LS01	.60
74LS02	.60
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74LS05	.75
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74LS11	.75
74LS12	.80
74LS13	.90
74LS14	.80
74LS15	.80
74LS19	.90
74LS20	.60
74LS21	.90
74LS22	.90
74LS24	.90
74LS26	.90
74LS27	.90
74LS28	.90
74LS30	.60
74LS32	.60
74LS33	.60
74LS37	.70
74LS38	.80
74LS40	.80
74LS42	1.20
74LS47	1.80
74LS48	1.80
74LS49	1.80
74LS51	.70
74LS54	.80
74LS55	.80
74LS63	2.80
74LS73	.60
74LS74	1.00
74LS75	1.00
74LS76	1.00
74LS77	1.00
74LS78	1.10
74LS83	1.20
74LS85	.85
74LS86	.60
74LS90	1.20
74LS91	1.20
74LS92	1.20
74LS93	1.50
74LS95	1.20
74LS96	1.20
74LS107	.90
74LS109	.90
74LS112	.70
74LS113	.70
74LS114	.80
74LS122	1.30
74LS123	1.30
74LS125	1.00
74LS126	1.00
74LS132	1.00

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74LS393	1.80
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74LS396	2.50
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74LS441	5.50
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74LS443	5.50
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74LS623	5.95
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74LS640	3.95
74LS642	2.75
74LS643	2.75
74LS644	2.75
74LS645	2.75
74LS668	1.75
74LS669	1.75
74LS670	2.75
74LS673	12.55
74LS674	12.55
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74S10	1.00
74S11	1.00
74S15	1.60
74S20	1.20
74S22	1.50
74S30	1.00
74S32	1.00
74S37	1.70
74S38	1.70
74S40	1.20
74S51	0.80
74S64	1.20
74S65	1.20
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8131	5.95
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8228	5.50
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8238	9.50
8243	8.50
8251	6.90
8253	7.50
8255	5.50
8257	16.50
8259	6.50
8275	38.50
8276	28.50
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8283	6.50
8284	8.50
8286	6.50
8287	6.50
82S23	5.95
82S123	5.95
8304	6.95
8748	59.00
8749	58.50
8820	6.95
8830	6.95
8832	6.95
8833	6.95
8834	6.95
8835	5.95
8T13	2.95
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8T26	3.00
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High impedance AC/DC millivoltmeter

This easy to build instrument will measure AC and DC signals down to a couple of millivolts, with negligible circuit loading.

by ROB EVANS

To successfully measure the voltage levels around most audio circuitry, a meter with quite sensitive ranges and negligible circuit loading is required. The average digital multimeter has a high input impedance, offering minimal loading effects, but rarely has a more sensitive range than 200mV. An equivalent analog style multimeter may have an input impedance of only 4k ohms for a 200mV range, causing serious loading on higher impedance circuits.

The AC/DC millivoltmeter described here is inexpensive to build, has an input impedance of about 7M ohms, and a minimum range of 10mV. This makes it an ideal instrument for testing signal paths and offset voltages in circuitry containing op-amps or transistors. Also, if a standard multimeter is available, this can then be freed to measure other less critical circuit parameters.

In order to maintain a low construction cost, the unit uses an inexpensive meter movement and aluminium box, readily available components, and only one 9V battery. Other features that have been included are battery test and meter zero positions, and a reverse polarity indicator for the DC ranges. The meter scaling and range switch have been calibrated in 10dB steps, to enable relative decibel readings to be made without reaching for the calculator!

Circuit principles

The basis of the circuit appears in Fig.1, as an op-amp with a meter connected in the feedback loop. When a voltage is applied to the non-inverting input, the op-amp output will drive so as to cause the same voltage at the inverting input. Assuming the op-amp input draws negligible current, the meter current may easily be calculated. With the inputs at a potential of 120mV, 1mA will flow through the resistor (120 ohms) and the meter. Consequently, this circuit behaves somewhat like a voltage to current converter. The meter chosen for this design requires 1mA for full scale deflection (FSD), therefore in our simplified circuit an input of 120mV will read as maximum (10) on the scale.

The complete circuit

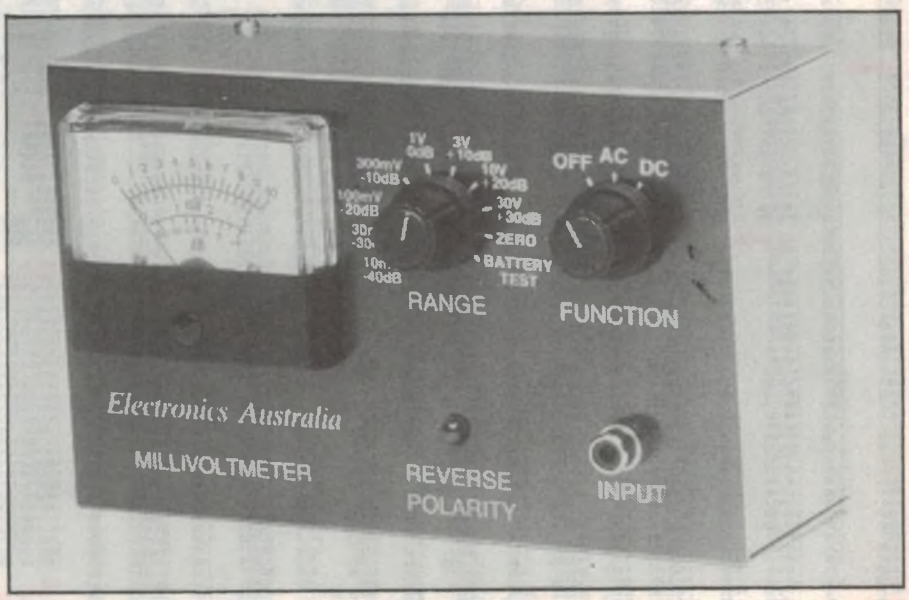
As can be seen in the overall circuit diagram, a diode bridge (D1 to D4) has been added to the output of the meter current driver IC2a. This allows current to flow in only one direction through the meter, regardless of the input voltage polarity. That is, AC signals will be rectified and DC voltages will always cause a forward meter reading, regardless of their polarity. To reduce needle "jitter" at very low frequencies, this rectified signal is filtered by C3.

The diode bridge and meter are included within the negative feedback loop of the op-amp, thereby cancelling any introduced losses or non-linearities, while the maximum available current is limited by R17 so as to avoid meter damage if (or when!) the unit is overloaded.

To achieve the required sensitivity of 10mV, a further stage (IC1) with a gain of 12 has been added. This forms a non-inverting amplifier with the gain set by R15, R12, and RV1 or RV2. This stage will deliver the required 120mV output to drive the following stage, while providing the overall offset adjustment by RV3.

The final gain of the circuit needs to be slightly higher when reading AC voltages due to the meter responding to the average driving current, while calibrated in RMS voltage. The average value of a sine wave is about 10% lower than its RMS value, and this difference is catered for by the selection of a different gain trimpot for each function. Switch 2c selects RV2 for AC measurement and RV1 for DC readings.

To create the eight switched ranges for the millivoltmeter, a resistor voltage divider attenuates the input signal in 10dB steps. The range switch SW1 selects the appropriate "tap" for the range in use, or the common line for the zero set position. The resistors selected for this task are common 5% preferred values, although if higher range accuracy is required, closer tolerance components may be chosen. The sum of this resistor chain is about 7M ohms, therefore the input impedance of the



millivoltmeter will cause negligible loading on the circuit under test.

The last range switch position is a battery test facility, and is enabled in the DC function via SW2b, R11 and R10. The function switch also removes the input isolating capacitor C1 via SW2a when DC is selected, while the remaining section SW2d applies power to the circuit.

The remaining parts of the circuit are the power supply reference and the reverse polarity indication, which simply illuminates a LED if the output of IC2a swings negative with respect to the common line.

To prevent the polarity indicator reacting to AC signals, the output of IC2a is filtered by R18 and C2 when applied to the base of Q1. Therefore, only a continuous negative signal will saturate Q1, and in turn, Q2 via R19. The

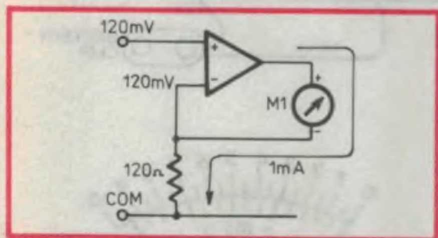
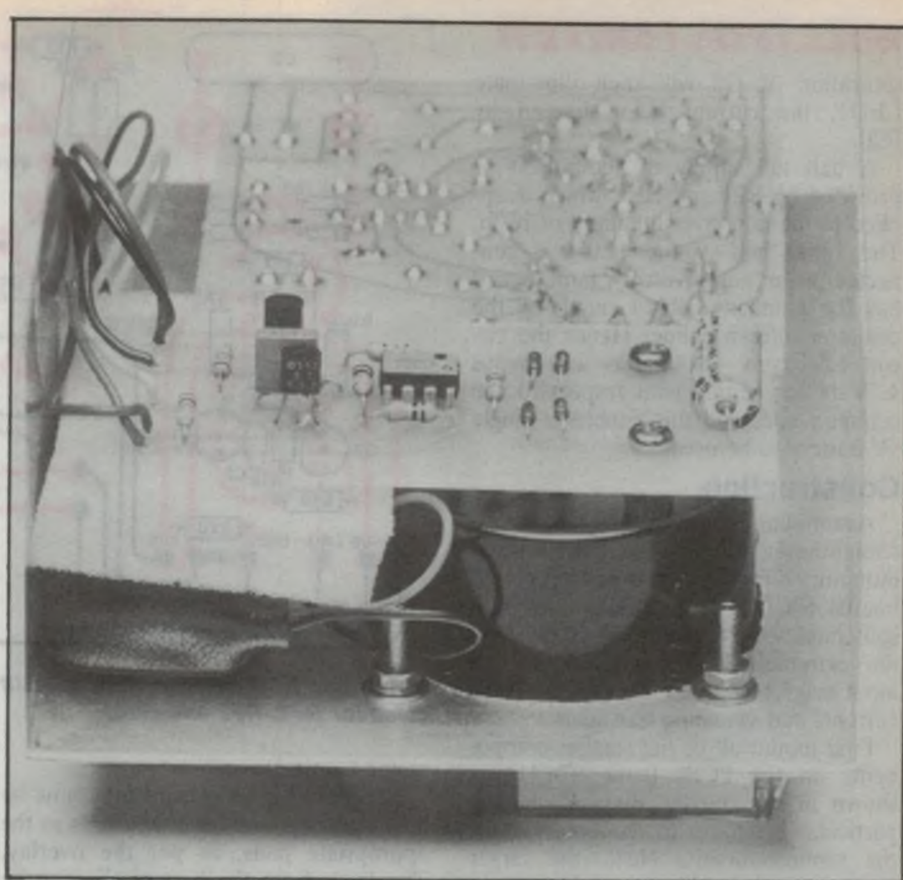
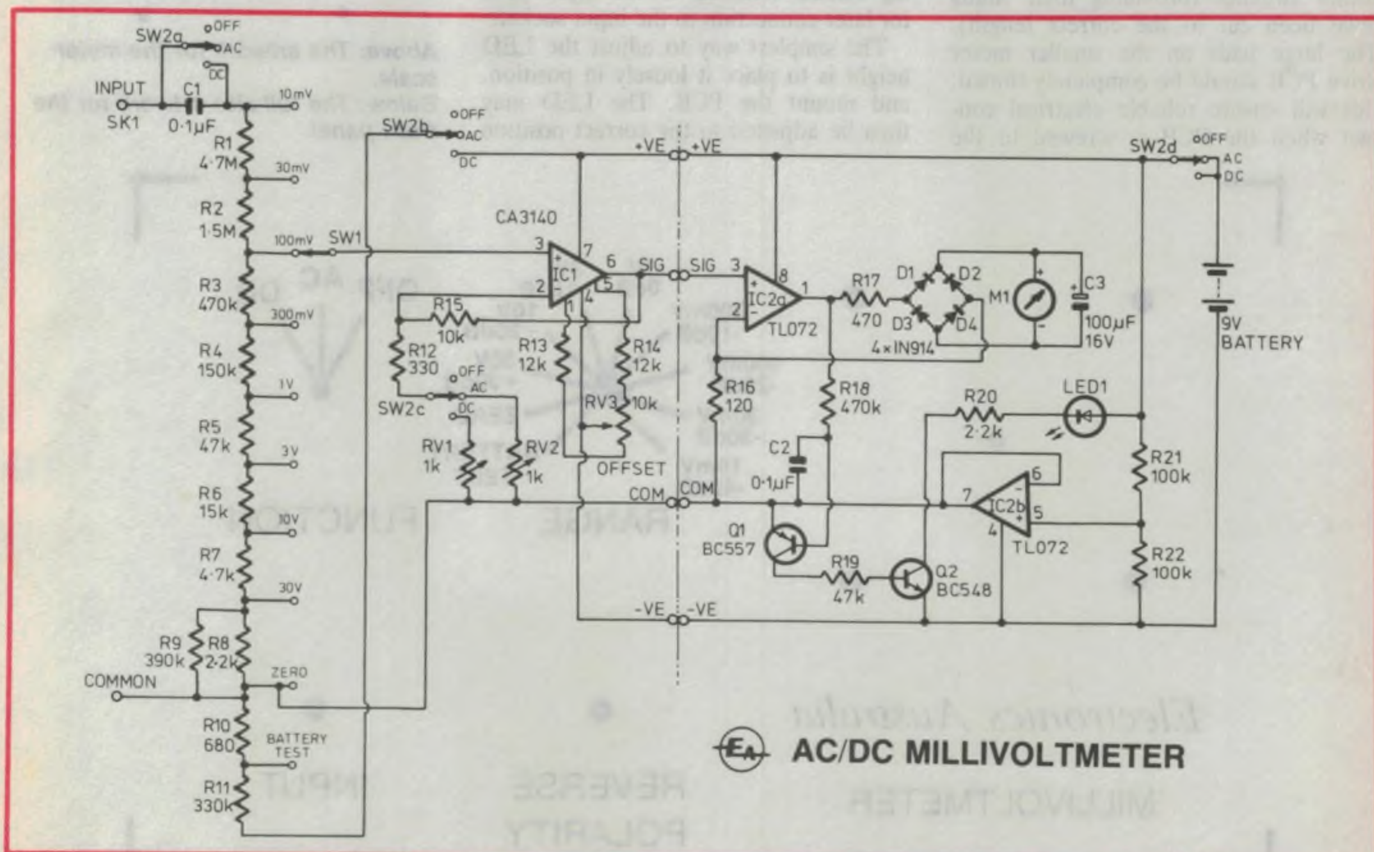


Fig.1: The basic meter drive circuit.



Inside the Millivoltmeter: Note that the meter drive PCB is mounted component side out, while input PCB is copper side out.



The overall circuit diagram. The signal is applied to the meter driver IC2a via the input attenuator, and input amp IC1.

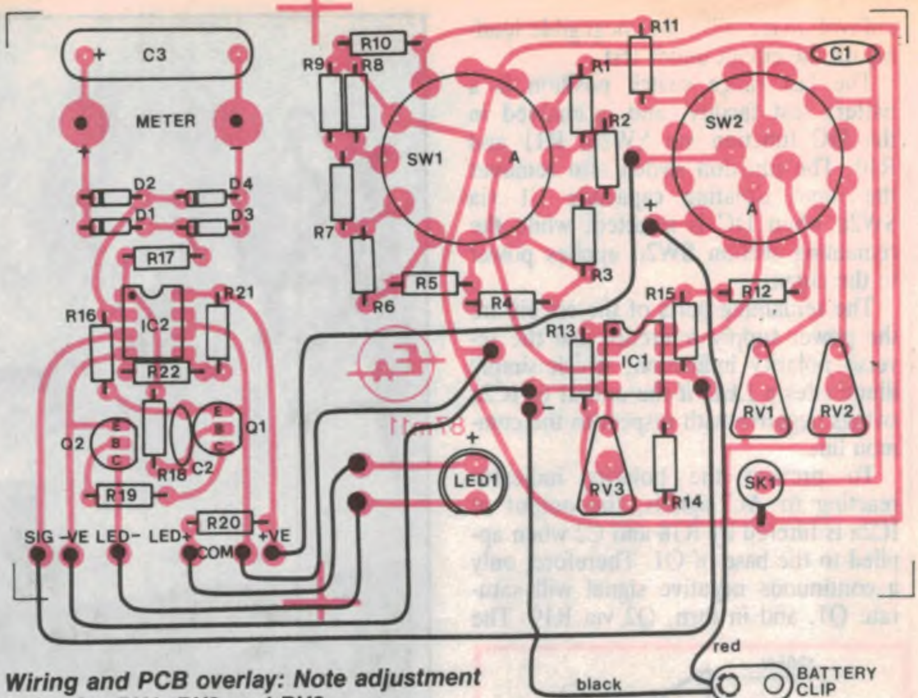
saturation of Q2 will then illuminate LED1, the current being limited by R20.

A half rail supply of about 4.5V is provided by R21 and R22, which is applied to the non-inverting input of IC2b. This other half of the TL072 is connected as a non-inverting buffer, and has the mundane job of supplying the common reference line. Hence the circuit effectively has a plus and minus 4.5V power supply with respect to the common line, and this enables a single 9V battery to be used.

Construction

Assembling the millivoltmeter is quite straightforward, all the components mounting directly on two printed circuit boards (PCBs). The circuitry has been split into two PCBs to ensure stability, the extremely high impedance of the input stage being very sensitive to stray currents and switching transients.

First mount all of the smaller components on the PCBs (code 87m11) as shown in the overlay diagram, paying particular attention to the polarities of the semiconductors. Next, the larger components should be soldered in place, working from the trimpots to the rotary switches (providing their shafts have been cut to the correct length). The large pads on the smaller meter drive PCB should be completely tinned; this will ensure reliable electrical contact when the PCB is screwed to the meter terminals.

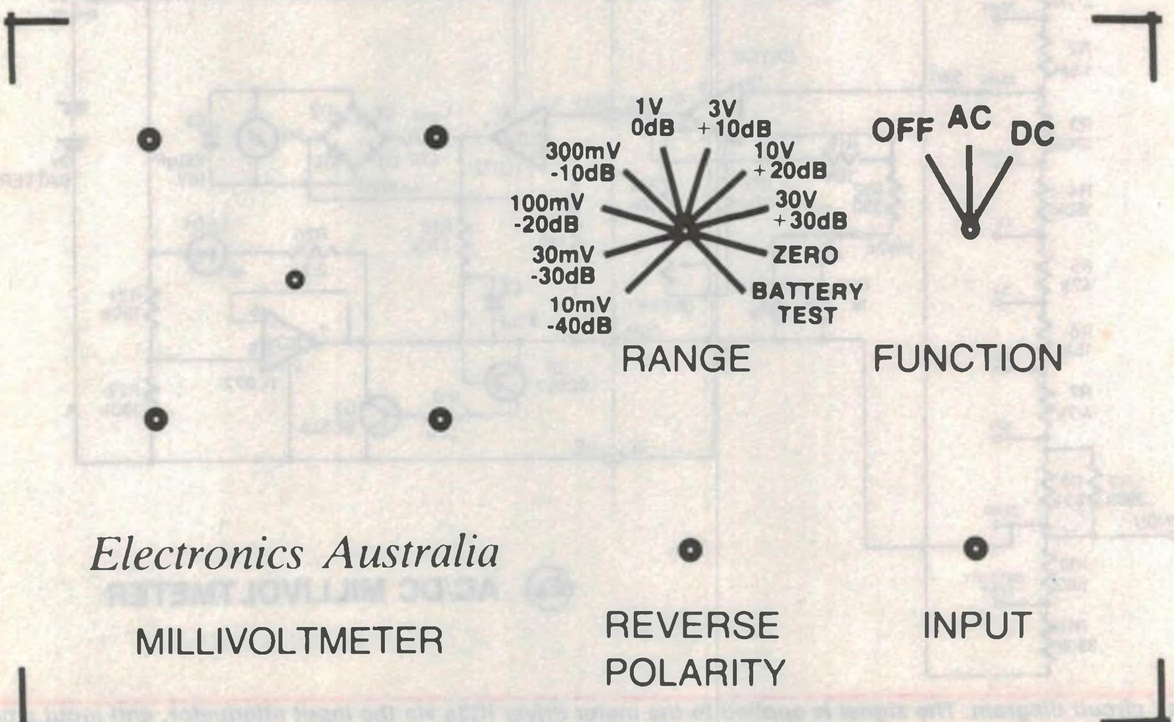


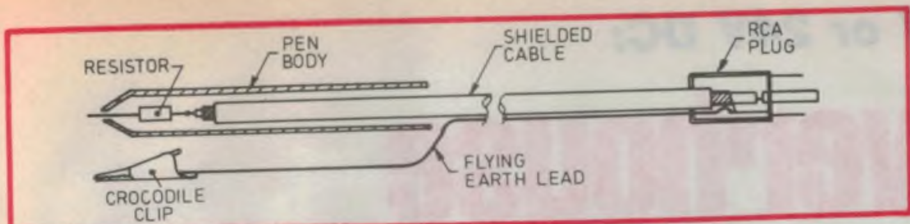
Wiring and PCB overlay: Note adjustment holes for RV1, RV2 and RV3.

Lengths of hookup wire may now be connected between the two PCBs at the appropriate pads, as per the overlay. The leads from the battery clip can be connected, and a couple of component leg offcuts soldered to the input pads for later connection to the input socket.

The simplest way to adjust the LED height is to place it loosely in position, and mount the PCB. The LED may then be adjusted to the correct position

Above: The artwork for the meter scale.
Below: The full size artwork for the front panel.





Details of simple probe.

in the front panel and the legs soldered in place.

When the PCBs are mounted, the battery may be slid under the meter drive PCB with a small piece of foam rubber to hold it in position. If the millivoltmeter is likely to come in for some rough treatment, the battery may be more securely located on the rear panel by a clamp fashioned from a piece of scrap aluminium.

Calibration

The first step in calibrating the millivoltmeter is to set the offset voltage to electrically balance the instrument. This is achieved by carefully adjusting RV3 for a zero meter reading, while the range switch is in the "zero" position.

The offset adjustment may be a little confusing, as the reverse polarity LED may stay on despite a zero meter reading. This is due to IC2a operating with very little negative feedback when diodes D1 to D4 are not forward biased i.e., no voltage across the meter movement. Therefore the op-amp output will swing either positive or negative until the diodes are forward biased, causing an offset of about plus or minus 0.5V. Hence, the offset adjustment RV3 should be set at a point just before the meter swings towards a positive reading.

Some sort of AC and DC reference voltages are desirable to set the gain calibration trimpots RV2 and RV1. Before adjustment, these voltages should be arranged to give as close as possible to a full scale reading. If a reference voltage is not available, a known (and trusted!) meter could be used for calibrating one of the higher ranges. Naturally, the other ranges will automatically be adjusted as set by the input voltage divider.

When calibrating and using the millivoltmeter on the AC range it should be noted that, like most meters, it is an average reading instrument that is calibrated in RMS voltage. Therefore, non-sinusoidal waveforms may produce misleading measurements. This does not present much of a problem, as most circuit testing is carried out with a sine-wave source.

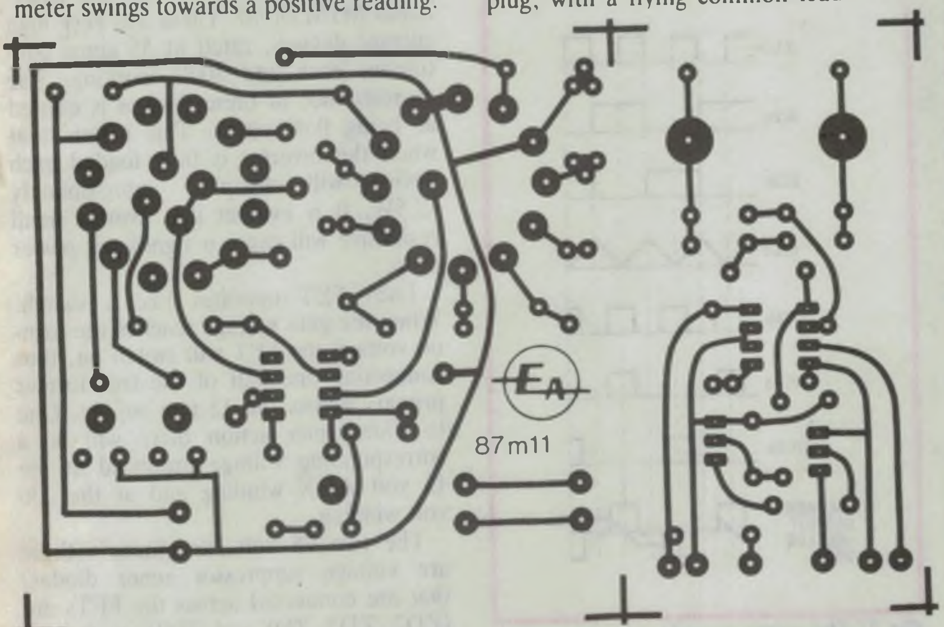
Using the millivoltmeter

A simple probe may be constructed for convenient signal tracing through a circuit. A low value resistor can be fitted in the end of a discarded ball pen body (the type with a narrow opening), with the axial lead out wire forming the probe tip. Shielded cable is then used to connect the probe to a suitable RCA plug, with a flying common lead terminated in a crocodile clip. Of course, any lead used for the input of the millivoltmeter should be well shielded due to the high sensitivity of the instrument.

When measuring voltages it is a good idea to initially select the highest range (30V), and then progressively select the more sensitive ranges until a reasonable pointer deflection occurs. This method will avoid any serious overloads.

The frequency response of the AC range is more than adequate for audio applications, ranging from 10Hz to about 40kHz. Care should be taken to select the AC function in this case, for the rectifying nature of the meter drive will respond to these signals if DC is selected, giving false readings.

The supply current drain of the millivoltmeter is about 7mA. Although this will rise when the reverse polarity LED illuminates, the battery will rarely need to be changed. Its terminal voltage is easily monitored with the battery test facility, which reads 10V FSD and is enabled in the DC function.



Full size PCB artwork for both the input and meter boards.

Parts list

1 aluminium case, 150x55x95mm
1 meter, 1mA FSD, 58x52mm
1 PCB, code 87m11, 88x120mm
1 1-pole 10-position PCB mount, sealed rotary switch
1 4-pole 3-position PCB mount, sealed rotary switch
2 knobs
1 RCA panel mount socket

Semiconductors

1 CA3140 FET input op-amp
1 TL072 BIFET op-amp
1 BC558 PNP transistor
1 BC548 NPN transistor
4 1N914 diodes
1 5mm red LED

Capacitors

2 0.1uF metallised polyester
1 100uF 16V axial mount electrolytic

Resistors (all 0.25W 5%: see text)

1 4.7MΩ	2 12kΩ
1 1.5MΩ	1 10kΩ
2 470kΩ	1 4.7kΩ
1 390kΩ	2 2.2kΩ
1 330kΩ	1 680Ω
1 150kΩ	1 470Ω
2 100kΩ	1 330Ω
2 47kΩ	1 120Ω
1 15kΩ	

1 10kΩ horizontal trimpot
2 1kΩ horizontal trimpots

Miscellaneous

9 volt battery and suitable snap connector, hookup wire.

240V AC from 12V or 24V DC:

The Powerhouse

This husky new DC-AC inverter design picks up where most of the others drop off. It will deliver up to 600VA of smooth mains power from either a 12V or 24V DC source, and is therefore ideal for campers, farmers, boating enthusiasts and building site workers.

by PETER HARRIS

Power inverters are very handy devices, providing the ability to use mains-powered equipment, tools and appliances in places far removed from a normal mains power point. Fully electronic inverters also offer the advantage of quiet, pollution-free operation, plus the convenience of automatic no-hassle operation.

The last inverter to be described in *Electronics Australia* was the 300VA unit of September 1985. This has been extremely popular, but almost inevitably there were those who wrote in asking "Haven't you got a design for one delivering higher power?". Until now we didn't, but now we do. If you're one of those who've been waiting, I think you'll find your wait has been worthwhile.

The new Powerhouse inverter delivers a full 600VA — twice that of the previous design. It also features the ability to run from 24V DC as well as the 12V accepted by the earlier design. Other features include voltage regulation, a LED indicator which shows when the battery voltage is getting low and a choice of either manual or auto starting, at the flick of a switch. In auto-start mode, the inverter draws virtually no current from the battery until the 230V appliance in the load circuit is turned on.

Both the DC input and AC output of the Powerhouse are fused, using readily available 3AG cartridge fuses. Replacement fuses should therefore be available wherever the inverter is taken — even back o'Bourke.

By the way, the Powerhouse design has been developed by the R&D department of Altronics Distributors, in Perth WA. This company has retained copyright for the PC boards used in the project. Needless to say complete kits for the Powerhouse are available from Altronics, under the catalog number K 6770 — please see the company's ads.

Circuit description

The circuit can be broken up into several sections, as this will make it easier to understand. They are 1. the oscillator; 2. the driver circuit; 3. the voltage regulation circuit; 4. the power supply and auto-start circuit; and 5. the low battery voltage shut-off circuit.

1. OSCILLATOR This uses an RC circuit using one section of a 40106 or 74C14 CMOS Schmitt trigger (IC1).

The oscillator works as follows: Initially the input to pin 6 of IC1 is low and the output is high. Capacitor C1 will start to charge up via R1 and RV1 until the upper hysteresis level of the Schmitt trigger is reached, at which point the output will switch low. This then starts to discharge the capacitor, until the lower hysteresis level is reached, when the output switches high again. The frequency at which this is set to operate at 100Hz — twice the ultimate output frequency.

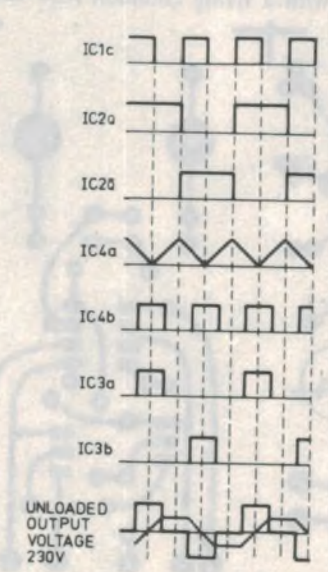


Fig.1: The main waveforms present in the Powerhouse when it's working.

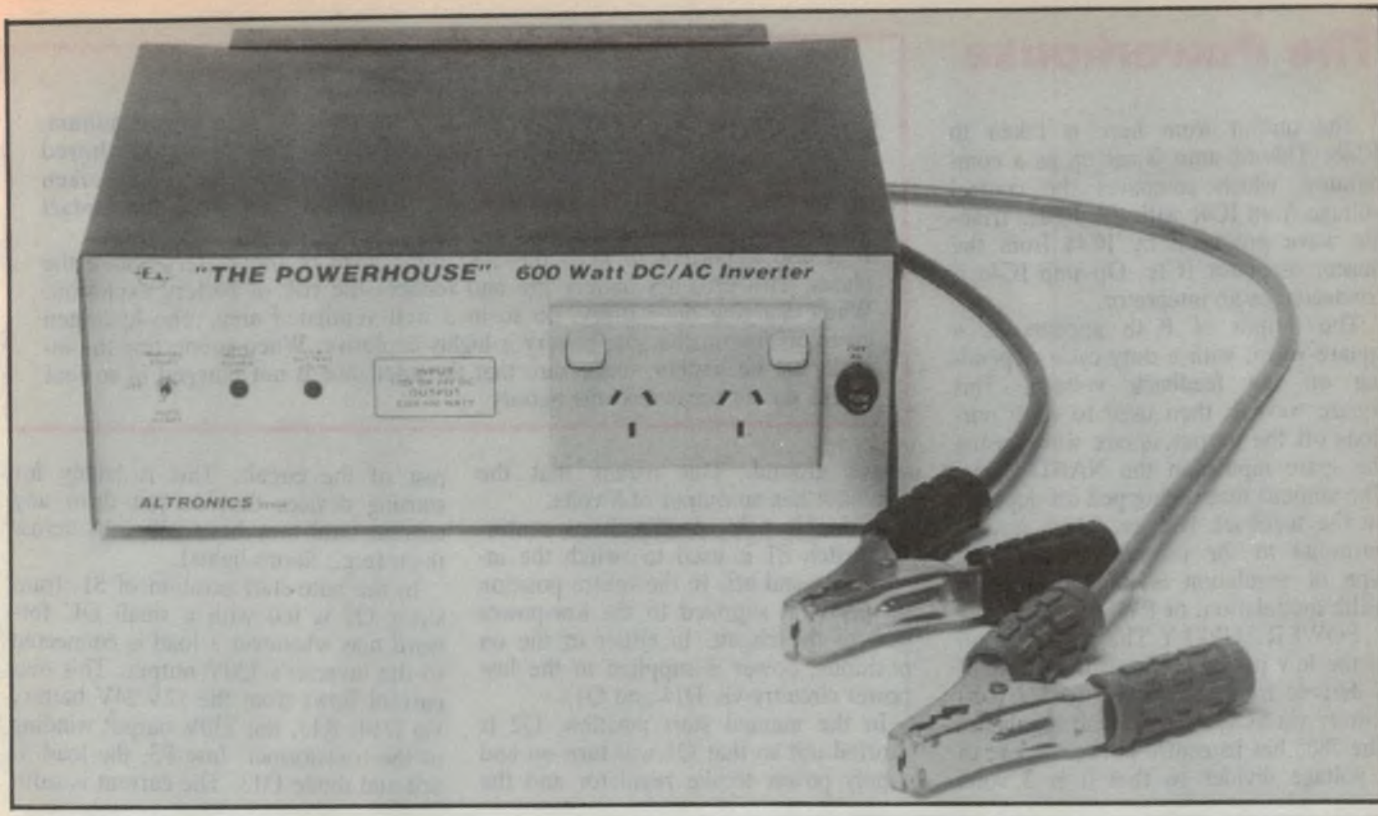
The output of IC1 pin 6 is fed into pin 3 of IC2, a dual flipflop connected in toggle mode. In this mode the outputs only change state when the clock input (pin 3) goes high. This ensures a perfectly symmetrical output square wave, at half the input frequency — 50Hz. The flipflop has two outputs that are 180° out of phase with each other, i.e., when one output is high the other output is low. These outputs are labelled Q and Q-bar.

The flipflop outputs are each fed through two NAND gates (see later) to a pair of paralleled Schmitt inverters. The inverter outputs then fed to the power of the PCB.

2. DRIVER CIRCUIT This section is on the K 6770B PCB. The devices used to switch the output on and off are TMOS type power FETs and are designated MTM55N10. These are very high current devices, rated at 55 amps continuous each and 100V working. The on-resistance of these devices is quoted at being 0.04 ohms. This means that when the inverter is fully loaded each device will dissipate approximately 12.5W. It is evident that even a small resistance will cause a significant power drop.

Each FET operates like a switch. When the gate voltage reaches the turn-on voltage the FET will switch on, thus connecting one half of the transformer primary across the 12 volt supply. Due to transformer action there will be a corresponding voltage produced at the 12 volt AUX winding and at the 230 volt winding.

The two 75 volt "transorbs" (these are voltage suppressor zener diodes) that are connected across the FETs are (ZD2, ZD3, ZD8 and ZD9) are to protect them from over voltage. This can be caused by inductive loads connected



As the battery clips suggest, the Powerhouse inverter is meant for those BIGGER jobs . . .

to the inverter. Similarly the 1N4002 diodes, 1.5k 5W resistors and 100uF capacitors are used to suppress very large voltage spikes that could otherwise destroy the transorbs (extra protection!).

The 13V transorbs (ZD1, ZD5, ZD6 and ZD7) that are connected to the gates of the FETs are used to ensure that no input voltage to the gate can destroy the FETs. The 4.7k resistors connected from gate to ground of each FET are used to ensure that each FET is fully turned off when it is not being driven.

Lastly the FETs have a built-in diode between drain and source, to stop back EMF (negative spikes) and also to provide protection against reverse connection of the battery leads. In the latter case the diodes will conduct and thus blow the fuses.

The power transformer of the inverter has two pairs of primary windings, and these are connected according to the battery voltage to be used. For use with a 12V battery the second pair of windings is connected in parallel with the first, while for use with a 24V battery they are connected in series.

3. VOLTAGE REGULATION This utilises the 12 volt AUX winding on the transformer. The voltage generated in this winding is rectified and smoothed by D1-D4, R8, RV2 and C9. The DC voltage at the wiper of RV2 is thus proportional to the output voltage on the transformer.

This voltage is then fed into an inverting op-amp formed by IC4c, connected as an inverting comparator with a gain set at 3300/220 = 15. This compares the voltage from RV2 with a nominal 5.1V reference voltage developed by zener diode ZD1, applied to the positive op-amp input. So if the feedback voltage from RV1 falls below 5.1 volts, the output of IC4c will swing high. The value of the 3.3k resistor in the feedback path has been chosen for the best regulation characteristic.

SPECIFICATIONS

Nominal supply voltage .... 12V or 24V DC
Output voltage .... see table below
Frequency .... see table below
Regulation .... see table below
Maximum load 600VA
Standby current 16mA

LOAD POWER (W)	INPUT CURRENT (A)	INPUT VOLTAGE*	OUTPUT VOLTAGE ** V RMS (AVG)	OUTPUT FREQUENCY (Hz)
0	0	13.2	250 (225)	50.8
40	2.9	13.0	242 (223)	50.6
100	7.9	12.7	237 (220)	50.6
150	13.6	12.5	233 (221)	50.6
300	29.5	12.2	225 (225)	50.7
450	45.7	12.0	219 (230)	51.6
600	66.9	11.8	204 (223)	51.0

Notes

* During tests, prototype unit was powered from two 40 amp-hour batteries connected in parallel. Input voltage variations shown are therefore likely to be typical.

** As the inverter's regulation circuit uses an average value measuring rectifier, its output voltage is substantially constant in terms of average value (figures in brackets). Due to changing form factor in the PWM rectangular output waveform, this causes changes to the RMS output as shown. Apart from lighting or heating loads, the average value is likely to be more relevant in many applications.

WARNING!

Equipment to be operated from this inverter must be in a safe condition, since the voltages produced are at mains potential. This means that frayed cords, exposed unearthed metal parts (unless double insulated), and broken or wet insulators must be repaired before the item is used. **Note that contact with both output lines could prove fatal!**

It is also important to keep the electrolyte level of the battery above the plates. This prolongs battery life and reduces the risk of battery 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 the inverter to the battery, make sure that the appliance is not plugged in so that sparks do not occur near the battery.

The output from here is taken to IC4b. This op-amp is set up as a comparator, which compares the control voltage from IC4c with the 100Hz triangle wave produced by IC4a from the master oscillator IC1c. Op-amp IC4a is connected as an integrator.

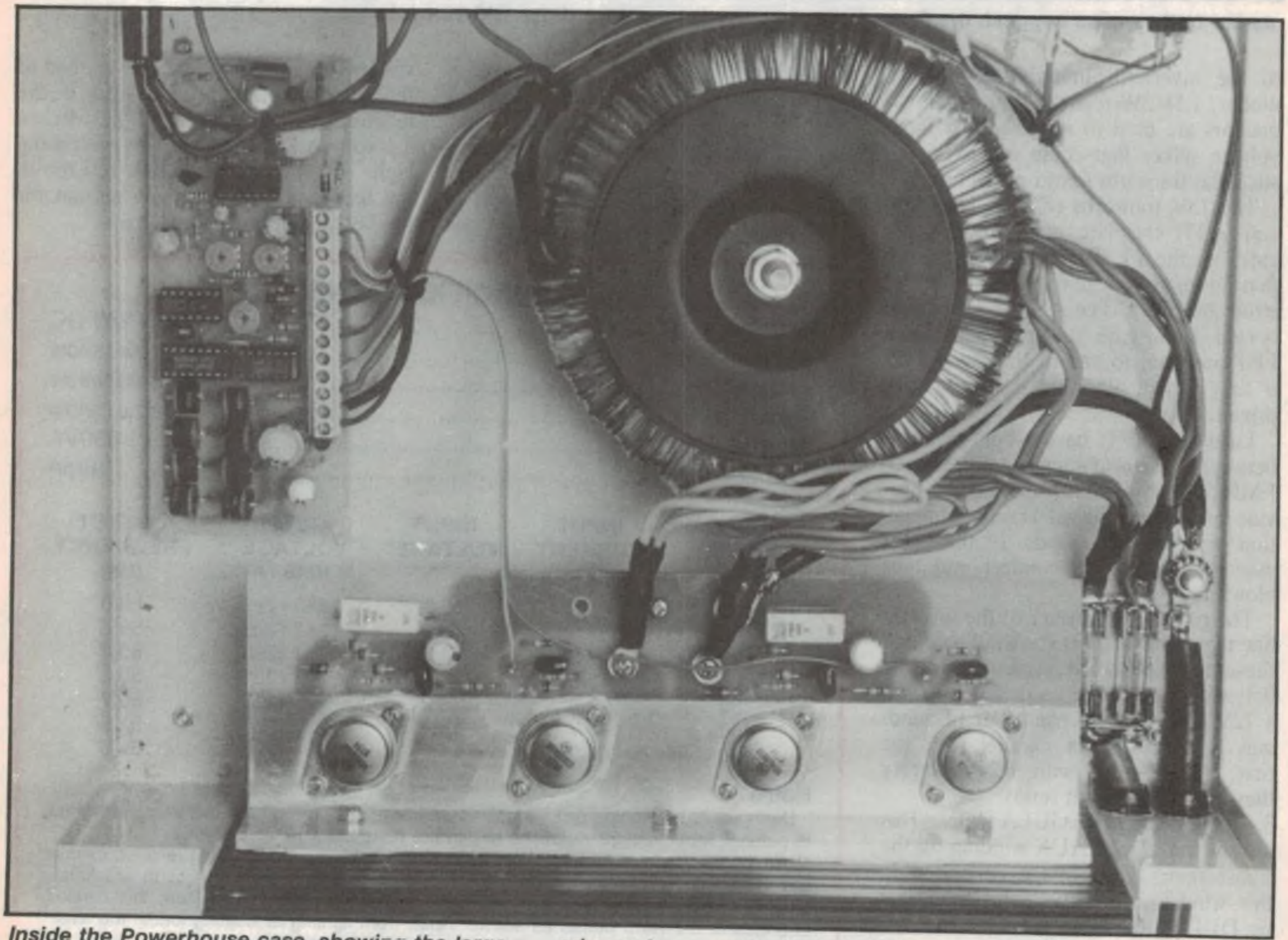
The output of IC4b appears as a square wave, with a duty cycle depending on the feedback voltage. This square wave is then used to chop portions off the output square wave, using the spare inputs on the NAND gates. The amount that is chopped off depends on the feedback voltage, which is proportional to the output voltage. This type of regulation is known as pulse width modulation, or PWM for short.

4. POWER SUPPLY The power for all of the low power sections of the circuit is derived from the 12 volt (or 24 volt) battery via SC1, a 7805 5 volt regulator. The 7805 has its centre pin connected to a voltage divider so that it is 3 volts above ground. This means that the regulator has an output of 8 volts.

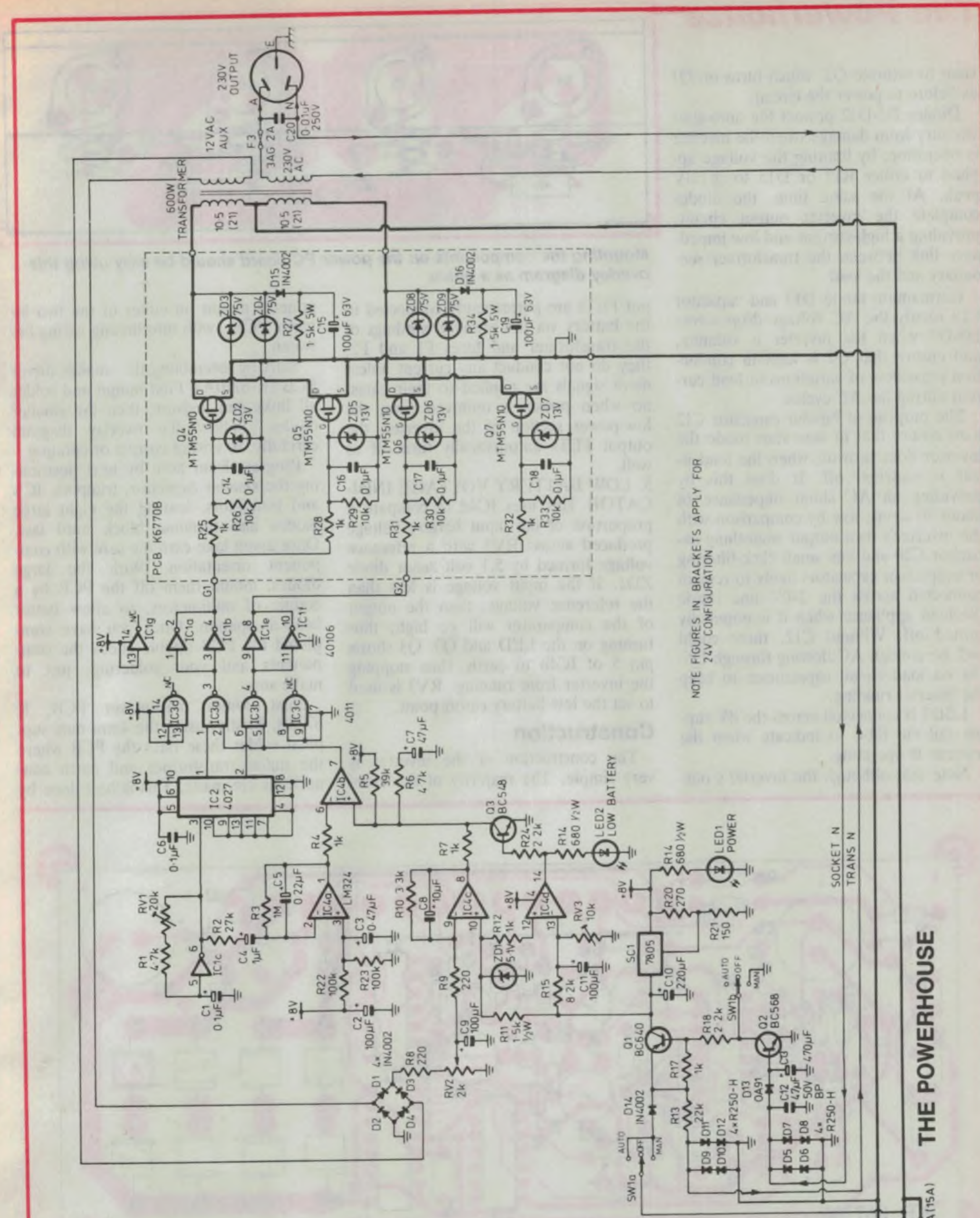
A double pole, double throw centre-off switch S1 is used to switch the inverter on and off. In the centre position no power is supplied to the low-power part of the circuit. In either of the on positions, power is supplied to the low power circuitry via D14 and Q1.

In the manual start position, Q2 is shorted out so that Q1 will turn on and supply power to the regulator and the rest of the circuit. This is handy for starting devices that do not draw any current until they have 230 volts across them (e.g., fluoro lights).

In the auto-start position of S1, transistor Q2 is fed with a small DC forward bias whenever a load is connected to the inverter's 230V output. This bias current flows from the 12V/24V battery via D14, R13, the 230V output winding of the transformer, fuse F3, the load itself and diode D13. The current is suffi-



Inside the Powerhouse case, showing the large wound-core transformer. Note that the power PCB in this prototype unit was a mirror image of the final design. The full circuit schematic is shown opposite.


THE POWERHOUSE
NOTE FIGURES IN BRACKETS APPLY FOR 24V CONFIGURATION
600W TRANSFORMER
12VAC AUX
230V OUTPUT
230V AC
PCB K6770B
LED1 POWER
LED2 LOW BATTERY
SOCKET N
TRANS N
BATT
2×30A (15A)

cient to saturate Q2, which turns on Q1 as before to power the circuit.

Diodes D5-D12 protect the auto-start circuitry from damage when the inverter is operating, by limiting the voltage applied to either R13 or D13 to ±1.3V peak. At the same time, the diodes complete the inverter output circuit, providing a high-current and low impedance link between the transformer secondary and the load.

Germanium diode D13 and capacitor C13 rectify the AC voltage drop across D5-D8 when the inverter is running, and ensure that Q2 is kept in conduction regardless of variations in load current during the AC cycles.

The purpose of bipolar capacitor C12 is to ensure that in auto-start mode the inverter does turn off when the load itself is switched off. It does this by providing an AC shunt impedance of about 70 ohms, low by comparison with the inverter's own output smoothing capacitor C20 and any small click-filtering or suppressor capacitors likely to remain connected across the 240V line inside the load appliance when it is nominally turned off. Without C12, there could well be enough AC flowing through D5-D8 via load circuit capacitance to keep the inverter running.

LED1 is connected across the 8V supply rail via R14, to indicate when the inverter is operating.

Note that although the inverter's output FETs are permanently connected to the battery via the primary windings of the transformer and fuses F1 and F2, they do not conduct any current unless drive signals are applied to their gates. So when power is removed from the low-power section of the inverter, the output FETs automatically turn off as well.

5. LOW BATTERY VOLTAGE INDICATOR This uses IC4d to compare a proportion of the input battery voltage produced across RV3 with a reference voltage formed by 5.1 volt zener diode ZD1. If the input voltage is less than the reference voltage, then the output of the comparator will go high, thus turning on the LED and Q3. Q3 shorts pin 5 of IC4b to earth, thus stopping the inverter from running. RV3 is used to set the low battery cutoff point.

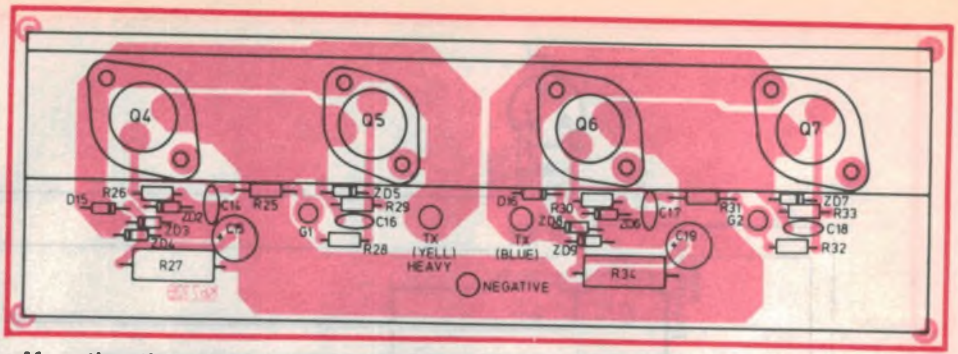
Construction

The construction of the inverter is very simple. The majority of the components mount on either of the two integral PCBs, with interlinking wiring between.

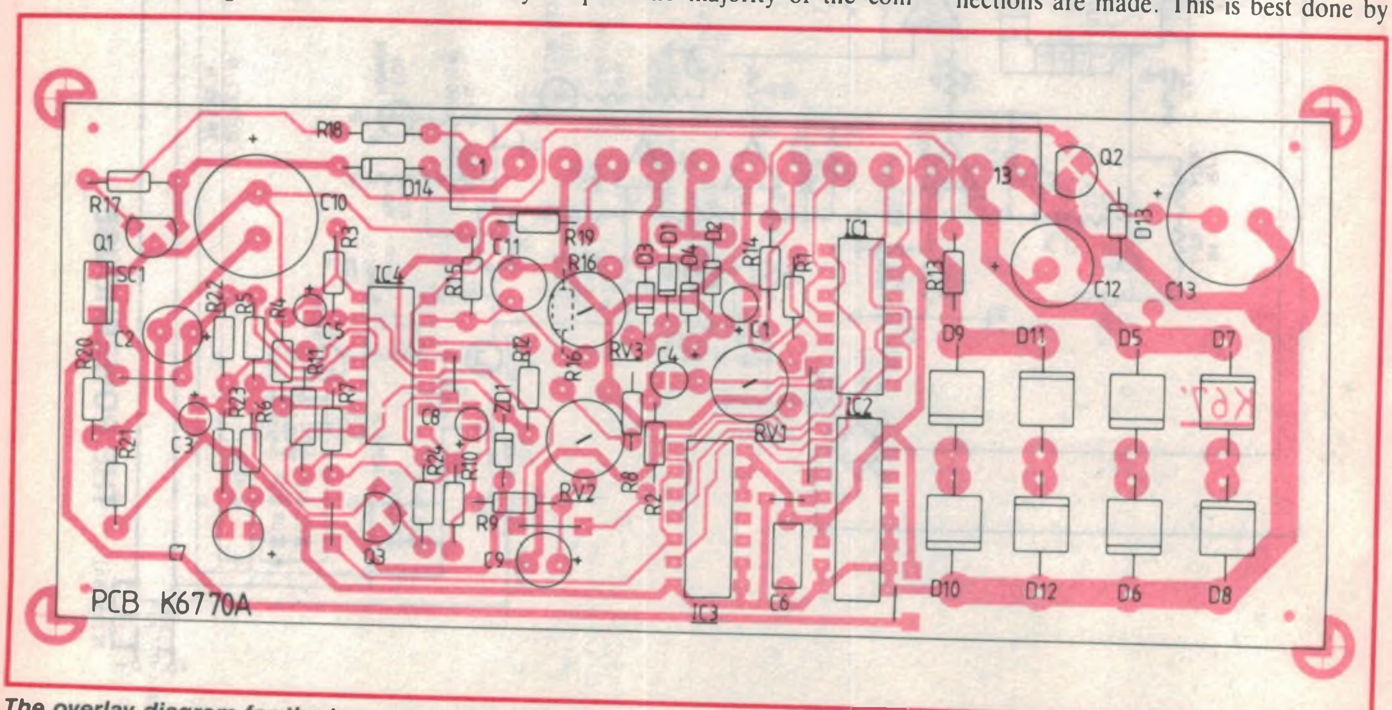
Start by assembling the smaller driver PCB (K 6770A). First mount and solder all links and resistor, then the smaller diodes. Follow the overlay diagram carefully, to ensure correct orientation.

Progress from here by next positioning the smaller capacitor, trimpots, IC's and transistors, leaving the eight large diodes and terminal block until last. Once again take extreme care with component orientation. With the large diodes, mount them off the PCB by a couple of millimetres, to allow better heat dissipation. Once you have completed the PCB double check the components and your soldering, just to make sure.

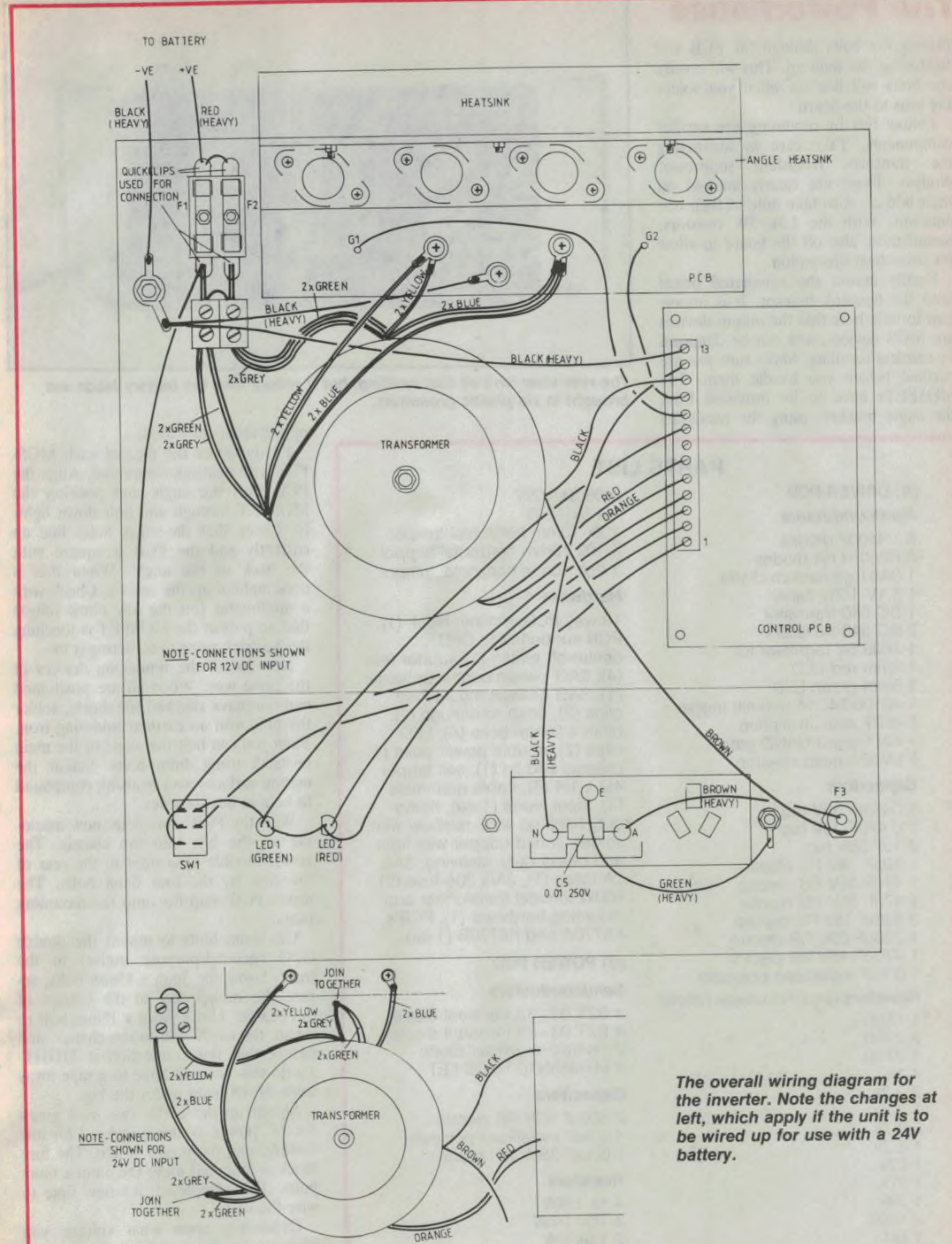
Next comes the power PCB, K 6770B. Firstly, using the 4mm nuts supplied solder these onto the PCB where the mains transformer and earth connections are made. This is best done by



Mounting the components on the power PC board should be easy using this overlay diagram as a guide.



The overlay diagram for the low-power PC board. Take care when soldering in the terminal strip,to avoid solder bridges.

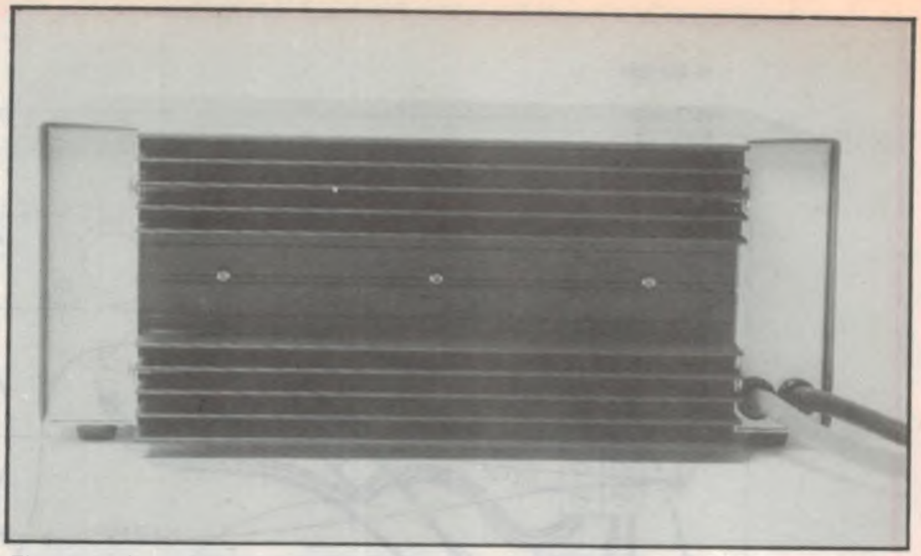


The overall wiring diagram for the inverter. Note the changes at left, which apply if the unit is to be wired up for use with a 24V battery.

placing the bolts through the PCB and tightening the nuts up. This will ensure the bolts will line up when you solder the nuts to the board.

Follow this by mounting the smaller components. Take care in identifying the transorbs (transient suppressor diodes). These are clearly marked on their bodies. Also take note of their orientation. With the 1.5k 5W resistors, mount these also off the board to allow for some heat dissipation.

Finally mount the completed board onto the heatsink bracket. It is important to note here that the output devices are MOS devices, and can be damaged by careless handling. Make sure you are earthed before you handle them. The MOSFETs have to be insulated from the angle bracket, using the insulating mica washers provided.



The rear view isn't all that exciting, but it shows how the battery leads are brought in via plastic grommets.

Firstly smear the face of each MOSFET with heatsink compound. Align the PCB with the angle and position the MOSFET through and bolt down lightly. Check that the other holes line up correctly and the PCB is square with the back of the angle. When this is done tighten up the screws. Check with a multimeter (on the low ohms range) that no part of the MOSFET is touching the heatsink prior to soldering it in.

Now install the remaining devices in the same way. When all are positioned and you have checked for shorts, solder the pins with an earthed soldering iron. Then you can bolt the angle to the main heatsink using 4mm bolts. Smear the mating surfaces with heatsink compound to help in heat transfer.

With the PCBs complete, now assemble all the bits into the chassis. The power module is secured to the rear of the case by the four 6mm bolts. The driver PCB snap fits onto the mounting posts.

Use 4mm bolts to mount the double GPO (general-purpose outlet) to the front. Using the 3mm x 15mm bolts, secure the rubber feet to the bottom of the chassis. Use a 4mm x 15mm bolt to secure the earth lead to the chassis, and ensure that this connection is TIGHT. To do this you will have to scrape away some of the paint under the lug.

Mount up the LEDs (we used green for AC power available and red for low battery) and the power switch. The fuse block is mounted using the 3mm x 6mm bolts. This completed, it's now time to wire the unit.

Depending upon what voltage you want to run the unit from (12 volts or 24 volts) this will determine how the

PARTS LIST

(A) DRIVER PCB

Semiconductors

5 1N4002 diodes
8 R250-H 6A diodes
1 0A91 gemanium diode
1 5.1V 1/2W zener
1 BC 640 transistor
2 BC 548 transistor
1 7805 5V regulator IC
1 5mm red LED
1 5mm green LED
1 40106/74C14 Schmitt trigger
1 4027 dual JK flipflop
1 4011 quad NAND gate
1 LM324 quad op-amp

Capacitors

1 0.22uF 35V tag
1 0.47uF 35V tag
2 1uF 35V tag
1 10uF 16V RB electro
1 47uF 16V RB electro
1 47uF 50V RB bipolar
3 100uf 16V RB electro
1 220uF 63V RB electro
1 470uF 16V RB electro
1 0.1uF metallised polyester

Resistors (all 1/4W unless noted)

1 150Ω
2 220Ω
1 270Ω
4 1k
2 2.2k
1 3.3k
2 4.7k
1 8.2k
1 22k
1 27k
1 39k
2 100k
1 1M
2 680Ω 1/2W
1 1.5k 1/5W
1 2k 10mm horizontal trimpot
1 10k 10mm horizontal trimpot
1 20k 10mm horizontal trimpot

Hardware

13 way PCB terminal block (1), PCB supports (4), DPDT centre-off switch (1), rubber feet (4), 3AG panelmount fuse holder (1), 3AG chassis mount fuse clips (2), 4mm solderlugs (2), 6mm x 20mm bolts (4), LED clips (2), double power point (1), chassis and lid (1), self tapper 4G x 1/4 (8), cable grommets (2), input leads (1 ea), heavy duty hook up wire, rainbow wire, solder, tinned copper wire light and heavy duty, sleeving, 3AG 2A fuses (1), 3AG 20A fuse (2), 600W toriodal transformer and mounting hardware (1), PCB's K6770A and K6770B (1 ea).

(B) POWER PCB

Semiconductors

4 BZT 03 –13 transient diode
4 BZT 03 –75 transient diode
2 1N4002 or similar diode
4 MTM55N10 TMOS FET

Capacitors

2 100uF 63V RB electro
4 0.1uF metallised polyester
1 0.1uF 250V AC rated

Resistors

4 1k 1/4W
4 10k 1/4W
2 1.5k 5W

output transformer is wired (see diagram). Note that the wires that connect the transformer primaries to the PCB should be soldered to the crimp lugs, and then bolted down securely.

The fuse block has two fuses that are paralleled together, using the heavy tinned copper wire that is supplied. The incoming positive and the centre tap of the transformer solder directly to the tags on the fuse block. The main earth for the MOSFETs is run to the chassis earth point using the heavy duty black wire, and is attached to the solder lugs by crimping and soldering.

All other wiring is straightforward. Use the rainbow cable for wiring to the switch and the LEDs. The 230 volt side of the transformer is fused via the panel mount fuse holder. Ensure you follow the wiring diagram carefully and double check your work.

Set up and testing

Once the inverter has been constructed and all the components and wiring have been checked, then power can be applied to the circuit.

If it draws large amounts of current (or blows the fuse), then disconnect the G1 and G2 wires from the power PCB and try again. If it still blows fuses, then there is a problem with the power FET PCB, so disconnect the battery leads and find the problem.

The most probable cause of blowing fuses would be a short from the case of a FET to ground or the battery leads are the wrong way around! Note that there will be a small spark when it is connected up. This will be the 100uF capacitors charging up.

If the fuse only blows when G1 and G2 are connected there is a problem on the control PCB. Pull the PCB out of the case and give it a good hard look. 95% of all problems occur through careless construction, bad soldering, components wired in the wrong way around, etc.

Once the unit has passed the "smoke test" you can proceed to set it up properly. If you have access to a frequency counter, then connect it to either G1 or G2. Rotate RV3 fully anti-clockwise and set RV2 at centre position. Connect a 100W (or similiar) light globe to the output and switch on (either MANUAL or AUTO).

Adjust RV1 for a reading of 50Hz on the frequency counter. If no frequency counter is available, then the use of a frequency sensitive device can be used to set the frequency. An example should be a mains clock, a record turntable or a small fan with an induction motor. The speed of these devices will vary with frequency — so adjust RV1 so the speed of the devices matches that of the same device operated of the mains.

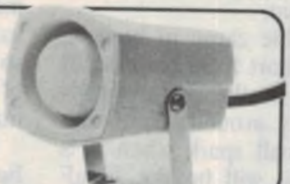
Next set the output voltage. This can be done using a true RMS meter, or by using the comparison method. Plug a small load into the inverter (approximately 100W) and switch on. Measure the output voltage and adjust RV2 for a reading of 230 volts. Alternatively, compare the brightness of the globe to the brightness of the same globe running off the mains. Adjust RV2 accordingly.

The last thing to do is to set the low battery voltage cutoff point. For this a variable voltage supply is needed. Disconnect the G1 and G2 leads from the power FET PCB and reconnect the supply. For the 12 volt version set the DC supply for 10 volts, then adjust RV3 until the LED just comes on. For the 24 volt version, set the DC supply for 20 volts an adjust RV3 for cutoff as before. Finally reconnect the G1 and G2 leads and give the inverter a full test. Then put the lid on.

You should now have a fully functional 600 VA inverter.

JAYCAR No 1 FOR SERVICE

TWEETY PIE



This incredibly little piezo screamer measures 57(L) x 33(H)mm emits a 116dB wail. It's deafening! As used in the screamer car alarm kit.
Cat. LA-5255

ONLY $17.95

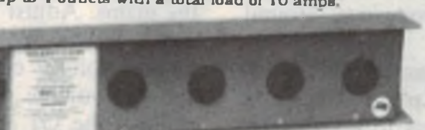
SQUEAKY CLEAN MAINS FILTERS

TWO BRAND NEW MODELS, BOTH FULLY APPROVED BY THE ELECTRICITY AUTHORITY

4 OUTLET

The MS-4020 will supply up to 4 appliances. Each 240V socket is independently filtered. The filter will suppress interference from RF sources, spikes, transients and lighting, and supply up to 4 outlets with a total load of 10 amps.
Cat. MS-4020

$269.00



2 OUTLET

The two outlet will handle up to 7.5 amps. The two sockets are not independently filtered although.
Cat. MS-4025

$99.00

BEWARE! There are many mains filters on the market. One sample we evaluated had only one capacitor in it!

RS232 SURGE PROTECTOR

The RS232 surge protector is used to protect RS232 ports from the possibility of costly damage from large voltage pulses caused by lightning or other power problems.
Cat. PA-0885

$19.95

RS232 MINI PATCH BOX

The RS232 mini patch box is used to make custom RS232 interfaces.
Cat. PA-0880

$9.95

FEMALE/FEMALE GENDER BENDER

Saves modifying or replacing non mating RS232 cables by changing from male to female. All pins wired straight through.
Cat. PA-0884

$18.95

RS232 MINI TESTER

This tester indicates the presence of all important interface lines by LED illumination when signal is active. All 25 pins are connected straight through.
Cat. PA-0886

$19.95

NULL MODEM

The RS232 null modem is used to replace a set 25 pin RS232 connectors with transit DATA and receive DATA across CONNECTED.
Cat. PA-0883

$9.95

NEW

50 & 100W MOSFET AMPLIFIER 'BRICK'

NOT A KIT - INSTANT POWER!

At last, a good value AUSTRALIAN MADE amplifier module that is rugged, has the heatsink built in and is cheap!
The 'Jaybrik' as they are called are basically rugged Mosfet power amplifiers manufactured to high standards on fibreglass board with a special DIECAST heatsink. All board components are enclosed in a special conformed coating that ensures that the amp will operate in extreme environmental conditions. If in the unlikely event of a repair being necessary the coating can be picked away and the offending component replaced. The Jaybrik will drive either 4, 8 ohms or 100V line step-up transformers and has unconditional stability. They are virtually bullet proof.
They are ideal for professionals who need slave P.A. in a hurry or any Hi Fi or sound reinforcement application. You simply connect filtered DC and a signal to them and they are guaranteed to go!
So check out the specs. You will find them stunning for a PROFESSIONAL amplifier module.

JAYBRIK

SPECS:

J-100 100W RMS min into 8Ω, with 45-0-45 3A transformer and 1 x 8000μF/75 filter cap each rail and 6A bridge rect. 45-0-45 is MAS permitted power supply voltage. (This will produce 30V across 8Ω which is 112.5W). Max off load volts! 125.
Distortion: <0.1% max any frequency typ 0.06%. 0.018 @ 1kHz.
Frequency Response: 20 - 20kHz ±0dB (-3dB @ 200kHz)
Sensitivity: 850mV p.p. for rated output
Impedance: 47kΩ
S/Noise: Over 100 dB W.R.T. 850mV
Stability: Unconditional
Cat. AA-0382

$125.00

NEW

J-50 50W RMS min into 8Ω, with 25-0-25 2A transformer, 1 x 4700μF/50V filter cap each side and 3A bridge rect.
All other specs the same or better than above.
(Filter capacitor values must be doubled for use on 4Ω loads)
Cat. AA-0380

$99.00 Sorry no pic yet!

JAYCAR PROUDLY REINTRODUCE TWO QUALITY STEREO MIXERS

BVL STEREO MIXER (SM2550)

Specifications:
Input:
Microphone: 0.5mV 600 ohms
Pick up: 3mV 50k ohms
Tape/Tuner 150mV 100k ohms
Output: 250mV
Frequency Response: 20Hz - 20kHz ±1dB
Tone Control Treble: 10kHz ±12dB
Tone Control Bass: 100Hz ±12dB
Distortion: Less than 0.07%
Signal/Noise Ratio: More than 60dB
Headphone Impedance: 4 - 16 ohms
Dimensions: 12.52 x 8.26 x 3.34 inches
VU Meter
Cat. AM-4200

$169.00

BVL MULTI FUNCTION STEREO MIXER EQUALISER (MQ7200)

Specifications:
Sensitivity:
Phono: 3mV
Mic: 1mV
Line (tape or tuner): 150mV
Signal/Noise Ratio:
Phono: 55dB
Mic: 60dB
Line: 65dB
Frequency:
Phono: 20Hz - 20kHz (RIAA ±2dB)
Mic: 20Hz - 20kHz ±3dB
Line: 20Hz - 20kHz ±3dB
Channel Balance: 0.5dB
T.H.D.: Less than 0.03%
Headphone Impedance: 4 - 16 ohms
Equaliser:
Centre frequency: 60Hz, 250Hz, 1kHz, 4kHz, 12kHz
Control Gain: ±12dB
VU meter

NEW

Cat. AM-4202

$299

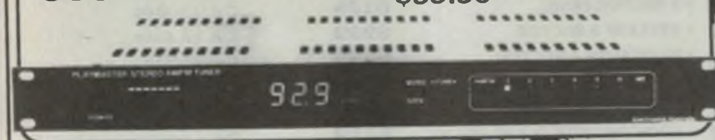
AM/FM STEREO TUNER SYNTHESISED

Ref: Dec '85 - Feb '86
Cat. KA-1635
$599.00

REMOTE CONTROL

Ref: EA April 1986
Cat. KA-1636
$99.50

AUSTRALIAN MADE

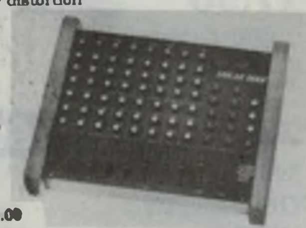


8 CHANNEL AUDIO MIXER JAYCAR 8002

A balanced input/output 8 channel mixer with features found in units costing well over $2000!

MAIN FEATURES:
• Balanced 600 ohm mic inputs/line inputs • Input attenuators • Cannon connections included in the price • Bass, mid and treble equalisation on each input • Effects (i.e. echo etc) capability • Foldback on all 8 inputs • Stereo pan on all 8 inputs • 60mm slide faders used throughout • 19" rack mount capability for console mount • Professional black front panel with format borders and multicoloured knobs to assist function identification • Designed for quick and easy service • VU meters • Only high quality components used • 5534A OP amps used for low noise and very low distortion

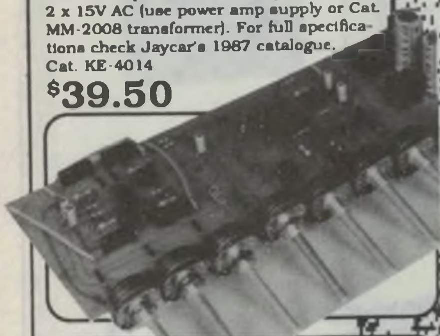
Cat. KJ-6504
$595.00



As illustrated $714.00

MIXER PREAMP

Ref: ETI July 1980
Ideal companion for power amp modules. Mixes up to 4 inputs (high and low level) with individual level controls. High performance 3 band tone controls. Kit comes complete with case. Operates from 2 x 15V AC (use power amp supply or Cat. MM-2008 transformer). For full specifications check Jaycar's 1987 catalogue.
Cat. KE-4014
$39.50



TEMPERATURE PROBE FOR DVM

Ref: ETI July 1983
• extends the function of your multimeter to measure temperatures from -55° to +150°C
Cat. KE-4033
$27.95

30 VOLT - 1 AMP BENCHTOP POWER SUPPLY

Variable output from 3 - 30 volts and variable limiting over 2 ranges.
Cat. KA-1574
$89.50

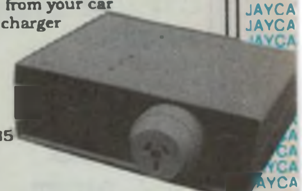
PARAMETRIC EQUALISER

Ref: ETI July 1986
This module can be used on its own or in gangs as effects units and also in synchronous sweep effects.
Cat. KE-4724
$23.50

12-230 VOLT INVERTERS

40 WATT

Ref: EA August 1985
• Run 240V appliances from your car
• Also use as a battery charger
Cat. KA-1598
$99.95

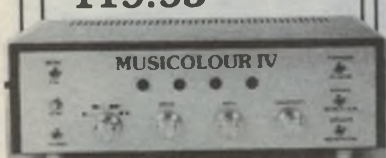


300 WATT

Ref: EA September 1985
• Toroidal transformer
• Automatic regulation
• Current limiting
• Thermal overload protection
Cat. KA-1610
$249.00

MUSICOLOR IV

Ref: EA August 1981
• 4 channel musicolor • 4 different chaser patterns • Auto & manual reverse chase • Sound triggered chase • inbuilt electret microphone • Safe - opto isolated circuitry.
Cat. KA-1010
$119.95



CAR ALARM SCREAMER

Ref: EA August 1986
Incorporates two sensors and utilises a piezo screamer inside the car.
Cat. KA-1675
$34.95

TRANSISTOR TESTER

Ref: EA August 1983
• Tests transistors, SCR's and Diodes without having to unsolder them.
Cat. KA-1119
$21.50

DUAL SPEED MODEM $169.00

Ref: AEM December 1985
Cat. KM-3040

CDI KIT

Ref: ETI Feb/March 1985
Cat. KE-4690
$79.50

JAYCAR No1 FOR KITS AT CHRISTMAS

JAYCAR No.1 FOR CHRISTMAS

GIVE A MULTIMETER FOR CHRISTMAS

• ECONOMY POCKET
- 2000Ω/volt
- size 90 x 50 x 30mm

Cat. QM-1001
$17.50

• LOW COST
- 10,000Ω/volt
- 19 ranges

Cat. QM-1015
$23.50 **SAVE $6**

• WITH CONTINUITY BUZZER
- 20,000Ω/volt
- 10A DC range

Cat. QM-1022
$39.95

• ELECTRONIC FET VOM
- Transistor tester
- Centre zero adjust
- Peak to peak & rms reading

Cat. QM-1050
$79.95

• 10 AMP DIGITAL
- Transistor tester
- Vinyl case

Cat. QM-1530
$89.95

• 10 AMP WITH CAPACITANCE METER
- Digital
- Transistor tester
- Vinyl case

Cat. QM-1540
$129.00

• 4 1/2 DIGIT - 10 AMP
- Transistor tester
- Diode tester
- Data hold

Cat. QM-1550
$179.00

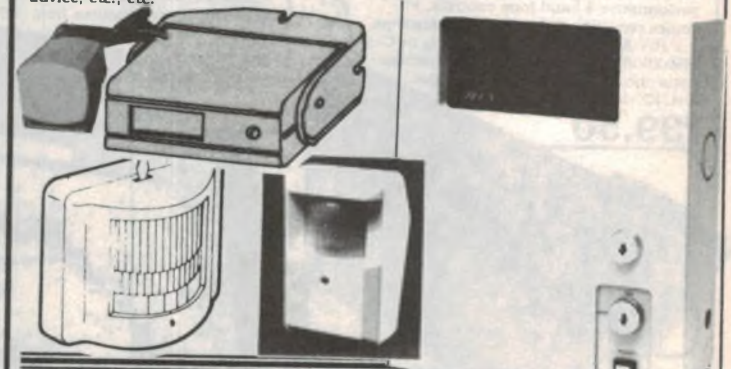
• DIGITAL WITH FREQUENCY COUNTER
- Capacitance tester
- Transistor tester
- 20 amp current
- High impact case

Cat. QM-1555
$159.00 **SAVE $10**

INSTALL THAT ALARM OVER THE HOLIDAYS

+ 2 SECTOR PANEL	$129	Cat. LA-5162
+ KEYLESS 5 SECTOR	$209	Cat. LA-5168
+ HI QUALITY 4 SECTOR	$259	Cat. LA-5170
+ DIGITAL ACCESS KEYPAD	$99.50	Cat. LA-5160
+ IR MOVEMENT DETECTOR	$99	Cat. LA-5017
+ ECON PIR WITH PULSE COUNT	$119	Cat. LA-5018
+ DELUXE WITH PULSE COUNT	$139	Cat. LA-5019
+ TWEETY PIE SCREAMER	$17.95	Cat. LA-5255

For full specifications see our 116 page 1987 catalogue - it's FREE
Plus all accessories for the DIY alarm installer - cable, power supplies, back-up batteries, buzzers, sirens, reeds & magnets, stickers, car alarm kits, key switches, window tape, advice, etc., etc.

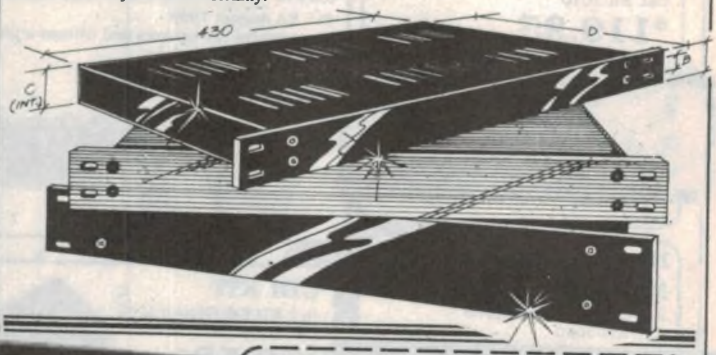


DELUXE RACK CABINETS

These beautifully crafted rack cabinets will give your equipment a real 1st class appearance. All aluminium construction. Removable top and bottom panels. Natural or black finish. All dimensions conform to the International Standard. Ventilated lid. Deluxe brush finish anodised front panel. Individually cartoned. Supplied in flat pack form and easily assembled in a few minutes.
Side elevation: D=254mm; C (internal chassis height); B (mounting bolt centres).

	Finish	A	B	C	Each	+5
Cat. HB-5411	Natural	44	34	38	$65.00	$62.00
Cat. HB-5413	Natural	88	57	82	$80.00	$76.00
Cat. HB-5415	Natural	132	89	126	$95.00	$90.00
Cat. HB-5410	Black	44	34	38	$65.00	$60.00
Cat. HB-5412	Black	88	57	82	$85.00	$80.00
Cat. HB-5414	Black	132	89	126	$95.00	$90.00

Beware of other rack cabinets that do not conform to International Rack sizing. Mounting hole centres conform exactly to International Racking specifications both vertically and horizontally.



VIATEL SELLOUT

We have a small quantity of Viatel terminals left, which we are clearing out for Christmas at silly prices. Both units are 2nd hand, but are in good looking condition. See previous ads for full specs.
- Viatel terminal with 14" colour monitor

Cat. XV-2210
WAS $499 NOW $299 SAVE $200

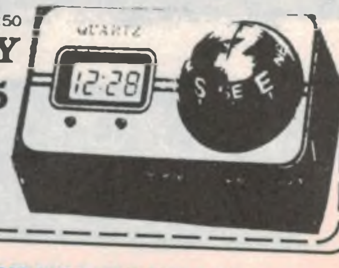
- Viatel adaptor for your TV (with remote) Cat. XV-2212

WAS $199 NOW $129 SAVE $70

QUARTZ CLOCK/COMPASS

GREAT XMAS PRESENT FOR DAD

This great small product has many applications. It's a quartz digital clock and a compass in one small, handy size.
Cat. XW-0250
ONLY $5.95



JAYCAR No 1 FOR SAVINGS

UNBELIEVABLE ELECTROLYTIC BUY

Through Jaycar's surplus stock buying scheme, we have purchased a substantial quantity of an electro that would normally be out of reach of the hobbyists pocket. This electro is made in Germany by ROEDERSTEIN!

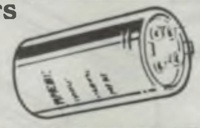
6,880uF 63V LONG LIFE ONLY $7.50!!

That's right ROEDERSTEIN brand long life, high ripple current etched electrodes, screw terminals - all class! And at a price below "Taiwanese". These are absolutely fantastic for power supplies for high power amps, etc.
Electrical to DIN 41332
Tolerance -10 +50%
Dimensions 50(D) x 80(H)
Terminal M5 screw

Cat. RN-6712
$7.50

QUANTITY DISCOUNTS

1 - 5	$7.50
6 - 10	$7.00
11 - 24	$6.50
25 - 99	$6.00



12 VOLT ILLUMINATED PUSH ON/OFF

Similar to the one used in the Red Light Car Alarms and in our flasher deterrent kit.
RED
Cat. SP-0742
YELLOW
Cat. SP-0740

DIRT CHEAP!!

LOWER PRICE
WAS $21.50
SAVE 26%
NOW $15.95

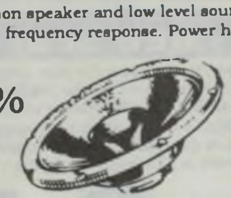
Red Flasher Kit which incorporates red switch also reduced to only $19.95 - Cat. KJ-7000 SAVE $8.50

Jaycar's Direct Imports Saves you money

ECONOMY 8" PA WIDERANGE - 8 OHM

This speaker has high efficiency and is ideal for extension speaker and low level sound reinforcement use. The heavy magnet and dual cone results in a wide frequency response. Power handling 10 watts, 200mm diameter, frequency range 60 - 18kHz.
Cat. CE-2325

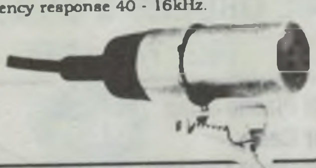
WAS $13.95 SAVE 15%
NOW $11.95
10+ $11.50 ea



DIRT CHEAP!!

QUALITY TIE CLASP MICROPHONE

Low impedance, omni-directional electret condenser. A very small microphone which clips on to your tie. Supplied with 3 metres of cable and 3.5mm plug. 1k ohm impedance. Frequency response 40 - 16kHz.
Cat. AM-4067
$29.95



MASSIVE SCOOP PURCHASE
ROVER NEGATIVE ION GENERATOR

Yes, we've made another scoop purchase. The importer contacted us with his dilemma and we purchased a quantity of these fully imported fully guaranteed air purifiers. These units are 240 volt operated, draw about 1/2 watt, deliver about 250 billion ions per second, and cover about 25 square metres. It's even supplied with a Tester PC board and spare needles. If you've ever wondered about negative ion generators, this MUST be the time to buy one. These were selling for about $80. Jaycar has a limited quantity available for:
Cat. YX-2905
$29.95 **SAVE $50**

DIRT CHEAP!!

CORDLESS PHONE

The fabulous Portable Telephone that you can take anywhere around the house, garden or swimming pool. Microprocessor controlled with a range of up to 250 metres and absolute clarity.
Features:
- Simple to use and easy to install - just plug in
- Operating range up to 250 metres (800 ft)
- Security code system with 16,348 combinations
- Call function at base unit to alert handset
- Pulse dialling with audible tone feedback at the touch of a key

Cat. YT-7065
SAVE $70
WAS $269
NOW ONLY $199

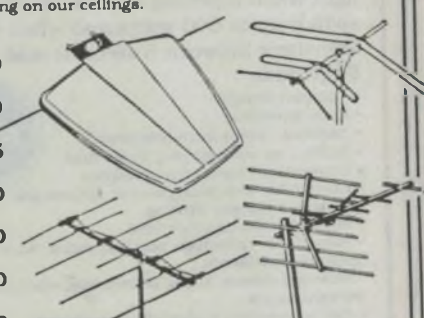
FREE CATALOGUE

If you don't already own a copy of the Jaycar 116 page 1987 Engineering Catalogue drop into any one of our showrooms for a free copy. If you can't get in send a large SAE and we'll forward you one.

TV ANTENNA SELLOUT

This is your chance to grab a TV antenna at a bargain price. All these are discontinued lines and are greatly reduced in price. Some are display models hanging on our ceilings.
Personal shoppers only.

- Caravan Antenna. Built in amp. VHF/UHF and FM
  Cat. LT-3120 **WAS $99.50 NOW $50.00**
- HILLS UHF/VHF Pathfinder
  Cat. LT-3152 **WAS $139.50 NOW $99.50**
- VHF Metropolitan to near fringe
  Cat. LT-3165 **WAS $57.50 NOW $39.95**
- VHF Gutter Grip
  Cat. LT-3170 **WAS $43.50 NOW $32.50**
- UHF Phased Array - vertical style
  Cat. LT-3182 **WAS $69.50 NOW $39.90**
- HILLS UHF Trucolour - 18 element
  Cat. LT-3184 **WAS $89.50 NOW $59.50**
- Sportsman TV antenna - channel 4 and 5A VHF
  Cat. LT-3190 **WAS $59.95 NOW $35.00**



UNI-DIRECTIONAL WIRELESS TIE CLASP TYPE MICROPHONE

This incredibly small microphone just clips on your tie or collar and transmits on FM. No more messy wires to trip over.
- Tunable FM 88 - 108MHz
- Frequency response 100 - 10kHz
- Electret condenser type

Cat. AM-4068
$36.50

Government Instrumentalities, Schools, Public Companies.

If you wish to purchase from us, simply send us your official order and we will give you a complimentary 30 day account.

6802 CPU

Cat. ZZ-8050
NORMALLY $15.95
X'mas Special
$7.95

JAYCAR No.1 FOR NEW PRODUCTS

GREAT XMAS GIFT

LCD THERMOMETER TRAVEL ALARM CLOCK

NEW

BRAND NEW DESIGN

It's about the size of a credit card, measures 85 x 55 x 8mm thick and is supplied in a handy wallet.

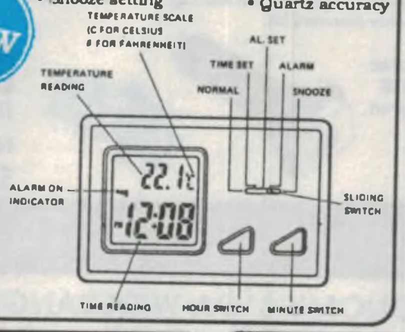
Ideal for travelling. It has an alarm which is LOUD enough to wake even a heavy sleeper AND it has snooze function. It's easy to set the time and alarm time. Display temperature in either Celcius or fahrenheit. Uses one LR-44 battery.

Cat. XW-0392

$29.95

Features:

- Easy to read
- Temperature in °C or °F
- Loud alarm
- Snooze setting
- Easy to set
- Small size
- Carry wallet
- Quartz accuracy



Key-Fob style Burglar Alarm Transmitter Case

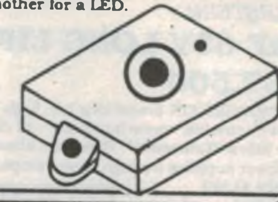
We dare not say which professional alarm company sold us this one! But after months of searching we have a product for our 1988 product line-up.

The (black) case measures 42(L) (plus a little more for a keyring hole) 34(W) and only 11.8mm deep! The case is held together by one screw. The internals are 40.5 x 31 x 9.7mm deep - enough room for a transmitter and battery. The top of the case has a special hole for a pushbutton and another for a LED.

Cat. HB-6072

$3.95

10+ $3.65 ea



NEW

MAX232 - NEW SEMI

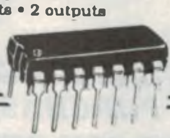
Dual RS232 receiver/transmitter. For new designs, the MAX232CPE makes an excellent replacement for the 1488 and 1489.

Features: • Meets all EIA RS232C specs • Generates ±9V output from 5V supply • Highly useful when ±12V supply is required for RS232 drivers, but is not available • ±30V input levels • Also converts RS232 levels to TTL levels • 2 inputs • 2 outputs

Cat. ZK-8824

$12.95

NEW



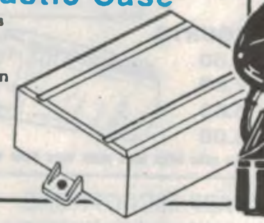
Bulkhead Mount Plastic Case

A unique clip together case that features moulded in mounting feet on the sides.

Measures 87(L) x 67(W) x 31(D)mm.

Ideal for car burglar alarms, etc. Black in colour. Cat. HB-6075

A bargain at only $2.00



AT LAST!

Ammonium Persulphate 400g in a screw top plastic jar. No more messy plastic bags. Keeps harmful moisture out, child guard cap. EASY TO USE, easy to store - SAFE.

Cat. NC-4254 **$5.95**

NEW

MAIL ORDERS ONLY - 008 022 888
MAIL ORDERS & ENQUIRIES
(02) 747 1888

AIR DUSTER

New product from Electrolube.

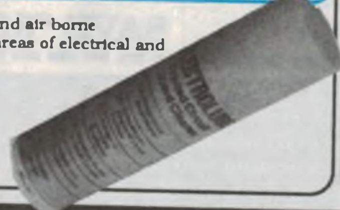
It's pure compressed inert gas for removal of dust and air borne contamination from very delicate and inaccessible areas of electrical and electronic equipment.

400 ml spray pack - 550g nett

Cat. NA-1018

$11.95

NEW



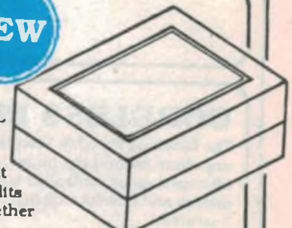
Mini-Mini Plastic Snap Together Case

NEW

- Our Smallest General Purpose Box!

At last. A box for those REALLY SMALL projects - FM bugs, remote sensors, miniature radios, etc. Black in colour measuring (external) 45 x 35 x 19mm it is ideal for many applications. Case splits halfway down the sides and snaps together to save space.

Cat. HB-6070 **$1.95** **10+ $1.75 ea**



NIGHT SECURITY SENSOR

This brilliant new product uses a built-in passive infra red (PIR) detector that reacts instantly to body heat, and activates a light when a person approaches your home. The light is automatically turned off when the person leaves. The sensor will switch up to 600 watts and when set will only operate at night. After triggered, the lights can be adjusted to remain on anywhere between 5 seconds and 10 minutes.

Features:

- Compact design
- Fully automatic
- Security - keeps intruders away
- Safety - no more groping in the dark
- Convenient - hands free operation
- Compatible with incandescent, flourescent, quartz and halogen lighting
- Indoor/outdoor applications
- Suitable for entrances, porches, patios, stairways, garages, basements, hallways, closets, attics, storerooms, warehouses, workshops, etc.
- Can be operated in daylight or darkness

NEW

Specifications:

- Detection coverage - 12 mt long x 110° wide (fan shape)
- Detection zone - 38 beams
- Mounting height - 1.8 - 2 metres
- Power consumption - 3 watts maximum
- Lighting load - 600 watts max.
- Water resistant
- 240V AC operated

DON'T PAY $199 use existing lights

Cat. LA-5130

ONLY $115

NEW ZEALAND CUSTOMERS

You can purchase goods from us TAX FREE When you order by mail or call in to any of our stores ask about TAX FREE prices.

VU METER

Brand new meter, as used in our 8002 mixers. Overall size 48(W) x 45(H)mm meter size 44(W) x 25(H)mm. Yellow background with the words "REC LEVEL" on meter.

Cat. QP-5058

$9.95

JAYCAR No1 FOR ELECTRONICS

SCOOP PURCHASE!!

MICROPROCESSOR CONTROLLED/ SOLENOID OPERATED HI FI CASSETTE DECK MECHANISM

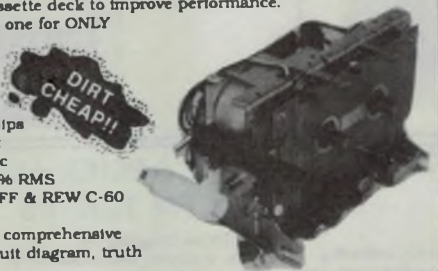
You guessed it, another Jaycar buy far, far below manufacturers cost where you buy at a normally silly price because other people have lost heavily. This time its a VERY HIGH QUALITY cassette deck mechanism that cost over $35 US in 1000 lots! This JAPANESE MADE mechanism is deck only - i.e. a door is not fitted nor are there buttons. The deck is not operated by mechanical buttons and all control is by electric signals, therefore the deck could easily be software controlled.

The deck also features an air damper cylinder for soft eject, massive capstan flywheel, Hi Fi head and excellent specs. (see below).

This deck is ideal as either a fast high capacity PC memory storage or as a retrofit to an existing cassette deck to improve performance.

Worth at least $80, grab one for ONLY

$24.95



Cat. AC-1590

SPECS:

- 4 track, 2 channel Philips compact cassette deck
- Tape speed 4.75cm/sec
- Wow and flutter <0.12% RMS
- Winding time 110 sec FF & REW C-60
- Working volts 9 - 15V
- Supplied with 12 page comprehensive manual including circuit diagram, truth table, etc.

BARGAIN COMPONENT PACKS

80 Electrolytics $10 Cat. RE-6250
150 Mixed Capacitors $10 Cat. RE-6260
35 Pots, Trimpots, Sliders $10 Cat. RP-3902
100 mixed Semiconductors $10 Cat. ZP-8990
100 mixed BC type transistors $11.95 Cat. ZT-2170
100 3mm & 5mm LEDs $19.50 Cat. ZD-1694
100 mixed IC sockets $24.95 Cat. PI-6490
50 assorted Pots $7.95 Cat. RP-3900
50 assorted Resistor Networks $10 Cat. RR-3380
Assorted Pot Cores $9.95 Cat. LF-1280
20 Precision 1% & 2% Capacitors $12.50 Cat. RG-5198
25 RT Kermet Tantalums $5 Cat. RZ-6692

PHOTO INTERRUPTER

This device enables you to turn a circuit on and off optically.
It consists of a moulded plastic housing with an IR LED facing a phototransistor across a gap. Any object in the gap will interrupt the IR beam and consequently switch the phototransistor on and off. The device is very fast and ideal for counting, timing or sensing.

FEATURES:
- PCB or chassis mounting
- Low cost
- Rugged one piece construction
- Very fast

APPLICATION:
- Counter sensor
- Tachometer
- Opto ignition
- Edge sensor
- Tape end sensor

$8.95

(Around 1/4 the price of its European 'Cousin')

Full specs supplied with each unit.
Cat. ZD-1901

Sorry no room for a picture!

AT LAST!

A high quality RF Modulator for Audio AND Video

We have finally sourced a good quality stable VHF Modulator for both audio and video input signals.

This unit which measures a tiny 35(L) x 25(W) x 13(D) (excluding coax (RCA) output socket and input terminals) is made in Japan by National (Matsushita). It is used on the well known NV-180 VCR and has output switchable on VHF Ch 3 or 4 Aust.

The small size belies its performance! It uses state-of-the-art surface mount componentry (which also helps reduce parasitic stray capacitance) and even has a surface acoustic wave (SAW) filter!

SPECS:

Power	+9V
Input	Video: line level (input attenuator provided) Audio: line level
Output	CH 3 or 4 (Aust VHF) switchable RCA type coaxial socket

Connection details and circuit diagram provided.
Cat. LM-3840

$29.95

NOW IN STOCK "QUALITY" RANGE OF BANANA PLUGS

A new range of US style banana plugs.

RED
Piggy back style
Cat. PP-0390
BLACK
Piggy back style
Cat. PP-0391

$1.95 ea

10+ $1.75 ea

Note: a multimeter probe can be inserted into the back of the plug.

RED
Flexible type
Cat. PP-0394
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Flexible type
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85¢ ea

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We have just purchased a quantity of VHF TV antennas from a wholesaler who is no longer in the TV antenna business. The antennas are a 7 element type suitable for metropolitan areas. They have excellent gain and directivity for areas with moderate signal strength! For coax use use outdoor balun Cat. LT-3026 $3.75. Australian made. These will never be this cheap again.

Cat. LT-3166

NORMALLY $57.50

SAVE $17.55

ONLY $39.95

AVTEK MEGAMODEM - NEW MODELS

Don't buy imported/unsupported modems when Australian designed and manufactured models cost less. Compare the features - look at the value. 12 month extended warranty on both modems.

SPECIFICATIONS:

Speeds	300 Baud Full Duplex - both models 1200/75 for VIATEL - model 123 1200 Baud Full Duplex - both models
Data Standards	V21, V22 - both models V23 - 123 model only
Command Set	Hayes with extensions)
Interface	CCITT V24 (RS232)
Data Format	Asynchronous
Power	<2 watts
Size	27(H) x 120(W) x 157(D)mm
Indicators	8 LEDs

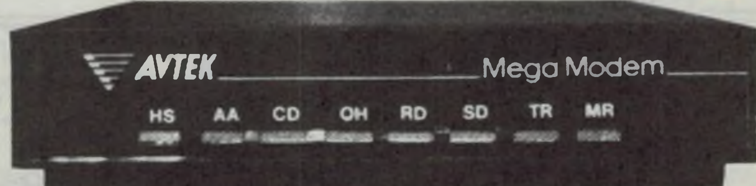
Internal diagnostic loop back.

NEW

Model 12 Cat. XC-4850
$375

Model 123 Cat. XC-4855
$449

AUSTRALIAN MADE



AVTEK MINIMODEM STILL AVAILABLE Cat XC-4825 **$199**

BREADBOARDS

100 hole - Cat. PB-8810
$3.75
640 hole - Cat. PB-8812
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840 hole - Cat. PB-8814
$17.50
1680 hole - Cat. PB-8816
$39.95
2420 hole - Cat. PB-8818
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$69.95

(Note: PB-8816/18/20 are all mounted on a metal frame with banana terminals).

JAYCAR No1 FOR NEW & EXCITING KITS

NEW KITS FOR DECEMBER

24 TO 12V CONVERTER

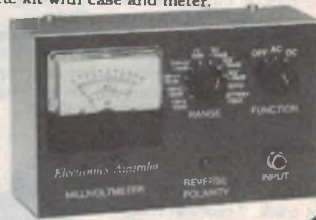
Ref: Silicon Chip Dec '87
Well suited to run 12 volt appliances from 24 volt. Can deliver up to 5 amps.
Complete kit
Cat. KC-5017
$59.00

TELEPHONE RINGER

Ref: Silicon Chip Dec '87
If you are tired of the sound of your phone, try this kit. Mounts inside phone - includes buzzer.
Cat. KC-5015
$19.95

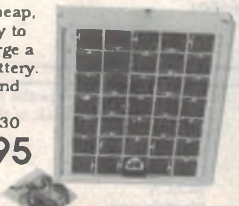
HIGH IMPEDANCE AC/DC MILLIVOLTMETER

Ref: EA Dec '87
This kit will measure AC and DC signals down to a couple of millivolts, with negligible circuit loading. Complete kit with case and meter.
Cat. KA-1695
$46.50



SOLAR GENERATOR

Ref: ETI Dec '87
This is a cheap, no fuss way to trickle charge a 12V car battery. PC board and parts.
Cat. KE-4730
$12.95



UNIVERSAL SPEED CONTROL & LAMP DIMMER

Ref: Silicon Chip Dec '87
Use for control of drills, fans, electric blankets, soldering irons or a dimmer. Complete kit with box, mains leads, etc.
Cat. KC-5016
$18.95

SUB CARRIER ADAPTORS FOR FM TUNERS

Ref: Silicon Chip Dec '87
Listen to hidden transmissions on FM broadcasts.
PC board and components.
Cat. KC-5014
$22.95

OCTAVE EQUALISER MODULE

Cat. KM-3064
$49.95

Ref: AEM Dec '87
This one octave EQ module is suited for PA and professional use. Kit supplied with all components, pots, PCB. No box or hardware.

PASSIVE "BANDPASS" SUBWOOFER

AUSTRALIAN MADE

Ref: AEM Sept '87
After much interest in this project, we wil have available the 3mH inductors. The woofers, speaker terminals, cable and innerbond are normal stock lines.

P25WO-08 10" woofer
Cat. CW-2136
$196.00 each

3mH Inductor
Cat. CX-2640
$13.50 each

CAPACITANCE METER FOR D.M.M.

Ref: Silicon Chip Nov 1987
A great project from a new monthly electronics magazine - Silicon Chip.
Add a two range capacitance tester for only $27.95.
Ranges are 0 - 2200pF and 0 - 2.2µF. Complete kit.
Cat. KC-5010
$27.95

1GHz Digital Frequency Meter!

Ref: Silicon Chip Nov '87
This superb 1GHz digital frequency meter will outperform any other instrument in its price range. It uses the highest performance ICs, provides both frequency and period measurements, and features an 8 digit LED readout.
Cat. KC-5013
ONLY $299.00

VOICE OPERATED RELAY

Ref: EA Nov 1987
Eleviates the need to push the button when using a microphone.
Shortform kit, no hardware.
Cat. KA-1692
$24.95

DIRT CHEAP!!

OFF HOOK INDICATOR FOR PHONE

Ref: Silicon Chip Nov 1987
If you have two or more telephones on the one line, with this project a LED will flash on the phones not used to indicate the line is in use. One kit is needed for each telephone.
PC board and components supplied. (Unit mounts in telephone).
Cat. KC-5011
$19.95

HIGH QUALITY GUITAR PREAMP

Ref: ETI Nov 1987
Features of the ETI 1424 include a top boost and normal input, two pre-eq line inputs, bass & treble controls, effects send and return, sweep eq, 4 post eq & line inputs and master volume. PCB pots supplied when available. 6.5mm sockets, transformer and knobs are not supplied.
Cat. KE-4729
$45.00

METRONOME

Ref: EA Nov 1987
Printed circuit board and electronics supplied. No box.
Cat. KA-1693
$19.95

VOLTAGE & CONTINUITY TESTER

Ref: EA Nov 1987
This handy voltage and continuity tester tests AC and DC voltages and also continuity in wires and cables.
Cat. KA-1694
$29.95

CAR RADIO POWER SUPPLY

Ref: Silicon Chip Nov 1987
Put that old car radio that's laying around to good use as a mantle/kitchen/garage/sunroom radio. Our kit includes PCB, transformer and components. You need the radio and speakers. 6 x 4 speakers $10.95 each (Cat. AS-3014)
Cat. KC-5012
$28.95

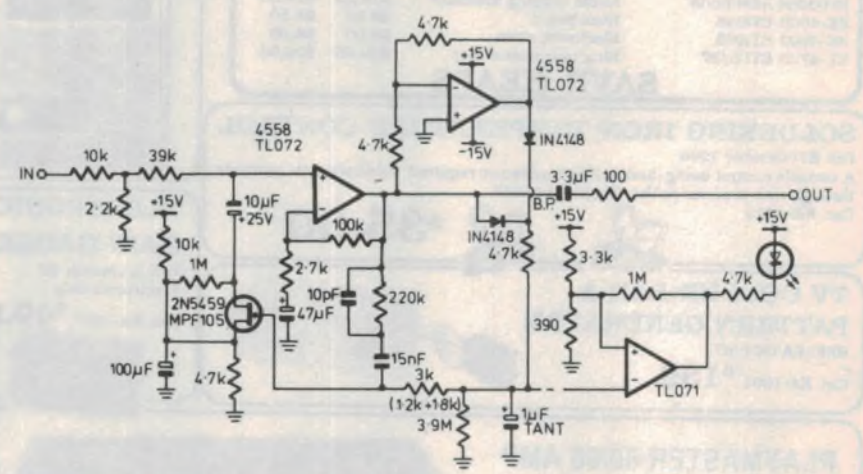
JAYCAR MANAGEMENT AND STAFF WOULD LIKE TO WISH ALL OUR CUSTOMERS A VERY MERRY CHRISTMAS & A HAPPY NEW YEAR

NEW KITS FOR NOVEMBER

Circuit & Design Ideas

Interesting circuit ideas from readers and technical literature. While this material has been checked as far as possible, the circuits have not been built and tested by us. As a consequence, we cannot accept responsibility, enter into correspondence or provide constructional details.

Fast peak limiter



This audio limiter employs a FET as a variable resistance to attenuate the input signal according to a control voltage (CV). It offers unusually good performance with low cost and component count.

A 4558 dual op-amp provides gain and full wave peak detection. The 4.7k 3.9M and 1uF tantalum capacitor set the attack/release time constants while the 3k, 220k, 10pF and 15nF capacitor form the distortion cancelling network. If 50% of the signal across the FET is applied to the gate then non linearity in the FET is minimised. Applying this signal in the way shown here avoids delaying changes in the CV caused by the usual 2:1 divider network around the FET.

All resistors and capacitors have been optimised for least distortion across the audio band — 0.3% THD typically for 1kHz and up, with 1.65V RMS output.

Attack time with the values shown is 5ms, with a release time of 1.0s. Noise level is –80dB unweighted with respect to an output of 1.65V RMS.

The optional Schmidt Trigger circuit provides a visual indication when the CV exceeds 1.6 volts, corresponding to a 1dB gain reduction. Maximum reduction is about 40dB.

Phil Allison,
Summer Hill, NSW.

$30

Soldering iron timer

This circuit is basically a timer connected to a relay to switch the mains. R1 and C1 create a time lapse as C1 charges via R1. When C1 reaches 2/3 rail voltage, pin 3 goes low and RLY1 turns off the soldering iron. With this circuit you can have a good 20 minutes soldering.

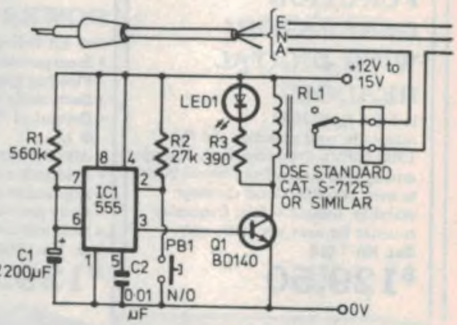
To switch on the iron again, press PB1 and the whole cycle starts again. When you turn the circuit off via PB1, C1 discharges via pin 7.

The same circuit could also be used to turn on a porch or stair landing light for say five minutes, using a smaller capacitor for C1.

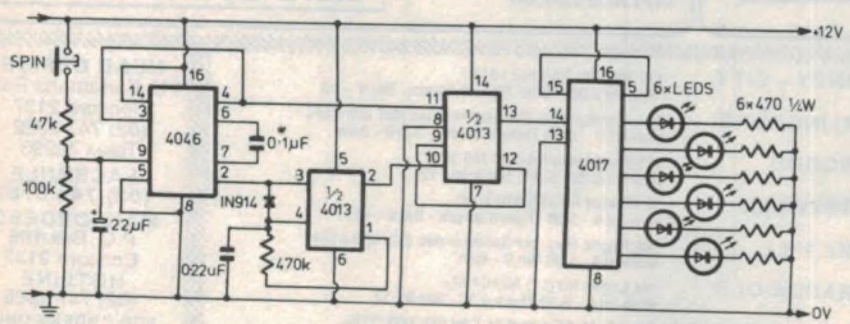
Paul Daniels,
Townsville, Qld.

$15

Editor's Note: It might be a good idea to add a 68 ohm resistor in series with pin 7 of IC1, to limit discharge current, in view of the high value used for C1.



Electronic die for games

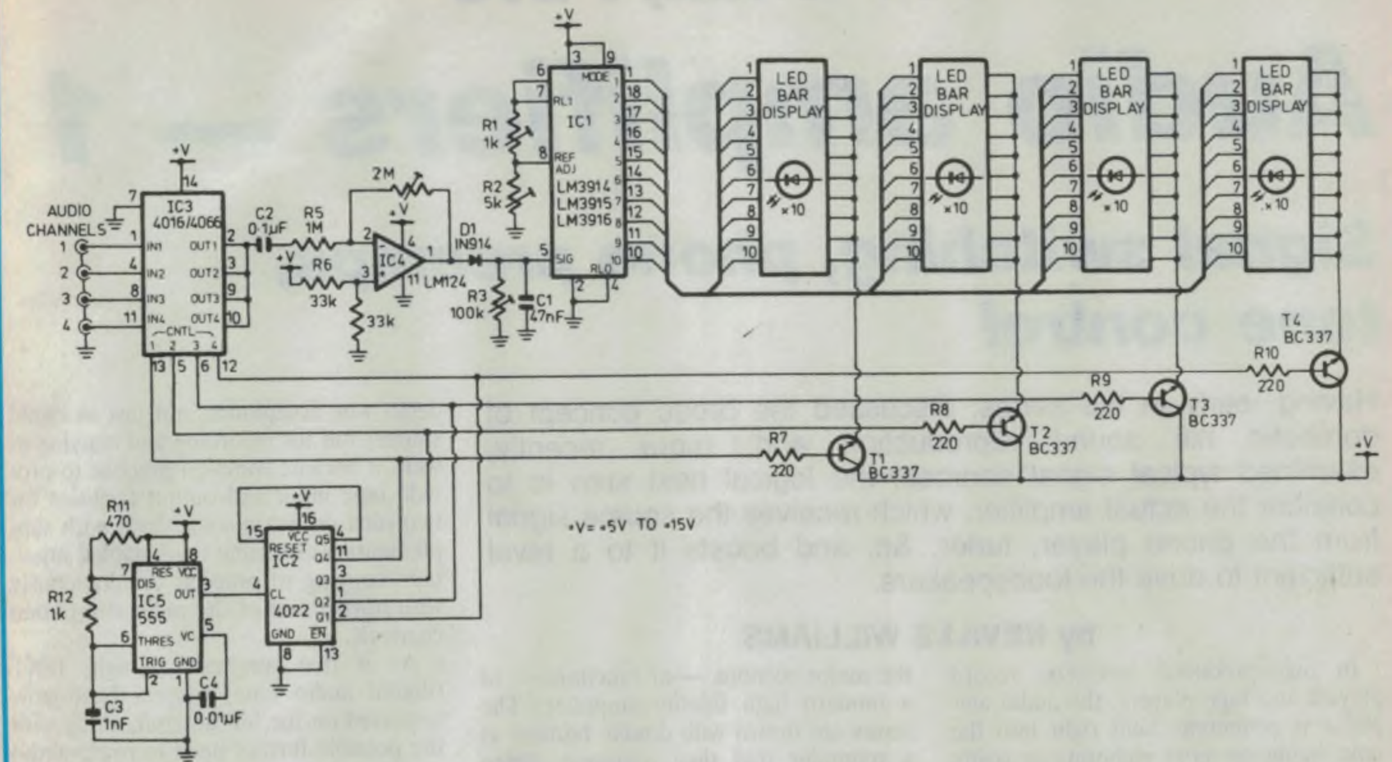


This circuit was designed to select 1 of 6 categories in a quiz game based on "Trivial Pursuit" questions.

When the pushbutton is pressed, the LEDs speed up to the maximum speed as set by the capacitor on pins 6, 7 of the 4046. When released, the LEDs slow down until the timing of the 4013 is exceeded, upon which they stop. This is needed as the 4046 in the VCO mode does not go down to zero and otherwise the LEDs would creep slowly.

Dave Duffy,
Thornlands, Qld.

$15



Multi-channel display

Bar graph displays, which appear on almost all audio equipment, can look quite impressive, especially when used in spectrum analysers. However, a typical analyser requires at the very least four bars each channel, for an adequate representation of the audio spectrum. The simplest way to do this would be to use four bar graph display chips (most commonly the LM3915's) for each channel.

Unfortunately, this could end up being unnecessarily expensive, with each chip costing about $6.00. The more displays, the higher the cost. For the typical cost-conscious experimenter, there is an alternative, which enables a large number of channels to be displayed using only one display chip.

The answer lies in multiplexing. Here's how it works:

A 555 oscillator, running at 20kHz or more feeds the clock of a sequencer, IC2. This is configured to decode the first four outputs and then reset itself, starting the sequence again. The outputs of IC2 feed two things: the control inputs of IC3, and output transistors T1 — T4. This forms the basis of the multiplexing.

The output of IC2 enables one of the audio inputs to IC3 to pass through to IC4, where it is isolated and amplified. The output of IC4 is then rectified and filtered, to make sense of the rapidly changing audio signal, and enters IC1, the display chip. Two variable presets R1 and R2, control display brightness and full-range setting respectively.

The ten individual outputs from IC1 are connected to each of the four displays, which are driven by transistors T1 to T4, driven in turn by IC2. This effectively means that audio channel 1 will appear only on display 1, channel 2 will appear only on display 2, and so on. The clock frequency of IC2 is 20kHz to prevent any switching interference which could affect the audio signal at the inputs of IC3.

Although the circuit shown here has only four inputs, this number could be increased up to ten by the use of more 4066's and LED displays, and by using a 4017 in place of the 4022. Displaying more than 10 audio channels would be possible by, for instance, using a 4 to 16 Line Decoder and binary counter in place of IC2.

D. Burchell,
Pascoe Vale, Vic.

$30

An introduction to hifi, Pt.16

Audio amplifiers — 1

Signal switching, phono preamps, tone control

Having, early in the series, discussed the broad concept of domestic hifi sound reproduction and, more recently, examined typical signal sources, the logical next step is to consider the actual amplifier, which receives the source signal from the phono player, tuner, &c, and boosts it to a level sufficient to drive the loudspeakers.

by NEVILLE WILLIAMS

In mass-produced receivers, record players and tape players, the audio amplifier is commonly built right into the unit, being no more elaborate or costly than is necessary to satisfy the immediate requirement.

In the context of high fidelity reproduction, however, the amplifier is more likely to be a physically separate unit and designed on a more generous basis, with a view to obtaining the highest possible quality of sound reproduction, consistent with acceptable cost and complexity.

In the discussion to follow, frequent reference will be made to technical terms and concepts explained in two earlier chapters in this series. Readers may care to check back over them by way of revision:

Hifi Stereo: what it means in simple terms (March 1986, p.10); and

Hifi facts and figures (April 1986).

Fig.1 depicts in block schematic form the major sections — or functions — of a modern high fidelity amplifier. The boxes are drawn with double borders as a reminder that they represent stereo units providing for two identical signal channels. The input and output signals are assumed to be stereo but, to avoid visual clutter, no attempt has been made to show the connecting lines and switch functions in duplicate.

In most domestic situations, hifi amplifiers are used in conjunction with a range of signal sources and normal practice is therefore to provide such amplifiers with multiple input sockets at the rear and an associated signal selector switch on the front panel.

In the early days, one could get by with three selectable inputs: Phono, Radio and a spare channel marked "Aux" (Auxiliary) but this soon expanded to four: Phono, Radio, Tape and Aux.

Subsequently, when compact cassette decks won acceptance, not just as signal sources but for recording and copying as well, it became common practice to provide tape input and output facilities for two such decks, in some cases with supplementary switching that enabled tape/-tape copying to proceed simultaneously with normal use of the radio and phono channels.

As if that was not enough, DAT (digital audio tape) players have now appeared on the hifi horizon, along with the possible further need to route audio signals from TV/video equipment through the sound system. Tomorrow's signal select function may well need to cope with a multiplicity of inputs, such as indicated in Fig.1, along with signal feeds back to the recording devices.

The provision of so many stereo signal select/feed options poses a very real practical problem for the designer. The one-time use of a rotary switch and multiple stereo pairs of shielded wire leads is much too clumsy, necessitating either pushbutton electronic switching using CMOS devices, or else unshielded tracks on a PC board combined with extraordinary care with layout (see the Playmaster 60/60 amplifier, May 1986).

Input signal levels

With the sole exception of the phono player, all of the signal sources nominated in Fig.1 contain internal electronic circuitry, which processes the signal as appropriate, compensating it to a nominally flat frequency response and boosting it to a convenient level for input to the amplifier.

It has become accepted practice over the years to provide a nominal output signal level of between 0.5V and 1.0V RMS, with an effective source impedance ranging from a few hundred to a few thousand ohms. Output signals of this general order are often (but rather loosely) described as being at "line" level, signifying that they are ready to feed directly to an amplifier.

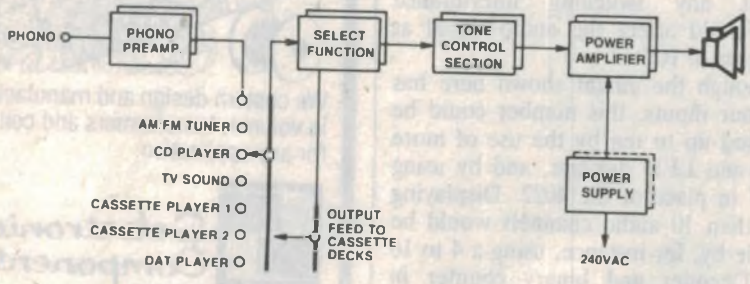


Fig.1: The major sections in a hifi amplifier. Switching on the front panel selects the desired signal and passes it through a tone control system to the main amplifier which, in turn drives the loudspeakers.

In turn, domestic amplifiers are commonly designed with a "line" input sensitivity of around 0.25V (250mV RMS). In other words, they are capable of delivering full rated power with an input of that order. Most amplifiers therefore have gain to spare which, if nothing else, may be reassuring to the user.

When fed with a larger input signal (typically 0.5V or more), the amplifier volume (or gain) control must therefore be set well back to reduce the signal input — and the amplifier output — to the desired level. With typical amplifiers and signal sources, a comfortable listening level is commonly reached with the volume control at about the "10 o'clock" setting. With the control at "12 o'clock" (half rotation) the volume level is usually quite high, the system running into overload somewhere beyond that.

There is no cause for concern if, with some signal sources, the volume control needs to be advanced further than suggested above, provided the system can still be driven to the desired level. It is simply a case of a somewhat smaller input signal requiring extra amplification.

If, on the other hand, normal listening level is achieved at "8 o'clock" and full volume at "10 o'clock", there is cause for concern. Not only may the volume control be unpleasantly critical in use, but it could be that the signal being fed to the amplifier is of greater amplitude than it is meant to accommodate — with the possiblity of overload and distortion on peaks, irrespective of volume control setting.

This situation is most likely to arise with compact disc players, some of which have a nominal output signal level of around 2.0V RMS and no provision to reduce it. The logical course is to insert a resistive attenuator pad in the respective left and right channel signal leads to reduce the level by about 3:1. Details of a switchable attenuator for this purpose were given in the January 1986 issue (see Fig.2).

Phono preamplifiers

Phono decks — or "black disc" players present a problem of the reverse kind in that, lacking any in-built signal processing circuitry, they deliver a signal which is neither flat, in terms of frequency response, nor adequate in terms of amplitude. (For a detailed discussion of phono decks, see chapters 4 and 5 in this series, May and June 1986).

It is true that piezoelectric (crystal and ceramic) phono cartridges can deliver a signal that is reasonably flat and reasonably close to "line" level but, with rare exceptions, their overall electrical performance and mechanical characteristics fall well short of high fidelity equipment standards.

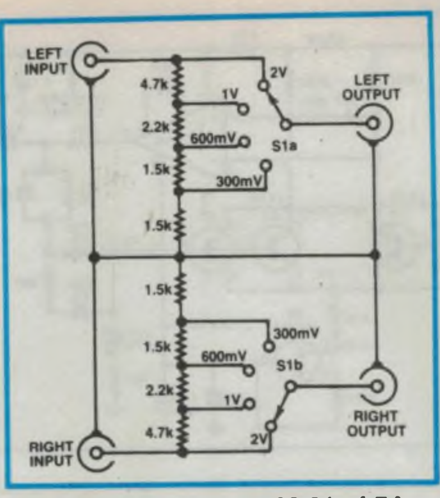


Fig.2: Described on pp.90-91 of EA for Jan 1986, this switchable stereo attenuator can reduce the nominal 2.0V output from a CD player to 1.0V, 600mV or 300mV, thereby avoiding the risk of input overload distortion.

Virtually all hifi phono cartridges are therefore of the "magnetic" variety, with a nominal signal output of around 5mV. Moreover, the frequency response is far from flat, being down by about 18dB at 30Hz and up by almost the same amount at 15kHz. To correct this situation, the signal needs to be processed through a preamplifier compensated to the so-called RIAA characteristic which must:

(1). Amplify it to nominal "line" level — around 0.5V RMS; and

(2). Boost the bass end by up to 20dB and cut the treble in a similar manner, to achieve an overall characteristic which is hopefully flat, within about 1dB, from 30Hz to 15kHz. (See Fig.3).

Prior to the arrival of solid-state devices, designers had no choice but to use valve type preamplifiers but, with such a low level of signal, especially at the bass end, it was difficult to provide the required degree of amplification without the signal being compromised by noise inherent in the valve circuitry, by 50Hz hum injection from the cathode/heater wiring, and by microphonic effects resulting from vibration of the valve electrodes.

It was especially difficult to achieve a sufficiently low noise level with a phono preamplifier built into the same case as the rest of the amplifier and power supply. It became quite common practice, therefore, to accommodate the phono preamplifier in a small metal box connected by cable to, but isolated from, both the phono deck and the remainder of the amplifier.

Solid-state preamplifiers

Being small in size and without a heater circuit, transistors seemed to offer a way around these difficulties but they proved to have problems of their own, which took some time for manufacturers and designers to sort out: junction noise, low input impedance, limited frequency response, and overload on peak signal levels.

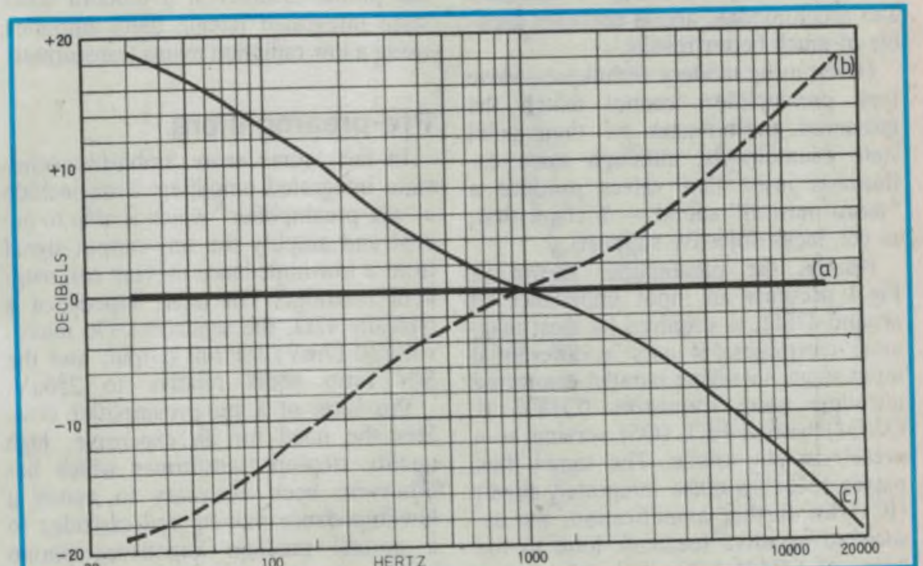


Fig.3: Curve (b) is the nominal frequency characteristic of a magnetic phono cartridge, and (c) the required response of a compensated preamplifier. Ideally the two curves would together produce (a) but, in practice, a resultant within 1dB from 30Hz to 15kHz would be good.

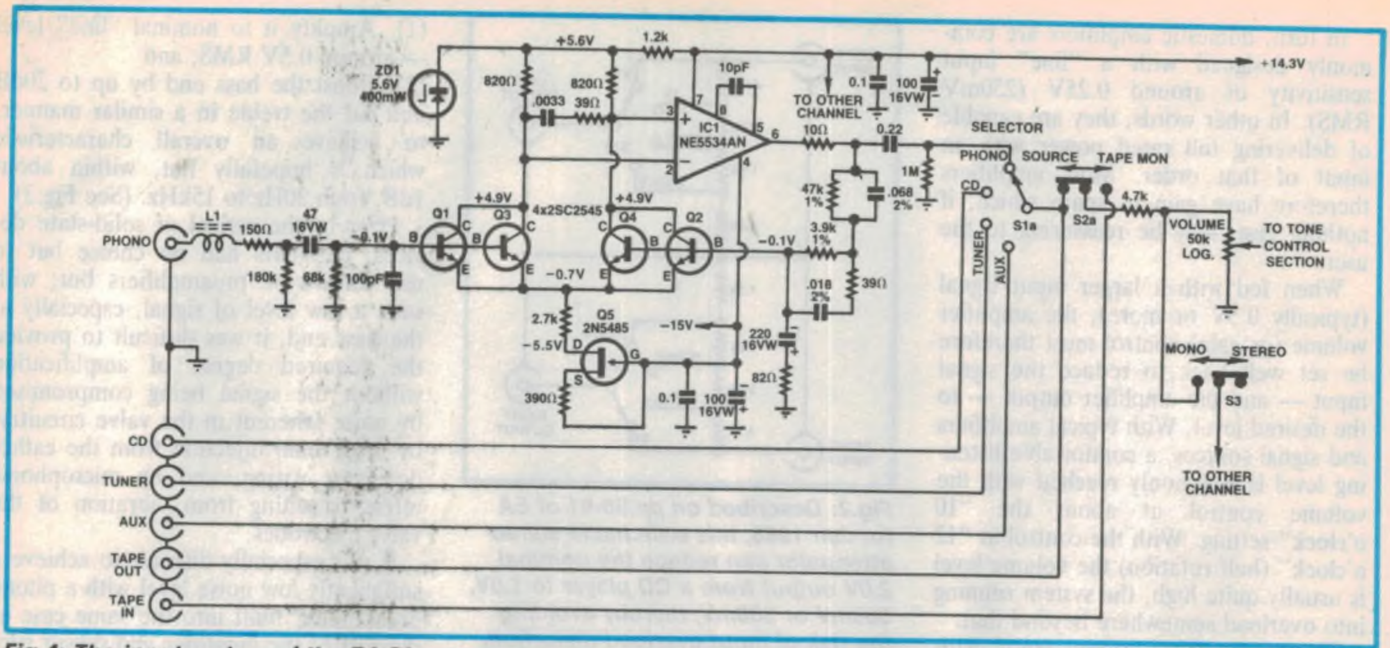


Fig.4: The input system of the EA Playmaster 60/60 integrated amplifier, lifted from the full circuit on p.37 of the June 1986 issue. It includes the circuit of one channel only of the compensated phono preamplifier.

But those problems have long since been overcome by the development of better transistors and better components generally and, more particularly by ultra-low noise transistors, ICs and circuit techniques able to reduce noise greatly in the audio passband.

Fig.4 shows the circuit of one channel of a typical modern phono preamplifier, lifted from the full circuit diagram of the Playmaster 60/60 amplifier (EA June 1986, p.37). It is functionally quite complex, compared with a single EF86 stage from the valve era, but with modern components and techniques, it would probably be easier to assemble and accommodate and is certainly capable of much better results.

(Even using modern techniques, valve type preamplifiers cannot match the measured performance of their solid state counterparts, although some enthusiasts insist that valves produce a "more musical" sound — a claim that, as yet, lacks objective support).

Briefly, the preamplifier shown in Fig.4 presents an input impedance of around 47kΩ, as required by most magnetic cartridges. It uses a differential input stage, involving parallel-connected ultra-low noise transistors (Q1/Q3 & Q2/Q4) with a FET (Q5) serving as a preset current source. The signal then passes to a low-noise integrated circuit (IC1) for further amplification, the associated negative feedback loop to the bases of Q2/Q4 being tailored to produce the required RIAA frequency compensation as indicated in Fig.3c.

Following IC1, an RC coupling network (0.22uF/1MΩ) attenuates possible turntable/disc rumble components below 20Hz, before making the signal available to one pole of selector switch S1a. Fewer input options are provided than shown in Fig.1, with connections for one tape deck only. The circuit does, however, include a mono/stereo switch (S3), a facility not previously mentioned.

Measured input sensitivity of the phono channel, as shown, is 4.3mV for full output and the signal/noise ratio at 1kHz, relative to 10mV input, is 89dB unweighted, using a routine magnetic cartridge. The latter figure is typical for the phono channel in a modern solid-state integrated (single unit) amplifier, using a low radiation mains transformer.

Pre-preamplifiers

In fact, some more ambitious solid-state integrated amplifiers even include a "pre-preamplifier" which is able to accept and amplify the tiny output signal from a low-impedance moving coil magnetic cartridge. The input impedance is typically 47Ω, the sensitivity 170 microvolts (0.17mV) for full output, and the S/N ratio 68dB relative to 250uV.

Provision of a pre-preamplifier obviates the need for an expensive, high quality step-up transformer which has otherwise been necessary to match a low-impedance moving coil cartridge to a normal medium impedance phono input.

An effective, compensated phono preamplifier has been an essential feature in domestic hifi amplifiers for the past 40-odd years but, ironically, that situation may be about to change, with the rapid swing to compact disc and the further possibility of digital cassettes. Phono decks certainly stand exposed as the one signal source unable to deliver a "line" signal.

With the pressure on amplifier manufacturers to cut costs where they can, the possibility must be seen of the phono preamplifer becoming an external option or, more logically, an integral part of the phono deck itself. Having in mind the motor and arm control electronics that is now relatively commonplace in modern turntables, the inclusion of signal processing circuitry would not present any great hassle.

Tone control system

From the early 1930s at least, most receivers and amplifiers have featured some kind of tone control, most commonly involving a switch or a potentiometer which served to introduce a bypass capacitor across the audio signal circuit. The value of the capacitor was chosen such that it would progressively attenuate frequencies above about 2kHz, producing what was euphemistically called a "mellow" tone.

Critics preferred to describe it as "muffled"!

Listeners interested in quality reproduction largely rejected simple "top-cut" tone controls as inappropriate for a quality system, but their opinions diverged.

Some spurned tone controls altogether on the grounds that hifi components should be engineered, as far as possible, for a flat frequency response

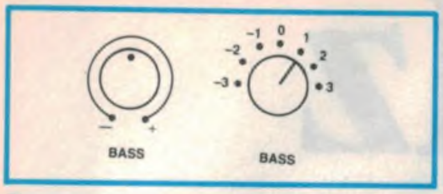


Fig.5: Potentiometers (left) offer smoother tone control than switches (right) but the attendant circuitry must be carefully designed if response in the median position is to be truly flat.

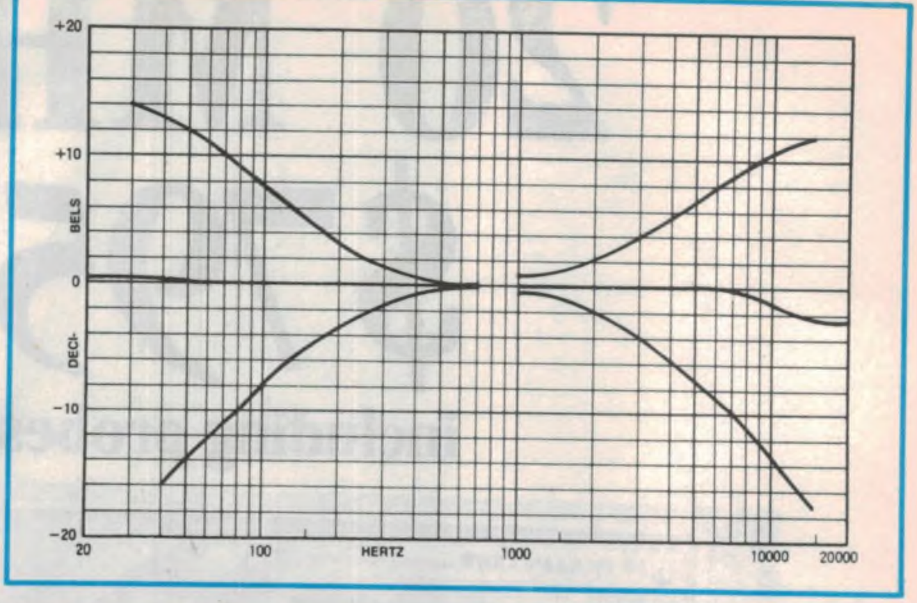


Fig.6: Typical adjustment range of the bass and treble tone controls fitted to a fairly basic hifi amplifier. Ideally, the response should be truly flat with both controls at a clearly identifiable median position.

and left that way! Over the years, many amplifiers have conformed to that philosophy, with little more on the front panel other than an on-off switch and indicator, a channel selector and a volume control.

Other enthusiasts have been equally insistent that frequency compensation facilities were desirable, because they would permit the user to compensate for tonal imbalance that might occur anywhere from the signal source to the listening room. Judicious correction could restore full enjoyment of the performance.

That view has obviously prevailed in that, historically, most high quality commercial amplifiers (and systems) have included tone control facilities.

In their most basic form, (hifi) amplifier tone controls involve two multi-position switches, or two potentiometers, controlled by knobs on the front panel, marked respectively "BASS" and "TREBLE", and calibrated to indicate a level response in the median position, progressive boost when turned clockwise, and progressive cut when turned anticlockwise (Fig.5).

Switches were popular initially but potentiometers gained acceptance by reason of their smoother action. The use of calibrated knobs and, in many cases, mechanical indexing, allows particular settings to be identified.

Fig.6 shows the measured adjustment limits of the bass and treble potentiometers in a typical, modest hifi amplifier. With the bass control in the median position, the bass response is flat down to 20Hz, the limit of the graph, to within less than 0.5dB — an entirely acceptable figure.

Turning the bass control clockwise causes the curve to deviate from reference at about 500Hz — referred to as the "turnover" frequency — climbing to a maximum available boost of +14dB at 30Hz. Turning the control fully anticlockwise produces a slightly steeper attenuation curve, as shown.

At the high frequency end, the maximum available boost is +12dB at 15kHz while, again, the attenuation curve is somewhat steeper. However, with the treble control in the median position, the high frequency response is down by 2dB at 15kHz — not disastrous but certainly open to criticism.

Ideally, the response through a tone control stage should be flat right across the audio band, to within a fraction of a decibel, when the bass and treble controls are set to their visual median position.

Extra knobs and switches

Bass and treble controls with "turnover" frequencies as shown — 500Hz and just over 1000Hz respectively — have the advantage that their effect is subjectively obvious and the user is left in no doubt about their effect. However, it is not possible to boost or cut the very deep bass or the very high treble, without simultaneously boosting or cutting frequencies nearer the centre of the range.

To overcome this limitation, supplementary controls can be provided (Fig.7) which allow turnover frequencies to be selected closer to the extremes of the audio band. To the technically inclined music lover, they can be both meaningful and useful for such tasks as boosting the deep bass, cutting rumble, adding sparkle to the upper treble or selectively reducing top-end noise.

Unfortunately, the cost factor and the potential for confusion for the uninitiated is such that turnover controls are relatively rare.

By way of partial compensation many commercial amplifiers, provide low and high frequency attenuation filters, which can be cut in or out of circuit with simple toggle switches. The low frequency or "subsonic" filter is intended to operate below about 30Hz, mainly to combat rumble components from the phono turntable or disc. The high frequency filter operates above about 7kHz, to take the edge off residual noise or distortion.

Unfortunately, high/low filters often look more impressive on the panel than they sound in practice. Being of relatively simple configuration, they simply do not provide a sufficiently sharp cutoff beyond the turnover frequency to be really effective.

For extra measure, many amplifiers also feature a "Loudness" switch which has the effect of boosting the bass and perhaps the treble by a fairly arbitrary amount. The idea is to compensate for the subjective frequency loss that occurs when circumstances dictate that music be listened to at an unnaturally low level.

On the plus side, a loudness control

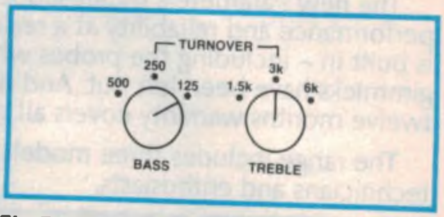


Fig.7: Means to select bass and treble control turnover frequencies — a useful feature for users able to understand their effect.

compensates for low listening level at the flick of a switch; on the minus side, it can completely unbalance the sound if it is inadvertently left on when the amplifier is operating at normal room volume.

The defeat switch

With such an array of facilities to "doctor" the frequency response, it may be somewhat reassuring to find, on many amplifier panels, a "Defeat" switch which effectively cuts the tone control system out of circuit, when set to the position variously marked "Defeat", "Direct", "DC", &c.

Defeat switches provide a ready means of comparing tonal balance with and without compensation but, more importantly, they provide a desirable option for the kind of listener, referred to earlier, who is intolerant of anything but a flat amplifier!

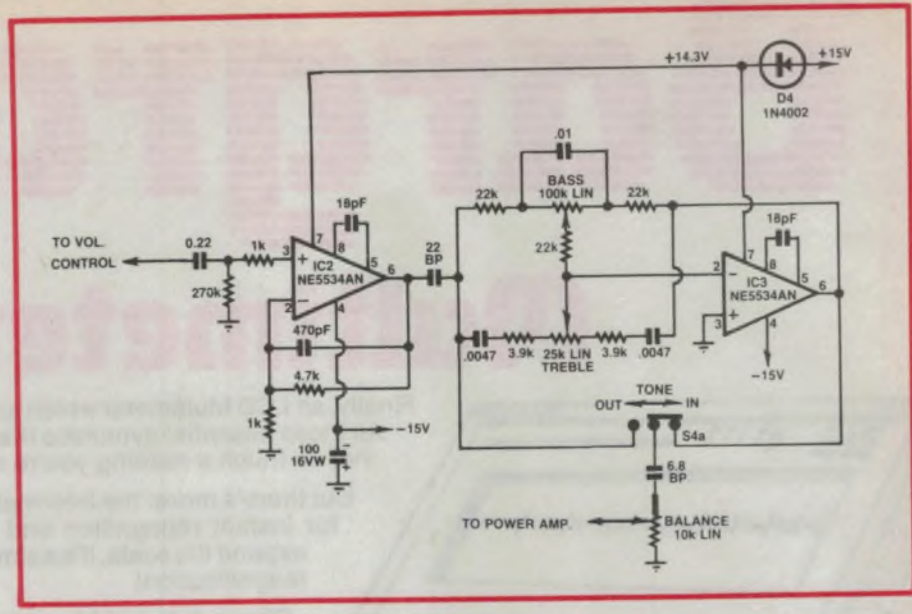


Fig.8: Also from the Playmaster 60/60 amplifier, this tone control section is typical of modern practice. Measured frequency response range is quoted as a symmetrical plus and minus 12dB at 50Hz and 10kHz.

Fig.8 shows the circuit of a typical tone control section, again lifted from the full circuit diagram of EA 60/60 stereo amplifier. Deliberately unpretentious, it provides neither loudness compensation nor hi/lo filters.

Taken directly from the main volume control at the output of the selector system (Fig.4) the signal passes to the input of IC2 (pin 3) and appears, duly amplified, at pin 6. One feed goes direct to the Tone In/Out switch, while a second feed is routed through the bass/treble tone control network and IC3. The signal which is ultimately fed to the Balance control and thence to the main amplifier is either flat or subject to control, depending on the setting of the switch.

(To be continued)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THE THEVENIN-NORTON STORY

Always been a little unsure of the circuit theorems of Thevenin and Norton? Here's an easy to understand explanation . . .

by BRYAN MAHER

Once upon a time (Oh no, he's going to tell another fairy story!) when a certain electronics lecturer had to go off to have his tonsils out, a young, over-confident know-it-all student named Harry offered to act as Apprentice Tutor teaching a class of avid students, the youngest of whom were a pair of twins named Sue and Fred. Harry was tired of spending all his nights devising laboratory experiments, only to find the students could perform them in thirty minutes flat. He decided to really challenge them.

Purchasing a lot of black boxes, one for each student, Harry had the college technician build into each box a copy of a circuit we show here as Fig.1. As you can see, his circuit consisted of six batteries (voltage sources), four current sources and twenty seven resistors in a complex pattern. A multi-pole switch was also wired in so that if the user wished she/he could switch off all the power in such a way that:
(a) all voltage sources were removed and their position shorted out; and (b) all current sources were removed and their position simply left open.

The Task

The complete circuit was concealed within the box, the only access to the circuit from the outside world being via the two terminals shown. The task young Harry presented to the students was simply:

"From any measurements you care to make at those two terminals on the outside of the box, can you tell me what circuit is inside the box? The box is sealed, you cannot look inside but all circuits are the same, all voltage and current sources are ideal or near enough".

The students laboured long and hard, racking their brains for a week. All except the twins, Sue and Fred, who simply took their boxes home where each made two measurements:

1. With the voltage and current sources switched on, they measured the output voltage at the box terminals when no external load was connected thereto. They called this V1.
2. With all sources switched off (voltage sources replaced by a short circuit, current sources replaced by an open circuit) they used an external ohmmeter to measure the equivalent resistance at those two terminals. They called this "the resistance looking back into the box" and named this value R1.

Fred then quietly purchased another box which looked identical, fitted a switch and two terminals, but inside his box he installed an extremely simple circuit, with just one battery as a voltage source and one resistor in series with it, as in Fig.2.

Fred chose his battery of the same voltage as the previously measured V1, and chose his one resistor the same as the previously measured value R1.

Sue, to do something more interesting still, also purchased an identical box fitted with the switch and two terminals, but built a different circuit inside her

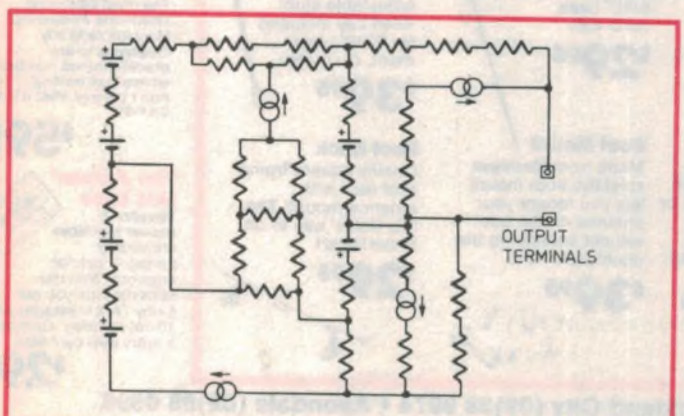

Fig.1: Harry's foolish circuit. Current sources are shown as linked circles, while switches are not shown for clarity.

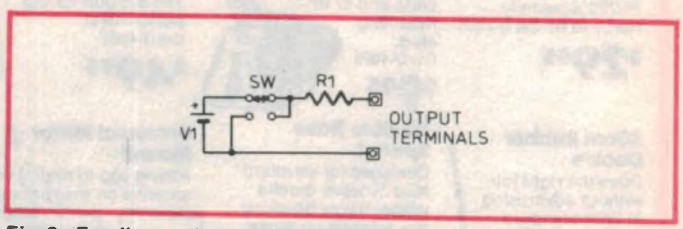

Fig.2: Fred's equivalent circuit (Thevenin Equivalent).

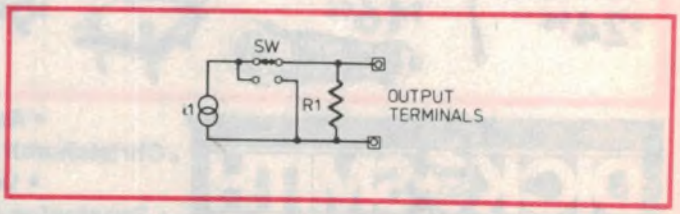

Fig.3: Sue's equivalent circuit (Norton Equivalent).

box. She used the same value resistor R1, but connected it straight across the two terminals, also connecting a current source in parallel with the same two terminals as in Fig.3.

A few minutes quiet reflection, and she had decided what value of current her current source i1 should be. To do this she simply used Fred's values of V1 and R1, and calculated what current would flow if Fred were to short-circuit his box's terminals. This current is obviously given by
i1 = V1/R1

Using that value i1 for her current source, she assembled her circuit and box.

Each putting a secret mark for identification of their boxes, the twins threw the two original boxes made in the lab into the rubbish can, quietly returned to college and placed their own boxes with all the others in the lab.

Three measurements

Next day in Laboratory class the "apprentice-tutor", believing he had outwitted his students, offered to open one box in front of the class and show them the thirty seven components. When asked were all the circuits the same he replied "yes" and proceeded to demonstrate all possible external measurements which could be made at the two terminals.

He could think of three possible tests thus:

1. With all sources switched off (all voltage sources removed from circuit and replaced by a short; all current sources removed from circuit and their position left open) he applied an ohmmeter to the output terminals and noted the reading. This test he applied to every box, with the same result.
2. With all sources switched on he measured the output voltage at the terminals with no external load connected thereto. Repeating his test on every box, he showed that they all read the same.
3. With all sources switched on, he short-circuited the output terminals via a current meter and noted the value of short circuit current. Quickly he demonstrated that every box gave the same result.

The apprentice-tutor then claimed his tests were sufficient to show that all boxes contained the same circuit, that complex collection of thirty seven components, Fig.1. He (with a smirk of triumph) now proudly displayed this circuit diagram to all students.

Feeling a little put down, a few students asked to see the boxes opened, wishing to see this fantastic complex circuit which had defeated them. The apprentice tutor complied.

Choosing a box at random, his knowing smile broadened as he proceeded to open it to display the contents. He would enjoy showing them his complex circuit.

Surprise

But his face changed to ghost-like bewilderment at what he saw! For as luck would have it he had picked up Fred's box — empty except for one battery and one resistor!!! In panic, fearing some trick, he grabbed another box, opened it quickly and lo-and-behold there was nothing in Sue's box but one resistor and one current source!

In a frenzy now, the tutor opened a third box, relieved at last to find his complex circuit of 37 components. But he was now really between a rock and a hard place! He had to explain how all boxes gave identical readings in all possible measurements that could be made from outside!

Desperately calling "time out", Harry raced home to bury his nose in his favourite electronics text book to find the answer, realising that he must have missed something in his own education. Could it have been one of those days he "wagged it" to go sailing?

Thevenin-Norton

There in his text book for all to see was the theorem which Fred had discovered. Harry read:

"Thevenin's Theorem: Any DC circuit at all (think of Fig.1) **connected to two terminals, can be regarded as equivalent (in its effect on external circuits connected to those two terminals) to a different circuit consisting of one voltage source V1 and one resistance R1 in series** (think of Fig.2) **provided that:**

1. V1 is made the same as the voltage which would be measured at those terminals if all external connections were removed.

2. R1 is made the same as that resistance which would be measured looking back into the circuit from the two terminals, with all external connections removed from those terminals, and all sources reduced to zero (all voltage sources off and shorted out, all current sources off and left open circuit).

3. The above two independent measurements/calculations are sufficient. However, as an option, a third measurement/calculation is possible. If the two terminals were short circuited while all sources are switched on, either calculate (or measure, if safe) the short-circuit current i1 which would flow if the two terminals were shorted. (Caution! Do not actually short those terminals if danger or damage will result!!). Such a calculated (or measured) short-circuit current makes a third item of information. The three measurements form a dependent set, i.e., only any two are needed, from any two the third can readily be calculated, as they are related by
R1 = V1 / i1

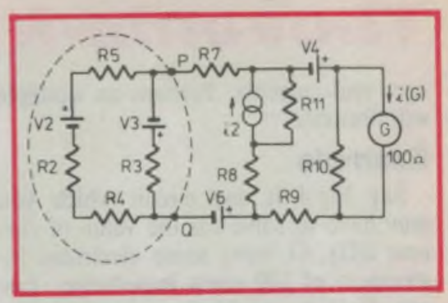

Fig.4: A real circuit example of Thevenin-Norton Equivalent reductions. The task here is to calculate i(G) given the values of all components and voltage sources, and the current source i2. P and Q are two arbitarily chosen points so chosen to enclose a simple circuit section within the dotted loop. The text explains.

So that, thought Harry, explains what Fred had done. Now what about Sue's circuit? No voltage sources, only a current source and one resistor (Fig.3). Soon Harry found in his trusty text book Norton's Theorem which reads:

Nortons Theorem: Any circuit at all (for example Fig.1) **connected to two terminals can be regarded as equivalent (in its effect on any external circuit connected to those two terminals) to a different, very simple circuit consisting of one current source i and one resistor R1 both in parallel with those two terminals** (as Fig.3) **provided that the three conditions (as given above for Thevenin's theorem) are met.**

Impossible task

Harry realised what Sue had done — all was now revealed to him. Clearly the task he had set those students was impossible for, as Sue and Fred had demonstrated, the three dependent measurements listed above are the only ones possible and they will never establish the actual details of a circuit connected to those terminals — only the *equipment* circuit.

You gentle reader, may wonder if this story is of any use to you? Yes, oh yes! It is of great benefit to all who seek to solve circuits, i.e., find values of voltages and currents. Perhaps an example will illustrate.

Example

Say Fig.4 is any circuit which you may have to solve for the value of current i(G), G being some electronic instrument of 100 ohms impedance. You can, in your imagination, nominate any two points P and Q in the circuit, call them two "terminals" and through them draw a closed ring around any parts of the circuit you wish, as the dotted line in Fig.4.

The only rules are that: (i) the dotted ring drawn does not cut any wire or component, but must cut through both points P and Q and (ii) components within the dotted ring must be linear, which implies constancy and reciprocity (ie end-for-end-ability).

Now you can call that dotted ring your black box, the points P and Q the imaginary "terminals", and you can imagine everything outside that ring to be removed. By relatively simple calculations you can calculate the values of V1, R1 and i1 which would be measured at "terminals" P and Q if the dotted ring and the components within were the only ones existing. Use the three rules already explained above.

You are now at liberty to redraw the whole circuit Fig.4 but substitute in place of V2, V3, R2, R3, R4 and R5 a different circuit section as in Fig.5 where the values of V1 and R1 were calculated as above. You will agree that Fig.5 already looks simpler than Fig.4.

Notice that we are not saying Fig.4 and Fig.5 are the same. No! they are very different circuits. What we are saying is that the currents and voltages in the right hand portion, outside that dotted ring, are the same in Figs.4 and 5.

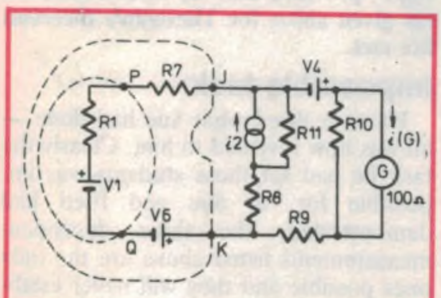

Fig.5: V1 and R1 are the Thevenin equivalent of the six components inside the dotted loop PQ in the circuit Fig.4. Next step is to choose points J and K to produce a still simpler equivalent to the real circuit.

But how does that help our quest? We wanted to know the current i(G)! Be patient — we'll get there.

Now select two other suitable points in Fig.5, say J and K. Through these we can draw a second dotted ring, following the same rules as before. By the same process as above, we now find suitable values for V1b and R1b such that one voltage source V1b with one resistor R1b in series is equivalent to everything inside the dotted loop JK (which includes the smaller loop PQ).

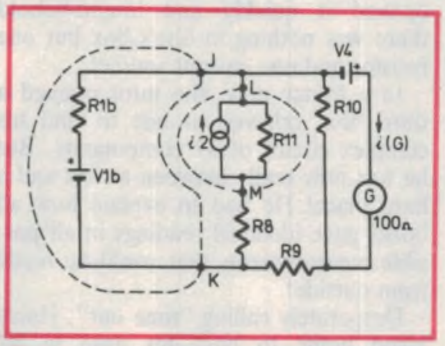

Fig.6: V1b and R1b are the Thevenin equivalent of everything within the dotted loop JK (including the loop PQ of Fig.5). The next step uses the dotted sub-loop LM.

The result is Fig.6, and Thevenin's theorem asserts that the current i(G) is the same in Figs.6, 5 and 4.

That current source

Now to do something about the current source i2. In Fig.6 we have redrawn slightly the connection to R11, carefully, without changing the circuit, so we can see points L and M and the little dotted sub-loop thru them.

Now, using Norton's theorem, (i.e., the external equivalence of Sue's circuit with the circuit produced by Fred), we can imagine substituting inside dotted loop LM one voltage source V1c in series with one resistor R1c. The values of these imaginary components are found by the three rules as before. The result is Fig.7, again without any change in the current i(G).

Clearly R1c and R8 are equivalent to a single resistor of numerical value (R1c + R8). By now it is clear how we should take the next step using points N and S, resolving (in our imagination) everything within that loop to one voltage source in series with one resistor.

Then the final step using points W and X, in like manner, would (in our imagination) reduce everything inside the dotted loop to one voltage source

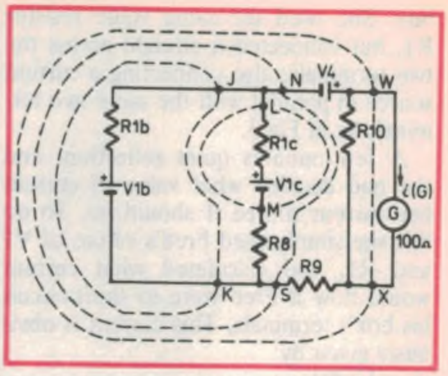

Fig.7: Substituting a voltage source V1c and series resistor R1c for the current source and parallel resistor of Fig.6, makes an equivalent circuit which has all the same type sources. Next we use dotted loop NS to reduce all within it to one voltage source and one series resistor. Lastly we use dotted loop WX to arrive at the final equivalent circuit.

V1e and one resistor R1e as in Fig.8. Again we can assert that the current i(G) in Fig.8 is the same as that in Fig.4.

Success!! Fig.8 immediately gives us the solution to the problem, for the current i(G) which we sought is simply:
i(G) = V1e / (R1e + 100 ohms)
that 100 ohms being the resistance of the instrument G.

We make no claim that the above use of Thevenin's and Norton's theorems is the best approach to the solution of every circuit problem. Indeed some questions are much better tackled by other methods. There is no universal "best way" to solve every problem.

But Thevenin-Norton is an excellent method and should be included in every student's repertoire (and aren't we all students?).

Applications

Some circuit problems lend themselves well to this approach, particularly those in which part of the circuit is to stay constant while another part is to take on a range of values, and results

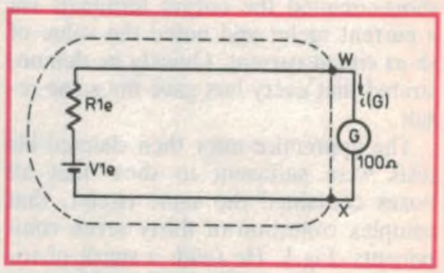

Fig.8: The final equivalent circuit, where current i(G) in the external circuit is the same as in Figs. 4,5,6, and 7.

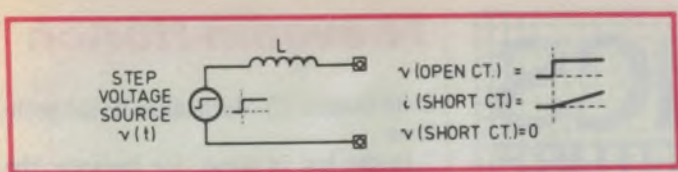

Fig.9: The Thevenin equivalent of a circuit with non-sinewave sources.

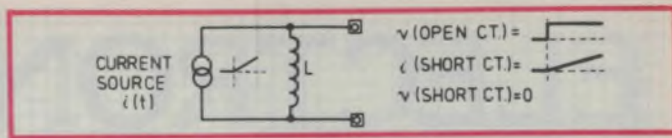

Fig.10: The Norton equivalent of Fig.9. Notice that the current generator i(t) in Fig.10 has a different waveform to the waveform of the voltage generator in Fig.9.

calculated for each case. For example if any one of a number of instruments "G", each having different resistance, were to be used in Fig.4, with no change in the rest of the circuit.

To calculate the current i(G) for each case, we could, as a mental exercise, carry out the imaginary reduction from Fig.4 to Fig.8. Having done that reduction once only, it would then be only a moment's work to find current i(G) for any number of resistance values of instruments "G".

Alternating currents

You may have a question: "What about AC voltage and current sources, capacitors and inductance? Can these be included?"

The answer is "Yes — definitely yes!" But with one condition: that each passive component be "linear", as defined above.

If in your problem all voltage and current sources are of sine waveform and the same frequency, f, (not necessarily in phase) then the concept of inductive reactance ($XL=2\pi fL$), capacitive reactance ($XC = 1/2\pi fC$), impedance (Z=SQRT[r2 + (XC — XL)2]) and the AC version of Ohm's Law (i=v/Z) may be used.

If on the other hand the voltage and/or current sources are mixed frequencies or of non-sine waveform the terms XL, XC and Z cannot be used (unless we use Fourier Transformation).

Different waveforms

However, no matter what the circumstance, we can always resort to the fundamental form of Ohm's law, viz:

vR = iR
vL = –L diL/dt
iC = C dvC/dt
vC = (1/C)Integral(iC)

In a circuit containing one or more inductive and/or capacitive elements, unless all sources are of sine waveform and the same frequency, then the equivalent Thevenin voltage source and the equivalent Norton current source will have different shape waveforms.

For example suppose the Thevenin voltage source is an upward step function and the series passive element is a pure inductance L, as in Fig.9. Then in the Norton equivalent, Fig.10, the same pure inductance L becomes the parallel passive element but the waveform of the current source becomes an uprising ramp function.

To see that this must be so, consider that the short-circuit current must be an uprising ramp function and the open circuit voltage has to be an upward step function in both Figs.9 and 10, and in the original circuit of which Figs.9 and 10 are equivalent reductions. Considering the presence of the inductance in the equivalent circuits, the terminal voltage and current demand the voltage waveforms shown.

Just what waveforms exist in the sources of the original un-reduced circuit depends on that circuit, but may well be different from that in either equivalent.

Generality

One last question can be heard faintly in the distance: "Is all this nice stuff restricted to electronic problems?" The answer is "No . . . . . . the theorems of Thevenin and Norton are perfectly general."

Indeed this is quite true. They have been applied successfully to solve such diverse puzzles as (a) Loudspeaker drive/suspension mechanics (b) Heat flow questions, as in the cooling of multiple transistors on heatsinks. (c) Mechanical rotational dynamics (d) Water flow question in irrigation systems (e) Air flow predictions in underground

What is a Current Source?

An ideal DC current source is an active electronic circuit with two output terminals, a nominal current rating io, and the property that no matter what value of load resistance is connected externally between those terminals, the current through the load is always exactly io.

You could regard the current source as a box which always puts out the same value of current.

This implies that the current source can automatically change its output voltage in such a manner that always the same current flows in the external load. This is not magic — such sources can be built, though the ones we build do not quite achieve the ideal characteristic of absolutely constant current io. Current sources have a very high (ideally infinite) value of output resistance.

Many different circuits are used to implement current sources, a simple example is shown here. In Fig.11, Q1 is a PNP transistor with high hFE, say 1000. Because of ZD1 there always exists 6 volts drop from A to B and assuming Q1 always has 0.6 volt drop from emitter to base, it follows that R2 always has 5.4 volts across it. But a constant voltage across a constant resistor R2 must mean a constant current through it. In this case the constant current thru R2, given by

i=V/R2
=(5.4 volts/5400 ohms)
=1.0 mA.

As the base current of Q1 is very small (only 1.0 microamp), it follows that the collector current, which is io, is always 1.0mA, at least within 0.1% — except when there is no external load connected, of course. Or a load of more than 15k, in fact.

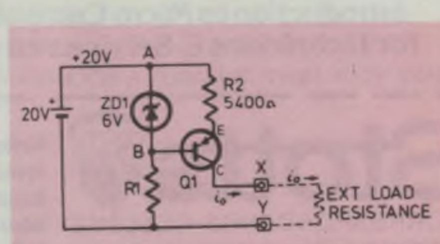

Fig.11: A simple approximate constant current source. Any resistance in the range zero ohms to about 15k placed across terminals XY will have (1.0 mA +/- 0.1%) flowing through it.

mine tunnels (f) Mechanical linear problems

In the last of these, for instance, the version of Ohm's Law used is

fB = Bv
fm = m(dv/dt)
fk = k(integral(v))

where v = velocity; f = force; B = frictional damping; m = mass; k = spring constant

Here velocity and force are the analogues of electrical voltage and current respectively, while friction damping, mass and spring constant are respectively the analogues of electrical conductance, capacitance and "inverse inductance". The mechanical and analogous electrical systems are called "Duals".

Last words

Two final comments before we say "Enough!!" and resume a recumbent posture:

(1) Recall that we demand the restriction of "linearity" (implying constancy and reciprocity), on the components within our imaginative "black box", and in the Thevenin and/or Norton equivalent circuit, everything within those "dotted rings" in Figs.4 to 8.

However no such restrictions apply to external components and sources. Indeed the external load may be anything, active or passive, linear or non-linear. It may even contain non-linear resistors, diodes, transistors, vacuum tubes, generators or even regenerative electric motors. Anything.

(2) We have only said that the original circuit and the Thevenin and/or Norton equivalents are *equivalent at the terminals*. They are, in general not the same inside the "black box". For example the power dissipated within the "dotted ring" in the original real circuit may be very different to the power dissipated within the Thevenin equivalent.

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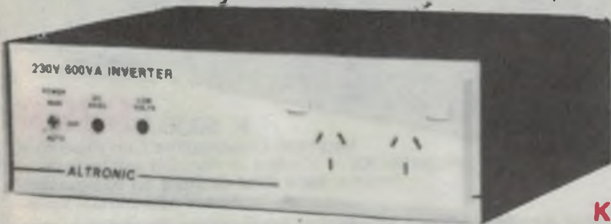

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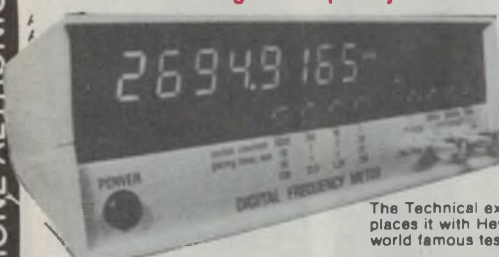

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(See Silicon Chip Mag. Nov 1987 for Details)

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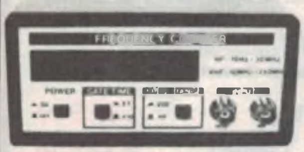

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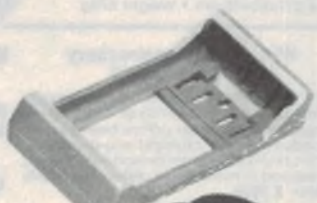

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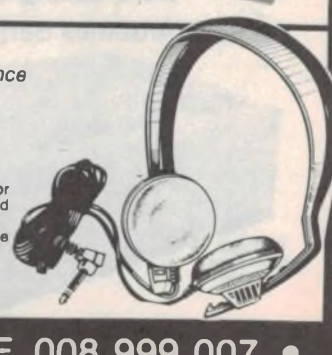

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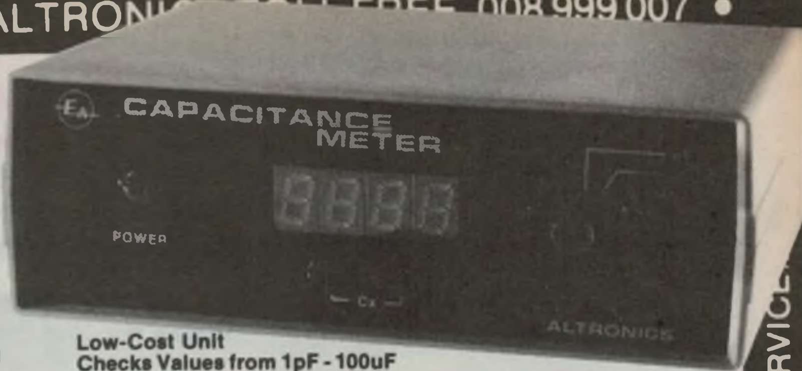

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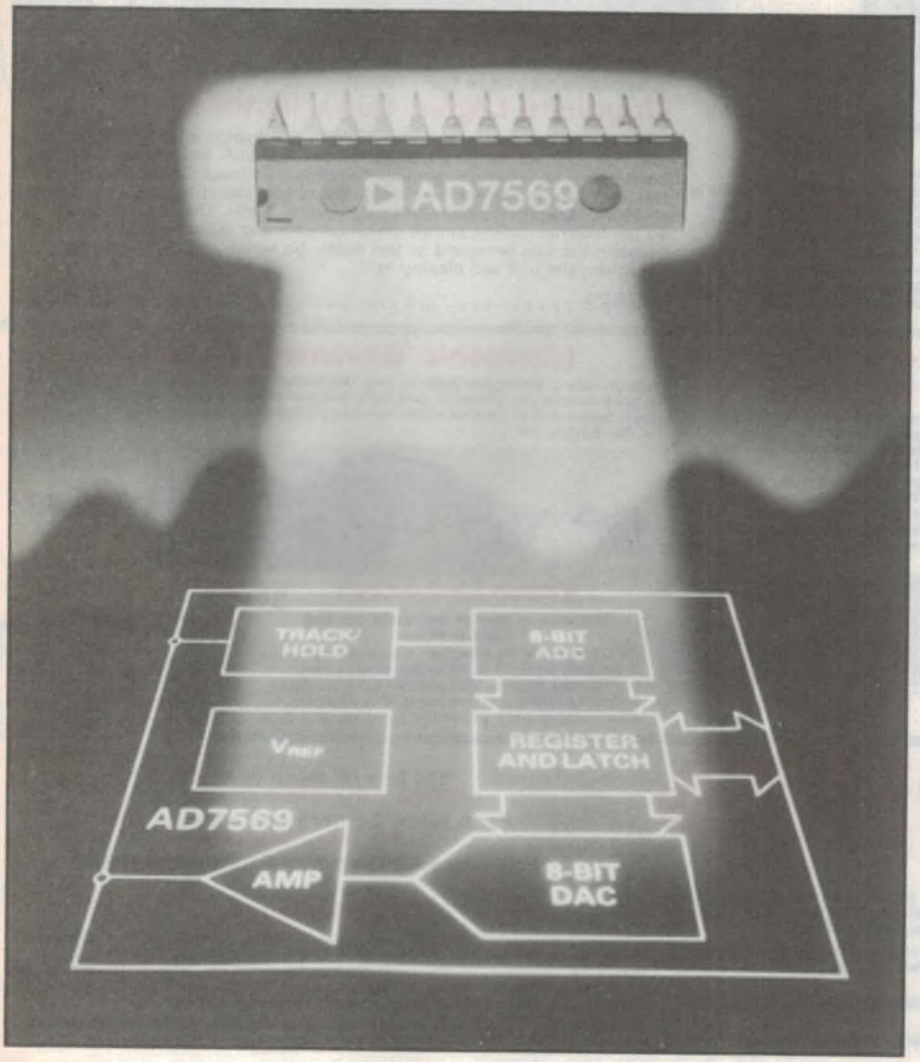


Complete analog I/O port on a chip

A new monolithic analog I/O port from Analog Devices combines an 8-bit analog-to-digital converter (ADC), an 8-bit digital-to-analog converter (DAC), a track-and-hold (T/H) amplifier, buffer amplifier, and voltage reference. The ADC guarantees a 2us maximum conversion time to 1/2LSB; the DAC is buffered by the on-chip amplifier and guarantees a 1us *voltage-settling* time to 1/2LSB. Replacing as many as five discrete ICs, the AD7569 saves board space and reduces component cost.

Analog Devices' proprietary LC^2MOS IC process combines low-power CMOS devices and high-speed, high-accuracy bipolar transistors on a single chip. CMOS transistors are used in the converters' switches track-and-hold, and the chip's logic interface. Bipolar devices are used to build the high-speed JFET-input buffer amplifier, comparator, bandgap reference, and DAC current sources.

The AD7569 is well-suited for applications such as disk drives, where the drive can monitor head position with the ADC and control positioning with the DAC. Modems can use the AD7569 to transmit and receive data. Combined with a single-chip DSP processor, the AD7569 permits designers to build DSP filter circuits with a half-dozen or fewer ICs.

Further information is available from Parameters, 25-27 Paul Street North, North Ryde 2113.

Ultra fast diodes for switchers

NSD Australia has released a wide range of International Rectifier ultra-fast diodes for use in switching power supplies and inverters, or as free-wheeling diodes. All six devices in the range offer recovery times between 20ns and 60ns and are rated at 400V, while current ratings range from 1A to 25A.

Of the six device families, three are twin-chip devices, and are offered in both common-cathode and common-anode configurations so that fast recovery full bridge circuits can be realised.

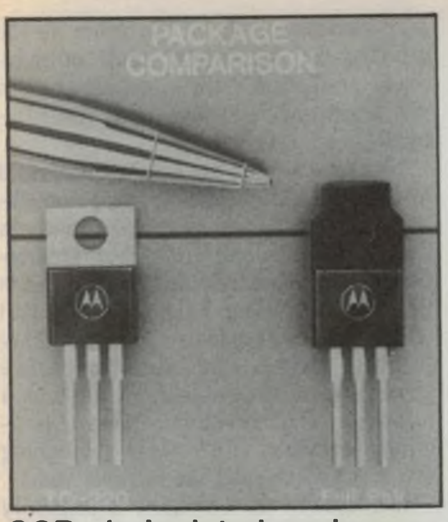
The products in International Rectifier's new ultra-fast diode range are the 11DF and 31DF series of 1A and 3A axial-lead diodes; the 5TF Series of 5A diodes, supplied in the TO-220 package; the 10CTF and 10JTF Series of 10A dual centre-rap rectifiers in the TO-220 package; the 16CPF and 16JPF Series of 16A dual centre-tap rectifiers in the TO-247AA package; and the 25CPF and 25JPF dual centre-tap rectifiers — again in the TO-247AA package.

For further information contact NSD Australia, 205 Middleborough Road, Box Hill 3128.

High performance ECL logic array

Motorola has announced the MCA1500M, third in a series of ultra high-performance ECL bipolar arrays built with the company's high density, oxide-isolated MOSAIC II process. The MCA1500M array contains logic power of over 1500 equivalent 300 picosecond gates, plus 1152 bits of 3.5ns configurable RAM organised in four blocks of 32 x 9. Predefined memory configurations allow either single port or dual port operation. The routing flexibility and macrocell structures are designed for "next generation" high technology system applications.

A special design feature of the MCA1500M is dedicated on-chip test circuitry which provides circuit designers guaranteed RAM quality independent of configuration or user-provided test vectors. The array also features two write strobe generators, to simplify criti-

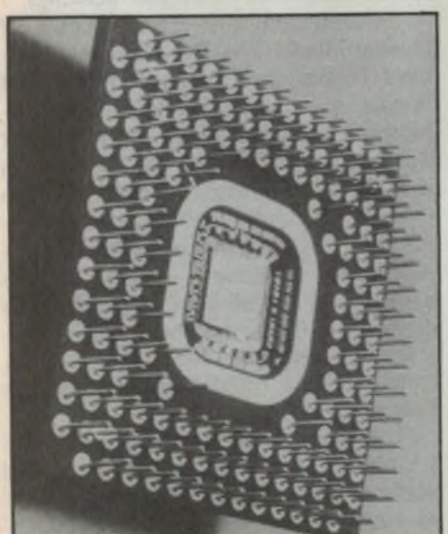


SCRs in isolated packs

Motorola has announced the availability of two series of SCRs in isolated TO-220 or Full Pak packages. The MCR218FP and MCR225FP series, identical electrically to the MCR218 and MCR255 series, offer the added advantage of simplified mounting.

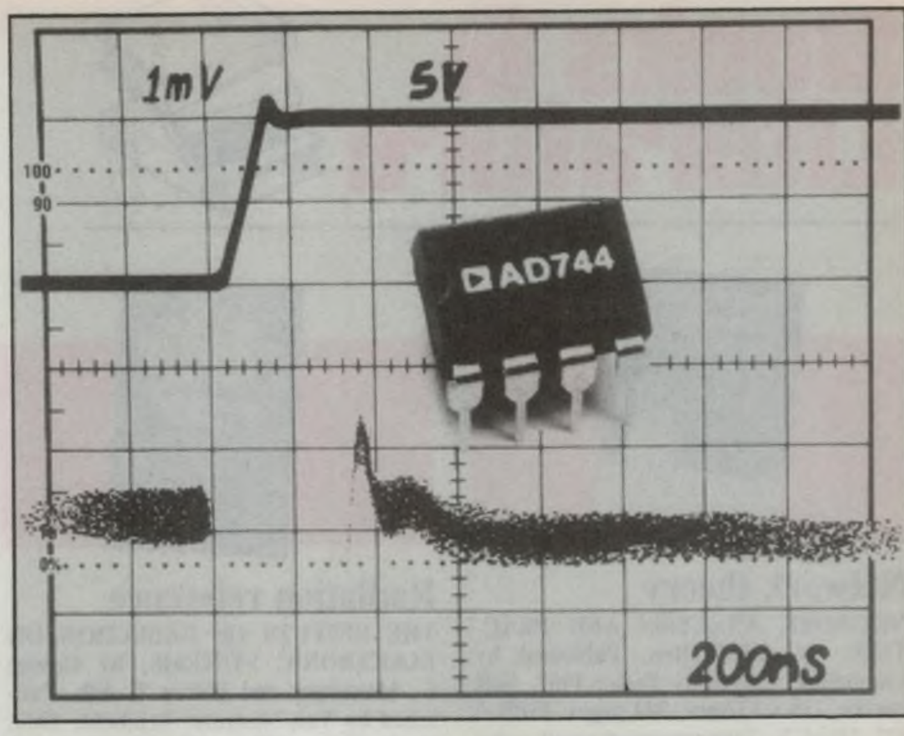
The new series offer blocking voltages to 800 volts, low thermal resistance, high heat dissipation and high surge current capability. Each series consists of five devices having repetitive peak off-state voltages and repetitive peak reverse voltages ranging from 50 volts to 800 volts. The MCR218FP series is rated at 25 amperes.

Applications for these SCRs include AC control applications such as motor controls, heating controls and power supply crowbar circuits.



cal memory timing and to improve performance.

For more information contact local Motorola Sales Offices or authorized distributors.



Fast settling BiFET op amp

A new monolithic op amp is claimed to offer the industry's fastest settling time for a BiFET op amp, along with outstanding DC and dynamic specifications. Analog Devices' AD744 typically settles to 0.01% in 500ns, and a maximum of 900ns. Along with a tested slew rate of 50V/us minimum, specifications for DC performance are also excellent: the 100%-tested maximum voltage offset of 250uV and drift of 3uV/C° are approximately half that of competitive products.

The extremely low 0.0003% total harmonic distortion (THD) — nearly ten times better than competitive op amps — and very low noise make the AD744 suitable for high-speed applications such as DAC output buffers and cable drivers, as well as active filters, wideband preamps, and demanding audio designs. Noise is tested and guaranteed to be below 4uV peak-to-peak over the 0.1 to 10Hz band; open-loop gain is a minimum of 250V/mV.

Internal compensation provides stable operation in a unity-gain inverting configuration or as a gain of 2 follower, with a gain bandwidth product of 13MHz. Optional external compensation increases the gain bandwidth product significantly: a product of greater than 200MHz with an inverting gain of 1000 is typically achieved. The external compensation also allows driving higher capacitance loads of at least 2000pF with a 12.5V/us slew rate.

The outstanding AC and DC performance of the AC744 are the results of BiFET technology, laser drift trimming, and ion-implanted JFETs.

For further information is available from Parameters, 25-27 Paul Street North, North Ryde 2113.NN

Fast switching PIN diode

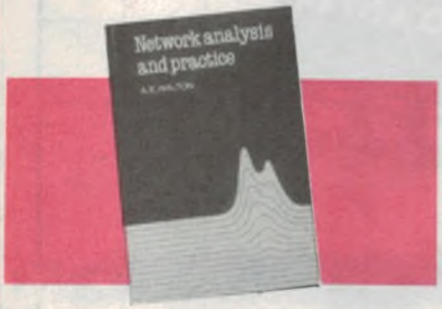
Hewlett-Packard has announced a new low-capacitance, fast-switching beam lead PIN diode ideal for use in phased-array radar and similar applications. HPND-4018 applications include phase shifting and switching, and the diodes are designed for use in stripline, coplanar waveguide or microstrip circuits.

The low capacitance window of the HPND-4018 is guaranteed at a minimum of 0.015 picofarads (pF) and a maximum of 0.025pF to offer consistent performance in phased-array applications. Lower capacitance yields improved isolation at higher frequencies.

Maximum series resistance is 4.6 ohms at a forward current of 10 milliamps and a frequency of 100MHz. Low resistance at low bias level translates into low power consumption for applications such as phased-array radar, that use a large quantity of diodes.

For further details contact VSI Electronics, 16 Dickson Avenue, Artarmon 2064.

Books & Literature



Network theory

NETWORK ANALYSIS AND PRACTICE, by A.K.Walton. Published by Cambridge University Press, 1987. Soft covers, 228 x 152mm, 344 pages. ISBN 0 521 31903 X. Recommended retail price $36.50.

Another theory text, this time on the analysis of circuit networks and written for undergraduate engineering and physics students. The author is a lecturer in physics at Sheffield University in the UK.

Two initial chapters provide an introduction to the subject, dealing first with the basic concepts of charges, fields and potentials and then with derivations such as current, resistance, EMF, generators, internal resistance and matching. This then leads on to a third chapter, introducing Kirchoff's laws and the theorems of Thevenin and Norton.

Building on this foundation, the later chapters progress through capacitors, inductors and AC analysis, transformers, bridges, attenuators, filters and transmission lines. The discussion then moves to nonlinear and active networks, and to techniques such as the Fourier and Laplace transforms. A final chapter deals with filter synthesis, including Butterworth and Chebyshev. The book itself ends with some 50 practice/tutorial problems, with answers to all of them and worked solutions to many.

The emphasis throughout is on a good basic understanding, with sufficient maths to allow complete analysis and design. This should make the book very suitable as a text for either private study or a college/uni.

The review copy came from the local branch of the publisher, but copies should be available from all major and technical bookstores. (J.R.)

Radiation reference

THE EFFECTS OF RADIATION ON ELECTRONIC SYSTEMS, by George C. Messenger and Milton S. Ash. Published by Van Nostrand Reinhold, 1986. Hard covers, 237 x 158mm, 587 pages. ISBN 0 442 25417 2.

It may sound a rather esoteric subject, but the subject of this book is becoming more and more relevant to electronics designers — for two reasons. One is the need for more and more electronics for satellites and space vehicles, which need to function reliably for long periods of time; the other is the growing use of various kinds of man-made radiation, for applications in manufacturing, testing and measurement.

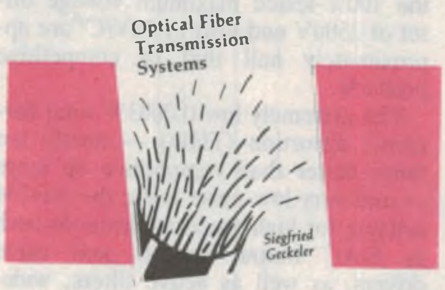
The two authors are very experienced in this area, Messenger being a consultant engineer with a background in radiation hardening for space applications, and Ash a scientist with long experience in nuclear reactor control and weapons development. In this book they've encapsulated their collective knowledge of the subject, to serve as a reference. It is developed from a post-graduate course in Nuclear Hardening given at UCLA over the last few years.

Incidentally the emphasis is primarily on the transient effects of radiation ("TREES"), although a chapter on electromagnetic pulse ("EMP") effects is included for completeness.

The treatment seems to be very thorough, with chapters dealing with the effects of various kinds of radiation on semiconductor and other devices, measurement and many aspects of design for radiation hardening.

For those who need to go into this area, it should be a valuable reference work.

The review copy came from the local office of the publisher, in Melbourne, but copies should be available from academic and technical bookstores. (J.R.)



Fibre optics

OPTICAL FIBER TRANSMISSION SYSTEMS, by Siegfried Geckeler. Published by Artech House, Inc., 1987. Hard covers, 237 x 162mm, 378 pages. ISBN 0 89006 226 9.

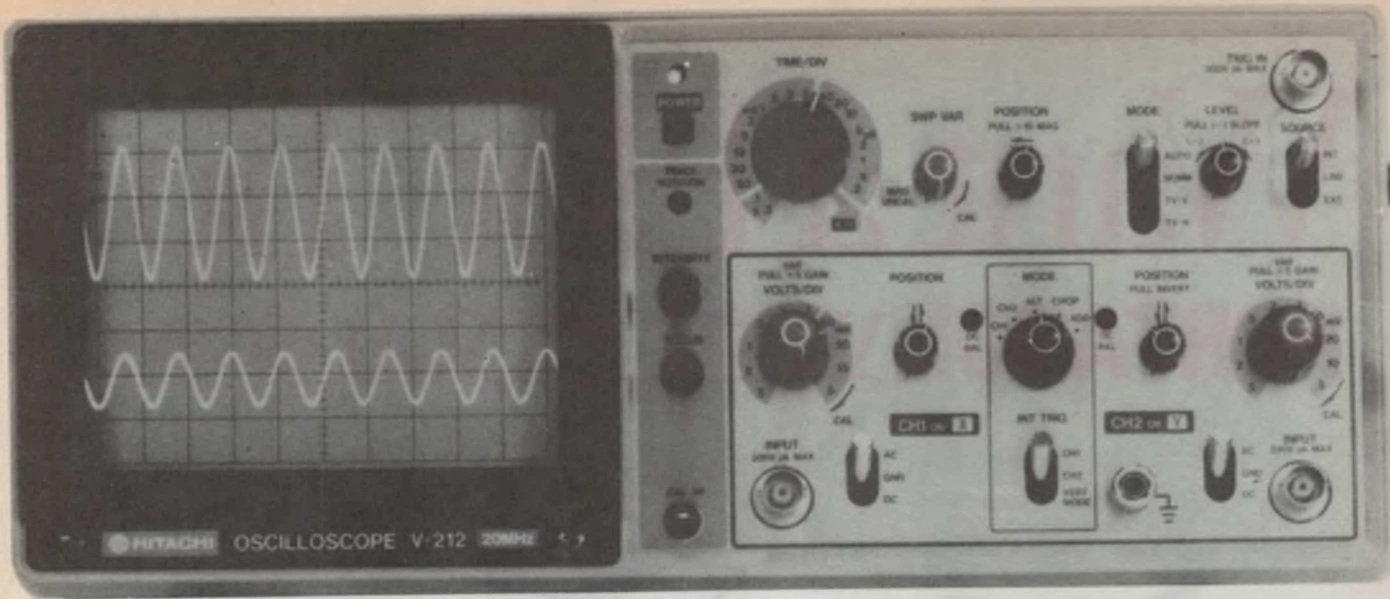
A very impressive text on the theory of fibre optics, written for both practising design engineers and senior students in communications. The original edition was written in German, as the author is an experienced engineer working in the R&D laboratories of Siemens. The emphasis throughout is on the physical meaning of theory, but with sufficient discussion of the mathematics to ensure that the reader can proceed with putting the theory to work.

The basic flow of the book's contents can be judged by its chapter headings: 1 — Introduction, 2 — Fundamentals of Optical Fibers, 3 — Foundations of Systems Theory, 4 — Propagation of Light Waves, 5 — Single Mode Fibers, 6 — Multimode Fibers, 7 — Optical Fiber Transmission Systems. The book ends with 12 data appendices, each giving a program in BASIC for the practical application of the main computational procedures discussed earlier in the book. These are all kept simple, both to allow them to be run on readily available PCs, and to allow them to be translated into other languages such as Pascal or Fortran if desired.

A very thorough and comprehensive treatment, and as up to date as you're likely to find in any book on this fast-moving subject.

It's not for the beginner, but for the engineer or senior engineering student, it would make a most valuable reference.

The review copy came direct from the publisher in the USA. (J.R.)



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Vertical Deflection	
Sensitivity	5mV/div to 5V/div in 10 calibrated steps ±3%. 1mV/div, 2mV/div ±5% when using x5 magnifier. Uncalibrated continuous control between steps 1 : < 2.5.
Bandwidth	DC to 20 MHz (−3 dB). DC to 7 MHz (−3 dB) when using x5 magnifier.
Rise Time	17.5 ns. 50 ns when using x5 magnifier.
MAX. Input Voltage	300V (DC + AC peak) or 500Vp-p AC at 1 kHz.
Input Coupling	AC, GND, DC.
Input Impedance	1MΩ approx. 25 pF.
Display Mode	CH1, CH2 (normal or invert), ALT, CHOP, ADD
CH1 Vertical Signal Output	Voltage: approx. 20mV/div into 50Ω Bandwidth: 50 Hz to 5 MHz (−3 dB) into 50Ω.
X-Y Operation	CH1: X-axis. CH2: Y-axis.
Sensitivity	5mV/div to 5V/div. 1mV/div, 2mV/div when using x5 magnifier.
Bandwidth	DC to 500 kHz (−3 dB).
Phase Difference	3° or less from DC to 50 kHz.
Horizontal Deflection	
Sweep Time Range	0.2 µs/div to 0.2s/div in 19 calibrated steps ±3%. 100 ns ±5% when using x10 magnifier (20 ns and 50 ns uncalibrated). Uncalibrated continuous control between steps 1 : < 2.5.
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Trigger Mode	Automatic (sweep runs in absence of a triggering signal and for signal below 30 Hz), Normal (sweep runs when triggered), TV-V, TV-H.
Trigger Source	CH1, CH2, V-MODE, External, Line.
Trigger Sensitivity	

	20Hz to 2MHz	2MHz to 20MHz
CH1 and CH2	0.5 div	1.5 div
External	20mV	800mV

Trigger Coupling	AC.
Trigger Slope	+ or −
Calibrator	Square wave. Voltage: 0.5V ±3%. Frequency: Approx. 1kHz
Power Supply	Voltage: 100/120/220/240 V ±10%. Frequency: 50/60/400 Hz. Power consumption: approx. 30 W.
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Accessories Supplied	Two AT-10AJ1.5 probes, Fuse, Power cable, Operation manual.

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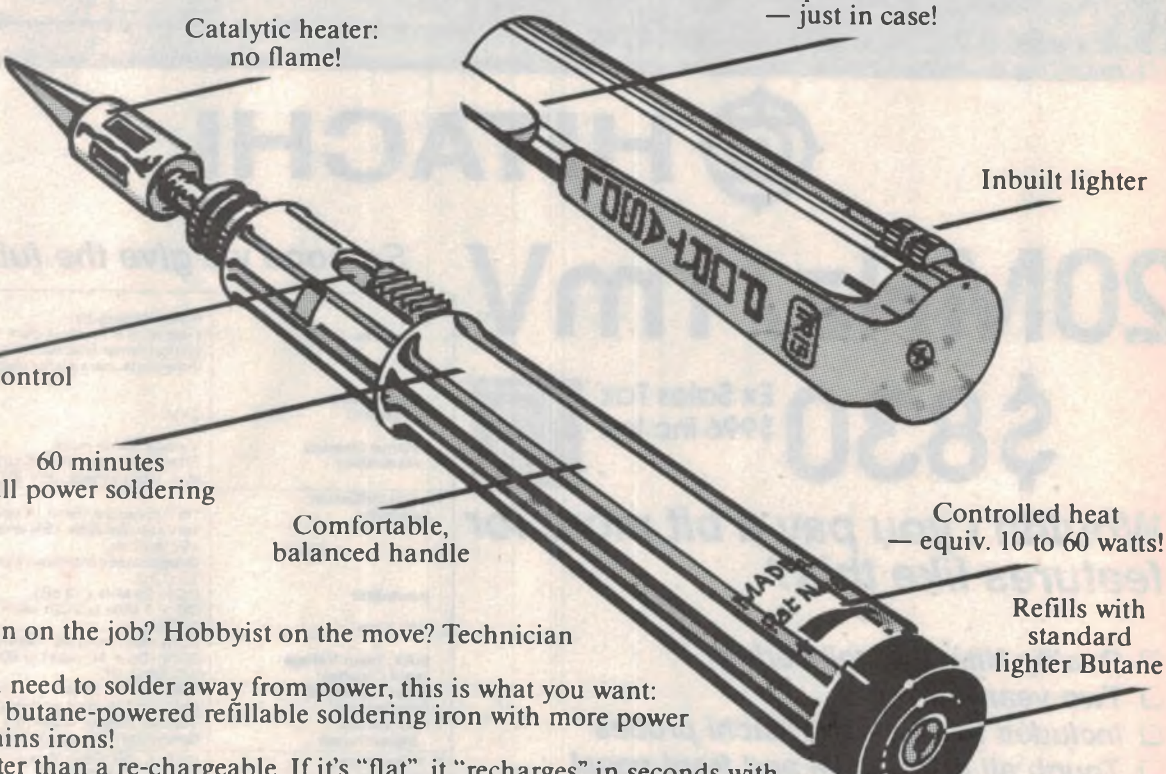

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COMPUTER KIT REVIEW:

Build your own "turbo" AT clone!

Dick Smith Electronics has just released a kit which lets you put together a multi-speed 80286 based PC/AT compatible, in whatever configuration you fancy. Here's what Jim Rowe found when he put together an advance sample . . .

A few short years ago when I acquired my IBM PC (one of the original models), it seemed pretty snazzy compared to the old 8-bit clunker I'd been using previously. But then IBM brought out the XT, then the AT — and my plain-vanilla PC started to look rather elderly. When the clone makers of Taiwan started to crank out their "me too" models, only faster and cheaper, the poor old PC seemed to become positively prehistoric.

I considered getting one of those "speedup" boards, the ones that substitute an 80186 or 80286 chip for the original CPU and crank up the clock speed as well. But somehow these always seemed to cost much more than you'd expect.

Besides, I've always had the strong suspicion that this would turn out to be only part of the story. After all, much of the reason for my original PC's modest speed is its use of floppy disks, and its 256K of RAM (quite modest by modern standards). To get any kind of significant increase in speed and convenience, you'd probably have to add a hard disk drive and controller, replace the existing RAM chips with faster chips to cope with the higher clock frequency, and add another 384K to them with a RAM card. Along with the speedup board itself, this would cost almost as much as the original machine — and certainly more than one of the latest AT clones from Taiwan.

More than I could justify, certainly. Especially since my PC is used mainly for word processing and a few spreadsheets. So until now, I've been persevering with it, and keeping a weather eye on the price of AT clones in case they should drop to an affordable level.

Basically that was still my position a couple of weeks ago, when I discovered that Dick Smith Electronics was about to release a new AT clone in low-cost kit form. So when the opportunity came to assemble an advance sample kit for this review, I jumped at the chance. Particularly when I learned that the kit was essentially a "knocked down" machine, which didn't involve any soldering or other tedious low-level assembly — just bolting pre-assembled (and tested) modules together and plugging in cables to connect them all up.

Yes, I know it's been possible for quite a while now to put together an AT clone from separate cards and modules. Most of the things you need have indeed been available, from one place or another. But to do this you'd have needed the time to track them all down and then make sure they were of good quality and mutually compatible. Experience has shown that both quality and compatibility can vary widely — from excellent to terrible (the same applies to built-up clones, of course).

You'd also have needed quite a deal of knowledge and experience, to put it

Above shows what the kit components look like, opposite below what they go together to make (with our monitor) . . .

all together and configure it successfully.

What DSE's people have done to change this is do all the sourcing for us, gathering together a set of high quality, mutually compatible modules. At least the things had better be of high quality, because I understand DSE is offering them with a full 12-month warranty — that's confidence for you!

To guide even the fairly green builder through the business of putting it all together, DSE is also producing a set of assembly manuals. At the time of writing this, the manuals were not quite finished, and I could only refer to what were essentially early proof copies. However from what I've seen, they're going to be very good by the time the kits become available.

Finally, DSE will also be backing up the kits with its service and support resources, well established after the years of supporting products like their respected Multitech range. So a kit builder is certainly not going to be all alone out in the cold, as they would be after putting together a "bitser" of their own.

By the way, the modules making up the kits are all going to be available separately, so you don't have to buy them all at once. This also means that you could buy them separately, as add-on or conversion modules for other computers. But naturally DSE won't be able to guarantee that they'll always be totally compatible with other computers. For that, you'll be on your own . . .

The kit itself goes together to make a standard 8-slot AT level machine, with space on the motherboard for up to 1 megabyte of RAM and able to run at any of four clock speeds: 6MHz, 8MHz, 10MHz or 12MHz. It features a 200W switch-mode power supply and a choice of video, I/O, disk controllers and drives, all housed in a standard two-tone bone coloured box. There's also a choice of either 84-key or 101-key keyboards.

In theory then, it all sounds great. But how did it turn out in practice?

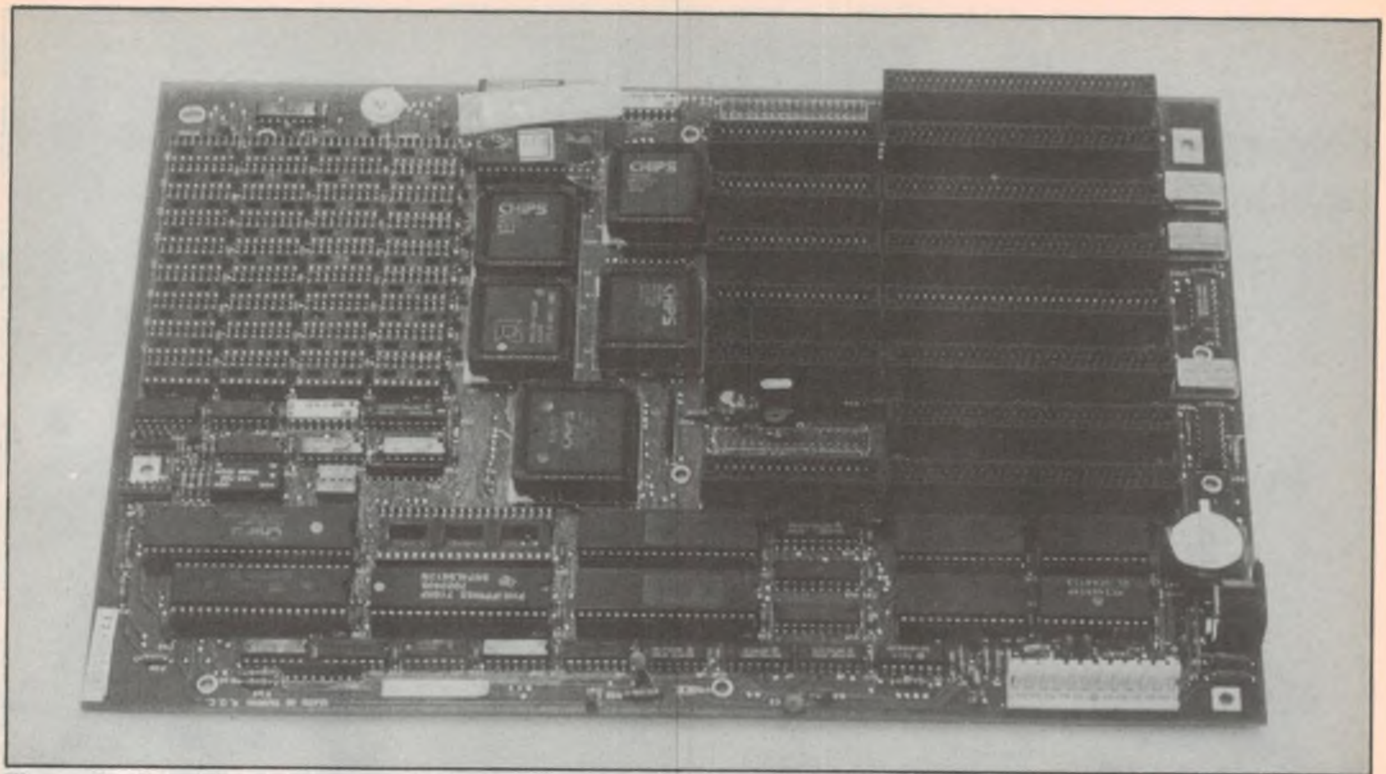
Well, the sample kit turned up as a massive carton, containing what seemed like 30 different smaller boxes with the individual modules. Actually there *were* a few more boxes than you'd normally get, because DSE sent me a few extras to try out — like the alternative keyboards and graphics display adaptors. Normally with a particular configuration of your choice, you'd get about eight or nine boxes and perhaps a tube of RAM chips (assuming you bought the lot at once).

Everything seemed to be attractively packaged, and protected against damage.

Opening up the boxes revealed the expected collection of parts, as shown in one of our pictures. Of these the largest was the now-fairly-standard "compact AT clone" metal case with hinged lid and moulded plastic front panel, as used to house many built-up machines; at the other end of the spectrum were the various nuts and bolts used to screw everything together, and even a little "DSE" label ready to stick into the recess on the front panel.

In between were the 200W power supply unit, complete in its box with fan; the main "baby AT" motherboard; floppy and hard disk drives; various plug-in cards and assorted mounting hardware. Not forgetting the rubber feet to stick on the bottom of the case, and the keys to operate the keyboard lockout switch.

Just about everything appeared to be made in Taiwan, as you'd expect. Most



The motherboard for the kit, before the RAM chips were plugged into the sockets at top left.

AT-Clone Computer Kit

of it unbranded, but with every appearance of being well made and having gone through QC procedures. Needless to say, the basic 80286 chip set on the mother board is by Chips & Technologies; the same applies to the main chips on the EGA display card. The main chips on the hard/floppy controller card were by Zilog.

The motherboard uses the BIOS from Award Software, as used in many of the Taiwan clones. I haven't seen any comparison between this and the better-known Phoenix BIOS, in terms of IBM software compatibility, but the word from the experts seems to be that they both ensure a very high degree of compatibility.

The floppy disk supplied with the sample kit was an unbranded 1.2 megabyte type of Taiwanese manufacture, while the 20Mb hard disk was a type PT-925 from the US firm Cogito.

Putting the sample kit together was a little tricky in places, because DSE's master assembly manual hadn't even got to the proof stage, and I had to fall back on my own experience and instinct. But there weren't too many problems — mainly because PC-clone modules are now pretty standardised, and in any case they're pretty well all designed for rapid assembly on kitchen tables in Taipei apartments, by relatively unskilled people!

The main motherboard sits inside the bottom of the case on a combination of plastic spigots and tapped metal spacers, and without the manual it was a little hard to work out which went where — to ensure proper support when the other cards were plugged in. But I worked it out with a bit of trial and error, using the slots and holes in the case as a guide.

Similarly it wasn't too clear whether one should fit the power supply unit first, or the motherboard. I opted initially for the former, because it looked as if the mounted board might make it difficult to manoeuvre the supply into its corner. But that turned out to be wrong — it was even harder to slide the PCB into position with the supply in place! Presumably the manual will make this part clearer for others.

By the way, before mounting the switch-mode supply in position I undid the screws which fasten the top and front of its case, to look inside. After all, the safety and reliability of the whole computer will depend on those innards, and the way they're put together. Certainly the sample looked quite well made, and talking with the DSE technical support people later I gather that they've checked it out very carefully.

I found assembling the rest of the kit pretty straightforward, apart from the disk drives. How these were to be mounted wasn't at all self-evident, but I eventually discovered that by undoing two small screws at the top of the metal drive cage, this could be moved backwards and lifted right out to fit the drives inside. The cage clips into lugs on the bottom of the case, as does the power supply.

The drives themselves have to be fitted with small plastic runners, which attach to each side using short screws. Each drive is then slid into the desired position in the cage, from the front, rather like drawers in a desk. The cage is then refitted into the main case, making sure that the drives don't slide out the front again while you're doing so!

Another point you have to check before mounting the hard drive is that it's set up for the right drive select address. This is done using a small link, located underneath the drive itself at the rear.

There is literally no soldering to do in assembling the kit, because all cabling is supplied ready assembled. All you need to do is identify where they go, and connect them up.

Needless to say, there are various links and DIP switches to check on the various boards, before you mount them and connect things up. Even before this there's the somewhat fiddly business of plugging the RAM chips into the motherboard, being careful while you do so not to either break their pins or damage them with static charge (they're MOS devices).

I must confess that I usually detest this operation, because as supplied by the chip manufacturers the chips always have the two rows of pins splayed apart — so you have to carefully bend them together a bit before they'll fit into the sockets easily. But the DSE manual for the motherboard was quite helpful here, suggesting that you connect the power supply to an earthed power point (with both turned off) so that its case provides an earth reference. So I did this, and nudged the pins of each chip together on the power supply case, before plugging them in. It worked out very well, and the RAM all checked out perfectly when I later fired the thing up.

You have a choice of video/graphics adaptor card, as there are three available. These are a mono adaptor (MDA) with parallel printer port; a colour adaptor (CGA), also with printer port; or an extended colour graphics adaptor (EGA), with the usual multiple modes including Hercules. The EGA card doesn't include a printer port, by the way, so to get one using this adaptor you need to get the separate I/O card.

I actually elected to use the CGA, both because it comes with a built-in printer port and because I wanted to try out the computer with my existing video monitor. This has a standard composite-video input, and the MDA and EGA only have separate-synch TTL video outputs.

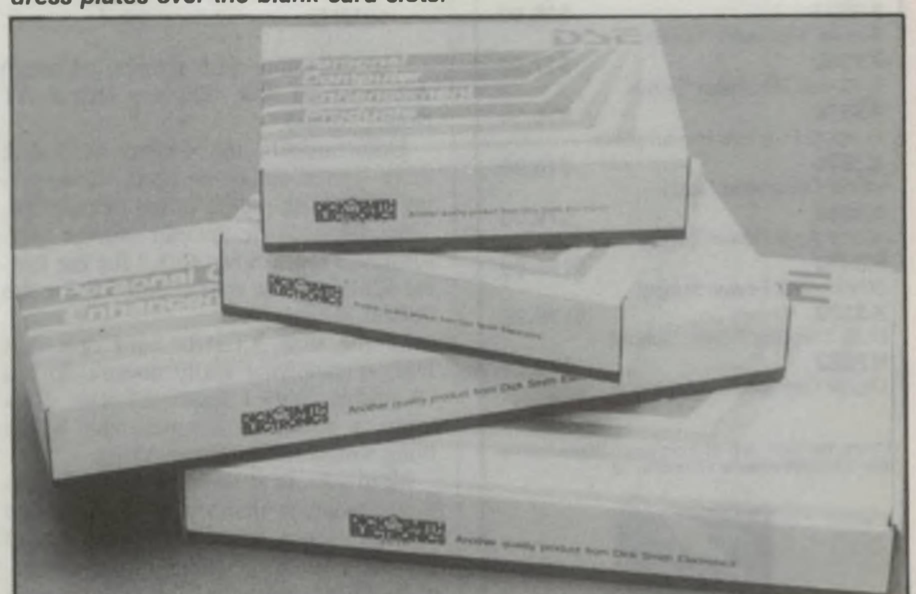
All in all, the whole job took about 3 hours to assemble, and this was at least partly because I didn't have the benefit of the main assembly manual. With this, my guess is that it should probably take about 2 hours at the most.

When it was complete, I hooked it up to the monitor and turned on the power. Everything sprang to life very smoothly, and after a short delay I was greeted with an error message indicating that the hard disk was devoid of any operating system. So it was a matter of turning to the manual and working through the system setting-up procedure, using the programs supplied by DSE on a "DSPREP" floppy disk. You also need disks with the operating system you intend to use — usually MSDOS.

I understand that DSE will be able to supply the appropriate MSDOS Version 3.2, but as a separate item. It doesn't come with any of the kit modules.

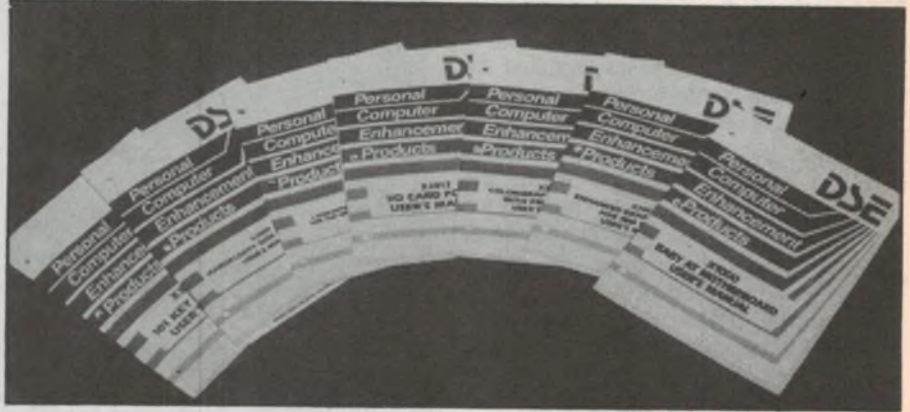
Setting up the sample kit machine turned out to take longer than it should, because the first floppy disk supplied

A look inside the case of the completed computer, before fitting the rear dress plates over the blank card slots.



As you get them from DSE, the modules are neatly packaged in separate boxes.

AT-Clone Computer Kit



A selection of the manuals for the individual kit modules. There's also a master assembly manual.

with DSPREP turned out to be a dud. However when this was remedied, everything went smoothly. Basically the procedure involves doing first a physical or "low level" format of the hard disk, then setting up the DOS partitioning, next doing the logical or "high level" formatting using DOS's FORMAT utility, and finally copying the contents of the DOS floppies over into the hard disk.

How does it perform? Not too badly at all. I sooled Peter Norton's Advanced "System Information" utility onto it, and it came up the following CI (computing index) figures for the kit's CPU performance compared with an original IBM PC/XT:

Clock speed	CI rating
6MHz	5.1
8MHz	7.7
10MHz	9.2
12MHz	11.7

These are quite fast figures, although not quite up with the very fastest AT clones around.

Unfortunately the Cogito hard disk drive turned out to be pretty slow, giving a DI (disk index) rating of only 1.4. This dragged the overall Norton performance index down to 8.2 for the fastest 12MHz clock speed, and 5.5 for the default 8MHz speed.

So the slow XT-style hard disk that DSE is supplying really doesn't do the kit justice. With a faster AT-style drive using a voice-coil stepper, the whole thing would really scream along.

Mind you, as it stands you're still getting a machine that will work from five to eight times faster than my original PC. This is a very healthy improvement, although scarcely the "blinding" speed claimed in the DSE ads for the kit. It depends on your eyesight, I suppose!

Now for the big question — how much does it all cost, and do you save much by putting your clone together from a kit?

Well, according to my calculations, you *can* put together a working kit for around the $2100 claimed by DSE in its ads. This would be with the cheaper 84-key keyboard, a basic 256Kb of RAM, the CGA card, the floppy disk controller card and a single 1.2Mb floppy drive. It would not include a monitor or the DOS.

But if you want a real step-up from a standard floppy based PC, you'd need to pay rather more. For a machine with 101-key keyboard, 640K of RAM, the EGA display card, the I/O card, the hard/floppy controller and 20Mb hard drive as well as the 1.2Mb floppy, you'll be paying around $3800. This is again not counting the monitor or DOS.

So you won't exactly be saving a fortune, because there are fully assembled AT clones around for somewhat less than this if you shop around. But on the other hand, you'll be learning quite a lot about how a computer goes together. And as DSE points out, you'll have that feeling of satisfaction when it springs into life, and be able to skite to your friends that you built it.

There's also the matter of service and support. It's hard to put a value on this, until sometime after you buy the machine when it goes bung. With one of the really cheap clones, you might well be on your own.

I for one certainly enjoyed putting the sample kit together. All I have to do now is work out how I can afford to buy one — preferably the one I've already put together!

Needless to say, you'll find the AT computer kits at all Dick Smith Electronics stores, and at many of its larger dealers.

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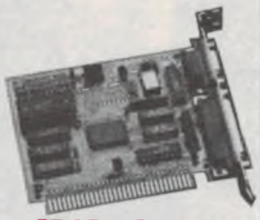

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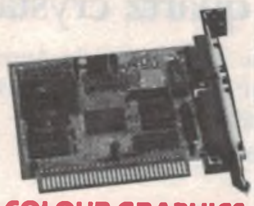

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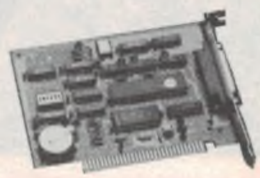

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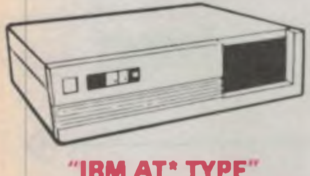

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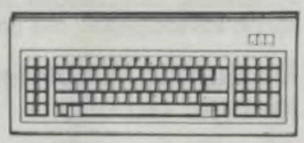

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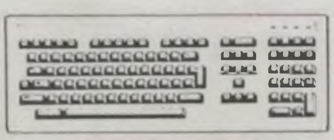

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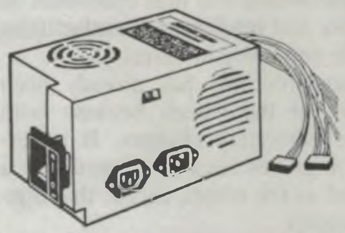

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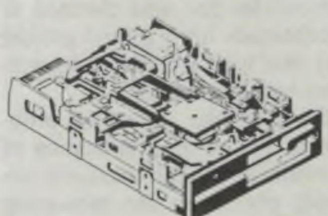

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Principles of Logic Analysis — 1

This is the first of a short series of articles which give an easy to understand introduction to the basic principles of logic analysis and the use of a logic analyser. It is written for anyone who needs to know more about troubleshooting in digital circuits.

by WOLFGANG SCHUBERT

Digital technology has developed dramatically since the first microprocessors were introduced onto the market in the middle of the seventies, and is exerting a continuously increasing influence on all technological areas and thus also on daily life.

Home computers used nowadays as a hobby have a greater performance than the large data processing systems used a few years ago for commercial applications. Traffic lights are controlled depending on requirements and thus contribute to a better flow of traffic. Robots and intelligent manufacturing machines are being used more and more in industry.

The invention of the microprocessor has already been compared with the invention of the wheel, because both products have resulted in revolutionary changes. It is certainly true that digital technology has been developed into a tool just as useful for mankind as the wheel, except that digital technology is far more complex.

The special problems of digital technology result from this complexity — at the time a breakdown occurs. It is easy to see whether a wheel is broken, but in the case of a digital circuit it is necessary to use special test procedures because man is unable to detect the events in such circuits.

Such methods of measurement are referred to as "logic analysis". The purpose of this series of articles is to provide an easy-to-follow insight into the problems associated with measurements on logic circuits and the possible solutions using modern aids such as logic analysers.

Many potential users are not acquainted with the fundamentals necessary to understand logic systems; for this reason logic analysis is considered as "complicated" and "unfathomable". It is hoped that these articles will help to eliminate this deficiency by informing the reader of the principles of logic analysis, thereby enabling him to master complicated measuring problems himself.

The target group includes electronics engineers and students approaching the end of their electrical engineering or computer science studies. The articles are also directed at those in whose fields digital techniques have gained ground (such as mechanical engineers) and who are therefore confronted with measuring problems in logic circuits.

The first article deals with the particular measuring problems associated with logic circuits. Following a discussion of the differences between logic circuits and other electronic circuits and the resulting demands placed on the measuring equipment, the various types of faults in logic circuits will be explained using examples.

The deficiencies of classical instruments such as oscilloscopes and voltmeters for measurements in logic circuits will be shown in the second article, by examining where they can be used. The logic analyser proves to be the "made-to-measure" instrument for the special measuring problems associated with logic circuits.

The fundamentals of logic analysis will then be treated in two parts:

- The basic idea of data reduction upon which logic analysis is based.
- Implementation of this basic idea in a logic analyser.

The two basic types of logic analyser, state analyser and timing analyser, will then be presented and their application limits compared.

A basic knowledge of digital techniques is required for understanding these articles; further knowledge of microprocessors is advantageous, but not essential.

Measuring problems in logic circuits

In order to understand what special measuring problems can occur in logic circuits, it is necessary to examine the most important differences between logic circuits (such as microcomputers) and other electronic circuits (such as analog modules). These differences directly result in the demands made on the measuring equipment.

When compared with other circuits the following demands are made on measurements in logic circuits:

There are only very few signals in an analog module such as an amplifier, which are passed on step-by-step (not considering feedback signals) and which depend on one another in a clearly defined manner. Troubleshooting is therefore

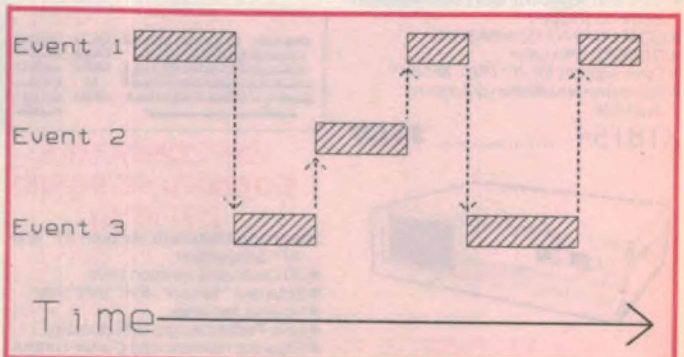
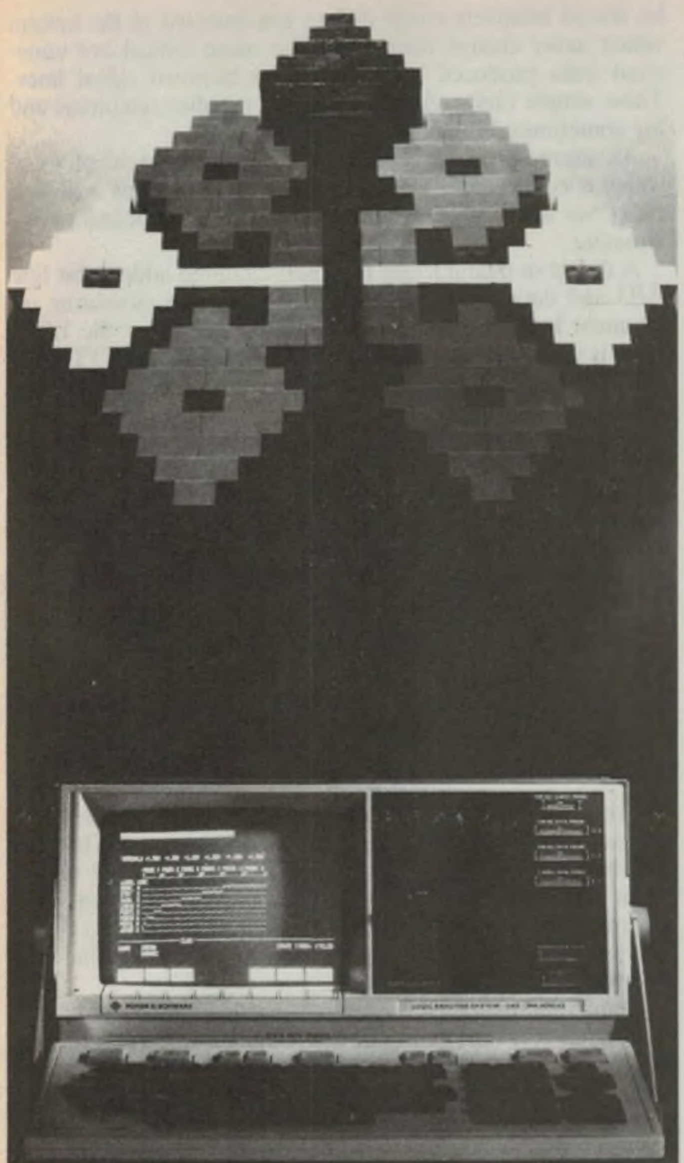


Fig.1: In digital systems, specific processes or events are quite often not continuous.



An example of a modern logic analyser. Like most modern instruments, it is itself based on a microprocessor. (Courtesy Rohde & Schwarz)

relatively simple in such circuits if the circuit is examined starting at its output and then progressing to the input step-by-step until the fault has been found.

In contrast to this there are often very many signals in digital modules which are independent of one another.

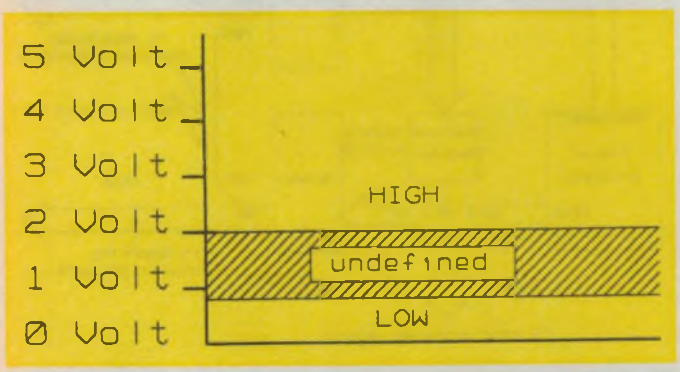


Fig.2: Signal levels in TTL logic circuitry fall into three basic categories: high, low or "undefined".

A8...A15	Eight most significant address bits
AD0...AD7	Eight least significant address bits, multiplexed with data bus
ALE	Address latch enable
S0, S1, IO/M	Machine cycle information
RD/	Read signal
WR/	Write signal
READY	Ready message from peripheral module
HOLD	Hold request from other processor
HLDA	Hold acknowledgement to other processor
INTR	Interrupt input
INTA/	Interrupt acknowledgement
RST5.5, RST6.5, RST7.5	Restart input
TRAP	Non-maskable restart interrupt
RESET IN/	Reset input
RESET OUT	Reset acknowledgement
X1, X2	Crystal connections
CLK	Clock output
SID	Serial data input
SOD	Serial data output

Table 1: Signals associated with the 8085 microprocessor. Although all related to its operation, they are relatively independent.

A standard 8-bit microprocessor such as the 8085 already has more than 30 signals (address bus, data bus and control signals) which are completely independent of one another and must therefore be monitored simultaneously during the measurements.

Another factor adds to the difficulties if this CPU controls a module. All other signals in this module are dependent on the CPU signals, but this dependence is often very difficult to determine because of the storage characteristics of many digital components and the cause of a faulty signal need not necessarily be present when the fault is present, but may already belong to the past.

Initialization belongs to this problem area. If a module is not correctly initialized when switched on, the undefined status of storage components such as flip-flops or RAMs can influence the subsequent response of the module in an unpredictable manner. This effect therefore also depends on the storage characteristics of digital components.

It can be particularly inconvenient when testing computer systems that the examined process is not continuous, but is interrupted at unforeseen times by other processes. This occurs particularly with multi-user or multi-tasking applications. The measuring instrument used must therefore be able to differentiate between the process to be monitored and other processes being executed.

Analog processes can be displayed very well on an oscilloscope if they are periodic. But non-periodic signals are often encountered in computer systems. Some processes important for fault detection only occur once, and must be immediately detected.

On the other hand, qualitative information on the signal level in logic circuits is often sufficient. Digital circuits operate with only two voltage levels, HIGH and LOW. For example, TTL circuits recognise voltages below 0.8V as LOW and voltages above 2.0V as HIGH. This fact can be used when carrying out measurements in digital circuits by omitting the determination of the exact analog value of a voltage and by simply classifying all voltages into HIGH or LOW level depending on their magnitude relative to a defined threshold value (e.g. 1.4V with TTL).

With this simplification it must always be remembered that the interpretation of an analog signal by the measuring instrument and the device-under-test as LOW or HIGH may be different. Great care is required in the case of signals which lie near the voltage thresholds.

It is usually sufficient to determine the level at discrete points in time. Digital systems are usually clock-controlled. The storage elements in such systems such as flip-flops, memories and processors only accept the data at their inputs at the point in time when a clock pulse or transition "edge" occurs. All changes in signal at the inputs are ignored if those changes occur outside a particular window centred around the active clock edge, with the size of this window being determined by the setup and hold times of the respective circuit components. For this reason it is often permissible to ignore all changes taking place outside this window, when measuring digital circuits.

Troubleshooting

The usual reason for carrying out measurements in a digital circuit is to trace a fault. The most common faults in digital circuits can be divided into two classes: state errors and compatibility errors.

State errors are common to all information processing systems: signals may be faulty without this being recognised by their physical form, i.e., the signals appear to be correct.

The most common faults of this type are stuck-at errors where a signal remains constantly at LOW or HIGH because of a short-circuit or component failure. These faults can still be traced relatively easily if lines are detected in the system which never change their level. Far more critical are undesired links produced by short-circuits between signal lines. These simple faults often lead to very peculiar symptoms and are sometimes difficult to trace.

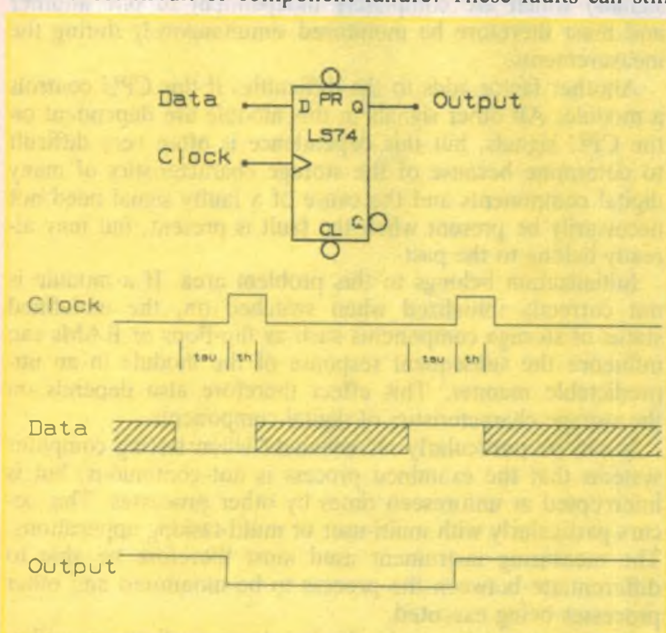


Fig.3: A D-type flipflop as an example of a clock controlled system.

An example is the microprocessor in the system of Fig.4 which is connected via a buffer to separate address and data buses via which it accesses the hardware of a measuring instrument.

A defect in manufacture has short-circuited address bit line AB3 and data bit line DB7 on the bus to the measuring instrument hardware. Since the driving capacity for the LOW level is stronger than that for the HIGH level in a TTL circuit, both signals become LOW if either AB3 or DB7 go LOW.

This short-circuit leads to two errors: when writing at particular addresses in the hardware, incorrect data are entered, and when writing particular data, these are applied to incorrect addresses. The following table exemplifies this using four possible write processes.

Address	Data	Response of accessed hardware
51238H	83H	Correct: 83H in 51238H
51237H	23H	Correct: 23H in 51237H
51238H	23H	Incorrect: 23H in 51230H
51237H	83H	Incorrect: 03H in 51237H

These two errors do not always occur, but only if the CPU accesses the hardware of the measuring instrument. The data bus buffer is not switched through to the measuring instrument hardware if the CPU accesses one of the other CPU boards and an interaction between addresses and data therefore does not take place. In this case the system behaves completely normally.

Compatibility errors, the second type of fault are present if the signal level or timing differs from those of correct signals. Such signals are generated for example by crosstalk between lines. Malfunctions may be triggered if the glitches produced exceed the switching threshold of the logic family used.

Level errors may occur because of component failures or mistakes made during circuit development, with the result that the specified HIGH and LOW levels can no longer be

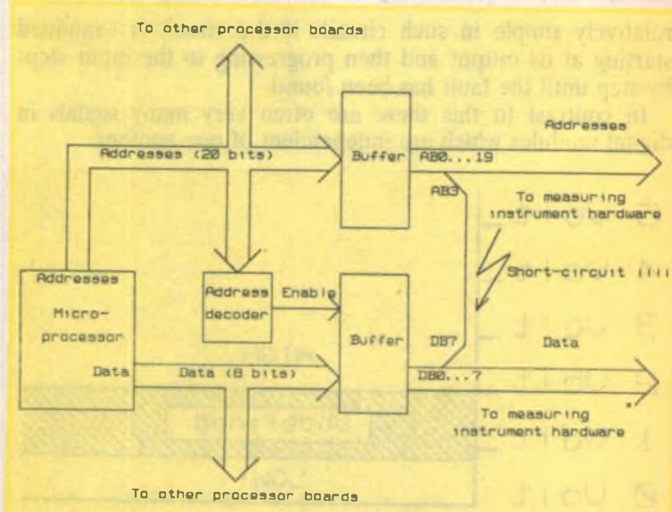


Fig.4: A microprocessor system with a short circuit between address and data lines.

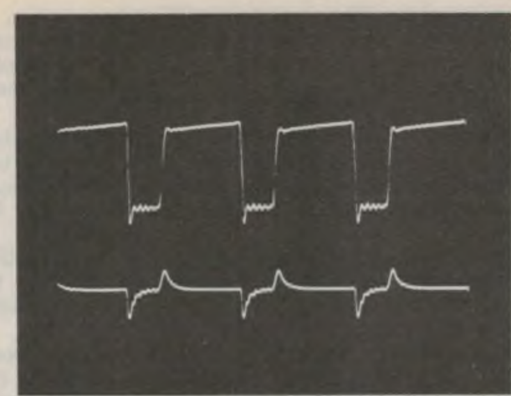


Fig.5: Glitches produced in one signal (bottom) by crosstalk from another (top).

attained on certain lines and other components which use these lines are inputs can no longer respond correctly.

Timing errors where the relationship between several signals is disturbed so that the connected components can no longer operate correctly are very common.

The last two types of error often occur together if the fan-out of the driving circuit is exceeded.

The following example (Fig.6) serves to explain the effects of timing errors when the cross-hatched areas represent undefined status on the address and data buses.

A RAM is written into correctly if the processor first applies the addresses, then the data, then accesses the write-line (see 1) and subsequently removes the data and addresses again. However, if the write pulse is removed too late (see 2 and 3), either incorrect data are applied to the correct address (case 2) or incorrect data are applied to the incorrect address (case 3).

In the last case it can even happen that several undesired write processes are activated simultaneously, because the address bus may be in an undefined level range and the address decoding of the RAM can therefore address several memory cells at once.

Function analysis

It is sometimes necessary to test digital circuits which function fault-free, for example with a view to optimization. A differentiation can be made here between two types of measurements: data flow analysis and performance analysis. With data flow analysis measurements, the data flow is monitored between the source and the acceptor. In a computer-controlled system the processor can be one of the sources or acceptors.

Through measurements on the processor it is possible to analyse the addressing of other system components by the processor, the reading in or outputting of data and the data flow from the program memory to the processor, and thus the program execution.

A further case for measurement is the interface of a computer system to peripheral units. Examples include measurements on the IEC bus, RS-232 interface or Ethernet.

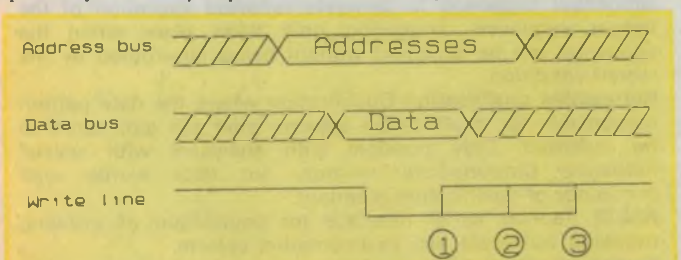


Fig.6: Timing considerations when writing into a RAM.

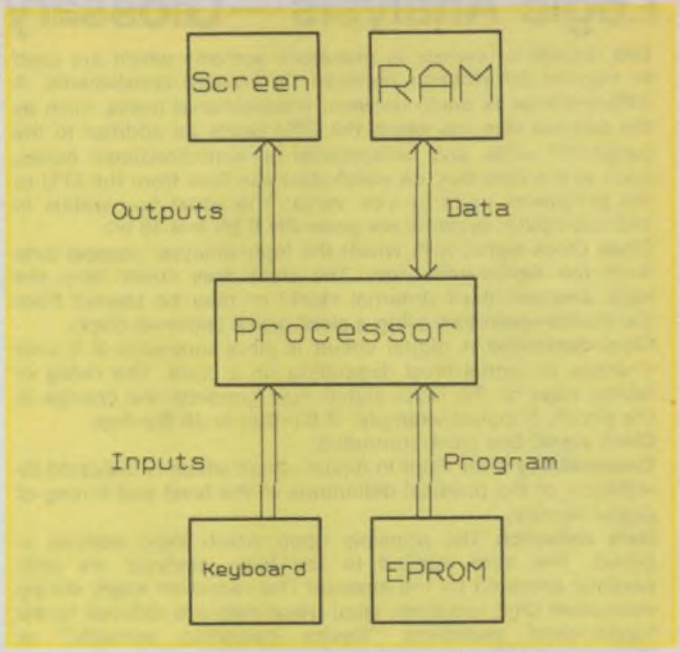


Fig.7: Data flows in a typical computer system.

With performance analysis, if a qualitive criterion (whether certain data have occurred) is of major importance, this is supplemented in performance analysis by a timing component. The measurement is used to determine whether data have occurred within a specific period. This is important for program optimization where it is necessary to determine the computation time required for certain parts of the program.

All these test functions, which can be grouped together under the term "function analysis", require test equipment able to interpret the data contained in the digital signals and to represent the data to the user comprehensibly. It is therefore clear that the suitability of classical test equipment is very limited for such measurements because the required intelligence is missing, as will be outlined in the next article.

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Glossary of terms overleaf. ▶

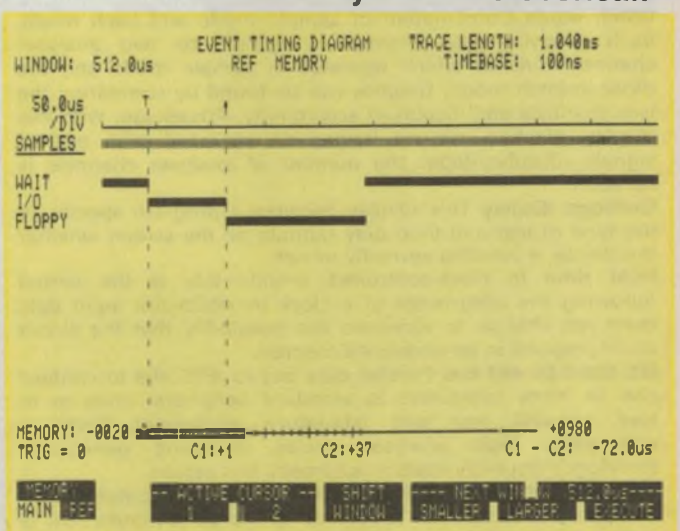


Fig.8: Performance analysis of a computer system using an event timing diagram.

Logic Analysis—Glossary

Bus Groups of signals in processor systems which are used to transfer information between the system components. A differentiation is made between unidirectional buses, such as the address bus, on which the CPU sends an address to the peripheral units, and bidirectional or multidirectional buses, such as the data bus, on which data can flow from the CPU to the peripheral units or vice versa. The usual bus widths in microcomputer systems are generally 8 bit and 16 bit.

Clock Clock signal with which the logic analyser accepts data from the device-under-test. The clock may come from the logic analyser itself (internal clock) or may be tapped from the device-under-test using a clock probe (external clock).

Clock-controlled A digital circuit is clock-controlled if it only changes its signal level depending on a clock. The rising or falling edge of the clock signal may generate the change in the circuit. Simplest example: D flip-flop or JK flip-flop.

Clock signal See clock-controlled.

Compatibility error Fault in digital circuit which is indicated by violation of the physical definitions of the level and timing of digital signals.

Data reduction The principle upon which logic analysis is based. The data applied to the logic analyser are only partially accepted by the analyser (1st reduction step); during evaluation (2nd reduction step) these data are reduced to the fundamental statement "Device operating correctly" or "Device not operating correctly".

Don't care During specification of the data pattern for triggering or qualification, the Don't cares (symbolised by an "X") represent channels which do not affect data qualification, i.e., are not taken into account.

ECL Emitter Coupled Logic, a family of digital circuits for very high speeds ($>$100MHz). Disadvantage: high current consumption.

Ethernet Widely used local area network (LAN). Operates with only one coaxial cable, serial transmission with 10Mbit/s and CSMA/CD protocol. Because of its high speed it can be used to generate small computer networks. Since the coaxial cable can be tapped at any position by a transceiver, this network is particularly suitable for widely spaced systems where the installation costs are to be kept as low as possible.

Event timing display Special type of display in the LAS from Rohde & Schwarz. The user can define start and stop criteria for events which are then displayed as bars with a linear time axis.

Glitch Brief change in signal on a line. Malfunctions may occur if this line is a clock signal for a flip-flop or memory. Glitches cannot usually be detected using normal logic analyser sampling because they are of very short duration (in the nanosecond range). In such cases latch mode and glitch mode are used.

Glitch mode Combination of sample mode and latch mode. Each external data channel is applied to two analyser channels, one of which operates in sample mode and the other in latch mode. Glitches can be found by comparing the two channels and displayed accordingly. Advantage: with this display glitches can no longer be confused with normal signals. Disadvantage: the number of analyser channels is halved.

Go/Nogo display This display requires a program specific to the type of test and then only outputs on the screen whether the device is working correctly or not.

Hold time In clock-controlled circuits this is the period following the occurrence of a clock in which the input data must not change to eliminate the possibility that the circuit could respond in an undefined manner.

IEC-625/IEEE-488 bus Parallel data bus to IEEE 488 to connect one or more computers to standard peripheral units or to also connect test and laboratory equipment such as voltmeters, logic analysers, relay switching panels. Is therefore frequently used in automatic test setups.

In-circuit emulator Development aid for microprocessor software/hardware. The processor of the device-under-test is replaced by a link to a development system which enables the user to develop programs, load them into the device-under-test, execute them step-by-step and to observe the registers of the CPU simulated by this arrangement.

Latch mode Analyser mode to determine glitches between the sampling points. All changes in level are extended by a special circuit such that they can be detected by the next clock.

Level-discrete The logic analyser recording is level-discrete because all analog voltages of the examined signals can be assigned to one of the logic levels LOW and HIGH, where the exact magnitude of the applied voltage is no longer considered.

Level error Level errors are present if the limits for HIGH and LOW levels can no longer be obtained for the logic family used and the response of the components connected to these lines becomes unpredictable.

Long-time evaluation Any type of evaluation which represents the results of several measurements or an extended period of measurements in reduced form. Statistical evaluations are typical examples.

Master/slave mode Common operation of two or more analysers where one is responsible for trigger detection (master) and the other(s) for the actual recording. Useful, for example, to combine the trigger intelligence of a state analyser with the speed of a timing analyser.

Multiple clock Modern analysers are able to use several external clocks simultaneously for recording. This multiple clock is primarily used in the analysis of multiplexed bus systems.

Multiplex bus Bus upon which qualitatively different information, such as addresses and data, can be transferred in sequence. The information is transferred on the bus with different clocks so that the peripheral units connected can differentiate between the different types.

Multi-tasking system Computer system on which several processes can be executed simultaneously. The CPU jumps between the processes time-controlled. Generic term for multi-user systems.

Multi-user system Computer system on which several users can work simultaneously. Since the CPU of such a system can only execute one process at a time, switching is made between the individual users and the executed programs time-controlled. Only intelligent logic analysers can follow individual programs specifically by simply eliminating all unrequired processes.

Parallel monitoring Characteristic of modern analysers in trigger or qualifier sequence. Several conditions can be monitored simultaneously and lead to completely different analyser responses.

Posttrigger Triggering where the posttrigger counter is set (to the depth of the analyser memory) such that all data in the analyser memory occur after the trigger.

Pretrigger Triggering where the posttrigger counter is set (to zero) such that all data in the analyser memory occur before the trigger.

Probe Circuitry detached from the logic analyser for the adaptation of device-under-test. Universal probes for general uses, uP probes and interface probes for processors and interfaces.

Qualification Method to reduce the data applied to the analyser memory: only data corresponding to patterns set by the user are read in; all other data are ignored.

Ranges Numeric ranges which can be specified in intelligent analysers in the data pattern definition. The data pattern is recognised if any value within this range occurs.

Restart Additional criterion which can be defined with sequential triggering to generate renewed execution of the trigger sequence. Triggering only takes place when the sequence can be executed without being interrupted by the restart condition.

Retroactive qualification Qualification where the data pattern responsible for qualification appears after the data word to be recorded. Only possible with analysers with special hardware (intermediate memory for data words until occurence of qualification criterion).

RS232 Popular serial interface for connection of printers, modems, terminals, etc., to a computer system.

Sample mode Normal operating mode of an analyser: only the input levels present at the time the clock occurs are transferred to the analyser.

Sampling frequency Important variable for examining signal delay times using a timing analyser. The sampling frequency must be many times larger than the limit frequency of the signals to be analysed to ensure sufficient accuracy.

Selector Freely programmable qualification facility in the Logic Analysis System LAS from Rohde & Schwarz.

Sequencer Freely programmable trigger facility in the Logic Analysis System LAS from Rohde & Schwarz.

Sequential qualification Qualification method with which the qualification criterion can be changed during the measurement depending on the occurrence of preset data patterns.

Sequential triggering Triggering method where several data patterns must occur in an exactly defined sequence before triggering takes place.

Setup time In clock-controlled circuits this is the period prior to the occurence of a clock in which the input data must not change to eliminate the possibility that the circuit could respond in an undefined manner.

Skew Offset between the logic analyser channels. Different delay times in the analyser channels mean that simultaneous events can no longer be displayed as simultaneous.

Start/stop measurement Means of reducing the quantity of data reaching the analyser memory. Data input is interrupted when a stop criterion occurs and started again by the start criterion.

State analyser Logic analyser for the use of measurements in clock-controlled systems such as computer circuits where the logic data and not the signal times are important. Features: low limiting frequency, high trigger intelligence, many channels.

State display Display of data stored by the analyser in the form of a list where the data for each point in time are displayed numerically (binary, decimal, octal, hexadecimal or ASCII).

State error Faults in a digital circuit where signals are logically incorrect but cannot be physically differentiated (level, timing) from correct signals. The logic analyser must have an interpretative function in order to trace such errors, i.e., it must be able to differentiate between "faulty" and "correct" signals.

Stuck-at error Short-circuit on a signal line with the effect that this line can no longer change. Can be found most rapidly using the logic analyser timing display.

Time analyser Logic analyser optimised for the use of measurements in systems where the signal times are important. Features: high limiting frequency, low trigger intelligence, few channels.

Time-discrete The logic analyser recording is time-discrete because the voltage levels of the signals can only be observed at particular times. No information is available on the response of the signal lines between these clocks (unless latch mode is used).

Time display Display of data stored by analyser in the form of a multi-channel oscillogram.

Timing error Timing errors occur with signals which must have a defined relationship in time to other signals. Violations in the setup and hold times are the most common errors.

Timing measurement Capability is implied when using internal clocks, provided all data are recorded, because the intervals between data are then multiples of the internal sampling period. In all other cases the analyser must have a hardware time measurement facility in which the time can be stored for each data word.

Triggering Release of the final phase of a logic analyser measurement. The posttrigger counter (adjustable by user) is started and terminates the measurement when the counter has run down. The detection of a data pattern by the analyser is a trigger criterion.

x/y display Type of display with which each possible combination of the displayed channels is assigned a point on the screen which is marked should this combination occur.

y/t display Type of display with which the data are entered on a time axis as quasi-analog variables. EA

REACTANCE-FREQUENCY CHART

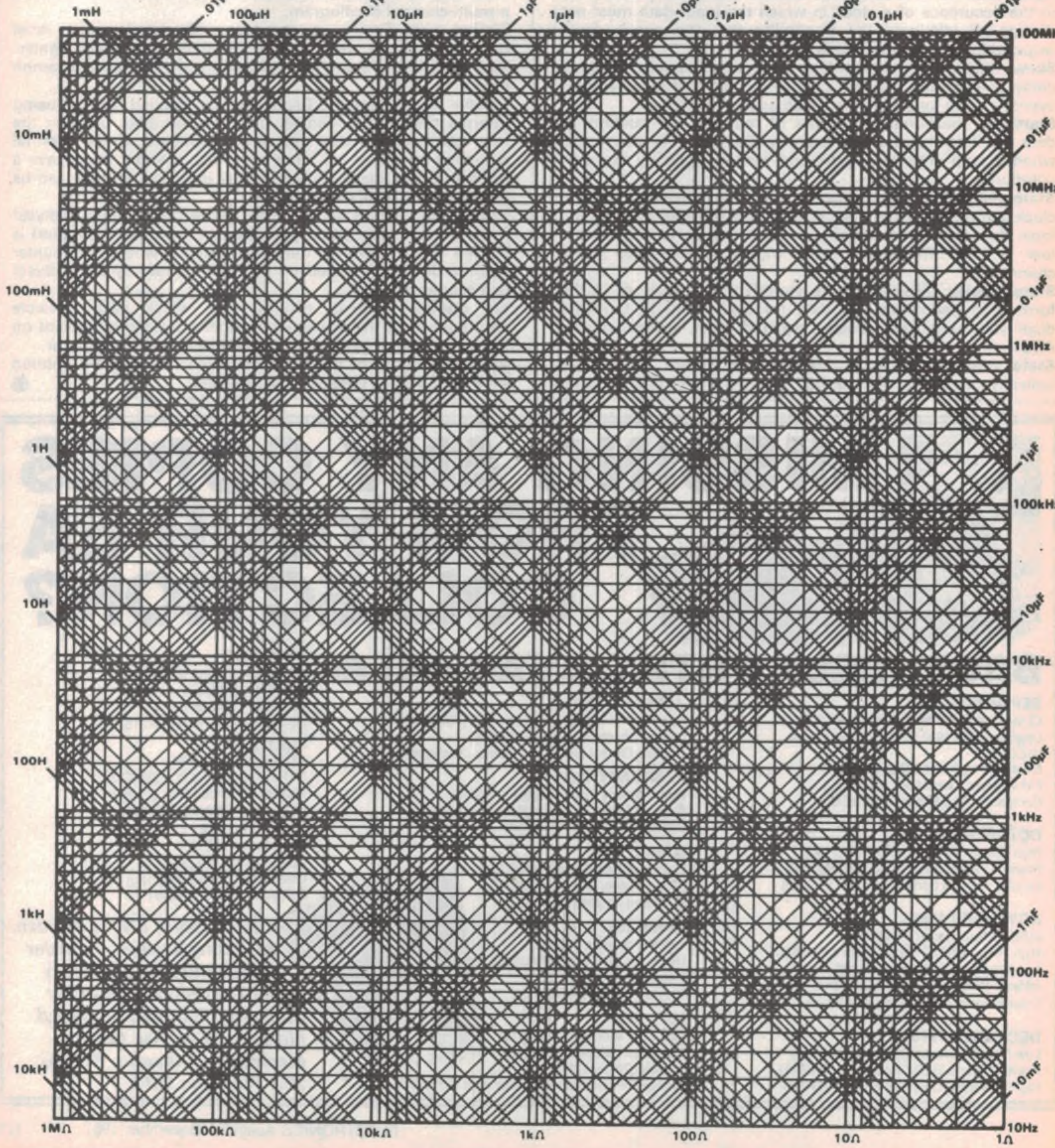
This chart can save a great deal of time when selecting values for coupling and bypassing capacitors, etc. Using it you can frequently avoid tedious calculations.

To find the reactance of a capacitor at a given frequency, follow the 45° capacitance value line until it intersects the horizontal frequency line, then read downwards to the ohms scale at the bottom. The reactance of an inductor can be read in a similar manner.

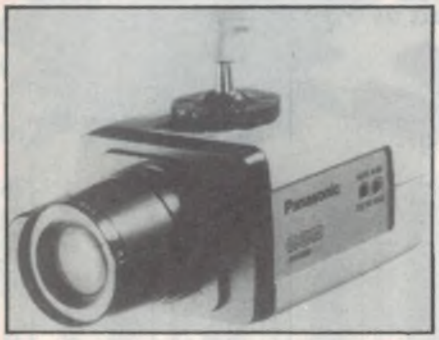
The chart can also provide information about resonant circuits. For example, locate where particular values of L & C intersect and read off the resonant frequency. If frequency is known and either L or C, find the intersect and read off the remaining value. Again, by following along a particular frequency line, a variety of LC options for resonance can be determined.

To design simple 6dB/octave speaker crossover networks, follow the appropriate resistance line up to where it intersects the desired crossover frequency and read off the required values of L & C.

Interpolate for values between the lines, using a needle point for increased accuracy.



New Products...



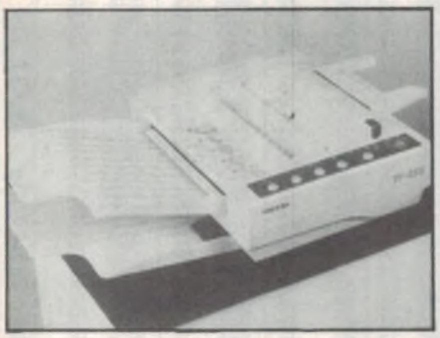
Colour CCTV camera

Panasonic has streamlined its colour, closed-circuit TV camera WV-CD110 by putting the auto tracking white balance through the lens. This feature was previously a side piece on the camera.

Other features of the new model WV-CD110 ANC include:

- 1/2" Charge Coupled Device (CCD)
- 12V DC power from dedicated power supply (PS10) or colour TV monitor (CM110)
- 280 lines resolution (horizontal), 350 lines resolution (vertical)
- 10 Lux minimum at F/1.4
- Choice of lens from wide angle to zoom

The camera is available from all usual Panasonic stockists.



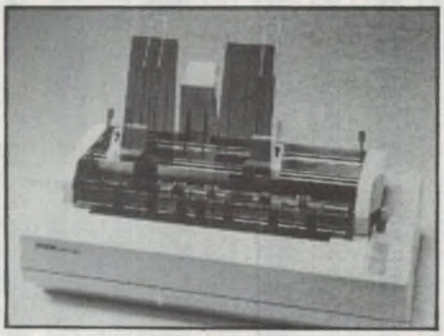
Economy fax

Toshiba's new desk-top facsimile machine is intended for the small business or an executive's personal unit. It has most of the functions of higher-priced machines, but is one of the least expensive on the market.

The TF-222 is very easy to operate, has half-tone facilities, (to enable transmission of photographs), a journal of transmission and reception including time and date, security code for polling and speedy transmission times. It carries a standard 100m paper roll which is the equivalent of 350 sheets.

Toshiba's TF-222 is the smallest in the company's new machines, which form the basis of its entry into the market. The machines are all self-diagnostic, which allow speedy and accurate diagnosis of faults.

Further information from Toshiba (Australia), 84-92 Talavera Road, North Ryde 2113.



24-pin printers

Epson has introduced the LQ-850 and LQ-1050, claimed to be the most advanced 80 and 136 column 24-pin dot matrix printers in Australia.

The LQ-850 and LQ-1050 print bidirectionally in both draft and letter quality modes, resulting in higher print speeds of 264cps in draft and 88cps in LQ. The paper slew rate is 70% faster than for previous models. Graphics are also printed bidirectionally, with 360 horizontal dpi and 180 vertical dpi.

Other features include 55dbA low noise level; ESC/P emulation; two built-in letter quality fonts selectable from the front control panel; built-in parallel and serial interfaces and a 6K buffer.

The printers are designed to handle both cut-sheet and continuous media simultaneously, thus eliminating the inconvenience of constantly changing between cut sheet feeder and tractor.

Further information from Epson Australia, Unit 3, 17 Rodborough Road, Frenchs Forest 2086.

2Mb micro floppy

TDK has released an enlarged storage capacity 3.5" double sided, high density micro floppy disk (MF-2HD), providing up to 2.0Mbyte storage capacity. Depending on the operating system used, TDK claims the MF-2HD has either 1.6 or 2Mbyte storage capacity.

The secret to this enlarged recording capacity is attributed partly to TDK's ultra thin coating technology, which involves controlling their high density Avilyn magnetic formulation to within 0.05 microns surface thickness. The MF-2HD is also the first disk to utilise an electron beam cured binder technique, developed by TDK, which involves the high density coating of the disk being penetrated by an electron beam. This causes excitation and ionization of the binder molecules, resulting in an extremely hardened structure. This technique is said to assure reliability and data safety even after 20 million passes.

The MF-2HD compliments the existing TDK range of micro floppies including the MF-1DD (500k) and the MF-2DD (1M), and has a recommended retail price of $13.50 each. TDK also market the M1D (250k), M2D (500k), and the M2HD (1.6M) in the 5.25" range.

Further information from TDK stockists.

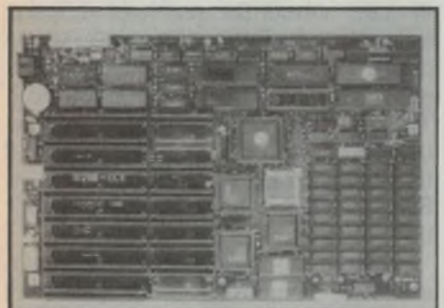
Australian-made conductivity meter

TPS has just released its new Australian-made model 2100 laboratory conductivity meter. The 2100 is a 5-range conductivity meter for economical laboratory use, and can be used over the full range of conductivities found in lab applications. Cells with 3 different k factors can be used.

Temperature readout is also provided from a sensor in the cell. The 2100 has recorder output facility, and a zero adjustment to compensate for longer cable effects. The meter is fitted with a probe support clamp and rod, which provides a convenient method of support for the cell during measurements.

A complete range of precision Platinum/Glass cells is available for use with this instrument, in either flow-through or dip-cell configurations.

Further information from TPS, 4 Jamberoo Street, Springwood 4128.



"Baby AT" motherboard converts IBM PC/XT

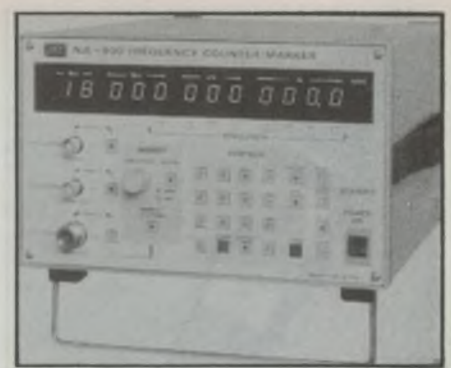
Electronic Solutions has just brought out a "Baby" version of the AT motherboard. Using surface mount technology, the company has managed to pack in full expansion capabilities (including 8 expansion slots) in around half the space of the "normal" AT. The mounting holes allow the board to be dropped straight into an existing PC/XT case.

Features include:

- 80286-8 processor running at 10MHz, switchable to 6MHz
- Speed test 11.7 on Norton utilities
- 7 channel DMA for disk and special I/O
- 8 expansions slots (6 full AT standard)
- On-board battery backup configuration and real time clock
- Phoenix ROM BIOS for complete PC/AT compatibility
- Accepts up to 1MB of RAM on the motherboard (640k fitted)

For people building an AT from scratch, Electronic Solutions can supply all the other bits, including cases, power supplies, expansion cards and keyboards.

For further information contact Electronic Solutions, PO Box 426, Gladesville 2111.



18GHz counter with marker generator

ACL Special Instruments, a division of Associated Calibration Laboratories, has released the JRC Model NJL-900 mircoprocessor based Frequency Counter. This 12 digit, 10Hz to 18GHz counter features not only automatic frequency measurement but also 4-rule arithmetics and PPM (parts per million) display.

The NJL-900 can also generate a marker signal in the range of 1 to 18GHz, for use when observing frequency characteristics on a CRT display.

The optional GPIB (IEEE-488) interface makes all functions of this equipment programmable, thus allowing the unit to interface with various automatic instrument systems.

Further information from ACL Special Instruments, 27 Rosella Street, East Doncaster 3109.

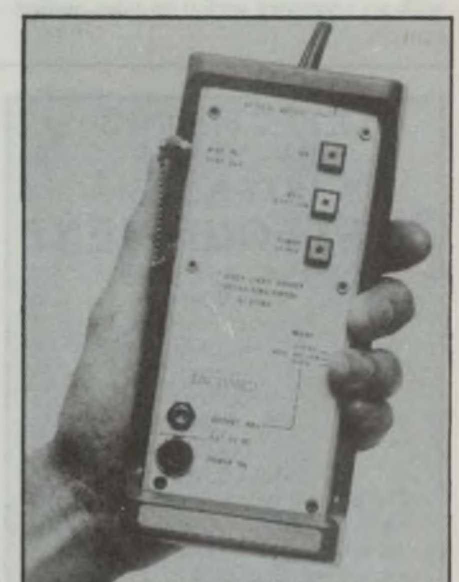
All-mode HF transceiver

Icom's newest all-mode HF transceiver, the IC-761, is designed for the HF operator who wants more than just a radio. The IC-761 is a true all-mode transceiver (SSB, CW, RTTY, AM, FM). It also features an automatic antenna tuner; an electronic CW keyer; general coverage communications receiver and 100% duty cycle power supply — all with full computer control capability and provision for connection of an external manual or automatic linear amplifier, external automatic antenna tuner, RTTY or AFSK terminal unit, slow scan TV unit, etc. 12V DC power is available from a rear panel jack on the IC-761 to power accessories.

Icom involvement in Arctic and Antarctic expeditions has led to the development, for the IC-761, of a high stability crystal unit incorporating a built-in temperature compensating oven heater. This provides frequency stability of better than 100Hz over a temperature range from −10 to +60 degrees Celsius.

For the DXer or contest enthusiast the IC-761 includes a low distortion speech compressor with full metering, long and short duration variable pulse level noise blanking, front-panel controlled VOX operation, receive and transmit incremental tuning, and ultra-deep (30dB) notch filter to eliminate annoying carriers, true IF monitoring, 20dB preamplification with minimal degradation of signal quality, switchable AGC, passband tuning, IF shift and switchable filtering.

Further details from authorised Icom dealers.



Handheld laser light sources

Kingfisher International has introduced a range of handheld laser light sources for use in fibre optic measurement applications. Available with 850nm, 1300 and 1550nm outputs, the sources feature a temperature stabilised laser providing stable output within two minutes of switch-on.

The light sources offer precision performance in an extremely compact package, measuring only 165 x 75 x

New Products...

29mm. Other features include externally applied analog modulation from DC-300MHz, internal 270Hz chopping, an internal fibre cladding mode stripper, 16 hours battery running time and an optional 20 minute timer.

The KI2000 Series features top quality design and a metal case to provide reliable performance. Normal accessories include a hard carry case.

Applications include optical loss measurements, receiver bandwidth testing, research, manufacture and installation of optical fibre equipment for telecommunications.

Further information from Kingfisher International, 14 Excalibur Avenue, Glen Waverley 3150.

Handheld digital tachometers

The new British made Concorde range of digital, handheld tachometers is designed and made by Compact Instruments. The range consists of four models, two contact and two optical, all with an accessory socket to take remote sensors.

A special feature is their ability to measure extremely low speeds with high accuracy. All versions can measure down to 3rpm and resolve to three decimal places. In addition, direct measurements of speeds from 3,000 to 500,000 rpm in either fully autoranging or manual modes is possible. Optical models achieve this exceptionally wide speed range using only one reflective mark per revolution. The contact models can also measure linear speeds down to 0.3 metres/minute.

Two of the four models in the range offer three additional functions; these are count, time accumulated and time interval. The count function detects pulses so that any repetitive event can be monitored, i.e., revs, objects, strokes, etc. The time accumulated function measures the time in seconds between the first pulse after switch-on to the last pulse before switch-off, with a resolution of ±0.01 secs. Time interval records the time in seconds between successive pulses and displays a result in the range 0.01 to 99,999 seconds, autoranging.

All models are supplied with a carry purse, a set of alkaline batteries and instructions whilst the contact versions also include a cone and a metric disc for making linear measurements (m/min).

Further information is available from Warsash, PO Box 217, Double Bay 2028.

Screwdriver grips screws

The Wiha screwholder-driver, precision-made in West Germany, is claimed to have solved the problem of losing screws in confined places. A strong plastic sleeve over the screwdriver shaft grips the underside of the screwhead. The screw can then be placed in position, given a few turns, released, and then turned tight in the usual manner. For removing a screw, you just reverse this procedure.

A set of four screwholder-drivers is available, comprising 3, 4 and 5mm drivers for slotted screws and a 1# for Phillips-head screws. The tools should be especially useful for industrial electricians working in confined spaces and tightly packed enclosures, also for electronics and computer engineers.

Available from leading electrical wholesalers. Trade enquiries to Wattmaster Alco, PO Box 75, Ermington 2115.

High speed air ioniser

Rheem Protective Packaging Products has introduced a new high speed air ioniser. The "Dynastat" 5000 is the latest addition to the Rheem range and allows a worktop area of almost a square metre to be electrostatically neu-

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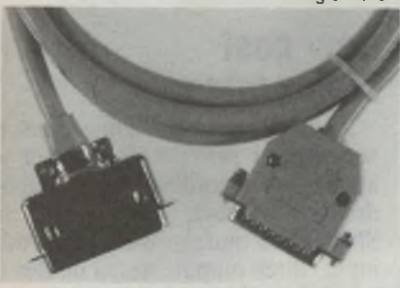

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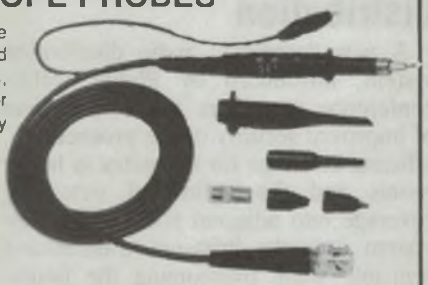
Specification

Position x1
Bandwidth : dc to 10MHz / Input Resistance : 1MΩ (scope input) / Input Capacitance : 40pF + scope cap / Working voltage : 600Vdc (inc peak ac)

Position Ref
Scope input grounded / Probe Tip grounded through 9MΩ

Position x10
Bandwidth : dc to 100MHz / Risetime : 3.5ns / Input Res : 10MΩ (when used with scopes having 1MΩ input / Input C : 11.5pF when used with scopes having 30pF input capacitance / Compensation range : 10 to 60pF / Working Voltage 600Vdc (inc peak ac)



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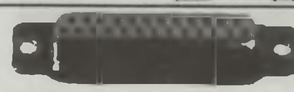

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DA15P	2.34	2.11	1.17
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9 pin	1.60	1.44	90¢
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36 way male	6.60	5.94	3.30
36 way fem	9.50	8.55	5.28
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L1950A Appliance Inlet **$2.20**

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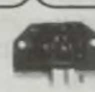

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Precise ion-compensation circuitry and a variable speed fan mean the flow of ionized air is regulated to adjust to altering conditions, so any workspace in reach of 240 volt GP outlet can be rendered anti-static at any time.

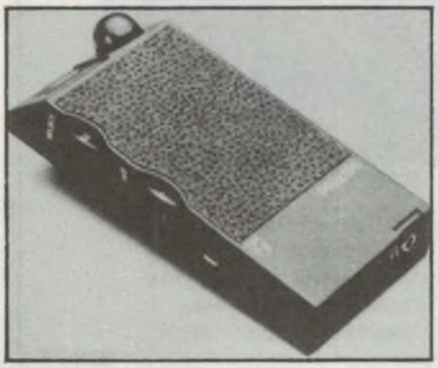
For further information contact Rheem Protective Packaging Products, 3 Burrows Road, Alexandria 2015.

Programmable step attenuator

A compact binary step attenuator, programmable to provide 0 to 75dB in 5dB steps from DC to 18GHz, has been released by Weinschel. The Model 150-75 offers high-speed and self-disconnecting switching, positive latching, long switch life, high reliability and a compact size. These features make the Model 150-75 suitable for a wide range of applications including test instrumentation, ATE, or as an OEM component for system use.

The Model 150-75 is rated for 1 watt CW and 100 watts peak power (10 microsecond) pulse width. It requires an operating voltage of 24 +/- 6V DC. At 24V, the switching current is approximately 125mA. Maximum insertion loss is 2.2dB, and overall dimensions are 45.2 x 133.4 x 22.9mm. It weighs 0.31 kg.

Further information from Rohde & Schwarz Australia, 13-15 Wentworth Avenue, Darlinghurst 2010.



Cordless audio distribution

A new "cordless" audio distribution system, introduced by Philips, offers conference organisers the combination of improved security of the proceedings, efficient coverage for delegates in larger rooms and the option of extending coverage into adjacent rooms. The new system uses the infra-red transmission principle while overcoming the limitations of earlier infra-red equipment.

The Philips high-efficiency infra-red radiator gives a coverage of approximately 525 square metres using 12 channels. This is ten times greater than most radiators currently available on the market.

The infra-red receivers use rechargeable batteries. If the intensity of the received infra-red light falls, the output of the receiver is muted to suppress disturbing noise and to extend the battery operation. Batteries can be charged inside the storage suitcase which can hold 55 receivers.

Mono and stereo headphones can be used with the receivers, which come in seven and twelve channels models.

For further information contact Philips Scientific & Industrial, 25-27 Paul Street North, North Ryde 2113.

Low cost stage mixer

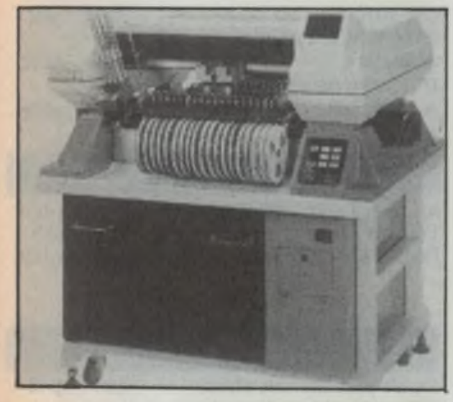
Audio Telex Communications has a new budget priced Q-Tek mixer aimed at the live recording, stage, public address and disco users. The model SM8000 features 8-channel mic/line input, three output, stereo master monitor and auxilliary.

A built-in 2/3 octave graphic equaliser and facilities for talk over make this mixer well suited for disco systems and

stage productions. It is an attractive unit with coloured knobs for easy identifications. Illuminated VU level meters and peak indicators are also a feature.

The price tag is $853 plus tax for the standard version, or $999 plus tax for the model with low impedance balanced microphone inputs and phantom powering for electret microphones.

Further information from Audio Telex Communications, 120-124 Beaconsfield Street, Auburn 2144.



Compact surface mount machine

The new Yamaha TM4600S is an SMT assembly machine designed for small/medium scale manufacturing applications. It can accommodate PCB sizes from 50 x 30mm to 250 x 350mm, can be fitted with either two heads or one head and a dispenser, and places a part in less than 0.9 seconds. The heads have a rotating mechanism and can place parts at 0, 90, 180 and 270 degrees.

The YM4600S accepts 46 kinds of 8mm tape feeder, and will also take 12mm tape feeders, vibratory feeders, stick feeders and tray feeders. Tape feeders can be changed in one minute. Programming can be performed off line, so a machine need not be stopped for programming.

Cost of the YM4600S is around $55,000. Further details are available from Hawker Richardson, with offices in Melbourne, Sydney and Adelaide. In Melbourne phone (03) 20 2461.

New catalog

Tandy's 1988 Annual Catalog features 148 full-colour pages with the latest in electronic technology — 2,860 different products and 150 exciting new releases — all exclusive to Tandy.

The catalog is available free from over 350 Tandy stores and dealers Australia-wide. EA

Jogger Logger

Continued from page 66

Final adjustments

Having seen our test results, it is time to put on your running shorts and take off with your own Jogger Logger.

Switch the Jogger Logger on and run, say 200 steps. The display should now read "0020". If the display reads "0019" or "0021", then you shouldn't worry yet. Repeat the test with longer distances.

If the Jogger Logger doesn't count right then there are two possibilities. If the error is less than 50% then it is most likely that the Jogger Logger is shaking more (or less) than it should. In this case you might have to review the positioning of the Jogger Logger. Readjusting the vibration sensor might give an improvement.

If the error is quite large, then you should readjust the Jogger Logger. If the count is too low, than the gap between the sensor contacts should become smaller. If the count is too high, then the gap has to be widened. Don't turn the screw too much at a time.

If you are lucky, then the Jogger Logger will be properly adjusted at first go. In the alternative case you might have to run a few kilometres to get it right. Still, the adjustment isn't too difficult.

The Jogger Logger allows quite a range of different running styles. It is possible however that when the it is adjusted for a heavy person, it may not work properly for a light person, and vice versa.

Finally, after having adjusted the Jogger Logger, we secured the adjustment by putting a drop of cement on the thread of the screw. EA

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Satellite Siren — further notes

A number of readers have requested further information on this project (September 1987) — particularly on how to actually install the unit into an existing alarm system. Here we include a simplified explanation and a connecting up diagram.

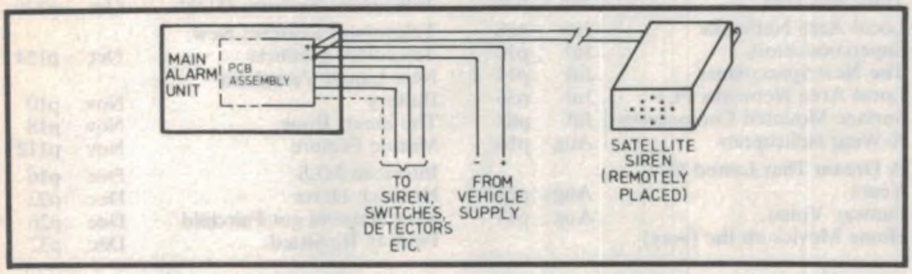
The Satellite Siren is a second, self contained "backup" alarm that is activated only when the main alarm wiring is interfered with or the vehicle battery is disconnected. It of course includes its own backup battery, circuitry and a siren.

As can be seen in Fig.1, the Satellite Siren does derive its power from the main alarm, but only for keeping its NiCad batteries charged. Whilst power is connected to the siren its batteries are being kept at full charge and the siren is deactivated. However if the wiring loom to the main alarm is cut, the battery is disconnected or the wires connecting the satellite siren are cut, the Siren is activated. Once this occurs the only way to disable the Satellite Siren is by operating the key switch provided.

When one realises that the addition of only a back up 12V battery into an existing alarm system could cost up to $35 (10AA NiCads) the Satellite Siren starts to look like a pretty good proposition. And whilst it automatically provides "back up battery operation" it also provides the benefit of a totally self contained second alarm system which is remotely placed with respect to the main alarm.

When installing a satellite siren the two required wires should be blended into the existing main alarm loom. It would also be good practice not to correctly colour code the two wires (anything except red and black would do). The required wiring should also be tied to existing car looming rather than being kept separate. The points mentioned should be considered as good practice in any alarm installation.

We hope that the additional information included here answers all of the interested readers questions.



60/60 Amplifier

I have come across some interesting faults in the Playmaster 60/60 amp I purchased as a kit from Jaycar Electronics.

Firstly, all the line inputs are reversed, that is: Red is left, Black is right. This input error is in the PCB, which is modified from the original in the socket section. Correct channelling is easier to achieve by reversing all input plugs. Originally this was apparent only at the tape sockets. I back-tracked from the monitor switch and found the signals from the source switch exited A = Left, not Right. This results in a reversed path from sockets to switch, then "correction" (excluding tape) as it enters the pre-amp. A check with an ohmmeter between the Tape Out socket and e.g. CD Sockets will show if the switch is reversed.

Note: This switching error was also in the CD Voltage Adaptor kit I purchased at Jaycar.

My amp also had a low frequency hum from the outputs. More so the left channel. This was rectified by constructing copper shield around the Jones transformer. Now completed, I find the 60/60 to be a first class amplifier. (A.G., Artarmon, NSW)

• The PCB change made by Jaycar was apparently approved by the original designers, and made because the input connectors used in the prototype became unavailable. But you should have been advised of the change, we agree.

Lap scoring

I am seeking information re electronic equipment suitable for lap scoring and/or judging, particularly as below:

1. Is there any equipment suitable for lap scoring of motor cycles or karts, with pick up from radio frequencies or other methods which could be fed into a computer for automatic listing?

2. Is there any suitable equipment available, without the use of tapes connected to micro switches, for judging of athletic events either for a straight race lanes and or circuit events?

I hope that some of the wizards that read your magazine may be able to help. There is no doubt plenty of room for improvement in both cases I have mentioned. (G.J., Burnie, Tas)

• Unfortunately, we have not to date done any projects on lap scoring or judging. We will, however, keep both subjects in mind, and perhaps be able to do a project on them in the future.

Capacitance meter

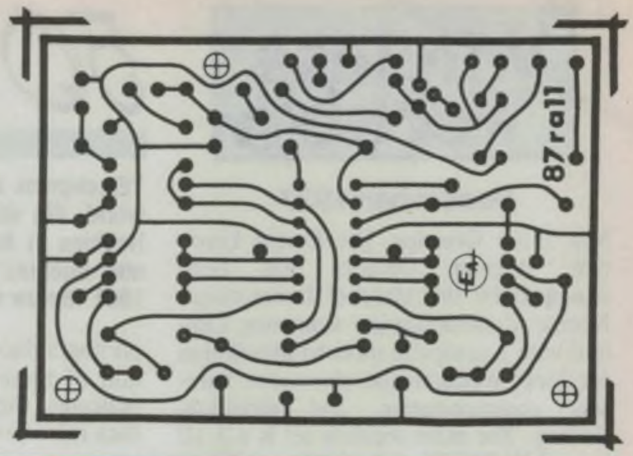
A short time back, I completed from a kit supplied by one of your advertisers the Digital Capacitance Meter, of August 1985. My problem is that the display and decimal points function, but with the appropriate capacitors across the terminals no adjustment of any of the trimpots causes any variation in the display figures on any of the three ranges. Can you offer any suggestions. (R.H.D., Yass NSW)

• Assuming you have double checked the PCB for correct component orientation, the next step involves some form of test equipment (e.g. oscilloscope or multimeter). The inactivity of the display indicates a fundamental problem with your project. The reference and gating oscillators should be checked for the appropriate pulse trains, and the display driver IC4 should be tested for its correct updating function.

This is the second letter we've received lately describing the same problem. We're beginning to suspect a batch of faulty ICs.

Oops!

The PCB artwork for the Voice Operated Relay on page 66 of the November 1987 issue was reproduced double size instead of actual size. For people wishing to construct this project here it is again, actual size!



Notes & Errata

UHF DOWN CONVERTER (April 1986, File: 6/TVT/6): The connections to VR3 are shown reversed in both the wiring diagram of page 26 and the inside photo of page 27. The bias voltage fed to the tuner module should increase with clockwise rotation, and this will occur if the connections to the ends of the pot are transposed.

SIMPLE PYROMETER (October 1987, File: 3/MS/131): When adjusting the offset nulling using preset pot VR1, the thermocouple probe input socket should be short circuited to closely simulate the input bias current conditions when the probe is connected.

UHF REMOTE CONTROLLED KEY (January 1987, File: 3/MS/126): Some readers have commented that sometimes the system fails to operate, but operation can be restored by touching the copper side of the transmitter board. Soldering a 100k ohm resistor across the LED in the transmitter solves this problem, providing a DC return between supply and ground.

ULTRASONIC BURGLAR ALARM (April 1987, File: 3/AU/51): A 4.7k resistor should be added across the frequency adjustment potentiometer (VR2). This reduces the frequency range of the transmitter and greatly simplifies the frequency adjustment procedure. The transmitter frequency will be approximately 40kHz with VR2 set to its mechanical centre adjustment. Also the alarm has a tendency to trigger from a drop in supply voltage. This was initially considered an advantage but in practice proved a disadvantage. The problem can be solved by supplying the alarm from a simple 9V voltage regulator circuit. Note that a kit for a suitable regulator (including small PCB) is available from Oatley electronics for $4 including postage and packing.

If for any reason readers find that sensitivity of this project is insufficient it can be easily increased. This is done by reducing the value of R2 from 47k to 27k. A further increase in gain is possible by also reducing the value of R5 to 27k ohm.

Letters *Continued from page 5*

the 3% to 5% error of the meter. If the amplifier is worse than "typical" then this error may be ten times greater!

This is a small point but important if the accuracy of the instrument is important, particularly if this error is "eliminated" by tweaking VR2, the calibration control. This would result in scale factor and offset errors of significant values particularly at the low end of the instrument.

Phil Denniss,
Dept. of Plasma Physics,
University of Sydney.

Comment: Thanks for pointing out the error, Phil. What can I have been thinking of? My face is red (blood red, that is, I don't need a pyrometer to check!)

Black & white video

Your article in the August issue on old black and white video recorders by Jim Lawler has given me new hope.

Having had video recordings done on a black and white Akai VT100 1/4" reel to reel back in 1973, I am desperate to re-record these tapes onto VHS.

I have tried all avenues as far as transfer studios are concerned but to no avail. If anyone has the facilities or machine to duplicate these tapes I would be very grateful if they could phone me on (02) 631 4683 or write to the address below.

Frank Williams,
19 Vernon Street,
Greystanes NSW 2145.

Wireless Weekly 3d

50 and 25 years ago...

"Electronics Australia" is one of the longest running technical publications in the world. We started as "Wireless Weekly" in August 1922 and became "Radio and Hobbies in Australia" in April 1939. The title was changed to "Radio, Television and Hobbies" in February 1955 and finally, to "Electronics Australia" in April 1965. Below we feature some items from past issues.

December 1937

New Liner Orcades: The Orient Line's new steamer Orcades has been equipped by the Marconi International Marine Communication Company Limited with a complete modern installation for long, medium and shortwave wireless communication and direction-finding. The main wireless set is a 1 1/2 kw. C.W./I.C.W. transmitter, with an aerial rating of 750-1000 watts covering the wave ranges 583-820 metres and 1875-2400 metres.

Phototubes Used in Sorting: A new device for tabulating from business records has been devised by M.E. Gould of Washington, using a rectangular bank of 200 phototubes to register indexing impulses projected upon them from a motion picture projector whose film contains the records. Each frame of the film resembles a punch-card of the conventional tabulating machine, except that each punch hole is replaced in the film by a square black dot impressed photographically on the film. The position of these black dots on each form indicates the classification and other data relative to the particular record.

RADIO, TELEVISION and HOBBIES

December 1962

New Radio-Telephone: The "Vanguard" 25-watt boot-mounting mobile radio-telephone is the latest addition to the Pye Telecommuication equipment. It features a highly transistorised design, a very low noise receiver, a new noise compensated high stability muting circuit and choice of 25 or 50 kc/s channelling by change of I.F. block filters. Extensive use has been made of printed circuits, transistors and other solid state devices to give high performance combined with maximum reliability.

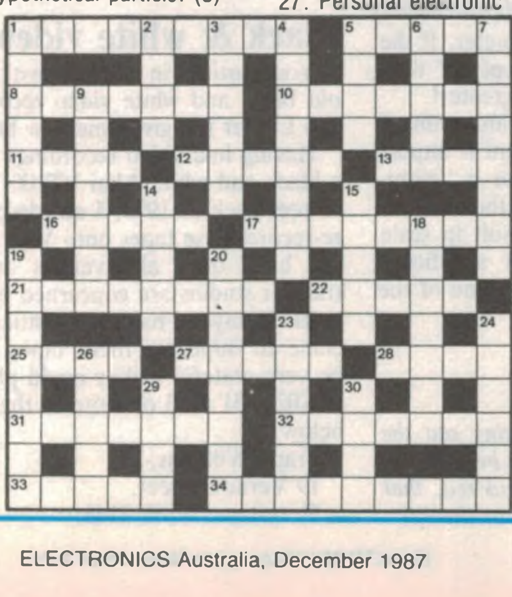
Forecast breakdown: A reliable system has been developed to detect the likelihood of component failure leading to the breakdown of a piece of machinery, using standard noise recording and oscilloscope equipment.

The system employs computer techniques to analyse the noise made by a machine based on the theory that likely sources of machine breakdown — gear teeth starting to chip or crack, uneven bearing raceways, cracked bearing holders, etc — introduce a periodic component into a generally uniform sound level.

DECEMBER CROSSWORD

ACROSS

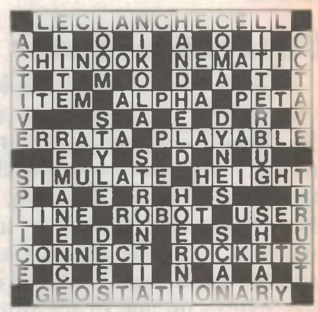
1. Practice of voice-based communication system. (9)
5. Fascinating characteristic in a particle theory. (5)
8. Rocket range. (7)
10. Said of simple AM/FM radio. (3-4)
12. Hypothetical particle. (5)
13. Prefix having factor value of 10^9. (4)
16. Unit of luminance. (5)
17. Illegal marketing of tapes. (8)
21. Type of microphone. (8)
22. Brand of multimeter. (5)
25. Said of region of infra-red. (4)
27. Personal electronic message receiver. (5)
28. Responded to Earth's gravitional field! (4)
31. Solve by repeated calculation. (7)
32. Name of the first navigational satellite. (7)
33. SI unit. (5)
34. Code-based communication system. (9)



DOWN

1. Masts for television transmission. (6)
2. Apple-based diagrams for distribution to information-hungry folk. (4)
3. Unable to propagate electromagnetic radiation. (6)
4. Pertaining to Yb. (8)
5. Complementary metal-oxide semiconductor. (4)
6. Brand of computer. (5)
7. Said of speakers designed for part of audible spectrum. (3-5)
9. Scientific satellite series. (7)
14. Form wire into braid. (5)
15. Conductor with strands. (5)
18. Some printers have them. (3,4)
19. Element preceding titanium in periodic table. (8)
20. Part of an incandescent lamp. (8)
23. Said of brain calculations. (6)
24. Car air-conditioners have a solenoid to control this. (60
26. Expert (at least in one department!). (5)
29. Plug type. (4)
30. Bell did it in 1 across. (4)

SOLUTION FOR NOVEMBER



Special Publications from Electronics Australia

FUNDAMENTALS OF SOLID STATE. Now in its second reprinting — which shows how popular it has been! It provides a wealth of information on semiconductor theory and operation, delving much deeper than very elementary works but without the maths and abstract theory which make many of the more specialised texts heavy going. Starting with a background chapter on atomic theory, the book moves easily through discussions on crystals and conduction, diode types, unijunction, field effect and bipolar transistors, thyristor devices, device fabrication and microcircuits. A revised glossary of terms and index complete the book. *Fundamentals of Solid State* has also been widely adopted in colleges as recommended reading — but it's not just for the student. It's for anyone who wants to know just a bit more about the operation of semiconductor devices. **$4.50**

DIGITAL ELECTRONICS. Electronic equipment plays an important role in almost every field of human endeavour and every day, more and more electronic equipment is 'going digital'. Even professional engineers and technicians find it hard to keep pace. In order to understand new developments, you need a good grounding in basic digital concepts and *Introduction to Digital Electronics* can give you that grounding. Tens of thousands of engineers, technicians, students and hobbyists have used this book to find out what the digital revolution is all about. This new fourth edition has been updated and expanded to make it of even greater value. No previous knowledge of digital electronics is necessary — The book includes an excellent coverage of basic concepts. **$4.50**

BASIC ELECTRONICS. This popular text has now been re-issued. *Basic Electronics* is almost certainly the mosty widely used reference manual on electronics fundamentals in Australia. Written as a basic text for the electronics enthusiast, it is also being used by radio clubs, secondary schools and colleges, and WIA youth radio clubs. It begins with the electron, introduces and explains components and circuit concepts and progresses through radio, audio techniques, servicing, test instruments, television, etc. If you've always wanted to know more about electronics, but have been scared off by the mysteries involved, let *Basic Electronics* explain them to you. Easily understood diagrams and text make this the perfect introduction to the growing and exciting world of electronics. We've even included five electronic projects for the beginner. **$4.50**

SOLD OUT

PROJECTS & CIRCUITS. If you like building electronic projects in your spare time, you can't afford to miss out on this exciting book of popular projects from *Electronics Australia*. Just look what's inside! **Audio and Video Projects:** Video Amplifier for Computers and VCRs, Video Enhancer, Vocal Canceller, Stereo Simulator for Tuners and VCRs, Guitar Booster for Stereo Amplifiers. **Automotive Projects:** Transistor-assisted Ingition System, Breath Tester, Low Fuel Indicator, Speed Sentry, Audible Turn Indicator. **Mains Power Control Projects:** Musicolor, Photographic Timer, Driveway Sentry, Touch-lamp Dimmer. **Power Supplies and Test Equipment:** Battery Saver for Personal Portables, Dual Tracking ±22V Power Supply, 3 1/2-Digit LCD Capacitance Meter, In-Circuit Transistor Tester. **Plus EA's 10-year project index.** **$4.50**

WIRELESS WEEKLY. Our own time machine! It may look like a book, but don't let it's appearance fool you. There are no whirling dials and control levers; but once you open the cover, it'll take you on an incredible journey backwards in time. You'll find yourself back in the 1920's, when Australia's first few radio stations were just getting established and a typical radio set cost ten weeks' wages. We've chosen a collection of highlights from the 1927 issues of 'Wireless Weekly': You'll find some front covers, a few editorials, the best new items, a collection of typical do-it-yourself radio set designs, and some selected pages from the programme listing. Plus a sprinkling of the original advertisements, of course. These are particularly fascinating because they show prices and put everything into proper context. Send today for ***The Best of Australia's Wireless Weekly in 1927*** . . . A fascinating and nostalgic trip into our radio past. **$3.95**

ELECTRONIC PROJECTS FOR YOUR CAR. How can you extend the performance of your car without it costing an arm and a leg? With these selected projects from *Electronics Australia* you can add all of the gadgets you've dreamed of: Cruise Control, Courtesy Light Delay, Deluxe Burglar Alarm, Headlight Reminder, Audible Reversing Alarm, Transistor-assisted Ignition with Optoelectronic Trigger, Driveway Sentry, Speed Sentry, Tacho/Dwell Meter, Breakerless Ignition, Audible Turn Signal and more easy-to-build projects to add value, interest and safety to your pride and joy! PLUS Feedback from those who have built the projects themselves and Bright Ideas for you to develop yourself: Automatic Antennae Retraction, 6V Car Adaptor, Fuse-Failure Indicator and more . . . **$3.95**

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AMIDON FERROMAGNETIC CORES: Large range for all receiver and transmitter applications. For data and price list and 105X220 SASE to: R. J. & U. S. Imports, P.O. Box 157, Mortdale, N.S.W. 2223. N.S.W: Geoff Wood Electronics, Lane Cove. Webb Electronics, Albury. A.C.T.: Electronic Components, Fyshwick Plaza, Vic.: Truscott Electronics, Croydon. W.A.: Willis Trading Co., Perth.

EX-ABC AUDIO TAPES: ¼" wide on 10½" **Standard** metal spool $6.85. **Robust** metal spool $12.85 7" spool $2.85. 5" spool $1.25. Post extra. Also in stock ½", 1" and 2" tapes. Waltham Dan, 96 Oxford St., Darlinghurst, Sydney. Phone (02) 331-3360.

NEW RADIO VALVES: For entertainment or industrial use. Waltham Dan, 96 Oxford St., Darlinghurst, Sydney. Phone (02) 331-3360.

MAGAZINES: E.T.I. Mid 72 to 83 $2.50. Issue or best offer — Box 59, Batlow 2730.

500 PIECES UPD8288D: Bus controller for 8086 family processors $6 each. 500 pieces UPD8259 AC. Programmable interrupt controller $2.80 each. The lot for $3500. Brand new, ex stock. Ph (02) 758-1298 or 750-3062.

OLD VALVE RADIOS (8): Plus several chassis, spare parts, valves and manuals. $600 the lot or make an offer. Bob Rochfort, 132 Hawker Street, Quirindi 2343, phone (067) 46-2000.

MECH. THROUGH HOLE PLATE GRIPLET MACHINES: Best Offer, Jemal Products, PO Box 168, Victoria Park, WA 6100. (09) 350-5555.

INTO SIGNAGE?: We have surplus to our requirements 20 only Ferranti-Packard 4.1 inch 5 x 7 dot matrix digits. These units have been used but in A1 condition. They are fitted with stopped yellow dots for high visibility. A bargain at $75 each. SYSTECH PTY LTD. Phone (002) 34-6533 AH (002) 25-2898.

NEW VINTAGE RADIO VALVES: From $1, including 6L6G, 809, CV4060. Send SSAE for price list. SUPER 80 Disassembler $9, Assembler with full screen editor $15. R. Vowels, 93 Park Dve., Parkville 3052.

STD BUS MICROCOMPUTER: Mictrotrix Micromaster HD 64180 CPU.S12k-bytes ram. 2 system. Loaded and tested. $460. (08) 250-1869.

BUILD THE AEM MARCH 87: STAR PROJECT 256K printer buffer and save hundreds of dollars on the cost of any commercially available unit. Double sided board, Eprom & inst. $39 plus $3 P&P. Optional boards to suit buffer include Serial converter board $18, Printer switch $8, and computer switch $12, IBM type printer cables $15 plus $3 P&P. Components also available. Eg: Used 4164's 9 for $10. For more info. send SAE to Don McKenzie, 29 Ellesmere Cres., Tullamarine 3043.

EA MAGAZINE COLLECTION: 1967 — latest $100. Ph (03) 531-8314.

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PLAYMASTER 200 100+100W AMP: Built and tested, good condition, $390 or NEAR offer. Nigel (02) 398-8088 AH (02) 32-4722 BH.

WANTED

WANTED: Shure M91E cartridge (NOT 91ED). Phone (02) 871-1943.

ELECTRONICS BOOK SALE.

HOW TO DESIGN ELECTRONIC PROJECTS
R. A. Penfold **BP0127**
The aim of this book is to help the reader to put together projects from standard circuit 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. *128 pages* **$9.00**

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Therefore this book, besides including both simple and more sophisticated burglar alarm circuits using light, infra-red and ultrasonics, also includes many other types of circuits as well, such as gas and smoke detectors, flood alarms, doorphone and baby alarms, etc. *112 pages* **$9.50**

AN INTRODUCTION TO Z80 MACHINE CODE
R. A. & J. W. Penfold **BP0152**
Takes the reader through the basics of microprocessors and machine code programming with no previous knowledge of these being assumed. The microprocessor dealt with is the Z80 which is used in many popular home computers and simple programming examples are given for Z80-based machines including the Sinclair ZX-81 and Spectrum, Memotech and the Amstrad CPC 464. Also applicable to the Amstrad CPC 664 and 6128. *114 pages* **$10.00**

COIL DESIGN AND CONSTRUCTION MANUAL
B. B. Babani **BP0160**
A complete book for the home constructor on "how to make" RF, IF, audio and power coils, chokes and transformers. Practically every possible type is discussed and calculations necessary are given and explained in detail. All mathematical data is simplified for use by everyone. *96 pages* **$9.50**

HOW TO GET YOUR ELECTRONIC PROJECTS WORKING
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