CSIRO DEVELOPS NEW MULTI-SATELLITE ANTENNA FOR PAY TV

WIN HP TEST GEAR WORTH $11,000!

Australia's Top Selling Electronics Magazine

Electronics Australia

WITH ETI

AUSTRALIAN PUBLICATION

NDD

OCTOBER 1992

Aust* $4.95

NZ $6.95 incl GST

LOUIS CHALLIS REVIEWS AN ADVANCE SAMPLE OF PHILIPS' NEW DCC

LOW COST UNIT PROTECTS YOUR HIFI SPEAKERS

BUILDING OUR NEW SPECTRUM ANALYSER, VALVE STEREO AMP

9 312966 123633

Registered by Australia Post - Publication No. NBP 0240

Electronics Australia WITH eti

Volume 54, No.10

October 1992

AUSTRALIA'S LARGEST SELLING ELECTRONICS MAGAZINE — ESTABLISHED IN 1922

Instruments, hard & soft

In this month's feature on test and measuring instruments we look mainly at free-standing instrument hardware (see page 132), but there's also details of new PC-based instrumentation in the Computer Products section (page 150), and a review of the DADiSP software package, designed especially for manipulating, reducing and plotting technical data — like that from measuring instruments (page 144).

Magellan nears the end...

NASA's 'economy' spacecraft has mapped Venus, and is now likely to be scrapped — see page 20.

On the cover

Philips is no doubt hoping that its new DCC-900 digital compact cassette recorder will be smiled upon by the market as warmly as its advance review sample was favoured by lovely Donnah Estrella. Louis Challis reviews the DCC-900, starting on page 12. (Photo by Greg McBean).

Video and Audio

Features

Projects and Technical

Professional Electronics

Columns and Comments

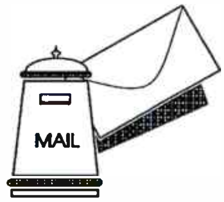
Departments

Electronics Australia

MANAGING EDITOR
Jamieson Rowe, B.A., B.SC., SMIREE, VK2ZLO
FEATURES EDITOR
Peter Murtagh, B.SC, Dip.Ed.
TECHNICAL EDITOR
Rob Evans, CET (RMIT)
TECHNICAL CONSULTANT
Peter Phillips, B.Ed., Dip Ed., ECC
CONTRIBUTORS
Neville Williams, FIREE, VK2XV
Jim Lawler, MTETIA
Arthur Cushen, MBE
Tom Moffat, VK7TM
Peter Lankshear
SECRETARY
Ana Maria Zamora
PRODUCTION EDITOR
Milli Godden
DRAFTING
Karen Rowlands
COVER DESIGNER
Clive Davis
PRODUCTION
Patrice Wohlnick, Mal Burgess
ADVERTISING PRODUCTION
Anthony Macarounas
CIRCULATION MANAGER
Michael Prior
PUBLISHER
Michael Hannan
ADVERTISING MANAGER
Selwyn Sayers (02) 693 9734
HEAD OFFICE - EDITORIAL
180 Bourke Road, Alexandria, NSW 2015
P.O. Box 199, Alexandria 2015
Fax number: (02) 693 6613
Reader Services: Phone (02) 693 6620
Subscriptions enquiries: phone (02) 693 9751
Book Shop enquiries: phone (02) 693 9751
INTERSTATE ADVERTISING OFFICES
MELBOURNE: 504 Princes Highway, Noble Park, Vic 3174. Phone (03) 795 3666.
Fax: (03) 701 1534, Nikki Roche.
BRISBANE: 26 Chermside Street, Newstead, Qld 4006. Phone: (07) 854 1119.
Fax: (07) 252 3692, Bernie Summers.
ADELAIDE: 98 Jervois Street, Torrensville, SA 5031. Phone: (08) 352 8666,
Fax: (08) 352 6033, Mike Mullins.
PERTH: Allen & Associates, 54 Havelock Street, West Perth, WA 6005. Phone: (09) 321 2998,
Fax (09) 321 2940, Tony Allen.
NEW ZEALAND: 63-73 View Road, Auckland, New Zealand. Phone: (09) 443 0250,
Fax: (09) 443 0249, Advertising Coordinator
UNITED KINGDOM: John Fairfax & Sons (Aust), 12 Norwich Street, London, EC4A 1BH.
Phone: (71) 353 9321, Fax: (71) 583 0348
ASIA: Headway Media Services Ltd, Room 2101, Causeway Bay Centre, 15-23 Sugar Street, Hong Kong. Phone: 516 8002,
Fax: (862) 890 4811, Adrian Batten.
ELECTRONICS AUSTRALIA is published by Federal Publishing Company, which is owned by General Newspapers Pty Ltd.
A.C.N. 000 117 322
Double Bay Newspapers Pty Ltd.
A.C.N. 000 237 598
and Brehmer Fairfax Pty Ltd.
A.C.N. 008 629 767
180 Bourke Road, Alexandria, NSW 2015.

Typeset and printed by Hannanprint, 140 Bourke Road, Alexandria, NSW for Federal Publishing Company.
Distributed by Newsagents Direct Distribution Pty Ltd, 150 Bourke Road, Alexandria, NSW 2015. (02) 693 4141.
The Australian Publication emblem on the front cover of this magazine is there to proudly signify that the editorial content in this publication is largely produced and edited in Australia, and that most of the advertisements herein are the products and services available within Australia.
ISSN 1036-0212
*Recommended and maximum Australian retail price.

LETTERS TO THE EDITOR



Power relay project

With reference to the above project (January 1992), I have found it to be very useful with the home computer, but am a little concerned that the project recommended using a five amp fuse for safety. It is a well known fact in the electronics world that semiconductors have a tendancy to burn out before a fuse and with three amp diodes in the circuit — you guessed it.

This was proven when a 2400W heater was inadvertantly plugged into the master socket. Instead of the fuse blowing as it should do, the diodes became a frizzled mess, the box melted and, well, I wont't bother explaining the state of the PCB or the fuse carrier. I therefore recommend that perhaps a two amp fuse would make the project a bit safer, in the case of the odd mistake as explained above.

I do feel that this is a matter of importance and should therefore be published in the near future, even if for the sake of safety.

Thanks for a great magazine.

A.J. Donald,
Glenfield, Auckland NZ.

Comment: We specified a 5A fuse to reduce the likelihood of 'nuisance' blowing during switch on, Mr Donald. However, if your unit doesn't do this with a 2A fuse fitted, by all means use the lower rating for added safety.

Chip source

About 10 years ago, I purchased and successfully constructed the (then current) 'Playmaster Stereo Tuner' kit from Dick Smith Electronics.

Recently, the CMOS display driver chip AY-3-8112 went defunct. I exhausted all efforts in trying to locate a replacement, by contacting all your usual advertisers, and whoever they suggested.

The question is obvious, I suppose: do you know of anywhere that I may be able to obtain the AY-3-8112 chip, or a suitable replacement for same? Failing this, is it possible to modify the circuit in some way to use a different chip?

I am not very technically minded as far as design is concerned, but I am enthusiastic (and usually successful) in constructing many of your kits — including ALL of the early Playmaster Hi-Fi series.

You probably hear it often enough, but seriously, keep up the good work with your magazine (I'll pay more for postage IF I have to, too), as I have been reading and collecting this magazine now for around 30 years. Well done!

Gavin McLeod,
Comboyne, NSW

Comment: We don't know of a current source of the chip, Gavin, but perhaps one of the suppliers will see this letter and provide this information. We'll try to offer a substitute option, when time allows.

Amateur radio kits

In January/February 1990, *EA* published a long article on kits. Whilst some kits from these manufacturers may no longer be available, the article is still a good starting point for anybody wanting to get into kit construction.

As the Activities Officer for the Midland Amateur Radio Club, I plan to present a talk in November on the current state of play in the kit field. To this end, I was wondering if you could bring me up to date or perhaps put some of this letter in 'Letters to the Editor', as kit producers may wish to contribute to my planned talk and consequently bring me up to date.

Many thanks and 73's,
Dennis Fraser, VK3JHB,
PO Box 224, Kyneton, Vic. 3444

Westminister doorbell?

Would it be possible to consider a project for an electronic door bell using the traditional 'Westminster chimes'?

I am familiar with the October 1988 article, which is technically great. However, I feel there would be a big demand for the Westminister chimes, if this can be managed electronically.

R. Wilkins,
Chapel Hill, Qld.

Comment: We'll see what can be done, Mr Wilkins. It doesn't sound too difficult — but these things never turn out to be as easy as they sound.

Also had trouble

I would like to add my confirmation of the problems experienced by Mr Iain Whyte (*EA* June, 1992).

I have found that several projects published in electronics magazines are impossible to construct because the specified

[illegible]

(or alternative parts) are impossible to find in Australian electronics shops.

I have another complaint. Some dealers who advertise in electronics journals do not reply to letters, even though I always enclose a stamped addressed envelope for reply. I can quite understand that many young people would soon become disillusioned and frustrated and would be inclined to abandon electronics as a hobby.

Henry Morley,
Horseshoe Bay, Qld.

Comment: Like Mr Whyte, you don't say which magazine projects you've had trouble with, Henry. Hopefully not any of ours, because we go to a lot of trouble to check component availability.

Caller ID

I've just read Louis Challis in your April issue. In his CES report, he seems far more impressed by the prospect of 'caller identification' than I am.

'Caller identification' is itself misleading. What is provided is the number from which the incoming call was placed — which may not tell you who is calling, if the call is placed from anywhere except a home phone. Being able to reject a call without identification doesn't sound all that handy to me. Unless you recognise the number (as an enemy, or a mother-in-law), you have no idea whose call you are rejecting. Maybe it was a prank call, or a telemarketing call — but maybe it was *EA*, saying you had won one of their subscriber competitions.

As for good reasons NOT to transmit a calling ID, imagine the situation of a battered wife phoning home from a woman's refuge to try to find out if the children are still OK. Would she want the husband to find out whose phone she is using? Or someone calling one of the many 'help line' services for distressed persons, for drug abuse victims and so on. I can imagine a variety of people who have legitimate reasons not to want to provide details of their home phone.

Business has the most to gain from universal calling phone ID. I can see Domino Pizza greeting you by name on the third ring, and confirming that you want the usual delivery order — no time wasted getting an address or other details. I also see effective information gathering practices, if businesses can identify all their callers. You and I can expect to have some very accurately targeted advertising and junk mail. Somehow I don't find this prospect all that appealing.

I do hope there is some debate on this matter before we get the system all installed.

Eric Lindsay,
Faulconbridge, NSW ❖

EDITORIAL VIEWPOINT

Never any shortage of ideas for construction projects!

I don't know how many times I've been asked how we keep coming up with the ideas for our electronics construction projects. Generally this seems to be the first question I'm asked, whenever I meet any of our readers or someone who looks through the magazine even casually.

The funny thing is that coming up with ideas for *EA*'s projects has never been a problem, over the many decades we've been publishing. Quite the contrary, in fact — most of the time, we have more ideas than we can possibly ever develop!

Of course quite a few ideas come from you, our readers. Understandably, many of you write in or send us a fax with details of projects you'd like to see. These are all considered carefully, and if an idea seems both popular and promising, at least one of us adds it to our list of 'projects to work on'.

There's also lots of feedback from many of our advertisers — especially the firms who sell project kits and/or PC boards and other key components. The people in these firms have very good contact with project builders, and they soon get to hear which projects prove popular, which ones may have given difficulty and which other project designs people have expressed a need for.

The kit and PCB firms are also good at letting us know when existing and popular project designs may have become hard to build, due to parts being dropped by manufacturers or suppliers. So in many ways they form an excellent ideas-gathering network — for which we're very grateful.

And finally, there's ideas from our contributors and ourselves. Most of us are pretty steeped in the subject, and we're constantly reading magazines, application notes and other material from around the world. It's amazing how many ideas for projects are generated in this way alone, let alone the other sources.

In short, then, there's never *any* shortage of ideas for our construction projects. The only real problems are to find the time to develop the ideas into fully-fledged and tested designs, ready for publication — and then to find enough space in the magazine, to fit in all of the information *you* need to build them!

By the way *this* month, you'll find details of a new protection module for your expensive hifi speakers, developed by Rob Evans from the circuit he included in his very popular Pro Series One Amplifier. There's also the construction details for Tean Tan's flexible valve stereo amp and my own spectrum analyser adapter — plus a simple electronic thermometer from Peter Murtagh.

Next month we'll have another batch of projects, from either our own workbenches or those of our contributors. Electronics is such a constantly-changing and exciting field that I'm sure we'll *never* be short of ideas, for projects to keep you interested in building your own equipment.

Project building can be very satisfying, as well as allowing you to save a lot of money. If you haven't tried building anything as yet, I can warmly recommend it...

Jim Rowe

What's New in VIDEO and AUDIO

Lucasfilm Home THX audio processor

The new Lexicon CP-3 Digital Surround Processor is a Lucasfilm Home THX Audio system processor developed to reproduce the same audio experience of the finest motion picture theatres in the home environment.

Pioneered by the studios that have produced feature films like the Star Wars and Indiana Jones series, the THX system enables a home system to recreate the magic of effects as well as sounds that actually move with their visual sources. Under development since 1980, the THX system also permits the home theatre to reproduce the full dynamic range of a film's soundtrack.

Using Dolby Pro Logic to decode and 'steer' surround sounds to their proper locations, the THX system enhancements in the surround processor provide additional equalisation to achieve the proper sound balance in the home, as well as increased diffusion and envelopment of the surround sound.

Lexicon has been named by Lucasfilm to develop audio electronics for the Lucasfilm Home THX Audio system. The CP-3, the first product of this special collaboration is claimed to fully deliver the initial promise of the home theatre concept.

The CP-3 also includes sonic processing for the enhancement of any musical recording to restore the acoustics of the original performance environment, from a jazz club to a symphony hall, a cathedral to a giant rock arena.

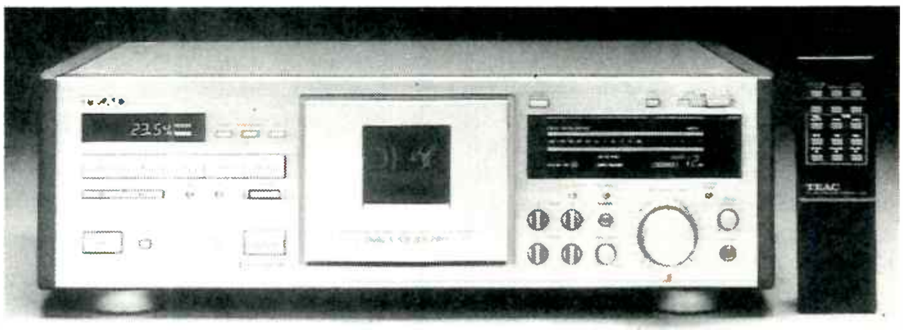
While the CP-3 is designed to fully complement the Home THX amplifiers and loudspeakers, it is fully compatible with virtually any audio equipment.

For further information circle 184 on the reader service coupon or contact Audio Insight, Unit B, 5 Skyline Place, Frenchs Forest 2086; phone (02) 975 3011.

JVC, Hughes making big screen HDTV

Japanese firm JVC is to develop a consumer version of a special high resolution, high brightness LCD colour TV projector originally developed by Hughes Aircraft in California. The Hughes projector is said to provide resolution higher than that for HDTV from an LCD panel 50mm wide, with a projected image that is easily viewed in normally lit rooms

Dolby-S cassette deck from Teac



The recent release by Dolby Laboratories of its new Dolby S noise reduction system allows analog cassette decks to meet the challenge of the digital recording format. Taking advantage of the new technology is Teac, which recently announced its first Dolby S, three head cassette deck to the Australian market.

The Teac V-8000S is one of the first cassette decks to incorporate Dolby S, in addition to the more familiar Dolby B, Dolby C and Dolby HX-Pro headroom extension system. Since the Dolby S circuitry has (at the time of printing) not yet been compressed into a single VLSI chip, its inclusion has imposed a significant premium in manufacturing costs. The Dolby S electronics in fact occupies a major part of the amplifier's circuit board.

Dolby S provides more than 20dB of noise reduction in the middle/high frequencies where tape hiss is most objectionable. It achieves this performance with technology that minimises the possibility of audible side effects. Dolby S has evolved from techniques used in the widely acclaimed Dolby SR (Spectral Recording) system. Unlike Dolby C, Dolby S also adds 10dB of noise reduction in the lower mid range where normally mid range 'blurring' or 'grundge' often detracts from the clarity and smoothness of the reproduced sound.

The V-8000S is designed with user adjustable bias, tape sensitivity and individual channel calibration controls are situated to the right of the centre mounted cassette well. This enables adjustment for the variations of tape formulation within the same tape type. It also incorporates a CD direct input, CD level check, electronic linear tape counter, ON/OFF display, CD synchro connect (when used with other Teac components) and an infra remote controller.

The V-8000S is covered by a five year parts and labour warranty, and is available at selected Teac dealers and department stores.

For further information circle 182 on the reader service card or contact Teac Australia, 106 Bay Street, Port Melbourne 3205; phone (03) 646 1753.

even when expanded to 10m across. The Hughes projector does not operate in the same manner as other LCD projectors, with a matrix of electrically-controlled pixel cells; instead it uses an optical system to focus an image from a CRT screen onto a special panel having an amorphous silicon layer, a dielectric mirror and an LCD layer sandwiched together between transparent electrodes.

The LCD panel then acts as a 'image light valve', modulating light from a high intensity lamp.

At present the projector requires three CRTs and three panels — one per primary colour — for full colour images, but Hughes is apparently working on an improved version which allows the three colour images to be time-multiplexed via a single panel. This uses direct electrical imaging on the LCD panel, using a wafer of single-crystal silicon.

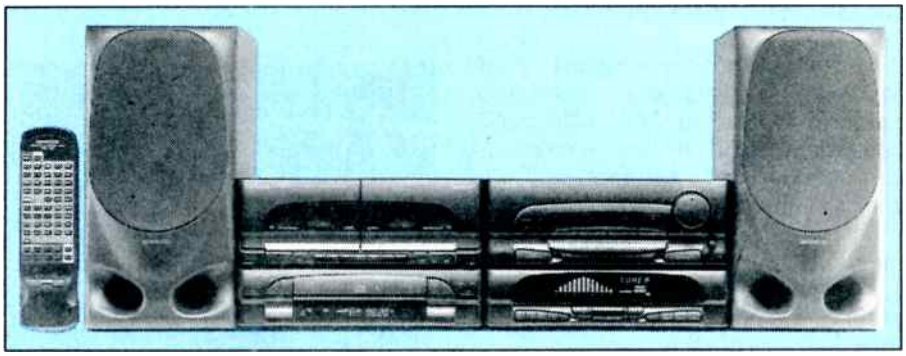
New mini system from Kenwood

Kenwood's new UD-300 mini component system is designed for home, office or study environments. It combines a 25 watts per channel amplifier/ seven band graphic equaliser/spectrum analyser, AM/FM stereo tuner/double cassette deck/CD player, and 45 watt, two way speakers. Special features include presence modes that can accentuate the critical mid-range frequencies for a more 'lively' musical ambience.

Additionally, the seven band graphic equaliser allows customised tailoring for different acoustical room environments with convenient memory presets for most often used settings. Versatile karaoke facilities include Mic Mixing and Hit Master function. The Hit Master function will effectively cancel the vocal portion of the music enabling the user to sing along with a 'karaoke' effect.

The heart of the UD-300 mini component system is the combined A-AB amplifier/graphic equaliser/spectrum analyser that offers 25+25 watts RMS. A motorised volume control is used, which is claimed to be superior to the noisier electrical type. The amplifier also offers Kenwood's NB (Natural Bass) circuit and a sub-woofer output.

The UD-300 is covered by Kenwood's three year parts and labour warranty and has a recommended retail price of $1299.



High quality speakers from Qld

Queensland loudspeaker manufacturer Star Acoustics, based on the Gold Coast, has released a range of locally made high quality speakers using a novel triangular prism-shaped enclosure which inhibits internal standing waves and also provides greater rigidity than conventional enclosures.

The systems all use hardwired crossover systems with very heavy gauge matched air-cored inductors and quality polypropylene capacitors.

Smallest system in the range is the Symphony, which uses a 125mm Focal midrange driver with a 25mm dome tweeter and sells for an RRP of $1698. Then comes the Dynamics, which has a 200mm woofer and a tweeter level control to allow balance adjustment for personal taste or to match the environment, and with an RRP of $1998.

Next in the range is the Concerto, in a floor-standing cabinet 1m high and with a 175mm bass-midrange driver and a kevlar inverted dome tweeter (RRP $2398). Top of the range is the Maestro system, which combines a 200mm polykevlar woofer, a 125mm neoflex midrange and a 30mm kevlar inverted dome tweeter in a 1200mm high three way phase-linear bass reflex system (RRP $7498).

Further information is available by circling 181 on the reader service card, or by contacting Star Acoustics, PO Box 158, Bond University, Gold Coast 4229; phone (075) 75 2704.

New Distributor for Celestion

Amber Technology has been appointed as the exclusive Australian distributor for Celestion International Ltd., of the UK, manufacturer of high performance loudspeaker systems and components.

Amber's professional audio division will distribute the extensive range of Celestion professional loudspeakers to the OEM, public address and retail music markets.

The complete Celestion range will also be marketed by Amber's network of specialised audio retailers.

'Pro Series' NiCad dischargers

For full capacity and longest working life, NiCad battery packs need to be deeply cycled. Often a discharger unit is required to ensure full discharging before the pack is re-charged. The new Keene Electronics 'Pro Series' of dischargers is designed to suit the NiCad packs used in Sony, JVC, Sanyo and Canon camcorders, and will discharge packs faster than the standard range while still cutting off accurately at the correct voltage of 0.9V per cell.

All models in the Pro Series range are covered by a three year warranty. They are available from VideoCam Accessories, PO Box 2000, Strawberry Hills 2012; phone (02) 698 1470. ❖

"I can see clearly, now!"

New Australian anti-glare process

An Australian firm has developed a new process for removing reflections from the screens of TV sets and computers, and independent tests have shown it to be surprisingly effective.

by BARRIE SMITH

I have always been intrigued by the conflicting demand that a computer screen is required to show high resolution displays, aided by little or no reflection from the screen's surface, while the domestic TV receiver has perpetually suffered from a mirror-like surface that (until recently) was also grossly curved. The combination has always made enjoyable TV viewing in the daytime something of a challenge.

While touring a TV receiver factory recently, I asked why the latter type of display had never received the same anti-reflection treatment afforded the computer screen. The answer was 'we're working on it'.

Well, it turns out that the factory itself (Panasonic) was not working on it — but a Brisbane company has in fact produced a treatment, and the latter company contacted me with information about their process.

Now many companies — like Panasonic — are considering its introduction to their products and assembly lines.

Computer screens at the offices of Brisbane City Council were given onsite treatment using the Vision-Clear formulation. Oscilloscopes, depth sounders, and many other displays can all benefit from the process.

Eye strain

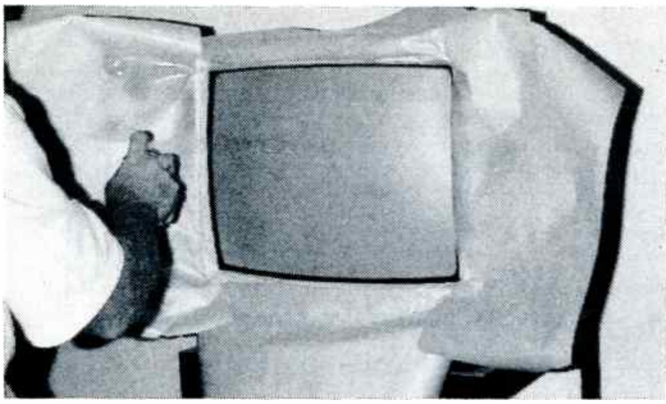
A poll quoted in the *Wall Street Journal* (19/11/91) revealed that 47% of office workers cited eye strain as a serious concern. More specifically, the American Optometric Association reported its members see more than eight million VDT-related eyestrain cases a year. Some 37% of these were directly attributable to factors such as screen glare and poor lighting or screen resolution.

In response, an optical coating company announced that sales of its anti glare filters have climbed by more than 50% in the last three years. Apple Computer, among others, uses an anti-glare treatment on its displays which scatters light and provides control of brightness and contrast.

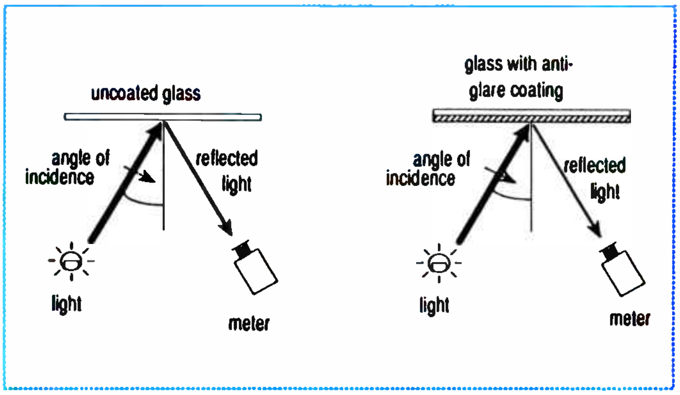
No figures are available on glare-induced eyestrain in home TV viewing. However, it is estimated there are currently nine million TV sets and two million computer screens within Australia — so an answer or cure for the problems of screen reflection would in itself be not only a technological advance in terms of eye health, but constitute a product of considerable commercial potential.

Brisbane company Vision-Clear Marketing, after handling a European anti-glare product, realised the potential of such a treatment. Due to supply and cost problems importation was ended, but steps were taken to develop a local process that would surpass it in effectiveness. This took place in the late 1980's, and was marketed in a limited fashion in Brisbane.

In the last year, redevelopment was undertaken to conform to changes in the propellants allowed to be used, under ozone protection requirements — and to adjust to changes in computer technol-



Onsite treatment of a domestic TV screen. An odour is given off but this has been minimised by adding a deodoriser to the Vision-Clear formulation.



The experimental set up used to compare the reflected light from glass which had not been coated, with that given the two kinds of Vision-Clear treatment.

ogy. Expenditure reached the vicinity of $150 - 200,000, due to the close parameters required in the manufacturing process.

Formally known as LC008 Clear Anti-Glare Aerosol Lacquer (Patent Pending) the product is supplied ready for use in an aerosol can.

The chemical content includes petroleum hydrocarbon, acetone, ester solvents, methyl iso-butyl ketone, alcohols, resins/plasticisers, nitrocellulose, surface treated silicon dioxide and other additives.

Two grades are manufactured — standard, for TV sets, and a grade for computer and similar displays which preserves the higher resolution of the latter screen.

LC008 can be used not only on TV/computer displays, but also digital readout panels, X-ray units, oscilloscopes, depth sounders, laptop screens, register and teller units. Units with non-glass screen surfaces are usually fitted with an acrylic laminate — the latter being treated with the coating so as to allow replacement — as the coating cannot be removed from this type of surface.

Once applied, its major advantage is that it allows the display screen to be placed virtually anywhere, without need for drawn curtains or closed blinds. Outside viewing is also possible.

The application process is reasonably simple, once the screen is cleaned and the screen surround masked. The coating is then simply sprayed on, as evenly as possible.

Approximately four to six screens/hour can be coated by one service person, dependent on the unit's location within the site and the number of service personnel used.

An odour is given off, but this has been reduced by adding a deodoriser to the product. Vision-Clear is non-toxic in the amount used, but applicators do use a surgical nose and mouth mask when coating a number of screens. The product is only available as a 'service supplied' product, mainly due to the demands of the application process.

Under normal use the life span is indefinite. While guaranteed for five years — under certain conditions — the coating can be damaged by scratching with a metal object or some solvent liquids. Cleaning is by means of a soft damp cloth.

Visually, the coating is matte. In most cases approximately 10% definition loss is experienced, but it is possible to reduce this to about 5%. The company claims an average person would have difficulty in determining the difference. Interestingly, the curvature of a coated screen does not substantially affect the degree of reflectivity...

Sample	Angle of Incidence	Reflected Luminance	Percentage Reflectance
Uncoated	10°	0.291	100
	20°	0.340	100
	45°	0.474	100
TV(N)-1	10°	0.012	4.1
	20°	0.020	5.9
	45°	0.023	4.9
TV(N)-2	10°	0.012	4.1
	20°	0.021	6.2
	45°	0.022	4.6
VDU(N)-1	10°	0.055	19.0
	20°	0.080	23.5
	45°	0.096	20.3
VDU(N)-2	10°	0.056	19.3
	20°	0.081	23.8
	45°	0.096	20.3

The results obtained by the Physics Department of Queensland's University of Technology are tabulated here. Note that the 'TV' formulation gives a higher degree of glare reduction than the 'VDU' formulation.

Independent tests

The company contracted the Physics Department of Queensland's University of Technology, to test the system. The results are enlightening.

The tests were conducted in the Physics Dept's Photometric Laboratory. Measurements were made by shining a standard incandescent light source onto

"I can see clearly, now!"

glass samples coated with the product. Light source colour temperature was 2850K (+/-50K). The illumination was 'coned' to a diameter of about 25mm — to concentrate the light source at a central point on the test samples.

The amount of reflected light was measured at differing angles of incidence, using a calibrated, spot reading light meter, in photopic response range and with a cosine adaptor attached.

Final assessment of the test results used the ratio of reflected light from the coated sample to that from the uncoated one, and the figure based on the degree of relative percentage reflectance.

The samples used were:

1. An uncoated, clear sheet of glass.
2. Glass sheet — TV (N) — coated with the TV formulation spray.
3. Another sheet of glass — VDU (N) — coated with the computer standard spray.

TV (N) refers to Television Neutral, VDU (N) refers to Visual Display Unit Neutral.)

Two same size samples of each of the glass pieces were supplied to the laboratory. Measurements were made at 10, 20 and 30 degrees of incidence. The results in the table can be interpreted by deducting the percentage reflectance figure from the TV (N) or VDU (N) from the uncoated sample, i.e., 100% - 4.1% = 95.9% effective reduction at 10 degrees.

It's worth noting the difference between reflectivity of the VDU (average 21%) and the TV samples (average 5.8%) — the latter being coated with the lower resolution standard spray.

Market potential

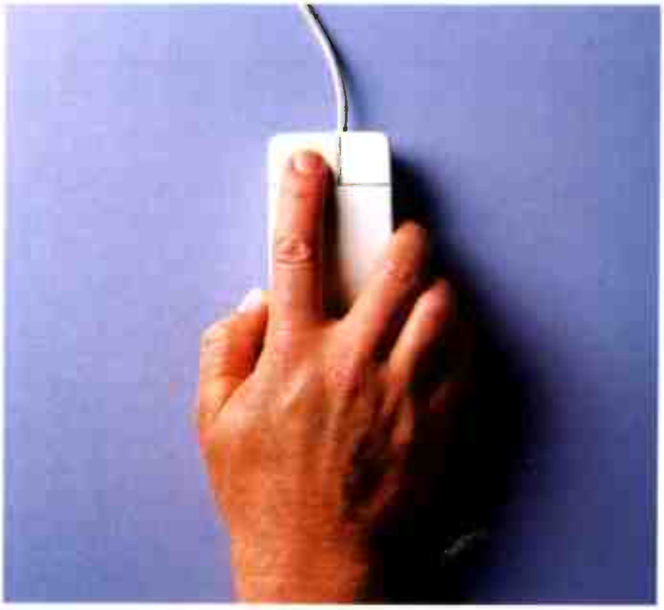
Obviously, with an installed base of millions of TV sets and computer screens, the Australian market looks most attractive. However, believing themselves to be 'on a good thing', the company is currently negotiating with a North American company for manufacturing, distribution and marketing. It is believed there is no substantial opposition product in that market. Talks are also being held with TV manufacturers and suppliers — Sharp, Sony, Panasonic and other majors — plus retail outlets.

The future for Vision-Clear is obviously looking 'bright' — with a low value of reflection! Further information is available from Vision-Clear, 4 Park Road, Milton Qld 4064; phone (07) 367 1602, fax (07) 367 0436. ❖


sonics

There are two ways to do your math.

Drag. Click-n-drag.

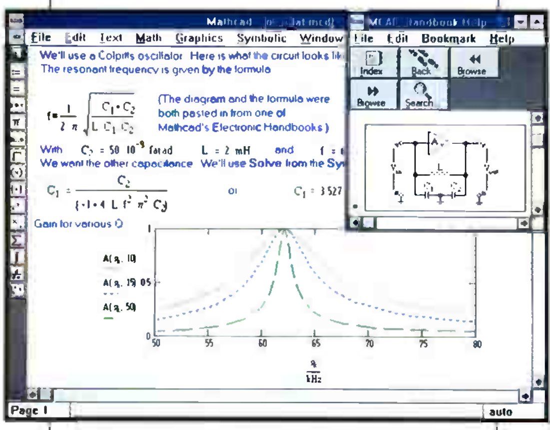


Solve problems fast with Mathcad 3.1.

Don't let calculations keep you from getting work done. Cruise through problems with the math package that's fast, all-purpose—and easy: Mathcad 3.1.

The one-step system.

Mathcad 3.1 is much more than just a number-cruncher. It's an integrated math



system that performs everything from addition to symbolics—easily and naturally. Because it works the way you think.

Just type your calculations anywhere on the screen—just like a scratch pad—and you're done. Mathcad does the calculating. Updates answers when a variable changes. Graphs in 2-D or 3-D. Even accepts bitmapped graphics.

A quick menu pick gives you full symbolic calculation capabilities. So you can do any integral, Taylor series, or infinite sum with click-n-drag simplicity.

Done calculating? Mathcad prints out presentation-quality documents complete with equations in real math notation.

NOW UNIX 3.1 AVAILABLE

Give your math a hand.

To help you work even faster, Mathcad 3.1 includes a Standard Electronic Handbook for instant access to hundreds of standard formulas, useful data, and commonly-used equations. Ready for interactive use, just click-n-paste them into your work. Without ever opening a reference book.

And now there are three new optional Electronic Handbooks,* created with the leading publishers of technical handbooks: The CRC Materials Science and Engineering Handbook, Machine Design and Analysis from McGraw-Hill, and the Mathcad Treasury of Methods and Formulas. Plus optional Applications Packs with modifiable templates for all major engineering and science fields.

PC MAGAZINE EDITORS' CHOICE
Mathcad 2.5
3-14-89 issue.
Best of '88
Best of '87

200,000 people already rely on it.

Mathcad's the best-selling math software because it gets results. Here's how:

- Easy to learn and use Microsoft® Windows or UNIX® interface
- Easy to use symbolic calculations
- Standard Electronic Handbook with hundreds of useful built-in solutions
- Optional Electronic Handbooks available
- Differentials, FFTs, cubic splines, matrices and more
- 2-D and 3-D graphics
- Presentation-quality documentation
- Optional Applications Packs with adaptable templates for Electrical, Mechanical, Civil and Chemical Engineering, Statistics, Advanced Math, and Numerical Methods
- PC DOS and Macintosh® versions also available

$20 demo disk.

For a Mathcad demo disk, or upgrade information, call (03) 866 1766 (or fax (03) 866 3318).

*Electronic Handbooks require Mathcad 3.1 and Microsoft Windows 3.0 (or higher) or UNIX.

Hearne Marketing Software
458 St. Kilda Rd, Unit 36, Melbourne 3004
Phone: (03) 866 1766
Fax: (03) 866 3318

The answer is Mathcad®

READER INFO NO. 43

Hearne Marketing Software, 458 St. Kilda Rd, Unit 36, Melbourne 3004 • Phone (03) 866 1766 • Fax: (03) 866 3318
MathSoft, Inc., 201 Broadway, Cambridge, MA 02139 USA • Phone: 617-577-1017 • Fax: 617-577-8829


THE PHILIPS DCC900 DIGITAL CASSETTE RECORDER

Early next year, Philips is planning the Australian release of recorders and software for its new DCC (digital compact cassette) system. However this month Louis Challis had the opportunity to run his instruments and educated ears over the first production sample to reach our shores, of the new DCC900 'high end' DCC recorder. So here's what you can expect, around February or March...

As I sit here listening to Charles Dutoit conducting the Montreal Symphony Orchestra in their rendition of Bizet's 'L'-Arlesienne Suites', I have a strange feeling of *deja vu*. My memories slip back to the year 1955, for it was then as I clearly recall, that I purchased my first 10" 33rpm long play recording. The title was, as you may well have guessed, Bizet's 'L'Arlesienne Suites' — the only difference being the conductor (Sir John Barbirolli) and the orchestra (the famed Halle Orchestra).

So it is indeed fitting that the first pre-recorded Digital Compact Cassette (DCC) that I should play on the new Philips DCC900 Recorder should be that very same piece of music which initiated me to the real joy of LP records, and once again stirs new emotions as it heralds yet another monumental change in the way that you and I will listen to our music.

It is little more than 18 months since Philips announced its auspicious decision to market DCC. In the intervening period, they have taken this bold and revolutionary new concept from what I originally observed by way of far from perfect prototypes, all the way through to the initial run of production machines which they initially promised would be in Australian stores before Christmas. *(Editor's Note: Now it looks like February or March, before there will be enough production to supply Australia.)*

The DCC system has now been developed to the point where the very first production machine to reach *EA* for review is an extremely sophisticated and powerful competitor for DAT, which it will eclipse — solely because it is has the support of the software companies, which are providing the pre-recorded media so critical for the success of this kind of product.

Of course, most of us in the business realise that DCC still faces a very real threat from the equally potent Sony Mini Disc system. And it may yet face an ongoing healthy competition from the original Philips Compact Cassette, (both in the pre-recorded and blank format), which it will only slowly displace in the market place.

But what *is* DCC, and in what way does it pose a threat to the other systems? More importantly, why can't all these different systems live together in harmony?

The background

For answers to such questions, we really have to go back a full century in time to the end of 1880's and the beginning of the 1890's.

It was then that Thomas Alva Edison developed his cylindrical records, and dominated that brand-new market for

most of and certainly the early part, of the next 20 years.

At almost the same time as Edison developed his wonderful invention (within a year, in fact), a most unlikely inventor by the name of Emile Berliner invented what was then perceived to be an equally unlikely, but most competitive product: the now famous disc recording system, which only toy manufacturers had any real interest in until just before the turn of the century.

Initially Emile Berliner had a tough time competing with Edison, but within a decade their respective positions had reversed and the public, (and the licensees manufacturing their respective products) had rejected the Edison 'rolls' in preference to the Berliner disc recordings.

There were obviously a number of reasons for that rejection, but the most important then, and what I perceive to be equally important today, was that nasty economic factor. At the time it was the cost of manufacturing the Edison rolls. Berliner's disc recordings could be stamped out in the twinkling of an eye, and mass-produced far more cheaply than could the Edison rolls. In much the same way the Berliner record players did not require the fine and careful tolerances of the mechanical lead screws, on which each Edison reproducer was entirely dependant. The result is now history, and the public had voted for the better and more practical system, with their money.

As I see it, in the end the public knows what it wants, and although it is often fickle and obviously nurtured by advertising hype, it generally sees through the fog of blarney in the end and comes to its own intuitive and/or considered opinion.

Now there are very potent and similar parallels that may yet be drawn in the next year or so, between the Philips DCC system and the Sony Mini Disc system. However those issues and a discussion in depth is more appropriate in a later review, and particularly when it is backed by all the pertinent facts.

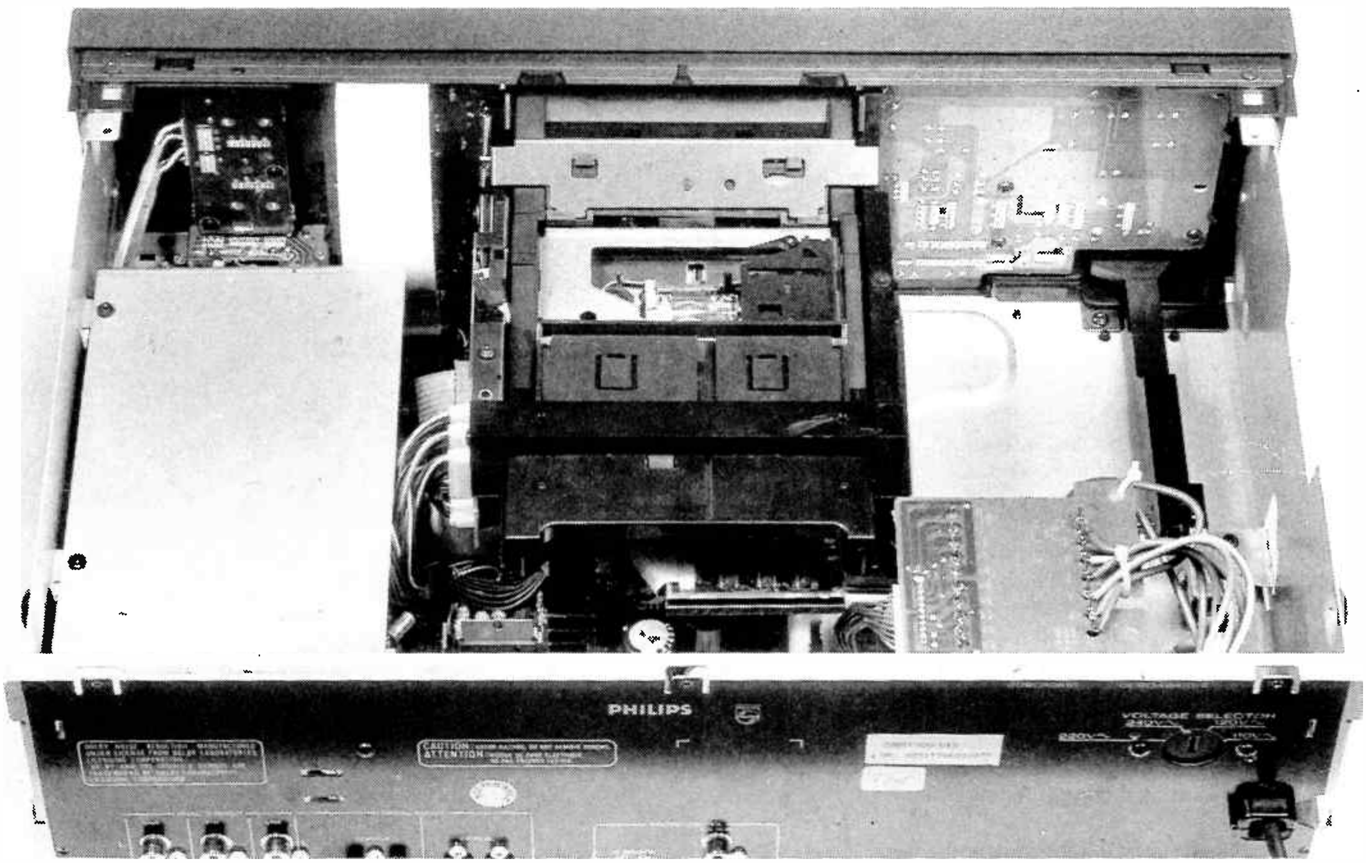
At the end of World War II, the wonderful German invention of magnetic tape recording took the public by storm, as it gave those of us who could afford it the opportunity to record what we wanted to, when we wanted to. But there were plenty of vexing user problems with the original reel-to-reel tapes and recorders, which Philips understood only too well, and were taken into good account when they developed the Compact Cassette system in 1963.

Now although Philips had invented the concept, and controlled almost every aspect of its subsequent use, they inexplicably extracted no royalties from any of the subsequent recording equipment or blank compact cassette manufacturers. Their only requirement was that the users should strictly conform to their (Philips) technical standards in all respects.

Very laudable, you may think! Well yes, it was — except that by so doing, they missed out on what I would guess to be somewhere around $5 billion in royalties. Which even nowadays can't really be scoffed at — particularly if you look at Philips' published global profit and loss balances, for the last few years.

When Philips and Sony developed what I perceive to be the most important hifi-related invention of the 80's, namely the CD, the accountants in their respective firms presumably whispered in their respective directors' ears quite early in the piece, and as a result the name of the game became 'Licensing Royalties'. And this policy has been quite evident ever since. So nowadays it's not how many *you* sell that matters, but rather how many *everybody* sells that determines how well you do in the end.

Needless to say, after investing countless millions of dollars in the development of DCC, (once more all by themselves), the accountants and top management at Philips decided to apply the same formula. The problem was that to get DCC accepted by the rest of the world, Philips needed some other strong players in its team to convince everybody else that they had the 'muscles to Win'.



Inside the DCC900. Most of the critical circuitry is hidden under the shield plate on the left, although some of the digital processing circuitry is visible on a small PC board just at the back of the central transport deck.

As it happens, Sony wasn't prepared to be in the front line of the Philips team, as they earnestly believed that their own Mini Disc had more pluses and that it would eventually become the preferred system — or put more bluntly, the system that the public is going to vote for. So when Sony would not join the team, Philips did a deal with Matsushita, Sony's arch rivals, and in exchange for some very attractive financial inducements, Matsushita and its affiliates fronted up behind the captain, so that the heavies were there to support in the ruck.

The new cassettes

Now that you understand the background, it's about time we talked a bit more about the product, namely DCC. Philips decided to integrate the best features of the tried and proven compact cassette into an entirely new digital system. So DCC uses a cartridge which is a cross between a standard compact cassette (with almost identical external dimensions), and the key packaging elements of a 3.5" floppy disc (which as it happens was developed by Sony). That particular Sony related design element is the neat dust-exclusion shutter — as dust happens to be one of the most potent and dangerous enemies that the new Digital Compact Cassettes will face.

As access and spooling is all controlled from the one side, the other face of the cassette is perfect for fancy artwork, and of course that's precisely what they have elected to provide. The design also picks up the detection tab concepts of the compact cassette by way of a series of indents (or holes), so that the DCC recorder/player knows how much tape is on the cassette.

Because of the unusual high frequency data requirements, the tape is a video format chrome or cobalt doped ferro-oxide coating, whose thickness is less than four microns (um) and whose width is a conventional 3.76mm. Each tape on the cassette has an A and B side, but instead of turning the cassette over, the heads rotate to provide access to both halves of that miniscule 3.76mm wide coating.

The digital signal is recorded on eight parallel tracks, each of which is only 185um wide — out of which only a tiny 70um is actually scanned during playback. The difference of 115um is actually a safety factor to reduce the sensitivity to azimuth error. There is a ninth track on each side of the tape, on which (subcoded) information relating to the data display and related control functions are recorded.

With such small track widths, and with an obvious mass production requirement, conventional recording heads were obviously out. The designers had to develop cost-effective recording and playback heads with really subminiature dimensions, suitable for this application. That was obviously no mean feat.

The DCC heads then had to be similarly matched by a pair of compatible analog playback heads, specially designed for the standard compact cassette and which could also be rotatable so as to cover both sides of a standard compact cassette — as these would need to be played for some time in to the future.

Philips met both needs by drawing upon its experience in transistor and IC manufacturing techniques, and using thin film technology to produce two entirely different types of recording and playback heads. Very little has yet been said about the integrated recording head technology, which will be worthy of an article in its own right. By contrast, the magneto-resistive playback heads are at least described in general terms in Philips' preliminary literature.

With a system as complex as this, one of the most sensitive issues which the designers had to address was the problem of tape alignment, as any errors in azimuth or track alignment would quickly destabilise things and result in total failure of what would otherwise have been a well conceived system. The tape alignment techniques which they finally adopted were innovative and relatively simple. The head incorporates a fixed azimuth tape guide, through which the upper edge of the tape is gently forced against a (hardened) reference surface, to ensure that the alignment is positive.

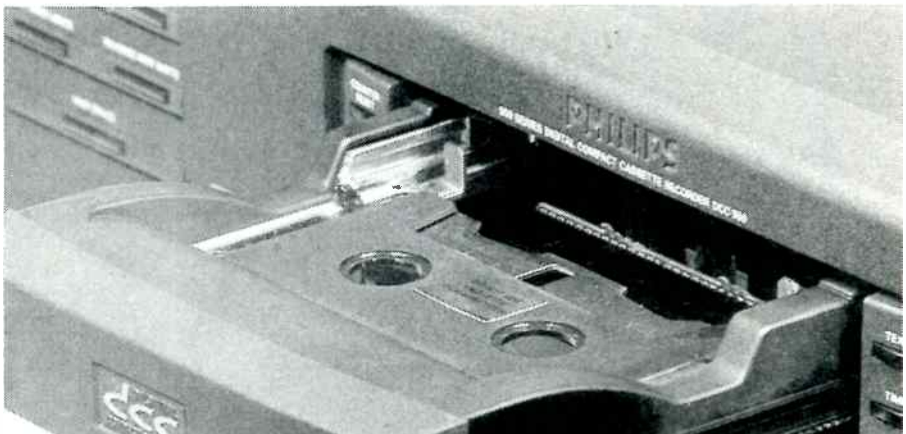
The edge of the tape is forced against the guide by using a sloped lower face at the base of the head assembly. The resulting curvature of the tape forces it up against the upper reference surface, and the curvature of the tape stiffens the magnetic surface and simultaneously forces it against the heads — so that no complicated pressure pads are needed. Provided the edges of the tape have been cleanly and neatly slit, then the alignment is positive and nigh-on perfect.

Compression needed

As you may well realise, even with eight parallel data tracks, it's not possible to encode linearly two high quality audio channels, with data being sampled at anywhere near the 32kHz, 44.1kHz or 48kHz sampling frequencies for which this system has been designed. When you add the complication of error correction data, and other special requirements which this system uniquely imposes, something has to be discarded as this format simply can't cope with this amount of data.

Philips realised this very early in the piece, and called in their own acoustical consultants, who developed the 'Precision Adaptive Sub-Code' (PASC) digital coding and compression system.

The basic underlying concept behind this PASC coding is that the audible frequency spectrum with which we hear may be divided in to a series of critical bands, and each of those individual bandwidths can appropriately *mask* the sound energy in adjacent bands provided the level of the dominant band is appropriately greater than the level in the adjacent band. In addition there are a



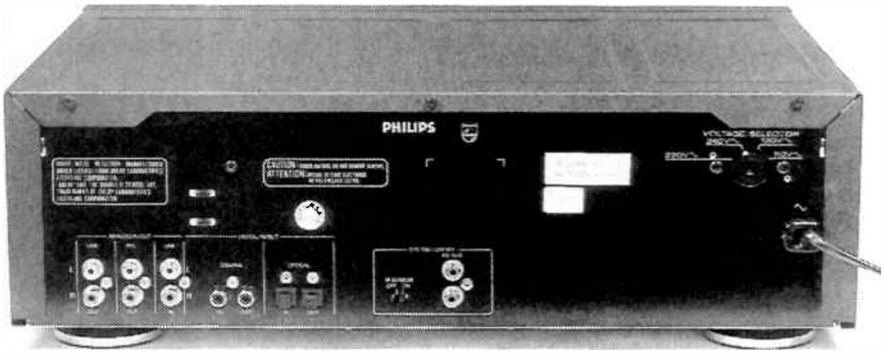
The recorder has a roll-out tray rather like a CD player. The DCC cassette is located accurately in the tray by suitable guides.

range of frequencies and related sound levels, defined by a curve which is technically known as the 'normal threshold of hearing', below which most people (apart from a few), cannot normally hear.

The acousticians at Philips realised that if one were prepared to go far enough in making use of the principles of masking in a sensible and systematic manner, and simultaneously adopt the principle that sound levels below the threshold of hearing can similarly be excised, then you could cut down the data to be recorded by more than 75%, without the listener being aware of this deletion.

Of course that's exactly what they did. And as I have proven to myself in much the same way that you will soon be able to prove to yourselves, you just don't hear any difference. The reason being that the PASC system expeditiously calculates the thresholds of dynamic audible perception during its analysis and signal encoding process, so that the encoded data requires less than 25% of the data bit rate capacity of a conventional PCM (Pulse Code Modulation) system.

Yes, this is certainly 'cheating', but I can assure you that it is nonetheless aurally legitimate — and more importantly, it works! This was virtually the only way that Philips could make eight parallel heads encode or decode the digital data and still retain the same critical tape speed of 4.76cm/s — and hence the same tape playing times as analog compact cassettes.



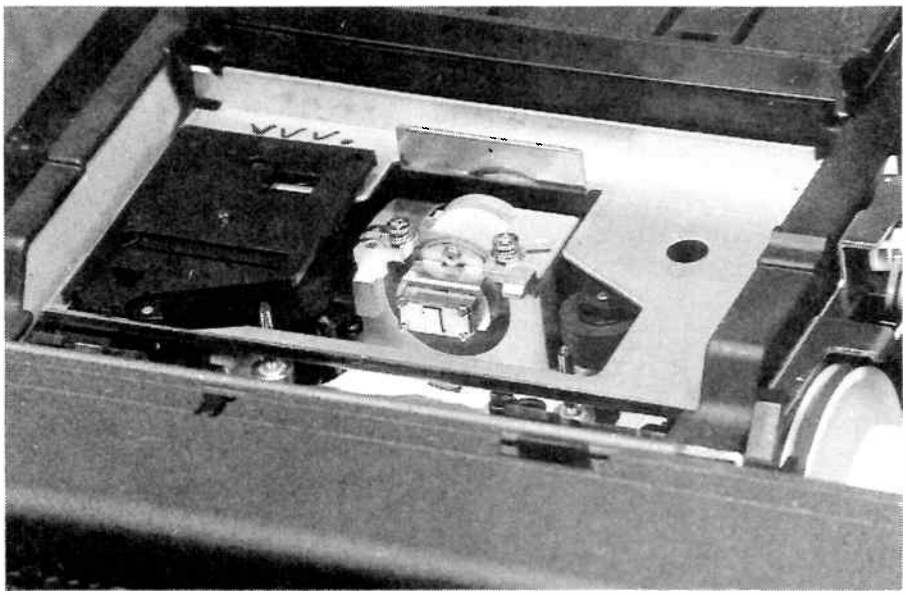
The rear panel has the expected array of input and output connectors — plus a few extras. These include variable analog outputs as well as fixed, both coaxial and optical digital inputs and outputs, and two ESI remote control connectors.

At last, the DCC900

The DCC900 is the first of the new DCC recorders, and as a high-end model it is radically different in its visual and functional concepts as well as in its performance potential when compared to the simple compact cassette recorders with which we've become so familiar over the last 25 years.

The most obvious difference is the number of new control functions which it incorporates. The most significant of these are located on the left hand side of the front panel, identified by the label 'Marker Controls'. There are six of these pushbuttons, in two groupings, which provide similar functions to those which have been developed for the DAT system. These include an Auto Start Marker, which may be selected on or off, and a Start Marker Write for manually recording a start marker at the start of each new track of music.

Then there's the Renumber button, for checking through the complete tape and correcting those numbers which may be out of sequence. The residual marker controls relate to the Auto Reverse Mode and these include the Next Marker Write, for writing the next marker in sequence; and Reverse Marker Write, for writing a reversing marker so that the tape will reverse at that point; and lastly Marker Erase, for erasing a marker at that specific location.



A close up shot with the recorder's cover off, showing the special thin-film head assembly. This rotates through 180 degrees to record/play the second half of a tape, removing the need to turn over the cassette.

If these controls and their descriptions appear somewhat alien and an unnecessary complication, let me re-assure you that they are only required if you intend to carry out your own recording and you wish to provide the same flexibility in terms of rapidly finding individual tracks, in precisely the same way that you are able to with pre-recorded software.

The average older person, who is less skilled at handling new equipment of this type, will more than likely purchase pre- recorded cassettes and so avoid the need to master a new technology with its associated new language. (This has been the trend in America with such equipment, and I have no doubt it will prove so in Australia).

Below the marker controls are the main power switches, the optional timer switches and a Dolby switch, through which Dolby B and C may be selected when playing standard analog cassettes.

On the right-hand side of the panel there is a reasonably large and appropriately labelled pushbutton for opening and closing the cassette loading tray, adjacent to which is a large recording level (volume) control, which is sensibly placed directly above a smaller balance control.

Adjacent to these controls is the input selector switch, by means of which you select conventional analog inputs, digital inputs or optical inputs from external line inputs — which would typically come from a CD player, DAT recorder, CDV player, FM radio or whatever.

On the two outer and upper edges of the recording tray, there are four pushbuttons. These respectively provide Counter Reset for resetting the tape counter; a Repeat button, which has three modes which are cyclically selected and which allows you to repeat the current track, repeat all tracks, or to disable the func-

tion; a button labelled Text which allows you to display the album's title, track title, the artist's name, the total number of tracks on the tape, and the time into the tape (by sequentially activating the button so that the display identifies itself and then provides the generally abbreviated text identification); and the Time button, through which you can select the different time modes provided — which are respectively absolute time, track time, remaining time and the normal counter mode which is presented directly in seconds.

At the bottom of the deck a shallow sloping panel incorporates the normal tape recorder playback controls, as well as record function controls. As I noted, there are some unusual record controls, the first of which is Append, which searches for a recording position on the tape, and which when finally found, then activates the Recording Pause mode.

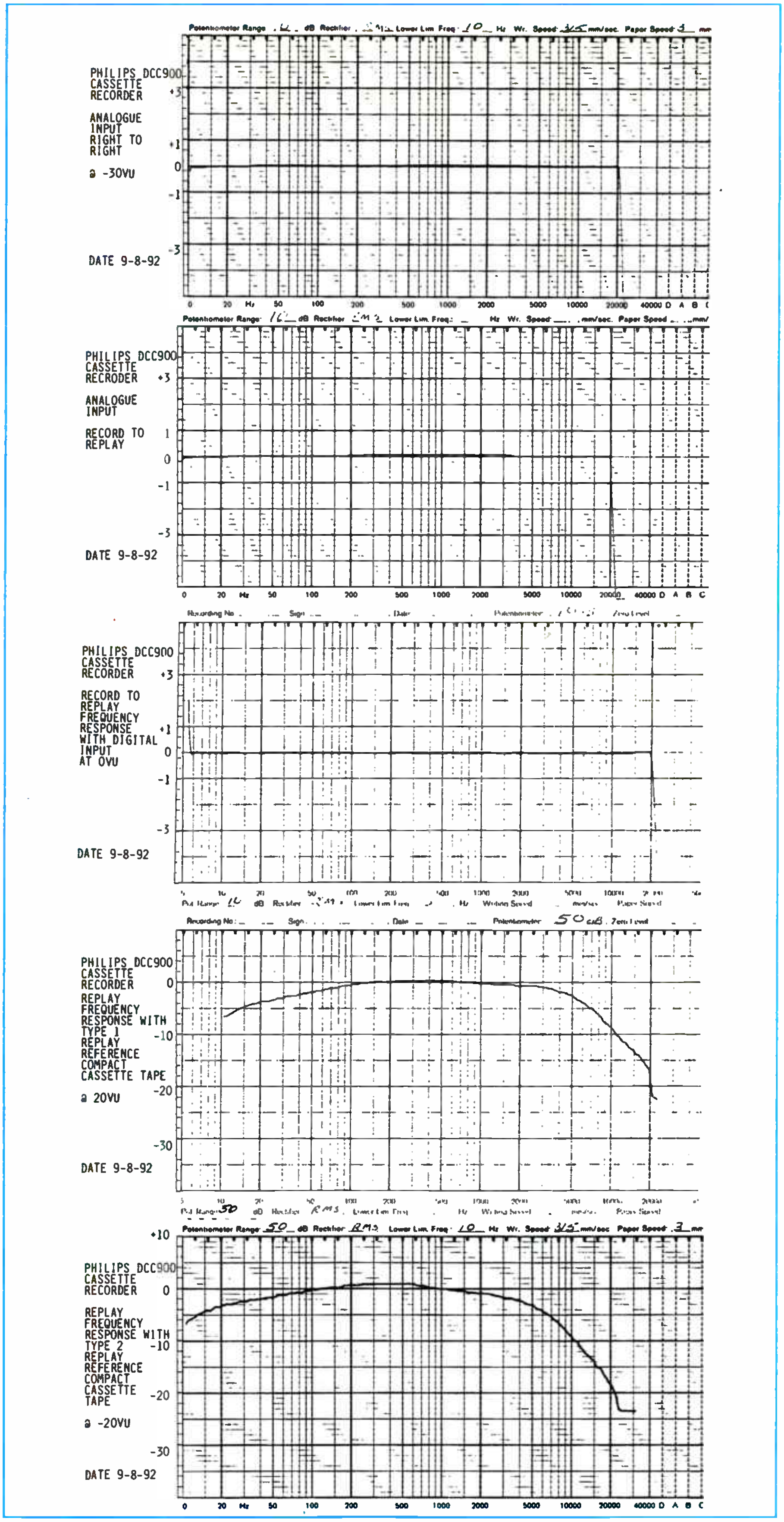
The time to find this position on the track was significantly longer than I would have expected (or would have liked), and as I soon discovered, the recording button can only be activated after you have selected and activated the Append switch, which was a trifle confusing at first. Two other conventional controls provided include a Record Mute, for recording silent passages, and last but not least a CD Sync switch, which facilitates automated and synchronised recording from your CD player — provided it has a matching ESI bus socket and control circuitry (about which I will have more to say later).

In the middle of the recording tray is an extremely comprehensive and well conceived multi-coloured fluorescent display, which formats its peak reading bar-graph type meters so as to conform to the tape format which has been loaded.

Thus by way of example, in the DCC mode the recording display has its top level set to zero VU, above which the red overload light is rapidly activated — as unlike a conventional analog compact cassette, DCC will not tolerate excursions beyond that level. When a conventional compact cassette is loaded however, the DCC900 immediately recognises the change in format, and the display has the zero VU displaced down by 10VU points to the left. In this mode the display's top level changes to +10VU, in conformity with normal compact cassette practice.

The only other controls on the front panel are the headphone volume control and a 6.5mm stereo socket for headphones on one side, and a somewhat innocuous infra-red detector for the excellent remote control with which the DCC900 is supplied, on the other.

On the back panel there are 10 coaxial



The main response plots obtained for the DCC 900. The three uppermost curves show the excellent digital record/play response, with both analog and digital inputs, while the lower curves show the rather disappointing analog performance.

Measured Performance Of The Dcc Digital Compact Cassette Recorder - Model No.DCC 900 Serial No. MZ 01920601087

1. Frequency Response

Record to Replay	Digital input	5Hz to 20kHz +/- 0.1dB
	Analog input	2Hz to 22kHz +/- 0.2dB

2. Linearity
Record to Replay at (1kHz)

Nominal Level	Left Output	Right Output
0dB	0.0	0.0
-1.0	-1.0	-1.0
-3.0	-2.9	-2.9
-6.0	-5.9	-5.9
-10.0	-9.9	-9.9
-20.0	-20.0	-20.0
-30.0	-29.9	-29.9
-40.0	-39.9	-39.9
-50.0	-51.2	-49.9
-60.0	-60.3	-61.2
-70.0	-69.9	-69.4
-80.59	-80.4	-89.3
-85.24	-83.8	-84.7
-89.46	-89.0	-89.7

3. Channel Separation

Frequency	Right into Left dB	Left into Right dB
100Hz	72	70
1kHz	76	73
10kHz	70	68

4. Distortion (@ 1kHz)

Level	2nd	3rd	4th	5th	THD%
0	-87.2	-103.0	-	-111.5	0.0044
-10	-89.2	-	-	-	0.0039
-30	-	-80.4	-	-	0.0096
-40	-71.4	-73.2	-72.9	-75.6	0.045
-50	-	-61.7	-64.9	-62.9	0.112
-60	-57.4	-	-	-48.0	0.42
-70	-	-40.4	-52.6	-45.5	1.12
-80	-39.8	-38.9	-37.7	-35.0	2.7
-85.24	-37.5	-27.5	-35.7	-20.1	11.0
-89.46	-	-	-26.4	-13.9	20.0
-91.24	-23.2	-8.9	-19.2	-13.9	43.0

5. Replay Frequency Response with Standard Compact Cassette.

Type 1 Tape 30Hz to 5kHz + 0 -3dB
Type 2 Tape 40Hz to 5kHz + 0 -3dB

sockets, plus two optical connections, which are an unusually large number of connectors for a consumer-orientated tape recorder. These include a pair of variable outputs (whose output level is controlled by the remote control), two outputs with fixed level, a pair of line input sockets, a coaxial digital input socket and a matching coaxial digital output socket to serve a digital amplifier or other suitably configured equipment. The two optical sockets are designed for connection to digital equipment such as CD's, DAT's, CDV's, or satellite tuners for input, or conversely to a digital amplifier for the digital output.

Last but not least are two sockets, through which the ESI (or Enhanced System Intelligence) remote control may be connected. This is in effect a somewhat contradictory feature, as the designers have elected to make it easier for you to automatically record tapes from your CD player or other equipment with what would be best described as 'one step, two switch functional control' — so that you can produce perfect tapes without even the need to adjust your volume controls, and thereby have perfect tapes each time.

This approach is even more simple than you think, in that all the relevant coding information is automatically transferred to the tape; you don't have to even mark your start and finish ID's.

The inside of the unit is very solidly constructed — a hallmark of Philips' conservative design philosophy — and the printed circuits are loaded with LSI and conventional IC chips. I anticipate that the second generation of DCC recorders will use significantly fewer and I suspect significantly larger chips, to simplify the electronics design.

Objective testing

Having whetted my appetite, I proceeded to put the first DCC recorder to reach Australia through its paces. My first and most critical observation was the almost unbelievably flat and broad frequency response that the DCC component of the recorder displayed during its record to replay frequency response evaluation.

This performance betters any DAT recorder that I have yet reviewed, and is undoubtedly an essential feature if Philips and its supporters are to convince the

[illegible]

purists that even if they are losing some data (which they can't hear), then they aren't going to lose any of the data that they *can* hear.

I repeated the evaluation using the digital input with data taken from a number of our CD test discs, and not surprisingly I found that the record/replay performance by means of this input source was equally good.

Having excited myself with the superb record-replay response of the DCC900, I thought that it would be a good time to determine whether the linearity would prove to be as good — and also what the signal to noise ratio would be like. Well, the linearity proved to be good — almost as good as some of the best CD players, but not quite as good as the latest and best DAT's, nor the professional CD players and recorders, which obviously have the edge when playing this critical numbers game.

The signal to noise ratio also turned out to be good, with a genuine 94dB(A) performance. This is truly excellent, when you consider how much data must have been excised and modified in the intervening PASC data encoding process.

It was then that I thought that I should look at the recorder's abilities when it comes to replaying conventional analog compact cassettes. I loaded two reference replay cassettes, and to my surprise, the performance was not nearly as good as I would have liked — nor frankly would I have expected, when reviewing a piece of equipment that is going to sell for approximately $1400.

The frequency response was modest to poor, exhibiting a high end response that was comparable to a cheap compact cassette recorder in your car, or a cheap 'boom box' which you can pick up for $200. The thought struck me: is Philips trying to uplift the new medium in the public's estimation, by offering a reduced performance from the old medium? Perish the thought — Philips wouldn't be so sneaky! Anyway, if they are, I would suggest that they reassess this position. This is not the way to advance the new medium, by sticking daggers in the back of the old.

I progressed to evaluations of channel separation, which were excellent but not superb — although I acknowledge they are more than good enough for home recording. I then evaluated the DCC's record to replay distortion characteristics, which are superb at the top of the range, and more than adequate down to - 70dB (which puts it on a par with the conventional compact cassette) and rapidly approach the same high levels as a conventional CD player, once you go below the -70dB point.

I was in such a hurry to take the player home to write this review that I forgot to check out the wow and flutter figures. For this I have metaphorically kicked myself afterwards, but it was too late because I only had the system for the weekend.

Listening tests

I must admit in the short time that I had the DCC900 I had a lot of fun, for although I complained loudly about its quirks and new features which took some getting used to, the music that it produced is exemplary, and the few pre-recorded tapes provided were good to excellent — although I suspect poorly selected to display the best features of the medium.

I was not fazed by this problem, and decided to record my own tapes using my own material so that I could carry out the type of A-B checks and comparisons which are essential. Here again I drew on the resources of my external support group, who have displayed critical and objective capabilities which I suspect are better than my own.

The first tape we recorded was of soprano Kathleen Battle combined with trumpeter Wynton Marsalis in *Baroque Duet* (Sony Classical SK 46672). This is a truly outstanding disc, making it more than suitable for this task.

We carefully A-B'd the disc with the tape, and I noted with amusement that nobody in the test group could tell the difference between the original and the tape copy — no matter how hard they tried. Kathleen Battle's beautiful voice is a particularly good reference source for comparison, as is Wynton Marsalis' trumpet, yet there was absolutely no audible or detectable difference between the two sources.

I progressed to more conventional pieces of piano with orchestra, featuring Yefim Bronfman and Esa-Pekka Slonen in Rachmaninov's Piano Concertos No.2 and 3 (Sony Classical SKJ47183). This particular rendition displays truly passionate playing, matched by superb recording techniques.

Once again in A-B testing we just could not pick the difference between the original CD version and the DCC tape copy. In point of fact half of the group were convinced that the CD was the tape, and that the tape was the CD — and they tried very hard.

The last disc that I used for A-B comparisons was a relatively unusual disc featuring the Robert Hohner Percussion Ensemble, in a disc entitled *Different Strokes* (Digital Music Products DMP CD 485, distributed by PC Audio in Brisbane). The broad-band music and data contained on this disc provides extremely difficult signal content for any tape recording medium, and although it may not satisfy all tastes, is nonetheless as interesting and novel as it is suitable for comparative testing speakers or tape recorders.

Again, as hard as we tried, we simply could not pick the difference between the original and the tape copy. As a result of this we firmed up our view that the DCC900 will be extremely hard to beat.

For the heck of it, we then took a Nakamichi Dragon (which is admittedly five years old), and repeated the exercise with two of the three test discs. Although this was a somewhat unusual approach, what we found was that if you have a top of the line analog cassette recorder using the best metal tapes (which is what we did), the differences in record to replay performance between it and a DCC are neither as wide nor as marked as either you or we may have expected.

Although we proved that DCC is better, we still formed the view that there is still plenty of life and considerable mileage left in conventional analog cassette recorders, particularly where the recorders are in the upper quartile of current technology.

Summary

Based on my brief and somewhat rushed assessment, I am now convinced that DCC offers a direct path through which the average purchaser can achieve higher home recording fidelity without necessarily having to dig too deeply into their pockets. Having purchased one of the new recorders, he or she will be able to purchase much better quality pre-recorded tapes than have been previously available, and derive a direct and obvious benefit.

Notwithstanding this obvious advantage, I suspect that it won't necessarily be the excellent fidelity and frequency response of DCC which will determine its long-term success or failure. This may well hinge upon ergonomic design features, and in particular the functional operating time — including the delays in operating the record mode and searching for specific tracks.

It's possible that these delays may alienate users, because the public has now become used to the convenience and speed of operation of the ubiquitous CD. The degree to which we have come to expect this responsiveness and speed may well determine whether DCC ultimately gets the 'thumbs up' or the 'thumbs down', in the marketplace.

The Philips DCC900 recorder has a width of 440mm, a height of 150mm and a depth of 335mm. It weighs 9kg, and present indications are that when released, it will have an RRP of $1400.

Our thanks to Philips Australia for the opportunity to review the advance sample machine. ❖

[illegible]

New Product Range Release

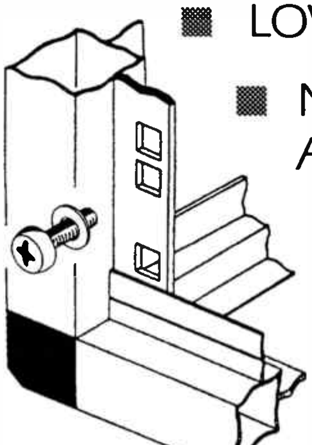
19inch MODULAR EQUIPMENT RACK FRAMES AND ACCESSORIES

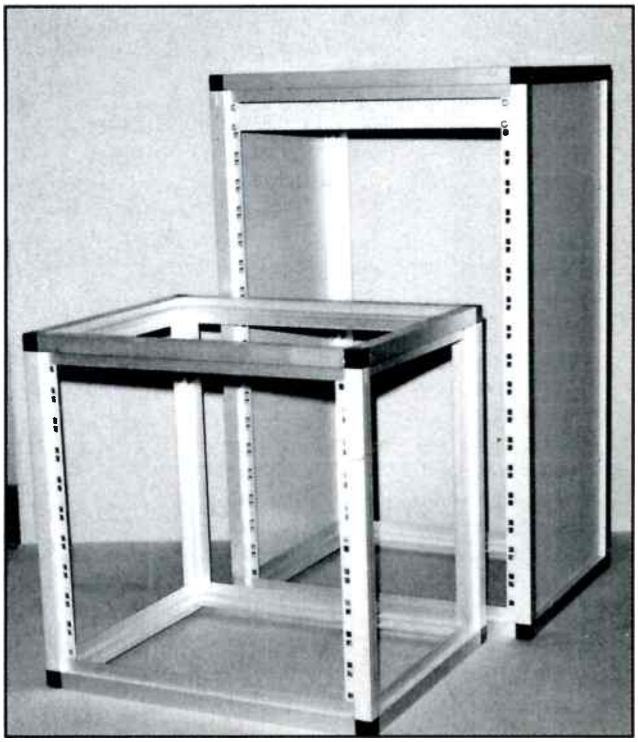
ZIP-RACK 'TYPE 46'

46cm – 460mm DEEP

OFFERING

- EXTRA SIZES
- MORE ACCESSORIES
- LOWER PRICES
- NATURAL or BLACK ANODISED FRAMES
- FOREST GREY or BLACK TEXTURE COVER FINISHES





READER INFO NO. 6

THE UNIQUE ZIP-RACK DESIGN

SIMPLE, FAST & EFFECTIVE THATS ZIP-RACK

Twelve lengths of **ZIP-RACK** hollow section aluminium extrusion are interconnected using black ABS plastic corner connectors. This requires only a rubber mallet or similar tool. The assembly is self aligning and can be further strengthened by 'pop' riviting the overlapping flanges at each corner.

TYPE 46 RACK DATA: RACK WIDTH 540mm. RACK DEPTH 460mm. 1U (RACK UNIT) =44.45mm OR 1 3/4". FOR EQUIPMENT/PANEL CAPACITY DEDUCT 90mm FROM TOTAL RACK HEIGHT

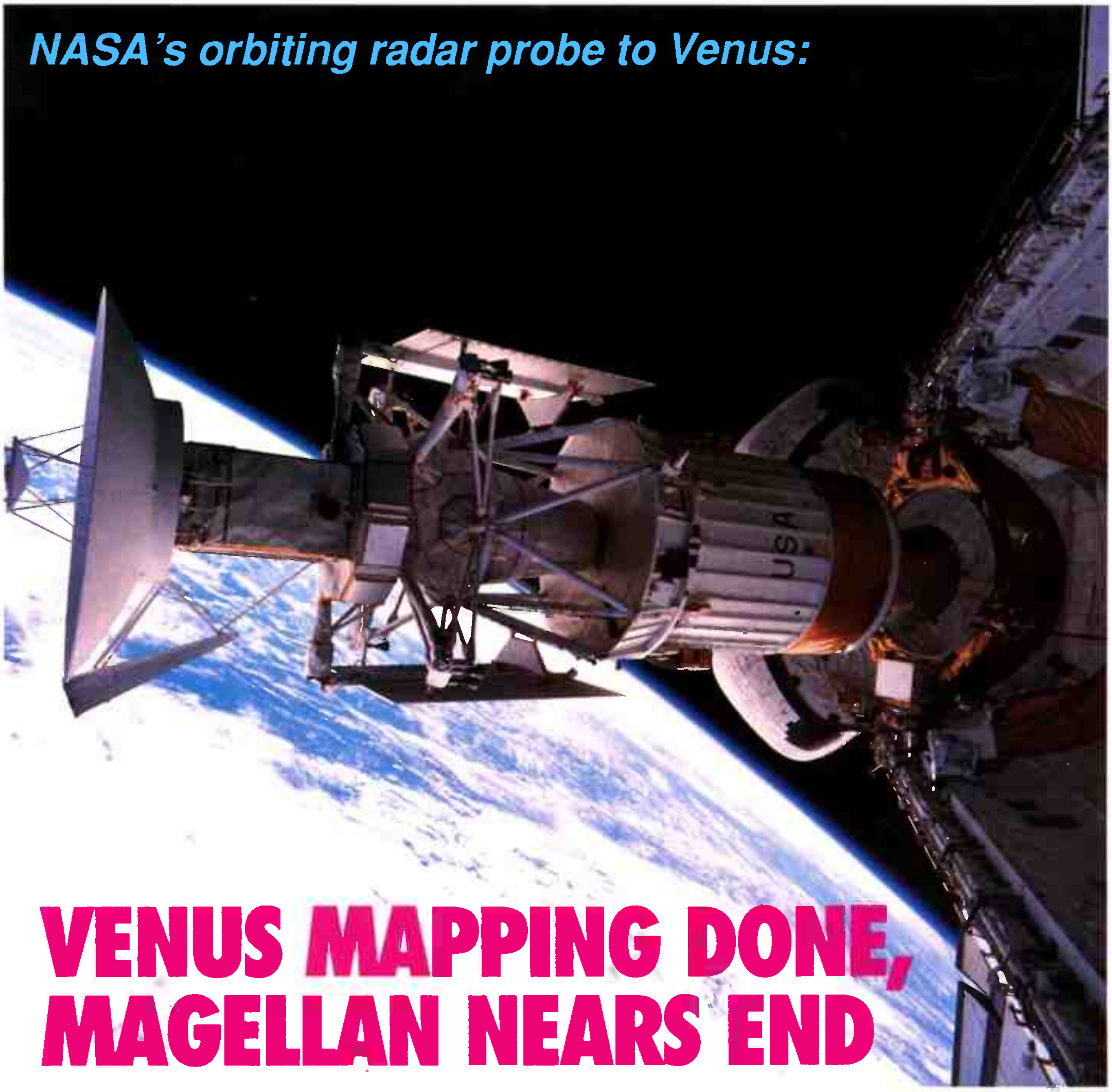
RACK PANEL CAPACITY	ZIP-RACK FRAME IDENT NO STD.	ZIP-RACK FRAME IDENT NO BLACK	ZIP-RACK FRAME PRICE $	COVER SET IDENT NO. GREY	COVER SET IDENT NO. BLACK	COVER SET PRICE $	TOTAL RACK HEIGHT
4U	F04	F04BK	125	C04	C04BK	41	268
6U	F06	F06BK	135	C06	C06BK	49	357
9U	F09	F09BK	145	C09	C09BK	65	490
12U	F12	F12BK	155	C12	C12BK	79	624
15U	F15	F15BK	165	C15	C15BK	90	757
18U	F18	F18BK	175	C18	C18BK	99	890
24U	F24	F24BK	185	C24	C24BK	129	1157
30U	F30	F30BK	215	C30	C30BK	145	1424
40U	F40	F40BK	245	C40	C40BK	189	1868

ACCESORIES		PRICE $
6/01	M6 PACK: 12 M6 Clip Nuts, 12 M6 Ph. Screws, 12 Nyl Washers	10
6/01BK	As 6/01 in Black	10
6/02	100 M6 Clip Nuts	39
6/03	100 M6 Screws	12
6/03BK	100 M6 Screws Black	12
6/04	100 M6 Washers	7
6/04BK	100 M6 Washers Black	8
CT2	Cantilever Tray 2U	45
CT3	Cantilever Tray 3U	49
CT4	Cantilever Tray 4U	55

ZIP-RACK is made by "The **ZIP-RACK** Company" Factory 2, 7 Michellan Court, Bayswater Victoria 3153. Australia.
Under licence to AUTOTRON AUSTRALIA P/L. The **ZIP-RACK** Designers

Beware of illegitimate copies without the **ZIP-RACK** name. For product sales, wholesale pricing & product literature

Phone: (03) 729 7255 or Fax: (03) 729 6017



NASA's orbiting radar probe to Venus:

VENUS MAPPING DONE, MAGELLAN NEARS END

In May 1989, NASA launched an 'economy' spacecraft which then made its way to our neighbouring planet Venus. Three months later, *Magellan* entered Venusian orbit and began methodically scanning the planet using its synthetic aperture X-band radar. Since then it has sent back an incredible stream of high resolution images, which have provided scientists with many surprises. But with the planet now almost fully mapped, budget cuts look like forcing NASA to 'pull the plug' on *Magellan* next year.

by KATE DOOLAN

1989 was the year that saw the re-emergence of space science in the United States, after a decade long hibernation. The incredible *Voyager 2* spacecraft encountered the planet Neptune for the first time in August. In October, *Galileo* started its long journey to Jupiter. But earlier, *Magellan* had become the first planetary spacecraft to be launched from the space shuttle and sent on its way to Venus.

For the last two year then, the *Magellan* spacecraft has been mapping Venus and providing scientists with a most thorough picture of the planet which was always thought to be Earth's twin. It has been found that Venus is not the sedate planet that it was supposed to be, but a planet with a violent geological history.

Venus is located 108 million kilometres from the Sun and 48 million kilometres from Earth. Named after the Roman god-

dess of love and beauty, Venus is covered by thick, swirling clouds made up of sulfuric acid droplets. The atmosphere is comprised of carbon dioxide with traces of water vapour.

The planet's surface has continent-sized plateaus, deep canyons and mountains thought to be as high as Mount Everest. The surface has a temperature of 470°C, which is sufficient to melt lead. It could be said that Venus is the ultimate women's world, as nearly all the features of the planet are names after women of history and mythology.

The only exception is Montes Maxwell — a mountain named after James Clerk Maxwell, a scientist who did much of the early work on Venusian geology. Unusually, a day on Venus is 243.0 Earth days long which is longer than the planet's year of 224.7 Earth days.

Because of Venus' close proximity to Earth, both the United States and former Soviet Union have been sending spacecraft to the planet for the last 31 years. The most recent spacecraft to travel to Venus before *Magellan* were the Soviet's *Venera 15* and *16* which radar mapped Venus during 1983. During the following year, the Soviets again sent two balloons and landers which sent back data on previously known surface features.

It was in the mid seventies that scientists at the Jet Propulsion Laboratory (JPL) in Pasadena California, decided to design a *Voyager-type* spacecraft to explore Venus in the same detail that *Voyager* had studied the outer planets.

However, gone were the days in which the National Aeronautics and Space Administration (NASA) received large budgets for planetary science. In the early eighties, there were dangers that the planetary science programs would be wiped out altogether.

In response to this danger, the JPL scientists decided to redesign their planned spacecraft to make it the Venus Orbiting Imaging Radar, with only one scientific instrument — a synthetic aperture radar. But political problems were threatening even the lower cost project.

Congressional funding for the Venus Orbiting Imaging Radar was approved in mid 1984 and the program started later that year. There was a cost to this: the American efforts for the return of Halley's Comet in 1985/86 were cancelled and the only scientific activity planned was a space shuttle flight that never flew.

Shortly after the start of construction the VOIR was rechristened *Magellan* after the famous Portugese explorer Ferdinand Magellan (1480 - 1521) who became the first man to circumnavigate the world.

Magellan was scheduled to be launched in 1987 from the space shuttle, but the *Challenger* accident delayed launch until 1989. The accident also caused a redesign of *Magellan's* journey to Venus, as the liquid fuelled Centaur Upper Stage that was to be used was cancelled as a result of *post-Challenger* investigations. So JPL designers had to adapt the spacecraft to the solid fuelled (and safer) Inertial Upper Stage.

Economy model

Magellan is not your average planetary spacecraft, as it was constructed from spare parts from other planetary spacecraft such as *Mariner, Galileo, Viking* and *Voyager* to save money.

Magellan is 6.4 metres high and weighs 3460 kilograms. Electrical power for the spacecraft is provided by two solar panels measuring 12.6 metres in diameter.

The solar panels supply 1200 watts of power to *Magellan* during its mapping phases. The panels have a single degree of freedom about the solar array axis, to allow tracking of the Sun despite the changing position of the spacecraft during its flight. Voltage regulation to the spacecraft is tightly controlled by a shunt regulator unit, which diverts excess power from the solar panels to maintain voltage at proper levels.

Both direct and alternating current are provided, with DC power at 24 to 33 volts, and 2.4 kilohertz AC power at 50 volts. Two 26.5Ah 22-cell nickel cadmium batteries provide power to *Magellan* when it is in the shadow of the planet. This allows normal spacecraft operations independent of solar illumination.

The attitude of the *Magellan* spacecraft in relation to the planet is controlled by three reaction (momentum) wheels driven by electric motors. Their motion stabilises the spacecraft and maintains its proper attitude.

During *Magellan's* journey to Venus, it was pointed in the proper direction with the help of gyroscopes which were continuously updated using stars as reference guides.

Twenty four multipurpose liquid propellant hydrazine thrusters provide several functions — spacecraft attitude control, trajectory and orbit correction and reaction wheel decelerations.

Positioned in the middle of the ten sided equipment bus is a single propellant tank, which at launch contained 132.5 kilograms of monopropellant hydrazine.

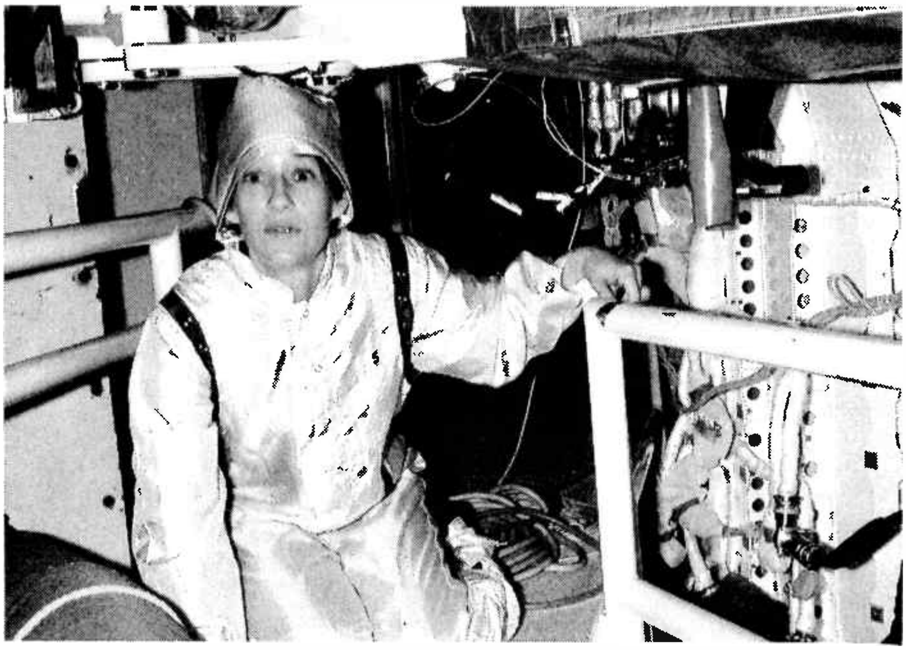
A helium tank is attached to the struts of the propulsion module structure and can be used, if necessary, to offset drops in the pressure of the hydrazine system. The STAR 48 solid rocket motor was used for orbital insertion at Venus.

At launch it weighed 2146 kilograms of which 2104 kilograms were propellant. The motor's 30,000 kilograms of thrust reduced the speed of transfer from interplanetary trajectory into orbit around Venus.

Control systems

Commands transmitted from Earth to *Magellan* are received by the radio frequency subsystem and are relayed to the command and data subsystems (CDS), where they are interpreted and acted upon. This system also controls the acquisition and storage of engineering and science data and sends that information back to Earth.

The CDS stores command sequences for



Prior to departure, in KSC's Vertical Processing Facility, STS-30 Mission Specialist Mary Cleave performs a sharp-edge inspection of the spacecraft 'Magellan'.

up to eight days of radar operation of the mapping phases. There is also a provision for receiving and immediately executing separate commands issued from the ground.

Engineering data is normally transmitted to Earth over a real time S-band link, which has transmitting power of five watts. When a real time link is not possible, the data is tape recorded and played back by way of the X-band high-rate link which has transmitting power of 20 watts. (S-band is 2 - 4GHz, X-band is 8 - 12GHz).

Magellan's brains are comprised of two ATAC 16 computers, which are located in the attitude control subsystem, and four 1802 microprocessors in the Command and Data Subsystem. All the computers are in a duplication configuration as insurance against breakdowns. The computers are fully reprogrammable and are modified equipment from the *Galileo* spacecraft.

The radar scanning data is stored on two multitrack digital tape recorders, for later playback over the high rate X-band link. There is no provision for real time transmission of radar data, because the large antenna must be pointed at Venus whilst mapping.

Data storage capacity of the tape recorders is about 1.8 billion bits each. The tape recorders are used primarily for the recording of radar data, but as noted earlier, low rate engineering data can also be stored during mapping or at other times when engineering data cannot be transmitted back to Earth in real time.

Radio links

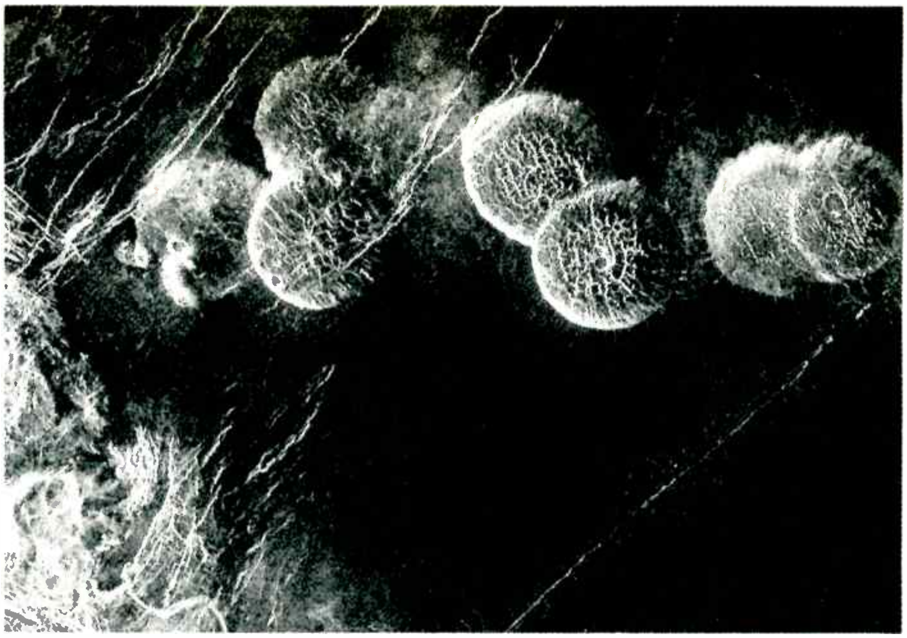
Magellan Telecommunications Subsystem (TCS) contains all of the hardware required to maintain communications with Earth. The subsystem contains the radio frequency subsystem and the low-gain, medium-gain and high-gain antennae.

Magellan is capable of receiving X-band or S-band uplink signals whilst transmitting data downlinks via X-band or S-band simultaneously. The uplink data rates are 7.8125 or 62.5 bits per second. From Venusian orbit, engineering data is sent to Earth at 1.2 kilobits per second through the high-gain antenna via S-band while simultaneously transmitting the recorded radar data at 268.8 kilobits per second. Backup data rates of 40 bits per second for engineering telemetry and 115.2 kilobits per second for radar data are available for emergencies.

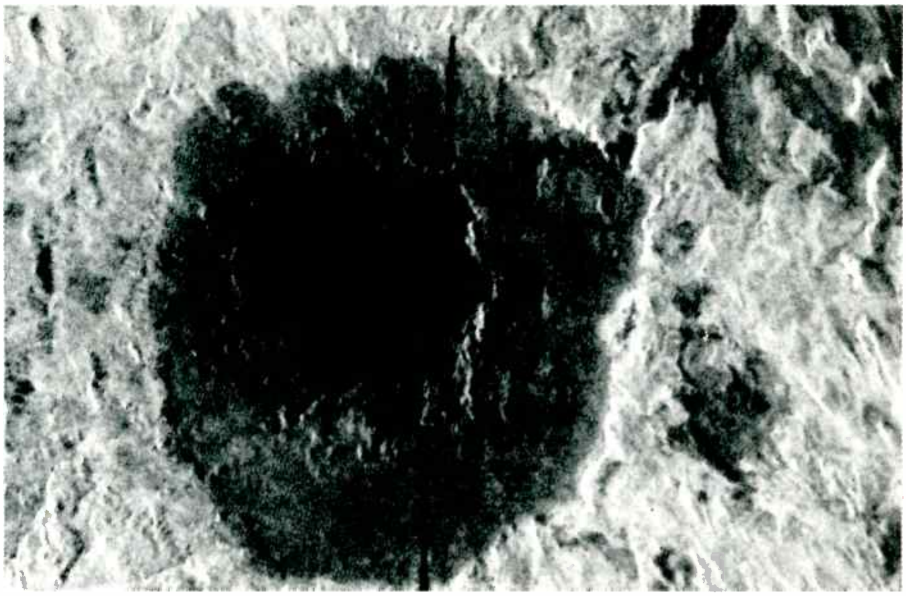
The radio frequency subsystem is an assembly of separate units joined together by RF, control, power and telemetry cabling. It is joined to the S-band antenna by semi-rigid coaxial cables and the X-band high-gain antenna feed by two waveguide runs. The high-gain antenna is constructed of lightweight graphite epoxy sheets mounted to an aluminium honeycomb for rigidity. The medium-gain antenna is a conical horn 460mm in diameter and 610mm long. The low-gain antenna is a cylinder 380mm long and 100mm in diameter.

To communicate with Earth, *Magellan* uses the facilities of the NASA Deep Space Network (DSN). With stations located in California, Spain and Australia, the spacecraft has been able to communicate with ground controllers every minute of its mission. The NASA Tracking and Data Relay System is also used as a backup for the Deep Space Network.

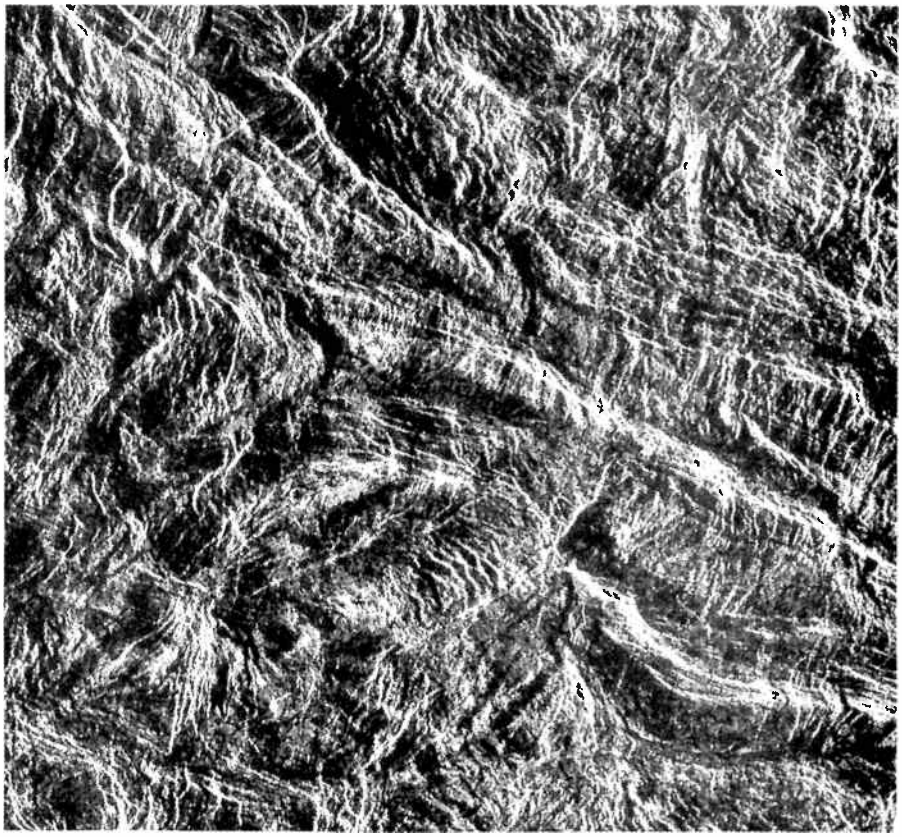
With a conventional radar, the resolution of an image depends on antenna size — the bigger the antenna, the better the resolution. However, having a large antenna on *Magellan* would be too expensive and too difficult to manipulate. To solve this dilemma, the signals from *Magellan's* Synthetic Aperture Radar (SAR) are computer processed on Earth so that they im-



The eastern edge of Alpha Regio is shown here. Seven circular, dome-like hills, averaging 25km in diameter with maximum heights of 750 metres, dominate the scene, and are thought to be very thick lava flows on relatively level ground.



This image is the crater Cleopatra, located on the eastern slopes of Maxwell Montes, the highest mountain range on Venus. Cleopatra measures about 100km across and 2.5km deep. From the data available, scientists have been unable to determine if Cleopatra was a meteorite impact crater or a volcanic depression.



The complex pattern of intersecting ridges and valleys called 'tessera', indicate that this portion of Alpha Regio in the Lavinia region has undergone many episodes of horizontal motion. The tessera covers an area of about 125km.

Shown here are three large meteorite impact craters from the Lavinia region. Found in an area of fractured plains, the craters show many features typical of meteorite impact craters, including rough (bright) material around the rim, terraced inner walls and central peaks.

itate the behavious of a large antenna on the spacecraft. By using this synthesis process, the onboard radar sensor operates as if it has a large antenna and it produces high resolution images even though *Magellan* has a small antenna. This computerised process of 'aperture synthesis' is what gives the SAR its resolving power as well as its name.

As *Magellan* passes over the Venusian surface, its dish antenna looks downward and to the left side of the spacecraft's orbit path. For 37 minutes, the SAR antenna emits several thousand radar pulses each second. Travelling at the speed of light, the pulses strike and illuminate a 25 kilometre wide swath of the planet's surface, and then immediately bounce back and are received by the spacecraft.

By recording the returned pulses, two measurements on each pulse allow location of each point on the planet's surface. The first measures the time it takes for the radar signal to return to *Magellan*, giving the spacecraft's distance to that point. The second measures the returned signals for their Doppler effect — a shift in frequency caused by the spacecraft's motion over the surface. This second measurement gives the location of the point with reference to the spacecraft's line of flight, since *Magellan* is either approaching or receding from the point.

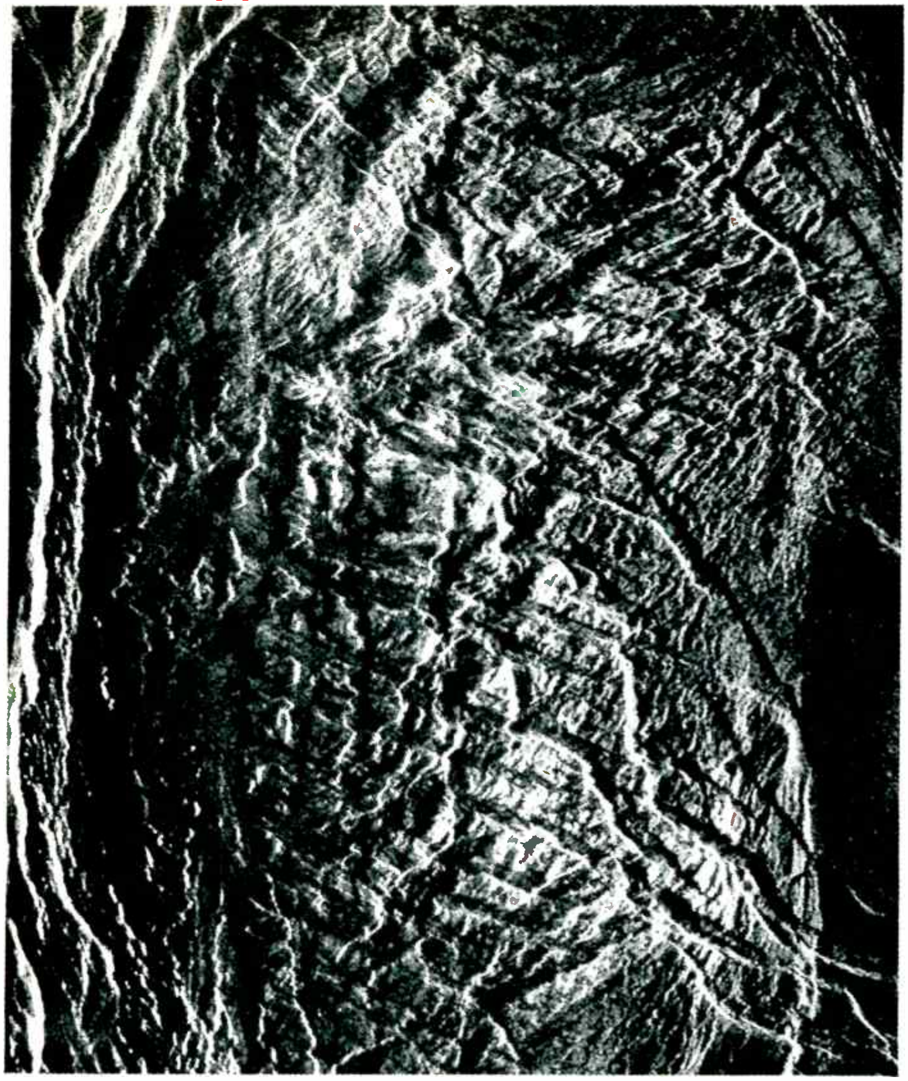
Construction costs

The *Magellan* spacecraft itself was built by Martin Marietta Corporation while its Synthetic Aperture Radar was constructed by the Hughes Aircraft Company. The *Magellan* probe is managed by the Jet Propulsion Laboratory and the Tracking and Data Relay System is managed by the Goddard Space Flight Centre. The delay caused by the *Challenger* explosion resulted in Magellan's costs going up by US$200 million, to a total mission cost of US$500 million. Another US$90,000 was added to the mission cost in October 1988.

Whilst undergoing final preparations to launch, a technician at the Kennedy Space Centre, incorrectly connected the spacecraft to a test battery and caused an electrical fire. Fortunately the spacecraft was not seriously damaged and the launch preparations continued on schedule.

Magellan was launched into space on the STS30 space shuttle mission, the fourth shuttle mission after the commencement of shuttle flights after *Challenger*. The mission commanded by Dave Walker, pilot Ron Grabe and Mission Specialists Mary Cleave, Mark Lee, and Norm Thagard had a launch window of only 25 days. If *Magellan* missed that launch, it would have had to wait another two years for

Venus mapped



This image was taken from the eastern flanks of Freyja Montes in Ishtar Terra, and is dominated by a highly fractured dome measuring approx. 70 x 125km. The 'turtleback' appearance is the result of two sets of intersecting fractures.

launch. Fortunately, the shuttle *Atlantis* was delayed for only one day and was launched from the Kennedy Space Centre in Florida on May 4, 1989.

Once in Earth orbit, *Magellan* was launched from the payload bay and then it was propelled into a Venus trajectory by the Inertial Upper Stage (IUS). Once *Magellan* was outside the Earth's gravitational influence, it had a relatively uneventful cruise to Venus and was inserted into orbit around the planet on August 10 1990.

Arriving at Venus, however, *Magellan* caused the ground controllers at JPL nothing but trouble. On the day it arrived in Venusian orbit, the spacecraft's communications system stopped working.

Soon after, the system started working and then failed again. To ensure that *Magellan* would keep working, ground controllers tracked down the problem which was attributed to a faulty computer chip. After a 20 day checkout, *Magellan* began mapping Venus and the surprises started.

Many surprises

The radar images sent back have been the most detailed images ever seen of Venus. The terrain of the planet was revealed to have a tortured topography, with fault like cracks in regular patterns. Craters as large as the combined areas of Melbourne and Sydney were discovered as were congealed rivers of lava measuring up to 320km long. Earthquakes or more correctly 'Venusquakes' were also detected.

Magellan completed its first mapping cycle in May 1991 and in that time mapped 84% of the planet. It then started its second mapping cycle. Using images from both the first and second cycles, scientists began to use the stereo imaging to make comparisons of the Venusian surface. In August 1991, scientists comparing two images found the largest canyon in the Solar System. The canyon, 6000 kilometres long and 1.8 kilometres wide, is longer than the River Nile. But unlike the Nile, the canyon is a single channel lacking tributaries and is the same width for its entire length. Another discovery at the same time was a crumbling cliff, which had been caused byVenusquakes.

The biggest shock came in November 1991. Scientists studying images of the planet's second tallest mountain 'Maat Mons' discovered that the mountain was recently covered by lava.

Rocks that sit on top of most Venusian mountains appear to weather quickly in the hot atmosphere, which creates soil that is rich in iron sulfide. This mineral shows up easily on radar. If the Maat Mons peak does not show traces of iron sulfide, it means that it has been covered by lava in only the last couple of years.

Resurfacing on the Venusian lowlands by lava flows appears to take place on a regular basis, as the lowlands are free of craters. This is said to be caused by periodic lava flows. *Magellan* has found evidence of these lava flows, which include domelike upwellings and *hardened* streams of rock trailing down the sides of the planet's mountains.

As yet, *Magellan* has not found any volcanoes erupting, but scientists have ample evidence to suggest that Venus is the fourth body in the Solar System to have an active volcano system — after Earth, Jupiter's moon Io and Neptune's moon Triton.

End in sight

As exciting and successful as the *Magellan* mission has been for NASA, it is not being allowed to continue. Recent budget cuts by NASA Headquarters have ordered that the *Magellan* be cancelled in 1993.

Another prominent solar system mission casualty is that of the Comet Rendezvous Asteroid Flyby (CRAF), which has been cancelled completely. The budget cuts have been attributed to the much-maligned *Space Station Freedom* project, beginning to take priority at NASA in both time and money.

As of January 1992, *Magellan* had mapped 95% of the Venusian surface. By the time of its cancellation, it will have mapped all of the planet — adding greatly to our knowledge of the planet that until recently was thought to be Earth's twin. Not a bad achievement, for a leftover spacecraft.

The author would like to thank Mary Hardin and Dr Craig Waff, of the Jet Propulsion Laboratory, for their assistance in the completion of this article. ❖

See the review in Electronics Australia March 92 – **"Electronics Workbench is certainly the easiest simulator I've ever used"** Peter Philips

Electronic Workbench

The Electronics Lab you keep in your PC!

YES you can now build, simulate and test Analog and Digital Circuits without laying your hands on a single component!

It's so easy with Electronics Workbench®. Do it all with the mouse – drag new parts from the parts bin, drop them onto the breadboard and click to run wires. Editing circuits is easy as wires are re-routed automatically.

It's much faster than building real circuits . No faulty parts! It's the result of 10 years innovation and thousands of students, hobbyists and engineers have been using the Workbench since its introduction in 1988.

Analog Module includes

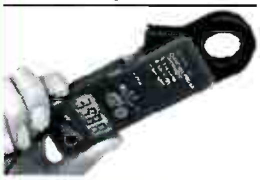
- Comprehensive parts bin includes op-amps, zeners, transistors etc
- Function Generator with sine, square, triangle etc
- Oscilloscope with dual trace, int/ext trigger, nanosecond timebase upto 999MHz
- Bode Plotter for frequency responses and phase shift (-200 to +200dB)
- SPICE Simulation plus transient and steady-state simulation

Digital Module includes

- Comprehensive parts bin with gates, flip-flops, half adders, displays etc
- Word Generator up to 16x8-bits
- Logic Analyser with 8 channels, int/ext trigger
- Logic Converter converts between gate, truth table and boolean

Professional version has inhanced colour interface, supports maths co-processor. Requires IBM AT or PS/2 with 286 or greater, hard disk, 640kB RAM, Microsoft mouse, EGA/VGA and DOS 3.0. **$429.00**

Personal Plus Version is monochrome. Requires PC/XT/AT or PS/2 , 2 floppies or hard disk, 512kB RAM, Microsoft mouse, CGA/EGA/VGA/Hercules graphis adaptor and DOS 3.0 or greater. **$299.20**



APPA 35 CLAMP METER

- *4000 count display*
- *Autoranging*
- *Measures to 350A ac*
- *Conductors to 25mm diameter*
- *Measures voltage to 750Vac, Ohms to 40kΩ and continuity with beeper*
- *Large 12.5mm LCD display*
- *Data Hold button*
- *Built-in belt clip*

$142.80 $119.00 ex tax

SCOOP PURCHASES

This month we have two bulk buy bargains for you –

400V, 35A Bridges

normally $5.40 each but buy 10 for just $40.00. Branded, but sorry we aren't allowed to tell you the name!

25 pin D Conectors

Buy a tray of 50 for just $35.00 Male or Female (not mixed at this price) We also have plastic backshells at $35.00 for 50 or metallised at $80.00 for 50. Now is the time to stock up!

Kikusui SCOPES

60MHz 3 Channel Scope

- 5mV/div dc to 60MHz
- 5ns/div to 0.5s/div A and B

COS5060B $1860.00

40MHz 2 Channel Scope

- 5mV/div dc to 40MHz
- 20ns/div to 0.5s/div Main
- 0.2μs to 0.5ms/div Delayed

COS5041 $1373.00

20MHz 2 Channel Scope

- 5mV/div dc to 20MHz
- 20ns/div to 0.5s/div

COS5020 $916.00

Handy Probe Multimeter Ideal for tight spots

tests Logic too!

No need to turn your head to read this multimeter. The readout is right there in the probe! Auto and manual ranging, 3.5 digit large 14mm LCD display - all in a handy probe. Logic testing function for CMOS/TTL. Data Hold button, Diode test, Continuity buzzer. Display shows all functions. Protected to 250V

- DC Voltage from 200mV to 500V
- AC Voltage from 2V to 500V
- Resistance from 200Ω to 20MΩ
- AC/DC Current to 200mA
- Continuity check to 2kΩ
- Logic Testing to 1MHz and 1μs
- Diode Test 2V

$55.00

Arlec Tools Drill 'N Drive

Rechargeable two speed drill and screwdriver

Features :

- Two speeds - Drill 325rpm Screwdriver 150rpm
- Forward and reverse operation
- Pilot light for dark corners
- Drills timber, metal and hardened plastic

Supplied with

Rechargeable batteries
AC adaptor
3 dril bits – 2.0, 3.0, 4.0mm
2 slotted and 2 Philips screwdriver bits

A really handy tool for just **$69.95**

Hot Air Gun

Features

- Dual 400/600°C temperature range
- 1600W output
- Built-in safety handle
- Hanging hook for storage
- 12 month warranty

Many uses for **$59.95**

SerialTest

PC-based Protocol Analyser & Data Line Monitor

The new version of Serialtest turns ANY PC into a full-featured serial data protocol analyzer — even laptop and notebook computers – for both synchronous and async data. Serialtest unleashes the power of your PC for data communications testing with a simple, user-friendly interface and either! The new ComProbe plugs in to your printer port. With Serialtest and your PC, there is no longer any need to buy or rent expensive, dedicated protocol analyzers.

The Serialtest package includes Serialtest software and Frontline's RS-232 ComProbe™ adapter. The ComProbe connects to your computer via the parallel printer port *(no need for plug-in cards)* and allows Serialtest to work with both synchronous and asynchronous devices.

Serialtest's monitor mode shows you exactly what information is flowing between any two serial devices — both data bytes and control signals. Source mode allows you to interactively simulate either the DTE side or DCE side of the communications link.

Serialtest Async is similar to Serialtest, but is limited to async-only testing. The package includes Serialtest Async software and custom cabling which works in conjunction with the serial ports on your PC.

Anyone who works with serial data communication needs Serialtest. Field service engineers and system integrators will appreciate the portability and ease-of-use. Communication specialists and network supervisors will enjoy the power and flexibility. No matter what the industry, Serialtest will prove to be an indispensable tool.

Look at ALL these features –

Protocols: Async, SDLC, Sync, X.25, HDLC, SNA

Data Capture: data bytes, control signals, and error conditions. Capture data to RAM and directly to disk with no file size limit.

Data Display:

Frame/Packet level: one decoded frame/packet per line.

Byte level: split-line DTE over DCE or mixed using reverse video for DCE.

Characters displayed in hex, ASCII, EBCDIC, or Baudot.

Nonprintable characters displayed using hex, mnemonics, graphics, dots.

Captured data can be searched; search patterns can include wildcard characters.

Control Signal Display:

Live breakout box includes timing diagrams and counters.

Captured control signal transitions can be viewed in relation to captured data bytes using timing diagrams.

Timestamping: *Absolute or relative display of event time. Delta time and effective data rate calculations.*

Triggers: *Character strings, control signals, and error conditions can be used to activate and deactivate data capture. String triggers can include wildcard characters.*

Device Emulation: *Transmit data entered from the keyboard, Serialtest capture files, or any DOS file. Modify control signals. Use hardware and software flow control including user-defined XON/XOFF characters.*

Configuration Management: *Name and save an unlimited number of configurations.*

User Interfaces: *Pop-up menus and context-sensitive help allow new users to be up and running quickly. Command line options can be used to further simplify operation.*

SerialTest Sync/Async with Comprobe **$2480.00** (ex tax) **$2536.00** (inc tax). *Allow $15 P&P*. Plug Pack **$24.95**. SerialTest Async is still **$480.00**. Demo disk $10.00 refundable on purchase

Lab 4 –All you need in a single instrument!

Ideal for the professional and keen hobbyist. Saves bench space. High accuracy yet low cost. Just check the features –

Function Generator

- Sine, square, triangle, skewed sine, pulse, TTL level square
- Covers 0.02Hz to 2MHz

Frequency Counter

- 1Hz to 100MHz
- 15mV sensitivity to 60MHz

Digital Multimeter

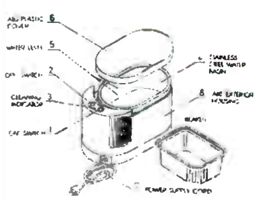
- 3 1/2 digit LCD
- Auto/Manual ranging

Power Supply

- 0 to 50V, 0.5A
- 15V 1A and 5V 2A fixed

Incredible value – **$898.10 inc tax $774.20 ex tax**

Save on Ultrasonic Cleaner



The latest high-tech way to clean PCB's, switches, watches, drafting pens - even your dentures! Let the millions of tiny cavitation bubbles clean the surface 40000 times per second. 165x90x50mm container holds half a litre and is made of 304 stainless steel. Some people are charging a lot more.

Our's are still only **$150**

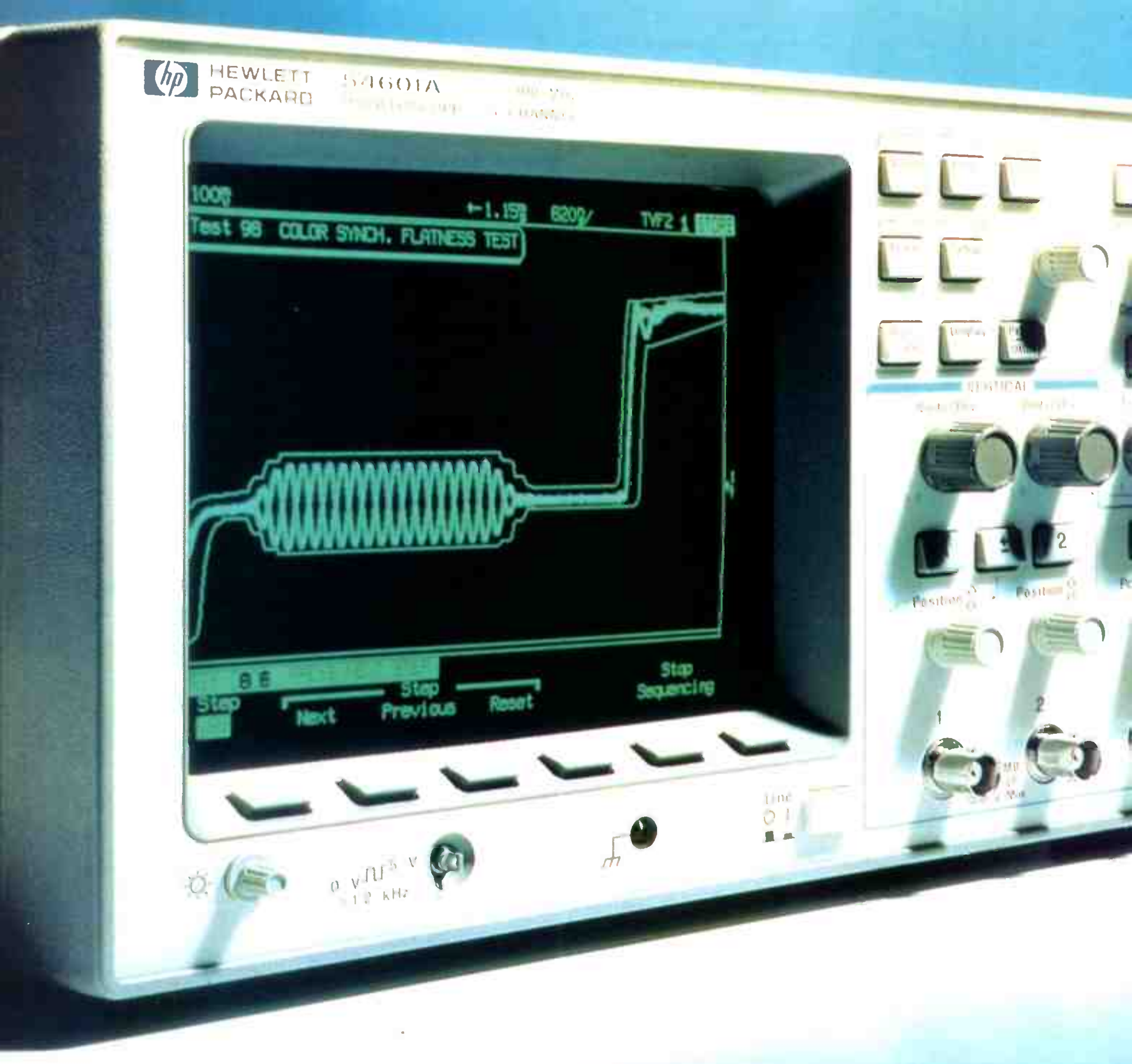
8.30am to 5.00pm Mon to Fri. 8.00am to 12 noon Saturday.
Mail Orders add $5.00 min to cover postal charges.
Next day delivery in Sydney add $8.00.
All prices include Sales tax unless stated otherwise.
Tax exemption certificates accepted if the line value exceeds $10.00.
BANKCARD, MASTERCARD, VISA, CHEQUES or CASH cheerfully accepted.

Geoff Wood Electronics Pty Ltd

READER INFO NO. 7 **(inc in N S W)**

229 Burns Bay Road, Lane Cove West N S W (Corner Beatrice Street)
Mail Orders to – P O Box 671, Lane Cove N S W 2066
Telephone : (02) 428 4111 Fax : (02) 428 5198

[illegible]



■ Take a close look at the HP 54600 oscilloscope, and you can't help but notice certain things.

The HP 54600 looks and feels like an analog scope, with dedicated knobs and a display that responds instantly to your control changes. Yet it has all the digital power that analog can't give you – high accuracy, automatic measurements, hard copy output and programmability. And superior viewing of virtually any waveform, even at low rep rates and slow sweep speeds.

■ No. of channels	2 or 4
■ Bandwidth	100MHz
■ Timebase accuracy	0.01%
■ Vertical accuracy	+/– 1.5%

A Better Way.

HEWLETT PACKARD

HP E3610A

HP E2373A

HP 34401A

HP 4263A

Win this superb H-P basic test instrument set.

Now, more than ever before, there's a great incentive to subscribe to Electronics Australia – or to renew/extend your existing subscription: the chance to win this superb collection of Hewlett-Packard test instruments, valued at $11,500!

All new subscriptions, renewals and extensions received from now until January 27, 1993 will be in the draw. So by renewing NOW, you'll have an excellent chance to win the instruments for yourself.

Here's what you could win:

- An HP 54600A 100MHz bandwidth two-channel digital sampling oscilloscope (DSO), with high accuracy measurement facilities and the fastest response, 'look and feel' of an analog scope. An amazing instrument, valued at $3900!
- An HP 34401A precision 6-1/2 digit bench type 'system' digital multimeter (DMM), with an accuracy of 0.0035% (DC), reading speeds to 1000/second and the ability to communicate with a computer for automated testing. A true lab-grade instrument valued at $1600!
- An HP 4263A high precision benchtop/system digital LCR meter, which can make true 'four terminal' measurements on virtually any discrete passive component, at frequencies between 100Hz and 100kHz. Measures L, C, R, Q, D and lots more – valued at $5500!
- An HP E3610A bench DC power supply, rated at 30W output with fully adjustable voltage and current, 0.01% load and line regulation and less than 2mV p-p ripple and noise output. Valued at $460!
- An HP E2373A handheld 3-1/2 digit DMM, offering eight measurement functions, high visibility display and rugged reliability. Valued at $150!

This great set of top quality H-P instruments – worth $11,500 – could be yours. Simply subscribe! A 1 year subscription to Electronics Australia is only $47which includes postage.

PLUS everyone that subscribes or renews their subscription to Electronics Australia will receive a Dick Smith Voltage tester – absolutely free. Valued at $7.95, anyone would find this voltage tester a handy friend. It's a pencil style probe for checking voltages in the range of 150, 300, and 500 volts DC or 110, 220, and 380 volts AC. It's a fast way of knowing if a cable is 'live' and also just how 'live'.

HOW TO ENTER: Simply phone our toll free number 008 800 933 and have your credit card details ready. If you do not have a credit card then fill out the coupon attached and post. If the coupon is missing, send your name, address, phone number and cheque to: Federal Publishing Company Reply Paid No. 3, P.O. Box 199, Alexandria, NSW 2015. Any enquiries can be made by phoning (02) 693 6666. Unsigned orders cannot be accepted.

CONDITIONS OF ENTRY: 1. The competition is only open to Australian residents authorising a new or renewal subscription to Electronics Australia before last mail on 27.01.93. Entries received after closing date will not be included. Employees of the Federal Publishing Company Pty. Ltd., Hewlett Packard, their subsidiaries and families are not eligible to enter. 2. South Australian residents need not purchase a subscription to enter, but may enter once by submitting their name, address and a hand drawn facsimile of any coupons to the Federal Publishing Company Pty. Ltd., PO Box 199, Alexandria, NSW, 2015. 3. Prizes are not transferable or exchangeable and may not be converted to cash. 4. The judge's decision is final and no correspondence will be entered into. 5. Description of the competition and instructions on how to enter form a part of the competition. 6. The competition commences 23.09.92 and closes last mail on 27.01.93. 7. The draw will take place in Sydney on 29.01.93 and the winners will be announced in a later edition of Electronics Australia. 8. The prize is 1 x $3900 HP 54600A digital sampling oscilloscope, 1 x $1600 HP 34401A digital multimeter, 1 x $5500 HP 4263A digital LCR meter, 1 x $460 HP E3610A bench DC power supply, 1 x $150 HP E2373A handheld digital multimeter. All prize values exclude sales tax. Total Prize valued at $11,500. 9. Subscriptions are not refundable. 10. The promoter is the Federal Publishing Company Pty Ltd, 180 Bourke Rd, Alexandria NSW 2015. Permit No. TC92/0000 issued under the lotteries and Art Union Act 1901; Raffles and Bingo Permit Board No. 92/0000 issued on 00/00/92; ACT permit no. TP92/0000 issued under the Lotteries Act 1964; NT permit No. 92/000.

For more information and a data sheet on Hewlett Packard products, call the H-P customer information centre on 008 033 821, Melbourne callers phone 272 2555.

When I Think Back...

by Neville Williams

Fred Thom and Tasma - 2: From wires and relays to wireless

After gaining experience in radio receiver manufacture at L.P.R. Bean/Stromberg-Carlson, Fred Thom and John Smith left in 1929 to form their own manufacturing company. This flourished for many years, with their brand name 'Tasma' becoming widely known all over Australia. But in the 1950's they began to strike trouble, as did many other local manufacturers.

In 1927, the name L.P.R. Bean & Co disappeared — to be replaced with Stromberg-Carlson Australia, still headed up by Mr L.P.R. Bean. And that's how, as a raw recruit to the industry in the early 1930's, I myself first heard of Mr Bean — from itinerant wirers in local radio factories. In anecdotal terms, that (adjectival) 'so-and-so from Strommys' was the personification of everything they resented in the system!

Reading through the draft of these articles, Fred Thom queried the above observation as an exaggeration. He had worked as Bean's foreman in the early days, he said, and would have known if he had been unduly provocative.

He did concede, however, that Bean had once ruled that process workers visiting the toilets between normal breaks had to 'clock-off' while so occupied! This was in addition to whole production lines being made to clock off, if production was held up by a temporary shortage of components.

Fred Thom says that, from about 1927, the Bean/Stromberg organisation scaled down its involvement in telephone equipment and moved into the importation and manufacture of radio receivers, with the US company having become part owners of the Australian operation.

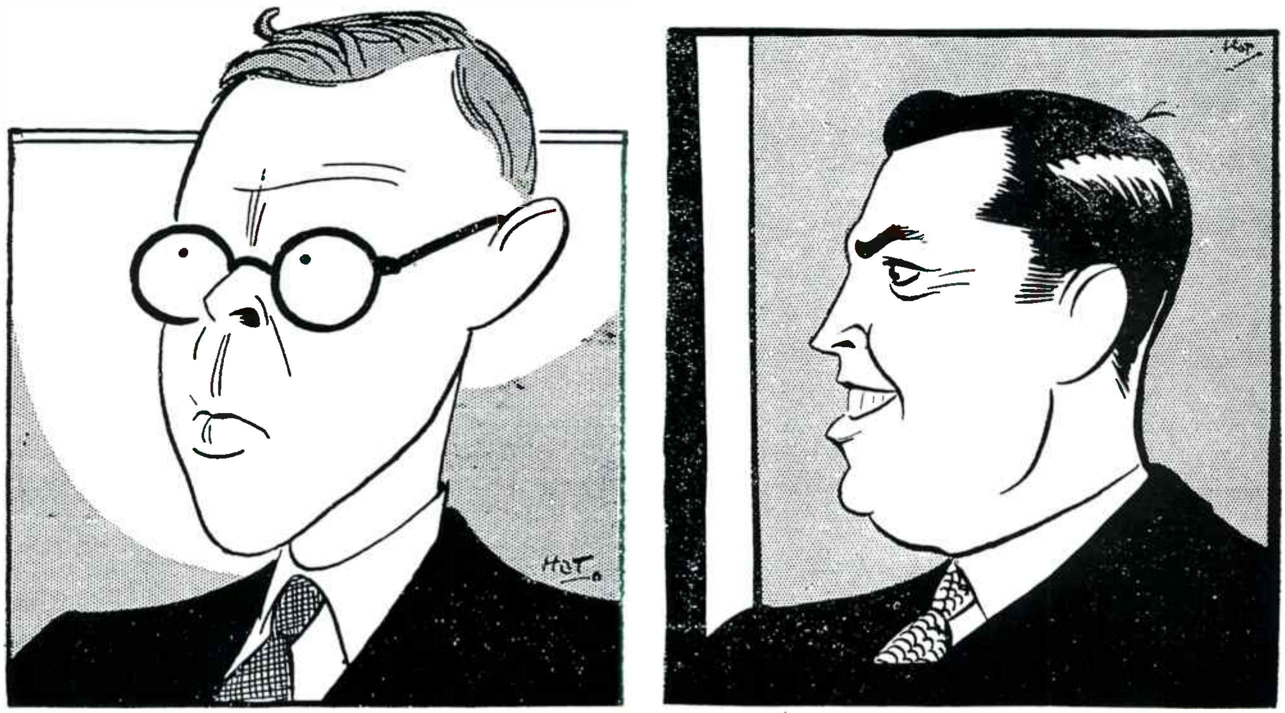


Fig.4: Caricatures of Fred Thom (left) and his partner John Smith, as published in our predecessor, Wireless Weekly, in late 1934. The cartoonist went by the nom-de-plume 'Hotpoint'.

When I Think Back...

As an employee, and observing what was involved, Fred Thom began to think: "If I can build receivers for Strommys, I can do the same for myself!"

So in 1929, he and two other Stromberg-Carlson employees, John E. Smith and George Woodward, resigned to form a new company to manufacture domestic radio sets. Thom and Smith were to be co-founders, with Woodward, a toolmaker, becoming their first employee.

As electrical/mechanical trainees, none had any formal qualifications in radio. Their total cash reserve amounted to a meagre £500 ($1000) plus a £1000 loan. But nevertheless they did very well. As it turned out, Woodward subsequently went his own way and formed G.W. Engineering — leaving Thom & Smith Pty Ltd to gain wide industry recognition as the manufacturers of 'Tasma' brand equipment.

Fred Thom was accepted in 1932 as a foundation member of the IRE Aust (Institution of Radio Engineers), over the signatures of E.T. Fisk (President) and N.S. Gilmour (Secretary), being made a Fellow in 1940. He was also awarded life membership of the IEEE (USA).

Thom & Smith was well placed to take advantage of the 'golden age of radio' — the 1930's — and Tasma receivers took their place alongside other major brands on the Australian radio scene. By 1938, the firm had around 600 active dealers Australia-wide.

Fig.4 shows the circuit of a table model Tasma autodyne 445kHz superhet, which conforms closely to the trends detailed in the 'Think Back' column for November 1991.

In conversation, Fred Thom told me that in its formative period, Tasma used consignment selling to good effect. They would consign modestly priced receivers to selected prospects, e.g. schoolteachers, with an invitation to try them out in their own environment. If unwanted, they could be returned without obligation. If the recipients wished to keep them, payment could be arranged.

"At a time when new receivers were in strong demand", said Fred, "few if any were returned".

Tasma subsequently diversified into the production of car radio receivers — again with encouraging consignment sales, and an even more encouraging bulk order from Ford. The latter sets were branded 'Tasma-Ford' in a suitable script.

This, in turn, ultimately paved the way for T&S to get involved in two-way mobile communication systems. It was a courageous step, because the production of automotive equipment using valves and vibrator-type power supplies was never an easy way to 'make a quid'!

'Buy Australian'

Fred recalls that, around 1934, the Chief Engineer of the Australian Post Office decided that the letting of con-

About the size of it!

The finishing touches were being added to Fred Thom's new factory, sited directly opposite the existing Thom & Smith factory.

Signwriter: "You want 'Thom Electronics Pty Ltd' painted across the front of the building?"

Fred Thom: "That's right."

Signwriter: "How big do you want the letters?"

Fred Thom: "How big are the ones across the road?"

Signwriter: "I wouldn't know."

A few minutes later, passers-by might have noticed Fred Thom and the signwriter carrying an extension ladder across busy Botany Road. Fred steadied it against the T&S factory wall, while the signwriter ran his rule over the sign.

Signwriter: "The letters are so many inches tall."

Fred Thom: "Then make ours bigger than that!"

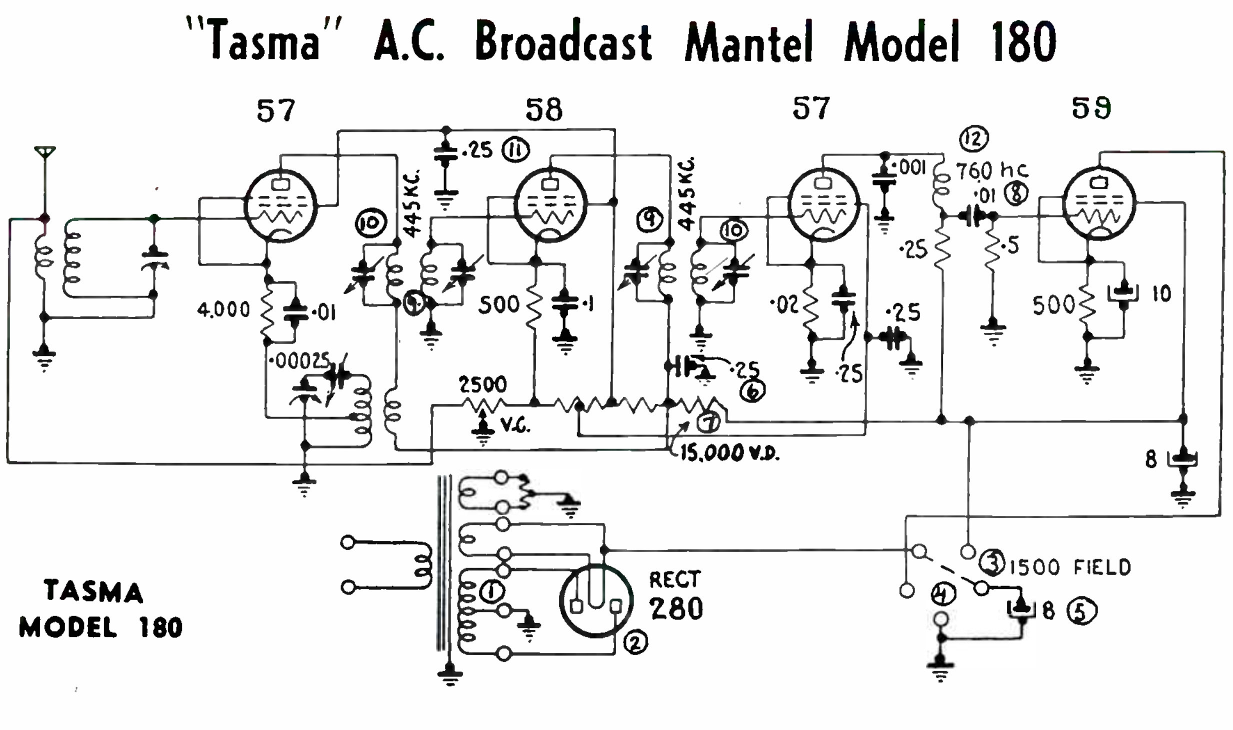


Fig.5: Circuit details of the Tasma model 180 receiver, an early mantel model released in 1933. Reproduced from the HRSA Newsletter for January 1991, the numbered circles relate to points which restorers may need to check.

[illegible]

[illegible]

tracts for telecommunication components had become a ritualistic allocation to major suppliers like STC and GEC.

On the assumption that key items like the 3000-type relay could not be mass produced in Australia, these firms had allegedly been submitting non-competitive quotes for the imported product. This, said the Chief Engineer, was a nonsense!

Accordingly, he approached Thom & Smith and said that if they would tool up for local production — at their own risk — using Australian raw materials, he would place an initial order for 10,000 units and do his best to support future expansion.

Despite their preoccupation with radio, T&S decided to 'give it a go'.

They found a local supplier of nickel-silver for the springs, while enamelled wire had become available from Rola. After a hassle about quantities, BHP came up with suitably annealed iron for the cores and, much to the surprise of STC, AWA and others, Tasma achieved the 'impossible': an all-Australian 3000 type relay.

Locally made telephone dials were also said to be out of the question, but another Australian company came up with them. In the end, the APO's 'made in Australia' initiative was rewarded with hundreds of thousands of pounds worth of local production, with something like 60 permanent employees involved in Tasma alone.

Price-competitive, and with the advantage of being Australian-made, Fred says that Tasma became one of the firms which finally forced companies like STC and AWA to commit themselves to local production of telecommunications equipment, including complete automatic handset telephones.

This diversification carried over into the wartime years, with Thom & Smith for one, becoming deeply involved in radio and radar equipment for the armed forces. T&S made transmitters by the hundreds, ranging from 150W to 500W, both AM and FM and from 150kHz to 150MHz.

To emphasise the point, Fred and his son Ian showed me a carton full of instruction manuals, for all manner of free-standing and rack mounted professional equipment — a world apart from telephones and domestic receivers.

In a profile of Fred Thom and Tasma, *Rydges* magazine for March 1, 1952 accords a share of the credit for Tasma technology to their Chief Engineer, Eric Fanker.

It also adds that, in addition to major items like the above, Tasma mass produced smaller items — such as 100,000 relays and 100,000,000 plastic bullet tip cores for .303 ammunition.

"We made all manner of things" says Fred. "You name it, we made it and it performed well in the field!"

Post-war problems

With the cessation of hostilities, military orders lapsed overnight and it was back to civilian telephones — with a huge back-log of new service requirements worldwide, which swamped the resources of overseas manufacturers. If Australians wanted new phone services, Australian firms like Tasma had to provide the equipment — as well as coping with a huge demand for new post-war radio receivers.

This was followed by the Korean war, and already stretched companies were faced with renewed calls for military equipment — to be supplied on a cost-plus 5% basis, with the Government keeping tight rein on the total. In that environment, it proved difficult, if not impossible, to cover overheads.

"Being intensely Australian", according to Fred Thom, "and from a sense of duty", his company went along with the arrangement, diverting a large proportion of their resources for a totally inadequate return — and in the process, compromising normal commercial production and profit!

Fred says that he tried in vain to reason with the bureaucrats, but, aware that they were "on a good thing, they wouldn't come to the party".

With a staffing level of around 800, Thom & Smith were suffering 'appalling losses'. The position was exacerbated by

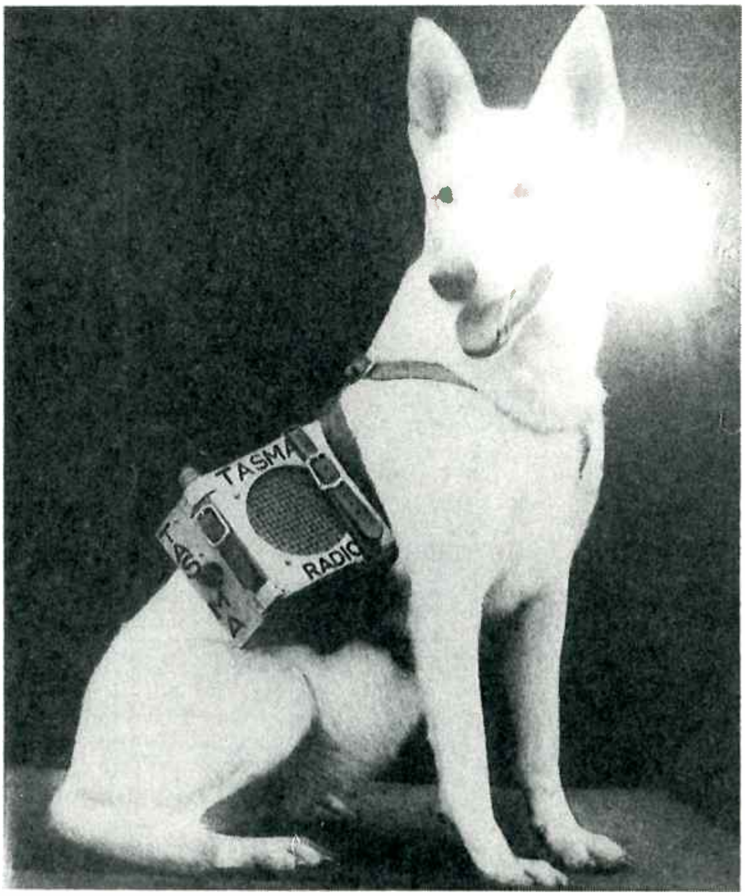


Fig.6: The NSW police dog 'Zoe' fitted with a portable radio prominently marked 'Tasma'. At the time, the idea appeared to have potential for difficult rescue situations.

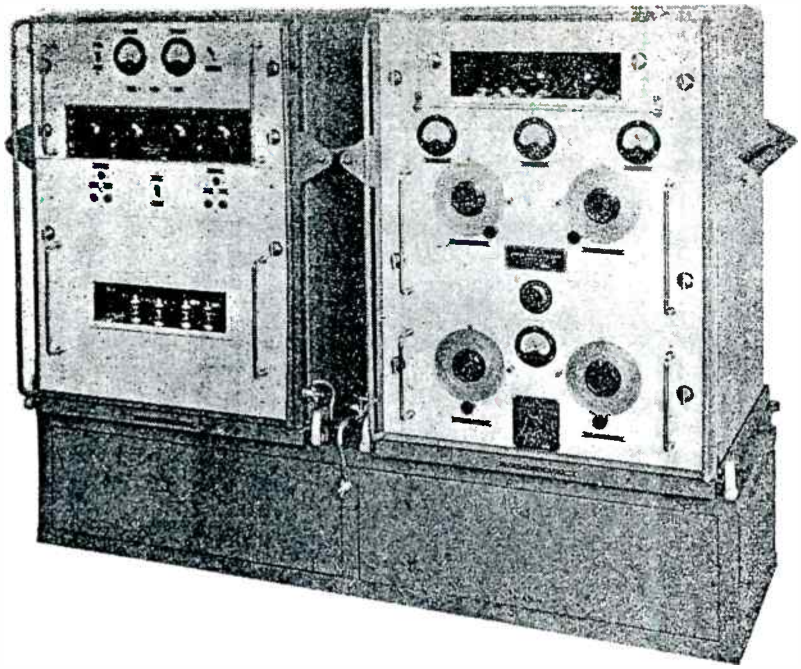


Fig.7: Produced by Thom & Smith, the AT-15A was used principally by the RAAF. Operating in the frequency range 150 - 500kHz, the 350/500W transmitter was used mainly for homing and airport control.

an exasperating strike, and around 1952/3 the company was faced with a severe liquidity crisis. This was with television looming, and there was no overseas affiliate to which they could turn for support.

Thom & Smith's answer was to merge with President Consolidated, a high profile refrigerator manufacturer. The merger was by an exchange of shares, with Thom & Smith becoming a subsidiary company but retaining its public identity.

The crisis appeared to be under control, especially when Fred Thom managed to negotiate a licence in the USA to re-design, manufacture and market in Australia TV receivers branded 'Motorola'.

But the ink on the licence had scarcely dried when President Consolidated encountered a liquidity problem of its own. Assured that everything was under control, Fred Thom carried right on with the repositioning of his old company for 'Motorola' TV production, drawing what assurance he could from the Motorola licence in his pocket and the parcel of President shares that he had accepted in lieu of cash for their part-ownership.

Eventually, however, President folded completely — exposing Thom & Smith as a key viable asset.

At that point, Fred might conceivably have bought back his old company. But, as he says, he had insufficient real 'brass' — just a parcel of relatively worthless President shares which, with hindsight, he should have unloaded while they were still saleable.

So he had to negotiate the enforced sale of his entire one-time business to the Pope group. Unwisely ("I was a silly bugger") he agreed to the transfer to Pope of the Motorola licence which, with hindsight, he should have renegotiated for himself. That rendered him redundant, and just over a year later, Pope terminated his services as manager ("I was out on my ear!").

Pope replaced Fred Thom with another old-timer, Bert Israel. But I gather from the TSA monograph that it wasn't a very rewarding relationship — with Pope, in turn, being taken over by the Simpson group.

Rather than retain Thom & Smith as a going concern, however, Simpsons terminated TV set production, selling up the premises, the tooling and everything.

The historic telecommunications 3000 relay equipment was purchased by the Spastic Centre and it, along with Bert Israel and a hand-picked group of employees, became an essential component of that organisation's Centre Industries.

Fred Thom, meanwhile, with a few thousand dollars capital salvaged from the debacle, had built a smaller factory across the road from the original Tasma premises in Botany Rd, Mascot.

There he founded a new company, Thom Electronics, taking on board contracts which he could handle with other employees from the original Tasma staff, and without the specialised tooling that had gone to Centre Industries.

Some time later, and by agreement, James N. Kirby bought into Thom Electronics, retaining Fred Thom as manager.

This time around, however, Fred sold a part-interest in the business but retained title to the premises, so that he also became the landlord. Between them, Kirby held rights to the Crosley label, Fred knew how to build TV receivers from the Motorola days, and the Crosley TV range duly appeared on the Australian market.

Realising, as landlord, that the enterprise was outgrowing the existing premises, Fred Thom privately sought and found a much larger factory in the suburbs. After "squeezing the banks and God knows what", he secured a purchase option on it and offered to lease it to Kirbys at the existing 'per foot' rate, which they accepted.

So it was, as Fred says, that he "oversaw the production of thousands of television sets" — many of them on his own premises — but always for somebody else. "There were all sorts of Tasma products, but never a Tasma TV".

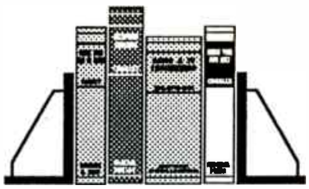
But as the wheel of circumstance turned, General Electric bought first one third, then another third of Kirbys. "And so help me," says Fred Thom, "GE made a mess of it, too. The refrigerators went to Rank and the rest is just a memory".

He concludes: "Fortunately, as General Electric, they still had to rent the factory from me — and that fed me until the operation folded!"

Nowadays other lessees are supporting the Thom family, but the Tasma brandname has passed into history.

Such then is the bewildering Thom & Smith/Tasma/Thom Electronics story, as told by Fred Thom himself. Some may see it as an industrial 'whodunnit'; to others it will be but a sad reminder of a fate which befell a whole array of once prosperous Australian electronics manufacturers. ❖

NEW BOOKS



Vintage radio

OLD TIME RADIOS! RESTORATION AND REPAIR, by Joseph J. Carr. Published by Tab Books, 1991. Soft cover, 235 x 188mm, 256 pages. ISBN 0-8306-3342-1. Price $36.95 plus postage.

Now that collecting old radios and other equipment of the valve era has become quite a flourishing hobby, there's a growing need for information on how valve-based circuits work and the most efficient troubleshooting and repair techniques to use with them. (What a pity that many of us threw out our old data books and manuals!)

This book by well-known US technical author, columnist and radio amateur Joseph Carr is designed to provide a good basic introduction to radio receiver operation, the operation of valves, the various kinds of valve radios and then the practicalities of repairing and restoring valve radios. And it seems to do this extremely well, to my mind. The material is logically ordered, the coverage is quite thorough and the text is written in Mr Carr's usual easy to read style. And although it's written mainly for the US market, most of the content is equally applicable here.

In short, a book that should be of great interest and value to anyone involved in repairing and restoring old radios — especially those just starting out.

The review copy came from Arthur Courtney of Resurrection Radio, 51 Chapel Street (PO Box 1116), Windsor 3181. (J.R.)

Micro-based systems

MICROPROCESSOR SYSTEM DESIGN, by Michael Spinks. Published by Butterworth-Heinemann (Newnes), 1992. Soft cover, 245 x 190mm, 247 pages. ISBN 0-7506-0279-1. Recommended retail price $69.95.

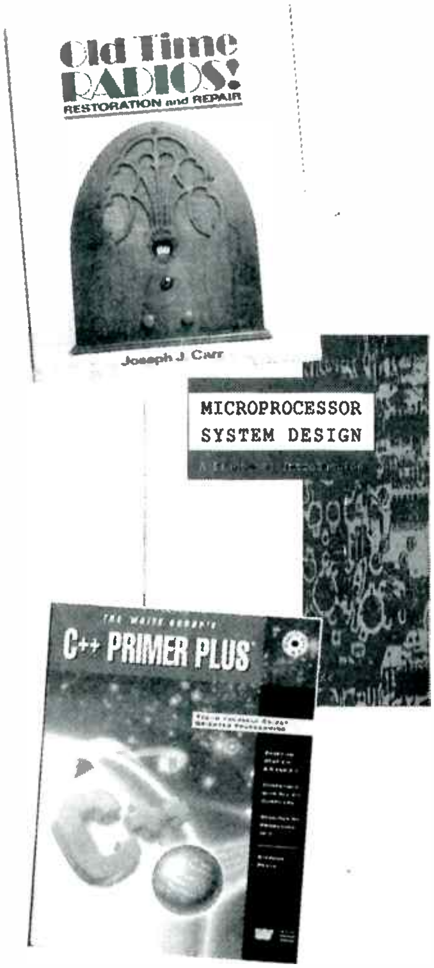
This book is an introduction to the concepts and techniques which go into the design of electronic circuits, especially those based on microprocessors. It takes a practical approach and concentrates on a few relatively simple techniques, which can be combined to build up complex circuits. Almost all the circuits and ideas presented have been used in real industrial situations.

The basic building blocks of electronic systems are covered in chapters 1-2, on digital logic and analog components. The book then covers the more advanced topics of op-amps and programmable array logic (PALs). Microprocessors and the bus-based system are dealt with in chapters 5-6, while the final two chapters give miscellaneous circuits plus practical techniques like prototyping, debugging and PCB layout.

The book is very easy to read, and well laid out and illustrated. It also claims that 'no previous knowledge of electronics is assumed', and the meaning of all terminology is fully explained. However because the amount of material covered is quite extensive, I suspect that someone truly without *any* 'previous knowledge' would find it hard going.

However, for the new engineer, technician or electronics student who wants to understand how 'real-life' circuits are developed, or who wishes to revise or extend their knowledge in this area of microprocessor system design, then the book should be very useful.

The review copy came from Butterworths, 271-273 Lane Cove Road, North Ryde 2113. It is available from technical bookshops. (P.M.)



Primer for C++

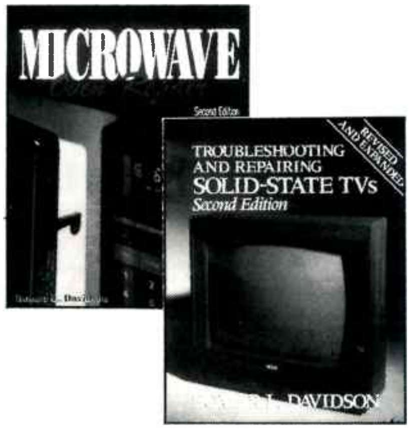
THE WAITE GROUP'S C++ PRIMER PLUS, by Stephen Prata. Published by Waite Group Press, 1991. Soft covers, 228 x 178mm, 720 pages. ISBN 1-878739-02-6. Recommended retail price $55.00.

With object-orientated programming or 'OOP' very much the current vogue, this introductory book on the 'generic' C++ OOP language should be of considerable interest. It has been very well received in the US, winning author Dr Stephen Prata the Computer Press Association's 1990 Best How-To Computer Book Award. Prata is a teacher of astronomy, physics and computer science at the College of Marin, in Kentfield, California, and has also written popular books on UNIX, QuickC, QuickBASIC and standard C.

As the name suggests, he has written this further book to provide a sound, practical yet easy-to-follow introduction to C++, for those with some background in programming but not necessarily in C. This makes it a bit different from many others, which assume you're already quite proficient in C.

From my quick inspection, it seems to be well planned, clearly presented and quite accessible — features we've come to expect from both Dr Prata and other Waite Group authors. So if you're in the market for a C++ primer, this one certainly belongs on your short list.

The review copy came from distributor Woodslane, of 8/101 Darley Street, Mona Vale 2103, but copies should be available at all major and technical bookstores. (J.R.) ❖



TAB/McGraw-Hill NEW & BESTSELLING BOOKS

REPAIR AND MAINTENANCE

TROUBLESHOOTING AND REPAIRING SOLID STATE TVs, 2nd edition
Davidson 0.8306.3893.8 RRP $41.95
Homer Davidson ran his own radio and TV repair business for 38 years. Packed with examples, photos and diagrams for every kind of TV circuit, this book helps you pin-point and fix virtually any malfunction quickly and easily. Covers HDTV, stereo sound circuitry, modular chassis and large screen models. 605 pages.

TV REPAIRS FOR BEGINNERS, 4th edition
Zwick 0.8306.2180.6 RRP $37.95
Completely updated and illustrated with schematics and photos, this book makes it easy to find and correct a huge variety of problems on all types of set. It even guides you on which repairs you can safely do yourself and which need professional help. 354 pages.

TROUBLESHOOTING AND REPAIRING VCRs, 2nd edition
McComb 0.8306.3777.X RRP $34.95
McComb explains to the technician how to carry out routine maintenance, and supplies flowcharts for faultfinding and repair. He even covers problems not caused by the VCR, like anti-copying signals! 412 pages.

HOME VCR REPAIR ILLUSTRATED
Wilkins 0.8306.3711.7 RRP $37.95
Most VCR problems are caused by one component that is worn, loose, bent or dirty. Save money by doing the repair yourself—you don't need expensive tools or test equipment! Detailed photos illustrate how to find and correct most common VCR problems. 383 pages.

TROUBLESHOOTING AND REPAIRING CAMCORDERS
Davidson 0.8306.3337.5 RRP $42.95
Gain a profitable new skill fixing home video cameras! This book contains all you need to know about cassette problems, automatic iris, white balance and focus, servo circuits, motors, audio circuits and mikes—and much more! 533 pages.

LENK'S VIDEO HANDBOOK: Operation and Troubleshooting
Lenk 0.8306.4072.X RRP $44.95
The all-in-one guide to consumer video! Includes chapters on colour and b/w monitors, Beta and VHS VCRs, cameras, camcorders and 8mm video, featuring operating procedures, circuit theory, sample test and adjustment procedures, simplified circuit diagrams and a logical troubleshooting approach. 384 pages.

TROUBLESHOOTING AND REPAIRING COMPACT DISC PLAYERS
Davidson 0.8306.3107.0 RRP $32.95
All the latest technology used in component, portable and in-car units is here. The manufacturers provided the literature and schematics used in this book, so you'll be able to repair servo control loops, remote control systems, optical lenses and laser assemblies, and the rest! 338 pages.

MICROWAVE OVEN REPAIR, 2nd edition
Davidson 0.8306.3457.6 RRP $37.95
All there is to know to efficiently repair microwaves, and it is PRACTICAL, using only the bare minimum of theory. With hundreds of detailed working illustrations and photos and step-by-step instructions. 370 pages.

TROUBLESHOOTING WITH YOUR TRIGGERED-SWEEP OSCILLOSCOPE
Goodman 0.8306.3891.1 RRP $35.95
Are you getting the most out of your oscilloscope? They now do a lot more, but are easier to use—if you know how! This is an invaluable practical guide to using all the functions of your triggered-sweep oscilloscope, or to choosing one if you're thinking of buying. 309 pages.

PROJECTS AND GENERAL

GORDON McCOMB'S GADGETEER'S GOLDMINE! 55 SPACE-AGE PROJECTS
McComb 0.8306.3360.X RRP $35.95
If you're ready to move up to (or already into) high-tech experiments with lasers, fibreoptics, power supplies, high voltage devices and robotics, look no further! Build your own plasma sphere generator, make holograms and lots more projects. 406 pages. **Warning! High voltages can be dangerous!**

THE ROBOT BUILDERS BONANZA: 99 Inexpensive Robotics Projects
McComb 0.8306.2800.2 RRP $29.95
This guide offers a complete collection of proven project modules that you can mix'n'match to create an almost endless variety of highly intelligent and workable robots. For novices and intermediates, you'll find all you need to build a typical robot—body and frame, power and locomotion, hands and arms, eyes and ears, navigation and control. 326 pages.

ALARMS: 55 ELECTRONIC PROJECTS AND CIRCUITS
Rakes 0.8306.2996.3 RRP $24.95
Smoke and fire alarms save thousands of lives every year. Tripped burglar alarms scare off would-be intruders. Now you can secure your home or car with this book and its tips and advice for building and installing each project. Also includes temperature, flood, radiation alarm circuits and more. 170 pages.

HOME REMOTE CONTROL AND AUTOMATION PROJECTS, 2nd edition
Horn 0.8306.2196.2 RRP $31.95
Complete instructions and diagrams for 77 projects to make life easier! Plans include intruder detectors, flood and temperature alarms and automated lighting. There are also sections on potentiometer ICs, stepper motors, timers and using personal computers for control. 301 pages.

DESIGNING AND BUILDING ELECTRONIC FILTERS
Horn 0.8306.3933.0 RRP $29.95
Whatever sort of filter you're interested in, you'll find it here. Simplified maths with examples and practical circuit plans show you how to build almost every kind of filter, from passive low-pass to active band-reject, from state-variable to voltage controlled and digital filters. 300 pages.

THE RADIO AMATEUR'S DIGITAL COMMUNICATIONS HANDBOOK
Mayo (KR3T) 0.8306.3362.6 RRP $28.95
Whether you're a beginner or an experienced packet radio enthusiast, this handy guide has all the information you need. All major digital modes are included, with protocols and procedures. It also shows you how to equip or improve your own station. 208 pages.

MASTERING TECHNICAL MATHEMATICS
Crowhurst 0.8306.3438.X RRP $47.95
Originally a 4-volume set, this book gives better understanding by explaining how and why math principles work. Includes step-by-step illustrated instructions and alternative methods for solving problems. A practical self-teaching guide to technical mathematics—from counting to calculus. 586 pages.

All books are softcover.
Prices and availability are subject to change without notice.
RRP = Recommended Retail Price.

MONEY-BACK GUARANTEE—ORDER FORM

Name: ____________________

Company: ____________________

Address: ____________________

____________ P/code: ________ Ph: ________

I enclose payment now by: ❑ Cheque ❑ Visa ❑ Bankcard ❑ Mastercard ❑ AMEX

Card number ____________ Signature: ____________

Expiry date __/__/__

* If not completely satisfied, books can be returned in resaleable condition within 21 days of date of invoice for a full refund.

Qty	ISBN	Author	Title	RRP$

Postage & Handling	$6.00
TOTAL$	

MAIL or FAX TO: McGraw-Hill Book Company Australia Pty Limited
4 Barcoo Street Roseville NSW 2069 A.C.N. 000 473 674 Telephone: (02) 417 4288 Facsimile: (02) 417 5687 **92EA10**

Construction Project:

HIGH QUALITY STEREO AMPLIFIER USING VALVES - 2

In the first of these articles, the author explained the philosophy behind the project, and described in detail the circuit design and operation. This month he moves on to cover the construction and testing of the amplifier. As he explains, the design is quite straightforward and should not give any problems providing you follow the steps described.

by TEAN Y. TAN, B.E. (Hons.)

To ensure that constructors don't experience any problems getting the parts to build this amplifier (some of them are now rather harder to obtain than they once were!), I have made arrangements to source them myself, and supply them direct to readers as a kit.

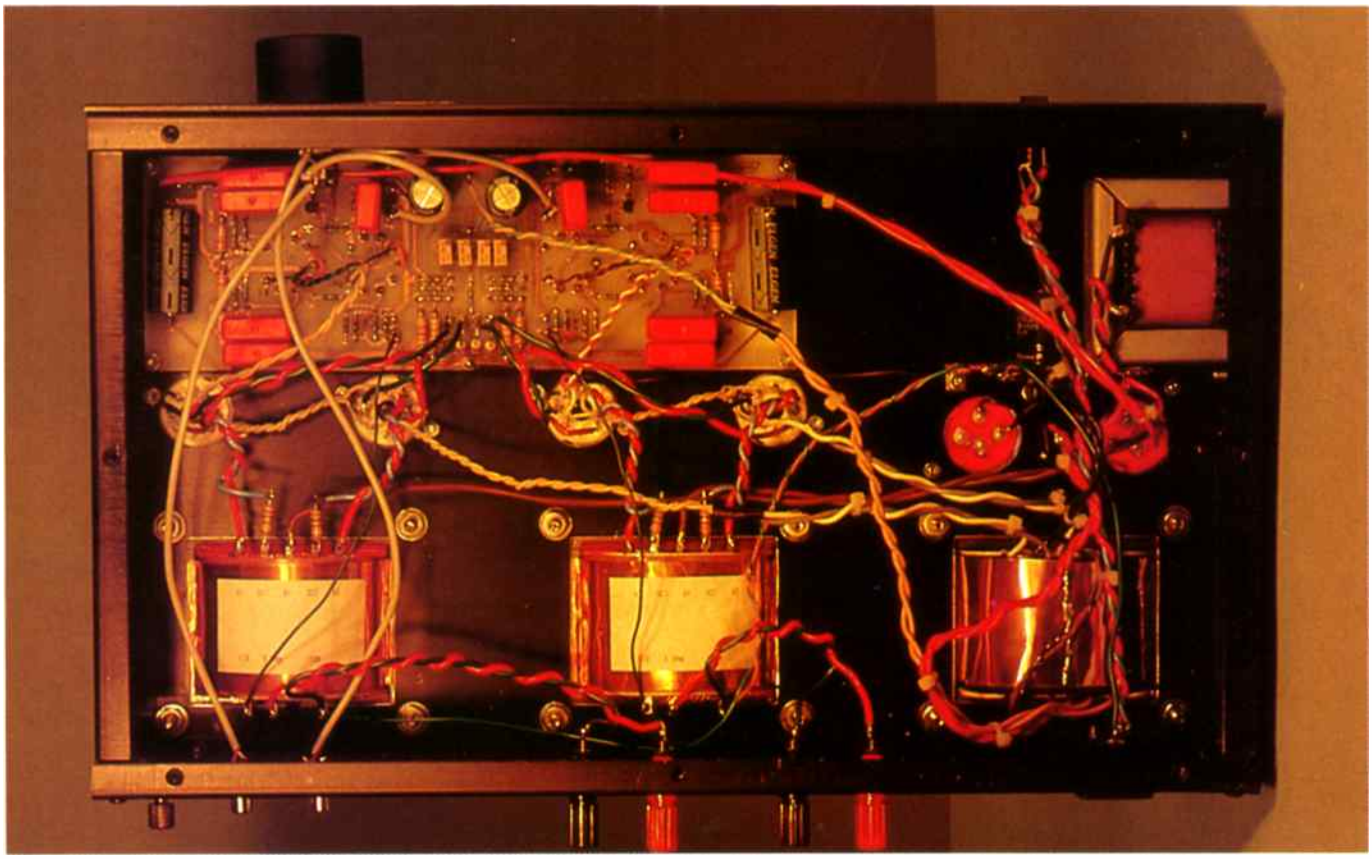
Only the highest quality components and parts are supplied, and the kit is complete as shown in the parts list. It even includes a special chassis, manufactured in Australia.

I estimate that builders with some construction experience should not take more than 10 hours to build the amplifier. The tools required for the construction are a soldering iron, solder, screwdrivers, a small adjustable spanner, a multimeter and a jumper lead with alligator clips at both ends. The use of the last item will become apparent under the section on safety precautions.

The kit can only be obtained directly from Contan Audio; for further details please refer to the end of this article.

Safety precautions

It must be strongly emphasized at this point that builders must take due care when constructing this project. Unlike



Here is a general view looking under the chassis. The output and power transformers are visible at the bottom, near the rear, with the filter choke at upper right. The PC board at upper left supports all of the low level circuitry.

other amplifier projects using solid state components, the present design involves very high voltages — 350V AC on the secondary side of the power transformer and as high as 500V DC for some of the plate and screen wiring and components, quite apart from the usual 240V AC on the primary side of the transformer.

All of these voltages are potentially very dangerous.

The following precautions should therefore be taken before applying mains voltage to the amplifier, and making subsequent measurements:

1. The mains earth should be connected to the chassis, in a reliable and secure fashion.
2. All of the 0V terminations shown on the schematic as going to chassis ground should be connected to the chassis. This will be elaborated upon in the next section.
3. The correct fuse must be inserted in the IEC socket fuseholder.
4. Use only *one hand* when measuring any voltages — preferably the right hand. The left hand should not be touching any part of the amplifier, or any earthed metal objects. The common terminal of the multimeter is connected to the chassis ground using the alligator jumper lead.
5. Switch off the amplifier before making any adjustments — e.g., changing components, or correcting any faulty soldered joints in the amplifier.
6. Do not plug in any valve when the power is ON.
   Always turn the power OFF before plugging in any tube; if necessary check the B+ voltage before plugging it in.
7. Do not make measurements unless you are wearing suitable footware. This means ideally rubber or plastic soled shoes, although leather-soled shoes are suitable if you are on a perfectly dry floor.

The builder should make sure that he or she takes the above safety precautions. The project is designed so that if constructed as shown, you should be able to measure any voltages on the amplifier without removing or touching any components, parts or the PCB. All the voltages are within easy access.

Construction

You are encouraged to build this amplifier step by step, using the following procedure to reduce the risk of making any mistakes.

By tackling the assembling in stages and testing as you go, any problems which may arise are likely to be isolated and located easily, before they result in any component damage.

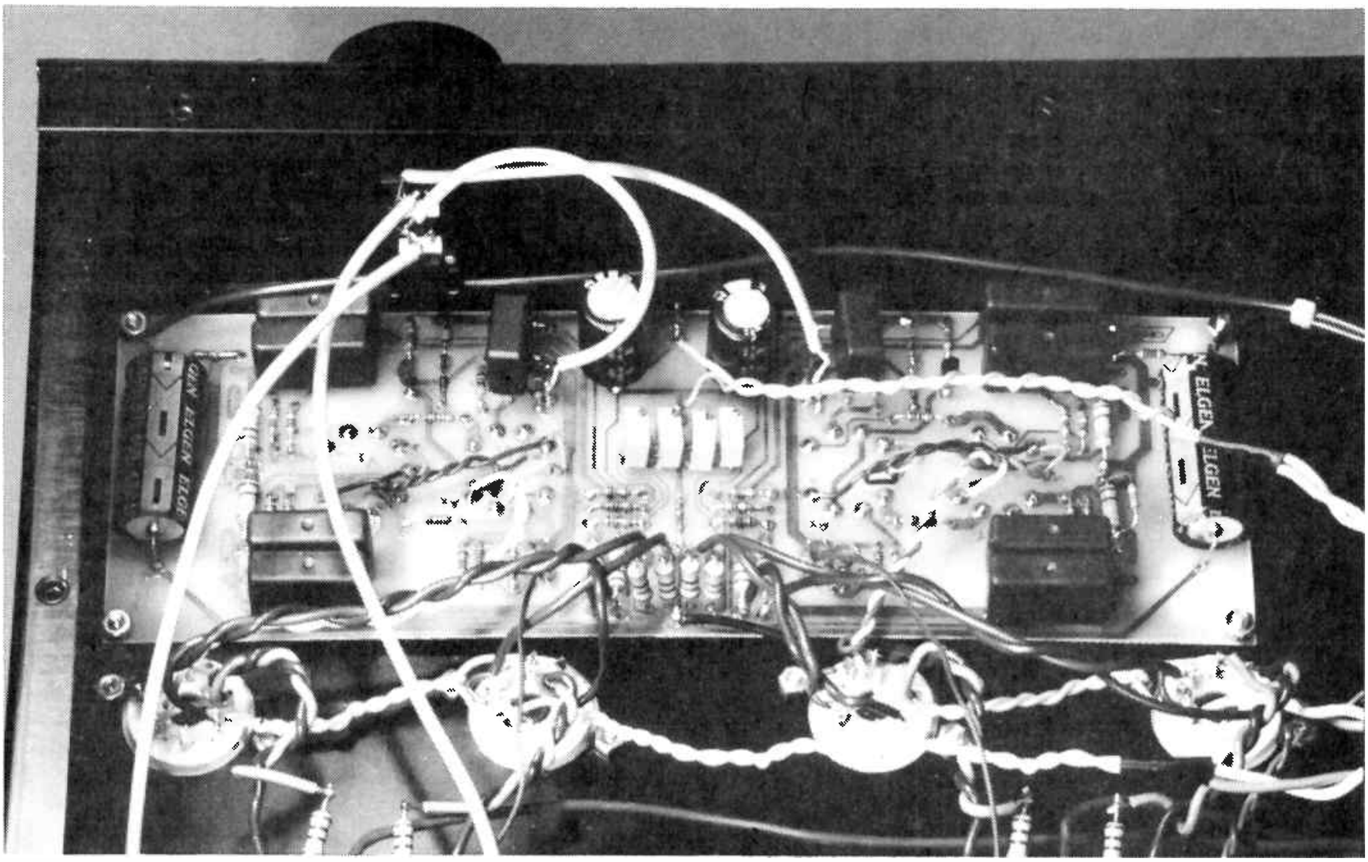
To help you in assembling the amplifier, we are providing a diagram showing the location of all parts mounted on the PCB (Fig.1), plus another showing the wiring between the PCB and all of the components mounted separately (Fig.2). These plus the photographs should make the assembly quite straightforward.

STEP 1: Mechanical assembly

First of all, mount the two pairs of octal sockets for the output valves (V3 and V4) underneath the chassis, with the socket rings and screws provided. Note the correct orientation (Fig.2).

Then mount and tighten the following components to the chassis:

A. The front panel.
B. The RCA input terminals.
C. The earth screw terminal.
D. The speaker terminals.
E. The IEC captive power plug and fuseholder.
F. The power switch.



Here's a close up of the PC board assembly, with the four output valve sockets just below it. Note the way that the valve heater wiring is twisted together, to minimise any external field and prevent hum injection into the signal circuitry.

G. The volume control pot, if you are fitting one.

H. The output transformers, together with their protective covers (provided). Refer to Fig.2 for the correct transformer orientation.

J. The power transformer, again with its protective cover. Fig.2 gives the correct orientation.

K. The 8-way terminal strip, for supporting C8 and C9, etc. Make sure that you scrape a small amount of the lacquer away from the inside of the chassis, around each mounting hole, and use a 'star' lockwasher between each foot of the tagstrip and the chassis, so that when the mounting screws are tightened, there is a really good metal-to-metal contact via the lockwashers and bared metal.

L. The filter choke L1. This mounts on the end of the chassis; ensure that the terminal connections are located underneath and not exposed.

M. The main reservoir electrolytic capacitors C10 and C11, with the rings and screws provided. Mount the rings underneath the chassis.

N. The main rectifier bridge B1. This mounts under the chassis between C10 and C11.

Before mounting, bend each lead carefully about 8-10mm from the body, into a small loop (say 2mm ID), to allow easy soldering of the connection leads. Then cut off any excess lead length. The bridge attaches to the chassis using a single machine screw, nut and lock washer.

This completes the assembly of the main items, apart from the PC board.

STEP 2: PCB assembly

A single PCB measuring 255 x 85mm is used to mount the majority of the smaller components, along with the sockets for the input and driver valves (V1, V2) for each channel. Note that the components are mounted on the same side as the tinned copper tracks, except for the valve sockets which are mounted on the reverse (top) side.

With reference to the circuit diagram and Fig.1, fit and solder the components in the following sequence:

A. All of the resistors, diodes and zener diodes. Note that the power dissipation for R1 and R2 exceeds 0.3 watts, under quiescent conditions, so for adequate ventilation, bend the leads of these resistors so that they mount about 3mm up from the surface of the PCB.

B. The valve sockets. These mount on the reverse side, orientated as shown in Fig.1 so that the pins pass through the holes in the PCB and solder to the pads on the copper side.

C. The BC546 transistors (one per channel — Q1).

D. The bias trimpots P2 - P5. Fit the centre two, P3 and P4 first, then the outer P2 and P5. Each trimpot should be mounted with its adjustment screw towards the front panel and C12/C13.

E. All of the electrolytic, coupling and bypass capacitors. Take care with the polarity of electrolytics C5 (x2), C12 and C13 — this is shown clearly in Fig.1.

With everything thus fitted to the PCB, you should now make a final check that everything is in its correct place and orientated correctly.

Then you are ready to mount the complete PCB assembly under the chassis, with the components facing inwards and the valve sockets passing through the clearance holes in the chassis.

Use the sticky tape provided as spacing, and fasten the PCB to the chassis firmly with the machine screws and nuts provided.

STEP 3: Hard wiring

You should now be ready for the 'hard' wiring — that which connects between the major items, and between the PCB assembly and the rest of the components.

The suggested sequence of wiring is as follows. Note that pairs of wires should be twisted together where appropriate, and that although the description below describes the wiring for one channel, both need to be wired up. Fig.2 should be used as a guide, along with the photographs.

A. First fit the 240V AC wiring between the IEC plug/fuseholder, the On-Off illuminated power switch and the primary connection lugs of the power transformer. Make sure that this wiring is all in suitable cable, with mains-rated insulation. Also fit the earth lead (green or yellow/green insulation) between the IEC plug's 'E' lug and the earth lug at the L1 end of the terminal strip, so that it makes a reliable connection to the chassis.

2. Connect the high voltage (350V AC) secondary winding of the power transformer to the bridge rectifier B1, as shown in Fig.2, and then complete the HT supply wiring involving C8, C9, C10 and C11, L1, R29 and R30.

Double check your wiring, to make sure you have not made any errors. Do NOT connect the output of this supply to the PCB, as yet.

The following step is advisable, but not compulsory; it involves powering up the amplifier at this stage, to check that the correct HT voltage is being produced. If you do this, first connect your multimeter carefully between the chassis (earth lug of the tagstrip) and the '+' side of C10, with the multimeter set to its 1000V DC range.

Then connect the mains cord, and apply the power. The meter should read approximately 500V, if all is well with your wiring. If the voltage is correct, remove the power and allow the capacitors at least 20 minutes to discharge before proceeding further.

The only way to avoid this wait is to fit an additional temporary discharge resistor from the '+' terminal of C10 to chassis, BEFORE applying the power for the test.

A 100k, 1 watt resistor used in this way will reduce the capacitor discharge time down to about two minutes. Don't forget to remove this resistor, though, after it has done its job.

By the way, while you are carrying out the above test, you can check that the On-Off switch is illuminated when power is applied.

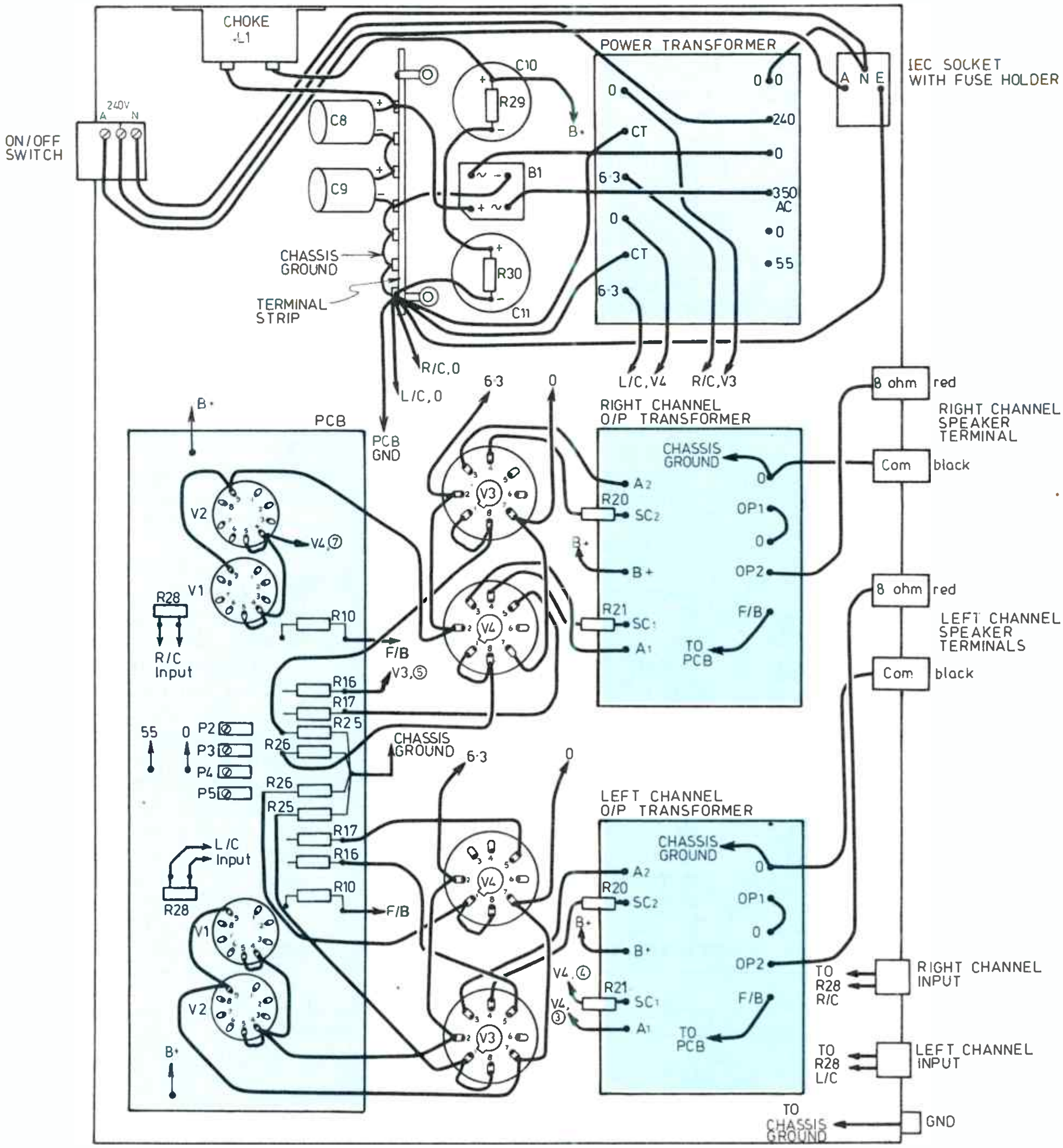
3. Wire up the output valve heaters, for V3 and V4 in both channels. Connect lugs 2 and 7 of each V3 socket to the same lugs on the V4 socket in the same channel, and then connect pins 2 and 7 of the socket nearer the power transformer, for each pair, to the outer lugs of one of the 6.3V heater windings (i.e., the '0' and '6.3V' lugs). In other words, the heaters for the output valves of the right channel go to one winding, and those of the left channel to the other winding.

Note that the centre-tap (CT) of each heater winding on the transformer must be connected via a short insulated wire, to the 'chassis ground' lug of the main tagstrip. The heaters for V1 and V2 of each channel are then connected to the output valve heaters for the same channel.

Lugs 4 and 5 of each V1/V2 socket are connected together, and connect to say lug 2 of V3 or V4, while lug 9 of V1/V2 connect to lug 7 of V3 or V4.

All of the heater wiring is shown in basic form in Fig.2. However it is very important to *twist together* each pair of

[illegible]



Use this overall wiring diagram as a guide in making the connections between all of the main items, and also between the PC board and the rest of the circuit. Note that for clarity, the heater wiring is not shown here twisted together. Note too, that the wiring for the optional volume control is not shown — but is clearly visible in the photographs.

Valve Amplifier - 2

(insulated) wires used to make the various heater connections, from the power transformer to the output valve sockets, between the output valve sockets and to the V1 and V2 sockets. This is necessary to prevent induction of hum into the signal circuitry.

4. Connect lug 3 (plate) on each V3 socket to the 'A2' lug on its corresponding output transformer; then connect lugs 4 (screen grid) on each V3 valve socket to the matching 'SC2' lugs of the transformers, via resistors R20. When this is done, connect lugs 3 of the V4 sockets to the 'A1' lugs of the matching output transformers, and finally connect lugs 4 of each V4 socket to the remaining 'SC1' lugs respectively, via resistors R21. Again these connections are shown in Fig.2.
5. Connect lugs 5 (control grid) of each V3 socket to R16 of each channel, on the PCB, and lugs 5 of each V4 socket to the corresponding R17. Then connect lugs 1 (suppressor grid) and 8 (cathode) together on each V3 and V4 socket, and connect each V3 socket's lugs to the R25 for that channel (on the PCB), and each V4's lugs to the corresponding R26.
6. Connect the 'B+' lug of each output (O/P) transformer to the positive terminal of C10.
7. The output transformers are optimized for either eight ohms or two ohm loads. (For those who require four or 16 ohms, please ask for a different transformer type.) It is believed that the transformers supplied will cater for over 90% of users, as most modern speakers are nominally of eight ohms.

For eight ohm operation, connect the two secondary windings of each output transformer in series, as shown in Fig.2. For two ohm speakers, the connections should be connected to parallel — that is, connect 'O' to 'O' and 'OP1' to 'OP2'.

Once you've connected the two output windings together in either series or parallel, then wire them to the speaker terminals as shown, and connect each 'common' speaker terminal to the chassis earth.

8. At this stage, DO NOT wire the feedback (F/B) lugs of each output transformer to the PCB. This is done later, after troubleshooting the circuit.
9. Connect the 'B+' pad at each end of the PCB (next to R22) back to the positive terminal of reservoir capacitor C10. Also connect the '0' pad at the centre rear of the PCB back to the chassis ground lug of the tagstrip.
10. Connect '55V' and '0' pads on the PCB (between C12 and C13) to the similarly marked terminals on the power transformer.
11. Connect the RCA input connectors to the PCB inputs, using shielded leads (outer braid to earth). Note that when the volume control pot is not fitted, resistors R28 are connected across the PCB input lugs along with the leads from the input connectors.
12. Connect the earth terminal to the chassis ground.
13. Connect the copper flux reduction straps of each transformer (three total) to chassis ground, also.

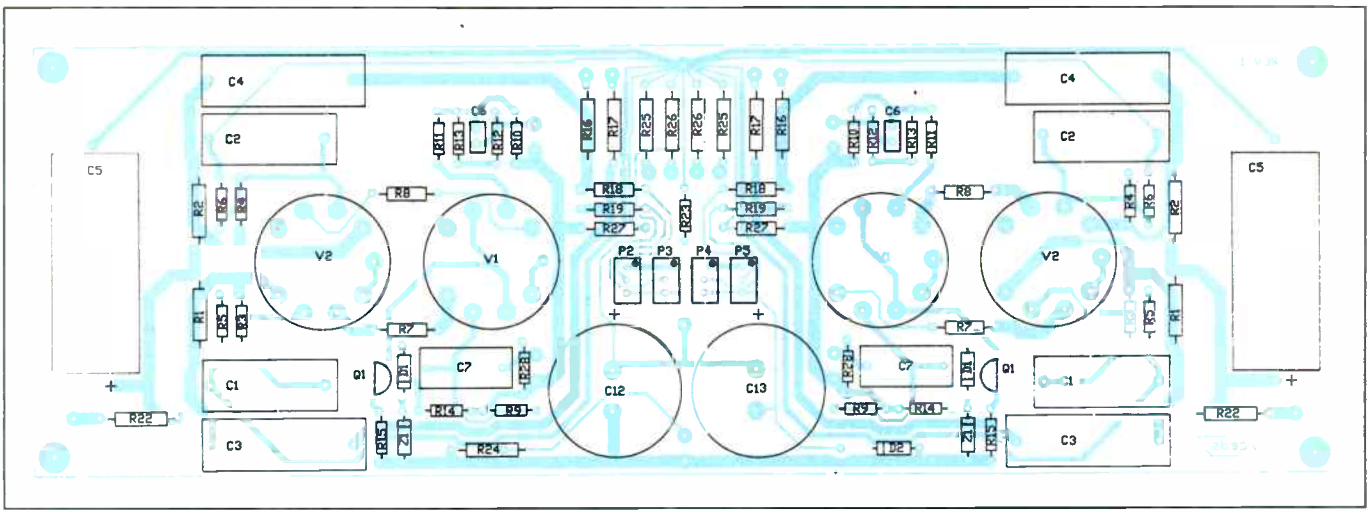
The amplifier should now be fully assembled, but before going any further I suggest that you check the above steps again to ensure that nothing has been missed.

Testing time!

Now it is time for you to test whether everything has been wired correctly. As discussed earlier, the safe method to perform any measurements is to have the common terminal of the multimeter connected to chassis ground, via the aligator jumper lead.

First, plug in the valves V1 and V2 for both channels. DO NOT plug in the power tubes just yet. Then apply power to the amplifier, and the following voltages should be checked with the help of the circuit diagram:

1. The B+ (at say the + terminal of C10) should be about +495V DC +/-10V.
2. The B- (at the junction of C13, D2 and R24) should be about -77V DC +/-2V.
3. The emitter voltage at each transistor Q1 (where it connects to R15) should about -50V DC +/-2V.
4. Pins 1 and 6 of V2 should about +220V DC +/-10V DC. Note that this voltage will change when the power tubes are plugged in, as the B+ drops. As discussed in part one, the difference in voltage between pin 1 and pin 6 can be as high as 20V DC, due to mismatch of the valves. By swapping the valves around, it is possible to minimise this voltage difference.
5. The bias voltage for each output valve should be adjusted via the appropriate trimpot. Pots P3 and P5 control the bias current for the V3 valves, while pots P2 and P4 control the bias for each V4. Before plugging in the output valves, the pots



Placement of all of the parts in their correct places on the PCB should be a straightforward job using this overlay diagram as a guide. Note that all components except the valve sockets are mounted on the copper side.

[illegible]

should be adjusted such that the voltage at lug 5 of each output valve socket measures approximately -44V DC. This is to set the bias current for each output valve to not more than 40mA when they are plugged in.

When you have performed all of the above tests and adjustments, you are ready to turn off the power and plug in the output valves. Then you can turn on the power again, and after waiting for them to warm up (allow say one minute), re-check the main voltages.

With the output valves plugged in the B+ at C10 will normally have dropped to about +475V DC, while the voltage at pins 1 and 6 of each V2 should be between about +180V and +200V DC.

Trimpots P2, P3, P4 and P5 should now be adjusted so that the quiescent cathode current for each output valve is set initially to about 30mA. The builder can experiment with other current levels later, once the amplifier is operational (although I suggest that you do not use currents higher than 60mA, as this would considerably shorten valve life).

The easiest way to monitor the cathode currents is by measuring the voltage at each valve cathode (lug 8 on each V3/V4 socket) — this reflects the voltage drop across the 10 ohm cathode resistors R25/R26.

For 30mA, each trimpot should be adjusted to produce +300mV at the appropriate cathode lug. Make sure you check and if necessary adjust the voltage at each of the four cathodes.

If all is well so far, you are now ready to connect the negative feedback to each amplifier channel. Turn off the power, wait 30 seconds or so and then connect the 'F/B' lug on each output transformer to resistor R13 for that channel, on the PCB.

Use insulated hookup wire, of course. Then turn the power back on. If there are no funny noises from the output transformers, then the polarity is correct. Otherwise there is a 180% phase shift between the output and input, resulting in positive feedback.

Troubleshooting

If the above voltages are not right, check the following:

1. If the B+ line measures zero volts, check the mains fuse. If the fuse is there but has blown, you may have a short circuit somewhere or have made a mistake in your connections. If the fuse blows again, when you replace it, there is almost certainly a short somewhere. Check your wiring around the rectifier bridge, the polarity of all electrolytics (especially C8, C9, C10 and C11), and the heater wiring.

PARTS LIST

Resistors

R1,R2	220k 1W 5% carbon
R3,R4,R5,R6,R9	1M 0.25W 1% metal film
R7,R8	100 ohms 0.25W 1% metal film
R10	510 ohms 0.25W 1% metal film
R11,R27	10 ohms 0.25W 1% metal film
R12	1k 0.25W 1% metal film
R13	22k 0.25W 1% metal film
R14	56k 0.25W 1% metal film
R15	12k 0.25W 1% metal film
R16,R17	2.2k 1W 5% carbon
R18,R19	470k 0.25W 1% metal film
R20,R21	1k 1W 5% carbon
R22,R23,R24	10k 0.25W 1% metal film
R25,R26	10 ohms 1W 5% carbon
R28	100k 0.25W 1% metal film
R29,R30	470k 1W 5% carbon

Capacitors

C1,C2	1uF 250V polycarbonate
C3,C4	0.47uF 400V polypropylene
C5,C8,C9	47uF 450V electrolytic
C6	39pF ceramic
C7	0.68uF polypropylene
C10,C11	680uF 250VW electrolytic (chassis mtg)
C12,C13	100uF 160V electrolytic

Semiconductors

D1	1N914/1N4148 signal diode
D2	1N4004 1A/400V rectifier
B1	BR1010 10A/1000V bridge
Z1	1N971B 27V/400mW zener
Q1	BC546 NPN transistor

Valves

V1	12AX7/ECC83 dual triode
V2	12AT7/ECC81 dual triode
V3,V4	6CA7/EL34 power pentode

Miscellaneous

T1	Power transformer, with cover
T2	Output transformer, with cover
L1	Filter choke, 1.5H
P1	Dual ganged 100k log pot, matched
P2-P5	50k 0.25W multi-turn trimpot
F1	IEC captive mains plug with 1A fuse
SW1	SPST 250V mains switch with neon

Four octal valve sockets; four miniature 9-pin valve sockets; four insulated screw terminals (two red, two black); two RCA audio sockets; one screw terminal for earthing; mains cord with 3-pin plug and IEC socket; one 8-lug tagstrip for mounting C8, C9 etc; hookup wire, shielded wire, mounting clips for large electrolytics, nuts, bolts, lock washers, solder etc.

If the B- line measures a positive voltage instead of the correct negative voltage, you have probably wired D2 the wrong way around. This may have caused damage to either D2 or C13.

2. If the voltages at pins 1 and 6 of V2 are too high, check that your heater wiring is correct — there should be 6.3V AC between pins 4 and 5 and pin 9, for each of valves V1 and V2 in each channel. Also check that the bias current is correct, by checking the correct orientation of zener diodes Z1 and signal diodes D1, and each transistor Q1. The voltage across each resistor R15 should be about 27V DC +/-0.5V.
3. If positive feedback occurs when you connect the feedback loops, then change over the wiring at the O/P transformer. That is, swap the wires connecting to the A1 and A2 lugs, and also those connecting to the SC1 and SC2 lugs. Normally this should not be necessary.

Listening tests

Now that you have finished the construction and testing of your amplifier, it is time to reap the reward and listen to it.

At normal listening levels, the sound should as described in part One. Otherwise, there is something wrong with your construction.

The slight brightness reported in part one of these articles is mainly due to the output valves. After replacing them the brightness should disappear altogether. The sound is now more balanced and as a result there is better imaging.

For those builders who like to experiment, there are a number of options worth exploring. Examples include setting the output valves for Class A operation and connecting them for triode operation. These options were discussed in part one. Free advice will be given to those who purchase the kit.

I hope you will enjoy building and listening to this amplifier, as much as I have enjoyed designing, testing and manufacturing it.

Obtaining a kit

As noted in the first article, kits for the Stereo 80 valve amplifier are only available from Contan Audio, of 37 Wadham Parade, Mount Waverley, Victoria 3149; phone (03) 807 1263.

The price of the kit, including all parts and valves, is $999 plus postage without volume control, or $1035 with the special matched dual-gang volume control. These prices include sales tax.

If required, the amplifier can alternatively be supplied fully assembled and tested for $1249 without volume control, or $1284 including volume control.

Individual parts for the design are also available, such as the output and power transformers, chassis, valves etc. Please ring for prices. All parts are guaranteed for one year, except for the valves which are only covered for six months. ❖

[illegible]

FORUM

Conducted by Jim Rowe

A reader who's really put some speaker cables under the microscope!

As I mentioned last month, our discussion of 'low noise' power cables a couple of months ago prompted a reader to send in a report of some fairly extensive testing he did to compare the performance of one of those much-vaunted fancy speaker cables with a couple of standard low cost cables. I think you'll find both his tests and the results quite interesting...

The reader concerned is Mr Brendan Jones, of Bondi Junction in Sydney, who is a professional engineer working in a fairly large local R&D laboratory. He explains in his cover letter that he decided to carry out the tests on speaker cables after being annoyed by the 'endless and ridiculous claims' being made for them. The idea was to put three types of cable through a series of comparative tests, to see just how different they really are.

The tests Mr Jones applied to the cables were those suggested by fellow readers of the 'Internet' electronic newsgroups 'rec.audio' and 'rec.audio.high-end', to which he apparently belongs. He notes that the cables were tested from a purely electrical point of view; there were no listening tests, due to the great difficulty in setting up a valid subjective test.

But I think that's enough introduction from me — let's give Mr Jones the floor. His report is quite long, and we don't have space to present it in its entirety; however I think we can present enough of it to make the exercise worthwhile. Here's his introduction:

In some hi-fi circles, much attention has been given to speaker cables as a possible source of distortion or colouration in delivering the signal from the power amplifier to the speakers. This has led to a number of high-end speaker cables being designed, that are claimed to overcome the inherent deficiences in their cheaper counterparts, and hence deliver a purer, cleaner and less distorted sound.

These high-end cables use materials and designs, such as special dielectrics, special design and arrangement of conductors, and conductors made of special forms of copper (e.g., oxygen-free copper or copper with aligned 'crystals'), that are claimed to give better performance.

The deficiencies in cheaper cables are often said to include:

- *High resistance per unit length;*
- *High dispersion (frequency spread);*
- *No consideration of the skin effect;*
- *Poor frequency response;*
- *Poor transient response.*

In order to test the significance of each of these parameters, three similarly constructed cables, but cables of quite different 'reputation' were electrically tested to ascertain their comparative performance using very accurate electronic test and measurement equipment.

The cables chosen were Monster Cable (around $10 per metre), 7.5A 240V mains flex (around $1 per metre), and a cheap generic 'figure 8' speaker cable (most commonly used for speakers, around 40 cents per metre).

All of these cables consist of helically wound fine wires in each bundled conductor, and each bundled conductor is insulated with some form of plastic or dielectric coating. The bundled conductors are then run parallel to each other and separated by a certain distance, in what is known as a 'figure 8' configuration.

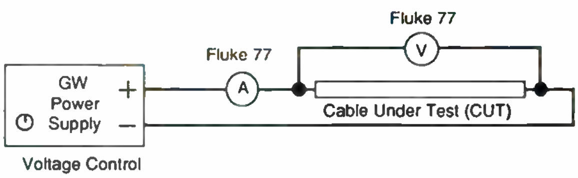
Parameters tested

Essentially there are four electrical tests that can be performed, that will provide a good basis for comparison of the three cables. These tests are:

(1) DC passive measurements
(2) Frequency and phase response
(3) Transient response
(4) Power compression

As the cable samples used were different lengths (from 2.5 to 4.5 metres), the results have been expressed as a 'per unit length' measure, to enable direct comparison wherever possible.

To perform the tests, an extensive array of quite accurate and powerful test equipment was assembled. The equip-



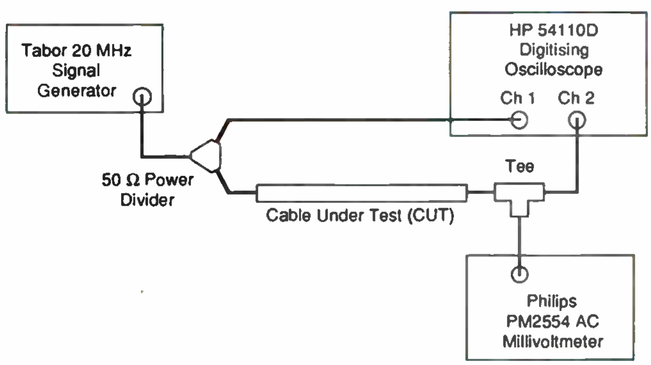
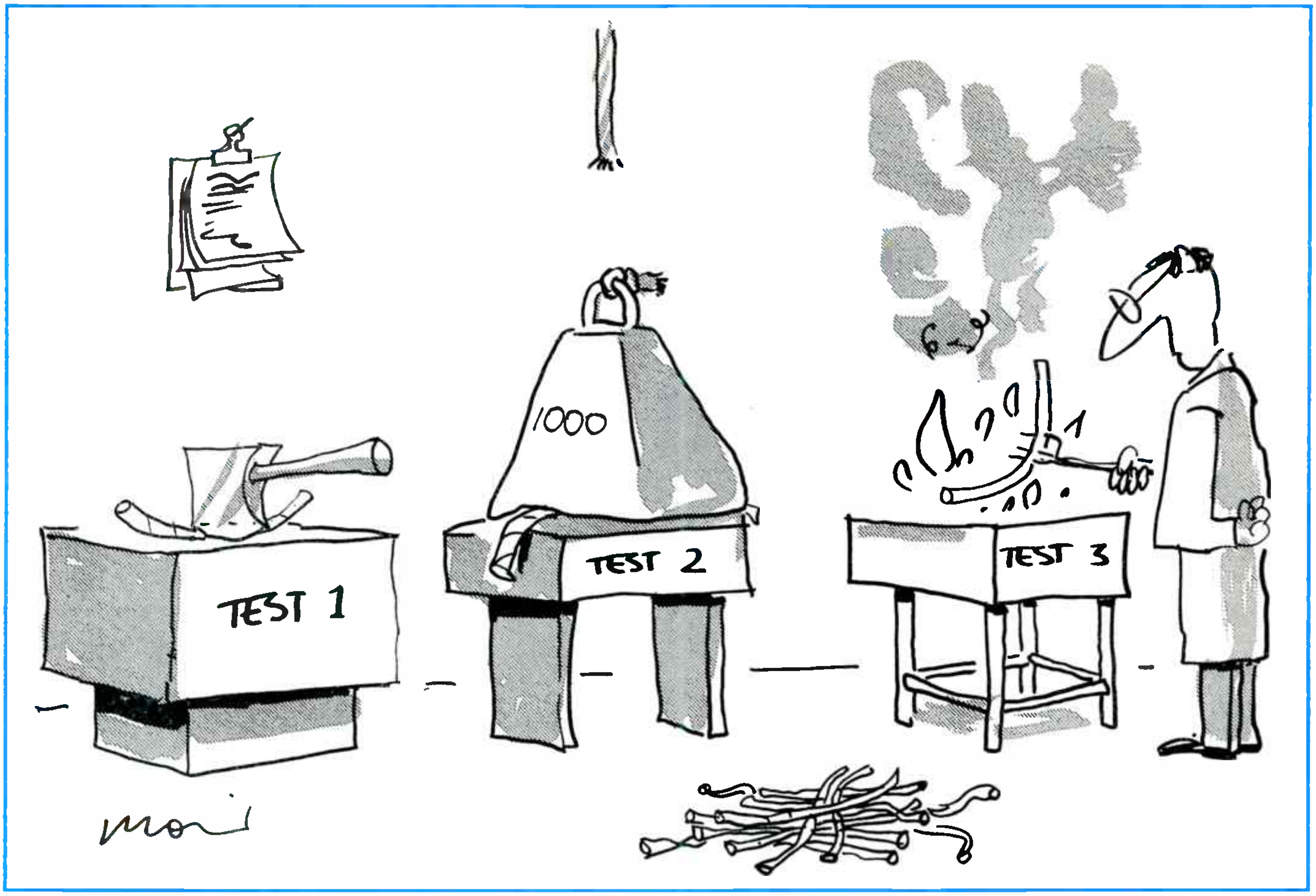


Fig.1 (above): The test setup used by Mr Jones to measure DC cable resistance.

Fig.2 (right): The setup used to measure cable frequency and phase response.

FORUM



ment used in each test segment is listed below:

(1) Fluke 77 multimeter; Parameters 7080B multimeter; GW dual tracking 3A laboratory power supply; HP8753B 3GHz network analyser.

(2) HP8753B 3GHz network analyser; HP54110D 1GHz digitising oscilloscope; Tabor 8200 20MHz function generator; Philips PM2554 2Hz-12MHz AC millivoltmeter.

(3) Tektronix CSA803 communications signal analyser with TDR head.

(4) GW dual tracking 3A laboratory supply; Fluke 77 multimeter.

Tests and results

The first tests Mr Jones carried out were those for the passive parameters of the cables — DC resistance, capacitance and inductance.

DC resistance was measured using the setup shown in Fig.1, using 3.5-digit Fluke 77 DMM's to measure the voltage drop of the cable at various current levels. The various readings were then averaged. Here's how Mr Jones' describes the results:

The Monster Cable had the lowest DC resistance per metre, of 15.9mΩ/m, but not significantly lower than the mains flex, which came in at 22.0mΩ/m. The generic figure-8 cable fared poorly at 114.2mΩ/m.

However the power lost in a speaker cable is not great (unless the cable run is very long) as a total cable resistance of around 0.1Ω for four metres of low resistance cable is fairly insignificant compared to the nominal speaker impedance of 8Ω (although the speaker impedance may vary greatly from this and have both capacitive and inductive components).

Lower cable resistance will largely manifest itself as a slight volume increase, as less power is lost in the cable. However, depending upon the complex source impedance (of both the power amplifier and the speakers), it may also effect the damping ratio of the speakers and 'muddy' the sound. Hence a rule of thumb would suggest that the lower the resistance of the cable, the better.

The capacitance of each cable was then measured, using the capacitance range of the Parameters multimeter. The results were:

Monster Cable:	49.8pF/m
Mains flex:	82.7pF/m
Figure 8:	45.9pF/m

Finally the inductance of each was measured at 300kHz, using the H-P network analyser. As Mr Jones notes:

This measurement is valid because the cables were short enough not to behave like transmission lines until about 10MHz. The wavelength of a 300kHz signal in these cables is around 700 metres, much longer than the 3 to 4m lengths used, and so any antenna or transmission line effects are negligible.

The measurements obtained were 699nH/m for the Monster Cable, 587nH/m for the mains flex and 141nH/m for the figure-8.

Next, Mr Jones measured the frequency and phase response of each cable over the range 10Hz - 10MHz, using the setup shown in Fig.2. The Philips AC millivoltmeter was used to measure the amplitude response, and the DSO to measure the phase response. Mr Jones notes here that:

The T junction does not disturb the time delay measurements, as the input impedance to the AC millivoltmeter is 1M. In the time delay measurements, there was a phase offset due to the difference in cable path lengths between the signal generator and the oscilloscope. This phase offset was calculated and removed from the results to give a true indication of the phase response of the cables alone. Note that at low frequencies, the phase offset became so small as to be difficult to measure accurately.

Hence below about 10kHz, the results were so close as to be virtually unmeasurable on the equipment used.

The frequency and phase responses so measured are graphed in Figs.3 and 4. It is evident from these graphs that the cables perform so similarly in the audio band (20Hz to 20kHz), with zero phase ripple and around 0.05dB attenuation ripple, that it is difficult to conceive of there being any audible difference on the basis of frequency response alone.

Note that a 0.05dB attenuation ripple means that the variation in power delivered to the speaker over the audio band is around 0.01%. It is very unlikely that this would be audible. Also, the ripples were so similar for each cable (mains flex was marginally the best), that no one cable has an advantage over another, in this respect.

It is also possible that this ripple is an artifact of the AC millivoltmeter precision. This is accurate to 1% from 10Hz to 400kHz, 2% from 400kHz to 6MHz and 4% from 6MHz to 12MHz.

While on the subject of frequency and phase response, Mr Jones also checked the dispersion characteristics of the three cables:

It is often claimed that the higher frequencies in an audio cable travel faster than the lower frequencies, and that this leads to signal 'smearing' unless the cable is designed to carry the higher frequencies on a longer physical path. This frequency smearing effect is called dispersion.

Electromagnetic theory indicates that firstly, it is not possible to carry different 'parts' of the audio signal on different conductors, and secondly that for such a frequency smearing to be audible, the required difference in propagation speeds across the audio band are ridiculously large. For example, if a 0.1° phase shift of a 20Hz signal relative to a 20kHz was audible, this would require the 20Hz signal to arrive at the far end of the cable 14us after the 20kHz signal. In 14us light travels 4.2km, so if the 20kHz signal travels at near the speed of light, this frequency smear is not even possible unless the speaker cable is longer than 4.3km!

The units of dispersion are s/Hz, and can be calculated by dividing the measured time delay difference over the corresponding frequency difference. Dispersion can also be expressed on a per-unit-length basis, as s/Hz/m.

All the cables had EXTREMELY small values of dispersion, of the order of picoseconds/Hz. This translates to a worst-case phase shift of a 20Hz signal to a 20kHz signal of around 0.1 MILLI degree per metre of cable. It is EXTREMELY unlikely this would be able to be detected by the human ear.

The figure-8 cable had the lowest dispersion of 0.44ps/Hz/m, with Monster Cable at 0.66ps/Hz/m and mains flex at 0.79ps/Hz/m.

The only conclusion possible is that audible 'cable smear' is extremely unlikely in copper cables at audio frequencies.

Transient response

Mr Jones then measured the transient response of the cables, using the Tektronix communications signal analyser with time-domain reflectometry (TDR) head. This produces a 10kHz square wave of 1V p-p amplitude, and a pulse risetime of 20ps (picoseconds). The idea was to measure the signal reflected from the end of a mismatched cable, to determine the propagation delay, characteristic impedance and transient response to an applied ultra-fast risetime pulse.

The cables were connected to the TDR head one at a time, initially with the far end open circuited. By measuring the reflected signal 'round trip' time delay and dividing by twice the length of the cable, its propagation velocity could be determined. The Monster Cable turned out to have the highest propagation velocity, at 71.8% the speed of light, with the mains flex next at 70.6% and the figure-8 slowest at 66.1%. As Mr Jones observes these figures 'are really of no consequence in an audio system, but they are interesting'.

The free end of each cable was then connected to a sampling head on the Tektronix, to measure the transient response of each cable to the 20ps risetime 1V p-p signal. Mr Jones reports here:

The results showed very little difference in the transient response in any of the cables tested. The cable rise times were 3.2ns for the Monster Cable, 2.2ns for the mains flex and 2.3ns for the figure-8 cable. These rise times mean that the cable response is adequate out to the tens of megahertz region, some nine octaves higher than the limit of human hearing.

The step responses showed the most marginal of ringing, the frequency of which would be very much higher than what the ear could hear. Hence the transient response appears to be an irrelevant factor in these cables.

Power compression

Mr Jones' final tests were designed to see whether any of the previous behaviour, which was all measured at relatively low voltage and current levels, might vary at the current levels which would occur in a typical hifi system. As he

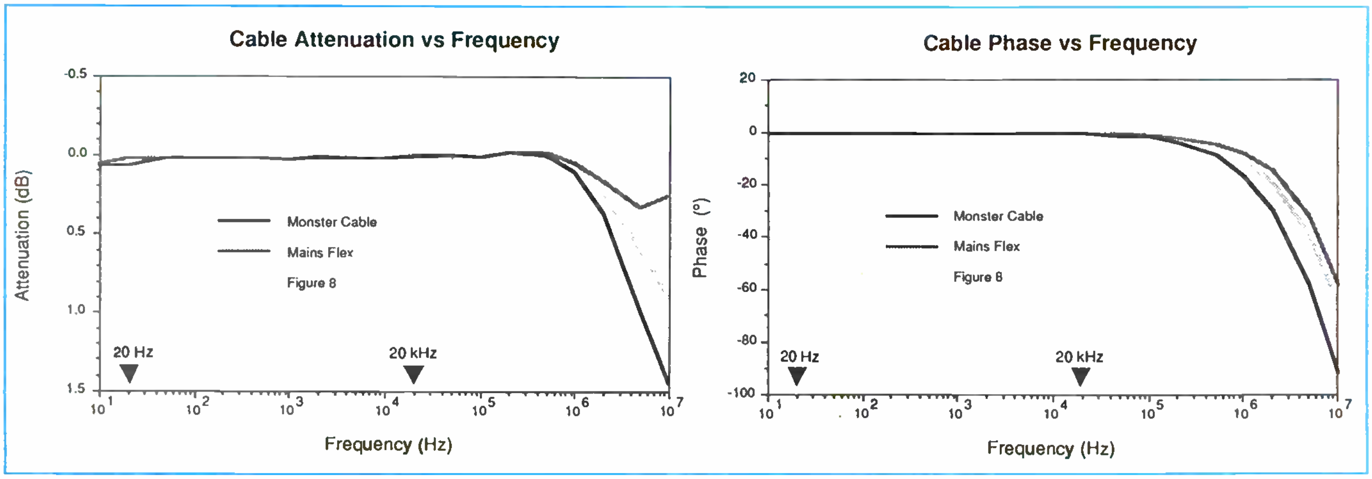


Fig.3 at left shows the measured frequency responses of the three cables, with their phase responses at right.

[illegible]

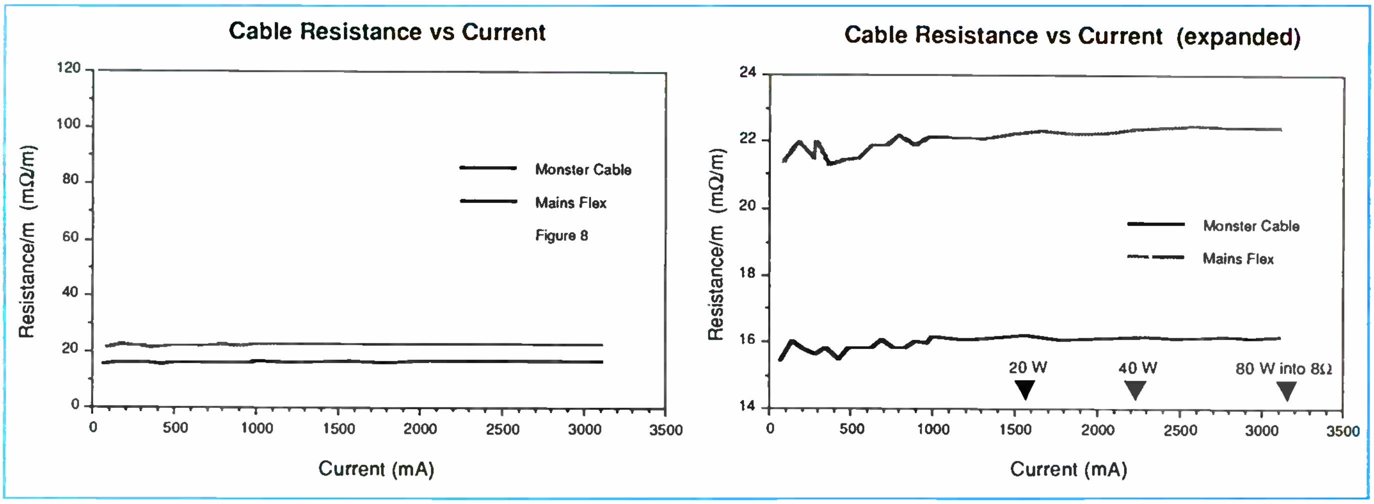


Fig.5(a) at left shows the variation in DC resistance/metre of the cables, at different levels of direct current, measured by Mr Jones to determine the likelihood of power compression. Fig.5(b) at right is an expanded view of the lower two curves.

points out, a power of 100W delivered into an 8Ω load requires an RMS current of 3.5A — so speaker cables typically carry quite appreciable currents.

First of all, the DC resistance per metre of the cables was measured at various current levels, from low levels up to a maximum of 3.11A (the maximum available from his supply). This corresponds to nearly 80W of power into an 8Ω load.

The results are plotted in Fig.5(a) and (b), and they show virtually no non-linear changes (the irregularities at low levels are due to limited precision in the voltmeter used). The figure-8 cable shows a 4% increase in resistance over the current range, while the other two show only about 1-2% increase — as well a having a significantly lower resistance anyway.

As Mr Jones notes, this result does not take into account any effects which might conceivably occur when AC is flowing, instead of DC. He then proceeds to discuss the possibility of nonlinearities due to skin effect, as some people have suggested:

The formula for skin depth in a good conductor is given by reference (1) as:

$$\delta = 1/\sqrt{\pi f \mu \sigma}$$

where f is the frequency, μ is the permeability of the material (for a conductor, $\mu_o = 4\pi * 10^{-7} H/m$) and σ is the conductivity (for copper = $5.8*10^{7} S/m$). δ in metres, and is the depth at which the electric field inside a conductor falls to 1/e, or 36.8% of its surface value.

At DC, the skin depth is infinite and hence the current density is uniform across the conductor. Skin depth is NOT dependant upon the absolute level of current, unless the media becomes non-linear.

At 20Hz the skin depth in copper is 14.78mm, and at 20kHz it is 0.467mm. As the individual conductors in the cables are a minimum of 0.06mm in radius, this means that at 20Hz the current density at the centre of the conductors is 99.9996% of that at the skin, whilst at 20kHz this drops to only 99.987%.

Thus the cables should behave as essentially uniform conductors all the way to 20kHz, and essentially no different to the way they behave at DC. Hence we can conclude that our low current measurements should still be valid at high currents up to at least 1MHz, where the skin depth becomes equal to the individual conductor radius.

However what is the effect of the presence of the other conductors in each bundled conductor? If the individual conductors have good electrical contact with each other (which they will, unless the strands are individually insulated, as in Litz wire), then each bundled conductor will behave similarly to a solid conductor of the same size. This makes a nonsense of the claim that staggered strand sizes are used to carry the different 'parts' of the audio signal — they effectively behave as a single conductor.

Conclusions

Mr Jones offers the following comments in his conclusion, at the end of the report:

The results indicated that of the five alleged deficiences in cheaper cables, only the first — higher resistance — is borne out by electrical measurement and electromagnetic theory. Claims with respect to the skin effect, cable dispersion, transient response and frequency response appear to be unsubstantiated.

Of the parameters tested, only the passive parameters (resistance, inductance and capacitance, or R, L and C) appear to be significant in an audio system, and of these resistance is probably the most important. Choosing a cable with a lower resistance will marginally improve the power transfer to the speakers and hence result in a slight increase in the speaker volume. This slight increase in volume is probably what most people will judge as 'better' in the allegedly superior cables.

A low resistance cable will also make the amplifier source appear 'stiffer' (i.e., give it a source impedance closer to zero), and hence make the amplifier more effective in driving the speaker cones faithfully.

The results suggest an interesting follow-up experiment. The R, L and C characteristics of a high end cable could be measured and effectively simulated with a lumped model consisting only of passive components, and then a double-blind test performed to see if audible differences could be detected between the high-end cable and its passive component model. If the results were negative, it would appear that the passive parameters are the ONLY parameters of importance, and hence any desired cable performance could be emulated by deriving the passive model.

In conclusion, if you want to choose a low resistance cable, then 10A or 15A mains flex or any other suitably high current capacity cable with large conductors or a large number of conductors will most likely perform more than adequately — and at a much lower price than Monster Cable or any other high end speaker cable.

In high-end systems where the L or C may be important, the source (amplifier) and load (speaker) response could be measured and then the R, L and C of a cable designed to give the overall fre-

(Continued on page 93)

[illegible]

[illegible]

[illegible]

Cellular radio technology update:

AOTC'S NEW CELLULAR MOBILE NETWORK - 2

In this second article explaining how the digital GSM cellular radio telephone system operates, the author describes the techniques that GSM uses to extend the battery life of mobiles, and also to overcome interference and minimise fading effects. He also explains why GSM offers far higher security than AMPS, and the ways in which it offers greater operational flexibility.

by ROBERT OWEN

Unlike the current cellular mobile telephone system AMPS, which uses 25kHz FM radio channels with each channel being able to transmit only one voice call, the GSM system will use 200kHz digital channels, with each digital channel being able to handle eight simultaneous voice calls.

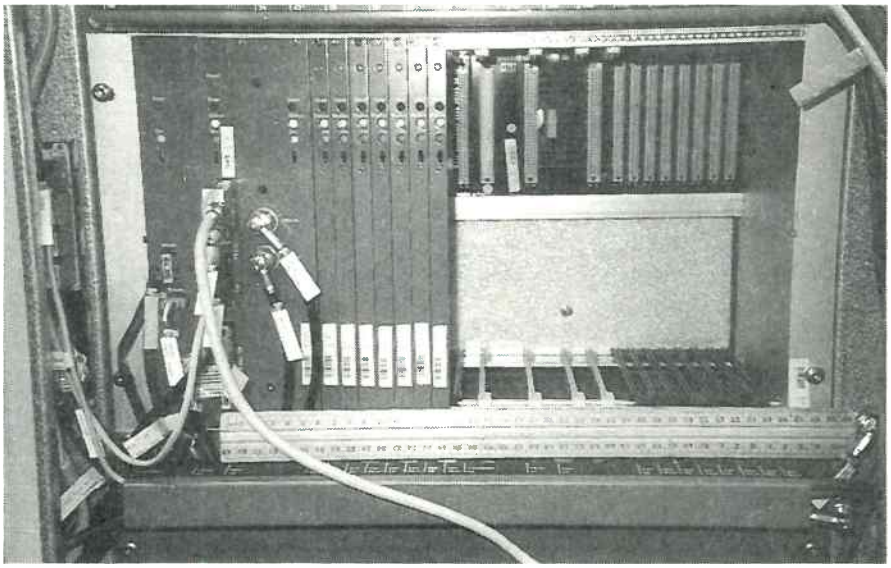
The method GSM uses to digitise the eight voice calls is similar to the way the public telephone network digitises and multiplexes 32 voice circuits over one pair of wires — see 'Our Evolving Network of Communications' in *Electronics Australia*, November 1991 to January 1992.

Suppose we have a cell radius of 30km. A transmission burst from a mobile station (a mobile phone) 30km from the base station (the cellular network's receivers and transmitters) would arrive 100 microseconds later than would be the case if the mobile station were located near the base station. To put a long guard period between each of the eight bursts would be inefficient, but on the other hand we cannot allow bursts from distant mobile stations to overlap bursts from nearby stations.

What GSM does is to measure the round trip delay from the base station to the mobile station and back to the base station — for a mobile 30km away, this would be about 200us.

The base station then sends a control message to the mobile station instructing it to retard or advance transmission of each burst, so that bursts arrive at the base station without overlapping adjacent time slots.

Using this technique, the time at which a burst arrives at the base station can be controlled to within 2us — approximately half a bit period.



Part of a GSM base station. The two plug in cards at far left are part of the radio transmitter and control channel circuits, while the large card in the middle contains the radio receiver. The seven cards to the right of this are identical, and each control one of the eight time-slots on a GSM frequency.

Even though frequencies are re-used every three cells, there is a possibility with high power mobile stations that a radio burst will travel across many cells and interfere with other users on the same frequency. To overcome this, the base station measures the signal strength of each mobile station operating within its cell, and instructs each station to lower its RF output power to a level just sufficient for the call to be clearly received by the base station.

Obviously, both timing and power output need to be adjusted continually as a mobile station moves through a cell. In order to perform this, each of the eight voice circuits in a GSM channel has a control circuit for this type of control information to be passed from the base station to the mobile, and vice versa.

The majority of mobile station transmissions will involve speech. Furthermore, because only one person at a time will be speaking, on average each one-way circuit will only be carrying voice for less than half the time.

To exploit this, the mobile station will contain a 'voice activity detector' that will distinguish between speech and silence (or background noise). Usually, only when the mobile subscriber is speaking will the mobile station transmit signals to the base station. Most of the rest of the time the mobile station will not transmit RF.

This gives two major advantages.

AT&T'S NEW CELLULAR MOBILE NETWORK - 2

Firstly, the time during which a mobile station can interfere with another station is approximately halved.

Secondly, for small hand-held phones where most of the power is consumed by the RF amplifier, battery life will be significantly extended.

If GSM used this technique alone, during silent periods the listener would hear nothing — not even the background noise associated with the distant subscriber. Switching from speech with its background noise to silence has been found to be highly disturbing to the listener. This is particularly the case as background noise from a mobile subscriber is likely to be high.

To overcome this, the voice activity detector extracts the background noise from the speech and periodically transmits to the base station the value of the background noise. Even though the value of the background noise is only transmitted over the RF circuit periodically, the base station will send to the listener regenerated background noise during the time that the other person is not speaking.

Anybody who has listened to FM radio while driving will have experienced fading due to multipath interference while passing large buildings. Fading during a cellular call is irritating to the listener and can result in calls being dropped.

Fortunately, fading is localised and does not usually extend more than half a wavelength. Thus at 900MHz — the frequency at which GSM operates — fading is unlikely to extend more than 17 metres.

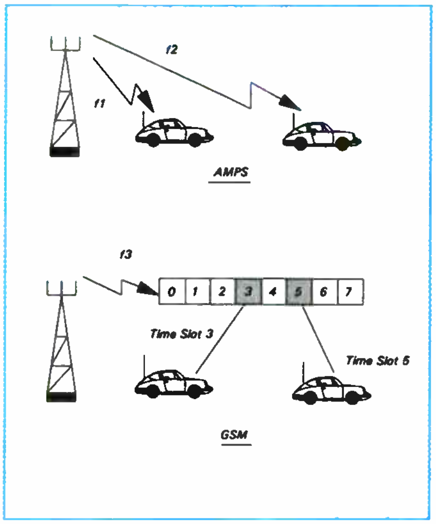


Fig.4: Whereas the AMPS system uses different frequency channels for each subscriber, the GSM system uses different time slots on the same frequency. Note that only one direction is shown.

Although this amount of fading is acceptable for vehicles travelling at highway speeds, some vehicles may remain in a particular frequency's fade region for some time — for instance while waiting at traffic lights, while moving slowly during rush hour or while standing with a hand-held phone.

To minimise the affect of fade, GSM designers have introduced a technique called *frequency hopping*. Because any fading at a particular location is likely to be restricted to a single frequency, it will probably only affect a single mobile station that happens to be located there. Base stations, instead of keeping mobile stations on a single frequency, will randomly change the transmit and receive frequencies for all mobile stations within a cell to other frequencies — 217 times each second.

Using this technique the effect of fade will be different for every burst; signal drop-outs will thus be short and can be compensated for by error correction techniques. Frequency hopping is independent of the change in frequency that occurs when a mobile station moves from one cell to another during a call.

Because fading at a particular location is unlikely to extend more than half a wavelength, at every base station there are two receiver antennas with a single transmitter antenna located between them. The two receiver antennas are used so that if one of the antennas is in a fade region, hopefully the other antenna will be able to pick up the mobile station's signal.

The fade pattern around a city due to signals from a base station is likely to be static, because the base station's antenna and large buildings are in fixed locations. Moving trains or large trucks could, however, cause temporary fading. At the base station's antenna, however, a particular frequency could fade in and out as the transmitting mobile station moves around. Fade and radio cover are the two most difficult problems that cellular radio engineers need to consider when planning a network.

One of the problems with the analog AMPS cellular mobile phone system was security. To encrypt an analog voice circuit was too expensive to be practical, and anybody could listen to a mobile phone call with a correctly tuned receiver. With GSM, however, the digital radio transmission makes encryption very simple.

Whenever a mobile station makes a call, the relevant base station sends a message to a central database requesting the encryption algorithm unique to that mobile station. This encryption algorithm is already stored in the memory of the mobile station. The encryption algorithm is then used to encrypt voice between the mobile station and base station.

If the subscriber passes through several cells during the course of a call, the encryption algorithm is changed automatically every time the mobile station is handed over to the new base station. Also, if a mobile station transmits in the same cell for a long period, the

GSM: A technical summary

In Australia as well as in Europe, the frequency ranges 890-915MHz and 935-960MHz have been reserved for GSM. The lower of these frequency bands is used for transmissions from mobile stations to base stations, while the higher band is used for base station to mobile transmissions. If a mobile station uses a frequency F(ms) to transmit to a base station, that base will transmit back to the mobile at a frequency F(bs) which is exactly 45MHz higher.

i.e., F(bs) = F(ms) + 45MHz

For example if the mobile transmits on 900MHz, the base station will 'reply' on 945MHz. The same time slots are used in both directions.

A frequency band in GSM is 200kHz wide. Therefore the theoretical number of frequency channels is:

(915 - 890) * 1000/200 + 1 = 126

In practice not all of these channels are available, since the top and bottom 200kHz channels are used as guard bands. Hence only 124 frequency channels are available.

Because each frequency channel can support eight time slots, the total number of simultaneous voice coils that can be handled are thus 124 x 8 = 992.

If an area is covered by repeating a pattern of seven cells, then each cell will be able to support 992/7 = 141 (approximately) simultaneous calls. This is because a frequency cannot be re-used in any of the other six cells making up the seven-cell pattern.

A base station typically has a cell radius of 35km and has an RF power output of 10 watts — although this could go up to 50 watts over difficult terrain or over the very large radius cells expected in rural areas. A hand-held mobile station used in a very small street-sized cell (called a micro-cell) would typically have an RF power output of about 100mW.

In order to keep the transmitted power of a mobile station to a minimum, a base station can command a mobile to reduce its power output.

A GSM mobile can alter its power output at the rate of 2dB every 60 milliseconds. Thus a mobile station can step through a complete range of 15 steps (30dB) in less than a second (900ms).

Unlike the public switched telephone network, which uses 64kbps digital channels to transmit speech, GSM uses voice compression and a data rate of 13kbps per time slot, to transmit speech with the same quality as the PSTN. GSM uses quadrature phase-shift keying (QPSK) to modulate the digital data onto the RF carrier.

AOTC's new cellular mobile network - 2

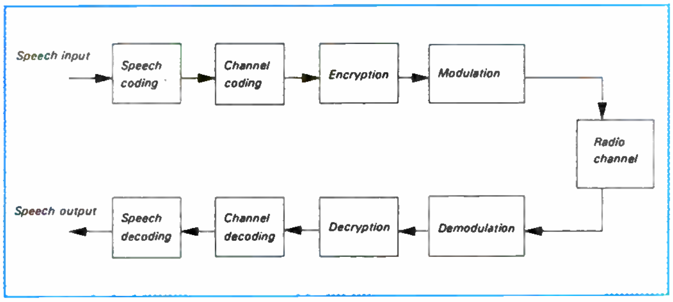


Fig.5: With GSM, the speech links involve coding and encryption as well as modulation on the transmit side, and decryption and decoding in addition to demodulation.

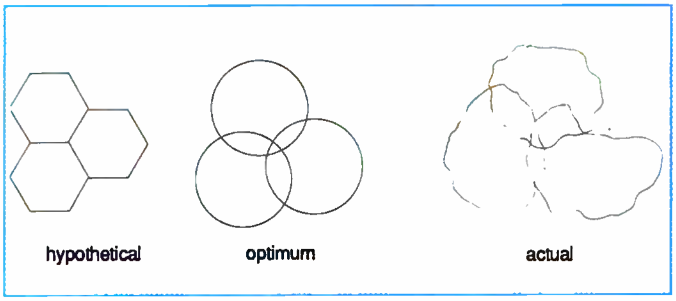


Fig.6: The hypothetical shape of each 'cell' is hexagonal, while the optimum shape is circular. The actual shape of cells is neither, of course, but varies considerably.

encryption algorithm is again changed periodically. Encryption, together with random frequency hopping, makes unauthorised interception of GSM calls very difficult.

Another problem with AMPS has been using the system to transmit data instead of voice. Because one AMPS call took up a whole RF channel, a break in transmission would disrupt any data being sent.

Every time a mobile station moved from one cell to another there would be a momentary break in transmission as the mobile station stopped communicating with one base station and started communicating with the new base station. Although the break in transmission was fairly quick — it can be detected by a careful listener on a voice call — it was long enough to disrupt a call that involved sending data.

With GSM, however, the digital transmission method ensures that any data being transmitted remains intact and that there is no break in continuity during handoff. This, together with other techniques such as error detecting codes, has ensured that GSM mobile stations can be used to transmit faxes and for other forms of data communications. Indeed, GSM is designed to be compatible with ISDN and can transmit data to or from a mobile station at 9.6kbps.

With the older AMPS, obtaining a mobile station was part of the subscription to the service — every subscriber had his own mobile station for personal use. Information such as the subscriber's identification number was stored on PROMs within the mobile station. Obviously this situation was inconvenient as it did not allow subscribers to use other mobile stations to make calls.

With GSM, the mobile station will not contain any information unique to a subscriber; instead, each subscriber will be given a 'smart card', called a *Subscriber Identity Module Card*, which can be inserted into any GSM mobile station in the same way that a banking card is inserted into an automatic teller machine. It will be the smart card that contains the subscriber's personal identification number, encryption algorithm and charging information.

Using a smart card makes the GSM system much more flexible for subscribers. For example, a GSM mobile station could be installed in every taxi; all the passenger would need to do to make a phone call would be to enter his smart card into the mobile station and any calls made would be charged to his own account.

Also, by inserting his smart card, the GSM system would know where the subscriber was located and route any incoming calls to the taxi's mobile station.

So far we discussed the use of GSM for both voice and data communications. Another feature soon to become available is the Short Message Service, which allows a caller to send to the mobile station a short alphanumeric message up to 160 characters in length. The Short Message Service is thus a form of paging.

If the message is being sent to a mobile station that has been turned off or is out of radio range, the cellular system will store the message and transmit it to the mobile station when they resume contact with the network.

In these two articles we have seen how the new GSM system will considerably increase the sophistication of AOTC's cellular radio network. To the subscriber it will give better speech quality, greater reliability and a wider range of features; to AOTC it will give better frequency usage and a more manageable network.

Australia, by being one of the first countries in the world to implement GSM is again showing itself to be a leader in telecommunications. ❖

AMPS: Technical basics

The frequency bands used for the current AMPS analog cellular phone system are 825-845MHz (mobiles to base) and 870- 890MHz (base to mobiles). As with GSM, base stations return a call from a mobile on a frequency exactly 45MHz higher.

The AMPS system uses frequency channels 25kHz wide. Hence there are a theoretical total of

$(845 - 825) * 1000/25 + 1 = 801$

available frequency channels. Only one voice call may be made per frequency channel, in any adjoining group of cells.

The AMPS system uses analog FM transmission.

NOTES & ERRATA

STOP PRESS: A $40 RECEIVER FOR WESAT RECEPTION!

Have you been interested in trying to receive weather satellite images, but put off by the price of a suitable receiver?

Well, your problems appear to be solved. Tom Moffat, who designed the Wesat decoder described in our June-July-August 1992 issues, reports that he has discovered a readily-available receiver which is fine for Wesat reception, but costs only $39.95.

The receiver is the Digitor Multi-Band unit sold by Dick Smith Electronics, as catalog number D-2838. Tom has found that this set not only tunes the vital 137MHz band, but has adequate IF and FM detector bandwidth to give undistorted reception of Wesat signals.

Tom says the set's sensitivity isn't quite up to the job, but if used with the WIA 'VK5' preamp as discussed in the August article, it works surprisingly well with Wesat signals in the sub-microvolt range.

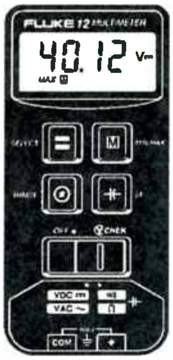
Currently Tom is testing the Digitor set further, and is also on the lookout for other low cost sets that may be suitable. We hope to publish the results of his investigations soon, so stay tuned!

OBIAT PTY LTD YOUR ONE STOP DISTRIBUTOR OF TEST & MEASURING INSTRUMENTS

Fluke 10 Series – The only thing Fluke skimped on is the price!

For high performance at the lowest price, get your hands on a Fluke 10 Series...

- New V Chek™ determines continuity/ohms. Most of the time it's the only setting you'll need!
- New Min/Max recording with relative time stamp and Continuity Capture™.
- Autoranging with manual option
- Sleep Mode shuts down automatically.
- Capacitance from 0.001µF to 9999µF.
- Safety to UL1244, IEC1010, CSA and VDE
- Fast and accurate to 600Vac or dc plus ohms to 40MΩ



Fluke 10
4000 count digital display • 1.5% basic Vdc accuracy • Fast continuity beeper • Diode test • Sleep Mode • Two year warranty

Fluke 11
Adds V Chek™ • Capacitance 0.001 to 9999µF • 0.9% basic dc volts accuracy

Fluke 12
Adds Min/Max recording with relative time stamp • Continuity capture™

Call us for the best prices on all Fluke Instruments. As one of Australia's largest distributors of Fluke, we wont be beaten on price!

Fluke 80 Series - the most popular Multimeter ever made by Fluke.

The Fluke 80 series is the first multimeter that can be truly called "multi".. it offers not only standard features, but special functions usually limited to dedicated instruments,plus innovations only Fluke can bring you. Like duty cycle measurement; or automatically store the highest, lowest and true average (mean) of readings for a few seconds or up to 36 hours; or record maximums and minimums for days; or the audible MIN MAX Alert™ that beeps for new highs or lows.

- ***Min/Max/Average recording stores highest, lowest and true average of all readings***
- ***Selectable response time to record turn-on surges or drift etc***
- ***1ms peak Min/Max hold on 87 to capture elusive transients or half-sine surges to 400Hz***
- ***Audible Min/Max Alert™ signals readings above or below previous limits***
- ***Splash and dust proof and impact resistant case***

83
• Volts, Amps, Ohms, diode test, continuity, frequency and duty cycle, capacitance, Touch Hold™, relative, protective holster • 0.3% basic dc accuracy • 5kHz Vac • Analog bargraph with zoom • 3 year warranty

85
• 0.1% accuracy • 20kHz Vac

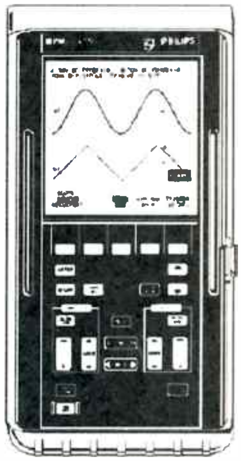
87
• High resolution analog pointer • True rms ac • 1ms peak Min/Max • 4 1/2 digit mode • Back lit display

FLUKE
Made in USA

Philips 90 Series – 50MHz Bandwidth Digital Storage Scope plus...

PHILIPS

- 25MS/s 2 channel digital storage
- 8-bit,25 levels/div vert. resolution
- 10ns/div to 5s/div timebase
- Store 8 waveforms (95 & 97) and 10 set-ups (97)
- Measuring cursors (95 & 97)



...Full 3000 count DMM

- Functions include Min/Max, Touch Hold™, Relative & %, Autoranging etc
- dBm, dBV and dBW (95 & 97)
- 5 Soft Keys/Pop-Up Menus
- 12cm 240x240pixel Super Twisted Nematic LCD screen
- Floating up to 600Vrms
- Optical RS-232 Port (97)
- Low Power (4 hr internal battery)
- Built-In component and baud rate testers and a sine, square and ramp signal generator (97)

Model 93 Basic instrument
Model 95 Adds measuring cursors and recording function
Model 97 Adds waveform and set-up memories, back-lit LCD, generator functions, RS-232 interface

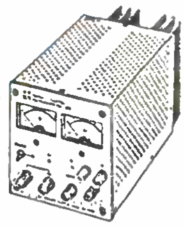
BLACK✱STAR
Video Monitor Tester 1410

• Checks MDA, CGA, EGA, Hercules, PGA, VGA, SVGA, 8514A, XGA and TV formats • Microprocessor controlled • Intelligent alpha-numeric display • Analog RGB, TTL-IRGB, Secondary RGB, Horizontal/Vertical/Composite syncs • Colour Bars, Test Card, Crosshatch, Dots, Ramp, Focus, Horizontal Lines, Vertical Lines, Raster and Checkerboard • Full control over output signals • 15.625 to 48.5kHz Line Frequencies • 49.9 to 87Hz Frame Frequencies • Inverse Video • Separate Analog and TTL Outputs • 1V and 0.7V Video • Easy Connection via 9-way and 15-way 'D' and BNC Connectors ***$1198.00 ex tax $1375.00 inc tax***

'TESTCARD' Easy-to-Use PC Monitor Test Software
• Choice of colours, backgrounds & Test patterns ***$115.00***

Topward Bench DC Power Supplies

- Excellent value – direct import pricing!
- Short Circuit protected
- Constant Voltage & constant current modes
- Single, dual and triple output models available



Model	Ranges	Ex Tax	Inc Tax
2303	30V/3A	$305.00	$365.00
4303	±30V/3A, 5V/3A	$595.00	$710.00
4306	±30V/6A	$895.00	$1070.00
4603	±60V/3A	$990.00	$1190.00

FREE 20 page Shortform Catalogue available.
Ask about our Account facilities and special arrangements for Education and Government Departments.
Express delivery throughout Australia and South Pacific.

Detailed brochures and specifications available. We are factory trained to advise on your requirements for general purpose Test & Measuring Instruments

OBIAT PTY LTD

129 Queen Street, Beaconsfield P.O.Box 37 Beaconsfield NSW 2014
Tel : (02) 698 4776 Fax : (02) 699 9170
Call us for the name of your local stockist **READER INFO NO. 9**

bankcard VISA MasterCard

Moffat's Madhouse...

by TOM MOFFAT

A musical battle of the sexes

How many of you readers out there own big stereos? Plenty, I'll bet. A lot of interest in this magazine comes from people wanting to read about, and build, fine audio equipment. My own stereo amplifier is one of the *Electronics Australia* Playmaster kits, the MOSFET amp from (as I remember) 1983. It's getting a bit long in the tooth now, but it's still an excellent performer.

The amp is hooked to a pair of Australian-made Leak speakers which are even older — around 1968 vintage. Back then, I was working for GTV-9 television in Melbourne, where the Leaks were being used as studio monitors. I wanted the best, so I got Leaks too. Since then I've seen and heard lots of pretty flashy speakers in hifi shops, but nothing matches the Leaks in my opinion. So they'll be staying around for a while longer.

Feeding the amp is a collection of audio gadgets — an AM-FM tuner, a stereo video, a cassette deck, and a Sony CD player which I believe was the third unit to be imported into Tasmania. The thing cost me a fortune, but I just *had* to be among the first! When I first had my CD player, everyone else thought CD's were weird...

The Leak speakers are very efficient when compared with today's units, so even with the 25 watt Playmaster amp the whole system packs a pretty big wallop. That's a shame, because I seldom get to use it to its full capabilities. The problem, in my house, is women.

We recently acquired a bass guitar which now joins our musical menagerie — including three other guitars, one flute, one accordion, two synthesizers, one piano, two blastophones, and one elderly wind-powered organ. The bass guitar was supposedly for my son Steven, who's studying it in his high school music class, but I also find uses for it in the jazz band I play with.

The way we learn music around my place is to put something on the stereo and then play along with it. Steven's main source of inspiration has been a CD of music from the sound track of the film *The Blues Brothers*. He's seen me learning all the guitar parts for the songs, and now he's learnt them himself on bass guitar.

The other day I pulled out another CD Steven never knew I had, called 'Genuine Houserockers Music II'. You get the idea. Steven soon had the bass guitar hooked up to its big amp, thundering along with the stereo which was bellowing out such gems as 'Mojo Boogie'. Blues Brothers all over again, but a whole new collection of tunes.

In the midst of all this my teenaged daughter came home from school. You know how in cartoons you sometimes see captions with icicles dripping from words? Well icicles were dripping from her words, as she said "lovely music", and sulked off to her room. And this wasn't an isolated incident.

Steven and I have learned to enjoy our music surreptitiously, while all female members of the family are out. We keep one eye out the window overlooking the driveway, so when Mum's car pulls up we can hit the 'abort' button on the CD player. This short-circuits any insulting comments about our tastes in music, and its effect on female happiness.

Last Christmas my family gave me a brand new, never been played, video of the *Blues Brothers* film, knowing I liked it so much. This particular video has a stereo sound track, which seems to be every bit as good in quality as the CD of the same music. That means the sound deserves to be played through the stereo — LOUD — while watching the video. Trouble is, every time I put the video on, the female side of the family retires to the far end of the house, dripping icicles as they go.

This whole business raises an interesting scientific question: Is one's taste in music somehow linked to hormones?

The problem mentioned above works both ways. The women in the family have music they like — which are mostly songs sung by women, interestingly enough. Women like Barbara Streisand and Bette Midler. Steven and I, on the other hand, find recordings by these artists less than pleasant, so the women don't usually play them while *we* are around.

It's not just in our family. When singer Tom Jones comes to town, his audience (I'm told) is almost entirely women. I wouldn't know by personal experience, since I've always steered clear of his concerts. His records are bad enough. (Sorry Tom, but it's just a matter of taste.)

And then there's James Blundell. He played in Hobart the same night as our Burglar's Dog band was playing in the usual pub, but that night our audience was pretty short on women. Where were they? Wrest Point Casino, lapping up James Blundell.

Remember when girls used to faint at the sight of the Beatles?

Even one song can be performed in different ways that are poles apart in the sex appeal stakes. Take for example, the old classic 'The Glory of Love' - you know the one: "You got to live a little, love a little..." The very best version of this song was recorded by a guy named Big Bill Broonzy back in the 1930's. At the start of the song, before he started the singing, he played it through several times on the guitar in a nice bright finger-picking style. I spent many long hours studying his recording, learning to play that guitar solo.

Then along came Bette Midler, with the same song: "You got to liiiiivvvv uh little..." — slow, dreary, horrible, the song completely murdered. Yet this is the version the women like.

What a miserable, bigoted, male chauvinist diatribe this month, eh? But there's more to come.

From that same Bette Midler film *Beaches* which gave us 'The Gory of Love' comes another song, something about a hero (I have tried to blank it from my mind). One afternoon I found

my daughter learning this dirge on the piano (Oh no — Oh no!).

But there's worse. On a trip to the supermarket I heard it again, loud and clear — coming from the Muzak! Right there for all the lady shoppers, yeah! Bette Midler records on the Musak, how very appropriate.

No, I shouldn't insult Muzak; after all they gave me my first job in electronics, indirectly (you can rest easy now, ladies). Muzak is 'background' music and background means 'unobtrusive' — and unobtrusive music is generally dull and boring, if you take any notice of it. That's the point, you're not supposed to take notice of it. If it helps take the pain out of the dentist's drill, then that's good.

When I was in high school every kid had a part-time job to make some spending money and help defray family expenses. There were lots of jobs back then, of course.

My job was in the local FM broadcast station, where I was allowed to play classical records and announce from time to time "This is KHFM, fine music for Albuquerque through frequency modulation".

The station also held the local agency for Muzak, and whoever was doing the on-air shift was also required to keep an eye on two gigantic reel-to-reel tape players that were the source of Muzak for the whole city, distributed by a network of telephone lines. There wasn't much money for a kid working in the studio, since your real payment was supposed to be the glory of broadcasting your own voice on air. The big bucks was in installations.

Every new Muzak subscriber had to have his premises wired up with speakers in the ceilings, speakers in the walls, or headphones for the dentist's chair. This meant crawling through the roofs and under the floors, through the dark and spider webs, mixing it with the rattlesnakes and tarantulas.

Qualified technicians were in charge of such installations, but there was no way they were going to crawl around under buildings. The solution: hire a kid to do it. In particular, a kid named Tom Moffat, who was silly enough to do such things just to raise some spending money. I also learned from working at that FM station that there's good money in climbing broadcasting towers, to paint them or change light bulbs. That was a pretty good earner over the years.

Just the other day, as I was putting a BNC connector on the end of a cable, I was reminded of the second job I had in electronics. There was a government contractor which was constructing a big telemetry system for a missile test range. The system was made up of a bank of perhaps eight equipment racks, filled with receivers, demodulators, and all the other bits and pieces needed to gather and record data.

I was hired as sort of a temporary trainee-technician-flunkie-kid, to assist the real technicians. Every signal line in this telemetry system was of 50-ohm coaxial cable; every cable had two ends; and every end needed a BNC connector. It was my job to put on those BNC connectors. I put on BNC connectors all morning, I had lunch, I put on BNC connectors in the afternoon, and then I went home. I dreamt of BNC connectors at night.

That was a miserable job. I thought I was going to learn about electronics, but instead I became a machine for putting on BNC connectors...

Nowadays there are crimp-on BNC connectors, which save the trouble of manually stripping and preparing the cable and then screwing the bits of the connector together. But *they* are for mass production: if you want to do one or two BNC connectors you do them the old way, like I did in my youth.

I still cringe from BNC connectors today. During development of a weather satellite receiving system, I discovered that the connections feeding the antenna coax into the preamplifier were not in the best condition, and they were messing up the system noise figure. A new BNC connector was in order, and as I installed it I felt every cramp and twinge in my hands that I felt from the hundreds of BNC's I installed in my youth. Old memories die hard!

Back to music for a moment: You may remember the Moffat's Madhouse column from March, about old-time mechanical musical instruments. It appears there are a lot of people interested in such things out there. That column seems to have generated more mail than all the other Madhouses put together. One fellow sent me a catalog from a place in the USA that sells recordings of all kinds of interesting musical stuff, including my own Aeolean paper-roll wind organ.

Another real prize came from a reader who was a fellow admirer of that Robot Orchestra in Sydney. It seems the Robot Orchestra's owner has produced a tape to promote the machine for use at parties and functions. The reader sent me a copy of the tape.

A testament to the musical quality of this tape is the fact that it is now on the 'banned' list at home, along with the Blues Brothers and Genuine Houserockers and all my noisy Zydeco records. In other words, it's great!

All that interest in mechanical music and the availability of recordings makes me wonder if there shouldn't be more of an outlet for this kind of stuff. Maybe I should approach the ABC with a proposal to do an occasional program segment for them, for Radio National or ABC-FM.

I'll bet heaps of people would listen to it. But I don't think many would be women! ❖

[illegible]

THE SERVICEMAN

A collection of 'not worth fixing' items rescued from the rubbish tip

A steady trickle of correspondence has given us enough fresh and varied material to make this a 'Contributor's Month'. We have the intriguing story of a number of different items rescued from being thrown on the rubbish tip, by a contributor who describes himself modestly as a 'kitchen table serviceman'. There's also a tale of re-repairing a set that has been 'fixed' by a competitor — and diplomatically explaining to the customer why this was necessary...

On top of the pile is a letter from K.D., of Taringa in Queensland. K.D. has appeared in these pages before, when he chased a dozen faults around an old Philips K9. He is back with another Philips — this time a K11 — along with a few other items whose problems had threatened to get them junked.

He has called his story '...It's Not Worth Fixing!', and this is how he tells it:

As an amateur serviceman, most of the jobs I get are from friends. Over the past few months I've had a spate of jobs where the owners told me that "the equipment isn't worth fixing". In each case the problem turned out to be something quite simple.

The first item was literally saved from the tip. I'd called in to visit a friend, and saw his old Philips K11 television amongst a load of rubbish on his trailer. He said that it had recently 'failed totally' and, thinking it not worth repairing, he had bought a new set. Despite the age of the set I knew that it had always given a superb picture, so I asked him to dump it at my house.

When I switched the set on, I found that it wasn't as dead as my friend had thought. The sound was normal, but the picture was only a blurry blob. It took only a second to realise that the focus had failed; and about as long to replace a faulty 5.6M resistor in the focus chain. In less than five minutes, the set was again delivering a first class picture!

I rang my friend and told him t hat he could pick up his television — but he wouldn't hear of it and insisted I keep the set. I didn't refuse, and now use the K11 as a 'loan' set when I have others in for repair.

The next job was a large Sony stereo radio-cassette featuring a solenoid-controlled tape transport, digital frequency readout and clock, as well as facilities for the connection of a turntable and an auxilliary source. The unit had two faults: it would destroy tapes, and intermittently the sound would drop to a very low level, with some distortion. The tape problem was easily solved with a new pinch roller.

The sound problem was a little more difficult. It affected both channels equally, and was present irrespective of which input was selected. I didn't have a copy of the circuit, but chose to start my search at the volume controls, as they were the most identifiable part of the amplifier chain.

The signal level was reasonable here, so the problem was probably in the power amplifier. I wasn't too concerned with the details of the circuit but, as the fault affected both channels, I reasoned that it must be in an area of the amplifier common to both channels.

The unit is of an age that it uses mostly discrete transistors, so I simply traced through the signal path and whenever I found two components the same (one for each channel) I mentally checked them off as not being the cause of the fault.

My search lead me to a resistor which had no mate. It connected to two other resistors, each of which connected to the base of a transistor in the signal path. Connecting the end of this unpaired resistor to the earth rail gave me a working amplifier. All I had to do now was find out what this part of the system was supposed to do.

While the amplifier components were all in one small area, the track from this lone resistor meandered off across the board. I followed it to a transistor, half hidden behind a plastic moulding forming part of the chassis.

The track from the base of this transis-

[illegible]

tor disappeared behind the moulding. Removing the large main circuit board was out of the question, as it would involve disconnecting dozens of wires, and stripping all the hardware from the chassis, so I resorted to connecting one end of an ohmmeter to the track and probing about the board until I found the other end. It turned out to go to a small switch which was part of the input selector bank. A little experimentation showed that the contacts of this switch closed momentarily each time a different input was selected.

I scratched my head for a while, then realised that this system must briefly mute the amplifier each time the source is changed, and that the 'fault' condition represented the muted state. I didn't bother to work out the details, but decided to test the transistor first.

The transistor was faulty, but with it located behind the chassis, removing and replacing it generated a certain amount of swearing — and more than a little plastic melted onto the barrel of my soldering iron. But with this done, the Sony performed perfectly.

The next visitor to my bench was a Thorn 9007 television. It was completely dead. Once again I didn't have a copy of the circuit, so I just had to 'play it by ear'.

The most obvious thing to do was check all the fuses, and I found F591 blown. I followed the wires from this fuse to the horizontal output stage. The output transistor Q503 was OK, so I had to look further afield.

On this set, the horizontal and vertical output transistors are mounted on a metal assembly, with a small circuit board between them. There are only a few components involved with the horizontal output on this board, so I started there.

Murphy must have been on holidays, because a 100uF electrolytic capacitor (C535) in the base circuit of the output transistor was faulty. Another cheap and quick job resulted in a further set saved from an early retirement.

When I saw the condition of the next job to arrive, though, I was almost prepared to throw it straight into the bin.

I was asked to give an opinion on two items, for a friend who works for a mining company. The items in question were a Sanyo portable colour television and a Titan Betamax video recorder. Both had been used in the South Australian desert and were covered in — and full of — fine red bulldust.

The television was functional, but the centre of the screen was badly scratched due to rubbing against something while being transported. The damaged area was about the size of my hand, and the picture in this area was virtually unwatchable. The company wasn't prepared to spend any real money on the repair, so I had to devise a simple means of fixing the surface of the picture tube.

As my 'real job' is a research chemist, I immediately thought of using a suitable monomer to fill the scratches, then polymerising it in place. (Hold on! This is an electronics magazine and we'll have none of that sort of language here! — Ed.) But the budget wouldn't even stretch to this, so in the end I dissolved some hard colourless wax in hot toluene and applied this solution to the screen.

The end result, after a lot of buffing, was an acceptable picture — when viewed from more than a couple of metres. It wouldn't be acceptable in a domestic situation, but as the only source of entertainment on a remote drill site it will be more than adequate.

(One point that should be made here is that scratches can seriously weaken the bulb of the picture tube. If the scratches are more than just superficial, the tube should be discarded. — Ed.)

The video recorder was a different proposition. The tapes that came with it were so contaminated that you could shake a dust storm out of them. The recorder wasn't in much better shape. As well as the dust, it contained dead moths and an assortment of small leaves and seed pods. I imagined that the heads and tape path would have been badly damaged.

I spent about an hour cleaning it all out, and with a clean tape it gave surprisingly good results. Granted it wasn't a perfect picture, but the recorder has been used at home for a couple of months since, with only a single tape, and still gives the same results. It never ceases to amaze me how much abuse things like VCRs can take, and still bounce back.

The last item was a five year old Teac VHS video recorder which wouldn't rewind or fast forward. When either of these functions was selected, the recorder would display the appropriate symbol for a few seconds, then switch itself off and flash the 'tape' symbol to indicate a fault.

With the bottom cover off I could tell that the motor and belt were functional. Without a manual I had to use a process of elimination to work out what combination of gears should turn for the fast winding functions. It appeared that one gear wasn't toggling across properly, and a gentle push here resulted in a soft click from somewhere on the top of the deck.

After this the fast winding functions would work once only. If the motor was stopped a further 'push and click' cycle was needed.

On the top of the deck I eventually narrowed the problem to two nylon levers, almost hidden at the front of the deck. Both levers moved relative to the chassis and to each other. The top one had a spring-loaded catch, that was supposed to lock onto the end of the lower one each time the transport came to a stop. The latching action failed by just a whisker to engage.

I removed, cleaned, and lubricated this assembly, without any improvement. After quite a lot of poking and prodding I reached the conclusion that the problem probably lay with the top lever. This lever is pulled to the rest position by a spring and the stop is formed by a rubber collar around a metal finger pressed from the chassis.

This rubber collar had deformed slightly, due to the constant pressure from the lever. I simply rotated the collar by 180°, and the problem was solved. I estimate that the deformation of the rubber collar amounted to less than a millimetre, but it was enough to effectively prevent the catch from working and so make the recorder useless.

This fault took me about two hours to solve. I doubt that anyone could have done it much quicker, unless they had seen the exact fault before. Who would ever think that a tiny rubber stop would cause a problem like this?

Well, those are a few simple faults I've encountered recently. I can't help but wonder, though, what would have happened to these items if the owners hadn't known a 'kitchen table serviceman' such as myself. I'm sure most of them would never have been repaired, but consigned to the local tip.

Thanks for those interesting items,

THE SERVICEMAN

K.D. You might only be a 'kitchen table serviceman', but you've uncovered at least one unusual fault that will be of value to a lot of us professionals. Don't disparage your efforts. There's a place for everyone who approaches the job in a conscientious and workmanlike manner.

Repairing a repair

Now we come to a story from a frequent contributor. It's from L.K., of Daintree in far northern Queensland. I usually look forward to L.K.'s next contribution, because of his wry sense of humour and witty pen. This time, however, he is quite serious and his pen writes more in sorrow than wit. I'll let him tell the story in his own words:

In my opinion, one of the worst jobs a serviceman can encounter is having to correct a shoddy repair by another technician. It's even worse when that other technician is known to you — even though he may be your opposition!

It is not just that person who is seen in a poor light, but the trade as a whole which is degraded in the eyes of the public.

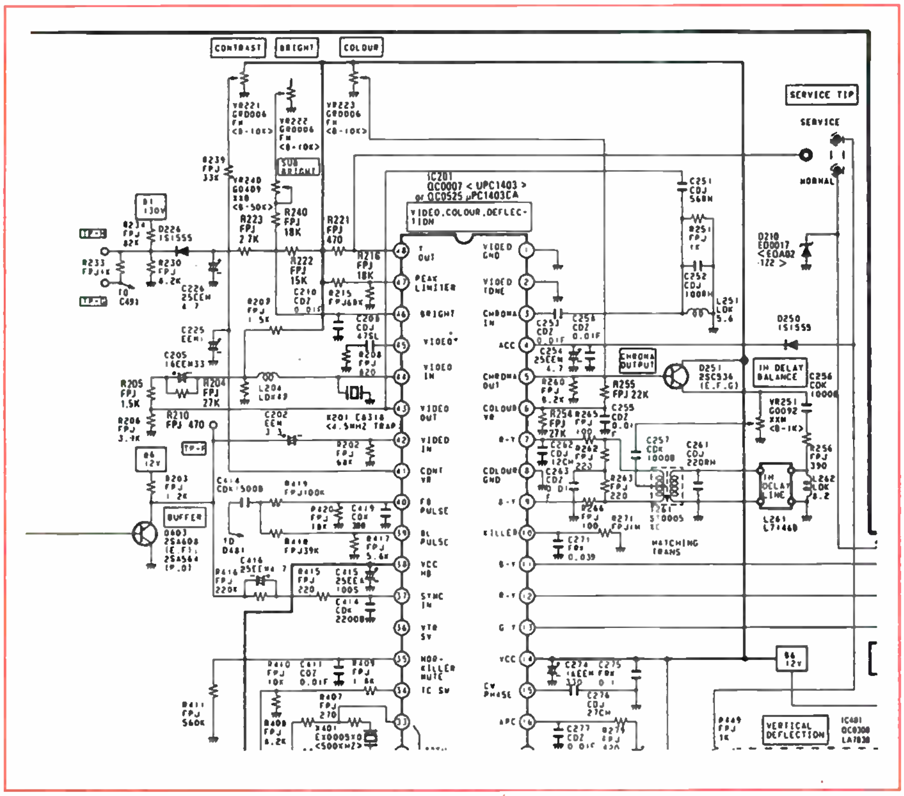
The saga began when a woman brought a Sanyo portable colour television to me, explaining how she had been advised that the picture tube was faulty. Wisely, I think, she just wanted a second opinion before outlaying the cost of a replacement. It was a reasonably late model set, fitted with an 83P chassis.

"Could you do it today?" she asked. "Yes, I can", I replied, believing that I had a brief, straightforward task ahead of me.

Later, I slipped the back off, lined the set up on the bench, and switched on. The picture tube sprang to life immediately — the filament glowing white hot, like an incandescent bulb. My initial thought was that it had shorted to itself about half way along its length, which would have confirmed the other technician's diagnosis. But this job was not to be so easy.

I switched the set off and was about to measure the heater resistance when I noticed two wires coming from those pins on the tube socket — and then looped several times around the line output transformer's core. Definitely not a Sanyo original!

Not knowing the history of the set, my thoughts changed direction. It now seemed as though the tube had developed a low emission problem, and that this was someone's brute force method of milking a little more life from it. (By raising the filament voltage, one also raises the cathode temperature — thus releasing more of the available electrons.) Still, my task was to prove it — or cure it.



Contributor L.K. was asked to provide a 'second opinion' on a Sanyo portable colour TV which supposedly had a faulty picture tube. In fact, it turned out to have a hard to find fault in a relatively low cost component, in this part of the circuit.

I removed one loop of wire from the core as a precaution, because the way it was glowing, I was afraid that the heater might fail completely while it was in my shop. When next I applied power, things looked a little safer and nearer normal. The picture itself came up dark, but without any sign of the 'pasty' look so common when a tube is showing the signs of age. I tried disconnecting the antenna, but the resultant snow was too dark for me to draw any conclusions.

It was, in fact, just like the brightness control had been backed off. But a quick check proved that it, and the sub-brightness control, were turned all the way up. For the first time, I became suspicious that this set might have some other subtle fault.

A voltage check around the tube's base board didn't reveal anything abnormal. I followed this with an investigation of the two brightness controls, but again I drew a blank.

But I still wasn't convinced, and fired up the CRO to observe the DC level of the back porch. I hoped this would reveal, quickly, if I had some sort of pedestal fault present. The measurement came up at 90V, which in my experience was getting on for 20V too high for a tube of that kind. The tube was simply being biased off!

Another careful scan of the schematic brought me back to the brightness circuitry and IC201 (which seemed to do just about everything but boil the kettle!)

Having already looked at both potentiometers, I eyed the IC suspiciously — that is, until I noticed it had recently been changed. As a result, I felt that not only was a malfunction in that department unlikely, but also that I was following someone else around the trail.

Turning again to the brightness area, the measured voltage on pin 46 of IC201 was only 7V at its maximum — a mite short of the suggested 8.4V. Yet the 18k resistor R222 was spot on, and C226 was not leaking.

I began pondering the ramifications of a shorted D226, when I realised what should have been obvious. If R234, an 82k resistor to the 130V rail, had gone high, it would allow the diode to conduct — thus shunting the brightness components with R230, an 8.2k to earth.

Sure enough, that is just what I found. And replacing R234, refitting the original heater wiring to the tube base and resetting the sub-brightness control brought the set back to normal operation, with no signs of any adverse effects from its maltreatment.

Just the same, I still wonder how much the life of the tube has been shortened as a consequence.

[illegible]

Looking back along the path, I presume that my predecessor had worked to much the same routine as I had, until he changed the IC. When this proved unhelpful, he must have felt convinced that a tube fault existed, and so boosted the filament in a 'nothing to lose' effort at squeezing out the last few hours from it.

To me, the most difficult part of this job was not the diagnosis and repair, but the embarrassment of having to explain diplomatically to the customer that a mistake had been made, while trying not to downgrade the individual concerned or the trade as a whole. It is not a job I would leave to the counter staff, though I'll admit the temptation is often there.

I can quite understand your concern, L.K. I imagine that most of us have had, at some time or another, to re-repair (if that term is permissible) the shoddy work of others. And as you say, trying to explain it without making the whole industry look disreputable is not an easy task.

3 times 2 = 7?

Now on to happier things — although our next contributor would not have thought so at 3am on a cold winter's morning. The story comes from Mr A.F., of Balwyn in Victoria, and comes in the form of a personal letter.

It seems that in the event he solved the problem without getting out of bed! Oh, how I wish I had lesser mortals to do the hard yakka for me, while I lay back doing the thinking, in comfort.

Enough dreaming, though. Here's A.F.'s story:

The story in the December issue about the fault in a broadcast transmitter reminded me of a problem I had around 1960. At that time I was responsible for all transmitters in Victoria carrying the ABC programmes — the PMG's Department provided the transmitters and all technical staff, and the ABC provided the studio buildings and programme staff.

About 3.00am I was woken by a frantic call — they were rebuilding the aerial coupling unit and needed a 6nF capacitor. They had three 2nF capacitors which each measured within a few per-cent of 2nF, but when they were connected in parallel the combination measured 7nF.

They had separated and measured the capacitors a number of times, then connected them in parallel again. Each time they were individually 2nF, but each time the three combined read 7nF. Where was the extra 1nF coming from? Could I please come out and help immediately?

It was a good hour's drive to the transmitter. They had been working on the problem since midnight, and were frozen through from standing about in the middle of a paddock in an icy wind. They were too cold to think clearly any more. But the coupling unit had to be ready to use by 6.00am, when the station opened. Some quick thinking was needed.

Before you try to work it out, I had better give you some more background information. The aerial was an 'inverted Delta' type. It consisted of three 30-metre wooden poles, spaced about 100 metres apart on the corners of an equilateral triangle. The aerial consisted of a wire strung between each pole, with a downlead from each apex to a central feed point just above the ground.

The 'wires' were actually a group of wires, arranged around circular spreaders so that they formed a hollow tube about 150mm in diameter. The whole aerial looked like a three-sided pyramid standing on its point — hence the name 'Delta'.

The aerial had a high capacity to ground and was electrically short — about 1/10 of a wavelength — so that the input impedance was about 4.5 ohms. The coupling unit was being upgraded for use with a 10kW transmitter, so the input current to the aerial would be about 45 amps.

Now, the capacitors used for this sort of application are not exactly small. They are housed in a steel box, they are oil-filled to increase their voltage rating and to help with cooling. Finally, the leads are brought out on two large, ceramic insulators. I

t's a long time ago, but memory suggests that each capacitor was about 500mm long, 300mm wide and about 250mm high. The three capacitors were

[illegible]

joined in parallel with two pieces of 37mm x 3mm copper busbar, about 800 or 900mm long.

There wasn't really time to drive out to the transmitter site. Anyway, I've done my share of freezing alongside coupling units and it's much easier to think clearly in a nice warm bed, even at 3.00am. So it became a question and answer session:

Q1: How was the capacitance measured?

A1: It was measured at 620kHz (3AR) using an RF bridge. It didn't matter which end of the busbar it was connected to — the result was always 7nF.

Q2: What value is measured if the bridge is connected across the centre capacitor?

A2: (After several minutes of measuring and re-checking) About 6.5nF.

So there was the clue. At 620kHz, a 6nF capacitor has a reactance of around 43 ohms. 7nF has a reactance of about 37 ohms, a difference of about 6 ohms.

Where is all this leading? Well, at 620kHz a 1.5uH inductor has a reactance of about 6 ohms. Then remembering that a capacitor has a negative reactance and an inductor a positive reactance, then putting a 1.5uH inductor in series with a 6nF capacitor will make it appear to have a capacitance of 7nF when measured at 620kHz.

It's not hard to imagine that the leads joining up the three capacitors could easily have an inductance of around 1 to 2uH. And the 6.5nF approx measured across the centre capacitor — I'll let you work that out!

The moral of the story is that you cannot afford to forget the effects of circuit inductance, as I said in a recent letter to Peter Philips.

Now to another matter. I was browsing through some of my earliest copies of 'Radio and Hobbies' over the Christmas holidays, and came across a couple of items that may interest you. There's an editorial on licensing servicemen, and an article on repairing volume controls. The latter brought back to me memories of trying to chose the 'right' grade of graphite pencil to repair a worn track. Try the 'Hamlet Approach': 2B or not 2B.

You might enjoy reading the attached photocopies when you get a few moments to relax — just to remind you how easy things are these days.

With my very best wishes for the long and continued success of your column. It's the first thing I read each issue (after the Index, that is).

Thanks for your letter A.F., and for the kind wishes expressed in the last paragraph. It's nice to know that people appreciate our humble efforts.

I've chosen to use the transmitter story as it carries a useful reminder that an application of basic theory can sometimes be of benefit. Not that those poor individuals in the paddock would have appreciated the niceties of positive and negative reactance at 3am in mid-winter!

Next, your reference to the old *Radio and Hobbies* magazines and one of the wartime editorials was quite timely. There is some strong feeling in the trade that servicemen should be licensed, and the old editorial reminds us that the industry was not always as free and easy as it is today.

The old licensing system was a wartime necessity, but it guaranteed to the public that servicemen were qualified and accountable. Nobody wanted to lose the licence that provided his living.

The same applies today and some kind of licensing system would give the public protection over shoddy workmanship and un-ethical practices. Unfortunately, it won't stop careless work, but it would provide an avenue for compensation.

And finally, your reference to repairing old volume controls. It was a real trip down memory lane. I well remember the pencil problem and the fact that the only grade available during and just after the war was the old HB (Hard and Black!).

These were useless for repairing the carbon tracks on old potentiometers, though I do remember having some success by grinding the pencil onto fine sandpaper, then transferring the black powder to the track and binding it with a thin solution of bone glue.

Who would bother these days — assuming one could even get inside the miniature and sub-miniature pots used in modern equipment? Hasn't life changed?

Well, that's all for this month. I don't know what next month will bring, but you can rest assured that it will be interesting. ❖

Fault of the Month

Kreisler 59-03 CTV

SYMPTOM: The sides of the picture are bowed inwards. The East-West pincushion adjustment and width controls have not effect. Top and bottom lines are quite straight.

CURE: The core of L792 is either missing or misplaced. The inductance of this coil controls the line frequency current to the width modulator.

This information is supplied by courtesy of the Tasmanian Branch of The Electronics Technicians' Institute of Australia (TETIA). Contributions should be sent to J. Lawler, 16 Adina Street, Geilston Bay, Tasmania 7015.

[illegible]

World Radio History

RITRON QUALITY 4 year warranty!

RITRON 286-16's are now only $1199 with a 4 year warranty!

RITRON 386SX-31

80386SX 25M CPU
1 MEG RAM EXP TO 8 MEG
31Mhz LANDMARK SPEED TEST
1.2M JAP F.D.D. 512K VGA CARD
40M HARD DISK DRIVE,
101 EXTENDED "CLICK" KEYBOARD
MINI CASE & 200W POWER SUPPLY
SUPA VGA COLOUR MONITOR
1024 x 768 Res 0.28" D.P
SERIAL PARALLEL GAMES PORTS
4 YEAR PARTS & LABOUR WARRANTY IBM* COMPATIBLE SPREADSHEET, WORDPROCESSOR & DATABASESOFTWARE INCLUDED.
* SHAREWARE SOFTWARE
ASSEMBLED & TESTED IN AUSTRALIA.

Genuine Australian, Fully Upgradable DR DOS 6.0 supplied with every system. DOS 5 $50 extra

$1,299 TAX INC.
$1099 TAX EX

RITRON EXECUTIVE 386-57

80386-33 CPU 64K CACHE ON BOARD MEMORY
1 MEG RAM EXP TO 16 MEG
57Mhz LANDMARK SPEED TEST
40 MEG HARD DISK
1.2M JAPANESE BRAND F.D.D
101 EXTENDED "CLICK" KEYBOARD
SERIAL PARALLEL GAMES PORT
MINI CASE & 200W POWER SUPPLY
SUPA VGA COLOUR MONITOR (1024 x 768 Res) 0.28" DP
512K VGA CARD (256 COLOURS) IBM* COMPATIBLE
4 YEAR PARTS & LABOUR WARRANTY
SPEADSHEET, WORDPROCESSOR & DATABASE SOFTWARE INCLUDED.
*SHAREWARE SOFTWARE
ASSEMBLED & TESTED IN AUSTRALIA

Genuine Australian, Fully Upgradable DR DOS 6.0 supplied with every system. DOS 5 $50 extra

$1,479 TAX INC.
$1,249 TAX EX

OPTIONAL EXTRAS

ADD PRICE TO BASE SYSTEM COST. PLUS $25-$100 INSTALLATION

512K VGA CARD..$50 1M VGA CARD..$100

TO CHANGE A 40M HARD DRIVE TO A
85M HD add $120
126M HD add $175 105M HD..$150
200m HD add $595 170M HD..$495

EXTRA RAM
1M add $55 2M add $110 4M add $220
WINDOWS 3.00.$69 WINDOWS 3.1.$159

SOUND CARDS
SOUND COMMANDER.......... $149
THUNDER BOARD.......... $199
SOUNDBLASTER II.......... $175
SOUNDBLASTER PRO.......... $369
FLOPTICAL DRIVE add.......... $695
21 M/BYTE DISC TO SUIT.......... $39
CD ROM SOUND BLASTER PACK.......... $949
PARRADISE WINDOW ACCELERATOR..... $325

RITRON EXECUTIVE 386-65

80386-40 CPU 64K CACHE ON BOARD
1 MEG RAM EXP TO 16 MEG
65 Mhz LANDMARK SPEED TEST
40 MEG HARD DISK 12ms ACCESS TIME
1.2M JAPANESE BRAND F.D.D
101 EXTENDED "CLICK" KEYBOARD MINI CASE & 200W POWER SUPPLY SERIAL, PARALLEL, GAMES PORTS
512K VGA CARDSUPA VGA COLOUR MONITOR (1024 x 768 Res) 0.28" 4 YEAR PARTS & LABOUR WARRANTY SPEADSHEET, WORDPROCESSOR & DATABASE SOFTWARE INCLUDED. *SHAREWARE SOFTWARE

Genuine Australian, Fully Upgradable DR DOS 6.0 supplied with every system. DOS 5 $50 extra

$1,479 TAX INC.
$1,249 TAX EX.

WITH 200 MEG DRIVE
$2,099 TAX INC.
$1,799 TAX EX.

RITRON EXECUTIVE 486-75

80486SX-20 CPU
1 MEG RAM EXP TO 32 MEG
75Mhz LANDMARK SPEED TEST
40 MEG HARD DISK
1.2M JAPANESE BRAND F.D.D
101 EXTENDED "CLICK" KEYBOARD
MINI CASE & 200W POWER SUPPLY
4 YEAR PARTS & LABOUR WARRANTY
SERIAL, PARALLEL, GAMES PORTS, 1MEG VGA CARD
SUPA VGA COLOUR MONITOR (1024 x 768 Res) 0.28" DP
SPEADSHEET, WORDPROCESSOR & DATABASE
SOFTWARE INCLUDED. *SHAREWARE SOFTWARE
ASSEMBLED & TESTED IN AUSTRALIA.

Genuine Australian, Fully Upgradable DR DOS 6.0 supplied with every system. DOS 5 $50 extra

$1,499 TAX INC.
$1,249 TAX EX.

WITH 200 MEG DRIVE
$2,099 TAX INC.
$1,799 TAX EX.

RITRON EXECUTIVE 486-157

80486-33 CPU
256K ON BOARD CACHE. 1 MEG OF RAM
157Mhz LANDMARK SPEED TEST
40 MEG HARD DISK
1.2M JAPANESE BRAND F.D.D
101 EXTENDED "CLICK" KEYBOARD
SERIAL, PARALLEL, GAMES PORTS
512K VGA CARD. IBM* COMPATIBLE
SVGA COLOUR MONITOR (1024 x 768 Resolution) 0.28"DP
MINI CASE & 200W POWER SUPPLY
4 YEAR PARTS & LABOUR WARRANTY
SPREADSHEET, WORDPROCESSOR & DATABASE SOFTWARE.

Genuine Australian, Fully Upgradable DR DOS 6.0 supplied with every system. DOS 5 $50 extra

$2,099 TAX INC.
$1,779 TAX EX.

WITH 200 MEG DRIVE
$2,674 TAX INC.
$2,299 TAX EX

RITRON EXECUTIVE 486-157

200Mb HD AND TOWER CASE

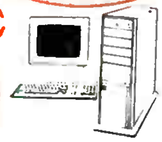
80486-33 CPU 256K ON BOARD CACHE. 4 MEG OF RAM
157Mhz LANDMARK SPEED TEST
200 MEG HARD DISK
12ms ACCESS TIME
1.2M JAPANESE BRAND F.D.D
3.5" 1.44M JAPANESE BRAND F.D.D
101 EXTENDED "CLICK" KEYBOARD
SERIAL, PARALLEL, GAMES PORTS
1 MEG VGA CARD. IBM* COMPATIBLE
TOWER CASE & 220W POWER SUPPLY
SUPA VGA COLOUR MONITOR (1024 x 768 Res) 0.28" DP
4 YEAR PARTS & LABOUR WARRANTY
SPEADSHEET, WORDPRCESSOR & DATABASE SOFTWARE.
ASSEMBLED & TESTED IN AUSTRALIA

Genuine Australian, Fully Upgradable DR DOS 6.0 supplied with every system. DOS 5 $50 extra

$3,395 TAX INC.
$2,895 TAX INC.

RITRON EXECUTIVE 486-200+

200Mb HD AND TOWER CASE



80486-50 CPU 256K ON BOARD CACHE. 4 MEG OF RAM
200+Mhz LANDMARK SPEED TEST
200 MEG HARD DISK 12ms ACCESS TIME 1.2M JAPANESE BRAND F.D.D
3.5" 1.44M JAPANESE BRAND F.D.D
101 EXTENDED "CLICK" KEYBOARD
SERIAL, PARALLEL, GAMES PORTS
1 MEG VGA CARD. IBM* COMPATIBLE
TOWER CASE & 220W POWER SUPPLY
SUPA VGA COLOUR MONITOR (1024 x 768 Res) 0.28" DP
4 YEAR PARTS & LABOUR WARRANTY
SPEADSHEET, WORDPRCESSOR & DATABASE SOFTWARE.
ASSEMBLED & TESTED IN AUSTRALIA
IDEAL CAD MACHINE!

Genuine Australian, Fully Upgradable DR DOS 6.0 supplied with every system. DOS 5 $50 extra

$3895 TAX INC.
$3299 TAX EX.

RITRON EXECUTIVE 486-EISA

200Mb HD AND TOWER CASE

80486-EISA CPU 256K ON BOARD CACHE. 4 MEG OF RAM
167 Mhz LANDMARK SPEED TEST
200 MEG HARD DISK 12ms ACCESS TIME 1.2M JAPANESE BRAND F.D.D
3.5" 1.44M JAPANESE BRAND F.D.D
101 EXTENDED "CLICK" KEYBOARD
SERIAL, PARALLEL, GAMES PORTS
1 MEG VGA CARD. IBM* COMPATIBLE
TOWER CASE & 220W POWER SUPPLY
SUPA VGA COLOUR MONITOR (1024 x 768 Res) 0.28" DP
4 YEAR PARTS & LABOUR WARRANTY
SPEADSHEET, WORDPRCESSOR & DATABASE SOFTWARE.
ASSEMBLED & TESTED IN AUSTRALIA
IDEAL CAD MACHINE!

Genuine Australian, Fully Upgradable DR DOS 6.0 supplied with every system. DOS 5 $50 extra

$4699 TAX INC.
$3999 TAX EX

ROD IRVING ELECTRONICS Est:1977

MAIL ORDER HOTLINE: 008 33 57 57. ORDER FAX LINE: (03) 543 4871 ENQUIRES (03) 543 7877
HEAD OFFICE: 56 RENVER RD, CLAYTON. PH: (03) 543 2166. FAX (03) 543 2648
MELBOURNE: 48 A'BECKETT ST, MELBOURNE. PH. (03) 639 1640. FAX: 639 1641.
OAKLEIGH: 240C HUNTINGDALE RD, OAKLEIGH. PH: (03) 562 8939 FAX: (03) 562 8940
NORTHCOTE 425 HIGH ST. NORTHCOTE, PH. 489 8866. FAX: 489 8131.
SYDNEY:74 PARRAMATTA RD, STANMORE. PH: (02) 519 3134. FAX: (02) 516 5024.
NEW STORE - ADELAIDE: 241-243 WRIGHT ST, ADELAIDE. PH:(08) 211 7200 FAX: (08) 211 7273
BLUESTAR COMPUTERS:
MELBOURNE: 271 MAROONDAH HWY, RINGWOOD, PHONE: (03) 870 1800 FAX: (03) 879 3027
SYDNEY: 115 - 117 PARRAMATTA RD CONCORD. PH: (02) 744 5526 FAX: (02) 744 5405.

FREIGHT CHARGE BASED ON 35KG COMPUTER SYSTEM

Melb-Metro.$12.00	Vic country....$19.00
Sydney....... $17.00	NSW country.$39.00
Adelaide...... $17.00	S.A country...$39.00
Bribane...... $24.00	QLD country.$55.00
Canberra.... $18.00	W.A country..$74.00
Darwin........ $40.00	Insurance:-
Perth.......... $31.00	$1 / $100 Value.
Tasmania....$53.00	

OUR POLICY.

Come to us with a written quote on a computer system and we will beat that price.
WE WON'T BE UNDERSOLD!*
*Conditions Apply.

NOW OPEN ADELAIDE STORE 241-243 WRIGHT ST, ADELAIDE PH: (08) 211 7200 FAX: (08) 2117273

5.25" from 35¢ CHEAP BULK DISK PRICES! 3.5" from 60¢

NO BRAND DISKS

ALL DISKS INCLUDE WRITE PROTECTS & ENVELOPES
BOXES OF TEN DISKS LIFETIME WARRANTY

	1-9	10+	50+	100+	500+
5 1/4" DS/DD	$4.50	$4.40	$4.30	$3.25	$3.50
5 1/4" DS/HD	$8.50	$8.25	$8.10	$7.50	$6.60
3 1/2" DS/DD	$7.90	$7.20	$6.90	$6.50	$6.00
3 1/2" DS/HD	$14.95	$12.90	$11.95	$10.50	$9.90

MEMOREX DISKS

	1-9 boxes	10+
3 1/2"DD	$19.95	$18.95
3 1/2"HD	$45.95	$42.95
5 1/4"DD	$14.95	$12.95
5 1/4"HD	$23.95	$22.95

VERBATIM DATALIFE

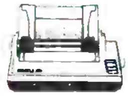
	1-9 boxes	10+
3 1/2"DD	$23.95	$22.95
3 1/2"HD	$44.50	$42.50
5 1/4"DD	$17.95	$16.95
5 1/4"HD	$24.95	$22.95

VERBATIM VALUELIFE

	1-9 boxes	10+
3 1/2"DD	$21.95	$19.95
3 1/2"HD	$39.95	$37.95
5 1/4"DD	$11.95	$10.95
5 1/4"HD	$18.95	$16.95

YOU'LL HAVE TO GO A LONG WAY TO FIND DISK PRICES LIKE THESE.

SAVE ON OUR GREAT RANGE OF EPSON PRINTERS

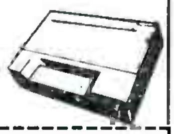


LX-400 80 Col, 9 Pin Dot Matrix, 180 Cps Draft 30 Cps NLQ, Pull Tractor
C22054..................$249

LX-850 80 Col, 9 Pin Dot Matrix, 240 Cps Draft 48 Cps NLQ, Push Tractor, Smart Park Feature
C22074..................$365

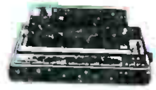
FX-1050 136 Col, 9 Pin Dot Matrix, 264 Cps Draft, 54 Cps NLQ, Push Tractor, Smart Park Feature.
C22067......................$925

SQ-850 80 Col, 24 Nozzel ink jet, 600 Cps Draft, 198 Cps LQ, Push Tractor, Smart Park Feature.
C22052......................$1,225

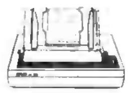


LQ-100 80 Col, 24 Pin Dot Matrix 200 Cps Draft, 72 LQ, Built-in sheet feeder,8 fonts, 2 scalable fonts.
C22070..........................$475

ADELAIDE STORE NOW OPEN!
241-243 WRIGHT ST, ADELAIDE.
Ph: (08) 211 7200. Fax: (08) 211 7273



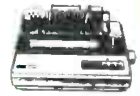
SQ-2550 80 Col, 24 Nozzel ink jet, 600 Cps Draft, 198 Cps LQ, Push Tractor, Smart Park Feature,
C22099........................$1995



LQ-400 80 Col, 24 Pin Dot Matrix, 180 Cps Draft, 60 NLQ Pull Tractor
C22070......................$439

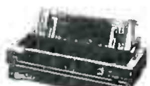
LQ-570 80 Col, 24 Pin Dot Matrix, 252 Cps Draft, 84 Cps, NLQ Scalable Fonts 8 to 32 points, 11 LQ Fonts 360 x 360 DPI, Top, Rear, Bottom and Front paper feed paths, Convertable Push/Pull Tractor.
C22068........................$575

LQ-870 80 Col, 24 Pin Dot Matrix,330 Cps Draft, 110 Cps NLQ, Scalable Fonts, 8 to 32 points, 11LQ Fonts, 360 x 360 DPI, Top, Rear, Bottom, & Front paper Feed paths Convertable Push/Pull Tractor.
C22072........................$895

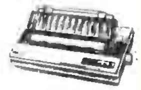


LQ-860 80 Col, 24Pin Dot Matrix' 295 Cps Draft,98 CPS LQ, Colour Standard,Push Tractor Smart Park Feature. C22073..............$1095

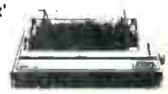
LQ-1070 136 Col, 24 Pin Dot Matrix, 252 Cps Draft., 84 Cps NLQ, Scalable Fonts, 8 to 32 point, 11 LQ Fonts, 360 x 360 DPI, Top, Rear, Bottom, and Front Paper Feedpaths, Convertable Push/Pull Tractor
C22066..........................$775



LQ-1170 136 Col, 24 Pin Dot Matrix, 350 Cps Draft., 110 Cps NLQ, Scalable Fonts, 8 to 32 point, 11 LQ Fonts, 360 x 360 DPI, Top, Rear, Bottom, and Front Paper Feedpaths, Convertable Push/Pull Tractor
C22127..........................$1,149



LQ-1060 136 Col, 24Pin Dot Matrix' 292 Cps Draft, 98 Cps LQ, Colour Standard,Push Tractor, Smart Park Feature.
C22096..............................$1,395



LQ-2550 136 Col, 24Pin Dot Matrix' 400 Cps Draft,133 LQ Colour Standard,Push Tractor, Smart Park Feature.
C22064..........................$2,049

IBM CARDS

SAVE BIG DOLLARS ON THESE DRASTICALLY REDUCED IBM CARDS!

PRINTER CARD	$19
6M RAM CARD	$249
2 PORT SERIAL CARD	$39
GAMES CARD	$19
CLOCK CARD	$39
512/576K RAM CARD OK RAM	$69
2 WAY FDD CONT.	$89
4 WAY FDD CONT.	$129
VGA 16 BIT 256K	$59
VGA 16 BIT 512K	$79
VGA 16 BIT 1 MEG	$129
16M HD CACHE CARD OK RAM	$495
HDD IDE /FDD	$19
HDD IDE/FDD/SPG	$39
8 BIT ETHERNET CARD	$195
16 BIT ETHERNET CARD	$245
AT HD CONTROLLER	$149
MULTI I/O CARD	$99
MONO COLOUR CARD	$69
EGA CARD	$99
DIAGNOSTIC CARD	$795
TTL PRINTER CARD	$79
FAX CARD	$595
6M AT EX/EXP	$225

HARD DRIVE SPECIALS

WE WON'T BE BEATEN ON PRICE!

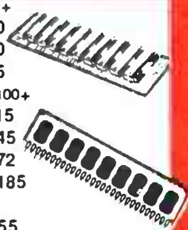
PRICES ARE WITHOUT PADDLE CARDS & BRACKETS

40M SEAGATE DRIVE	$329
85M HD 17ms ACCESS. VOICE COIL. 2 YEAR WARRANTY	$425
105M HD 19ms ACCESS	$495
126M HD 16ms ACCESS. VOICE COIL. 2 YEAR WARRANTY	$545
170M 2 YEAR WARRANTY	$695
212M HD 12ms ACCESS. VOICE COIL. 2 YEAR WARRANTY	$795
NEW 340M H.D.D	$1295

MOTHERBOARDS

286 16/21	$119.00
386SX-16	$190.00
386SX-25/31	$199.00
386SX-33/41	$265.00
386-25	$365.00
386-33 64K CACHE	$375.00
386-40 64K CACHE	$395.00
386-33 128K CACHE	$425.00
486SX-20	$425.00
486-33 64K CACHE	$895.00
486-33 256K CACHE	$995.00
486-50 256K CACHE	$1695.00

MEMORY



MEMORY	1-9	10-99	100 +
41256-08	$2.95	$2.75	$2.50
44256-08	$7.95	$7.75	$7.50
44256-07	$8.95	$8.50	$7.95

SIMMS	1-9	10-24	25+	100+
256K-80	$21	$19	$17	$15
1M x 9-70	$49	$48	$47	$45
1M x 9-60	$79	$77	$75	$72
4M x 9-80	$219	$209	$199	$185
SIPPS 1M x 9-80	$79	$69	$59	$55

MONITOR SPECIALS

SUPA VGA
COLOUR MONITOR
"3 YEAR WARRANTY"
This stylish and reliable monitor has been designed for Australian conditions & comes with a 3 year warranty.
SPECS: cte: 14" 90° deflection, dark tint, non-glare.
Display size: 245+/5mm x 180+/-5mm x 180+/-5mm
Resolution: (max): 1024 x 768. Dot Pitch: 0.28"
only $439.00

TECO
SUPER VGA
MULTISCAN
COLOUR MONITOR
NON-INTERLACED
1024 x 768..............$599.00

CALL US FOR A QUOTE ON ANY OTHER MONITOR YOU REQUIRE.

ROD IRVING ELECTRONICS

ROD IRVING ELECTRONICS MAILORDER HOTLINE: 008 33 5757

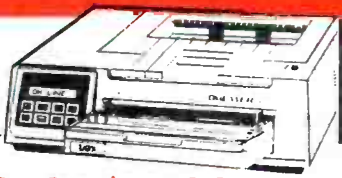
OKILASER 400 IT'S LOWEST PRICE EVER!

It's the cheapest it has ever been! The famous OKILASER 400 Laser printer at only $1299! Reliable and compact, it fits neatly into the smallest of offices. Highly reliable due to its latest LED imaging technology. The OL400 offers excellent print quality, superior paper handling, and a variety of fonts which rivals some of the more expensive laser printers on the market

5 year warranty on LED system head.

No moving parts (LED SYSTEM HEAD) recycles its own toner! Approx. 1.8 ¢ per copy.

$1095 Ex Tax



Due to the devaluation of our currency against the yen, prices will rise very soon.

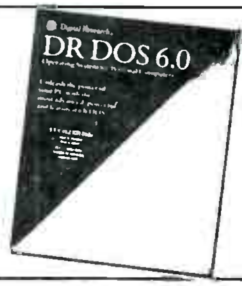
Only $1299 Hurry very limited offer.

Double your disk storage with.... DR DOS 6.0

The most advanced, fully DOS-compatible operating system available today. It's everything you need to run your DOS, Windows, and networking applications faster.
Maximize hard disk performance, keep your system and Data secure, and make your PC easier to use.

DISKMAX: Improves your PC's overall performance so you can get more work done in less time. Its optional automatic file compression feature potentially doubles your hard disk storage space.
MEMORYMAX: moves DR DOS buffers, drivers, TSRs and networking software outside the 640K memory area, leaving more memory for your DOS, Network and Windows applications.

THIS MONTHS PRICE **$89.00**



SOUND BLASTER 2

with FREE MINI SPEAKERS

The sound blaster II is the ultimate sound board that easily plugs into any slot in your IBM, PC, XT, AT, 386, etc.

- TEXT- TO SPEECH SYNTHESIZER
- 11 VOICE FM MUSIC SYNTHESIZER
- DIGITIZED VOICE OUTPUT WITH 4KHz TO 44,1KHz SAMPLING RATE
- DIGITIZED VOICE INPUT (8 BIT ANALOGUE TO DIGITAL CONVERSION)
- BUILT-IN MIDI INTERFACE FOR CONNECTING MUSICAL INSTRUMENT.
- BUILT-IN JOYSTICK PORT
- BUILT-IN STEREO POWER AMPLIFIER
- BUILT-IN STEREO POWER AMPLIFIER

BUNDLED SOFTWARE INCLUDES -
SBTALKER FOR READING ASCII FILES & DR SBAITSO
VOXKIT-VOICE DEVELOPMENT TOOLKIT FOR RECORDING SOUNDS TALKING PARROT MIMICS YOUR SPEECH
FM INTELLIGENT ORGAN - CREATES ORCHESTRA LIKE MUSIC USING YOUR PC KEYBOARD AS INPUT.
JUKEBOX - A WINDOWS THREE APPLICATIONS.

X18012...............**$175.00**

SOUND BLASTER 2 with 256 COLOUR SPACE QUEST1 X18018....$229

SOUND BLASTER PRO

MORE THAN JUST - LISTENING EXPERIENCE! THE SOUND BLASTER PRO CARD EASILY INSTALLS INTO YOUR IBM PC/AT AND 100% COMPATIBLES.
(286 AND HIGHER RECOMMENDED)
PACKAGE INCLUDES:

- SOUND BLASTER PRO CARD
- RCA AUDIO CABLE
- 5.23" AND 3.5" DISKETTES
- VOICE EDITOR II
- SBTALKER (TEXT-TO-SPEECH SOFTWARE)
- FM INTELLIGENT ORGAN SOFTWARE
- CD MUSIC PLAYER
- MMPLAY PRESENTER
- DOS DRIVERS AND WINDOWS DLL
- SB MIDI - A MIDI FILE DRIVER
- SBSIM - A SB STANDARD PROGRAMMING TOOL

plus WINDOWS 3.1 Drivers

SYSTEM REQUIREMENT
- IBM PC/AT OR 100% 286 AND HIGHER COMPATIBLES (286 AND HIGHER RECOMMENDED)
- MINIMUM 512KB RAM
- DOS 3.0 OR HIGHER
- EGA OR VGA (VGA RECOMMENDED)

MICROSOFT® WINDOWS™ COMPATIBLE

X18021........**$335.00**

SOUND BLASTER PRO V2

MORE THAN JUST - LISTENING EXPERIENCE! THE SOUND BLASTER PRO CARD EASILY INSTALLS INTO YOUR IBM PC/AT AND 100% COMPATIBLES.
(286 AND HIGHER RECOMMENDED)
PACKAGE INCLUDES:

- SOUND BLASTER PRO CARD
- RCA AUDIO CABLE
- MIDI CABLES
- 5.23" AND 3.5" DISKETTES
- SP PRO MIDI SEQUENCER SOFTWARE
- VOICE EDITOR II
- SBTALKER (TEXT-TO-SPEECH SOFTWARE)
- FM INTELLIGENT ORGAN SOFTWARE
- CD MUSIC PLAYER
- MMPLAY PRESENTER
- DOS DRIVERS AND WINDOWS DLL
- SB MIDI - A MIDI FILE DRIVER
- SBSIM - A SB STANDARD PROGRAMMING TOOL

SP PRO MIDI SEQUENCER SOFTWARE

SYSTEM REQUIREMENT
- IBM PC/AT OR 100% 286 AND HIGHER COMPATIBLES (286 AND HIGHER RECOMMENDED)
- MINIMUM 512KB RAM
- DOS 3.0 OR HIGHER
- EGA OR VGA (VGA RECOMMENDED)

X17050........**$375.00**

CD-ROM PACKAGE

This CD-ROM Drive provides a total solutions with a low cost entry into the revolutionary multimedia information technology. A key component in the Multimedia Upgrade Kit, It has a mass storage necessary to run the data-intensive multimedia application. CD-ROM drive will also fit into any 5.25" half-height drive bay on your IBM compatible (XT's not compatible)
FEATURES:

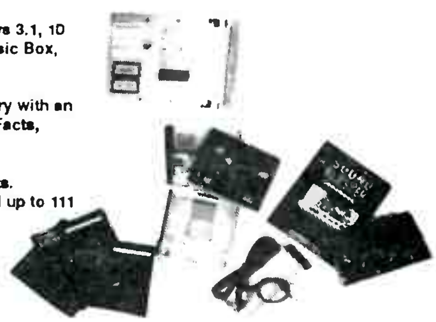
- Includes Sound Blaster Pro (short version)
- CD quality sound (you can even play normal audio CD's)
- Ability to display photographic images & motion video (requires VGA display)
- Audio jacks for quality sound through your own speaker system- 630 Mb of data on one compact disc
- Full compliance with multimedia extensions 1.0
- Front mounted stereo headphone jack and volume control

MICROSOFT WINDOWS 3.1 (with Multimedia extensions) - Full implementation of Microsoft Windows 3.1, 10 Mb of help data, multimedia accessories including Music Box, Sound Recorder, Juke Box and more.

MICROSOFT BOOKSHELF- A complete reference library with an Encyclopedia, Thesaurus, Atlas, Quotations, Book of Facts, Dictionary and Columbia Dictionary of Quotations.

CREATIVE'S SOUNDS- Superb music and sound effects. Includes audio clips, 29 compositions in 4 formats and up to 111 sound effects.

X17060....**$949.00**

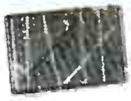







SPECIAL OFFER ON SOLAR PANELS.OFFER ENDS 31st OCTOBER BUY NOW AND SAVE!!!!!

SOLAR POWERED PRODUCTS



ENCAPSULATED SOLAR CELL MODULE 0.45V 200mA

These are ideal for simple solar experimemts. Can be connected with other solar cells.

Z19001......................$2.95

SOLAR MOTOR KIT

This is a great starter kit consisting of a 0.9V 400mA solar cell and a small motor with a 48" wire. Great for beginner or just the curious!

Z19040................$9.95

RECHARGABLE SOLAR GARDEN LIGHT

Automatically turns on & off at night & day.

- Detachable solar panel for indoor & outdoor use.
- Unique protection for low voltage discharge circuitry makes charging quick & easy
- Easy to install, equipped with accessories for easy assembly.

Place it beside the house number, pathway, or in the garden,

S PEEDY CHARGING : ONLY 6 HOURS OF CHARGING WILL GIVE 12 HOUR OF USE AT NIGHT.

Z19060..................$39.95

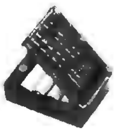
ON SPECIAL!

SOLAR WOODEN MODELS

Build great little solar powered wooden models with this kit! There are 3 different models to choose from a helicopter with working motor, aeroplane with working motor and gramophone that plays music.

Each kit contains a set of precut plywood, PVA cement, assembly instruction sheet, solar cell module, musical IC or small DC motor, wire and sand paper.

Z19044 Aeroplane...........$17.95
Z19046 Gramophone......$17.95
Z19048 Helicopter...........$17.95



SOLAR BATTERY CHARGER FOR 'AA' SIZE BATTERIES

Z19050......................$12.95

SOLAR BICYCLE WARNING LIGHT AND BATTERY CHARGER. for 2 'AA' size batteries

Z19056.................$19.95

SOLAR MUSICAL KEYCHAIN WITH LIGHT.

Never lose your keys again with this clever little device.

The solar powered keychain with light will let you find where you left your keys where you left them just by listening to music. The solar powered light will always let you find that illusive keyhole in the dark. A very handy idea and all run on FREE power!

Z19060..................$4.95

SOLAR CAR BATTERY CHARGER

Never worry about your car battery going flat when left without being used over a prolonged period of time.

Simply place the solar power unit on your dash or near a window in your garage and plug it into your car cigarette lighter.

The unit consists of solar cells in a housing with 1 metre of cable and cigarette lighter plug.

Z19054.......................$29.95

KEYCHAIN BATTERY ANALYZER FOR TESTING ALL SIZES OF BATTERIES

Z19062.................$4.95

SOLAR PANELS ON SPECIAL THIS MONTH!

OFFER EXPIRES 31st OCTOBER. SAVE $10

12V. Voc 16V (max) 18V
Isc 400mA (max) 500mA
WAS $99.00
Z19028....NOW $89.00

OFFER EXPIRES 31st OCTOBER. SAVE $20

12V Voc 16V (max) 18V
Isc 800mA (max) 1000mA
WAS $199
Z19036....NOW.$179.00

OFFER EXPIRES 31st OCTOBER SAVE $40

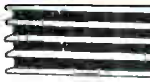
12V 16V (max) 18V
Isc 1200mA (max) 1500mA
WAS $299
Z19038..........NOW. $259.00

EDUCATIONAL SOLAR ENERGY KIT

Learn what Solar power is. With this great kit you can make an electrical circuit. Learn how to increase voltage, increase current.

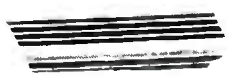
Z19040..........................$9.95

NEW HARDWARE



BONDED HEATSINKS IDEAL FOR HOT IC'S

Length 32mm
H10668.........................$2.95
Length 19mm
H10670.........................$2.50



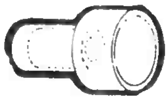
RIBBON CABLE

Colour: Multi. Reel size: 100m 12 conductor flat rainbow cable. Each 1.2mm diameter core is colour coded and can be easily separated.

Conductors 12 x 7 strands/0.12mm

PVC: Each with 1.2mm dia.

..................................$1.95



CRIMP CONNECTORS - NYLON

Ideal for joining wires and cables together

- 12 amp • Size: 0.5-1.5mm • Gauge: 22-16

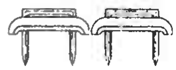
100Pcs $14.95

- 20 amp • Size: 1.5-2.5mm • Gauge: 16-14

100Pcs.............$15.45

- 50 amp • Size" 2.5-6.0mm • Gauge: 12-10

100Pcs.............$15.95



INSULATED STAPLES

For speaker cable and other figure eight cable.

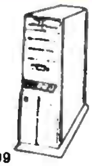
- Takes cable with a maximum width of 5 mm.

Pack of 100.........................$4.50

INTEL CO-PROCCESSORS

Cat No.	Type	Price
U21841	287XL	$210.00
U21851	387DX	$459.00
U21854	387SX-16	$310.00
U21855	387SX-25	$335.00

COMPUTER CASES

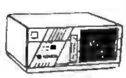


TOWER CASE

Give your computer that professional look

X11105.....$199
220W Power supply to suit X11102......$199

BOTH FOR ONLY $295



FLIPTOP CASE WITH 200W P.S
X11100........$85.00

NEW STYLE MNI CASE WITH POWER SUPPLY
X11103...........$129

COPY HOLDERS

COPY HOLDER YU-H33

- Copy area 9 1/2" x 11"
- Sliding line glide
- Flat metal base

C21060.................$39.95

COPY HOLDER YU-H32

Adjustable arms allows easy positioning

- Copy area 9 1/2" x 11"
- Sliding line glide
- Clamping Mounting

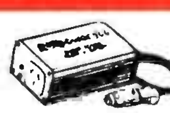
C21062..................$39.95

GRIP CLIP COPY HOLDER

- Attaches to the top your monitor
- Put your copy right where you need it.
- Spring clip to hold paper
- Velcro at mount for easy removal

C21065..................$14.95

RITRON POWER 200



The RITRON POWER 200 is a pocket sized inverter with punch. It will power a myriad of appliances including TV's, Video's, drills, lights, laptops and computers, just to name a few! Continuous power rating is 140 watts, However it will run most appliances with a name plate rating of 200 watts. Surge rating is a very real 400 watts .

.........................$159.00

DON'T PAY ~~$189.00~~.

DEALER & WHOLESALE ENQUIRES WELCOME.

IC MEMORY

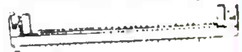
EPROM

Cat No.	Type	Price
U20550	2716	$11.75
U20560	2732	$9.00
U20590	2764	$6.95
U20540	27128	$7.50
U20542	27256	$9.00
U20544	27512	$12.50

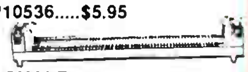
CMOS EPROM

Cat. No.	Type	Price
U20591	27C32	$14.95
U20592	27C64	$5.50
U20593	27C128	$7.50
U20594	27C256	$9.00
U20595	27C512	$11.50
U20546	27C010	$22.50

SIMM SOCKETS



SINGLE
P10536.....$5.95



DOUBLE
P10538............$6.95

These are good quality SIMM sockets with metal clips at the ends and not the plastic ones which tend to break.

PLASTIC DISK HOLDERS

3 /12" PLASTIC DISK HOLDER

- Holds 5 disks

Comes in 6 different colours

C16050	Red	C16054	Yellow
C16052	Orange	C16056	Green
C16058	Blue	C16060	Grey

Only ....$3.50 Each.

5 1/4" PLASTIC DISK HOLDER

- Holds 6 floppy disks

C16030.....$3.50

5 1/4" DISK STORAGE CASES

- Made of Sturdy black flexible plastic.
- Holds 10 or more 5 1/4" disks.
- Display positions

	1-9	10+	100+
C12820	$3.95	$3.50	$3.00

MEMOREX

3.5"Plastic disk holder

- Holds 10 Disks

C12840.....$3.95

3 1/2" DISK STORAGE

- 40 x 3 1/2" disk capacity
- High impact plastic lid & base

C16040..........................$6.95

MONITOR MOVER ARM

MONITOR MOVER ARM

Position your monitor exactly where yuo want int Maximize desk space.

- Solid steel structure
- Height Adjustment
- Span 33cm
- Maximum load 50kg

C21079..............................$189.00

ROD IRVING ELECTRONICS

MAILORDER HOTLINE: 008 33 5757

[illegible]

The Operational Amplifier

The first IC to appear in this series was the 555 timer, described in part 15. In this part, we describe another IC, called the operational amplifier. As you'll see, these are amazing devices that are capable of performing a wide range of useful functions.

by PETER PHILLIPS

Years ago there were two types of computers, called the analog computer and the digital computer. These days, virtually all computers are digital, and the analog computer has been largely superseded.

The analog computer was a relatively simple device and consisted of a number of high gain amplifiers, called *operational* amplifiers. The idea was to connect the various amplifiers so they could solve a mathematical expression and thereby perform an operation.

A classic example is to use an analog computer to design the suspension system of a car. Although the equation for the system is complex (called a second order differential equation), with appropriate connections, a string of op amps can be connected to solve the equation.

In this case, a bump in the road would be a pulse input from a variable voltage source, adjusted for various sizes of bumps. The output is a waveform on an oscilloscope.

Other adjustments in the circuit would include spring stiffness, the viscosity of the fluid in the shock absorbers and so on. Once connected, the designer can then fine tune all the components so that the bounce resulting from a bump gives the best response for the system, as displayed on the oscilloscope.

Although such an operation is beyond the scope of this series, this example illustrates the versatility of the operational amplifier. In fact, because the op amp is such a useful device, a large number of books have been written about these devices.

We'll keep things more basic and describe a few of the more commonly used applications. But if you want to take the topic further, be assured there is no shortage of literature on the subject.

The op amp

As we've already said, an op amp is an amplifier with a very high voltage gain. The schematic symbol of the op amp is shown in Fig.1(a), which as you can see shows one output and two input terminals. The power supply is connected to the other two terminals.

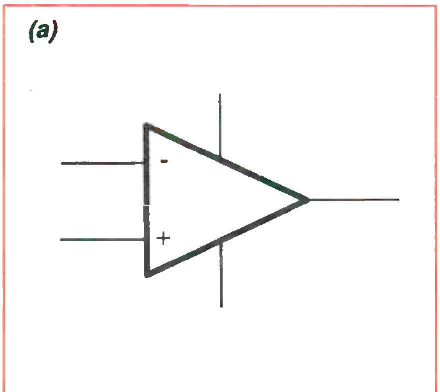
The signal inputs are known as the *inverting* input, shown with the '-' sign, and the *non-inverting* input, indicated with the '+' sign.

An important point to keep in mind is that the signal input to the amplifier is applied between *both* input terminals. The input signal voltage to the op amp is therefore the voltage *difference* between these two terminals, shown as vd in Fig.1(b). This voltage is often called the differential input, as the op amp amplifies the voltage difference between these terminals.

For example, if both inputs are at +1V, there is no difference and the output will be zero. However, if one terminal is at +1V and the other is slightly more positive, a voltage difference is present between the inputs and an output voltage will result.

The power supply for an op amp is slightly different to most ICs, and usually requires a *dual-polarity* supply, shown by the two batteries in Fig.1(b). This supply has three terminals: positive, negative and the common (or earth) terminal.

This type of supply is necessary to allow the output to go either positive or negative, depending on the polarity of the input voltage. While it is possible to operate an op amp from a single rail supply and to use a coupling capacitor at the output as in a conventional transistor



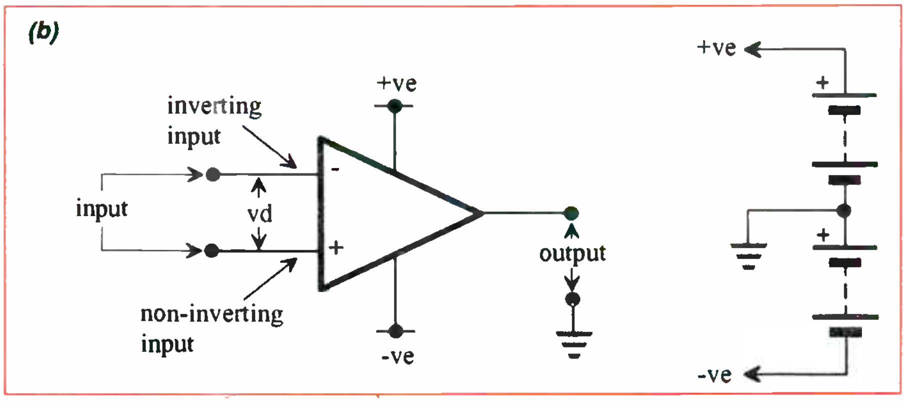


Fig.1: The symbol of the op amp is shown in (a). The dual-polarity power supply shown in (b) illustrates the usual type of supply required by an op amp. The input signal is applied between both inputs and the output is between the output terminal and ground.

[illegible]

[illegible]

amplifier, most op amp ICs require a dual-polarity supply for best operation.

Op amp characteristics

It is useful to consider the op amp as an *ideal* amplifier, as in most cases the actual characteristics are not far removed from the ideal. The first of these is the voltage gain.

An ideal op amp is assumed to have a voltage gain of infinity. This means that an output will occur for a differential input of zero. In practical terms, this means the voltage difference at the input terminals is low enough to assume it is *virtually* zero.

The usual voltage gain of an op amp is around 200,000, meaning a differential input of only 10uV gives an output of 2V. This is a very useful point to remember, as it means we can often (though not always) assume that the voltages at both input terminals of the op amp are equal, as in reality they often differ by a only a few microvolts.

The next characteristic is input resistance. Ideally, this should be infinitely high (or open circuit). If the input resistance is ideal, no current flows into the input terminals. In practice, the input resistance (resistance between the input terminals) is generally between about 1M ohms and over 100M ohms, depending on the type of op amp. Therefore, while a small input signal current may flow, it is small enough to be ignored.

Then comes output resistance. The ideal value is zero, and in most practical cases this value is again small enough to be ignored.

Of course, this doesn't mean the op amp can supply unlimited current to a load, as it would quickly burn out. Most op amps have some form of internal current limiting to prevent them burning out if the output is shorted to ground, but under normal operating conditions, the output resistance is low enough to assume it is zero.

The next characteristic is frequency response (or bandwidth). This is a rather strange characteristic as the ideal bandwidth is infinity. That is, the ideal amplifier can amplify frequencies from 0Hz (DC) to frequencies above that of light. In fact, practical op amps often have a rather low bandwidth — often as low as 10Hz. However, given suitable external circuitry, the useful response can be extended to over 1MHz, which for most applications is high enough to regard as ideal.

Another interesting characteristic is the assumption that a zero output will result for a zero differential input. In practice, if the differential input voltage is zero, a small DC output voltage will often result.

This is called *offset* and can be cancelled or *compensated* with external circuitry. Most op amps have some facility to allow adjustment for obtaining zero offset, which becomes important when a DC signal needs to be amplified.

One point we need to make is that many op amps have a small DC bias current flowing through both input terminals. This current is similar to the base current required in a transistor, and is produced by the internal circuit of the op amp. The main consideration is that a DC path to ground for each input terminal needs to be provided by the external circuit.

Ideally, the DC resistance to ground from each input terminal should be the same. In some cases, the DC bias current will flow to ground through the signal source, meaning it needs to be DC coupled to the op amp. All the circuits shown in this part have the required DC paths, although for simplicity, their resistance has not been made equal.

There are other characteristics associated with an op amp, but we'll leave these for now and explain them as the need arises. The best way to explain how all this fits together is to describe how the op amp can be used as a basic amplifier.

Inverting amp

An op amp on its own has too high a voltage gain to be useful, in a lot of circuits. As we've already explained, a few microvolts at the input terminals of the op amp will produce several volts at the output. To reduce the voltage gain to a useful value, *negative feedback* has to be applied to the op amp.

You might remember we discussed negative feedback when the transistor amplifier was described. This type of feedback is a connection from the output back to the input, arranged so the output voltage *subtracts* from the input voltage. The amount of feedback is determined by the feedback circuit, and is often some sort of resistive network that supplies a fraction of the output back to the input.

The amplifier circuit we are going to describe is shown in Fig.2, and is called an *inverting* amplifier, for reasons that will become clear. As you can see, the circuit is quite simple, consisting of the op amp and two resistors. The power supply connections aren't shown to make the diagram easier to read, and the power supply connections of Fig.1(b) would normally be used.

The feedback is provided by both resistors, in which resistor Rf connects the output back to the inverting input, with resistor R1 acting with Rf to reduce

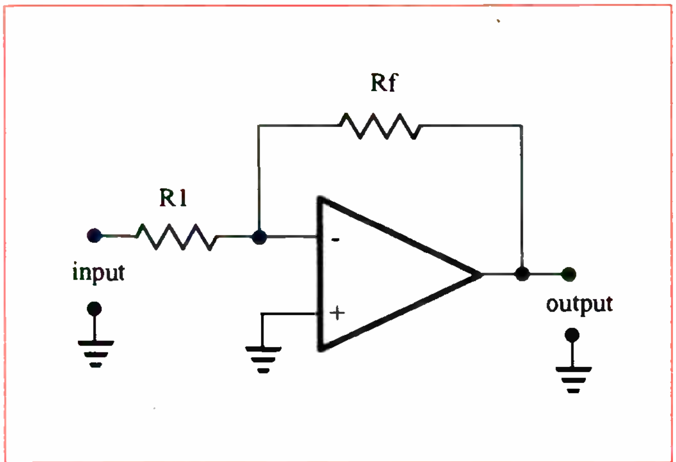
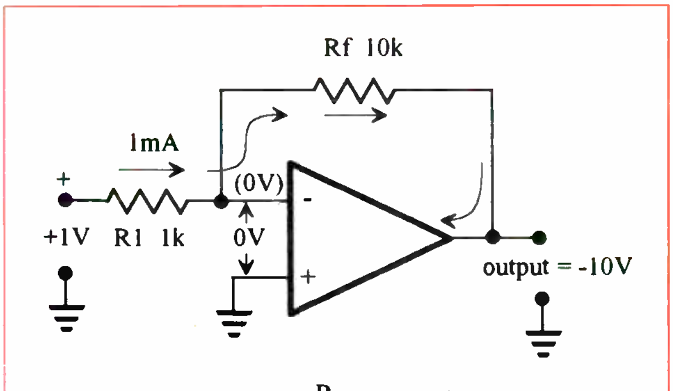


Fig.2: The basic inverting amplifier is shown here. The (+) input is connected to ground, and the input signal is applied between ground and to the op amp via R1.



$$Av = (-)\frac{R_f}{R_1} = (-)\frac{10k}{1k} = -10$$

Fig.3: In this diagram, a current of 1mA flows in R1 and Rf due to the 1V input voltage. The output voltage of the op amp will be a value that therefore causes 1mA in Rf.

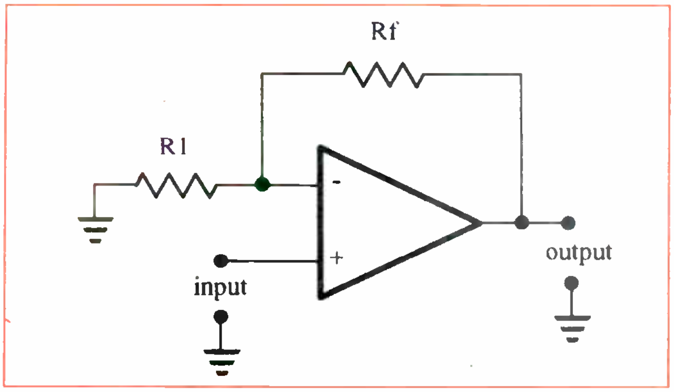
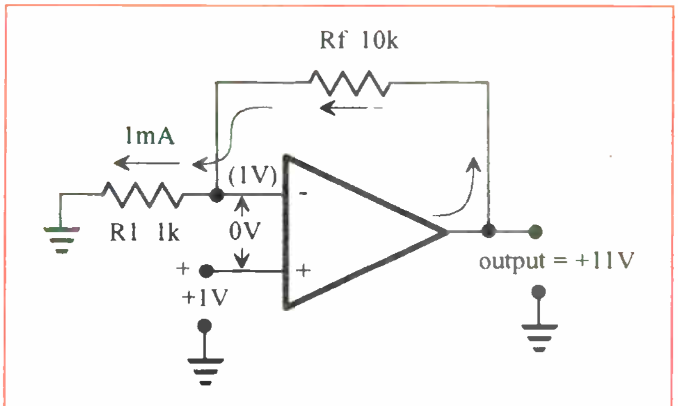


Fig.4(above): The basic non-inverting amplifier has the same feedback as the inverting amplifier in Fig.3, but the input voltage is applied directly to the (+) input of the op amp.



$$Av = \frac{R_f}{R_1} + 1 = \frac{10k}{1k} + 1 = 11$$

Fig.5(right): The analysis of the non-inverting amplifier is shown here, in which a current of 1mA flows in both R1 and Rf. The differential input voltage will be zero, as the voltage at both input terminals is the same. As the equation shows, the gain for this circuit is also determined by the external resistors. This circuit has a high input resistance.

the amount of feedback. To show how this circuit works, we can use Ohm's law.

In Fig.3, values have been included, with an input voltage of 1V DC applied between R1 and ground. Because the differential input across the input terminals of the op amp can be assumed to be zero, the voltage at the (-) input of the op amp will equal the voltage at the (+) input. That is, the voltage at the (-) input is 0V.

Because one end of R1 is at +1V (the input side) and the other is 0V, the voltage across the resistor is 1V. By Ohm's law, this will cause a current of 1mA to flow in R1. However, because the input resistance of the op amp is very high (ideally an open-circuit), the current in R1 cannot flow into the op amp, and therefore needs to flow in Rf.

For a current to flow in Rf, a voltage drop must be present, which by Ohm's law must be 10V, with positive on the left and negative on the right (at the output terminal of the op amp). Because the left side of Rf is at 0V, as we've seen, the output of the op amp must be -10V. Notice how the current in Rf flows into the output terminal of the op amp.

By using Ohm's law it is relatively easy to show that the voltage gain (Vout/Vin) of the circuit equals Rf/R1. The proof doesn't matter, but the equation (shown also in Fig.3) is important. What this shows is that the gain of the circuit is determined entirely by the resistors. In fact, many op amp circuits can be analysed this way, and some quite complex circuits can be reduced to nothing more than Ohm's law.

In practice, if you built this circuit, you would find that the voltage gain would be very close to 10. To change the gain, you simply change the values of either R1 or Rf. For example, if Rf was changed to 100k, the gain would be 100.

Another point to note is that the polarity of the output is the opposite to the input. That is, for a positive input, the output is negative. This is why the circuit is called an *inverting* amplifier, as the output has an inverted (or opposite) polarity. If an AC signal was connected to the input, the output would be 180° out of phase with the input. The gain is still 10, and if the input was 1Vp-p, the output would be -10Vp-p. The minus sign refers to the phase inversion.

The next point is the input resistance of the circuit. We said before that the input resistance of an op amp is (ideally) infinite, but this is not true for the whole circuit. In fact, because the input voltage is applied across R1 (as the other end of R1 is at 0V), the input resistance of the *circuit* equals R1.

In some cases, such a low input resistance may not suit the application, and another circuit configuration, called the non-inverting amplifier might be required.

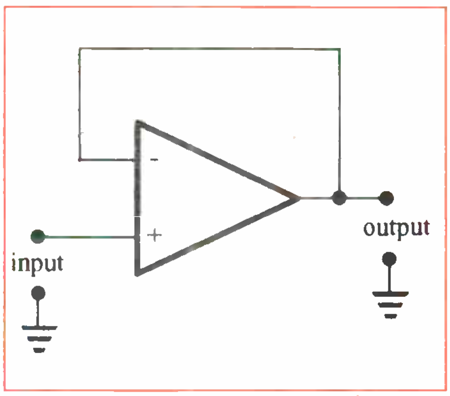


Fig.6: The non-inverting amplifier can also be used as a buffer by connecting the output directly to the (-) input. The gain of the circuit is unity, and the input resistance is equal to the input resistance of the op amp.

Non-inverting amp

The circuit of the non-inverting amplifier is shown in Fig.4. In this circuit, the input voltage is connected directly between the non-inverting input and ground. The feedback network is still needed, this time with R1 connected to ground.

However, because the input resistance of the op amp is (ideally) an open-circuit, the input resistance seen by the signal is very high, and equals the actual input resistance of the op amp. But this time, the gain of the circuit is slightly higher than for the inverting amplifier, assuming the same value resistors.

In Fig.5, the values are included, again with 1k for R1, 10k for Rf and a +1V input. Because the differential voltage between the op amp input terminals is zero, the voltage at the (-)input will equal the input voltage.

Therefore, because R1 is connected to ground, it will have a voltage across it of +1V, again causing a current of 1mA. This current comes from Rf, supplied by the output of the op amp.

As before, because the current in Rf is 1mA, there has to be a voltage drop across Rf of 10V. However, as the left side of Rf is at +1V, the other end needs to be at 11V to give the 10V drop.

[illegible]

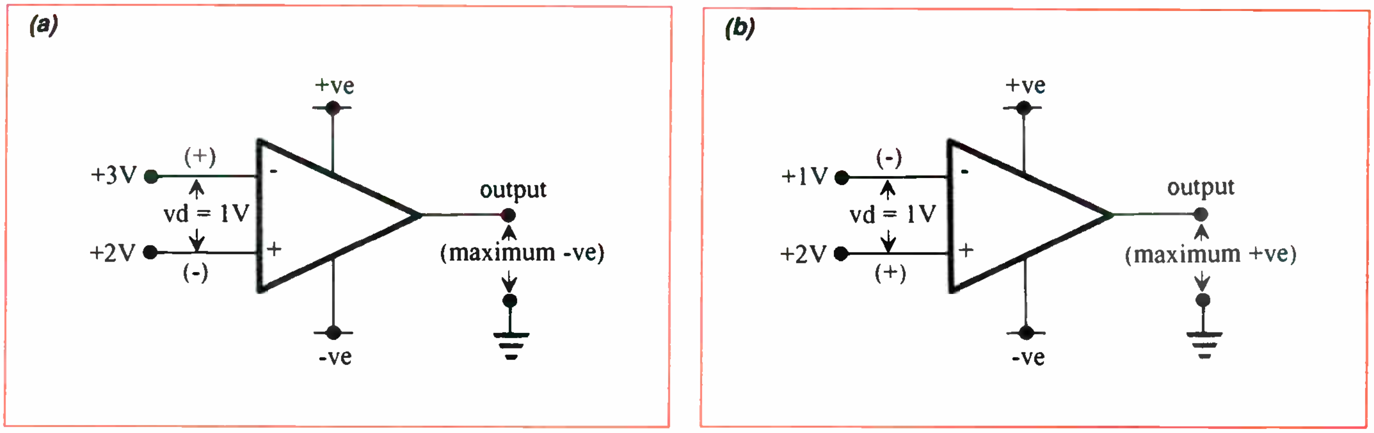


Fig.7: The operation of the comparator is shown here. In (a), the (-) input is positive compared to the (+) input, giving an output that is maximum negative. The opposite condition is shown in (b).

Therefore the output voltage of the op amp is +11V, which is 1V higher than the previous circuit.

The equation to determine the voltage gain (Vout/Vin) of the non-inverting amplifier equals (Rf/R1) + 1, which can also be proved with Ohm's law. To reduce the gain of the circuit in Fig.5 to 10, Rf could be reduced to 9k, or R1 could be increased to 1.1k. So again, the voltage gain of the circuit is determined entirely by the external resistors. But this time, the input resistance of the circuit is very high, being equal to the input resistance of the op amp.

Notice also that here the polarity of the output is the same as the input, hence the term *non-inverting* amplifier. A popular use for this circuit configuration is as a non-inverting *buffer*.

In some applications, it is necessary to connect a buffer stage between the input and the rest of the circuit to ensure the input source is not loaded by the circuit. This might apply when the signal source has a high output resistance, such as some types of microphones, record player pick-ups and so on.

A buffer stage using an op amp is shown in Fig.6, in which the output is directly connected to the (-) input. In this circuit, because the voltage at the (-) input will equal that at the (+) input, the output voltage equals the input voltage. In other words, the circuit has a very high input resistance and also a voltage gain of unity.

Also, the polarity of the output will be the same as the input. This is similar to the emitter follower circuit described in previous parts of this series, and for this reason it's sometimes called a *voltage follower.*

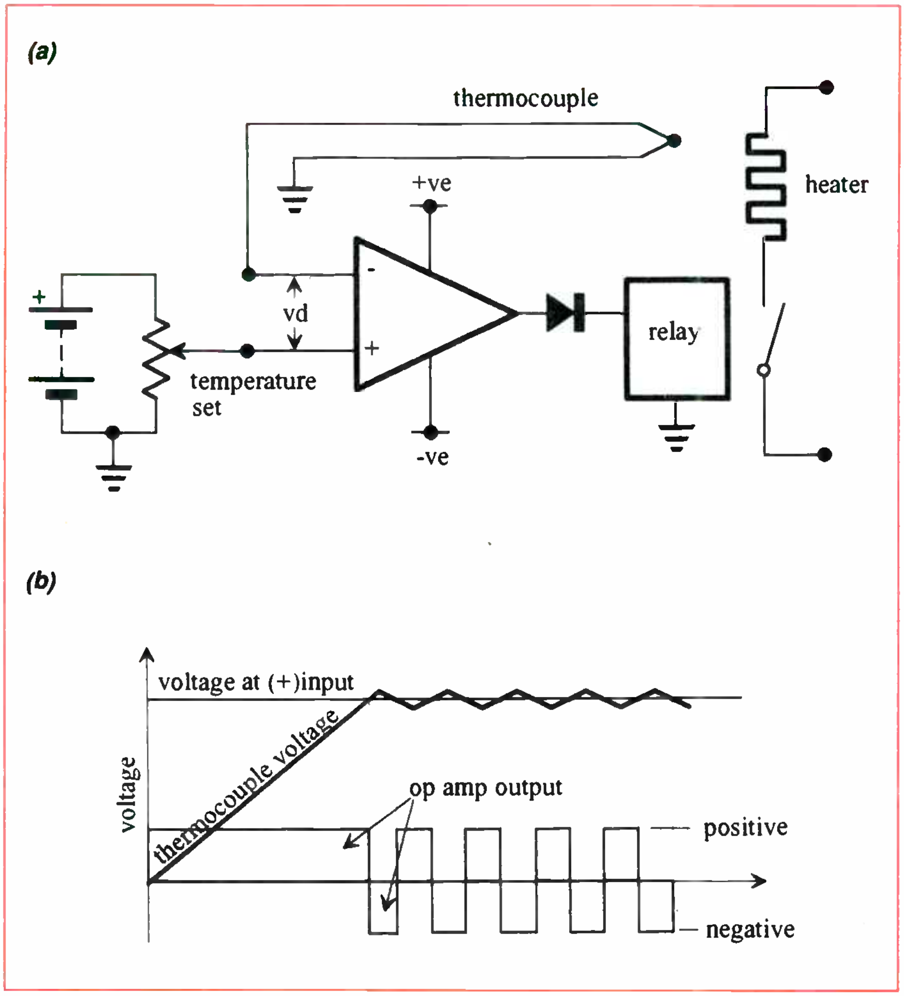


Fig.8: The comparator can be used in a control circuit, such as that shown in (a). The relay, driven by the op amp, switches the heater element, and a thermocouple senses the temperature. The action of the circuit is shown in (b).

The comparator

The circuits described so far all use negative feedback to reduce the gain of the circuit. The operation of circuits with negative feedback can be analysed on the assumption that the negative feedback keeps the differential input voltage at zero. However, there are times when the full gain of the op amp is required, and negative feedback is therefore not used. One very common circuit that doesn't use negative feedback is the *comparator.*

A comparator is a circuit that has only two possible output voltages: maximum positive and maximum negative, with a value virtually equal to the supply voltage. The polarity of the output voltage will depend on the polarity of the dif-

ferential input voltage, which is best explained by Fig.7.

As shown in Fig.7(a) when the (-) input is more positive than the (+) input, the output is negative. Put another way, a negative output results if the (+) input is negative compared to the (-) input.

In Fig.7(b), the (+) input is positive compared to the (-) input, giving a positive output. Obviously, we can also say that a positive output occurs if the (+) input is positive compared to the (-) input. A point to notice is that the differential input to the op amp is no longer zero as it was for the amplifier circuits.

The reason is there is no connection from the output back to the (-) input to allow the amplifier to make the voltage at the (-) input equal to that at the (+) input.

Applications

The comparator is therefore (in theory) the simplest circuit of all, as it has no external components. It has many uses in electronics, and is often part of the interface between an analog circuit and a digital circuit.

A typical use of a comparator might be to control the temperature of a heater. In this example, shown in Fig.8(a), the temperature is set by the voltage applied to the (+) input.

The output of the op amp is connected to a relay, which is switched on when the output of the comparator is maximum positive. Otherwise, the relay is off as the diode prevents the negative output voltage of the op amp from operating the relay. The relay is used to switch power to the heater element.

A thermocouple senses the temperature, and is connected between the (-) input and ground. As the temperature rises, the output voltage of the thermocouple increases as in Fig.8(b).

When the thermocouple voltage exceeds the voltage at the (+) input, the op amp output swings negative, turning off the relay. When the temperature cools, the thermocouple voltage falls, allowing the op amp to turn on the relay (and the heater element).

Although the comparator seems to be a simple circuit, it requires careful design of the PCB layout to prevent noise at the inputs from affecting the operation. Also, the switching action at the output can generate spikes in the power supply, causing interaction with other parts of the circuit.

A basic op amp can be used as a comparator, but in most cases, ICs specifically designed to perform the comparator function are preferred. These ICs can usually operate from a single rail supply, and feature fast switching at the output.

But what happens if both inputs of a comparator are at the same voltage? When this happens, the output of the comparator becomes rather unstable, as noise at the inputs will cause the output to oscillate between maximum positive and maximum negative.

To prevent this, *positive* feedback can be applied — giving a circuit called a Schmitt trigger. This and other applications will be described in the next part, including some you might like to construct and experiment with.

We'll also describe some more characteristics of the op amp and explain the differences between the various types of op amps.

(To be continued) ❖

A Basic Guide to Colour
TV & VCRs

Two very popular series of articles, published in Electronics Australia in the late 1980's, have now been combined into a separate publication. Students, the home handyman, even the serviceman, will find that the latest publication from Electronics Australia gives a wide and comprehensive insight into the electronics involved in colour television and video cassette recording.

The author, David Botto, is a television, video and electronics service engineer with many years of 'on-the-bench' experience. He's also designed, constructed and maintained a wide range of test instruments. David's wealth of exerpience and vast knowledge of colour television and VCR's have been put together to give you the facts, figures and basic knowledge you need, to understand just how these entertainment machines work.

Available now from your local newagent or by mail order. Price in Australia is $4.95, with an extra charge of $2 for post and packaging, when ordered by mail, from -

The Book Shop,
Federal Publishing Company,
P.O. Box 199,
Alexandria, NSW. 2015

WORLDWIDE

. . . the choice is crystal clear when you want custom made quartz crystals FAST!

"THE AUSTRALIAN COMPANY" — *the choice is crystal clear*

Hy-Q International

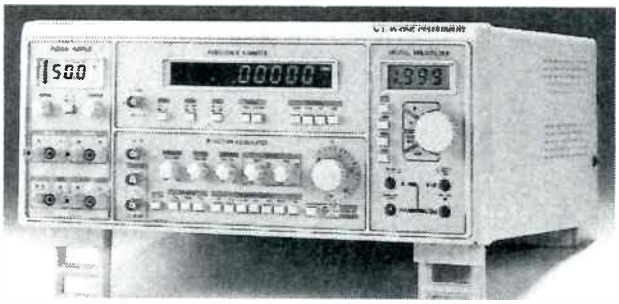
Be it a Jumbo Jet or a local courier Hy-Q appreciate that stand down time represents lost revenue — so we have tailored our operation for efficient, fast service as a world leader in crystal technology with our bases on four continents . . . in Australia, Singapore, Great Britain, USA . . . we have the resources and technology to unequivocally guarantee our quality and service. Hy-Q also manufacture and stock Crystal Filters, Dil Oscillators, MPU Crystals, Clock Crystals, SPXO and TCXO Oscillators etc.

EXPRESS!!!
Our special emergency service slips into overdrive to despatch within *six hours in special circumstances — 24 hours for others.
Normal despatch for custom quality crystals is ten working days.
*Providing order received before 10am.

17 WINTERTON ROAD, CLAYTON VICTORIA 3168
(P.O. Box 210, Clayton 3168)
TELEPHONE: (03) 562 8272
FAX: (03) 562 9009

READER INFO NO. 4

Emona LAB4
Four instruments in one package!



The LAB4 has four full function test instruments:

- **DC POWER SUPPLY**
  Triple output; 5V, 15V, 0-50V
- **DIGITAL MULTIMETER**
  Full function, auto-ranging
- **FUNCTION GENERATOR**
  0.02Hz-2MHz, with SWEEP
- **FREQUENCY COUNTER**
  1Hz-100MHz input range

INDEPENDENT INSTRUMENTS
Each instrument in the LAB4 is completely independent and can be switched ON or OFF as required. The LAB4 has only one 240V mains input, saving on multiple power points.

Each instrument is clearly defined with neatly laid out and labelled front panel controls. Also, the LAB4 is compact and only takes up a small space, compared to four bench-top instruments.

LAB4
Test Instrument Package
$774 (excl. tax)

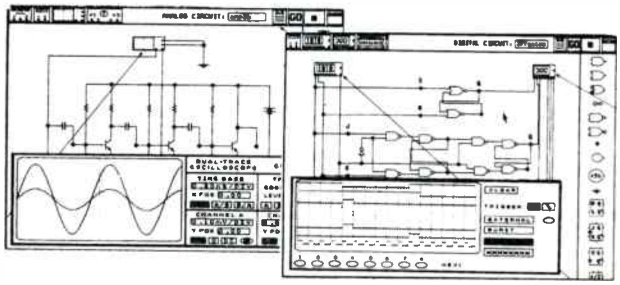
EMONA
INSTRUMENTS

NSW .... (02) 519 3933
VIC .... (03) 889 0427
QLD .... (07) 397 7427

DISTRIBUTORS
Perth .... (09) 244 2777
Adelaide .... (08) 362 7548
Hobart .... (002) 34 2233

READER INFO NO. 10

Electronics Workbench®
The electronics lab in a computer!



A simple, intuitive and very powerful teaching tool, Electronics Workbench lets students and hobbyists design and test both analog and digital electronic circuits, without the delays and expense of a laboratory.

FEATURES
● Quick and simple circuit entry ● Digital and Analog Modules included, complete with all components ● Simulated instruments: dual trace scope, spectrum analyser, function generator, multimeter, digital word generator and logic analyser ● Complete control over all component values and parameters ● Print: circuit schematics, parts list, instrument readings, macros ● Logic conversion – truth table to Boolean formula to logic gates ● Customisable hypertext help system

THREE VERSIONS
• **Professional Version:** EGA/VGA colour display; unlimited components
• **Personal Plus Version:** Monochrome display; unlimited components
• **Personal Version:** Monochrome display; limited to 20 components per circuit

EWB
Professional single user
$429 (plus $7 p&p)

EMONA
INSTRUMENTS

NSW .... (02) 519 3933
VIC .... (03) 889 0427
QLD .... (07) 397 7427

DISTRIBUTORS
Perth .... (09) 244 2777
Adelaide .... (08) 362 7548
Hobart .... (002) 34 2233

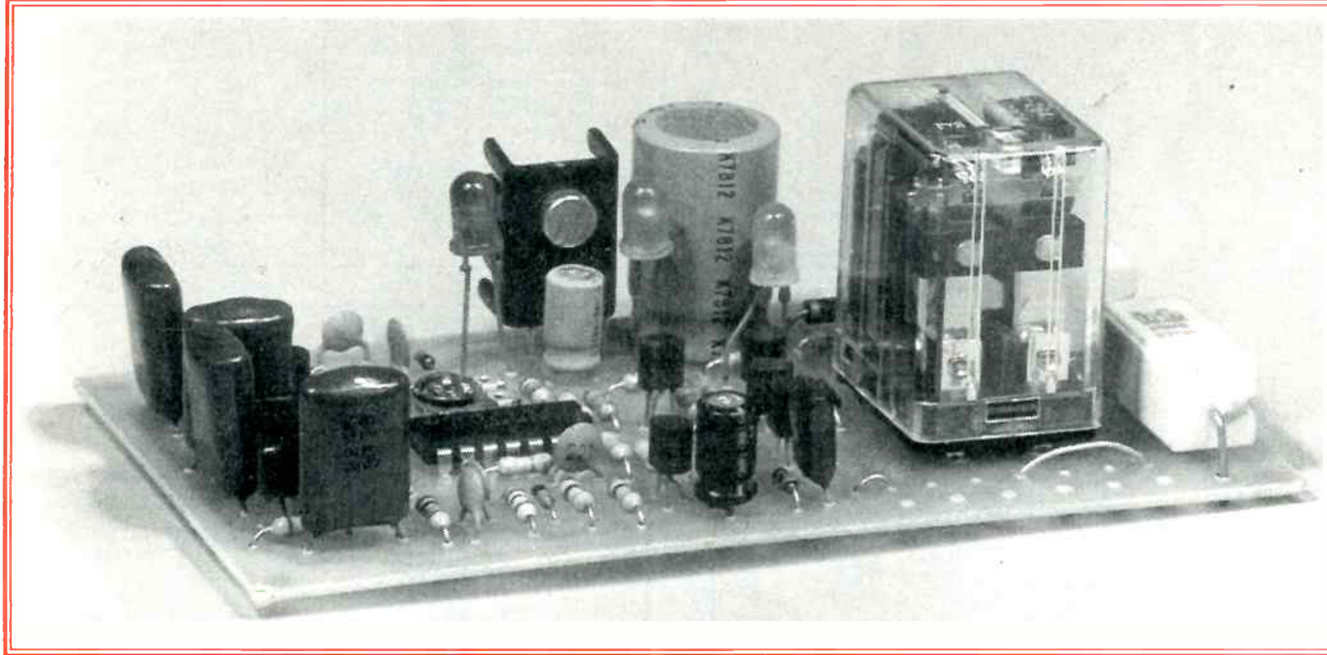
READER INFO NO. 11

[illegible]

Flexible loudspeaker protection circuit

Dubbed the 'Protector', this small module will save your expensive loudspeakers from damage due to an amplifier fault or destructive drive signals. It includes an 'intelligent' de-thump circuit, and can be either built into an existing amplifier or housed in its own enclosure as a free-standing unit.

by ROB EVANS



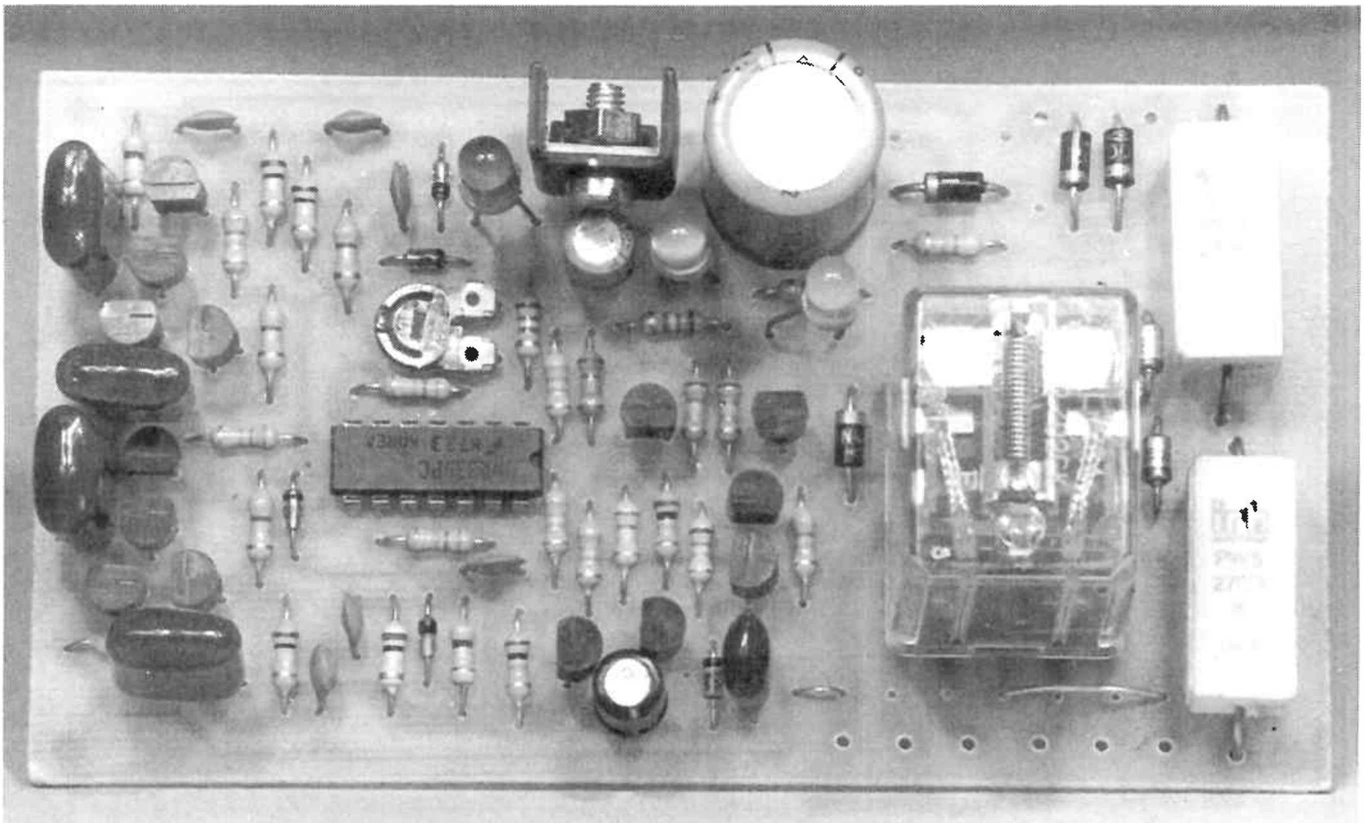
It's safe to say that if you are running a set of hifi or PA loudspeakers from an amplifier which doesn't feature loudspeaker protection, then you're taking quite a risk. To put it simply, the reason behind this danger is really the limited power handling of the components inside the speaker box, which are designed to handle AC signals at audio frequencies.

If you take a two-way hifi loudspeaker which has a nominal power handling of say 150W for example, then it would be reasonable to drive these speakers with a similarly powered amplifier — so theoretically, your speakers are not in danger. If this amp is of a contemporary DC-coupled design and develops a fault however, chances are that the output will 'latch up' to one of its internal power supply rails. The full DC supply rail voltage — which would be around plus or minus 50V for a 150W amplifier — is therefore applied directly to your hapless speakers.

Since a typical 8-ohm loudspeaker will have a DC resistance of about six ohms, a 50V source will cause at least eight amps to flow through the bass driver's voice coil in a continuous manner. Not surprisingly, the 150W driver suffers a gruesome death as it attempts to handle the resulting 400W of dissipation. There will be smoke, possibly fire, and very likely a few expletives...

While you can take some small comfort in the fact that the tweeter will survive the carnage — since the crossover network will invariably block DC voltages with its series-connected filter capacitor(s) — don't relax yet. There is another fate waiting for this relatively fragile device.

For a tweeter to handle high-frequencies with a reasonable response time, the cone/dome and voice coil assembly must be of a very light construction so that it can move rapidly. While this in turn means that the voice coil can only dissipate quite limited amounts of power, the nature of recorded music means that there is only a small amount of high-frequency energy which needs to be reproduced by the tweeter, for a



A shot of the completed Protector, in its prototype form. In this case the unit has been configured to suit a high-powered amplifier (200W into eight ohms) — note that the components for Power Supply 3 have been fitted, so that the circuit can be installed inside the amp and powered from its positive supply rail.

balanced overall sound. And of course, the crossover network ensures that the much larger low-frequency energy is not passed to the tweeter.

So under normal circumstances, a tweeter with a raw power rating of say 20W will be more than happy in a 150W loudspeaker system. But as we all know, things have the unfortunate habit of not remaining 'normal'...

Imagine for a moment that the driving amplifier has become unstable at high frequencies, and begins to oscillate at some supersonic pitch — which of course, even the most refined human ears won't pick up. In this case, the energy is dutifully passed to the tweeter by the crossover network, where the voice coil attempts to both respond to the frequency, and dissipate the resulting heat build-up.

It really has no hope on either count, since both the frequency and the power level are just too high; the amp will invariably oscillate at full power, and at frequencies of up to a few megahertz. So, as the old rhyme goes: pop goes the tweeter...

Unfortunately, a tweeter can also be dispatched in short order when an amplifier is driven into severe clipping. This is due to the large amount of high-frequency energy which is generated when the amp's output is driven into the 'end-stops' (the supply rails), where the drive signal takes on a harmonic content approaching that of a square-wave. In practice, this energy would exceed the tweeter's 20W rating, and overheat the voice coil after a reasonably short period of sustained amplifier overload.

While you may consider the chances of *your* amplifier running into sustained distortion to be quite remote, since of course the audible result is extremely obvious, many a careful listener has been tricked by the large dynamic range produced by a compact disc player, for example. All it takes is to set the amplifier's volume too high during (say) a quiet section at the beginning of the disc, then unwittingly pop out of the room for a moment just as the full recorded level kicks in — thereby driving your amp into an unchecked overload.

A less convoluted scenario is the infamous party, where the volume of the music simply gets louder as the night wears on. As celebrations reach a hedonistic peak, nobody (except the neighbours) seems to notice or care that the music has become grossly distorted — thanks to each passer-by giving the volume knob another tweak. Needless to say, the host (or parents of) will find their speakers sounding decidedly 'flat' the next day, thanks to a set of expired tweeters.

As an aside, we know of one festive situation where a three-way speaker system first lost its tweeters, then the midrange drivers ("What's wrong with the sound? Never mind, turn it up"), and then the electrolytic capacitors in the crossover network — which exploded inside the enclosure, as their voltage rating was exceeded.

Finally, the amplifier overheated, blew its output transistors and delivered its DC supply rail to what was left of the speakers. Needless to say, this in turn took out the bass drivers ("What happened to the music, and what's that smell?"). Then, fortunately, the amp's fuses gave out before the driver's coil former caught fire. After a brief moment of silence as those present observed the smouldering remains, a search was quickly mounted for a portable tape player...

That's a hand-on-heart true story, by the way.

Likely or unlikely, the above situations (except perhaps the last) are certainly on the cards, and can be very

Flexible loudspeaker protection circuit

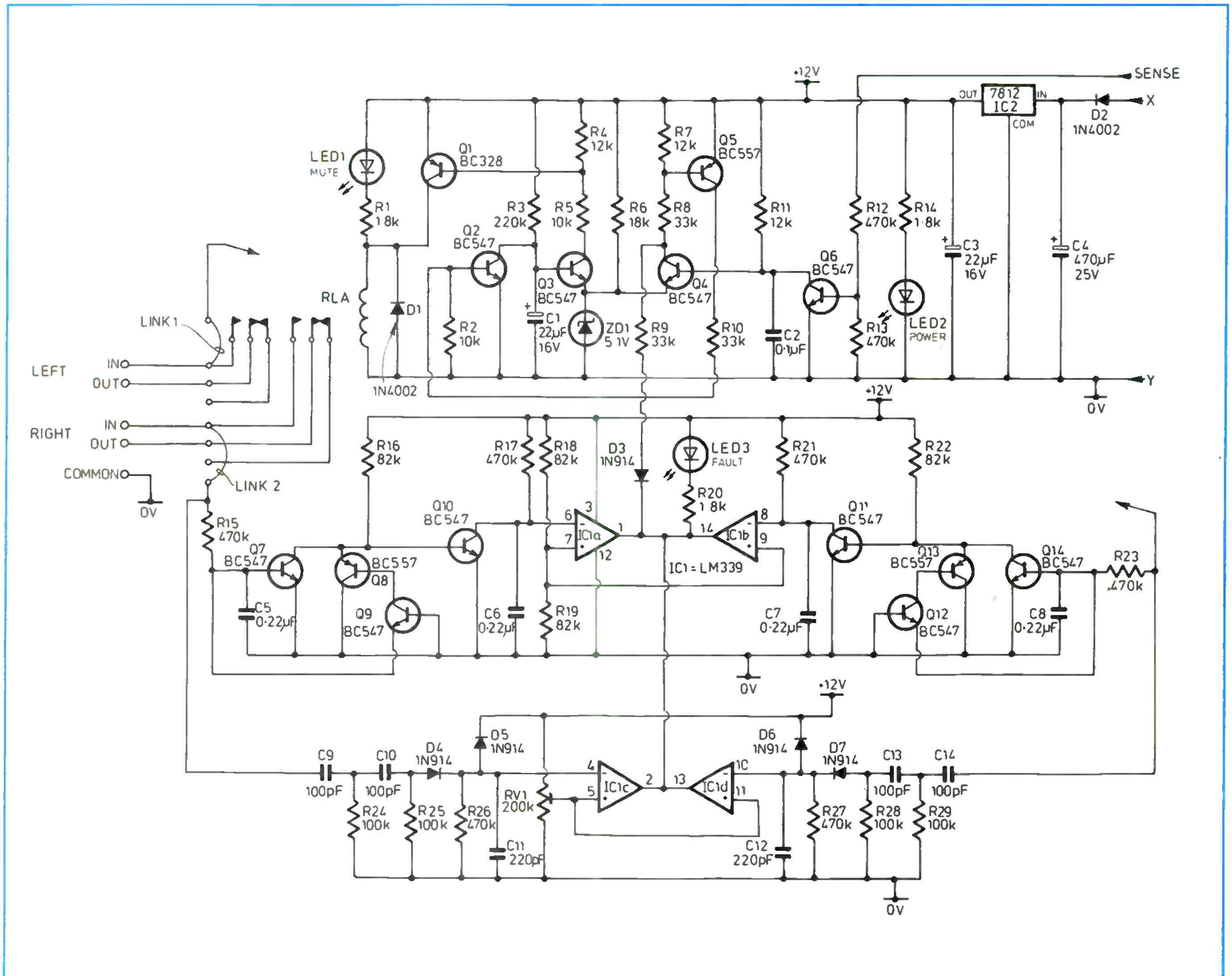


Fig.1: The Protector's main schematic diagram. The upper section of the circuit controls the action of the speaker switching relay RLA, while the circuitry based around IC1 in the lower half of the diagram senses DC (IC1a/b) and high-frequency (IC1c/d) error conditions.

expensive to rectify. It's on these grounds that our new speaker protector offers particularly cheap insurance against loudspeaker damage, since it offers protection against both dangerous DC levels, and excessive drive at high frequencies.

As a bonus, the Protector also has turn-on and turn-off muting, which is rather more sophisticated than the simple de-thump circuits of past designs.

The new circuit is based around the action of a muting circuit which simply disconnects drive to the loudspeakers for a few seconds via a heavy-duty relay, and can be 'triggered' by a number of different events. These events include power-on, power-off, a DC error, or a high-frequency (HF) error.

Note that while a power-on event will trigger the muting action as in past de-thump circuits, our new design also responds to a power-off condition, where the same muting sequence will occur.

This slightly unusual approach means that the speakers are immediately disconnected when the power is shut off — thus preventing any audible clicks and thumps which can be generated as the amp's supply rails begin to fall.

This has the further advantage that if the power is only momentarily interrupted, the speakers will be disconnected for a few seconds while the amplifier's circuit re-stabilises. When this situation happens to many amplifier/de-thump circuit combinations, the speakers will tend to respond with a loud thump since the turn-on muting sequence does not last for its full period, or may not even occur at all.

By the way, this basic muting circuit and its turn-on/turn-off sensing arrangement is taken almost directly from the signal muting section of the Playmaster Pro Series 2 preamp, as published in the October 1990 issue of *Electronics Australia*.

This worked well in the Playmaster preamp, and many readers have apparently constructed just this part of the circuit for other signal muting jobs. Rather than re-inventing a very effective wheel, we've used it as the basis of the Protector's circuit, with a few minor modifications.

As mentioned above, our circuit is arranged so that this muting action is also triggered by a DC or HF error. These

[illegible]

[illegible]

[illegible]

conditions are sensed by additional circuits, which monitor signals from both amplifier channels (the Protector is a stereo unit) and initiate a muting sequence if the DC or HF level rises beyond a pre-set point. Note that while a brief DC or HF error will cause the speakers to drop out for the muting period, a sustained fault will cause the circuit to remain in its muted state until the problem is cleared.

So if you are using speakers where the amplifier provides only limited protection, or none at all, the Protector is a very worthwhile investment. It's compact, quite inexpensive, and is suitable for both hifi and PA speakers driven by amplifiers rated at up to several hundred watts.

The circuit

Referring to the main schematic diagram (Fig.1), you can see that the Protector's circuit has been arranged in three main sections. The relay control and de-thump circuitry is shown at the top, while the DC and HF detection circuits are shown at the centre and bottom of the diagram, respectively.

As mentioned, the relay control (or muting) circuit — based around Q1 to Q6 — is virtually identical to that in the Pro Series 2 preamplifier, and functions in the same manner. The heart of the circuit is two simple comparators formed around Q3 and Q4, which sense the voltage across capacitors C1 and C2, respectively.

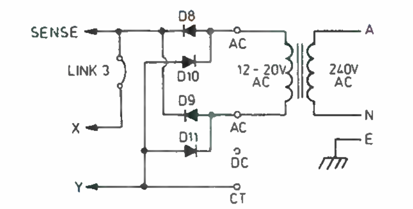
When power is first applied to the unit, C1 is initially in a discharged state (ignore Q2 for the moment), holding the base of Q3 to a low potential. Since the emitter of Q3 is held at around 5V by ZD1 and its associated resistor R6, it will be reverse biased (off) until its base potential rises above about 5.8V (5.1V + 0.7V).

Therefore, Q3 cannot supply base current to Q1 via R5 during this initial period, allowing Q1 to be held in an off condition by pull-up resistor R4. The speaker-switching relay RLA is therefore de-energised, and the speakers are disconnected. Note that in this condition, LED1 will be energised via R1 and the relay coil, indicating a 'mute' condition.

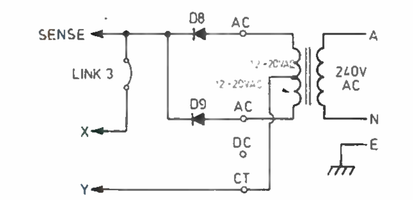
After a few seconds have elapsed however, C1 will have charged to around 5.8V via R3, causing Q3 to become forward biased. The increasing collector current in Q3 will then bias Q1 hard on, energising RLA and connecting the speakers — LED1 will then extinguish, since Q1's collector has risen to around 12V.

The remaining part of the relay control circuit is used to re-trigger this muting sequence in response to a DC or HF 'error' condition, or if the AC supply has been interrupted.

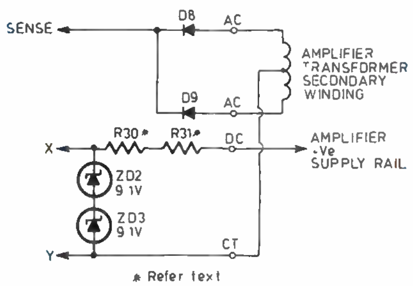
The state of the AC supply is detected via the 'sense' line (connected to R12), which samples the rectified AC input at the junction of D8 and D9 in the power supply circuit, as shown in Fig.2.



Power Supply 1



Power Supply 2



Power Supply 3

Fig.2: You have a choice of three power supply configurations, depending upon whether the unit is powered from its own transformer with a single or centre-tapped secondary winding, or from the main power transformer of a 'host' amplifier — the PCB accommodates all three options.

Regardless of which power supply circuit is used (supply 1, 2 or 3), the sense voltage will be a 100Hz waveform which swings between 0V and a value representing the peak voltage of the transformer's secondary winding — that is, a rectified AC signal which has not been filtered.

Returning to the main circuit (Fig.1), you can see that this signal is applied to the base of Q6 via R12 and the pull-down resistor R13. This in turn means that while AC is present, Q6 will be biased on — except for the short durations when the sense voltage drops below about 1.4V, which will occur as the original AC waveform passes between its positive and negative swing.

So while the AC supply is present, Q6 will be turned off for a few milliseconds at a 100Hz repetition rate — that is, once every 10ms. The idea here is that during these brief periods, C2 is allowed to charge towards the positive rail via R11, and is then rapidly discharged as Q6 turns on again. Note that the component values for C2 and R11 have been chosen so that C2 will charge to a peak level of about 2 volts during the few milliseconds while Q6 is off.

Therefore, the base of Q4 is presented with a voltage which briefly ramps up to around 2V at regular intervals. While the AC signal is present, this waveform will be ignored by Q4, since it is arranged as a comparator with a threshold or triggering voltage of around *5.8 volts* — the circuit here is identical to that of our first comparator, based around Q3.

When the AC supply is disconnected however, Q6 will be off for a longer period, allowing sufficient time for C2 to charge to the 5.8V triggering level of Q4. The increasing current in Q4 will then bias Q5 hard on, which in turn drives Q2 into saturation.

Since Q2 is connected directly across the main turn-on delay timing capacitor C1, this is immediately discharged. So Q3 turns off, and the relay drops out as detailed above. Thus the muting relay will disconnect the speakers just a few milliseconds after the AC supply is disconnected. Note that as the Protector's DC supply falls, the circuit will not have enough power to re-energise the relay, or complete the power-up timing cycle.

On the other hand, if the AC supply is only *interrupted* rather than disconnected for an extended period, the circuit will complete the turn-on timing cycle as if the unit had been just switched on. This is because C1 is immediately discharged once the circuit has detected a lack of AC supply, and will then slowly charge towards the 5.8V triggering level if power has been is re-applied.

In practice, this means that if you (say) inadvertently turn the amplifier's mains switch off then rapidly on again, the Protector will mute your speakers for the *full* de-thump timing period — no chance of nasty thumps and bangs through the speakers as the amp recovers from the drop-out.

Since the AC-off detector (based around Q4) simply pulls the base of Q5 low to initiate the Protector's muting sequence, this is a convenient point to connect the output of the DC and HF error sensing circuits, based on IC1a/b and IC1c/d respectively.

The LM339 comparators have open-collector outputs (that is, an NPN output transistor with its emitter connected to ground), enabling all four comparators to drive the same 'trigger' line which connects to the collector of Q4 via R9 and isolating diode D3. We therefore have a simple OR scheme, where if the output of any of the comparators — or Q4 — goes low, Q5 will be biased on and the muting sequence activated.

Note that LED3 ('fault') and its associated limiting resistor R20 is connected to the output of the four comparators, so that an extended DC or HF error will be indicated as a fault condition — in other words, it shows that if you had bypassed the Protector at this time, your speakers would probably fry...

By the way, D3 has been included to prevent Q4 from activating LED3 when the AC supply is interrupted, as this could hardly be considered as a fault condition.

It is definitely a cause for concern however, if a significant DC level appears at the loudspeaker terminals. This condition is sensed by a circuit formed around IC1a for the right channel, and an identical arrangement for the left channel based on IC1b. The following description concerns the right channel.

The amplifier output, at the contacts of RLA, is connected to both Q7 and Q9 via the current limiting resistor R15 — which also forms a low-pass filter in conjunction with C5. Whenever the output of the amplifier is driven to more than +0.6V by a DC or low-frequency AC signal, then Q7 is biased on, thereby shorting current through R16 away from the base of Q10, turning it off.

In a similar fashion, if the input swings less than -0.6V, then Q9 is biased on and supplies base current for Q8, which in turn again removes the drive from Q10, turning it off. As in the case of the AC sensing circuit, a timing capacitor is then allowed to charge towards a comparator's triggering voltage.

In our DC sensing circuit, timing capacitor C6 will charge via R17 to comparator IC1a's triggering point of 6V, as set at its positive input (pin 7) by the voltage divider formed by R18 and R19. If the capacitor's voltage does reach 6V, IC1a will drive its output to a low level (since we are using the inverting input at pin 6), thereby supplying base current to Q5 via D3, R9 and R8. As previously discussed, this will cause the muting relay to activate.

The time constant associated with R17 and C6 means that if Q10 is off for more than about 100ms, then the voltage across C6 (the comparator input) will reach the 6V trigger level, and a 'fault' condition will occur. Since Q10 is turned off by either Q7 or Q8/Q9 in response to a positive or negative input level, respectively, then an input transition (+ve to -ve) must occur within this period in order to avoid a fault condition. The transition will cause both

Input Voltage Range	R30, R31
71 - 80V	330 ohms
61 - 70V	270 ohms
51 - 60V	180 ohms
41 - 50V	120 ohms
31 - 40V	82 ohms
15 - 30V	link (omit ZD2 and ZD3)

Fig.3: Use this table as a guide to the value of the 5W dropping resistors (R30 and R31) in Power Supply 3, as shown in Fig.2. A 200W (into eight ohms) amplifier might have a positive supply rail of say 68V, meaning that 270 ohm resistors should be used.

Q7 and Q8 to be off as the input passes through 0V, allowing Q10 to discharge C6.

In practical terms, this means that for input signals which have a frequency greater than about 5Hz, the signal voltage will pass through 0V within the required time period, and the comparator will not be triggered. For signal frequencies *less* than about 5Hz however, which of course includes DC, the circuit will quickly trip into its fault condition and remain in that state until the problem is cleared.

The HF detecting circuit shown at the bottom of the schematic uses a much simpler approach in sensing an error condition. Here, the signal from the amplifier first passes through a second-order high-pass filter composed of C9, R24, C10 and R25 (referring to the right channel circuit), which is set to around 40kHz.

The resulting high-frequency energy (if present) is then passed to a simple half-wave rectifier formed by D4 and R26, and the consequent DC signal smoothed by C11 and passed to the comparator input at pin 4 (IC1c).

As you would expect then, if the amplifier is generating enough HF energy to produce a DC level at pin 4 which is *greater* than the reference voltage at pin 5, the comparator will drive its output to a low level and trip the muting circuit. Note that in this circuit, the reference or trigger level is set by trimpot RV1 rather than a fixed voltage divider, as in the DC sensing circuit. This allows the user to adjust the Protector's sensitivity to unwanted supersonic signals (more of this later).

By the way, D5 has been included to prevent damage to the comparator's inverting input in the event of an extremely *large* high-frequency signal appearing at the amplifier's terminals. In this situation, D5 will become forward biased, preventing the rectified signal from exceeding a level of about 12.6V.

That's about it for the main circuit. The remaining components involve the power supply, and the various power transformer options as shown in Fig.2.

Power supply 1 will most likely be used if you have elected to run the Protector from its own small transformer. A single secondary winding is used here to drive a full-wave rectifier formed by diodes D8 to D11, with the resulting rectified AC connected to the 'sense' line, and to point X via Link 3.

Note that in all of the power supply configurations (1, 2, and 3) the Protector's 12V supply is ultimately derived from point X. Considering power supply 1 for the moment, the unfiltered DC is passed to isolating diode D2 (in Fig.1), which in turn feeds smoothing capacitor C4.

The resulting DC level supplies the 7812 regulator IC2, which produces the circuit's stabilised +12V supply rail. Further smoothing is provided by C3, while LED2 and its limiting resistor R14 provide a 'power on' indication.

Power supply 2 is intended for use with a separate transformer which has a *centre-tapped* secondary, rather than a single winding as used with supply 1, or where you intend to power the Protector from a low-voltage winding on the amplifier's own transformer — such as its pre-amp power supply winding. Thanks to the centre-tap, only two diodes (D8 and D8) are needed for a full wave rectifier in this case. The sense line

[illegible]

and unfiltered DC (point X) connections are the same as in power supply 1.

The final power supply configuration (supply 3) has been included for situations where the Protector is to be powered directly from an amplifier's transformer, but a separate low-voltage winding is not available — such as in slave or PA amplifiers based on power amp modules. Here the sense line is connected to its own full-wave rectifier based on D8 and D9, while point X is supplied by a simple voltage dropping/pre-regulator scheme driven from the amp's DC supply rail.

If the amplifier has a DC supply rail of say 70V (a typical figure for a common 300W amp module) and both R30 and R31 have a value of 270 ohms, then about 96mA will flow through ZD2 and ZD3 if there is no load at point X: I=(70-18)/(270+270). However, the load at point X — the Protector's main circuit — draws around 90mA when the relay is energised, leaving 6mA flowing through ZD2 and ZD3.

As you would expect from this type of voltage stabilisation circuit, the zener current will increase as the load current drops (say, when the relay is de-energised), and the voltage at point X is maintained at 18V. While the above example can be used to calculate the appropriate resistors for other amplifier supply rails, we've included a table (Fig.3) showing suggested component values for a wide range of DC input voltages, to make things a little easier.

So whether you use power supply 1, 2 or 3 will depend upon how you plan to install the Protector. If you want a standalone unit that can be used with any amplifier, it will need its own transformer which should be wired as shown in power supply 1 for a single secondary winding (12V to 20V AC), or supply 2 for a centre-tapped secondary (12-0-12V to 20-0-20V AC).

On the other hand, if you intend to install the Protector inside an existing amplifier, you'll need to use the power supply 2 arrangement where a low-voltage centre-tapped secondary winding is available, or power supply 3 where only the main (higher-voltage) winding is accessible.

Of course if there is sufficient space inside the amp's case, you could install a small transformer to run the Protector, and connect its primary winding to the output side of the amp's main power switch.

Construction, options

All of the Protector's components (except the power transformer, if used) fit onto one small printed circuit board (PCB) which measures 115mm x 64mm, and is coded 92lp8. The components are quite tightly spaced on the board in order to keep its overall dimensions to a minimum, so the smaller parts (resistors, diodes, etc) will need to be installed first.

You will need to decide which of the power supply configurations suits your requirements, and fit the components as shown in the component overlay diagram, while referring to the schematics shown in both Fig.1 and Fig.2. As usual, take particular care with the orientation of any polarised components, such as the electrolytic capacitors and all of the semiconductors — note that there are both NPN (BC547) and PNP (BC557) transistors, and the relay-driving transistor Q1 is a more robust BC328.

If you have elected to use power supply 3, measure the amplifier's positive supply rail, and select the appropriate 5W resistor combination from the table in Fig.3. Of course you can work out the values yourself if you prefer. Note that these resistors will dissipate around 2.5 watts each and will get reasonably hot while the Protector is operating, so they should be fitted at least couple of millimetres proud of the PCB, so as to promote cooling. The zener diodes on the other hand, will only be handling less than 100mW each and should remain quite cool.

Note also that there are three links on the PCB. Link 3 is used to configure the power supply, and is not fitted in the power supply 3 arrangement. Conversely, links 1 and 2 are always included, and are used to cater for the variation in contact-to-pin wiring of the commonly available relays.

To set the position of links 1 and 2, you will need to identify which pins correspond to the normally-open contacts on the relay that you intend to use — quite a simple job with a multimeter. While looking at each set of contacts, establish which pin connects to the normally-open contact itself (rather than the moving-arm contact), and install the link in this position.

As shown in the circuit diagram (Fig.1), this means that the Protector will sense the incoming signal from the amplifier so that in the case of an extended HF or DC fault, the circuit will remain triggered for the duration.

Wiring the contacts in this fashion also means that you have the option of connecting the relay's spare contacts (normally closed) to the amp's *negative or common* line, for extra safety where a high-powered amp is used.

The theory here is that if a large DC fault occurs in the amplifier, an arc will probably occur as the moving contact opens the circuit to the speaker. In a high-powered amp in particular, where the supply rails may be 70V or more, the arc is likely to be maintained even when the contacts are fully open and the speaker would still be effectively connected to the faulty amp — not a happy scenario...

With the closing contacts connected to the common line (the amp's negative terminals) however, a short is applied across the speakers when the relay is de-energised, shunting the arc back to the amp. If the arc is still maintained, the amplifier will blow its protective fuses — thereby saving your speakers.

While this 'crowbar' approach might sound rather destructive, remember that your speakers will invariably be more expensive to repair than your amp — and besides, it's probably in deep trouble anyway, due to the DC fault which started events in the first place.

The relay itself must have contacts of a suitable rating for the amplifier in question, so take note of these specifications when making your choice. In this respect, we have arranged the PCB layout to suit two of the more common

PARTS LIST

1 PCB 64mm x 115mm, coded 92lp8
1 PDT heavy-duty relay, 150 to 200 ohm coil resistance
1 Small TO-220 heatsink

Resistors

All 0.25W 5%: 8 x 470k, 1 x 220k, 4 x 100k, 4 x 82k, 3 x 33k, 1 x 18k, 3 x 12k, 2 x 10k, 3 x 1.8k
1 200k horizontal-mounting trimpot

Capacitors

1 470uF 25V PC-mount electrolytic
2 22uF 16V PC-mount electrolytic
4 0.22uF metallised polyester
1 0.1uF metallised polyester
2 220pF ceramic
4 100pF ceramic

Semiconductors

1 LM339 quad comparator
1 7812 three-terminal regulator
10 BC547 NPN transistor
3 BC557 PNP transistor
1 BC328 PNP transistor
4 1N4002 power diode
5 1N914 signal diodes
1 5.1V 1W zener diode
3 5mm LEDs: red, yellow, green

Extra parts for power supply 1

2 1N4002 power diode

Extra parts for power supply 3

2 9.1V 1W zener diode
2 5W resistors; see table (Fig.3)

relays available from component suppliers: the large 'heavy duty' DPDT relay featuring 10A contacts, and the smaller 'high power' relay which offers contacts rated at 5A. These will suit high-and medium-power amplifiers, respectively.

Alternatively, you may have a suitably rated relay in your junk box which doesn't match the PCB layout. In this case the relay could be mounted off the board, and short lengths of heavy duty cable run from the PCB pads to the relay pins. Of course the relay coil must have a 12V rating, and if its resistance is not in the range of about 150 to 200 ohms, you will have to measure the current drawn by the Protector's circuit and recalculate the values for R30 and R31 (if you are using power supply 3).

Note that both the current drawn by the Protector, and its DC input voltage will determine the dissipation in the 12V regulator (IC2), which should normally fitted with a small heatsink. If the input voltage is about 18V, such as in power supply 3, and the relay coil's resistance is in the range mentioned above, then the IC will be handling less than 1W.

On the other hand, you may have elected to use a dedicated transformer (supply 1 or 2) with a secondary rating of 20V AC, which leads to a DC input voltage of around 28V and a higher dissipation in the regulator chip. While this is still only about 1.5W with the specified relay, remember that a lower coil resistance will increase the figure and a larger heatsink may be needed — particularly if you plan to install the unit in a case which offers little in the way of ventilation slots.

If you have in fact elected to fit the Protector and its matching transformer in a box, the 240V mains wiring *must* be connected in a safe manner. The mains cable should pass through the box wall via a suitable grommet, then be solidly anchored inside using a 'P-clamp' or similar mounting hardware. The active and neutral leads can be terminated to the transformer's primary winding, and any exposed connections covered with some form of insulation.

The mains earth lead (green/yellow) should then be reliably connected to the power transformer's body via a solder lug, which should be attached to the transformer frame via a nut, bolt and locking ('star') washer. If you are using a *plastic* rather than metal box however, both the transformer and the earth lug should be solidly bolted or screwed (with lockwashers) to a small section of aluminium plate, which in turn is mounted into to the case via *separate* bolts or screws. In this way, the electrical connection between the mains earth and the transformer is maintained, regardless of the condition of the case material.

Note that we have elected to leave the Protector's common line (0V) 'floating', rather than connecting it directly to the mains earth at the transformer frame. This is because when the unit is connected to an amplifier (that is, once it's installed), this line will return to the mains earth via the amp's 0V line.

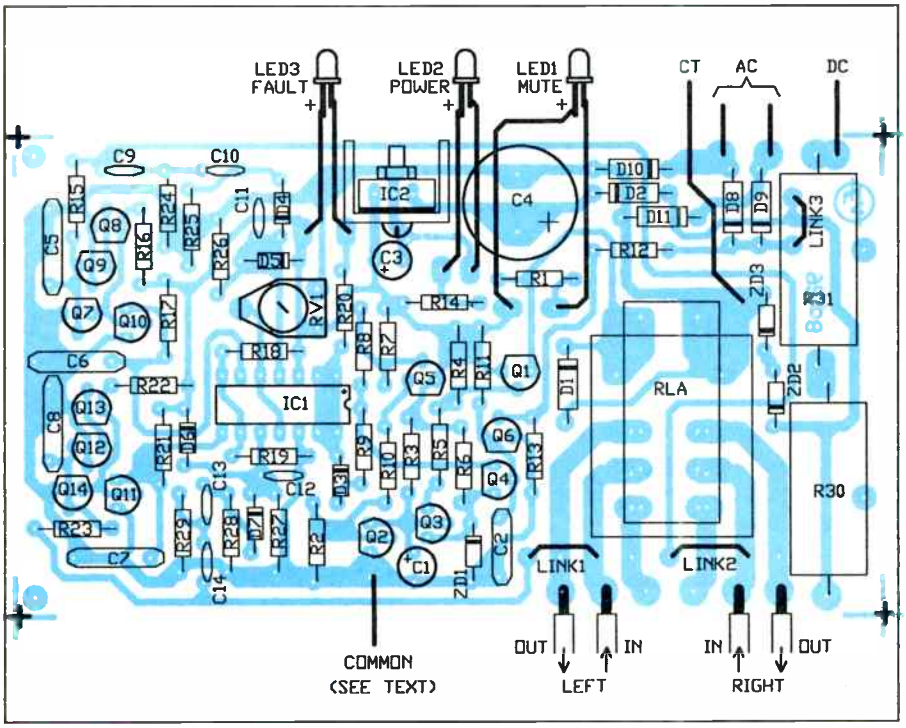
Alternatively, if you have one of those 'double-insulated' amps with a two-core mains lead, then the Protector's circuit is happy to electrically 'float' with the amp's internal circuitry — a typical off-the-shelf transformer to suit the Protector will have an insulation rating of least 3.5kV, by the way.

To finish installing the Protector into a box, securely mount the PCB inside, fit the three LEDs to the front or top panel, then complete the remaining wiring as shown in the component overlay diagram and Fig.2 (for the power supply). Of course, you will need to fit a series of speaker wire connectors to the box, which should be wired to the PCB as shown. The actual connectors could be made up from a strip of insulated tagstrip, a number of banana sockets/posts, or a four-way moulded speaker terminal (the type with spring-loaded crimp connectors).

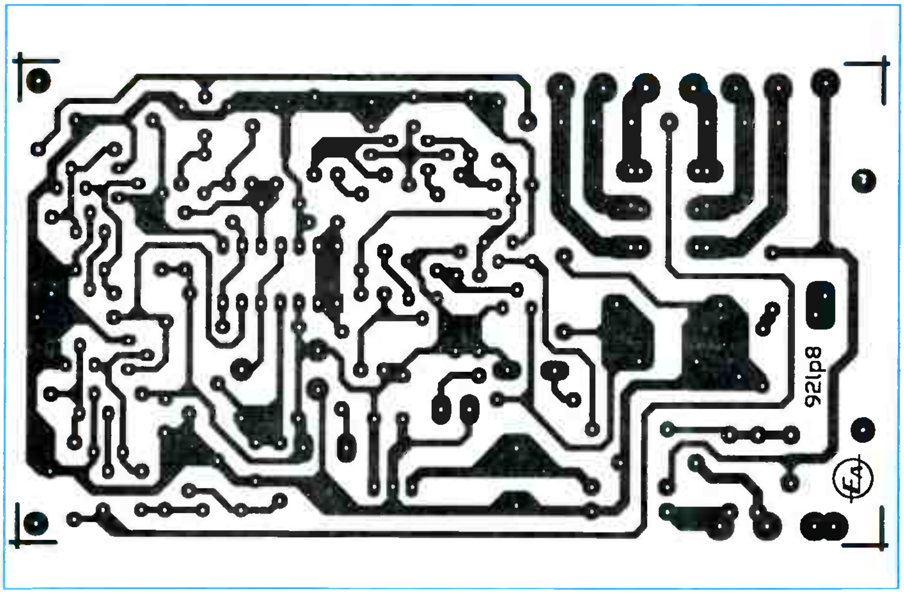
If you have decided to install the Protector inside an amplifier, you should find the job to be quite straightforward. In this case, the PCB should be mounted in close proximity to the speaker outlet terminals, and the existing wiring modified so that the Protector's relay contacts will mute (disconnect) the output to the speakers as required. The status LEDs can be installed in some visible position, or simply left out of the circuit since they play no directly active part — the Protector will draw a little less current, however.

Then connect the unit's 'AC' inputs to the secondary winding of the amp's power transformer, and the 'CT' connection to the amp's 0V line, which ultimately connects to the secondary's centre-tap.

Note that power supply 2 in Fig.2 should be used to power the Protector from an amp's low-voltage secondary winding (say, its preamp supply), while the circuit shown as power supply 3 is



Follow this component overlay diagram during construction. Note that all of the optional components are shown installed, so you will need to decide which configuration suits your needs, and fit only those parts — for example, 'link 3' is not used at the same time as R31.



A full-sized reproduction of the Protector's PCB pattern, for those intrepid constructors who make their own boards.

designed to suit an amplifier's higher-voltage secondary winding (which supplies the power amp stage).

By the way, the 'common' connection shown on the PCB overlay does not need to be connected when the Protector is installed inside an existing amplifier, since the centre-tap connection (CT) links the 0V lines between the two circuits as required.

When the unit is powered from a separate transformer however, the 'common' connection on the PCB should be wired to the left or right *negative* speaker connections, so as to connect the 0V lines together.

Also, if the amplifier in question is of a *valve* design, you will need to re-wire the relay connections so that a resistive load is switched in place of the speakers when muting occurs. This is because valve amps can suffer internal damage (through arcing) when the output load is disconnected.

Note that while the Protector's HF sensing is useful for a valve amp, its other features are of little benefit — these amps generally cannot deliver a DC level to the speakers, and don't tend to produce turn-on/off thumps.

Commissioning

Once the Protector's circuit is complete and the PCB hard-wired to its external connections, it may be worthwhile to double check the relay contact wiring in particular. If this is correct, the relay's moving arm contacts will ultimately connect to the speakers, while the normally-open contacts should connect to the amplifier outputs.

Note that links 1 and 2 must also be connected to the normally-open contacts, so that the Protector will be sensing signals at the amplifier outputs, rather than at the speaker connections.

These checks are rather important, since a mistake in the wiring could actually *short* the amp's output, thereby blowing the protective fuses, or even causing the destruction of its output transistors. By the way, if you have wired the normally-closed contacts to the common (negative) line for arc-suppression purposes, then these connection should also be checked.

Once you are satisfied with your wiring, turn RV1 to its mid position and apply power to the Protector — that is, turn on the associated amplifier. At this stage, both the green (power) and the yellow (mute) LEDs should immediately illuminate, indicating that the 12V rail is present and the relay has not yet engaged, respectively.

Then after a few seconds, the mute LED should go out and the relay will pull-in with a quite audible 'click'. Note that the red (fault) LED should not illuminate, except for perhaps a brief flash when power is first applied — unless of course, the amplifier already has a HF or DC fault!

If you wish to check the action of the DC sensing circuit, you'll need to temporarily disconnect links 1 and 2, then connect a battery or other DC source to the Protector's error sensing inputs (the junction of R15 and C9 for the right input).

The relay should almost immediately drop out and the 'fault' LED should illuminate; this condition should remain as long as the DC source is connected. If the DC level is only briefly applied, the relay should drop out for a few seconds as the Protector goes through its muting cycle.

The HF sensing circuit is a little more difficult to check, unless you have an oscillator which can deliver a couple of volts at frequencies above the audio band. If such an instrument is at hand, connect the signal to the Protector's input as detailed above and check that the circuit behaves in the same manner. Note however that you may need to increase the circuit's HF sensitivity by adjusting trimpot RV1.

How RV1 is finally set for normal operation will need to be determined by experimentation, since the circuit tends to respond to large transient signals as well as a continuous burst of high-frequency energy. Try playing a high-quality source (say, a CD player) at your typical listening level, and increasing the protectors HF sensitivity (with RV1) until the circuit begins to occasionally mute. Then back-off the adjustment a little, so that it will not trip under normal circumstances.

Alternatively, you might like to concentrate on the Protector's ability to detect the HF energy produced by excessive clipping. In this case, connect your amplifier to a dummy load, increase the drive level until hard clipping occurs, then adjust RV1 until the circuit trips into muting. You should then check that the Protector will not also trip under normal listening conditions.

If the above methods are not satisfactory, or you can't be bothered with such fine-tuning, simply leave RV1 at its mid-position. If the circuit is working correctly, you can be sure that a substantial (that is, tweeter damaging) level of HF energy will be detected as an error, and the speakers disconnected.

Since this setting of RV1 corresponds to a peak signal of 6V, then a HF input level greater than 4VRMS will trip the circuit — this represents a theoretical power level of only 2 watts into an 8 ohm tweeter. The HF circuit will also trigger at frequencies below 40kHz, but with a reduced sensitivity since the filter rolls off at around 12dB per octave.

Once you are satisfied that the Protector is working correctly, and your installation job is complete, you can move on to the more important business of listening to music.

Since your new Protector circuit is watching over those expensive loudspeakers, you can sit back and enjoy the experience of worry-free listening. ❖

Circuit & Design Ideas

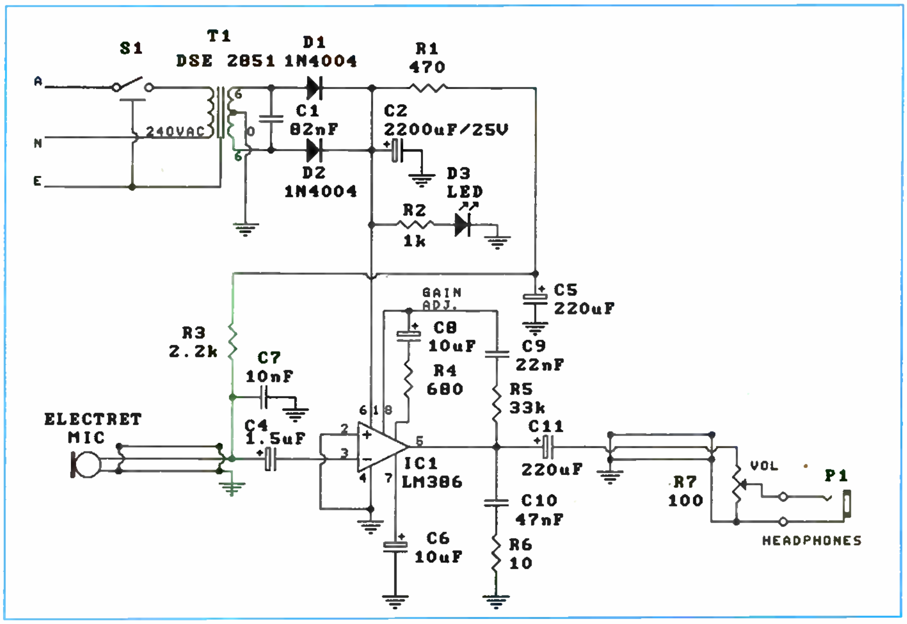
Interesting circuit ideas from readers and technical literature. While this material has been checked as far as possible for feasibility, the circuits have not been built and tested by us. We therefore cannot accept responsibility, enter into correspondence or provide further information.

TV headphones amp

My friend has a hearing problem, which presented no problem with his original TV which came equipped with a headphone jack. But when this set played up and was replaced, the new model had no such provision.

His new set was of the now-common live chassis type, necessitating an isolation device if tapping across the loudspeaker.

This would have been no problem, except that tampering internally with the set would certainly have made void his warranty. Instead, I built the circuit shown.



An electret microphone was used to pick up the sound signal. This type of mic was used because of its low cost and resilience to magnetic and electric fields (e.g., frame buzz and 50Hz hum). It is mounted as close to the front of the speaker as practical, and wired back to the amp via screened cable.

The amplifier is built around the LM386 chip, which needs only a few components for smoothing, power supply and audio shaping.

The 33k/22nF combination provides negative feedback for high frequency, such as horizontal pickup and annoying background clashes. This can be altered for personal preference.

And the 680 ohm/10uF combination sets the amplifier gain to give sufficient signal at the headphones — with volume to spare.

Hum pickup is minimised by careful placement of the mic cable and keeping the circuit floating from the mains earth. The mains earth is only connected to the transformer frame and to the body of the on/off switch, for safety.

Warwick Talbot,
Toowoomba, Qld $40

Telemetry converter

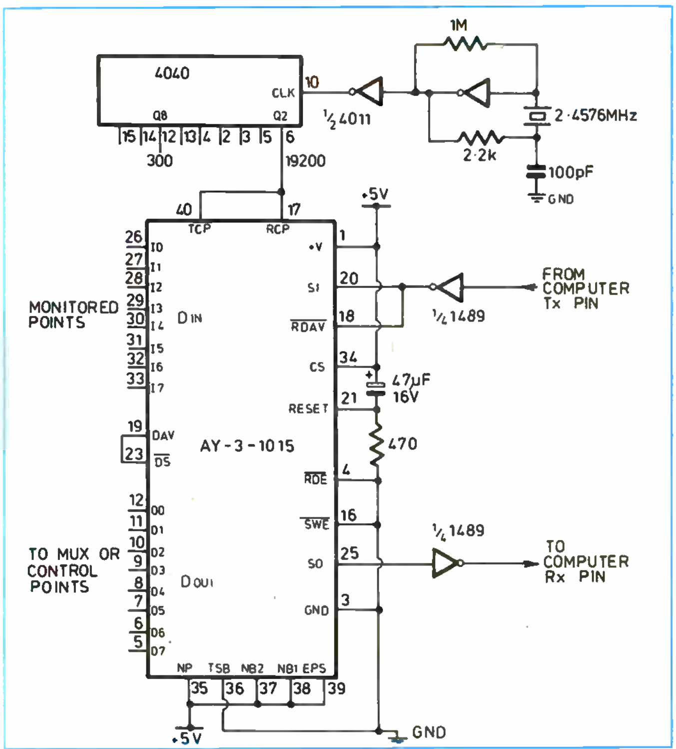
This circuit was designed to convert the BCD output of a thermocouple thermometer to serial data for logging by a PC. It uses an AY-3-1015 UART and a few supporting chips to relay the logic state of eight points through the serial line to the computer.

The UART acts as a parallel to serial converter. Conversion is triggered by sending two control bytes from the computer. The falling edge of the first byte arrives at SI and RDAV-bar, forcing DAV low. This strobes eight bits on Din (I0-I7) into the shift register and serialises them to SO. The conversion returns two bytes but the first byte should be discarded and the second byte used. The input levels should be TTL.

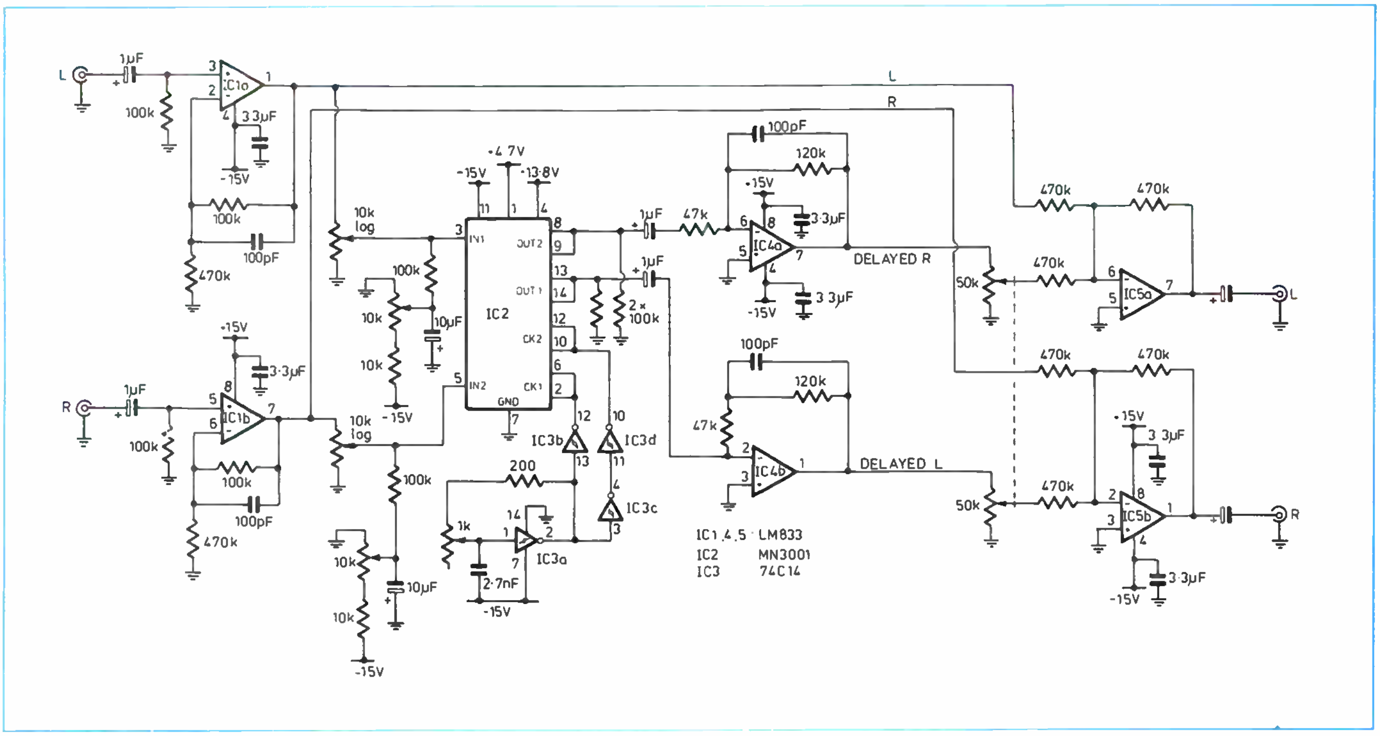
Data rates ranging from 19,200 to 300bps can be selected by jumpering the appropriate output of the frequency divider to the UART clock pins. The computer port should be set for eight bits (NB1 and NB2 at logic '1'), no parity (NP logic '1') and one stop bit (TSB logic '0').

More than eight points can be monitored by using the Dout outputs (O0-O7) to control input multiplexers. For example, using one bit to control each multiplexer allows 64 points to be monitored. In this case, each control byte should have only one bit on. The Dout outputs can also be assigned for device control. A MAX-232 can be substituted for the 1488/1489 chips, in which case only a 5V supply is required.

Ken Yap,
Lane Cove, NSW $40



[illegible]



Heightened stereo effect

To emphasise the stereo effect of an amplifier, an extra set of imaging speakers are often used, driven out of phase, and set up to produce destructive interference of the left channel at the right ear, and vice versa.

This circuit achieves the same effect, but removes the need for the second set of speakers. It does this by adding smaller, delayed versions of the left and right signals to the right and left outputs. When the delay is properly set to account for the path length difference of the speakers to each ear, the stereo effect is heightened greatly.

The input signal is first buffered by IC1, then passed to IC2, an MN3001 Bucket Brigade Device (BBD). The input level and biasing are set by the 10k pots for each channel (input pins 3 and 5), and are adjusted for the lowest distortion and best signal-to- noise ratio.

The clock signal for IC2 is produced by a 74C14 hex Schmitt trigger, with the period set by the 200 ohm resistor and the 1k pot. This produces a delay of approximately 0.1-0.8ms.

The output from IC2 is amplified by 8.5dB by IC4 to account for losses in the BBD. It is also inverted and filtered above 20kHz to remove any clock noise from the signal. Each channel is then mixed, via IC5, with the delayed version from the other channel. The imaging volume is set by the 50k dual-ganged pot.

The appropriate delay can be easily worked out by simple maths. Find the path difference between each speaker to one ear and divide it by the speed of sound, 330ms^{-1}.

More simply, drive one channel with a tone, and the correct settings will be obvious when the other ear is blocked — there will be a noticeable volume drop. Note, of course, that the listener must be in line with the middle of the two speakers.

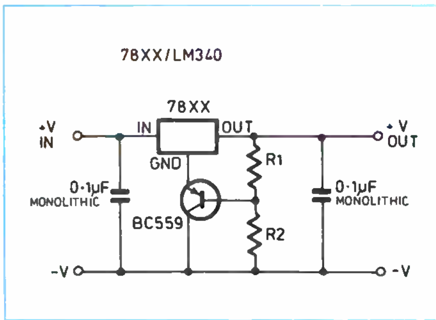
Mark Kelly,
Camberwell, Vic $45

Improved adjustable 3-pin regulator

The traditional method of increasing the output voltage of a three-terminal regulator is to connect the 'GND' pin to the junction of two suitably-chosen resistors in series across the output.

Unfortunately, the quiescent current of the regulator makes it necessary for these resistors to be of quite low value in order to 'swamp' this current.

This results in excess current consumption and the need to 'fine tune' the resistor values for the quiescent current of the individual regulator. And in some variable circuits, it can be hard to find pots with appropriately low resistances.



By the simple addition of a BC559 transistor as shown, about 99.5% of the quiescent current can be diverted away from the voltage divider, eliminating these problems.

By assuming that both I_{R1} and I_{R2} are approximately 1mA, we can find suitable values for R1 and R2.

$R1 = V_{R1}/1mA$

$= (V_{R1})k$ ohms

$R2 = (V_{OUT} - V_{R1})k$ ohms

where $V_{R1} = V_{REG} + 0.65$, and V_{REG} is the regulator's nominal voltage.

This circuit has the same line and load regulation and stability as the traditional one, and the only disadvantage is that the regulator dropout voltage is increased to about 3V.

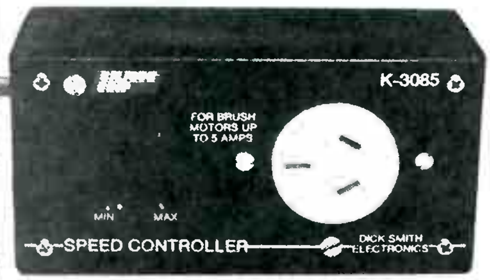
Bob Parker,
Carlton, NSW $40

DICK SMITH ELECTRONICS

SENSATIONAL NEW KITS

UNIVERSAL MOTOR SPEED CONTROLLER

This easy to build kit is designed for regulating the speed on heavy-duty power tools. It's ideal for circular saws, electric drills, lawn edgers, jig-saws, grinders and other appliances which are rated at 5 amps and have a 'brush type' motor. This new improved design has a higher current rating and uses a Triac rectifier instead of a SCR. As well, it monitors the 'back-EMF' voltage from the motor, so though the drill speed is controlled, it won't bog down when the going gets tough. Complete with deluxe pre-punched screened front panel, components, PCB and flush mounted mains socket.



NEW

Cat K-3085

$46.95

Also Available Individually

Insulated Triac (BTA 10-600B)
As used in K-3085

Cat Z-4515 $5.95

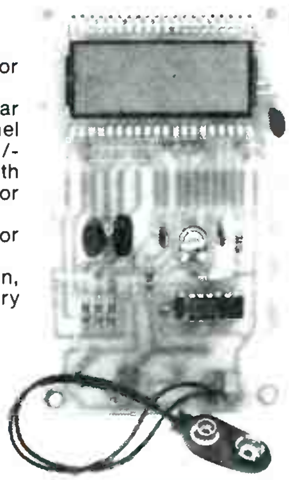
3½ DIGIT PANEL METER

NEW

An easy to build kit which is perfect for monitoring voltages, including anything from power supplies to car batteries. This general purpose panel can be built to read voltage up to +/- 200V DC or current up to 2A (or both with suitable switching). It's ideal for the hobbyist, student and any application where you need to monitor voltage or current accurately and precisely. Complete with LCD screen, all components, PCB and a 9V battery snap. (Requires 9V battery)

Cat K-7502

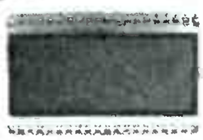
$39.95



Also Available Individually

Liquid Crystal Display with data sheet.
As used in K-7502

Cat Z-4175 $14.95



MINI 1.5V TO 9V DC CONVERTER

NEW

Here's an easy way to replace those expensive 9 volt batteries with cost-efficient 1.5 volt cells. This easy to build kit uses just 3 components and allows any type of 1.5V cell (AA,C,D,N or AAA) to replace a more expensive 9V battery. What's more, the PCB measures just 17 x 43mm and fits easily inside a 9V battery compartment.

Cat K-3231

$9.95

AUDIO SWEEPER

A buget-priced kit for audiophiles, sound experts, enthusiasts... in fact anyone involved or interested in sound. This affordable audio test system analyses the performance (mid, treble & bass) of speakers, speaker enclosures, filter circuits and room acoustics. It consists of a sweeping audio test signal generator and a metering amplifier which measures the results. The kit comes complete with a deluxe pre-punched front panel, plastic instrument case, PCB, hardware (including dB meter) and all components.

NEW

$109 Cat K-7352

Semiconductor Of The Month!

TDA 1514A 50 WATT/RMS HIGH POWER AMP As used in K-5600

NEW

This new hybrid module semiconductor has an inbuilt SOAR (safe operating area) protection and extremely quiet operation. Data sheets available in all stores.

Cat Z-6117 $19.95

Please contact your nearest store for availability

SCANNER BOOKS

Register of Government Radio Frequencies NSW & ACT	B-4100	$29.95
Scanner Fanatics Frequency Register of NSW	B-4102	$24.95
Scanner Fanatic Frequency Register of Vic	B-4104	$24.95
Australian Radio Frequency Handbook	B-9601	$14.95

DATA & REFERENCE BOOKS

Towers International Transistor Selector	B-4600	$49.95
Resistor Colour Code Chart	B-1000	$ 5.95
Philips Linear Databook	B-5553	$49.95
Philips IC & Semiconductor Reference Guide	B-5552	$18.95
SGS-Thompson CMOS 4000 Databook	B-5560	$24.95
SGS-Thompson SCR & TRIACS Databook	B-5564	$24.95
SGS-Thompson DIODES Databook	B-5566	$29.95
SGS-Thompson Small Signal Transistor Databook	B-5568	$19.95
Motorola RF Devices Databook	B-5400	$29.95
Motorola RAMs & EEPROMS Databook	B-5402	$19.95
Motorola Thyristors Databook	B-5404	$19.95

ELECTRONICS & HOBBY BOOKS

Electronics Tips & Techniques	B-1600	$29.95
Mastering IC Electronics	B-1612	$39.95
Home Remote Control Projects	B-1614	$29.95
Basic Electronics Theory	B-1615	$39.95
101 Opto Electronics Projects	B-1617	$29.95
Encyclopedia of Electronic Circuits Vol.3	B-1760	$54.95
Introductory Electronics	B-3635	$18.95
Aviation & Space Science Projects	B-6702	$16.95
Electronics for Model Railways	B-3642	$ 2.95
14 FM Bugs to Build	B-3650	$ 3.50
Data Sheet on PCB Making	B-6005	$ 1.25
Guide to NiCad Batteries	B-6040	.95c
Wire & Cable for Electronics	B-1618	$49.95
RF Interference Handbook	B-2401	$19.95

SHORTWAVE RADIO BOOKS

Shortwave Listening Guidebook	B-2040	$29.95
Passport to World Band Radio	B-2050	$34.95
World Radio & TV Handbook	B-2092	$35.95
Radio In Australia	B-2300	$ 4.90

AMATEUR BOOKS

Yaesu Amateur Radio Log Book	B-2029	$ 9.95
Yaesu Ham Operators World Map	B-2030	$ 6.95
ARRL YAGI Antenna Design	B-2105	$29.95
ARRL Antenna Handbook 16th Ed.	B-2209	$39.95
ARRL Radio Handbook, 1992 Ed.	B-2225	$49.95
Secrets of RF Circuit Design	B-2311	$39.95
Your Gateway to Packet Radio	B-2402	$24.95
AX-25 Packet Radio Protocol	B-2403	$14.95
W.I.A. Into Electronics	B-2313	$ 9.95
W.I.A. Novice Electronics	B-2317	$ 9.95
W.I.A. 1000 Questions for Novice Candidates	B-2316	$ 9.95
W.I.A 500 Questions for AOCP Candidates.	B-2318	$ 9.95

SATELLITE TV BOOKS

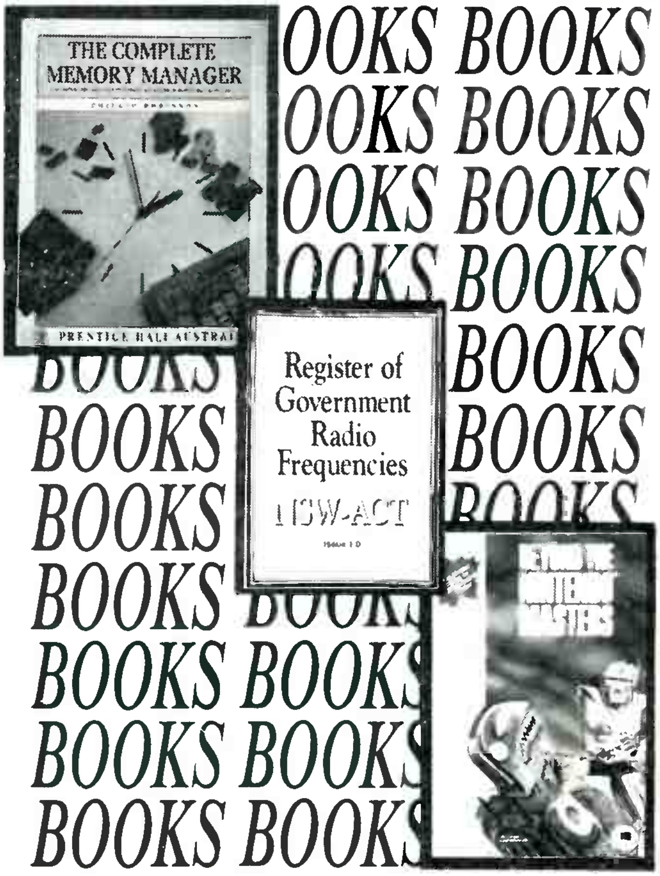
Satellite TV - Pacific Region	B-2321	$29.95
ARRL Satellite Antology	B-2400	$15.95

CB RADIO BOOKS

The Screwdriver Experts Guide	B-2324	$19.95
CB International PLL Data Book	B-2326	$19.95
Understanding CB Radio	B-2327	$36.95
CB EPROM Data Book	B-2329	$14.95

LEARN ELECTRONICS THE FUNWAY

Funway Into Electronics Vol.1	B-2600	$ 4.95
Funway Into Electronics Vol.2	B-2605	$ 6.95
Funway Into Electronics Vol.3	B-2610	$ 6.95



COMPUTER BOOKS

The Complete PC Memory Manager	B-6097	$39.95
RS232 Made Easy. 2nd Ed.	B-6098	$49.95
PC Architecture & Assembly Language	B-6099	$28.95
GW BASIC Primer Plus	B-6100	$59.95
DOS 5.0 User's Guide	B-6101	$39.95
IBM PC Contiguration Handbook	B-6203	$59.95
The 486 Book	B-6205	$69.95
Quickstart Works For Windows	B-6385	$24.95
Quickstart Windows 3.1	B-6391	$24.95
Quickstart WordPerfect for Windows	B-6397	$29.95
WordPerfect for Windows By Example	B-6398	$59.95
WordPerfect 5.1 Quick Reference	B-6400	$19.95
Microsoft Word 5 Quick Reference	B-6402	$19.95
MS.DOS 5 Quick Reference	B-6404	$19.95
Norton Ultilities 6.0 Quick Reference	B-6407	$19.95
Lotus 1-2-3 Release 3.1 Quick Reference	B-6408	$19.95
Hard Disk with DOS 5.0 Quick Reference	B-6413	$19.95
PC Tool 7.0 Quick Reference	B-6415	$19.95
Guide To XTREE Quick Reference	B-6416	$19.95
Windows 3.1 Quick Reference	B-6417	$19.95
QUATTRO PRO 4 Quick Reference	B-6418	$19.95
The Complete DOS 5 with Batch File Disk	B-6500	$69.95
Atari Portfolio Guidebook	B-8700	$39.95
A Kid's Guide to Computers	B-6700	$19.95

GAMES BOOKS

Leisure Suit Larry Bedside Companion	B-6900	$22.95
Beyond the Nintendo Masters	B-9800	$19.95
Mastering Nintendo Video Games	B-9802	$18.95
Tricks of the Nintendo Masters	B-9804	$19.95
The Complete Nintendo Video Games Guide	B-9806	$19.95
Winner's Guide to GAME BOY	B-9808	$18.95
Winner's Guide to SEGA	B-9810	$18.95

B1374

[illegible]

[illegible]

FLUKE MULTIMETERS

"Regarded by industry professionals as the most forgiving multimeters ever made!"

Fluke 12 Multimeter

With a 3 ¾ digit (4000 count) display and a V-check which automatically changes modes. What's more, it has continuity capture which records intermittant opens and shorts as brief as 250mS. In addition, the min/max record and time stamp lets you capture precisely what occurred and when. Hook it up, walk away, then come back and find out what happened... it's that easy!

Cat Q-1612

2 YEAR WARRANTY! **$159**

Specifications

DCV: 4000mV, 4V, 40V, 400V, 600V
Accuracy: (0.9% +2 for 4000mV & 4V range) (0.9% +1 for 40V, 400V & 600V ranges)
ACV: 4000mV, 4V, 40V, 400V, 600V
Resistance: 400 Ohm, 4K Ohm, 40K Ohm, 400K Ohm, 4M Ohm, 40M Ohm
Capacitance: 1uf, 10uf, 100uf, 1000uf, 10,000uf

Fluke 10 Multimeter

A tough and dependable multimeter designed for true one-hand operation. It has a 3 3/4 digit (4000 count) display, as well as auto and manual ranging. With AC/DC voltage measurements (to 600 volts), continuity beeper, Ohms & diode tester, digital display, and overload protection. The Fluke 10, a new generation in speed, versatility and value.

Cat Q-1611

2 YEAR WARRANTY! **$109**

Specifications

DCV: 4000mV, 4V, 40V, 400V 600V
Accuracy: (1.5% +2 for 4000mV & 4V ranges) (1.5% +1 for 40V, 400V & 600V ranges)
ACV: 4000mV, 4V, 40V, 400V, 600V
Resistance: 400 Ohm, 4K Ohm, 40K Ohm, 400K Ohm, 4M Ohm, 40M Ohm

LEADS AND CLIPS

Industrial Test Lead Set

Silicon insulated test leads (63" long). With shrouded right-angle connectors, interchangeable stainless steel test probes and safety alligator clips. **$79.95**

Cat Q-1652

Alligator Clips

Set of two black and two red slip-on clips for right-angle test leads. **$12.95**

Cat Q-1660

Right-Angle Test Leads

Shrouded input plugs which will not pull out of meter during use. Single piece construction. 1 metre long. **$19.95**

Cat Q-1650

Deluxe Test Lead Kit

Everything in a handy soft carry pouch. Comes with interchangeable tips - 2 alligator clips, 2 spade lugs, 1 retractable hook tip & 2 standard pointed tips. Includes shrouded banana plugs. **$59.95**

Cat Q-1658

Fluke 10 & 12 Holster

Snap your meter into this yellow holster and it will absorb shocks and protect it against damage. With tilt stand and a moulded hanger loop which can be used as a probe holder. **$24.95**

Cat Q-1614

Fluke 10 & 12 Softcase

The best way to keep your Fluke series 10 meter safe and organised. There's room for leads and small accessories as well. **$24.95**

Cat Q-1616

High Voltage Probe

$199

Measuring high voltages made easy and safe. Division ratio is 1000:1. Measures up to 40kV or 28kV RMS AC. Has 1000Mohm input resistance.

Cat Q-1690

Also Avalialable!....

70 SERIES II FLUKE MULTIMETERS

The all new Series II Fluke professional quality multimeters give you better value, better performance and more features than ever before. All of the '70 Series' meters now have 'Touch Hold', Diode Test, Continuity beeper, Automatic Self Test, Sleeper Function and exceptionally long battery life as standard features.

Fluke 73 Series II — Cat Q-1603 — **$199**

Fluke 75 Series II — Cat Q-1605 — **$299**

Fluke 77 Series II — Cat Q-1607 — **$349**

MAJOR DICK SMITH ELECTRONICS AUTHORISED STOCKISTS:

NSW: ARMIDALE New England Electronics 711655 BALLINA Ballina Electronics 867022 BATEMAN'S BAY: Baycity Sight & Sound 725030 BATHURST: Electronic Frontiers 323933 BOWRAL: Bowral Electrical Supplies 611861 BROKEN HILL Hobbies & Electronics 884098 COOTAMUNDRA Cootamundra Music & Lite 422561 COFFS HARBOUR. Coffs Harbour Electronics 525684 DENILIQUIN: Deni Electronics 813672 DUBBO: Chris's Hi Fi 828711 FORSTER Forster Village Electronics 545006 GOULBOURN Tunlive 22 1288 GRAFTON: Repairs & Spares 421911 GRIFFITH. Miatronics 624534 INVERELL Inverell Electronics 221821 KEMPSEY. P&L Leonard 631134 LEETON: Leeton Audiotronic 532800 LIGHTNING RIDGE Lightning Ridge Solar Power 29 1013 LITHGOW. Douroy Photographics 513173 LISMORE: Decro Electronic Services 214137 MOREE: Moree Electronics 522091 MUDGEE: Headware 723895 MURWILLUMBAH Strings & Things 723684 NARRABRI Namoi Computer Service 923274 NELSON BAY Nelson Bay Elect & Hobbies 813685 NOWRA: Nowra Electronics 210722 PARKES: Strad Music Ctr 623366 PORT MACQUARIE Hastings Computer Service 840255 RICHMOND Silicon Crafts 784101 TAREE Manning Electronics 512233 ULLADULLA: Coastal Electronics 553989 WAGGA WAGGA: Phillips Electronics 216558 WALGETT: Walgett Electronic Centre 281116 WELLINGTON Wellington Service 452325 WINDSOR Hawkesbury Electronics 776722 YASS: Warmington Electrical 261116 YOUNG: Keith Donges Electronics 821279 **VIC:** ARARAT: Jerram Electronics 522345 BAIRNSDALE LH & LM Crawford 525677 BENALLA North East Electronics 622710 CASTLEMAINE Inspect Electrics 723773 COLAC: Colac Electronics 312847 ECHUCA Gilmour Electronics 822956 MILDURA Pullman Auto Pro 232882 MORWELL Roylaine Pty Ltd 339458 SHEPPARTON Andrew Guyatt Electronics 219497 SWAN HILL: Nyah District TV Service 329303 ST. ARNAUD St. Arnaud Appliances 951069 WARRAGUL: Roylaine 234255 WARRNAMBOOL Koroit St Elec Services 627417 WONTHAGGI South Gippsland Photo Service 721411 **QLD:** AYR. Delta Electrix 831566 BLACKWATER: Cool Tronics 825827 BOWEN: Delpro Agencies 86 3477 BUNDABERG Bob Elkin Electronics 521785 CALOUNDRA Electro-mart 918533 DALBY Hobby & Electronics 625770 DYSART: Dysart Videotronixs 582107 GLADSTONE: Electronic Enterprises 726660 INGHAM: Masons Electronics 763188 INNISFAIL Innisfail Hi-Fi 612014 KINGAROY MD & MM Siegle 624535 LONGREACH Longreach Sound & Communications 583307 MACKAY: Stevens Electronics 511723 MARYBOROUGH: Keller Electronics 214559 MT ISA Outback Electronics 433331 NAMBOUR Nambour Electronics 411966 PIALBA: Keller Electronics 283749 STANTHORPE Granite Belt Communications 813333 **TAS:** BURNIE: Electronic City 314760 DEVONPORT: Al Electronics 248322 **SA:** MT GAMBIER Hutchesson's Communication 250400 PORT LINCOLN. Basshams TV & Comp World 830075 WHYALLA: Eyre Electronics 454764 **WA:** ALBANY: Micro Electronics 412077 BUNBURY: Micro Electronics 216222 GERALDTON Batavia Lighting & Electrical 211278 KALGOORLIE Today's Electronics 215212 KARRATHA: Pilbara Office Supplies 854836 MANDURAH Mandurah Hi Fi 5812206 PORT HEDLAND: Ivan Tomek Electronics 732531

SANGEAN

With Cassette Player!

All-Band World Receiver

Open your ears to the world with the stunning Sangean ATS-818CS. This fantastic receiver covers Longwave and continuous shortwave frequencies from 1.62 to 30MHz and local AM/FM stations (FM stereo with optional headphones). What's more, with an inbuilt BFO (beat frequency oscillator) it can receive many HF SSB transmissions including marine, aircraft, amateur and commercial broadcasts. An inbuilt tape deck even allows you to play your favourite tapes and pre-set it to record broadcasts. Top features include five-way tuning, 45 station memories, a full function digital display, dual time and alarm clock. A dual conversion receiver design offers switchable filters and an adjustable RF gain control to provide optimum reception. It's simply brilliant!

Cat D-2842 **$399**

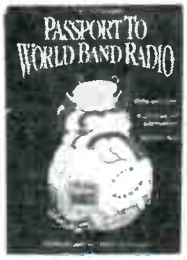
EXCLUSIVE

Shortwave Listeners Guidebook
Harry Helms

Learn how to tap into the exciting and 'live' the world of shortwave! This valuable book tells you how to get the best programs, news and broadcasts from around the world. As well, there's tips on choosing the right antenna, conditions affecting reception, international & domestic broadcasting and more.

Cat B-2040 **$29.95**

Passport To World Band Radio 1992



A valuable guide on how to get started with your shortwave receiver. It's packed with useful information, with everything from what's on, to the best (& worst) SW radios. If you've just discovered shortwave radio, are just starting out, or want to keep up with the latest world changes, this book is a definite must-have!

Cat B-2050 **$34.95**

World Radio TV Handbook 1992

One of the most sought after books among shortwave enthusiasts. With up to date and complete listings of international radio and TV stations. Provides frequencies, addresses, call signs, ID's... you name it.

B-2092 **$35.95**

Easy To Use

Easy Etch Engraver

A quick and effective way to make sure your tools don't get mixed up with others. This reliable engraver lets you quickly mark tools, stereo equipment and household valuables with a permanent identification or serial number. It's easy to handle and has steel bits so you can engrave on metal, plastic, wood and most materials. Complete with 12V plug pack and long cord.

Cat T-4753 **$39.95**

Quick and Easy!

Heat 'n Strip Gun

Cut your work time by half! This handy tool is ideal for heatshrink work, removing old paint, removing vinyl tiles, loosening rusted or over-tightened nuts, drying... and hundreds of other uses. It's lightweight, mains operated and has a dual temperature range (400 & 600°C).

Cat T-4845 **$64.95**

Ideal for PCB work!

Super Tool

A must for any hobbyist or enthusiast! This extremely high quality tool is perfect for PCB and other precise work. It sands, polishes, drills engraves, and mills. What's more, it comes with a wire brush, milling cutters, grinding wheel, high speed drills, chuck collets, eraser sticks and mains adaptor. Complete with handy, go-anywhere plastic case.

Cat T-4754 **$79.95**

DS XPRESS PHONE & MAILORDER SERVICE
Outside Sydney (FREE Call) 008 22 6610 Sydney And Enquiries - 888 2105
FAX: (02) 805 1986 or write to DS XPRESS, PO BOX 321 N/RYDE NSW 2113
All Major Credit Cards Accepted. O/Nite Courier Available.
24 HOUR DESPATCH OF ALL ORDERS

DICK SMITH ELECTRONICS

NSW • Albury 21 8399 • Bankstown Square 707 4888 • Blacktown 671 7722 • Brookvale 905 0441 • Bondi 387 1444 • Campbelltown 27 2199 • Chatswood Chase 411 1955 • Chullora 642 8922 • Gore Hill 439 5311 • Gosford 25 0235 • Hornsby 477 6633 • Hurstville 580 8622 • Kotara 56 2092 • Liverpool 600 9888 • Maitland 33 7866 • Miranda 525 2722 • Newcastle 61 1896 • North Ryde 878 3855 • Orange 618 400 • Parramatta 689 2188 • Penrith 32 3400 • Railway Square 211 3777 • Sydney City 267 9111 • Tamworth 66 1711 • Wollongong 28 3800 **ACT** • Belconnen (06) 253 1785 • Fyshwick 280 4944 **VIC** • Ballarat 31 5433 • Bendigo 43 0388 • Box Hill 890 0699 • Coburg 383 4455 • Dandenong 794 9377 • East Brighton 592 2366 • Essendon 379 7444 • Footscray 689 2055 • Frankston 783 9144 • Geelong 232 711 • Melbourne City 399 Elizabeth St 326 6086 & 246 Bourke St 639 0396 • Richmond 428 1614 • Ringwood 879 5338 • Springvale 547 0522 **QLD** • Booval 282 6200 • Brisbane City 229 9377 • Buranda 391 6233 • Cairns 311 515 • Capalaba 245 2870 • Chermside 359 6255 • Rockhampton 27 9644 • Southport 32 9033 • Toowoomba 38 4300 • Townsville 72 5722 • Underwood 341 0844 • **SA** • Adelaide City 232 1200 • Beverley 347 1900 • Elizabeth 255 6099 • Enfield 260 6086 • St. Marys 277 8977 **WA** • Cannington 451 8666 • Fremantle 335 9733 • Perth City 461 3261 • Midland 250 1460 • Northbridge 328 6944 **TAS** • Hobart 31 0800 • Launceston 344 555 **NT** • Stuart Park 81 1977

B1374







VHF/UHF SPECTRUM ANALYSER ADAPTER - 2

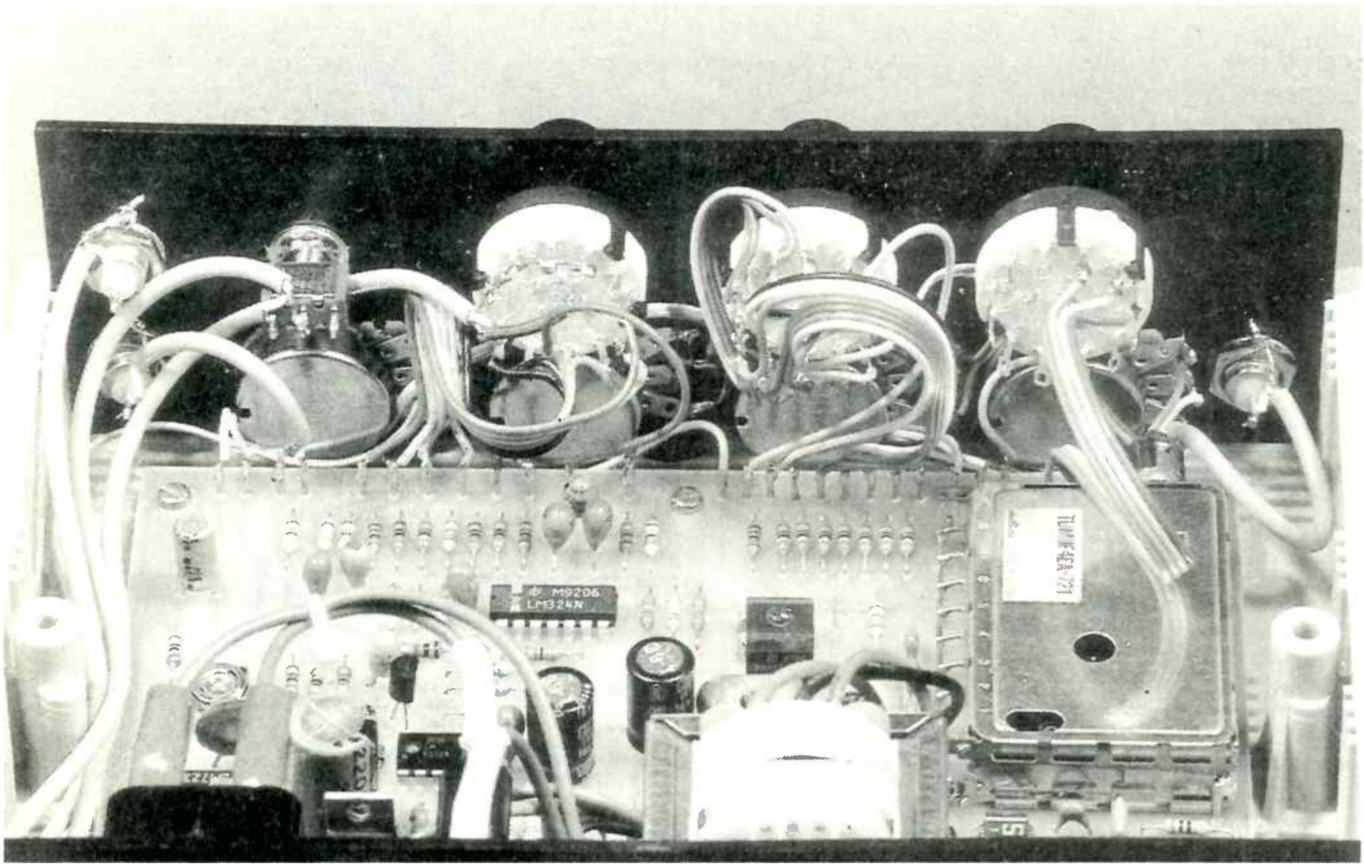
As promised last month, here are the constructional details for our new spectrum analyser project, plus information on how it is set up and used. As most of the parts mount on a PC board, construction is quite straightforward.

by JIM ROWE

The analyser is housed in a standard compact plastic instrument case, of the type having a 'U'-shaped top and bottom, and removable front and rear panels. The nominal width and depth are 200mm and 160mm respectively, and the front panel artwork has been designed to be compatible with the two slightly different cases currently available: that from Jaycar Electronics, with a height of 70mm (Cat. No. HB-5912), and that from Dick Smith Electronics with a height of 65mm (Cat. No. H-2505).

Inside the case, most of the components and circuitry are supported by a single-sided PC board. This measures 166 x 114mm, and is coded 92vsa9. The only components not mounted on the PCB are the various controls and connectors mounted on the front panel, and the connectors, mains fuseholder and power transformer which are mounted on the rear panel. More accurately, the transformer is mounted on a small earthed metal plate, which is in turn mounted on the rear panel — to ensure adequate safety if the transformer ever overheats. This will be discussed further later.

The location of all of the parts mounted on the PCB should be fairly clear from



A close up view inside the case, showing the front part of the PCB assembly and the wiring to the front panel controls and connectors. The tuner module is attached to the board by soldering to four PCB pins — one at each corner.

the PCB overlay diagram and the photographs. Note that the varicap tuner module is mounted on its side, with PCB pins used both to attach the case to the board (by soldering to the case), and to make most of the actual connections to the tuner. The only exception is the RF input, which connects to the rear of the front-panel BNC socket via a short length of co-axial cable and an RCA plug.

By the way, the reason for mounting the tuner module on its side (when it is designed to mount vertically, with its connector pins passing directly through the PCB) is to ensure compatibility with different tuner modules. These can vary in terms of width and mounting lug spacing, so by mounting the module on its side, we can accommodate the variations more conveniently. For example the earlier TUMUF4EA-706 module can be used instead of the -721 module specified, if you have one.

Construction

The logical way to begin construction of the analyser is by assembling everything that mounts on the PCB. Here the first step is to fit the 52 PCB pins, which are used for making many of the off-board connections as well as attaching the tuner module.

You can see where most of the PCB pins go from the overlay diagram and the photo's — virtually all of them are either along the front or back edges of the board, or around the tuner's location. All pins pass through the board from the top (component) side, and are soldered to the pad underneath, with their *longer* end above the board (measured from the 'bulge').

The next step is to mount the tuner module, on its side and inside the PCB pins that are located at each corner. You should find that when you do this, the tuner's own connection pins will all line up with the row of PCB pins, ready to be soldered together.

However before you do this, carefully bend the 'corner' pins (with a pair of needle-nosed pliers) until they are all nicely nudging the ends of the module, when it is in the correct location. You'll probably have to remove and replace the module a few times, to bend these pins conveniently and test the result. Then when everything seems to line up nicely, solder the four corner pins to the module case to hold it in position, and finally solder the various connection pin junctions.

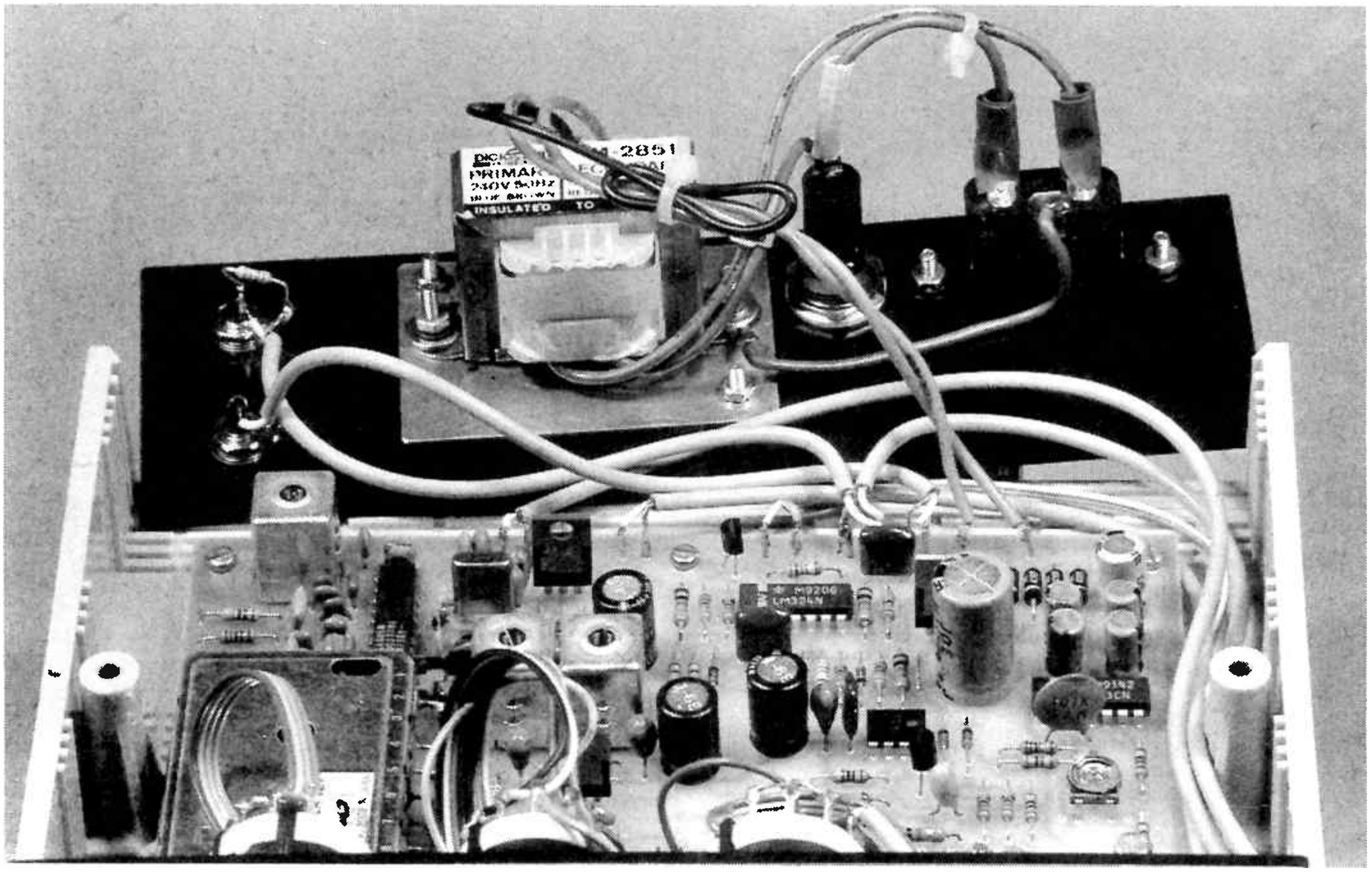
At this stage I suggest you fit all of the small passive components, with the resistors first, then the metallised polyester, ceramic and monolithic capacitors. Take care with virtually all of these capacitors to mount them as close as possible to the board, without straining their pigtails, and then to solder them quickly and carefully to avoid overheating.

Before proceeding further, mount the two PCB links so that you don't forget them later. One is next to R53, and the other is near R3. Both are visible in the PCB overlay.

The electrolytic and TAG tantalum capacitors would be next, taking care to mount all of these with the correct polarity as shown on the PCB overlay. Then fit the signal, rectifier and zener diodes, again taking care with their polarity.

Next follow the trimpots RV4 and RV6, the discrete transistors, the ceramic filters F1 and F2, the 47uH RF choke and the crystal X1. Both the filters and crystal should be mounted as close to the board as possible, without straining their pins, and again soldered quickly and carefully to avoid overheating.

The next step is to wind the coils L/1, L2 and L3. These are all wound on readily available 4.85mm formers, which have mating 6-pin bases and shield cans (DSE Cat. No. R-5020, R-5010 and R- 5000, or similar). IF transformer L1 is fitted with



In this second close up, looking towards the rear, we see most of the rest of the board assembly along with the rear panel and its components. Note that the power transformer is mounted on a small square of aluminium sheet.

an F29 ferrite slug (DSE Cat. No. R-5030), while L2 and L3 are fitted with F16 slugs (DSE Cat. No. R-5025). Both windings of L1 are wound using 0.5mm enamelled copper wire, which is also used for L2; however L3 is wound using 0.25mm enamelled wire.

Winding details for all three coils are shown in the small box. Make sure you terminate the coil windings on the pins shown, as the PCB pattern is designed to match these connections. When the coils have been wound and checked, they can then be mounted on the PCB. Make sure you orientate them correctly, and then push the base pins through the PCB as far as they will comfortably go.

Then solder the pins to the PCB pads, and carefully clip off the excess pin ends. Then fit the shield cans, soldering their attachment/earthing pins to the earth copper and again clipping off the excess. Finally fit the threaded slugs, preferably slipping a 25mm length of fine rubber thread into the former first, to act as a 'brake' against slug movement due to vibration.

The last step in completing the PCB assembly is to fit the ICs. These all mount directly on the board, although sockets could be used for U4, U5, U6 and U7 if you wish.

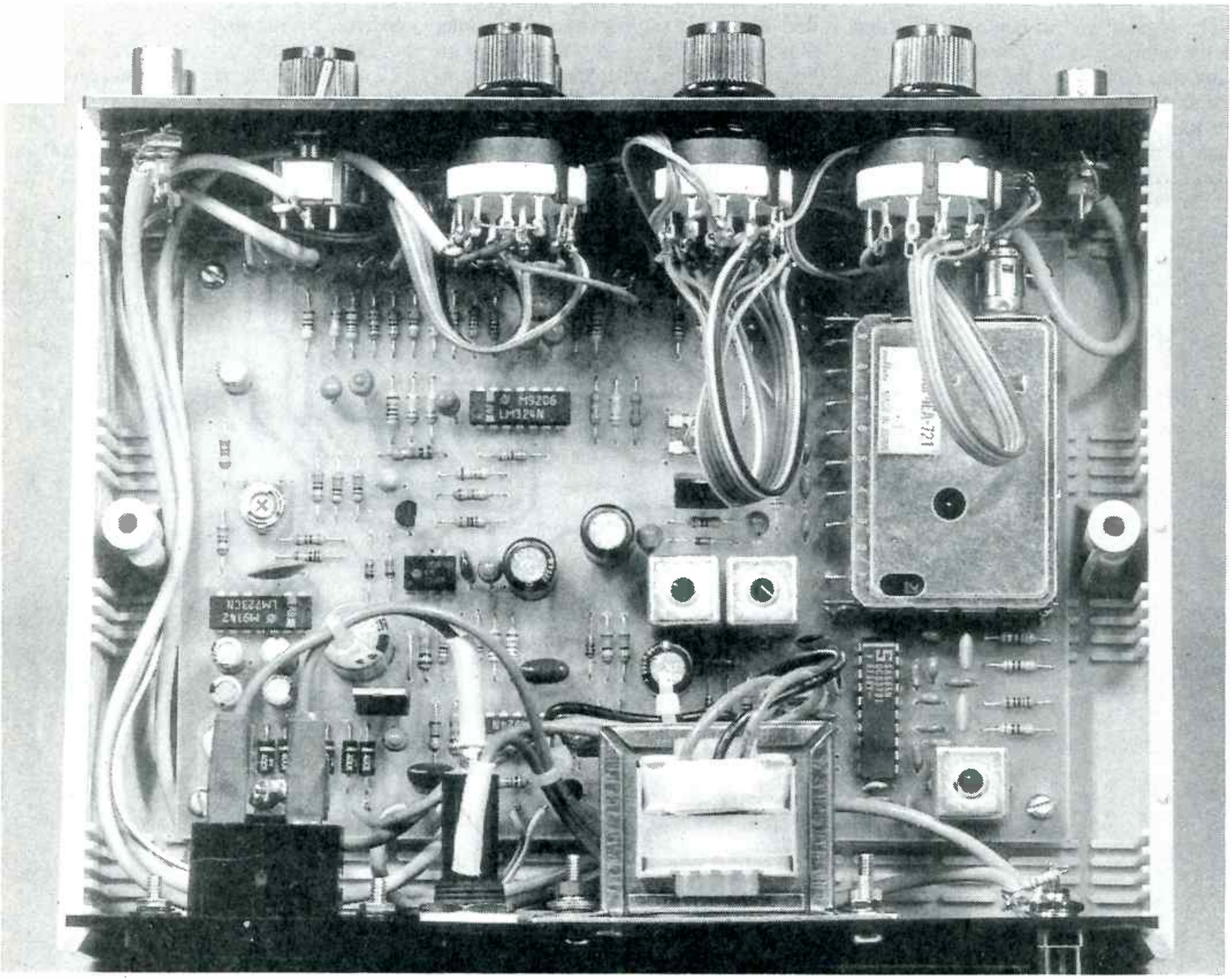
Do NOT attempt to use a socket for IF amplifier chip U1, however — this chip needs to be mounted as close as possible to the board, with minimum lead lengths, to ensure stable operation.

Don't forget regulator IC's U2, U3 and U8. These all mount vertically, and are orientated as indicated in the overlay diagram — which also shows the orientations for all of the other IC's.

With the PCB now fully assembled, you can turn your attention to drilling the holes in the front panel, to accept the various connectors, switches and pots. You should be able to use a photo copy of the front panel artwork to locate the holes correctly, but it is usually advisable to use the components themselves as a guide to the exact hole sizes — there are quite a few different sizes in current use, when it comes to pot and switch mounting bushes.

You may also wish to drill 'blind' holes from the rear of the panel, to accept the locating/anchor spigots on some of the controls.

After drilling and reaming the various holes to size, you can then fit the Dynamark (formerly Scotchcal) front dress plate, if you're using one, and cut holes in this to match the main con-



Here is a general view looking into the analyser's case, showing where everything goes. Almost all of the circuitry and components mount on a single PC board.

trol and connector holes. Then the various parts can be mounted — after cutting the pot and switch spindles to length, of course. The final step is to fit the control knobs.

The rear panel assembly is next prepared, in a similar way to the front panel. Here there are a smaller number of holes, but two of these are relatively large: that for the captive IEC mains plug, which is rectangular, and that for the mains fuseholder which is round.

These are best prepared by drilling a series of small holes inside a marked-out area, cutting between these with a sharp knife, and filing the holes carefully to their final size.

As mentioned earlier, the mains transformer is firmly mounted on a 55mm square of 1mm-thick aluminium sheet, using 3mm countersink-head machine screws, nuts, flat washers and 'star' locking washers. A solder lug is fitted underneath one of the mounting nuts, to allow a wire to be connected to the earth lug of the IEC plug.

The complete assembly is then mounted on the plastic rear panel, with the transformer orientated so that its 240V primary leads will exit from the *bottom* when the panel is fitted into the case, using a pair of standard 3mm screws, nuts and lock washers.

When the plug, fuseholder and transformer assembly are mounted on the panel, the transformer primary leads can then be connected to the 'N' lug on the IEC plug, and the fuseholder lug nearest the panel.

The other fuseholder lug is then connected to the the 'A' lug of the IEC plug. Note that all four of these mains connections should be carefully made, and provision also made for insulating them after soldering using either varnished cambric sleeving or 'heatshrink' sleeving — to ensure that they can't be touched inadvertently.

It's also advisable to use small nylon 'cable ties' to bind together the two 'live' leads connecting to the IEC plug lugs, and also the transformer primary and secondary leads. This helps prevent accidental contact, should any one wire break away from its soldered joint.

Don't forget to fit the earthing wire from the transformer solder lug to the IEC plug's 'E' lug, too. This should be in mains-type wire, with the usual green or green/yellow striped insulation.

The RCA connectors can also be fitted to the far end of the rear panel, to complete this assembly. Note that although bleed resistor R60 is visible in the photographs wired directly across the back of the audio output socket, this resistor is probably best mounted on the back of S3b, the sweep width switch — as shown in the wiring diagram.

You should now be ready for the final step in assembly of the analyser: mounting the PCB in the lower half of the case, and making all of the connections between it and the front and rear panel assemblies. This is done most conveniently by laying the panels 'face down' in front of their final positions, and wiring in the various internal leads in a methodical fashion, using the wiring diagram and photographs as a guide.

Note that the leads to all of the signal connectors are made in light-duty coaxial cable, while most of the rest of the wiring can be done using 'rainbow' colour-coded ribbon cable separated into appropriate conductor groups.

The 12.6V AC secondary leads from the power transformer connect directly to the input pins at the rear of the PCB. You may wish to shorten these leads a little, to keep them from draping over the board circuitry when the unit is fully assembled.

And once all of the connections have been made, you can slot the front and rear panels into the lower case. You'll then be ready for the next phase: firing it up.

Testing and adjustment

Before applying the power, set both of the preset trimpot RV4 and RV6 to their fully anticlockwise positions, as viewed from above. Also have a DMM handy, set to say the 20V DC range, and with its negative test lead connected to the earthy side of one of the BNC connectors, ready to check the supply voltages.

Now apply the power, and quickly check the voltage at the input pin of 12V regulator U8 — the pin nearest C49. This should measure about +17.5V. Now quickly check the voltage at the output pin of the same IC, which should measure +12V, and also the output voltages from U2 and U3. These should read close to +9V and +6.2V respectively.

If any of these voltages are well away from the nominal figures, and/or any of the regulator IC's are getting noticeably hot, switch off the power immediately and check for wiring errors. The odds are you've connected something in the wrong way around!

All being well, however, change your DMM to the next higher DC volts range and check the voltage at pin 11 or pin 12 of U7. This should read about +32V, if the voltage doubling rectifier diodes and capacitors are fitted to the PCB correctly.

The next step is to measure the voltage at pin 4 of U6, or on the rotor lug of sweep rate pot RV2. This will probably read around +25V or so. With the meter still connected, now is the time to slowly turn trimpot RV6 clockwise, using a small screwdriver, until the DMM reading rises to +28V. Your tuning/sweep voltage supply rail will now be set correctly.

All being well so far, you can hook your 'scope up to the analyser adapter, connecting the Y output to the scope's Y input and the X output to the scope's X input. Or if your scope doesn't have an X input, connect the analyser's rear 'Trig Out' to the scope's external trigger input — or even to its second Y input, if it doesn't have an external trigger input. Set the scope's Y input gain to 1V/div, or thereabouts.

There will probably be very little to see on the main Y input, at this stage, except perhaps a DC level of a few hundred millivolts. But you should be able to get plenty of X deflection, if you're in X-Y mode, from the analyser's 8V p-p sweep sawtooth — or alternatively good time-base locking, from its 11V p-p trigger pulses.

The timebase should be set to around 2ms/div, if you are using triggering, with the analyser's Sweep Rate pot set to about mid range. The presence of trigger pulses and a sweep sawtooth indicates that the analyser's sweep oscillator circuitry is working correctly, of course.

Now you should be ready for the analyser's alignment. For this, you should ideally have some kind of RF signal generator, or perhaps a small transmitter/transceiver capable of generating a signal in one of the analyser's three frequency bands. If you use a transmitter or transceiver, you'll also need a dummy load to feed most of its output into (the analyser will probably detect enough leakage to let you do the alignment).

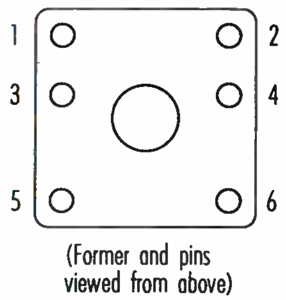
If all else fails, you can even perform the alignment reasonably well using signals from a suitable TV antenna — providing you're not in an outer fringe area.

With a signal generator or a TV antenna, the analyser's RF input can be connected directly, using a suitable length of coaxial cable. The signal generator should be set to a frequency near the middle of one of the analyser's bands (say 75MHz, 170MHz or 600MHz), and to produce an output of say 40-50uV.

At this stage the analyser's band switch should be set to the band you'll be aligning it on, its RF gain control fully clockwise, both centre frequency controls to about mid range, and the Sweep Width switch to 'Max'. The Sweep Rate pot can be left at mid range, and the Audio Muting pot fully anticlockwise. The Bandwidth switch can be set to 'Low'.

VHF/UHF Spectrum Analyser Adapter - 2

Coil winding details

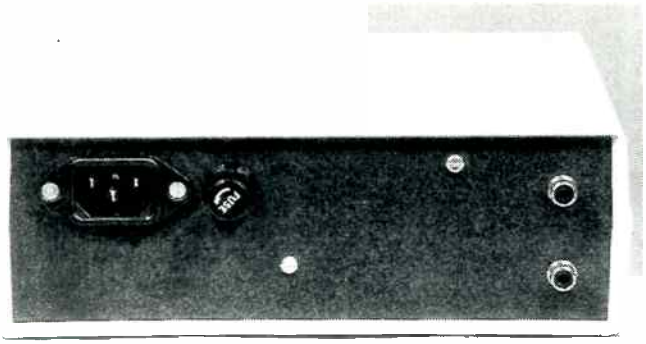


L1 (F29 slug):
Primary 1 turn 0.5mm ECW, between pins 1 and 2
Secondary 8 turns 0.5mm ECW, between pins 5 and 6

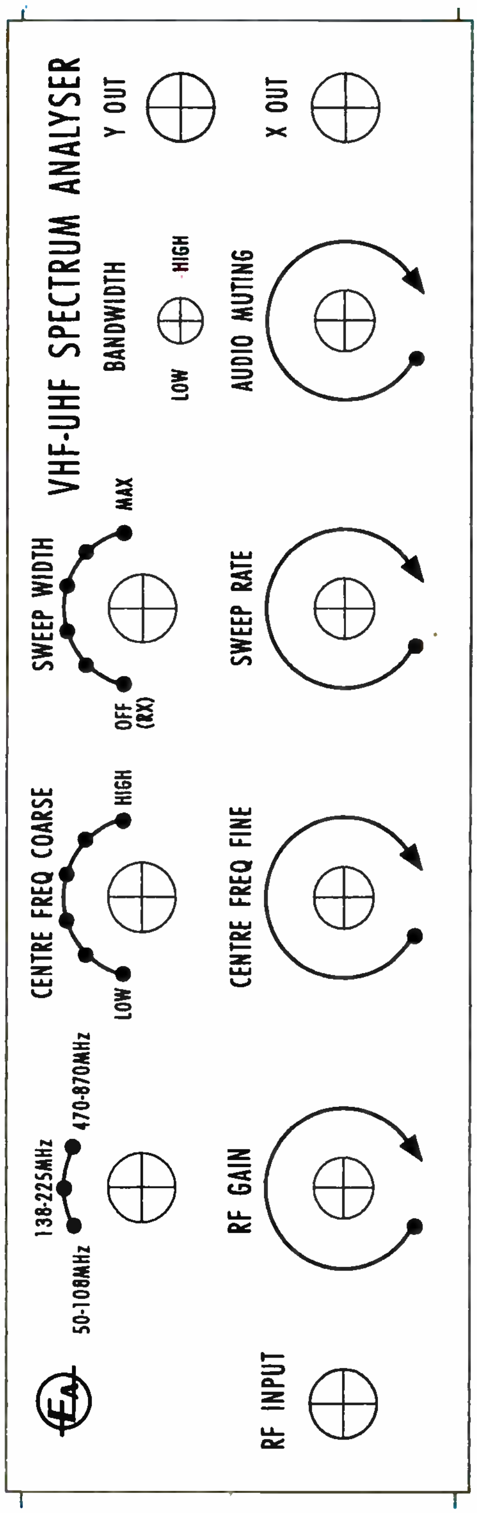
L2 (F16 slug):
8 turns 0.5mm ECW, between pins 5 and 6

L3 (F16 slug):
20 turns 0.25mm ECW, between pins 1 and 2

Above are the winding details for the IF transformer L1, the crystal oscillator coil L2 and the quadrature sound coil L3. All three coils are wound on miniature (4.85mm) formers, fitted to 6-pin bases. The various windings are terminated on specific pins, as shown.



Above: The rear panel of the analyser. At upper left are the captive IEC mains plug and fuse holder, while at far right are the audio output (top) and trigger output connectors. The two additional screws visible are used to attach the power transformer mounting plate to the plastic rear panel.

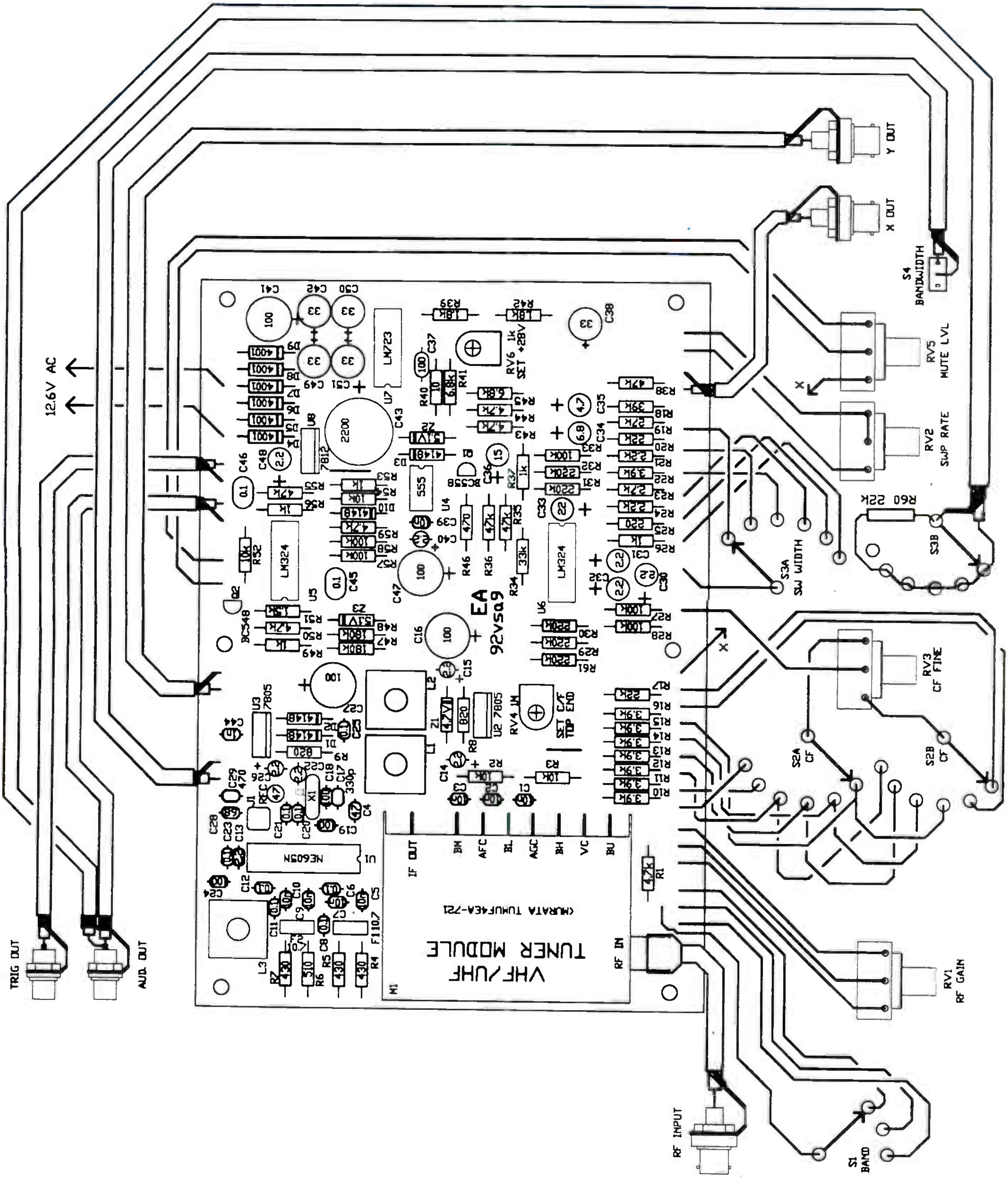


Right: The front panel artwork for the analyser, reproduced here actual size for those who wish to make their own Dynamark front panel. The small lines at each end indicate where the panel is trimmed if you are housing the analyser in the case sold by Dick Smith Electronics — which is a few millimetres shorter than that sold by Jaycar Electronics and others.

By now, you should be able to see at least one 'blip' on the scope's display, if you're using a generator or a transmitter/transceiver, or perhaps quite a few if you're using a TV antenna. In the latter case you might even have to turn down the RF Gain pot a little, to reduce the clutter.

The idea now is to use the Centre Frequency controls to move the single blip (or a suitably prominent one, with a TV antenna), to the very centre of the scope trace. Then reduce the Sweep Width one step (to 'zoom' in), and if necessary re-centre it again. Then reduce the Sweep Width once more, by which time you should have the blip quite clearly visible on a relatively uncluttered trace. If you have difficulty identifying the blip, try varying the signal generator's frequency — which will make the blip move along. Or turn your transmitter on and off, which will make it 'come and go'.

What if there's still no blip evident at



No prizes for guessing that this is the wiring diagram for the analyser, showing all of the connections between the PC board and the various controls and other off-board components. Don't worry if you can't make out the components on the board itself — these are more clearly shown in the PCB overlay diagram.

all? This will probably be due to the crystal oscillator coil L2 being way off, which can prevent the oscillator from operating — or allow the crystal to oscillate on its fundamental, instead of the correct third harmonic. So try adjusting the slug in L2, until a blip appears.

At this stage the peak of the blip should be about half screen height. If it's higher than this, turn down the analyser's RF gain control until it is; if it's too small, either turn up the gain or increase the generator's output a little.

Now try adjusting the slug in IF transformer L1. It should be possible to 'peak' this — that is, find the slug position where the blip's height reaches a maximum. If the slug was well away from this position to start with, the blip's height may grow quite a lot as you approach the peak, so if this happens keep turning down either the analyser's RF gain, or the generator's output, to keep the blip height roughly half of the screen. This prevents overloading effects, and ensures that you can easily see the effects of your adjustments.

When L1 is nicely peaked, try adjusting the slug in oscillator coil L2. Again there should be a setting of the slug which causes a peak in the blip amplitude, and that's where the slug should be set.

There's also a tiny slug in the tuner module's own IF output coil, which you can adjust for a peak as well. The slug is accessed via a hole in the tuner's case, just near the IF output pin (the one nearest L1). But the slug is *very* small, so you'll need to use a very small alignment tool and be very careful. Its tuning is quite broad, but a little tweaking can often produce a worthwhile improvement.

By the way, all of the analyser's coil slugs should of course be adjusted using a *plastic* alignment tool or a suitably filed plastic knitting needle — don't use a screwdriver, as this will upset coil operation. Also make sure that the alignment tool's tip correctly fits the slot in each slug — the ferrite material is quite brittle, and can be easily broken.

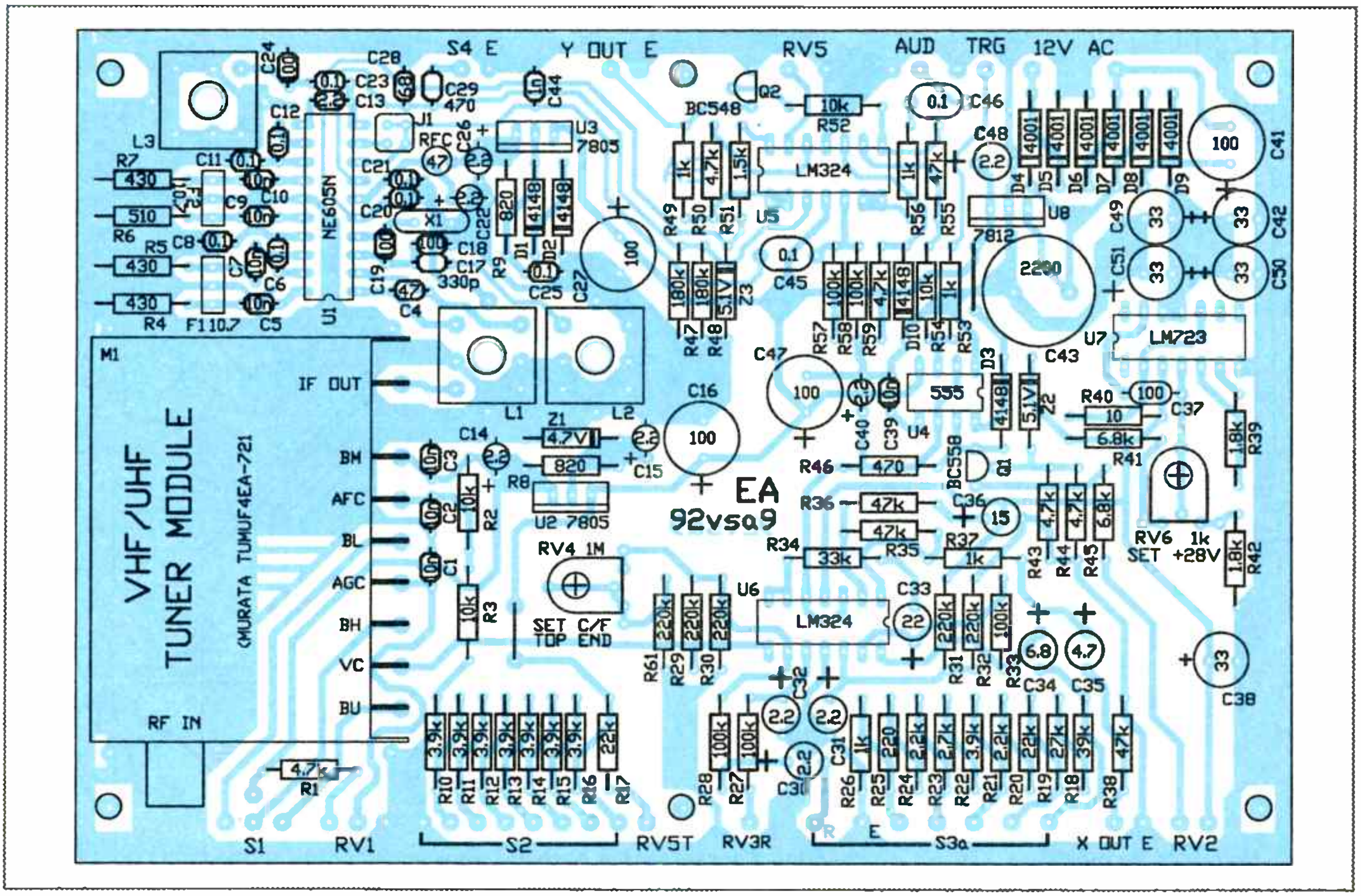
I actually had to make a special and very small tool to align the tuner's output coil, because of its very tiny slug. This was made from a discarded plastic crochet needle, but cutting off the hook and then carefully filing the end into a tiny 'blade'.

By now your analyser's main alignment is essentially complete; you can now adjust detector coil L3 for the best audio output when the analyser is being used as an FM receiver.

To do this, you'll need to connect the analyser's rear audio output socket to a suitable small audio amplifier, to allow you to hear the output (shortly). You'll also need to remove the signal generator's output, if you've been using one, or turn off the transmitter if you've been using that approach. Then connect either a TV antenna, or some other antenna which can provide a suitable source of reasonably wideband FM signals, to the RF input.

Suitable signals are the main sound carrier from a TV station, or the signal from an FM broadcast station — so the next step is to manipulate the centre frequency and sweep width controls until you have identified such a signal, and centred its 'blip' on the scope trace.

It shouldn't be difficult to find a



Here is the PCB overlay diagram, showing where everything goes on the board. Note that many of the components associated with the IF amplifier chip U1 need to be mounted as close as possible to the board itself, to minimise lead length. The NE605N chip must also be soldered directly into the board, to ensure stable operation. Header block J1 is not used.

[illegible]

suitable FM broadcast signal, near the top of the analyser's 50-108MHz band, or a TV sound signal on any of the bands. You'll soon learn to identify TV station signals, from their appearance on the trace: a main single blip for the vision carrier, plus two closely-spaced blips for the stereo sound carriers, 5.5MHz higher in frequency (i.e., to the right, on the scope display). Often there's another small blip corresponding to the colour subcarrier, at about 75% of the distance between the vision and picture carriers; a typical TV station's signal group was shown in the lower left-hand picture on page 67 of the September article.

Once you've identified a reasonably strong FM sound carrier, the idea is again to centre it on the scope trace, and 'zoom in' on it step by step, by switching to lower settings of the sweep width control. Each time you switch to a lower setting, you'll generally need to adjust the centre frequency pot slightly, to keep it in the centre. Then finally, when you have it nicely centred and 'expanded' in the lowest of the five sweep width ranges, switch the Sweep Width switch to its final 'Off' position.

You should now be able to hear the demodulated FM audio, although it may well be a little weak, noisy and distorted. If you can't hear anything, check that your Audio Muting pot is fully anticlockwise (or fully clockwise, if you've wired it with the connections to the ends transposed!). You may also need to adjust the gain of the audio amplifier, to achieve a reasonable audio level.

You'll notice that the 'blip' has apparently disappeared from the scope screen, but is replaced by a horizontal line. This is actually the 'peak' of the blip, spread to the full width of the horizontal sweep. If you try adjusting the Centre Frequency pot slightly, you'll find that the line moves up and down — in this 'FM Receiver' mode, the scope can be used as an S meter.

Carefully set the Centre Frequency pot so that the line moves to its maximum vertical position (peaking the signal tuning), and if necessary adjust the analyser's RF Gain pot so that the line's position is comfortably above the centre of the screen. Then try adjusting the slug in detector coil L3.

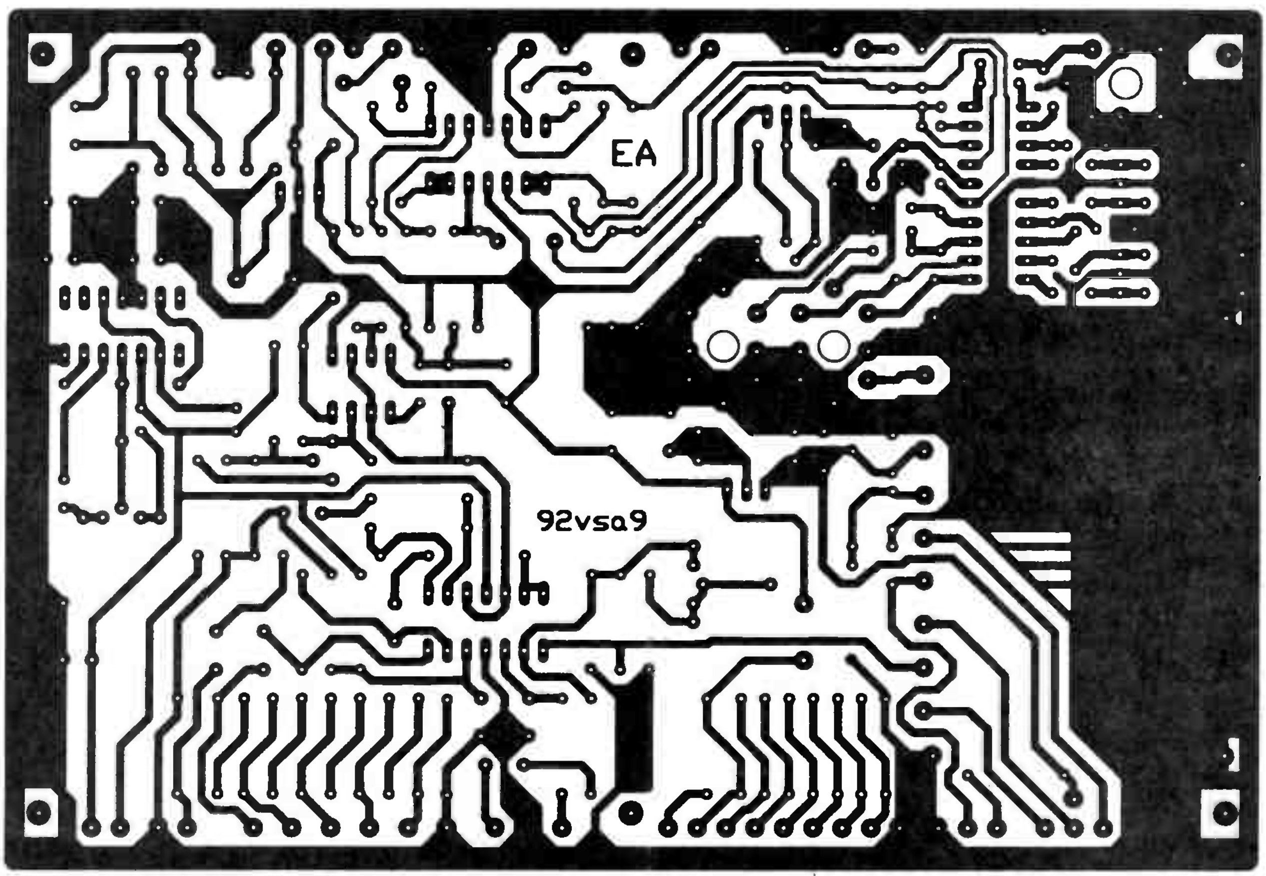
The tuning of L3 is fairly broad, but you should be able to find a position of the slug where the audio output is loudest and clearest — with virtually no distortion, and very little if any noise. This is the correct setting.

The final step in adjusting your analyser is to set trimpot RV4 to its correct value. You may recall that this pot is used to set the gain of the sweep output stage, for optimum operation.

To make this adjustment, disconnect the analyser's Y output from the scope, and re-fit its usual test probe. Then set the scope's Y input for a sensitivity of say 5V/div (taking into account the probe attenuation), and attach the probe tip to either the tuning voltage pin of the analyser's tuner module (pin 7, 'Vc'), or the end of resistor R29 nearest to the front panel. You will now be able to view the tuning/sweep voltage applied to the tuner.

Now set the Centre Frequency switch and pot to the middle of their overall range — say with the switch on position 3 (from anticlockwise) and the pot fully clockwise. With the Sweep Width switch set to the 'Off' position, you should see a horizontal line about halfway up the scope screen.

If you switch the Sweep Width control to its next position, the line should become a linear ramp — sloping upward to



And finally, here is the PCB pattern for the analyser, reproduced actual size as usual, for those who wish to make their own board.

the right, by a small amount. Switching to the higher Sweep Width positions should increase the slope of the ramp, until in the maximum sweep width setting it will reach maximum slope, and probably also develop horizontal sections at its ends — due to overswing of the sweep output stage.

Now, using a small screwdriver, slowly turn trimpot RV4 clockwise. The slope of the ramp will gradually reduce, and as it does the horizontal segments at top right and lower left will shrink. The centre frequency will also change slightly, so you will need to adjust the centre frequency pot as you go, to keep the ramp symmetrical both horizontally and vertically on the screen.

Keep turning up RV4 until the horizontal segments at the ends of the ramp have just disappeared, leaving a diagonal ramp whose peak-to-peak amplitude is achieving the maximum possible linear swing. This is the correct setting for RV4, and your spectrum analyser is now fully aligned and ready for use.

Troubleshooting

Apart from problems due to wiring errors and accidental swapping of components or fitting them into the PCB with the wrong orientation, there's not a lot that is likely to go wrong with the analyser, assuming you've followed the foregoing description carefully. In any case many of the possible pitfalls have already been mentioned, along the way.

If the DC voltages all check out correctly, and there's a X-output sawtooth and/or trigger pulses, but otherwise the analyser seems 'dead', with no blips visible on the scope display, the most likely cause is that you have a low activity quartz crystal, which is refusing to oscillate.

In all but the most stubborn of cases this can be remedied by connecting a 33k, 27k or 22k resistor from pin 3 of U1 (NE605N) to ground. This increases the quiescent current in the chip's internal oscillator transistor, and gives it a little more gain, to persuade the crystal to oscillate.

Note that this external emitter resistor should *not* be reduced below 22k. If the crystal still refuses to oscillate (which you can monitor using the scope probe applied to pin 4), you probably have a faulty crystal and it's better to replace it.

The external resistor is only likely to be needed with low activity crystals, by the way. The chip's internal circuitry is quite adequate to oscillate with all normal crystals.

PARTS LIST

Resistors

(All 1/4W 5% unless specified)

R1,R43,R44,R50,R59	4.7k
R2,R3,R52,R54	10k
R4,R5,R7	430 ohms 1%
R6	510 ohms 1%
R8,R9	820 ohms
R10,R11,R12,R13,R14,R15,R16,R22	3.9k
R17,R20,R60	22k
R18	39k
R19	27k
R21,R24	2.2k
R23	2.7k
R25	220 ohms
R26,R37,R49,R53,R56	1k
R27,R28,R33,R57,R58	100k
R29,R30,R31,R32,R61	220k
R34	33k
R35,R36,R38,R55	47k
R39,R42	1.8k
R40	10 ohms
R41,R45	6.8k
R46	470 ohms
R47,R48	180k
R51	1.5k
RV1,RV3	10k linear pot
RV2,RV5	20k linear pot
RV4	1M lin mini trimpot
RV6	1k lin mini trimpot

Capacitors

C1,C2,C3,C5,C6,C9,C10,C39	10nF monolithic
C4	47uF NPO ceramic
C7,C8,C11,C12,C20,C21,C23,C25	0.1uF monolithic
C13	2.2pF NPO ceramic
C14,C15,C22,C26,C30,C31,C32,C40,C48	2.2uF 25VW TAG tantalum
C16,C27,C47	100uF 16VW RB electrolytic
C17	330pF NPO ceramic
C18,C19,C24,C37	100pF NPO ceramic
C28	68pF NPO ceramic
C29	470pF NPO ceramic
C33	22uF 16VW TAG tantalum
C34	6.8uF 35VW TAG tantalum
C35	4.7uF 35VW TAG tantalum
C36	15uF 16VW TAG tantalum
C38,C42,C49,C50,C51	33uF 35VW RB electrolytic
C41	100uF 25VW RB electrolytic
C43	2200uF 25VW RB electrolytic
C44	1nF 50VW metallised polyester
C45,C46	0.1uF 50VW metallised polyester

Semiconductors

D1,D2,D3,D10	1N4148 silicon signal diode
D4,D5,D6,D7,D8,D9	1N4001 1A/100V silicon diode
Q1	BC558 silicon PNP transistor
Q2	BC548 silicon NPN transistor
U1	NE605N FM IF amp/detector
U2,U3	7805 5V regulator
U4	555 timer
U5,U6	LM324 quad op amp
U7	LM723 adj. voltage regulator
U8	7812 12V regulator
Z1	4.7V 400mW zener diode
Z2,Z3	5.1V 400mW zener diode

Miscellaneous

X1	26.175MHz crystal (see text)
F1,F2	10.7MHz ceramic filter (see text)
L1,L2,L3	Coil, wound on 4.85mm former with 6-pin base, shield can and slug (see winding data)
M1	VHF/UHF tuner module (Murata TUMUF4EA-721)
RFC	47uH RF choke
S1	Three pole, 3 position rotary switch
S2,S3	Two pole, 6 position rotary switch
S4	SPDT miniature toggle switch
T1	12.6V/150mA power transformer

1 x plastic instrument case, 200 x 160 x 70mm (see text);
1 x IEC mains input plug, panel mounting;
1 x 3AG fuseholder, panel mounting screw-in type with 500mA fuse;
3 x BNC sockets, single-hole panel mounting type;
2 x RCA audio sockets, single-hole panel mounting type;
1 x RCA plug, compact type with short pin (see text);
7 x small instrument knobs;
52 x PCB pins;
light 75-ohm coaxial cable;
shielded audio cable;
hookup wire;
square of 1mm aluminium sheet, 55mm square;
3mm machine screws, nuts and locking washers;
solder, etc.

Using the analyser

You've probably gained at least a general idea of how the analyser is used from the discussion this far.

The bandswitch is used to set the band to be examined, while the centre frequency controls allow you to bring virtually any frequency in each band to the centre of the scope trace, for examination.

The Sweep Width switch allows you to examine the full band initially, if you wish, and then zoom in to any particular signal or band segment of interest. The RF gain control allows you to achieve maximum gain for very weak signals, or lower it to prevent overload and generation of spurious products with very strong signals.

The purpose of the Sweep Rate pot is to allow fast sweeping (with lower visible flicker) when this is possible.

However as this can cause some distortion of narrow-band signals, due to the analyser's modest IF selectivity, the pot

[illegible]

also allows you to slow down the sweeping when required. Often the pot can be left in the centre of its range.

The Bandwidth switch allow you to introduce additional filtering when you're looking at signals under noisy conditions, making them easier to examine. However in the 'low' position it can cause the apparent amplitude of signals to be reduced, especially when you're using a high sweep rate. Hence the 'High' position, to allow more accurate examination of signals when conditions allow.

And finally there's the Audio Muting control, which only operates when you're using the analyser in its 'FM receiver' mode.

Here the control acts very much like a traditional 'squelch' control: in the fully anticlockwise position, virtually all signals are heard, but as you turn the control up, only stronger and stronger signals are able to surmount the gating barrier. This allows you to reduce listening fatigue by gating off the noise between signals.

An important point to remember, when you're using the analyser for spectrum analysis, is that the maximum sweep width you can use at any time depends upon the centre frequency setting. The full sweep setting will only give an undistorted sweep when you have the centre frequency controls set for the middle of each band; as you adjust the centre frequency controls to move further away from the mid-band setting, the sweep width will need to be reduced to match — or you'll get some strange effects, as the sweep output circuitry 'hits its limits'.

Generally this shows up on the scope display as a 'plateau' or 'dead area' on one end of the trace, where the X sawtooth is still providing sweep, but the analyser's tuning is not able to follow any further.

It's an effect that tends to happen even with the most elaborate laboratory analysers, and after using the instrument for a while you'll soon learn both to recognise the symptoms and adjust the controls to remove or at least minimise them.

A final point. When you switch off the sweep to listen to the modulation on a signal of interest, the analyser effectively becomes an FM receiver — with the centre frequency switch and pot as its tuning controls.

Up on the UHF band the tuning does become a little critical, but with care it's quite possible to tune in quite narrow-band FM signals — using the scope 'S meter' as a guide.

With a sensitivity of better than one microvolt, the analyser is actually quite a useful little VHF/UHF receiver in this mode. Even though it has a reasonably broad selectivity (170kHz), you can even listen to quite narrow-band signals, if your external audio amplifier has a reasonable amount of gain.

Its main shortcoming is that if there are a number of narrow-band signals very close together (i.e., all within the 170kHz passband), you'll tend to hear them all together.

As mentioned in the first article, it would be possible to improve the selectivity of the instrument both as an analyser and as a receiver, by substituting a 10.7MHz crystal filter for the first ceramic IF filter F1. I'll leave this for the more adventurous and well-heeled contructors...

Now for the obvious question: could the analyser somehow be used to look at signals below 50MHz, or in the 'gaps' between the current bands?

That's the next step, and I'm currently working on a suitable 'up-converter' project to do the job, in between other projects. If there's sufficient interest, I'll try to finish it and publish the details.

In the meantime, I hope you find the present spectrum analyser adapter a useful addition to your workbench. ❖

[illegible]

[illegible]

AUTOMOTIVE ELECTRONICS

with MAJOR AL YOUNGER (USAR, Ret.)

Engine basics - 4

Last month, we discussed the ignition system. This time we'll conclude our brush-up on engine basics with a look at the intake, emission/pollution control and electrical systems. With the basics out of the way, I'll be able to devote future columns to my favourite subject: the practicalities of automotive electronics, and what you need to know to fix the car.

First of all, let's look at the intake system. To better understand this system, it is divided into two parts: the air intake and the mixture intake (carburettor & manifold).

The thermostat air cleaner (TAC) is the active portion of the air intake subsystem. The TAC has two functions: to help maintain a carburettor temperature of about 93°C, which is the design centre, and to heat the air-fuel (AF) mixture, to aid in combining and atomising. Some systems also use heating elements placed under the carburettor.

Fig.1 shows a vacuum (vac) type of TAC. Some models have a thermostat hooked directly to the damper assembly door and do not require a vacuum motor. Later models have a duct system bringing in outside air, attached to the snorkel. If the duct is removed, the system gets too much heat from under the bonnet. People who don't understand the purpose of this system often disable it, most often by blocking off vacuum.

TAC operation

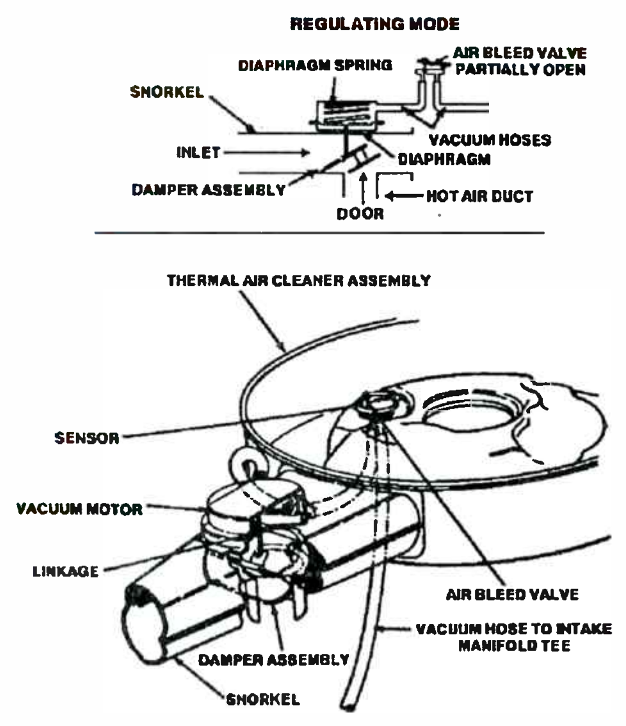
In an engine's initially cold state, the TAC door is closed to hot air. When the engine is started, the vacuum, via the thermostat (or sensor) vac switch, operates the vac motor to open the door. This allows hot air to enter from the exhaust oven, which heats the incoming air and this in turn heats the carburettor.

When the thermostat closes (at correct heat), vacuum is switched off to the vac motor and the door closes, allowing incoming air only. On a hot start, the vacuum is not available to the vac motor — so the hot air door remains closed. This is the default for a failed system; i.e., when there is no vacuum, the door remains closed.

Mixture intake

The mixture intake consists of a carburettor (Fig. 2) and an assembly of passageways called the intake manifold. The carburettor mixes the air/fuel and the intake manifold routes the mixture to the valve intake ports, in a manner which ensures that they all get equal mixture volume and pressure.

The proportions of air and fuel in the mixture delivered to the cylinder are controlled by the carburettor. The pro-



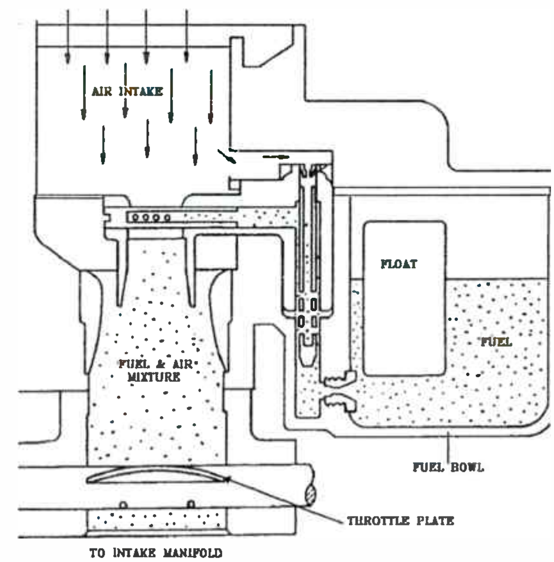
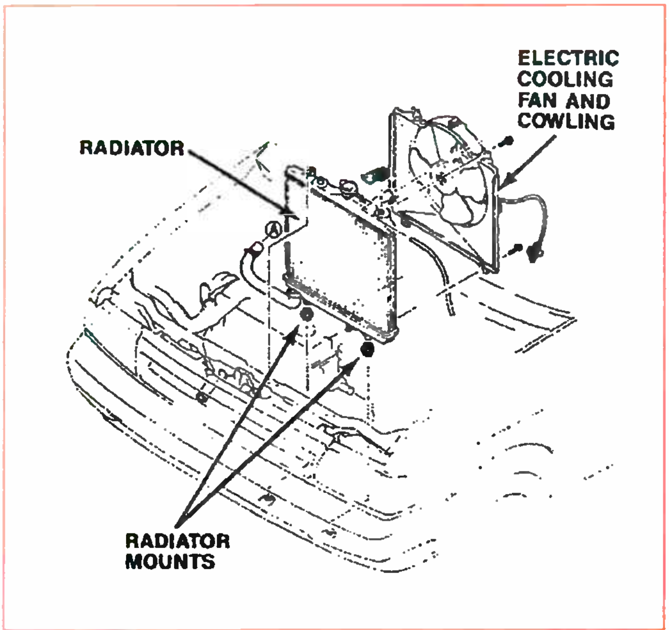


Fig.2 (above): The construction of a conventional curcurettor, used to mix air and fuel in the correct proportions.

Fig.1 (left): The components making up a vacuum-operated thermostatic air cleaner (TAC).



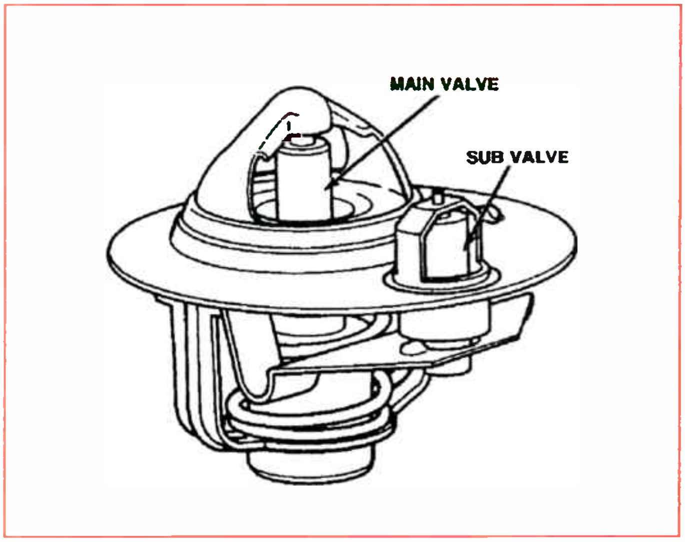


Fig.4 (above): The construction of a typical thermostat.

Fig.3 (left): The components of an engine cooling system.

portions are expressed by the ratio of the mass (weight) of air to mass (weight) of fuel. This ratio is appropriately called the air/fuel ratio (AFR). In normal operation, the AFR varies in the range between 12:1 and 17:1.

The control over AFR is achieved by the throttle plate, part of the carburettor itself. The throttle plate, which acts as an air flow valve, is controlled in turn by your foot, moving the accelerator pedal up and down.

Reviewing what we've said so far, the TAC controls the temperature of the incoming air, bringing it to a specified design centre value. A disabled TAC system greatly effects engine efficiency. The mixture intake supplies fuel and air, in a particular ratio (AFR), to the intake valve ports,via the intake manifold. The incoming amount is controlled (demanded) by the throttle plate — i.e., the accelerator.

If you find the AFR a little confusing, think of it as showing X parts of air to one part of fuel, and remember that there is always much more air than fuel.

The cooling system

Is heat a friend or a foe? We most often think of heat as a foe, since it usually represents lost energy. It can also be destructive, if not controlled properly. But if it *is* controlled properly, it becomes friendly and can be used to ensure optimum engine operation.

The main purpose of the cooling system (Fig.3) is to maintain the engine temperature at a prescribed optimum 'design centre' value.

Before we get into this, though, let's purge our minds of dis-information and 'witches tales'.

'We don't need thermostats here!' This is false — there are only two elements that control engine temperature: the fan and the thermostat. Without a thermostat, most engines run too cold.

'Water works fine, you don't need coolant.' This is false too — since DuPont developed anti-freeze, commonly known as 'coolant' fluid, no engine has been designed for water only, except marine engines.

I find it easy to convey the importance of temperature to electronics people. We understand the idea of parameters having an optimum or 'design centre value', because we have had to live with this concept in electronics. So although high temperature is most often the 'foe', all this really means is that in practice temperature must be controlled — just as in electronics.

As you can see from Fig.3, the basic components of the typical cooling system are the fan and the thermostat. The fan is controlled by a thermal switch, or may be switched on with the air conditioner. The thermal switch has a specified temperature setting. In electronic models, it may be computer controlled. If your vehicle has a belt-driven fan, make sure the belt is in good repair. A slipping belt will cause overheating.

The thermostat (Fig.4) is selected to regulate engine temperature to its design centre value. It has a temperature element (spring) that maintains a closed position until the correct temperature is

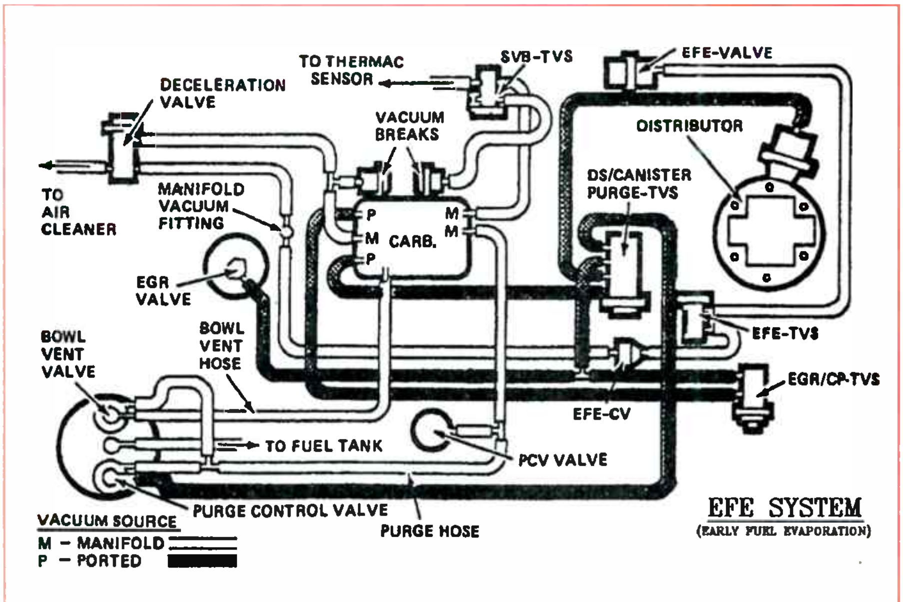


Fig.5: The emission control system for a modern car, excluding the electronics.

reached, and then opens to cover an opening. This restricts flow, causing the coolant to rise in temperature. On most modern cars the thermostat controls temperature at just below the boiling point of water (100°C).

Whenever you need to change a thermostat, make sure it is made for the right temperature setting. On an engine with electronic control, a 10° difference may effect operation. The industry has just started stamping the temperature on the thermostat — it's that important.

Coolant

The amount (percent) of coolant fluid, relative to the water in a new car used to depend on whether it had an air conditioner fitted (any way to save a dollar!). The effect of the fluid is to raise the water's boiling point, to a degree depending upon the percentage (or ratio) of fluid to water. This information is listed on the container. Some coolants also have additives, to maintain a clean cooling system. The containers all have warnings against ingesting...

If you break down in the 'bush' and plan on drinking the water-coolant mixture, don't. If there's nothing else, dig a hole and use a piece of plastic sheet and a tin to make a simple distilling system, to extract the water and leave the rest. Otherwise you may need a rather larger hole — for you!

Without coolant fluid added to the water, the modern car engine would most likely be boiling all the time. Despite the common misconception of coolant as 'anti-freeze', it's actually more important in summer than in winter. The only reason it is used in winter is to stop expansion caused by freezing

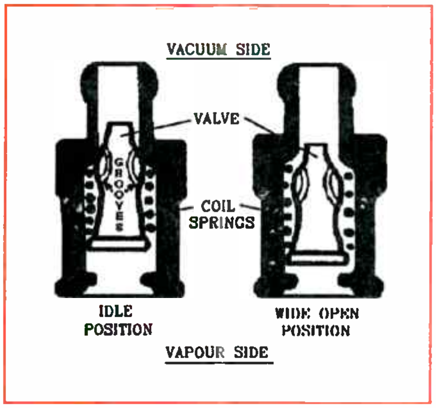


***Fig.6:** The positive crankcase ventilation valve, or 'PCV'.*

— which may crack the engine block. There are hand-held testers which indicate when coolant should be added or changed.

The radiator cap is a deceptively simple device which can allow an engine system to self destruct. Its function is very simple, but often misunderstood. It is not just to allow for fluid expansion, but to maintain pressure. Maintaining pressure aids circulation and insures that there is no air pockets in the system. Some engines *require* pressure, because the heads and even the water pump are above the radiator.

This brings up another point: if you are changing your coolant, read the owner's manual. Many a Jaguar and Renault owner has found out why — with a very large bill, for another engine.

Radiator caps are rated by pounds of pressure, and are so labelled. A tester is available; see your local mechanic. If you put the wrong one on, you're in trouble. A cap designed for too high a pressure may cause hose or radiator bursting; one for too low a pressure can allow overflow and overheating.

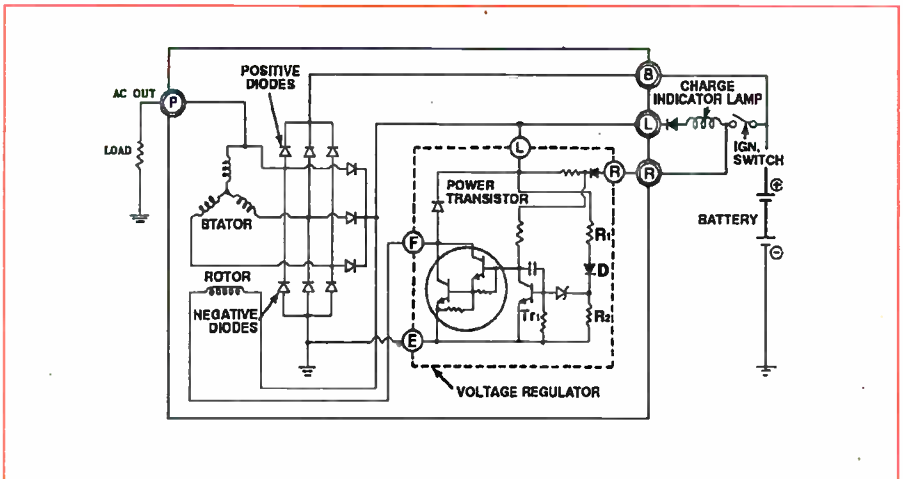


***Fig.7:** The modern alternator contains a three-phase AC generator with a matching rectifier system, and uses electronic voltage regulation.*

Be very careful when working on a hot coolant system. I know very few mechanics who have not been burnt. Burns are very, very painful, as I can testify myself...

If you need to replace a coolant hose, go for quality. Some cheap hoses will cut when tightening, and have a tendency to collapse. Hoses and belts should be changed periodically — see your local mechanic. Don't be that bloke broken down with a steaming engine, in the middle of Pacific Highway in peak hour traffic.

E & P controls

Many people think that emission and pollution controls are only on electronically controlled vehicles, but this is not true. What happened is that as pollution standards rose, the mechanical, electric or vacuum operated systems could not meet those higher standards.

Fig.5 shows an emission control system without electronics. As you can see, it is quite complicated. For this article we will concede that the optimum AFR of 14.7:1 could not be achieved without electronics, and discuss only engine emissions.

Engine emission control regulates engine and fuel tank vapours. The engine vapours are controlled by a PCV (positive crankcase ventilation) valve, a very simple device illustrated in Fig.6.

The PCV valve is placed where it has access to the engine crankcase vapours — usually in the engine valve cover. At idle, the vacuum pulls the check valve up, closing the vent. At cruise, the vacuum drops, the valve drops, allowing the vacuum to draw the vapours into the intake manifold. If it fails in the up (closed) position, the vapours may be seen escaping from the oil filler tube; if it sticks down (open), you will have a vacuum leak. This will cause hard starts, stalls and poor or no idle, with very little effect at cruise.

To control fuel tank vapour emissions, a vapour collection tube runs from the fuel tank to a charcoal canister, under the bonnet. Vacuum pulls the vapour to the canister, where it is stored. At cruise, vacuum from the intake manifold draws the vapours into the manifold. Note that this is basically *what* happens; exactly *how* it is done depends upon the system.

Electrical system

As we all know, the modern car demands a lot of electrical power. Some luxury cars have alternators that will supply 2kW, and starter motors that draw up to 450 amps. The high currents demand good cables and connections.

Modern alternators have very good reliability and require very little maintenance. Checking the driving belt and the connections is all that is required. Most failures are traced to an over-current condition — i.e., a bad or shorted load, generally a bad battery.

Most of you probably know how alternator works, so it will not be discussed in depth. As Fig.7 shows, it is an AC generator with built-in rectifier diodes and a regulator (internal or external) that controls the output by controlling the DC field current. The advantages over the DC generator formerly used are that output is controlled by demand, and is more easily controlled. Some alternators also output AC voltages for external use. Of course the main function of the alternator is to maintain a fully charged battery.

The starter motor

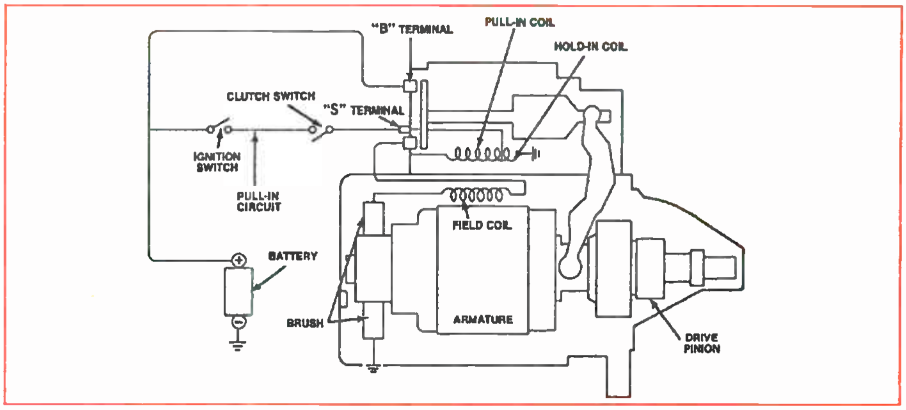


Fig.8: The starter motor. It may need to draw up to 450 amps to crank a large, cold high compression engine.

This was Dr Kettering's first invention, back in 1912 (Fig.8). The high compression engine has placed an increased demand on starters; with a large engine starting cold, up to 450 amps may be required. The manufacturer is faced with increasing the current capacity or using reduction gears.

The starter is a DC motor with high current requirements. Most fail because of low supply voltage — generally caused by poor cables, poor connections or a sick battery.

A surprising number of auto problems are caused by poor earth paths — which can produce anything from failure to start, to instrument panel fires.

I personally test earth connections with power on, using a voltmeter to check for any significant voltage drop. If there is any, the connection is bad...

Laymen should beware when 'tapping' their car's electrical system to run accessories. A lad I know powered his stereo booster amplifiers off the circuit that powered the car's computer. When he turned the boosters on, the fuse to the computer blew. A word to the wise...

Next time, we're going to take a look at maintenance. To keep an automobile in operating condition is just as important as in electronics, and involves scheduled routine maintenance and timely visual inspections. Weekly or monthly visual inspections are a must, and when a problem is found, fix it — now. It won't get better later, just cost more! ❖

FORUM

(Continued from page 43)

quency and phase response desired — as the R, L and C of a cable are directly related to the material and size of the conductors, their separation and the dielectric used. Not only would this technique lead to less guesswork about what cable may be best; it would probably lead to a much lower-cost solution.

Well, there you are. My thanks to Brendan Jones for sending in a copy of his report, and allowing me to reproduce from it. In some areas, I guess it either repeats some of the points that have been made by either other readers or myself in previous discussions, but by expressing them in a different way Mr Jones has contributed further clarification.

I don't know about you, but I was very interested to see the results of the measurements that Mr Jones was able to carry out, some of them using using quite esoteric and expensive equipment that few of us have access to. It's gratifying that his measurements basically backed up what my own intuition and experience have caused me to say all along: that the only objectively demonstrable 'critical parameters' of a speaker cable are that it should have a low resistance, and a reasonably high current-carrying capacity.

What did you think about Mr Jones' suggestion that it may be the slight increase in volume provided by some of the really 'huge' speaker cables, by virtue of their slightly lower resistance, that causes people to judge them as 'better'? Perhaps he's right — it's probably as likely an explanation as many I've heard, and it may explain why I myself simply couldn't hear what *I* regarded as any significant difference, when I compared the very expensive Cardas cables with cables consisting of 'doubled-up' heavy mains flex.

Mr Jones' suggestion of a possible follow-up experiment is also an interesting one. If the 'sound' of one of those really expensive cables could be simulated using a low-cost lumped parameter filter, even the platinum-eared brigade could save themselves quite a lot of brass — or even gold-plated, oxygen-free, single crystal copper!

And that's about all we have space for, this month. I hope you'll join me again next time, when we'll look at some other areas of interest and controversy.

I think we'll give fancy audio cables a rest for a while though, don't you? ❖

NEW KITS FOR EA PROJECTS

The following new kits have been released for recent *EA* projects:

LOW COST AUDIO SWEEPER (August-September 1992): Dick Smith Electronics has released a kit for this project. The kit includes all specified components, and features a pre-punched and silk screened front panel, a pre-punched rear panel with descriptive label, and a 12V plug pack. Also included are all of the electronic components for the measuring microphone — everything except the metal tubing. The DSE kit is listed by Cat. No. K-7352 and is priced at $109.00.

FLEXIBLE SPEAKER PROTECTOR (October 1992): Jaycar Electronics is releasing a kit for this project. The kit includes the PCB and all components except those for the optional power supplies, and features 1% resistors, MKT metallised polyester capacitors and a heavy duty relay with 10A contact rating. The Jaycar kit is listed by Cat. No. KA1745, and is priced at $29.95.

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

[illegible]

[illegible]

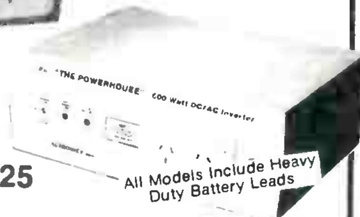
JET EXPRESS DELIVERY· AUSTRALIA WIDE

ALTRONIC COMPONENTS

Famous Altronics Inverters

Get 240V AC from your car, truck or boat battery. The Altronics range includes an inverter for nearly every application. Fantastic for camping, boating, farms and anywhere else 240V AC isn't available. Each size inverter is available in kit form or fully built and tested. The 300 and 600 Watt Inverters now feature new improved circuitry using multiple mosfet outputs making them even more reliable with a genuine 300 or 600 watt continuous power rating. Our latest model, the 1200 Watt Powerhouse offers excellent value for money and performance. It features crystal locked circuitry and a massive 2400 watt power surge making it ideal for small fridges, vacuum cleaners, power tools etc.
Any model an absolute necessity where 240V isn't available. Call Altronics today for more information on freecall 008 999 007.

300 Watt
K 6750 Kit Version **$279**
K 6755 Built-up **$379**



All Models Include Heavy Duty Battery Leads

600 Watt
K 6770 Kit Version **$499**
K 6774 Built-up 12V Input
K 6775 Built-up 24V Input **$625**

1200 Watt
K 6790 Kit Version **$799**
K 6792 Built-up 12V Input
K 6793 Built-up 24V Input **$999**

New Improved Models
These fantasic inverters now offer even better performance and reliability by utilizing new multiple Mosfet technology and circuit design.

300 Watt Economy Inverter

Amazing Low Price!

Turn 12V DC to 240V AC. This fantastic inverter will power lights, TV's tools, electric shavers and a whole host of other appliances. Great for camping, out in the bush and any place where 240V is not available. **Features:** • Complete with over current circuit breaker • Fused 240V output • Built in panel meter to monitor output voltage • panel meter to monitor output voltage • Strong steel case and chassis

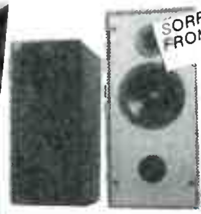
M 8120 **$249.00**

Vifa Speaker Kits

These kits use quality Vifa speakers made in Denmark and specially engineered enclosures for optimal performance. Black wood grain veneer make them ideal for any decor and situation. These two way models include high grade crossovers, speaker terminals and removable front grille. Simple construction with only basic tools and skill required. These kits are complete and include speaker cloth, damping material, grille clips, speaker terminals, screws and parts. Outstanding performance for the fraction of the cost of commercial equivalents.

VIFA SA-50
2 Way Bookshelf System,
50 Watts RMS
Normally ~~$399.00~~ pr
Now Only **$299.00** pr

SORRY — NOT AVAILABLE FROM ALTRONIC DEALERS AT THESE PRICES



VIFA SA-100
2 Way,
100 Watts RMS
Normally ~~$799.00~~
Now Only **$699.00** pr

Stereo Extension Ceiling Speaker Kit

Want a set of high grade extension speakers for the back patio, games room, den, workshop, kitchen? Well here at Altronics we have put together this great kit which includes speakers, grilles, cable, screws and even a wall mounted volume controller. The speakers are our high quality 4" C 0626 dual cone drivers, with stylish white grilles - ideal for mounting in the ceiling. Volume control mounts in standard electrical wall box and includes 6 volume settings as well as off. Includes 2 x 20m cable.

C 0988 Normally ~~$99.00~~, Now Only **$69.00**

Includes Speakers, Grilles, Volume Control & Even Cable!

Famous Vifa 5" Woofer

SAVE A HUGE 50%

We have a huge surplus of Vifa C13WG-08-08 woofers. These quality drivers offer high performance in both ported and sealed enclosures. Exceptionally smooth response useable up to 5kHz. Careful design and construction using rubber surround makes it possible to obtain an amazing 50 watts RMS power calabicity. Fantastic replacement or new construction speaker.

C 3110 Normally ~~$98.00~~ Now **$49.00**

6.5" Carbon Fibre Woofer

A fine driver using only high quality components and technology. For example barium ferrite magnets, revolutionary Kapton voice coil and unique carbon fibre cones. Because of the high water resistant structure of carbon fibre these speakers are ideal for boats and automotive use. Max input power 70 watts or 30 watts RMS. Resonant frequency 65Hz. See Altronics '92 catalogue for full details.

C 3034 Normally ~~$82.65~~
This Month Only **$59.95**

15" PECC Woofer

These Poly Emulsion Coated Cone (PECC) woofers offer excellent quality and performance. With a maximum power rating of 200 watts or 120 watts continuous and a frequency response down to 30Hz these drivers make an ideal sub-woofer or replacement bass speaker. Massive 2.5kg nett weight. See Altronics '92 catalogue for full details.

MASSIVE 120 WATTS RMS!

C 3032 Normally ~~$235.00~~
This Month **$169.00 ea**

Motorola Piezo Tweeter

This new bullet tweeter looks and sounds great. Genuine Motorola KSN 1165A. Features 400 watt maximum power capability frequency response 1.8kHz to 30kHz and SPL at 93dB (2.83v/1m). 91 x 91mm mounting hole centres. Specifications available on request. Simply wires in parallel to your woofer. No crossover or capacitor required. As it presents almost no load to your amp it doesn't effect the overall speaker system's impedance. Fantastic for hi-fi or disco speakers.

C 6160 **$39.95**

Weather Proof Monitor and Sound Column Speakers

This fantastic new range of monitors and columns just have to be heard to be believed. Designed by the Altronics engineer team with extensive consultation from audiophiles and architects, these speakers are absolutely ideal for hi-fi extensions and P.A. Constructed from rugged extruded aluminium and UV resistant plastic makes these units both weatherproof and built to last. The drivers used are 4" carbon fibre with an inbuilt coxial tweeter. Ported design makes bass response incredibly smooth and deep.
Two sizes available, 30 and 60 watts RMS, in a black or white powder coat finish. Mounting these speakers are made easy by employing the new "Wacki" bracket system. Call Altronics today for a free colour brochure.

30 Watt Monitor Series
C 0924 8 Ohm White
C 0925 8 Ohm Black **$149.00 ea**
C 0927 100 Volt Line White
C 0928 100 Volt Line Black **$160.00 ea**

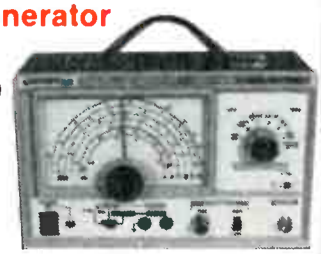
60 Watt Column Series
C 0936 100 Volt Line White
C 0937 100 Volt Line Black **$245.00 ea**

Audio Frequency Generator

Specifications:
Frequency: 10Hz - 1MHz
Accuracy: +/-3% + 2 Hz
Output Waveforms: Sine/Square
Output Level:
Sine: 8V rms
Square: 10V P-P
Output Attenuator: -20dB, -40dB and fine adjust

Q 1540 Normally ~~$325.00~~ Now **$250.00**

RF Signal Generator



With provision for internal and external modulation.
Specifications: Frequency Range: 100kHz - 150MHz in 6 ranges **RF Output Level:** 100mV rms
Accuracy: +/-3%
Modulation: • Internal (30% depth): 1kHz •
External: 50Hz-20kHz •
Crystal Locked Oscillator

Q 1550 Normally ~~$299.00~~ Now **$225.00**

Universal Wacki Bracket

Proudly Made In Australia

Yet another Altronics innovation, proudly designed and made in Australia. These great new speaker mount brackets simply screw onto the wall and speaker allowing a universal 50° angle of adjustment. Suitable for speakers up to 5kg. No special tools required. Available in white or black. A must for any extension speaker.
H 8010 White
H 8012 Black **$39.95 pair**

PHONE ORDER TOLL FREE 008 999 007

Experimenting with Electronics

by PETER MURTAGH

Electronic thermometer

Last month's project, our LED 'loudness display', can be easily adapted to display changes in temperature. How warm is your room, how hot is your bath water? Build this circuit, and you can find out!

The five LEDs in last month's project lit up in turn as the sound picked up by the microphone became louder — to turn on each extra LED required a further 0.5V increase in the output. This month we will re-use the same LED display circuit, but to sense the temperature differences we will use a thermistor — a new component to this series.

As with last month's circuit, the signal from the sensor needs to be amplified, but this time we will use a DC amplifier instead of an AC one. You will find, if you compare this and last month's schematic diagrams, that despite looking very much the same on first inspection, the feedback arrangement for the two amplifiers is really quite different.

We have also made some minor changes to the LED display section — diode D1 no longer needs to feed into a capacitor to smooth its rectified AC signal, and each of the five LEDs now has its own current-limiting resistor. While this latter modification is not really necessary, it does make the LEDs glow a little bit brighter since they no longer have to share a fixed current.

The use of a thermistor is interesting, because normally we have to stabilise our circuits to *overcome* current changes caused by changing temperature — such changes are usually regarded as a problem. However, we have chosen a thermistor as the sensor for this project precisely because it *is* sensitive to temperature changes. A 'thermistor' is literally a temperature-sensitive resistor ('therme' is the Greek for heat).

Data for thermistors is quoted as their resistance at 25°C. Quite often, some indication of how much they vary will also be given. For example, the thermistor we used (DSE Cat. R-1797) is a 100k thermistor, with a -5.2% change per degree Celsius. Recognise its colour coding (reading from the leads)? — brown-black-yellow.

The quoted percentage resistance variation is only an approximation, since the resistance change is not linear with temperature. But we can work out that our sensor will vary from about 230k-30k as the temperature varies from 5°- 50°C.

Note that the resistance *decreases* as the temperature *increases*, which is the opposite to a normal ohmic resistor. Such a thermistor is called an NTC thermistor (Negative Temperature Coefficient), and this explains the *minus* 5.2% change given in the Dick Smith data. (Positive temperature coefficient thermistors also exist.)

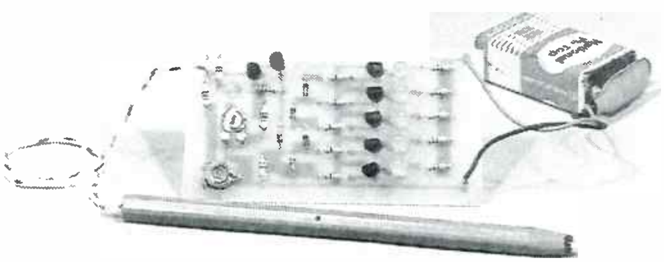
We have used this thermistor resistance change to alter the voltage at the base of transistor Q1, so that the amplifier built around transistors Q1 and Q2 will increase its output as the temperature increases. We have added trimpot RV1 so that you can adjust the point at which the first LED turns on (the start of your temperature range), while trimpot RV2 allows you to alter the gain of the amplifier (the total temperature range covered from 'no LEDs on' to 'all LEDs on').

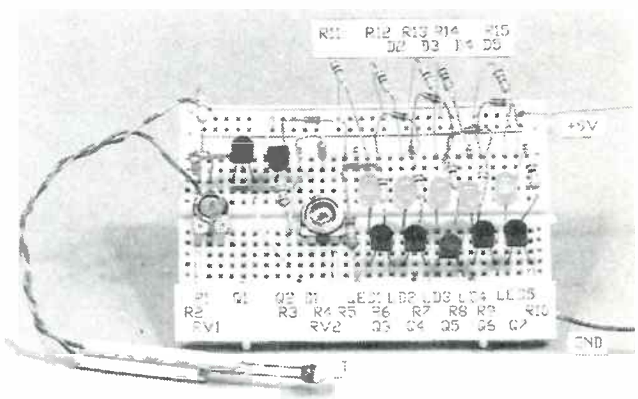
By varying the two trimpots, we had no trouble in calibrating our 'thermometer' for two different temperature ranges: 5°-30°C (typical room temperatures), and 10°-50°C (typical tap water temperatures: cold water in winter and ordinary domestic hot water).

Construction

If you have already built last month's 'loudness detector' circuit, and wish to convert it to measure temperature change, you only have to add the DC amplifier section — shown on this month's schematic diagram to the left of diode D1.

You will also have to modify the original circuit by cutting the tracks between the collector of transistor Q2 and D1, and between capacitor C3 and D1. The output of your new amplifier will then be fed into the top (positive end) of diode D1.





***Right:** If you can't see all the connections on this breadboard layout for the circuit, refer to the schematic diagram for more details.*

[illegible]

Experimenting

If you are building the whole circuit from scratch (which the component list and the rest of this article will assume), then start your construction.

Solder the components in the usual order, with the more rugged components first: resistors, diodes (including the LEDs), transistors and finally the thermistor. Take the usual care with the polarised components.

Refer to Fig.3 to identify which lead is which for the LEDs, diodes and transistors. As in last month's project, Q2 is the only PNP (BC558) transistor — the rest are NPNs (BC548). The thermistor is not polarised, so its leads can be inserted either way.

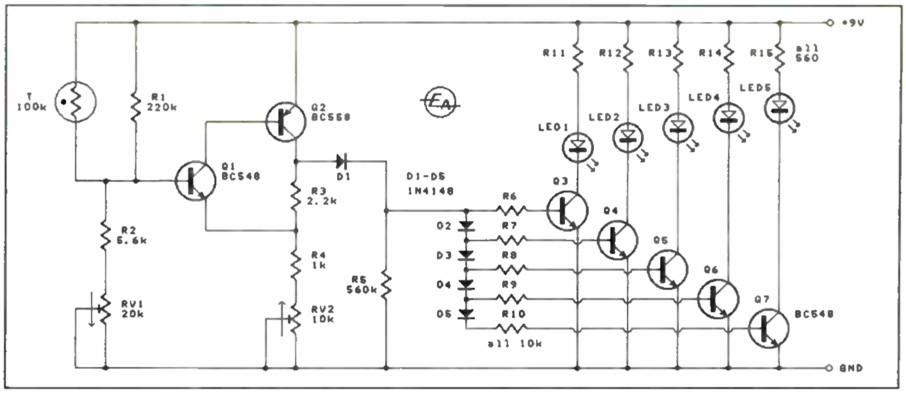
If you only intend to measure air temperature, then you can solder the thermistor directly to the PCB. But you will probably want to measure water temperature as well, so you need to waterproof the sensor. (When our thermistor accidentally got wet, its resistance dropped from its normal 100k to about 1k — which turned all five LEDs fully on. And it took a few days to fully dry out and regain its correct resistance. So take care!)

Very simple waterproofing can be done by wrapping the thermistor in thin plastic sandwich wrap. Make a funnel shape in the wrap and insert the thermistor. Then use an elastic band to tie in the top edges of the plastic.

However, this approach didn't prove to be very satisfactory. It proved difficult to completely seal the plastic, so the water sometimes leaked in. Also, the plastic layers made the sensor a lot slower to react to temperature changes.

A better probe can be made by sealing the thermistor into the plastic casing of an old ball-point pen (as shown in the photo of our PCB design).

This method is more sensitive, since the head of the thermistor makes direct contact with the water whose temperature we want to measure, and the water itself is kept well clear of the thermistor's base and leads where it can interfere with its resistance.



The changing resistance of thermistor 'T' affects the bias on transistor Q1. Trimpots RV1 and RV2 set the start and range of the temperature scale (arrows show trimpot clockwise rotation).

Calibrating

Once you have completed your circuit, you then have to adjust the temperature range to suit your requirements. Use RV1 to set the start of your range, and RV2 to set the extent of the range. Unfortunately, the two settings interact, so you will need to adjust each trimpot a few times after altering the other one.

If you wish to calibrate your circuit quite accurately, you will find that a laboratory-type thermometer will come in very handy. In the absence of a thermometer, you can use a cold water/ice block mixture (keep adding ice until it no longer melts) to give 0°C, while the hottest water from a hot water tap is usually about 50°C.

Start the calibrating process by setting both trimpots to approximately mid positions. Then insert your temperature probe in the cold water (or cold air, if you have not waterproofed your sensor).

Turn RV1 anticlockwise to gradually turn off the LEDs, or clockwise to turn them on. Set the first LED as desired for the lower end of your temperature scale — fully off, just starting to glow, or fully on.

Next use your hot water to turn the LEDs on. If they turn on too quickly, then the gain of the DC amplifier is too high. Turn it down, by adjusting RV2 anticlockwise. Of course, if the probe reaches its top temperature and all the LEDs are not yet on, make a clockwise adjustment to increase the gain.

If you had to decrease the gain (by increasing the resistance of RV2), then a side effect of this adjustment is that you have also decreased Q1's base current. You will find, when you re-check your lower temperature limit, that you will need to turn RV1 slightly clockwise to compensate.

Similarly, increasing the gain increases the brightness of LED1 at its starting point — which is another way of saying that your scale now starts at a lower temperature than your requirement.

Hence, after adjusting either RV1 or RV2, you will have to adjust the other trimpot. We used two cups for the cold and hot water standards, side by side, and alternately dipped the probe into each. After several 'ups and downs', we were able to calibrate the scale as required.

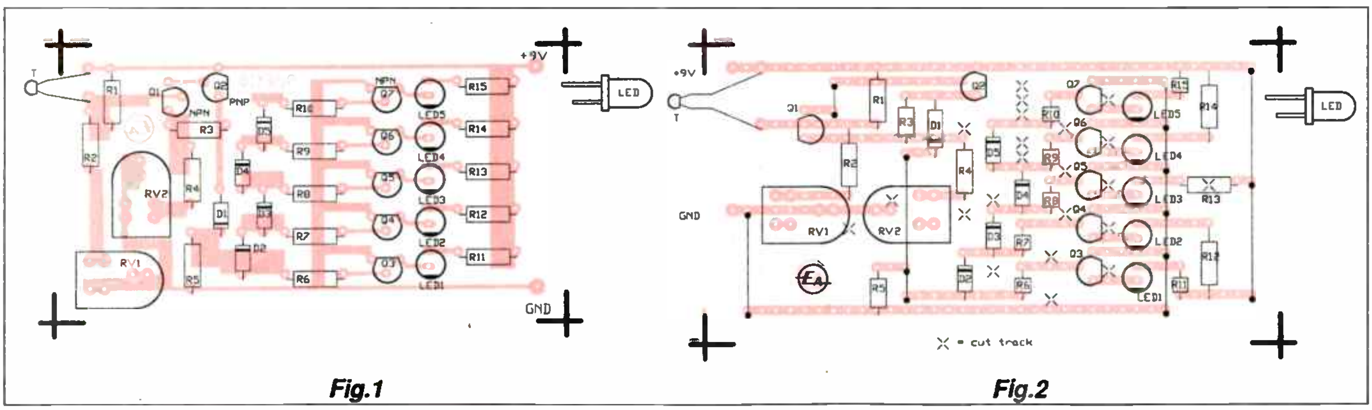
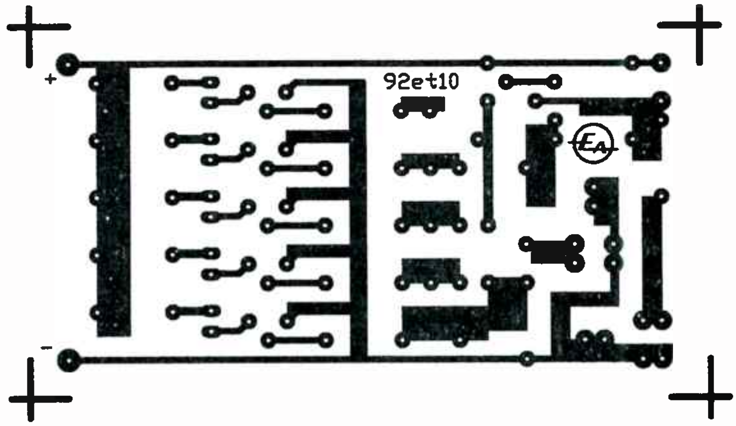


Fig.1: The component layout on the printed circuit board. Note that Q2 is the only PNP transistor — the rest are NPNs. Fig.2: The stripboard layout. Make certain that you break the copper tracks at all the 'cut track' positions.

[illegible]



The PCB pattern is shown actual size to allow experimenters, if they wish, to make their own boards.

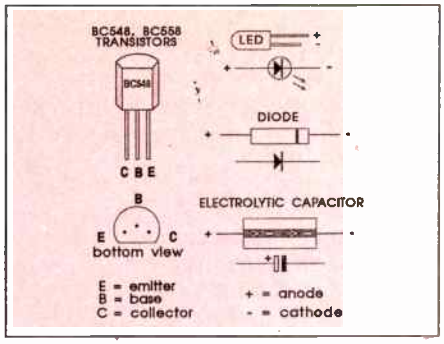


***Fig.3:** The component leads identification diagram for the polarised components used in the circuit.*

Changes

The values of the two trimpots and their associated resistors (RV1+R2, RV2+R4) have been chosen to allow the temperature scale to vary from about zero to 60°. This should allow sufficient variation for most applications. However, you can further increase the temperature range by increasing the value of R4 and/or decreasing R3 (decreasing the gain) — or vice versa. However, if you reduce the value of R4, remember that R4 can be the only resistor which limits both the emitter current of Q1 and the base current of Q2. So don't make its value too small or your transistors could burn out!

You can also further adjust the starting temperature. If you have turned RV1 fully anticlockwise and LED1 is still too bright (or too many LEDs are on), then reduce the value of resistor R2. The smaller the combined resistance of R2 +RV1, the smaller the voltage at the base of transistor Q1.

Resistors R11-R15 determine the brightness of the LEDs. Our 560 ohms value gives a current of about 13mA. If you want them brighter (and are not using a battery), then decrease the value below 560, perhaps to 470 or even 390 ohms; and if you are using a battery, then make it last longer by decreasing the brightness, and increase the resistance to 1.2k, or even 1.5k.

PARTS LIST

Miscellaneous

PCB 90x50mm, coded 92et10
9V battery
5 LEDs, any colour
hookup wire, solder, etc.

Resistors

All 1/4W, 5%

1	220k	R1	red-red-yellow
1	5.6k	R2	green-blue-red
1	2.2k	R3	red-red-red
1	1k	R4	brown-black-red
1	560k	R5	green-blue-yellow
5	10k	R6-R10	brown-black-orange
5	560 ohm	R11-R15	green-blue-brown
1	20k trimpot	RV1	horiz. mount
1	10k trimpot	RV2	horiz. mount

Semiconductors

1	100k	NTC thermistor	
5	1N4148	signal diodes	D1-D5
6	BC548	NPN transistor	Q1,Q3-Q7
1	BC558	PNP transistor	Q2

How it works

As mentioned earlier, the resistance of thermistor T decreases as the temperature rises. Since the thermistor is connected between the positive supply rail and the base of transistor Q1, this decrease in resistance results in a smaller potential drop across T. Because of this, the voltage drop across the base-emitter junction of Q1 increases — so its base current increases, causing its collector current also to increase. This in turn causes increases in transistor Q2's base and collector currents.

As a matter of fact, we have 'padded' the thermistor T with a 220k resistor R1. By connecting R1 in parallel with T, we can make the resistance variation more linear, but connecting R1 this way also reduces the total change in resistance from 30k-330k to 27.5k-104.5k. This reduction comes in handy, since it allows us to extend our temperature scale up to 60° — its effect is equivalent to reducing the gain of the amplifier.

Notice the arrangement of the main load resistance for transistor Q2 — series resistors R3+R4+RV2. These resistors form a potential divider, with a tap back to the emitter of transistor Q1. This connection provides negative DC feedback, because an increase in the voltage at the join of resistors R3 and R4 results in a decrease in the voltage applied across Q1's base- emitter, and hence a decrease in the current to be amplified by Q1/Q2. Check these calculations for yourself, assuming that transistor Q2 is turned hard on and the voltage at its collector is 9V: if trimpot RV2 is turned fully clockwise, the voltage at the emitter of Q1 will be 2.8V, and if fully anticlockwise, 7.5V. So the first position gives minimum feedback and greatest DC gain, while the second gives the exact opposite. If the gain is at its greatest, then it will take the smallest temperature range to turn all five LEDs on.

We have set up the circuit so that turning RV2 clockwise increases the brightness of the LEDs. Hence, if you want a larger temperature scale, then decrease their brightness to take longer for them all to turn on; and vice versa.

We will only briefly describe the operation of transistors Q3-Q7 which drive the five LED display. (If you want more detail, refer back to last month's issue.)

As the collector voltage of transistor Q2 increases, that voltage is applied to the bases of the five driver transistors along the diode chain, D1-D5. Since the voltage drop across each diode is about 0.6V, it takes approximately an extra 0.6V to turn each extra LED on. This voltage drop is slightly larger than in last month's circuit, because the base currents in transistors Q3-Q7 are larger (this was explained in more detail last month).

In practice, our measurements showed that if the collector voltage of Q2 was <0.9V no LED was on, and if it was >3.8V all five LEDs were on. But the increase was not linear — there was a 0.45V difference between the first and second LEDs, but 0.7V between the fourth and fifth.

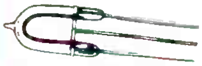
Transparencies

A high contrast, actual size transparency (negative) for the PCB used in this circuit is available for only $2. This will allow you to etch your own printed circuit board. This special price applies for transparencies for all projects in this series only. Write to *EA*'s reader services division.

Happy experimenting — and please send us your comments on the circuits we have published, as well as ideas for future projects. ❖

[illegible]

DISCOUNT COMPONENTS



XENON/STROBE TUBES
As used in projects or as replacement.
S14050.................$3.95

CHROME LED BEZELS
9 mm hole, available 3 colours
S14030 Red.........$1.20
S14032 Green.....$1.45
S14034 Yellow....$1.45

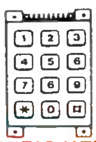
GREY FLAT RIBBON CABLE

cat no.		$/Mtr
W12614	14way	$1.90
W12616	16way	$2.20
W12620	20way	$2.50
W12624	24way	$2.90
W12625	25way	$3.20
W12626	26way	$3.60
W12634	34way	$3.90
W12636	36way	$3.90
W12640	40way	$4.90
W12650	50way	$5.90
W12660	60way	$6.90

10 TURN WIRE WOUND POTENTIOMETER
Spectrol Model 5341/4" shaft. Equivalent (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 R14080 1K
R14090 2K

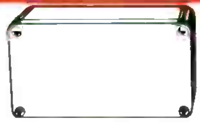
1-9	10+
$12.95	$10.90

R14130 50K.............$16.95
R14140 100K...........$15.95



NUMERIC KEYPAD
Unencoded keypad, 10 digit keys plus two utility keys. Light grey in colour.
OUTPUT ARRANGEMENT:
Output Pin No. Symbol
1......................N.A.
2......................Shield plate
3......................Column 2
4......................Row 1
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



DIE CAST BOXES
Diecast boxes are excellent for RF sheildingand strength.
Screws are provided with each box.
H11451
100 x 50 x 25mm........$8.95
H11452
110 x 60 x 30mm........$9.50
H11453
120 x 65 x 40mm.......$10.50
H11461
120 x 94 x 53mm......$13.95
H11462
188 x 120 x 78mm....$15.95
H11464
188 x 188 x 64mm....$29.50

GENERAL PURPOSE TRANSISTORS
PN100: a NPN general purpose medium power amp and switch with continuous collector current up to 500mA.
PN200: a PNP general purpose amp at collector currents to 1 AMP.
Both are TO-92 plastic package.

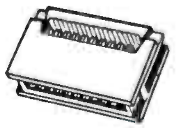
PN100 REPLACES:
PN2221, PN2222, PN2222A, PN3585, PN3568, PN3569, PN3643, PN5133, 2N2219A, 2N2222A, 2N3414, 2N3415, 2N3416, 2N3417, 2N3700, 2N3704, 2N3904, 2N4123, 2N4124, 2N4401, 2N5088, 2N5210.

PN200 REPLACES:
PN2907, PN2907A, PN3638, PN3638A, PN3640, PN3644, PN4121, PN4143, PN4248, PN4249, PN4250, PN4355, PN4916, PN4917, PN5910, 2N2905A, 2N3467, 2N3702, 2N3906, 2N4125, 2N4126, 2N4291, 2N4402, 2N4403, 2N5086, 2N5087, 2N5447.
PN100......T90001
PN200......T90002

1-9	10+	100+
$0.20	$0.18	$0.15

SUPER BRIGHT LEDS
- RED.................Z10146
- GREEN...........Z10147
- YELLOW........Z10148

1-9	10+
$1.00	$0.90

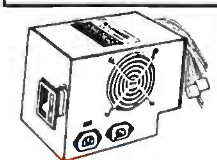


CARD EDGE CONNECTORS
1" SPACING

P12060	10pin	$3.95	$3.50
P12062	20pin	$4.25	$3.75
P12064	26pin	$4.50	$3.95
P12066	34pin	$4.95	$3.95
P12068	40pin	$5.95	$4.95
P12070	50pin	$6.95	$5.95

DIODES
BUY IN BULK & SAVE!

Cat No.		10+	100+	1000+	10K
Z10135	IN4148	$0.05	$0.04	$0.03	$0.02
Z10105	IN4002	$0.06	$0.05	$0.04	$0.03
Z10107	IN4004	$0.08	$0.06	$0.05	$0.04
Z10110	IN4007	$0.10	$0.07	$0.06	$0.05
Z10115	IN5404	$0.18	$0.14	$0.13	$0.11
Z10119	IN5408	$0.20	$0.16	$0.15	$0.14



POWER SUPPLIES
XT P.S 150W..........$139.00
FULL TOWER
220W P.S...............$149.00
MINI TOWER
200W P.S...............$89.00
BABY AT
P.S 200W................$89.00
SLIMLINE BABY AT
P.S. 200W...............$89.00

BREAD BOARDS
This inexpensive range of modular interlocking units enables a quick easy way of experimenting with new circuits and ideas. There are two main units consisting of a terminal strip or distribution and a central plug in unit.
- 100 holes.
P11000................$2.75
- 840 + 100 holes
P11007...............$14.95
- 1280 +100 holes
- P11010............$26.95
- 2560 + 700 holes
- P11018.............$69.95

COMPUTER CABLES
- Six conductor shielded computer interface cable.

W12670 • CIC6 6 con.

1-9M	10M+	100M+
$1.30M	$1.10M	$1.00M

W12672 • CIC9 9 con.

1-9 M	10M+	100M+
$1.60M	$1.50M	$1.20M

W12674 • CIC12 12 con.

1-9M	10M+	100M+
$2.50M	$2.20M	$1.90M

W12676 • CIC16 16 con.

1-9M	10M+	100M+
$3.50M	$3.20M	$2.50M

W12678 • CIC25 25 con.

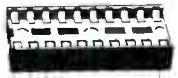
1-9M	10M+	100M+
$3.90M	$3.40M	$3.00M

NICADS
Save a fortune on expensive throw away batteries with these quality Nicads and Rechargers!

	1-9	10+	100+
Size AA 450mAH	$2.95	$2.75	$2.50
Size C 1.2 A H	$9.95	$9.50	$8.95
Size D 1.2 A H	$9.95	$9.50	$8.95

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

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



WIRE WRAP IC SOCKETS
These quality 3 level wire wrap sockets are tin plated phosphor bronze.

		1-9	10+
P10579	8pin	$1.50	$1.40
P10580	14pin	$1.85	$1.70
P10585	16pin	$1.95	$1.80
P10587	18pin	$1.95	$1.80
P10590	20pin	$2.95	$2.75
P10592	22pin	$2.95	$2.70
P10594	24pin	$3.95	$3.50
P10596	28pin	$3.95	$3.50
P10598	40pin	$4.95	$4.50

WOW! WHAT PRICES!

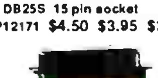
IDC PLUGS & SOCKETS
WOW ! FROM $1.00

D TYPE IDC PLUGS

	1-9	10+	100+
• DE9P 9pin plug			
P12166	$1.50	$1.20	$1.00
• DA15P 15pin plug			
P12168	$1.50	$1.20	$1.00
• DB25P 25 pin plug			
P12170	$4.50	$3.95	$3.50

D TYPE IDC SOCKETS

	1-9	10+	100+
• DE9S 9 pin socket			
P12167	$1.50	$1.20	$1.00
• DA15S 15 pin socket			
P12169	$1.50	$1.20	$1.00
• DB25S 15 pin socket			
P12171	$4.50	$3.95	$3.50



IDC CENTRONICS 36 WAY PLUG & SOCKET

	1-9	10+	100+
• Plug P12200	$3.95	$3.00	$2.95

• Socket P12201

ECONOMY TRANSFORMERS

	1-9	10+
2155 240V 6-15V 1A M12155	$8.95	$7.95
2156 240V 6-15V A2 M12156	$13.95	$12.95
2851 240V 12-6V CT 250mA M12851	$4.95	$4.50
6672 240V 15 30vc 1A tapped M16672	$12.95	$11.95

12V DC FANS
80 x 80 x 25.4mm
12V DC. 1.7 Watt 0.14 Amp
T12469...............$18.95
10+ fans, only $17.95

FANS
Quality fans for use in power amps, computer hotspot cooling etc.
Anywhere you need plenty of air.
240V 4 5/8" T12461..$16.95
115V 4 5/8" T12463..$16.95
240V 3 1/2" T12465..$16.95
115V 3 1/2" T12467..$16.95

TOGGLE SWITCHES

		1-9	10+
S11010	S.P.D.T	$1.20	$1.10
S11020	D.P.D.T	$1.30	$1.20

ICB VOLTAGE REGULATORS BARGAINS

Description	1-9	10+	100+
7805UC	$0.50	$0.45	$0.40
7812UC	$0.50	$0.45	$0.40
7815UC	$0.50	$0.45	$0.40
7905UC	$0.60	$0.55	$0.50
7912UC	$0.60	$0.55	$0.50
7915UC	$0.60	$0.55	$0.50
78L05	$0.40	$0.30	$0.28
78L12	$0.40	$0.30	$0.28
LM324	$1.00	$0.90	$0.80
555	$0.40	$0.38	$0.33
741	$0.50	$0.45	$0.39

9 PIN D SWITCH BOXES
2 WAY................$59.95
4 WAY................$69.95
MONITOR & KEYBOARD SWITCH BOXES $69.50

MINIATURE HOBBY VICE
- Lever operated suction base grip for instant mounting & portability.
- Mounts on smooth non-porous surfaces
- Ideal for holding & other small objects .

T12458.........................$6.95

PC BOARD HOLDER
Better than an extra pair of hands
A must for all PCB work.
T12444..............$9.95

QUALITY 3mm LEDS

	1-9	10-99	100+	1K
1000+				
Z10140(R)..	$0.15	$0.12	$0.10	$0.08
Z10141(G)..	$0.20	$0.18	$0.15	$0.12
Z10143(Y)..	$0.20	$0.18	$0.15	$0.12
Z10145(O)..	$0.20	$0.18	$0.15	$0.12

QUALITY 5mm LEDS

Z10150(R).	$0.15	$0.12	$0.10	$0.08
Z10151(G).	$0.25	$0.20	$0.18	$0.12
Z10152(Y)..	$0.25	$0.20	$0.18	$0.12

FLASHING LEDS

RED 5mm	1-9	10+	100+
Z10159	$1.10	$1.00	$0.80

RECTANGULAR LEDS

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

DB25 CONNECTOR SPECIALS

		1-9	10+	100+
P10880	DE9P	$1.00	$0.80	$0.60
P10885	DE9S	$1.00	$0.70	$0.60
P10891	DA15S	$1.00	$0.70	$0.60
P10892	DA15C	$1.00	$0.90	$0.60
P10895	DA15S	$1.00	$0.80	$0.60
P10902	DB25C	$1.00	$0.80	$0.60
P10904	DB25P	$1.00	$0.80	$0.60
P10905	DB25S	$1.00	$0.80	$0.60

MOSFET SPECIALS

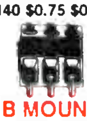
	1-9	10+	100+
2SJ49	$9.50	$8.00	$7.00
2SJ56	$10.00	$9.50	$8.50
2SK134	$8.50	$8.00	$7.00
2SK176	$9.50	$8.90	$ 6.90
2SJ50	$9.50	$8.50	$7.00
2SK135	$9.50	$8.50	$7.00

ELECTRET MIC INSERTS
With pins for easy board insertion. C10170

1-9	10-99	100+	1000+
$1.20	$1.00	$0.90	$0.70

TRANSISTORS BUY IN BULK & SAVE!

	1-9	10+	100+
BC 547	$0.15	$0.10	$0.07
BC 548	$0.15	$0.10	$0.07
BC 549	$0.15	$0.10	$0.07
BC 557	$0.15	$0.10	$0.07
BC 558	$0.15	$0.10	$0.07
BC 559	$0.15	$0.10	$0.07
BC 327	$0.20	$0.15	$0.12
BC 337	$0.20	$0.15	$0.12
BD 139	$0.75	$0.60	$0.50
BD 140	$0.75	$0.60	$0.50



PCB MOUNTING SCREW TERMINALS
(INTERLOCKING ENDS)
These terminals feature interlocking ends to form any number of connections. Standard 5mm spacing pins.

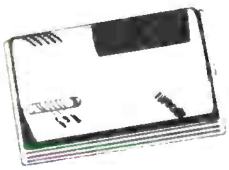
P10520	2way	
1-9	10	100+
$0.75	$0.70	$0.60
P10521	3 way	
$1.00	$0.90	$0.80

ROD IRVING ELECTRONICS
MAILORDER HOTLINE: 008 33 5757

[illegible]

ARLEC 24 HOUR MULTIPURPOSE TIME SWITCH

Multi-purpose is the key word when it comes to this product!
Not only will it provide home security by turning on your lights and electrical appliances giving the illusion that you are still home, but it can also turn your electrical heating and cooling appliances on & off automatically so that you can wake up or come home to a warm or cool house.
And just think of the advantages of being able to record radio programs while your not even home.
This timer switch automatically switches appliances
On & Off up to 24 times each day!
M21900......................$35.95



MOTION ACTIVATED ENTRY ALARM

A handy little device which announces visitors and protects property with a loud alarm or soft chime when the beam of protection is crossed. Great for home security, apartments and people who travel and stay in hotel rooms to protect them from intruders.
Can also be used for store entries, offices, basement stairs and garages. Great for providing a warning for children around pool areas and other places where they can be in danger.
SPECS:
- 9 volt battery required (not included)
- Instant chime: one sound per entry
- ALARM: 10 second exit delay after turning on.
- Alarm sounds for 30 seconds (85db at 3 feet) and then automatically resets.
- Includes screws,wall anchors and two sided tape.

S15074......................$64.95

RUN WINDOWS 15 TIMES FASTER WITH THE PARADISE ACCELERATOR CARD FOR WINDOWS

A super VGA display adapter designed for users of Windows and CAD applications. It accelerates the performance of Windows & Windowing programs by up to 15 times that of a standard VGA.
It even outperfoms some costly VRAM based accelerator cards.
Opening, closing, scrolling and resizing of windows are instantaneous!
It has the latest VGA standards. This means accelerated, high resolution graphics displayed with a palette of up to 32,768 colours.
Comes packaged with software utilites and drivers.
- 1 MByte of on-board Memory
- Emulates IBM PS/2, VGA, MCGA, CGA, MDA, & Hercules display adapters.

X18083.....................$325.00

TWO-METER HAND HELD TRANSCEIVER

LOOK AT ROD'S NEW TOY!

With a frequency coverage of a full 144-148 MHz.
- Power supply is a 9.6v D.C. nicad pack & a 240 volt charger is supplied

Desktop charger is an optional extra.
TRANSMITTER
- Output power is 2.5 watts in the HIGH conditions & 1 watt with LOW output. Operates in both SIMPLEX & DUPLEX modes at 600 KHz above or below the receive frequency.

RECEIVER
Sensitivity is more than 1.2dB at 0.35uV. Audio output power is 300 mW / Output Impedance of 8 ohms.
Similar units sell for $499 (LCD Digital readout)
OUR PRICE $295.00
Desk 240V Battery Charger $99..00

VIDEO BLASTER

"YOU AIN'T SEEN NOTHIN' YET!"

The Video Blaster is the next logical step in multimedia. Just imagine being able to integrate video and audio source from laser disc, VCR, or camera, and combine VGA graphics into a brand new psychedelic world of multimedia presentations.
Video blaster supports lifelike colours on your standard VGA monitor.
The characteristics of Red, Green & Blue - brightness, contrast, hue - can be controlled: stereo audio volume can also be individually mixed via the software.
With Video Blaster, video images can be digitized and captured through the Video Blaster for use with other programs for storage, presentation, and even animation! Experience the thrills and ease of graphics overlayed with video sources through the Video Blaster.
Cropping, scaling, masking and zooming are standard features supported by the Video Blaster.
X17040...$799.00

WOW! ONLY $159.00 FOR A SOUND CARD!

MORE COMPATIBLE, MORE FEATURES, MORE UPGRADES, MORE SOFTWARE.

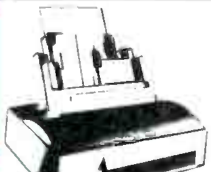
Sound Commander fx is not just compatible to * Adlib, • Sound Blaster and * Cover Speech Thing, IT HAS MORE!
• Optional full stereo • Karaoke Mixing capability with echo effect • Full MIDI interface • Remote Control Expansion • Programmable functions.
Upgradeable to 22-voice True Stereo
The Sound Commander fx is built with an extra socket for you to plug in another *YAMAHA FM synthesizer chip to upgrade it to full stereo with 22-voice. It's that simple to get stereo when you want it.
Karaoke Mixer with Echo Mic Input is directed tom the power amplifier for Karaoke mixing with echo effects
DSP RAM Buffer
8K DSP RAM for PCM digitized sound and MIDI output. Programmable for updating functions and storage of digitized instruments.
MIDI Interface
Standard UART interface with 8K DSP RAM buffer built-in to connect MIDI instruments directly (No MIDI Box or Adaptor required)
Digital to Analog Convertor
*Sound Blaster Compatible in mono mode. Digitized Music, Voice and sound effects are played back in full stereo with selectable sampling rates of 4K -44.1K.
Analog to digital convertor
Plus a FREE pair of Dynamic Speakers
Bundled Software. • CD Studio • Karaoke Software • SoundTrack Utilities
• Show Partner™ Lite:- Friendly presentation software with powerful effects. Will work with SoundTrack to produce slide shows or full fledge animation with digitized sound and FM Music.
only $159.00

The Little Squrit BJ-10 ex

Printing Speed	
High Quality	83cps (10cpi)
High Speed	83cps (10cpi)
Print Width	203mm
Resolution	Up to 360 x 360 dpi
Built-in Fonts	Courier, Prestige, Elite
Dimentions (w x d x h)	310mm x 216 x 48mm
Weight	Approx. 1.8kg AC

C22218.................................$589.00

BJ300 Bubble Jet Printer



Printing Speed:	
High Quality	150cps (10cpi)
High Speed	300cps (10cpi)
Print Width	203mm
Resolution	Up to 360 x 360 dpi
Built-in Fonts	Courier, Prestige, Gothic
Weight	Approx. 6.9kg

C22226........................$1049.00

BJ330 Bubble Jet Printer

Printing Speed:	
High Quality	150cps (10cpi)
High Speed	300cps (10cpi)
Print Width	340mm
Resolution	Up to 360 x 360 dpi
Built-in Fonts	Courier, Prestige, Gothic
Weight	Approx. 8.8 kg

C22227..................................$1195.00

ROD IRVING ELECTRONICS

MELBOURNE: 48 A'Beckett St. Ph: (03) 663 6151.
Computer sales: Ph 639 1640. FAX: (03) 639 1641
NORTHCOTE : 425 High St. Ph: (03) 489 8866
FAX: (03) 489 8131
OAKLEIGH: 240C Huntingdale Rd, Ph: (03) 562 8939
SYDNEY: 74 Paramatta Rd. Stanmore. N.S.W.
Ph: (02) 519 3134 or (02) 565 1458, FAX: (02) 516 5024
ADELAIDE: 241-243 Wright St, Adelaide. Ph: (08) 2117200
MAIL ORDER: 56 Renver Rd, Clayton Vic, 3168
Ph: (03) 543 7877 FAX ORDERS: (03) 543 2648
Mail Order Hotline: Ph: 008 33 5757
DEALERS: BLUESTAR COMPUTERS
(Computer Products only)
MELBOURNE: 217 Maroondah Hwy, Ringwood.
Ph: (03) 870 1800
SYDNEY: 115-117 Parramatta Rd, Concord. Ph: (02) 744 5526
MAIL ORDER & CORRESPONDENCE
P.O BOX 620, CLAYTON, VICTORIA, 3168.

QuickShot™

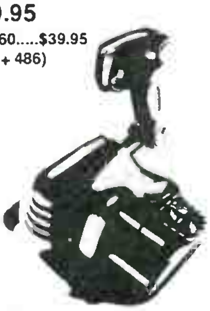
AVIATOR 5

- AUTHENTIC AIRCRAFT CONTROL YOKE
- AUTOMATIC CONTROL YOKE CENTERING
- COMPATIBLE WITH IBM PC, XT AT AND 386*
- 4 POSITIVE RESPONSE FIRE BUTTONS
- REALISTIC ALTITUDE/LEVEL INDICATOR
- 2 DUAL-SPEED TURBO FIRE BUTTONS
- X-AND Y-AXIS TRIM CONTROL SWITCHES
- 6-FOOT CABLE WITH 15-PIN CONNECTOR
- STABILIZING SUCTION CUPS
- 6 U.S MILITARY INSIGNIA STICKERS

C14250........................$89.95

* Requires Smart Games Card...C14260.....$39.95
(YOU HAVE TO USE THESE IN A 386 + 486)

INTRUDER 5



- OMNIDIRECTIONAL GRIP
- COMPATIBLE WITH IBM PC, XT, AT AND 386*.
- AUTOMATIC CONTROL STICK CENTERING
- 2 POSTIVE RESPONSE FIRE BUTTONS
- 2 DUAL-SPEED TURBO FIRE SELECTORS
- POP-UP FIRE BUTTON COVER
- X AND Y- AXIS SWITCHES
- 6-FOOT CABLE WITH 15-PIN CONNECTOR
- STABILIZING SUCTION CUPS
- 6 U.S MILITARY INSIGNIA STICKERS

C14240..............$79.95

* Requires Smart Games Card C14260....$39.95

SMART GAMES CARD

SUPPORTS 4.77 TO 80MHz

Complete with Calibration software
FEATURES:
- Intelligent software controlled game card
- Compatible with IBM PC/XT/AT/386/486
- Complete with easy-to-use menu driven calibration software on 5.25" floppy diskette
- Software selectable clock speed - from 4.77 to 80MHz
- Automatic clock speed adjustment for advanced users
- Hot-key program for fine-tuning clock speed during game
- 2 15-pin joystick port-supports 1 or 2 joysticks operation

C14260.................$39.95

STOP PRESS!

ADELAIDE STORE NOW OPEN: 241-243 WRIGHT ST, ADELAIDE. PH: (08) 211 7200. FAX: (08) 211 7273

QuickShot™

QUICKTRAC 100

A new concept in Mice!
What do you do when you haven't got enough room on your desk to use a mouse?
You get a Quicktrac 100.
The latest innovation in mice technology. Unlike a normal mouse the Quicktrac does not require any operating space other than that taken up by its tiny footprint.
You simply have to use your fingers to control the curser rather than move your whole hand. Use your thumb to roll the tracking ball . The Quicktrac 100 is responsive enough to detect changes without much thumb movement. The left and right control buttons can be controlled by your index and right finger, respectively and the key-lock button by your middle finger.
They're are great for laptops and notebooks or anywhere where there is very little desk space.
100% Microsoft Mouse compatible.
Includes Qtrac™ Driver software
QMenu™ Pop-Up Library
Menu making Utility
DB9 to DB25 Adapter.
System Requirements: Any IBM, PC, XT, AT or compatible computer
- One 9-pin or 25-pin RS232 serial port.

A NEW INNOVATION !

C14230...............$69.95

LAMINATOR Go-Go

Is that precious photo of your loved ones in your wallet getting a bit tattery? Don't lose those precious memories protect them by laminating them with your own laminating machine
Important Business cards, membership cards, recipes etc. last a life time longer when laminated.
Now ROD IRVING ELECTRONICS have imported this laminator that your budget can afford.
Don't pay hundreds of dollars for some big machine
Pay a 1/4 of the price for an attractive compact laminator that is so simple to use. Heats up in only 2 to 3 minutes.

A91100.............................$95.00

Laminate Sheets....95mm x 57mm (2.25" x 3.25") for business cards
A91110.....................$18.95 pack of 100

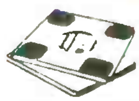
Laminate Sheets....156mm x 112mm (4.25" x 6.75") for photo's with punch holes for photo albums
A91111....................$11.95 pack of 24

Laminated Sheets....135mm x 95mm (3 3/4" x 5 5/16") for photo's and cards
A91113..........$8.95 pack of 24

Laminate sheets....110 mm x 170mm (4.25" x 6.25")
A91112................$10.95 pack of 24

DO UP YOUR MONITOR & SAVE!

NOW BELOW 1/2 PRICE!



MONITOR STAND

- Fits large monitors with feet separation up to 10" x 11"
- Eliminates neck craning
- Elevates monitor for increased comfort.
- Fully adjustable while in use
- Stable 25° tilt 360° turn
- Anti Skid feet

D11100 12".......$9.95
D11102 14"......$12.95

ANTI GLARE SCREEN

Relieve eye strain and headaches and increase production with these anti glare screens

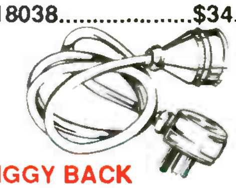
12" Screen.................$9.95
14" Screen.................$19.95

NEW POWER OUTLETS

12 WAY POWER BOARD

This is the big daddy of them all. Get the most out of your power points with this 12 way power board. Don't kill youself by loading up the power point with Double adaptors. This is the safe and neat way to use 12 appliances out of the one socket.
Comes with a 1 metre fitted cord and plug and is rated 10amps, 2400 watts. Also has overload protection.

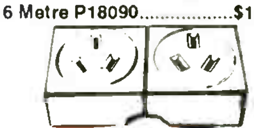
P18038...................$34.95



PIGGY BACK EXTENSION LEADS

This is the new look in extension leads. Makes other extension leads look old fashion!
It's a 240 Volt, 10A extension lead which is fitted with a socket on one end and a piggy back double adaptor plug on the other. Turns your one point power point into two while giving you the benefit of an extension cord.

1 Metre P18060.................$5.95
2 Metre P18070.................$6.95
4 Metre P18080.................$9.95
6 Metre P18090.................$11.95



"CLICK DOUBLE ADAPTOR"

Unique dual adaptor. More than just a double adaptor.
Holds plugs more securely than old fashioned double adaptors
- 1 x right handed adaptor
P18022................................$5.50
- Twin pack with left & right hand adaptors
P18024.. .....$9.95

US/EUROPEAN TO AUST. MAINS ADAPTOR

Converts any two pin US or European plug to an Australian tow pin AC plug
- Designed for use with 240 volt AC operated appliances

P18012.... ....$5.95

ARLEC DEGAUSSING WAND

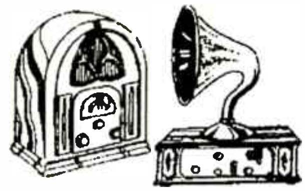
Does your colour monitor or colour T.V. have a purity problem (colour that's not pure over the whole screen).
Double Insulated.
Input: 240V 50Hz 2 AMP
Rating: 2 min on 30 min off

T12316.................$98.95

[illegible]

Vintage Radio

by PETER LANKSHEAR



RCA's first TRF receiver

In 1925, the Radio Corporation of America released its first TRF receiver for domestic broadcast reception. Built by General Electric, the Radiola 20 offered ganged tuning, two RF stages and a regenerative detector, using a circuit which had similarities to the well-known Browning Drake design. It provided a high order of performance, for a high but attainable price.

The Radio Corporation of America was incorporated in October 1919, in a takeover of American Marconi by a consortium of General Electric, American Telephone and Telegraph, Westinghouse, and the Wireless Specialty Apparatus Co. Between them the consortium members held not only the very important Armstrong Regeneration and Superheterodyne patent rights, but also they controlled just about every other major radio patent — which other manufacturers could not use without an RCA licence.

With close affiliations to overseas organisations (Australia's Amalgamated Wireless being a case in point), RCA had access to worldwide developments. This, together with their patent monopoly, gave them the potential to be the world's leader in radio technology. It is important to realise that prior to 1930 RCA had no manufacturing facilities of its own, but concentrated on operating and on marketing products made by its principals.

An interesting situation arose here. AWA were the agents for RCA receivers sold in New Zealand, but because AWA made their own receivers, often with a strong RCA influence — even to the extent of taking over the name 'Radiola' — Australian RCA imports were handled by Australian General Electric until 1930, when import restrictions cut them out altogether. RCA sets sold in Australia could not display the name 'Radiola'.

Initially, RCA had not been keen to become involved in the broadcasting craze, which they had regarded as ephemeral. But when it became clear that broadcasting would not go away, it began selling receivers designed and built by GE, Westinghouse and WSA.

RCA did not exploit its very powerful position effectively. Although by late 1925 the US industry's 'standard' receiver consisted of two RF stages, a detector and two audio stages, no RCA radios had previously been of this type.

For various reasons, including previous overproduction, the company had not made regular annual model changes, and consequently, for the 1925-26 season, they had an odd range of receivers on offer. Some was old stock, the 'bottom of the line' model being the primitive two valve variometer-tuned regenerative Westinghouse Radiola III — discounted to only $15. Then there was the 1924 'first generation superheterodyne' from GE, reduced to $116 but still expensive.

With one exception, all the new 1925 RCA models were superheterodynes, ranging from the $195 model 24 to a stratospheric $575 for the model 30. Comparative rates are not available, but it would not be unreasonable to multiply these prices by a factor of 10 for a guide to today's values.

RCA needed a current model that was priced more competitively. Their answer was the Radiola model 20 TRF, priced at $102.50 but still in the upper price range. To quote two examples, this was nearly 60% dearer than the equivalent $65 Stewart Warner 300, described in this column for May 1991, and 30% more than the 20C Atwater Kent. To be fair though, the RCA 20 was a more complex and higher performance receiver.

High price, quality

The cabinet styling and internal construction of the RCA 20 reflect the 'up market' character of RCA receivers.

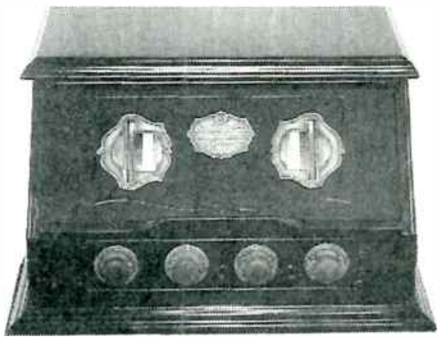
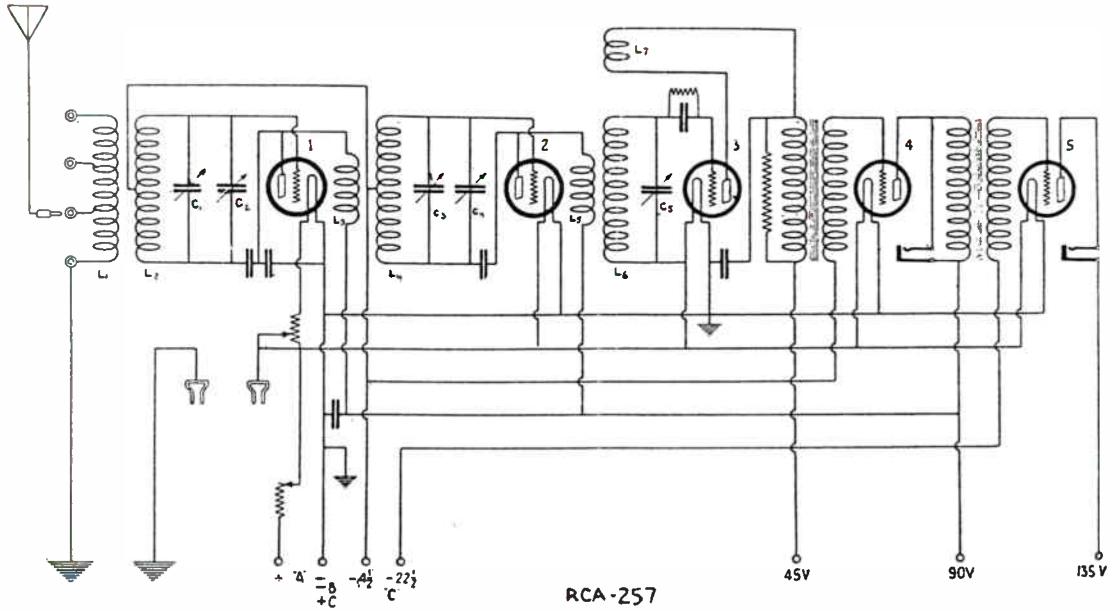


Fig.1 (above): This table model version of the RCA 20 has an overall black cabinet made by the Salt-Smith Trust of Salem, Indiana.

Fig.2 (left): The more common finish was natural wood with black stained borders, as shown on this floor model — which incorporates a battery box made by the Jamestown Mantel Co. Note the optional plug-in filament voltmeter to the right of the four lower controls.



The schematic for the RCA 20. No values are given for the three fixed capacitors, but the HT bypass is known to be 2uF and suitable bypass values for the detector grid leak and anode are 250pF. The grid leak resistor is not critical, and can be any value between 1M and 3M. The regeneration howl suppressor resistor across the primary of the first audio transformer is typically 100k.

Whereas the average 1925 receiver was pretty functional, comprising a rectangular box with a front panel featuring three large tuning knobs, two smaller filament control knobs and the odd switch, RCA receivers were more ornate, with some attempt to look like a piece of furniture.

All the 1925 RCA receivers had similar cabinets featuring a sloping front panel, lift-up lid and and elaborate routed decoration on the front and sides. As can be seen from the photographs, there were two Model 20 colour options, one being all black and the other two-toned, with black edgings around polished wood enclosed within the routed patterns.

The main panel was sloped at a 45° angle, with two large thumbwheel controls and ornate brass escutcheons. One, as would be expected, was the tuning control — in this case labelled 'station selector' — but the other one, called 'amplification', was not a volume control. It was in fact a regeneration control, working through a linkage to adjust a feedback or 'tickler' winding.

Ganged tuning

A significant feature of the RCA 20 was ganged tuning. Until about 1927, the standard TRF had three tuning controls, creating difficulties for users who did not have three hands! The problem was well recognised, but aerial coupling methods and tolerances between tuning capacitors made ganging very difficult.

Although RCA was not the earliest to use single knob tuning, its model 20 can be regarded was the first really successful receiver to feature ganging. Even so, it was necessary for the trimmers to be manually operated. (Readers of last month's column will hopefully recall that Majestic receivers still used aerial trimming in 1930.)

The model 20 was therefore RCA's first conventional TRF, and it proved to have excellent performance, incorporating two triode RF amplifiers — neutralised for optimum gain and stability — and with regeneration for high gain and selective detection.

Although popular here and in Europe, and for home construction, regeneration was used by few American makers, doubtless because royalties were payable to RCA and many users had difficulties with yet another control.

Fig.3: Only an ornate embossed brass badge was good enough for RCA. To avoid conflict with AWA's rights to the name 'Radiola', badges on sets intended for Australia had the name altered to Radio 20.

The inevitable two transformer-coupled audio stages completed a generally tidy design.

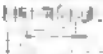
Late in 1924, G.H. Browning had described a sensitive receiver that was to become very popular with home constructors right through to the 1930's. Special features of the Browning Drake, as the circuit became known, were a neutralised RF stage, and regeneration controlled by a moveable feedback winding. Add a second RF stage to a Browning Drake circuit, and you have the essentials of the RCA 20.

We will never know for sure, but one could speculate that the GE design team who, after all, had not previously produced a TRF, had studied Browning's design and built on it...

Unusual construction

At this period of development, the usual internal construction of radios was for components to be mounted on a shelf or baseboard. But the RCA method was quite different, perhaps reflecting the communications and electrical engineering background of General Electric.

The model 20 receiver was built around a more or less triangular frame. Through the centre was a resilient rubber



and spring-mounted bakelite moulding, carrying valve sockets and mountings for the audio transformers and three RF coils. At the rear was a terminal board and a pair of neutralising capacitors. A pair of carbon resistors, a 2uF HT bypass capacitor and two mica capacitors rounded off the parts list.

On the front of the frame was the main sloping panel, backed by a metal plate carrying the three tuning capacitors and the regeneration control. Two filament rheostats and two three-plate variable capacitors (used as trimmers) together with a pair of phone jacks, were mounted on a narrow vertical wooden strip at the bottom front. Also on this strip were two pin jacks for monitoring the filament voltage using an optional plug-in voltmeter.

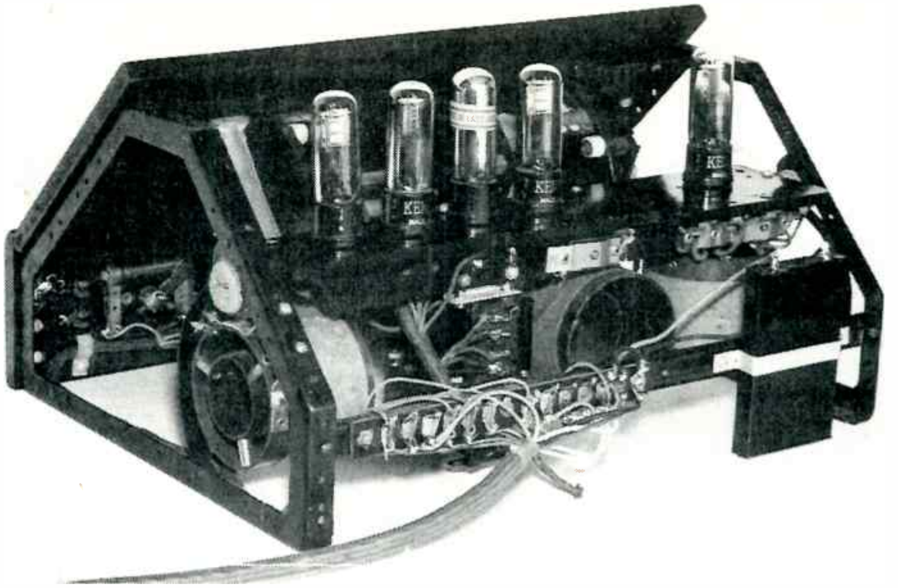


Fig.4: In this rear view of the chassis, the detector coil with its primary mounted inside on three spacers is visible at lower left. The set's three coils are mounted mutually at right angles, underneath the sprung valve deck.

There was no shielding for the three RF coils. Instead, they were mounted mutually at right angles to avoid coupling. A complication of the neutralisation was the need for tappings on the tuning coils, and isolation of the tuning capacitor rotors by insulated flexible couplings.

The whole assembly of frame and panels fitted neatly into the cabinet, to be secured by four screws on the underside.

Dry battery power

As is well known, the standard American valve used in the vast majority of receivers during the mid 1920's was the 201A, featured in our April 1991 column. The filaments of a set of 201A valves drew 1.25 amperes, from a messy 6-volt lead acid battery which threatened to rot everything in the near vicinity and also required frequent recharging.

Although it was a most successful GE development, few RCA receivers used the 201A. They preferred instead the 3.3-volt 60mA filament general purpose type 199 and the 132mA filament type 120 output valves, and for the RCA 20 recommended a filament battery of a 4.5 volt series-parallel combination of six No.6 dry cells.

These would have increased running costs, but customers who were prepared to pay the higher prices for RCA receivers were probably quite happy to pay extra for the convenience of having dry batteries for the filament supply.

The 20 in operation

Ganged tuning does make operation of the RCA 20 simpler than its contemporaries, but even so, some skills have to be developed for good results. By later standards, regeneration control is not very smooth and the thermal inertia of the filaments delays the response to adjustment of the gain control.

The tuning control is not calibrated in frequency, but has a surface suitable for pencil marking of station locations. As tuning is varied, a small amount of trimmer readjustment is required.

As would be expected, with controls adjusted correctly, and connected to a reasonable aerial, the 20 is better than its contemporaries and is comparable with some modern receivers. In a suburban location, the limiting factor is background noise.

The number of surviving RCA 20 receivers rescued by collectors shows that it was a durable receiver. Although not common here, two of the RCA Victor 'Alhambra' models and some Canadian Westinghouse receivers were based on the model 20, which proved to be popular and it remained in production until late 1927 — by which time it had become a floor model, with a new and larger cabinet.

Next month we will describe some restoration procedures for this and similar receivers. ❖

SOFTWARE TRAINING

The cheapest and most effective method

by

VIDEO

REUSABLE
LEARN IN YOUR OWN TIME
AT YOUR OWN PACE

TITLES INCLUDE:
INTRODUCTION TO DOS
WINDOWS
WORDPERFECT
HARVARD GRAPHICS
PC TOOLS
NORTON
RRP $30.00 each

ADVANCED TITLES:
DOS
WORDPERFECT
LOTUS
VENTURA
PAGEMAKER
WORD
DBASE
HARVARD
DESIGNCAD
PASCAL
DACEASY
and more.
FROM $75.00

COMPUTER SERVICES

AUSTRALIA WIDE
4 YEARS WARRANTY

SYSTEMS

THE JOEY-386X KEYBOARD COMPUTER
WITH REMOTE TO TV OPTION

80386SX-16/20/25
80386DX-25/33/40
80486DX-25/33/50
FOR
FILE SERVERS
CAD STATIONS
WORK STATIONS
ISA & EISA AVAILABLE

ADD ONS

512K VGA TO TV CARD
GENLOCK FOR AMIGA
1MB VGA WITH CEG
NON INTERLACED HI-RES
14"-15"-17"-20" MONITORS
PAL/NTSC TO RGB/VGA
DESKTOP PUBLISHING

SOFTWARE NETWORKING

NOVELL/POWERLAN/KOALAN/UNIX

SELF ESTEEM THROUGH NUMBER
MATHS EDUCATION

ON LINE SUPPORT
AND EXPERT ADVICE

CALL FOR THE BEST PRICES NOW!

AUSTRALIAN MADE MOTHERBOARDS & SYSTEMS

AUTHORISED SERVICING ON: COMPAQ, ZENITH, & MOST MAJOR BRANDS

FOR MORE INFORMATION CALL

cci

26 FULTON STREET OAKLEIGH SOUTH VICTORIA 3167
TEL: (03) 562 9900 • FAX (03) 562 9615

READER INFO NO. 25

[illegible]	[illegible]
[illegible]	[illegible]

[illegible]

[illegible]

OCTOBER SPECIALS FROM JAYCAR

REMOTE CONTROL SWITCH

(Wireless Receiver / Transmitter)

At last a quality Remote Control unit with two transmitters for under $100!

The Transmitters

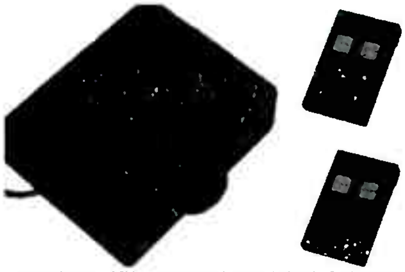
The keyfobs have two buttons on them, one LOCK and one UNLOCK with a LED to show unit has transmitted. Size is normal keyfob size 60 x 35 x 14mm and has a keyring.

The Receiver

It's a black box with a 4 way terminal block for external connections. These are for +12V, -12V, LOCK and UNLOCK.

Features

There are separate outputs for lock and unlock which are both momentary (approx 0.5 seconds). There are two separate relays, one for lock and the other for unlock, which will switch currents up to 2 amps which is adequate for most applications. There is also a switch which allows the output relays to switch either to ground or to +12V to an external control circuit. Both transmitters and receiver have DIP switches for coding. There are 6,561 different codings available. Remote control range is 28 metres. Ideal for controlling central door locking, car alarms, etc., etc., etc. Supplied with two transmitters and one receiver.



Cat. LR-8822

$79.95

NEW from Jaycar

MAGNAVOX 12" WOOFER MADNESS

Another scoop purchase. About 1/2 price.
Magnavox 12J is a 12" woofer with a black cardboard cone and foam surround.

Specifications

Power Handling	60W RMS program
Resonant Frequency	30Hz
Frequency Response	30 - 6000Hz
Voice Coil Dia.	25mm
Sensitivity	87dB 1W 1mt
Magnet Weight	190 grams

Cat. CW-2126

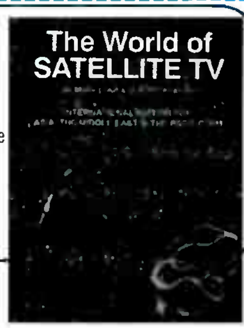
NEW from Jaycar

BARGAIN PRICE $25 ea

THE WORLD OF SATELLITE TV By Mark Long and Jeff Keating

This book provides everything you'll need to know about selecting, installing, operating, and maintaining your own satellite TV system. DBS, digital video compression, HDTV, and other innovations coming your way are also presented in a down-to-earth style that is accessible to everyone. The World of Satellite TV, with its maps, charts, and satellite "footprints" should serve as a valuable addition to the library of both newcomers and experienced satellite TV viewers. Also included is information on satellite TV in Australia, and footprint maps and transponder allocation charts for all satellites in the region.

222 pages, softcover 246 x 187mm. Cat. BC-1145 **$34.95**



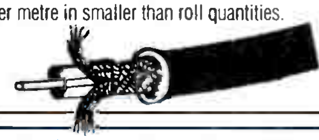
HEAVY DUTY 75Ω COAX CABLE MADNESS

We've bought a quantity of quality 75Ω coax from a large company because their purchasing dept ordered white instead of black. This coax is basically the same as our WB-2004 heavy duty coax which sells for $1 metre or $70 per 100mt roll. Because it's white we've halved the roll price.

SPECIFICATIONS
Conductor - solid 1/0.70mm.
Overall diameter - 7.3mm.
Screening A1/Polyester/A1 tape 0.05mm. Braiding 0.16mm PACW.
Resistance - 44.8Ω/Km.
Capacitance at 1kHz 67pF/m.
Attenuation -13dB/100m max.
Cat. WB-2005

ONLY $35 per 100 metre roll

60¢ per metre in smaller than roll quantities.



CRO MADNESS

Save 20% on 6.4MHz CRO

Cat. QC-1910

Normally $399
OCTOBER $319.20

Save 10% on 20MHz CRO

Cat. QC-1900

Normally $699 OCTOBER $629.10

See catalogue for full details. Probes are extra. Cat. QC-1910 use QC-1912 $45. Cat. QC-1900 use QC-1902 $39.50 ea.

Cat. QC-1900 ↑

THE 12 VOLT BIBLE FOR BOATS

By M. Brotherton

This book is a nuts and bolts primer on 12 volt electrical systems for boat owners who are not skilled electricians. It's also ideal for anybody interested in 12 volt power systems. Chapters include: Basic Theory of Electricity, Electric Circuits, The Battery, Wiring, Controls (switches, fuses, meters, etc) Transducers (lights, motors, pumps, fridges, consumption, etc.), Recharging the Battery, Troubleshooting.

174 pages, softcover, 147 x 230mm

Cat. BT-1342

$28.95

BUILD THIS NiCAD BATTERY DIS-CHARGER KIT

REF: SC JULY 92. This battery discharger is specifically designed for video camera or mobile telephone batteries. It can be set for different types of batteries from 6-12V and will save you money by reviving that dud battery. This circuit is powered by the battery under discharge and, therefore, doesn't require a plugpack, making it completely portable. The Jaycar kit is supplied with diecast box, PCB and all specified components.

Cat KC-5120

$27.95

SAVE $25 ON DMM WITH EVERYTHING

TES Multimeter

3.75 digit
4000 count, 39 range.
Inductance, capacitance, frequency, temperature, logic, peak hold, data hold, 20A
Cat. QM-1475

WAS $169
NOW
$144

Dolby Surround Sound Decoder Kit

Ref: EA January 1992. Experience cinema sound in your own lounge room. The Dolby "Surround Sound" process increases the sensation of "being there" by producing an effects channel to create surround sounds which a conventionals stereo system can't produce. Hook this simple kit in conjunction with your Hi Fi VCR or stereo TV and take full advantage of movies recorded with Dolby encoding. Short form kit - includes PCB, and all on board components. Cat. KA-1741 **$39.95**








HOOK-UP WIRE/AUTO CABLE
SAVE $3 per pack in OCTOBER

Don't miss this opportunity to stock up with quality cable at crazy crazy low prices. We've bought thousands of packs of Arista cable, and you can save a fortune. There are 5 different sizes and colours of each size. All the cable is packaged in blister packs. They are available in large packs of one roll each colour. One large pack for each cable size.

HUW5
14/0.25mm, 18 gauge OD 2.4mm. Black, green, red, white, yellow. 12 metres per colour. Total length 60 metres. Arista catalogue price $5.95 per colour. Total $29.75

Cat. WH-3019 **WAS $12.95 NOW $9.95**

HUW6
10 amp hook-up wire. Size 16 x 0.3 = 4.8mm. OD 2.6mm. 16 gauge. This is equivalent to our WH-3040 heavy duty hook-up wire. 8.6 metres of each colour. Total length 43 metres, 5 colours. Arista price $29.75

Cat. WH-3020 **WAS $10.95 NOW $7.95**

HUW7
12 amp hook-up wire. Size 19 x 0.36 = 6.8mm. OD 2.9mm. 14 gauge. This is equivalent to our WH-3050 extra heavy duty hook-up wire. 6 metres of each colour. Total length 30 metres, 5 colours. Arista price $29.75

Cat. WH-3021 **WAS $9.95 NOW $6.95**

HUW8
15 amp auto cable. Size 19 x 0.45 = 8.55mm. OD 3.5mm. 12 gauge. This is equivalent to about 4mm auto cable. 3.6 metres of each colour. Total length 13 metres, 5 colours. Arista price $29.75

Cat. WH-3022 **WAS $9.95 NOW $6.95**

HUW9
25 amp auto cable. Size 19 x 0.59 = 11.21mm. OD 4.4mm. 10 gauge. Suitable for the heaviest jobs. 2.4 metres of each colour. Total length 12 metres, 5 colours. Arista price $29.75

Cat. WH-3023 **WAS $7.95 NOW $4.95**

BUY 10 - LESS 10%

SEMICON'S TRANSISTOR INDEX (DATA & EQUIVALENTS)

This book represents an absolute bargain considering the data it contains. A huge data book listing data for thousands of transistors, as well as a large equivalent section. The book is designed for the Engineer and Technician. Section 2 lists manufacturers names and addresses • Section 3 is the huge alphanumeric listing of transistors with specifications • Section 4 lists FETs with specs • Section 5 covers unijunction transistors • Section 6 is the substitution guide • Section 7 covers devices with the prefix CV • Section 8 lists 100's of transistor outline drawings and terminations.

591 pages Size 242 x 170mm

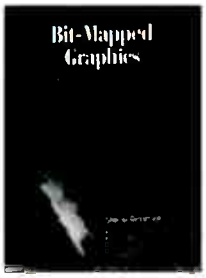
Cat. BM-2477

$19.95

BIT-MAPPED GRAPHICS

By Steve Rimmer

A programmers' guide to understanding and using the most popular IBM PC and Macintosh graphics files formats. Featuring plenty of ready to use source code and bit-mapped graphics illustrations. You'll learn how to: • Navigate through MacPaint, GEM/IMG, PC paintbrush, GIF, and TIFF graphics file formats • Use different types of graphics drivers - including Hercules, CGA, EGA, and VGA • Reproduce graphics on LaserJet, dot matrix and PostScript printers • Create bit-mapped graphics with object-oriented programming techniques • Use dithering and other algorithmic image manipulation methods.



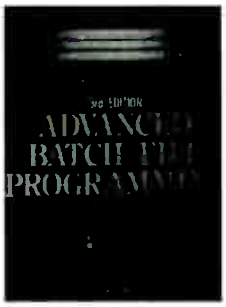
Softcover, 492 pages 234 x 187mm

Cat. BT-1344 **$59.95**

ADVANCED BATCH FILE PROGRAMMING

3rd Edition by Dan Gookin

You'll learn about • DOS commands and syntax • Batch file programming tools and techniques • Customising CONFIG.SYS and AUTOEXEC.BAT • Macros and control languages for popular applications • Writing and troubleshooting interactive batch files • Improving batch files with BASIC, EBL, Builder and Beyond-Bat • Programming batch files in OS/2 • Sample programs and a complete batch file cookbook.



Covers DOS 3, 4 and 5. "A goldmine of shortcuts, tricks and techniques in using batch files". Computer Shoppers.

499 pages, softcover, 234 x 187mm. Includes disk

Cat. BT-1346 **$65.95**

MS-DOS BATCH FILE PROGRAMMING

3rd Edition by Ronny Richardson

This book teaches you the latest approaches and techniques for writing batch files, including programs that add password protection, solve parameter problems, load and manage TSR applications, change system configurations, and much more. With the batch files found here, you'll be able to build:

• Your own menu system to handle all your programs • A complete document archive system to prevent losing important data files • A library of batch files to protect your computer from viruses • Customise AUTOEXEC.BAT and CONFIG.SYS files • BASIC programs to beef up your batch files • Patches to the operating system using DEBUG and Norton Utilities. Includes DOS 3, 4 and 5. 410 pages, 234 x 187mm Includes disk.

Cat. BT-1348 **$59.95**

UPGRADE YOUR IBM COMPATIBLE AND SAVE A BUNDLE

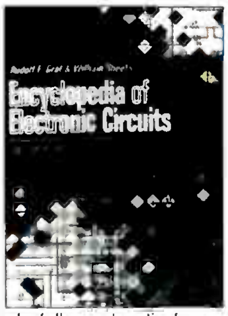
2nd Edition by Aubrey Pilgram

Don't buy a new computer, upgrade! This book offers you step-by-step, illustrated instructions show you exactly how to: • Replace original motherboards with 80286, 80386 and 80486 processors • Add new floppy and hard disk drives • Install BIOS and RAM chips, graphics cards and memory fax, and network boards • Plug in state-of-the-art monitors, laser printers, modems, input devices, and other peripherals. If you know how to handle a screwdriver, you can have all these enhancements and more for a fraction of the cost of buying a brand-new PC.

245 pages 232 x 185mm

Cat. BT-1350 **$44.95**

ENCYCLOPEDIA OF ELECTRONIC CIRCUITS VOLUME 4



This fourth Edition offers you hundreds of all new schematics for the most up-to-date electronic circuits, straight from the drawing boards of industry leaders such as Motorola, Texas, National etc. There are 104 chapters from Active Antennas to Wireless Microphones. Most of the circuits have appeared in publications since 1988. There are literally 100's of circuits and most use common garden variety components

Soft cover, 729 pages 234 x 187mm

Cat. BT-1352 **$69.95**

NEW BOOKS

DOS BEYOND 640k

2nd Edition by James Forney

This book has it all for RAM restricted DOS users. Includes • the 80486 processor • Windows multitasking • VM/386 and DESQ view • Alternate operating systems such as PC-MOS/386 • XMS memory management techniques • Extended Industry Standard Architecture (EISA) • High speed multitasking software for the 8088 • DOS 5 and DR DOS 5 • Running Lotus 1-2-3 and WordPerfect with extended expanded memory. Also explained is how you can access memory installed above DOS's 1Mb ceiling, and how to use memory in the 640k - 1Mb region that, although reserved by the system actually is not used by DOS.

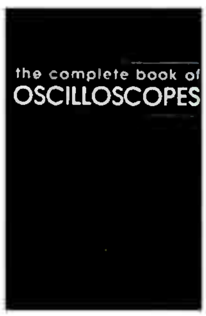
Softcover, 283 pages 234 x 186mm

Cat. BT-1354 **$49.95**

COMPLETE BOOK OF OSCILLOSCOPES

2nd Edition by Stan Prentiss

This book examines in detail virtually every aspect of CROs and their use, including advanced testing procedures: • Digital storage CROs • spectrum analysers (from DC to 21GHz) • logic and signature analysers • metal cable and fibreoptics time domain reflectometry • storage and A/D/A converters • GPIB, RS-232 and future BUS instrument connectors • digital printers and much more. If you work with CROs for any experimental or troubleshooting purpose, you'll need this book.



Softcover, 305 pages 233 x 187mm

Cat. BT-1356 **$37.95**





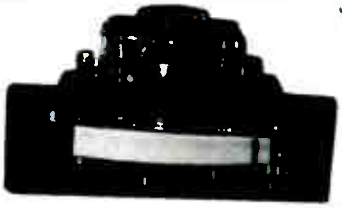




HIGH QUALITY EDGE METER BARGAIN

This meter is a high quality Japanese made edge meter.
It is a 100V AC FSD moving coil type. It can easily be changed into an Amp or Milliamp meter by using a shunt resistor. The meter scale is blank, so you can easily put your own scale on it. Size: Front bezel 73(W) x 25mm. Panel cutout 58(W) x 18mm. Depth from front panel 63mm. Height at rear 34mm. To buy these today you would pay around $30 - $35

Cat. QP-5060 **OUR PRICE $14.95**



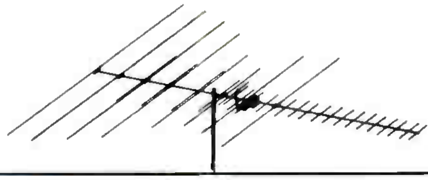
ANSWERING MACHINE /DATA CASSETTES

Another surplus deal to save you lots of money. This time its Maxell brand data cassettes. These are high quality Japanese made DC-300. We originally thought they were 300 minutes, because the window has a lot of tape showing. Upon further checking we found them to be 60 minutes, 30 minutes per side - and these use high quality thick tape. These are ideal for answering machines, computer data, etc. We've seen these in catalogues for $8.95 each.
Cat. AR-1470

JAYCAR PRICE
$1.95 ea
Box of 10 for $15

THE BIGGEST TV ANTENNA

This is the biggest antenna we have ever seen. It's an extremely high gain UHF/VHF/FM antenna for outer metropolitan areas where signal reception is deep fringe. Includes 75 ohm balun. Also suitable for metropolitan areas where multiple outlets are required. Boom length is 2.9m.Cat. LT-3155 **$199.50**



2 COMPUTER/1 PRINTER AUTO SWITCH

This is a non-power auto data switch designed for using one printer on two computers. No need to switch, does so automatically and uses no power. Time out 5-6 seconds, provides "Release" signal for the PC to avoid "Lock" problem when the other PC is printing. Suitable for IBM compatible systems. Cat. XC-5088 **$69.95**

5A DRILL SPEED CONTROLLER KIT

NEW KIT

Ref: Silicon Chip September '92
This new speed controller can be used with power tools rated up to 5 amps. It can be used to control the speed of circular saws, electric drills, lawn edgers and other appliances with universal "brush type" motors. The Jaycar kit is supplied with a jiffy box, PCB, surface mount mains socket and components.

Cat. KC-5123 **$39.95**

QUALITY DISCS AT SILLY PRICES

5 1/4" DSDD Cat. XC-4730 **$5.50** pkt 10
5 1/4" DSHD Cat. XC-4732 **$10.50** pkt 10
3 1/2" DSDD Cat. XC-4736 **$9.75** pkt 10
3 1/2" DSDH Cat. XC-4738 **$15.95** pkt 10

Sub C NiCad

Repair your battery pack for RC cars and power tools with Sub C's. Ours are the lowest price too! 1.2Ah
Cat. SB-2456 **$6.95**

9V RECHARGEABLE

Normally $19.95
October $16.95 Cat. No. SB-2458

STUDIO 3-55L SPEAKER SALE

12" 3 way speaker kit incorporating Magnavox 12w woofer, midrange and Philips dome tweeter. Power handling 50 watts programme. Cabinets are black and fully built. See the 1992 catalogue for full details.
Cat. No(s). CS-2480/2

NORMALLY
$499
OCTOBER
$449
SAVE $50

EXTENDED TRADING HOURS FOR YORK ST STORE

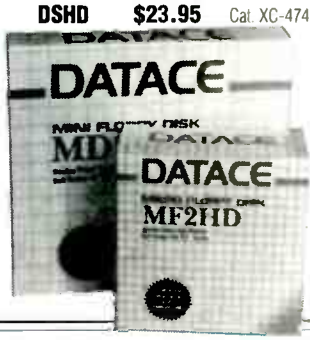
For your convenience now open Mon-Fri 8.30am to 6.30pm. Thurs till 8.30pm. Sat 9 - 4pm

DATACE DISKS 100% ERROR FREE

LIFETIME WARRANTY

At last. High quality disks without the high quality price. We had these disks independantly tested and they consistently outperformed that other expansive brand we used to stock. The Bit dropout was up to 30% less! Call into any store for your copy of the report. After the quality, the next best thing is the price.

5.25"	**DSDD**	**$9.95**	Cat. XC-4740
5.25"	**DSHD**	**$14.95**	Cat. XC-4742
3.5"	**DSDD**	**$14.95**	Cat. XC-4746
3.5"	**DSHD**	**$23.95**	Cat. XC-4748



FANTASTIC PRICES

120mm 240V
Cat. YX-2514
Catalogue Price
$27.50
NOW
$17.50
SAVE $10

80mm 115V AC
Buy 2, connect in series to 240V and get double the exhaust volume.
Cat. YX-2520
SPECIAL PRICE $10
NOW $7.50 SAVE $2.50

TURN YOUR SURPLUS STOCK INTO CASH!

Jaycar will purchase your surplus stocks of components and equipment. We are continually on the lookout for sources of prime quality merchandise.

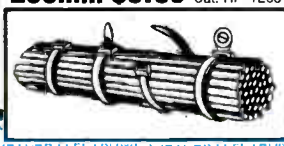
Call Mark Harris or Bruce Routley now
(02) 743 5222

MOTOR SIREN

This 12 volt motor driven siren really lets out a blast. It's very small compared to most sirens measuring only 82(H) x 80(L) x 74(D)mm. Limited quantity.
Cat. LA-5252 **WAS $24.95**
NOW $19.95 SAVE $5

CABLE TIES IN 100'S

100mm $4.95 Cat. HP-1203
150mm $8.95 Cat. HP-1204
200mm $9.95 Cat. HP-1205



10% OFF 6V GEL BATTERIES

1Ah Was $8.95 NOW $8.05
Cat. SB-2479
6Ah Was $14.95 NOW $13.46
Cat. SB-2477
8Ah Was $16.95 NOW $15.25
Cat. SB-2478

STEREO SPEAKER PROTECTOR

NEW KIT

Ref: EA October 1992

This small module will save your expensive loudspeakers from damage due to an amplifier fault or destructive drive signals. It includes an "intelligent" de-thump circuit and can be either built into an existing amplifier or housed on its own. Kit includes PCB, relay and all specified components excluding extra power supply parts. Cat. KA-1745 **$29.95**

SAVE ON CELLULAR PHONE BATTERY ELIMINATORS

When you are in your car, use your car power and save your telephone batteries. Simply slide the battery pack out of the phone, and replace it with the Eliminator. It has a curly cord attached with a cigarette lighter plug.
Cat. MP-3110 Motorola Micro Tac • Cat. MP-3112 Novatel PTR800 • Cat. MP-3116 NEC P300 • Cat. MP-3114 Motorola 9800/9500

WAS $59.95 OCTOBER SPECIAL $39.95

SAVE $20 on each item

TOWER DATA BOOKS: SELLOUT

Sadly, we can no longer buy Towers books at the prices we were paying. So, we've slashed the prices to clear the final stock out. See catalogue for full details.

IC SUBSTITUTION MANUAL

Cat. BM-4552 **WAS $49.95 NOW $34.95 SAVE $15**

TRANSISTOR SELECTOR

Cat. BM-4554 **WAS $35 NOW $30 SAVE $5**

OP AMP & LINEAR IC SELECTOR

Cat. BM-4556 **WAS $29.95 NOW $17.95 SAVE $12**

DIGITAL IC SELECTOR

Cat. BM-4558 **WAS $29.95 NOW $14.95 SAVE $15**

DIODE & SCR INDEX - NEW EDITION

Cat. BM-4560 **WAS $39.95 NOW $24.95 SAVE $15**

MICROPROCESSOR SELECTOR

Cat. BM-4564 **WAS $12.95 NOW $8.95 SAVE $4**

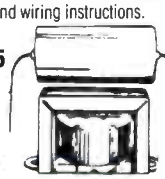
HEAVY DUTY HOT LINE FILTER

Huge 20 amp current capacity. Ideal for high power amplifiers in car audio systems. Virtually eliminates ignition noise via the resistive lead to battery. Complete with capacitor and wiring instructions. Inductance 0.5mH.

Cat. AA-3075 **NORMALLY $14.95**

OCTOBER $9.95

SAVE $5



SCOPE ALARM KEYPAD SALE

If you've bought a Scope 6 alarm from us (or are going to), don't miss this. Intelligent remote keypad to arm/disarm and program the system. 7 segment readout, use up to 3 per alarm.
Cat. LA-5183

WERE $49.95

NOW $20

SAVE $29.95

8" TWINCONE SPEAKER SALE

Ideal for multispeaker sound reinforcement where 4 ohm speakers are required. Quality speaker made in New Zealand. Limited quantity. 10 watt power handling. Frequency range 60 - 15kHz. Cat. CE-2322 **Catalogue price $9.95**

NOW $6.95 SAVE $3

WHITE CONE MIDRANGE SLASHED

A quality midrange with a sealed back and foam surround. Huge 10oz magnet makes it efficient and gives good midrange reproduction. As used in the Studio 3-55L speaker kit.

Power Handling	80W RMS system
Frequency Response	350Hz - 5.5kHz
Resonant Frequency	350Hz
Sensitivity	94dB

Cat. CM-2080

Normally $28.50

NOW $20

SAVE $8.50

12V DC - 240V AC INVERTER - NEW MODEL

Now ultra reliable. Features include: • Low battery alarm - an audible buzzer sounds when battery voltage drops to 10.7 volts • Low battery shutdown - activated when battery discharges to 10.0 volts, which prevents damage to battery • Electronic circuitry protection - prevents potential damage from overloads and inadequate ventilation • High surge current capability - starts difficult loads such as lamps, motors and inductive loads.
See catalogue for full specifications.
Cat. MI-5030

Catalogue price $189.50

OCTOBER PRICE $159.50 SAVE $30

AT LAST - THE ECONOMICAL WAY TO STORE RESISTORS

These trays have 36 compartments and are designed to accept 1/4 or 1/2 watt resistors. There is space beside each compartment to write in texta the value of each resistor. If more than one tray is required they will stack inside each other - so you can find a resistor - or capacitor, or nut, bolt, etc in a jiffy. We have sold thousands of assorted resistor packs over the years. One popular pack being the RR-1697 which has 85 different values (10 of each value).
To store this pack in these trays you will need 3 (36 x 3 =108) and you'll have 23 compartments free for other parts. The size of each tray is 395 x 260 x 20mm deep. We think they are a great idea.

Cat. HB-6340 **$6.50 ea**

NEW FROM JAYCAR

Jaycar ELECTRONICS

HEAD OFFICE
6 Leeds Street Rhodes 2138
Telephone (02) 743 5222
FAX (02) 743 2066

POST & PACKING	
$10 - $24.99	$ 3.75
$25 - $49.99	$ 4.50
$50 - $99.99	$ 6.50
OVER $100	$ 8.00

MAIL ORDERS
P.O. Box 185 Concord 2137
ROAD FREIGHT ANYWHERE IN AUSTRALIA (up to 20kg) $14.00

MAIL ORDER VIA ☎
FREE CALL - FOR ORDERS ONLY
(008) 022 888
HOTLINE (02) 743 6144

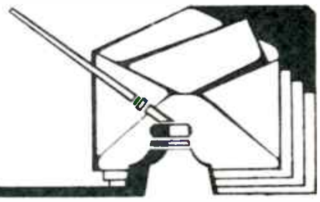
ADELAIDE SA	190 Wright St (Cnr. Selby St) (08) 231 7355 Fax (08) 231 7314 Mon-Fri 9 - 5.30 Fri 8.30 - Sat 9 - 12
BURANDA QLD	144 Logan Rd (07) 393 0777 Fax (07) 393 0045 Mon-Fri 9 - 5.30 Thurs 8.30 - Sat 9 - 4
COBURG VIC	266 Sydney Rd (03) 384 1811 Fax (03) 384 0061 Mon-Fri 9 - 5.30 Fri 8.30 - Sat 9 - 4
MELBOURNE CITY	Shop 2, 45 A'Beckett St City (03) 663 2030 Fax (03) 663 1198 Mon-Fri 9 - 5.30 Fri 8.30 - Sat 9 - 2
SPRINGVALE VIC	887-889 Springvale Rd Mulgrave (03) 547 1022 Fax (03) 547 1046 Nr Cnr. Dandenong Rd Mon-Fri 9-5.30 Fri 8.30 - Sat 9 - 2
SYDNEY - CITY	129 York St. (02) 267 1614 Fax (02) 267 1951 Mon-Fri 8.30 - 6.30 Thurs 8.30pm - Sat 9 - 4
BANKSTOWN	363 Hume Hwy Cnr Meredith St (02) 709 2822 Fax (02) 709 2007 Mon-Fri 9 - 5.30 Thurs 8.30pm - Sat 9 - 4 - Sun 10 - 4pm
GORE HILL	188 Pacific Hwy (Cnr. Bellevue Ave) (02) 439 4799 Fax (02) 439 4895 Mon-Fri 9 - 5.30 Thurs 8.30 - Sat 9 - 4pm
PARRAMATTA	355 Church St (Cnr. Victoria Rd) (02) 683 3377 Fax (02) 683 3628 Mon-Fri 9 - 5.30 Thurs 8.30pm - Sat 9 - 4pm Sunday 10am - 4pm
PENRITH	199 High St (047) 21 8337 Fax (047) 21 8935 Mon-Fri 9-5.30 Thurs 8.30 - Sat 9-4pm Sun 10-4pm
RHODES	6 Leeds St (02) 743 5222 Fax (02) 743 2066 Mon-Fri 9 - 5.30

MasterCard · American Express Cards Welcome · VISA






Information centre



Conducted by Peter Phillips

Looking further ahead into the digital future

This time around we get a glimpse of what could be a most interesting project, examine a few reader hassles with existing ones and discuss the Scott connection. To keep you busy, there are also *two* What?? questions this month — although you're really on your own with one of them.

Today's audio technology is largely centred around digital devices, particularly the CD player. While most of us own one, and probably enjoy it immensely, there is a growing band of enthusiasts wanting to 'get at' the data from a CD. Many CD players have a subcode output, and some have other outputs that are not really explained in the manual for the player.

An emerging field is DSP (digital signal processing), and ICs that can do incredible things with digital audio are now becoming available. One of our regular correspondents (G.L., Ringwood Vic) who first raised a few questions about CD subcodes last year, suggests that 'DSP will become the buzzword of the 90's, just as digital was in the 80s and solid state was before that'.

He also reckons that DAELEA (pronounced day-leer), an acronym for Dynamic Adaptive Equalisation of Listening Environment Acoustics, is likely to become as familiar as Dolby. Never heard of it? Well, there's lots more acronyms to come, but eventually they will mean something, particularly if we have some hardware to do whatever the acronym stands for.

Circuits for examining subcode are starting to surface, and I suspect we are at the edge of what could be the next area of general interest for enthusiasts. Whether we'll all need degrees in digital audio is another matter, but when you realise that the Z80 is now nothing more than the 555 of the microprocessor world, it's obvious that we seem to be able to adapt to almost any techological advance, even it takes a little while.

Our first letter this month is about CD digital audio, although it may raise more questions than answers. However, it shows what we may be in for, and I think indicates that the time is coming when we can get out of the armchair and take our CD player into the workshop, where the best entertainment is anyway...

CD subcodes

The following letter, by the author's description, is a 'cut-down' version of a previous letter that was too long to include in these columns. The letter briefly explains CD subcodes, and ends with — no! I won't spoil the author's surprise...

Most CD decoder or digital filter chips now incorporate an output function known as the 'Digital Audio' or 'Subcode Data' output. The more upmarket machines have an output socket on the rear of the player, either in the form of an RCA/phono style coaxial output or a 'Tosling' fibre-optic transmitter port. The two outlets provide the same information; the only difference is the transmission method.

Either way, the signal is in the bi-phase encoding pattern and runs at a clock speed of 2.8224MHz. The format is known as SPDIF (Sony/Philips Digital audio InterFace), and is basically a subset of the AES/IEC/EBU standard for digital audio interfacing systems. The data in this serial line alternately sends left and right audio channel samples in 32-bit bursts; that is, each 32-bit burst has 16 bits used for the digital audio data. The other 16 bits are used to tell the decoder certain statistical details such as the sampling rate (32, 44.1, 48kHz etc); whether it is audio data or other data such as CDROM, CD-Interactive etc; if copying is permitted as per the SCMS (serial copy management system) used in DAT machines, two or four channel audio, consumer or professional source equipment; if de-emphasis needs to be applied to the DAC circuitry; the 'category code' which states if the source is from a CD, DAT, PCM adapter etc; a CRC parity flag; the master clock accuracy; a 'Data Valid' flag; block and frame sync bits; and a 'U' bit.

There are other bits as well, but the explanation of their use is long and detailed and changes depending on whether the source is domestic or professional gear. The CD subcode system uses the U bit for data transmission. The U bit is not defined in the AES/EBU/IEC standard. It was decided by Sony and Philips during the development of the CD system, and the subcode standard was published in the much sought after Philips CD-DA 'Red Book' standard, which is only available to manufacturers.

The Subcode itself contains eight parallel data streams tagged P, Q, R, S, T, U, V and W. Each channel is built up over time to give a 'subcode block', such that each of the channels forms a 98-bit word, which is completely updated exactly 75 times a second. So in each 32-bit word from the decoder or filter chip, there is an audio sample and subcode bit; that is, seven bits.

So, the sequence of transmission is Q1, R1, S1, T1, U1, V1, W1, sync, Q2, R2, S2, T2, U2, V2, W2, sync, and so on until Q96, R96, S96, T96, U96, V96, W96. Then the whole system wraps around and starts again. Bits Q-W97 and Q-W98 are used as frame sync bits. As there is only one U channel bit sent in each 32 bit digital audio word, during the time it takes to construct a full block of subcode, there are 1176 audio samples sent at a rate of 75 frames per second. This gives an audio rate of 1176 x 75 = 88,200 left and right samples per second, or a 44.1kHz audio rate.

Only the Q bit is used in normal CD players. The R-W bits aren't used in standard CD's but this area is used to contain the graphics information on discs encoded in the CD+G (plus graphics) format. For CD-I applications, all the subcode bits are used, along with some of the audio bit sectors. One should note there is an unfortunate double usage of the terms P and Q

Information centre

[illegible]

channel in CD jargon. You must be careful not to confuse the subcode P and Q channel bits with the P and Q channel bits used in the CIRC error detection-correction system of the decoder chip. They are totally different bits.

The Q channel has several 'modes of operation'. Of the 96 bits, several are used for control, sync, CRC redundancy, padding and address bits. The remainder are used as 'active bytes' to contain user data. The way these are used depends on the address mode code. Essentially, the active bytes are used to convey any or all of the following: track and index number, absolute time, relative time (in minutes, seconds and frames), point and start time of a track, lead-in or lead-out flags, barcode catalog number of the disc, year of recording, serial number, owner and country codes and pause bits.

Although it would be possible to decode this information with hard-wired logic gates, it is more feasible to use a microprocessor. This way, alphanumeric titles can be assigned to discs by having the microprocessor recognise the unique barcode number on any disc that is inserted into the player.

The exact details of the way the subcode data is decoded is a closely guarded secret, held by the audio equipment makers. However, by now you may have guessed that I happen to have discovered these details. The bad news is, I'm not going to let on.

But the good news is I'm in the advanced stages of designing an outboard DAC unit for readers to construct for use with CDs, DATs etc. The unit uses the very latest in 1-bit DAC technology in a state-of-the-art, class A configuration and will have FULL subcoding information displayed on the front panel including a few fancy extras, such as CD+G decoder with RF output. It will have multiple coaxial and fibre-optic inputs, a headphone output and infrared remote volume, as well as automatic switching between 32, 44.1 and 48kHz sample rates. It will also be available for a fraction of the price of commercially sourced products. But you'll have to wait a bit longer while the prototype undergoes full testing, before it hits the press. (S.M., Townsville Qld).

I suppose most readers are rather like me when it comes to CD players — they are a unit that either works or not, and that's about it. They can sometimes be repaired if you have the manual but, more often than not, you probably need alignment jigs. In other words CD's are a technology that's rather inaccessible, which is something we electronic types are not entirely at home with.

Anything that allows us access to the innermost workings of CD technology is to be welcomed, so S.M., I for one am certainly looking forward to more details. And now back to more arcane matters.

NiCad discharger

The next letter asks a simple question; fortunately one that also has a simple answer...

Using more and more NiCad batteries, I am experiencing some trouble, such as reversed cell polarity. I have therefore decided to build the NiCad discharger described in September 1989.

After purchasing all the components, I sat down and read your article again to get the full picture. However, nowhere in the article do you explain why switch S2 has two positions for AA batteries.

There are even two different values of discharge resistors for these two settings. I would be grateful if you could please explain? (G.D., Burwood NSW).

When I designed the discharger, I pored over suppliers' catalogues and found that there are two sizes of AA rechargeables: 500mAh and 600mAh. The most common type seems to be the one rated at 600mAh, but you just never know. Therefore, the easiest way was to include both. This was explained in more detail in the article describing the companion charger.

And while we're on the topic of chargers...

Solar charger

The solar charger described in *EA* for February, 1992 has been very popular with constructors. Unfortunately, several errors crept into the article, and these were described as errata in the August edition. However, not everyone has caught up with the errata, including our next correspondent:

I have recently purchased the solar charger kit, described in February 1992. In the layout diagram, component R2 is not shown and the parts list and the circuit diagram don't agree with the value of some components. Also, I plan to use the project to charge 12V batteries and I am confused as to how the charger is connected to the solar panel. Could you please help? (R.M., Mt Gambier SA).

First the errata. Resistor R2 is located directly beneath C2, between C2 and IC1. This resistor is 22 ohms, not 220 ohms as shown on the circuit diagram. The other incorrect value is R1. This resistor is shown as 180 ohms on the circuit and also in the parts list. Both are wrong — R1 should be 180k.

Regarding your confusion about connecting the charger to a solar panel, I must admit to being unable to explain it any differently to the article. The board is simply connected to the solar panel as shown in the layout diagram. That is, the top wire in the diagram connects to the positive output of the solar panel, and the bottom wire connects to the negative output. However, you might have some confusion about connecting the battery. A 12V battery is best connected with the positive lead of the battery connected to the lead marked 'to battery +' and the negative lead to the common of the circuit. This is the same connection as the negative lead of the solar cell.

Car wiring

Figuring out the wiring of a car trailer plug can be quite a business, particularly if there's also a fault in the wiring. The next letter describes a rather unusual testing method that the author has used successfully over the years:

To check caravan and trailer wiring, I use a 12V, 100VA (or more) transformer. To find the earth, clip one end to the frame and touch out the plug contacts until a good hefty spark identifies a short circuit. Then using the known earth, identify each pin using the acronym LISTER. That is Left indicator, Interior light, Stop light, Tail light, Earth and Right indicator. This method blows no fuses and wastes no battery power, although it can only be used near a 240V power outlet. (R.M., Auckland NZ).

An interesting method, R.M., and probably more reliable than an ohmmeter test. Because it applies pretty much the same test as the actual operating conditions, faults such as poor earth connections, blown globes and so on are quickly identified.

I'm familiar with the Utilux trailer plug, which has earth as the centre pin. The others are, to rearrange your acronym, TLRSA, where A is an auxiliary circuit (or interior light for a caravan). The pin numbers are from 1 to 5, with 5 the auxiliary circuit. However, one never knows where the wires might be connected, as 'standards' always have their exceptions.

Scott connection

I'm glad the next correspondent took the time to write, as I too had a few misgivings about the answer to the What!! question posed in June.

The Scott connection, as explained in July in answer to the June What?? question, is a means of connecting transormers to give a 2-phase supply from a 3-phase supply, and details are rather hard to find. In fact, I analysed the reference material given to me by the contributor of the question, and decided that the least said in the

[illegible]

question (and the answer) the better. I'll explain later, but first the letter...

In response to the answer published in July 1992 to the question from June, I would like to make an observation. The answer given is only partly right — connecting two similar transformers as shown will certainly provide the correct phase relationship between the voltages for the 2-phase load, but not the correct voltage levels for balanced loading.

I have drawn a diagram (see Fig.1) using a phasor representation of the voltages, which is a technique often used by electrical engineers (of which I am one). In case they may be unfamiliar, let me explain. They are like vectors, but differ in that a vector representation of alternating voltages would show a rotating diagram.

In this stationary diagram, the phasors show the inter-relationships of voltages relative to a rotating datum. But the magnitude of the voltage is proportional to the length of the line representing it, and its phase angle relative to the common datum is shown by its direction. In Fig.1, the balanced 3-phase supply lines are designated A, B and C.

The transformer connections are also shown in Fig.1, in which you can see that the centre-tap of transformer 1 is at a potential midway between supply phases A and C (because A and C are connected to opposite ends of a single winding). But the potential difference between this centre-tap (X) and phase B is not equal to that between A and C. In fact, taking magnitudes only: $V_{XB} = V_{AB} \times 0.866$.

It is clear from the geometry that the phase relationship of the output voltages is a right angle, which is correct for a balanced 2-phase system, but the output voltages are not of equal magnitude — which they ought to be. With V_{XB} *applied to half the primary winding of transformer 2, its output voltage will be 1.732 times greater than that of transformer 1. You would obtain a voltage closer to the other if the whole primary winding of transformer 2 had been connected to* V_{XB}*, but the two would still not be equal.*

To obtain equal output voltages, the standard Scott-connected transformers have turns ratios differing by 0.866. That is, for equal secondary turns, the primary turns of transformer 2 should be 0.866 times the primary turns of transformer 1.

Thus, in the given conditions of the problem, with two similar transformers (taking that to mean that they have equal turns ratios), there is no possibility of connecting them to give a balanced 2-phase output. Sorry about that! (K.M., Kangaroo Ground Vic).

Don't be sorry K.M. I agree with you. When this question was given to me, the text describing it included a phasor diagram that I soon realised was impossibly wrong. I discussed this with a colleague, and we both felt there should be a ratio of 0.866 somewhere in the system. However, the text made no reference to this, so I decided to present the answer as given in the text, but in the hope that some discussion would arise. And fortunately it did.

In fact, another writer (P.M., Busselton WA) makes the same point, so perhaps *I* should say 'sorry about that' as my skill with three-phase phasor diagrams died some years ago and although I knew there was something wrong, I wasn't sure what. So thanks to both K.M. and P.M., for putting us all straight — I was waiting for your letters!

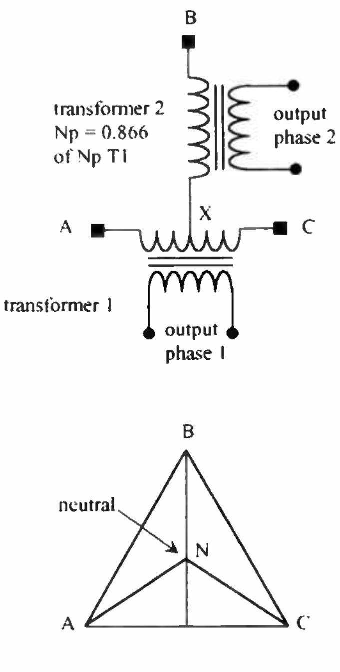


Fig.1

Resistor network

As you can see from the last letter, sometimes I have to take a punt when I present the answer for a What?? question. But at other times, I just plain 'give up' and pass it all over to you, folks. I used to be red hot with resistor networks (I could Thevenise and Nortonise along with the best of 'em), but these days time is rather a problem, and rather than solve the problem asked by the next writer, I'm simply going to present it:

I first read this question some 30 years ago. I have yet to hear of, or work out the answer. Perhaps you can present it in your column and maybe get me an answer.

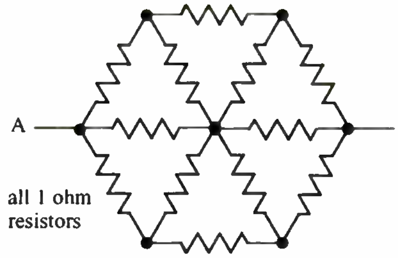


Fig.2

The problem is: what is the resistance between points A and B for the network of one ohm resistors shown in Fig.2? (R.V.H., Kallangur Qld).

So there it is everyone, all we need is the answer. If I was able to offer a prize, I'd be glad to give it to the first correct answer — except I don't *know* the correct answer!

However, I'm sure *someone* out there can solve this problem, and the best I can offer is the glory of having your name in print. And you'll also have the gratitude of our correspondent, who will have waited over 30 years for the answer!

Car alarm

The next letter describes a problem in our Car Burglar Alarm presented in February 1991. It also gives a simple solution to the problem...

After constructing the February 1991 car alarm, I found it worked perfectly on a bench supply set to 13.8V. However, it would not latch on the delayed input when connected to a 12V car battery (with a terminal voltage of 12.6V). I checked everything with a logic probe and it appeared OK up to C4. The warning light was flashing quickly, indicating that the main latch was operating and the clock was changing frequency.

It appeared as though the alarm latch was not receiving a sufficiently strong pulse, although I had an indication on a logic probe, suggesting something was getting through. If I applied a pulse to pin 3 of IC3:A the alarm would operate, so I checked the various components around this part of the circuit, including C4.

I then changed C4 to a 220nF, and everything worked correctly. I have since built a second alarm, and it displayed the same fault. I don't understand why, but it seems the value of C4 is too low. Apart from this problem, the alarm is a great kit, and I have a few people wanting me to build them one. (P.F., Warragul Vic).

Thanks P.F. for your kind remarks about the project, and for sending this simple solution to a problem that didn't show up during testing of the prototype. I think the

[illegible]

reason is due to variations in the characteristics of IC3. Perhaps the IC used in the prototype was more sensitive (as far as triggering is concerned) than those you have used.

Being an edge-triggered flipflop, if the risetime of the pulse applied to the clock terminal is not as sharp or as high as it should be, unreliable triggering will occur when the supply voltage is reduced. Increasing the value of C4 is the easiest solution, although it's likely the problem could also be solved by increasing the value of R5.

Radar detector

When I first read this letter, I thought perhaps the writer had somehow missed all the controversy that raged a few years ago when radar detectors were declared illegal. But not so, the question is about radar detector *detectors*!

I have a question which I hope you can answer, and which may be of interest to other readers. Is it possible to detect the presence or operation of a radar detector?

I have heard police advertising that they have devices which can do just that, but I am yet to be convinced that it can be done. After all, a radar detector is supposedly a passive device. What is there to detect?

If, as it seems to me, the authorities are bluffing us, I wonder about the ethics of such law enforcement methods. (B.R., Calwell ACT).

Years ago I played around with radar detectors. The unit concerned consisted of a microwave antenna in the form of a specially shaped rectangular aperture that focused onto a microwave detector diode.

Thereafter, the modulation from the detector diode was amplified by a conventional piece of audio circuitry. I recall that the diode was the expensive bit, and I think I destroyed it by doing something to it I shouldn't have done, like measuring its resistance with an ohmmeter.

As the years progressed, radar detectors became not only more popular, but smaller and more reliable. But, as far as I know, they all operated the same way. I am not aware of any technology that can detect the presence of what amounts to a microwave tuned circuit, just as it's not possible to detect the presence of a radio or a TV set by merely sensing its tuning stage. Certainly, an operating TV set can be detected by the RFI it produces, but a radar detector as you say, is passive.

It may be that some types of radar detectors produce an output, and these are the types being referred to by the police. Still, if this is the case, it's a rather blanket statement to suggest all types can be detected. Although now rather academic, it's an interesting question which someone might be able to throw some light on.

Some might argue that the question of ethics applies equally to those using a radar detector, and those who claim they can detect these devices. I should point out that *EA* has always maintained that radar detectors are unethical anyway, and for this reason, we have never described one as a project. Still, this doesn't preclude a technical discussion about them. After all, they are illegal, and if the police *can* somehow detect them, then it shouldn't worry any of us honest citizens!

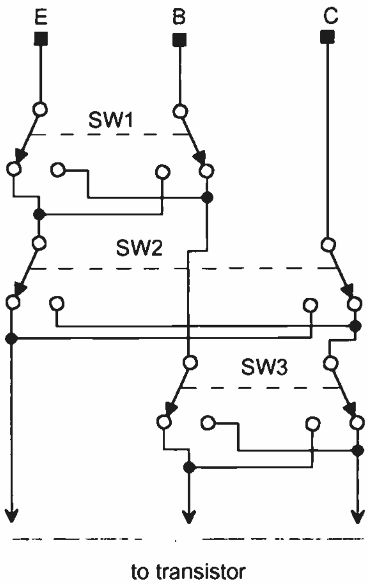


Fig.3:

What??

It seems there's an almost endless supply of questions that involve resistors. This month's question comes from Graham Leadbeater, of Ringwood in Victoria. Graham asks:

Using only perfect one ohm resistors, construct a network that gives a total resistance of pi ohms, correct to six decimal places. That is, 3.141592654 ohms. What is the minimum number of resistors required?

Answer to September's What??

A possible solution is shown in Fig.3. For no switches operated (as shown), the terminals to the transistor under test are EBC. With SW1 operated, they become ECB, with SW2, CBE and BEC for SW3. If both SW1 and 2 are operated you get BCE, with CEB for SW1 and SW3.

There are other possible switch combinations (SW2 and 3 or SW1, 2 and 3), but these only duplicate some of the permutations already listed. ❖

SHORTWAVE LISTENING

by Arthur Cushen, MBE

New countries and new voices on air

International broadcasting is expanding, and Costa Rica and Hawaii are about to join the countries with international services. Also, many of the Republics of the former Soviet Union are now operating their own services, such as Radio Ukraine International. The exchange of facilities also continues, with Radio Japan's broadcasts now being relayed by the BBC.

The Spanish Foreign Radio in Madrid has constructed transmitters in Costa Rica, to carry programmes into the Caribbean and South America. There will be three 100kW transmitters in service and all broadcasts will be in Spanish. There has been some delay in getting the transmitters operational, according to Radio Nederland, but by the time this is published, the three transmitters should be in service. The transmitters will operate from 2200 - 0500, and will carry the best of the Spanish World Service, linked by satellite from Madrid.

The frequencies are yet to be decided, but it is expected that the tropical band, 60 metres, will be used, along with frequencies in the six, nine and 11MHz bands.

New voice from Hawaii

A second international voice from Hawaii is planned to be in operation by December 1993. Hawaii's first shortwave operation was that of the Voice of America, which I first heard at 0900 on 15 May 1947 — they were using 100kW on 15,250kHz. For the following several years, KRHO, the call of the Voice of America station, was heard on an additional six frequencies, until it was taken out of service in the late 1950s.

The newcomer to shortwave from Hawaii will be KWHR. The owners are WHRI, operated by the LeSea Broadcasting Corporation from South Bend, Indiana.

KWHR will be built on the big island of Hawaii, and will be able to reach a large part of Asia, the Central Pacific and Australia. The transmitter will probably be a Harris 100kW similar to the ones being used by WHRI. With its slewable curtain antenna, it should cover from Sydney to North of Tokyo. Programmes will be fed from WHRI, in Indiana by satellite. In the call of the new station, 'K' is the call for stations west of the Mississippi and then 'W' stands for World, 'H' for Harvest and 'R' for radio.

The goal of WHRI, which already owns a television station in Hawaii, is to be on air by December 1993. Its curtain array will operate on nine to 18MHz, but due to propagation problems during daylight hours, a smaller antenna will be used for the Pacific broadcast.

Shown here are people in Ceel Buur in central Somalia, as they tune into the BBC Somali Service's reports about fighting in Mogadishu. The 'Missing Persons' programme also has a large listening audience. (Photo credit Hamish Wilson.)

Japan using BBC relay

Radio Japan is using the facilities of the BBC transmitter at Skelton in the United Kingdom, to broadcast into the Middle East, Europe and Africa. Following a series of test broadcasts, the relay is now in regular operation. Transmissions are on 9670 and 9695kHz, 0400 - 0800UTC and on 9770kHz, 0400 - 0600. Broadcasts in English are heard between 0500 - 0600 and 0700 - 0800. Other transmissions in English are 2100 - 2200 on 11,735kHz and 2300 - 2400 on 6025 and 6160kHz.

Radio Japan is interested in the reception of its new BBC relay, and is requesting reception reports to Radio Japan/NHK Tokyo, 150-01, Japan.

Russian AWR transmitters

Recently Adventists World Radio began broadcasting to Europe over Radio Moscow facilities. The broadcasts are coordinated in a studio near the edge of Red Square in Moscow.

AWR is using three different transmitters for these new broadcasts. A 250kW transmitter at Samara reaches into Scandinavia and Northern Europe; from Ekaterinburg a 200kW transmitter targets the countries of Germany, Poland and Czechoslovakis; and a 250kW transmitter located in Moscow will broadcast to Rumania, Yugoslavia and Italy. This quick expansion for AWR has brought along with it some tough new challenges.

New studios and equipment are being organised, personnel are being recruited and trained, and the programme distribution system is being streamlined.

English is broadcast on 0430 - 0500 on 15,125kHz; 0600 - 0630 on 11,775kHz, and 1600 - 1630 on 15,125kHz.

ELWA returns to shortwave

During 1990, the Civil War in Monrovia resulted in the giant complex of VOA being completely destroyed — the same fate suffered by ELWA, the well-known gospel broadcaster. The Voice of America has remedied the situation somewhat by opening four 100kW transmitters in Botswana, while ELWA is back in Monrovia and is operating on FM.

ELWA has been quick to return to the devastated city and its FM broadcasts are operating 20 hours a day, giving good local coverage.

When the staff returned, they found that nearly all the facilities were destroyed; studios were levelled, transmitters demolished and generators smashed. The only salvageable items were a few antenna.

Its plans for the future include the installation of two 10kW shortwave transmitters which will enable ELWA to again reach the 25 West African language groups it served in the past.

It will be received worldwide by shortwave listeners, as it has been over the past 37 years of operation. ELWA did not miss a day's broadcasting except for the Civil War, and was back in operation in January 1992 after 18 months of silence.

AROUND THE WORLD

ALASKA: KNLS Anchor Point has announced its schedule which is valid to March 27, 1993. English is broadcast at 0800 - 0900 on 7365kHz, and 1300 - 1400 on 11,580kHz, but from September 27 this will be changed to 7355kHz. Other languages up to September 26 are: Russian 0900 - 1000 on 11,820kHz; Mandarin 1000 - 1200 on 9600kHz; Russian 1200 - 1300 on 7365kHz and 1600 - 1800 on 9615kHz. From September 27, broadcasts up to 1300 will be on 7365kHz, up to 1700 on 7366kHz, then to 1800 on 6150kHz.

AUSTRALIA: Radio Australia is testing on the very high frequency of 25,750kHz at 0800 - 0900 daily. The tests are from the Darwin 250kW transmitter and are being sent on a polar path so that scientific investigations can be carried out on the performance of the signal. Radio Australia's 'Communicator', a programme on the latest developments in the media and communications world, is heard on Tuesday at 0930 and repeated at 1130, with the best reception being on 9580kHz for both transmissions. At 1130 transmissions are also heard on 6080, 7240 and 9710kHz.

BOLIVIA: Radio Fides from La Paz carries a transmission of request music in Spanish up to 0600 on Sunday. The frequency of 4845kHz has been received with the alternate channel of 6155kHz providing fair preception.

BOTSWANA: The Voice of America is operating four 100kW transmitters, and these have been heard from 0400 - 0700 carrying English programmes, some at very good strength. At 0500, 9885 and 15,600kHz are the best channels received. Earlier at 0400 - 0500, the English Service is on four frequencies: 7265, 7280, 9885 and 11,940kHz, but only 9885kHz is audible in this area. A special verification card is being issued for VOA Botswana, and reports should go to the Voice of America, Washington DC 20547, USA.

GUATEMALA: Station TGNA, a gospel broadcaster with the call sign standing for 'Telling Good News Abroad' is heard on 3300kHz with English up to 0430. This is audible mainly in the winter months, but there is an alternative broadcast available at 1100 in a local language.

NEW ZEALAND: Print Disabled Radio, Levin ZLXA is now being widely received in the South Pacific on two frequencies. The normal evening broadcast is at 0600 - 1000 Monday to Friday, on 3935kHz using 1kW. ZLXA's new frequency is 7290kHz, operating Sunday to Thursday from 2200 through to 0600 the next day. Despite its small 250 watts of power, it has been reported from Australia in its initial test. Reports are requested, along with return postage, to ZLXA, PO Box 360, Levin.

TONGA: The Tonga Broadcasting Commission's transmitters were struck by a hurricane late last year and put out of service. Its mediumwave outlet of 1017kHz was soon back in operation, but the shortwave transmitter on 5030kHz was in a different building which was severely damaged.

Early plans were announced to move the shortwave transmitter of 1kW to the mediumwave building and this has been accomplished. However, it has now been found that the transmitter has some faults. It is not on the air at the time of preparing this material, but when it returns, it should be heard closing at 1000. There have been reports from North America of reception of Tonga on 5030kHz but it is obvious that the listener is tuned to the Solomon Islands on 5020kHz.

UKRAINE: Radio Ukraine International, Kiev, has English to Europe and North America 0000 - 0100 on many frequencies, with 12,040 and 12,060kHz giving the best reception. The station, previously known as Radio Kiev, is requesting reception reports on these transmissions.

UZBEKISTAN: Radio Tashkent has a new morning service to Asia which is giving good reception in the South Pacific. The broadcast in English is at 0100 - 0130 on 7235, 7325, 9740 and 11,975kHz, with the last channel giving the best reception.

BBC Somali service

In war-torn Somalia where there is chaos, famine and no Government, the main source of local news for the population is the BBC Somali Service.

Interesting items from one of the refugee camps in Ethipia indicate that the keenness to listen is such that one Somali exchanged his food ration for some batteries so he could tune in the BBC.

In a country starved of food, shelter and health care, the BBC brings information, education and entertainment in the language of the people. Its Missing Persons programme, on the air six days a week, provides a vital link for families torn apart by war and famine.

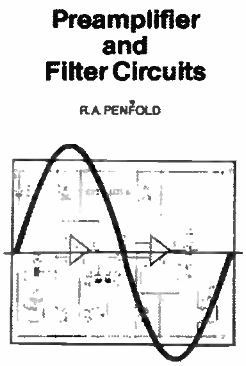
The broadcasts in Somali commenced in 1957, and are now broadcast one hour a day. The Somali Broadcasting Service is listed as broadcasting on mediumwave from Mogadishu using 962kHz with 150kW, and on shortwave 7200kHz with a schedule 0300 - 0500, 0900 - 1200 and 1500 - 1900.

It is interesting to note that Radio Omdurman in the Sudan is also using 7200kHz, and has been received at 1745 when testing its 100kW transmitter. ❖

This item was contributed by Arthur Cushen, 212 Earn St. Invercargill, New Zealand who would be pleased to supply additional information on medium and shortwave listening. All times are quoted in UTC (GMT) which is 10 hours behind Australian Eastern Standard Time.

Electronics Australia

BOOKSHOP

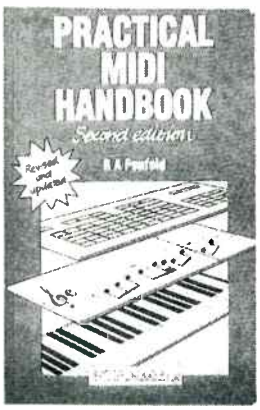


Preamplifier and Filter Circuits
This book provides circuits and background information for a range of preamplifiers, plus time controls, filters and mixers. The circuits described are simple and previous experience of electronic project construction is not needed.
CODE: BP 3090 PRICE: $11.00

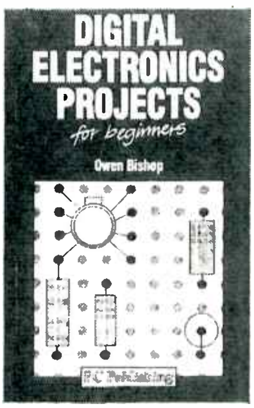
Practical Digitial Electronics Handbook
This book introduces digital circuits, logic gates, bistables and timers as well as microprocessers, memory and input/output devices. It will prove invaluable to anyone involved with the design, manufacture or servicing of digital circuitry.
CODE: PC 1004 PRICE: $21.95

Introducing Digital Audio, CD, Dat and Sampling. - Second Edition:
This book bridges the gap for the technician and enthusiasts who have worked with audio circuits. It includes oversampling methods and bitstream techniques and technical terms.
CODE: PC 1007 PRICE: $19.95

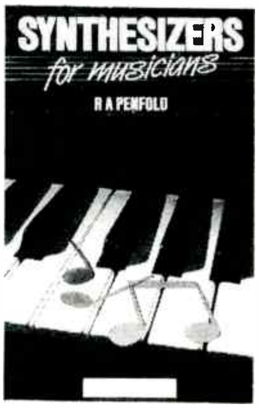
Computers and Music - An Introduction:
This book explains how to simply set up your own computer music studio. It covers the basics of computing, running applications programs, wiring up a MIDI system plus everything about hardware and the programs.
CODE: PC 1006 PRICE: $23.95



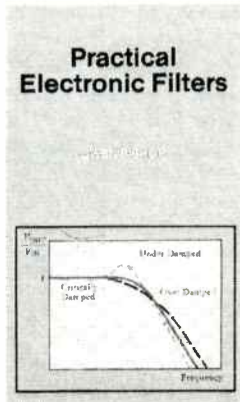
Practical MIDI Handbook
Refers to the powerful capabilities of MIDI and how to exploit it, with no knowledge of electronics or computing. It reviews the latest developments in MIDI covering keyboards, drum machines, sequences, mixers, guitars etc.
CODE: PC 1002 PRICE: $21.95



Digital Electronic Projects for beginners
This book provides simple, yet detailed instruction on practical projects. Covering instrumentation to home security plus circuit diagrams, this reference book also offers 'fun' projects for newcomers to electronic construction.
CODE: PC 1011 PRICE: $18.95

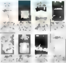


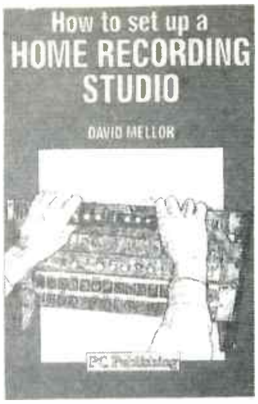
Synthesizers for Musicians
Written especially for musicians, this book explains how to get the best from your synthesizer or sampler. If you want to go beyond using the factory presets or the random poking of buttons, then this is the book for you.
CODE: PC 1003 PRICE: $18.95



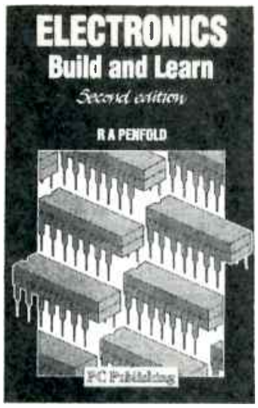
Practical Electronic Filters
Practical Electronic Filters explains in a simple form, the understanding of how to work a filter. It presents projects to apply in and around the home, including diagrams that are suited to the beginner and a more advanced constructor.
CODE: BP 2990 PRICE: $13.00

BOOKSHOP

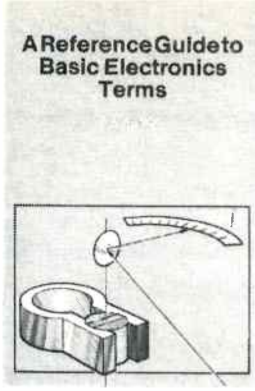




How to set up a home Recording Studio
If you have a studio at home or are about to set one up, this book is for you! It describes the setting up of an 8 to 16 track studio with an outline of the musical and recording gear needed.
CODE: PC 1009 PRICE: $21.95



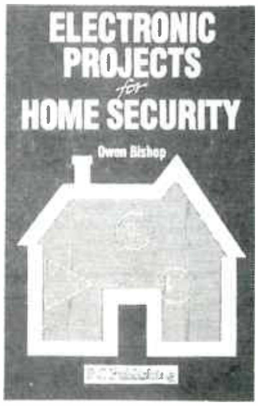
Electronics - Build and Learn
This book is the perfect balance of theory & practice. It introduces common electronic components and how they are built into useful circuits. An essential for the beginner, providing practical tests and experiments.
CODE: PC 1008 PRICE: $18.95



A Reference guide to Basic Electronic Terms
A comprehensive A to Z guide of electronic terms. This book chooses and explains some of the more important fundamental terms (over 700), making the explanations easy to understand and avoiding high level mathematics.
CODE: BP 2860 PRICE: $16.00

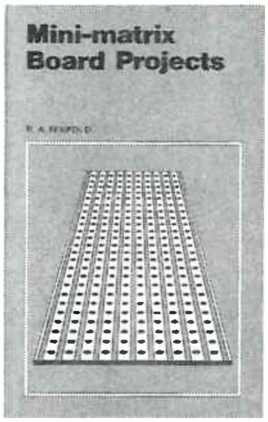
EVERYDAY ELECTRONICS
DATA BOOK
Mike Tooley BA

Everyday Electronics Data Book
This book is an invaluable source of information of everyday relevance in the world of electronics. A must for everyone involved on electronics who wants to put theory into practice.
CODE: PC 1012 PRICE: $26.95



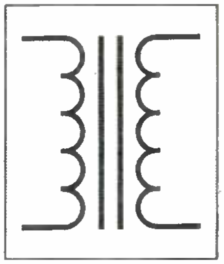
Electronic Projects for Home Security
This book deals with the many aspects of home-security and how to construct your own security system. It covers the latest in technology, whilst remaining simple and reliable in its instruction.
CODE: PC 1010 PRICE: $21.95

Electronic Power Supply Handbook
This book covers the topic of electronic power supplies, including batteries, simple AC supplies, switch-mode supplies and inverters. Subjects dealt in detail are devices, their operating principles and typical circuits.
CODE: PC 1001 PRICE: $23.95

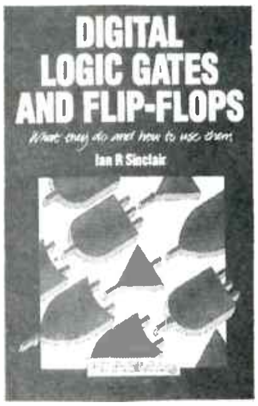


Mini Matrix Board Projects
This book provides you with 20 useful and interesting circuits, all of which can be used on a mini matrix board, which is just 24 holes by 10 copper strips.
CODE: BP 9900 PRICE: $6.50

Coil Design and Construction Manual
B B BABANI



Coil Design and Construction Manual
A unique book for both the professional and home constructor on 'How to Make' your own R.F., I.F., Audio and Power coils, chokes and transformers etc.
CODE: BP 1600 PRICE: $6.50

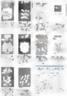


Digital Logic Gates and Flip-Flop
Intended for enthusiasts, this book aims to provide a firm understanding of gates and flip-flops thoroughly and from the beginning. It is for the user who wants to know more than a few rules of thumb about digital circuits.
CODE: PC 1013 PRICE: $26.95

The PC Music Handbook
This book takes the reader through the creative possibilities of the personal computer. Full of practical tips on equipment plus explanation of sequencing, sampling and notation.
CODE: PC 1005 PRICE: $28.95

HOW TO ORDER

To order, simply fill in the coupon, remembering to include the code numbers and $5.00 postage and handling. If the coupon is missing, write down the names, code numbers and prices of the books you require. Include your name, address, phone number, plus cheque, money order or credit card details (card type, card number, expiry date and signature) and send it all to Federal Publishing, Reply Paid No. 3, PO Box 199, Alexandria, NSW 2015. Please allow at least 28 days for delivery and please sign all orders.



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.

October 1942

Radio licences: The latest return of broadcast listeners' licences shows that South Australia has 22.51 licensed radio receivers to 100 people.

Western Australia is next with 19.73, Tasmania has 19.56 and Victoria 19.14. New South Wales has a percentage of only 17.94.

The total number of licensed sets throughout the Commonwealth at July 31st last was 1,330,619, an increase of 10,546. Half this increase resulted from new provisions requiring operators of more than one radio receiver to obtain a supplementary licence.

Picturegram service suspended: The picturegram service, by means of which facsimiles of photographs, prints and all kinds of documents may be transmitted telegraphically between Melbourne and Sydney is to be suspended for the duration of the war.

The facility has been in operation nearly 14 years, and the maintenance of the service under present conditions represents a serious problem to the departments because of the difficulty of securing replacement parts.

October 1967

Microcircuits: Nowadays, just about every news-sheet and technical journal related to electronics is heavy with articles on microcircuits, integrated circuits or ICs — call them what you will. To copywriters they are 'new and exciting', but I suspect that a good many technically involved people — and certainly hobbyists — basically resent their appearance. Transistors took some getting used to, but they were distinct components, large enough to be handled and capable of being incorporated individually into design.

But ICs, with their circuitry concentrated onto a single microscopic chip, make the best efforts of circuit designers to date look unspeakably clumsy by comparison.

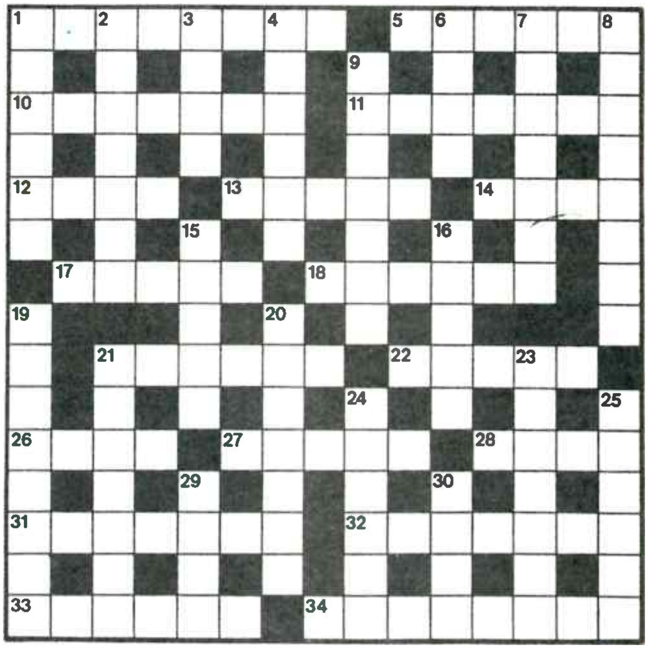
Like it or not, microcircuits are destined to dominate electronics. We may as well move over now!

Seismic centre in Sydney: A $1m seismic data processing centre has been opened in Sydney by Texas Instruments to speed oil search and other geophysical work in Australia.

It will provide the first advanced seismic services in Australia. Previously, all data requiring extensive processing had to be shipped out of Australia.

The computer, called a digital seismic data processing unit, eliminates much of the cluttered information contained in seismic data. It does this at high speed and produces a chart which depicts the significant contours of subterranean areas more clearly than has previously been possible. The use of Texas Instruments' technique in Canada had pinpointed oil-producing structures so accurately that about 80% of wells drilled produced oil. ❖

EA CROSSWORD



ACROSS

1. Central part of IBM. (8)
5. Colloquial term for telephone. (6)
10. That which denotes a number. (7)
11. Coupling device. (7)
12. A form of capacitor structure. (4)
13. Aims sensor or beam across a surface. (5)
14. Type of rectification, —— wave. (4)
17. Subject to analysis. (5)
18. Titanium ore. (6)
21. French scientist, Blaise ——, noted for hydrodynamics law. (6)
22. Repetitive parts of computer program. (5)
26. The —— switch is mercury based. (4)
27. Operational problem. (5)
28. Selenography is the study of the ——. (4)
31. Silhouette of a circuit, etc. (7)
32. Items that lift and separate. (7)
33. Type of antenna. (6)
34. The last word in IBM's expansion. (8)

DOWN

1. Said of two-digit notation. (6)
2. Measures values of variables. (7)
3. Accepted average standard. (4)
4. Join tape, etc. (6)
6. Metal used in solder. (4)
7. Power rating. (7)
8. Said of space in Geissler tube. (8)
9. Metallic element number 72. (7)
15. Word in logic table. (5)
16. Said of one of an ellipse's axes. (5)
19. Country of origin of Alexander Bell and James Maxwell. 8)
20. Add-in vocal system. (7)
21. New name for handheld computer. (7)
23. Communication from public to radio station. (5-2)
24. Ionised gas. (6)
25. Well-known brand of computer. (6)
29. American gospel music with blues blend. (4)
30. Composer of keyboard (or clavier) music. (4)

SOLUTION FOR SEPTEMBER

EA with ETI marketplace

ADVERTISING RATES FOR THIS PAGE

SMALL ADS: The minimum acceptable size of 2 centimetres x one column costs only $50. Other sizes up to a maximum of 10 centimetres are rated at $30 a centimetre. **CLASSIFIEDS:** $4 for 40 letters. Just count the letters divide by 40 and multiply by $4, ROUND UP TO THE NEAREST WHOLE NUMBER. **CLOSING DATE:** Ads may be accepted up to the tenth of the month two months prior to issue date. **PAYMENT:** Please enclose payment with your advertisement. Adress your letter to: **THE ADVERTISING PRODUCTION MANAGER, ELECTRONICS AUSTRALIA, P.O. BOX 199, ALEXANDRIA NSW 2015 FAX: (02) 693 9997**

FOR SALE

T.V.YOKE EXCHANGE
Prompt service.
Refer transformer rewinds this page.
Phone (065) 761 291
Fax (065) 761 003

UNUSUAL BOOKS: Fireworks, Locksmithing, Radar Invisibility, Surveillance, Unusual Chemistry and More. Send SASE for catalogue to : Vector Press, Dept E, PO Box 434 Brighton SA 5048.

WEATHER FAX PROGRAMS: For IBM XT/AT's *** "RADFAX2" $35, is a high resolution, shortwave weather fax, morse & RTTY receiving program. Suitable for CGA, EGA, VGA & Hercules cards (state which). Needs SSBhf radio & RADFAX decoder. *** "SATFAX" $45, is a NOAA, Meteor & GMS weather satellite picture receiving program. Needs EGA or VGA, & "WEATHER FAX" PC card. *** "MAXISAT" $75 is similar to SATFAX but needs 2mb of expanded memory (EMS 3.6 or 4.0) & 1024 x 768 SVGA card. All programs are on 5.25" or 3.5" disks (state which) + documentation, add $3 postage. ONLY from M. Delahunty, 42 Villiers St, New Farm 4005, Qld.
Ph (07) 358 2785.

MY AUSTRALIAN DESIGNED: Low cost super fast Z80 micro-controller development system has gained acceptance already with educational institutions. Pop it on the end of any PC MSDOS or Z80 machine and away you go. Boards, EPROM, and 720K disk $76 including postage for a short form kit. Gee, I wish I had this when I was a kid. For more info. send a 45¢ stamp to Don McKenzie 29 Ellesmere Cres Tullamarine 3043.

FIX-A-KIT
KIT REPAIR AND CONSTRUCTION
3 months warranty on repairs
12 months warranty on construction.
technical assistance.
HYCAL ELECTRONICS
Design, Manufacture, repair of electronic equipment
(02) 633 5477

SELL OLD RADIOS: Valves, Keys, Transformers, Books 07 356 6052.

OVER 4000 PRINTER BUFFER KITS: sold from home since Jan 85. A 4Mb SIMM/SI PP version can be built with only 7 additional common chips. Z80 based. Speeds from 4 to 10Mhz. Short form kit $52. For more Info send 45c stamp to Don Mckenzie 29 Ellesmere Cres Tullamarine 3043.

AMIDON FERROMAGNETIC CORES: For all RF applications. Send business size SASE for data/price to RJ & US IMPORTS, BOX 431 KIAMA NSW 2533. Agencies at Geoff Wood Electronics, Sydne: Webb Electronics, Albury: Assoc TV Service, Hobbart: : Truscott Electronics, Melbourne.

8051 MICRO-COMPUTER /PROTOTYPING PCB $30: Similar to my ROMLoader EA Jan 92. Provisions for 8255 PPI,9346 EEPROM, 2k - 32k SRAM, 2k - 32k EPROM, MAX232, DIP switches & expansion header. Send A4 SAE for article. Tantau PO Box 206 Gordon 2072.

CIRCUIT SIMULATION
Learn it the friendly way with the best student software
Micro-Cap III analog $65
Micro-Logic II digital........................$65
and top books by respected authors:
Electronic design,
circuit and systems $46
Digital Microelectronics...................$46
All post free in Australia
p.s We support our student customers!
Call David on (02) 639 3507
David Spalding Pty Ltd
458 Blackett Dr. Castle Hill NSW 2154

TRANSFORMER REWINDS
ALL TYPES OF TRANSFORMER REWINDS
TRANSFORMER REWINDS
Reply Paid No.2, PO Box 438 Singleton, NSW 2330. Ph: (065) 76 1291, Fax: (065) 76 1003

DESIGN & DEVELOPMENT
The "ONE OFF " Specialists
DALEY ELECTRONICS PTY. LTD.
ACN 005 279 809
84 Keys Rd Moorabbin (03) 555 5153

SIMPLE IBM PC DATA ACQUISITION AND CONTROL: C001-Plans and software for a one chip, 8 channel analog to digital converter that plugs into the printer port. Suitable for laptops or desktop-$25.00 •C002-A small, 15 degree per step, unipolar, stepper motor plus plans for a one chip printer port interface and software source code showing how to drive the motor in wave, full step and half step modes-$25.00•C003- Plans and software for a remote four button keypad. Uses the serial port, no external power required-$25.00. All prices include post and packing within Australia. To order send cheque or money order to lambda systems PO Box 259 Unanderra NSW 2526 or send SSAE for more info.

WANTED

OLD MICROPHONES FOR COLLECTOR: Ribbons, Carbons, Condenser from Broadcast and PA.
John Henderson 09 279 1234

LEGIBLE COPY: Audio IC OP AMP Applications, by W.G.Jung, pref 3rd ed., Pub. Howard Sams. Will pay new price or neg. Offers please: PO Box 65 Hall, ACT, 2618. (06) 230 2429

TRAEGER SSB 100: Channel kit for 2MHz, preferably 2020KHz or complete transceiver if price is right. Contact Nic Mclean (08) 261 3977
Fax (08) 266 3477

RCS RADIO PTY LTD
Established 1933
IS THE ONLY COMPANY WHICH MANUFACTURES & SELLS EVERY PCB & FRONT PANEL published in EA & Silicon Chip.
651 Forest Road. Bexley 2207 AUSTRALIA
RING (02) 587 3491 FOR INSTANT PRICES.

KIT REPAIRS
Kits repaired from all magazines.
Switchmode power supplies repaired.
Design work from start to finish.
Computer software consultancy.
Ring anytime 9am-9pm Mon-Sun
EEM Electronics
10 Bouverie Place, Epping Vic 3076
(03) 401 1393

Send Postage Stamp For List Of Other Items Including Valves • Send Postage Stamp For List Of Other Items Including Valves
Send Postage Stamp For List Of Other Items Including Valves

Amateur Radio News

35th JOTA this month

The 35th annual Jamboree on the Air (JOTA) is being held this month, on 17-18 October, and is expected to involve some 400,000 scouts and guides around the world.

In Australia about 40,000 boys and girls are to take part in this international activity, thanks to the co-operation of radio amateurs and electronics/computer enthusiasts. JOTA is the high point in the radio scouting calendar, and some 160 JOTA stations are planned to be operating in NSW alone.

The importance of JOTA has been recognised by the World Federation of Great Towers (WFGT), which is staging its Children's WorldCom Day on October 17 to associate it with the Jamboree. Included in the 17 towers taking part in the WFGT event will be the Sydney Centrepoint Tower and the Telecom Tower in Canberra.

The Centrepoint Tower operation is being staged by the Bankstown Amateur Radio Club, in conjunction with the Central Sydney area of the Scout Association.

WA holding 'Hamfest 92'

Alex Petkovic VK6APK, of the Northern Corridor Radio Group in Western Australia, has advised that the Group will be staging 'Hamfest 92' on Sunday November 1st. This year's event is expected to be the largest yet seen in WA, and as in previous years entry will be free.

Further details are available from the NCRG by contacting the Group's station VK6ANC, or by mail to PO Box 244, North Beach 6020.

Going overseas?

Want to be recognised as an amateur wherever you go? The WIA's Federal Office has on hand stocks of the Institute's badge, in the internationally recognised diamond shape. There are two versions, the standard diamond badge, and one with space to have your own callsign engraved.

Both versions can be obtained through the WIA's Divisional Bookshops for $4.00 each. If not in stock already, the Bookshop Officers will be happy to get them in for you.

New radio club in NE Adelaide

The North East Radio Club (NERC) is a relatively new group operating in the north-eastern suburb (Tea Tree Gully) area of Adelaide. It is affiliated with the WIA, and has established a club station with the callsign VK5GRC.

Goals of the club are to bring together people with a common interest in electronics and radio communication, and to increase public awareness of the role of licensed radio amateurs.

Membership is open to people of all ages, with the common interest — ranging from junior experimenters, through scanner and shortwave listeners, CB radio operators and radio amateurs.

Club activities include training, technical assistance, lectures, field days and running a technical reference library.

Club president is Peter VK5ZFW, with Rob VK5KP as chairman of the membership committee.

Further information is available from the North East Radio Club Inc., PO Box 568, North Adelaide 5006.

Morse exams

The WIA Exam Service reports that some candidates are failing simply from nerves, rather than from lack of ability to receive Morse code.

One of the main hopes of the devolved system was that in smaller groups and in familiar surroundings, candidates would be more relaxed and so able to perform better.

Most examiners go out of their way to make conditions comfortable for candidates, some of them playing the practice section two or three times to help settle the nerves before the actual test is run. Others have taken considerable trouble to ensure the best possible quality reproduction of the tapes.

The Exam Service sends its thanks to those who have made so much effort for the sake of amateur radio's new recruits.

It also sends a word of advice to those candidates who are practising sending Morse code by automatic means: the regulations say that the candidate must demonstrate the ability to send 'by hand', so go back to the old key and practise on it, before you attempt the examination! ❖

Electronics Australia's

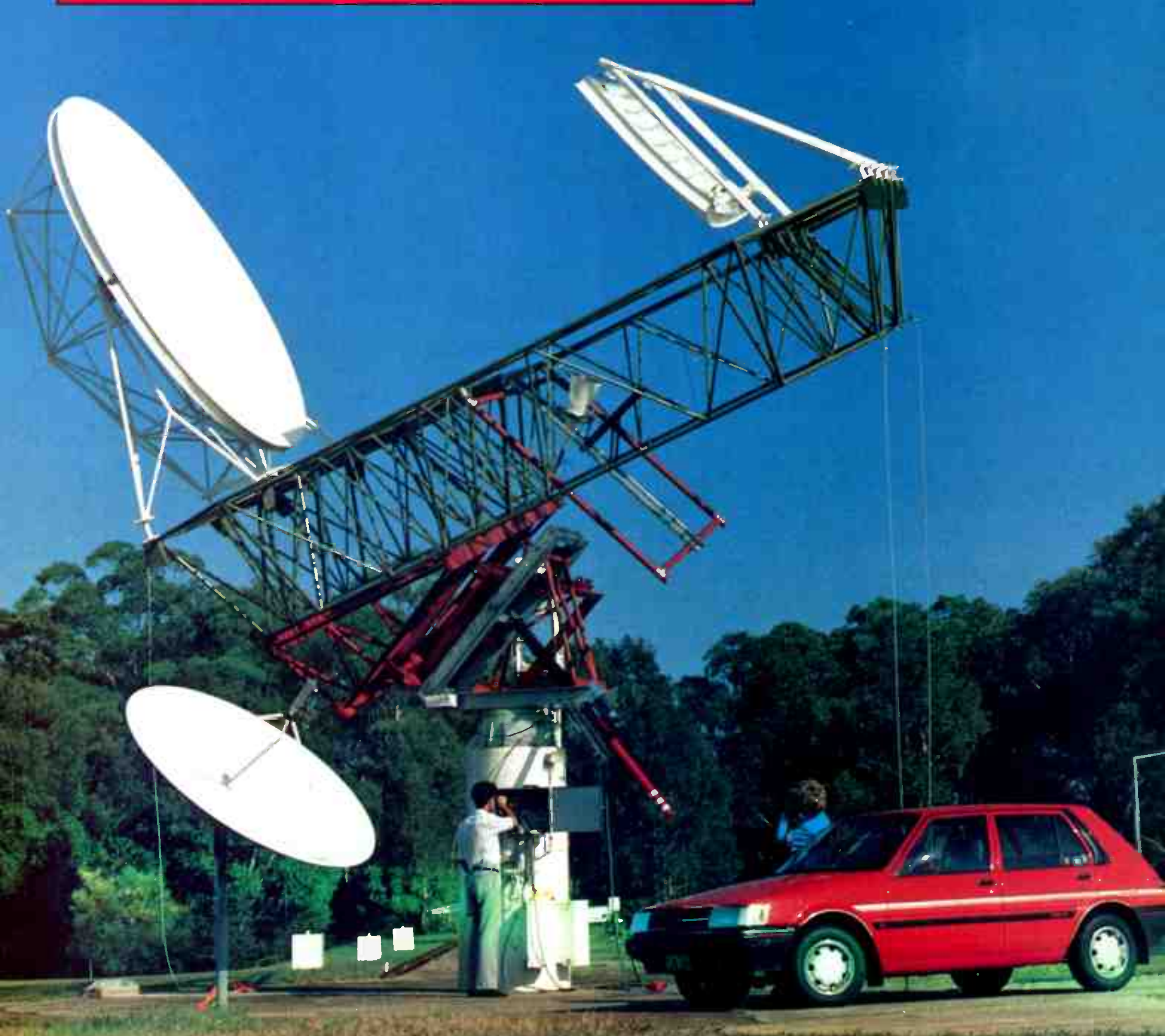
Professional Electronics

S • U • P • P • L • E • M • E • N • T

REVIEW OF DADiSP 3.0: DATA ANALYSIS/DISPLAY PACKAGE FOR PC'S

TEST & MEASURING INSTRUMENTS FEATURE

RF SIGNAL GENERATORS: KEY PARAMETERS



TESTING CSIRO'S MULTI-BEAM SATELLITE ANTENNA

Professional Electronics

NEWS HIGHLIGHTS

CSIRO DEVELOPS MULTI-BEAM SATELLITE ANTENNA

Until now, one of the limits to the growth of communications and broadcasting via satellites has been the cost of antennas — in terms of both money and 'real estate'.

Parabolic dish antennas must generally be used, in order to achieve sufficient gain, and conventional designs have sufficiently narrow beam widths that a separate dish must be used for communication with each satellite.

However this has now changed. Australia's CSIRO Division of Radiophysics, with support from the Department of Defence, has developed a novel multi-beam antenna which provides a cost-effective way to access more than one satellite using a single antenna.

A development from the traditional Cassegrain system, the new antenna uses an offset secondary reflector and special shaping of the reflectors to allow them to be used by multiple feedhorns. For a particular orientation of the reflectors, each feed horn can be positioned to access a different satellite.

Tracking or moving to a different satellite can be done merely by moving the feed horns, using low power positioners, while additional satellites can be accessed by adding further feed horns.

The Division has constructed a prototype antenna with a 3.6m diameter primary reflector (pictured), built using a fast method of manufacturing reflector panels for doubly-curved asymmetric surfaces.

Tests have shown that the approach yields antenna efficiencies of greater than 70% over 94% of the coverage arc.

The prototype antenna is designed for the 11 - 14.5GHz band and covers any 20° of the geostationary arc (including inclined orbits up to +/-3°). Gain at 14.5GHz is 53.3dB, and that at 11GHz is 50.9dB.

Talks for commercial development of the antenna are under way, according to CSIRO team leader Dr Trevor Bird.

MOTOROLA REVISES IRIDIUM PLAN

Motorola Inc has recently announced revised plans for its Iridium system, the proposed global telephone system based on an array of low-earth-orbiting (LEO) satellites. As part of the revision, the number of satellites required has been scaled back from 77 to 66. However the company has also increased the number of channels per satellite, to maintain the system's capacity.

The new plan is estimated to have a cost of US$3.4 billion, a little higher than the original estimate.

The US Federal Communications Commission has awarded experimental licences to Motorola and four other rival consortia, to test their proposed systems via a small number of satellites. One of the other proposed systems is from Loral and Qualcomm, calling for 24 satellites and an estimated cost of only US$1.5 billion.

SONY DEVELOPS BLUE SEMI LASER

Sony researchers have developed a semiconductor diode laser which produces blue light, with a wavelength of 447nm. The diode has an active layer of zinc selenide 48nm thick, with a layer of zinc-magnesium-sulphur selenide on either side — one doped to become P-type, and the other to become N-type.

Currently the laser must be maintained at -196°C, using liquid nitrogen. Sony's researchers are hopeful of developing a version which operates at room temperature, as the availability of a laser with such a short wavelength would allow a considerable increase in the amount of information stored on CD's, CD-ROMs and LaserDiscs.

YET ANOTHER VIRUS FOUND

Melbourne-based virus buster Roger Riordan has uncovered still another nasty virus unleashed in the IBM-compatible DOS PC environment. Dubbed 'Twin Peaks', the new nasty apparently overwrites the first 1310 bytes of infected files, before displaying the message 'Welcome to Twin Peaks. Your PC now has the Twin Peaks Virus'.

According to Roger, initial tests suggest that the virus infects only .COM files, but can infect read-only files. It appears to contain code to rename files. The

NEWS HIGHLIGHTS

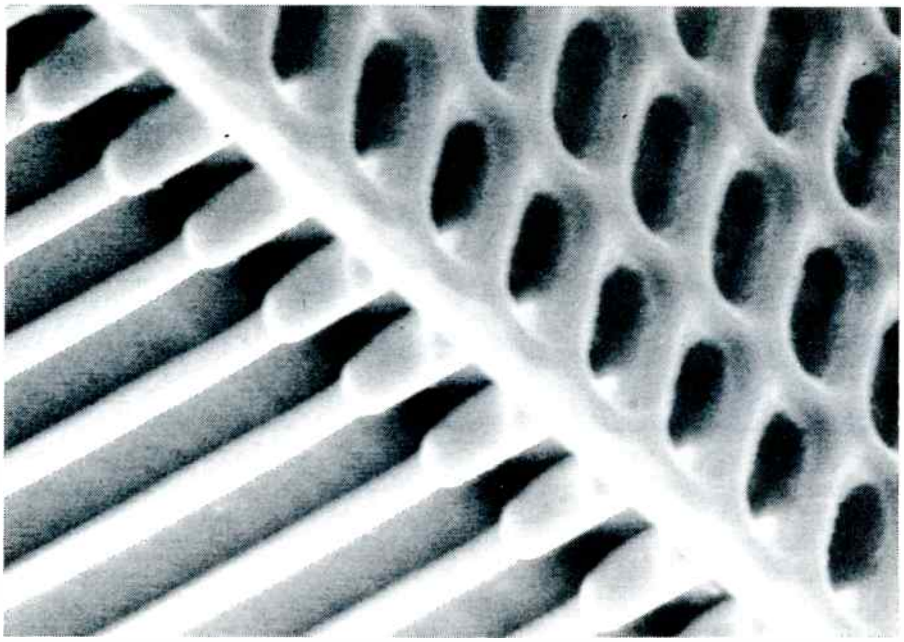
64Mb DRAM MADE BY IBM, SIEMENS

IBM and Siemens have developed a computer memory chip that can store more than 64 million bits of data — four times the capacity of the most advanced memory chip used in computers today. Their goal is to have the chip available for mass production by the mid to late nineties.

The new DRAM chip, which measures 10.7 x 18.1mm, can store the equivalent of about 6000 pages of double spaced typewritten text, and can read all 64 million-plus bits on the chip in a fraction of a second. The chip was developed using an advanced CMOS technology process. The small conductors on the chip measure 0.4 microns in width, or approximately 200 times thinner than a human hair. One of the smallest features is the transistor gate insulator, which measures only 10 nanometres thick.

The chip uses a buried-plate trench cell. The 64-megabit chip, which operates on a single 3.3 volt power supply, employs many novel features that contribute to its high performance and reliability. Among them are borderless contacts that avoid the necessity to provide a border around the metal that forms electrical contacts to specific areas of the chip.

IBM and Siemens began their joint development on the 64 megabit chip in February, 1990. The work is being carried out at the IBM site in Essex Junction, Vermont, and the IBM Advanced Semiconductor Technology Centre (ASTC) in East Fishkill, New York, in the United States of America.



origin is unknown, but it was found on a Melbourne bulletin board, in a file called MIPS.COM.

Needless to say, Roger has incorporated detection for the new virus in the latest update of his anti-viral program VET (V7.0). However due to the way the virus destroys file data, infected files cannot be repaired and must be deleted.

For information in VET, contact Cybec on (03) 521 0655.

SANGEAN RADIO PRIZEWINNERS

The 20 lucky *EA* subscribers who won a Sangean ATS-818CS PLL synthesised 'World Receiver' radio in our April-June subscription promotion, sponsored by Dick Smith Electronics, were:

Mr J. Messenger of Goolwa Beach, SA;
Mr R.M. Russell of Moree, NSW;
Mr Wrightson of Uriadla, SA;
Mr G.R. Skyring of Lutwyche, Qld;
Mr M. Byrne of Bundaberg, Qld;
S. Ceprow of Camberwell, Vic;
Nunawading Adventist College, Vic;
Mr D. Pulford of Forestville, NSW;
Mr D. Horsfall of Wahroonga, NSW;
Mr A.L. Birkett of Parkholme, SA;
Mr D. Gill of Berowra, NSW;
Mr R. Sbrana of Footscray, Vic;
Mr James of Eden Hills, SA;
Mr E. Dasecke of Ravenshoe, Qld;
Mrs I. Hicks of Cranebrook, NSW;
Mr D.C. James of Anula, NT;
Mr Cameron of SAS-7, Gilberton SA;
Mrs M. Dawkins of Bordertown, SA;
Mr Jones of Hamersley, WA; and
Mr S. Campbell of Hughesdale, Vic.

By now all of these winners should be happily enjoying their new multiband AM/FM radios, each of which was valued at $399. Our thanks to Dick Smith Electronics for making these prizes available.

OFFSHORE ISO 9002 PCB ASSEMBLY

A competitive offshore PCB assembly service has been introduced to Australia by Sydney firm, Aaron Pty Ltd. A manufacturing facility near Singapore, under experienced Swiss management, offers reliable low cost PCB assembly. Working to quality standard ISO 9002, the service includes PCB manufacture, component sourcing and door-to-door transport at favourable rates.

The service is ideal for businesses with medium to large volume jobs, with single or double sided through-hole assembly, who feel they could be more competitive on the Australian or overseas markets, or whose insertion machine capacity is overloaded.

"Employing staff in more profitable activities by having the run-of-the-mill jobs executed by outside resources can result in substantial savings and increased competitiveness', says Marketing Manager Walter Schellenberg.

International clients who take advantage of this service include Telefunken, Saba, Nordmende, Turner and IF.

Further information is available from Aaron, 3/2A Pioneer Avenue, Thornleigh 2120; phone (02) 484 8244.

NASA TESTING PERSONAL BEACONS

A group of dedicated Alaskans has started a three year experiment that ultimately could result in saving the lives of thousands of campers, boaters and others. The Alaskans will test the use of a small emergency radio transmitter, known as a Personal Locator Beacon or PLB, to communicate with a 10 year old search and rescue satellite system that, up to now, has been used primarily for aircraft and ship emergencies.

The experiment is being carried out with the cooperation of NASA, the National Oceanic and Atmospheric Administration, the US Air Force and the US Coast Guard.

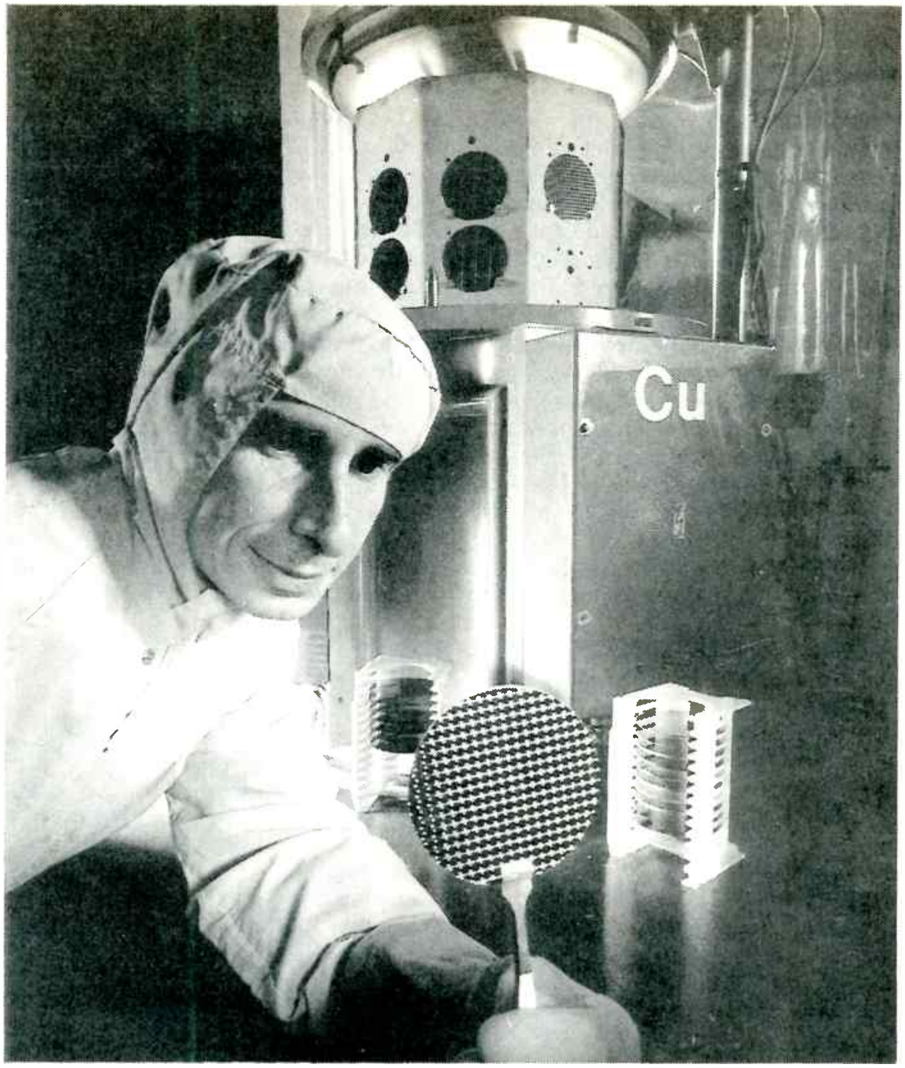
The satellite system, an international program known as COSPAS-SARSAT, has been responsible for saving more than 2300 lives since it was started in

1982. Principal partners in this program are Canada, France, Russia and the US.

The PLB program calls for four low-Earth-orbiting satellites to be in operation. Currently, there are six satellites — three Russian and three US — circling the Earth in polar orbit. However, only four are fully operational, the other two having lost some of their capabilities.

The North Slope Borough is one of the most remote areas of Alaska. It covers 92,000 square miles (an area about the size of Utah) and has what might be described as eight towns and villages. There are no roads to speak of, and travel is accomplished by amphibious vehicle in the summer and by snowmobile in the winter, explained Charles Caldwell, project coordinator for the borough.

Twenty beacons, which currently cost between US$1200 and $1700, will be used in the experiment. The beacons, which transmit the emergency signal on a 406MHz frequency and also have a 121.5MHz signal to allow search parties to 'home-in' on the location will be loaned to qualified applicants.



BNF-Fulmer, a materials research and development company based in Wantage in Southern England, has set up an advanced 'micro-engineering' centre to develop small mechanical components such as pressure sensors and accelerometers. Here a technician checks a wafer of silicon sensors.

AWARD TO NZ'S 'ELECTRONIC' WASHER

A new type of domestic washing machine has won New Zealand's premier scientific award. The Rutherford Award was made to the developers of the Fisher & Paykel Smart Drive, which uses electronics to reduce mechanical complexity to a minimum, and is powered by an innovative long life electric motor.

In making the award to recognise innovation in energy efficiency, judges said the Smart Drive 'uses half the electricity a mechanical clothes washer takes for a cold water wash'. The award was announced to shareholders at Fisher & Paykel's annual meeting, where the Chief Executive, Mr Gary Paykel, said it was a tribute to the multi-disciplinary team who developed the machine, which was introduced to the Australian market in May.

The meeting was told customer demand for the machine on both sides of the Tasman had exceeded expectation, and production was ramping up to produce auto washers at record rates.

The award judges, chaired by Auckland University Professor John Boys, said the Smart Drive was revolutionary because it had the fewest moving parts of any clothes washing machine in the world. As well, the electronic controller constantly monitors each agitator action and fine-tunes it to suit the size of the load.

The innovative brushless DC motor, moulded in high-tech thermo-plastic polyester, which drives the agitator directly through a single shaft, is a world first — conceived, designed and manufactured by Fisher & Paykel.

Fisher & Paykel has signed an agreement with Camco of Canada and GE Appliances of the United States, for both companies to investigate the use of Fisher & Paykel washing machine technology.

CONFERENCE TO EVALUATE WARC '92

The Centre for International Research on Communications and Information Technologies (CIRCIT) in Melbourne is holding a two day Conference in December with wide ranging national and international participation.

The participative framework of the Conference will include:

- general and specialised users;
- new technologies and potential applications industry/system developers and suppliers;
- other representative interests including policymakers, regulators, general carriers; and
- other service providers in the new competitive environments.

to service flow-ons which will be available as a result of the decisions of WARC '92.

A special focus will be the new global/regional systems, such as Low Earth Orbit Satellites (LEOs) and Broadcasting Satellite Services (BSS), and complementary terrestrial digital and high quality systems that will service combinations of domestic and international uses and potential needs.

The Conference is being held on December 2-3, and the cost will be $595.

NEWS BRIEFS

- ***Thomas Electronics*** has been appointed as distributors in Australia for the Electrohome range of video display monitors.
- Dr Katherine Woodthorpe has been appointed to the position of National Executive for the ***Scientific Exporters Group***.
- The second Australian Conference on Telecommunications Software ***ACTS '93*** will be held at the Wollongong University NSW, from February 17-19. Original papers are being sought for presentation at the conference. Further information from the Conference Secretary, IREE Australia, PO Box 79, Edgecliff 2027; phone (02) 327 4822.
- ***Hypertec***'s new address is Unit 4, 112-118 Talavera Road, North Ryde 2113; phone (02) 805 0111.
- As part of its export expansion plan, Melbourne-based anti-viral software developer ***CYBEC*** has given I & J (Perak) Sdn. Bhd of Ipoh the sole rights to distribute VET within Malaysia. After only 2-1/2 years of existence, Cybec now has a staff of 10, up from four one year ago.
- Rockwell Digital Communications Division, a division of Rockwell International, has just appointed Melbourne-based ***Tronic Bits*** as its Australian and New Zealand distributor.

For further information contact Katherine Brain on (03) 616 8888 or fax (03) 616 8800.

OPTUS B1 LAUNCH SUCCESS

The Optus B1 satellite was launched successfully at 9.00am on August 14.

The Chinese Long March 2E rocket lifted off without any hitches and safely delivered the spacecraft into low earth orbit, approximately 200km by 1000km above the earth. The satellite then separated from the rocket 11 minutes after lift-off.

At 11.00am the large solid fuel rocket motor known as the Perigee Kick Motor (PKM) was automatically fired for 125 seconds, sending the spacecraft into transfer orbit (300km by 36,000km above the earth) and on its way to the final geostationary orbit. It was expected that the B1 satellite would reach its final orbit by August 24.

NEW INMARSAT-A STATION FOR INDIA

A new Inmarsat land earth station (LES) has opened in Arvi, near Bombay, India. The Arvi LES, operated by Videsh Sanchar Nigam Ltd (VSNL), India's overseas communications company and Inmarsat's Indian signatory, is the 37th to provide access to Inmarsat's global mobile satellite communications network.

The LES, which will provide Inmarsat-A services for ships at sea and users on land, was formally inaugurated by India's minister of state for communications Rajesh Pilot. Located east of Bombay, the LES provides coverage for all of Africa, the Middle East, Europe and most of Asia and Australia via Inmarsat's Indian Ocean Region Satellite.

The Inmarsat-A mobile satellite communications system provides direct dial telephone, facsimile, telex, e-mail and data communications to more than 18,000 users worldwide. Although Inmarsat-A satellite terminals have been designed primarily for use on board ships, land transportable models are available for a wide range of applications for the news media, relief workers and others who frequently operate in remote areas.

"The Arvi LES will be progressively upgraded to provide high-speed data services by the end of this year," said VSNL chairman and managing director, B.K. Syngal, speaking at the opening. "By that time we also plan to commence Inmarsat-C services."

VOLUNTEERS NEEDED BY TADVIC

TADVIC — Technical aid to the Disabled (Victoria) is looking for new volunteers and clients in the Melbourne metropolitan area and country Victoria. TADVIC is a voluntary non-profit cooperative, with nearly 200 members in Melbourne and branches in Ballarat, Bendigo, Shepparton, Geelong and Bairnsdale. New branches in the Latrobe Valley and Mildura hope to be in operation by the end of 1992.

Volunteers are generally qualified tradespeople, engineers, technicians or experienced designers and have access to a workshop. They provide their technical skills for free and clients are asked to meet costs of materials and travelling expenses.

TADVIC's aim is to fill gaps in the disabled equipment market. If a suitable item is not available commercially, TADVIC will usually have a volunteer able to design and make an item to the client's specification. Experience with people who have disabilities is not necessary.

TADVIC's clients have all sorts of disabilities and come from all age groups. Design ideas are developed by the client, the volunteer and a TADVIC Occupational Therapist. Clients are initially visited where the equipment is to be used, e.g., home, work, school, local pool, library, shopping centre or gym. This assists greatly in getting the right design for the situation.

Projects range from simple 'fix-it' jobs to more complex inventions requiring many hours of work. All projects are supervised and coordinated by occupational therapists employed by TADVIC.

Further information on becoming either a TADVIC Volunteer Member or a client can be obtained by phoning Barbra or Philomena at the office on (03) 698 5222 (ask switchboard to put you through to TADVIC), or by writing to TADVIC at PO Box 88, South Melbourne 3205.

ALCATEL TCC WINS MAJOR NEW CONTRACT

A new contract to provide 2400km of cable for SEA-ME-WE2, the longest submarine optical system in the world, has been awarded to Australia's Alcatel TCC, justifying the ambitious expansion program launched two years ago. At that time, the company reached a strategic decision to increase its manufacturing capacity to a production level of more than 6000km per year.

This most recent order is in addition to the 11,000km of optical cable the company is already manufacturing for PacRimEast and PacRimWest. These systems, and the TASMAN 2 cable Alcatel TCC has just installed between Sydney and Auckland will form the 16,500km South Pacific Network, linking the region to the evolving global digital network.

PacRimWest will run between Australia and Guam, with connections to Japan and Asia. PacRimEast will link New Zealand with Hawaii, connecting to North America and Europe. PacRimEast will be operative by March 1993; PacRimWest, by December 1994.

Manufacture and installation of SEA-ME-WE2 (South East Asia-Middle East-Western Europe) will be undertaken by Alcatel Submarcom of France, STC of the UK and AT&T of America.

It will comprise over 18,000km of optical fibre submarine cable, 160 submerged repeaters and branching units, and 18 land based terminals in 13 sites. Operation is scheduled for June 1994.

The portion of SEA-ME-WE2 Alcatel TCC will be manufacturing is slightly longer than TASMAN 2, and the ability to incorporate such a major contract, while still meeting PacRim deadlines is claimed to indicate the level of efficiency at which the company is operating. ❖

[illegible]

NEW PRODUCTS

Low cost butane torch

The Hotery MT-100/T multi-purpose compact butane torch comes with both needle-flame burner and soldering tip attachment, and can be used for precision heating, soldering or as a 'hot knife' for cutting plastic materials.

It uses readily available butane gas, as used in cigarette lighters, and the inbuilt tank can be refilled in about 10 seconds.

A knurled ring on the flow valve allows smooth and convenient adjustment of the torch's heating.

Available from Jaycar Electronics stores (Cat. No. TS-1410), the torch is priced at an attractive $12.95. Replacement soldering tips are also available, for only $9.95.

Microwave transmitter/receiver

Intron Electronics has released a new range of Microwave Modules to complement its existing Doppler Sensor production. The range includes a Microwave source, a Transmitter, Data Receiver, Receiver and a Movement Detector. All Modules are self contained with inbuilt antenna, and control/signal conditioning circuitry and require only a DC supply to be fully operational.

All modules are calibrated to operate in the ISO 2.4GHz band. They can be used for a wide range of applications, including data transmission, security, remote control, traffic control, motion detection, moisture sensing, etc.

Evaluation kits are available and special designs can be produced for high volume applications. The modules are housed in a small plastic casing size 63 x 50 x 20mm, and connections are via a 4 x 0.1" pitch pin connector at the base.

For further information circle 242 on the reader service coupon or contact Intron Electronics, Factory 2/971 Mountain Highway, Boronia 3155; phone (03) 720 1449.

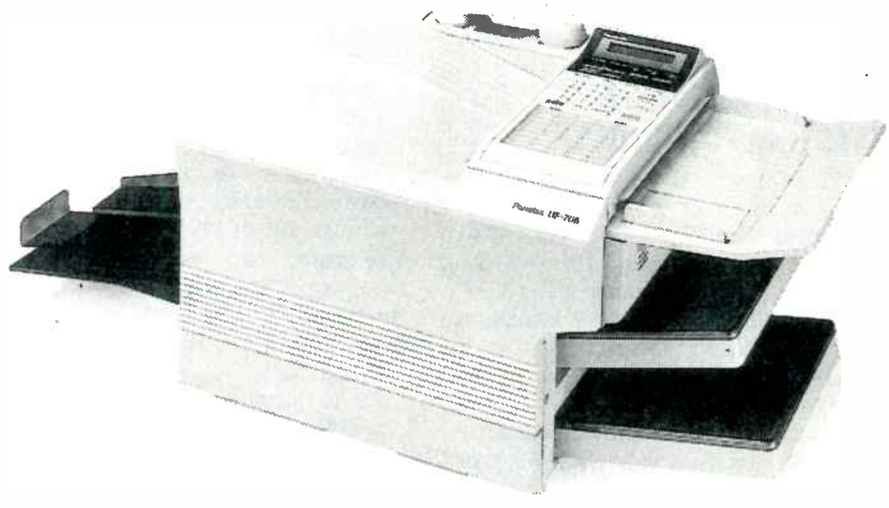
Plain paper laser faxes

Panasonic has launched a new generation of plain paper Laser facsimiles, offering extra features. Panafax model UF-733, for example, offers automatic collation so that pages are received face down and in the correct order.

It also has a consumable status report which indicates when toner, developer and paper are low, so there is less chance of machine downtime when they need replacing.

And to ensure incoming data is never lost during reception, the UF-733 features overlap printing, allowing 10mm bottom to top overlap between split pages.

Like the UF-733, its big brother, Panafax UF-766 has a host of features for its price. Fast scanning stores documents into memory at the rate of three seconds per page. Its dual access capability means that you can scan documents in at any time, whether the UF-766 is already engaged in transmitting or receiving, thus eliminating people needing to queue to send a fax.



The batch transmission feature on the UF-766 uses a program key to reserve non-urgent documents for timer transmission to commonly used destinations. The machine automatically brings documents together and transmits them to the specified station at one time, saving money by using off peak telephone rates.

Recommended retail price for the UF-733 laser fax is $4699, and for the UF-766, $5999.

For further information circle 241 on the reader service coupon or contact Panasonic Australia, 1 Garigal Road, Belrose 2085; phone (02) 986 7629.

E24 resistors

Dick Smith Electronics has announced the availability of the full E24 range of 0.25W metal film resistors for immediate delivery.

The range includes all standard values from 10 ohms to one megohm, with 1% tolerance and 10ppm tempco. Maximum working voltages are 200V at 125°C and 250V at 70°C.

Produced by vacuum depositing selecting metals and passivative materials on to high grade ceramic rods, the devices exceed the requirements of MIL-R-10509F and MIL-R-22684.

For further information circle 243 on the reader service coupon or contact Dick Smith Electronics, PO Box 321, North Ryde 2113; phone (02) 888 3200.

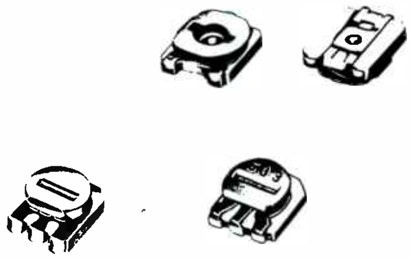
SMD trimmer pots

Murata Manufacturing has released its range of nickel barrier layer construction SMD trimmer potentiometers.

The RVG4H and RVG3A series termination has a better solder wetability, as well as higher solder leaching resistance, with its nickel barrier layer construction. It has an ultra-low profile design with a thickness of 1.5mm, and a light weight of 60mg and is suitable for reflow soldering.

Also suitable for either reflow or flow soldering is the RVG4J03/J04 series with its low profile design (1.75mm) and the extremely small (3.5 x 3.0 x 1.5mm) RVG3A01 series. The resistance range for all types is 100 ohms to 2M with a tolerance of +/-25%, TC +/-250ppm/°C and rated voltage of 50V DC.

For further information circle 244 on the reader service coupon or contact IRH Components, 1-5 Carter Street, Lidcombe 2141; phone (02) 364 1766.



Surge protector

HPM Industries has received an Australian Design Award from Standards Australia for its innovative Surge Arrester. The Surge Arrester, CAT XL777PA, has been designed to replace an existing standard powerpoint, thereby protecting all applicances plugged into any powerpoint on that circuit — upstream or downstream.

After repeated 'clamping' of minor surges or the clamping of a major one, the module within the powerpoint may become overstressed and stop providing protection. If this happens, a light within the module will extinguish and an alarm will sound. Protection is restored by replacing the module. This does not require calling an electrician.

For further information circle 247 on the reader service coupon or contact HPM Industires, 4 Hill Street, Darlinghurst 2010; phone (02) 361 9999.

Dual 20W switching PS

The FLU2-20 is a new series of low profile, dual output, 20W switching power supplies, in a compact 75 x 130mm open frame format with a maximum component height of 30mm.

Three models provide primary output of +5.0V at 3.0A (+/-5% adjustable) and secondary output of 12V at 1.0A, 15V at 0.8A, or 24V at 0.5A.

High performance features of the FLU2-20 include zero minimum load requirement, a universal input range of 85V AC to 265V AC and an onboard EMI/RFI suppression filter that exceeds VDE/FCC Class B requirements by 10dB. The series offers short circuit and over-voltage protection, soft start and a 16ms hold-up time with 115V AC input.

Efficiency for the series is 65% typical, while the line regulation is 0.2% for the primary output of 0.5% for the secondary.

Primary load regulation is specified at 1%, with maximum output ripple and noise at 1%, peak-to-peak. The mean time between failures for the series is 210,000 hours.

For further information circle 249 on the reader service coupon or contact Priority Electronics, 5/23 Melrose Street, Sandringham 3191; phone (03) 521 0266.

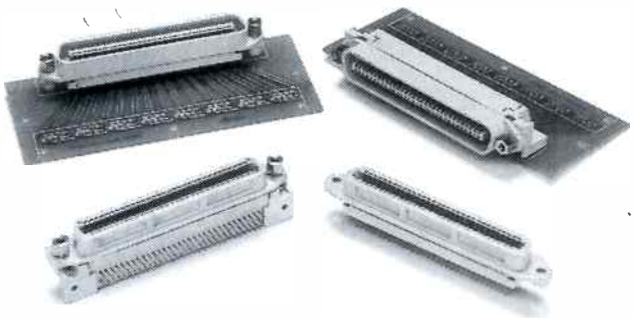
PCB connectors

Viking has extended the Vitel series of connectors to include a comprehensive range of PCB connectors in both straight and right angle versions.

They are designed to meet the stringent demands of the telecommunications industry, and are available in 24, 36, 50 or 64 positions, and also in right angle to standard or reverse orientation.

The Viking connector is designed for flow soldering, and is provided with a choice of either metric or imperial hardware (4 - 40 UNC). The connectors are easily fixed to the printed circuit board by the use of standard or self tapping screws.

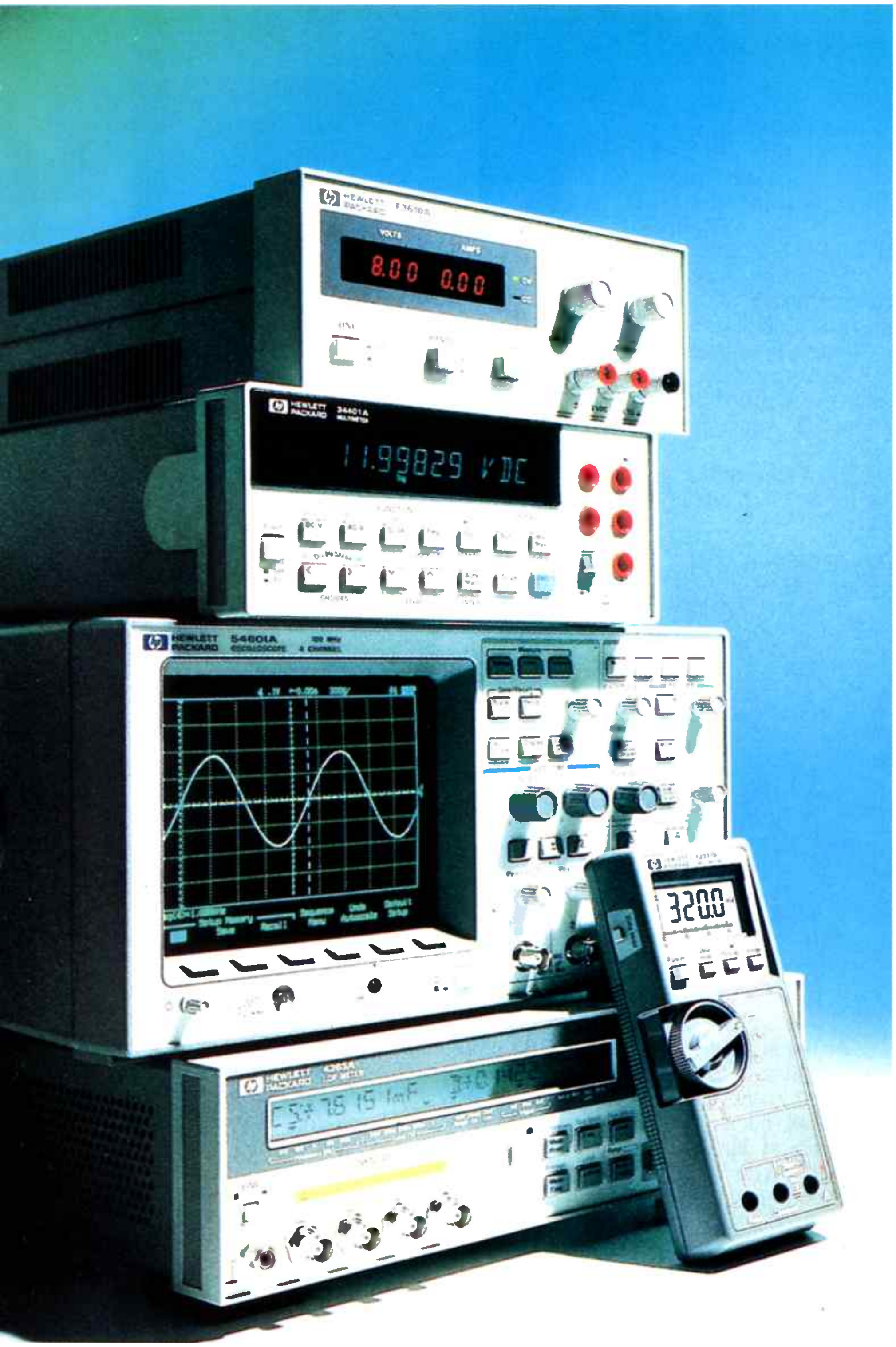
For further information circle 250 on the reader service coupon or contact Alpha Kilo Services, PO Box 180, Lane Cove 2066; phone (02) 428 3122. ❖







Within budget. Without compromise.



With HP basic instruments, performance costs less than you expect.

Now you don't have to accept trade-offs in a basic test instrument. Because HP offers the performance you want at prices you can afford.

Need a dual-range output power supply? The HP E3610 Series makes choosing a 30 Watt DC power supply easy-especially when you consider the low noise and value for money at around $460.

What about a digital multimeter for bench or system use? The rugged 6 or 61/2 digit HP 34401A does both with uncompromised performance for less than $1,635.

You won't find a better 100 MHz digitizing scope than the HP 54600 Series. It combines an analog look and feel with digital trouble-shooting power for around $4,040 (2-channel) or $4,695 (4-channel).

At less than $5,780, the HP 4263A LCR Meter lowers the cost of high precision 100Hz to 100kHz benchtop and system component measurements.

And the 8-function HP E2373A is just one of the HP E2300 Series 3 1/2 digit handhelds priced from $160 to $310.

For more information, call our Customer Information Centre on 008 033 821 or Melbourne 272 2555, and we'll send you a data sheet that shows how affordable performance can be.

A Better Way.

HEWLETT PACKARD

*Prices exclude sales tax.

The latest test and measurement products

Economy 60MHz, 20MHz scopes

Dick Smith Electronics has announced the release of four new oscilloscopes, enhancing its range of Digitor test instruments.

The new models include an economical 20MHz base model analog unit; fully featured 20MHz and 60MHz analog instruments; and an advanced 20MHz analog/ digital model.

The full featured 20MHz and 60MHz models offer component test, beam find and dual timebase facilities, in addition to the usual functions, while the 20MHz digital storage/analog model also features dual 2k x 8 trace buffers with trace roll, save and plot facilities. Prices for the four models range from $699 to $1599.

For further information circle 201 on the reader service coupon or contact Dick Smith Electronics, PO Box 321, North Ryde 2113; phone (02) 888 3200.

Single phase power meter

Yokogawa has released a new single-phase high accuracy AC/DC power meter, intended for appliance power consumption and single-phase power distribution measurement.

Known as the 2534, the new meter is capable of measuring AC and DC power at levels of up to 600V at 20A, to an accuracy of 0.5%. The measuring range is selected automatically, or may be manually controlled. An unusually wide AC input bandwidth of 10Hz to 20kHz allows more accurate power measurement, even in the presence of complex current waveforms such as caused by PCs, fax machines or TVs.

In addition to measuring voltage, current and power, the 2534 can also measure and display apparent power, reactive power, power factor, phase angle, watt hours and frequency from 4Hz to 22kHz. A memory card interface is provided allowing readings to be saved and later plotted, or loaded into a PC. Optional RS232 and GPIB interfaces are also available.

Fur further information circle 202 on the reader service coupon or contact Yokogawa Australia, Private Mail Bag 24, North Ryde 2113; phone (02) 805 0699.

Ultrasonic measurement system

A new measurement system called V-Scope makes it possible to measure position, velocity and acceleration without the need to run wires or cables to the object whose motion is being measured.

The system is analogous to a satellite tracking system. A transponder attached to the body sends ultrasound signals which are received and processed by V-Scope components. These signals are activated by an infrared signal sent from a button on the transceiver tower.

There are three systems available: the VS-40 which can monitor one to four bodies in a single axis, with a maximum sampling rate of 50Hz; the VS-100 which can also monitor up to four bodies, but in one, two or three dimensions, at up to 100Hz; and the VS-110PRO for up to eight bodies in one to three dimensions, at up to 200Hz sampling.

An individual transponder button is required for each body being monitored, as well as a separate tower for each dimension. So the VS-40 has one tower only for 1D motion, whereas the other two systems have three.

The information is first processed by the V-Scope microcomputer (which contains a Motorola 68000 microprocessor), and then connected via the RS232 serial port to an IBM PC or compatible for further processing. As well as logging the information, the PC can also be used to control the V-Scope microcomputer in its 'slave' mode.

The VS-40 configuration costs $850, the VS-100 $4850, and the VS-110PROF $9071. The VS-100 can be purchased in a simplified ID version, the VS-100/1 for $2564, and later upgraded for full 3D measurements. The quoted prices include transport costs.

The latest test and measurement products

For further information circle 203 on the reader service coupon or contact IDM Instruments, 6 Carmen Stree, Dandenong 3175; phone (03) 706 7837.

Polyphase calibration source

University Paton Instruments (UPI) has released a new Australian designed and manufactured precision DC/AC polyphase calibration source.

This new unit, called the 'Examiner Series 3001' has been designed in collaboration with the CSIRO's National Measurement Laboratory, and will be a valuable instrument for laboratories who test and calibrate electrical instruments.

The calibration source combines into one compact unit a polyphase current and voltage standard. Its features include: excellent stability (20ppm); 0.5% accuracy; DC to 100kHz; voltages to 300V phase-to-neutral, 150VA per phase; and currents to 20A (200VA per phase).

The source is also capable of generating arbitrary waveforms, and the calibration of single and three-phase indicating and measuring instruments and transducers, including power and energy. Designed as a fully integrated system, the Examiner series 3001 gives control of all parameters, including phase of all vectors. It is operated via a friendly graphical user interface on a PC.

For further information circle 205 on the reader service coupon or contact University Paton Instruments, PO Box 402, Riverwood 2210; phone (02) 534 6100.

High resolution counter/timer

Thurlby-Thandar's new TF830 high resolution counter timer uses the reciprocal frequency counting technique to achieve high resolution at all frequencies. The system yields at least seven digits of resolution per second of measurement time, and can measure low frequencies to a resolution of 0.001mHz.

The TF830 is also available with the optional RS232 interface, conforming with the Thurlby-Thandar ARC system (addressable RS232 chain).

All front panel functions can be remotely controlled and measurements can be read back to the controller. This makes it suitable for use in a wide variety of automatic measurement systems.

In addition to frequency measurement up to 1.3GHz, the TF830 offers period measurement, frequency ratio, pulse width measurement and event counting. Pulse width measurements can be made from rising to falling edge, or vice-versa.

Using input socket A, frequency can be measured from 5Hz to 25MHz, with resolution 0.001mHz to 100Hz. Socket B measures frequency from 20MHz to 1.3GHz, with resolution from 1Hz to 10kHz.

Period can be measured from 10ns to 1us, pulse widths from 1us to 26s, with a resolution of 100ns. Using sockets A and B, the ratio of two frequencies is displayed as eight digits. The TF830 can operate from disposable batteries or AC line.

For further information circle 204 on the reader service coupon or contact Nilsen Instruments, 200 Berkeley Street, Carlton 3053; phone (03) 347 9166.

Digital barometer

Vaisala's Digital Barometer PA 11 is a precision instrument, providing accurate and reliable barometric pressure measurements over the range of 800 to 1050hPa.

The PA 11 consists of three independently operating aneroid capsules and transducers, controlled by a microprocessor. Triple redundancy ensures excellent long term stability and measurement accuracy, even in the most demanding applications. Each pressure transducer is an aneroid capsule with capacitive elements, installed in a vaccum inside the aneroid, with a pressure-frequency converter controlled by the microprocessor. The aneroid capsule temperature is measured by an internal temperature sensor providing accurate compensation.

The 10 - 28V DC powered barometer has a 4.5 digit liquid crystal display with 12.5mm high digits. It can display the three hourly pressure trend with a plus/minus sign to indicate increasing or decreasing pressure. An audio alarm indicates low battery voltage or an out-of-range transducer.

Interfacing to printer, computer, terminals, automatic weather stations is by a standard serial output.

For further information circle 206 on the reader service coupon or contact Vaisala, 4/8-12 Sandilands Street, South Melbourne 3205; phone (03) 696 5699.

Test & measurement products

Electrostatic voltmeter

Monroe Electronics' model 263 high speed electrostatic volt meter uses a hybrid circuit which combines DC electrometer techniques with AC chopper circuitry, to produce an extremely high speed instrument for accurate measurement of electrostatic and other high impedance sources, without physical contact. Response rates faster than 50 microseconds are possible.

The model 263 incorporates a model 1027 probe, which consists of a standard tuning fork and wideband preamplifier.

This small probe (7.9 x 7.9 x 73mm, with a 1.75mm aperture diameter) is available in both end and side viewing configurations. High resolution and transparent probe configurations are also available.

The range of the model 263 is to 2kV, with autopolarity with a 0.1% accuracy (DC). Readout is via a large digital LCD display, and a recorder output is also provided. Instrument drift is quoted at less than 0.01V per hour, after one hour warm up.

For further information circle 207 on the reader service coupon or contact Zenology Sales, 245 Springvale Road, Glen Waverley 3150; phone (03) 802 0599.

Noise factor meter, source

Hewlett-Packard has introduced two noise-figure-measurement products that aid in design and production test for direct broadcast satellite (DSB) and personal communications network (PCN) system applications. The products are the HP 8970B Option 020 noise figure meter, which has an extended input-frequency range of 10MHz to 2.047GHz, and the HP 346B Option H42 noise source, which offers major improvements in noise-figure accuracy for the 10GHz to 15GHz DBS frequency range. The new products make more precise characterisations of low noise block downconverters (LNB) with almost a 2-to-1 improvement in measurement uncertainty.

The HP 8970B Option 020 performs high-accuracy noise-figure measurements on components for direct broadcast satellites to 2.0476Hz with lower measurement uncertainty, as well as eliminating the need for a costly and complex external downconverter. To match the new 2.0476Hz intermediate frequency (IF) of a LNB, users previously required an external instrumentation local oscillator/downconverter to extend the 1.6GHz upper limit of HP's previous model.

Major features included in the new meter include simultaneous gain and noise figure measurement, second-stage correction, low-instrumentation uncertainty (<0.1dB) and automatic local-oscillator control. For PCN applications, it can also be used for cellular radio systems that operate in the 1.96GHz frequency band, such as digital Europe cordless telephone and Japanese digital cellular. Because it can make direct noise figure characterisations of cellular receivers and components without external downconverters, it provides a distinct cost advantage for the customer.

The price of the HP8970B Option 020 is $21,300 and the HP 346B noise source is $2700. ❖

[illegible]

[illegible]

[illegible]

Modern RF Signal Generators & their use - 2

In this second of three articles adapted from a seminar given by engineers at Marconi Instruments in the UK, we discuss the various performance parameters by which an RF signal generator is judged. This covers aspects such as frequency stability, distortion, spurious signals and incidental components, sideband noise and residual modulation.

The design of a signal generator is a delicate balance of performance and cost, and limitations in the performance of instruments are inevitable. Some of these limitations are due to fundamental physical constraints (e.g., thermal noise) whilst others are related to the design itself. Since the perfect signal generator does not exist, users have become accustomed to accepting some limitations in the interest of obtaining an economic solution to their needs. In addition to inaccuracies caused by imperfections in the instrument, other errors can be introduced by the operator in the way the unit is connected to the device under test.

Some of the errors due to instrumentation inaccuracy can be allowed for by making measurements with other instruments. For example the modulation depth of a signal generator could be checked with a modulation analyser when a more accurate result is required (e.g., in ILS test applications). Whilst this correction technique can work for some parameters, it cannot improve the performance in areas such as distortion and noise.

Frequency stability

Frequency stability can be defined as the degree to which an oscillating source produces the same frequency throughout a specified period of time. Every RF source exhibits some amount of frequency instability. This stability can be broken down into two components — long term and short term.

Short term frequency stability contains all elements causing frequency changes about the nominal frequency of less than a few seconds deviation, and is often seen as residual modulation components. Long term stability describes the frequency variations that occur over long time periods, expressed in parts per million per hour, day, month or year.

Short term stability consists of randomly fluctuating phase noise terms which can be observed on an ideal spectrum analyser (one which has no sideband noise of its own). There are two types of fluctuating phase noise terms:

1. Deterministic — discrete signals appearing as distinct components in the spectral density plot. These signals, commonly called 'spurious', can be related to known phenomena in the signal source such as power line frequency, vibration frequencies, or mixer products.
2. Random — commonly called 'phase noise'. The sources of random sideband noise in an oscillator include thermal noise, shot noise and flicker noise.

DC coupled frequency modulation systems can also give rise to instability, as the method of producing this type of modulation usually requires that the phase locked loop which controls the stability is unlocked to allow the frequency to be directly controlled by an external voltage. In earlier signal generators the selection of 'DC coupled FM' caused an offset in the carrier frequency, which was followed by a gradual drift of up to 100Hz per hour. When testing narrowband radio equipment the offset and the drift cause measurement

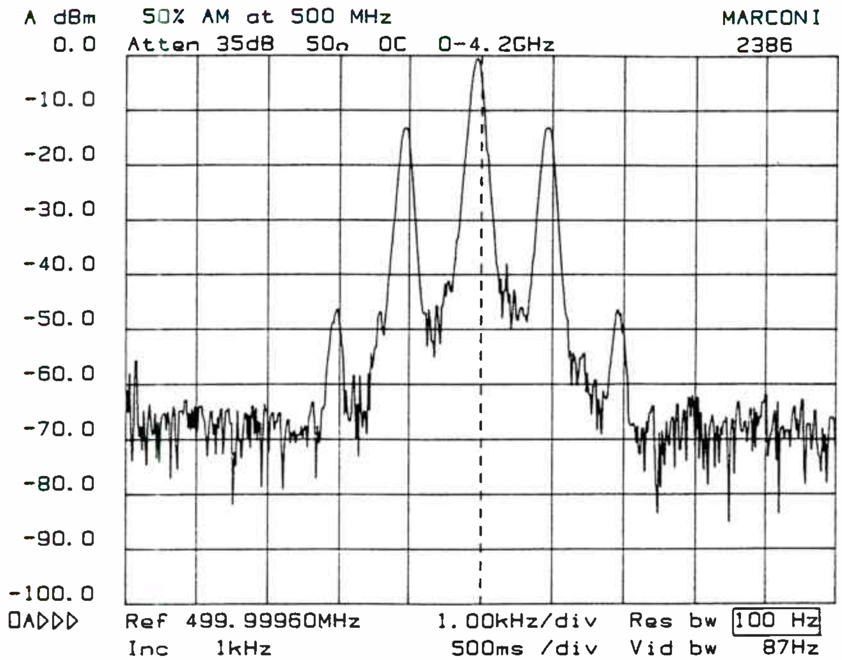


Fig.2.1: Spectrum analyser display showing AM distortion.

[illegible]

[illegible]

[illegible]

problems, and in some cases operators find it necessary to connect external equipment to their signal generators to determine the amount of drift so that they can compensate for it.

Fortunately with the later generator of synthesised signal sources the offset and drift problems have been virtually eliminated.

With regard to long term stability most modern signal generators use a crystal oscillator as their primary frequency reference, and such oscillators exhibit a gradual change in frequency with time as the crystal ages. This drift is usually in an upward direction (i.e., the frequency of the oscillator rises with time). Some means for resetting the oscillator is always provided and a facility for using an external frequency reference, such as a signal produced by a rubidium or caesium beam oscillator, is normally provided.

Distortion

Harmonics of the carrier frequency usually do not cause measurement problems, but if necessary they can be suppressed using a low-pass filter to pass the wanted frequency and eliminate all the unwanted harmonics. Distortion of the modulating signal may be reduced by substituting a low distortion oscillator in place of the standard internal oscillator, but the distortion associated with the actual modulation circuits cannot easily be removed and must be accepted as a fundamental limitation of the design. If better performance is needed, the user will need to identify an instrument with a better specification.

Modulation distortion associated with AM (see Fig.2.1) can sometimes be observed using a spectrum analyser, but care should be taken when interpreting the results as the presence of small amounts of FM will also give rise to sidebands which occupy the same position as the AM distortion sidebands.

With frequency modulation the effect of distortion cannot be seen on a spectrum analyser and a linear demodulator must be used to provide a signal which can be interpreted by a distortion analyser. In most applications the level of distortion introduced by modern signal generators when used in the FM mode can be considered to be negligible, for all but the most demanding applications.

Spurious signals

The modern signal generator is usually based on a frequency synthesised oscillator, and may also contain mixers, multipliers and dividers to extend the frequency coverage.

These components will inevitably introduce unwanted spurious signals, and the instrument will contain filters and buffering circuits which are designed to reduce the level of the signals that are products.

A major problem with these spurious signals is that the position of the components cannot easily be predicted by the user. The presence of such signals limits the ability of the generator when used for testing the out-of-band performance of a receiver, and if the level of these components is particularly high, it is even possible that the in-band performance measurements will also be subject in error.

Non-harmonically related signal products may be removed by careful filtering, but this is likely to be impractical if measurements need to be made at a number of different frequencies. The only satisfactory solution is to use a source with a performance which is at least 10dB better than the receiver measurement requirement, or to use an instrument which produces its output without the aid of mixers.

Incidental components

When a signal source is producing amplitude modulation, imperfections in the modulation circuits and the RF amplifiers will cause small amounts of FM to be produced at the same time. Similarly, AM components will be produced by imperfections in an oscillator system which is designed to provide frequency modulation.

These incidental FM on AM and AM on FM components limited the usefulness of the generator, when measuring the ability of a receiver to reject unwanted modulation, and there is no simple way of improving the performance of an instrument for this type of test. Again, the only satisfactory solution is to use an instrument with a performance which comfortably exceeds the required receiver measurement value.

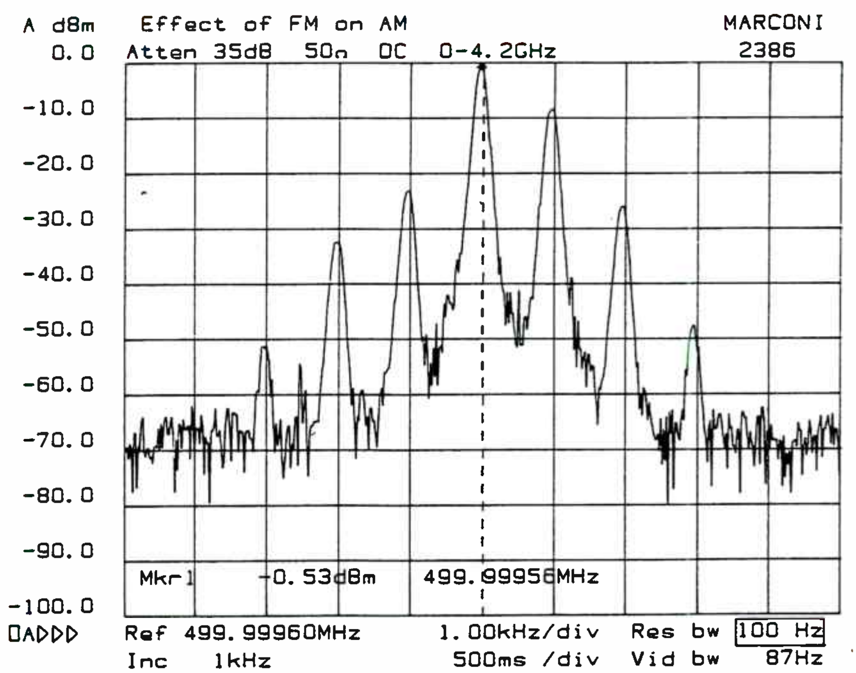


Fig.2.2: Effect of FM on AM.

Residual modulation

When measuring receiver signal to noise ratio, the user will switch the generator modulation on and off to record the ratio of the two receiver output values. Any noise modulation components which remain when the modulation tone is switched off will inevitably limit the measurement ability, and it is possible that the ratio measured is not the receiver performance, but that of the generator.

Residual modulation due to noise will always be present on any signal source and will be specifed, although the bandwidth in which it is measured may be different from that of the receiver. Residual components due to AC power line frequencies will also be present, but their effect will usually be small compared with the noise.

Reduction of residual components is rarely possible, but it is worth checking that hum fields from nearby equipments are not increasing the problem. If this fails to produce the necessary improve-

ment, the only alternative is to use a signal source with a better performance.

Sideband noise

The unmodulated output from a signal generator is often thought of as a single spectral line, but in reality the output spectrum is spread across a wide range of frequencies. Conventionally the noise distribution of the signal is specified in a 1Hz bandwidth and curves are often given which show the way this noise varies with offset from the carrier (see Fig.2.3).

Close to the carrier the level of the noise sidebands will be related to the design of the RF oscillator in the generator, but at larger offsets the noise falls to a constant level which extends across the full range of the instrument.

The sideband noise of a signal generator limits its ability to measure the adjacent channel rejection of narrowband receivers, since the noise will be detected by the receiver and may lead to a lower apparent rejection value being indicated.

The use of filters to remove sideband noise is impractical, because of the circuit complexity needed to achieve the necessary reduction of sideband noise without suppressing the carrier and its modulation components. If sideband noise is limiting the measurement, the only real solution is to use a better signal source.

Sideband noise characteristics of different types of generators vary widely, and in general it is true that the noise produced by a low cost generator will be higher than that produced by a high priced unit.

Conversion of sideband noise figures, usually given in dBc/Hz, to assess the available adjacent channel rejection measuring ability is a complicated exercise as the user needs to take into account the receiver bandwidth, the channel spacing and the shape of the generator curve, but as a simple approximation 52dB should be subtracted from the modulus of the sideband noise figure at the required channel spacing.

For example a generator with a specification of -122dB/Hz at 20kHz offset would give an adjacent channel measuring capability of 70dB (122 - 52) and a generator with a rated performance of -146dB/Hz would allow adjacent channel measurements of up to 94dB (146 - 52).

Level inaccuracies

The output level of a signal generator often covers a range of over 140dB, and very careful attenuator design, construction and testing is needed to provide the best overall accuracy. Inaccuracies at high output levels may be allowed for by checking the output with an accurate power meter or voltmeter, but at low levels the user is unlikely to have access to test equipment which can make measurements with the required accuracy. Since the user has no way of improving the accuracy at these low levels, there is no alternative but to allow for the rated inaccuracies of the source.

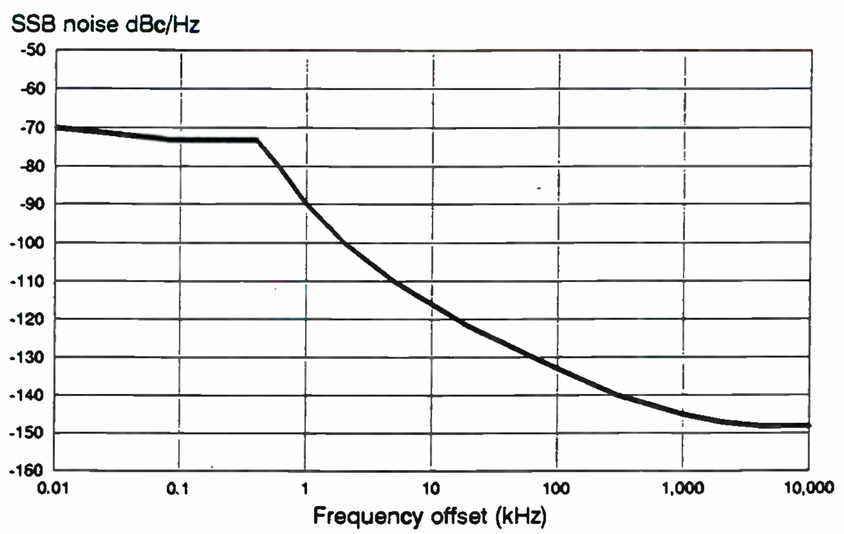


Fig.2.3: Typical SSB noise curve of a synthesiser.

Connection errors

In addition to errors caused by limitations of the generator performance, inaccuracies also occur because of the connections between the source and the unit under test. Obvious problems occur because of the use of poor quality cables or connectors, and because of inaccuracies associated with any matching units or attenuators that are used. These problems can usually be minimised or their effect allowed for.

A less obvious effect is caused by the impedance mismatch which will often occur between the signal generator and the device being tested and in extreme cases this can introduce additional errors as high as +/-1dB. This type of error can be reduced by the simple technique of connecting a good quality 20dB attenuator pad between the generator and the item under test.

User aspects

Although technical performance often dominates the decision making process when selecting a signal generator, consideration also needs to be given to aspects related to the ease of use and the long-term cost of ownership.

Units which are difficult to operate will inevitably cause problems when used by inexperienced operators, and even experienced engineers have been known to have difficulties when using features which they rarely access.

Other criteria of importance may be the number and type of modulation oscillators available. One kilohertz and 400Hz are usually sufficient for the standard receiver tests, but further tests require other frequencies — for example, when measuring the AF response. In addition to the functional features of a product, the user also needs to give careful thought to the long-term support of the unit.

Most organisations now insist that their test equipment is calibrated on a regular basis, so that they can maintain the quality of their own operation. Calibration costs money, and the faster it can be done the lower the overall cost will be. Most modern signal generators can be tested automatically using GPIB control and in some units the adjustment of the performance can also be handled by bus control, providing a further potential cost saving.

The third and final article in this series will describe the use of a signal generator to measure the performance of a receiver. ❖

SIEMENS

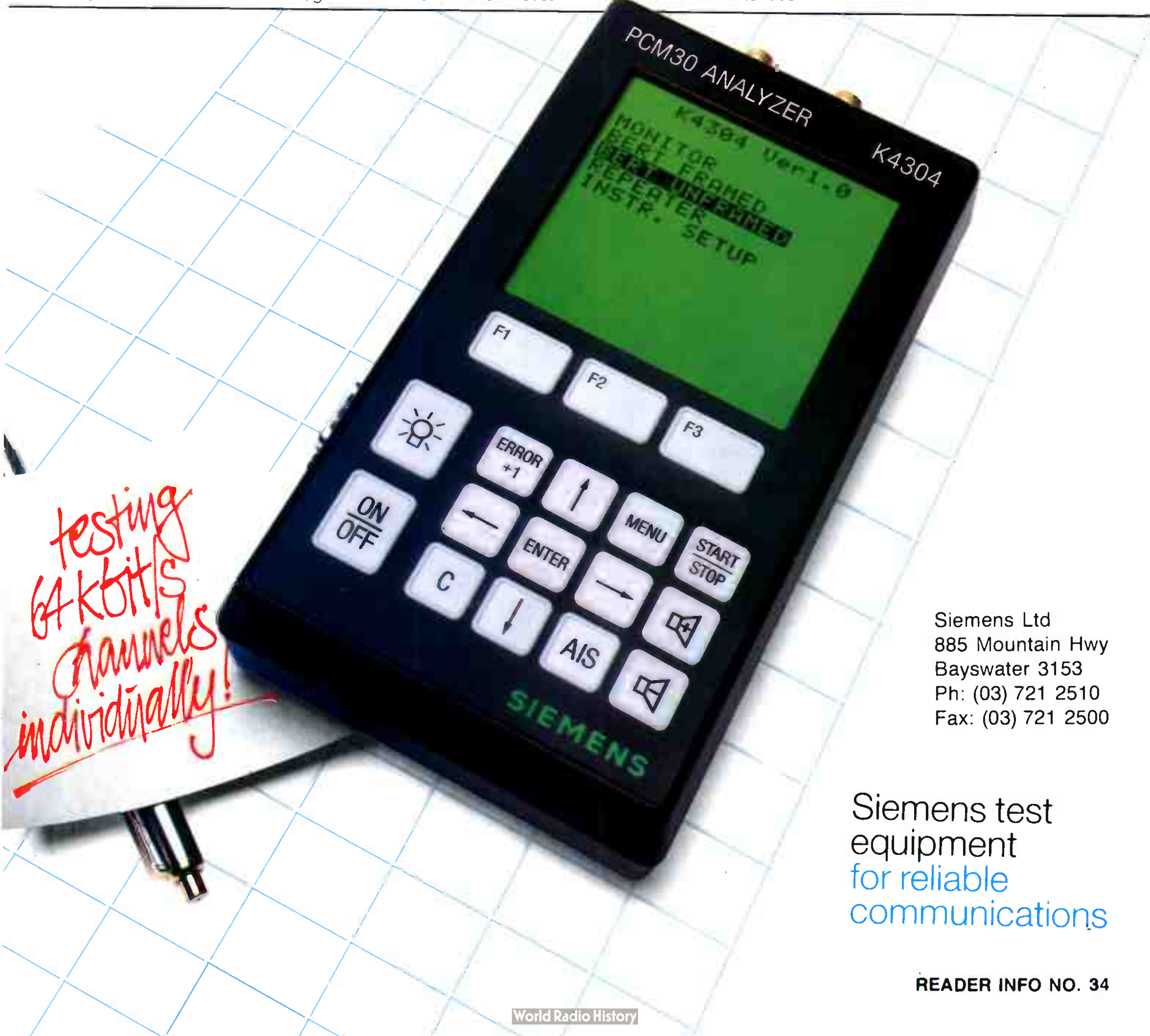
PCM 30 analyzer K 4304

Now with remote monitoring

Soon you will never want to be without the K4304 again. Partly because you can always take it with you wherever you go to make bit error measurements in 2-Mbit/s systems. But especially because the K4304, despite its small size, has a performance equal to that of large units. It is transmitter and receiver in one. It diagnoses during operation — as an in-service monitor for 2-Mbit/s transmission routes and their 64-kbit/s channels. And it can operate out of service as a bit and code error tester.

Its individual features:

- ☐ in-service: Bit error measurements from the frame alignment signal and code error measurements
- ☐ Detection of CRC4 errors
- ☐ Drop and insert functions
- ☐ Bit error evaluation in accordance with CCITT Recommendation G.821
- ☐ Testing of regenerative repeaters
- ☐ External printer port
- ☐ Remote monitoring via V.24 interface



Siemens Ltd
885 Mountain Hwy
Bayswater 3153
Ph: (03) 721 2510
Fax: (03) 721 2500

Siemens test equipment for reliable communications

READER INFO NO. 34

Handheld DMM and 1.2GHz frequency counter

Jaycar Electronics now has available two interesting digital meters. Its latest multimeter model includes — as well as the usual ranges — measurement of frequency, capacitance *and* temperature and inductance. The company is also offering a very compact handheld frequency counter, which covers a wide spectrum from 10Hz-1.2GHz.

The new multimeter, model TES-2360, has a 3-3/4 digit (reads up to 3999) liquid crystal readout, and in appearance is very similar to many other meters on the market. It uses a 30-position rotary switch, combined with three slider switches ('on-off', 'DC-AC' and 'hold'), to allow selection of the various ranges.

Four sockets are provided at the bottom of the case for 10A, mA/uA, Common and V/ohms. (Though not labelled on the meter, the V/ohms socket is also used for frequency, temperature and logic level measurements.)

However, the meter uses special sockets for measuring both capacitance and inductance. These are slit sockets at the left side of the front panel, which allow component leads to be inserted directly into spring contacts to minimise test lead errors.

Readouts for this very versatile meter are via 16mm digits, which appear to be larger than usually provided. Its clear, uncluttered display is very easy to read. As you would expect these days on any reasonable model, the meter features autopower-off (after 30 minutes), low battery and overload indications, and diode testing combined with a continuity buzzer.

The meter is protected by a solid case, which is fitted with a tilt stand. The case also has two grooves, one at each side of the display, into which you can also slide the base of the general-purpose test probes provided.

You can use this handy facility to make a probe extend beyond the top of the meter for single-handed measurements or, by inverting the probe, for storage.

The rotary switch gives you access to five ranges for both DC and AC voltages: 400mV, 4V, 40V, 400V and 1000V/750V (DC/AC). The DC accuracy is (±0.5% + 1 count) on all ranges, with the AC accuracy being 1%+3 for the first four ranges and 1.2%+3 for 750V.

Similarly, there are four current ranges: 400uA, 40mA, 400mA and 10A. The DC and AC accuracies for the first three ranges are 1%+1 and 1.2%+3 respectively; while for the 10A range they are 1.2%+1 and 1.5%+1.

Resistance is measured over six ranges: 400 ohms, 4k, 40k, 400k, 4M (all 0.8%+2 accuracy), and a high 40M (1.5%+2). Frequency is measured over four ranges: 4kHz, 40kHz, 400kHz and 4MHz (all at 0.5%+1), with a maximum input sensitivity of $1V_{RMS}$ and a maximum applied voltage of $350V_{RMS}$.

An accuracy of 5%+10 applies to the

frequency counter

five ranges for both capacitance and inductance. These ranges are: 4nF, 40nF, 400nF, 4uF and 40uF; 4mH, 40mH, 400mH, 4H and 40H. And the accuracy for the temperature range of -40° to +150°C is ±3°. (The display can be in either Celsius or Fahrenheit — for °F the accuracy is ±5°.) A special temperature probe (with a diode sensor) is provided for these measurements.

How it performed

With a few exceptions for larger AC currents, all the measurements which we made were well within the stated tolerances.

Four volts-DC measurements were made, in the range 200mV-10V, with a Fluke model 8050A being used to calibrate our standards.

Five volts-AC readings were also made (200mV - 32V), along with five amps-DC (400uA - 100mA) and six amps-AC (400uA - 1A). This last mentioned current reading produced a measurement error of -5.1%, which is well outside the quoted 1.5%+3.

Two further AC current measurements were made on the 10A range, and checked with a Goldstar DM, model 6335. A 5A and 10A reading on the TES-2360 produced errors of -1.80% and -1.91%, respectively. Both these readings are just outside the quoted accuracy.

Seven resistance readings from 100 ohms-393k and 11 capacitance readings from 1nF - 10uF (checked against an HP 4263A meter) proved accurate, along with five frequency readings from 5kHz - 2.5MHz (checked against a Goodwill GFC 8100G reference).

We were unable to check the inductance ranges, not having any suitable standards. Likewise for the temperature range — though a check against a laboratory mercury thermometer gave DMM readings in icy water of 5.9°C (3°C); room temperature, 24.3°C (24°C); and hot water, 69.5°C (72°C). So compared with the mercury thermometer, all readings were within the stated ±3°.

We noticed that the temperature probe seemed to be slower in coming to its final reading for the colder temperature than for the hotter one, taking about an extra minute to settle.

Frequency counter

The model WFC-308 Wisher frequency counter is very compact, with the case measuring only 130 x 80 x 35mm, and weighs 350g.

It is powered by an 8.4V rechargeable battery, which requires a 12V/500mA plugpack for recharging. The battery can give over four hours of operation. The counter has an eight red-LED digit display for its two ranges. A three-position slider switch combines the on/off switch and range selector.

Range A is MHz (20MHz - 1.2GHz), with three gate times of 2.56s, 0.25s and 0.02s (selected by a second slider switch), while range B is kHz (10Hz - 20MHz) with its gate times of 2s, 0.2s and 0.02s.

Input impedance is 50 ohms (range A) and 1M//80pF (range B), with the maximum input voltage being $5V_{P-P}$ and $100V_{P-P}$, respectively.

The sensitivity for the B range is quoted at <15mV from 10Hz - 20MHz; and for the A range <21mV from 200MHz - 1.0GHz. This figure increases as you move towards the top and bottom of the range, reaching <22mV for 1.0GHz - 1.05GHz and <185mV for 21MHz - 26MHz.

Test results

Our standard for the frequency measurements was a 5MHz signal produced by an HP crystal-oven VXO. This was checked against a 5MHz VNG communications channel, and produced a beat frequency of less than 2Hz. This provided more than adequate accuracy to test the WFC-308.

The basic stability of the counter over several hours proved to be about 2ppm, comfortably within the 4ppm specification. Interestingly, the meter under-read only for the first five - six minutes, after which it over-read with a continuously increasing inaccuracy.

So, for practical use, after about five minutes heating, the meter should operate with its maximum accuracy. This makes it very useful for field measurements, where quick readings are required and the meter is normally switched off when not in use.

The sensitivity of the readings was also checked. On the B range, 10MHz and 20MHz both recorded about $10mV_{RMS}$; while on the A range, the results were 18mV (25MHz), 6mV (100MHz) and 5mV (500MHz). These were all well lower than quoted sensitivities.

With no input on the higher range, the pre-scaler chip self- oscillated — not unusual — and typical input signals easily over-ruled the oscillations, so this was not a problem.

Finally, testing a 500MHz signal with the three gating positions gave readings of 501.1479 (2.56s), 501.147 (0.25s) and 501.15 (0.02s).

These results were as expected, but were done because of a confusing paragraph in the manual saying that the readout on range B (actually range A!) needed to be divided by '10' — it doesn't!

Inside the case

Two self-tapping screws secure the front and back sections of the sturdy case of the meter, which is further held by two plastic clips. This makes it quite difficult to open when you don't realise what is still holding the sections together.

Inside the case, the rechargeable battery takes up over 50% of the space, occupying the bottom half. The top half has a metallic shield and one PCB which holds all the electronic components. Near the bottom of this board are the two crystals (one for each scale), along with their calibration trim capacitors.

Summary

The major advantage of the TES-2360 DMM is obviously the additional ranges that it offers. It offers all the usual tests, plus frequency, inductance, capacitance and temperature — quite an impressive array. And the temperature probe reacts quite quickly to temperature changes.

In favour of the frequency counter is its very compact size, and its ability to be used in the field, allied to its large frequency range — up to 1.2MHz. We believe both meters represent good value for money.

But why do the manuals of such Taiwanese products have to contain so many spelling mistakes and contradictory information?

For example, the counter panel labels range B the lower band, while the manual reverses this; and there is the confusing 'divide by 10' instruction for the higher frequency range.

Also, the DMM manual gives two sets of data for the temperature probe, quoting accuracy as ±2°C in the first and 3° in the second.

I suppose we are getting used to such Taiwanese English as "When finished the measurement. Switch OFF the battery" and "As battery power is not sufficient. LCD will display 'BT' Replacement with one new batterie type 9V is required".

Although these deficiencies do not detract from the operation of the two meters, it would be very pleasant if they could be corrected.

The prices for the TES-2360 DMM (Jaycar catalog No. QM-1475) is $169, and for the WFC-308 (QT-2330) is $299. Both meters are available from Jaycar stores. (P.M.) ❖

Solid State Update

KEEPING YOU INFORMED ON THE LATEST DEVELOPMENTS IN SEMICONDUCTOR TECHNOLOGY

Wide bandwidth op-amp

A new wide bandwidth, current-feedback operational amplifier, model 623, is now available from Burr-Brown.

The new part has a small and large signal bandwidth of 280MHz, an output current capability of +/-70mA and a slew-rate of 2000V/us.

Along with other equally impressive parameters, these make the OPA-623 very suitable for application in high-resolution video. RF and IF circuits and in communications equipment. It is also available as a photomultiplier tube preamplifier.

The new circuit design and process achieves performance that is unattainable with monolithic IC technology. It includes, however, a monolithic integrated current-feedback amplifier. It provides 280MHz large-signal bandwidth at +/-2.5V output level, as well as the 2000V/us slew rate.

For further information circle 273 on the reader service coupon or contact Kenelec, 48 Henderson Road, Clayton 3168; phone (03) 560 1011.

IF amp chip

Avantek, a subsidiary of Hewlett-Packard, has introduced a TO-8 packaged amplifier combining high reverse isolation with relatively low gain, operating in the 10 to 1500MHz intermediate-frequency range.

This combination of performance and dynamic range of receivers in communications, electronic defence, electronic intelligence and radar systems.

The design of this new amplifier is free of ferrite couplers or transformers, and exhibits typical performance of 11.5dB gain with 50dB of reverse isolation (at +25°C), and good efficiency over a 10 to 1500MHz bandwidth.

Designated UTO-1576, the amplifier's high reverse isolation with moderate gain makes it particularly suitable for use in pre-amplification and post -amplification for passive mixers — as a buffer for oscillators, switches or filters and as a general-purpose IF or RF amplifier.

Used as an RF amplifier, the UTO-1576 can help improve the suppression of radiated LO signal at the antenna.

Guaranteed performance features of the UTO-1576 amplifier include 10.5dB small-signal with 0.5dB gain flatness, 5.0dB noise figure, +9dBm output power (1dB gain compression) and 40dB reverse isolation, over the 0 to +50°C temperature range. Performance is specified over the full -55 to +85°C temperature range.

Also available is the UTC-1576, which is the same amplifier packaged in a 25 x 21 x 13mm aluminium case, equipped with RF connectors and RFI-filtered DC feedthrough.

For further information circle 279 on the reader service coupon or contact VSI Promark Electronics, 16 Dickson Avenue, Artarmon 2064; phone (02) 439 4655.

Fast EPROM programmers

The HEP Series of 8Mb EPROM Programmers is aimed at the mass production high speed market of EPROM programming.

The HEP-808 can program EPROMs from 2716 to 278000, including page-mode EPROMs and EEPROMs, to 28256A's. It has eight sockets, extra

2Mb BIOS chip

In response to the growing size of the BIOS (basic input/output system) code required to support today's advanced desktop and mobile computers, Intel Australia has extended its Boot Block flash memory product line to include both a 2Mb and a 4Mb device. Flash memory's nonvolatility and read/write functionality allows PC BIOS to be upgraded quickly and easily without losing critical system boot code.

Available in user-configurable x8 and x16 architectures for optimum system design, the new 2Mb 28F200BX/002BX and 4Mb 28F400BX/004BX feature 60ns access times, allowing zero wait-state performance with many of today's highest performance microprocessors, such as the 25MHz Intel386TMSL.

The 28F200BX/002BX Boot Block architecture features one lockable 16KB boot block to securely store the basic boot code required to initialise the host system, eliminating the possibility of inadvertent erasure; two 8KB parameter blocks for storing product codes, setup parameters or system diagnostics; and two main blocks of 96KB and 128KB each for storing ROM-executable programs such as MS-DOS, specialised video drivers, basic and advanced power management (APM), and card and socket service utilities. The 4MB 28F400BX/004BX is similarly configured, but adds two 128KB main blocks.

To reduce system-level power consumption and extend the battery life to today's mobile PCs, the two new devices feature a deep powerdown mode (0.2uA typical), low active and standby power requirements (25mA and 0.1mA, respectively), plus a new automated power saving feature that allows the chip to shift

into a 0.8mA static mode between reads. Each is also available in 3.3V read versions.

The new chips, manufactured on Intel's 0.8um ETOX-III process technology, are available in 60, 70 and 80ns access speed versions.

For further information circle 271 on the reader service coupon or contact Intel Australia, PO Box 1486, Dee Why 2099; phone (02) 975 3300.

Solid State Update

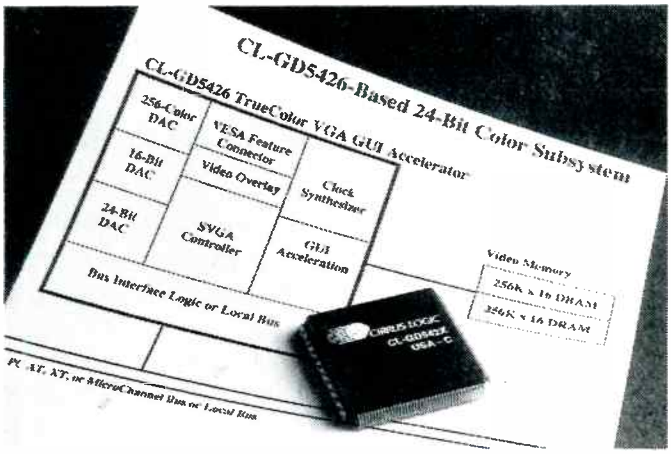
Fast 24-bit VGA controller chip

Cirrus Logic has introduced its 'TrueColor VGA' family of four pin-compatible, single-chip graphics controllers which combine 16 and 24-bit colour industry-standard VGA and SuperVGA compatibility, and graphical user interface (GUI) acceleration.

The TrueColor VGA family is claimed as the first pin-compatible set of graphics controllers to offer a seamless upgrade path from accelerated SuperVGA to cost effective 24-bit, or 'true-colour' solutions. This provides designers of desktop computer systems and add-in boards a line of products spanning the complete range of features necessary to support users of Microsoft Windows and the growing market for true-colour applications.

The family of products includes the CL-GD5420 SuperVGA controller, the CL-GD5422 VGA controller (which adds 16 and 24-bit colour capabilities to the 5422's feature set), the CL-GD5424 local bus VGA accelerator and the CL-GD5426 VGA GUI accelerator. All devices feature on chip RAMDACs and frequency synthesisers, allowing even a complete subsystem with full GUI acceleration and 24-bit (16.8 million) colour capability to be implemented using a single chip and as few as two standard DRAMs. The family supports the entire VGA and SuperVGA resolution range from 640 x 480 pixels to 1280 x 1024 pixels, as well as dot clock rates of up to 80MHz.

For further information circle 275 on the reader service coupon or contact Cirrus Logic, 3100 West Warren Avenue, Fremont CA 94538 USA; phone (510) 623 8300.



operation keys, and menu window-driven software.

This software allows file loading, saving, full screen editing for binary and ASCII data, blanking, checking, reading programs, verifying and auto use. The chip is capable of programming eight 27256's in 20 seconds.

The 808 can be connected with the TCU-500, a controlling unit to become a stand-alone, high-speed programmer with no connections needed to the PC/XT/386.

For further information circle 278 on the reader service coupon or contact Baltec Systems, PO Box 107, Paddington 4064; phone (07) 369 5900.

Discontinued ICs

Due to declining usage as the market has moved to more up to date technologies, Philips Components has decided to discontinue certain lines.

The product families to be discontinued are:

- 74XXX TTL logic,
- 74LSXXX low power TTL logic,
- 74SXXX Schottky TTL logic,
- 10K ECL, and
- 74AC/ACTX CMOS logic.

Philips says it will concentrate its resources on the HEF4000, PC74HC/HCTXX, 100K, N74FXX, 74ABTXX, Futurebus, Multibyte, and 74HLL33XXX logic families.

For further information contact Philips Components, PO Box 373, North Ryde 2113; phone (02) 805 4455.

Power suply monitor

Maxim's MAX690A/MAX692A microprocessor (uP) supervisory circuits reduce the complexity and number of components required to monitor power supply and battery functions in microprocessor systems.

The functions include power-on reset, battery back-up switchover, power-fail or low battery warning, and programmable watchdog timer.

Guaranteed RESET assertion at Vcc = 1V prevents faulty microprocessor operation at low power supply voltages, while low supply currents (1uA maximum in back-up mode and 350uA maximum in operating mode) conserve system powe and extend battery life.

The chips include a precise threshold detector and 140ms timer to generate a high quality reset signal under all conditions of power-up, power-down, momentary power interruptions, and brownouts.

The MAX690A threshold detector trips at 4.65V for 5% power supplies, while the MAX692A trips at 4.4V for 10% supplies.

Applications include low-power controllers, intelligent instruments, and any uP or uC system that requires accurate power supply monitoring and battery switchover.

For further information circle 272 on the reader service coupon or contact Veltek, 18 Harker Street, Burwood 3125; phone (03) 808 7511. ❖

32-bit RISC chip for portables

VLSI Technology has introduced the newest member of its ARM (Advanced RISC Machine) 32-bit RISC microprocessor family, the ARM610.

Targetted for cost effective, battery operated systems such as the recently announced Apple Computer 'Newton' family of Personal Digital Assistants, the 610 is claimed to give the highest performance-per-watt in the industry, offering 29k Dhrystones at 25MHz, with a dissipation of less than 600 milliwatts. Availability in the new Thin Quad Flat Pack (TQFP) package allows the 710 to be used in applications where space is at a premium.

The ARM610 consists of a 32-bit RISC processor, a memory management unit (MMU), 4KB of cache memory, write buffer, and full boundary scan circuitry, and offers low power consumption (4.5 milliamperes/MHz). It is fully supported by software development systems that run on Sun, DOS, and Macintosh operating systems, enabling fast and efficient code compilation.

For further information circle 276 on the reader service coupon or contact VLSI Technology's Inquiries Dept, 134, 200 Parkside Drive, San Fernando, Calif., 91340; phone (408) 434 7905. (Quote reference code ARM610).

Software Product Review:

DSP'S DADiSP 3.0 GRAPHICS WORKSHEET

Wouldn't it be nice if scientists and engineers had a package like a more sophisticated form of the spreadsheets used by accountants and managers, which could quickly and easily process, 'boil down' and plot their experimental/testing data in graphical form? They do, as it happens. It's called DADiSP, and it can perform all manner of impressive tricks.

by JIM ROWE

One of the biggest chores in many areas of science and engineering is to 'boil down' raw experimental or measurement data, into a meaningful form — where you can see what all that data *means*, and discover the underlying trends. Generally this means getting it into graphical form, because we humans find this form the most easily and quickly digested.

Back in the 'BC' era (before computers) this was all done by tedious manual calculation, tabulation and plotting; but when calculators and computers came on the scene, these were soon delegated to do the number-crunching hackwork. It was much the same in accounting.

Of course for a long time, computers were not much good at anything *other* than sheer number crunching. For quite a while you even had to write a new program, each time you wanted them to perform a new kind of crunching job — but this changed with the evolution of electronic spreadsheets, which provided the ability to perform quite powerful data manipulation and tabulation, without the need for programming in the traditional sense.

Soon spreadsheets were also able to plot and graph the processed data, too — simplifying even the last phase of data reduction, at least for accountants and managers.

But scientists and engineers were still left with many of *their* needs unmet, because until recently spreadsheets could only perform relative unsophisticated maths: addition, subtraction, multiplication, division, totalling and so on. They've been little more than the equivalent of the four-function calculator, in data reduction terms.

If you wanted to perform things like a fast Fourier transform (FFT), or a time integral or differential, or fancy statistics, or matrix manipulation, or exponentiate, or plot a 3-D or 4-D graph, you've generally been on your own. It was largely back to writing custom programs...

Enter a US firm called DSP Development Corporation, with its DADiSP package (pronounced *day-disp*) — an 'interactive graphics worksheet' designed especially for scientists, engineers and other technical people.

DADiSP is essentially a graphically-orientated development from, and enhancement of, the electronic spreadsheet. And at the same time it's designed specifically for the management, analysis, reduction, transformation and display of technical data. In place of the spreadsheet's 'cells', it substitutes graphical windows, each of which can display either raw or derived data in a multiplicity of forms.

Inside the package there's a huge library of processing functions, able to perform anything from simple maths to very sophisticated functions, and then plot the results in virtually any desired form.

And the key to DADiSP's appeal is that you don't need a PhD in advanced maths to drive all of these high-powered data reduction, manipulation and display tools. Just as you can drive a spreadsheet by simply keying in simple expressions, and indicating the cells whose contents are to be manipulated, DADiSP lets you call up its functions and facilities in much the same way.

You simply indicate the window in which the result is to appear, the window or other source which is to provide the data to be used, and then select the desired analysis functions from its pop-up menues.

Then the result simply appears — generally within a few seconds. Change the data in the source window, and the display in the derived window or windows changes to match; it's just like a spreadsheet, where the result of any change 'ripples down' to the result at the bottom...

Just as with a spreadsheet, DADiSP also lets you print out your results, in this case in high quality graphical form. And you can save a complete worksheet on disk, ready to be used again at a later stage, with new data.

You can get the data into DADiSP in two broad ways: as a computer file, or directly from an instrument or measuring system hooked up to your computer via the IEEE-488 (GPIB) bus.

The package will 'import' disk file data in a variety of forms, including ASCII, Lotus PRN, byte-wide, 16-bit integer, IEEE 32-bit floating point or IEEE 64-bit double precision formats, and it can also 'export' processed data in any of the same formats.

Importing of data directly from IEEE-488 based instruments is performed using an optional accessory package, called DADiSP-488, which allows convenient menu-driven control of the instruments, and transfer of data from them.

A different accessory package called DADiSP/LT performs the same broad functions with many of the popular A-D data acquisition boards.

When it comes to DADiSP's data manipulation and reduction functions, there are literally too many to even list here. Even the basic package seems to

DSP'S DADISP 3.0 GRAPHICS WORKSHEET

have well over 200, ranging from maths and statistical functions through type conversion, trig and hyperbolic functions to matrix functions, series generation, peak analysis and transformation.

In the last of these areas alone there's five kinds of FFT (including 2-D), DFT, auto-and cross-correlation, convolution and 2-D convolution, Hamming, Hanning and Kaiser windowing, spectrum and power spectral density.

Yet another DADiSP optional accessory package called DADiSP/Filters allows you to design and use both FIR (finite impulse response) and IIR (infinite input response) filter functions.

For display of both raw and processed data, DADiSP provides options of a line graph, a scatter plot, stick or bar charts, a waterfall plot, a 3-D plot, a 4-D 'colourisation' or a basic table of numbers. You can also scroll, expand or compress the data in any direction, zoom in on a region of interest, add grids, adjust the scaling law, overlay multiple graphs, adjust the colours and so on.

By the way, a single DADiSP worksheet can contain up to 100 different windows, each with raw or derived/transformed data.

The more windows you have the smaller they become in their basic form arrayed on the screen, but you can always zoom any window up to full screen to examine its content in detail. When the windows are printed out they are each blown up to full page size, as well.

DADiSP is compatible with a variety of printers, from Epson and compatible dot-matrix types, through Oki Microline, Panasonic and Toshiba 24-pin models to HP Thinkjet, Paintjet and LaserJets and compatible lasers. At present it doesn't seem to be able to drive a PostScript printer directly, but it *can* direct PS output to a disk file for printing via another package.

System requirements

There are X-Windows versions of DADiSP for high-end workstations such as those of Sun, HP, IBM, DEC, NeXT, Concurrent and others.

However there is also a version which runs on IBM-compatible PCs, which runs under DOS 3.0 or later and uses its own windowing user interface. This version is able to address up to 16MB of RAM.

The PC version needs a 286, 386 or 486 processor, with a 287 or 387 floating point co-processor recommended for 286 and 386 systems to enhance processing speed. It requires 640k of conventional memory and at least 2MB of *extended* memory.

It does not use *expanded* (EMS) memory, and in fact is incompatible with many EMS memory managers.

It can work with virtually any of the standard video display cards, although an EGA, VGA or Hercules card will naturally give rather better display resolution. The package also needs about 2.5MB of free disk space for installation on a hard disk — which is again desirable, to speed up operation.

By the way, DADiSP is protected using a hardware 'dongle', which must be plugged into the computer's printer port before the package will run.

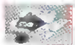
This is both protection against unauthorised distribution, and to ensure that only one copy of an authorised user copy can be in use at any one time.

Trying it out

A sample copy of DADiSP 3.0, the latest version of the package for the PC, was kindly sent to our office by DSP's Australian distributor Interworld Electronics and Computer Industries, so we could try it for ourselves.

We installed it on a 486-based machine running at 33MHz, with 3MB of extended memory and an S-VGA graphics adaptor, running DOS 5.0. The installation itself didn't present any problems, although it took rather longer than we expected.

As part of the initial configuration we found that the package doesn't seem to be able to take advantage of the S-VGA enhanced resolution modes; the highest option is essentially standard



DSP's DADiSP 3.0 Graphics Worksheet

VGA. In the absence of direct PS printing we also set it up to print in HP Laserjet II mode, and set up our dual-mode laser accordingly.

The computer concerned is normally set up with XMS and EMS memory managers, to provide both 3MB of expanded memory as well as the same amount of extended memory. This generally works out well, allowing a wide variety of software to have sufficient memory for its needs.

And DADiSP seemed quite happy with this setup when we fired it up immediately after installation; it was only when we tried running it again the next day, that it refused to run — throwing up mysterious error messages, which weren't explained in the manuals (Murphy's law!).

It was after studying the 'Troubleshooting Tips' section at the rear of the User Manual that we discovered that DADiSP really doesn't like to share its computer with virtually *any* memory managers — especially any kind of EMS manager.

Not a very friendly package, it seems — you have to use a different AUTOEXEC.BAT and CONFIG.SYS combination, if you normally run such managers, so that DADiSP can have the hardware all to itself...

Still, when it *is* running, it is a very impressive package indeed. The ability to derive transformed and reduced versions of data, quickly and directly in graphical form, makes it extremely powerful.

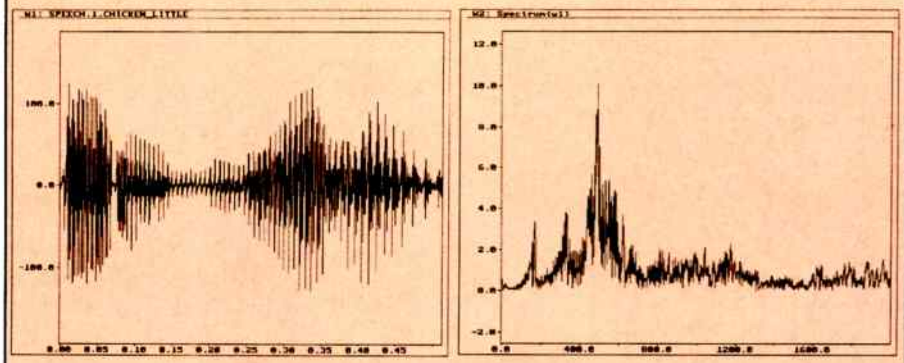
Just as an example, I set up four windows W1-4. Into W1 I fed a 'raw' data sample — which happened to be a sample of digitised speech ('Chicken Little'), supplied as part of DADiSP's built-in demo/tutorial.

Then I told DADiSP that in W2, I wanted to see a plot of the frequency components in the W1 sample — i.e., a spectrum plot.

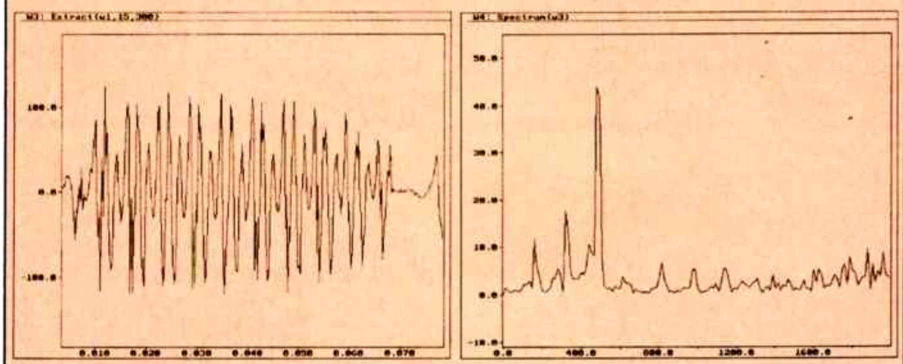
This was done very simply with the mouse, by selecting window W2, calling up the appropriate menu, selecting the spectrum plot function and finally typing in 'W1' as the source of data for the function.

Within a second at most, the spectrum plot appeared in the W2 window of the diagram — showing a main peak at about 500Hz, lesser peaks at about 180Hz and 350Hz, and a reasonable amount of 'noise'.

Then I told it that in W3, I wanted to see an expanded version of the first 75ms of the signal in W1, to examine the first 'burst' of speech in greater detail. This appeared almost immediately, the moment I made the final click with the mouse button.



Reduced to less than 30% of their actual size, here are four window print-outs from DADISP 3.0. W1 at top left shows a digitised sample of speech, while W2 at top right shows the spectrum plot derived from W1 by DADISP. W3 at lower left shows the first 75ms of the W1 sample, and finally W4 shows the spectrum plot of this smaller sample.



Finally, I called for another spectrum plot in W4, this time from the smaller speech sample in W3. As before this appeared within a second, and as expected the plot of this smaller sample was similar to the first, but with lower resolution and less 'noise'.

The four windows of this example are shown in the diagram, as printed out via the laser printer. As printed each one is almost A4 size.

Other functions turned out to be equally easy, and to operate with the same impressive speeds. Presumably this was partly because I was using a 486/33MHz machine, but even on 286 and 386 machines I gather it's still reasonably speedy — as long as you're running a co-processor.

In short, then, my impression of DADiSP in operation is that it's an extremely powerful tool for the analysis, reduction and presentation of technical data. Yet at the same time it's surprisingly easy to use.

The combination of these two important qualities should make it of enormous value to scientists, engineers and anyone else who needs to work with technical data.

My only gripes are that it would be nice if DADiSP could print directly to a PostScript printer, and if it wasn't quite so finicky about sharing the computer with memory managers. But perhaps these things are part of the price we pay, for DADiSP's power and speed...

Talking about prices, the version of DADiSP 3.0 which runs on IBM compatible PCs is priced at $2765 plus P&P where applicable.

Further information on the package is available from Interworld Electronics and Computer Industries (Aust.), 1G Eskay Road, Oakleigh South 3167 (PO Box 300, Bentleigh 3204); phone (03) 563 7066. ❖

PC DIAGNOSTICS MADE EASY

SLASH DOWNTIME AND OPERATING PROBLEMS

With PC Probe™ you'll save time and money when your PC starts acting up. In one easy-to-use package you get Diagnostics, Virus Protection (for over 700+ known viruses), Benchmarks (including the famous LandMark System Speed Test™), Performance Enhancement Utilities, and System Information. Combined, this arsenal of tools will keep your system up and running at peak performance and remove the mystery about what's inside.

PC Probe diagnostic testing quickly isolates the source of hardware problems, even locating bad RAM chips. It tests system board, RAM, video, keyboard, com ports, floppy and hard drives, Ethernet card and more. Run PC Probe tests in batch mode or single pass, remote or on-site.

THE 5 MINUTE SOLUTION TO FLOPPY DRIVE FAILURE

With **Alignit™** you can *clean, diagnose, and align* your floppy drives in minutes *without* a scope. Patented technology requires only screwdriver to perform ANSI-accurate alignments (.3 mil).

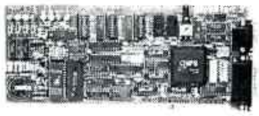
Alignit is *ideal for corporate users with* 2 or more PCs because it includes a **"GOLD STANDARD"** feature so you can align all your PCs to the same in-house standard, *guaranteeing that all your floppies are perfectly interchangeable* between PCs.

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

PC WON'T BOOT? THEN JUST KICKSTART IT!

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

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



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

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

HARD CORE TESTING FOR PROFESSIONALS

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

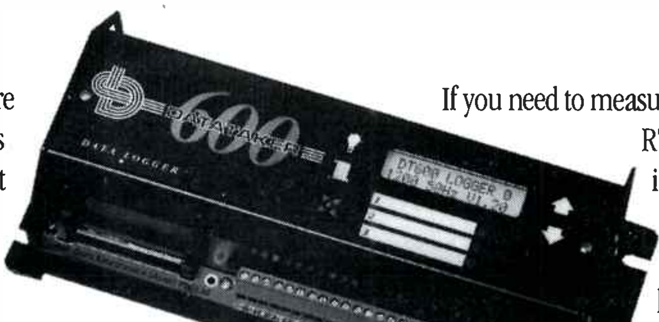
Intended for professional service and repair technicians, Service Diagnostics is also *easy to use* for the novice. Clear, concise on-line help and intuitive menus make finding system problems a breeze. Tests all CPUs, math chips, all memory, floppy, fixed and non-standard disk drives, standard/non-standard printers, system board, video, com ports and all keyboards. Utilities include low-level reformat, log bad sectors, edit bad sector table; the partition editor allows you to set up multiple partitions; *back-up program* transfers hard disk image on unformatted floppies and allows for *restore* after reformat.

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

Interworld Electronics & Computer Industries (Aust) Pty Ltd 1G Eskay Road, Oakleigh South, VIC 3167 Tel: (03) 563 7066 Fax: (03) 563 7337

READER INFO NO. 35

Talk to the Australians who build the world's most popular data logger.



There is a simple reason we are popular with our users. Datatakers are the simple solution to the most complex data logging and monitoring problems.

If you need to record data from a few or many hundreds of sensors we have a model for you. If you need transportable memory storage we have memory cards. If you need to monitor processes and have and have alarms when setpoints are reached we can help you. If you need to operate in remote areas on battery power, with modems or radio links we can help.

If you need to measure thermocouples, strain gauges, RTD's, counters, voltages, currents, in fact any measurement, we can help you. If you need an LCD display for data and alarms we have the answer.

Talk to us now. The solution to your problem will be simple, won't cost the earth and will be a joy to use.

In over twenty six countries engineers turn to Datataker. In Australia you can talk to the people who designed them.

Data Electronics 7 Seismic Court, Rowville Vic. 3178. Tel: (03) 764 8600. Fax: (03) 764 8997.

READER INFO NO. 36

Silicon Valley NEWSLETTER

Apple & Toshiba in PDA venture

Apple Computer is teaming up with Toshiba to develop jointly a second type of Personal Digital Assistant (PDA) device, which will run under advanced new multimedia operating software being developed by the Kaleida joint venture between Apple and IBM.

The so-called 'Sweet Pea' system will be handheld, and run programs and data stored on optical disks. It will cost under US$1000 when it is introduced around the middle of next year.

The announcement comes less than a month after Apple announced the Newton, a handheld PDA that is being developed in cooperation with Sharp Electronics. While the Newton will be aimed at business executives, travelling salesmen and other professionals, Sweet Pea will be targeted at consumer and educational markets.

While not releasing any details of the device, Apple chief John Sculley said during a speech before the Digital World conference in Beverley Hills that Sweet Pea will be the first product to run under a version of the 'Script X' multimedia operating system being developed at Kaleida.

Sculley also said that Apple, in an effort to set the standard for multimedia PDA's will probably licence portions of Script X to other companies that want to develop other PDA's. This would help Apple push Script X as an industry standard, which in return would cause more application companies to develop programs for Script X-based PDA's.

Already, Sculley said, three companies — including two of the world's largest entertainment companies, Time Warner and Paramount — have committed themselves to developing titles for Sweet Pea. Apple's Claris software group will also develop a number of initial applications.

In his speech, Sculley explained Apple needs to team up with major Japanese electronics companies and licence them critical technology because the cost of developing the PDA market is too prohibitive for Apple alone. "We can't drive down the cost of these PDA's without the know-how of companies like Sharp and Toshiba."

Apple's Claris software development subsidiary is housed in this imaginative building, which features outdoor garden areas on two of the upper floors. The group will be developing software packages for Apple's new 'Newton' and 'Sweet Pea' Personal Digital Assistant (PDA) products.

IBM, Toshiba to team up on Flash

In a move that could shake the foundations of the Intel-dominated Flash memory market, IBM is entering a joint venture with Japan's Toshiba to develop new generations of Flash chips — which both companies would incorporate into their own computer products, as well as sell on the open market.

The teaming of IBM and Toshiba could have major implications for the Flash market. Both companies are already at the leading edge of DRAM memory chip design and development. If they are able to transfer their design and manufacturing expertise in DRAMs to the Flash market, Intel would face two new formidable competitors.

For IBM, a major commitment towards Flash also signals an internal determination that solid state memories, in the long run, will be the memory vehicle of choice for a number of key product lines — perhaps even desktop PCs. For Toshiba, a jump into the still small Flash market could give the company a head start when the Flash business takes off in a big way — which is expected during the second half of this decade.

Toshiba, like most Japanese DRAM makers, is frantically looking for ways to leverage their high-density DRAM manufacturing technology into other more profitable product lines. Flash memories, which still command very high prices per million bits of chip capacity, are a natural field for the Japanese to explore.

Dataquest in San Jose predicts that Flash memories will turn into a US$1.5 billion market in the next three years, up from just US$130 million in 1991.

Ironically, it was Toshiba which developed the first Flash memories, in the mid-1980s. But the company, too busy trying to become the dominant DRAM supplier, failed to make Flash memories a high priority. That allowed several American firms, most notably Intel, Xicor, and Seeq to acquire a vast majority of the Flash market.

Interactive TV system to go nationwide

Hewlett-Packard's 'Interactive Network' TV play-along system is selling so well during its first couple of months that the system's parent firm has announced plans for a national US sales program.

Until now, the IN console, which lets consumers interact with live television programs via a video game like console, has only been available in California.

While HP is producing the console the network is being operated by Interactive Network. Company president David

Lockton said his firm has received new venture capital that will allow it to offer the system on a nation wide basis.

The IN system receives digital data transmitted over unused portions of local FM radio stations. The signals are synchronised with TV broadcast signals. Viewers, watching a game show, can answer questions being asked of the game's contestants and the system will show how well they did.

TV education programs could be revolutionised with this online interactive capability. Eventually, viewers may be able to win prizes as the system's central computer will be able to track the scores of individual viewers.

When the system was launched earlier this year, IN and HP said they hoped to be able to sell a million units in its first year. IN's Lockton said sales so far are well ahead of this schedule.

Japan's new chip agreement may fail

Too few American semiconductor vendors are making the kinds of chips that Japanese buyers need most and for that reason it will be difficult for Japan to allow foreign marketshare to increase quickly, according to Nobuo Kanoi, chairman of the Foreign Semiconductor Committee of the Electronics Industry Association of Japan (EIAJ).

The statement is the first public indication that Japan may not be able to implement the terms of the emergency agreement the EIAJ signed recently. That agreement was aimed at quickly boosting the foreign share of the US$20 billion Japanese chip market from its current stagnant 14% level to around 20%, as it is supposed to by the end of this year under the US-Japanese Chip Trade Agreement of 1991. Kanoi made his comments in response to President Bush's warning to Prime Minister Kiichi Miyazawa that Japan must do more to improve foreign access to its automotive and semiconductor markets.

Kanoi said Japanese electronics companies are doing their best to buy more foreign semiconductors. But they are also confronted with a severe recession and they must spread the economic hardship among all of their suppliers: "Japan doesn't treat others badly, while treating itself well."

One of the reasons progress in market share will be slow, he explained, is that many semiconductors used by Japan's electronics industry are application specific, and it takes time to work with new vendors to develop such chips.

"The problem is that there are very few American companies that can supply exactly what customers need here," Kanoi said. He added that while Japanese companies can buy more American standardised parts, this represents only a small part of the market. "Even if the inside of a chip is identical, if the packaging or dimensions are different, we can't use it."

At the Semiconductor Industry Association office in San Jose, spokeswoman Angela Newlove disputed Kanoi's statements.

"A year ago, we signed an agreement with the Japanese government and they determined that we have the products that they could use, and they agreed the 20% market share was achievable. The joint statement we signed with the EIAJ was to implement an emergency measure to try to achieve this 20% share. Here we are one month later and Kanoi is talking about why it won't succeed, instead of how he plans to make it succeed."

Intel invests in VLSI Technology

In a move designed to bring Intel chips into the potentially huge market of products that blend traditional consumer electronics with advanced computer technology, Intel announced it has agreed to buy a 20% equity position in San Jose chip maker VLSI Technology. As part of the deal, the Santa Clara chip maker will allow VLSI to develop and manufacture new versions of its low power 386SL processor.

The deal means a major strategic shift for Intel. Since it terminated its technology exchange agreement with AMD in 1987, Intel has tried hard to remain the sole source for its line of X86 processors. Recently, AMD, Cyrix, Chips & Technology and Texas Instruments have brought competing clones of the 386 and 486 chips to market.

In addition to receiving US$50 million in cash from Intel in return for 20% of its stock, VLSI will now be allowed to make low power versions of the Intel 386SL — chips designed for a new generation of handheld devices such as PDA's. Already VLSI is producing a low power RISC processor for Apple Computer's new family of PDA's.

Intel wants to ensure its processors will play a signficant role in the PDA market. Intel itself may not be interested in producing the PDA chips, which will be high volume, low price in nature, and often require considerable customisation.

But at the same time, Intel does not want to see all of the PDA business end up in the hands of its competitors, such as AMD and Texas Instruments. Taking an interest in VLSI will ensure Intel an indirect role in the market for PDA processors.

Intel said it chose VLSI because of that company's strength in the area of customisable chips and its expertise in low power consuming components.

VLSI said it will use some of the Intel money to expand its Texas-based manufacturing facilities.

Intel delays 586 launch

Intel is delaying the launch of its next generation P-5 (586) microprocessor, in an effort to avoid the same embarrassment the company suffered with bugs that surfaced following the launch of the previous 386 and 486 processors. Originally scheduled for this fall, Intel said it now expects the P-5 to debut in the first quarter of 1993.

Industry analysts said there may have been additional motives to the delay. Besides giving engineers more time to get rid of any remaining bugs, the delay will give Intel the opportunity to use fab lines in Oregon and New Mexico that were reserved for P-5 volume production, to produce more of Intel's best selling 486 chips.

The decision to delay the P-5 was also aided by the recent court victory over AMD, which is keeping a major competitor out of the 486 market. The absence of AMD and its ability to produce high volumes of 486 chips will keep 486 prices at a stable and profitable level. Even Cyrix, which recently entered the 486 market, is unlikely to unleash a price war as long as its sales continue to meet targets.

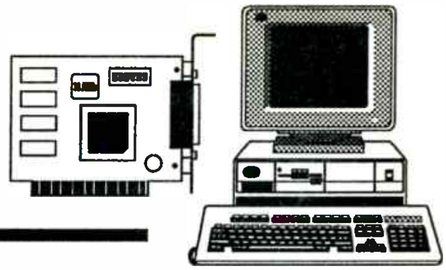
The only drawback for Intel is that the delay may hurt the company's strategy of pitting the P-5 against SPARC and MIPS RISC processors in the workstation arena. Intel has said it is confident that the 66MHz P-5, which contains some three million transistors, will be able to compete effectively in the workstation market.

H-P wins huge workstation order

Hewlett-Packard has been awarded one of the largest single contracts in workstation history, as the German Bundespost's Telekom division has signed a purchase agreement worth US$125 million for HP's line of workstations and printers.

The equipment will be delivered over the next several years. It is part of a major technology restructuring program underway at the German Bundespost whose Telekom unit is Europe's largest telecommunications carrier. ❖

Computer News and New Products



Low cost PCB software

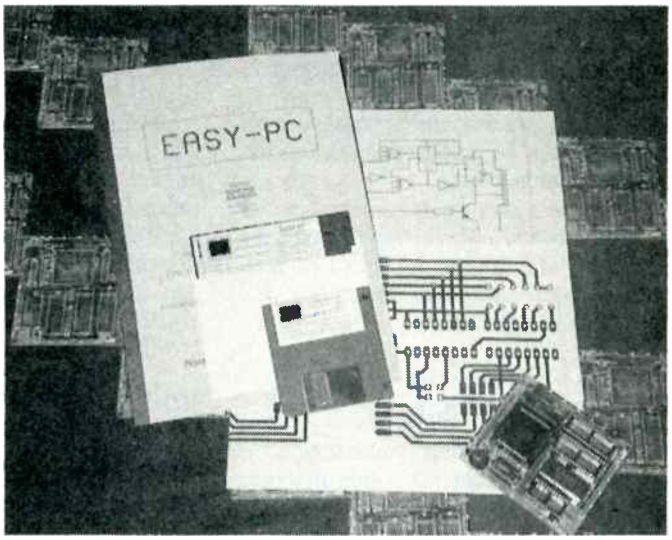
Easy-PC is a PCB and schematic diagram design program which produces professional quality output, but costs only $249.

The package has the power to handle multilayer boards with up to eight conductor layers, plus top and bottom silk screens and solder resists. It allows 128 different track widths and pad sizes to be used, from 0.002 to over 0.5" with full surface mount support.

Schematic diagrams can be quickly created in an identical manner to the PCBs, while check plots and artworks can be produced on dot matrix printers, pen plotters or laser printers, and Gerber files can be generated for photo plotting.

Two additional libraries are also available: library 1, a collection of over 1000 schematic drawing symbols covering 13 logic families, including microprocessors, memories and support chips; and library 2 which contains over 500 surface mount component land patterns for passive devices, DILs, quads, flatpacks, chip carriers and PLCCs.

Easy-Link now also has a file translator which allows Gerber files from older PCB design programs to be translated into Easy-PC's format.



For further information circle 166 on the reader service coupon or contact Plunkett Industrial Electronics, 21 Blacks Road, Gilles Plains 5086; phone (08) 261 3799.

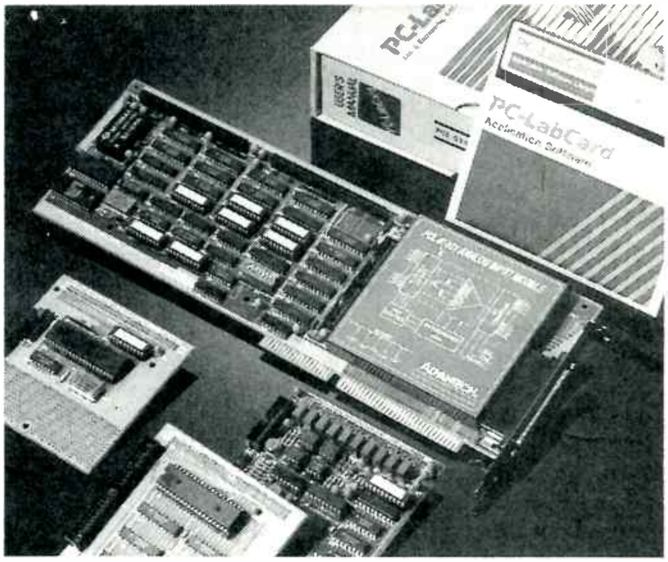
Customised DA cards

The PCL-814 represents a new generation of modular PC-compatible Data Acquisition Cards. The cards' task-orientated design offers the user greater flexibility when customising their data acquisition system. This is achieved by plugging in only the modules that are required for the application.

The card comes equipped with a 14-bit resolution 100kHz high performance A/D module, which provides 16 channels of differential analog signal measurements. But the special feature of the PCL-814 is that it has two 64-pin 'piggy-back' connectors for function expansion, using plug-in modules. There are currently three different I/O plug-in modules available, the PCL-814-DA-1, PCL-814-TC-1 and the PCL-814-DIO-1.

The PCL-814-DA-1 modules provides two channels of 12-bit D/A output. Each channel can be individually configured for voltage or 4-20mA current loop. The PCL-814-TC-1 is a general purpose counter/timer module with an on-board 1MHz crystal timebase — the module uses an AMD 9613 counter timer chip to provide five channels of 16-bit up/down counters. The PCL-814-DIO-1 module is equipped with an 8255 PP1 chip to provide 24 bit digital input/output configuration.

For further information circle 163 on the reader service coupon or contact Priority Electronics, 23-25 Melrose Street, Sandringham 3191; phone (03) 521 0266.



Remote operation software

Neutrik's new AS03 Software allows full remote operation of its A Series Audio Test Instruments, including the A1 Audio Test & Measurement System. Designed to run on IBM XT, AT and compatible computers, the AS03 provides enhanced measurement functions for the A1 audio test set.

Employing full bidirectional communication, the AS03 package provides complete control of all A1 functions. It features a window-controlled user interface with mouse support and on-line help for ease of operation.

AS03 expands the capability of the A1 Audio Test System with enhanced measurement functions, including: fixed range measurements, amplitude sweeps, time sweeps, table sweeps, external sweeps (frequency and level), tolerance curves, calculation of tolerances and a tolerance comparison function. It can simultaneously display several response curves on screen for comparison, as well as load and save graphics and tables to disk. The package is supplied with a wide selection of printer and plotter drivers.

For further information circle 162 on the reader service coupon or contact Amber Technology, Unit B, 5 Skyline Place, Frenchs Forest 2086; phone (02) 975 1211.

Low cost programmer

The ChipMaster 3000 is a new low cost PC/XT/AT or compatible universal pin-driven programmer from Logical Devices. Its 40-pin standard ZIF socket can directly program over 1000 different devices such as E/EE/PROMs, PALs, GALs, FPLAs, PEELs, EPLDs, EEPLDs, and Microcontrollers. SMD devices can be supported through optional adaptors.

The ChipMaster software allows menu driven device selection by vendor's name and device part number. When a device is selected, its associated programming algorithm, voltage and timing parameters are automatically selected.

The ChipMaster hardware provides two programmable voltage sources (from 5V to 25.5V, 100mV step) to all 40 pins. A third high current source can be applied to the specific pin. With these features, the unit can support all silicon technologies — NMOS, CMOS, bipolar and ECL.

With the 'Device Options' command, users can edit device programming parameters such as Vpp, Vcc, PW, RETRY, etc. The unit will display all parameters using the same names found in vendors' published data books. With this feature, you can add new devices (if devices have the same pin configuration and waveform, but different voltage and timing specs). This provides an alternative to waiting for programmer and manufacturer's updates.

For further information circle 169 on the reader services coupon or contact Emona Instruments, PO Box K720, Haymarket 2000; phone (02) 519 3933.

Waterproof trackball

For applications in hostile environments, Penny & Giles Computer Products is shipping a new waterproof trackball, immersible in up to 60cm of water without tactile feel degradation.

All electronic parts are fully protected by O-ring seals, yet the 5cm diameter ball can easily be removed for ease of cleaning without compromising water-proof integrity. The ball movement is transmitted to the encoders via a novel drive mechanism. Resolution is 800 edges per ball revolution.

On the panel-mount version, the full range of interface options are available, including RS232 or TTL data stream. It supports most computer hardware, including IBM PC/AT, PS2 and RS6000, DEC Workstations 3100, VSV212 and VT240, Sun Microstations and Silicon Graphics cards. Mouse Systems, Microsoft and Summagraphics (bit pad 1 & 2) are all supported as well.

For further information circle 168 on the reader service coupon or contact University Paton Instruments, PO Box 402, Riverwood 2210; phone (02) 534 6100.

HP printer sharer

ASP has released its ServerJet Si printer sharer. This product is a card that plugs into the MIO interface slot of the HP IIIsi (and now HP DesignJet and HP PaintJet as well) and allows up to seven users to share the printer.

Maximum flexibility has been a design goal of the ServerJet Si. Six concurrent users can communicate with the printer via serial ports using low cost telephone jacks. A seventh user has access via a parallel port, or a second printer can be attached and addressed with the ASP software supplied.

If the HP IIIsi is required on a network, it can be connected via the ServerJet Si's parallel port, and six non-network connected users can still simultaneously share via the serial ports. This is important for network back-up or large file applications requiring fast print times.

The software supplied detects which

HP MIO device it is attached to, either the HP IIISi, the DesignJet plotter or the PaintJet XL colour printer. Each port can then be separately configured, including baud rates to 115.2k baud, auto emulation sense (PCL and Postscript), time out and hand shake. The parallel port can also be set up as either input or output. Set up is done from an attached PC or from the control panel of the HP IIISi itself.

The ServerJet Si comes standard with 1MB of memory but can be upgraded to 4MB for larger files. The ServerJet Si is the ideal partner for the big HP laser when a LAN is just not needed. It is priced at $1551, inc. tax.

For further information circle 167 on the reader service coupon or contact Sprinter Products, 22 Darley Road, Manly 2095; phone (02) 977 8155.

Sound Galaxy cards

The Sound Galaxy family of multimedia sound cards has been developed by Singapore-based Aztech Systems, and comprises the Sound Galaxy EX, Sound Galaxy BS and Sound Galaxy NX cards.

The top of the range Sound Galaxy NX card incorporates the four major sound standards of AdLib, Sound Blaster, Covox Speech Thing and Disney Sound Source, enabling users to run the largest library of education, presentation, multimedia and entertainment software of any sound card available.

The NX also includes both MIDI and CD-ROM interfaces, digital input and output and games ports.

The performance of the NX card is further boosted by a suite of powerful and popular software applications and utilities, including Monologues Speech to Text Synthesiser, Band-in-a-Box intelligent music accompaniment software, digital recording and playback utility and other utility software valued at over $600.

Also included with the Sound Galaxy NX card is a set of mini speakers which further enhance the sound quality output.

The suggested retail prices (inc. tax), for the Sound Galaxy cards are: EX $199, BX $235, and NX $379.

For further information circle 165 on the reader service coupon or contact Entcom, 5 Viewtech Place, Rowville 3128; phone (03) 764 3399.

Mac and PC demo packages

National Instruments Australia announces two free demonstration packages — one for its popular LabVIEW graphical programming software for the Macintosh, and one for its LabWindows software development system for DOS PCs.

The LabVIEW 2 Demonstration Package summarises the capabilities of LabVIEW 2, shows the user how to build a virtual instrument (VI), and examines a completed VI and its components. The demo package requires a Macintosh with at least 2MB of RAM, 2 MB of available hard disk space, and a 13" monitor.

The LabWindows Demonstration Program gives a comprehensive overview of the LabWindows 2.1 software development system for programmers using C and BASIC for data acquisition and instrument control applications.

The demo is based on a functional version of LabWindows, and includes example programs that show how LabWindows is used to develop application programs.

It requires a PC AT, EISA, or Micro Channel computer running MS-DOS (Version 3.0 or later), 2MB of memory, a minimum 80286 processor, and an EGA or VGA display adaptor.

For further information circle 171 on the reader service coupon or contact National Instruments Australia, PO Box 466, Ringwood 3134; phone (03) 879 9422.

Autodesk supports Windows NT

Autodesk has confirmed that customers of its computer-aided (CAD) software will be able to run AutoCAD on Windows NT, a new operating system being developed by Microsoft Corporation. A pre-alpha version of AutoCAD for Windows NT was demonstrated in Chicago in April.

Autodesk also has restated its intention to continue investigating extender technologies to provide a 32-bit version of AutoCAD for Windows 3.1, as well as reaffirming its commitment to new releases of AutoCAD for DOS.

When available, AutoCAD for Windows NT is expected to offer all of the capabilities of AutoCAD on other operating systems, as well as take advantage of the unique capabilities of Windows NT, including: faster performance, by virtue of 32-bit architecture; pre-emptive multitasking; protected mode, stable operating system; multiple AutoCAD for

READER INFO NO. 26

Windows sessions; and support for multiprocessor PCs.

For further information circle 170 on the reader services coupon or contact Autodesk Australia, 9 Clifton Street, Richmond 3121; phone (03) 429 9888.

Master Designer 6.0

P-CAD Master Designer 6.0 for DOS is the latest version of the printed circuit design package from CADAM, an IBM company. Version 6.0 now offers a full 32-bit database to handle the most dense PCB designs and facilitate fractional-thou grids.

It also features a new modern style interface and design manager that simplifies the control of projects, together with software display list graphics for accelerated screen redraw, automatic dimensioning and auto-resequencing by component or grid coordinates.

A new user interface called 'Prevue', uses icons, pop-up windows and pull-down menus. Its design manager ensures consistency between the schematic and PCB layout — it automatically updates the PCB and provides full automatic forward and backward annotation between the schematic and the layout.

Master Designer 6.0's 32-bit database operates with 386 and 486 code for unlimited design capacity. A 0.01-thou resolution database allows for extremely fine line design and mixed Imperial/Metric packages, without round-off error.

In addition, it is now possible to have up to 5000 pins per component and 1000 different pin types. Its Auto-Dimensioning feature supports simple to complex geometry, including point-to-point, datum, centre, diameter, radius and angular dimensions with user-controller tolerancing. This allows easy creation of fabrication and assembly drawings.

The package is DPMI compatible for Microsoft Windows, and offers a VESA driver to support most super VGA display cards.

An additional feature of the DOS-based Version 6.0 is that databases and libraries are compatible with the P-CAD Unix system, Premier PCB, running on SUN SPARCstation and the IBM RISC 6000. This enables cost effective networks with a mixture of DOS and Unix platforms.

For further information circle 173 on the reader service coupon or contact Quest International Computer, 1 Hamilton Place, Mount Waverley 3149; phone (03) 807 7444. ◆

EA DIRECTORY OF SUPPLIERS

Which of our many advertisers are most likely to be able to sell you that special component, instrument, kit or tool? It's not always easy to decide, because they can't advertise all of their product lines each month. Also some are wholesalers and don't sell to the public. The table below is published as a special service to EA readers, as a guide to the main products sold by our retail advertisers. For address information see the advertisements in this or other recent issues.

Supplier	State	A	B	C	D	E	F	G
Altronics	WA	•	•	•	•	•	•	•
Companion Computers	VIC		•					
Dick Smith Electronics	ALL	•	•	•	•	•	•	•
Emona Instruments	NSW						•	
Geoff Wood Electronics	NSW	•	•	•	•	•	•	
Jaycar Electronics	Eastern	•	•	•	•	•	•	•
Kalex	VIC			•				
Macservice	VIC						•	
RCS Radio	NSW			•				
Rod Irving Electronics	VIC	•	•	•	•	•	•	•
Scientific Devices	VIC						•	
TECS	VIC	•	•	•	•	•	•	•
Wagner Electronics	NSW		•		•	•	•	

KEY TO CODING:
A Kits and modules
B Tools
C PC boards and supplies
D Components
E IC chips and semiconductors
F Test and measuring instruments
G Reference books

Note that the above list is based on our understanding of the products sold by the firms concerned. If there are any errors or omissions, please let us know.

Electronics Australia Reader Services

SUBSCRIPTIONS: All subscription enquiries should be directed to: Subscriptions Department, Federal Publishing Co, PO Box 199, Alexandria 2015; phone (02) 693 9751.
BACK ISSUES: Available only until stocks are exhausted. Price A$7.50 which includes postage within Australia only. **OVERSEAS READERS SHOULD ADD A FURTHER A$2.50 FOR EVERY BACK ISSUE REQUIRED.**
PHOTOSTAT COPIES: When back issues are exhausted, photocopies of articles can be supplied. Price $7.50 per project or $15 where a project spreads over several issues.
PCB PATTERNS: High contrast, actual size transparencies for PCBs and front panels are available. Price is $5 for boards up to 100sq.cm, $10 for larger boards. Please specify negatives or positives.
PROJECT QUERIES: Advice on projects is limited to postal correspondence only and to projects less than five years old. Price $7.50.

Please note that we cannot undertake special research or advise on project modifications. Members of our technical staff are not available to discuss technical problems by telephone.
OTHER QUERIES: Technical queries outside the scope of 'Replies by Post', or submitted without fee, may be answered in the 'Information Centre' pages at the discretion of the Editor.
PAYMENT: Must be negotiable in Australia and payable to 'Electronics Australia'. Send cheque, money order or credit card number (American Express, Bankcard, Mastercard or Visa card), name and address (see form).
ADDRESS: Send all correspondence to: The Secretary, Electronics Australia, P.O. Box 199, Alexandria, NSW 2015.
PLEASE NOTE THAT WE ARE UNABLE TO SUPPLY BACK ISSUES, PHOTOCOPIES OR PCB ARTWORK OVER THE COUNTER.

METHOD OF PAYMENT: (Please circle correct method).

Credit Card: Cheque: Money Order:
Mastercard
American Express
Visa
Bankcard

Expiry Date:......................

|_|_|_|_| |_|_|_| |_|_|_|_| |_|_|_|_|_|_|_|

Name:..
Address:..
....................................Postcode:..............
Back Issues:..
....
....
Photostat Copies:..
....
....
....

No.of issues required:.....$7.50=..................
No.of copies required:.....$5.00=..................
No.of copies required:...$15.00=..................

Total Payment Enclosed $ ========

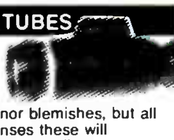
Signature:..
(Unsigned orders cannot be accepted).

ADVERTISING INDEX

This index is provided as an additional service. The publisher does not assume any liability for errors or omissions.

[illegible]

SECOND GENERATION TUBES



We have a limited supply of some 18mm fibre optically coupled 2nd generation image intensifier tubes. These are ex-military and may have some minor blemishes, but all produce full gain. With low light lenses these will produce useful images with as little as starlight illumination. Can also be IR assisted with IR LED's or low power torches, in rare situations where this may be required. The tubes require a 3V battery and a switch to make them operational. The viewer illustrated uses one of these tubes. It was constructed using some low cost plastic tubing and matching fittings for the case, a camera lens, and a low cost eyepiece. Plastic jewellers eyepieces can be used. **$620**

FOR THE TUBE AND THE SPECIFICATION SHEET

ULTRASONIC TRANSDUCERS

Scoop purchase. High quality "Murata" 40kHz ultrasonic transducers.

$4 per pair

Ring for higher quantity pricing

LASER GUNSIGHT

Small black anodised metal body. Removable pressure switch. Vertical and horizontal adjustments. Battery life more than 10 hours continuous. 5mW 670nM class IIIA laser. Range is about 150m, some would claim three times more. Shock tested to 2000g. One year warranty.

ON SPECIAL AT $249

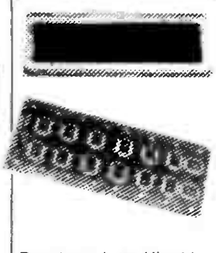
Price includes one rifle or pistol mount.

FILTER PCB ASSEMBLY

Contains mainly 8 modern ferrite transformers which are very easy to disassemble and rewind. Ferrite halves are clipped together and no adhesives are used between them or in coil winding. There are four identical small transformers and four indentical larger transformers. The transformers can be rewound for use in inverters, inductors, filters, etc.

$5 ea

LARGE LCD DISPLAY MODULE



Brand new large Hitachi LM215XB display, as used in some laptop computers. Yellow-green LCD reflective type, 480 X 128 dot display, effective display area of 242 X 69 mm, has 14 LSI ICs mounted on the rear of the PCB. Includes four pages of data sheets. Limited stock at a small fraction of their real value. **$39** ea.

Controller kit available for $25 including instructions.

LIGHT MOTION DETECTOR

Small PCB assembly based on a ULN2232 IC. This device has a built in light detector, filters, timer, narrow angle lens, and even a siren driver circuit that can drive an external speaker. Will detect humans crossing a narrow corridor at distances up to 3 metres. Much higher ranges are possible if the detector is illuminated by a remote visible or IR light source. Can be used at very low light levels, and even in total darkness with IR LED. Full information provided. The IC only is worth $16! Our price for the assembly is:

$6 ea. or 5 for $25

MUSIC ON HOLD PCB

PCB assembly based on a 7910 CF LSI music generator IC. Plays Greensleeves or Home on the Range, with a sound quality which is hard to believe. Full chords and accompaniment. Also produce two different alarm sounds. Apply 1.5-12V across two of connector pins to obtain music. Copy of E.A. project (Dec. 80) employing this IC is provided.

$5 ea

INFRA RED NIGHT VIEWER

These matching components were removed from brand new IR tank viewers. They include a large low light objective lens, a large prefocussed IR image converter tube, a power supply or power supply kit to suit the tube and an adjustable eyepiece assembly.

Make a professional infra red night viewer at a ridiculous price of: **$199**

For the set.

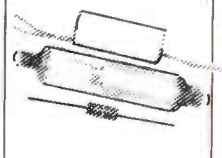
PROJECTION LENS

Brand new large precision projection lenses, which were originally intended for big screen TV projection systems. Will project images at close proximity, onto walls and screens and it has adjustable focussing. Main body has a diameter of 117mm and is 107mm long. The whole assembly can be easily unscrewed to obtain three very large lenses: two plastic and one glass. The basis of the cheapest large magnifier or projection system? Experimenters delight at

ONLY $28

(Item No. 0137)

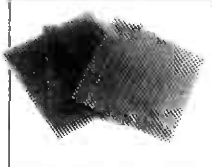
MINI GAS LASER SPECIAL



Very small tube and inverter to suit; suit long range gunsights, laser pointers. Incredible value at **$150**

Includes tube, supply and ballast resistor

SOLAR PANEL GIVEAWAY



Brand new 6 volt 1 watt amorphous solar panels, 150m x 150mm, will deliver one watt whilst charging 6-8V batteries. Two of these in series make a great 12V battery maintainer/charger. Have weather protection, and terminating clips are provided. Incredible pricing:

$10 ea or 10 for $85

EHT GENERATOR

Based on a brand new, very compact modern EHT flyback transformer which includes an EHT diode rectifier. We supply the transformer, a very simple circuit, and the components to suit. All you need to make a very simple EHT or DC or pulsed AC supply. Powered from 12V DC supply. Great for EHT experiments, EHT testing, plasma displays (large light bulbs can be used) etc. Total price for the transformer and the components is only: **$17**

METAL CASSETTES

You can hear the difference with these premium quality [..] min. pure metal cassettes. These were recorded on once, never played, and then bulk erased. The record tabs have been removed.

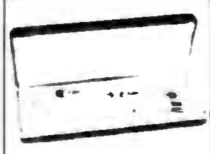
$6 ea or 10 for $50

STEPPER MOTORS

These are brand new units main body has a diameter of 58mm and a height of 25mm. Will operate from 5V, has 7.5 deg. steps, coil resistance 6.6 ohm and it is a two phase type. Six wires.

ONLY $12 ea. (Item No. 0140)

VISIBLE LASER DIODE POINTER-PEN



Suit teachers, doctors, businessmen, and other professionals. Improve and enhance all your presentations. Not a kit, but a complete commercial pen sized laser pointer at an incredible price!

ON SPECIAL AT $180

Small pen sized body. Runs on two small AAA battery. Battery life: 2-10 hours. Visible 5mW red (670nM) laser. Projects a visible red spot at more than 50 metres. As used for medical treatment by doctors and acupuncturists.

GEL BATTERIES

Famous high-spec Gates brand dual cell batteries, enclosed in a plastic moulding. 4V-5AHr per pack. Connect 3 packs in series to obtain a 12V/5AHr battery. Brand new, fresh stock, fully charged. Limited stocks at a giveaway price of:

$18 or 3 packs for $45

UV PENS

The writing of these pens is only visible under UV "Black Light"

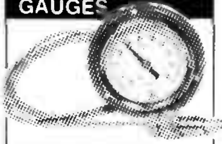
$2 ea or 5 for $18

PIEZO SIREN

Stock up on this limited stock surplus item. Brand new, 6-12V (6V/50mA, 12V/150mA). Giveaway at:

$6 ea or 5 for $25

PRESSURE AND TEMPERATURE GAUGES



Brand new, large MIL-SPEC guages. Overall diameter approx. 130 mm. Pressure guage reads from 0-16 bar. Temperature guage reads from −20 to 80 deg C and has a remote sensor attached to a 2m lead.

Pressure guage **$32**

Temperature guage **$29**

MYSTERY LASER

We have accumulated a good supply of some new and used tubes and heads with powers in the range of 0.5-2mW. These may have some small beam geometry problems. The tubes and the heads are guaranteed for one year! You can purchase one of these tubes/heads with our Universal 12V laser inverter kits for the price of the inverter only!

$79

OTHER PRODUCTS

We have heaps of lasers and night vision equipment.

I.R. BINOCULAR VIEWER

High quality military binocular IR viewer. Self powered, and originally intended to be mounted on a helmet. Focus is adjustable from 1 metre to infinity. Requires some IR illumination. Powered by one single 1.5V battery. Original fibreglass carry case provided. Limited stock.

ON SPECIAL $500

NICAD BATTERY PACK

A complete nicad battery power pack that was intended to be used in emergency lighting application. Contains 17 "D" size 1.2V/4 AHr batteries which can be easily separated into individual cells. New packs in their original packing.

$75 per pack

BARGAIN MONOCULAR VIEWER

A very small but complete IR telescope which only needs an EHT power supply, which is provided in kit form. PCB and all on board comp's only. Limited stock at a reduced special price.

$229

OATLEY ELECTRONICS

FOR SPECIALISED ELECTRONIC ITEMS, COMPONENTS AND KITS

PO BOX 89. OATLEY. NSW 2223

Telephone: (02) 579 4985 Fax: (02) 570 7910

Certified p&p: $6 in Aust. NZ (Airmail): $10

READER INFO NO. 39

Adilam Electronics, Setting new standards in the world of electronics distribution.

Adilam Electronics Pty. Ltd.
The Component Specialists

MELBOURNE
3 Nicole Close,
North Bayswater 3153
P.O. Box 664, Bayswater 3153
Telephone: (03) 761 4466
Facsimile: (03) 761 4161
Toll Free: (008) 800 482

SYDNEY
Suite 1, Ramsgate Plaza,
191 Ramsgate Road,
Sans Souci 2219
Telephone: (02) 529 2277
Facsimile: (02) 529 5893

AS 3902/ISO 9002 QUALITY SYSTEM

READER INFO NO. 40

• Capacitors • Connectors • Fans • Filters • Headers • LEDs • Plugs • Rectifiers • Relays
Resistors • SCRs • Triacs • Sockets • Switches • Terminal Blocks • Varistors