AUSTRALIA'S DYNAMIC ELECTRONICS MONTHLY

# Electronics Today INTERNATIONAL

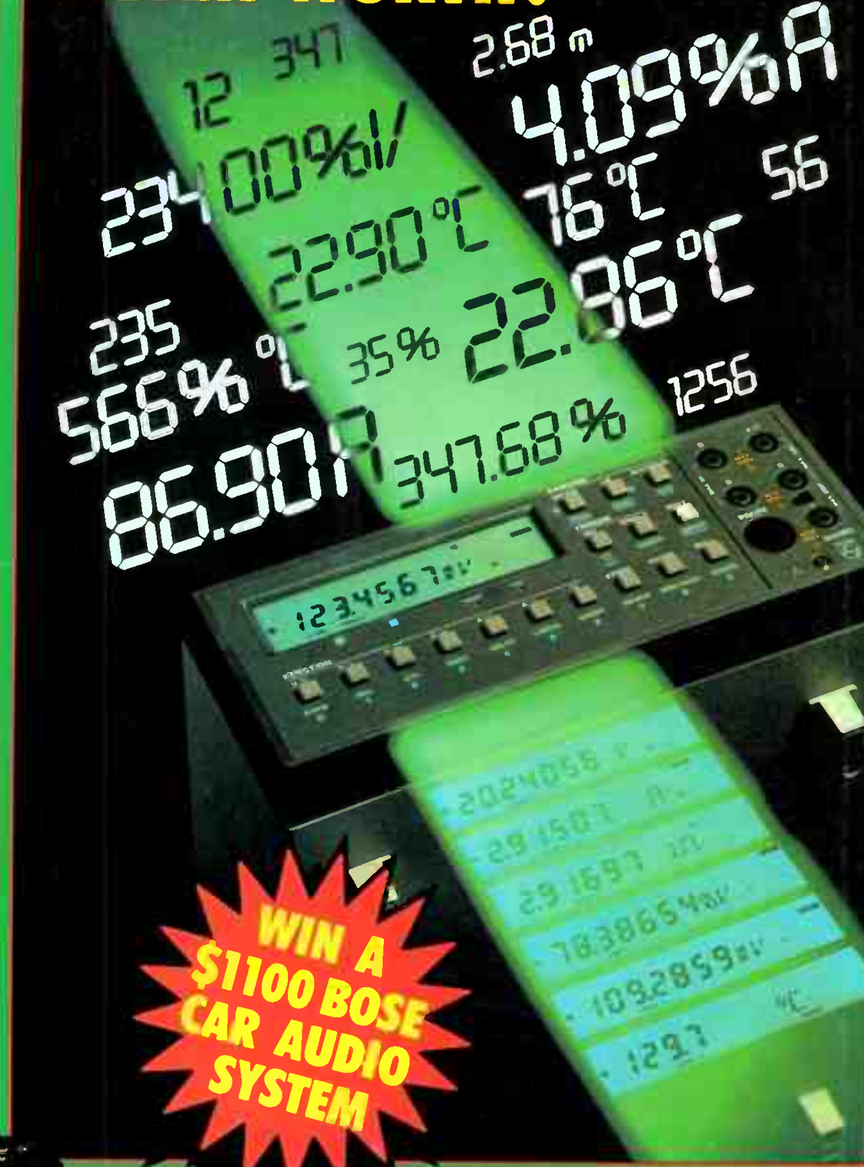
eti

MARCH 1987

$2.95* NZ $3.95 incl. G.S.T.

FREE! JAYCAR CATALOGUE INSIDE

## WHAT'S A BENCH METER WORTH?



**PROJECTS TO BUILD:**

- 16-BIT COMPUTER
- AM RADIO
- AMPLIFIER
- PASSIVE RADIATOR SPEAKER

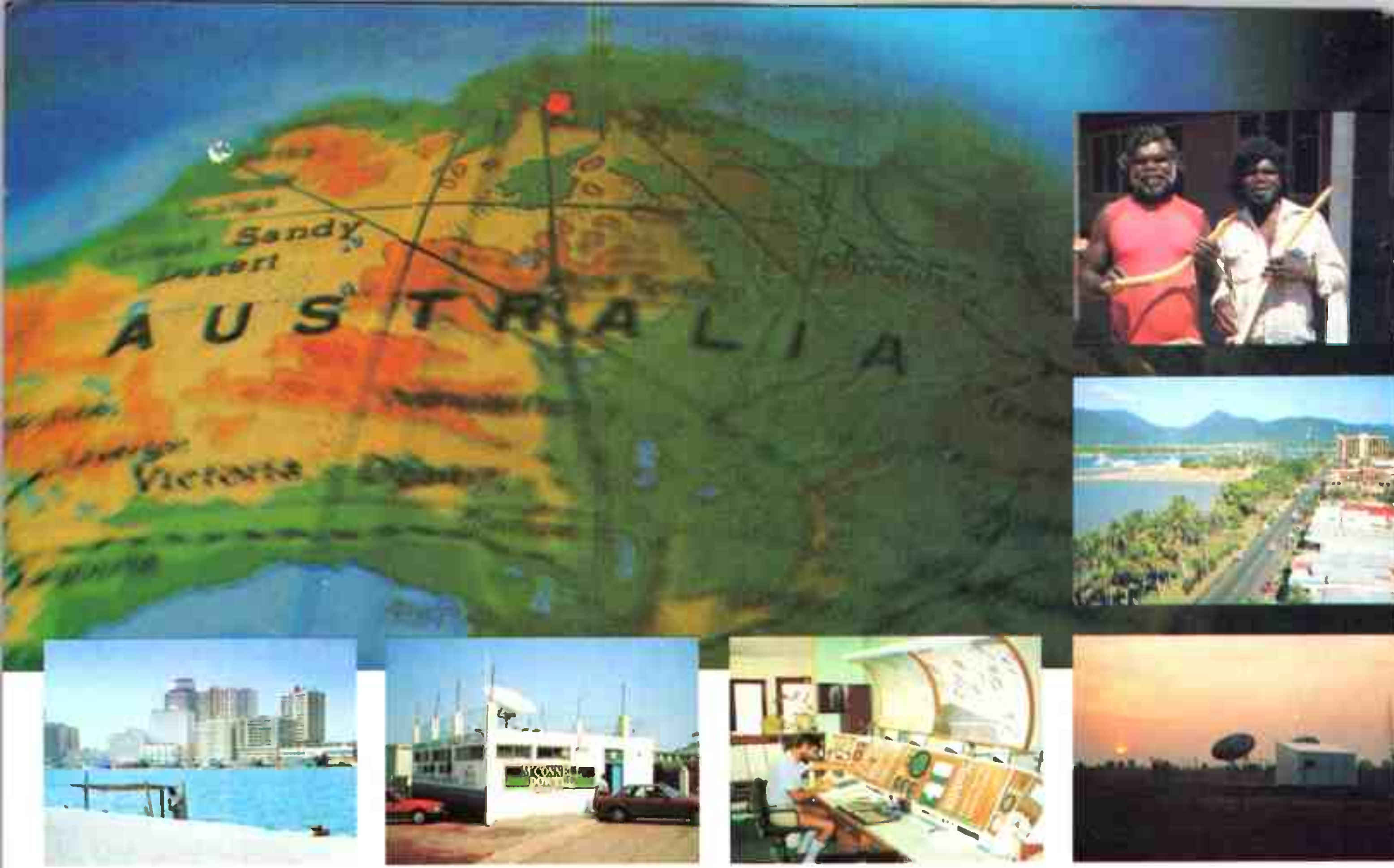
BUYERS' GUIDE TO HI-FI SYSTEMS

WIN A $1100 BOSE CAR AUDIO SYSTEM

EXCLUSIVE:

## CHALLIS COMPARES BOOKSHELF SPEAKERS

Registered by Australia Post. Publication No. NBP8487.


Sandy
Desert
AUSTRALIA
Victoria

Electronics Today INTERNATIONAL

MARCH 1987

## FEATURES



## REVIEWS



## PROJECTS



## OFFERS



## DEPARTMENTS



**COVER:** Design by Clive Davis. Photography courtesy Philips, Peter Beattie.


Page 20


Page 74


Page 100


Page 98

# Fluke breaks the old mold.


**The Fluke 37. A bold new shape emerges with more features for the money than any other bench DMM.**

Dollar for dollar, the new Fluke 37 is unbeatable. In addition to its breakthrough design — with built-in handle and storage compartment — it has all the high-performance features of the world's best, most reliable 3½ digit DMMs.

Autoranging, to eliminate guesswork. Audible Continuity, so you don't have to look at the display. An exclusive analog *and* digital display, for the best view of the signal being measured. Superior EMI shielding. And user-friendly features like auto self-test, auto battery test and auto-polarity. All this, *plus* a two-year warranty.

And, how many other bench meters give you these features? Min-Max recording, for monitoring signals. 38 components dedicated exclusively to input protection. Relative mode, to help you calculate changes in readings. And Fluke's patented Touch Hold, to give you an extra set of hands when you're taking critical measurements.

None. Not at *any* price.

FROM THE WORLD LEADER IN DIGITAL MULTIMETERS.

FLUKE®

**FLUKE 37**

- 0.1% basic dc accuracy
- Analog/Digital Display
- Volts, Ohms, Amps, Diode Test
- 30 kHz AC bandwidth
- Fused 10A Range
- Integral handle, storage compartment
- 2-year warranty

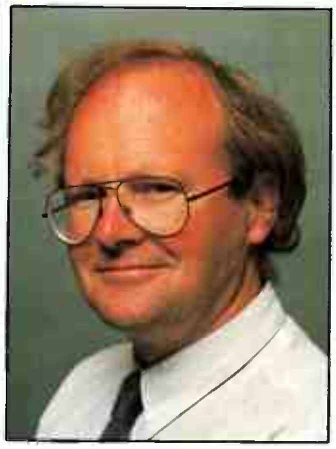
**ELMEASCO Instruments Pty. Ltd.**

*Talk to your local Elmeasco distributor about Fluke —*

- ***A.C.T.*** John Pope Electrical (062) 80 6576 • J Blackwood & Sons • George Brown (062) 80 4355
- ***N.S.W.*** Ames Agency 699 4524 • George Brown 519 5855 Newcastle 69 6399 • Bryan Catt Industries 526 2222 • D G E Systems (049) 69 1625 • Petro-Ject 550 1388 • David Reid 267 1385 • W F Dixon (049) 61 5628 • Macelec (042) 29 1455 • Ebson 707 2111 • Selectroparts 708 3244 • Geoff Wood 427 1676
- ***N. TERRITORY*** J Blackwood & Son (089) 84 4255, 52 1788 • Thew & McCann (089) 84 4999
- ***QUEENSLAND*** Auslec • Elecnic (075) 91 4199 • St Lucia Electronics 52 7466 • Cliff Electronics 341 4655 • L E Boughen 369 1277 • Fred Hoe & Sons 277 4311 • The Electronic Shop (075) 32 3632 • Thompson Instruments (Cairns) (070) 51 2404
- ***S. AUSTRALIA*** Protronics 212 3111 • Trio Electrix 212 6235 • Industrial Pyrometers 352 3688 • J Blackwood & Son 46 0391 • Petro-Ject 363 1353
- ***TASMANIA*** George Harvey (003) 31 6533 (002) 34 2233
- ***VICTORIA*** Radio Parts 329 7888 • George Brown Electronics Group 878 8111 • G B Telespares 328 4301 • A W M Electrical Wholesalers • Petro-Ject 419 9377 • J Blackwood & Sons 542 4321 • R K B Agency 29 7336 • Sirs Sales (052) 78 1251 • Mektronics Co 690 4593 • Truscott Electronics 723 3094
- ***W. AUSTRALIA*** Atkins Carlyle 481 1233 • Dobbie Instruments 276 8888 • Protronics 362 1044

*ADVERTISING INFO No. 2*

# *Editorial*



I've been following debates in the hi-fi press for years now about the pros and cons of various technologies; CD versus turntable, reel to reel versus cassette, one kind of noise reduction versus another, one kind of amplifier versus another, even one kind of speaker cable versus another.

I confess to a feeling of unreality when I read much of this stuff. Are we talking about improvements as the discerning listener might hear them, the engineer might measure them or the marketing man trumpet them on the streets? I have a horrible suspicion that it's the marketing man whose needs dominate.

This is not to say that the quest for perfection is a waste of time. It is not, but it does seem to have lost direction.

The human ear is a fairly good transducer, it has a reasonable response and it has some pretty good signal processing on the end of it. It's also both sensitive and wide ranging. For instance, the human ear has a logarithmic response to loudness with a lower limit set by the movement of molecules in the air and an upper limit set by the ability of the membrane to stay in one piece. It couldn't be much better.

But it does have limits, and there are many parts of hi-fi technology that exceeded those limits years ago. Just one example is to be found in amplifier distortion. It is possible to make amplifiers with distortion of the order of one part per thousand or better, and it has been possible for the last 30 years. The exercise is relatively trivial; certainly any first year engineering student has the tools to deliver an amplifier with vanishingly small distortion. The human ear cannot detect distortion under about a per cent or so.

The big practical improvement of the last 10 years has been the switch to digital signal processing. Even the best of turntables suffer from audible distortion, particularly at the record/needle interface. Cassette players have problems all of their own. But in both cases new technology threatens to completely eliminate any audible imperfections. The record is now being replaced by the CD, and the cassette will be replaced by digital audio tape (DAT) within the next few years.

Even so, the result will not be perfection. Speakers are the weak link. The one area where real progress is sadly lacking in high fidelity products, and where it is badly needed, has been sidelined by the glamour technologies.

It has proven remarkably difficult to solve the problem of speakers. Over the years, numerous alternatives have been tried to improve frequency response, power transduction, and distortion. They have ranged through electrostatic speakers, passive radiators, vented and folded enclosures and so on. Even more extreme measures have been taken with the introduction of sub-woofers and squarkers in separate boxes.

In spite of all the effort, the transfer of electrical energy to audio energy remains a difficult operation. Much of it is reducible to science, and very complicated science too, as an article this month demonstrates (the ETI-1409, p 50). But one also has the impression that much of it reduces to black art. This timber is held to be better than that timber, this shape better than that, this brace position better than that brace position, and so on.

It's the hallmark of an inexact science. To a limited extent this is excusable, since the final result, the sound of a speaker is a subjective experience. This or that is alleged to sound 'warmer' or 'crisper'. But as the great CD debate has proved, it's also a matter of education. CDs are objectively better than records on a number of important grounds, but many people find them objectionable, presumably because they don't sound right. An ear can be educated to like a certain amount of distortion, and equally to find it intolerable.

One way to turn an inexact science into an exact one is to throw some money at it. If the hi-fi makers took some of the money they spend uselessly reinventing wheels in amplifiers or chasing microscopic degrees of distortion, and spent it on fundamental research into loudspeakers, the nett result could well be genuine improvements in high fidelity, the first for a while. We need them.

**Jon Fairall**
**Editor**


**EDITOR**
Jon Fairall B.A.

**ASSISTANT EDITOR**
Mary Rennie B.A.

**EDITORIAL STAFF**
S. K. Hui B.Sc. (Hons), M.Eng.Sc. MIEEE, MIREE
Terry Kee B.Sc. (Hons), M. Phil.

**DRAUGHTING**
Bruce Mennie

**DESIGNER**
Clive Davis

**ART STAFF**
Ray Eirth

**PRODUCTION**
Mark Moes

**ADVERTISING MANAGER**
Peter Hayes B.Sc.

**ADVERTISING PRODUCTION**
Brett Baker

**SECRETARY**
Naomi Lenthen

**ACOUSTICAL CONSULTANTS**
Louis Challis and Associates

**RF CONSULTANTS**
Associated Calibration Laboratories

**PUBLISHER**
Michael Hannan

**MANAGING EDITOR**
Brad Boxall

**HEAD OFFICE**
180 Bourke Road, (PO Box 227, Waterloo, NSW 2017)
Alexandria, NSW 2015.
Phone: (02) 693-6666.
Telex: AA74488, FEDPUB.
Federal Facsimile: (02) 693-2842.

**ADVERTISING**
**New South Wales & Queensland:** Peter Hayes, Mark Lewis, The Federal Publishing Company, 180 Bourke Road, Alexandria, NSW 2015. Phone (02) 693-6666. Telex: AA74488 FEDPUB.
**Victoria and Tasmania:** Virginia Salmon, The Federal Publishing Company, 23rd Floor, 150 Lonsdale Street, Melbourne, 221a Bay Street, Port Melbourne, Vic. 3207. Phone (03) 646-3111. Facsimile: (03) 646-5494. Telex: AA34340, FEDPUB.
**South Australia and Northern Territory:** Dane Hansen, C/- John Fairfax & Sons, 101-105 Waymouth Street, Adelaide, 5000. Phone (08) 212-1212. Telex: AA82930.
**Western Australia:** Estelle de San Miguel, C/- John Fairfax & Sons, 454 Murray Street, Perth, WA 6000. Phone: (09) 481-3171. Telex: AA92635.
**New Zealand:** John Easton, 3rd Floor, Communications House, 12 Heather Street, Parnell, Auckland. PO Box 8770, Symonds St, 37-291. Telex NZ63122. Phone 79-6648 (Auckland).
**Britain:** Peter Holloway, C/- John Fairfax and Sons, 12 Norwich Street, London EC4A IBH. Phone 353-9321.
**USA:** Frank Crook, Sydney Morning Herald, 21st Floor, 1500 Broadway, New York, NY 10036. Phone 398-9494.
**Japan:** Bancho Media Services, Dai Ichi Nisawa Building, 3-1 Kanda Tacho 2-Chrome, Chiyoda-Ku Tokyo 101. Phone Tokyo (03) 252-2721.

**ELECTRONICS TODAY INTERNATIONAL** is published and distributed monthly by the Electronics Division of the Federal Publishing Company Pty Limited, 180 Bourke Road, Alexandria, NSW 2015 under licence from Double Bay Newspapers Pty Limited, General Newspapers Pty Limited and Suburban Publications Pty Limited. Printed by Hannanprint, Sydney. Distributed by Magazine Promotions. *Maximum and recommended Australian retail price only. Registered by Australia Post, Publication No NBP0407. ISSN No 0013-5216.

# Copy protection for recordings

**A major conflict of interest has arisen over the provision of anti-copy coding in pre-recorded records and cassettes. The Japanese electronic giants want to do without the decoding devices in order to promote sales of digital audio tape and recorders, cassette recorders and blank tape sales. On the other hand, the recording companies want new technology to prevent illicit recording, which is robbing them of millions of dollars every year.**

The system works by removing a band of frequencies. The notch is 300 Hz wide, 60 dB deep and centred on 3.84 kHz. Circuitry built into a recorder recognizes the notch and stops the machine from recording. Engineers think that the system will work, but some doubt the claims that it is "effectively inaudible".

If the proposal to adopt Copycode, as the system is called, is adopted, records will in future be coded by passing them through a series of sharp electrical filters. Apart from the question of whether the sensitive ear will detect the missing frequencies, the sharp filters could introduce phase shifts into other frequencies. This could cause other odd audible effects, especially in stereo. CBS, which invented the technique, insists that the worries are unfounded, but the company has failed to demonstrate the technology to prove otherwise.

The record industry association of America and the International Federation of Phonogram and Videogram Producers has already had one meeting with the Electronic Industries Association of Japan (EIAJ). CBS has also been on a major sales drive, demonstrating the new technology to EMI engineers in London and to British government scientists.

Governments are involved because it may only be through the intervention of governments that the EIAJ will be compelled to provide decoding equipment. Record companies are lobbying the EEC and US governments to impose a 35% import duty on devices without decoding.

# ERS-1 progress

The design of the Australian contributions to the ERS-1 European radar satellite is progressing with the development of a Fast Fourier Transform chip for the synthetic aperture radar (SAR). The work is being done by the CSIRO Division of Radiophysics, Computer Sciences of Australia, (CSA) and Austek Microsystems of Adelaide.

Over the past 10 years, Radiophysics has built up considerable expertise in real time signal processing. Most applications require the processing of a large amount of data, and of doing it very quickly. This leads to a requirement for powerful algorithms and scale integration of the resulting hardware.

This work was initially directed towards the needs of radio astronomy and later to the microwave landing system Interscan. More recently, a wider need for such techniques has become apparent.

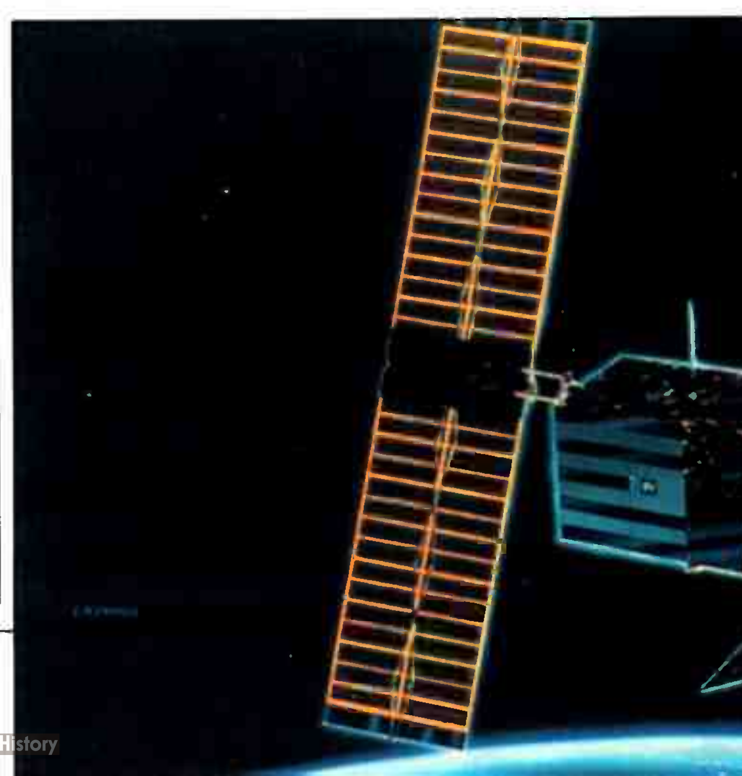
The first VLSI chip developed at Radiophysics was a correlator chip for use in the Australia Telescope. The chip was co-developed by Austek Microsystems. Some 5000 are required for the Australia Telescope receiver system.

The expertise so developed has now been utilized for the design of a Fast Fourier Transform (FFT) chip to operate some three to five times faster than any processors currently available. The chip will complete a 256 point transform in 0.2 ms and will be capable of operation in a variety of modes. It consists of approximately 90,000 transistors.

The design has been licensed to Austek Microsystems which sees a worldwide market. Austek has been instrumental in refining the specifications of the chip.

Possible applications include: spectral analysis for speech, sound, and vibration; high speed filtering for use in telecommunications, radar, and consumer electronics; and image processor modules for image coding, enhancement, and analysis. One of the first applications planned is a high-speed processor for data from the ERS-1 synthetic aperture radar (SAR) satellite.

In early 1985 the CSIRO Division of Radiophysics was approached by Computer Sciences of Australia (CSA) to advise on the possibility of constructing a special-purpose processor for SAR data from the ERS-1 satellite. The sidelook radar of the ERS-1 satellite will be capable of a resolution of 25 m on the ground and will open an im-



portant new remote sensing window for Australian users.

Initially, the aim was to use the technology and VLSI correlator chip designed for the receiver system of the Australia Telescope project. The processing requirements of a large synthesis radiotelescope have much in common with those for SAR, both in terms of scale and processing principles. It has since become apparent that a new development within the same Division of CSIRO for a chip to perform Fourier Transforms at very high speed would allow an even more cost-effective processor to be built.

Further development of the design for such a processor has been partially supported by a contract to CSA under Phase B of the DITAC-funded ERS-1 upgrade to the Australian Centre for Remote Sensing (formerly the Australian Landsat Station).

The design goal is to produce a processor capable of operation at near real time rates, while allowing an opportunity for Australian industry to gain valuable expertise. The performance would exceed that of a Cray II supercomputer for a fraction of the cost. World markets for such a processor have been estimated at $70m.

Efforts at the Division of Radiophysics have concentrated on algorithm development for SAR processing and innovative structures to best employ the Fourier Transform chip. Significant improvements on published SAR processing methods have been found possible. Detailed simulations of the proposed processing methods have recently been completed on both computer-generated SAR data and data from the ill-fated SEASAT satellite. These simulations have verified the accuracy and speed of the proposed methods.

The SAR processor as envisaged has not yet been subjected to a detailed design process. Nevertheless, it is clear that the processor will be capable of high performance while still retaining a modular structure. The modular structure would allow new versions of the processor to be configured for other satellites or requirements. Requirements such as these for precision processed ERS-1 data might also be handled with the same processor as a basis. The processor might also in the future form part of a complete airborne remote-sensing radar system capable of imaging in real time.

ERS-1 (Courtesy COSSA).

The more successful Ariane 1 shown here on its final test flight (courtesy COSSA).

# Ariane still down

Arianespace has announced further delays to the resumption of flights by the troubled Ariane launch system, which is due to carry Aussat III into orbit next year.

Arianespace had hoped to begin launching again in February, but difficulties in understanding the ignition system in the cryogenic third stage booster has meant that engineers have been unable to give the rocket the all clear.

The trouble started back in May 1986, when the third stage failed to function properly. Controllers destroyed the rocket four and a half minutes into a flight from the Kourou rocket range in French Guyana. The rocket's payload of communications satellites was destroyed as well. The incident happened in the middle of a particularly black period for the space industry, with major failures of all launch vehicles including the shuttle and other expendable US launchers.

Engineers reconstructing the incident believe that the third stage of the Ariane ignited, but then went out like a damp squid about 0.12 seconds afterwards. This prompted a major study of the ignition conditions of the revolutionary cryogenic motor. It was made by the French company Societee Europiene de Propulsion, and led to a complete redesign of the ignition system. It has now undergone 23 simulated high altitude firings on a test bed near Paris. However, engineers have now decided to initiate several new tests which will occupy the next few months.

In fact, they admit that even when these tests are complete, they will still not completely understand the ignition process. Arianespace has initiated a research program to get this information, but the knowledge will only be useful by the time of the Ariane V launch in 1990.

People in the space business believe Arianespace is being exceptionally cautious in its approach to the next launch. This is hardly surprising. After a string of failures, insurance costs are now making many a communications company think twice about the viability of satellite communications systems. Aussat is budgeting more than one third of total launch costs for insurance alone.

**SIEMENS**

# SIPMOS saves grams, joules and bucks

## Siemens new power transistors are a boon for designers.

By using SIPMOS® power transistors, you can develop systems with smaller, lighter power supplies. And which are more economical and reliable.
Furthermore, SIPMOS transistors are extremely fast switching and easy to parallel, with no secondary breakdown.
Most importantly, these advanced features increase the design possibilities for switch mode power supplies, asynchronous motor controls, audio amplifiers, DC convertors, proximity switches and inverters.
Innovative SIPMOS components arise from discoveries at the very forefront of technology.

The range includes:
- ☐ P channel and N channel.
- ☐ Small signal transistors including surface mount types.
- ☐ FRED FETS with fast recovery reverse diode.
- ☐ SMART FETS.

And other superior SIPMOS components are currently being developed by Siemens higher technology.

For more information, contact your nearest Siemens office.

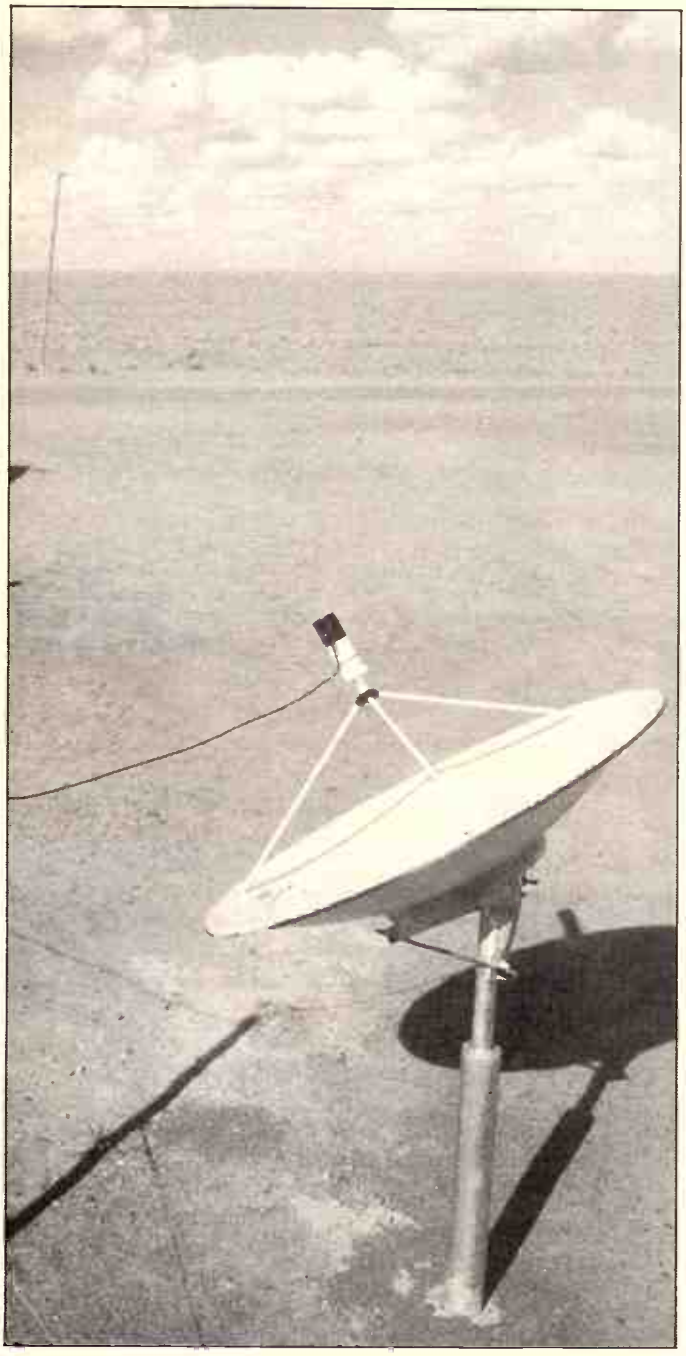
**Siemens Ltd.**
544 Church Street, Richmond, Vic.
Melbourne: (03) 420 7318 Sydney: (02) 436 8730
Brisbane: (07) 369 9666 Perth: (09) 362 0123

**Distributors**
Victoria: Promark Electronics (Vic) (03) 878 1255
Queensland: ECQ Electronics (07) 376 5677
New South Wales: Nexus Electronics Pty. Ltd. (02) 439 5800
Promark Electronics Pty. Ltd. (02) 439 6477
South Australia: Auslec (08) 269 1688
Protronics Pty. Ltd. (08) 212 3111
Western Australia: Reserve Electronics (09) 328 9755

# Siemens. A higher technology

*ADVERTISING INFO No. 3*

971/2803 CSA



## Express yourself

As reported in last month's ETI, SBS television satellite transmissions have now been encoded by the DOC.

Wally Shand, General Manager of Videosat, one of the companies trying to sell satellite TVRO systems in the outback, is urging Australians to write to the Minister of Communications or their local MP to express their disgust on the encoding of a public funded broadcaster.

Shand says "to give credit where credit is due, the recent World Cup soccer was superb, and other major and unencoded sports programs in the future will no doubt be of a similar standard. However, SBS is not a commercial station. It is funded by your tax dollar."

# Comment on proposed CB change

Public comment on a proposal to improve the CB radio service has been invited by the Minister for Communications, Michael Duffy.

At present CB users can operate on either AM or SSB transmission modes in the 27 MHz band.

The proposal is to phase out AM operations as follows: from July 1, 1988 cease type approval testing of CB equipment using AM; and from July 1, 1993 withdraw existing type approvals of CB equipment using AM, in effect ceasing the issue of new licences for AM from that date.

Existing licensees would be able to relicense approved AM equipment owned in 1993 for as long as it remains within the old specifications.

Mr Duffy said phasing out AM operations would have several advantages. It would reduce interference to home entertainment equipment such as television sets, VCRs and stereos. Interference to other users of radiocommunications equipment would also be reduced, and it would lead to more efficient use of the spectrum (one AM channel occupies the same amount of spectrum as two SSB channels).

"Ending AM operations would therefore mean in effect that more channels will become available to CB users," Mr Duffy added.

Mr Duffy also said that any decision on AM would not prejudice any wider review of the CBRS at a later data.

The Department would be consulting with interested persons and organizations about the phasing-out proposal. Comment should be forwarded to **The Assistant Secretary, Operations Branch, Radio Frequency Management Division, Department of Communications, PO Box 34, Belconnen, Act 2616.**

# Star grant to uni

The Australian Research Grants Scheme has allocated $500,000 to the University of Sydney to begin construction of a 640 m baseline high-resolution stellar interferometer.

The new instrument will be a larger version of a prototype built at the university's Chatterton department of astronomy over the past 15 years. It will be able to measure the apparent diameter of 50,000 stars brighter than 8th magnitude, with an accuracy of 2 per cent or better. The technique has to date been used to measure the apparent diameters of only about 30 stars, mostly very bright, to within an accuracy of 5 per cent.

Measurement of the apparent size of stars whose distance is known will allow fundamental scales of stellar diameters and luminosities to be established. And observations of close binary stars can give all the parameters of the system including their orbits and temperatures. The interferometer could also help to solve problems such as mass loss, by observing how a star's envelope appears to grow at longer wavelengths, and stellar rotation, by observing the flattening of the poles.

The essential technology for the interferometer telescope has been proved in the prototype developed by the Sydney University team, under Dr John Davis. This prototype, which will form the heart of the new instrument, has an 11.4 m baseline with a steerable mirror at each end. The mirrors capture the light from a star and reflect it to a central optical bench where the beams are combined and interference fringes can be observed.

The design of the new interferometer is a development of Michelson's classic interferometer, and operates on the principle of amplitude interference. Amplitude interferometry previously has not been a workable option because of blurring caused by atmospheric 'seeing' effects.

The half million dollar grant to the university marks the beginning of the government's policy of concentrating grant funds into fewer but more highly rewarding development projects.

# Breakthrough in keyboard

A Melbourne-based computer company has developed a major breakthrough in keyboard technology it claims will dramatically widen the scope and application of computers and computer-based systems.

The company, Pulsar Electronics Pty Ltd, has developed the Slimline membrane keyboard — a keyboard of 2 mm thickness that does not require expensive tooling, or electronics, and which can be used in virtually any electronically hostile environment.

The adhesive backed keyboard which is suitable for IBM PCs, can be affixed to any flat surface such as a desk or wall. It has no moving parts to fail and is highly resistent to climatic conditions, moisture and abrasion.

"We believe it has a life ex-

# Australian research: MSM wave technology

The Federal Government has released a report detailing the success of Australian researchers using special high frequency wavelength technology in fields ranging from industrial applications to navigation, communications and electronic warfare.

MSM stands for 'millimetre and sub-millimetre wave technology' and covers radiation of wavelengths from about 0.05 mm to 15 mm or, in terms of frequency, about 6000 GHz down to about 20 Ghz. This very broad range has many established and emerging applications due to properties which combine some advantages of both optical and microwave technologies including high bandwidth and spatial resolution, together with good penetration under adverse atmospheric conditions.

Australian R&D in MSM is impressive and at the forefront in several areas. There are about 60 degreed MSM R&D researchers in Australia distributed through about 18 establishments. The report identified about 50 R&D projects, many of them being of a cooperative nature between establishments.

However, the scale of private sector MSM R&D in Australia is almost non-existent.

# Manufacturing productivity report

The results of four studies concerning productivity growth in Australian manufacturing during the postwar period have been published in a Bureau of Industry Economics research report.

The first study, which examined the relationship between the rate of growth of production and the rate of growth of productivity, indicates that if future productivity trends follow those of the 1960s and 70s then an average annual growth rate of more than 4 per cent in the volume of production will be required to maintain or increase employment in the manufacturing sector.

The results of the second study indicate that technological progress during the postwar period was predominantly biased towards saving labour. It is estimated that approximately half of the gains from productivity growth over the period were passed on to the consumers of manufactured products via lower rates of price increase. The remainder of the productivity gains were distributed directly to labour and capital in the form of wage or profit increases.

# Offsets opportunity

The Minister for Industry, Senator John Button has announced that the Government's new Civil Offsets Program had achieved new commitments to industry development of $500 million and was proving itself a most effective way of bringing new technologies and new skills to Australian industry.

"In the eight short months since the revised offsets policy was put into effect — with its new emphasis on the development of export oriented, competitive capabilities in Australian industry instead of work and part production related to a specific contract — there has been a surge of new high technology offsets commitments entered into by suppliers," he said.

"As well as the introduction of the Pre-qualified Offsets Suppliers Scheme (PQOSS), which encourages long-term offsets activities by suppliers, there are also substantial forward commitments by companies involved in the program to build on and enhance their current work programs in Australia."

These activities include software and other research and development; overseas marketing of indigenous high technology products and services; procurement of high technology Australian products.

Senator Button said the program was confounding its critics in the way it was involving industry at all levels. Companies were now quick to accept the challenge of new opportunities.

# Electronic Act concerns SW listeners

The Electronics Communication Privacy Act which was recently presented in the US will have no immediate effect on radio hobbyists but could provide the basis for radical changes in access to radio signals.

In a debate which lasted nearly nine months, the radio listener's point of view was put forward at a hearing before the US Congress by Robert Horvitz on behalf of the Association of North American Radio Clubs (ANARC).

The intention of the legislation is to protect users of the mobile telephone system from unwelcome ears, and early drafts of the Act even went so far as to outlaw shortwave receivers. This caused alarm amongst radio amateurs and enthusiasts who proclaimed their right to monitor transmissions which has been legal since 1934.

At the moment there are two bills in existence — one Senate and one House of Representatives bill. It is expected that the President will sign the Senate version.

The new law establishes penalties for unauthorized reception of certain radio transmissions and recognizes radio and wire under a new legal category, 'Electronic Communications', and not as part of the public domain. The bill states that all electronic communicators have the right of privacy unless they meet certain conditions where they are not protected.

**— Arthur Cushen**

# technology

pectancy 10 times greater than conventional keyboards, and would be a must for many industrial controller type applications," said Pulsar's Managing Director, Phillip Delacretaz.

"It could well make 'push buttons' for such applications as cigarette machines, food dispensers, and electronic bank tellers redundant," he added. "Use of the Slimline can eliminate one of the major maintenance items in these sorts of machines.

"The possibilities for the handicapped spring readily to mind as it is possible to make a key the size of a fist and lay the keys out in any order or format such as a circle or an 'L' shape."

Mr Delacretaz said that while the keyboard was a little outside the company's mainstream of research and development, the company had taken it on 'as a bit of a challenge'.

"We needed such a product to meet specifications on a system for which we had been contracted and couldn't find its equivalent anywhere around the world. When we contacted a number of the leading keyboard manufacturers they said it was impossible.

"This got our backs up a little, and we had the germ of an idea on how it could be done, so we did it. It took us 18 months — the chip design slowed us down — but we did it."

Mr Delacretaz said the company has had an opportunity to examine the export potential of the product and it appears very good.

**Mr Bob McKinnon, Chief General Manager** of **Telecom Australia,** presented the first ever Approved Inspection Status certificate to SAGEM, the French manufacturer of screen-based telex terminals used in the Australian network.

The AIS is a quality assurance award provided by Telecom when it has confidence in the company's ability to deliver goods which conform to Telecom's standards as well as those of Australian Standard AS 1823.

The certificate was presented to Mr Philippe Odouard, SAGEM's Australian Manager, in front of a distinguished gathering which included Mr Ken Douglas, Telecom State Manager; Mr Philippe Jeanmaire, SAGEM Manufacturing Manager; Mr Guy Rouanne, Vice President of SAGEM and senior officers and staff of SAGEM and Telecom.

# Easinet scores

Easinet, the Melbourne based computer company, has been awarded the highest possible grant of $100,000 under the Australian Trade Commission's new High Technology Exporter's Scheme.

The High Technology Exporter's Scheme, established only last year, is to assist Australian-owned high technology firms in developing viable export markets. At present, the scheme is limited to companies which have already received investment capital recognition from either a registered Management Investment Company (MIC) or the Australian Industry Development Corporation (AIDC).

The High Technology Exporter's Scheme was first mentioned in the Prime Minister's address to the nation in June last year as part of Government measures to improve Australia's continuing balance of payments problems.

The High Technology Exporter's grant will enable Easinet to improve its overseas market position — a market position made possible, in part, by the 1985 investment injection from the largest MIC, BT Innovation. At the time, the capital investment from BT Innovation was the largest single investment from the MIC initiative.

MICs were established in conjunction with the Federal Government to raise tax deductible funds from the Australian public for investment in rapid growth Australian-owned companies like Easinet.

**NOTES & ERRATA**

**Project 611, MIDI matrix, September '86:** All output ports are incorrectly labelled with pins 4 and 5 transposed. All pin 4s are commoned together and pulled up via R21. Pin 5 is connected to the output buffers.
**Project 1412, Speaker switch, February '87:** The pc board artwork was incorrectly printed showing component side rather than copper side. To rectify: reverse the negative of the artwork.

# Digital phone study

Telecom's Research Laboratories have awarded a research contract to Philips Communication Systems in Melbourne for a two-and-a-half year study of future digital mobile radio telephones.

Telecom is currently in the final stages of putting its new cellular mobile telephone service into action and Philips has a contract to supply mobile terminals for this system. However, Telecom expects its capacity to be fully utilized within 10 years.

The new contract with Philips is to answer the future need for greater capacity, and a wider range of services. Both Philips and Telecom are currently studying suitable successors such as digital mobile cellular telephone systems. A major focus of the study will be on spectral efficiency — trying to fit the maximum economically feasible number of customers into the somewhat limited available radio band.

The considerable worldwide resources of Philips, particularly those of the research centre for digital mobile telephony in Nuremburg, West Germany, are being called upon to assist in the study. Work already carried out at the Nuremburg centre is at the leading edge of international developments in this field. As part of the project, Telecom hopes that significant technology transfer will occur, thus achieving the second aim of the contract, namely, to enhance the expertise of Australian industry.

Digital mobile radio systems are anticipated for major cities in the mid-1990s. These systems will provide telephone and digital communications, probably in the 900 MHz or 1.5 GHz bands. Terminal types will include pocket-style, in-car, and book-sized keyboard plus screen. A large range of digital services will be available (telex, electronic mail, videotex, data communications, etc) and they should be compatible with the new Integrated Services Digital Network (ISDN) planned for the fixed network. Low costs should appeal to a mass market. Some applications could involve terminals in vehicles, whilst others could involve pocket-style terminals for in-office/factory applications. With encryption, excellent privacy should be possible.

# Telecom's Langmore submission

Telecom has called for improved understanding of the role of telecommunications in economic growth and development. It says technological obsolescence in telecommunications infrastructure may have even more important implications to Australia's economic prosperity than physical obsolescence in other parts of the public infrastructure.

In a submission to the Langmore inquiry into Australia's public infrastructure, Telecom argues the role of telecommunications is becoming even more critical to economic growth and development.

"Over the next two decades, the merging of the technologies of computers and communications will reshape the social, industrial and business processes in the world.

It says the convergence of the communication and computer industries has already facilitated the massive expansion and growth of the information industry which has revolutionized the way people live and do business internationally.

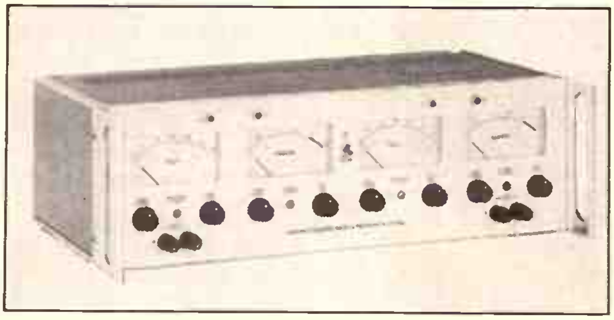
"It has also created new relationships involving technology transfer and changing patterns of trade. Indeed, today the major growth area in international trade is 'services' and its primary vehicle is instantaneous, worldwide communications."

"Any country failing to resource the necessary telecommunications infrastructure will place its people, its industry and its business ventures in a position of substantial disadvantage in relation to those countries rich in advanced telecommunications services," the submission says.

# LABORATORY POWER SUPPLIES

APLAB offer a complete range of regulated DC bench/rack power supplies combining high precision and regulation capabilities with continuously adjustable outputs.

Designed with single, dual and multiple outputs, these power supplies can be used in either constant voltage or constant current mode of operation.



**Standard models include:**

**SINGLE OUTPUT**

OUTPUT: Output VOLTAGE: Current
0-30V 0-1A to 30A
0-70V 0-2A to 10A

**DUAL OUTPUT**
0-30V 0-1A to 2A

**MULTIPLE OUTPUT**
0-30V 0-2A to 5A

**SCIENTIFIC DEVICES AUSTRALIA PTY. LTD.**
VIC. 2 JACKS RD., SOUTH OAKLEIGH. 3167
PHONE: (03) 579 3622 TELEX: AA32742
NSW: 559A WILLOUGHBY RD., WILLOUGHBY 2068
PHONE: (02) 95 2064 TELEX: AA22978
S.A. 31 HALSEY RD., ELIZABETH EAST. 5112
PHONE: (08) 255 6575 TELEX: AA88125

**EX STOCK**

*ADVERTISING INFO No. 5*

# WORLD-CLASS QUALITY.

**ADCOLA ROYEL**


240V APPROVED.

ASK YOUR NEAREST ELECTRONIC PARTS SUPPLIER!

Benefits:

- Lightweight, reliable, cool handles.
- Correct heat for Printed Wiring Boards.
- Many tip profiles available.
- No transformer required, plugs into 240V.

**LOW COST.**

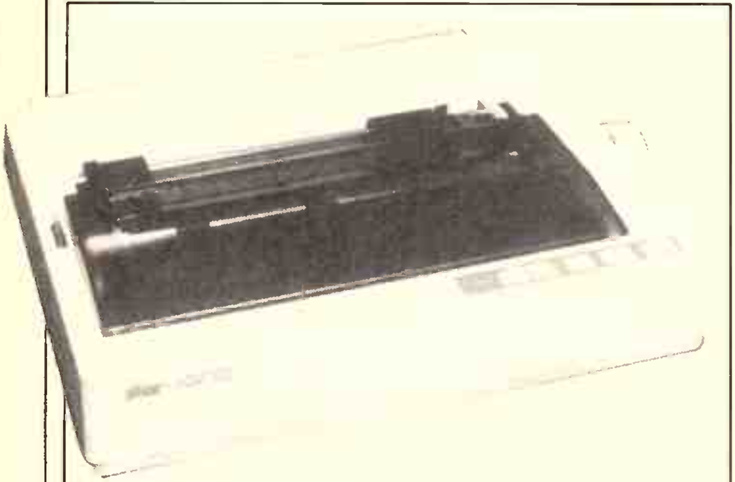
AUSTRALIAN MADE

USED SUCCESSFULLY THROUGHOUT THE WORLD.

■ QLD: (07) 277 4311 ■ NSW: (02) 709 5099 ■ SA: (08) 232 0001 ■ WA: (09) 381 5500 ■ TAS: (002) 34 2233

MHL 3691

*ADVERTISING INFO No. 6*



**STAR PRINTER WINNER**
The lucky winner of the fabulous Star printer competition we ran in our last November issue was G. Carlson from West Brunswick in Victoria. He received his booty from Bill Lloyd of Genisis Systems.

# Is Darwin the hole at the end of the Earth?

Speculation has been growing recently that the tropics north of Darwin form a huge interchange between the upper and lower atmospheres. If so, this area could be the main spot on Earth for the transfer of damaging atmospheric pollutants, particularly chloroflurocarbons (CFC), into the stratosphere.

CFCs are particularly dangerous because they react with ozone ($O_3$). Ozone forms a barrier against harmful ultraviolet rays from the sun. As yet, no one knows the mechanism that carries the chemicals into the ozone layer.

A month-long research project has been conducted in an attempt to find out. The project, costing $10 million, is called the Stratosphere-Troposphere Exchange Project (STEP) and involves 50 scientists from the US, Australia and China.

The key experiment will test a theory proposed by Edwin Danielsen, a meteorologist at NASA's Ames Research Centre in California. According to Danielsen, chemicals and water vapour are transported up to the stratosphere inside immense cumulonimbus clouds. These are anvil-shaped thunderclouds which straddle the tropopause, the upper boundary of the troposphere, the layer of the atmosphere where weather occurs. In the tropics near Australia, the tropopause occurs at about 17 kilometres up.

The tops of the clouds are chilled by radiative cooling into space, while the lower regions are warmed by heat from the Earth. The difference in temperature creates convective currents which carry air, water vapour and chemicals — including pollutants — upwards into the stratosphere.

Fifteen instruments were built to test the theory. They were flown aboard a Lockheed ER2 research aircraft, a civilian derivative of the U2 spy plane.

The plane flew from Darwin to altitudes of at least 20,000 metres to measure humidity and air motion within the clouds.

Two other major experiments were carried out as part of the project. The United States National Oceanic and Atmospheric Administration undertook a series of experiments aimed at finding out how tropical clouds heat the atmosphere.

The Bureau of Meteorology used radio-equipped weather balloons to study monsoon rains. A research boat from China will launch some of the balloons and provide radar measurements of storm patterns.

It is expected that when analyzed, the data from the US, Australian and Chinese teams will show how important Darwin is as a sink for pollutants.

# QUASAT mission

The CSIRO Division of Radiophysics is participating in Phase A studies for QUASAT (QUAsar SATellite), a proposed orbiting radiotelescope that would further enhance the capabilities of the Very Long Baseline Interferometry (VLBI) observational technique. This technique has been used in radio astronomy over the past 20 years or so, and is responsible for many of the great advances made in our understanding of the Universe over that period.

The resolution of Earth-based VLBI is limited by the physical dimensions of the planet. It has therefore been proposed that the angular resolution of radio interferometry might be extended by using radiotelescopes in space. The QUASAT project, originally proposed by NASA and ESA, would use a dedicated orbiting observatory for such a purpose.

During 1986, Australia was involved in not only the QUASAT mission studies, but also participated in an important technical feasibility study. In July and August, a US, Australian and Japanese team successfully tested the orbiting VLBI (OVLBI) concept by temporarily using an existing spacecraft as an orbiting radiotelescope antenna. The spacecraft used was TDRS E, the first satellite in NASA's Tracking and Data Relay Satellite System.

TDRS E was linked with the 64 m antennas at Tidbinbilla, Australia and Usuda, Japan to make VLBI observations of quasars. Baselines of up to 1.4 Earth diameters were achieved.

Australian participation in the QUASAT project has great potential to benefit Australian industry as well as Australian science. If some of the science is done here, then it will open up opportunities for Australian industry to tender for construction of parts of the new satellite.

More important for Australian industry is that much of the electronics and fabrication of the proposed orbiting radiotelescope would be similar to that of a communications satellite. Many Australian companies would therefore have a chance to get vital experience in the growing industry of making satellite sub-systems.

To help Australian industry to start making 'space qualified' sub-assemblies is one of the main reasons that both the CSIRO Division of Radiophysics and COSSA are pursuing an active role in the project.

Dr Dennis Cooper, Assistant Chief, CSIRO Division of Radiophysics, recently attended meetings in London and Moscow to evaluate Divisional and Australian involvement in the European QUASAT and USSR Radioastron OVLBI satellite proposals.

The QUASAT meetings included a joint science and 'Tiger' team review of a reduced scope QUASAT mission in the wake of the American shuttle program setback and a one-day seminar on the scientific objectives of space VLBI. A launch in 1995 is targeted. Australia could be involved in both bus structure and scientific payload.

In Moscow, a two-day meeting presented to potential foreign collaborators an overview of the USSR space VLBI proposal, due for launch in the 1990-92 time frame. The extent of foreign cooperation in the development of the science package was also discussed. The CSIRO Division of Radiophysics has been invited to supply parts of the 18 cm receiver system.

# Something for everyone


## DB CONNECTORS

| Cat. No. | Description | Price |
|---|---|---|
| P10880 | DE9P Male | $1.95 |
| P10881 | DE9S Female | $2.25 |
| P10882 | DE9C Cover | $1.20 |
| P10884 | DE9P R A Plug | $3.65 |
| P10885 | DE9S R A Skt | $4.25 |
| P10890 | DA15P Male | $2.10 |
| P10891 | DA15S Female | $2.25 |
| P10892 | DA15C Cover | $1.25 |
| P10894 | DA15P R A Plug | $4.25 |
| P10895 | DA15S R A Skt | $5.00 |
| P10900 | DB25P Male | $2.75 |
| P10901 | DB25S Female | $2.95 |
| P10902 | DB25C Cover | $1.25 |
| P10904 | DB25P R A Plug | $4.50 |
| P10905 | DB25S R A Skt | $5.95 |

## RELAY AND BASE

Can carry 10A at 28V DC or 5A at 240V AC. Supplies with Chassis Mounting Socket with screw terminals. Great for school projects and demonstrations, switching DC power supplies, central circuits and with contacts parallel up to 20A can be switched.

Cat S14074 $8.95

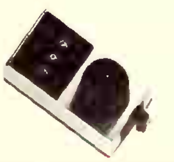
## ULTRASONIC TRANSDUCERS

Designed to transmit at 40kHz (L19990) and receive at 40kHz (L19991) with up to 20V I P on the transmitter. These units can't be heard and so are ideal for TV remote controls, water level detectors, burglar alarms, motion detectors and information carriers as they can be either pulsed or used in the continuous wave mode.

Full specifications below for design purposes.

**Maximum Input Voltage:** 20V rms
**Centre Frequency (kHz):** 40 ± 1.0
**Sound Pressure Level 10V RMS:** 110dB min
**Sensitivity (dB/v/ubar) min.:** -65 min
**Bandwidth (kHz):**
Transmit 4.0 (at 100dB)
Receiver 5.0 (at 73dB)
**Impedance:**
Transmit 500
Receiver 5000

Cat L19990 (Transmitter) $4.75
Cat L19991 (Receiver) $4.75



## SPECTROL MULTIDIALS

*Model 16-1-11 (.9")*
*Cat R14400* ***$26.95***
*Model 18-1-11 (1" x 1.75" Rect.)*
*Cat R14405* ***$45.95***
*Model 21-1-11 (1.82")*
*Cat R14410* ***$46.95***

## FERRITE AERIAL ROD

200mm x 9mm

Cat L11401 Normally $2.75
**SPECIAL, ONLY $1.50**

## CAR ANTENNA BOOSTER

- In-line instalation
- 12V boosts 100%

Cat A12073 $7.95

## SPECTROL 43P

Equiv (Bourns 3006)
Essential for precision work

| | | | |
|---|---|---|---|
| R14200 | 10R | R14290 | 10K |
| R14210 | 20R | R14300 | 20K |
| R14220 | 50R | R14310 | 50K |
| R14230 | 100R | R14320 | 100K |
| R14240 | 200R | R14330 | 200K |
| R14250 | 500R | R14340 | 500K |
| R14260 | 1K | R14350 | 1M |
| R14270 | 2K | R14360 | 2M |
| R14280 | 5K | | |

1-9 $1.95 | 10+ $1.75

## ECONOMY 4 CHANNEL MICROPHONE MIXER (MM1)

Its size and simplicity makes this mixer very portable and easy to operate.

SPECIFICATIONS:

- 4 low impedance 600 ohm microphone inputs
- Individual gain control for each microphone
- Master volume control
- Power on LED
- Inputs/Outputs - 6.3mm mono sockets
- DC operated (9V battery only)
- Input impedance 600 ohm
- Output impedance 1.5kohm
- Signal/noise ratio 55dB
- Frequency response 20Hz to 20kHz plus or minus 2dB
- Weight 320 grams
- Dimension 148 x 46 x 86mm
- Torque variable range 1-22dB
- Input sensitivity 1mV
- Output level 90mV (at input 5mV)
- T.H.D. 0.01%

Cat A12001 $44.95

## DB STAND OFFS

**At incredible prices! No need to pay absurd prices because we import them direct and pass on the savings to you!**

| | |
|---|---|
| 2 Pack P10930 | $1.00 |
| 10 Pack P10932 | $3.95 |
| 100 Pack P10934 | $20.00 |

## DC/DC CONVERTER

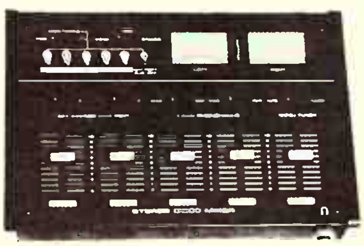
- Fail safe circuit protects against short circuit or wrong polarity
- Under dash mounting
- 13.8V DC input
- 7.5/9/12V DC output
- Current: 7.5V (900mA), 9V (1.2 amp), 12V (1.2 amp)
- 2 metres cord with 4 plug adaptor

Cat A15054 $21.95

## CANNON TYPE CONNECTORS

1-9 | 10+

P10960 3 PIN LINE MALE
$3.90 .................... $3.50
P10962 3 PIN CHASIS MALE
$3.00 .................... $2.50
P10964 3 PIN LINE FEMALE
$4.50 .................... $3.90
P10966 3 PIN CHASIS FEMALE
$4.95 .................... $3.95

## UNIVERSAL MIXER WITH CUE CONTROL (MM3)

- Microphone inputs 2 high or low impedance.
- Two stereo phono inputs magnetic or ceramic.
- 1 stereo line input for tape or tuner.
- Cue function with LED indicator for each input.
- Tape recorder output connections.
- Dual VU meters to monitor output and cue level.
- Mono/stereo mode selector.
- Battery test button to check their condition.
- DC or AC adaptor operation.

**Input Sensitivity:** Mic low 0.7mV at 600 Ohm Mic High 3.5mV at 50k ohm Phono Mag 2.5mV at 50k ohm Phono Cer 150mV at 100k Ohms
**Tape Tuner:** 150mV 50k ohms
**S/N Ratio:** More than 55dB
**T.H.D.:** Less than 0.5%
**Frequency Response:** 20 - 20kHz ± 2dB
**Output Level:** 300mV
**Recording Output:** 120mV
**Power Source:** 9V DC (PP100/9)
**Dimensions:** 265 x 195 x 70mm
**Weight:** 1.8kg

RRP $199 ........................................ **OUR PRICE $179**


## SEMICONDUCTORS!

**Always check with us before you buy!**

| | 1-9 | 10+ | 100+ |
|---|---|---|---|
| 2716 | $9.95 | $9.50 | $8.95 |
| 2732 | $8.95 | $8.50 | $7.95 |
| 2764 | $7.95 | $7.50 | $6.95 |
| 27128 | $6.95 | $6.50 | $6.25 |
| 27256 | $11.50 | $10.50 | $10.00 |
| 4116 | $3.95 | $3.50 | $2.95 |
| 4164 | $2.95 | $2.75 | $2.50 |
| 41256 | $4.95 | $4.50 | $3.95 |
| 555 8pin | $0.50 | $0.40 | $0.35 |
| 6116 | $3.95 | $3.75 | $3.50 |
| 6264 | $6.50 | $5.50 | $5.25 |
| 6802 | $5.00 | $4.00 | $3.75 |
| 6821 | $2.00 | $1.80 | $1.70 |
| 6845 | $5.00 | $4.00 | $3.75 |
| 7406 | $0.40 | $0.30 | $0.25 |
| 8250 | $29.95 | $27.95 | |

## NE5534AN

SCOOP PURCHASE!!!

1-9 $1.95 | 10+ $1.85

## WORLD MODEM CHIP

Cat U21614 Normally $49.50
**Save $25, SPECIAL $24.95**

## MEL9501

Have you blown up your Apple drive by plugging it in backwards or not turning off the power while changing boards? We have the MEL9501 chip!

**SPECIAL, ONLY $29.95**

## 8087

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

| | |
|---|---|
| 8087-3 (4.77MHz) | $299 |
| 8087-2 (8MHz) | $399 |
| 8087-1 (10MHz) | $649 |
| 80287-3 (6MHz) | $499 |
| 80287-7 (8MHz) | $699 |
| 8087-3 (4.77MHz) | $299 |

## SPEECH SYNTHESISER CHIPS!

**SPO256A-AL2:** Speech synthesiser chip, needs programming to work
$16.95

**CTS256-AL2:** Contains the code recognition circuit to enable the project to plug directly on the printer port or into an IBM PC
$29.95

**A SET OF EACH . $44.95**

## TEXTOOL SOCKETS

| | |
|---|---|
| P17016 16 pin | $14.50 |
| P17024 24 pin | $14.50 |
| P17028 28 pin | $19.50 |
| P17040 40 pin | $22.50 |

## SPRING RETURN TOGGLE SWITCHES

| | | WAS | NOW |
|---|---|---|---|
| S.P.D.T. | Cat S11012 | $2.25 | $1.95 |
| D.P.D.T. | Cat S11022 | $2.50 | $2.25 |

## QUALITY LEDS

| Cat. No. | Description | Price |
|---|---|---|
| Z10140 | 3mm Red | $0.20 |
| Z10141 | 3mm Green | $0.30 |
| Z10143 | 3mm Yellow | $0.30 |
| Z10145 | 3mm Orange | $0.30 |
| Z10150 | 5mm Red | $0.15 |
| Z10151 | 5mm Green | $0.30 |
| Z10152 | 5mm Yellow | $0.30 |

## MINI HAND HELD MEGAPHONE

Suitable for schools, sports meetings, boats, etc. Portable, lightweight and effective with anti howling dynamic microphone. High power output, low power consumption.

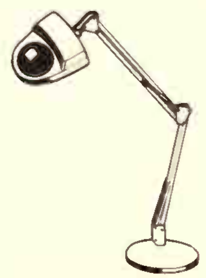
**SPECIFICATIONS:**
**Size:** 150mm diameter
**Power output:** 2/4 watt maximum
**Effective Distance:** 120 metres
**Power source:** 6 x "AA" batteries
**Power duration:** 6 hours
**Weight:** 0.6kg

Cat A ????? $69.95


## PANEL METERS GALORE!

We have a great range of panel meters at great prices!

| Cat.No. | Description | Price |
|---|---|---|
| Q10500 | MU45 0-1mA | 12.50 |
| Q10502 | MU45 50-0-50uA | 12.50 |
| Q10504 | MU45 0-100uA | 12.50 |
| Q10510 | MU45 0-5A | 12.50 |
| Q10518 | MU45 0-1A | 12.50 |
| Q10520 | MU45 0-1A | 12.50 |
| Q10525 | MU45 0-20V | 12.50 |
| Q10530 | MU52E 0-1A | 14.50 |
| Q10533 | MU52E 0-5A | 14.50 |
| Q10535 | MU45 VU PMetre | 14.95 |
| Q10538 | MU65 0-50uA | 16.95 |
| Q10540 | MU65 0-1mA | 16.95 |
| Q10550 | MU65 0-100uA | 16.95 |
| Q10560 | MU65 0-20V | 16.95 |

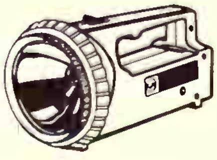


## ARGUS 726 ADJUSTABLE MAGNIFIER WITH LAMP

**Absolutely perfect for close up work!** Intricate PCB's, projects etc. will be a breeze under this superb adjustable magnifying lamp

- Magnifies 1.75 times
- 40 watt incandescent lamp
- 2 spring-balanced arms extendable to 95cm
- Adjustable head for optimum viewing angle
- Comes with desk clamp (interchangeable with base)
- Fantastic Value!!

Cat Our price $89



## RECHARGEABLE LANTERN

- Up to 1,000 recharges
- No more expensive batteries
- Beam length 1,050 feet
- Cannot be over charged
- Shoulder strap included
- 240V charge lead connects direct
- 12V Car lighter recharging lead (ideal for camping, travel, etc)
- Red safety shade cover

Cat A15053 **only $29.95**

## UV EPROM ERASER

Erase your EPROMs quickly and safely. This unit is the cost effective solution to your problems. It will erase up to 9 x 24 pin devices in complete safety, in about 40 minutes (less for less chips).

Features include:

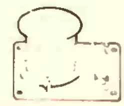
- Chip drawer has conductive foam pad
- Mains powered
- High UV intensity at chip surface ensures EPROMs are thoroughly erased
- Engineered to prevent UV exposure
- Dimensions 217 x 80 x 68mm

**WITHOUT TIMER**
Cat X14950 Normally $119
**Special, $89**

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

## CROSSOVER NETWORKS

Crossovers are essential for multiway speaker systems, otherwise your bass will be degraded by intermodulation distortion and cone break up, and your treble will be distorted by bass components. These crossovers are designed to channel only the frequencies that each driver can properly handle. Read the specifications to choose the correct one for your need.



## 2 WAY 60 WATT CROSSOVER NETWORK

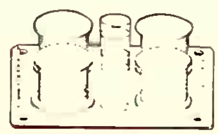
- 6dB attenuation
- Cross over point 3,500 Hz
- Impedance 8 ohms

Cat A16001 $7.95

## 3 WAY 60 WATT CROSSOVER NETWORK

- 6dB attenuation
- Cross over point 800 and 5,000 Hz
- Impedance 8 ohms

Cat A16003 $12.95



## 3 WAY 100 WATT CROSSOVER NETWORK

- 12dB attenuation
- Cross over point 800 and 5,000 Hz
- Impedance 8 ohms

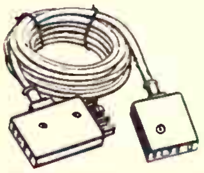
Cat A16005 $28.95

## PUSH BUTTON DIALLERS

Tired of old fashion dialling and re-dialling engaged numbers? These convenient push button diallers include last number redial (up to 16 digits) and instructions for an easy changeover.

Cat A12030 NORMALLY $19.95
**SPECIAL, ONLY $14.95**

# at Rod Irving Electronics!

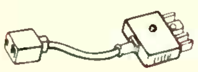


## TELECOMMUNICATIONS AUSTRALIAN STYLE ADAPTOR CABLE
- Australian socket to plug/socket
- Length 10 metres

Cat. Y16015 ........ $14.95

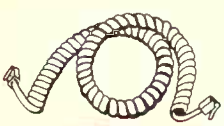
## U.S. TELEPHONE EXTENSION CABLE
- U.S. plug to 2 U.S. sockets
- Length 10 metres

Cat. Y16028 $9.95



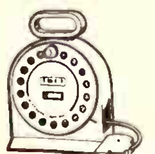
## TELEPHONE ADAPTOR
- Australian plug to U.S. socket
- Length 10cm

Cat. Y16026 $5.95



## TELEPHONE CURL CORD
- U.S. plug to U.S. plug
- Replacement hand set cord
- Length 4.5 metres

Cat. Y16023 $6.95



## TELEPHONE EXTENSION CABLE UNIT
Allows 15 metres of telephone extension cable to be neatly wound into a protable storage container. The reel sits on a flat base and has a handle to wind cable back on to it after use. No tangles - no mess! Ideal for the workshop, around the house, office, pool etc.

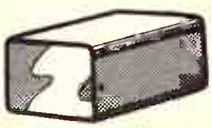
Cat. Y16013 $22.95

## HIGH EFFICIENCY RADIAL FIN HEATSINK
Black anodised with a thick base plate, this radial fin heatsink can dissipate large amounts of heat for maximum efficiency. Designed by Rod Irving.

| | | |
|---|---|---|
| 105x30mm | Cat. H10520 | $ 3.50 |
| 105x75mm | Cat. H10525 | $ 3.50 |
| 105x100mm | Cat. H10529 | $ 4.90 |
| 105x140mm | Cat. H10534 | $ 6.50 |
| 105x150mm | Cat. H10535 | $ 6.75 |
| 105x170mm | Cat. H10538 | $ 7.95 |
| 105x195mm | Cat. H10542 | $ 9.90 |
| 105x200mm | Cat. H10543 | $ 9.90 |
| 105x225mm | Cat. H10546 | $10.50 |
| 105x300mm | Cat. H10549 | $12.00 |
| 105x600mm | Cat. H10560 | $24.95 |


## DIECAST BOXES
Diecast boxes are excellent for RF shielding, and strength. Screws are provided with each box.

| | | |
|---|---|---|
| H11451 | 100 x 50 x 25mm | $ 5.95 |
| H11452 | 110 x 60 x 30mm | $ 6.50 |
| H11453 | 120 x 65 x 40mm | $ 6.95 |
| H11461 | 120 x 94 x 53mm | $11.50 |
| H11462 | 188 x 120 x 78mm | $13.50 |
| H11464 | 188 x 188 x 64mm | $29.50 |



## HORWOOD ALUMINIUM CASES

| | | |
|---|---|---|
| H10382 | 3 x 4 x 2 inches | $ 5.50 |
| H10383 | 3 x 4 x 3 inches | $ 6.50 |
| H10384 | 3 x 4 x 4 inches | $ 7.50 |
| H10385 | 3 x 4 x 5 inches | $ 7.95 |
| H10386 | 3 x 4 x 6 inches | $ 8.50 |
| H10387 | 3 x 4 x 7 inches | $ 9.50 |
| H10388 | 3 x 4 x 8 inches | $10.50 |
| H10389 | 3 x 4 x 9 inches | $10.95 |
| H10390 | 3 x 4 x 10 inches | $11.95 |

## RACK MOUNTING CABINETS
These superbly crafted rack cabinets will give your projects a real professional appearance.
- All dimensions conform to the International Standard
- Aluminium construction
- Removeable upper and lower panels
- Ventilated lid
- Choice of Natural or Black finish
- Quality brushed finish anodised front panel

A Internal Height mm
B Rear Width mm
C Depth mm

| A | B | C | Finish | Cat.No. | Price |
|---|---|---|---|---|---|
| 38 | 430 | 254 | Natural | H10401 | $49.50 |
| 82 | 430 | 254 | Natural | H10402 | $59.50 |
| 126 | 430 | 254 | Natural | H10403 | $69.50 |
| 38 | 430 | 254 | Black | H10411 | $59.95 |
| 82 | 430 | 254 | Black | H10412 | $69.95 |
| 126 | 430 | 254 | Black | H10413 | $79.95 |

## ½" HIGH INTENSITY RED LED DISPLAYS
**(Available in Common Cathode and Common Anode)**

**Dimensions:**
Overall 12.7mm across, 19mm high
Display 12.7mm(H) x 7.3mm(W)
Segment Width 1.2mm
Brightness 3400 ucd $I_F$ 10mA

**COMMON CATHODE:**
Pin 1 Segment E Pin 6 Segment B
Pin 2 Segment D Pin 7 Segment A
Pin 3 CC Pin 8 CC
Pin 4 Segment C Pin 9 Segment F
Pin 5 Segment Dp Pin 10 Segment G

| Cat No | 1-9 | 10+ | 100+ |
|---|---|---|---|
| Z10190 | $1.95 | $1.75 | $1.50 |

**COMMON ANODE:**
Pin 1 Segment E Pin 6 Segment B
Pin 2 Segment D Pin 7 Segment A
Pin 3 CA Pin 8 CA
Pin 4 Segment C Pin 9 Segment F
Pin 5 Segment Dp Pin 10 Segment G

| Cat No | 1-9 | 10+ | 100+ |
|---|---|---|---|
| Z10191 | $1.95 | $1.75 | $1.50 |

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

Cat. T12480 Normally $79.95
**SPECIAL, $69.95**


## SCOPE 60W SOLDERING SYSTEM
- Infinitely adjustable temp. 200 C to 470 C. Sliding control selects desired tip temperature (LED readout monitors tip temp.)
- Safety holder features ceramic burn-proof bush and can be converted to left-hand-side
- Soft and cool hand grip in pliable rubber
- Screw type connector prevents accidental plug removal and guarantees solid contacts
- Temperature lock allows production supervisors to control soldering temperatures
- Anti seize tip retention design reduces risk of thread seizure by removing locking nut to cooler end of barrel
- Optional 30W soldering pencil is available for finer work

Cat. T12900 Normally $229
**SPECIAL, $199**

## ANTISTATIC SOLDER SUCKER
- Light weight
- Sturdy construction
- Easy to remove tip
- Excellent value for money!

Cat. T11281 $13.95


## 150W IBM COMPATIBLE SWITCH MODE POWER SUPPLY
**DC output:** +5/13A, -5V/0.5A
+12V/4.5A -12V/0.5A
**AC Input:** 240V AC + - 15% 1.5A
47Hz - 63Hz

Cat. X11096 Normally $239
**Now only $149**


## HEATSINK COMPOUND
Heatsink compound is applied to the base and mounting studs of transistors and diodes. It maintains a positive heatsink seal that improves heat transfer from the device to the heatsink, thus increasing overall efficiency.

Cat. H11800 $2.95


## METEX 3800 MULTIMETER
This instrument is a compact, rugged, battery operated, hand held 3½ digit multimeter for measuring DC and AC voltage, DC and AC current, Resistance and Diode, for testing Audible continuity and transistor hFE. The Dual-slope A-D Converter uses C-MOS technology for auto-zeroing, polarity selection and over-range indication. Full overload is provided. It is an ideal instrument for use in the field, laboratory, workshop, hobby and home applications.

**Features...**
- Push-button ON/OFF power switch
- Single 30 position easy to use rotary switch for FUNCTION and RANGE selection
- ½" high contrast LCD
- Automatic over-range indication with the "1" displayed
- Automatic polarity indication on DC ranges
- All ranges fully protected plus Automatic "ZERO" of all ranges without short circuit except 200 ohm Range which shows "000 or 001"
- High Surge Voltage protection 1.5 KV-3 KV
- Diode testing with 1 mA fixed current
- Audible Continuity Test
- Transistor hFE Test

**SPECIFICATIONS**
**Maximum Display:** 1999 counts 3½ digit type with automatic polarity indication
**Indication Method:** LCD display
**Measuring Method:** Dual-slope in A-D converter system
**Over-range Indication:** "1" Figure only in the display
**Temperature Ranges:** Operating 0 C to +40 C
**Power Supply:** one 9 volt battery (006P or FC-1 type of equivalent)

Cat. Q91530 Normally $109
**SPECIAL $79**


## METEX 3530 MULTIMETER
This instrument is a compact, rugged, battery operated, hand held 3½ digit multimeter for measuring DC and AC voltage, DC and AC current, Resistance and Diode, Capacitance, Transistor hFE and Continuity Test. The Dual-slope A-D Converter uses C-MOS technology for auto-zeroing, polarity selection and over-range indication. Full overload is provided. It is an ideal instrument for use in the field, laboratory, workshop, hobby and home applications.

**Features...**
- Push-button ON/OFF power switch
- Single 30 position easy to use rotary switch for FUNCTION and RANGE selection
- ½" high contrast LCD
- Automatic over-range indication with the "1" displayed
- Automatic polarity indication on DC ranges
- All ranges fully protected plus Automatic "ZERO" of all ranges without short circuit except 200 ohm Range which shows "000 or 001"
- High Surge Voltage protection 1.5 KV-3 KV
- Capacitance measurements to 1pF
- Diode testing with 1 mA fixed current
- Audible Continuity Test
- Transistor hFE Test

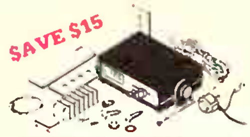
**SPECIFICATIONS**
**Maximum Display:** 1999 counts 3½ digit type with automatic polarity indication
**Indication Method:** LCD display
**Measuring Method:** Dual-slope in A-D converter system
**Over-range Indication:** "1" Figure only in the display
**Temperature Ranges:** Operating 0 C to +40 C
**Power Supply:** one 9 volt battery (006P or FC-1 type of equivalent)

Cat. Q91540 Normally $139
**SPECIAL $109**

## RECHARGEABLE ELECTRIC SCREWDRIVER
**The perfect tool for professional or handyman!**
- Long lasting NiCad battery
- Forward/Reverse Modes
- Detachable pistol grip
- Simple to use chuck
- 2 Flat tips
- 2 Philips tips
- Includes AC/DC charger

**PERFORMANCE DATA:**
**Gears Ratio:** 1:50
**Max. R.P.M.:** 150
**Max. Torque:** 3.2 (Newton Metre)
**Screwing Capacity:** 4 x 8/300
5 x 8/220

T12200 $99.50


## DIGITAL SPEEDO/ DIGITAL TACHO/ SPEED ALERT
- Digital readout (LED) for both tacho and speedo
- Alarm with sound at variable preset speed
- Audible beeper and visual indicator
- In built light indicator for night illumination
- Designed for 12 volt negative earth electrical systems
- Speedo 0 - 199kph
- Tachometer 0 - 9900kph
- Speed alert 40 - 120kph
- Complete with mounting hardware

Cat. A15064 R.R.P. $89.95
**OUR PRICE $74.95**

## HOOK UP WIRE
**Cat. No. Description**
W11251 13/12 TND BLK
W11252 13/12 TLD BROWN
W11253 13/12 TLD ORANGE
W11254 13/12 TLD YELLOW
W11255 13/12 TLD GREEN
W11256 13/12 TLD BLUE
W11257 13/12 TLD WHITE

**PRICES PER 100 METRE ROLL**

| 1-9 | 10+ |
|---|---|
| $5.95 | $5.00 |
| $5.35 | $4.50 |

W11260 14/20 RED
W11261 14/20 BLACK
W11265 14/20 BLUE
W11268 14/20 WHITE

**PRICES PER 100 METRE ROLL**

| 1-9 | 10+ |
|---|---|
| $12.00 | $10.00 |
| $10.80 | $9.00 |

W11270 24/20 RED
W11272 24/20 BLACK
W11274 24/20 GREEN

**PRICES PER 100 METRE ROLL**

| 1-9 | 10+ |
|---|---|
| $14.00 | $12.00 |
| $12.60 | $10.80 |

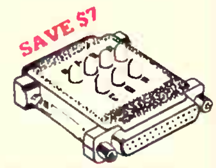
W11280 32/2 BROWN
W11282 32/2 BLUE

**PRICES PER 100 METRE ROLL**

| 1-9 | 10+ |
|---|---|
| $20.00 | $18.00 |
| $18.00 | $16.20 |

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

Cat. T12083 $14.95




## RS232 MINI TESTER
- Male to female connections
- All pin wired straight through
- Dual colour LED indicates activity and direction on 7 lines
- No batteries or power required

T D Transmit Data
D S R Data Set Ready
R D Receive Data
C D Carrier Detect
R T S Request to Send
D T R Data Terminal Ready
C T S Clear to Send

Cat. X15656 Normally $39.95
**SPECIAL, ONLY $32.95**

rie

**Rod Irving Electronics**
48 A Beckett St, MELBOURNE
Phone (03) 663 6151
425 High St, NORTHCOTE
Phone (03) 489 8866
Mail Order and Correspondence
P O Box 620, CLAYTON 3168
Telex AA 151938

**MAIL ORDER HOTLINE**
**008 335757**
**(TOLL FREE)**
(STRICTLY ORDERS ONLY)

**LOCAL ORDERS & INQUIRIES**
**(03) 543 7877**

POSTAGE RATES

| | | |
|---|---|---|
| $1 | $9.99 | $2.00 |
| $10 | $24.99 | $3.00 |
| $25 | $49.99 | $4.00 |
| $50 | $99.99 | $5.00 |
| $100 | $199 | $7.50 |
| $200 | $499 | $10.00 |
| $500 plus | | $12.50 |

FREE POSTAGE FOR ORDERS OVER $75 & UNDER 3KG!!

The above postage rates are for basic postage only. Road Freight, bulky and fragile items will be charged at different rates.

Certified Post for orders over $100 included free!
Registered Post for orders over $200 incuded free!

All sales tax exempt orders and wholesale inquiries to RITRONICS WHOLESALE, 56 Renver Rd, Clayton. Ph. (03) 543 2166 (3 lines)

MasterCard VISA

# R & D up, but watch out for rorts

Technology Minister Button and Science Minister Jones called a news conference recently to announce that R&D expenditure had risen dramatically, mainly because of the 150% tax deductability of R&D expenses. However, Department of Industry, Trade and Commerce (DITAC) officials have warned against abuse to the system.

The Ministers' move was promoted by an announcement from the Bureau of Statistics, which has just released revised estimates of expenditure and human resources devoted to R&D carried out in Australia by private and public business enterprises during 1984-85.

The main features of the new statistics are that:

- expenditure by business enterprises in 1984-85 was \$721 million;
- R&D expenditure by private business enterprises increased over the period 1981-82 to 1984-85 by over 60 per cent in constant price terms, while human resources devoted to R&D increased by 43 per cent; and
- receipts in 1984-85 for technical know-how sold overseas were \$28 million, but far short of the payments of \$158 million made overseas for know-how.

In their joint statement, the Ministers said, "The resurgence of R&D from the doldrums of 1981-82 is encouraging. As a percentage of gross domestic product, business expenditure on R&D has increased from about one quarter to about one third of one per cent.

"There is, however, no cause for complacency," the Minister said. "On the basis of these most recent statistics, investment in 1984-85 by Australian businesses was only one third that of the median for many OECD countries with whom Australia must compete in international markets. To reach roughly comparable levels of investment in technology by the end of the 1980s, Australian businesses will need to increase their performance by an annual average rate of about 25 per cent".

Senator Button added, "Advice I have received, based on registration for the 150 per cent taxation allowance for R&D, indicates that registrant companies propose to almost double their performance of R&D over the period between 1984-85 and 1986-87.

"This is heartening evidence of success of the Government's initiatives to encourage the business sector to be more innovative and to build on the technical inventiveness of Australians," he said.

However, Button appears determined not to allow the 150% deduction to turn into a tax rort. He warned late in December that the 150% tax incentive should be claimed only for expenditures incurred for genuine R&D which would definitely benefit Australia.

He said that if the growth of any company was found to be inflated by tax rorts or contrived schemes, the law would be changed to recoup the benefits gained by the companies concerned.

DITAC director of R&D policy, John McKenna said that the Federal and State Governments would conduct a "technical review" of the tax allowance scheme, which it was hoped would be completed before the August 1987 Budget session of Parliament.

As well as determining the course of the scheme through to 1990, the government would also identify abuses to the scheme during the review.

However, McKenna emphasized that abuses would be identified throughout the scheme's duration and that even legally approved arrangements could be regarded as abuses.

"The government is going to be pretty sensitive to abuse of the scheme. It would be quick to act, even if it found a scheme which was legally satisfactory but was considered to involve a contrived reallocation of wealth," Mr McKenna said.

"A company could damage the scheme if it unbolted the stable door, as it were, and let a whole lot of other companies bolt with it. The government would be negligent in not acting to prevent such a situation from occurring."

McKenna said that the technical review would also encompass other, more positive areas.

"The purpose of the review will not always be to see if there are ways of preventing people from exploiting the scheme," he said.

# BMAC for AM

The Department of Communications (DOC) is currently investigating the use of BMAC, the satellite TV transmission standard, for use over the new terrestrial Multipoint Distribution Service (MDS).

MDS is a method of program distribution that will be used to carry the recently announced Video and Audio Entertainment and Information Services (VAEIS). Broadcasters have been extremely concerned that reception of VAEIS in homes would undercut their monopoly, so the DOC has been looking at ways of providing encryption services. BMAC, with its ability to address individual receivers, is a natural choice.

The research plan being carried out by the department is to determine spectrum usage of BMAC in a terrestrial environment. The bandwidth is well known, 7.5 MHz, but the necessary guard bands are still a bit contentious. The tests, in the rf laboratory at Canberra, are to determine how many channels can be accommodated in the 2.3 GHz to 2.4 GHz and 2.076 to 2.111 GHz bands.

The department is still uncertain exactly how many licences will be required for VAEIS. So far, only a few have been released, and they have been for satellite-fed systems like Club Superstation and Skychannel.

# COMING EVENTS

**MARCH**

A series of seminars will be held in conjunction with the **International Technology Exhibition** in Canberra 3-7 March. For more information contact Total Concept Exhibitions on (02)938-2033.

**Hewlett-Packard Precision Architecture** is on display at the South Pacific Area Conference of Computer Users at the Brisbane Hilton 17-19 March. Contact Graham Coote on (07)57-7007 or Chris Kelly on (07)371-6984.

**PC87, the Eighth Australian Personal Computer Show,** is on 17 to 20 March at Centrepoint in Sydney. Contact Australian Exhibition Services on (03)267-4500.

An **International CAD/CAM Congress** on current realities and future directions will be held 17 to 20 March in Melbourne. Contact ACADS/FACE Congress Secretariat, 576 St Kilda Rd, Melbourne, Vic 3004. (03) 51-9153.

**The Fourth South Pacific Area Conference of Computer Users, SPARC '87,** will be held in Brisbane 17-19 March and is calling for papers. Contact Graham Coote on (07)57-7077.

**The Australian Computer Society's Annual PC Conference** will be held 18-20 March.

**The Queensland Electronic Distributors Association** will hold its next exhibition 24-25 March at the Brisbane Entertainment Centre. Contact Bob Hunt (07)854-1911 or Bob Heelan (07)277-4311.

**APRIL**

**The fourth workshop on small computer systems,** organized by Queensland Institute of Technology, is on 13-15 April and calling for papers. Contact Dr C. Chesmond, QIT Dept of Elec Eng, on (07)223-2484.

**Labex '87,** international lab and equipment and products exhibition is on in Brisbane at the Science Pavilion, RNA Exhibition Grounds, 31 March to 2 April. Contact BPI on (02)266-9799.

**ATUG '87 4th Australian Telecommunications Exhibition & Conference** will be held at the Hilton Hotel in Sydney 7 to 9 April. Contact Riddell Exhibitions on (03) 429-6088.

**The What's New in Electronics Exhibition** — electronics in process control — will be held 14-15 April at the State Sports Centre, Underwood Rd, Homebush, NSW.

**The 17th International Symposium on Industrial Robots** will be held 26-30 April at the Chicago Hilton & Towers. Contact RI/SME Public Relations, 1 SME Dr, PO Box 930, Dearborn, MI 48121. Ph 313/271-0777.

**MAY**

**Communications USA** (telecommunications, radio and satellite equipment) in Sydney 11-15 May. Contact Ken MacKenzie on (02)264-7044.

**Ausgraph '87** is on 11-15 May in Perth. Contact Conference Secretariat on (03)387-9955.

In a **CAD/CAM Congress** at the Regent Hotel, Melbourne, 17-20 May, a panel of experts will discuss technical computing applications. Contact (03)51-9153.

**Photographics '87,** an exhibition of the equipment and technology of photographics will be held 23 to 26 May at the RAS Showgrounds in Sydney.

**JUNE**

**Communications '87,** the Australian International Office Technology Exhibition, is on 1 to 4 June at the Royal Exhibition Building, Melbourne. Contact Australian Exhibition Services on (03)267-4500.

**PC87,** The Ninth Australian Personal Computer Show is on 1 to 4 June at the Royal Exhibition Building, Melbourne. Contact Australian Exhibition Services on (03)267-4500.

**Office Technology '87** will be held 1 to 4 June in Melbourne. Contact Australian Exhibition Services on (03)267-4500.

The **1987 Computing Systems Conference** will be held 17 to 19 June in Brisbane. Contact the Institute of Engineers, Australia, 11 National Circ., Barton, ACT 2600. (062) 73-3633.

**Videotex '87 Exhibition & Conference** is on in Melbourne over three days in June. Contact Riddell Exhibitions on (03) 429-6088.

**The Australian Hi-fi Shows '87** will be held Sydney 19-21 June at the Airport Hilton; Brisbane 3-5 July at the Gold Coast International Hotel; Melbourne 17-19 July at the Dallas Brooks Hall; Adelaide 24-26 July at the Adelaide Hilton.

**Videotex '87** to be held 30 June to 2 July at the Sheraton Hotel, Auckland. Contact the Secretariat on (649) 68-6955.

**The Third National Space Engineering Symposium** will be held 30 June to 2 July at the Australian Defence Academy in Canberra. Contact The Conference Manager on (062)73-3633.

**JULY**

**Automach '87,** an exposition on automated manufacturing and sponsored by the SME, is scheduled for 7 to 10 July in Sydney. Contact Adolph Greco on (02) 875-2377.

**The 1987 Perth Electronics Show** is on again at the Claremont Showgrounds, Perth from 29 July to 2 August. Contact address: 94 Hay St, Subiaco, WA 6008. (09)382-3122.

**AUGUST**

**A symposium on signal processing and its applications** will be held at the University of Qld 24-28 August. Those interested in participating contact the Conference Secretariat, ISSPA 87, Uniquest Ltd, University of Qld, St Lucia, Qld (07)377-2733.

**Nelcon '87** national electronics conference will be held 24-28 August at Auckland University, New Zealand. Contact B. S. Furby on (02)957-3017.

**SEPTEMBER**

**IREECON '87** will feature digital technology when it is held 14 to 18 September. Contact Heather Harriman on (02)327-4822.

**The 4th Australasian Remote Sensing Conference** will be held 14-18 September at the Adelaide Convention Centre. Contact John Douglas, South Australian Centre for Remote Sensing on (08)260-0134.

**Labex '87** international laboratory equipment and products exhibition is on 21 to 24 September at the Royal Exhibition Building, Melbourne. Contact BPI Exhibitions on (02) 266-9799 or (03)699-9151.

**OCTOBER**

**Computer Indonesia** will be held in Jakarta 20-24 October. Contact Australian Exhibition Services on (03)267-4500.

**The 38th International Astronautical Congress** will be held in Brighton, England, 10-17 October. The theme 'thirty years of progress in space' will be developed through a series of symposia. Contact the Austronautical Society of WA, COSSA, (09)397-5642.

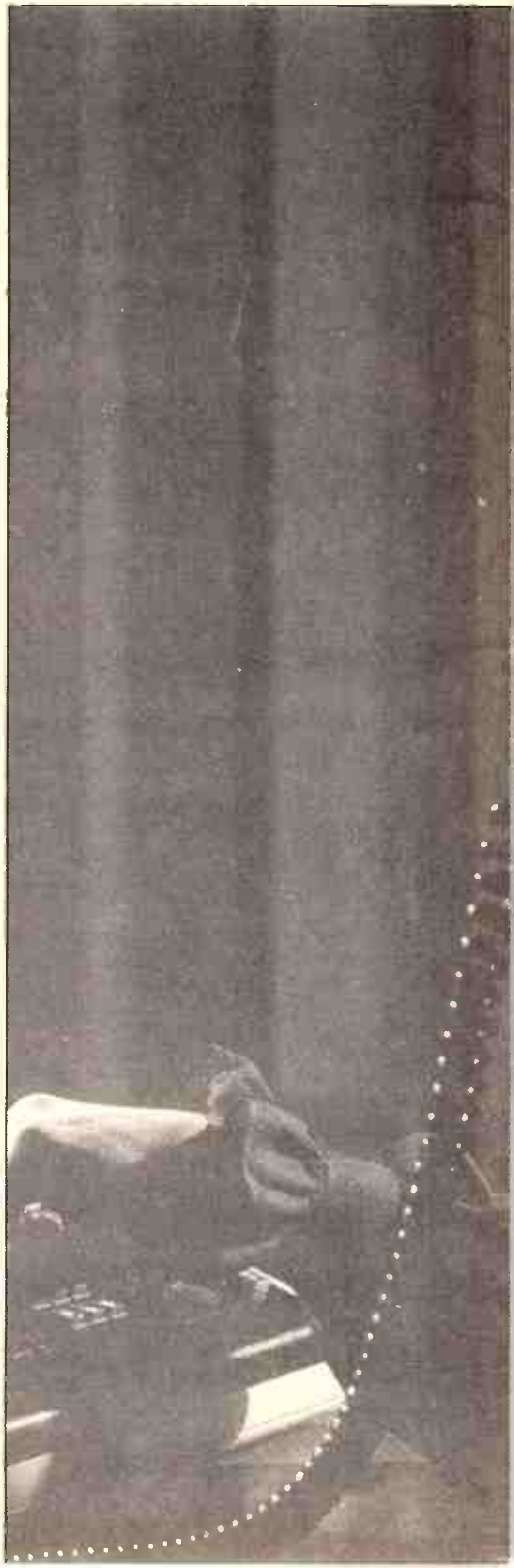
**NOVEMBER**

**CommuniTech and Computer '87** is on in Kuala Lumpur 11-14 November. Contact Australian Exhibition Services on (03)267-4500.

# PRIVATE COMMUNICATIONS SYSTEM FOR NORTHERN TERRITORY

***Efficient communication systems span the world more easily than a navigator's dividers, but someone left the Northern Territory off the map. Finally the Territorians are going to do something about it — and they're turning to private enterprise to achieve their goals.***

**Robert Phillips**



Imagine that you have been away from home for a few weeks and want to telephone home for a chat. Instead of using a telephone, you are obliged to go out in the street and use a loud-hailer to shout your greetings home.

Even if your voice were to be heard at home, how well would you be able to express yourself under such public conditions? That is exactly the standard of privacy that many Northern Territorians living in remote areas have when they use their HF radio phones to reach across the red and dusty outback.

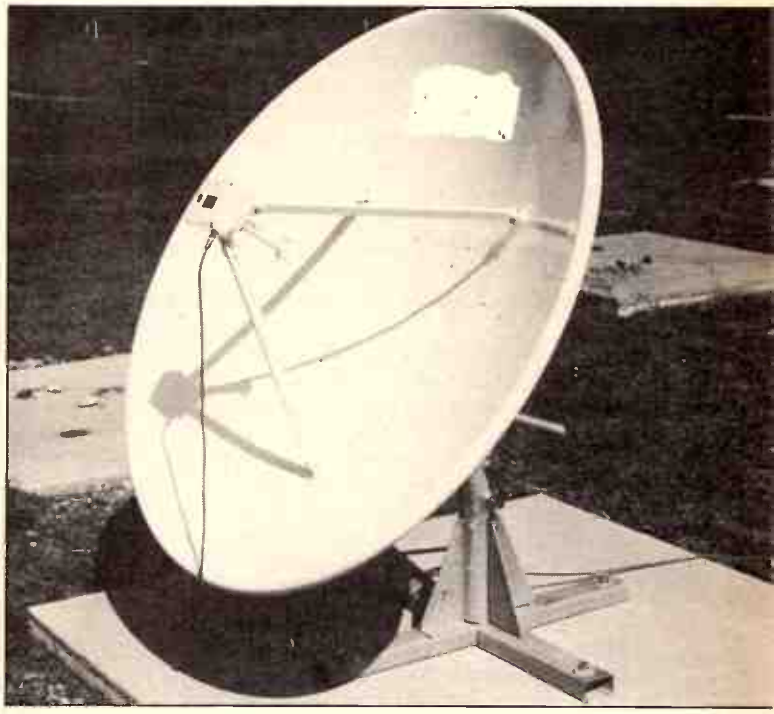
You may think this is not such a great inconvenience. After all, the purpose of such a call is really just to say hello and that you are well. If that is the case, then the next time you have to ring the doctor, imagine having the same conversation with him at the top of your voice on a peak hour train. Territorians probably have the best collection of euphemisms you have ever heard!

The Northern Territory Government is determined to do something to improve the standard of communication in the Territory and bring the whole system into at least the late 20th century, but preferably the 21st century. The amazing thing is that Queensland, faced with similar problems in its remote country areas, has all but solved the problems in the space of a couple of years. To understand why the Territory is so far behind, we need to review some history.

In about 1860 the Queensland surveyor-general, Augustus Gregory, pushed to have the area of the Northern Territory, which was then part of Queensland, split off from that State. Around the same time, John McDouall Stuart made his famous south-north crossing of the continent, and South Australia decided it would like the Territory to become part of that State. So in 1863 the Northern Territory was duly made the northern part of South Australia! It was still part of that State at Federation in 1901. The South Australians eventually found that the lack of communications with the north and the general cost of looking after the place was just too much, so in 1905 the Northern Territory was given back to Queensland. But Queensland did not really want it either, so, in 1911, it was given to the Federal Government. Nobody heard much about the Northern Territory after that. Even its representative in federal parliament 'Silent Sam' Caulder was so-named because he was not allowed to speak or vote in the House, only listen!

There have been one or two abortive attempts to expunge Darwin from the face of the Earth (so far, bombs and a cyclone have failed), but the Territorians refuse to go away. For years successive federal governments have reminded themselves that there are no votes in the Territory and so it has been left alone as much as possible. Undeterred, the Territorians have just gone ahead and through their own efforts built a $350 million gas pipeline to Darwin and now, after 100 years of broken promises, they are building their own railway system with private enterprise. Both projects are independent of federal help. Next, they are going to build a better, and private, internal communication system. It has to be 'private' because only Telecom is allowed to own public communication systems.

Queenslanders have been able to jump ahead because Queensland is a State. The Territory 'lost' its statehood in 1911, hence Territorians do not have the same ▶



constitutional rights for independent decision-making as most other people in Australia. Although they did get self-government in 1978, it is not statehood. But that's not going to keep them down.

It is difficult to know who history will identify as the 'father' of the struggle for better communications. There's Ray Hanrahan, the Northern Territory minister for business, technology and communications. And then there's the Territorian member of the legislative assembly and government whip, Colin Firmin, who has certainly been the struggle's driving force for a long time.

"The HF radio system was worthwhile back in the 1930s, 40s and 50s, but it is no longer the answer to anything out in the scrub," said Firmin. "There are long delays in trying to get onto the radio service and there is a very limited time when you are allowed to use the service. Once you finally connect, it has problems with both rain and sunspots causing radio interference, so that the quality of the service is very poor."

Firmin went on to point out that under its Rural and Remote Area Scheme, Telecom had announced a proposal to put in $400 million of digital radio concentrators across Australia. The program is floundering for a number of reasons. Some of them are financial, some are related to forward planning, and in the Northern Territory, in particular, there are also problems of running microwave towers over land that is now owned by Aborigines under the Northern Territory Land Rights Act.

"Since Aussat was first announced we have been saying that the best way is to use full satellite technology," said Colin Firmin. "The system is independent and you can place the satellite dish on the government buildings that are within the settlements."

Telephone service is not the only thing that the Government wants to deliver. With such a small population spread over such a large region, the government has unique problems in trying to reach out to the community and even to its own employees in the distant parts of the Territory. The aim is to provide meaningful government services to all Territorians in a cost-effective manner. One of the cost saving methods is to look for a single communication system that can provide voice, data and video. An all-in-one capability is far more acceptable than having to ask people to erect several different antennae for several different forms of communication. "What we are proposing, and are in the final stages of assessing, is a full Government network," Firmin said.

The Queensland Government system, Q-net, uses a dedicated transponder on Aussat and is in the final stages of testing as an operational network. They are testing things like telemetry, distance education, tele-medicine for the transmission of x-ray films and similar patient data, tracking every train in the State plus electronic mail and telephone services. The Northern Territory system is going to do all this and, said Firmin, "we have a few more innovative ideas".

One of the innovations is Firmin's "one stop government shop". The objective is for people to be able to dial a computer control centre and have their government questions answered instantly and/or facsimilied to wherever they happen to be. They will be able to pay bills from their remote site, transact land business, search information, get their driver's licence and car registration papers — all the services that are over the counter in a capital city. And the hackers won't get far since the central computer will be isolated from the government computers. People, rather than computers, will control the flow of information back to the enquirer. In addition, the computer-based controller of such satellite systems has the capability of recognizing the calling station. This is necessary so that the computer can monitor the status of stations on the net. The controller also needs to identify stations so that it can establish a 'trunk' between stations before a call can go ahead.

> *The Government has turned to private enterprise because Telecom is presently unable to provide all the needed services.*

The next question is the cost. At this stage the Government is not saying what is involved because it is still assessing the final proposals from companies tendering for the supply of the system. However the Q-net system has cost $7 million for the trial phase, so the whole system could be in the $30 million bracket. It depends on how many earth stations are deployed.

Canberra had Burley Griffen, Sydney had Utzon. Who will Darwin immortalize?

The Government sent out a request for expressions of interest in the project and received 14 replies from a wide range of companies. The replies were from predominantly Australian-based companies but there has to be a significant overseas element because that is the source of such technology. The respondents included Crooks Michelle Peacock Stewart (CMPS), McConnell Dowell and Nichols, ICOM, Microwave Consultants, Telecom, Aussat, NEC Australia and several other companies such as Plessey who are involved with combined submissions. The list has been reduced to four finalists: CMPS, ICOM, McConnell Dowell Nichols and Telecom. Each respondent has been asked to propose a system and a method of finance which meets the communication requirements with the least possible cost to the Northern Territory Government. The proposal is also to take into account offsets for the overseas element, preferably by making use of the Northern Territory's Trade Development Zone (the first such zone in Austrlaia). The Northern Territory Government would like to see the successful company set up an office in Darwin as it believes this would ensure more efficient maintenance of the system.

The Government has turned to private enterprise because Telecom is presently unable to provide all the needed services. Companies such as McConnell Dowell Nichols are not acting in competition with Telecom, but more as a supplement to it. The private companies have the equipment, skill and resources to go where Telecom cannot go. The companies are providing the infrastructure to broaden Telecom's net. As in Q-net, there will be opportunities for Telecom to extend its services with the aid of the new installation. Telecom will be able to put public phones at the end of the systems, with the coins going to Telecom not the private companies.

One of the beauties of a satellite-based system is the ease of extending it and changing the locations of earth stations. For example, in August 1986, during a major bushfire emergency in Idaho, USA, the Skyswitch Satellite Communications company of Colorado, was asked to help with emergency communications for the firefighters. It put two portable satellite earth stations on a truck and headed north-east for about 14 hours. Within 36 hours the first station was in contact with the fire control centre and within 60 hours, both stations were operational at frontline fire camps. Darwin had only one tenuous, fragile phone line for several days after Tracy.

So, when will the Northern Territory's new communication system happen? "The sooner, the better," says Colin Firmin. "The people in the scrub have been waiting for a long time for a system of some sort." ●

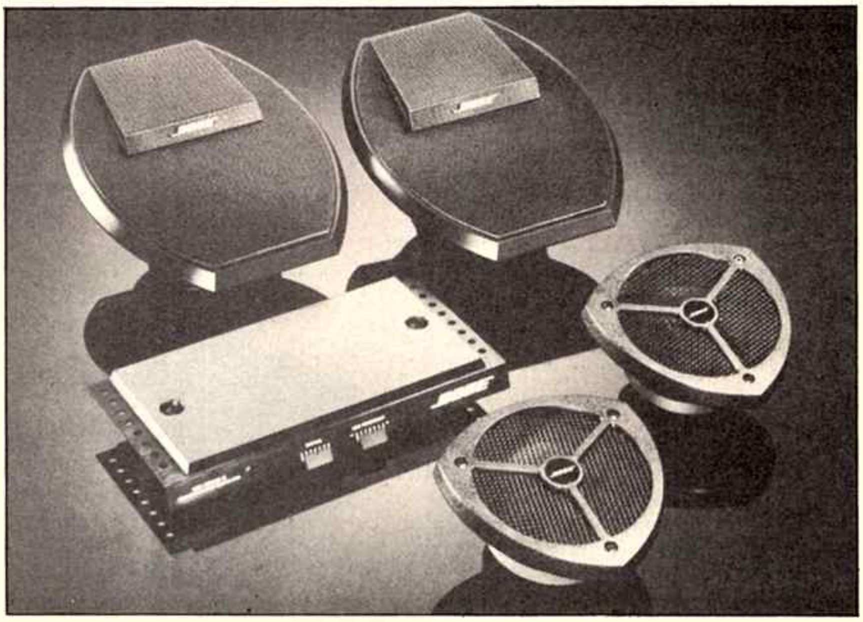
# WIN

## THIS STUNNING BOSE 1401 LARGE VEHICLE SYSTEM VALUED AT $1100.

The Bose 1401 Large-Vehicle System is designed to provide high-performance music reproduction in large cars, trucks, vans, recreational vehicles, and even boats. The system features a 1401 Series II Equalized Amplifier, two 4½″ door-mount speakers, and two 6″x9″ rear-deck-mount speakers.

**Bose Reliability**
The Bose 1401 Large-Vehicle System can withstand the unbelievable range of environmental conditions for which Bose Mobile Music Systems are famous. The speakers are virtually unaffected by extremes of temperature, moisture, direct sunlight, dirt, sand, salt and ozone. Their rugged, full-range design also makes it virtually impossible to destroy them with any music signal. The Equalized Amplifier contains a self-diagnosing protection system that continuously guards against abnormal load conditions, including short circuits. Finally, to be sure that your 1401 Large-Vehicle System sounds right in your vehicle, the Bose Syncom® II computer tests each speaker before it leaves the factory.

The Bose 1401 Large-Vehicle System — the perfect system for your larger car, truck, van, or recreational vehicle.



## IT'S EASY

***All you have to do is correctly answer 3 simple questions on the coupon below. Answers can be found in the text on this page.***

**Q** ***What sort of vehicle is the Bose 1401 system designed for?***

**A** ..........................................................................

**Q** ***What is the name of the Bose computer quality control test?***

**A** ..........................................................................

**Q** ***Is the Bose 1401 Series II amplifier equalized?***

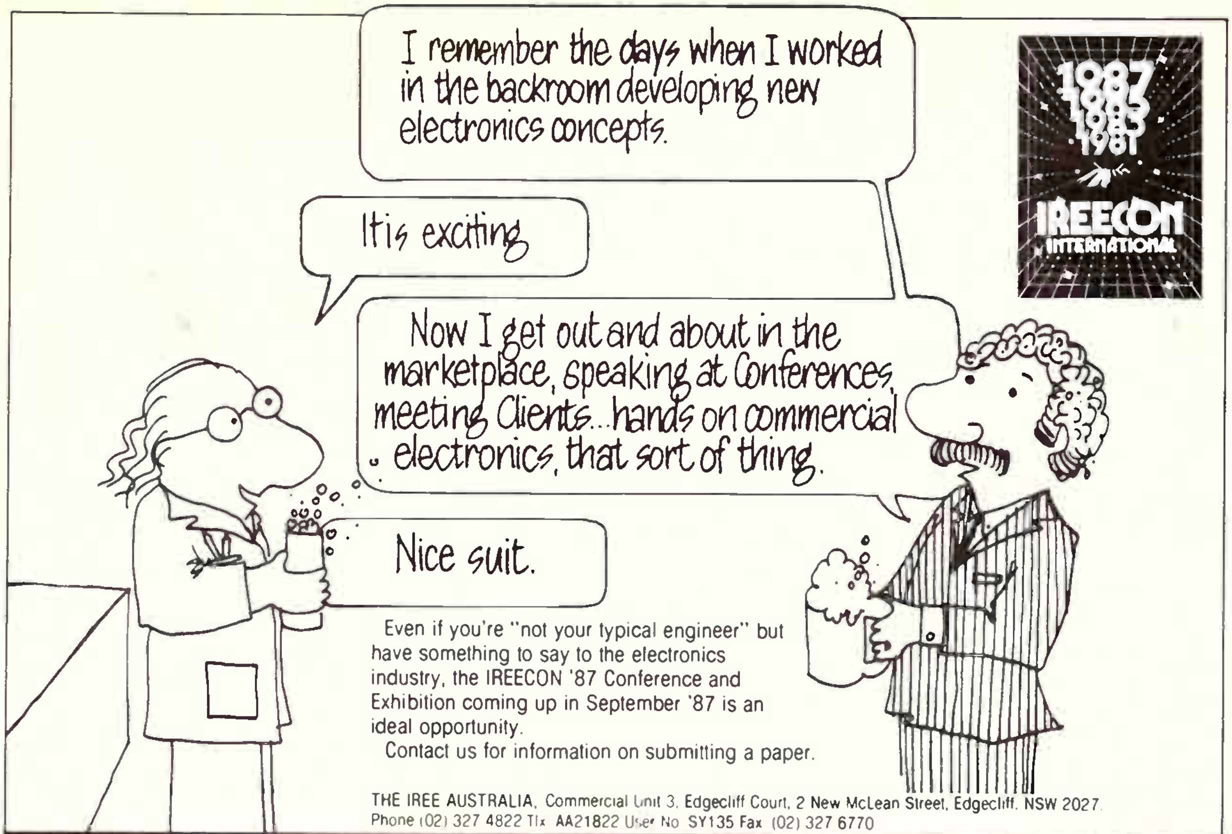
**A** ..........................................................................

**Please send entries to: ETI-BOSE COMPETITION**
**PO BOX 227**
**WATERLOO**
**NSW 2017**

Conditions:
This contest is open to all persons normally resident in Australia & New Zealand, with the exception of members of the staffs of Bose, The Federal Publishing Co, Hannanprint, Eastern Suburbs Newspapers and/or associated companies:

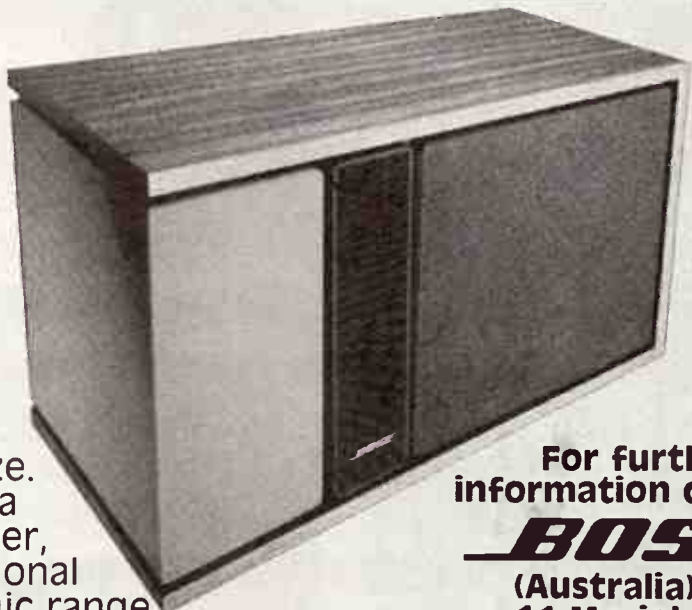
The winner will be notifed by telegram. Contestants must use the coupon entry form cut from the magazine or a photocopy with the date/page number cut from the magazine and attached. The contest is invalid in States where local laws prohibit entries.

Entries close 30th April, 1987.



I remember the days when I worked in the backroom developing new electronics concepts.
It is exciting
Now I get out and about in the marketplace, speaking at Conferences, meeting Clients...hands on commercial electronics, that sort of thing.
Nice suit.
1987
1985
1983
1981
IREECON
INTERNATIONAL



# GOVERNMENT AND INDUSTRY

***A new relationship is being forged between the government and the electronics industry to spur the development of local electronics. This is the view from industry.***


## Bruce Goddard

*Bruce Goddard, A.M., is President of the Australian Electrical and Electronic Manufacturers' Association.*


It is often very difficult for an industry such as ours which is largely managed by engineers to understand the arguments used by economists. Economics is replete with theory, while engineering is governed by laws which translate into observable facts, like Ohm's law.

But economics also has its laws, many of which were postulated in the first half of the 19th century — the classical period of economic thought.

Take the so-called law of comparative advantage. This has been the cornerstone of the Industry Assistance Commission's (IAC's) approach to Australian industry for perhaps the last 15 years. That law, in the simplest form, says that in a two-country, two-commodity world, both countries will gain from trade if they specialize in the product in which they have a comparative (or relative) cost advantage. Australia has followed this broad approach for many years by specializing in land intensive agricultural products.

How is it then that our relative trade performance continues to slide and has done so since the 1950s? If the theory works, why haven't living standards and economic growth rates between countries converged rather than diverged? If economics was based on observable facts, then it should have a law which says trade can also impoverish.

Professor Gregory Clark, an economist, recently wrote that:

*"Economic theory says that if Britain abandons its motorcycle industry to imports, this is good because it can now concentrate its resources in the car industry. Or, if Europe allows the Japanese to take over the audio industry, it does not matter because it can now specialize in up-market goods such as video-cassette recorders or compact discs.*

*"As the Japanese could have told the theorists long ago, it all works in reverse. If Britain loses its motorcycle industry, then its car industry becomes weaker, not stronger, because both were served by the same sort of technicians, parts suppliers, dealers and other staff and resources. If Europe abandons audio, it loses efficiency in producing certain items: say, the speakers needed for VCRs.*

*"An economy operates organically, not mechanically. The loss of one organ weakens, not strengthens, the rest of the body — as the Japanese realized long ago."*

One of the characteristics of much other theorizing is faith in the market as the allocator of resources to different uses such that these resources yield the highest real return to the community. However, governments often get landed with problems because the market fails to perform properly, as when we have high unemployment. The consequence of change falls disproportionately upon the minority within the population. Then political rather than economic issues make the prime running.

What conflicts of conscience such problems must cause the rational-minded public service economist! Especially when vote counting political masters demand that the problem be solved — not according to rational economic principles but to the realities of the ballot box.

If there is one single issue which manufacturing industry and government should be working on, it would have to be the reversal of our current account deficit in manufactured goods — particularly in the so-called high technology products area.

> *We estimated that even to get the present total trade deficit on current account down to reasonable proportions would require an annual growth in gross domestic product of two to three per cent — with all of it going to feed export growth.*

The seriousness of this problem is awesome in proportions. In the Association's submission to the IAC's export concession inquiry, we estimated that even to get the present total trade deficit on current account down to reasonable proportions would require an annual growth in gross domestic product of two to three per cent — with all of it going to feed export growth, ie, no increase in domestic expenditure. When combined with a gross foreign debt which exceeds a quarter of our GDP and an interest and capital repayment bill on that debt which soaks up about 30 per cent of our total export revenue, we must all be very concerned.

I think that by now, nearly everyone in business and in government understands the problems; it's agreeing on the appropriate solutions that is the stumbling block. Unless we get substantial support from all sides (and that includes a bipartisan political industry policy), then we will continue to meander, relying on luck and the vagaries of the invisible hand. We will continue to have short term changes in direction with changes of government.

The long term decline in our terms of trade for our traditional land-based exports has renewed interest in the manufacturing sector. I detect a new positive approach to assistance which is aimed at creating comparative advantage rather than merely hoping it will happen. This is a welcome change to which industry will respond where it can.

But there is no doubt that the structure of Australian manufacturing has changed massively over the last decade. There are some inherent weaknesses which cannot be remedied overnight. Many local manufacturing activities have disappeared and, once gone, will not be recovered. The base capability has been weakened.

Perhaps more so than most other countries, we have been open to international competition. This in itself should not be a cause of fear if:

(a) the rate of decline in the industries disadvantaged is broadly matched by the rate of growth in new industries; and

(b) the rate of change is within the economy's capacity to absorb.

In manufacturing, it is doubtful whether either of these conditions applied over recent years.

As an Association we have demonstrated our commitment to contribute to the policy formulation process through our involvement in a host of government working parties and committees. Attitudes on both sides have to change. On the government's side there is an understanding that policy cannot be formulated in a vacuum. For too long governments have believed that they have been the repository of all wisdom on industry policies. But industry must begin to understand the constraints of government. Industry has too often relied on short term measures to address symptoms of problems rather than the more fundamental causes. Hopefully, such mistakes have been relegated to the past.

But don't let anyone think the recent way of openness and wide involvement in decision making is the soft option. It is time-consuming, sometimes frustrating and often painful. And neither does it work in all policy areas. But compared with complete acceptance and implementation of, say, an IAC report, it is infinitely superior. The recent work we did on the telecommunications industry showed that very clearly.[1]

The electrical and electronic industries in Australia are at the forefront of technological change. Many of the products required to improve the productivity of Australia's basic industries are supplied by our industries. As an Association, we welcome the recognition of technology and R&D as important elements in Australia's competitiveness. There are areas of our industry which have shown very strong growth rates over recent years, well in excess of economic growth generally. There are other areas which are based on well established, mature technologies which can continue to grow steadily, given that they are updated in process and quality technology. Other areas such as those supplying the consumer market tend to fluctuate in concert with the business cycle. Our Association's coverage is extremely diverse and varied but all the signs are that the decline evident over the last decade has bottomed. Total employment in our industries was stable between 1984 and 1985 for the first time in many years.

So despite the problems which face us, I remain optimistic of the future of our industries. As long as the government's macro policies can deliver reasonable rates of economic growth with control of inflation and interest rates, these industries will obtain more than their fair share of growth.

I welcome what I perceive to be the spirit of cooperation between government and industry. The national preference agreement was also a welcome move towards improved cooperation between governments.

There is still a long way to go before we will genuinely pull together and act as one nation all supporting the common good but, given our lamentable past record in this area, one would have to say considerable progress has been achieved. That progress has, however, been aimed more at correcting the errors of the past rather than forging a new direction. Nevertheless, it is progress and I hope it will continue into areas such as offsets policy, technology, R&D, bringing research organizations into more direct commercial activity, etc, where common policies between State and Federal governments would be welcomed by industry.

1. A 150-page document detailing development strategy for industry growth, prepared by the Association for Senator Button and largely implemented.

# ROD IRVING ELECTRONICS
# "YOUR PERIPHERAL SPECIALISTS!"

## RED HOT BUYS


### IBM* COMPATIBLE DISK DRIVES

Tired of paying out more for Japanese Disk Drives? These "direct import" Hong Kong disk drives are the solution! They feature Japanese mechanical components, yet cost only a fraction of the price!

| Cat.No. | Description | Price |
|---|---|---|
| C11801 | 500K | Normally $199 |
| | SPECIAL, ONLY | $179 |
| C11803 | 1 M/Byte | $239 |
| C11805 | 1 6 M/Byte | $259 |

### COMPUTER LEADS

**CL33**

- IBM PC, XT and look-a-likes with 25 pin 'D' plug on computer end to Centronics 36 pin plug
- Length 2 13 metres

Cat. P19029 **$19.95**

### 2 & 4 WAY RS232 DATA TRANSFER SWITCHES

If you have two or four compatible devices that need to share a third or fifth, then these inexpensive data transfer switches will save you the time and hassle of constantly changing cables and leads around

- No power required
- Speed and code transparent
- Two/Four position rotary switch on front panel
- Three/Five interface connections on rear panel
- Switch comes standard with female connector

2 WAY Cat X19120 ~~$125~~ **$100**
4 WAY Cat X19125 ~~$145~~ **$115**

### 2 & 4 WAY CENTRONICS DATA TRANSFER SWITCHES

Save time and hassles of constantly changing cables and leads around with these inexpensive data transfer switches These data switches support the 36 pin centronic interface used by Centronics, Printronics, Data Products, Epson, Micronics, Star, and many other printer manufacturers

- No power required
- Speed and code transparent
- Two/Four position rotary switch on front panel
- Three/Five interface connections on rear panel
- Switch comes standard with female connector
- Bale locks are standard

2 WAY Cat X19130 ~~$125~~ **$100**
4 WAY Cat X19135 ~~$145~~ **$115**

## IBM* AT COMPATIBLE

**Assembled & Tested In Australia!**

- 6 MHz
- 80286 CPU
- 8 Slots
- 1 M/Byte Main Board
- 1 2 M/Byte Floppy Disk Drive
- 20 M/Byte Hard Disk
- Colour Graphics Display Card
- Floppy and Hard Disk Controller Card
- Printer Card and RS232
- 200W Power Supply
- Keyboard
- Manual
- 3 Months Warranty

**Only $3,695**

## IBM* XT COMPATIBLES from $795*

***Assembled & Tested in Australia!***

***3 Months Warranty!***

***$795:** 256K RAM Single Drive, Graphics and Disk Controller Card

**256K RAM:** 2 Disk Drives, Multifunction Card, Colour Graphics, Disk Controller, 1 Parallel Port **only $1,095**

**640K RAM:** 2 Disk Drives, Multifunction Card, Colour Graphics, Disk Controller, 2 Serial, 1 Parallel Port **only $1,195**

### RITRON 2 MONITORS

Stylish 20MHz, non-glare 12 inch monitors available in green or amber displays and featuring swivel base that tilts forward and back and swivels right to left!

Green Cat X14506 **Normally $235**
Amber Cat X14508 **Normally $239**
**SPECIAL, ONLY $179**


### INTRA 14" RGB HIGH RESOLUTION COLOUR MONITOR

**Compatible with IBM* and compatibles, and EGA Cards.**
**Why pay more?**
**Resolution:** 640 x 350 dots
**Dot pitch:** 31mm
**Display Format:** 80 x 25 characters
Cat X14514 **Normally $1,295**
**Our price $995**


### IBM* XT & AT COMPATIBLE EXTENDED KEYBOARD (105 KEYS)

These new keyboards are both XT and AT compatible!

- 20 Dedicated function keys
- Enlarged "Return" and "Shift" key
- Positive feel keys
- Low Profile Design, DIN standard
- Separate Numeric and Cursor control keypads
- Additional Functions.. Key-in-lock, Audio Beep, Previous Word, Next Work, Fast Repeat, Line Feed, Pause, Clear Screen, Reset

Cat.X12022 **WAS $299**
**SPECIAL, ONLY $199**

### APPLE* COMPATIBLE CARDS

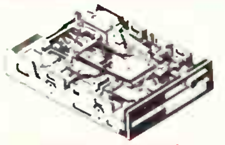
| | |
|---|---|
| **PRINTER CARD** | |
| Cat. X17029 | $89 |
| **DRIVE CARD** | |
| Cat X17019 | $79 |
| **80 COLUMN CARD** | |
| Cat X17025 | $85 |
| **SUPER SERIAL CARD** | |
| Cat X17035 | $129 |
| **RGB CARD** | |
| Cat X17039 | $79 |
| **PAL COLOUR CARD** | |
| Cat X17027 | $95 |
| **Z80 C/M CARD** | |
| Cat X17041 | $59 |

### IBM* XT COMPATIBLE CARDS

| | |
|---|---|
| **Colour Graphics Card** Cat X18002 | $129 |
| **Graphics Card** (Hercules compatible) Cat X18003 | $175 |
| **Floppy Disk Drive Controller Card** (2 Drives, 16 Bit) Cat X18005 | $129 |
| **Floppy Disk Drive Controller Card** (4 Drives, 16 Bit) Cat X18006 | $199 |
| **High Resolution Mono Card** Cat X18007 | $199 |
| **Colour Graphics & Printer Card** Cat X18010 | $169 |
| **768kB RAM Card** (without memory) Cat X18012 | $99 |
| **Printer Buffer Card** Cat X18017 | $37.50 |
| **Game I/O Card** Cat X18019 | $39.50 |
| **XT Motherboard (without memory)** Cat X18020 | $225 |
| **Clock Card** Cat X18024 | $59.50 |
| **RS232 Card (without cable)** Cat X18026 | $79.50 |
| **RS232 & Clock Card** Cat X18028 | $99 |
| **XT Turbo Motherboard** (without memory) Cat X18030 | $275 |
| **Multi I/O & Disk Controller Card** Cat X18040 | $199 |
| **I/O Plus Card** Cat X18045 | $139 |
| **768K Multifunction I/O Card** (includes cable but not 41256 RAM) Cat X18050 | $199 |
| **Hard Disk Controller Card** Cat X18060 | $299 |
| **Enhanced Graphics Adaptor Card** Cat X18070 | $499 |

### (AT COMPATIBLE)

| | |
|---|---|
| **Enhanced Graphics Adaptor Card** (Award Bios) Cat. X | $495 |



### NEC DISK DRIVES

**5 1/4" SLIMLINE**

- AT compatible,
- double sided, double density,
- switchable 1 6 M/Byte to 1 M/Byte unformatted
- 1 2 M/Byte to 720K formatted.

Cat C11906 **$295**

**8" SLIMLINE**

- Double sided, double density,
- 1.6 M/Byte unformatted.

Cat C11908 **$795**

MAIL ORDER HOTLINE
008 335757
(TOLL FREE)
LOCAL: 543 7877

### 20 M/BYTE HARD DISK DRIVE FOR IBM* AND COMPATIBLES

NEC drive with DTC controller card
Cat X20010 **WAS $1,250**
**SPECIAL, ONLY $995**
*IBM is a registered trade mark

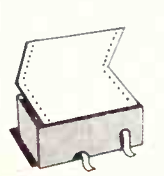
### APPLE* COMPATIBLE SLIMLINE DISK DRIVE

Japanese Chinon mechanism, compatible with Apple 2+
Cat X19901 Normally $225
**SPECIAL $195**

### SUPER 5 EP-1201 DOT MATRIX PRINTER

- 120 C P S
- Pica or Elite character set
- Print Modes, NLQ, Dot Graphics, Proportional Font, Draft
- Proportional Printing
- Reliable and Compact
- Proportional Printing
- Logic Seeking
- 1K Printer Buffer

Cat C20035 **only $595**



### COMPUTER PAPER

Quality paper at a low price! 2,500 sheets of 11 x 9 1/2", 60 gsm bond paper
Cat C21003 Normally $49.95
**SPECIAL, ONLY $44.95**

### 5 1/4" DISK STORAGE

Efficient and practical Protect your disks from being damaged or lost!
**Features...**

- 70 disk capacity
- Smoked plastic cover
- Lockable (2 keys supplied)
- Dividers/spacers

Cat C16025 **only $19.95**

### JUMBO 5 1/4" DISK STORAGE

If you've got lots disks, you'll appreciate the extra capacity of this disk storage unit when it comes to locating "that" disk!
**Features...**

- 100 disk capacity
- Smoked plastic cover
- Lockable (2 keys supplied)
- 9 Dividers/spacers

C16020 **only $24.95**
C16027 (Hinged Lid) **$26.95**

### 3 1/2" DISK STORAGE UNIT

- Holds up to 40 x 3 1/2" diskettes
- Lockable (2 keys supplied)
- High impact plastic lid and base
- Anti static

Cat C16040 **only $19.95**

### PAPER TAMER

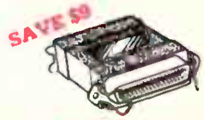
- Restores order to the top of your desk or work area
- Made of white plastic coated steel
- Stores up to 900 continuous sheets
- Allows perfect paper feed
- Allows easy examination of print out

C21050 Normally $59.95
**Special, only $49.95**
(Printer and paper not included)

### APPLE* II SERIES COMPATIBLE JOYSTICK

These joysticks have adaptor connectors to suit the Apple II, IIc, IIe and II+ computers. Features include selectable "spring centring" or "free floating" Electrical trim adjustments on both axis, 360° cursor control and dual fire buttons

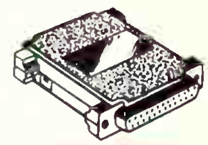
Cat. C14201 **$49.95**




### CENTRONICS GENDER CHANGERS

- Female to Female.
- Saves modifying or replacing non-mating Centronics cables.
- All 36 pins wired straight through.

Cat X15663 **Male to Male**
Cat X15661 **Male to Female**
Cat X15664 **Female to Female**
Normally $33.95,
**Only $24.95**



### RS232 GENDER CHANGERS

- Saves modifying or replacing non-mating RS232 cables.
- All 25 pins wired straight through

Cat X15650 **Male to Male**
Cat X15651 **Male to Female**
Cat X15652 **Female to Female**
Normally $19 95 each
**Only $14.95**

### RS232C NULL MODEM ADAPTOR

- Male to female connections
- Pins 2 and 3 reversed
- All 25 pins connected

Cat X15657 **Male to Male**
Cat X15658 **Male to Female**
Cat X15659 **Female to Female**
Normally $22.95
**Only $14.95**


rie

**Rod Irving Electronics**

48 A Beckett St. MELBOURNE
Phone (03) 663 6151

425 High St. NORTHCOTE
Phone (03) 489 8866

Mail Order and Correspondence
P O Box 620 CLAYTON 3168
Telex AA 151938


MAIL ORDER HOTLINE
008 335757
(TOLL FREE)
(STRICTLY ORDERS ONLY)

LOCAL ORDERS & INQUIRIES
(03) 543 7877

POSTAGE RATES

| | | |
|---|---|---|
| $1 | $9 99 | $2 00 |
| $10 | $24 99 | $3 00 |
| $25 | $49 99 | $4 00 |
| $50 | $99 99 | $5 00 |
| $100 | $199 | $7 50 |
| $200 | $499 | $10 00 |
| $500 plus | | $12 50 |

FREE POSTAGE FOR ORDERS OVER $75 & UNDER 3KG!

The above postage rates are for basic postage only Road Freight bulky and fragile items will be charged at different rates

Certified Post for orders over $100 included free!
Registered Post for orders over $200 included free!

All sales tax exempt orders and wholesale inquiries to
RITRONICS WHOLESALE
56 Renver Rd. Clayton
Ph. (03) 543 2166 (3 lines)

Errors and omissions excepted

*Apple and IBM are registered trade names

MasterCard VISA

# A (HAM) TALE OF THREE CITIES

*Amateur Radio in Kuala Lumpur, Singapore and Bangkok.*

**Thomas E. King VK2ATJ**

SARTS President, Selva, 9V1UV, regularly demonstrates amateur radio to would-be amateurs in the massive Singapore Science Centre while amateur classes held within the complex attract great interest from the island nation.

When amateur radio operators in Malaysia aren't able to access their favourite 2 metre repeater they immediately know that someone's been monkeying with the jungle-surrounded VHF system. And without fail the culprit turns out to be a monkey who's gone ape twisting repeater antennas or chewing the coax.

While Malaysia's two existing repeaters (another 144 MHz repeater is planned for south Malaysia while a 440 MHz repeater set-up is under consideration for Kuala Lumpur) are relative newcomers to the country's amateur scene, the hobby has a long history in this independent Southeast Asian country. It began on March 10, 1932 when the Malaysian Amateur Radio Transmitters Society (MARTS, PO Box 10777, Kuala Lumpur) was formed by a small group of enthusiasts in Kuala Lumpur. In those days Malaya was a British colony. The few founding fathers of MARTS were British expatriates who operated under the callsign VS2. (It's been 9M2 for West Malaysia and 9M6 and 9M8 for East Malaysia, since independence in 1957.)

The 'spark gap' period of amateur radio in Malaysia began to dramatically change in 1983 when discussions between MARTS officers and Jabatan Telekom (Malaysia's telecommunications authority) resulted in a radical change in attitude to the amateur movement and a markedly more liberal and enlightened interpretation of the rules and regulations.

The year 1984 heralded yet another major step forward with the introduction of objective type question papers for the technical exam. When detailed essay papers were previously required for the tech exam an average of only three to six candidates would sit for the gruelling test. In June 1986, 50 candidates took the objective test while an unprecedented 212 sat for the recent December exam!

Ham numbers are now about 200 and MARTS membership around the 250 mark (SWLs account for the difference). Both figures are set for an increase as the majority of those who appeared for the exams in 1986 receive their licences and join MARTS.

At a cost of about $A10 a year MARTS members enjoy club privileges which include contests and field days, a QSL bureau which handles around 2000 cards a month and an annual callbook. There are occasional get-togethers including the annual general meeting which was last held in mid January and there is the semi monthly MARTS newsletter. (The

**The founding father of amateur radio in Thailand**, Brig-General, Kamchai Chotikul, HS1WR, pursued the full legalization of amateur radio in his country, a cause carried forward by his widow Mayuree, HS1YL.

December issue was more like a magazine with 80 pages!)

Members (and non members) can keep up with Malaysia's changing amateur scene by attending regular 'meetings on the air'. While these broadcasts go out to enthusiasts on the 40 and 2 metre amateur bands, anyone watching TV3 on alternate Sundays can learn more about amateur radio from popular newsreader Ghazalie, 9M2GH. His 20 minute "MARTS Magazine" gives news about amateur activities in Malaysia, Southest Asia and the world, and has been of immense promotional benefit.

## Singapore

The amateur population in Singapore has also seen the benefits of media promotion. A three-sentence notice in the *Straits Times* in early 1986 drew 120 responses for the first amateur radio course ever conducted by the 18-year-old Singapore Amateur Radio Transmitting Society (GPO Box 2728, Singapore 9047). Sixty applicants were finally selected for the 12 week course on theory, rules and regulations, conducted inside the spacious Singapore Science Centre.

> ***Singapore has the highest per capita income in Asia and purchase of equipment is not a financial burden. Time is much more of a problem.***

While Singapore's amateur population is set to expand far beyond its current 70 hobbyists, amateur radio operators in this tiny republic are confronted with a number of curious situations all of which make interesting ham tales.

For instance Singapore has the second highest per capita income in Asia and purchase of equipment is not a major financial burden. Time is much more of a problem. The big 'time grabber' is work. The typical Singaporean approach to employment is one of long hours and total commitment.

Another problem is that due to Singapore's thousands of multi storey buildings and tens of thousands of flats, the erection of proper antennas is extremely difficult. It can only be done after the approval of building owners and, in the case of Housing Board of Singapore flats, is subject to an annual antenna licence fee of about $80.

If these dual difficulties can be solved would-be amateurs have a fairly straightforward path to achieving a licence. Candidates over 21 pay an application fee of about $6 to sit for the two-part written exam which is held every August. Upon its successful completion with passes of at least 60 per cent in each section candidates may apply, with a fee of about $3 to sit for a Morse exam. These are conducted in April and October. Would-be amateurs are required to send and receive 36 words in plain language in three minutes.

After candidates have successfully passed the written and Morse tests they have up to a year to apply for an Amateur Station Licence. Beyond that period the Morse test has to be taken again! A fee of about $17 is payable on the issue of the renewable licence which is valid for one year.

Several operating peculiarities exist in Singapore. For instance, first year licence holders are limited to Morse operations with a power of 20 watts (except on 160 metres where power is restricted to 10 watts). On the VHF and UHF bands operation is limited to a few spot frequencies. Individual approval to operate on these bands has to be obtained in writing. Operating power is limited to 15 watts and only crystal-controlled equipment is permitted. (Some softening on the 2 metres ▶

issue occurred in late 1986 when the Republic's first repeater began operating on 146.625/.025.) Mobile operation on HF, VHF and UHF is not permitted and maritime mobile operation is also forbidden.

One area where absolutely no problem exists is in the obtaining of equipment. A number of equipment suppliers such as Rico Pty Ltd (80 Genting Lane, Singapore 1134, telephone 745-8472) offers the latest equipment at substantial discounts. A paradox is that since some of the equipment available features amateur bands not available in Singapore certain pieces can only be purchased by amateurs from overseas who take their bargains with them when they leave the country.

While these incongruities are often discussed at SARTS monthly meetings (held on the last Thursday of the month at the YWCA, 6, Fort Canning Road) an entirely different attitude and a vastly different appraoch is taken to amateur radio activites in Thailand.

## Thailand

Amateur radio is a comparitively new activity in Thailand although it most certainly predates the 1965 founding of the Radio Amateur Society of Thailand. RAST was ably guided for many years by the late Brig-General Kamchai Chotikul, HS1WR. His widow, Mayuree HS1YL, is still a very active RAST member, who along with the 600 other members of the club, pursues her late husband's long term objective of the full legalization of amateur radio in Thailand.

A breakthrough came in mid November 1984 when the Thai Communications Minister, Samak Sundaravej, was the chief guest at RAST's 20th anniversary celebrations in Bangkok. It was his first personal contact with the society, the wireless hobby and the worldwide activities and achievements of amateur radio operators.

Since then a number of meetings on both formal and informal levels have taken place between RAST officers and senior officials of the Post and Telegraph Department. The Director General of the licensing organization, Mahidol Chantrangkook, has not only been understanding and helpful but has demonstrated such an interest in the hobby that RAST members donated and erected an HF triband Yagi at his home.

The most important meeting to date was in late 1985 when the frequency management committee of the Ministry of Communications summoned senior members from RAST to explain aspects of the hobby and to clarify certain points. The meeting was initiated by the Government and that in itself reflected a growing awareness of the amateur radio service in Thailand.

**Malaysia's involvement,** interest and development of packet radio and satellite communications has firmly placed the country as a amateur leader in Asia.

While debate among senior government officials continues on how best to fully legalize and regulate the Thai amateur radio service, RAST has been able to keep Thailand's amateur voice on the HF bands by applying for and receiving short term permission from the PTT to operate stations for special events and during recognized contests such as the All Asia DX Contest, the SEANET Contest, the European DX Contest as well as the CQ Worldwide contests. Contest operations are conducted from the club's HF station located at the Asian Institute of Technology which is about 45 km north of Bangkok. The call sign HS0A is used for contests and participation in special events such as the society's 20th anniversary and recent operation by the Japanese UNICEF Ham Club.

At the request of the Post and Telegraph Department, RAST set up a demonstration station within a telecommunications exhibition to mark Thailand's national communications day. The exhibition held at the Science Museum in central Bangkok forged a new and growing relationship between RAST and the Education Department of the Ministry of Education which administers the museum. Science Museum officials are keen for the society to establish a permanent club station and have offered spacious premises. The society (PO Box 2008, GPO Bangkok) is currently in the process of seeking permission for such a station and arranging for the equipment.

The central location of this proposed station and its planned operation by qualified members on virtually a daily basis should not only help promote the hobby among enthusiasts but should broaden the understanding of the activity among officials concerned with licensing.

Thailand differs from other countries by authorizing non-amateurs restricted use of the 2 metre amateur band. Those authorized must be Thai nationals who have passed a PTT-administered exam in radio theory and operating procedures. Operators known as radio volunteers are assigned a number to be used in conjunction with the two letter "VR" prefix. Contacts are established on the calling frequency of 144.5 MHz. Operators then shift to a clear frequency choosing from 144.6, 144.7, 144.8 or 144.9 MHz. (Repeaters are not authorized.)

The stated objective of VR licence holders is that they "are to act as the eyes and ears of the police". They are to report accidents and other incidents. Some VR operators have even been on patrol with police officers.

For visiting amateurs Thai hospitality may not just stop with a friendly RAST get-together as local Thais or expats often invite guests to see other aspects of lively Bangkok. It's a gesture which nearly always results in providing enough anecdotes and incidents to fill another article with tall tales of Thailand. ●

*WOOD FOR CHIPS ... WOOD FOR CHIPS ... WOOD FOR CHIPS ... WOOD FOR CHIPS ... WOOD FOR CHIPS ... WOOD FOR CHIPS ... WOOD FOR C*

## IBM PRINTER CABLE

Approx 1.5m long with quality connectors on each end. You couldn't buy the parts and make one yourself for the price. Were $22.50 but till current stock is exhausted you can have one for just **$15.00.**

## 10mm JUMBO LEDS

Yes the picture is just about actual size. They're a huge 10mm diameter. They have three legs rather than the usual two because inside there are two Leds to allow you to vary the brightness. Available in red, yellow or green all at **$1.45 each.**

## BOURNS TRIM-POTS

Continuing Geoff's policy of stocking only the highest quality components we have now added a range of Bourns trim pots.

**Rectangular 15 turn type 3006P series $2.20 each.**

**Square 25 turn type 3299W series $2.95 each.**

Both series are available in the following values -

| | | | |
|---|---|---|---|
| 10 ohm | 1k | 25k | 1M |
| 100 | 2 | 50 | 2 |
| 200 | 5 | 100 | 5 |
| 500 | 10 | 200 | |
| | 20 | 500 | |

## *BOURNS TRIM-POT TOOL*

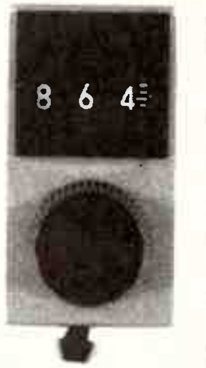
Handy little tool for setting trim pots. It's always hard to find a screwdriver that fits so get one of these drivers. One end has a screwdriver for recessed slots, the other end fits over actuator screws and won't fall off - so you can leave the tool attached in awkard locations while you make other adjustments! At only **$2.00** you'll soon recover the cost by saving time and frustration.

## MULTI-TURN DIALS

If you use multiturn potentiometers you need these beaut Spectrol Dials -

**Model 15, 10 turn digital Multi-Dial** has three digit readout. One turn of the knob gives a count of 100. Resolution is to one fifth of a digit graduations! Measures approx 45 x 25 x 25mm (inc knob). Incorporates lever action locking mechanism. **$36.50**

**Model 16, Multi-turn Dial** has fifty graduations with turns counter which counts up to 15 turns. Only 22mm diameter and 22mm high - ideal for cramped panel layouts! Lever action locking mechanism. **$24.00**



## R. F. CHOKES

An extremely wide range of miniature RF chokes is now available (values are in uH). **All $1.50 each.**

| | | | |
|---|---|---|---|
| 1 | 10 | 68 | 1000 |
| 1.5 | 15 | 100 | 2200 |
| 2.2 | 18 | 180 | 3300 |
| 3.3 | 22 | 270 | 4700 |
| 4.7 | 33 | 330 | |
| 6.8 | 47 | 470 | |

## CONNECTORS

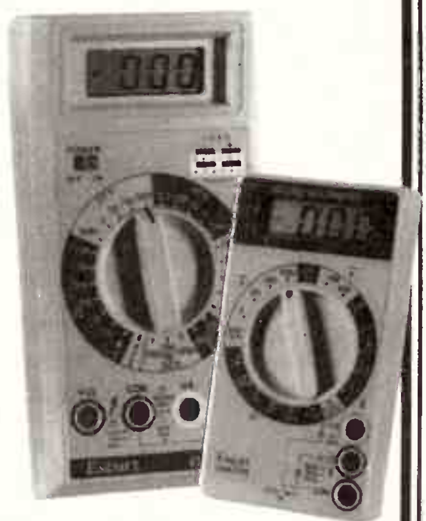
| | |
|---|---|
| **9-Way "D"** | |
| DE9P | **$2.30** |
| DE9S | **$2.40** |
| Backshell | **$2.20** |
| **15-Way "D"** | |
| DA15P | **$2.80** |
| DA15S | **$3.00** |
| Backshell | **$2.20** |
| **25-Way "D"** | |
| DB25P | **$3.05** |
| DB25S | **$3.20** |
| Backshell | **$2.20** |
| **37-Way "D"** | |
| DC37P | **$8.00** |
| DC37S | **$8.70** |
| **50-Way "D"** | |
| DD50P | **$9.00** |
| DD50S | **$9.80** |
| Centronics 36 Solder Male | **$6.45** |
| Centronics 36 Solder Female | **$9.50** |
| Centronics 36 IDC Male | **$10.50** |
| Centronics 36 IDC Female | **$11.85** |

## CRYSTALS

Most popular crystals are available ex-stock. Call us for latest pricing.

## CHECK TRANSISTORS, CAPACITORS AND CURRENT TO 10A

One multimeter does the lot - Vdc from 200mV to 1000V, Vac from 200mV to 750V, Adc from 200uA to 10A, Aac from 20mA to 10A, Ohms from 200ohm to 20Megs, Diodes, Continuity beeper, Capacitance from 2nF to 20uF. Plus measure hFE for PNP and NPN transisitors from 0 to 1000. Single rotary dial for unambiguous range selection. Auto-polarity 3½ digit display. Bright yellow case so you won't lose it! **EDM1111A $118.88 inc. tax ($103.03 ex tax).**



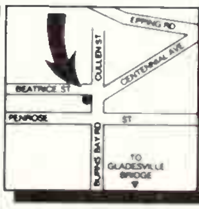
Measures only 126mm x 70mm x 24mm yet incorporates full 3½ digit multimeter including a continuity buzzer. Single rotary switch for fast convenient operation. Checks diodes too. Measures Vdc from 200mV to 1000V, Vac 200 and 750V, Adc from 200uA to 2A, Ohms from 200ohm to 2Meg. Special 1.5V battery test range with 1mV resolution and a continuity range which beeps when resistance is below 100ohm. Bright yellow case so you can't mislay it!! **EDM-70B $64.40 inc. tax ($55.52 ex tax).**

*8.30 to 5 Monday to Friday, 8.30 to 12 Sat.*
*Mail Orders add $5.00 to cover postal charges.*

***All prices INCLUDE sales tax.***

*Tax exemption certificates accepted if line value exceeds $10.00.*

*BANKCARD, MASTERCARD, VISA, CHEQUES*



## GEOFF WOOD ELECTRONICS P/L
INC IN NSW

**(02) 427 1676**

229 BURNS BAY RD.
(CORNER BEATRICE ST.)
LANE COVE WEST N.S.W.

TWX 71996
P.O. BOX 671
LANE COVE N.S.W. 2066

*OR CASH CHEERFULLY ACCEPTED*

***specialising in electronic components for the professional and hobbyist.***

... WOOD FOR CHIPS ... WOOD FOR CHIPS ... WOOD FOR CHIPS ... WOOD FOR CHIPS ... WOOD FOR CHIPS ... WOOD FOR CHIPS ... WOOD FOR CHIPS ... WOOD FOR CHIPS ...

... WOOD FOR CHIPS ... WOOD FOR CHIPS ... WOOD FOR CHIPS ... WOOD FOR CHIPS ... WOOD FOR CHIPS ... WOOD FOR CHIPS ... WOOD FOR CHIPS ... WOOD FOR CHIPS ...

# EXPANDING NEC's PORTABLE

*A modification to the PC-8201A to get the whole of bank #2 with a new IC.*


## Roger Davis

*Roger Davis is with the CSIRO, Division of Tropical Crops and Pastures, 306 Carmody Road, St Lucia, Qld 4067.*


The NEC lap computer, PC-8201A is widely used in Australian agricultural research both for *in situ* data entry via the keyboard and for automatic data logging of instruments via serial data lines or analogue-to-digital converters[1]. Local journalists use it to prepare copy for direct entry to typesetting computers.

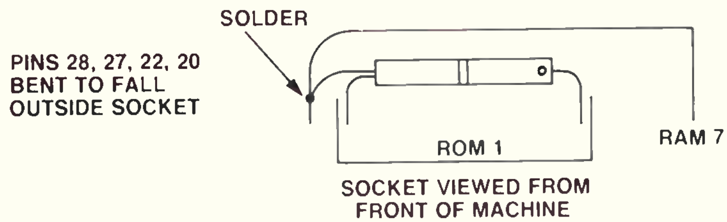



**Figure 1.** Mounting new 32K CMOS RAM in "ROM1" socket with four of its pins bent to fall outside the socket.

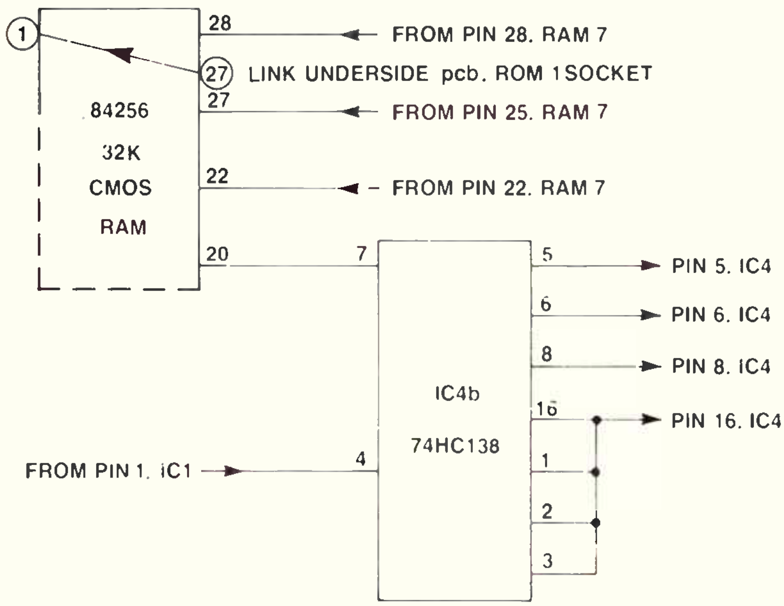



**Figure 2.** Circuit changes to use 32K CMOS RAM in NEC 8201A "ROM1" socket.

The 8201A may access any of three 32K read/write memory banks, but only one bank at a time. It normally comes with only 16K of memory — half of its bank #1. Bank #3 is made as an external plug-in module. Bank #1 and bank #2 may be filled up by plugging in special CMOS memory components (8201-06).

However, the price of a memory expansion unit, a hybrid 8K part, has not fallen in step with other CMOS memory over recent years which makes the expansion of the 8201A more expensive than equivalent systems. The recent release of 32K CMOS memory integrated circuits (84256) at a price lower than that of an 8K hybrid part prompted the development of a modification to allow one of these to provide the whole of bank #2 in a PC-8201A.

The 8K expansion sockets for the NEC 8201 are incompatible with the standard 28-pin JEDEC 8K pin connections and cannot be used with the low cost 8K CMOS memory parts (eg, HM6264) for two reasons. Firstly, the 8201A RAM sockets use 0.7 inch wide pin spacing, and secondly, each one is decoded as four 2K banks. (The 8201-06 memory hybrid consists of four 6117LP memory parts.) However, the 8201A has a spare socket for a second 32K ROM which does use standard JEDEC pin connections. By bending four of its pins so that they fall outside the socket (see Figure 1) prior to plugging in a 32K CMOS RAM (eg, 85256), the bank #2 32K can operate in the ROM socket. Vcc must be supplied from the standby power line as supplied to the other RAM sockets. RAM #7's lines for Vcc (28), WE-(25) and OE-(22) can be used by linking across to the 84256 pins 28, 27 and 22 respectively.

Under the pcb, A14 is linked across from its pin 27 on the ROM to pin 1 for the RAM. The 84256 CE-(20) signal is obtained from a new circuit which gates the bank #2 enable line with a memory enable line (E) which is low during power-down and with the IO/M-line. The most convenient way to provide this CE-signal without cutting any tracks is to mount a 74HC138 above an existing 74H138 (U4). This facilitates the connections to the required signals to control the new bank #2.

The new IC is to be designated U4B and only its pins 5, 6, 8, and 16 are soldered down to the original U4. Pins 1, 2, and 3 of U4B are connected to Vcc (ie, pin 16). Pin 4 of U4B is linked across to pin 1 of U1 to pick up the IO/M-signal.

Pin 7 of U4B provides the new CE- to be linked using a fine insulated wire (eg, 0.3 mm EnCu) to the new RAM's pin 20 (via a pcb feedthrough hole). The other

pins of U4B may be bent away or chopped off (see Figure 2). For details of the control signals see the full circuit diagram in the NEC service manual.[2]

Current consumption from the internal nicad backup battery increases from approximately 130 μA (bank #1 32K) to approximately 260 μA with both bank #1 and #2 fitted with 32K. This reduces the nominal backup battery life from 14 days to seven days. A fully charged main battery pack will extend the memory backup life by a factor of 10. Connection of the external supply (nominal 8.5 V) will recharge both the backup battery and a main nicad battery whether or not the computer is turned on.

The 8201A does not require that bank #1 be filled in order to use bank #2. Using this method of installing bank #2 is cheaper than filling bank #1 and thus one could use the new bank #2 as a primary memory bank of 32K with only the original 16K in bank #1. A convenient mode of operation may be to use bank #1 for programs and bank #2 for wordprocessing files. By setting the rear switch, PROTECT to ON, bank #2 is write-protected (the WE- line is disconnected from bank #2) and the presence of the extra bank cannot be detected by the software or by the operator.

The cost saving due to using the more recent memory is not without a minor disadvantage. During operation the computer draws 15 mA more when operating in bank #2 than it does when operating in bank #1. However, this difference is similar to the difference in current consumption of two computers (eg, 65-80 and 75-90 mA).

This modification has now been tested on eight machines with complete success. A similar procedure cannot be used to provide bank #3 without actually cutting pcb tracks and modifying the 8201's circuitry which may not be desirable.

*References*


1. Davis R. (1986) "RD35 Digital Voltmeter and solid state scanner designed for use with microcomputers via fully isolated interface," CSIRO Aust Div Trop Crops and Past, Trop Agron Tech, Mem No 44.
2. NEC (1983). *Personal Computer Service Manual PC8201*. NEC Corporation, Tokyo, Japan.

"the highest performance computer design ever published"
ETI Magazine December 1986

# POWER, PRICE, FLEXIBILITY AND COMPATIBILITY IN A 16 BIT KIT. THE AMAZING 1616.

At last a kit computer that sports similar features, specifications and classical design architecture to current PC's.

The 1616 offers the latest microprocessor, loads of onboard memory, expansion slots for your favourite add-ons and more! As well as software with the power to pull all these features together and make the 1616 function as a useful, high performance personal computer priced to suit any budget.

## THE CHALLENGE THAT IS WELL REWARDED.

Built up in easy stages, the 1616 offers a unique insight into the workings of 16 bit computers. Each stage can be tested by diagnostic functions, to ensure correct construction. In its complete form, the 1616 is comparable with today's commercial PC's, or, in partial form, it is perfect for research adaptations.

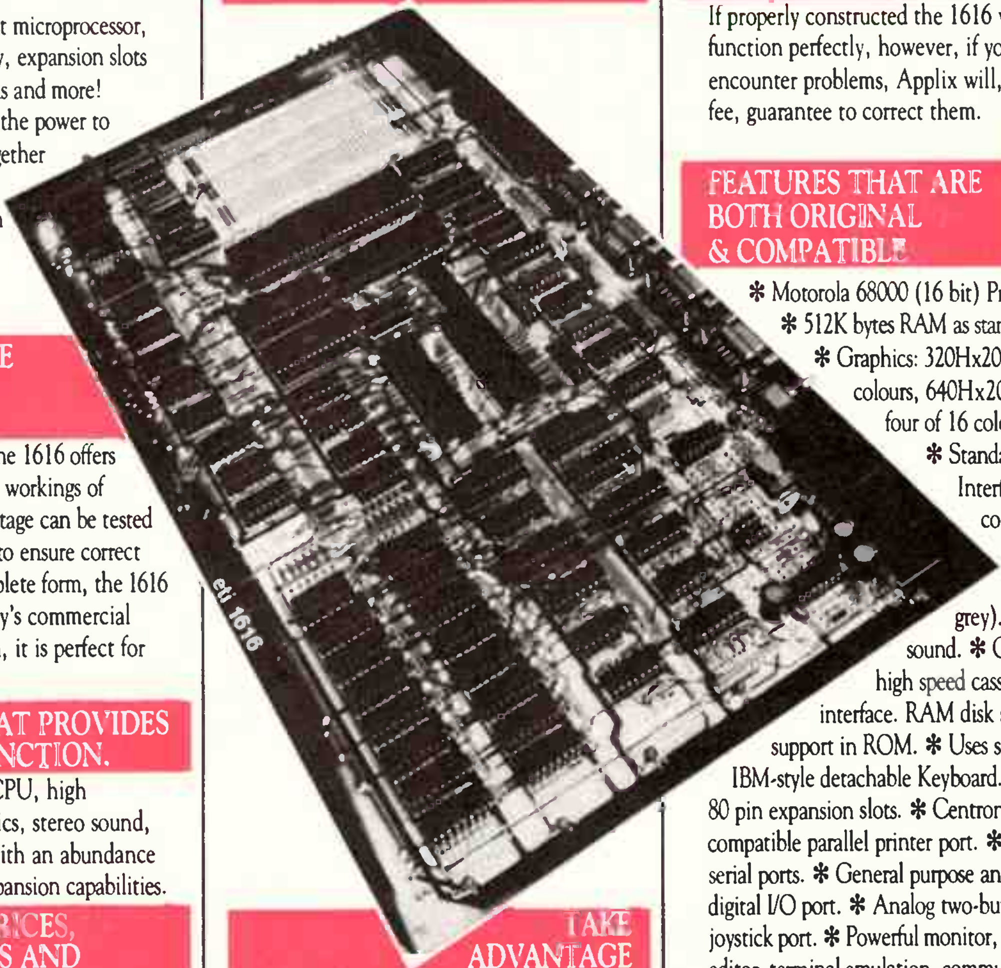
## HARDWARE THAT PROVIDES POWER AND FUNCTION.

Just imagine; a 68000 CPU, high resolution colour graphics, stereo sound, memory and software with an abundance of I/O and unlimited expansion capabilities.

## COMPETITIVE PRICES, TAX INCENTIVES AND FLEXIBLE PURCHASING.

The 1616 is available as a Basic Kit for $449 with the Board, Chips and Components. The Keyboard is $139 and the Power Supply Unit is only $69. Applix can arrange discounts for bulk purchases as well as all necessary tax exemptions for educational and business customers.

## THE 1616 KIT COMES AS A BARE BOARD, A BASIC KIT OR FULLY CONSTRUCTED.




## TAKE ADVANTAGE OF OUR SPECIAL CONSTRUCTION WORKSHOPS

Applix are conducting Construction Workshops for purchasers of the 1616. All areas of constructional techniques, componentry handling and final detailing will be covered in this special one day workshop at a very reasonable cost.

## SORRY, IT DOESN'T WORK! APPLIX GUARANTEES IT WILL!

If properly constructed the 1616 will function perfectly, however, if you do encounter problems, Applix will, for a flat fee, guarantee to correct them.

## FEATURES THAT ARE BOTH ORIGINAL & COMPATIBLE

✻ Motorola 68000 (16 bit) Processor ✻ 512K bytes RAM as standard ✻ Graphics: 320Hx200V 16 colours, 640Hx200V any four of 16 colours. ✻ Standard RGBI Interface or composite video (shades of grey). ✻ Stereo sound. ✻ On-board high speed cassette interface. RAM disk software support in ROM. ✻ Uses standard IBM-style detachable Keyboard. ✻ Four 80 pin expansion slots. ✻ Centronics compatible parallel printer port. ✻ Dual serial ports. ✻ General purpose analog & digital I/O port. ✻ Analog two-button joystick port. ✻ Powerful monitor, full screen editor, terminal emulation, communications, operating system and more.

## CONTACT APPLIX TODAY!

Applix Pty. Limited
324 King Georges Road, Beverly Hills.
P.O. Box 103, Beverly Hills.2209. NSW
Telephone: (02) 758 2688

APPLIX 1616

# 16-BIT COMPUTER Part 3

In part 3 of this project we describe the peripheral parts of the 1616 — the interfacing to keyboard and printer, the analogue input/output and the serial interface. We also begin a discussion of the software.

**Andrew Morton & Paul Berger**

THIS ARTICLE will describe the peripheral parts of the circuit. The major peripheral function devices of the 1616 apart from the video are the keyboard interface, dual serial channels, parallel printer port, cassette port, analogue interface, sound generation, user port and the expansion connectors.

### *The keyboard interface*

The IBM-compatible keyboard produces either 10 or 11 bits of clocked serial output depending upon the style of the keyboard. Schmitt triggers in IC34 clean the noise from the incoming clock and data signals. The leading two or three clock pulses from the keyboard are then discarded by the latches IC53 and IC49 and the remaining eight pulses are used to clock the data into the VIA's internal shift register. Filling this register causes the VIA to interrupt the 68000. Software then reads the incoming data from the VIA and lowers the VIA $\overline{\text{CLRKBL}}$ signal, preparing IC53 to receive the next keycode.

### *The serial interface*

The 1616's standard serial protocol is RS232C which is obtained by loading the serial drivers and receivers IC6-IC9 and linking pins on the serial jumpers. These jumpers may be wired to accommodate differing serial port pinouts. Other communication protocols such as RS422, MIDI and SDLC may be implemented by mounting a peripheral circuit board containing appropriate logic and drivers onto the serial jumper pins.

The 1616's serial interface is implemented using the Zilog Z8530 serial communications controller (SCC). The dual four-to-one data selector IC63 is used to generate the SCC's control signals $\overline{\text{SCCRD}}$ and $\overline{\text{SCCWR}}$ from the MC68000's bus signals. The SCC has no reset pin but is reset by simultaneously lowering both these signals.

The 3.75 MHz signal from the timing PAL is sufficiently close to the desired 3.6864 MHz for it to be used as the baud rate reference for the SCC. This signal is brought to the serial jumpers for this reason.

### *The parallel printer port*

The parallel printer port is a minimal Centronics interface. Characters are written to the 8-bit latch IC1, and the VIA $\overline{\text{CENTSTB}}$ signal is pulsed low to send the data to the printer.

Centronics-type printers send an acknowledge pulse to the host computer when they are ready for new data. This signal, $\overline{\text{CENTACK}}$, is buffered and passed to a VIA interrupt input pin.

The printer also transmits a busy signal which is high when the printer is not ready to receive data. This signal is buffered and passed to the VIA CENTBUSY input.

### *The cassette interface*

The tape recording format is a simple one: a binary 0 is represented by a 200 microsecond cycle and a binary 1 by a 400 microsecond cycle. To save data on tape the VIA is programmed to generate a stream of interrupts which provide the timing, and the VIA $\overline{\text{CLRCASIRQ}}$ signal is raised and lowered at interrupt time to generate the appropriate signal to be recorded.

Upon playback the recorded square-edged signals are greatly smoothed. The LM301 op-amp IC12 is used as a slope detector to cancel the effects of tape recorder bandwidth limitations. The LM319 comparator retrieves the original signal and produces a TTL compatible level.

The monostable IC33 has a timing period of approximately 300 microseconds and is used to decode the pulse-width modulation recording format: if two rising edges from the comparator are separated by less than 300 microseconds (a binary 0) then the monostable output will be low on the second rising edge; if the separation exceeds 300 microseconds then the monostable output will be high. On each rising edge of the output of IC11 during tape reading three things happen:

(1) The IC33 monostable is retriggered, starting the 300 microsecond timer.

(2) The previous output of the monostable is latched in IC32 and presented to the MC68000 via the input port.

(3) The flipflop IC32 is clocked and $\overline{\text{CASIRQ}}$ is lowered, interrupting the MC68000. The $\overline{\text{ECASRIRQ}}$ signal enables these cassette read interrupts. The cassette read interrupt software reads the data bit from the input port and resets the interrupt status by pulsing $\overline{\text{CLRCASIRQ}}$ low, thus presetting IC32.

Because the cassette I/O is software driven it is important that both the reading and writing interrupts be serviced by the MC68000 without any delay. For this reason the $\overline{\text{CASIRQ}}$ signal is put at a higher priority than any other interrupting device. (See ETI February for a discussion of interrupt priority levels.)

During cassette writing $\overline{\text{CASIRQ}}$ is generated by programming one of the VIA's internal timers to produce a continuous square wave on the PB7 pin. The flipflop IC49 is clocked by this waveform and requests the interrupt if the $\overline{\text{ECASWIRQ}}$ (enable cassette write interrupt) signal is low.

A bit on IC18, the analogue multiplexer port, is used to drive transistor Q2 and the relay which software uses to stop and start the cassette motor.

### *Analogue input/output*

The analogue input/output is centred upon the IC20/IC21 8-bit digital-to-analogue converter circuit (DAC). This DAC is used for the following things:

**General purpose analogue output and sound generation.** The dual 4-to-1 analogue multiplexer IC23 switches the buffered output of the DAC onto one of the four holding capacitors C39-C42. Although the voltage held on these capacitors will decay after a period, this technique enables us to produce four analogue signals using one DAC.

**Analogue inputs.** The 8-to-1 analogue multiplexer IC10 selects an input from amongst the joystick potentiometers and the six general purpose inputs and presents it to the comparator IC11. This com- ▶

parator compares the selected input with the DAC's output and a software successive approximations program is used to determine the input voltage level.

*Sound generation*
Sound output is produced by using the DAC to produce audio waveforms on C40 and C41. These are amplified by the dual audio amplifier IC13 and drive loudspeakers. Stereo sound is produced by quickly switching the output of the DAC between the two amplifiers.

The potentiometers RV1 and RV2 control the left and right output signal level and hence also serve as a balance control.

Low-level signals LEFTSIG and RIGHTSIG are available at the speaker connector for connection to audio equipment such as recorders and amplifiers.

*The user port*
The user port is a 34-way connector which makes available the 1616's power supplies, eight I/O pins from the VIA, six analogue inputs, two analogue outputs and an interrupt input. This port permits the user to implement his own control and interfacing projects.

*The expansion connectors*
The four 80-way expansion connectors make available various clock signals, the power supplies and all of the MC68000's signals. They are designed to accept add-on cards such as I/O expansion, disk controllers, memory expansion and coprocessors.

## PARTS LIST — ETI-1616

**Resistors**..................all 5%
R2..........................18k
R3, 6, 7, 17, 18, 19,
22, 28, 31, 36, 37...2k2
R4, 56, 57.............4k7
R5, 41....................10k
R8, 48....................330R
R9..........................68R
R10, 11, 20, 25,
26..........................56k
R12, 13..................15k
R14, 33..................150R
R15, 21, 39............33k
R16, 27, 32, 35,
38..........................1k
R23........................470R
R24........................220k
R29, 30..................120k
R34........................100R
R40........................3k3
R41........................8k2
R42-47, 50-55.......33R
R49........................2k2, 1% (not required if using 41256 RAM)
RV1, 2...................200k trimpot
†RN1.....................1k
RN3, 4, 5, 6............3k3

**Capacitors**
C1, 2, 11, 20, 24,
25, 43, 50, 51, 53,
68, 69, 84, 85, 92,
93..........................10μ tant
C5-13, 17-19, 23,
26, 28-32, 34-42,
44-48, 52, 54-67,
70-83, 86-91, 95....100n monolithic
C14........................390p ceramic
C15........................120p ceramic
C16........................56p ceramic
C21, 22, 27............220μ electro
C33, 93, 94............10n monolithic
C49........................100n greencap

Note that on revision B boards there are 2 x C93. The one located near C94 is the 10n monolithic. The one near C30 is a 10μ tantalum. The kit may be supplied with either low leakage electrolytics or tantalums.

**Semiconductors**
†IC1.......................74LS374 tri-state latch
IC2, 19, 28, 30.......74LS244 tri-state buffer
IC3.........................74LS298 quad 2 MUX with storage
IC4.........................74LS670 4 x 4 resister file
*IC5.......................VPAL 16R8 Video PAL
†IC6, †8.................1489 RS232C line receiver
†IC7, †9.................1488 RS232C line driver
IC10.......................4051 8-channel analogue MUX
IC11.......................LM319 dual high speed comparator
IC12.......................LM301 op-amp
IC13.......................LM377 dual 2 W amp
*IC14.....................MC68000-P10 CPU
IC15.......................6522 VIA
IC16, 18, 20...........74LS374 tri-state octal latch
†IC17.....................Z8530 dual series communications controller
IC21.......................DAC0800 8-bit DAC
IC22.......................LM324 quad op-amp
IC23.......................4052 dual 4-channel MUX
IC24.......................74LS32 quad 2-input OR gate
*IC25, *26.............27256 ROM
IC27.......................MC6845 CRT controller
IC29, 31.................74LS166 8-bit parallel in/serial out register
IC32, 49, 60...........74LS74 dual D-type flipflop with clear
IC33.......................74LS123 dual retriggerable one shot
IC34.......................74LS14 hex Schmitt trigger
IC35-38, 62...........74F153 dual 4-1 MUX
IC39-46, 66-73......41256-15 256 x 1-bit DRAM
IC47, 48, 52, 65.....spare
IC49.......................74F74 dual D-type flipflop with clear
*IC51.....................TPAL 16R8 timing PAL
IC53.......................74LS174 hex D flipflop with clear
IC54.......................74LS04 hex inverter
IC55.......................74LS32 quad 2-input OR gate
IC56.......................74LS148 priority encoder
IC57.......................74LS11 triple 3-input AND gate
IC58.......................74LS08 quad 2-input AND gate
IC59.......................74LS138 3-to-8 line decoder
IC61.......................74LS05 open collector hex inverter
†IC63.....................74F153 dual 4-to-1 MUX
IC64.......................74LS139 dual-to-4 decoder

This description of ICs supersedes the listing published ETI February.

D1, 2......................1N914
Q1..........................BC337
Q2..........................BC327
LED1, 2..................5mm, red

**Miscellaneous**
SW1.......................reset C and K 8168A
SW2.......................4-way DIL
RLY1.....................211-CD005M relay
OSC1.....................30 MHz TTL oscillator
ETI-1616 pcb

**Connectors**
speaker, cassette,
keyboard................pcb mount 5-pin DIN
video, joystick........pcb mount female DB9
power.....................5-way keyed dc power connector
16-way IDC strip
8-way pin strip
shunts to suit strip
†Centronics...........26-way right angle IDC header connector
†user I/O...............34-way right angle IDC header
†serial A, B...........pcb mount male DB9

*Parts preceded by * are in the mini kit supplied by Applix.*

*Parts preceded by † are only in the I/O kit supplied by Applix.*

## Construction

The 1616 is supplied with a construction manual which contains parts lists, circuit diagrams, further circuit descriptions and a step-by-step guide to constructing the project. An oscilloscope is highly desirable, however, a multimeter and a logic probe are sufficient tools for assembling the 1616.

There are basically two ways to build the 1616. The first way is to simply solder in all the components, plug in all the ICs and turn it on. This may at first seem to be the fastest and easiest way. Unfortunately, the chances of the computer working first go are fairly slim. Neither does it provide the constructor with any insight as to how the computer works or how everything fits together.

The second way is called progressive assembly and test (PAT) and is the method described in the 1616 construction manual. PAT involves breaking the construction into a number of small, simple steps. Essentially breaking the 1616's complex circuit into a number of smaller ones. As each step is completed, a number of simple checks are done ensuring that that step is working. If something is wrong it is corrected at this stage before proceeding to the next step. The steps are arranged in such a way that each will only work if the ones preceding it work, so you should never continue onto a step until the previous one works. By constructing the 1616 in this fashion, on completion of the last step everything should work. Also, by breaking the circuit up into a number of smaller ones, it gives a better understanding of how the computer functions.

Initial construction involves visual inspection of the board and components, then soldering in the resistors, IC sockets, capacitors and other discrete components. After verifying that this has been done correctly, the constructor proceeds to load the ICs into the sockets. Only 17 ICs are needed to get the MC68000 executing code from the EPROMs, at which stage the test programs in the 1616 EPROMs are used in concert with the construction manual to finish construction.

The setting of the quad DIL switch connected to IC19 is used by the MC68000 to determine which of the eight in-built test and diagnostic programs are to be executed. Some of the test programs generate waveforms for verifying circuit operation and debugging faulty circuitry whilst others perform internal tests and report their results.

## Software

The 1616's EPROM-based operating system software was written by Andrew Morton, the chief designer of the 1616. The operating system (1616/OS) influences the 'feel' and the capabilities of programs which run under it, hence it has been designed to impose few limitations on the programmer. This software will be used by implementations of other operating systems such as Digital Research's CP/M 68K, GEM and OS-9.

The command line interface philosophy follows the standard scheme (like CP/M, MS-DOS/PC-DOS, UNIX, etc) of typing in commands followed by the arguments appropriate to the command and receiving some response. It is a disk operating system which can run without any disks — cassette tapes are used to load files into the RAM disk and any changed or new files are archived on tape at the end of the session. Commands are provided which make this a very simple operation. The software is designed to support add-on disks, or other devices with which data may be transferred in 512 byte quantities.

1616/OS includes a powerful line editor for entering commands which incorporates full cursor control, last line recall and an undo command. The keyboard's 10 function keys are user-definable and may contain up to 31 characters. When a command containing wildcards is entered the system scans the disk directory and substitutes any matching file names into the command before it is executed; the '*' wildcard matches any group of characters and '?' matches any single character.

When a command name is typed at the command line interface it is compared with the 60 available built-in commands and if it is not found then the operating system searches the disk for a file of that name. If one is found and it is executable, it is loaded into memory and executed. If the file is a text file its contents are exe-▶

### 6522 VERSATILE INTERFACE ADAPTOR

The 6522 Versatile Interface Adaptor (VIA) is a very flexible I/O control device. Control of peripherals is handled primarily through two 8-bit bidirectional ports. Each line can be programmed as either an input or output. Several of the I/O lines can be controlled directly from internal interval timers for generating square waves or for counting externally generated pulses. To facilitate control of the many features of this chip, an interrupt flag, interrupt enable and a pair of function control registers are provided.

FEATURES:

★ Two 8-bit bidirectional I/O ports.
★ Two 16-bit programmable timer/counters.
★ Serial data port.
★ Expand handshake capability allows positive control of data transfers.
★ Latched input and output registers.

### Z8530 SCC SERIAL COMMUNICATIONS CONTROLLER

The Zilog Z8530 SCC is a dual-channel, multiprotocol data communications chip. The SCC functions as a serial-to-parallel, parallel-to-serial converter/controller. The SCC can be software configured to satisfy a wide variety of serial communications applications. The device includes on-chip baud rate generators, digital PLLs and crystal oscillators that help reduce the need for external logic.

FEATURES:

★ Two independent, 0 to 1 Mbit-second, full duplex channels, each with separate baud rate generation and digital PLL for clock recovery.
★ Asynchronous mode with 5 to 8 data bits and 1, 1.5 and 2 stop bits per character; programmable clock factor; break detection and generation; parity, overrun, and framing error detection.
★ Synchronous mode with internal or external character synchronization on one or two synchronous characters and CRC generation and checking.
★ SDLC/HDLC mode with frame level control, automatic zero insertion and deletion, 1-field residue, abort, CRC generation and SDLC loop back.
★ Local loopback and auto echo modes.

### BUILDING THIS KIT

The 1616 computer has been designed from the very beginning to be as simple to build as possible. We have tried to make the circuit as clean and reliable as possible. It is expected that you have constructed electronic kits before and/or have experience in digital electronics at either a hobbyist or professional level. If you are a complete beginner it might be best to try a smaller project first or make arrangements with a friend to help you just in case you get into trouble.

CONSTRUCTION WORKSHOPS:

If you need a little hand-holding, you may wish to take advantage of the construction workshops conducted by Applix. Please contact Applix, 324 King Georges Rd, Beverly Hills, 2209, (02) 758-2688, for further details.

'FIX IT' GUARANTEE:

If your built up 1616 fails to operate and you can not troubleshoot the fault(s) you may wish to take advantage of the Applix 'Fix It' guarantee. Our technicians will check and repair your 1616 as required, for the flat fee of $150. This fee includes any necessary component replacements, etc, that may be have been damaged during or after construction. Your 1616 must be unmodified and must be constructed using decent IC sockets to use the 'Fix It' service. If a kit is so badly constructed as to make repair impossible we reserve the right to return the computer and the service fee, in the condition received. The 'Fix It' fee only covers the actual computer. It does not cover your power supply, keyboard, expansion boards, etc. It is 'Fix It' service only, not a construction service. We want to see your 1616 working as much as you do!

BUILT AND TESTED:

If you feel you are not capable of building the 1616 and are not interested in the construction workshops you may wish to return the kit in its original condition and purchase a built and tested 1616 or arrange a refund. We can not accept a return once construction has commenced, if any of the component packs have been opened, or if the kit or cartons have been damaged in any way. Please contact Applix concerning pricing of the built and tested 1616 and returns procedure.

cuted in batch mode — parameters from the original command line are substituted into wildcard symbols in the text file and the resulting commands are presented to the command interpreter.

The command interpreter supports input/output redirection. This is a powerful feature which sets up the input source and output destination of the invoked command. A concept which must be understood is that of standard input and output. Most programs and built-in commands will obtain input from standard input and send output to standard output. Usually these will correspond to the keyboard and the VDU, however, the program does not know (and does not need to know) what physical devices these correspond to — this is up to the user who typed the command.

Standard input and output are reassigned to either I/O devices or disk files in the normal UNIX manner of using the '<' and '>' signs. Physical I/O devices require a character device driver program to be installed in the 1616's memory before they may be used. A character device driver is identified by a name followed by a colon; the character device drivers available when the 1616 is powered on are:

**CON**: This driver obtains input from the 1616 keyboard and sends output to the VDU.

**SA:** The SA: driver obtains input from and sends output to serial channel A.

**SB**: The SB: driver obtains input from and sends output to serial channel B.

**CENT:** This driver directs output to the parallel printer port.

As an example let us suppose that we have a program for converting characters from lower case to upper case which resides in the RAM disk file 'toupper'. This program should read characters from standard input, convert them to upper case and then write them to standard output. If we wish to use this program to convert characters coming into serial port A into an upper case file called 'myfile' we would type:

toupper <sa: >myfile

The command executor first redirects standard input to the SA: driver and opens a file called 'myfile' and directs standard output to it, then executes toupper.

It is possible to direct standard output to append characters to a file, rather than creating a fresh one by using the '>>' redirection command.

Next month we will discuss the software including system calls, the full screen editor, the Assembler and 1616/OS commands in detail as well as some sneak previews of the latest developments . . . Gosh, this is exciting!

## EXPANSION CONNECTOR PINOUT:

| Pin # | Name | Description |
|---|---|---|
| 1-2 | Com | System common ground. |
| 3-4 | +5 V | +5 V power supply. |
| 5-6 | +12 V | +12 V power supply. |
| 7-8 | −12 V | −12 V power supply. |
| 9-24 | D0-D15 | Data bus (D0-D15). Bidirectional, three-state data bus. |
| 25 | AS | Address strobe. This signal indictes that there is valid data on the address bus. |
| 26 | UDS | Upper data strobe. This signal indicates that valid data is available on data bus bits D8-D15. |
| 27 | LDS | Lower data strobe. This signal indicates that valid data is available on data bus bits D0-D7. |
| 28 | R/W | Read/write. This signal defines the data bus transfer as a read or write cycle. It also works in conjunction with UDS and LDS. |
| 29 | DTACK | Data transfer acknowledge. This pin is used by expansion boards to determine when another board or the main board has responded. |
| 30 | EXTDTACK | External data transfer acknowledge. This open collector signal is used by expansion boards and indicates that the data transfer is completed. When the processor recognizes EXTDTACK during a read cycle, data is latched and the bus cycle terminated. When EXTDTACK is recognized during a write cycle, the bus cycle is terminated. |
| 31 | BG | Bus grant. This output indicates to all other potential bus master devices that the processor will release bus control at the end of the current bus cycle. |
| 32 | BGACK | Bus grant acknowledge. This input indicates that some other device has become the bus master. |
| 33 | BR | Bus request. This input is wire ORed with all other devices that could become bus masters. It indicates to the processor that some other device desires to become the bus master. |
| 34 | HALT | Halt. When this bidirectional line is driven by an external device, it will cause the processor to stop at the end of the current bus cycle. When the processor has been halted using this input, all control signals are inactive and all three-state lines are high impedance. When the processor has stopped executing instructions, such as in a double bus fault condition, the HALT line is driven by the processor to indicate to external devices that the processor has stopped. |
| 35 | RESET | Reset. This bidirectional line acts to reset the processor in response to an external reset signal. An internally generated reset (result of a RESET instruction) causes all external devices to be reset with the internal state of the processor unaffected. A total system reset results from external HALT and RESET signals being applied at the same time. |
| 36 | VMA | Valid memory address. This output is used to indicate to M6800 devices that there is a valid address on the address bus and the processor is synchronized to enable (E) signal. |
| 37 | E | Enable. This signal is the standard enable signal common to all M6800 devices. The period for this output is ten MC68000 clock periods (six low; four high). |
| 38 | VPA | Valid peripheral address. This signal indicates to expansion boards that the device or region currently being addressed is an M6800 family device. |
| 39 | BERR | Bus error. This input informs the processor that there is a problem with the cycle currently being executed. |
| 40 | IPL2 | Interrupt control (IPL2, IPL1, IPL0). These input pins indicate the encoded priority level of the device requesting an interrupt. |
| 41 | IPL1 | |
| 42 | IPL0 | |
| 43 | FC2 | These function code outputs indicate the state and cycle type currently being executed and are valid whenever AS is active. |
| 44 | FC1 | |
| 45 | FC0 | |
| 46-68 | A23-A1 | Address bus (A23-A1). This 23-bit, unidirectional, three-state bus is capable of addressing eight megawords of data. It provides the address for bus operation during all cycles except interrupts. |
| 69 | STARTUP | Start up. Power on jump signal for use with expansion cards. |
| 70 | EXTVPA | External valid peripheral address. This input indicates that the device or region addressed is an M6800 family device and that the data transfer be synchronized with the enable (E) signal. This input also indicates that the processor should use automatic vectoring for an interrupt. |
| 71 | EIRQ0 | External interrupt request. These decoded inputs are used by expansion boards to generate interrupts. The level of the interrupt is determined by the setting of the 'INT LEVEL' straps on the main board. |
| 72 | EIRQ1 | |
| 73 | EIRQ2 | |
| 74 | EIRQ3 | |
| 75-76 | +5 V | +5 V power supply. |
| 77-78 | Com | System common ground. |
| 79 | CLK | Clock. 7.5 MHz system clock. |
| 80 | 30M | 30 MHz clock. |

```
ØØØØ1 REM12345678901234567890123456789012345678901234567890123456
ØØ1ØØ FORA=2309TO2351
ØØ11Ø READB:POKEA,B:NEXTA
ØØ12Ø DATA 33,Ø,24Ø,62,64,14,16Ø,113,35,61,32,251,33,192,243,62,64,113,35,61,32,
251,17,64
ØØ13Ø DATA Ø,221,33,63,24Ø,62,15,221,113,Ø,221,113,1,221,25,61,2ØØ,24,244
ØØ14Ø CLS
ØØ15Ø CURS1Ø,2:PRINT"IMAGINE HAVING TEXT ON THE SCREEN AND A BORDER"
ØØ16Ø CURS2Ø,4:PRINT"THAT CONTINUOSLY CHANGES"
ØØ17Ø FORA=ØTO255
ØØ18Ø POKE2315,A
ØØ19Ø S=USR(23Ø9)
ØØ2ØØ NEXTA
ØØ21Ø GOTO17Ø
```

## Titleblock

This is a short machine code routine that produces an outlined screen. The outline is programmed by POKEing the numerical value of the character into position 2315. The machine code routine is listed here with a simple example of the routines function.

The routine is placed in the REM statement of line one so make sure the line is typed as it appears.

**G. Heathcote**
**Inglebum, NSW**

```
ØØØØ1 REM12345678901234567890
ØØ1ØØ FORA=23Ø9TO2328
ØØ11Ø READB:POKEA,B:NEXTA
ØØ12Ø DATA 33,Ø,24Ø,1,Ø,4,126,254,16Ø,32,2,54,71,35,11,12Ø,177,32,243,2Ø1
ØØ13Ø CLS
ØØ14Ø CURS15,1:PRINT"/ / / / / / / / / / / / / "
ØØ15Ø CURS15,2:PRINT"/  THINGS CAN CHANGE  /"
ØØ16Ø CURS15,3:PRINT"/ / / / / / / / / / / / / "
ØØ17Ø POKE2317,47:POKE2321,92:S=USR(23Ø9)
ØØ19Ø POKE2317,92:POKE2321,47:S=USR(23Ø9)
ØØ21Ø GOTO17Ø
```

## Character change

This is a very handy machine code routine because it changes a certain character on the screen to another character. The different characters are easily POKED into different positions in the routine. Uses of the routine are varied but the most suited use is the quick changing of PCG characters from one type to another. A simple example is shown here after the routine. The example prints a heading and then changes the border continuously.

The positions to poke are as follows:

*POKE 2317,xx* (change character xx)

*POKE 2321,yy* (to character yy)

To run the machine code routine type *S=USR(2309).*

**G. Heathcote**
**Inglebum, NSW**

## Minimart



**READER SERVICES:** All enquiries regarding back issues, photocopies of articles, artwork or technical enquiries must be directed by mail to ETI Reader Services, PO Box 227, Waterloo, NSW 2017. Enclose cheque or money order to the appropriate value with your request. Relevant charges including postage within Australia and New Zealand are: back issues $4, photostat copies $4 per article or $8 if project spreads over more than one issue, artwork $5 per board or panel up to 10 $cm^2$ or equivalent, $10 for larger boards.

**TECHNICAL ENQUIRIES:** No enquiries by telephone will be accepted. Readers have two options: to submit a written enquiry with $5 money order or cheque and receive a postal reply, this service is limited to projects published within the last five years, alternatively they may forward enquiry without money and expect a published reply in the Feed Forward columns at the editor's discretion.

**GENERAL INQUIRIES:** For all inquiries about back issues, subscriptions, photocopies of articles, artwork or submitting articles, call (02) 663-9999 or write to ETI Reader Services, 180 Bourke Rd Alexandria, NSW 2015 (PO Box 227, Waterloo, NSW 2017).

**CONTRIBUTIONS:** Submissions must be accompanied by a stamped, self-addressed envelope. The publisher accepts no responsibility for unsolicited material.



**LIABILITY:** Comments and test results on equipment reviewed refer to the particular item submitted for review and may not necessarily pertain to other units of the same make or model number. Whilst every effort has been made to ensure that all constructional projects referred to in this edition will operate as indicated efficiently and properly and that all necessary components to manufacture the same will be available, no responsibility is accepted in respect of the failure for any reason at all of the project to operate effectively or at all whether due to any fault in design or otherwise and no responsibility is accepted for the failure to obtain any component parts in respect of any such project. Further, no responsibility is accepted in respect of any injury or damage caused by any fault in the design of any such project as aforesaid.

## Letters to the Editor

### COMPUTER WARE FOR JAILS

I AM CURRENTLY undertaking a computer programming diploma in order to improve my employment prospects prior to my probable release from prison in October 1987.

While I am able to do this using my own computer system there are many other prisoners who have no such opportunity to take similar steps to ensure their employability after their release.

Since this is a minimum security prison it has a higher proportion of prisoners who are nearing the end of their sentences and who will be released into the community in the near future. But unfortunately, because this is a prison 'farm', it has very limited educational resources of any kind — let alone for computer studies — and it seems there is little prospect of the Government being able to 'invest' in such resources in the near future (no votes in jails).

It is for this reason that I am now setting up a computer studies facility in the prison with the assistance of another prisoner/programmer.

We intend to run Computer Awareness Seminars for the other prisoners who pass through here, and to provide as much as possible in the way of hands-on study facilities so that people willing to make the effort will have the opportunity to do so.

*Computing Australia* ran an article on our efforts some time ago (and plans a follow up photo spread) which has helped to some extent with our efforts, but we are still in need of many items if our centre is to be a success.

We are still in need of hardware and systems, disc drives and tape recorders, (anything from old TRS80s to IBM clones are usable as far as we are concerned), not to mention software for Amstrad/IBM systems. So far we have one clone (from SCA) coming; a Macintosh (from YACRO); and my Amstrad; (we are trying to get a IIe, a Commodore, and some Amstrad systems). We have a population here of approximately 80 inmates (and rising) so we will need sufficient systems to allow multi users, and the software/reference publications to match. At the moment we are still in dire need of suitable programs and/or literature for Apple, Amstrad and IBM.

If you can assist us in any way we will be most grateful, and you will be helping to ensure that at least some prisoners will leave here as contributing members of society rather than as potential re-offenders.

**Gary Greaves**
**HM Prison Dhurringile, Vic**

### MORE PRECISION ON OTDRs

YOUR ARTICLE ENTITLED "Reflectometers", on the optical time domain reflectometer (OTDR) in the October edition is somewhat misleading, as it suggests that a fault cannot be located to a precision better than 25 m. This is not the case. The term "resolution" as used in the article refers to the "minimum separation distance between two localized features, such that the reflections of each are distinguish-

```
1000 OPEN4,4
1010 X=0:Y=0:C=160:PRINT"□"
1020 GETA$:IFA$=""THEN1020
1030 IFA$="◘"THENY=Y+1:REM CRSR DOWN
1040 IFA$="▔"THENY=Y-1:REM CRSR UP
1050 IFA$="▌"THENX=X-1:REM CRSR LEFT
1060 IFA$="▐"THENX=X+1:REM CRSR RIGHT
1070 IFA$="*"THENC=102
1080 IFA$="P"THENGOTO 1400
[illegible]

READY.
```

### Screen position plotter

This utility allows you to draw a lo-res design, picture, diagram or shape on the screen, using the cursor keys for movement and the * key to draw. When you have finished, pressing *P* will tell the Commodore to dump your design to the printer, as numbers, which can then be used in data statements in a program, in the form:

10 READ I:POKE 1024 + I, (character code)

It is useful for those who prefer to POKE their designs rather than print them.

**J. Vella**
**Tregear, NSW**

```
100 REM VOLTS ON CAPACITOR AFTER T SECS
105 REM FOR COMMODORE 64
110 REM H.W.BRYANT.
115 REM VC = VS(1-E↑-T/CR)
120 PRINT"□"
125 PRINT"CHARGE OR DISCH? 0=CHG 1=DIS"
130 INPUT X
140 PRINT "ENTER MICROFARADS";:INPUT C
150 IF C = 0 THEN END
160 PRINT "ENTER MEGOHMS";:INPUT R
170 A=C*R
180 PRINT "ENTER SECONDS";:INPUT T
200 B=(-T/A)
210 H=EXP(B)
220 E=1-H
230 PRINT "ENTER VOLTS";:INPUT V
250 G=V*E
260 IF X=1 THEN G=(V-G)
265 PRINT"CAPACITOR VOLTS=";G
270 PRINT"RERUN? YES=1 NO=0";:INPUT Z
280 IF Z=1 GOTO 120
290 IF Z=0 THEN END

READY.
```

### Charging voltage on a capacitor

The program is written for the Commodore 64 and is used to calculate the voltage on a capacitor in a charging or discharging circuit.

**H.W. Bryant**
**Albany, WA**

able". This is a completely different issue from the location of a single fault.

When fault finding, accurate and precise location of a single feature on the OTDR trace is required. The location of any feature on the OTDR trace is given by its leading edge. This result is independent of the pulse width. As the OTDR trace is obtained using digital sampling techniques, the precision to which this leading edge can be measured, is set by the distance between successive sampling points. Currently available third generation OTDR's feature sampling intervals down to 0.5 m, enabling location of a trace feature, such as a fault, to this precision.

**P. Skopakow**
**Fitzroy, Vic.**

### HELP REQUIRED ON SPEECH INTERFACE

I OWN AND operate Axent Recording Studio at Kogarah, NSW and have worked as a recording engineer for 12 years. I am a blind person and generally have no trouble operating the equipment, with most of it being off-the-shelf items requiring little modification. I use light sensing probes with audible output to read LEDs and indicate recording level. The studio is automated and the computer uses a Votracs voice unit to output whatever is displayed on the screen.

I am now striking a problem with the newer types of equipment coming from some of the Japanese manufacturers. On such things as reverb units, delay lines, sequencers and synthesizers, they are using screen displays to indicate functions and parameters which in itself is a bit of a nuisance, but more importantly they are using multi function buttons and alpha dials which do not give any mechanical indication to the user as to their position. Working with the more traditional knobs and switches I can gauge the position through touch which then tells me what function and what parameter is currently being used.

I need to find a way to interface a speech unit to such devices. I do not expect the problem to get better. I think that this change in equipment design is going to become more prevalent, and in time take over with the emergence of the all digital studio. I am writing to ask whether you or your readers could suggest an individual or a company which may be able to undertake this work for me. I am able to obtain the operational data and software information for the speech unit. I have spoken with both Roland and Yamaha and they are happy to make available software and hardware information on their particular products to assist.

Any information would be greatly appreciated.

**Ross McGregor**
**Kogarah, NSW**

*Any reader interested in working on this project should contact the writer on (02) 587-7946 in the first instance.*

*— Ed*

## Easy delete

Usually the only way to erase a line of a program is to type that line number and press RETURN. This is OK if you only have to erase a few lines. But what if you have to erase a lot of lines?

Let us say that you have a program numbered from 5 to 100 in increments of 5, and you want to delete lines 25 to 65. There are two methods to achieve this.

The first is to type *25* and RETURN, then type in *30* and RETURN and so on.

The second method is a lot faster. Type in:

*POKE774,0:LIST 25 — 65* and RETURN.

Only the line numbers from 25 to 65 will appear. Now using the cursor keys, move the cursor to line 25 and press RETURN. Keep pressing RETURN until you have passed line 65.

Now type in:

*POKE774,26:LIST* and RETURN

Your program appears (lines and program) minus lines 25 and 65. You have erased them.

**J. Vella**
**Tregear, NSW**

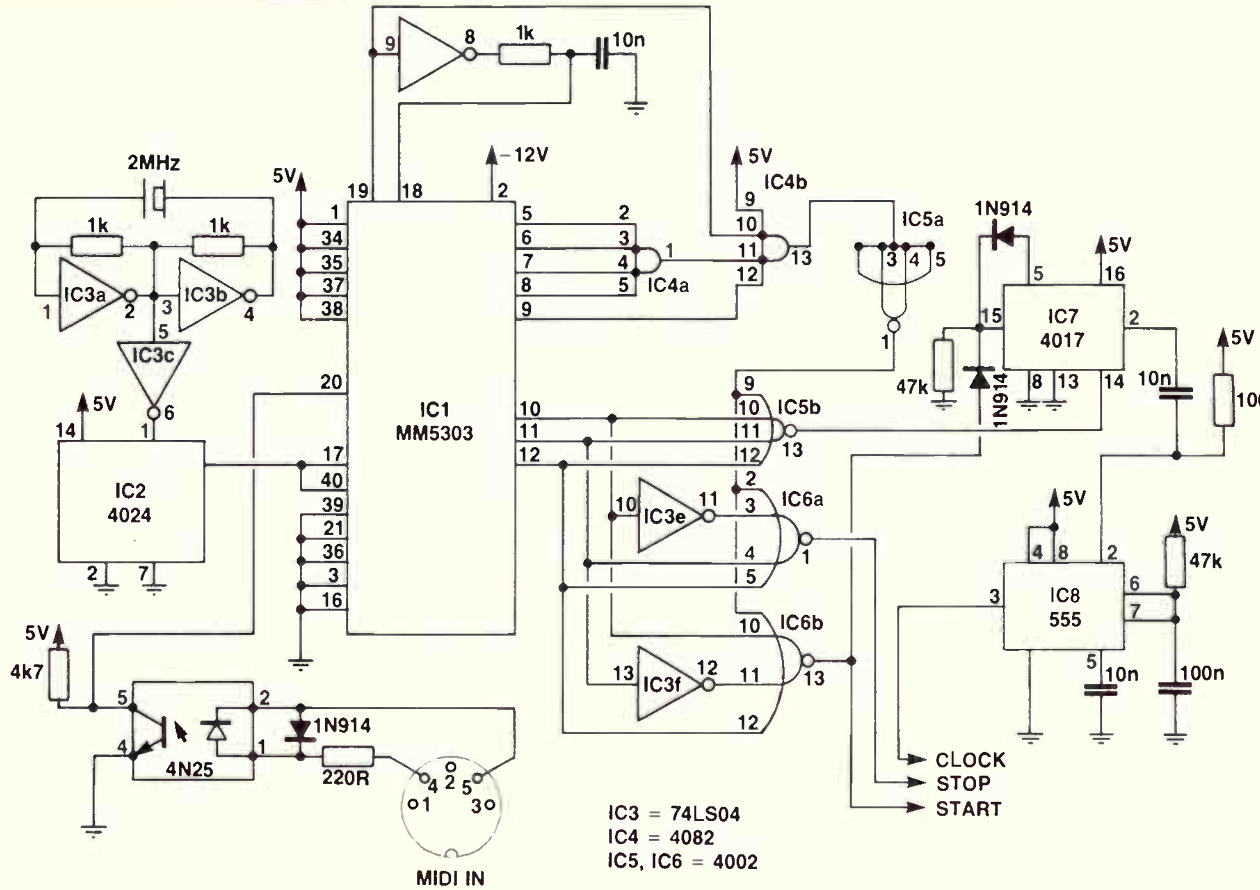
```
5 POKE53280,14:POKE53281,6
10 PRINT"[illegible]------------------------------------."
20 PRINT"I";SPC(37);"I"
30 PRINT"I";SPC(37);"I"
40 PRINT"I";SPC(37);"I"
50 PRINT"I";SPC(37);"I"
60 PRINT"I";SPC(37);"I"
70 PRINT"------------------------------------"
71 PRINT"[illegible]LR HOME = CLEAR GRID"
72 PRINT"DEL        = DELETE CHARACTER/BACKSPACE"
73 PRINT"RETURN     = GOTO NEXT LINE"
74 PRINT" WHEN CURSOR REACHES END THE  PRINT ?    PROMPT WILL APPEAR."
80 PRINT"[illegible]"
90 GETA$:IFA$=""THEN90
91 IFA$=CHR$(13)THENPRINT" ":PRINT"[illegible]":L=INT(P/37):P=(L+1)*37:GOTO120
92 IFA$=CHR$(34)THEN90
93 IFA$=CHR$(20)[illegible]THENPRINT"[illegible]":IFP/37=INT(P/37)THENPRINT"[illegible]":
94 IFA$=CHR$(20)[illegible]THENPRINT"[illegible]":P=P-1:[illegible]GOTO110
95 IFA$[illegible]THEN90
100 PRINTA$;"[illegible]":P=P+1
110 IFP[illegible]INT(P/37)AND[illegible]THENPRINT"I":PRINT"[illegible]",
120 IFP>185THEN150
130 GOTO90
150 PRINT"-"
160 PRINT"PRINT ?"
170 GETA$:IFA$=""THEN170
180 IFA$="N"THEN[illegible]
190 GOTO170
200 PRINT"
210 OPEN4,4
220 [illegible]
230 [illegible]
240 [illegible]
250 PRINT#4,CHR$(A);
260 NEXT:PRINT#4[illegible]
270 CLOSE4
280 RUN
```

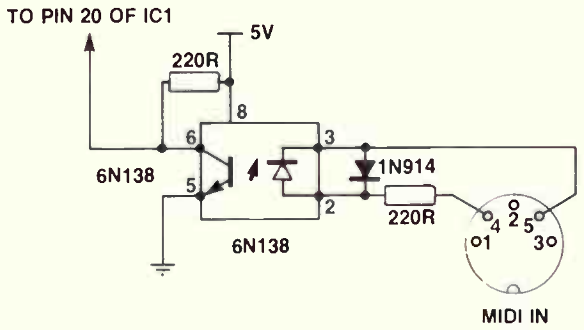
## Label maker

This short but handy program for the Commodore 64 is used with 10 x 3.5 cm labels to produce neat little labels that add a touch of professionalism to your disks — or whatever else you dream up for them.

**F. Mussger, R. Lang**
**Tailem Bend, SA**

## Idea of the Month




*MODIFICATION:*

## MIDI-sync

This circuit was created to synchronize MIDI equipment to non-MIDI equipment using the MIDI real time messages. The only commercially available equipment I have seen that does the same thing costs $150.

IC1, an MM5303, is set up for the MIDI format with 8-bit words, no parity and one stop bit. The baud rate is generated by a 2 MHz oscillator driving a 4024 as a divide-by-two which gives 31.25K baud.

The codes used are:

| D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
|---|---|---|---|---|---|---|---|
| 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 |
| timing clock | | | | | | | |
| 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 |
| start | | | | | | | |
| 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 |
| stop | | | | | | | |

As the D3-D7 bits are all high in the MIDI codes to be used, pins 5-9 of IC1 are ANDed together with the receiver data available output (pin 19 of IC1). This is then inverted by IC5a to work with the NOR logic decoders.

The decoded MIDI timing clock is taken from pin 13 of IC5 and fed into a 4017 which is set up as a divide-by-six to give one-to-one resolution.

The 4017 takes its reset from both itself and pin 13 of IC6. This ensures that pin 2 (the 0 output) of the 4017 is high on the first timing clock which sends pin 2 low and activates the 555. This is done because in MIDI the notes played in a beat coincide with the first timing clock. The 555 gives out a 5 ms pulse which is compatible with many older drum machines.

The stop and start outputs could be converted to give a run 1 stop bit by connecting them to an RS flipflop. A run 1 stop bit is used instead of start and stop in the sync 24 system.

***EDITORIAL MODIFICATION***

The 4N25 used in this idea requires 80 mA input current. MIDI supplies only 5 mA, so we suggest using a 6N138 in line with the modification added to the original diagram.

**Alan Downey**
**Speers Point, NSW**

## Microprofessor 1B memory expansion

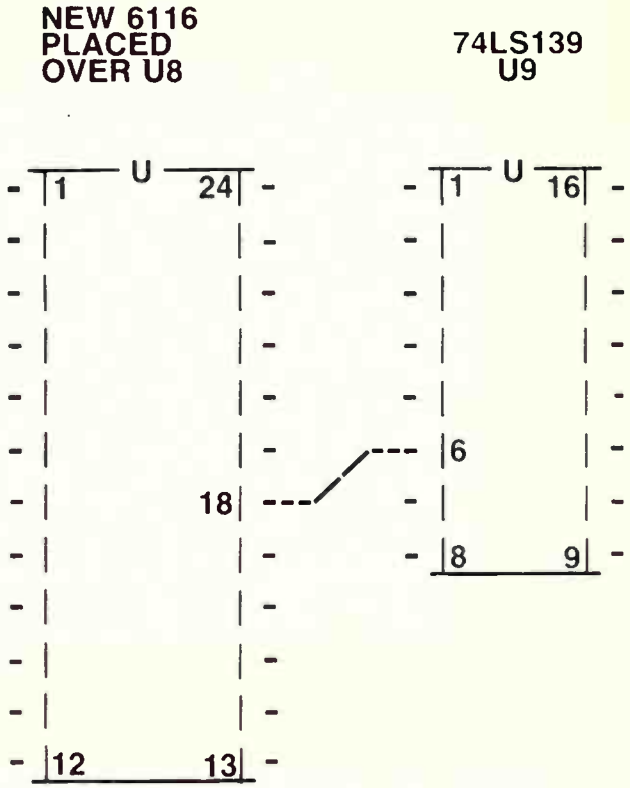
This modification provides an extra 2K RAM memory for the microprofessor 1B system. The requirements are simply an extra 6116 RAM chip and a short length of wire.

Pin 18 of the 6116 is bent out sideways and the chip placed firmly over the initial system RAM chip (U8 in the circuit diagrams). If the pins are bent slightly inwards, they will partially enter the socket for U8, and the new RAM chip will not need to be soldered into place. Then the wire is used to connect pin 18 of the new 6116 to pin 6 of the adjacent 74LS139 decoder chip (U9 in the circuit diagrams). A short length of wire wrapped onto pin 18 of the 6116 and soldered onto the pad at pin 6 of U9 should suffice for this connection. The layout of this modification is shown.

This modification takes advantage of the fact that memory addresses $1000_H$-$17FF_H$ are decoded by U9, but not used in the circuit. This range conveniently is a 2K block, so it can be mapped onto a 6116 RAM chip. Also access to the correct data, address and control lines are provided by simply stacking the new chip onto an existing 6116 chip in the circuit. All that is required is to connect the new RAM chip's select input (pin 18) to the correct output of the decoder, ie, pin 6 of U9.

The new RAM address is therefore $1000_H$-$17FF_H$. This area can then be accessed and used as for other RAM areas, and the ROM monitor will set the default PC to $1000_H$.

**I. Hogan**
**Glen Waverley, Vic**




Feed Forward needs your minds. If you have ideas for circuits that you would like to enter in our idea of the month contest, programs for the computing columns or just want a word with the editor, send your thoughts to:

Feed Forward
ETI, Federal Publishing,
PO Box 227,
Waterloo, NSW 2017

Contributors can look forward to $20 for each published idea/program which should be submitted with the declaration coupon below.

Programs MUST be in the form of a listing from a printer. You should indicate which computer the program is for. Letters should be typewritten or from a printer, preferably with lines double spaced. Circuits can be drawn roughly, because we have a draughtsman who redraws them anyway, but make sure they are clear enough for us to understand.

## 'Idea of the month' contest

Scope Laboratories, which manufactures and distributes soldering irons and accessory tools, is sponsoring this contest with a prize given away every month for the best item submitted for publication in the 'Ideas for Experimenters' column — one of the most consistently popular features in ETI Magazine. Each month, we will be giving away a Scope Soldering Station (model ETC60L) worth approximately $191.

Selections will be made at the sole discretion of the editorial staff of ETI Magazine.


**RULES**

The winning entry will be judged by the Editor of ETI Magazine, whose decision will be final. No correspondence can be entered into regarding the decision.

The winner will be advised by telegram. The name of the winner, together with the winning idea, will be published in the next possible issue of ETI Magazine.

Contestants must enter their names and addresses where indicated on each coupon. Photostats or clearly written copies will be accepted. You may send as many entries as your wish.

This contest is invalid in states where local laws prohibit entries. Entrants must sign the declaration on the coupon that they have read the above rules and agree to abide by their conditions.

**COUPON**

Cut and send to: **Scope-ETI 'Idea of the Month' Contest/ Computing Column, ETI Magazine, PO Box 227, Waterloo NSW 2017.**

"I agree to the above terms and grant *Electronics Today International* all rights to publish my idea/program in ETI Magazine or other publications produced by it. I declare that the attached idea/program is my own original material, that it has not previously been published and that its publication does not violate any other copyright.*"
* Breach of copyright is now a criminal offence.

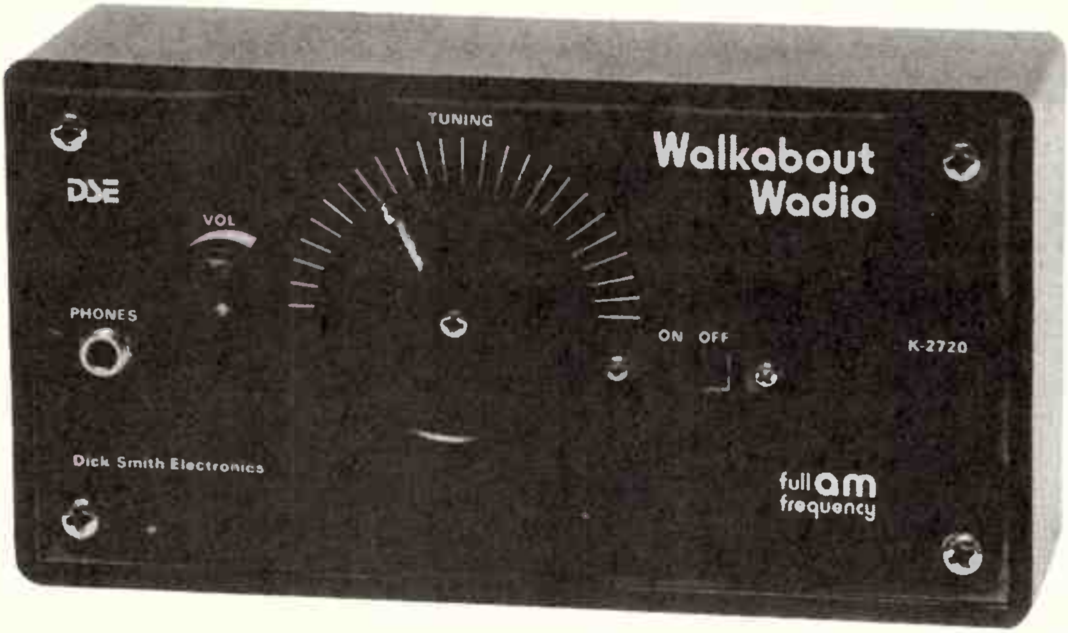
**Title of idea/program** ..............................

**Signature** .............................. **Date** ..............................

**Name** ..............................

**Address** ..............................

.............................. **Postcode** ..............................

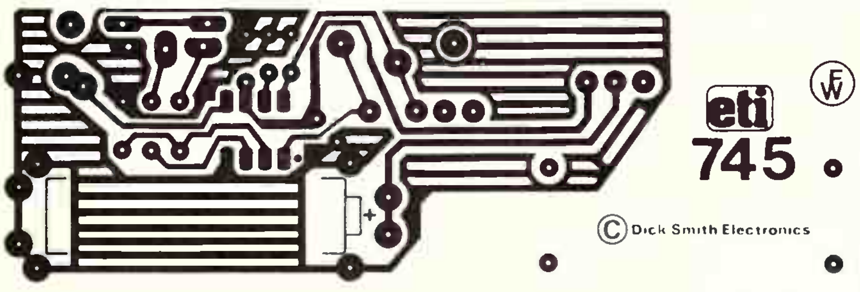



# WALKABOUT WADIO

Want to wisten to Wick Wakeman when walking? Have a whim for Wham while working? Then you need to build this wacky Walkabout Wadio.

**Marshall Gill**

*Marshall Gill is an engineer in the Research and Development section, Dick Smith Electronics.*

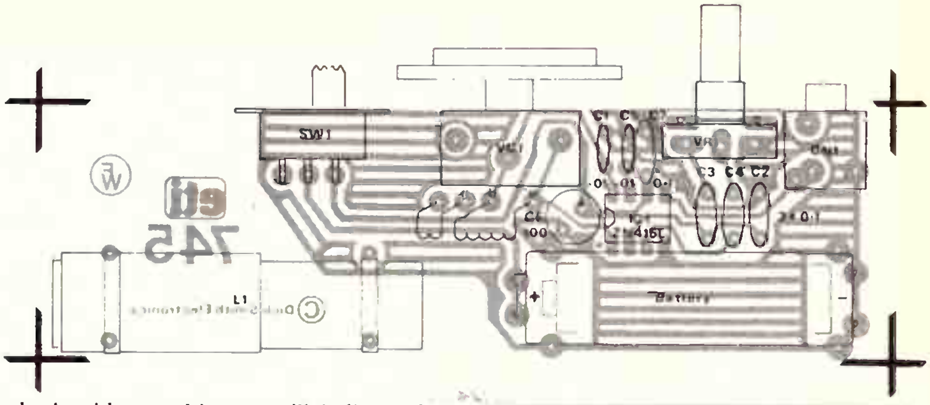



AFTER LISTENING TO FM, AM can be a bit disappointing. It lacks audio frequency response after traversing your radio's circuits. With this little number, you can put stride back into your AM listening pleasure trip. The project is simple, does not cost the earth and is easy to build. It's a good afternoon project that is very rewarding.

The design uses a tuned radio frequency (TRF) system. With this means of reception, the original audio bandwidth transmitted by the station is largely maintained. This receiver does not compress the bandwidth as in the case of conventional superhetrodyne radios.

The power is taken from a single 1.5 volt AA battery so it is completely safe to build and operate. Only a single integrated circuit and a handful of parts are required. The IC is based on the well known ZN414Z but upgraded as a ZN415 to directly drive a pair of 32 ohm headphones, the type used on 'Walkman' portables. You can use existing phones if you have such a system. If not, they can be purchased separately.

The receiver is designed to operate with strong signals from local stations so if you live at the back of beyond, it will not be much good to you other than to keep the flies out of your ears.



## Construction

Load, trim and solder all capacitors as shown. Solder in the IC with the correct orientation. The tuning capacitor leads are bent so that the front edge of the body aligns with the edge of the pc board. The switch is fitted by first soldering three short lengths of copper wire (the pigtails from capacitors) through the contact legs. Now thread these wires through the holes in the circuit board and solder in position so that the front of the switch lines along the edge of the pc board. Fit the four pc board pins to the battery connection points.

Mount the ferrite rod and coil as shown and secure with two nylon cable ties. Allow enough movement so that the rod can still be moved. The ties can be pulled tight after tuning. Terminate the coil leads as shown. The main coil connects across the tuning capacitor. The secondary coil is soldered to the two unconnected pads. This secondary winding of the coil is not used in this application. If you are not sure of the coil connections or the colours are not the same as described, a quick check with a multimeter will indicate the difference. The main coil (largest winding) will measure in the vicinity of 7 to 15 ohms. The secondary will be something like 0.5 to 2 ohms.

Before the volume control is fitted, the shaft should be shortened so that the knob fits almost flush with the panel surface. Use a fine saw to cut it to length, 16 mm to 17 mm from the body. Solder three short lengths of copper wire to the pot connections and bend the lugs around so they mate with the holes in the pc board. Be careful these connections do not short out on the pot position. Thread the three wires into the board. Fix the pot position by soldering the body to the two pc pins and then solder the remaining three wires. Mount the headphone socket so that it fits straight in position and aligns with the pc board edge.

Check all your work. The unit should now be operational. Slip a 1.5 V AA cell into position between the four pcb pins. It will be necessary to slightly bend the pins inward so that contact is made with the ▶

### ETI-745 — PARTS LIST

**Resistors**

| | |
|---|---|
| VR1 | 10k miniature pot 17mm diam |

**Capacitors**

| | |
|---|---|
| C1, 5 | 10n ceramic (0µ01) |
| C2,3,4,7 | 100n ceramic (0µ1) |
| C6 | 100µ 16V RB electro |
| VC1 | 120p mini plastic tuning gang with knobs and screws |

**Semiconductors**

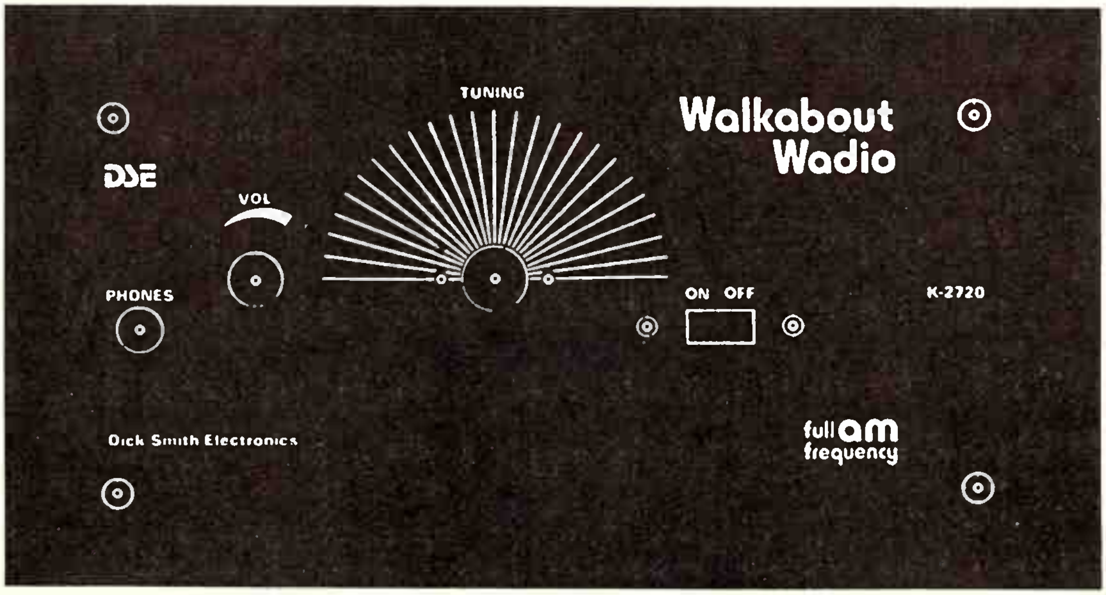
| | |
|---|---|
| IC1 | ZN415E |

**Miscellaneous**

| | |
|---|---|
| L1 | miniature 56mm x 15mm ferrite rod |
| CN1 | 3.5mm pc mount stereo earphone socket |
| SW1 | miniature SPDT slider (with screw hole) |

ETI-745 pc board; 6 x pcb pins; 2 x 75mm miniature cable ties; 1 x 15mm skirt plastic knob; 2 x M2.5x3 RH HP screws; 2 x M2x5 RH HP screws; Scotchcal or other label; 41x68x130mm zippy box.

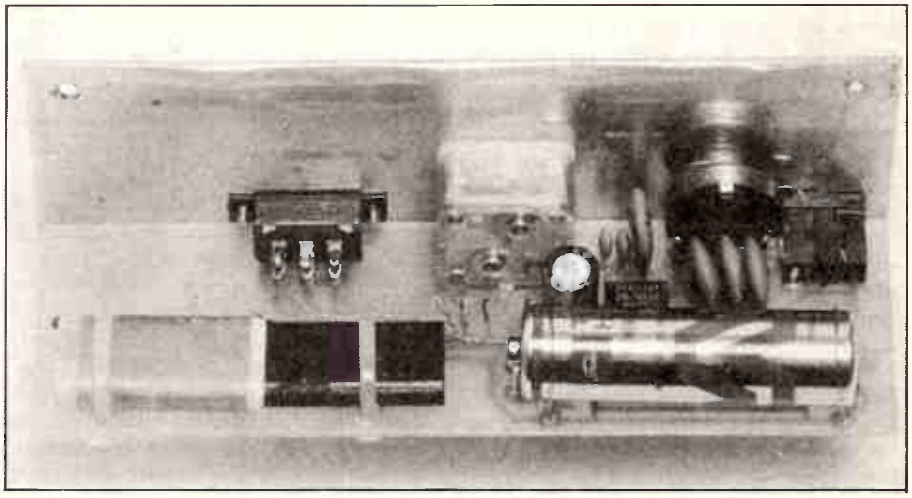
**Price: $19.95**
(not including batteries or earphones)
**available from Dick Smith Electronics**



centre terminal and the end cap. Adjust the pins to achieve a tight fit. Use a small length of tinned or enamelled copper wire threaded through the four holes provided to hold the battery in place. A simple tie under the board is enough to secure the battery position.

Try the receiver with the headphones plugged in and the switch on. It should tune the broadcast band from the high frequency end to the low.

It may be necessary to move the ferrite rod slightly to receive the lowest frequency stations in the band. The coil should be close to the end of the rod as shown in the component overlay diagram. To tune the high frequency end, adjust the lower trimmer capacitor on the tuning gang. If you are lucky enough to have access to an rf signal generator, the tuning range should be between 520 kHz and 1630 kHz. The movement of the rod inside the coil adjusts the low frequency end (the tuning gang plate fully messed) and the trimmer adjusts the high frequency end (the gang plates fully open).



## Fitting the board

The assembly is designed to fit inside a Dick Smith H-2853 Zippy box. The pc board slips into the third groove at each end. No modification of the case itself is required but the front panel has to be drilled. Use the front panel as a template to mark the hole centres. Place the label over the panel so that the edges align. Mark the positions with a sharp scriber, centre punch or similar tool.

Lightly mark only the corners of the switch cutout. Drill the holes as shown. The headphone socket is 6.25 mm, the volume control ferrule is 7 mm, the tuning gang shaft 9 mm, its screw holes are 2.5 mm, the switch screws are 2 mm. Drill a small hole in the switch cutout centre to accept a piecing saw blade and cut the rectangular shape. A needle could be used to dress this hole.

After cleaning all burrs from the holes, carefully stick the label to the front panel. Make sure it is correctly positioned before pressing it down onto the surface. Punch out the holes using the shank of the drill used to originally drill the holes. Use a sharp blade to cleanly cut around the switch cutout.

Place the pcb in the box and fit the front panel. Fix 2xM2.5 screws to the gang, 2xM2 screws to the switch. Fit the knobs. If you wish, mark a white line on the edge of the tuning knob to act as an indicator. ●

### ETI-754 — HOW IT WORKS

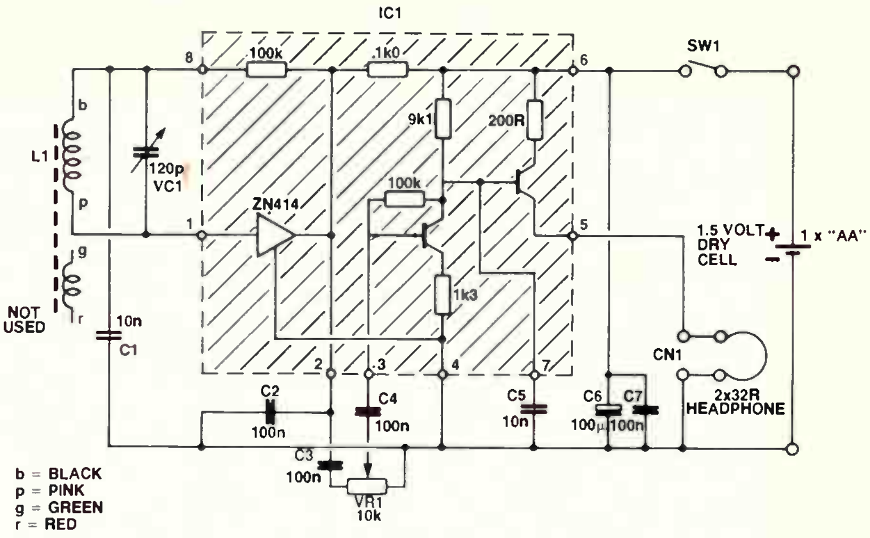
**This simple, high performance circuit is built around the Ferranti ZN415 integrated circuit. The TRF design uses a minimum of components to make an AM receiver. In addition to the ZN414 front end, the ZN415 has an output stage capable of driving headphones. The 8-pin DIL package operates from a 1.5 volt battery.**

**The circuit provides an rf amplifier, detector and agc stage along with an output stage to deliver up to 120 mV into a 64 ohm load.**

**The rf signal is picked up by the ferrite rod and tuned by L1 and the variable capacitor VC1. After several stages of gain at the signal frequency, the modulation is detected and output as audio at pin 2. VR1 provides a volume control and passes the audio to the output stage. The external headphones are driven from pin 5. The individual earpieces are wired in series to achieve the 64 ohms load.**

**The other components around the circuit provide bypass at various points to maintain stability and ac coupling to isolate dc levels at different sections. As the overall gain of the device is very high, component layout is critical. Any modifications to the circuit may result in instability.**

**As the circuit draws less than 3 mA, the battery is likely to last for 12 months or so. By the way, if you are tempted to power the receiver on a higher voltage, resist. Not only will the overall performance drop but it is likely that the IC could be damaged.**



# PASSIVE RADIATOR LOUDSPEAKER SYSTEM

This is the first in a series of three articles that describes the design of loudspeakers. Here we describe how to build a "passive radiator". Never heard of them? . . . Well read on.

Eric Stokes

A PASSIVE RADIATOR (sometimes called an ABR, or auxiliary bass radiator) is a loudspeaker system in which the bass speaker is not driven by an electromagnetic coil. There are two driven elements, a tweeter and a bass midrange, but the third speaker is passive, driven only by the low frequency acoustic energy emanating from the active bass driver. The advantage of this way is that you preserve the simplicity of two-way electronics, while approaching the response of a three-way system.

This article follows design criteria first established by R. H. Small, who developed many of the equations used in this exercise. For a justification of the equations see the reference list at the end of the article. The aim will be to derive a volume (VB) for the interior of the box. The actual dimensions of the cabinet are based more on aesthetics, bearing in mind the physical space requirements of the drivers.

A passive radiator should have two or three times the volume displacement (VD) of the active bass driver and at least the same or better suspension compliance (CMS) to be suitable in the system. Compliance has to do with the rigidity of the speaker system. In the case of CMS it refers to the speaker suspension only. In the case of air volume compliance VAS, it refers to the volume of free air that couples with the speaker diaphragm given its suspension stiffness.

In practice, the diaphragm mass of the passive radiator is adjusted to set the system resonant frequency (FB). This is done by adding mass to the voice coil cavity using some form of epoxy sealant which lowers the resonant point of the radiator. Bass extension is affected when the radiator replaces the decreasing driver output about FB. As a result, a passive radiator has a slightly higher cut off frequency than its vented box counterpart and a faster roll off which approaches a fifth order high pass attenuation rate.

## Testing

Our design is built around two speakers sourced from Jaycar Electronics, and a Philips tweeter. The tweeter is an AD 11610 T8. In our view this tweeter offers the best price/performance combination on the market today. It's readily available, inexpensive and it's a good performer. Power handling is rated at 100 W, more than enough for most amplifiers.

The midrange is a 150 mm clear polypropylene diaphragm speaker, while the passive radiator is 250 mm across, also with a polypropylene diaphragm. Incidentally, these polyprop diaphragm speakers just released by Jaycar are claimed to offer significantly better performance than conventional designs.

No data was supplied with the Jaycar speakers, so the first step was to obtain some figures to answer questions like: What is its bass cutoff frequency? How much program power will it handle? And how loud will it go?

**SPECIFICATIONS FOR 150 mm POLYPROPYLENE DRIVER**

| | |
|---|---|
| Free Air Resonance (Fs) | 43.75 Hz |
| Q of mechanical resistance (QMS) | 2.718 |
| Q of electrical resistance (QES) | 0.547 |
| Total speaker Q(QTS) | 0.437 |
| Air volume compliance (VAS) | 23 litre |

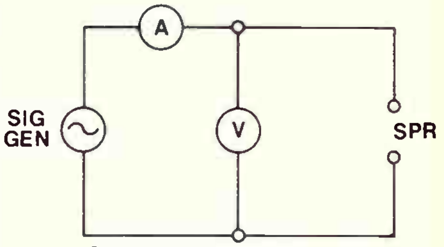



Figure 1. Speaker test circuit.

The first test is the free air test, aimed at ascertaining the characteristics of the driver independently of the enclosure. The first step is to measure the dc resistance of the voice coil, RE, and then to choose a calibrating resistor close to that value, in our case 6.8 ohms. Then connect the circuit as shown in Figure 1. The frequency generator is set close to 40 Hz and RC connected. When the voltmeter showed 1 volt the current Ic was measured. Ie could be calculated by:

$$I_e = I_c \frac{RC}{RE}$$

Replacing RC with the speaker, the minimum current Io was read when the speaker was held away from reflecting surfaces. Ro was calculated from:

$$R_o = \frac{I_e}{I_o}$$

Finally, two frequencies have to be found when the voltage is one volt and the current reads $I_e/\sqrt{R_o}$. The resonant frequency can then be found from:

$$F_s = \sqrt{(f_1 \times f_2)}$$

and the various Qs from:

Q mechanical (QMS)= $\sqrt{R_o} \times \frac{F_s}{f_2 - f_1}$

Q electrical (QES)= $\frac{QMS}{R_o - 1}$

Q total (QTS) $\triangleq \frac{QMS}{R_o}$

The results of this procedure on the Jaycar driver can be seen in a separate box.

The next step is to test for the speaker's volume air compliance in the box. A heavy duty 23 litre plastic bucket was used. The lid was cut off and a chipboard baffle was made. The speaker and baffle were then sealed into the bucket and the speaker lead holes also sealed. The speaker was connected into the test circuit and current determined for a volt reading on the voltmeter. This was $I_{oc}$. $R_{oc}$ can be derived from $I_c/I_{oc}$. F1 and F2 can be determined in the same way as previously, leading to:

$F_c = \sqrt{(f_1 \times f_2)}$

QMC= $\sqrt{R_{oc}} \times \frac{F_c}{(f_2 - f_1)}$

QEC= $\frac{QMC}{R_{oc} - 1}$

QTC= $\frac{QMC}{R_{oc}}$

## The box

Having determined the drivers to be used the next step is to determine the box parameters. Figure 2 shows the alignment graph for vented box systems with typical losses of 7 (typical of passive radiator systems). If total Q is about 0.44 we can see that the box compliance ratio ($\alpha$) is 0.79 and h, the tuning ratio, is unity. We can also read of the cutoff frequency ratio $f_3/f_s$ =0.9.

Knowing the compliance ratio we can now calculate the total internal volume:

$$\frac{VAS}{\propto} = \frac{23}{0.79} = 29 \text{ litres}$$

We need to add one litre for the volume of the crossover and a further fudge factor for the radiator static volume, bringing in a total volume of 31 litres. A suitable box may be made from particle board with internal dimensions 300 × 600 × 170 mm. We used 18 mm board, gluing and screwing all the joints to give it rigidity.

The enclosure's tuned frequency is given by:

$$F_b = h \times F_s$$

which in this case equals 43.73 Hz. The cut off frequency is 39.36 Hz. The closed box resonance frequency FC was found to be 57.13 Hz. $\sqrt{\propto +1}$ was 1.3391 so the sealed box frequency FSB is $\frac{67.13}{1.3391}$=42.66 Hz. The free air Qs were corrected by FSB/FS, so Qe =0.534 $\frac{(0.75+6.3)}{6.3}$=0.597 and QT works out to 0.487. This is close enough to the original calculation, so it was decided not to correct the volume of the box. In any event, the bass lift would only be in the order of 0.5 dB, which you can't hear anyway.

## The radiator

To see how well the design was going we mounted and sealed in the speakers. FL was found to be 40.65 Hz and FH was 85.47 Hz. The box tuned frequency was found to be FB = $(FL^2+FH^2-Fc^2)$ = 75.46 Hz which was way off the target of 42.66 Hz required. Predictably, the radiator diaphragm is nowhere near heavy enough to resonate the system at this frequency. To reduce its resonant frequency to the required level we need to add mass to the diaphragm. How much?

To find out, consider that the active bass box compliances ratio is:

$$\propto = FL^2 + FH^2 - \frac{FB^2 - 1}{FSB^2} = 0.79$$

$\delta$ the radiator box compliance ratio is found by solving the following equation,

$$\delta = \frac{\frac{FB^2 FSB^2}{FL^2 FH} - 1 - \frac{1}{\propto}}{2} = 2.19$$

The resonant frequency of the radiator $F_p$ is FB $= \frac{34.46}{2.19}$ Hz. However, we want it to resonate at $\frac{42.66 \text{ Hz}}{2.19}$ =19.48 Hz.

### INDUCTOR WINDING

**L1 989 $\mu$H turns, 1.1 mm wire on a 15 mm high former R0.45 ohms.**
**L3 214 $\mu$H 61 turns 1 mm wire on a 10 mm former R0.22.**
**L2 460 $\mu$H 89 turns 0.8 mm wire on a 10 mm high former R0.48 ohms.**
**L4 776 $\mu$H 114 turns 0.7 mm wire on a 10 mm former.**

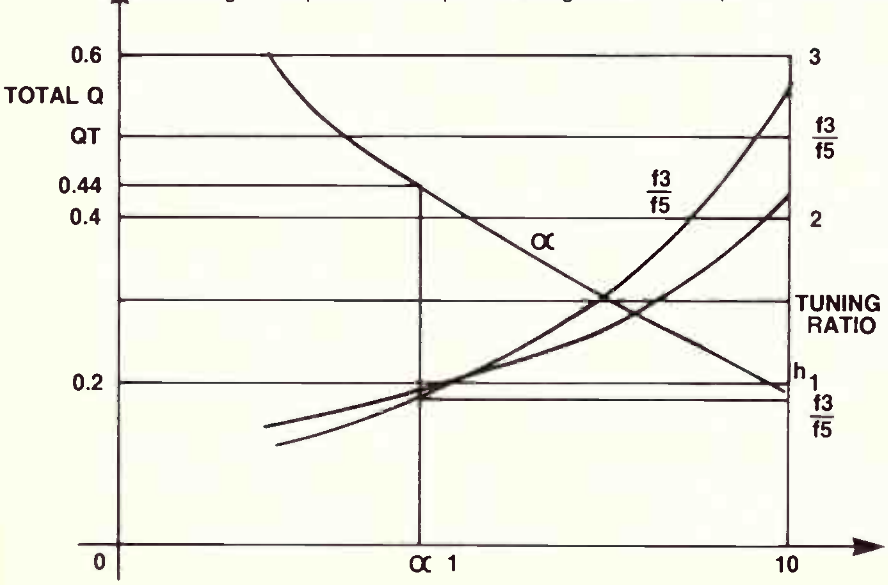
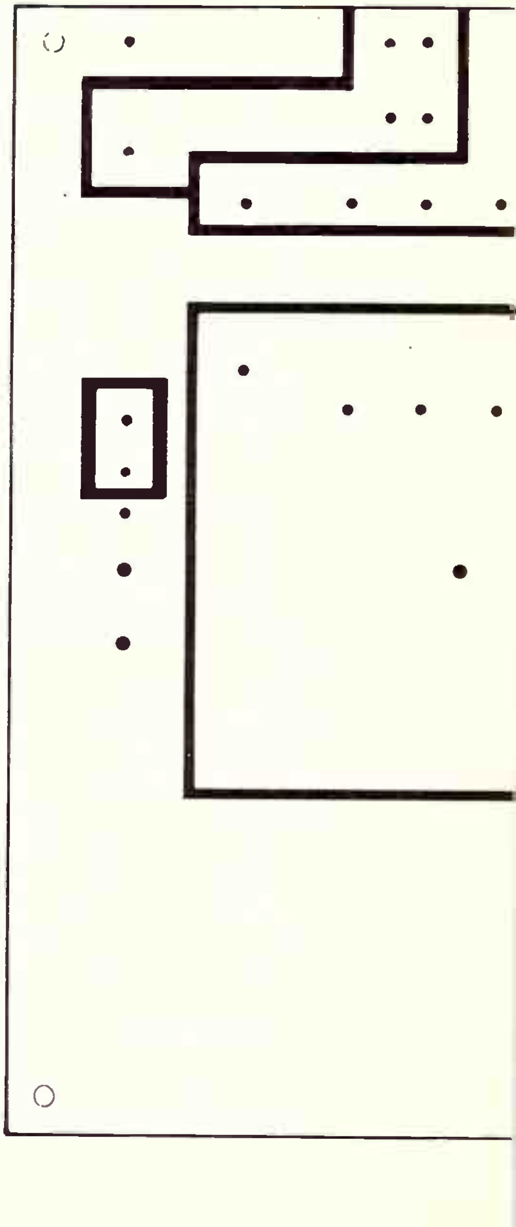


Figure 2. Speaker box compliance ratio against free air compliance ratio.



The VAS of the radiator is 29 × 3.796 = 111 litres.

The extra mass needed to lower the resonant frequency of the radiator from 34.46 to 19.48 Hz has to be calculated by first finding the radiator suspension compliance.

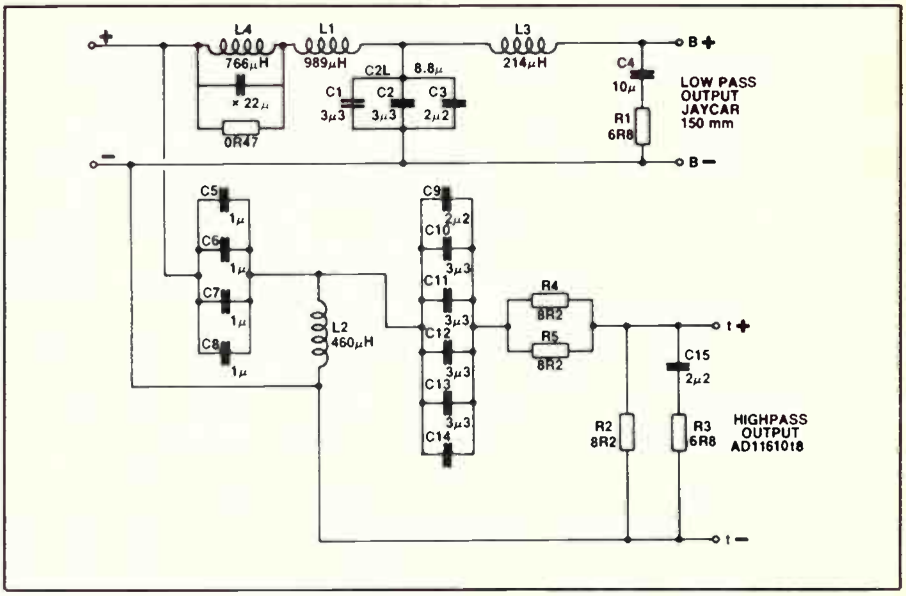
$$\mathrm{CMS} = \frac{\mathrm{VAS}}{P_{OC}{}^2 SD^2}$$
$$= \mathrm{lll}_e$$
$$= 1.18 \times 345^2 \times (30.17_e{}^{-3})^2$$
$$= 8.860_e{}^{-4}\frac{M}{N}$$

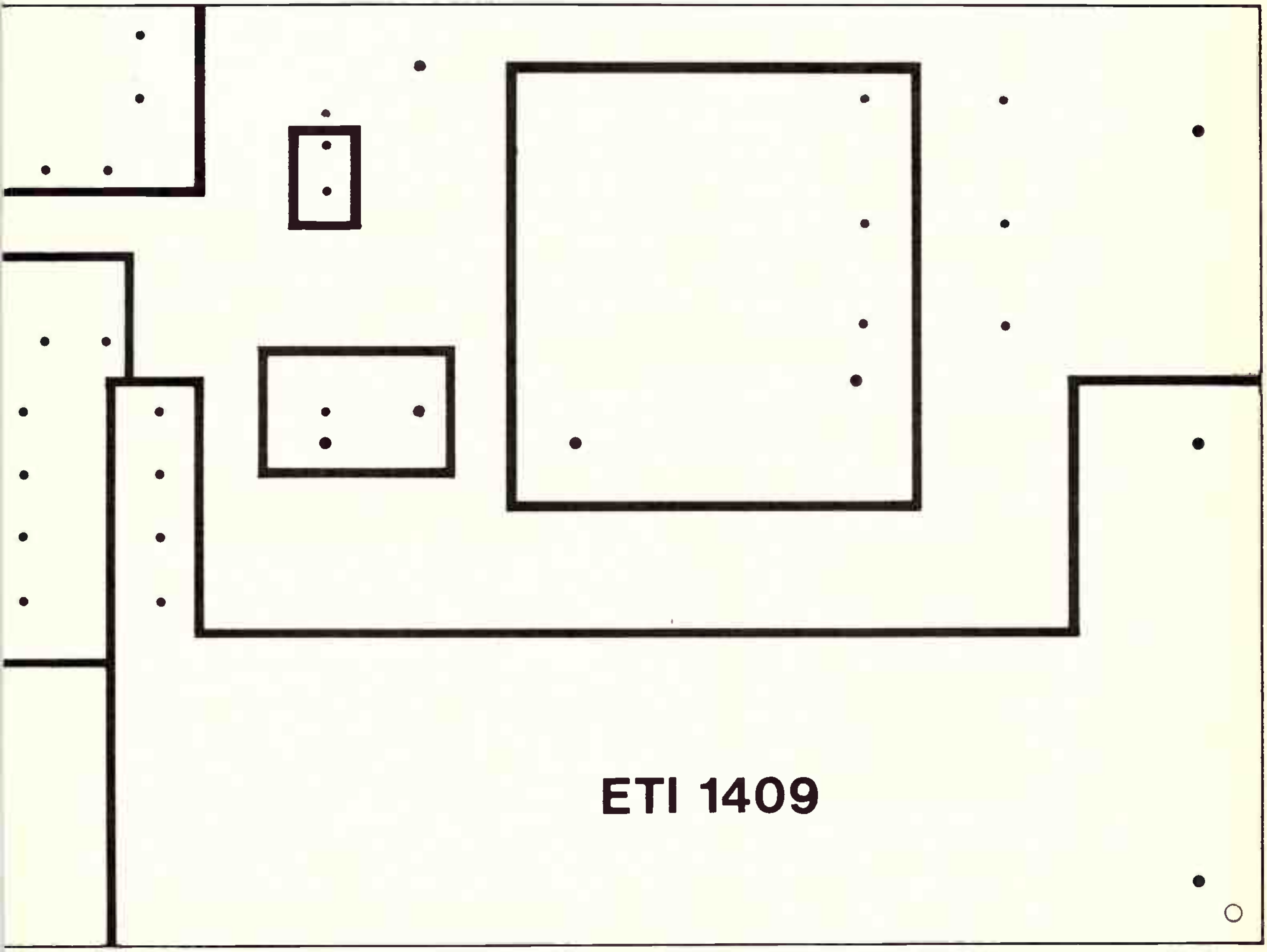
where SD is the area inside the speaker's suspension surround.

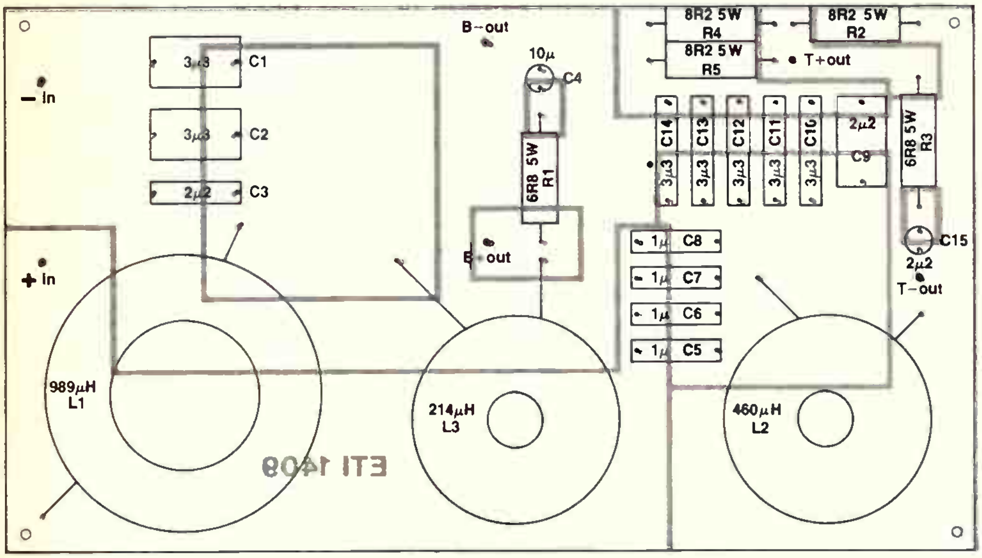
The diaphragm mass for 34.46 Hz is,

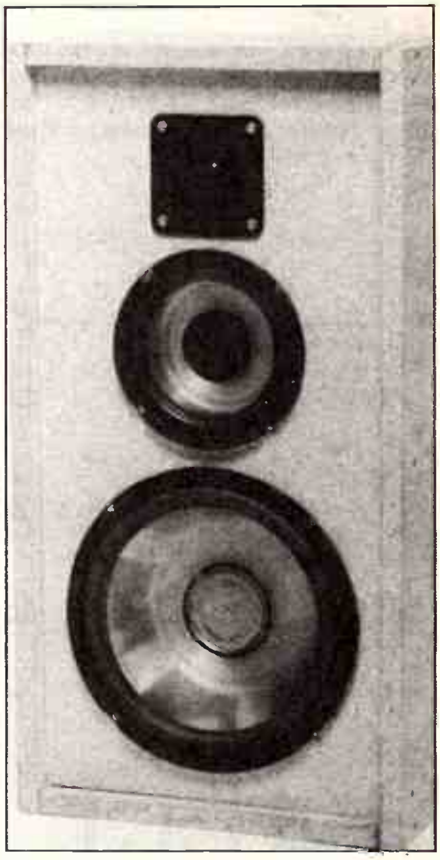
$$\mathrm{MMS} = \frac{1}{(2\,\mathrm{P1F_s})^2\,\mathrm{CMS}}$$
$$= 24.57 \text{ grams}$$

The diaphragm mass for 19.48 Hz is 76.90 grams so the extra mass needed is 76.90 − 24.57 = 52.33 grams. It should be obvious that the radiator needs to be modified. ▶





Selleys makes an epoxy bond two-part putty, stock number EB50g which in its handyman pack weighs 50 grams. This simplifies the task. Remove the dust dome of the radiator with a sharp knife or similar cutting instrument close to the plastic diaphragm, being careful not to cut the diaphragm. Having removed the dome, mix all of the putty as the instructions say. If it is difficult to mix, it can heated to soften it which makes it easier to knead and pummel. A couple of 10 second zaps in the microwave also helps.

When the putty is mixed, place and press it into the space under where the dust dome was and let it cure. The dust dome may be Araldited back into position being careful not to use too much because of the added mass of the Araldite. I elected not to replace the dome because the grille would hide it.

The system was retested and FL was 28.69 Hz and FH was 64.93 Hz, so FB from calculation was 42.14 Hz which is near enough to 42.66 Hz. This completes the bass alignment.

## Power

We can now calculate the amount of power we can put through the speaker. The displacement limited acoustic power ratings PAR and PER are:

$$PAR = 0.85\, f_3{}^4 VD^2$$
$$= 3.099_e{}^{-3}$$
$$PER = \frac{PAR}{N_o}$$
$$= 6.72\ W$$

so the program power handling is about 67 watts which works out to a sound pressure level of 98 dB.

Passive radiator suspension compliance should be at least equal to or lower than its associated bass driver, in this system the radiator suspension compliance is slightly higher which lowers power handling a small amount.

## Crossovers

The crossovers are just simple high and low pass filters, so we don't need to go too much into their design here. We need to specify a crossover frequency ($F_x$) and the slope of the filter. On the basis of experience, the crossover is a third order design, with $F_x$ set at 2500 Hz. The details are shown in Figure 3.

The only problem with these is winding the inductors. The details appear in a separate box.

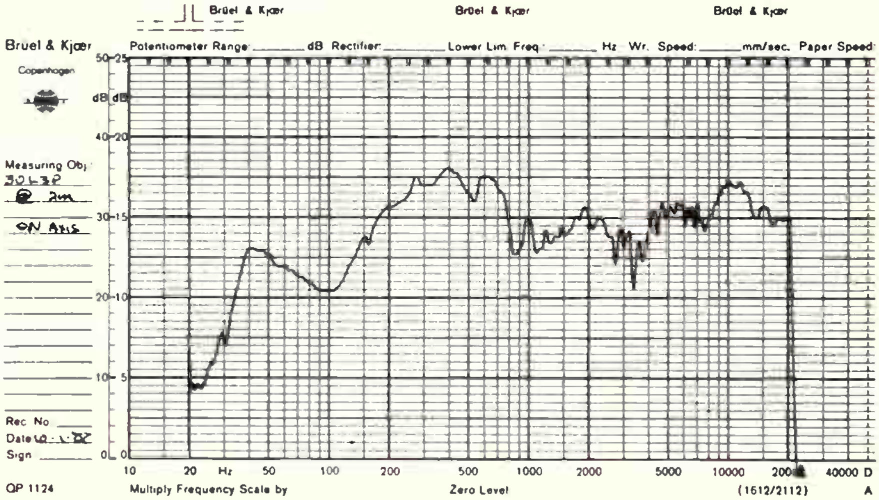
## References

(1) R. H. Small, "Vented Loudspeaker Systems", *J. Audio Eng. Soc.* Part 1: Vol 21, pp 363-372, 1973; Part 2: Vol 21, pp 438-444, 1973; Part 3: Vol 21, pp 549-554, 1973; Part 4: Vol 21, pp 635-639, 1973.

(2) R. H. Small "Passive Radiator Loudspeaker Systems", *J. Audio Eng. Soc.* Part 1: Vol 22, pp 592-601, 1974; Part 2: Vol 22, pp 683-689, 1974.

(3) J. E. Benson, "An Introduction to the Design of Filtered Loudspeaker Systems", *J. Audio Eng. Soc., pp 536-544.*

*(4) S. H. Linkwitz, "Passive Crossover Networks for Noncoincident Drivers", J. Audio Eng. Soc., Engineering Report.*



TEACH YOURSELF

## INSIDE YOUR COMPUTER 8

# MONITORS AND MODULATORS

*What are the options for displaying a computer's output? They range form the teletype to the monitor.*

**Phil Cohen**

Today's modern monitor sits atop keyboard and computer.

First, a little history. Way back when, the only way to get information into or out of a computer was by means of a 'teletype' — something like a cross between an electric typewriter and a washing machine. It had a keyboard and a printer built in, made a fair amount of noise and cost a fortune.

To replace the teletype, the visual display unit (VDU) was born. Basically, this has a screen (like a TV screen) in place of the printer and was affectionately known as a 'glass teletype'.

The VDU communicated with its host computer by means of a wire along which serial signals were passed, from the host to the VDU to tell it what to put on the screen, and from the VDU to the host to tell it what keys had been pressed.

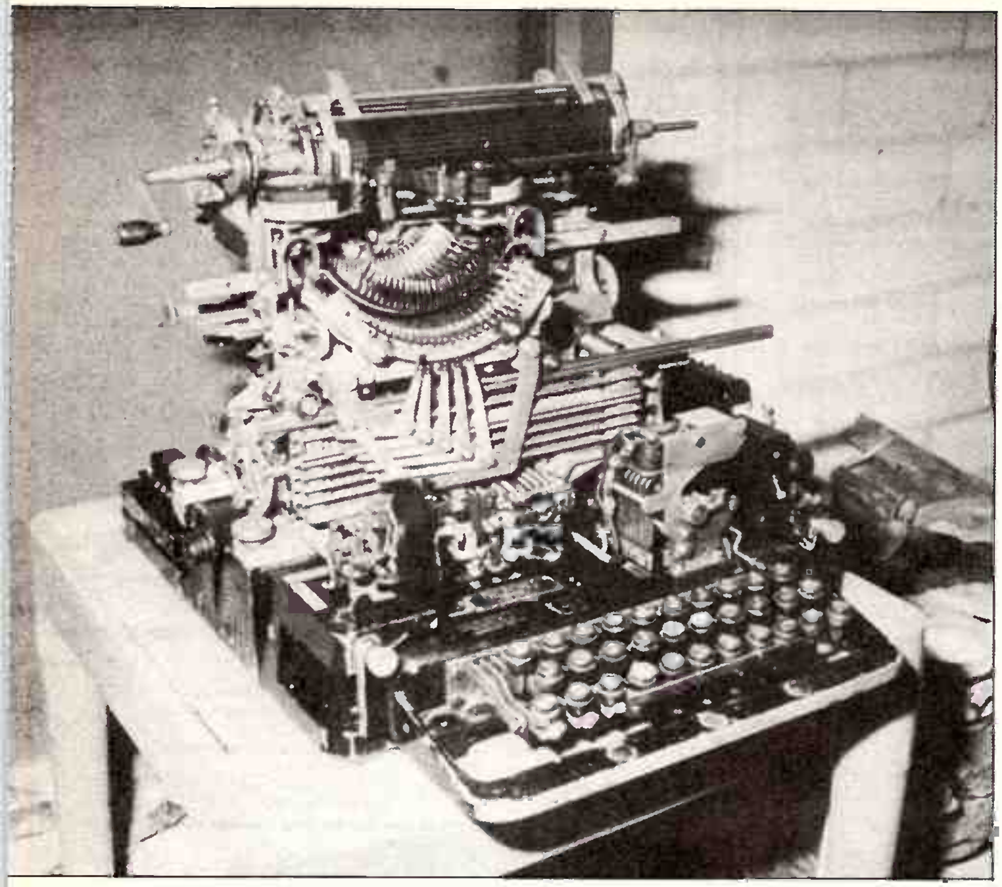
The VDU contained all of the circuitry to figure out where on the screen to put the characters that came from the host, where the cursor (the little flashing box or line that shows where you are about to type on the screen) was at any time, and to turn flashing characters on and off.

All the host computer had to worry about was what information needed to be output to the VDU, and what was coming in in the way of commands from its keyboard.

This simulation of a teletype, with the text moving up the screen (as paper moves up from a printer) worked OK for a while, but then people realized that you could actually use the system in another way, and screen-oriented applications were born.

These (and most modern micro applications programs are based on the same traditions) treat the VDU screen as a sheet of paper, rather than a roll. Prompts are put onto the screen by the host, and the user moves the cursor around the screen to fill in blanks (or data entry fields), which provide data for the host.

The upshot of all this was that instead of just telling the VDU what to print on the screen, the host had to have a way of controlling cursor movement, clearing the screen, and so on. This was done by inventing 'escape sequences', which are (normally) based on the host sending an



The insides of an old Model 15 Teletype.

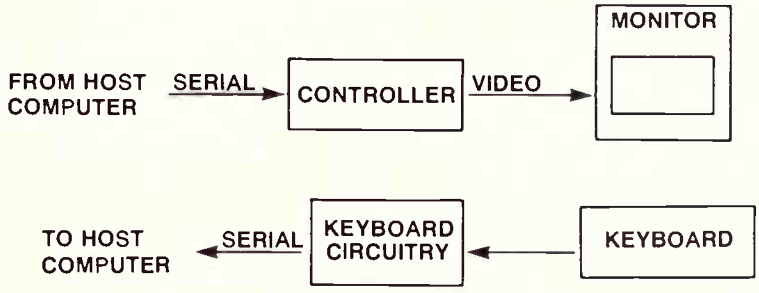



**Figure 1.** Monitor, keyboard and controller as a VDU.

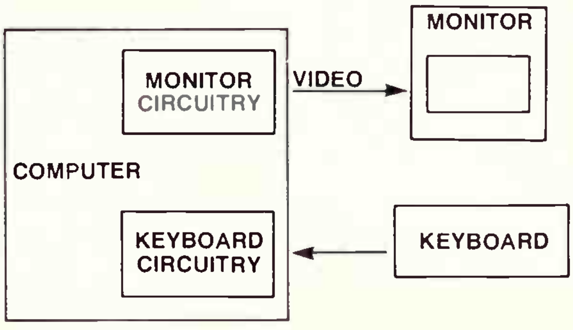



**Figure 2.** Monitor and keyboard attached to a microcomputer.

> *The use of TV sets as monitors is restricted these days to games computers. Anything that is intended for serious use has an output for a monitor.*

ESC (escape, ASCII 27) character followed by some more codes when it wanted to control the VDU rather than just sending data to it.

With the advent of the micro, the circuitry to do all of the clever VDU things was built into the box, but the escape sequences stayed. Instead of a host mainframe computer with a number of VDUs (VDTs or visual display terminals as they are called in the publishing industry for some unknown reason) attached to it, the micro had all of the clever electronics in a box, with a thing called a monitor sitting on top of it.

The monitor was simply a VDU with all the clever control bits removed and put inside the micro case instead. The output from the micro was in the form of a video signal, which told the electron beam flying across the monitor screen when to turn on and off to form the patterns of light and dark dots on the screen which made up letters and words (see Figure 2).

Now, it so happens that a monitor is very similar to part of a TV set — specifically, the part of the TV set downstream of the tuner which takes the information from the aerial and translates it into a video signal (see Figure 3).

Someone thought it would be a good idea for a home micro user to use his/her TV set as a sort of surrogate monitor — reducing the purchase price of the computer. But the problem was that there was no easy way (in TV sets of the day) to put a video signal directly into the video input of the monitor part of the TV set. The only input on a TV set was the rf input that was connected to the aerial.

So the video output from the computer had to be passed through something called a 'modulator', which did exactly the opposite of the tuner in the TV set. In fact, the modulator was practically a little TV transmitter — a fact borne out by the amount of rfi given off in early models!

The rf output from the modulator was fed into the aerial socket, turned back into a video signal by the tuner, and the whole thing showed a picture.

Bandwidth became a problem; with the signal going through two transformations ▶

## NEGATIVE AIR IONISER
### INCREDIBLE BARGAIN
### *75% off manufacturers recommended price!*

The 'Country Air' negative ioniser was advertised extensively on radio during last year for $200.

Well, to make a long story short, "Country Air' is no longer around. (Except as air in the bush).

Hundreds of partially assembled ionisers were left with the contract manufacturer. This manufacturer contacted Jaycar with their problem. Jaycar has underwritten completion of these ionisers but at a massive loss to the original parties.

Their loss is your gain however!

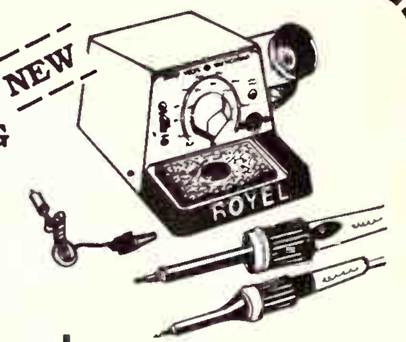
We can now offer you this very high quality product at only 25% of the manufacturers original selling price!

Grab one now and enjoy the benefit of a negative air ioniser at this price while they last.

**ONLY $49.95** *SAVE $150* over original price! Cat. XX-2902


## WORLD CLASS ADCOLA SOLDERING/ DE-SOLDERING STATION

NEW




See our Jan ads for full details.

**POWER CONTROLLER**
Cat. TS-1475
(no iron or desolderer supplied)
**$139.50**

**40 WATT SOLDERING PENCIL CT-6**
Cat. TS-1478
**$39.95**

**80 WATT SOLDERING PENCIL CT-7**
Cat. TS-1480
**$42.50**

**DESOLDERING PENCIL**
Cat. TS-1476
**$59.95**

## ADCOLA 240 VOLT IRONS

**S30 30 watt**
Cat. TS-1492
**$27.95**

**S50 50 watt**
Cat. TS-1494
**$29.95**

## TIPS

| For CT-6 and S30 irons | | For Ct-7 and S50 irons | |
|---|---|---|---|
| 0.7mm Chisel point | | 0.7mm Chisel point | |
| Cat. TS-1484 | $4.95 | Cat. TS-1488 | $5.95 |
| 1.5mm Chisel (standard) | | 2.5mm Chisel (standard) | |
| Cat. TS-1485 | $4.95 | Cat. TS-1487 | $5.95 |
| 3mm Chisel point | | 3mm Chisel point | |
| Cat. TS-1486 | $4.95 | Cat. TS-1490 | $5.95 |

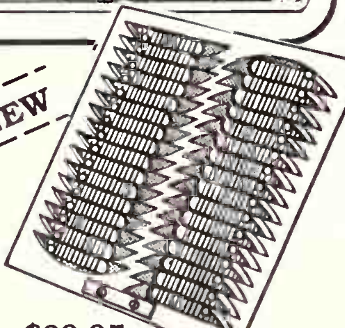
## LOW COST SOLAR PANEL
### - WILL CHARGE A LEAD ACID 12V BATTERY

NEW

We have purchase the surplus stock of a well known brand solar panel. The panel will deliver 16 volts at up to 200mA in bright sunlight. This is sufficient to slow charge a car battery!

The units are made in the USA and are completely epoxy sealed. They can be screwed into any flat panel. Ideal for boats, farms, etc.

Cat. M-9008

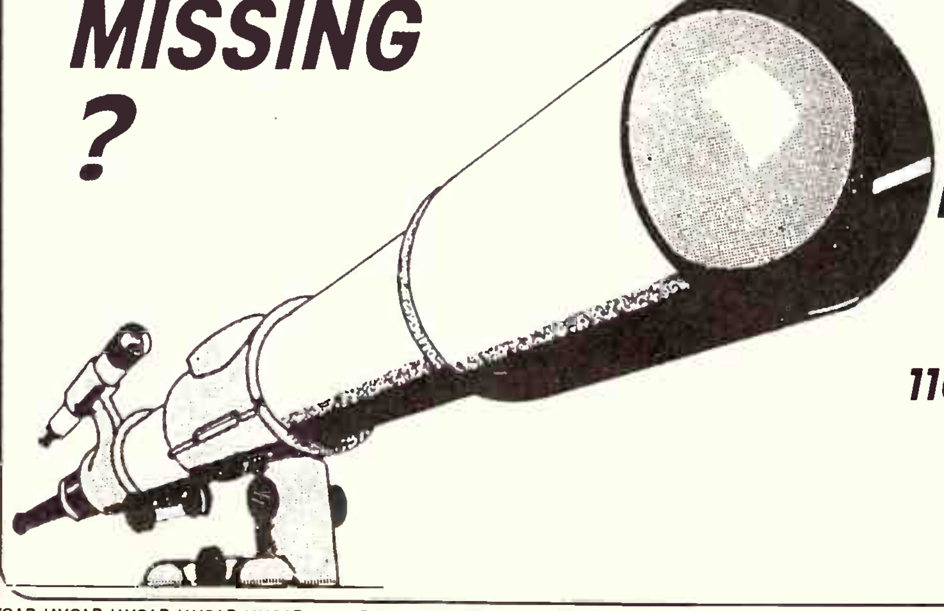


**$89.95**

WERE SELLING FOR $149.50 ELSEWHERE

**CONCORD OPEN ON SATURDAYS FROM 9am - Noon**

# *HAS THE JAYCAR CATALOGUE*
## (THAT WAS INSERTED IN THIS MAGAZINE)
# *GONE MISSING ?*



***— IF IT HAS SEND A NOTE OR LARGE (300 × 250) ENVELOPE TO US & WE WILL SEND YOU OUR NEW 1987 116 PAGE CATALOGUE — ONLY $1.00***

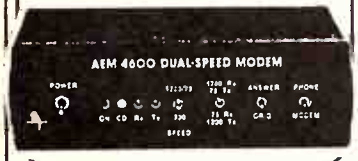
# JAYCAR NUMBER ONE FOR SUPERIOR KITS

AUSTRALIAN MADE

## AEM 4600 DUAL SPEED MODEM

Ref: AEM December 1985
Cat. KM-3040

**$179.00**




## LOW DISTORTION AUDIO OSCILLATOR

See EA December 1986
Cat. KA-1680

**$139.00**

### DELUXE CURRENT SENSE CAR ALARM

Ref: AEM October 1986 AEM 8501
This high quality Tillbrook designed unit includes case and Scotchcal front panel.
Cat. KM-3048 ONLY $98.50

## RS232 TO COMMODORE

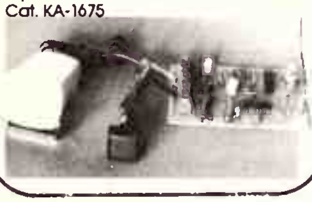
Ref: ETI July 1986
Supplied without Commodore edge connector
Cat. KE-4722

**$16.95**

## SCREAMER CAR ALARM

**$32.50**

Ref: EA August 1986
Incorporates two sensors and utilises a piezo screamer inside the car.
Cat. KA-1675



## TURBO TIMER

See EA Sept 1986
A simple sensor system to prevent car ignition being turned off before the Turbo unit has cooled down (approx. 90 seconds. A must for those with turbo charged cars.
Cat. KA-1679

**$29.95**

## DIGITAL SAMPLER ETI 142

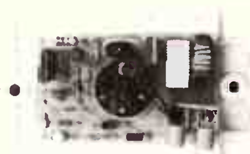
Cat. KE-4720

**$119.00**

## LIGHT SAVER

Ref: EA June 1986
Supplied without plate and epoxy.
Cat. KA-1670

**$15.99**



**1987 Catalogue.** Call in to any Jaycar store & for one dollar we will give you a copy of our all new 1987 catalogue. It's full of new products & valuable data! And, apart from the $1 — it's free!!

## NEW GENERATION CORDLESS PHONE

**Microprocessor controlled 200 metres range and absolute security**

Quite simply the finest cordless phone we have appraised. Naturally it is in total conformity to the 1986 Telecom specifications and is Telecom approved.
The range with the 39/30MHz RX/TX FM system is fabulous - as against the very short range cordless phones of yesteryear.
FEATURES:

- Operating range up to 750ft (250m)
- Security code system with 16,384 combinations
- Last number redial
- LED indicator on handset for low battery indication
- Hearing aid compatible

Cat. YT-7065

**ONLY $269.00**
**IN STOCK NOW**

## DUAL TRACKING POWER SUPPLY

Ref: EA 2/87
This kit will supply up to ±21.5 volts at 500mA. At 5 volts it will supply 3A and at 10-16V the current is 2 amp.
Cat. KA-1682

**ONLY $129.50**

## MODEL RAILWAY LIGHT CONTROLLER

For model train enthusiasts. Controls Signals, level crossings, etc. LEDs not supplied due to variations in gauge sizes.
Cat. KA-1563

**ONLY $21.95**

NEW

### SHOWROOMS

**SYDNEY** 117 York St (02) 267 1614
Mon - Fri 8 30 am - 5 30 pm
Thurs until 8 30 pm Sat 9 am - 12 noon

**CARLINGFORD** Cnr Carlingford & Pennant Hills Rd
(02) 872 4444 Mon - Fri 9 am - 5 30 pm
Thurs until 8 30 pm Sat 9 am - 12 noon

**CONCORD** 115 Parramatta Rd (02) 745 3077
Mon - Fri 8 30 am - 5 30 pm only

**HURSTVILLE** 121 Forest Rd (02) 570 7000
Mon - Fri 9 am - 5 30 pm
Thurs until 8 30 pm Sat 9 am - 12 noon

**GORE HILL** 188 Pacific Hwy (Cnr Bellevue Ave)
(02) 439 4799 Mon - Fri 9 am - 5 30 pm
Sat 9 am - 4 pm

**Jaycar ELECTRONICS**
INCORPORATING ELECTRONIC AGENCIES

**QLD. BURANDA** 144 Logan Rd (07) 393 0777
Mon - Fri 9 am - 5 30 pm
Thurs until 8 30 pm Sat 9 am - 12 noon

**HEAD OFFICE** 115 Parramatta Rd
Concord 2137
(02) 747 2022 Telex 72293

ROAD FREIGHT ANYWHERE IN AUSTRALIA $13.50

VISA · bankcard · MasterCard · AMERICAN EXPRESS Cards Welcome

**MAIL ORDER VIA YOUR PHONE**

**MAIL ORDERS**
P O Box 185 Concord 2137
(02) 747 1888 HOTLINE
(008) 022 888 TOLLFREE
FOR ORDERS ONLY

**POST & PACKING**

| | |
|---|---|
| $5 - $9 99 | $ 2 00 |
| $10 - $24 99 | $ 3 75 |
| $25 - $49 99 | $ 4 50 |
| $50 - $99 99 | $ 6 50 |
| OVER $100 | $10 00 |

before it got onto the screen, there was a lot of 'rounding' of the signal. This was particularly true for colour signals — in fact, when I reviewed the Apple micro way back when it first appeared in colour, I more or less said that colour wouldn't catch on in the home because of the very poor quality available on the screen once the signal had been through the wringer. OK, I was wrong.

Another possibility is to use a special TV set which has a video input. TV sets with this facility are rather expensive, but they do provide you with a free colour monitor — except that when you're playing with the computer no one else can watch TV.

My first monitor (for an Apple) was an old black and white TV set to which I had fitted a video input socket. Warning: beware of high voltages when playing in the back of TV sets.

The use of TV sets as monitors is restricted these days to games computers. Anything that is intended for serious use has an output for a monitor.

For monochrome (literally one-colour) monitors, there are about two standards for video signals. There's the old TV video standard and an IBM one, which uses a different form of synch pulse.

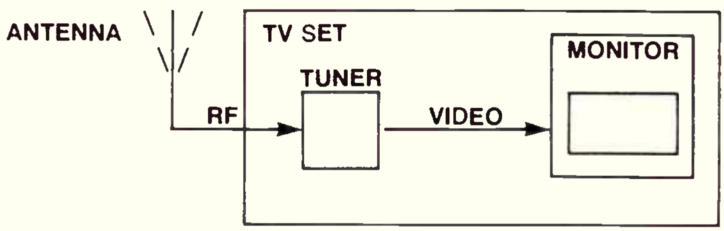



**Figure 3.** Monitor as a TV set.

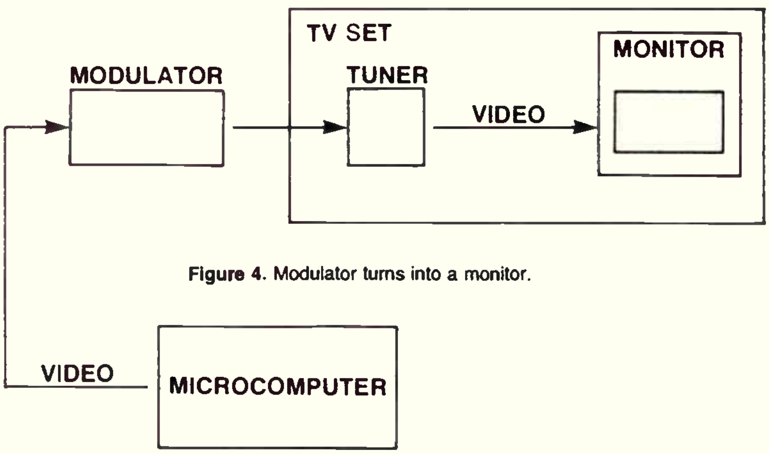



**Figure 4.** Modulator turns into a monitor.

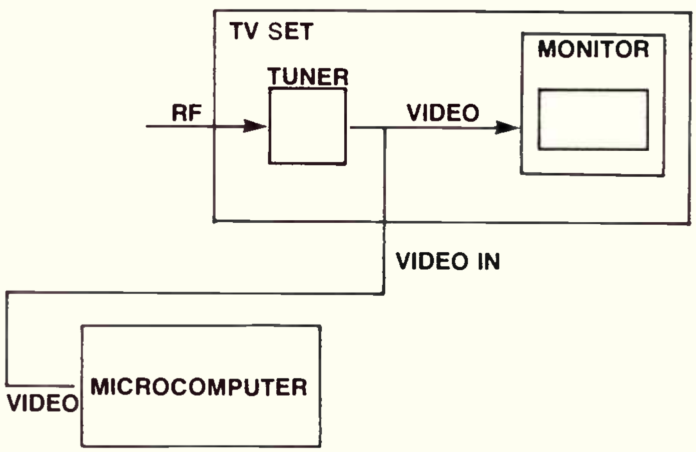



**Figure 5.** TV set with video input.

## Glossary

**Apple:** The company that brought out what was probably the first popular microcomputer.

**Bandwidth:** A measure of how much information can be handled by, say, a particular circuit.

**Data entry field:** A particular area (field) or areas set out on a computer screen for you to type some information (data) into.

**ESC:** Short code meaning escape.

**Escape:** One of the keys on a computer keyboard is labelled 'escape'. Originally, this was to be the key you pressed if you got into trouble — its meaning has changed over the years.

**Escape sequence:** A sequence of codes starting with escape usually involved in moving the cursor around the screen.

**Field:** A particular area on the screen.

**Glass teletype:** Another name for a VDU.

**Host computer:** The main computer that a VDU is connected to.

**Mainframe:** A large computer that won't fit on your desk! Usually, a computer whose 'housekeeping' functions are the responsibility of a specialist department inside your company.

**Modulator:** A device for turning video into rf.

**Monitor:** A TV-like device which takes video as an input.

**Monochrome:** Capable of showing only one colour or black (eg green and black, orange and black, white and black).

**rf:** Radio-frequency — in the context of computers, usually a video signal in rf form.

**rfi:** Radio frequency interference — produced by badly-designed circuits, particularly badly-designed computers!

**Rounding:** What happens to a signal when you put it through a circuit that has too little bandwidth — literally, the corners get taken off the waveform.

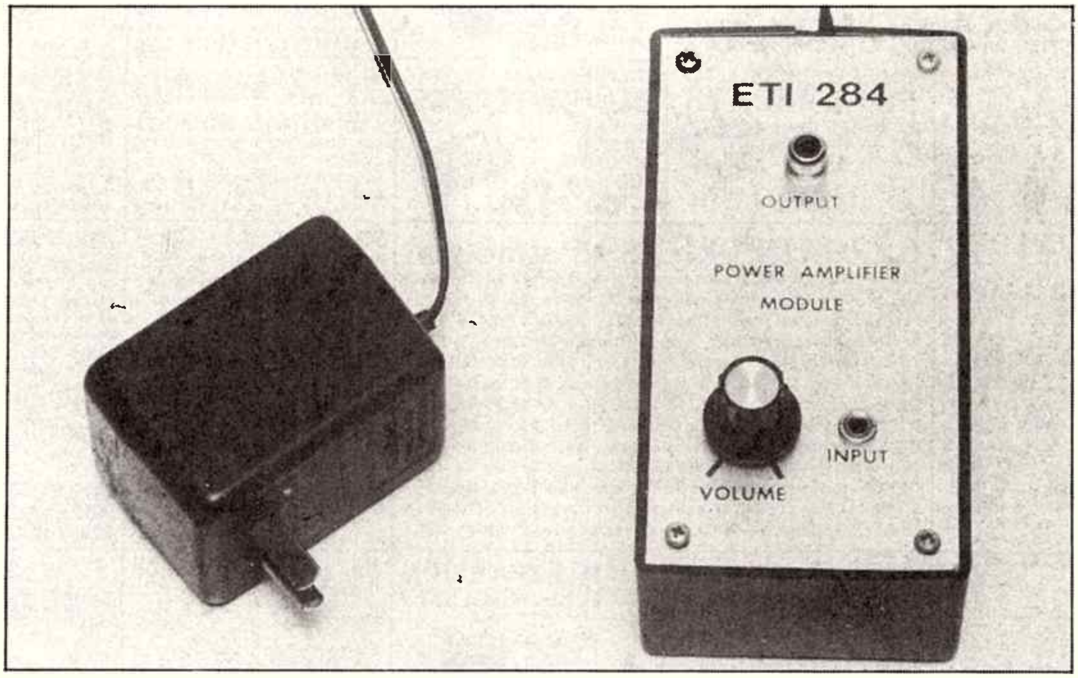
**Teletype:** An old keyboard and printer combination used as a VDU is now.

**Tuner:** The part of a TV set that captures and converts an rf signal into its video form.

**Video:** An electronic signal that specifies which dots on a display screen are going to be bright and which black. ●

TEACH YOURSELF

CREATING WITH ELECTRONICS 4




# OSCILLATORS AND AMPLIFIERS

*Not just a project but a whole learning experience for the tyro designer . . . This article describes construction of a versatile power amplifier module along with principles of bootstrapping, cascading, and amplifier design.*

**Peter Phillips**

Last month a range of concepts was presented in preparation for the circuitry contained in this article and subsequent parts of the series. We now move to actual circuits, commencing with a small general purpose power amplifier module. Various options are possible for construction of the module, including waiting until next month when a sine-square oscillator with in-built amplifier will be described.

The amplifier is presented as a device intended for many applications. For example, an intercom system can be built using two modules. Or you may want a small sound system for an earphone-only radio or cassette player. A mixer/graphic-equalizer unit is planned, which could be combined with two modules for a complete stereo amplifier. Whatever the application, the project will provide an introduction to audio amplifiers in general.

## Overview of the circuit

ICs that perform the function of this project are available, but modifying them to suit applications outside their design parameters is very difficult. For flexibility, cost, parts availability and learning purposes, discrete components only are used. The circuit is based on a direct-coupled amplifier, with a complementary symmetry output pair operating in class AB. This configuration is typical of most hi-fi amplifiers and has all the advantages and problems associated with such designs. But more of this later . . .

The pcb layout does not include provision for the power supply, a topic covered previously in parts 1 and 2 of this series. The specifications of the amplifier are included with the circuit diagram. No distortion measurements have been made, but a subjective listening test gave excellent results. The gain of the circuit can be increased, as later described, for intercom use. As well, the power output can be increased to 4.5 watts by raising the supply voltage to a maximum of 25 volts.

Figure 1 shows the block diagram of a typical audio amplifier. All the blocks are represented on the module except the preamplifier, and their operation is briefly described to provide a background that should help in understanding the circuit.

### *The FET*

A FET (field effect transistor) forms the

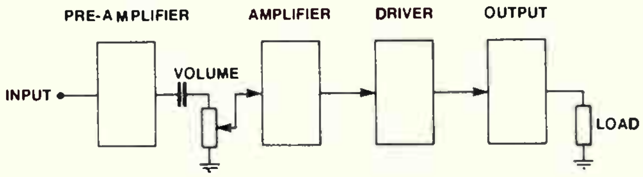



**Figure 1.** Block diagram of a typical audio amplifier.

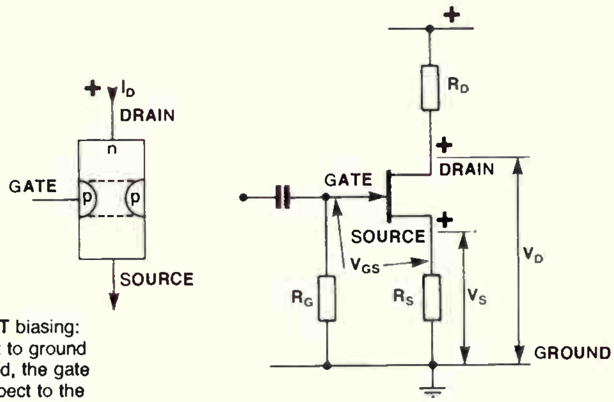
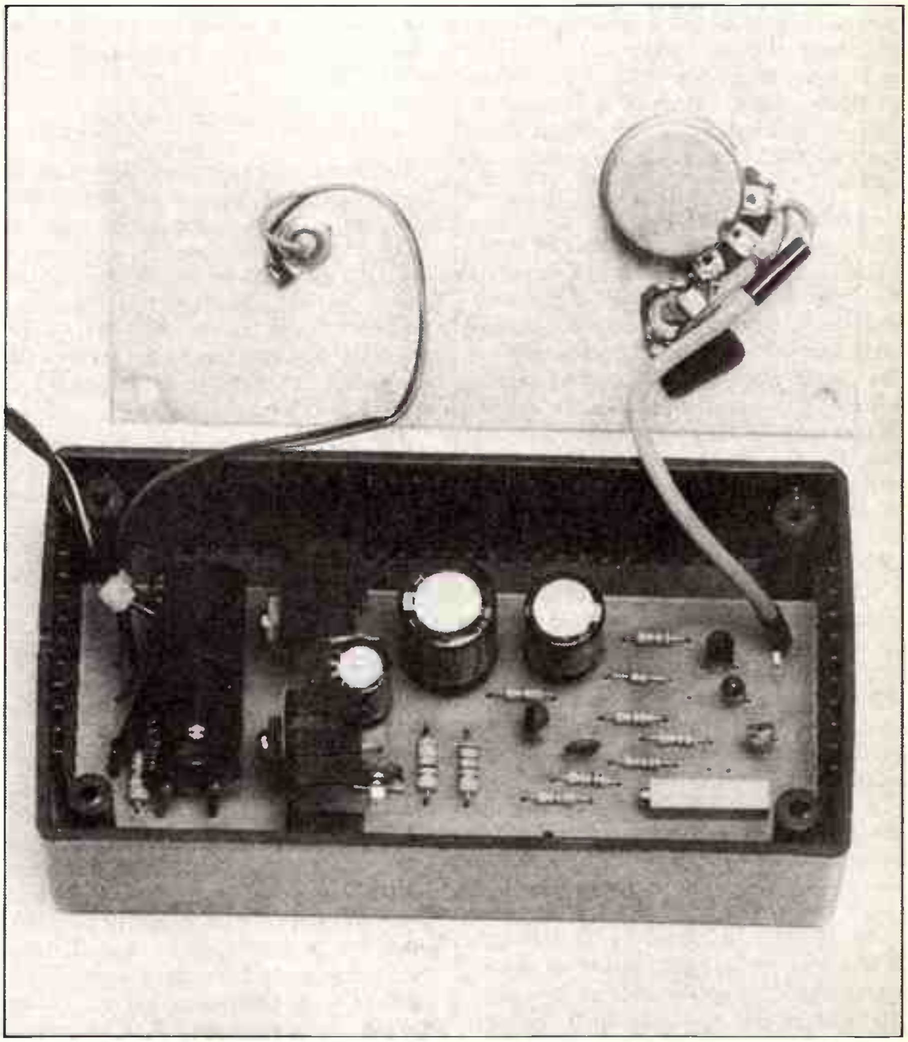



**Figure 2.** The n-channel JFET. FET biasing: because $V_S$ is positive with respect to ground and the gate is connected to ground, the gate (and) ground are negative with respect to the source.

first stage of the circuit to provide a high input impedance. The FET is a voltage controlled device in which the input voltage controls the current flowing through it. Figure 2 shows the internal construction of an n-channel JFET, (junction FET) as well as the circuit of a common source FET amplifier. Common source means the source terminal is neither an input nor an output terminal, but is common to the other two. The drain current ($I_D$) is a dc current directly controlled by the voltage present between the gate and source terminals ($V_{GS}$). If $V_{GS}$ is zero, $I_D$ is a maximum, called the saturation drain current, $I_{DSS}$. When the polarity of $V_{GS}$ reverse-biases the gate junction, (gate negative to source for n-channel FET), $I_D$ will drop as $V_{GS}$ is increased, eventually to zero if $V_{GS}$ is made sufficiently high.

$V_{GS}$ must always reverse-bias the gate junction, ensuring a virtual open-circuit at the gate terminal. The voltage *field* set up by the reverse bias is the controlling medium on $I_D$. If $V_{GS}$ is varied with an ac signal, $I_D$ will change accordingly. The voltage variation resulting across the resistor $R_D$ provides the amplified output signal. However, to ensure the signal doesn't forward bias the gate junction, a reverse dc bias voltage is required. This is usually done by grounding the gate terminal with a resistor ($R_G$ — up to 1M ohm) and using the dc voltage produced at the source terminal caused by the current flowing in the resistor ($R_S$) connected from source to ground. The value of $R_S$ is therefore chosen to establish the dc operating conditions of the FET, and typically should provide a voltage between 0.5 to 1 volt at the source.

Because no current flows in the gate junction, the input resistance of the FET▶



**Box and wiring.**

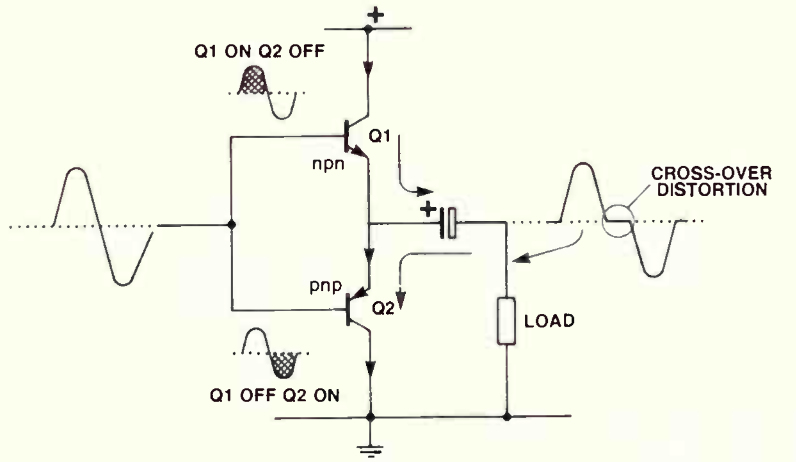


**Figure 3.** The complementary symmetry push-pull output stage.

amplifier is equal to the value of $R_G$. The voltage gain provided is modest, but the high input resistance makes the FET ideal as an input stage. The value of $R_D$ should produce a drain voltage of approximately half the rail voltage at the chosen drain current. The circut uses a quiescent $I_D$ of around 2-3 mA.

### *The amplifier block*

The complete circuit diagram is partitioned into sections to relate to Figure 1. The amplifier section comprises the FET and the common-emitter amplifier associated with Q2. Due to the high dc gain of the circuit, a low-leakage coupling capacitor for C2 is essential. Because the driver-output stage is direct-coupled to Q2, the bias for Q2 determines all following dc voltages. Most amplifiers use a similar arrangement, presenting difficulties in fault finding as a fault anywhere affects all the other dc voltages. The variable resistor RV2 is used to adjust the circuit to its optimum dc conditions. R5 provides dc and ac feedback for Q2 to stabilize it against changes in $H_{FE}$, permitting any suitable small signal transistor to be used. If more gain is required, a *bypass* capacitor can be placed across this resistor eliminating the ac feedback.

A critical factor in amplifier design is the power supply. Positive feedback can occur between stages and interstage *decoupling* is essential, performed by a series resitor (R6) and a filter capacitor (C2). Because the amplifier section also determines the dc voltages for all subsequent stages, a constant voltage must supply this section, accomplished by the Zener diode.

### *The driver/output section*

This section is the critical part of any amplifier, as it determines the efficiency and distortion figures. Efficiency of an amplifier relates input power and output power and is determined by the following equation:

$$\text{efficiency } \% = \frac{\text{audio power out}}{\text{dc power in}} \times 100$$

Efficiency is particularly important in high power amplifiers and in battery operated systems. For example, an amplifier designed for outdoor concerts may have a rated output power of 50,000 watts. If the unit is 50% efficient, then 50 kW out will require 100 kW in. As only half of this power is developed as audio power, the remaining 50 kW must be dissipated as heat.

The problem is the higher the efficiency, the worse the distortion, and vice versa. This conflict has occupied designers for years in a search for the ultimate circuit, and is where the class A versus class B tradeoff enters. The output stage converts the dc power into audio power and ideally should consume no power when there is no audio signal. However, all output devices need a current called the quiescent current for their operation. The question is how much quiescent current should flow?

The answer requires explanation of the terms 'class A' and 'class B' and a description of a complementary pair, push-pull output stage. Figure 3 shows the outline of such a circuit, comprising an npn and a pnp transistor (complementary pair), which should have matched characteristics (be symmetrical). The input signal is applied to both transistors, causing Q1 to conduct when the input signal is positive (push) and Q2 when negative (pull). The principle of each transistor providing half the output signal (or conducting for 180°) is known as class B operation.

However, because transistors don't conduct until the input voltage reaches 0.6 volts, this circuit would produce an output waveform with 'cross-over' distortion. This is caused when one transistor turns off before the other turns on. To prevent this, the 0.6 volts must be provided by the power supply in the form of a bias voltage to cause the transistors to conduct when the input signal is zero. The transistors will still turn on and off as before, but never be both off together. If the bias is high enough, the transistors will conduct all the time, with neither actually turning off as in class B operation. This is class A operation and offers the least distortion, but at the expense of efficiency.

Because class B operation produces cross-over distortion and class A is inefficient, a compromise, called class AB operation, is found somewhere between. It is usual to adjust the dc bias to obtain the best efficiency with the least distortion, and is an important adjustment. Other variables such as non-linearity in the transfer characteristics of the transistors, variations in transistor parameters over the input signal range, etc, all contribute to design difficulties. Eliminating distortion through careful design is a complex issue, made more difficult as power output capability is increased.

The circuit being used in our design is noteworthy for its simplicity. The circuit description details its operation but note that RV3 is used to determine the class of operation. A diode is used in the bias chain to provide some degree of temperature compensation, and many designs attach it to the main heatsink. Emitter resistors such as R9 and R10 are generally used in commercial designs to provide stability against temperature variations, etc. Bootstrapping is used; this is a general term meaning the circuit helps itself perform the required task.

## Construction

The supplied pcb layout will fit neatly into a medium sized zippy box, and an external dc plug-pack supplies the power. Vero board can be used as an alternative to the pcb if necessary. The presentation offered is an example only, and assembly is a matter of personal choice.

Component mounting should start with the low profile devices such as wire links and resistors. Care should be taken to ensure that the diodes, capacitors and transistors are correctly oriented. Mount suitable heatsinks on the output transistors before soldering them to the board. A small piece of aluminium, 20 mm square, will suffice if the finned variety shown on the prototype is not available. Insulate the heatsink on Q4 with a mylar insulator to prevent inadventent shorts to the dc supply.

After mounting them, adjust the variable resistor RV2 to its maximum value by turning it fully clockwise. Similarly, adjust RV3 to its minimum value. Both these components can be later replaced with fixed value resistors if required, once their value has been determined by experiment. As a guide, RV1 will end up at around 5k ohm, and the combination of RV3 and R9 will approximate to 27 ohms. Once all components are in, check particularly that the output transistors have the BD139 for Q4 and the BD140 for Q5. Also confirm that they are correctly oriented, with the metal side facing towards the centre of the pcb. Lastly, confirm that the capacitors, particularly C2, are correctly polarized.

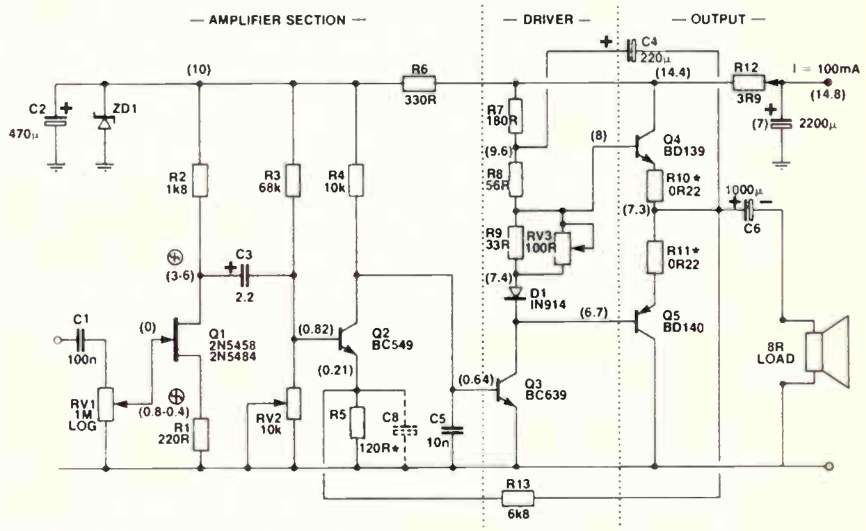
Before applying power to the circuit, connect an 8 ohm load to the output, and ensure that the capacitor C1 is connected between the input terminal and the volume control RV1. Set this control to minimum, then apply power, either from the suggested plug-pack or from an alternative source of around 15 volts dc. Switch on and confirm that neither output transistor gets hot. If it does, try adjusting RV2; perhaps it was incorrectly set in the first place. Setting the adjustments is ideally done with a signal generator and a CRO to observe the waveform. However, good results can be obtained with a dc voltmeter. Assuming all is well, measure the dc voltage at the emitter of either output transistor and confirm that it is nearly equal to the supply voltage. Adjust RV2 anticlockwise (reduce its resistance) to obtain a voltage around half the supply voltage.

Now connect the voltmeter across the series resistor R12 and adjust RV3 to give a voltage drop of approximately 0.4 volts to establish a quiescent current of 100 mA or so. Too little current will cause crossover distortion, too much will heat the output transistors unnecessarily. With the quiescent current set, readjust RV2 so that the emitter voltage at either output transistor is half the supply voltage.

When these settings are correct, the unit is ready to go using a speaker as the load (an 8 ohm speaker for best results). Touching the input terminal should give the characteristic hum, confirming that the amplifier is working. If a headphone radio is being used as the signal source, it may be necessary to connect a 39 ohm, ¼ watt resistor across the input terminals to provide a suitable load for the radio.

## Fault finding

Direct-coupled amplifiers are difficult to ▶




* SEE TEXT
⊕ WILL VARY WITH DEVICE
VOLTAGES MEASURED WITH DVM, NO SIGNAL.

SPECIFICATIONS:
(USING SUGGESTED PLUG-PACK WITH AN 8.2 ohm RESISTIVE LOAD)
MAXIMUM OUTPUT POWER (1kHz): 1.5 W rms
VOLTAGE IN FOR FULL OUTPUT POWER: 190 m Vp-p
VOLTAGE GAIN: 60 (35 dB)
BANDWIDTH: 24 Hz TO 180 kHz
INPUT IMPEDANCE: MAXIMUM OF 1M ohm
EFFICIENCY: 51% (ICQ SET AT 100mA)

## ETI-284 — HOW IT WORKS

**The input signal is applied to the volume control RV1 via C1, and the value of RV1 determines the input resistance of the circuit. The setting of RV1 (logarithmic taper to match human hearing) determines the signal level applied to the FET, Q1. R3 source-biases the FET, which is connected as a common source amplifier producing a gain of around 1.3. C2, a low leakage capacitor, connects the FET input stage to the base of Q2 which is a current amplifier for the driver, Q3. All subsequent stages are direct-coupled, and their dc conditions are set by RV2. The Zener diode, R6 and C2 provide a stabilized rail voltage for Q2 of 10 volts. This ensures stability in the dc conditions for the circuit despite supply voltage variations.**

**Q3 is the driver for the complementary symmetry output pair comprising Q4 and Q5. The output transistors are biased to operate in class AB, and provide unity voltage gain but substantial power gain. The biasing for the output stage is determined by the network made up of R7, R8, the parallel combination of RV3-R9 and D1. Raising the bias by increasing the resistance of RV3 will cause more quiescent current to flow in the output transistors, and move their operation towards class A. A value of 100 mA quiescent current is recommended.**

**Feedback to stabilize the dc conditions and to establish the overall gain of the circuit is provided by R13 and R5. The gain of the circuit is around 65, and can be approximated from the following equation:**

$$\text{voltage gain} = \text{voltage gain of FET} \times \left(\frac{R13}{R5} + 1\right)$$

**Bootstrapping to ensure full conduction of Q4 for the positive half cycle of the output signal is provided by C4. The optional emitter resistors, R10 and R11 offer protection against thermal runaway for the output transistors, and reduce the effects of any mismatch in their characteristics. As the specified value may be difficult to obtain, wire links can be substituted. Q4 and Q5 should ideally be a matched pair having identical dc current gains to minimize distortion.**

**The lower cutoff frequency is determined by the values of C1, C3 and C6. The value of C1 must match the resistance value of RV1 to maintain the quoted lower cutoff frequency. The specified value is suitable for potentiometers with a resistance of 100 k and greater. Refer to last month's article on how to calculate the value for C1 if a resistance value less than 100 k is used for RV1. C5 prevents oscillation but due to the low input impedance of Q3, does not materially affect the upper cutoff frequency. C7 and R12 filter the dc supply voltage, and are not required if a regulated supply is used.**

fault find, due to interaction between the stages. As an aid, voltage readings obtained from the prototype are included on the circuit diagram. These values are for no input signal, using the suggested plug-pack as the power supply. The plug-pack has poor regulation, and if excessive dc current flows due to circuit overload, the input dc voltage can drop below the required minimum of around 11 volts. In this event, remove power and allow the amplifier to cool down. Adjust RV2 to its maximum value, and recommence the set-up procedure. This will not occur under normal operation. Another problem arising from the poor regulation is ripple on the dc, which causes hum at the output.

The components R12 and C7 are used to filter the supply, and are not necessary if a regulated power supply is used.

Typical faults in a newly constructed circuit are wrong value resistors and incorrectly polarized components. Voltage readings similar to those on the circuit should be obtained for the FET and across C2, regardless of problems elsewhere. If these are correct, look for pcb track faults, wrong or faulty components or incorrect set-up. However, be assured . . . the circuit works!

## Modifying the circuit

If more output power is required, the dc supply voltage must be raised. For an amplifier of this type, the maximum possible output power can be calculated using the equation:

$$\text{maximum output power} = \frac{(V_{dc})^2}{8 \times R_{load}} \text{ watts}$$

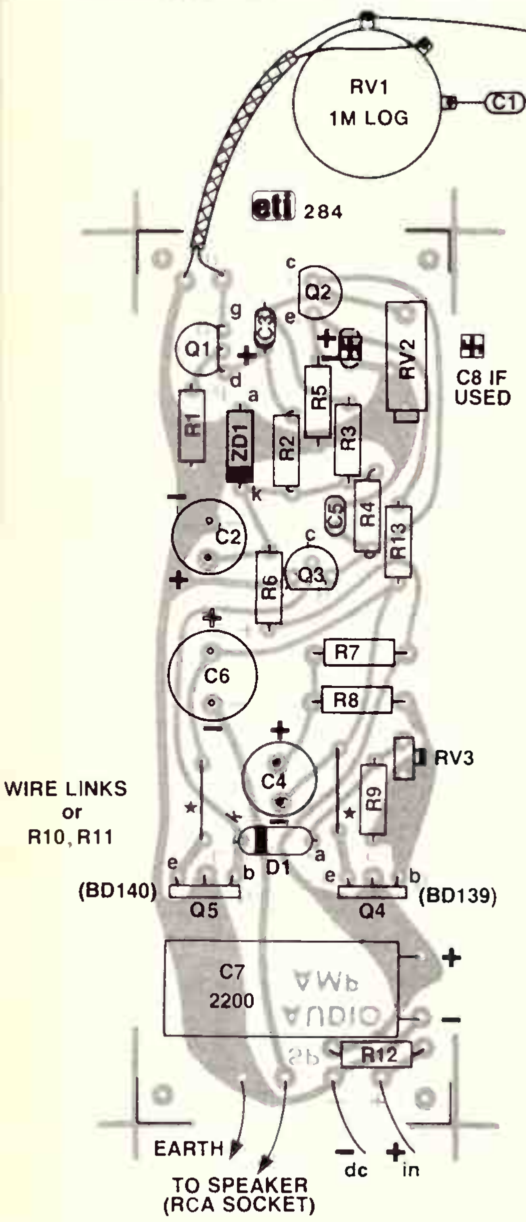
The actual output power will always be less than the figure from the equation due to voltage drops across emitter resistors (if present), and the output transistors, etc. However, the direct relationship between output power, dc supply voltage and the value of the load resistor is shown by this equation.

Increasing the supply voltage will also increase the bias voltage at the output transistors, and raise their quiescent current. The variable resistor, RV3 should be readjusted to keep the current at around 100 mA (120 mA if supply volts exceed 20 V). The value of R9 may need to be reduced to maintain RV3 within the range of supply voltages exceeding 20 volts.

The limit for the dc supply voltage is 25 volts, restricted both by the capacitor voltage ratings and the circuit design. For example, heat dissipation will increase. More significantly, high power amplifier designs use Darlington output transistors, or a configuration known as the quasi-complementary output stage to raise the current gain of the output transistors. The module can be adapted as the driver for an additional high power output stage, an issue beyond the scope of this article.

Increasing the gain of the circuit is another option if the module is to be used as an intercom system. The overall voltage gain is approximately determined by the values of R13 and R5. If a bypass capacitor (C8) is placed in parallel with R5, the circuit is essentialy in open loop for ac, and closed loop for dc. The gain will be very high, but will allow a small speaker to act as the microphone. By appropriate selection of the value of the bypass capacitor, the frequency response can be tailored to minimize hum from stray pickup. For example, a 47 μF capacitor will produce a lower cutoff frequency of approximately 600 Hz, ensuring clear speech free of 50 Hz hum. However, removing the ac feedback will compromise all other characteristics, and is recommended only for lo-fi use.

If two modules are to be used for a simple stereo amplifier, a more substantial power supply will be required. A 1 amp three terminal regulator will provide a good ripple-free dc supply and will minimize cross talk between channels. Use a 470 μF capacitor in lieu of the 2200 μF capacitor for C7 on each board and delete R12. The 470 μF capacitors will help handle transients. Power supply design was described in parts 1 and 2 of this series (ETI Oct-Nov, 1986).




## ETI-284 — PARTS LIST

**Resistors** ........ all ¼ watt 10% unless noted.

| | |
|---|---|
| R1 | 220R |
| R2 | 1k8 |
| R3 | 68k |
| R4 | 10k |
| R5 | 120R |
| R6 | 330R |
| R7 | 180R ½ watt |
| R8 | 56R ½ watt |
| R9 | 33R |
| R10,11 | 0R22 (optional, wire links if unavailable) |
| R12 | 3R9 ½ watt |
| R13 | 6k8 |
| RV1 | 1M ohm logarithmic or less to suit application |
| RV2 | 10k ohm, 10 turn trimpot |
| RV3 | 100R ohm miniature, vertical mount trimpot |

**Capacitors** ........ all 25V electrolytic unless noted

| | |
|---|---|
| C1 | 100n polyester, 100V or better |
| C2 | 470μ 16V |
| C3 | 2μ2 tantalum or mono |
| C4 | 220μ |
| C5 | 10n ceramic or polyester |
| C6 | 1000μ |
| C7 | 2200μ |
| C8 | 47μ (see text) |

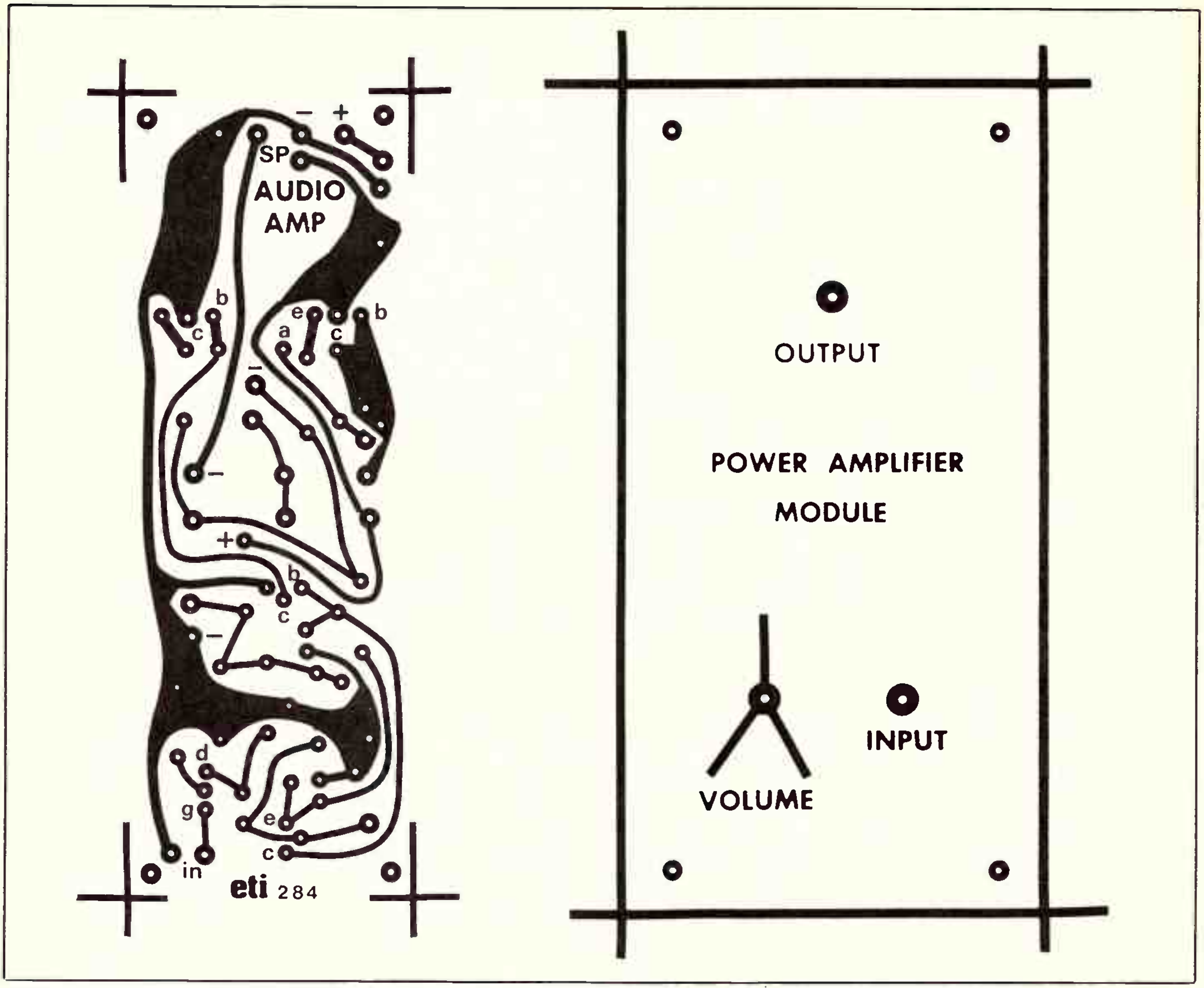
**Semiconductors**

| | |
|---|---|
| Q1 | FET type 2N5484 or 2N5458 |
| Q2 | BC549 or similar |
| Q3 | BC639 |
| Q4 | BD139 |
| Q5 | BD140 (preferably Beta matched to Q4) |
| D1 | 1N914 or similar |
| ZD1 | 1N961 or BZX79 10V, 400 mW Zener |

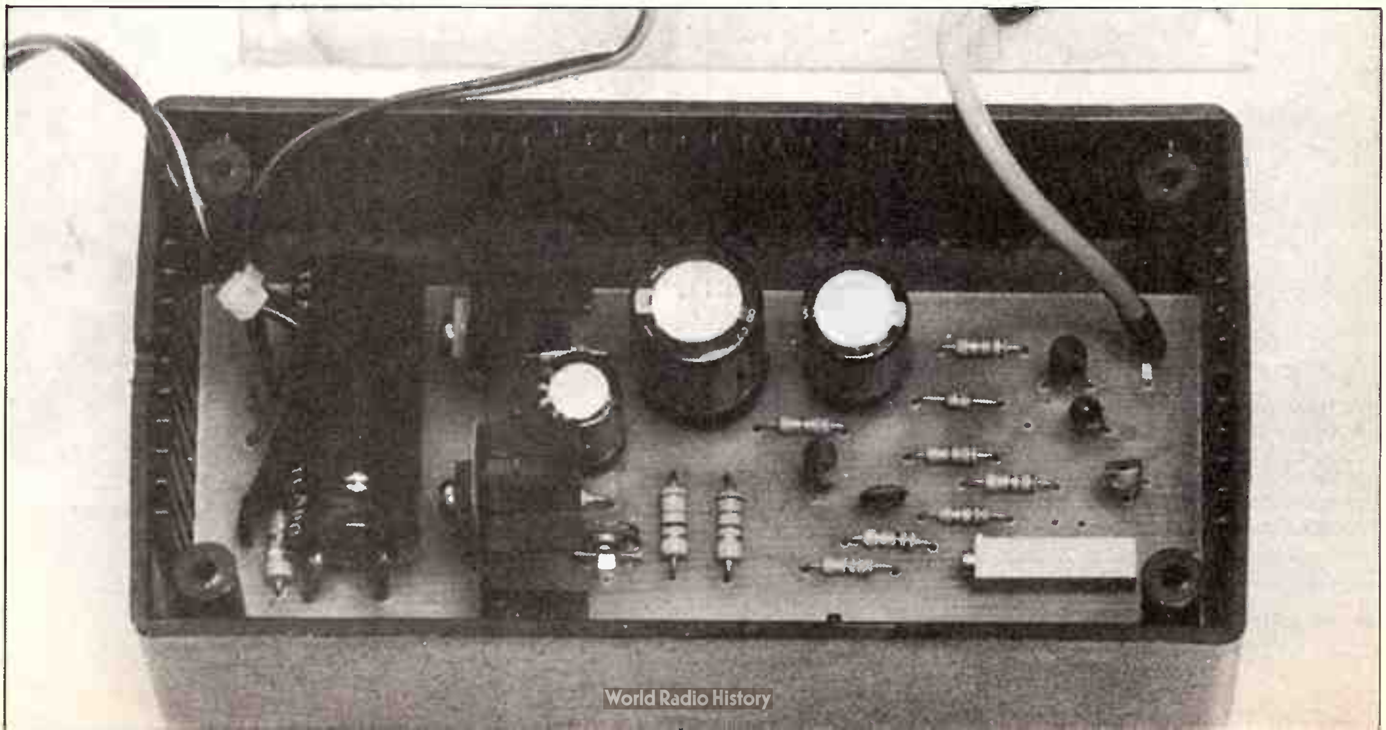
**Miscellaneous**

pcb or vero board; medium sized zippy box; 12V, 300 mA dc plug-pack; panel mount RCA socket; 3.5 mm panel mount phono socket; control knob; hook-up wire and coax; heatsinks.

**Price estimate: $15-$20**
without plug-pack

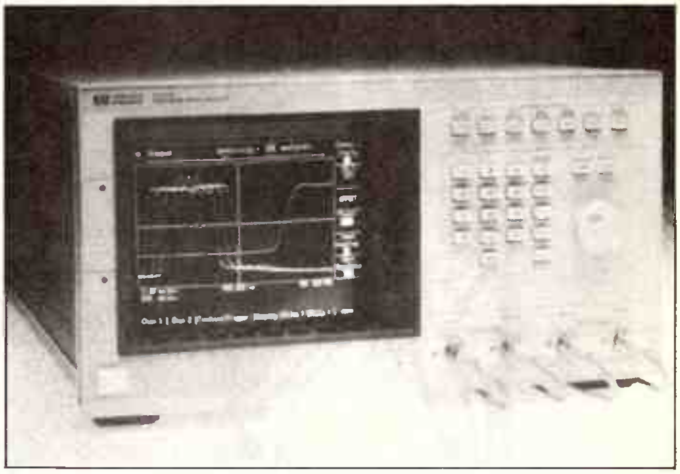



A close up of the board inside the box.



# 1 Gs digitizing scope

**Hewlett-Packard Australia has announced the introduction of the HP 54111D digitizing oscilloscope, with a 1 gigasample/second digitizing rate.**



The new scope has a 500 MHz repetitive bandwidth and a memory 8 Kbytes deep.

To produce the HP 54111D, HP was required to develop five state-of-the-art parts specifically for the product: gallium arsenide (GaAs) track-and-hold circuit, high-speed bipolar analogue-to-digital converter, NMOS time-base chip, NMOS high-speed 2K x 8 memory, and a 1 GHz saw oscillator.

By making this technological investment, HP believes that it can restructure the oscilloscope market from analogue to digital. Until the introduction of the HP 54111D, digital oscilloscopes did not compete well with analogue-storage oscilloscopes in the 250 MHz bandwidth range. However, by combining a super-fast digitizing rate with high bandwidth and deep memory, the HP 54111D will provide engineers with a digital alternative.

The HP 54111D's 1 gigasample-per-second digitizing rate translates into a 250 MHz single-shot bandwidth, enabling it to capture glitches as narrow as 1 ns wide.

With a variety of built-in analysis features and an 8-Kbyte-deep memory, the HP 54111D can compress, expand and measure the waveform. It can also position the window in positive or negative time with respect to the trigger, allowing the designer to trace a glitch back to its cause.

Among potential applications are analyzing critical signals in laser and other high-energy research. With sweep speeds up to 500 ps/-division, it can capture photodetector pulses single-shot, allowing the use of built-in routines to measure their parameters.

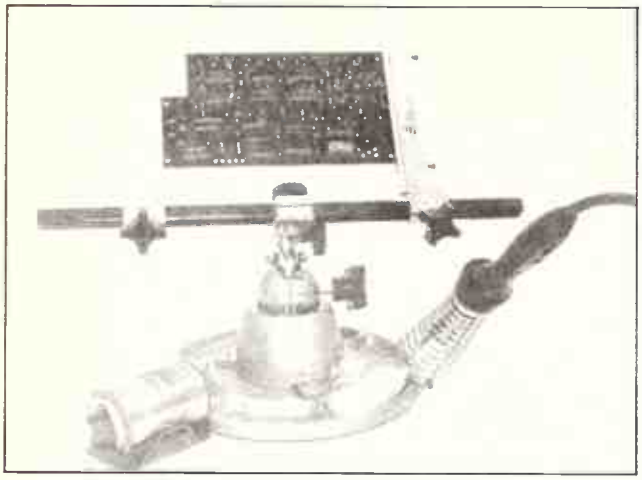
# Robot language

Australia currently has more than 600 robots, and there are many thousands in service internationally. And there is every reason to expect this robot population will grow at an increasing rate. As it does so there is an increasing need for standardization in the industry.

In a move reminiscent of that which has occurred in other industries, the biggest supplier is now imposing a standard on other manufacturers through the sheer weight of numbers. The biggest robot maker is a familiar name, General Motors through its subsidiary GM Fanuc, (GMF). Last year it introduced KAREL, touting it as the new industry standard for programming and communications in robotics.

Its designers claim it is easy to use and to understand, and is designed for the day-to-day operations manager who is not a computer wiz. It allows the user to create special routines which require fewer changes to the basic program, thereby resulting in greater flexibility.

Its key features include communications and sensor support, fast execution of programs, built-in diagnostics and user menus. It's similar to Pascal and is easy to program, read and modify.



A new soldering soldering station has been rleased by Scope laboratories. It features an adjustable spring loaded board holder on a 180 degree swivel, a stable tray with wiping sponge, non-slip feet and a solder reel dispenser. Price is $162 before tax. For more information, contact **Scope** on **(03)338-1566.**

**Mr Phil Hayes,** Manager, Robotics Division of John Hart Pty Ltd, the exclusive Australian distributor of the GMF KAREL programming language.

# World's fastest real time image processor LSI

The semiconductor Research Laboratory of Matsushita Electric Industrial (maker of National, Panasonic and Technics products in Australia) has developed the RISP-II, an improved version of the RISP (real time image signal processor) unveiled last February.

A single RISP-II allows an intelligent robot to detect the shape of an object in real time by processing image data at the speed of 10 nanoseconds (100 million commands per second), twice as fast as that of the first version. Parallel connection of multiple RISP-II allows for even higher-speed processing.

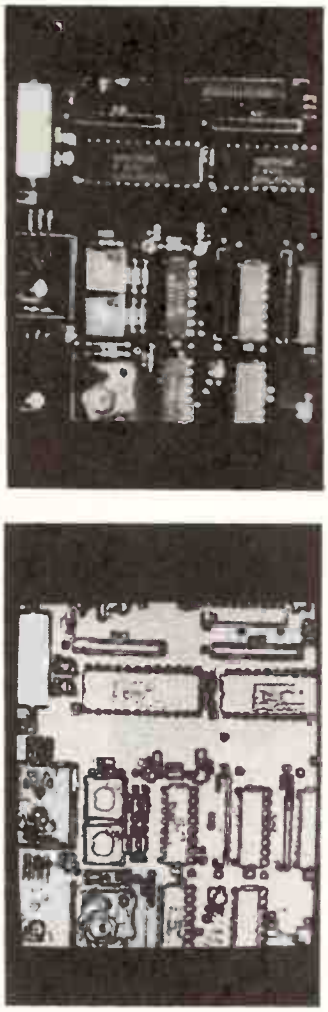
The need for high-speed image processing is increasing in various fields such as industrial robots, surveillance of production lines, medical equipment and artificial intelligence for the future. In those fields, it is necessary to process image data into digital signals so that a computer can recognize the image.

Conventional image-processing systems employ a specialized custom circuit board for each function with several LSIs. The new reprogrammable, one-chip RISP-II replaces the circuit board.

Matsushita employed its high-speed bipolar LSI technology of VIST (vertically isolated self-aligned transistor) for the RISP-II integrating 20,600 elements on each LSI chip. The RISP-II's expansion register also allows for expansion of a local area for more precise image processing.

For high-precision image recognition, the area for recognition must be flexibly expandable in accordance with the purpose of the image processing. The RISP-II can be programmed as often as necessary by individual users for specific purposes using its RAM memory area.

Functions include detecting the edge of pictures, removing picture noise, enhancing contrast, binary patternizing. As well as this, other functions are binary-pattern image data processing, pinning, pattern matching and enhancing picture quality of TV receivers.



**An original image (left)** and its binary pattern processed by the RISP-II.

Matsushita sees its applications in pattern recognition by robots; in medical equipment including CT scanners; for product surveillance on mass production lines; in image-input devices for telecommunication and office equipment; and in video information equipment.

Specifications are instruction cycle time: 10 nanoseconds; I/O image data length: 8-bits; image register: 3 × 3 pixels; internal data length: 16-bit; I/O level: ECL (emitter coupled logic); and power level: −5.2 V.

# Motorola's New TO220 triacs

Motorola has introduced a family of 27 isolated TO220 triacs that lower system cost, reduce mounting hardware and simplify assembly of product.

These isolated triacs are available in a wide range of current (6 to 25 amps) and voltage (220 to 800 volts) to give designers a choice for the most economical design. In many instances an isolated device may be substituted for a conventional non-isolated device and save the user a considerable amount of money by eliminating mica insulators and hard-to-use bushings, as well as reducing assembly costs.

These new thyristors are electrically identical to Motorola's standard line of triacs in the non-isolated TO220 package. The isolated triacs are capable of meeting the 1500 V UL requirement and offer increased reliability because the new assembly technique eliminates two solder joints found in internally isolated products.

This family of TO220 isolated triacs will find usage in applications such as motor controls, appliance controls, light dimmers and power supplies.

# VDO releases Little David

Instrument specialist VDO Australia has released a new, highly compact electric current/air pressure signal converter for industrial applications, where pneumatically controlled equipment can be linked by electrical circuitry.

The VDO Little David I/P converter (group 22/06) will convert standard electronic signals (0/4 to 20 mA) into standard pneumatic signals (3 to 15 psi/0.2 to 1 bar).

Its unique construction, with a fixed coil and low moving mass (100 mg) magnet, makes it a small size, lightweight instrument that is not sensitive to shocks or vibrations.

The VDO unit's principle of operation gives a linear correspondence of electric input and pneumatic signal output. It has European intrinsic explosion protection safe approval (E EX ib II CT6) and can be used in hazardous areas.

Two versions of the VDO I/P converter are available: a 106 mm (h) × 36 mm (w) single clip-on unit with ⅛" internal NPT connectors, suitable for mounting on DIN rails; and twin unit, arranged on a 100 mm (h) × 160 mm (d) Eurocard, suitable for mounting in 19" racks with quick release fasteners or M 2.5 screws. The rack-mounted twin unit's front panel is 128.5 mm (h) × 35 mm (w).

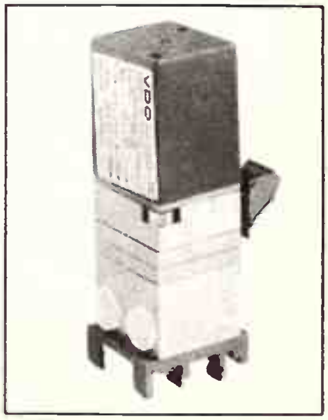
Both versions can be specified for direct or reverse characteristics, and for electric input ranges of 0.20 mA or 4-20 mA.

Connections are screw-type terminals, solder lugs, wire-wrap/permi-point pins or flat electrical connectors, and ⅛" NPT internal for air supply and signal output.

The new VDO I/P signal converter offers high output volume of approximately 1.6 scfm (3 kg/h), low air consumption (0.028 scfm), high resolution and short response time (0.3 s with 0.0035 cf of volume).

These features, combined with high adaptability for range of input and output, make the instrument a versatile tool for process applications.

The new Little David is available from VDO Australia and expert agents Australia-wide.

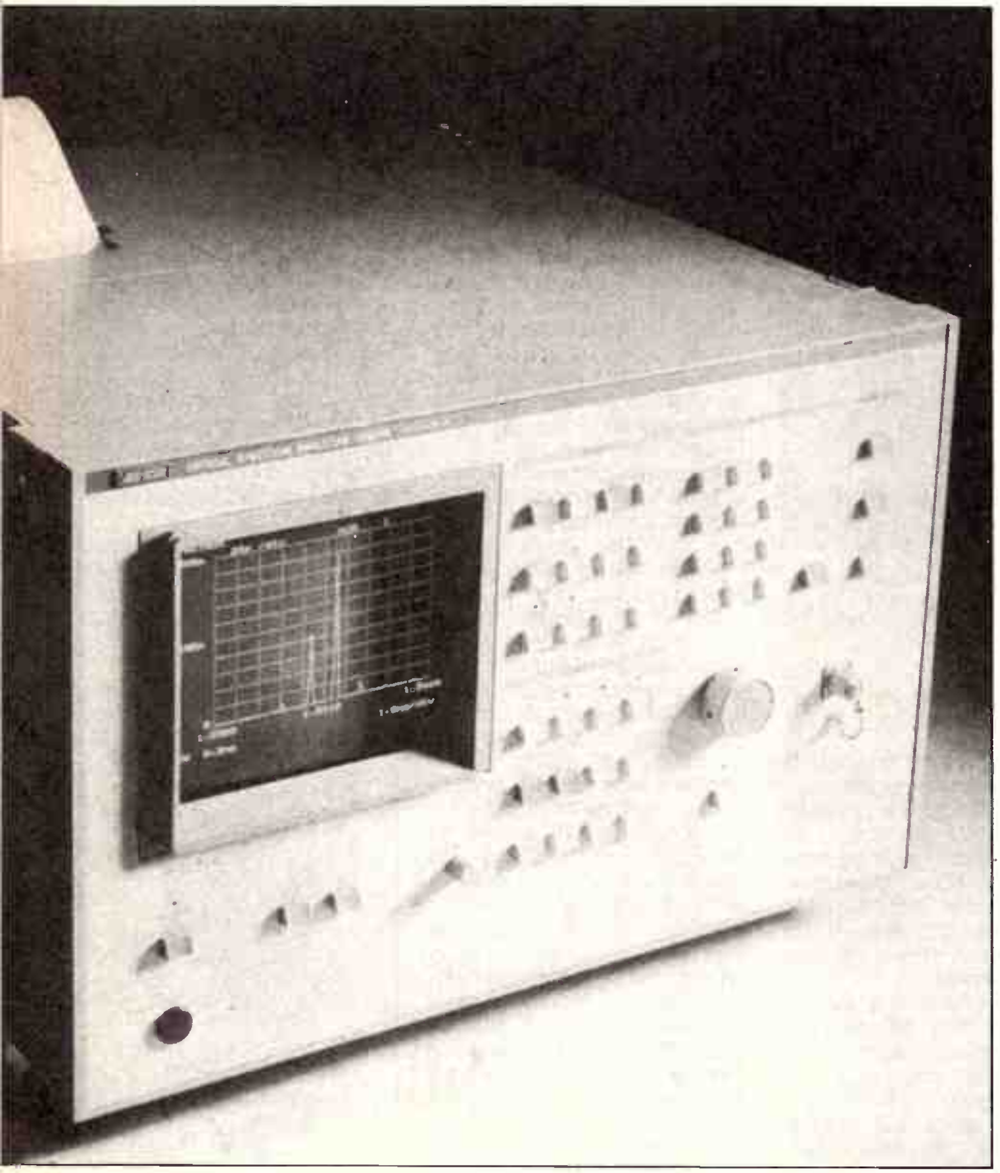


# OPTICAL SPECTRUM ANALYZERS

*Another in our occasional series on the practicalities of optical fibre usage. This month, we look at determining the 'colour' of the light.*

**Yoji Sonobe**

*Yoji Sonobe is with the measuring instruments division of Anritsu Electric, Tokyo, Japan.*



The Anritsu MS96A optical spectrum analyzer.

Optical fibre communications have rapidly become a reality. They have moved with surprising rapidity from being laboratory playthings to the mainstay of many existing and planned communications networks.

In addition, optical discs and other data recording and retrieval systems using light are already in use, showing how great the role of opto-electronics is becoming in our information-oriented society. Compact discs for audio reproduction, optical storage media, either in the form of cards or of discs, are also rapidly penetrating the marketplace.

The performance of these optical systems is determined by the spectra of the light emitting components of which they are composed. Specifying this spectra, being able to quantify it with certainty, is thus of tremendous importance to anyone wishing to design with such a system.

## Measuring

So the problem becomes: how to make this measurement? The device that does the trick is called an optical spectrum analyzer, by analogy with the similar device used in conventional electronic communications systems. Its capabilities include the ability to determine frequency and level over the range of interest. As a result, optical spectrum analyzers can best be discussed in terms of their wavelength range, sensitivity, resolution and wavelength accuracy. These necessary characteristics can be thought of as follows:

1. Wavelength range. For use in optical communications, the ability to measure 0.6 µm to 1.6 µm wavelengths and for use in visible light applications, around 0.37 µm.

2. Sensitivity. The ability to measure optical power of −60 dBm, necessary for measuring loss wavelength characteristics.

3. Maximum resolution. Resolution of

0.1 nm, necessary for measuring the spectrum of laser diodes.

4. Wavelength accuracy. An accuracy of ±1 nm for precise wavelength reading.

## Methods

Of course, there are different ways to do this. The two most favoured methods of spectrophotometry include dispersion spectrophotometry and interference spectrophotometry. The former method includes spectrophotometry by prisms and diffraction gratings, while the latter includes such methods as those using the Michelson or Fabry-Perot interferometer.

With the interference spectrophotometric method, light energy can be used in large amounts without using a slit. In addition, it has the advantage of allowing simultaneous measurement of all wavelengths of light. Shortcomings of this method include the fact that large-scale computations (Fourier transforms) are required, and when the measured wavelengths are short, extremely strict mechanical precision is demanded of the equipment used. This method is used in spectroscopes requiring high resolution of the far infrared range.

In contrast, the dispersion method is used for spectrophotometry of the ultraviolet, visible near infrared, and longer wavelengths. Wavelength sweep in spectrophotometry using a diffraction grating may be performed by the general method of revolving the diffraction grating, or light reception via a photo-diode array. In addition, some machines use an acoustic optical component equivalent to the diffraction grating, performing wavelength sweep electrically.

However, sufficient performance cannot be obtained for accurately measuring both

> ***However, sufficient performance cannot be obtained for accurately measuring broad wavelengths and also the narrow light emitting spectrum of laser diodes. For this reason, the optimum method is that in which the diffraction grating is revolved.***

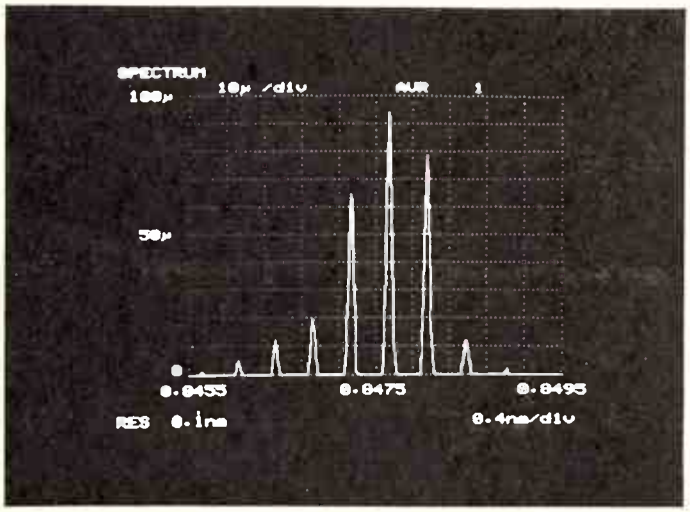



**Figure 1.** 0.85 $\mu$m LD spectrum.

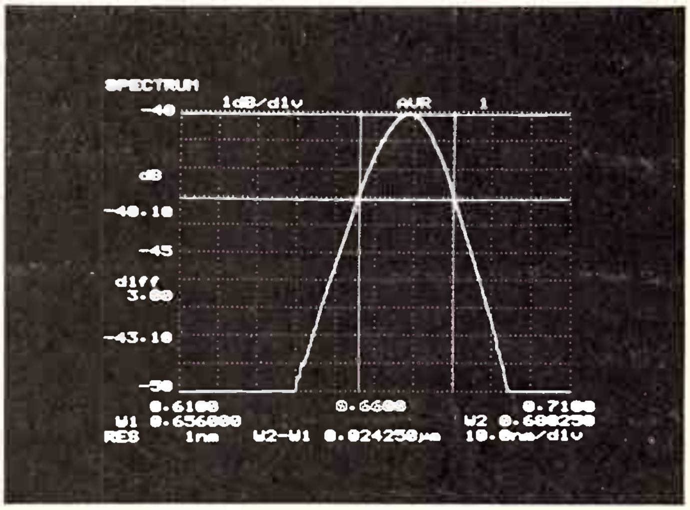



**Figure 2.** 0.66 $\mu$m LED spectrum.

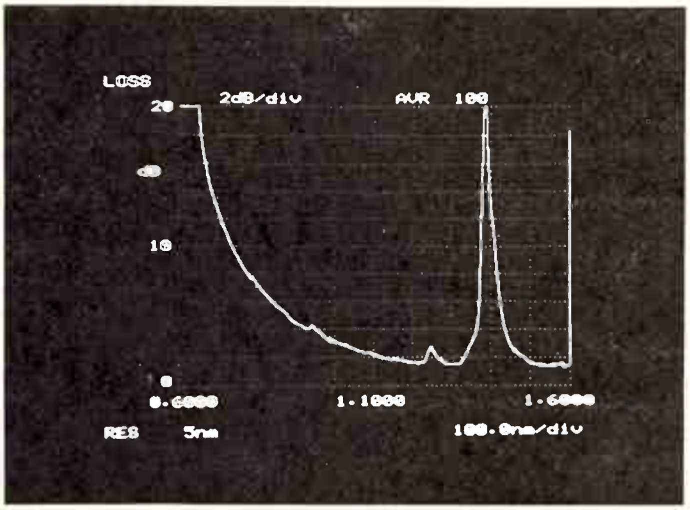



**Figure 3.** Loss wavelength characteristics of GI fibre (2 km).

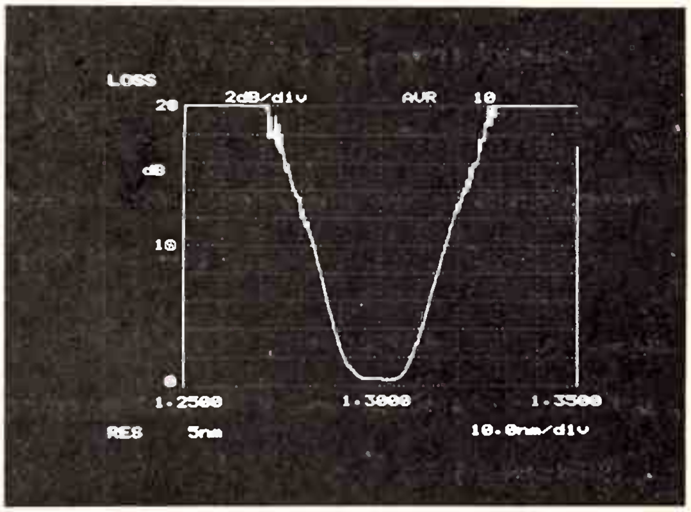



**Figure 4.** Loss wavelength characteristics of optical fibre.

broad wavelengths and also the narrow light emitting spectrum of laser diodes. For this reason, the optimum method is that in which the diffraction grating is revolved.

### Diffraction gratings

A diffraction grating is a piece of glass on the surface of which have been engraved minute grooves (several tens to several thousands per mm) at equal intervals. The principle of light diffraction using the diffraction grating is actually quite complex, but essentially it means that the diffracted rays of light will add or subtract depending on their phase relationship. When the light is projected onto a screen it produces patterns of light and dark, called fringes. The separation of these fringes is determined by the wavelength of the incident light and the distance between the grooves. Since the latter is well known, the former can be determined by studying the fringe pattern.

In a practical spectrum analyzer, optical systems are required to introduce the incident light to the diffraction system, and for condensing the beams.

Essentially, the optical energy is focused onto the diffraction grating. The light is them focused back onto an optical fibre, where its intensity is measured. By physically changing the angle of the grating, it is possible to map the interference pattern as it presents itself to the fibre. This allows computation of the frequencies present in the incident light.

### Composition

A practical instrument is composed of a photometry section and a control/processing section, with the photometry section further divided into spectrophotometry section, diffraction grating drive section and light receiver section.

The basic performance of an optical spectrum analyzer is determined by its spectrophotometry section characteristics. Items such as wavelength range, resolution and wavelength accuracy in particular depend upon the spectrophotometry section. When selecting a diffraction grating, the first element to be considered is its grating constant. The grating constant $d$ (= $1/G$, where $G$ equals the number of grooves per millimetre), has an inverse relation to the resolution and wavelength range.

To cover a wide wavelength range while maintaining a high diffraction efficiency, it is necessary to use a diffraction grating with a small number of grooves per mm. All things being equal, this will maximize the resolution of the instrument. However, since most current instruments have an optical fibre input, the resolution is relatively poor due to unavoidable limitations of the size of the image on the output slit surface. This is caused by the diameter of the input fibre core, and distortions of the image due to aberrations of the condensing optical system. Accordingly, in order to give the system sufficiently high resolution (<0.1 mm) for separating a semiconductor laser's longitudinal mode, it is necessary to use a diffraction grating with a large number of grooves per mm.

Another factor that needs to be considered is how accurately the diffraction grating can be moved. The accuracy of the drive method (in the case of most instruments, the motor) directly affects the accuracy of the wavelength. Normally, this conversion is performed mechanically by means of a sine bar and worm gear. With this method, the wavelength accuracy relies heavily on the mechanical parts, and is thus susceptible to vibration and temperature changes. In contrast, some modern instruments use a microcomputer to perform calculations and a linear connection is utilized in the mechanical section. A servo motor with excellent response characteristics is used for the drive motor. When the wavelength is set on the front panel, the CPU calculates the angle signal $\theta$, and this is passed through the D/A converter to the motor drive circuit. In this way, the diffraction grating rotation angle can be controlled accurately over a wide range.

After the light has passed through the diffraction grating the last task is to send it to the light receiver station. The principle characteristic of this section of the analyzer is its resolution.

The resolution setting is performed by controlling the output slit by means of a stepping motor. Also, since the wavelength range is a wide 0.6–1.6 μm, Si-PIN diodes and Ge-APDs are used for the light reception component. They are applied respectively to the wavelengths for which they have the best S/N. Light receiver switching is performed by an optical switch.

Optical filters are used for excluding secondary light generated by the diffraction grating but unnecessary to measurement. The light to be measured is chopped by a tuning fork chopper, and after photo-electric conversion, synchronous detection is performed. In this way, detection of low levels of light is made possible. The lowest level of light detectable is determined by the efficiency of the diffraction grating, the loss in the optical system used, the sensitivity of the light reception component, and noise characteristics. In the 0.6 μm–1.6 μ range, a sensitivity of −65 dBm or lower is achievable.●

## ADVERTISERS' INDEX

*ADVERTISING INFO No. 18*

# ADVERTISING INFORMATION COUPON

**Electronics Today INTERNATIONAL**

## ADVERTISING INFORMATION COUPON

*To find out more about the products and services in this issue, circle the ADVERTISING INFORMATION COUPON numbers from the advertisements, photocopy this coupon, enclose it in an envelope and send to:*

FREEPOST No. 4
E.T.I. Magazine
P.O. Box 227
Waterloo, N.S.W. 2017
**No stamp necessary if posted in Australia**

Please circle the category that best fits you.

**A. Engineer/Designer**
**B. Technical Officer**
**C. Technician**
**D. Programmer/Analyst**
**E. Manager**
**F. Interested Consumer**

Name ..............................................................................

Company ..........................................................................

Address ...........................................................................

.............................................................. Postcode ..............................

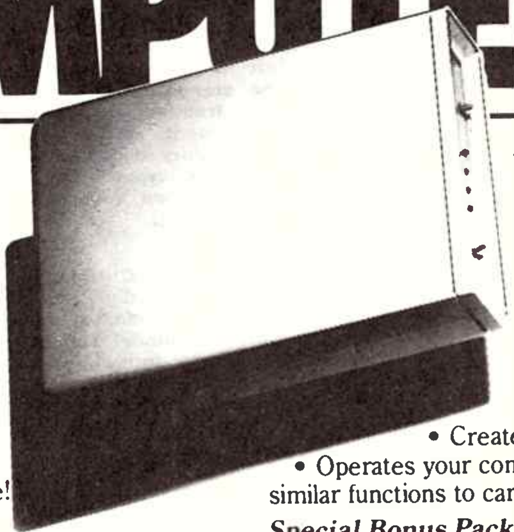
| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 26 | 51 | 76 | 101 | 126 | 151 | 176 | 201 | 226 | 251 | 276 | 301 | 326 |
| 2 | 27 | 52 | 77 | 102 | 127 | 152 | 177 | 202 | 227 | 252 | 277 | 302 | 327 |
| 3 | 28 | 53 | 78 | 103 | 128 | 153 | 178 | 203 | 228 | 253 | 278 | 303 | 328 |
| 4 | 29 | 54 | 79 | 104 | 129 | 154 | 179 | 204 | 229 | 254 | 279 | 304 | 329 |
| 5 | 30 | 55 | 80 | 105 | 130 | 155 | 180 | 205 | 230 | 255 | 280 | 305 | 330 |
| 6 | 31 | 56 | 81 | 106 | 131 | 156 | 181 | 206 | 231 | 256 | 281 | 306 | 331 |
| 7 | 32 | 57 | 82 | 107 | 132 | 157 | 182 | 207 | 232 | 257 | 282 | 307 | 332 |
| 8 | 33 | 58 | 83 | 108 | 133 | 158 | 183 | 208 | 233 | 258 | 283 | 308 | 333 |
| 9 | 34 | 59 | 84 | 109 | 134 | 159 | 184 | 209 | 234 | 259 | 284 | 309 | 334 |
| 10 | 35 | 60 | 85 | 110 | 135 | 160 | 185 | 210 | 235 | 260 | 285 | 310 | 335 |
| 11 | 36 | 61 | 86 | 111 | 136 | 161 | 186 | 211 | 236 | 261 | 286 | 311 | 336 |
| 12 | 37 | 62 | 87 | 112 | 137 | 162 | 187 | 212 | 237 | 262 | 287 | 312 | 337 |
| 13 | 38 | 63 | 88 | 113 | 138 | 163 | 188 | 213 | 238 | 263 | 288 | 313 | 338 |
| 14 | 39 | 64 | 89 | 114 | 139 | 164 | 189 | 214 | 239 | 264 | 289 | 314 | 339 |
| 15 | 40 | 65 | 90 | 115 | 140 | 165 | 190 | 215 | 240 | 265 | 290 | 315 | 340 |
| 16 | 41 | 66 | 91 | 116 | 141 | 166 | 191 | 216 | 241 | 266 | 291 | 316 | 341 |
| 17 | 42 | 67 | 92 | 117 | 142 | 167 | 192 | 217 | 242 | 267 | 292 | 317 | 342 |
| 18 | 43 | 68 | 93 | 118 | 143 | 168 | 193 | 218 | 243 | 268 | 293 | 318 | 343 |
| 19 | 44 | 69 | 94 | 119 | 144 | 169 | 194 | 219 | 244 | 269 | 294 | 319 | 344 |
| 20 | 45 | 70 | 95 | 120 | 145 | 170 | 195 | 220 | 245 | 270 | 295 | 320 | 345 |
| 21 | 46 | 71 | 96 | 121 | 146 | 171 | 196 | 221 | 246 | 271 | 296 | 321 | 346 |
| 22 | 47 | 72 | 97 | 122 | 147 | 172 | 197 | 222 | 247 | 272 | 297 | 322 | 347 |
| 23 | 48 | 73 | 98 | 123 | 148 | 173 | 198 | 223 | 248 | 273 | 298 | 323 | 348 |
| 24 | 49 | 74 | 99 | 124 | 149 | 174 | 199 | 224 | 249 | 274 | 299 | 324 | 349 |
| 25 | 50 | 75 | 100 | 125 | 150 | 175 | 200 | 225 | 250 | 275 | 300 | 325 | 350 |

MAR '87 *For a prompt reply: Post today!*

**POST TODAY!**

# $275 SOFTWARE & 300/1200 MODEM PACKAGE FOR ALL PC/MS-DOS COMPUTERS!

Full VIATEL support



Announcing the All-Australian HYPEC ELECTRONICS 300/1200 MODEM Comms Package!

**Never before such a Value-for-Money offer: Here's what you get for just $275:**

**HYPEC 300/1200 BPS MODEM:**

- Designed and manufactured in Australia to suit local communications standards.
- Optional HYPEC AutoDialer Accessory available!
- Suits any computer with RS232 Interface!
- Connects to Viatel at 1200/75 BPS!
- Dials up Bulletin Boards at 300 BPS Full Duplex!
- Goes on-line to Databases and remote Mainframes!

Telecom Approval pending.

**PLUS**

Australia's own feature-packed COMMUNICATIONS SOFTWARE PROGRAMME! **SuperCom II FREE OF COST! Yes! Normally $175 – it's FREE with your HYPEC Modem Package!**

*SuperCom II, Australia's own highly-acclaimed Communications Software Programme:*

- Provides full support for the Viatel Videotext system, in addition to all on-line databases and mainframe computers!
- Emulates all popular terminals!
- Automatic Log-on!
- Saves and replays frames, including Viatel!
- Sends and Receives to mainframes!
- Captures dial-up sessions to disk!
- Sets-up advanced dialling directories and batch command files!
- Uses Modem 7 & YAM batch transfer protocols!
- Creates & Edits custom terminal emulations!
- Operates your computer remotely in photostat mode, with similar functions to carbon copy*!

***Special Bonus Package Offer!*** HYPEC Automatic Dial-Up Answer Unit just $50 with every HYPEC Modem sold!

*You just won't beat this fantastic offer on communications equipment anywhere else. So call us on the HYPEC Hotline, and BUY AUSTRALIAN-MADE!* *Registered trade name.

***HYPEC ELECTRONICS PTY LTD***
***21 Ryedale Rd, West Ryde, Sydney NSW Australia 2114.***
***Tel: (02) 808 3666. Fax: 808 3596. Cable: LAMRON SYDNEY. Telex: AA71551 LAMRON.***
***TELEPHONE ORDER HOTLINE: (02) 808 3666.***

***Bank cheque, money order, Visa, Bankcard & MasterCard accepted.***

HYPEC ELECTRONICS

THE ADVERTISING AGENCY: HYPEC.7

ADVERTISING INFO No. 19

# SCRUTINY OF THE BENCH

*Weighing up the evidence on the modern bench multimeter. Do they offer anything beyond the DMM you put in your pocket?*

The first digital multimeters were introduced during the 1970s, and after a number of hiccups are now accepted as the industry standard. Essentially, the first DMMs simply duplicated the features of the analogue multimeters they replaced: they could measure the three basic electrical parameters to about the same level of accuracy.

Within a short order of time it became apparent that the hardware developed for these DMMs was amenable to developments in a number of areas. One was in adding computer control, another was increasing accuracy to the point where the instrument could serve as a laboratory standard.

There was a price for doing either of these things, however, and that was increasing size and complexity. It rapidly became impractical to power the DMM from batteries, and certainly impossible to slip it into a brief case. So a new instrument was born, the bench digital multimeter.

## Achitecture

There are two basic methods by which a digital voltmeter takes an input signal and turns it into a digital readout: successive approximation and multislope conversion.

A successive approximation analogue-to-digital conversion begins when an input voltage is sampled and allowed to charge up a capacitor. Then the input is disconnected and the voltage held on the capacitor is applied to a comparator, as in Figure 1. Meanwhile a reference voltage source is applied to the other input of the comparator. The comparator signals that the reference voltage is below the input, and the reference steps its voltage up one level and tries again. When the two are equal a signal is sent to the reference generator to stop further increases in voltage, and to send digital output to the display.

Multislope or dual slope conversion begins with the input at zero and all capacitors discharged. Then an input is applied to an integrator for a fixed time. (See Figure 2.) The output of the integrator is an upward ramp, the slope of which depends uniquely on the input signal. An extremely accurate counter keeps the input connected to the integrator for a fixed period, then disconnects it and connects a precision voltage reference of opposite polarity. Since the voltage is accurately known, the slope of the integrator output is also known, and the time it takes to return to zero is an accurate measure of the voltage at the disconnect time, which, of course, is directly related to the voltage on the input.

Both methods have their advantages and disadvantages. Successive approximation was the first method to be used, and offers cheapness and simplicity, but it provides no method of rejecting noise on the input without slowing down the measurement speed.

System accuracy is also a problem, as it depends on the internal resistance of the sample-and-hold capacitor. If this leaks at all during the conversion there will be errors in the final result. Even with high quality capacitors, errors in the order of 100 parts per million are not uncommon.

Another problem is that the accuracy of the approximation is only as good as the

**Fluke 37**
**The Fluke 37 has full autoranging on each test function. It features a 3.5 digit display with the standard Fluke analogue bar graph. The bar graph is uprated 10 times faster than the digits. It's claimed to be fully overload protected, in fact, according to Fluke literature, 31% of all components on board is dedicated to high energy protection. It has auto-hold, automatic self test and auto-polarity swapper. Frequency response is quoted at 100 kHz for the 3 dB point. Available from Elmeasco.**

**DSE Q1550**
**Dick Smith's entry into the world of digital meters is a 4.5 digit pushbutton meter using dual slope integration which leads to a high degree of immunity to noise. Vdc accuracy is quoted at 0.5%. It also features continuity and diode testing.**

**Philips PM2544**
**Philips calls this a logic multimeter because of the extensive microprocessor control built into the instrument. It measures all the standard electrical parameters plus frequency, event counting, time and peak voltage. It also offers plug-in memory modules for 'capture and compare' type trouble shooting. Philips claims an accuracy of 0.2% on the Vdc reading.**

**Keithley Model 196**
**Keithley Instruments of Cleveland Ohio has introduced a 6.5 digit multimeter onto the Australian market via Scientific Devices. The model 196 is designed in a half-rack format, and features 30 parts per million accuracy on Vdc as well as full GPIB programming.**

**Brown Boveri Scope Multimeter**
**The M2050 from Kent Instruments combines a digital multimeter with a solid state oscilloscope suitable for viewing low frequency signals. The multimeter features 32 measurement functions covering voltage, current and resistance. It has 3.5 digits. The LCD oscilloscope provides a high contrast graphic image of the waveform with a 128 x 64 dot-matrix.**

**Tai Tien CD1**
**A 7.5 digit meter from Taiwan. It has all the standard measuring ranges plus relative dB and frequency. Accuracy of 0.01 is claimed for Vdc. Available from Emona Instruments.**

Keithley Model 196

smallest increments of the reference supply. The more steps there are, the longer it takes to do the conversion but the coarser the result.

Dual slope is generally considered to be a much better method. It can provide good noise rejection by making the ramp-up time one or more multiples of the line frequency. The clock frequency is not directly related to the measurement accuracy, so it can be phase-locked to overcome supply frequency variations. The same is true of the integrator capacitor and resistor. The value of neither is directly related to the measurement accuracy. Since component accuracy is one of the big problems in developing accurate DMMs, this is an important consideration.

There are problems with dual slope integration, however. Since the whole system is tied to the power frequency, it is difficult to design it to be really fast. It may be possible to go to a few multiples of the power frequency, but that's all.

Another time related problem is that the answer to the conversion can only be known some time after the input is disconnected from the integrator. This will contribute to a slow autoranging capability.

## Significant digits

In truth, there is little to differentiate between these two methods in portable DMMs, which typically have three and a half digits. However, one of the justifications for a bench multimeter is a desire for greater accuracy. When multimeters start stretching to six, seven or even eight digits then the limitations of the methods become very apparent.

If multislope conversion is stretched to six digits, a range of problems affects the readings. For instance, dielectric storage effects in the capacitor give zero crossing errors even when the best grade capacitors are used.

Transistor switching at the beginning and ends of the ramps can cause errors that vary with temperature. At this level of accuracy, variations in clock timing during a long ramp-up or down can become significant as well. ▶

DSE Q1550

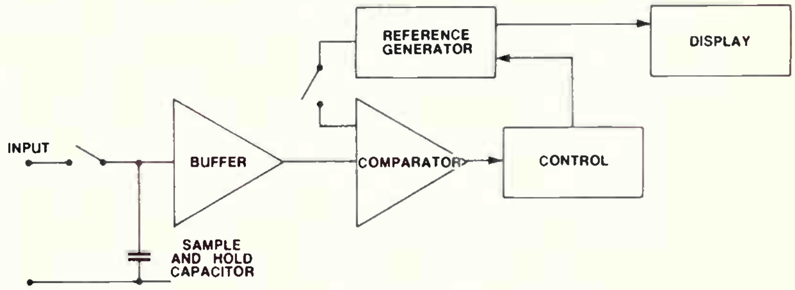



**Figure 1.** Block diagram of successive approximation architecture.

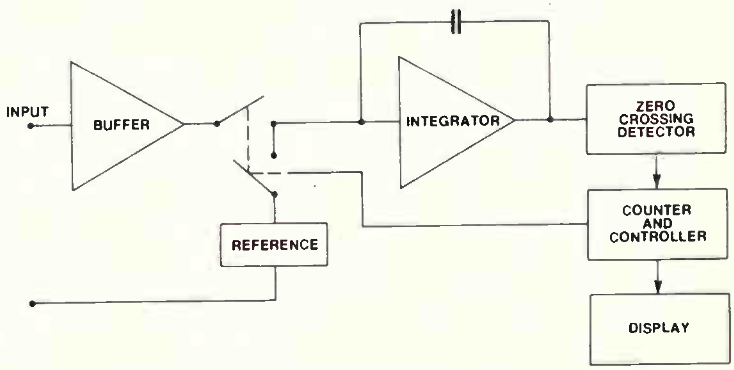
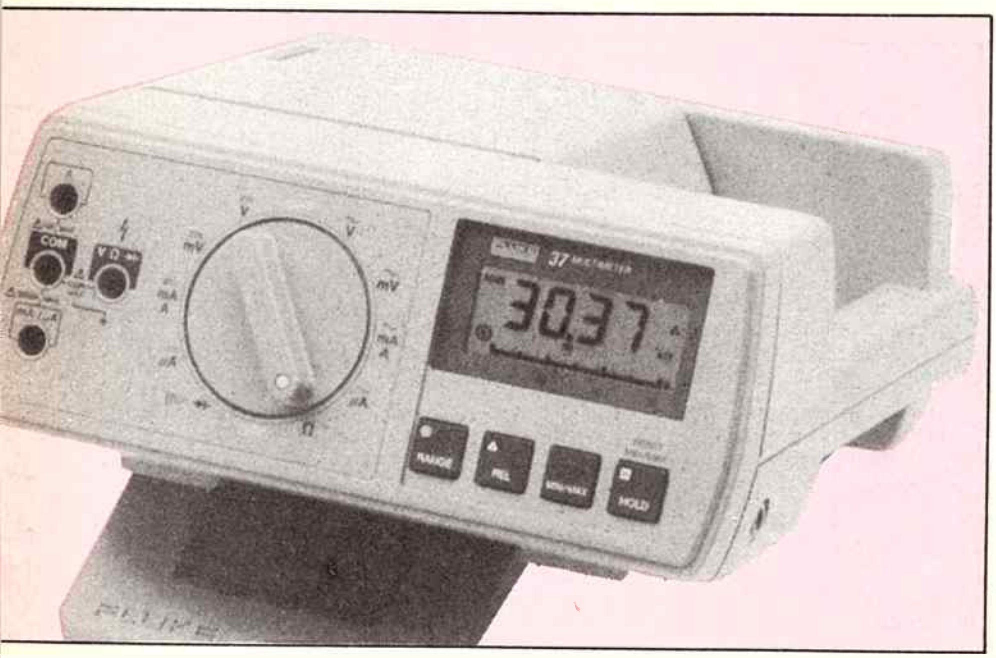



**Figure 2.** Block diagram of multislope approximation architecture.




**Fluke 37**

Generally, neither the dual slope nor successive approximation method will support meaningful measurement beyond six digits. Extra digits can be inserted, however, by mathematical means. Often the method is to integrate the reading over time and average out the results to give the remaining digit. For instance, if the instrument can reliably measure down to 1 microvolt, it is possible to average 10 measurements and get a reading with 0.1 microvolt accuracy. Sometimes this method is even extended to give a second statistical digit.

In many instances this probabilistic approach to measurement is not good enough. Recent work has attempted to find ways to improve the accuracy of dual slope so that it can be used on modern DMMs, and also to find new ways of doing the analogue-to-digital conversion that don't suffer from these inherent problems. One method, pioneered by Solartron, is called pulse width conversion.

In PWC, a square wave is applied continuously to the input. This is integrated and tuned into a triangular wave. Two comparators are connected to this in such a way that one detects the positive going peaks of the wave, the other the negative ones. The result is a series of pulses out of the comparators.

These pulse trains are fed to a circuit which compares the length of both pulses. If they are identical, then the input may be assumed to be zero. If an input is applied it will add to the square wave, forcing it higher and resulting in the pulses in the upper detector becoming longer. The difference between the length of the pulses is a measure of the voltage.

There are a number of advantages to this way of doing things. There is an inherent zero measurement built into it. And it is extremely fast. An out of range signal can be detected almost instantaneously so that autoranging can be done very quickly. This has the advantage of protecting the circuit from stress due to over-range signals.

*"Generally neither the dual slope nor successive approximation will support meaningful measurement beyond six digits. Extra digits can be inserted, however, by mathematical means."*

The method is inherently reliable and allows production of a genuine eight-digit instrument. The problem is that the ability to measure voltage is so sensitive that the reading can be swamped by a host of unexpected and unforseen parameters. For example, changes in humidity can change the surface leakage of the pc board, thermal shock can change component values slightly, even incorrect mounting of components can have an effect. If a highly stable six-volt Zener is mounted with one lead longer than the other, for instance, an error of roughly five parts per million can be thermally induced.

These considerations point to a need for additional circuitry to compensate for predictable changes in components over time. Long term drift in resistors can be fairly accurately predicted, and compensation arranged. The thermal co-efficient of resistors and semiconductors is also well known and can be compensated for by additional circuitry.

## Computer control

The type of operation one can expect changes with the accuracy of the instrument. A hand-held, three-and-a-half-digit machine will suffice for most trouble shooting and bench work. The big machines with six or eight digits really only come into their own in laboratories or assembly lines where precise measurement to within a few parts per million is mandatory.

These are also environments where various types of computer aided operation are of great help. Such operation can take the form of controlling the instrument, either with the aid of an on-board computer or remotely over a communications interface. Alternatively, an on-board processor can be used for performing some sort of numerical

manipulation on the results obtained, such as might happen in turning a voltage level into dB.

These days, it is comparatively simple to set up a network to control instruments. The key is the industry standard IEEE-488 interface. The standard was published in 1975 by the US-based Institute of Electrical and Electronic Engineers as an interfacing standard for instruments. Largely based on the Hewlett-Packard interface bus HPIB, the standard was revised in 1978 as the general purpose interface bus, or GPIB.

GPIB provides a mechanical, electrical timing and data standard for users. In a typical system, one device is selected as the controller, while other devices are defined as listen only (display), talk only (keyboard) or talk and listen (multimeter).

A typical application might be in a process line, where a series of measurements needs to be made. It's possible to imagine a situation where the device under test is plugged into the bus, along with a multimeter, a printer and a controller. The computer then stimulates the device into action, the multimeter makes measurements at a number of different points, perhaps scales some of them to make more sense of the readings, and then prints them out on a printer. In the event that any of the results are out of tolerance the multimeter sends a message back to the computer which sounds an alarm or stops the process.

Actually, with some modern multimeters, it's possible to dispense entirely with the controlling computer, since the multimeter itself has sufficient computing power to control the bus. ●

*The editor wishes to acknowledge the assistance of Tech Sales and Philips Scientific and Industrial Division in the preparation of this article.*


Tai Tien CD1

Brown Boveri


Philips PM2544

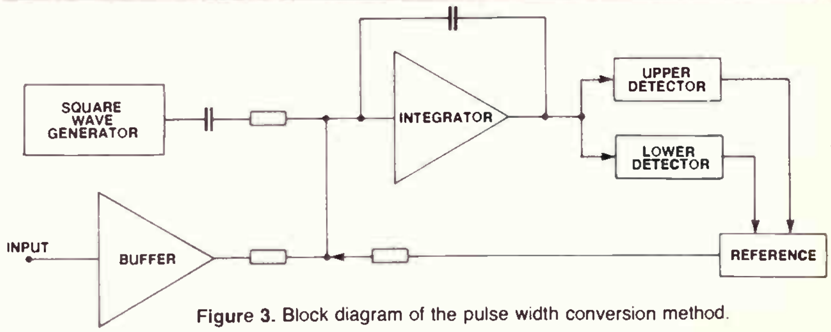



**Figure 3.** Block diagram of the pulse width conversion method.

ENGINEERING

# REPAIRING THE PHILIPS ELC2060 VARICAP TUNER

*A rundown of common faults and their likely sources from an experienced serviceman.*

**Gerry Nicholson**

Although this article concentrates on the Philips ELC2060 tuner, the principles outlined apply to most varicap tuners. While it is often difficult to obtain some specialized circuits and parts, the Philips tuner does not present these problems.

Some varicap tuners use MOSFETs in the rf stages, others such as the Matsushita ENV77405F use thick-films to accommodate some circuitry. Unfortunately, the thick-film is no longer available although we have managed to duplicate it.

The ELC2060 tuner was first released in this country in the Philips CTV model K11. Philip's first receiver (K9) had a miniature turret tuner. The ELC2060 tuner was used in early Kreisler pushbutton sets and in later Pye and Kreisler receivers, which were both Philips sets in disguise, as Philips took over both companies. Some Princess portables also use this tuner.

The tuner in a television receiver, as in any superhetrodyne receiver, must amplify that rf signal and produce an intermediate frequency of suitable amplitude with a favourable signal-to-noise ratio. In the case of Australian TV, the IF is 36.875 MHz. All television tuners have automatic gain control to maintain the IF output within certain amplitude limits for varying IF signal strengths.

Varicap tuners also need a variable tuning voltage (0 to 28 V) and band switching voltages to allow selection of the band required. A wideband varicap tuner is not practical since it could not be produced with sufficient gain to drive the IF amplifier.

Figure 2 shows the usual methods of tuning and band switching in a typical varicap tuner. Some later tuners use pin diodes for automatic gain control leaving the rf transistor unattenuated. The advantages of this type of gain control are shown in a separate box.

## ELC2060 DESCRIPTION

**The ELC2060 is a combined VHF/UHF tuner with electronic tuning and band switching covering the low VHF band with the channels 0 to 4 (frequency range 45 to 101 MHz), the high VHF band with the channels 5 to 11 (frequency range 101 to 222 MHz), and the UHF band with the channels 28 to 63 (frequency range 526 to 814 MHz).**

**Mechanically, the tuner is built on a low-loss printed-wiring board, carrying all components, in a metal housing made of a rectangular frame and front and rear cover. The two aerial connections (VHF and UHF) are on the two frame sides, all other connections (supply voltages, AGC voltage, tuning and switching voltages) are made via feed-through capacitors in the under side.**

**Electrically, the tuner consists of VHF and UHF parts. The VHF aerial signal is fed via an IF trap, combined with a high-pass filter, to a tuned input circuit, which is connected to the emitter of the input transistor BF200. The collector load of this transistor is formed by a double tuned circuit, transferring the signal to the base of the mixer transistor BF183. The oscillator is equipped with a transistor BF494. The four rf circuits are tuned by four capacitance diodes BB109G. A capacitance diode BB106 provides a frequency-dependent coupling of the rf input signal to the tuned input circuit. Switching between the low and high VHF bands is done by four switching diodes (BA182, BA243 and BA244).**

**The collector circuit of the mixer transistor is a single tuned IF resonant circuit, at the low end of which the IF signal is capacitively coupled out of the tuner (low capacitance coupling). An IF injection point is provided at the collector of the mixer, for aligning this circuit together with the IF amplifier of the television receiver.**

**The UHF part of the tuner consits of a tuned input circuit, connected to the emitter of the amplifier transistor BF183. The inter-stage network between this transistor and the self-oscillating mixer stage is formed by a double tuned circuit. A transistor BF181 acts as a self-oscillating mixer. The four tuned UHF circuits are tuned by four capacitance diodes BB105B.**

**The output of the self-oscillating mixer is fed to a double tuned IF circuit which is connected to the emitter of the VHF mixer transistor BF183, now operating as an IF amplifier in grounded-base configuration. Band switching between VHF and UHF is achieved by a diode BA243.**

**The tuner requires transistor supply voltages of +12 V, a switching voltage of +12 V, agc voltages, variable from +2, 4 V (normal operating point) to about +7.5V (maximum agc) and a tuning voltage, variable from +0, 5 V to +28 V.**

## Problems

A major source of problems in the Philips ECL2060 is dry joints where the pins are soldered to the circuit board, so the first thing to do is solder all these connections including both antenna pins. Be sure you do not cause any shorts by applying too much solder. It is a good idea to inspect your work afterwards with a magnifying glass.

The next most common fault is tuning drift caused by one of the varicap diodes becoming leaky. All of these diodes are in parallel to ground with an 820k resistor in parallel.

The easiest way to check for leaky varicaps is to use the highest range on your ohmmeter with a 9 V battery in series connected between pin 2 and ground. To locate the faulty varicaps lift the 22k resistors one by one until the leakage disappears. Use solder braid and don't apply too much heat or you may lift the thin tracks. The 22k resistors are marked with asterisks on the circuit diagram.

The VHF section uses BB109G diodes, the UHF section BB105 diodes. Replace these with BB809 and BB405 devices.

It is well to note that shorted varicaps also cause snowy picture or no picture, so always check for leaky varicaps before you waste time investigating other parts.

The ECL2060 uses a BF200 as the VHF gain-controlled rf amplifier and a BF180 as the UHF rf amplifier. Lightning and other electrical interference can destroy both or either of these devices. If you ▶

## PIN-DIODE ATTENUATOR

**Some tuners have an automatic gain control system employing pin diodes, rather than the well known method of varying the base bias of the rf preamplifier transistors. In these cases a separate adjustable attenuator in front of the rf transistors is used.**

**Pin diodes are made by diffusing the semiconductor with p dopant from one side and n dopant from the opposite side, with the process so controlled, that an intrinsic region separates the n and p regions.**

**With a negative voltage applied to the p side, electrons from the centre of the n region are carried in the direction of the positive voltage. The i region increases and so the junction capacity decreases.**

**When the positive voltage is applied to the p side, it carries electrons and holes to the centre of the i region and forward conduction occurs. With the increase of forward voltage the i region is supplied with carriers. This means the resistance of the i region decreases. (A difference of 0-10 V in forward voltage changes the junction resistance of the diode from 10k ohm to 1 ohm.)**

**The relatively large i region stores many carriers. Therefore a 'noticeable' change of the amount of carriers requires a relatively long time and the 'storage time' therefore is long.**

**A voltage applied to a pin diode which changes direction all the time will result in the amount of carriers in the i region, remaining almost constant. With rf voltages above 1 MHz applied to the pin diode, the junction resistance due to the long storage time remains constant.**

**With an rf voltage of a frequency above 1 MHz superimposed on a dc voltage (forward direction), it is now possible to vary the rf impedance of the diode with variation of the dc voltage. However, the value of the forward resistance is not affected by the amplitude of the applied rf voltage.**

***Advantages of gain control with pin diodes:***

**1. Good cross modulation performance due to gain control via a real resistive attenuator.**

**2. The rf preamplifiers may be equipped with high current transistors which have good cross modulation performance (approximately 100 mV for 1 per cent cross modulation).**

**3. No change in band pass response over the entire tuning range during field strength dependent gain control.**

**4. Input impedance of the preamplifier transistors remains constant.**

**5. Even gain control effect at all channels.**

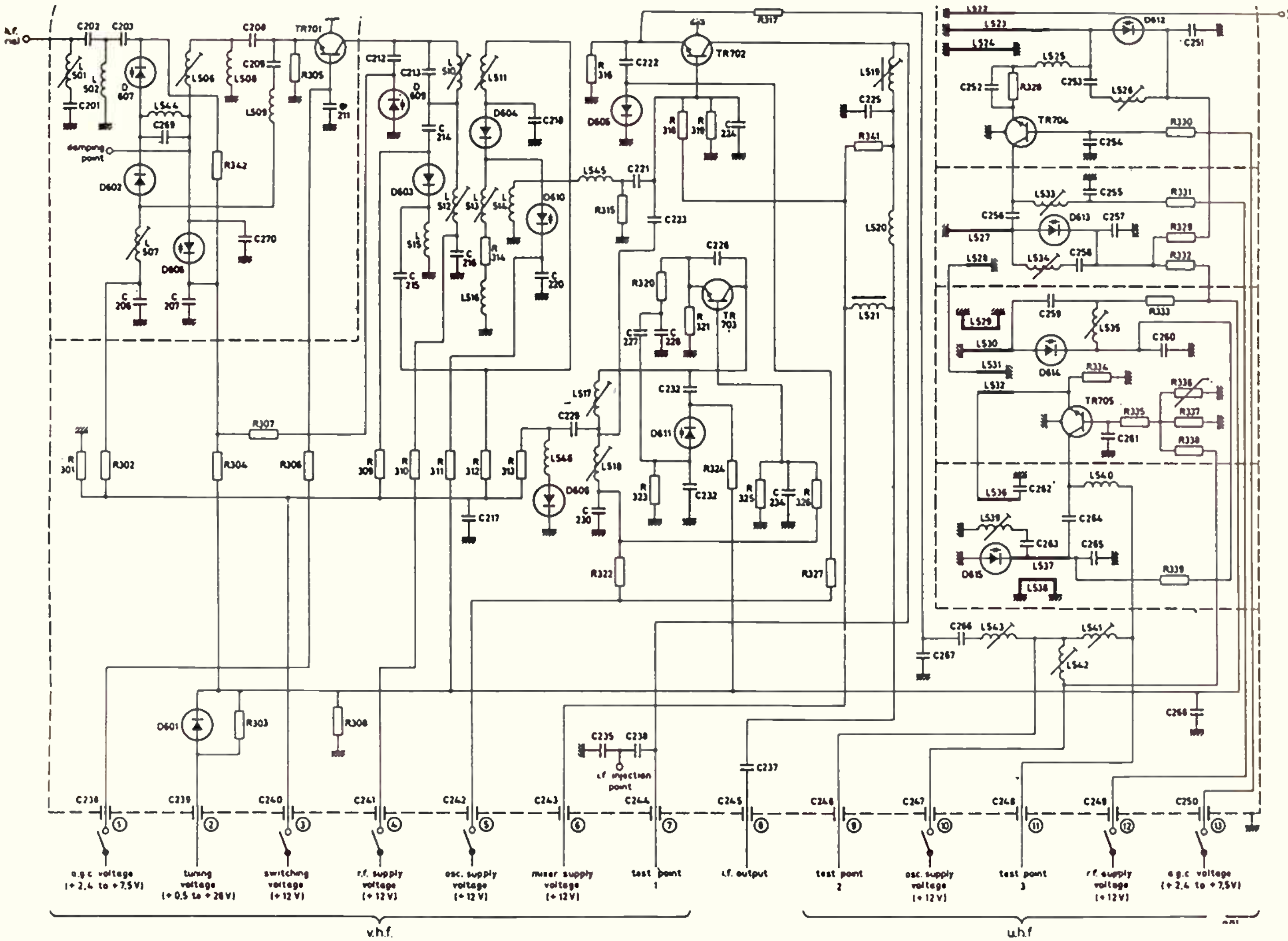



**Figure 1.** ELC2060 schematic.

have weak VHF or UHF check these transistors. Also check for dry joints at the antenna inputs and agc pins (pin 1 VHF, pin 13 UHF). If either rf stage is faulty, a metal pointer applied to the collector of either transistor should allow you to tune the channels with fairly reasonable gain.

The VHF mixer transistor BF183, the VHF oscillator transistor BF495 and the UHF mixer BF181 are less likely to be faulty. However, the BF183 occasionally fails.

If the tuner has no IF output, check that the IF output coil L519 has continuity and resolder it where the winding terminates onto the pins at the top. There is a small winding near the BF495 with foam inside it which sometimes deteriorates becoming resistive and causing trouble (this was a very hard fault to locate). Simply remove the foam — just in case — but don't bend the coil. Do likewise with another coil in the UHF section.

Another less common fault but which causes problems such as no band 1 is shorted or leaky switching diodes in the VHF section. These diodes are connected between pin 3 and ground with the anode to pin 3, so you will need to reverse the meter leads and locate the faulty one as you did with the varicap diodes — by elimination.

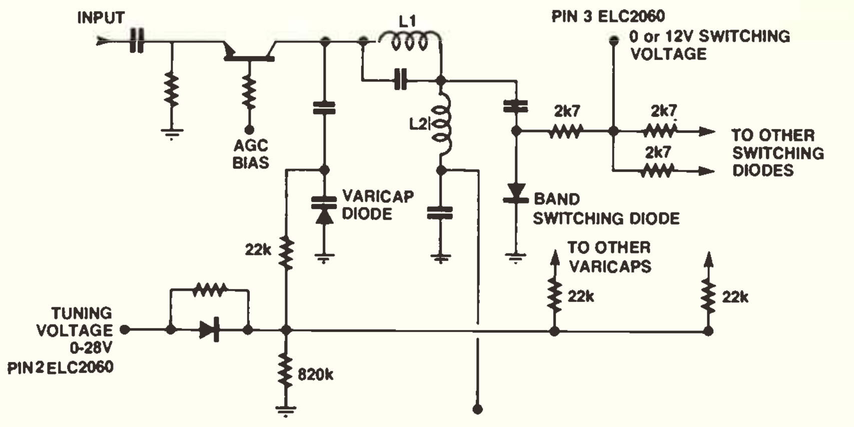



**Figure 2.** Tuning and band switching methods.

I have repaired hundreds of these tuners and have found a capacitor faulty only once: C217 was short causing no band 1.

Finally, once you have repaired the tuner run it for as long as possible in order to flush out any other leaky varicaps. Most ones will show up in the first half hour, especially if you tune the set to channel 10 which puts about 20 volts across the varicaps.

One further note: as long as no one has compressed or extended any of the small inductors in the tuner there is no need for realignment. ●

# HI-FI SYSTEMS BUYERS' GUIDE

*Hi-fi integrated systems are becoming increasingly popular. Below we have listed a selection of these systems commonly available. The price range of $1500 to $2500 is recommended retail price including tax, and has wide variations. This range has been chosen as one most accessible to the average buyer.*

*In our Hi-Fi Buyers' Guide the definition of a system has been restricted to those that have been designed from the ground up as integrated systems.*

*Some manufacturers are cashing in on the markets' desire for integrated systems by packaging their discrete units as systems. We have not included these in our survey. All the hi-fi systems included are integrated and have at least a tuner and cassette and quite often a turntable or compact disc.*

*All information including specifications has been provided by the manufacturer. We do not claim the list is comprehensive. Omission implies only that our records were incomplete at the time of print.*

*We have not included a fequency response for amplifiers because they are limited by the source.*

| BRAND | MODEL | RRP ($) | SIZE | TURNTABLE | TUNER Features; Freq Resp (Hz); SNR (dB) | CASSETTE Features; Freq Resp (Hz); SNR (dB) | EQUALIZER |
|---|---|---|---|---|---|---|---|
| Aiwa | V2100 | 1499 | midi | semi auto; belt driven | AM/FM stereo; digital; 30 Hz-15 kHz; 60 dB | single; dolby B; 2 heads; 30 Hz-15 kHz; 73 dB | 5 band |
| | V2200 | 1599 | midi | semi auto; belt driven | AM/FM stereo; 30 Hz-15 kHz; 73 dB | double; dolby B; hi speed dub; 2 heads; 30 Hz-15 kHz; 60 dB | 5 band |
| | VX2100 | 1899 | midi | n/a | AM/FM stereo; 30 Hz-15 kHz; 73 dB | double; dolby B; 30 Hz-15 kHz; 60 dB | 5 band |
| | VX2200 | 1999 | midi | n/a | AM/FM stereo; 30 Hz-15 kHz; 73 dB | double; dolby B; hi speed dub; 2 heads; 30 Hz-15 kHz; 60 dB | 5 band |
| Akai | Peo A202W | 1500 | maxi | semi auto; belt drive | AM/FM stereo; analogue; 30 Hz-15 kHz; 70 dB | double; dolby B; hi speed dub 2 heads; 30 Hz-16 kHz; 56 dB | 5 band |
| | Pro A302/ CD-A30 | 1849 | maxi | semi auto; belt drive | AM/FM stereo; analogue; 30 Hz-15 kHz; 70 dB | single; dolby B; 2 heads; 30 Hz-16 kHz; 56 dB | 5 band |
| | Peo-A70 | 1999 | maxi | semi auto; belt drive | AM/FM stereo; analogue; 15 Hz-30 kHz; 70 dB | single; dolby B; 2 heads; 30 Hz-16kHz; 56 dB | n/a |
| | Pro A90W | 2499 | maxi | semi auto; belt drive | AM/FM stereo; analogue; 30 Hz-15 kHz; 70 dB | double; dolby B; hi speed dub; 2 heads; 30 Hz-16 kHz; 56 dB | n/a |
| JVC | Midi-W5 | 1499 | midi | fully auto; belt drive | AM/FM stereo; digital | double; dolby B; hi speed dub; 2 heads | 5 band |
| | Midi-W1 | 1099 | midi | fully auto; belt drive | AM/FM stereo; digital; | double; dolby B; 2 heads | 5 band |
| Kenwood | 350 System | 2324 | maxi | belt drive | AM/FM stereo; digital; 70 dB | double; dolby B; 2 heads 20 Hz-15 kHz; 64 dB | 7 band |
| Onkyo | A22 Black | 2075 | maxi | semi auto; belt drive | AM/FM stereo; analogue; 40 Hz-15 kHz; 70 dB | single; dolby B/C; 2 heads 20 Hz-17 kHz; 56 dB | n/a |
| Pioneer | Avante 6000 | 2579 | | | AM stereo; FM stereo; digital; 30 Hz-15 kHz; 77 dB | double; dolby B/C; hi speed dub; 3 heads; 30 Hz-15 kHz; 56 dB | n/a |
| | Avante 5000 | 1879 | | fully auto; belt drive | AM stereo; FM stereo; analogue; 30 Hz-15 kHz; 77 dB | single; dolby B; 2 heads; 30 Hz-15 kHz; 57 dB | n/a |
| Sharp | System | 1799 | midi | bilateral; linear track; programmable; front load | AM stereo; FM stereo; digital; 60 dB | double; dolby B; hi speed dub; 2 heads; 30 Hz-15 kHz; 57 dB | 5 band |
| Sony | Precise V-50 | 2138 | midi | fully auto; belt drive | AM/FM stereo; SW; digital; 30 Hz-15 kHz; 80 dB mono/ 75 dB stereo | double; dolby B/C; hi speed dub; 2 heads | 7 band |
| | AV-200 | 1599 | maxi | semi auto; belt drive | AM stereo; FM stereo; 30 Hz-15 kHz; 80 dB mono/ 75 dB stereo | single; dolby B; 2 heads; 30 Hz-15 kHz; 65 dB | 5 band |
| Tandy | Realistic System-600 | 1499 | maxi | semi auto | AM stereo; FM stereo; analogue; 60 dB | single; dolby B; 1 head; 40 Hz-14 kHz; 61 dB | 5 band |
| | Realistic System-1000 | 2299 | maxi | semi auto | AM/FM stereo; digital; 60 dB | double; dolby B; hi speed dub; 1 head; 40 Hz-14 kHz; 60 dB | 7 band |
| Technics | Series X77 | 2499 | midi | fully auto | AM/FM stereo; 65 dB | double; dolby B; hi speed dub; 2 heads; 30 Hz-17 kHz; 66 dB | 7 band |

| **AMPLIFIER** Power (W per channel); SNR (dB) | **EXTRA FUNCTIONS** | **SPEAKERS** No; Size of Drivers (cm) | **COMPACT OISC** Features; Freq Resp (Hz); SNR (dB) | **REMOTE CONTROL** | **12V INPUT** | **LINE OUT** | **H'PHONE JACK** | **WARRANTY** (years) |
|---|---|---|---|---|---|---|---|---|
| 50 W per ch; 84 dB | aux | 2-way; 16 | n | n | n | n | y | 3 |
| 50 W per ch; 84 dB | aux | 2-way; 16 | n | n | n | n | y | 3 |
| 50 W per ch; 84 dB | aux | 2-way; 16 | programmable; 5 Hz-20 kHz; 93 dB | n | n | n | y | 3 |
| 50 W per ch; 84 dB | aux | 2-way; 16 | programmable; 5 Hz-20 kHz; 93 dB | n | n | n | y | 3 |
| 45 W per ch; 92 dB | | 2-way | | | n | n | n | 2 |
| 65 W per ch; 95 dB | aux; tape 2 | 3-way; 25 | programmable; 20 Hz-20 kHz | n | n | y | y | 2 |
| 100 W per ch; 100 dB | VCR; tape 2; laser disc | 3-way; 25 | | | | | | 2 |
| 130 W per ch; 100 dB | VCR; tape 2; laser disc | | | | | | | 2 |
| 50 W per ch | auto reverse | 3-way; 20 | y | 34 functions | n | y | y | 5 |
| 30 W per ch | aux; CD | 2-way; 16 | y | n | n | y | y | 5 |
| 30 W per ch; 79 dB | aux; CD | 3-way; 25 | programmable; 5 Hz-20 kHz | n | n | n | y | variable |
| 35 W per ch; 80 dB | 6 inputs; 4 speaker A&B | 3-way; 25 | programmable; x2 o'sampling; 5 Hz-20 kHz; 96 dB | n | n | n | y | 5 |
| 50 W per ch; 102 dB | | 3-way; 30 | programmable; 4 Hz-20 kHz; 97 dB | 13 functions | n | y, 2V ±5V | y | 3 |
| 50 W per ch; 102 dB | | 3-way; 25 | n | | | | | 3 |
| 40 W per ch | aux; CD | 2-way; 21 | n | n | | y | y | 1 |
| 40 W per ch | | 2-way; 21 | | 36 functions | n | y, 2V | y | 1 |
| 30 W per ch | | 3-way; 25 | | 13 functions | n | y, 2V | y | 1 |
| 45 W per ch; 75 dB | aux; CD | 3-way; 20 | n | y | n | n | y | 5 |
| 100 W per ch; 85 dB | video; CD | 3-way; 30 | n | n | y | n | n | 5 |
| 50 W per ch; 72 dB | | 2-way; 20 | n | n | n | | y | 2 |

# ANNOUNCING...

## *S.Y.M. Electronics has made available for the first time in Australasia over a hundred exciting projects.*

## *All these are available in kit form.*

**TCL3K - UNIVERSAL SOLID STATE TESLA COIL:** Is quiet and operates from either a 12 volt battery or mains power. Tremendous high frequency, high voltage effects similar to our BTC3 series. Design satisfies even the most demanding experimenter. Great for magic shows, special effects, science fair projects and plasma displays. This device is used for the popular sculpture lamps as seen on U.S. TV and science digests. **$322.50**

**LBT1K - LIGHT BEAM COMMUNICATIONS TRANSCEIVER:** As featured in elementary electronics, allows crystal clear two way communication of music or voice up to a line of sight distance (when properly aligned distance will be in excess of many kms.) Units are easily hand held with pistol type grip for sighting. Separate receiver and transmitter, optical system allows receiver to be used alone for listening to other sources of light. Units are self contained with batteries neatly fitting into hand grip. All controls and microphone are mounted on rear panel. These are highly functional useful devices and are available in either visible red or invisible IR. **$697.50**

**PWM50 - LONG RANGE PARABOLIC MICROPHONE:** With wireless FM transmitter not only allows the efficient picking up of distant and low level weak sounds but also wirelessly transmits them to a remotely located FM radio receiver. This set up is excellent for the serious nature listener who requires gathering sounds from distant target areas and then rebroadcasting to a conveniently located FM radio for recording and evaluation purposes. Use for nature studies in swamps, etc. May also be used with headsets. Kit with wireless **$747.50**

**USAR10 - SOUND OPERATED PARABOLIC MIKE:** Contains a sound activating switch along with the amplifier in the above PM3. It is intended for automatically recording sounds as they occur eliminating wasted and dead tape time. Can also be used to trigger any electrical device by sound. Unit is fully adjustable for both recording levels and recorder activation. **$597.50**

**ULO3K - ULTRASONIC GENERATOR:** This device is capable of generating accoustical ultrasonic energy. Unit has a frequency control and varies from 19-25KHZ. Device will atomize water and affect certain animals, can be used for proximity detection, remote control, echo ranging, destructive testing and directional intrusion devices. Many interesting experiments can be programmed using this device. **$172.50**

**POLICE CALL UNSCRAMBLER:** Allows you to decipher many of those interesting communications on the airwaves by simply connecting this neat little unit to the earphone jack on radio. **$247.50**

**BTC3K - EASY TO BUILD TESLA COIL:** Plans show how to construct a high voltage high frequency, source of electrical power capable of producing weird and bizarre effects on certain materials causing them to glow, disintegrate, burn, etc. when exposed to this energy. This amazing device will cause a regular household fluorescent lamp to light at a considerable distance without any connecting wires. The operator can demonstrate high voltage high frequency electricity jumping from the output terminal to a conductive object creating quite a conversation piece. Many spectacular experiments are possible with this device. It is built with flexible adjustments for the experimenter who wishes to explore the effects of these different settings and values. Care should be taken with this device as with any other high voltage apparatus. The unit also can be used for exciting all types of gas discharge tubes, x-ray tubes, plucker tubes, etc. It demonstrates Corona, St Elmos Fire and effects of high voltage, high frequency on many different types of materials. On a low humidity day with the device properly adjusted, it is possible to produce sparks 25 to 35 cm in length. **$797.50**

**FSM10 - FIELD STRENGTH METER:** This device is a great aid when using any wireless transmitter that transmits in and around the FM broadcast band. Relative field strength is indicated via a sensitivity adjustable meter. Turning knob calibrated to provide a frequency indication. Unit is a must for serious optimizing of any wireless transmitting system. **$147.50**

**LLS1 - LASER LIGHT SHOWS:** Plans include detailed drawings, parts list and all information to create a light show with excellent results. Three methods are included: laser diffractor system producing highly detailed flowing abstract patterns, sound to shape scanner producing lissajous figure of frequencies varying with the music source, and laser spirograph system producing these familiar type patterns. **$30.00**

**TESLA COILS:** This spectacular and highly visible effect produced by this device has been the subject of controversy for years. The high frequency high voltage energy produced possesses qualities unlike conventional electricity. It defies most insulation material, transmits energy without wires, produces heat, light and noise. Much research, money and effort was dedicated to research and actual construction of similar large devices capable of producing 60 metre lightning bolts and lighting lights 40 klms away. Nicholas Tesla was the originator of this research and was often thought of as a charlatan. As more progress was made in the electrical sciences it was soon realised that he was indeed responsible for many advances in development in energy production. He has now been credited with many advances and original techniques in the electrical sciences. His main theory, however, is still very much in question and many dedicated groups are hopeful in obtaining some break that will resurrect it. The Tesla Coil is the basis for this questionable research and never ceases to amaze all those who come in contact with its stunning highly visual and audible effect.

**ADA1K - DO IT YOURSELF COMPUTER:** Assemble it yourself from subassemblies. No wiring or soldering necessary (just plugs together). Hook up diagram included. Includes: keyboard, 2 cassette digital data drives, 2 game controllers, power supply. All memory boards, and one cassette. Operates CP/M, has built in word processor. Can be assembled at extra cost. **$495.50**

**SNP2K - SNOOPER PHONE:** This is the latest in home or office security devices that enables the user to dial their own telephone from anywhere in the world and listen in via a highly sensitive microphone that can be placed anywhere on the premises. Phone automatically turns on mike without ever ringing when last digit of number is dialed and remains activated for a predetermined time. Use to check premises against unauthorized intrusion, proper functioning of utilities and other machinery and security devices while away on vacation, etc. Easy to operate, installs with standard phone plug and extension jacks. Adjustable sensitivity can be preset to pick up any desired level of sounds. May also be used to turn on other electrical devices when used in conjunction with our SCU1. **$347.50**

**IJ5K - PULSED TV JOKER:** Little hand held device utilizes pulse techniques that will completely disrupt TV picture and sound! Great as a gag or party joke. Works on FM radio too. **$172.50**

**KGA5K - HIGH GAINS AMPLIFIER:** This super sensitive, ultra low noise device enables one to hear a world of sounds that would otherwise be impossible to hear without it. It is constructed on PC board and housed along with its controls in an aluminium mini box. It is all solid state and is intended to be used with the tubular or parabolic reflector type directional microphones. These devices can overhear a normal conversation over considerable distances. They may also hear through glass windows in houses or cars. These same devices are used extensively by U.S. law enforcement agencies and serious minded nature listeners. The amplifier can also be used by itself as a super sensitive ear or sound detection system. It contains an optional jack for use with our RWM3 remote wireless wizard transmitter that greatly extends it usable range. It also can be used for anti-intrusion alarms or as sound level meter and many other applications. **$222.50.**

**GRA1K - GRAVITY GENERATOR:** This unique machine demonstrates a simple electrical phenomena that produces an anti-gravity effect. You can actually build a small mock spaceship and without any visible means cause it to levitate. This is a great science fair demonstration as well as a very interesting device. Phenomena and method of use may be elaborated on and we welcome any suggestions and finding that the experimenter may come upon. **$497.50**

**HA1K - HELICAL ANTENNA:** The antenna that is only a fraction of the size of an equivalent one in performance. They are intended for use with any wireless receiver or transmitter in the 100-108MHZ range. **$27.50**

**RWN3K - REMOTE WIRELESS WIZARD REPEATER TRANSMITTER:** Allows any tape recorder Hi-Fi or other similar device to transmit its output to a nearby FM radio tuned to the desired frequency. Now you can have your favourite tapes, records etc., played on your good quality home Hi-Fi and rebroadcast to a portable or another conveniently located FM radio. The unit is self contained and does not require any internal wiring to these devices, just plugs into speaker or earphone output. The unit including battery is no larger than your thumb, but will broadcast over considerable distances. Also intended to rebroadcast remotely located parabolic, shotgun or other sensitive listening devices. Complete with necessary plugs, jacks. **$147.50**

**HA20 - HIGH GAIN ANTENNA:** Intended to be used with our FM receivers for picking up and greatly extending the range of any wireless devices. Can also be used with transmitting devices. **$47.50**

**SD50 - SEE IN THE DARK:** Lightweight and self contained allows viewing in total darkness. This all new unit is enclosed in rugged military grey PVC and comes complete with optics useful for image viewing, excellent source detection. A 'C' mount adaptor allows the use of video lens assemblies capable of providing positive image recognition either at long range via telephoto lens or close range via a wide angle system. Has many obvious uses and compares with units costing upwards of many thousands of dollars more. Intended for night surveillance yet may also be used for viewing targets designated by IR lasers, fibre optics, led, IR alarms, view thermal scenes, hot spots, flames, diseased vegetation, rust, weld joints, document and currency authenticity, rock, minerals and etc. **$597.50 (minus tube)**

*ADVERTISING INFO No. 21*

# Back by Popular Dem

## DATA & REFERENCE

**DIGITAL IC EQUIVALENTS AND PIN CONNECTIONS**
**A. Michaels** BP0140
Shows equivalents and pin connections of a popular user-orientated selection of European, American and Japanese digital ICs. Also includes details of packaging, families, functions, manufacturer and country of origin.
$16.00
*256 pages (Large Format)*

**LINEAR IC EQUIVALENTS AND PIN CONNECTIONS**
**A. Michaels** BP0141
Shows equivalents and pin connections of a popular user-orientated selection of European, American and Japanese linear ICs. Also includes details of functions, manufacturer, and country of origin.
$18.00
*320 pages (Large Format)*

**INTERNATIONAL TRANSISTOR EQUIVALENTS GUIDE**
**A. Michaels** BP0085
Helps the reader to find possible substitutes for a popular user-orientated selection of European, American and Japanese transistors. Also shows material type, polarity, manufacturer and use.
$12.00
*320 pages*

**CHART OF RADIO, ELECTRONIC, SEMICONDUCTOR AND LOGIC SYMBOLS**
**M. H. Babani, B.Sc.(Eng)** BP0027
Illustrates the common, and many of the not-so-common, radio, electronic, semiconductor and logic symbols that are used in books, magazines and instruction manuals, etc., in most countries throughout the world.
$4.00
*Chart*

**RADIO AND ELECTRONIC COLOUR CODES AND DATA CHART**
**B. B. Babani** BP0007
Covers many colour codes in use throughout the world, for most radio and electronic components. Includes resistors, capacitors, transformers, field coils, fuses, battery leads, speakers, etc.
$4.00
*Chart*

## AUDIO AND HI-FI

**BUILD YOUR OWN SOLID STATE HI-FI AND AUDIO ACCESSORIES**
**M. H. Babani** BP0220
An essential addition to the library of any keen hi-fi and audio enthusiast. The design and construction of many useful projects are covered including: stereo decoder, three-channel stereo mixer, FET pre-amplifier for ceramic PUs, microphone pre-amp with adjustable bass response, stereo dynamic noise filter, loud-speaker protector, voice-operated relay, etc.
$8.00
*96 pages*

**AUDIO PROJECTS**
**F. G. Rayer** BP0090
This book covers in detail the construction of a wide range of audio projects. The text has been divided into the following main sections: Pre-amplifiers and Mixers, Power Amplifiers, Tone Controls and Matching, Miscellaneous Projects.
All the projects are fairly simple to build and have been designed around inexpensive and readily available components. Also, to assist the newcomer to the hobby, the author has included a number of board layouts and wiring diagrams.
$8.50
*96 pages*

## COMPONENT SPECIFIC

**MODERN OP-AMP PROJECTS**
**R. A. Penfold** BP0106
Includes a wide range of constructional projects which make use of the specialised operational amplifiers that are available today, including low noise, low distortion, ultra-high input impedance, low slew rate and high output current types. Circuits using transconductance types are also included.
All of the projects are fairly easy to construct and a stripboard layout is provided for most of them so that even constructors of limited experience should be able to build any of the projects with the minimum of difficulty.
$8.50
*112 pages*

**MODEL RAILWAY PROJECTS**
**R. A. Penfold** BP0095
The aim of this book is to provide a number of useful but reasonably simple projects for the model railway enthusiast to build, based on inexpensive and easily obtainable components.
The projects covered include such things as controllers, signal and sound effects units, and to help simplify construction, stripboard layouts are provided for each project.
$8.50
*112 pages*

## AERIALS

**AERIAL PROJECTS**
**R. A. Penfold** BP0105
The subject of aerials is vast but in this book the author has considered practical aerial designs, including active, loop and ferrite aerials which give good performances and are relativley simple and inexpensive to build. The complex theory and mathematics of aerial design have been avoided.
Also included are constructional details of a number of aerial accessories including a pre-selector, attenuator, filters and tuning unit.
$8.50
*96 pages*

**25 SIMPLE AMATEUR BAND AERIALS**
**E. M. Noll** BP0125
This concise book describes how to build 25 amateur band aerials that are simple and inexpensive to construct and perform well. The designs start with the simple dipole and proceed to beam, triangle and even a mini-rhombic made from four TV masts and about 400 feet of wire.
You will find a complete set of dimension tables that will help you spot an aerial on a particular frequency. Dimensions are given for various style aerials and other data needed for spacing and cutting phasing lengths. Also included are dimensions for the new WARC bands.
$6.50
*80 pages*

**25 SIMPLE SHORTWAVE BROADCAST BAND AERIALS**
**E. M. Noll** BP0132
Fortunately good aerials can be erected at low cost, and for a small fractional part of the cost of your receiving equipment.
This book tells the story. A series of 25 aerials of many different types are covered, ranging from a simple dipole through helical designs to a multi-band umbrella.
$6.50
*80 pages*

**25 SIMPLE INDOOR AND WINDOW AERIALS**
**E. M. Noll** BP0136
Written for those people who live in flats or have no gardens or other space-limiting restrictions which prevent them from constructing a conventional aerial system.
The 25 aerials included in this book have been especially designed, built and tested by Mr. Noll to be sure performers and give surprisingly good results considering their limited dimensions.
$6.00
*64 pages*

**25 SIMPLE TROPICAL AND MW BAND AERIALS**
**E. M. Noll** BP0145
Shows you how to build 25 simple and inexpensive aerials for operation on the medium wave broadcast band and on 60, 75, 90 and 120 metre tropical bands. Designs for the 49 metre band are included as well.
$6.00
*64 pages*

## FAULT-FINDING

**HOW TO GET YOUR ELECTRONIC PROJECTS WORKING**
**R. A. Penfold** BP0110
The aim of this book is to help the reader overcome problems by indicating how and where to start looking for many of the common faults that can occur when building up projects.
Chapter 1 deals with mechanical faults such as tracing dry joints, short-circuits, broken P.C.B. tracks, etc. The construction and use of a tristate continuity tester, to help in the above, is also covered.
Chapter 2 deals with linear analogue circuits and also covers the use and construction of a signal injector/tracer which can be used to locate and isolate the faulty areas in a project.
Chapter 3 considers ways of testing the more common components such as resistors, capacitors, op amps, diodes, transistors, SCRs, unijunctions, etc., with the aid of only a limited amount of test equipment.
Chapter 4 deals with both TTL and CMOS logic circuits and includes the use and construction of a pulse generator to help fault-finding.
$8.50
*96 pages*

**AUDIO AMPLIFIER FAULT-FINDING CHART**
**C. E. Miller** BP0120
This chart will help the read- ... faults that might occur in audi- ... art are two "starting" r- ... reproduction and No Sound R... the most appropriate one of these, the ... the arrows and carries out the suggested ch... fault is located and rectified.
**UNAVAILABLE**
$4.00
*Chart*

## ELECTRONIC & COMPUTER MUSIC

**ELECTRONIC MUSIC PROJECTS**
**R. A. Penfold** BP0074
Provides the constructor with a number of practical circuits for the less complex items of electronic music equipment, including such things as fuzz box, waa-waa pedal, sustain unit, reverberation and phaser units, tremelo geneator, etc.
The text is divided into four chapters as follows:
Chapter 1, Guitar Effects Units; Chapter 2, General Effects Units; Chapter 3, Sound General Projects; Chapter 4, Accessories.
$9.50
*112 pages*

**ELECTRONIC SYNTHESISER CONSTRUCTION**
**R. A. Penfold** BP0185
Should enable a relative beginner to build, with the minimum of difficulty and at reasonably low cost a worthwhile monophonic synthesiser, and also learn a great deal about electronic music synthesis in the process. This is achieved by considering and building the various individual parts of the circuit that comprise the whole instrument as separate units, which can then be combined together to form the final synthesiser. Printed circuit designs are provided for these main modules. Later chapters deal with sequencing and some effects units.
$11.00
*112 pages*

**MIDI PROJECTS**
**R. A. Penfold** BP0182
Provides practical details of how to interface many popular home computers with MIDI systems. Also covers interfacing MIDI equipment to analogue and percussion synthesisers.
$11.00
*112 pages*

**MORE ADVANCED ELECTRONIC MUSIC PROJECTS**
**R. A. Penfold** BP0174
Intended to complement the first book (BP74) by carrying on where it left off and providing a range of slightly more advanced and complex projects. Included are popular effects units such as flanger, phaser, mini-chorus and ring-modulator units. Some useful percussion synthesisers are also described and together these provide a comprehensive range of effects including drum, cymbal and gong-type sounds.
$8.50
*96 pages*

**COMPUTER MUSIC PROJECTS**
**R. A. Penfold** BP0173
Shows some of the ways a home computer can be used to good effect in the production of electronic music. Topics covered include sequencing and control via analogue and MIDI Interfaces, computers as digital delay lines and sound generators for computer control.
$11.00
*112 pages*

## MISCELLANEOUS

**COIL DESIGN AND CONSTRUCTION MANUAL**
**B. B. Babani** BP0160
A complete book for the home constructor on "how to make" RF, IF, audio and power coils, chokes and transformers. Practically every possible type is discussed and calculations necessary are given and explained in detail. All mathematical data is simplified for use by everyone.
$9.50
*96 pages*

**AN INTRODUCTION TO Z80 MACHINE CODE**
**R. A. & J. W. Penfold** BP0152
Takes the reader through the basics of microprocessors and machine code programming with no previous knowledge of these being assumed. The microprocessor dealt with is the Z80 which is used in many popular home computers and simple programming examples are given for Z80-based machines including the Sinclair ZX-81 and Spectrum, Memotech and the Amstrad CPC 464. Also applicable to the Amstrad CPC 664 and 6128.
$10.00
*144 pages*

**A Z-80 WORKSHOP MANUAL**
**E. A. Parr** BP0112
This book is intended for people who wish to progress beyond the stage of BASIC programming to topics such as machine code and assembly language programming, or need hardware details of a Z-80 based computer.
$12.00
*192 pages*

**GETTING THE MOST FROM YOUR PRINTER**
**J. W. Penfold** BP0181
Details how to use all the features provided on most dot-matrix printers from programs and popular word processor packages like Wordwise, Visawrite and Quill, etc. Shows exactly what must be typed in to achieve a given effect.
$11.00
*96 pages*

## CIRCUITS & CONSTRUCTIONAL PROJECTS

**BEGINNERS GUIDE TO BUILDING ELECTRONIC PROJECTS**
**R. A. Penfold** BP0227
Shows the complete beginner how to tackle the practical side of electronics, so that he or she can confidently build the electronic projects that are regularly featured in the popular magazines and books. Also includes examples in the form of simple projects that you can build.
$8.50
*112 pages*

# and... Babani Books!

**50 PROJECTS USING RELAYS, SCRs AND TRIACs**
**F. G. Rayer** BP0037
This book gives tried and practical working circuits which should present the minimum of dificulty for the enthusiast to construct. In most of the circuits there is a wide latitude in component values and types, allowing easy modification of circuits or ready adaption of them to individual needs.
$8.50
*112 pages*

**POPULAR ELECTRONIC PROJECTS**
**R. A. Penfold** BP0049
Provides a collection of the most popular types of circuits and projects covering a very wide range of interests, including Radio, Audio, Household and Test Equipment projects.
$9.50
*144 pages*

**ELECTRONIC TEST EQUIPMENT CONSTRUCTION**
**F. G. Rayer** BP0075
This book covers in detail, the construction of a wide range of test equipment for both the electronics hobbyist and radio amateur. Included are projects ranging from a FET amplified voltmeter and resistance bridge to a field-strength indicator and heterodyne frequency meter.
Not only can the home constructor enjoy building the equipment but the finished product can also be usefully utilised in the furtherance of his hobby.
$8.00
*96 pages*

**REMOTE CONTROL PROJECTS**
**O. Bishop** BP0073
UNAVAILABLE
Aimed primarily at the electronics enthusiast ... to experiment with remote control as many of the ... for adaptation to the control of other circuits ... nations have been given so that the ... circuits work and can more ... purposes, depending on personal ... radio control systems considered but also infra- ... ultrasonic systems, as are the use of logic ICs and ... ation modulation, etc.
$9.50
*176 pages*

**ELECTRONIC GAMES**
**R. A. Penfold** BP0069
Contains a number of interesting electronic games projects using modern integrated circuits. The text is divided into two sections, the first dealing with simple games and the latter dealing with more complex circuits thus making the book ideal for both beginner and more advanced enthusiast alike.
$8.00
*96 pages*

**IC 555 PROJECTS**
**E. A. Parr** BP0044
Every so often a device appears that is so usefull that one wonders how life went on before without it. The 555 timer is such a device. Included in this book are basic and general circuits, motorcar and model railway circuits, alarms and noise-makers as well as a section on the 556, 558 and 559 timers.
$9.50
*176 pages (Available February 1987)*

**HOW TO DESIGN AND MAKE YOUR OWN P.C.B.s**
**R. A. Penfold** BP0121
Chapter 1 deals with the simple methods of copying printed circuit board designs from magazines and books and covers all aspects of simple P.C.B. construction as comprehensively as possible. Chapter 2 covers photographic methods of producing p.c.b.s and Chapter 3 deals with most aspects of designing your own printed circuit board layouts.
$6.50
*80 pages*

**POWER SUPPLY PROJECTS**
**R. A. Penfold** BP0076
The purpose of this book is to give a number of power supply designs, including simple unstabilised types, fixed-voltage regulated types, and variable-voltage stabilised designs, the latter being primarily intended for use as bench supplies for the electronics workshop. The designs provided are all low-voltage types for semi-conductor circuits. This book should also help the reader to design his own power supplies.
$7.50
*96 pages*

**HOW TO DESIGN ELECTRONIC PROJECTS**
**R. A. Penfold** BP0127
The aim of this book is to help the reader to put together projects from standard circuit blocks with a minimum of trial and error, but without resorting to any advanced mathematics. Hints on designing circuit blocks to meet your special requirements where no "stock" design is available are also provided.
$9.00
*128 pages*

**ELECTRONIC SECURITY DEVICES**
**R. A. Penfold** BP0056
Many people associate the term "security device" with only burglar alarms of various types, but in fact, any piece of equipment which helps to protect people and property against any form of danger could be termed a "security device".
Therefore this book, besides including both simple and more sophisticated burglar alarm circuits using light, infra-red and ultrasonics, also includes many other types of circuits as well, such as gas and smoke detectors, flood alarms, doorphone and baby alarms, etc.
$9.50
*112 pages*

**COMMUNICATION (Elements of Electronics — Book 5)**
**F. A. Wilson** BP0089
A look at the electronic fundamentals over the whole of the communication scene. This book aims to teach the important elements of each branch of the subject.
Most of the modern transmissions system techniques are examined including line, microwave, submarine, satilite and digital multiplex systems, radio and telegraphy. To assist in understanding these more thoroughly, chapters on signal processing, the electromagnetic wave, networks and transmission assessment are included, finally a short chapter on optical transmission.
$11.00
*256 pages*

**50 SIMPLE LED CIRCUITS**
**R. N. Soar** BP0042
Contains 50 interesting and useful circuits and applications, covering many different branches of electronics, using one of the most inexpensive and freely available components — the light-emmiting diode (LED). Also includes circuits for the 707 common anode display.
$8.00
*64 pages*

**IC PROJECTS FOR BEGINNERS**
**F. G. Rayer** BP0097
Offers a range of simple projects based around a number of popular and inexpensive linear and digital integrated circuits.
With most projects, complete layout and/or point-to-point wiring diagrams are included to help simplify construction.
$8.50
*112 pages*

**ELECTRONIC PROJECTS USING SOLAR CELLS**
**O. Bishop** BP0082
This is a book of simple circuits which have applications in and around the home and that are designed to be powered by the energy of the sun. Although, if the reader wishes, they could alternatively be powered by the ordinary button cells or small dry batteries
$8.50
*128 pages*

# ELECTRONICS BOOKS ORDER COUPON

**COUPON VALID FOR COVER DATE MONTH ONLY**

*BOOK SALES*

PLEASE ENCLOSE $2.50 per book for postage, handling and insurance.

*For airmail to Papua New Guinea, New Zealand, Oceania and Southeast Asia, add $5.00 to these charges.*

**(If insufficient space enclose separate list)**

| BOOK TITLE | BOOK NUMBER | QTY | PRICE TOTAL |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

Please tick box to indicate method of payment
**Cheque*/Money Order** ☐ *Please make payable to the Federal Publishing Company Pty Ltd

***Total price of books $ .........***
***Add postage and handling $ .........***
***($2.50 per book)***

*Put your cheque or money order in an envelope with this order and send it to:*
***Federal Direct, Freepost No. 4, P.O. Box 227, WATERLOO, NSW 2017***
*No postage stamp required in Australia.*

***TOTAL $ .........***

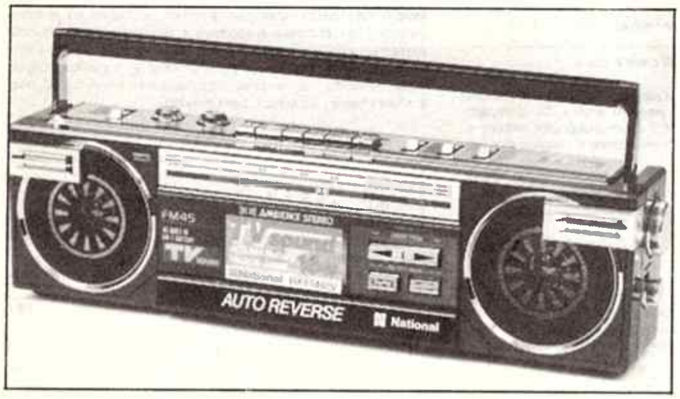
**Or charge my** ☐ **Bankcard** ☐ **Visa**
☐ **Mastercard** ☐ **American Express**

Card No: **Card Expiry Date** ......................

**Signature** ...............................................
(Unsigned orders cannot be accepted)

**NAME:** ...............................................
**ADDRESS:** ...............................................
...................................... **POSTCODE:** ..........
**TELEPHONE: (     )** ...............................................
Look for your order in 4-6 weeks **Date:** ..............................

# TV on radio




**The unique new portable radio/cassette recorder from National, the RXFM45V, features two bands for receiving TV audio signals as well as four other frequency bands including FM, AM and shortwave.**

The TV band enables listeners to tune into all Australian TV stations on the VHS band (in mono only). Advantages of such a set are that it enables the listener to tune into news, serials or soapies when away from home, or to record documentaries. Also, for those who may be hard of hearing, TV listeners can use headphones with the RXFM45V, turn up the volume to suit, then watch the TV with the rest of the family.

The two-way four-speaker system complements the powerful 16 watt output from the built-in amplifier. Three modes of listening can be selected: 'mono' is useful for listening to weaker FM or TV stations, as it greatly reduces the background hiss heard in these weaker signals; 'stereo' gives the expected separation or 'imaging' between the left and right channels; while the 'ambience' setting creates a psycho acoustic illusion that the speakers are more widely separated than they actually are.

The tape transport mechanism features automatic reverse so that both sides of a cassette tape can be played without having to turn the tape over. Direction of tape play (side 1 or side 2) can be instantly altered at the touch of a button. The two reversing mode control buttons allow only one side of a cassette to be played or both sides to be played endlessly for background music.

A built-in microphone ensures easy voice recording for home, work or school while its ac/dc operation make it a 'go anywhere' unit.

# KEF launches new flagship

Leading hi-fi loudspeaker specialist KEF Electronics is introducing a new model at the top of its highly respected Reference Series — KEF Model 107.

This new model is the result of a combination of bass extension down to a genuine 20 Hz, plus good sensitivity from a compact system, sonically flexible enough to be 'tailored' to it's specific surroundings, says KEF.

At the heat of the new model is the unusual hybrid active/passive dividing network.

Passive dividing networks have to perform the three quite distinct functions of splitting the signals into the appropriate frequency bands, equalizing and balancing the outputs from the various drive units to give a neutral tonal balance, at the same time presenting an acceptable load to the power amplifier. Response equalization in passive dividing networks can only be provided by attenuation, resulting in unnecessary loss of efficiency.

Model 107 avoids this problem by the passive network providing the frequency division and load matching functions only, while the equalization is performed by the active equalizer — KUBE.

According to KEF the inclusion of KUBE provides other benefits. A comprehensive range of adjustments allows the bass performance of the system to be tailored to the characteristics of the room, the specific site of the speakers in the room, the taste of the listener and the quality of the program. This is not the coarse adjustment provided by conventional tone controls and graphic equalizers, but a much more subtle affair which allows selection of the optimum bass cut off point, the degree of bass damping (Q), and the relative level of bass output, so that near optimum results can always be achieved.

Basic data specifications are:
frequency response: 20 Hz-20 kHz ±2 dB;
maximum output: 112 dB spl on program peaks;
amplifier requirements: 50-300 W (into 4 ohms);
impedance: 4 ohms resistive (20 Hz-20 kHz);
size: 1165 (h) x 330 (w) x 448 (d) mm;
weight: 45 kg.

The Model 107 will retail at the remarkable price of $7500 per pair.


# New Ortofon cartridge

Ortofon engineers have been at it again — developing new and improved pick-up cartridges! Six months ago they were able to introduce their first high output moving coil cartridges, splitting the total Ortofon moving coil program into three categories:

(a) low output MCs: Ortofon's original MC designs where extra step-up device is required to boost the low output signal;
(b) higher output MCs: models that can be connected directly to amplifiers with built-in MC inputs; and
(c) high output MCs: where additional amplification is not necessary.

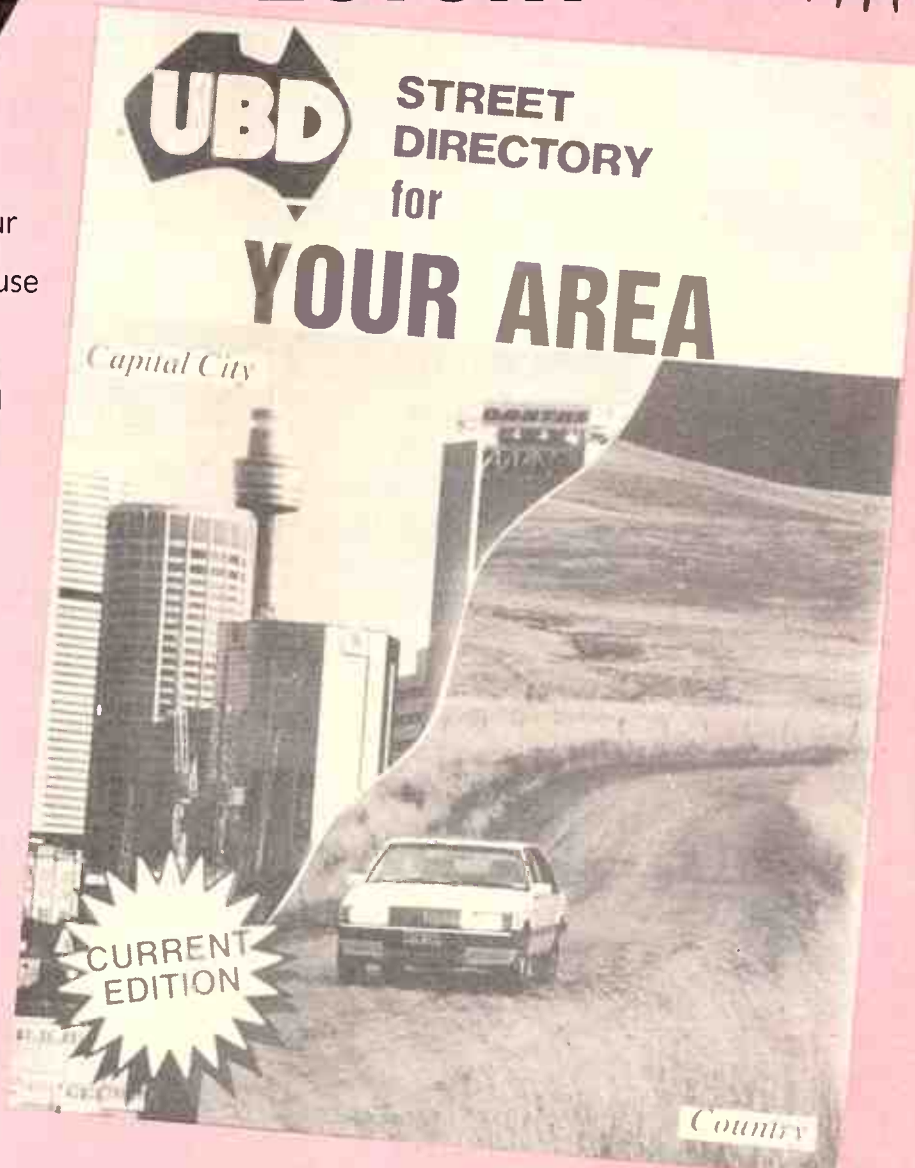
As a higher output MC, the new moving coil model MC 30 Super belongs to category (b).

The new MC 30 Super builds on the same construction principles as the MC 20 Super. New features include slimmer profile, Fritz Gyger diamond stylus — FG Type 1; conical shaped aluminium cantilever (like the one used in the MC 2000); Ortofon's improved wide range damping system with platinum disc between the two rubber damping bearings; improved high frequency damping (better rubber); pure silver thread for the coil windings; and stronger rear magnetic pole pins.

# SUBSCRIBE NOW!

**Special Bonus Gift!**

## FREE UBD STREET DIRECTORY




Need another Street Directory — to replace your old out-of-date edition? to have as an extra in the house or second car?
Here is your chance!
Simply subscribe or renew your subscription now and receive FREE the current edition of the most up-to-date, widely used Street Directory in Australia.

UBD Street Directories — used by Ambulance, Police, Fire Brigade, MWS & DB, Dept. of Main Roads, Taxi Co-ops, Couriers, Government Agencies and Fleet Owners.

## CAPITAL CITY OR COUNTRY DIRECTORY

## *See Subscription Coupon*

NT will receive Touring Guide and Local Map
SA. will receive an Adelaide Street Directory and State Touring Guide
TAS. will receive State Directory
NSW VIC QLD WA. indicate Capital City or State Directory

If coupon/card missing, please phone (02) 693-6666 and ask for the Subscription Department.

Note: Free gift is forwarded under separate cover. Please allow 3-4 weeks.

Offer closes last mail June 30, 1987.

# Sony expands video-8 line-up

Sony has released its latest video-8 camera, the CCD-V100, expanding its video-8 camcorder range to three models. All are targeted at different market segments, from simple operation for the whole family to the more professional home movie enthusiast.

While making full use of Video 8 technology the CCD-V100 offers a number of sophisticated video features which according to Sony were only previously found in broadcast quality units.

With the built-in seven-colour titling generator, a title may be either superimposed in the field or inserted at a later date in the home.

The seven-colour wiper function allows you to add effects to either the start or the finish of a scene.

Using the interval recording feature you can record eight frames every 15 seconds, repeatedly for 30 minutes, creating 30 seconds of video from 30 minutes of action. This is useful for speeding up events such as sunsets, flowers blooming, etc. The interval recording function can also be used for creating animated movies.

The auto iris, with manual override, lets you adjust for optimum image exposure in difficult situations such as a high contrast background or high contrast foreground scenes. The time and date can easily be recorded along with images.

The unit is also equipped with features facilitating manoeuvrability and portability such as an adjustable handgrip; linear auto white balance; through-the-camera-lens auto focus; and a variety of zooming speeds from wide to telephoto in five to 15 seconds. REC review allows you to replay the last few seconds of the previously recorded scene and an electronic view finder informs you of operation conditions.

The CCD-V100 Video 8 also offers high picture and sound quality. The CCD image sensor is claimed to be especially effective in low light recording.

The CCD-V100 is available at a suggested retail price of $3999.

# Yamaha's natural sound

Yamaha sees in the new year with the release of an impressive range of new 'natural sound' audio products.

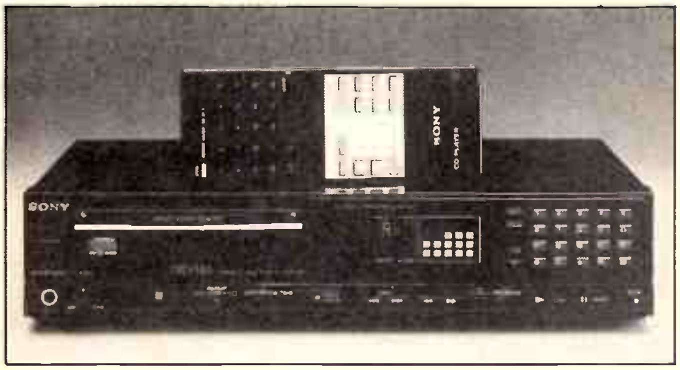
At the top of the list are four cassette decks — the KX-200, KX-400, KX-W500 and K-640.

The KX-200, at $349 RRP, is a basic one-way deck that includes full logic control, several automated features such as forward/reverse intro scan and repeat functions, and Dolby B/C noise reduction. The KX-400, at $499 RRP, adds Dolby pro dynamic bias servo (which significantly improves cassette recording quality), an auto fader and several other convenient controls.

Top of the range are the KXW-500, featuring double deck auto reverse, and the K-640, a superior single deck model with a host of advanced features including car EQ. Both cost around $699 RRP.

Other new releases include three amplifiers (AX-300, AX-400 and AX-500), three tuners (TX-500, TX-900 and T-85) and three receivers (RX-300, RX-500 and RX-700). They join the release, last month of three CD players in the CDX series of the natural sound range.

For more information, contact **Peter Logan** at **Yamaha** on **(03)699-2388.**




**The CDP-65** designed to be compatible with all Sony video and audio equipment.

# CD players galore

Sony has released three new and different compact disc players.

The D-700 player is a desktop unit specifically designed for the office or home or wherever shelf space is at a premium. Its linear skating front-loading design allows the unit to take up minimal space.

Other features include random music selection for up to 16 selected tracks, plus shuffle play and three-way repeat mode. Headphones have their own volume control. These advantages, together with automatic music sensor and music search give the D-700 features you would normally only expect in larger desk type units.

The D-700's RRP is $699.

The other two releases are the more conventional modular CDP-55 and CDP-65.

The CDP-55 has Sony's unilinear converter system, assuring music clarity. This model has wireless remote with five-repeat mode memory and is specifically designed to match Sony's supersession stereo component systems, both electronically and visually.

The CDP-65 has a number of distinct features. The automatic music selection 20-key direct music selection and quick index search is available via the supplied full function wireless remote commander. This means that the 1-20 keypad related to individual tracks on CD software for easy selection.

Another feature is the 20 track random music selection allowing the listener to play up to 20 tracks in any predetermined order.

Both the CDP-55 and the CDP-65 retail at $849.

# 1986 Hi-fi Grand Prix Awards

Category winners of 1986 Hi-Fi Grand Prix Awards were:
Amplifiers: Marantz PM-94;
Cassette Decks: Yamaha K-540;
Compact Disc Players: Pioneer PD-M6 (BK) Multi-Play;
Receivers: JVC R-X500B;
Speakers: Technics SB-RX50;
Tuners: No Award for 1986;
Turntables: No Award for 1986;
Technological Development: Yamaha DSP-1 Digital Sound Processor.

Amongst the judges was ETI's Louis Challis.

# Solar colour TV

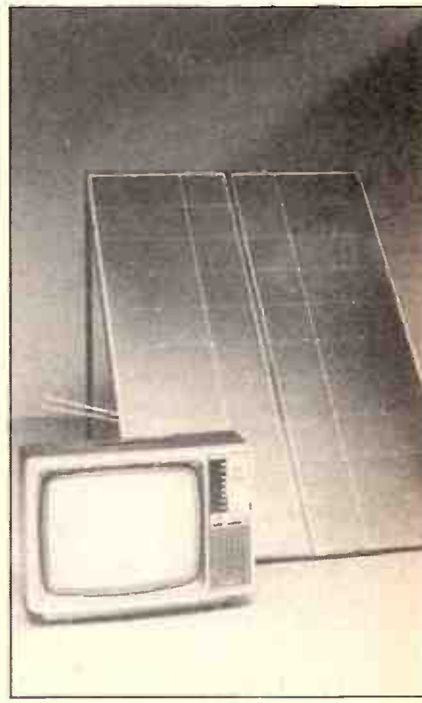
The Sanyo Electric Applied Research Centre in Japan has released prototypes of the recently developed solar powered TV system.

The system is composed of three parts — an Amorton module generating 50 watts of electricity, a compact sealed lead storage battery, and a 14" colour TV.

The Amorton module is capable of powering the television at a rate of up to four hours per day in areas with 2000 hours of sunlight per year. Even after two consecutive cloudy days Sanyo says the module will continue to function because of the storage battery's capabilities.

The television has achieved a 16 per cent reduction in power consumption and can run on either alternating or direct current.

Considerable interest has already been shown by China and Southeast Asia, where electricity shortage is a major problem. Sanyo is also assessing the market value of the TV in Australia, particularly for the more remote areas.



# News on the walkman

The ubiquitous walkman continues to be cloned and developed by many others besides its originator, Sony. But recently, Sony has released two new units with innovations in size and features.

The WM-F101 Super Walkman is not much larger in size than the audio cassette it plays, allowing easy portability with the same clear and powerful stereo sound Sony is renowned for. The unit's discreet size makes it ideal for the suit and shirt pocket or small clutch bag.

This walkman will deliver up to two hours of playback enjoyment on a single AA battery or the same playback period utilizing the optional BC-73F rechargeable battery system. The ultra thin battery can be recharged up to 300 times giving around 600 hours of listening pleasure.

The unit offers FM stereo/AM reception with two-mode auto reverse and continuous playback.

The WM-F202 Super Walkman gives playback as well as recording pleasure. The unit has a stereo recording capability via the one-point plug-in power stereo microphone supplied, that eliminates the need for microphone batteries by drawing power from the cassette recorder.

The WM-F202 is also cassette-case size with FM stereo/AM reception. It features two-mode auto reverse in playback and one cycle auto reverse in recording. It is compatible with optional ultra-thin rechargeable batteries making it a most economical unit.

Both units come with stereo earphones and are available in black, through the Sony Dealer network. The suggested retail price for the WM-F101 is $389, and the WM-F202 is $449.

The BC-73F rechargeable battery pack is also available at the suggested retail price of $79.

REVIEW

# AUTOCAD UNDER THE SPOTLIGHT

***The industry standard for PC-based CAD is still fighting off newcomers after four years. We look at the latest version, Version 2.5.***


## T. Pugatschew

*Tony Pugatschew is lecturer in Physics at SAIT, The Levels, Adelaide.*


CAD systems are examples of horizontal application tools in the sense that their use extends across many disciplines: architecture, engineering, advertizing, and so on. In all areas, there are three types of CAD system: cheap single purpose packages, developments of these tailored to entire processes, and expensive general purpose user-customized systems.

Protel, smARTWORK, Hiwire Orcad, McCAD, Abacus and numerous other packages are examples of the first category, cheap systems, optimized for a single purpose. These packages are popular, well priced and serve as an excellent introduction to more advanced systems. Users will find most schematics and layouts can be handled effectively using them. However, these specialized programs require translators before output can be used by another program in the design sequence.

Integrated systems such as Personal Computer's P-CAD or Racal's REDBOARD, complete schematic and pcb design, checking and simulation environments, are examples of the second category. They cost much more than a specialized system. The designer can produce a schematic, the system can autoplace the components in optimum positions and auto-route the board, as well as conduct design rule checks. An engineer who must design complex, high-density multilayer boards and who demands 100 per cent confidence in layout and accuracy will benefit from such systems.

The third category of package is the general design and drafting system such as autoCAD, PRODESIGN II, CADVANCE, VERSACAD, etc. Most of these have particular strengths in certain areas such as three-dimensional drafting. Since many of the functions performed by the specialized and integrated system can be mimicked by these systems it is important to examine their strengths and weaknesses.

## AutoCAD

Autodesk's autoCAD package was one of the first fully featured CAD packages designed to run on a personal computer. Due to considerable vision on the part of the makers, autoCAD has dominated the market ever since it was introduced. There are claims that nearly half of all personal computer-based CAD users use the system.

There are many reasons for its success. In the first place it was well thought out. It is extremely flexible, it's easy to customize. Macros (small segments of drawings) can be developed rapidly to increase productivity. Today, it has many of the features one is entitled to expect from an industry standard. There are textbooks, journals and extension systems supplied by third parties.

There is even provision for interfacing to an artificial intelligence system — LISP. The use of LISP permits the system to be expanded to do many parts of the design automatically. This has significant implications for productivity.

AutoCAD Version 2.5 is a two dimensional CAD package which is used to pre-

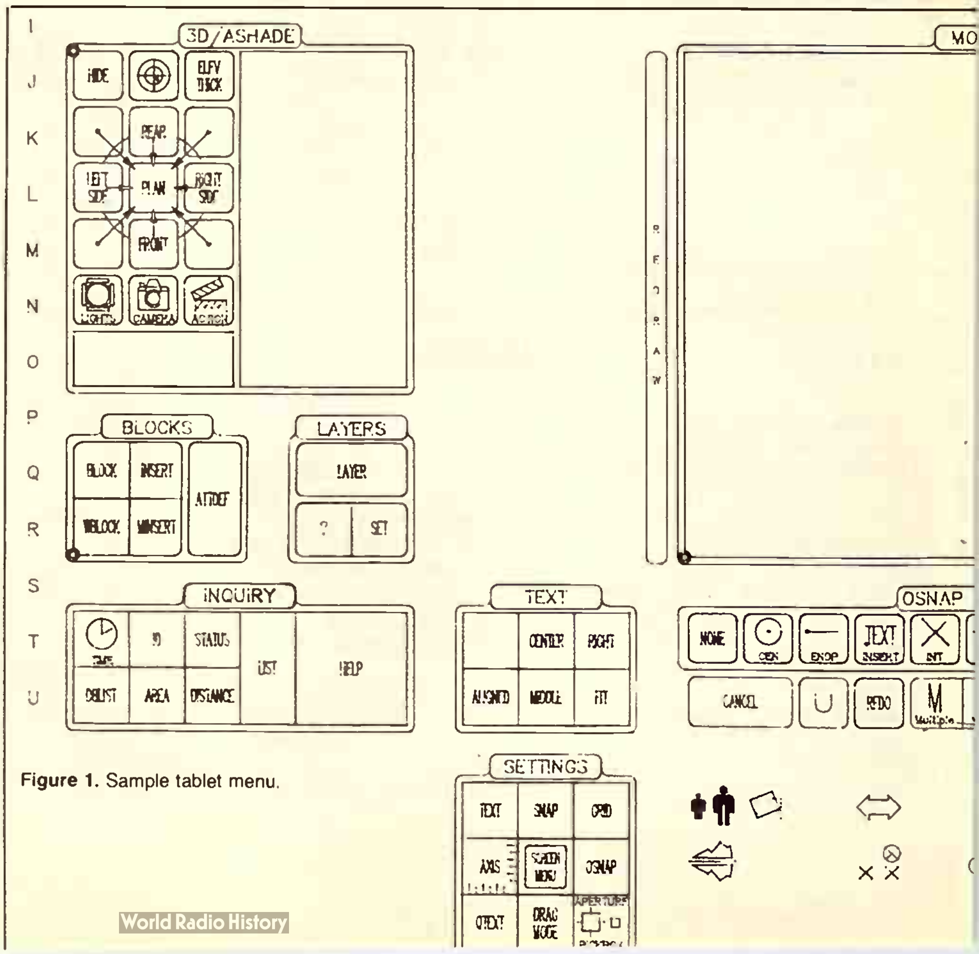
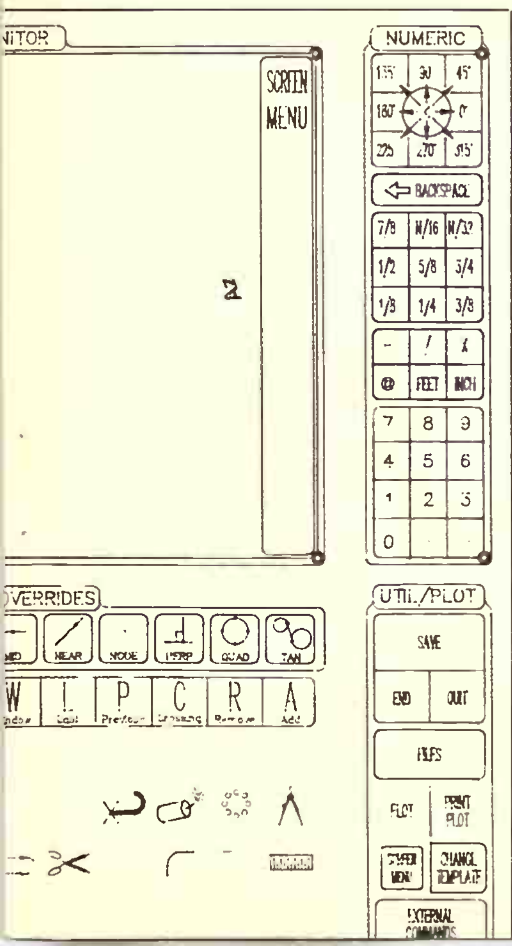



Figure 1. Sample tablet menu.

pare plane drawings. One hundred and twenty commands permit drawings to be constructed with the aid of several main facilities: entity draw, edit and inquiry, display controls, layers, drawing aids, blocks and attributes, and dimensioning.




## Hardware requirements

AutoCAD can run on IBM-compatible machines. A version is also available for use on 68000-based SUN systems and Apollo minicomputers. Of course, the 80286-based AT machines will run faster than the 4.77 MHZ 8088 IBM-PC family. The computer should have at least 512K and preferably 640K of RAM, the 8087 math-coprocessor and a hard disk.

AutoCAD is a large system and uses the disk for overlay files and maintenance of a continuous log file. The faster access offered by a hard disk is a real plus. The price of hard drives is dropping constantly so it is worthwhile to consider this option. The 8087 device speeds up autoCAD arithmetic since the system uses floating point representation for coordinates.

Mice, digitizers, trackballs, joysticks and light pens are very important because the user needs to address points on the screen which represent the drawing surface and select procedures from a comprehensive menu. The keyboard can be used with the arrow keys but it is certainly not as effective as a mouse.

A large variety of video cards and monitors are supported from the common CGA card right up to the high resolution cards.

## Description

Commands can be entered in several ways. The graphics screen is divided into four main areas — menu selection is on the right hand side of the screen. A three-line prompt area at the screen base and a single line of text on top of the screen reminds the user of current coordinate and layer details. Drawing is performed in the central section of the screen. A separate monitor can be selected for text input while a high resolution screen can be reserved for the graphics display. Selection of menu items invokes autoCAD commands. The menus form a hierarchical structure which speeds the selection of functions. It is also possible to set up a digitizing tablet with a large block of menu choices. A section of such a tablet is shown in Figure 1. Menu commands can also be entered from the keyboard and are displayed on the lower prompt area.

A line cursor can be positioned on the screen with the pointing device or keyboard arrow keys. AutoCAD features a DRAG mode which allows selected items to be dynamically moved across the screen. For example, when the circle command is chosen options are presented to draw the cricle — diameter, radius, three points, two points, tangent, tangent and radius

### *Library creation*

The major aim of CAD systems is to permit the efficient production of drawings and documentation which may be an entry into other areas, for example computer aided manufacture. It is important to produce library components which can be called up at will and inserted into the ▶

drawing. For example, an architect may require the use of particular windows, doors, etc. In the electronic schematic area the creation of standard symbols means that the library files are constantly in use. The user has to be able to create units as library components in an easy fashion.

Autocad uses the BLOCK command to assign a name to a drawing or a specified sub-unit of a drawing. A block is defined as a set of entities grouped into a compound object. BLOCK also requests details such as insertion point, scale and attributes. The WBLOCK command writes out the individual blocks to a disk file for use in other drawings. Symbol libraries can be easily created by the user or purchased from third-party vendors.

The main disadvantage of the saved block is that valuable disk space is used. Time is also spent in retrieving the block from the disk. However, because autoCAD uses a single block definition, regardless of the number of times the block is used in the drawing, the final drawing requires less disk space.

Another way of creating a library is to uses the SHAPE command. To draw a shape, the user must load a disk file containing the shape definition. The creation of shapes is not an easy task since each shape is defined in terms of a shapenumber, number of bytes and a shapename. Special codes define operations such as line displacement, vector length and direction. Shapes are useful entities because they are quicker to load and use than blocks which are saved sections of drawings.

*Editing*

Any displayed object may be moved with the MOVE command, copied with the COPY or MIRROR command and changed with the CHANGE command. Multiple copies of an object can be created with the REPEAT or ARRAY command which permits a circular or rectangular array to be drawn. This is particularly useful for multiple pads in an IC footprint. Objects can be rotated, enlarged or shrunk. An object may be divided into equal parts or measured sections. An inserted block can be disassembled or EXPLODED (is there violence in software???) into component parts.

An interesting command that is very useful for schematics is the STRETCH command which moves a selected object and preserves connections to other parts of the drawing. Unfortunately the connections are not maintained if the object is STRETCHED and ROTATED. This would be very useful for finding optimal component placement in the design of pcbs using a rat's nest presentation.

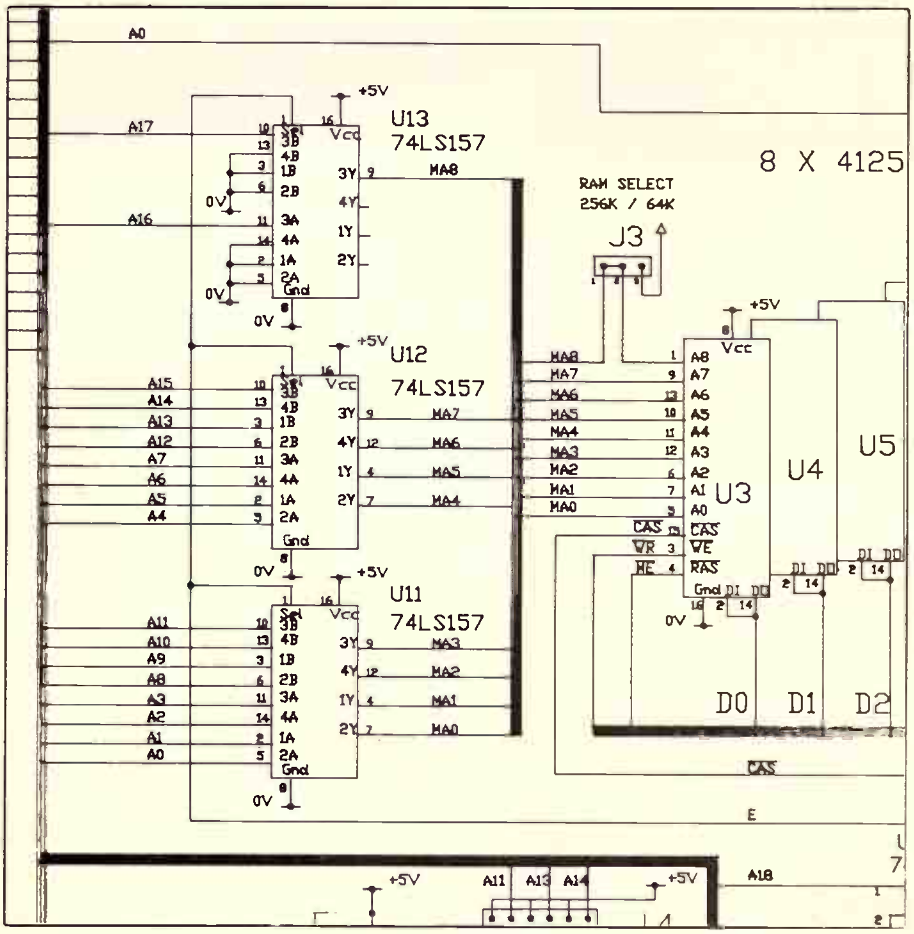
*Layers*

The use of layers is similar to the use of transparent overlays in conventional drawing. For example we may allocate several layers to a pcb — component side, solder side, silkscreen overlay, solder mask, etc The layer name, colour, line type and whether the layer is active can be specified with the type and whether the layer is active can be specified with the LAYER command.

There is no limit to the number of layers in a drawing. Layers must be turned on if editing functions such as MOVE, etc. are performed otherwise entities on the OFF layers will remain in place. The FREEZE and THAW commands are used to speed up screen regeneration by only redrawing layers where editing or entry is being performed.

*Drawing assistance*

The real attraction of CAD packages is the ability to produce professional drawings with the minimum of fuss. AutoCAD provides several commands that speed up this process. The SNAP command ensures that entities are entered at specified inter- ▶



vals. Board pads at 0.1 inch spacing are an obvious example. The ORTHO command ensures that lines are orthogonal or normal to each other.

The GRID and AXIS commands draw either a grid of dots at a specified spacing or a ruler axis on the side of the display. Tick mark frequency is requested from the user. The ADE-2 option enables the grid to be rotated at any angle and snapped to a specified drawing object.

The PER and TAN commands specify that lines are entered perpendicular to another line segment or tangent to an arc or circle.

*Special functions*

Databases and their management play an important part in engineering projects. One advantage of CAD systems over conventional drafting is that extensive information may be entered on each component, for example, the cost and supplier. Furthermore these component attributes can be integrated into a bill of materials, job costing or warehouse pick sheet.

Attributes are defined in autoCAD with the ATTDEF command. When a block with associated attributes is inserted into a drawing, autoCAD prompts for values of the variable attributes. After this has been entered the program draws the block, displays any visible attributes and stores the values of the invisible attributes. If some information is incorrect the ATTEDIT command comes to the rescue. The autoCAD system supplies some simple programs written in BASIC to provide a bill of materials from sample drawings so users have some good examples to follow. The ATTEXT command writes the attribute information to a disk file in a form suitable for analysis with a package as dBASE II.

*AutoCAD special features*

AutoCAD special features are really cream on the cake of this already impressive package.

The EXTEND command extends line, arc and polylines to meet other objects exactly. The OFFSET command simplifies construction of parallel or offset lines automatically. Automatic dimensioning features calculate the dimensions between selected points or the selection of an object. The HATCH command allows hatching of defined areas from a library of appropriate standard patterns for mechanical engineering and architecture.

The SCRIPT command permits the entry of a large number of commands which set up the drawing or replace repetitive key strokes. Slides or predrawn views or a complete drawing can be created with MSLIDE and viewed with VSLIDE. The DELAY command introduces a delay between the showing of successive slides.

*Design extensions*

It is obvious that menu customization and library file creation permit the system to be moulded to suit a particular application. Autodesk has permitted autoCAD commands to be used in a LISP language format. This means that the user can create specific commands with appropriate names such as ENTER-PINS which may draw an IC pad on the screen and ask for a device name and attributes. Expressions include arithmetic, trig, geometric, string, conditional, special data and display functions.

CADR, CDR, LIST and SETQ permit the user to write custom menus in which each selection is a short LISP function. The manual provides a lucid example of command design for an architectural application where a path filled with tiles is created. More examples would be welcome.

Most users would only value the LISP environment after they have used autoCAD for a time in order to appreciate the commands that are necessary in their area.

AutoCAD maintains a log file on each drawing so it is possible to analyze this and discover the types of repetitive command sets that are being used. LISP definitions can then be created to save time.

### Summary

To extract the maximum performance from a complex product such as autoCAD requires practice and discipline. The consistent design of menus, and the use of LISP programs requires a logical analysis of how the system should perform.

Since autoCAD is the topselling package, a large number of micro-based training aids are available, as well as self-study courses and training centres. Many users will find that the documentation is rather daunting and presented in a too formal text-book style.

The speed of the system has been significantly improved from past versions but the screen regeneration time is long for complex schematics (standard IBM-PC). This penalty was tolerable 18 months ago when no discrete schematic design or pcb system was readily available. The software market has not stood still. The rapid panning, intelligent menu design and comprehensive library files of a package such as Hiwires sets a blistering standard for competition with autoCAD.

The picture is complicated, however, by the existence of third part suppliers for autoCAD which significantly enhance its capacity. For instance, the autoboard system recently announced by the Great Softwestern Company, gives autoCAD an auto-routing and auto-layout capability. However, the auto-routing of a simple schematic consisting of several 74LS00 and 74LS08 components took so long I suspected a system malfunction. Partly, this is a result of limitations in the PC hardware, and it is worth remembering that updates are happening all the time.

### AutoCAD for schematics and pc boards . . . yes or no?

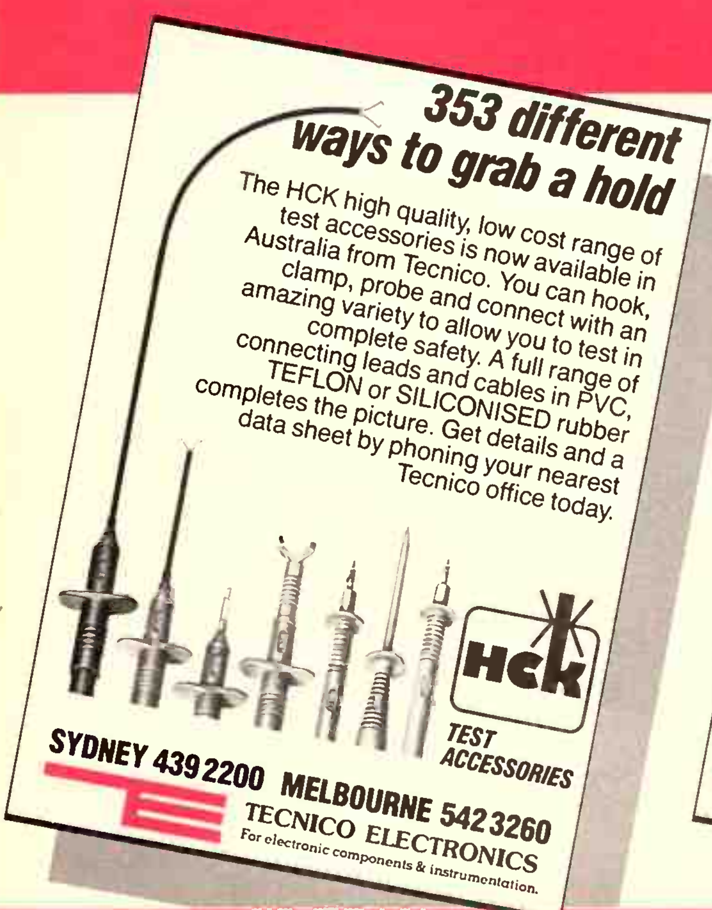
Dedicated packages like Protel and Hiwire win hands down over autoCAD. Speed ease of use and cost show that specific tasks are better handled by a master, rather than a jack, of all trades.

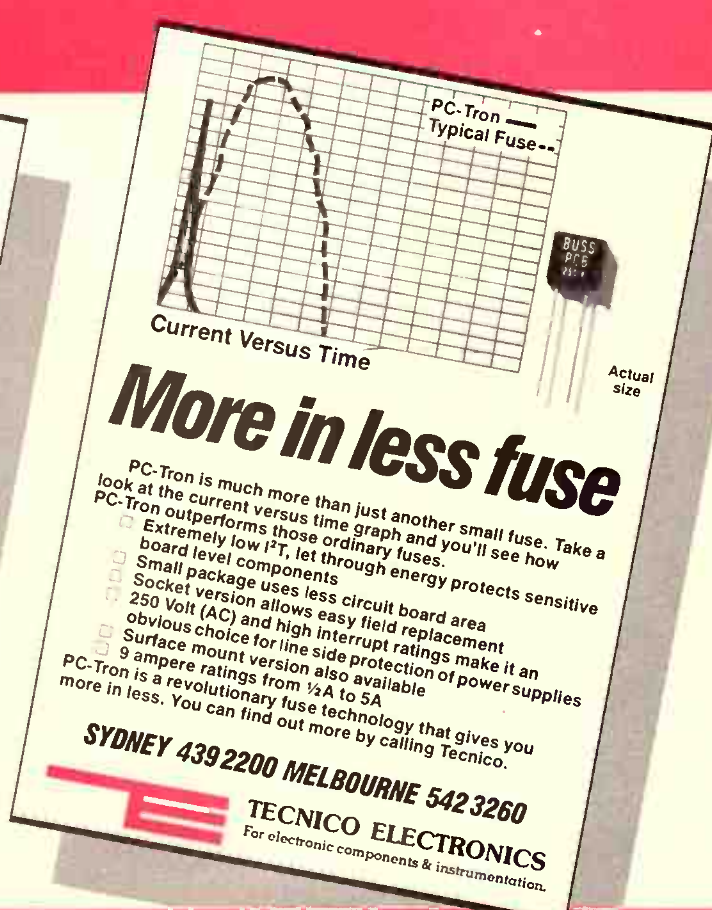
It's true that small schematics are handled equally well by both systems. However, the cost of autoCAD means that this is not a fair comparison. AutoCAD is typically three to four times more expensive than a simple PC-based dedicated system.

There is one caveat, however. Many areas in electronic engineering require more than just a schematic drawer for their CAD system. Here autoCAD comes into its own. The extensive command set and its other functions make it a breeze to draw mechanical diagrams, flow charts or timing diagrams.

Another point running in autoCAD's favour is its extensive customizing capacity. This is a valuable and unfortunately rare feature. The question to ask at this stage is whether a cheaper alternative to autoCAD is just as useful. We hope to review other systems in the future to provide some answers. ●

*Acknowledgements:*
*I would like to acknowledge assistance from Entercom (Aust) in providing a copy of autoCAD 2.5 and information on the support products, ASSCO (SA) for assistance with plotting supplies and information on new autoCAD literature. Mr Malcolm Raymond of Microlectronics Development Centre and Mr Ken Howard from Quentron Optics have permitted me to evaluate and use the P-CAD system. Technical and philosophical discussions with Mr W. Klompenhouwer of Maple Enterprises and Mr V. Dunda of Digital Concept Computers are much appreciated.*



REVIEW

# A CALCULATING PERFORMER


***A look at TI's all singing, all dancing new calculator for the person who forgets formulae.***

**Jon Fairall**

In this day and age, when pocket computers are as common as mud, it seems odd to build, never mind buy, a large calculator without BASIC in it. Yet that's just what TI has done, and there are some very powerful reasons why it's done so.

Just consider the specifications for the new TI-95. It has a 7.2K user memory which can be divided up into program steps, data registers and file storage space. When you switch it on, you have 5.2K of file space, 1000 program steps and 125 data registers. You can elect to have up to 4000 program steps, and 400 registers by eliminating the on-board file space. Alternatively, you can swap between steps and registers at the rate of eight lines per data register.

The file space is used to store programs, and acts just like a RAM disk. You can store as many programs as you like on it, calling and running them directly from the memory. Alternatively, the TI-95 comes with add-on memory modules, so it's quite practical to store programs there, not in the user memory.

If you need to manipulate numbers, this gives unparalleled flexibility. There is probably sufficient space to store every formula encountered in a typical year of undergraduate study. The alphanumeric functions ensure that programs can be made user friendly, by using meaningful labels to prompt keyboard entries.

One of the most powerful aspects of this is the soft keys, the five function keys directly under the display. Separate display windows directly above the keys can be labelled to read any three letter combinations. Pressing a key transfers program operation to a new branch in the program. This can be as simple as yes/no type alternatives, or something a lot more complex.

For instance, I wrote myself a demo program that would solve Ohm's law. You call a program from the file space called OHM (names and labels are only three digits or less). Three soft keys appear labelled E, I and R. Select E and a prompt 'enter voltage' appears; select R and 'enter resistance' appears. When you've filled any two of the variables a solution to the third appears in the screen as 1 −03 amps; ie, 1 milliamp.

The soft keys are also used, as you might guess, to extend the number of keys available on the front panel. For instance, the NUM key, causes two different menus to appear in the windows each with four choices of number functions like random number generators, integer or fraction selection and so on. It keeps the front panel down to manageable size, while making a quite extraordinary number of possibilities available to the user.

The programming language itself is quite straightforward. The algebraic operating system (AOS) allows the entry of an expression pretty much as it appears on a sheet of paper. It works by assigning priorities to each operation (brackets before multiplication before addition, for instance), and providing you are careful is pretty nearly foolproof.

There is the full range of functions you would expect on a scientific calculator — trig functions, factorials, logs and so on. It also has some neat little programs built in for solving quadratic and cubic equations, lowest common multiples and divisors and primes. There is also a full battery of statistic functions, means, deviations and interestingly, a linear regression program as well.

For conditional branching within the program there are nine different tests, plus 16 user flags which can be set and reset conditionally. It uses two ways of defining a jump, either by a line address, or using labels. A handy feature is that the labels are all defined with two letters rather than numbers, which makes for more meaningful labelling when programming. The first 26 memories can also be denoted by a letter rather than a number, so memory A is also memory 000. To make the branching even more powerful, the TI-95 also uses indirect addressing, by which the address can be made to depend on the contents of a memory.

Another form of conditional branching is done via subroutines. Like labels, these can be defined in terms of line number of label and directly addressed. As usual, subroutines must be terminated with a RTN (return) statement.

To store the fruits of your labours, there are load and save file instructions, plus a directory and delete file command. These can be aimed at either the internal memory or an optional cartridge. When the cartridge is in use it's possible to assign names to each one so that you don't get lost. There are also corresponding commands for the tape I/O.

> **“ There is the full range of functions you would expect on a scientific calculator — trig functions, factorials, logs and so on. It also has some neat little programs built in for solving quadratic and cubic equations, lowest common multiples and divisors and primes. ”**

Once you really get going on the TI-95, it's possible to get right into the heart of the processor. On switch on, system registers are all protected so the user can't get to them. Removing protection allows you access to the system flags (from 16 to 99), and the data and system registers. It's then also possible to store or recall a single byte in any part of user memory, any system register or cartridge. It's also possible to call assembly language subroutines. There are a number of these listed in the manual.

I didn't get myself into the situation, but according to the manual it is possible, in extremes, to disable the keyboard or the display by fiddling with the system like this, in which case one needs recourse to the reset button which is thoughtfully recessed into the left of the front panel.

One of the main justifications for doing all this is to make full use of the powerful I/O features on the TI-95. There is a 10-pin connector on the back of the unit that can be controlled by the unit. TI has a printer that works off this port, the PC324, but presumably you can control many other devices if you are sufficiently clever.

Not unnaturally, there are a few things wrong with the way the TI-95 works. For the most part they're trivial little things that ought to have been attended to in a device of this sophistication. For instance in order to delete a line, it's necessary to step to the left, then go to second function mode, then delete; three key strokes. There were calculators around 10 years ago that used one key stroke to do the same thing.

Much the same thing applies to inserting new lines in the program. Before you start work you are required to stroke the second function, then the insert button. It's surely not necessary. To add to the problem, many of the functions on the board will toggle the insert mode so that you can be inserting data and all of a sudden find yourself overwriting your program.

No doubt you get used to these things if you do enough programming, but they seem unnecessary.

Another thing I found annoying is that labels, file names and registers are sensitive to upper case or lower case alphanumerics. So 'a' is not the same as 'A'. This is silly, but even worse is that the procedure for changing the calculator from one mode to the other is laborious in the extreme.

These annoyances aside, the TI-95 is a joy to use. In the non-programming mode it seems almost viceless. It's aesthetically pleasing, with a nice heavy feel to it, sufficiently robust, in fact, to stand up to being thrown in the bottom of a sackful of books.

Finally, the thing that makes it all happen: the manual. I'm delighted to report, it's a beauty. It's thoughtfully laid out in two volumes, each divided into logical chapters, and it's simply and clearly written. The front piece credits 10 people with its development, which says something about TI's commitment to good marketing. ●

**RETAIL PRICES**

| | |
|---|---|
| **TI-95** | **$299** |
| **maths cartridge** | **$55** |
| **8K RAM** | **$69** |
| **stats cartridge** | **$55** |
| **PC324 printer** | **$249.95** |
| **cassette interface cables** | **$40** |

REVIEW

# A FINE BALANCE OF BOOKSHELF SPEAKERS

***Despite the advertizing hype, it is a finely balanced act choosing between bookshelf speakers. To prove the point rather than make your choice easier, we have reviewed four sets of bookshelf speakers that range notably in price but rather more indeterminately in performance.***

Louis Challis

Loudspeakers are unquestionably the most important component in your hi-fi system. There have been many thousands of different bookshelf speaker systems developed over the last 20 years, a few of which could be described as 'good' and an even smaller number of which could be described as 'outstanding'. The problem is that despite their appealing look and plenty of advertizing hype, bookshelf speakers are generally a retrograde step when you seek optimum performance.

Nevertheless, we decided to select four of the most notable bookshelf speakers currently marketed in Australia in order to undertake a comprehensive comparison review. The decision was prompted by a number of readers' requests, and by the fact that our houses and apartments are becoming decidedly smaller, and the cost of good speakers is rising at an alarming rate. Even though the costs of CD players and some amplifiers is dropping, the most critical elements, the speakers, are becoming more expensive and more difficult to place.

The four speakers selected were, the Bose 301 Series II, the B&W Matrix I, the Dali 3A and the JBL L20T. The real similarity these speakers have is their size and even then, there are obvious differences. One difference is in price. At one end of the spectrum you have the Dali 3As at $668 whilst at the other you have the B&W Matrix 1 selling at $1695 RRP. In the middle you have the Bose 301 Series IIs at RRP of $800 a pair and the JBL L20Ts at $858.

The Bose Corporation is located in Massachusetts in the US, the B&W Company in England, the Dali Company (which stands for Danish American Loudspeaker Industries) in Denmark and the JBL Company in California, US. The underlying design philosphies, and obviously their acoustical characteristics, are to a large measure directly related to their country of origin. See accompanying boxes for a rundown on the designs of these speakers.

## Objective testing

When it comes to testing speakers as neat and as small as these four the task turns out to be far less complex and messy then it is with larger speakers. In this case the almost 'shoe box' sized dimensions and modest weights impose no practical constraints and induce no hernias when carrying them into or out of our anechoic room.

### *Frequency response*

The first real problem came with the evaluation of the Bose 301 Series IIs, which were never intended to be evaluated in our normal way, under free-field conditions. For this reason the measured frequency response of the Bose looks far more lumpy than any of the other three speakers, irrespective of which of the 10 or so angles we attempted to measure the frequency response at. But even allowing for the reflective characteristics of the intended place of usage, I would be hard pressed to convince myself that under optimum conditions (as recommended in the handbook) the perceived frequency response would ever be flat. Nevertheless, the frequency response measured directly on the axis of the woofer, indicates that this unit has been well selected and is properly ported by the enclosure.

The method of mounting the tweeters, without the benefit of flush mounting provides a frequency response that can only be described as disconcerting. With the Bose 301s, we were hard pressed to define the term '30° off axis' and it behoves us to examine the polar plots a little later on.

By contrast the on-axis frequency response of the B&W Matrix Is is quite

B&W Matrix I

smooth at both 2 m and 1 m on axis, with a modest rise discernible between 200 and 600 Hz, and an almost flat response between 600 Hz and 11 kHz. Rather surprisingly the tweeter then suffers a 6 dB drop between 11 kHz and 20 kHz, which although measurable, would be in no way audibly disturbing. The measured response 30° off axis of the B&Ws exhibits no substantial droop, apart from a slightly higher attenuation at 20 kHz, which is then down by 12 dB instead of only 6 dB.

The Dali 3As exhibit a relatively smooth frequency response on axis, with the tweeter response extending out extremely smoothly in the 10-20 kHz region. At 30° off axis the response is still commendable with only a modest 8 dB droop at 20 kHz.

The JBL 20Ts provide a particularly good response for such a small low frequency driver, with only one significant droop at 1.3 kHz and a high frequency response that is exceptionally good all the way to 20 kHz and beyond. At 30° off axis the response is only 7 dB down and the rest of the response does not significantly change.

### *Input impedance*

When it comes to input impedances each speaker has a characteristic which is truly all its own. The Bose 301s exhibit a minimum impedance of 9 ohms, a maximum impedance of 31 ohms and a series of rises and falls which would make any roller coaster proud. The actual impedances are not dangerous or disturbing so much as relatively non-uniform at the lower end of the spectrum, in the region where you are likely to try to extract significant output powers.

The B&W Matrix Is, on the other hand, exhibit an impedance curve which is a credit to the system's designers. These are the first speakers that I have seen since the KEF 105s which have an iteratively optimized impedance characteristic. A curve as flat as this would not disturb any amplifier (even a bad one), and would allow the speakers to be paralleled with other comparable speakers.

The Dali 3As by contrast, have a minimum impedance of 6 ohms, a peak impedance of 42 ohms around the crossover frequency and a general impedance characteristic, which although not disturbing, does not look good when compared with the other speakers.

The JBL L20Ts have a minimum impedance of 5.5 ohms, a peak impedance of 35 ohms and because of the ducted port exhibit a general similarity to the Bose 301 Series IIs. This impedance curve would allow you to extract healthy powers from your amplifier, but it is not really optimized for paralleling with other speakers.

*Phase response*

The phase responses of the speakers were interesting. In the case of the Bose Series II it was not particularly easy to measure and caused us a few headaches. In the case of B&W Matrix Is, the curve proves to be remarkably smooth over the critical high frequency region.

For the Dali 3As the curve is also remarkably smooth over that critical high frequency region. The JBL's too was reasonably smooth, even though the phase relativity varies by approximately 240° over the critical high frequency region.

Dali 3A

JBL L20T

*Polar plots*

The polar plots clearly highlight significant design differences between each of the speaker systems. Whilst the Bose 301s exhibit a reasonably smooth polar plot at 1 kHz, with increasing frequency the non-uniformity of output reveals why we experienced so many problems in trying to determine an appropriate off-axis angle at which to measure the frequency response. The 10 kHz frequency response between 30° and 50° to the front and between -210° to -270° to the rear can be clearly seen to be the preferred angles of directivity.

The B&Ws exhibit remarkably smooth responses at all of the measurement frequencies, including 10 kHz, and although the tweeter starts to run out of steam at 15 kHz, it is quite clear that over the range 70 Hz to 15 kHz these speakers provide a smooth non-directional performance over the forward projection arc.

The Dali 3As also exhibit a generally smooth polar plot performance, although not quite as smooth as that of the B&W Matrix Is. Even so, as the cheapest speakers of the four tested, they most certainly shine in this area.

The JBLs also provide a good polar performance and, although the directivity at ▶

## JBL L20T

**The JBL Company is renowned for its high powered and professional speakers. Most people who are familiar with JBL products have seen them used in either rock concerts, professional recording studios or in acoustical laboratories. JBL has also been an innovator, particularly in the area of high efficiency, controlled directivity, power handling capacity and speaker reliability.**

**Now the professional speaker market does not necessarily keep a speaker manufacturer alive, and consequently over the last 30 years JBL has developed and marketed some truly exciting consumer oriented loudspeaker systems.**

**The L20T is one of the smallest loudspeaker systems that JBL has produced. The first and fundamental principle of JBL speakers has been their reliability and the L20T incorporates a 155 mm diameter driver with an attractively made and extremely solidly constructed diecast speaker basket. None of the other three speaker manufacturers begin to approach this in terms of stiffness.**

**This driver utilizes a very large ferrite magnet assembly, together with a polypropylene speaker diaphragm with a very flexible rolled edge surround. This driver and the associated tweeter are installed in an 18 mm thick (real) timber veneered enclosure, which is conventionally and solidly constructed. The speaker crossover network is also well manufactured with quality air coiled inductors and, it should be noted, with 'over rated' capacitors and high power resistors. JBL's experience in the professional field clearly shows through here.**

**The tweeter features a 25 mm diameter titanium diaphragm which the designers have taken special care to protect from those 'cotton pickin' fingers' by means of a heavy wire mesh grille. Tweeter diaphragms as light as this are extremely vulnerable and so easily destroyed that they warrant that extra bit of protection. The Model 035Ti tweeter is one of the neatest and most cost effective tweeters that JBL currently manufactures and the same excellent tweeter is used in all four models of the L series consumer speaker systems.**

**JBL has designed the L20T system to handle 100 watts continuous power and more significantly peak (transient) inputs of up to 400 watts when fed with program material conforming to the IEC shaped sound signal (TC29B Secretariat 138-September 1978).**

**The cabinet which incorporates a venting port on its front panel is well made. A small amount of low density fibreglass material is stapled to the inside faces and I suspect that the enclosure would benefit from the addition of a little more. This would likely change (and marginally improve in the region 200 to 500 Hz) the mid-band presence of the system.**

**The speaker grille is neatly made from open weave black cloth which has been carefully thermally bonded to a neat plastic frame.**

**The speaker terminals at the rear of the cabinet (which is also veneered in real timber) incorporates a large and sensible pair of universal terminals to which access is simplified through the same simple expedient that Dali has also utilized, of angling the terminals within the moulding.**

## BOSE 301A SERIES II

**Aram Bose's philosophy for loudspeaker design runs counter to the general rule. He believes that you need to deliberately provide a supplementary set of mid-frequency and high frequency primary reflections from the sidewalls of your listening room in order to replicate the characteristics of the original listening environment. To attain that aim, his various loudspeaker enclosure designs have incorporated multiple rearward and/or sideward pointing speakers. In some of his designs these are supplemented by active equalizers to compensate for the non-linear frequency response of the resulting systems.**

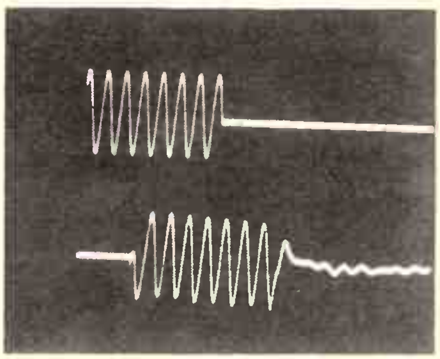
**The 301 Series speakers incorporates a pair of tweeters on the outer truncated corner of the cabinet. These point backwards at 45°, and forwards and slightly upwards, so as to create the spatial breadth and reflective characteristics of a live orchestra performing on a stage that is wider than your living room.**

**The 301 Series II enclosures are relatively light at 7.1 kgs. Each enclosure incorporates a 200 mm diameter driver with a polyurethane foam surround and a 54 mm diameter ducted port, which is positioned relatively close to the outer corner of the enclosure. The cabinet is manufactured from plastic veneered particle-board, 14 mm thick, and the two tweeters, which are mounted on the truncated corners with plastic brackets, have diameters of 75 mm. These speakers look a 'little lost' and ungainly and are covered by a neat open woven cloth covered plastic frame. The cloth has a different and contrasting light fawn colour.**

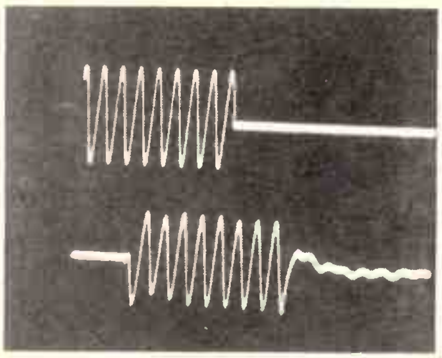
**The rear of the cabinet incorporates a simple speaker termination panel with a pair of red and black spring loaded sockets for terminating the bared ends of your speaker leads.**

**Inside the cabinet, the crossover network has been designed to provide two different transition frequencies for the respective tweeters. The lower and frontward pointing tweeter has a crossover operating at 2.5 Hz, whilst the upper and rearward pointing tweeter has a crossover frequency of 1.5 Hz. The designers have recommended minimum power amplifier ratings of 10 watts and 75 watts maximum (rms) per system.**

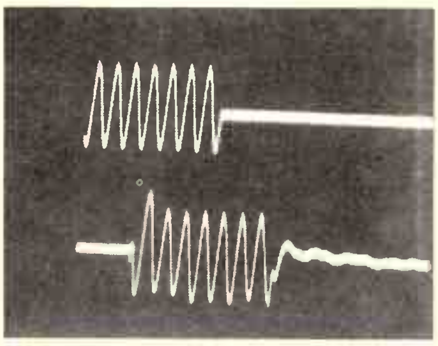
Tone Burst response for 90 dB steady state SPL at 1 m on axis, 1 kHz (2 ms/div). Upper trace is electrical input; lower trace is loudspeaker output.



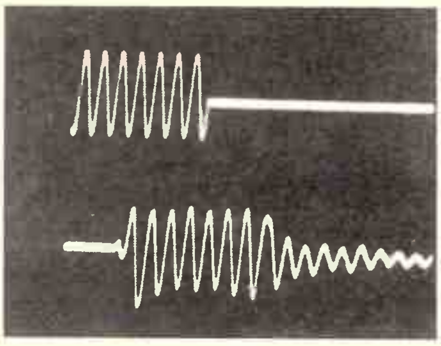
JBL L20T



B&W Matrix I



Dali 3A



Bose 301 Series II

10 kHz is somewhat sharper with a slightly narrower bandwidth than the competing units, their performance is still good.

*Sensitivity*

Distortion is a very important factor and particularly when the electro-acoustic conversion efficiency is simultaneously considered.

The Bose 301s have comparable sensitivity to the other three speakers. At low and medium frequencies their distortion characteristics are also comparable, however, at 6.3 kHz the measured distortion was higher than I would have expected and this characteristic can be expected to extend to even higher frequencies.

The Matrix Is have the lowest sensitivity of the four but with modest distortion at 100 Hz, (higher than I would expect in a system costing $1695). The distortion figures at both mid-frequency and high-frequency are, however, very low.

The Dali 3As have the highest sensitivity of the four systems (even if only marginally so). They exhibit relatively low distortion at low frequencies, moderate distortion at mid-frequencies and modest distortion at high frequencies.

The JBL L20Ts have intermediate sensitivity, with high distortion at low frequencies, which I guess is only to be expected when you use a 155 mm diameter woofer. Thereafter they have low distortion at mid-frequencies and low distortion at high frequencies.

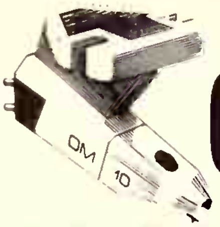
*Tone burst response, decay response*

The tone burst evaluation of each of the speakers tends to replicate some of the most significant characteristics of the distortion measurements, as well as those of the decay response spectra, which I will examine in detail below. In simple terms the Bose tone burst performance results are far from exciting, the results of the B&W Matrix and the Dali 3A's are good, whilst those of the JBL L20Ts are very good.

The decay response spectra of the Bose speakers clearly show both that the cabinet resonances are significant and the multi-directional propagation patterns interact, to produce what is a visually disturbing pattern. By contrast the B&Ws reveal a remarkably smooth decay response spectra, which is almost the equal of any I have yet seen. They have minimal signs of either speaker enclosure resonance or signs of speaker basket or transducer resonance.

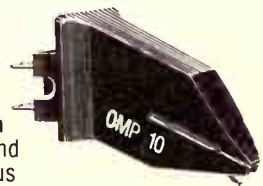
Even the Dali 3As perform reasonably well in this respect, although speaker enclosure resonances are visible, as are some of the minor resonances from the speaker basket. A notch at 8 kHz appears to be a diaphragm anti-resonance in the tweeter, ▶

# CAPTURE AN ORTOFON OM-10 FOR ONLY $89* AND ESCAPE TO DENMARK WITH SAS




**Now is the time to update your Hi-Fi system with one of ORTOFON's superb OM/OMP cartridges.**
By doing so, you will also have a chance to go to Denmark and visit the ORTOFON manufacturing plant.

## WHY THE ORTOFON OM/OMP SERIES CARTRIDGES?




If we were to take away their high output, adjustable mass, diamond quality, superior sound and stylus interchangeability, these cartridges would be no different from all 'the others'.
But with all these features and their sonic excellence, these cartridges have become the most successful range of cartridges ever produced by ORTOFON. In terms of value for money the OM-range is now recognised throughout the world as "the one to buy".

## WHAT THE EXPERTS SAY!

**GRAMOPHONE:** "... the OM-20 showed a more solid bass and midrange and freedom from edginess." "... The OM-30 had a more subtle sound quality with greater clarity and definition, a more positive stereo image."
**HIGH FIDELITY:** "The OM-40 is the best magnetic cartridge that this Danish manufacturer has ever produced ..."
**HI-FI CHOICE:** "ORTOFON OM-10 ... BEST BUY!!"
The nomenclature "OM" stands for Optimum Match. By removing the in-built 2.5 gram weight-plate, the OM cartridges can be perfectly matched to any medium or low mass tone arm. The technically identical OMP models are designed for use in P-mount tonearms.
All OM styli are interchangeable. If your budget does not allow the top model initially, start with the OM-10 and update the stylus later.

## THE PRIZE LIST

**Buy any ORTOFON OM/OMP 10, 20, 30 or 40 cartridge between 1st March and 30th June 1987 and you could win one of the following prizes:**

### 1st PRIZE:

7 days holiday in Denmark. Flying with SAS, The Businessman's Airline, to Copenhagen and return, including 6 nights first-class hotel accommodation and all transfers.
This exciting trip includes a visit to the Ortofon manufacturing plant, plus an opportunity to visit the Danish Royal Theatre, famous Tivoli Gardens and one of the many famous Danish jazz clubs.

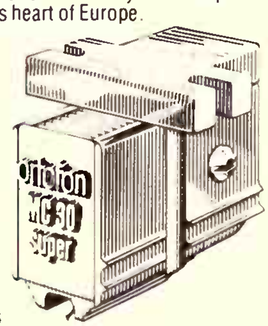
SAS

**THE BUSINESSMAN'S AIRLINE**

Next time you travel to Europe on business, why not give yourself a break and fly SAS, the Scandinavian way – one stop to Copenhagen, the business heart of Europe.

### 2nd PRIZE:

Ortofon MC30 Super Moving Coil Cartridge.
Valued at $800.




### 3rd PRIZE:

Ortofon MC20 Super Moving Coil Cartridge.
Valued at $600.

Full details and conditions of entry from your nearest ORTOFON specialist.

ortofon
accuracy in sound

For more technical information and reprints of reviews on ORTOFON's full range of products, contact Sole Australian Distributor:
**SCAN AUDIO Pty. Ltd., 52 Crown Street, Richmond, Victoria 3121. Phone (03) 429 2199**

SA4305

*ADVERTISING INFO No. 25*

which is neither audible nor disturbing.

Even though the JBL L20Ts are modest in size and in price, their decay response spectra are particularly good, although once again the low level resonances from the speaker enclosure make their presence felt. The speaker cabinet and transducer frames are not as well damped as I would like. The results manifest themselves as low levels of additive radiation right across the spectrum from 1 kHz to 20 kHz.

To check on the merits of the B&W Matrix I cabinet design I ran out a comparison curve of sidewall vibration. This was generated by a swept sinewave signal fed to the terminals of two loudspeaker enclosures. The electrical signal produced a nominal output of 90 dB of mid-band signal at 1 m for both the B&W Matrix Is and another similarly sized speaker enclosure with almost identical efficiency.

The measured acceleration level on the side panels of the two speakers clearly showed how efficiently the B&W structure attenuates the sidewall resonance to the point where secondary radiation from the cabinet surfaces no longer appears to be a significant problem. Similar test measurements on the other speakers did not result in such low levels. It is patently clear from both the measurements and from my subsequent subjective evaluation, that some of the subjective differences between these speakers is the result of cabinet resonances.

## Subjective testing

The subjective evaluation of the four speakers was a time consuming labour of love because each of these speakers is without question a well designed piece of equipment with more attributes than liabilities.

Because of the special rear wall mounting requirements of the Bose 301s, I was forced to modify the characteristics of my normal live end dead end (LEDE) listening room to provide the special reflective characteristics required.

The music I chose for my evaluations ▶

### DALI 3A

**The design of the Dali 3A speaker system has been based on some of the best proven design parameters for conventional bookshelf speaker systems. It features a sealed enclosure with a well developed 200 mm diameter woofer and an exciting 25 mm diameter tweeter capable of providing superb performance at frequencies well beyond 20 kHz.**

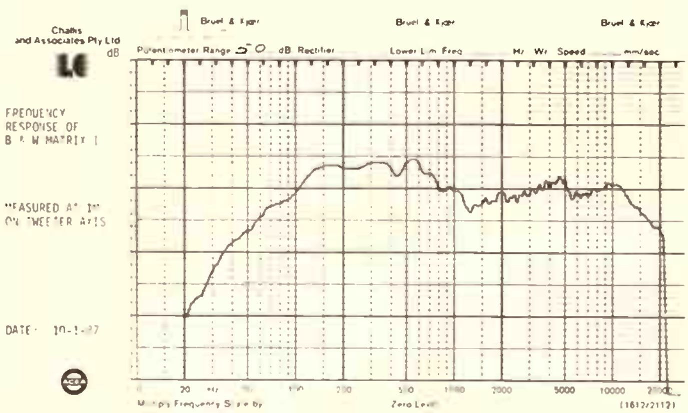
**The Danish speaker manufacturer has become world-renowned for the excellence of workmanship in mass produced timber and composite cabinet materials. A close inspection of the plastic veneered particle-board enclosure confirms that the Dali organization has applied the best features of Danish precision to the manufacture of this speaker. The cabinet is marginally larger than the other three systems. Both the woofer and the tweeter have been carefully recessed into the heavy front panel of the enclosure.**

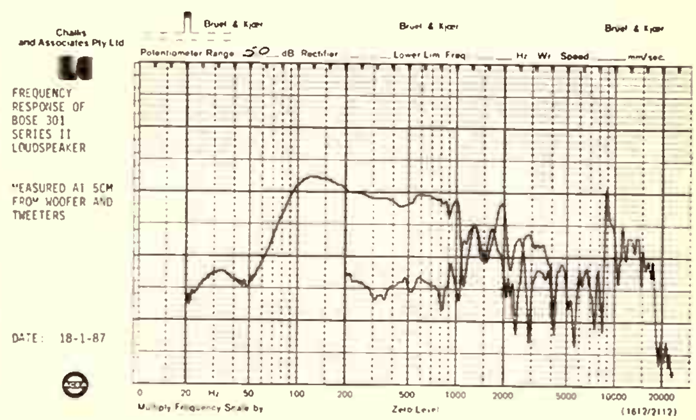
**The cabinet is fabricated from solid 25 mm thick particle-board and the drivers are representative of the latest and best OEM units manufactured by Vifa in Denmark.**

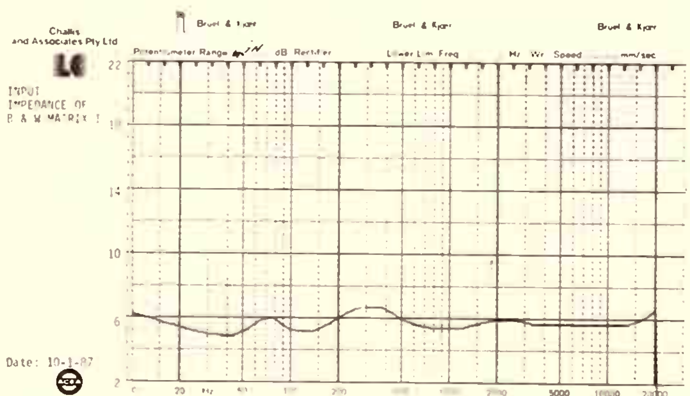
**The internal damping media inside the cabinet utilizes carefully shaped layers of heavyweight open cellular polyester foam overlying a thick layer of shredded cloth wadding. This provides the protection and separation in the area where the crossover network has been located.**

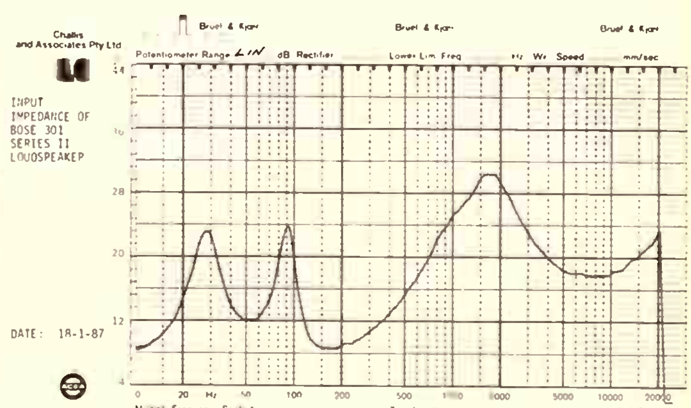
**The manufacturer has recommended amplifier power ratings of between 5 and 80 watts and aimed at achieving an equitable compromise between cost and performance.**

**The speaker connections are provided by means of a pair of colour coded universal terminals, which are sensibly angled on the plastic recessed terminal block at the lower rear corner of the speaker's back panel.**

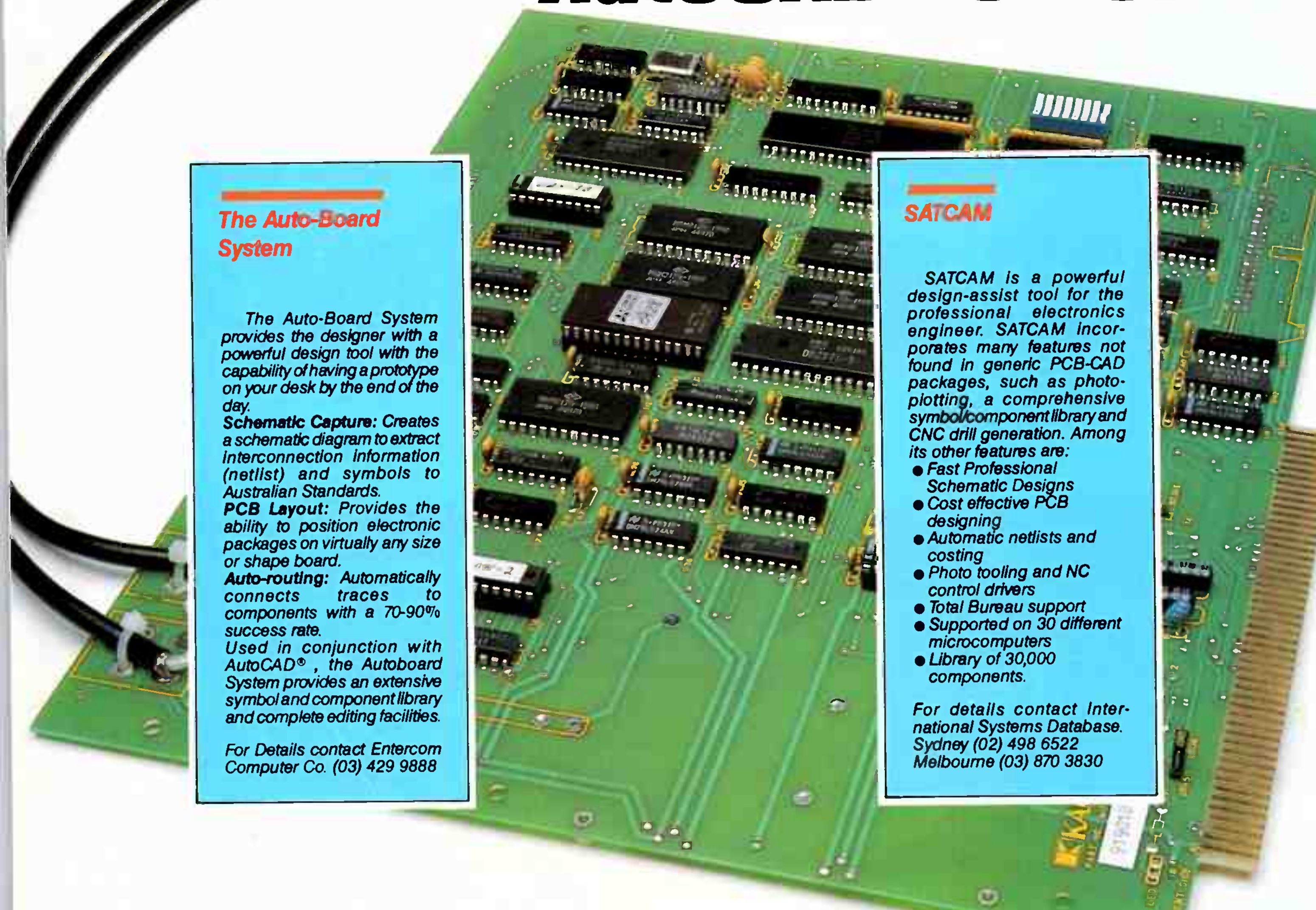


# AutoCAD® is PCB



## The Auto-Board System

The Auto-Board System provides the designer with a powerful design tool with the capability of having a prototype on your desk by the end of the day.

**Schematic Capture:** Creates a schematic diagram to extract interconnection information (netlist) and symbols to Australian Standards.

**PCB Layout:** Provides the ability to position electronic packages on virtually any size or shape board.

**Auto-routing:** Automatically connects traces to components with a 70-90% success rate.

Used in conjunction with AutoCAD®, the Autoboard System provides an extensive symbol and component library and complete editing facilities.

For Details contact Entercom Computer Co. (03) 429 9888

## SATCAM

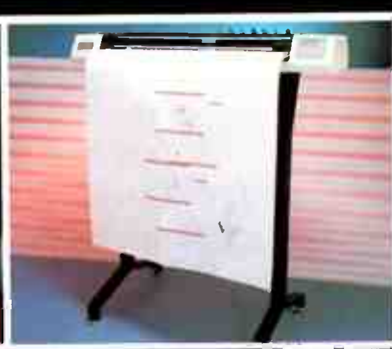
SATCAM is a powerful design-assist tool for the professional electronics engineer. SATCAM incorporates many features not found in generic PCB-CAD packages, such as photo-plotting, a comprehensive symbol/component library and CNC drill generation. Among its other features are:

- Fast Professional Schematic Designs
- Cost effective PCB designing
- Automatic netlists and costing
- Photo tooling and NC control drivers
- Total Bureau support
- Supported on 30 different microcomputers
- Library of 30,000 components.

For details contact International Systems Database. Sydney (02) 498 6522 Melbourne (03) 870 3830

The Auto-Board System and SATCAM are complete electronics/PCB CAD packages which fully integrate with AutoCAD®, the leading Computer-Aided Design solution. Whether you are a small or large company, AutoCAD® and SATCAM or Auto-Board System can increase your productivity and enhance your creativity.

The NCR PC8 Advanced Technology (AT) PC is an ideal CAD workstation with its 8 MHz 80286 processor and native 640 by 400 colour graphics capability.



Houston Instruments have defined the industry standard in low cost, high quality plotting with its best selling, A1 size, 16 ips DMP-52 plotter.

AUTOCAD®
NUMBER ONE IN AUSTRALIA AND WORLDWIDE

For further information or demonstration contact your nearest "Authorized AutoCAD® Dealer" by contacting us at ...
136 BRIDE RD., RICHMOND
VICTORIA 3121 AUSTRALIA
PHONE: (03) 429 9888 TELEX: 30625 ME1400

ENTERCOM

- AutoCAD® is a registered trademark of Autodesk Inc. USA
- NCR PC 8 is a trademark of NCR Inc.
- DMP 52 is a trademark of Houston Instruments USA
- Drawings provided and reproduced by kind permission of Colin Johanson EXECUTIVE OFFICE INTERIORS PTY LTD (Melb.)

ADVERTISING INFO No. 26

# They come with a longer warranty than a Rolls Royce.


# And they're quieter.

Interestingly enough, the warranty on a new Rolls Royce is only 3 years.

The warranty on our 6 new compact disc players is 5 years. And we don't have to worry about the ticking of the clock.

In fact, the only sound you'll ever hear from our new generation C.D.'s is the faithful, pin-sharp accuracy of the music.

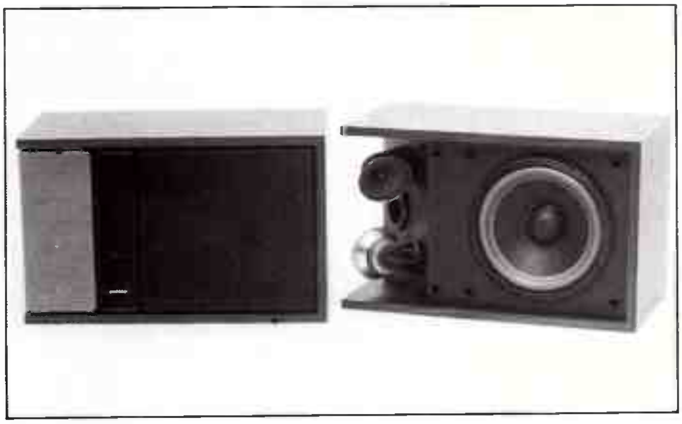
If you're wondering why we compare ourselves to the technical excellence of the world's leading car, the answer is simple.

We couldn't find a competitive C.D. player that could do the job.

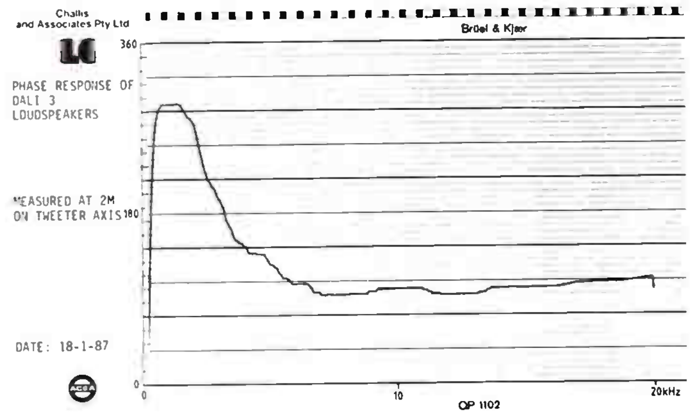
**YAMAHA** **5 YEAR WARRANTY.**

ADVERTISING INFO No. 27

Saatchi YAM 010



Bose Series II




was primarily CD-based, although I did resort to some of my tried and true spoken voice records for the critical 'voice realism' test. Using Robin Archer's *A Star is Torn*, I quickly discerned the ranking on human voice reproduction as being (i) B&W (ii) JBL (iii) Dali and (iv) Bose.

The subjective differences were not as marked as I would have expected and even the Bose 301As performed admirably with one notable difference. A speaker which is designed to disperse the sound as the 301As cannot achieve a realistic localization of source. With my eyes closed Robin Archer seemed to spread out, without the precise imaging that the other three speakers provided so effectively.

The second series of tests utilized tracks from a Delos Sampler entitled *Soundscapes Volume Two* (D/CD 3501) from which I used Wagner's "Das Rheingold" with the anvil clashes of the "Entry of the Gods into Valhalla" to assess the transient performance of each speaker. I used the A-B replay facility on the CD player.

Each of the four speakers provided excellent transient performance with peak signal levels as high as 110 dB, although at that level the Dali 3s and the Bose 301s were exhibiting a trifle more distortion than either the B&W Matrix Is or the JBL L20Ts.

Track 5 from the same disc is Beethoven's "Symphony No 8" and the Bose 301s provided a dramatic confirmation of their ability to replicate the physical breadth of an orchestra. I guess this compensates for their inability to localize an individual singer. On orchestral works of this type the Bose 301s really do have something to offer, and if large orchestra music is your scene then they really are worth an audition.

The next disc I used was a new Pickwick International from Virgin Records entitled *Impressions of Brass* (PCD 836) which, with plenty of brass, provided a discriminating set of data to evaluate the four sets of speakers with.

With grouped instruments playing together, the most significant difference between the speakers was that provided by the Bose 301s with a greater breadth of sound disperson and 'richer' sound than the other three. In this respect the Dali 3As and JBL L20Ts took on a slightly more stident tone, whilst the B&W Matrix Is exuded a feeling of slightly softer and almost muted characteristic (even allowing for the slightly lower output which I adjusted during their tests).

With a new Denon disc Buddy Rich *Tuff Dude* (33C38-7972) the equation took on a slightly different picture. Individual instruments were clearly and precisely audible, as were traces of colouration which the individual speakers produced. In this particular segment of the evaluation the ▶

## B&W MATRIX I

**The B&W Matrix I speaker is one of the most innovative and, as it would appear, one of the most expensive bookshelf speaker systems currently available in this country. One of the most striking features about B&W (which started off as Bowers and Wilkins in the late 60s) has been the extent to which their succeeding series of speakers have incorporated unconventional, but nonetheless technically exciting developments. The 'matrix' concept is one of its most unusual, and as it would appear, one of its most expensive developments.**

**The matrix concept is unusual. Most of us may be aware that by providing internal bracing elements between the opposing walls of the enclosure you are able to effectively dampen out (but not completely remove) the natural tendency for the enclosure to vibrate at one or more natural resonant frequencies. The trouble with adding bracing elements between the walls is that they reduce the available space in the cabinet. That is they both obstruct and limit your ability to incorporate appropriate quantities of suitable sound absorptive material. B&W's unusual approach to this problem was to form a plastic 'eggcrate' matrix into which individual rectangular strips of absorptive foam material could be inserted. The whole composite structure is then glued inside the cabinet walls. The space for the crossover network is left at the bottom of the cabinet from which there is normally minimal radiation. The space for the drivers is resolved by the use of an unusually heavy composite structure, about which B&W has deliberately said very little. All this sounds far simpler than it really is, and I must presume that the seemingly high cost of the Matrix I speakers is associated with the amount of hand work involved in correctly implementing the details.**

**The fully sealed cabinet is relatively deep at 310 mm overall (much deeper than any of the other speakers in this group). This is a direct result of the need to provide sufficient internal volume, whilst simultaneously minimizing the face area of the enclosure. This is essential as the front of the speaker enclosure is one of the hardest areas to stiffen. There is also a direct relationship between the depth of the speaker enclosure and its face area, if a given lower cut-off frequency is to be achieved. One of the results of incorporating all this extra stiffening material inside the cabinet is that its mass is increased dramatically: each of these small cabinets weighs 10 kg.**

**The 165 mm woofer and the 25 mm tweeter are the result of a long and extensive speaker development program, aimed at achieving unusual linearity of output, minimal distortion, minimal tendency to speaker break up at high power levels, and high power handling capacity. The performance of the new FFT2 high frequency transducer has been improved in three ways: by automating the construction, through the use of a ferro fluid in the air gap and by means of a high temperature voice coil to linearize the output at higher levels. As a further line of defence, the Matrix I also incorporates an automatic protection circuit which disconnects the tweeter when it is exposed to power (voltage) levels above a predetermined limit.**

B&W Matrix Is and Dali 3As provided a marginally superior performance to the JBL L20Ts. All three of these again sounded slightly more realistic and marginally less coloured than the Bose 301As.

*The Romance of the Flute & Harp* (PCD 835) which provided magnificent percussive source material from a harp confirmed the attributes of the B&W Matrix Is and elicited a superb performance from the Dali 3As and the JBL L20Ts.

The last disc that I used was from *Huey Lewis and the News* (CCD 1534) "The Power of Love". With this track played at average power levels of 80 watts input and peak levels well in excess of 250 watts, my family and all the neighbours were treated to a rare demonstration of how well small speaker enclosures can handle soft rock music without losing drivers, voice coils or even cross over components.

On this particular track all of the speakers performed particularly well and although none of the speakers produced worthwhile output below 60 Hz, all provided music with which almost any rock music afficionado would be satisfied.

Unfortunately, ranking the speakers involves two conflicting requirements, namely, an allocation according to sheer performance and a second allocation in terms of cost benefit.

So the two rankings are as follows:

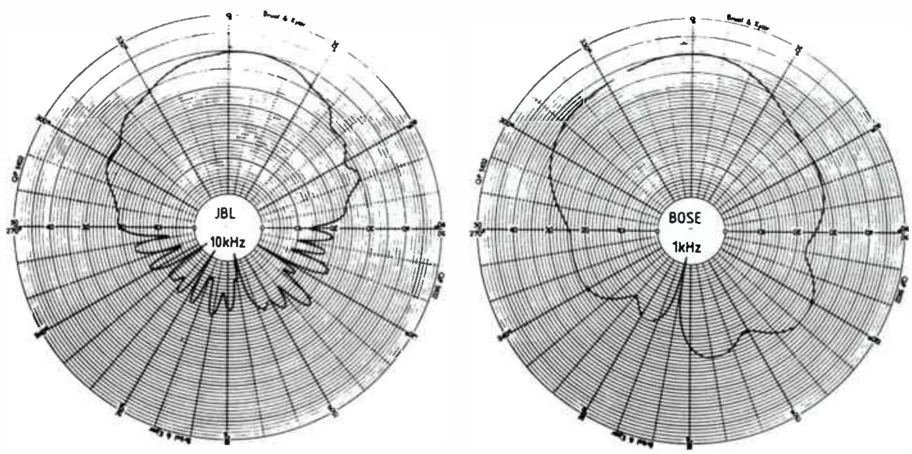
**Performance ranking**

1. B&W Matrix Is
2. Dali 3As
3. JBL L20Ts
4. Bose 301 Series IIs

**Cost benefit ranking**

1. Dali 3As
2. JBL L20Ts
3. B&W Matrix Is
4. Bose 301 Series IIs

Despite my rankings, the performance of the JBL L20Ts is still attractive because of their unusually small dimensions. This would put them at the top of the cost benefit ranking if you are really tight for space on your bookshelves. If you have a room without bookshelves then the Bose 301 Series IIs are still worthy of your assessment and consideration. ●




**Polar response plots.**

TABULATED MEASURED PERFORMANCE

| Model | Bose 301A Series II | B & W Matrix I | Dali 3A | JBL L20T |
|---|---|---|---|---|
| Dimensions | | | | |
| Height mm | 269 | 410 | 440 | 378 |
| Width mm | 434 | 230 | 280 | 241 |
| Depth mm | 236 | 322 | 250 | 240 |
| Weight kg | 7.1 | 10 kg | 7.7 | 7.7 |
| No of Drivers | 3 | 2 | 2 | 2 |
| Woofer diam mm | 200 | 150 | 200 | 155 |
| Tweeter diam mm | 7.5 | 25mm | 25mm | 25mm |
| Cabinet thickness | 14 | 18mm | 25mm | 20? |
| Frequency response Hz ± 6dB on axis | 90-15k | 55-20k | 65-20k | 80-20k |
| Sensitivity dB per watt @ 1m | 88 | 85 | 89 | 89 |
| Input impedance | | | | |
| Minimum ohms | 9 | 4.5 | 6 | 5.5 |
| Maximum ohms | 31 | 7 | 42 | 35 |
| Protection circuit | No | Yes | No | No |
| Distortion % for 96dB | | | | |
| @ 100Hz @ 1m | 4.42 | 5.14 | 2.74 | 7.1 |
| @ 1kHz @ 1m | 1.15 | 0.88 | 2.1 | 0.47 |
| @ 6.3kHz @ 1m | 10% | 0.31 | 0.79 | 0.43 |
| Decay response Spectra performance | ••• | ••••• | •••• | ••••• |
| Tone burst performance | ••• | •••• | •••• | ••••• |
| Power handling capacity watts | 120W | 120W | 80W | 100W 400Wpk |
| R.R.P.$ Finish | 800 | 1695 | 668 820# | 858# |
| Polar | •••• | ••••• | ••••• | •••• |

# Genuine Walnut Wood Veneer
••• Good
•••• Very Good
••••• Excellent

# when you need it... NOW!


## You'll need your 1987 Tech-Rentals Catalogue

Be absolutely sure you receive your free copy of the catalogue that contains the largest range of measuring instruments and computer equipment available for rent in the Southern Hemisphere.

Simply fax or mail the coupon to us today or phone Tech-Rentals in your state.

**TECH-RENTALS**

**TECHNOLOGY WITHOUT OBSOLESCENCE**

MELBOURNE 879 2266 SYDNEY 808 3055 BRISBANE 875 1077
ADELAIDE 344 6999 PERTH 322 1085 AUCKLAND (9) 50 4759

ADVERTISING INFO No. 28

ADVERTISING INFO No. 28

Please rush me my copy of Tech-Rentals 1987 catalogue

Name

Company

Address

Title

P.C.

To: TECH-RENTALS PTY. LTD.
12 Maroondah Highway
Ringwood, Victoria, 3134
Fax (03) 879 4310

## To rain or not to rain . . . that is the question.

Long time readers of this column will remember the Electronic Scarecrow, an absolutely amazing beast with which a large collection of thoroughly truthful gentlemen threatened to rid fruit bats once and for all of any desire to eat your local friendly farmer's produce.

Now comes news, also out of the deep north, of yet another gentleman with an electronic gadget that is all set to change your life forever (as they say on the back of book covers). A certain Mr Toyer of Clarence River on the North Coast of New South Wales will, for a fee, use electromagnetic energy to create a vortex which punches a hole in the stratosphere. This will cause rain to fall, which is a Good Thing. On the other hand, if too much rain falls this is a Bad Thing, so Mr Toyer's machine can be put into reverse, and stop rain from falling.

In fact, with the Toyer machine, we could wind up deciding just when and where we wanted every drop of rain to fall.

Ian Causley MP, (Lib, North Coast), who is not entering for the prize of most gullible twit in the house, brought Mr Toyer and his amazing machine to the notice of the Parliament. The deal is that the NSW Government should pay Mr Toyer $500 for every inch of rain that falls. If they do, Mr Toyer promises that he "will open the skies on the North Coast". The opposition is not committed to buying the device, but he did ask fellow parliamentarians to notice that it rained in November.

A twist to the story is that Mr Toyer is apparently being persecuted by the CSIRO. The CSIRO has given up its rain-making experiments, which depended on cloud seeding, and Mr Toyer says they're jealous of his success. We at ETI think this is very unfair.

Wang cares but emus don't.

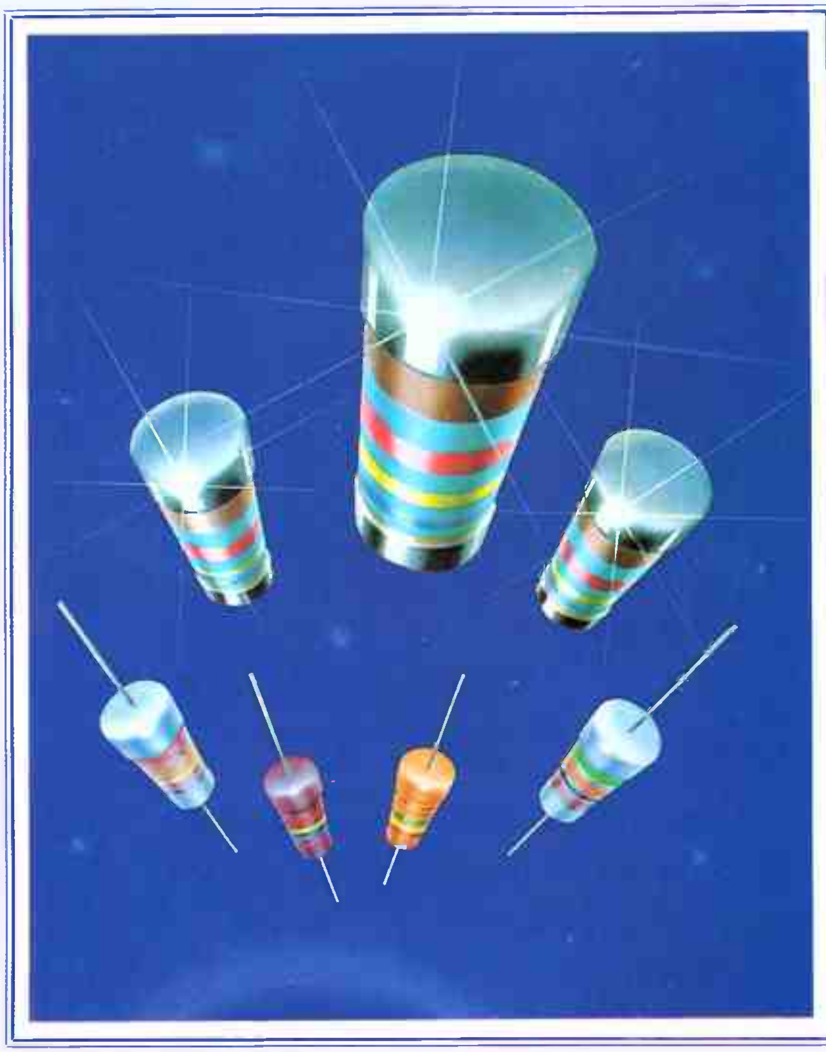
## Speech problems

The Australian vernacular is something dear to all our hearts, so it's nice to know that it still confuses the hell out of foreigners. Its intricacies are perhaps one of the few things we can call our own.

This was brought into focus recently by a small news gem that filtered across the ETI news desk. (Actually the ETI news desk is the same desk used by the secretary to type on, the engineers to eat on, and everybody else to put their feet up on. But the lack of editorial amenities around here is entirely another story.) The news gem we heard from a mate in the trade concerned technicians of a large foreign company who were saved from a fate worse than death recently when it was rumoured that corporate headquarters in the US decided that the company slogan was going to be "Wang Cares". The plan was that customer engineers would wear this gem of the copywriter's art blazoned across their chest, thus fostering a warm feeling towards the offending company.

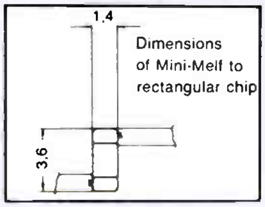
The idea was dropped like a hot potato when Australian executives were forced to explain the consequences of the Antipodean propensity for running words together. This is a problem in speech recognition, of course, and explains why no significant Australian contribution has yet been made to this science. It's also a problem of meaning. It needed to be explained that a word ending in 'g' running into another one beginning in 'c' ends up sounding like a letter 'k'. It may mean "Wang Cares" but it certainly doesn't sound like it.

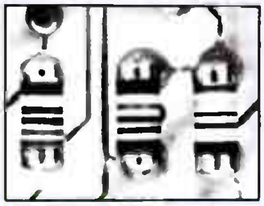
# Crusader and Beyschlag
# Always Ahead



## Mini-Melf SMD Resistors

Cylindrical Melf resistors have largely identical characteristics as conventional rectangular resistors however the Mini-Melf allows more flexibility in the design of the conductor pattern. Mini-Melf resistors solder easily on both the flat front end and on the cylindrical circumference of the caps. This means they can also be soldered on printed conductors which run across the resistor axis.



# CRUSADER ELECTRONIC COMPONENTS PTY. LTD.

**81 PRINCES HWY, ST. PETERS NSW 2044**
**Phone 519 5030 516 3855 (3 Lines) 519 6685 Telex 123993. Telefax 517 1189.**

**SYDNEY:** GEORGE BROWN & CO PTY. LTD. Phone 519 5855; GEOFF WOOD ELECTRONICS PTY. LTD. Phone 810 6845; **WOLLONGONG:** MACELEC PTY. LTD. Phone 29 1455; **CANBERRA:** GEORGE BROWN & CO. PTY. LTD. Phone 80 4355; **NEWCASTLE:** D.G.E. SYSTEMS PTY. LTD. Phone 69 1625; **MELBOURNE:** R.P.G. AGENCIES PTY. LTD. Phone 439 5834; JESEC COMPONENTS Phone 598 2333: ROSNIK DISTRIBUTORS PTY. LTD. Phone 874 3424; GEORGE BROWN & CO. PTY. LTD. Phone 419 3355; **BRISBANE:** L.E. BOUGHEN & CO. Phone 369 1277; COLOURVIEW WHOLESALE PTY. LTD. Phone 275 3188; **ADELAIDE:** PROTRONICS PTY. LTD. Phone 212 3111; D.C. ELECTRONICS PTY. LTD. Phone 223 6946; **PERTH:** SIMON HOLMAN & CO. PTY. LTD. Phone 381 4155; PROTRONICS PTY. LTD. Phone 362 1044.


# Philips' PM 3206 - your economic solution for day-to-day measuring problems.

"Philips' PM 3206 is a winner every time - and certainly when it comes to price/performance comparisons.

This top-value 'scope gives you full professional features, many of which are normally associated with much higher-priced instruments.

Features like a full 80 cm² rectangular screen, with internal graticule and a high-intensity spot. A 5 mV sensitivity across the full bandwidth of 15 MHz. Equal sensitivities on both X and Y channels for identical input loadings. And external Z-modulation for display of a third parameter like time. Plus full triggering facilities, including auto-triggering, TV triggering and A/B channel or external-source trigger selection. So check all the professional features that PM 3206 gives you, and compare them with any other 'scope in the same price class.

You'll see at a glance that PM 3206 gives you more performance, more functions and more value!

Contact, Philips Scientific and Industrial Equipment division

| | |
|---|---|
| Sydney | tel. (02) 888 8222 |
| Melbourne | tel. (03) 542 3600 |
| Brisbane | tel. (07) 844 0191 |
| Adelaide | tel. (08) 348 2888 |
| Perth | tel. (09) 277 4199 |

Other areas - toll free - (008) 22 6661

**PHILIPS**

PHILIPS **Test & Measurement**

*ADVERTISING INFO No. 35*