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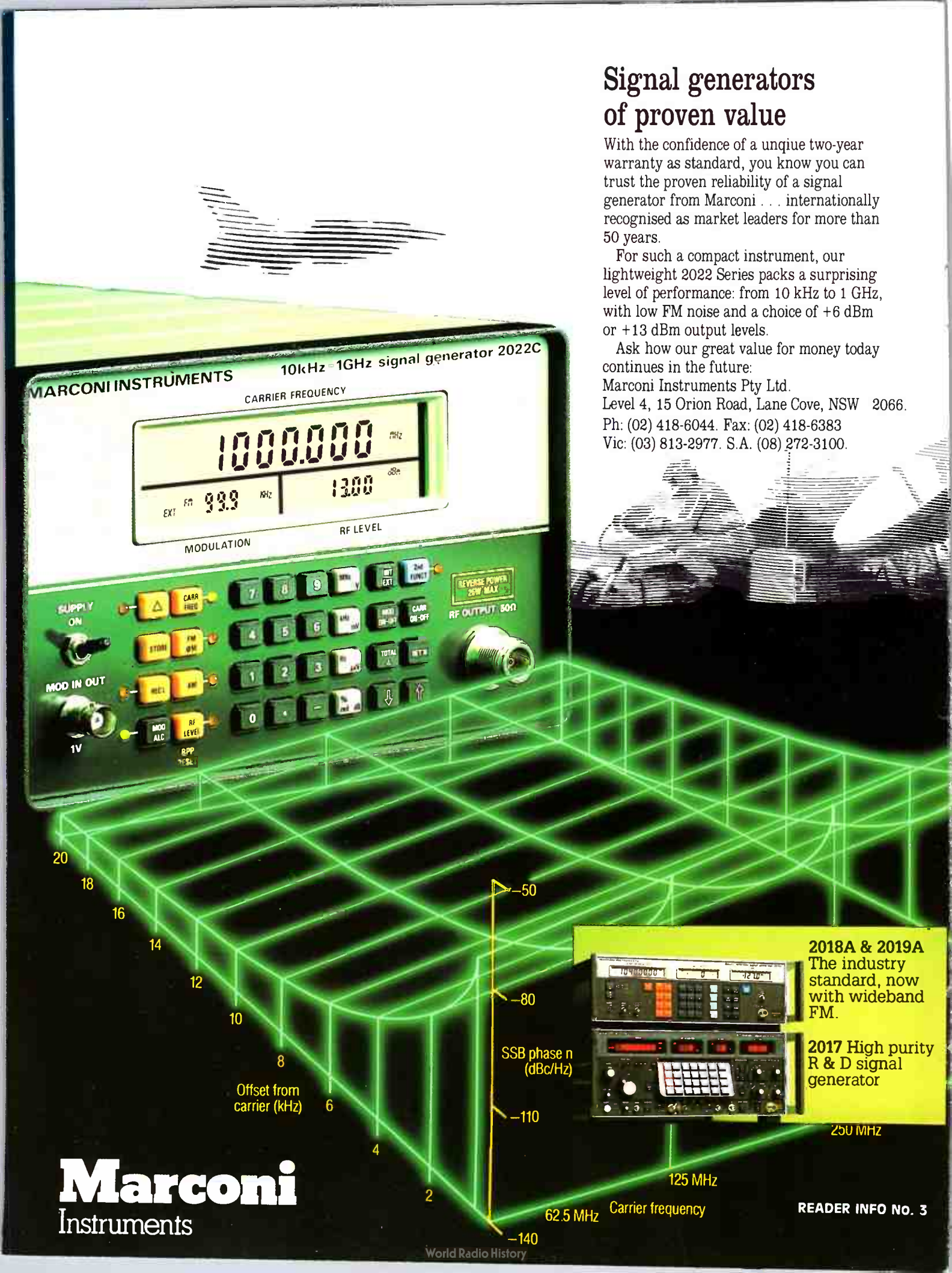

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DEPARTMENTS

SOUND INSIGHTS

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FREQUENCY

ROS BROMWICH

This month's ETI contains the beginning of an exciting new departure for us: a multipart series entitled The Building Blocks of Electronics. Written for us by Jack Middlehurst, ex CSIRO man and now freelancing in various fields, this set of articles is designed to answer the many requests we get for some back-to-basics material for those interested not completely in theory but in the what-can-I-do-with-it line of electronics.

We kick off this month with capacitance and resistance of analogue circuits. To demonstrate the applications we have ETI project 195, a signal injector/tracer which will be used in conjunction with every subsequent part of the series, thus being the all-purpose beginner's project. We hope that the approach that Jack's taken to the idea of a learning series matches the expectations of those of you who have asked for it and we look forward to hearing your responses.

Another feature for this month is, again, a subject too big to be handled adequately in one go: test and measurement equipment. As the range of instruments, both homegrown and imported, gets larger with every publication of the balance of trade figures it becomes harder to pick just which instrument will suit your needs best. Our feature, prepared by electronics editor Roger Harrison, attempts to clear the murk a little by telling you what's available, the best of what's new, the prices you should pay, and there's even some background theory thrown in as well.

A plea we often hear is 'Where do I get it and how much will it cost?' So we've resurrected Shoparound, a guide for project builders (with a few extras too) on where to obtain the bits you need; it's on page 92.

The preparations for IREECON 89 are going on apace this month and we are looking forward to being part of the events.

We are planning one of our own, to take place during the convention, probably to involve some 'best of the year' awards, although we haven't finalised the details at the time of writing. More next month on that.

We were to have a short feature about an agency which arranges trade agreements between Australia and Chinese companies this month, but the sad events in the latter country have compelled us to at least postpone the story, if not cancel it altogether, until the prognosis becomes a little more certain.

The clampdown on a nascent democratic movement leads to all kinds of dilemmas, not least the moral ones, for those engaged in energetically opening up the long closed trade, diplomatic, and human interactions between China and the rest of the western world. The rulers' actions in retaliating so ruthlessly against the protesters must put into doubt their good intentions towards freer relations with outsiders. And should we, in pursuit of the likely large profit, continue the liaisons which have been so painstakingly established?

Shortly after the evacuation of a planeload of Australians from Beijing a major company's man in China was seen on television, debriefing his colleagues on the situation and no doubt describing his own experiences of the violence. It was only a week or so after the clearing of Tiananmen Square, and there was talk of big purges of the movement's leaders, but it had already been decided that he would return to China and, apparently, that business would be as usual. Trade sanctions have of course been mooted but nobody appears to be all that interested, and indeed the big company executive expressed the oft-rehearsed view that sanctions hurt the ordinary people more than the government we dislike, the usual line. But in China we have an acute situation, which demands an appropriately swift reply if it's to have any effect on the minds of those running the place.

We surely cannot allow such crimes to go by and express pious hopes that there will be no repeat, while increasing the amount of business involvement at the same time. Would our response be different if it had happened in another country – New Zealand for example? I wonder.

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ELECTRONICS TODAY INTERNATIONAL is published and distributed monthly by The Federal Publishing Company Pty Limited, Inc. in NSW, 180 Bourke Road, Alexandria, NSW 2015 (02) 693 6666. Printed by Hannanprint, Sydney. Distributed by Newsagents Direct Distribution, Alexandria, NSW 2015. *Maximum and recommended Australian retail price only. Registered by Australia Post. Publication No. NBP0407. ISSN No. 0013-5216.

Industry News

Andrew Greatbatch

Ian Veltman

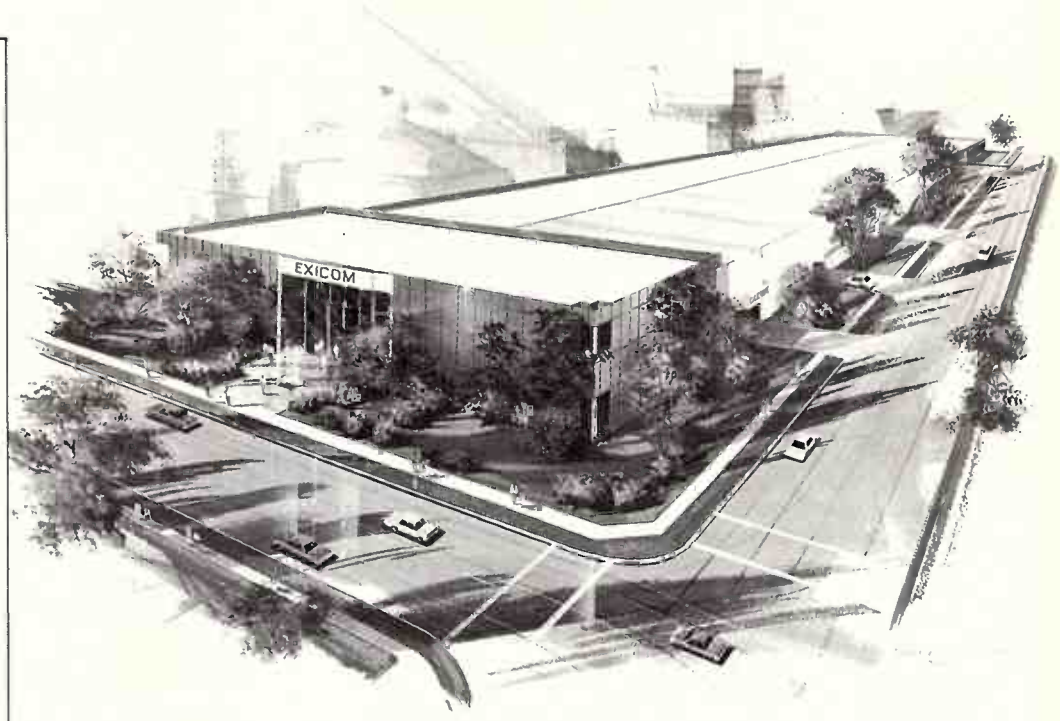
AWA MicroElectronics has expanded its sales and marketing team with the appointment of Andrew Greatbatch to the position of sales engineer and Ian Veltman to marketing engineer.

Both will work within the sales and marketing department headed by marketing manager, Toby Cross.

★ ★ ★

Gerald Allen has been appointed managing director of AT&T Australia Limited. He replaces M.L. (Lonny) Rush who has accepted a position with the AT&T Network Systems organisation in the USA.

Allen begun his career with AT&T in 1959, holding various technical and marketing positions in Michigan, Illinois, Ohio and New Jersey. Before this appointment he headed the Communications Services division of AT&T Ltd.



Exicom Limited's new $25m manufacturing site at Villawood, Sydney. It will be completed under a turnkey contract by February, 1990. Exicom is selling its present location at Ashfield, acquired in October last year as part of the purchase of the AWA telecommunications business. Among the innovations will be equipment to automate the production of standard telephone handsets of which Exicom is a major supplier to Telecom.

EEI '89

THE first EEI '89 (Electrical and Electronic Engineering International) will be held at the Royal Exhibition Buildings, Victoria from **31 July to 4 August, 1989.**

EEI has been created to provide a specialist selling forum for the electrical engineering and electronics industries. As an annual international exhibition, EEI will showcase the latest developments, products and trends for the Australian marketplace. It will provide industry exhibitors with the opportunity to meet and influence the key decision-makers.

EEI is endorsed by both Metal Trades Industries Association and the Australian Electrical and Electronic Manufacturers Association. EEI's blue chip exhibitors include Adaptaflex, BI Controls, L&B Electrical Components, Meltec, Open Technology Learning Resources and Parameters.

EEI '89 will also have the benefit of the guaranteed and massive trade attendances of AIEE '89 (Australian International Engineering Exhibition) which will be held concurrently. Thomson Exhibitions, organisers of both events, expect attendances of 25,000 from the international engineering community to attend AIEE.

For trade enquiries and bookings: Emma Brown, Thomson Exhibitions on ☎ (02) 332 3233.

It's not us!

A recent news item in the Financial Review regarding US communications company Icom Ltd's decision to go into liquidation has brought this concerned response from Icom (Australia) Ltd.

"We ... confirm that the said company, Icom Ltd, has no affiliation with Icom (Australia) Pty Ltd, nor is it a subsidiary of our parent company Icom Incorporated, Japan.

"We know little about Icom Ltd, or the products they sell. Our company, Icom (Australia) Ltd, is in no financial difficulty ... Our business remains steadfast."

Okay, folks?

Electronic book saga continues

THE latest version of this concept is Dynabook. It is a combination of a black-on-white touch-screen with a compact disc containing more than 500 books of information with pictures and sound commentary. However, the cost, $8080, will limit its use to specialised, professional applications, it is said.

Information is retrieved by touching the display in response to instructions on the screen. It makes use of compact disc read only memory (CD-ROM).

By adding a keyboard, Dynabook can also run PC-compatible CD-ROMs. The unit includes a three-in-one disc drive. Only 12 volts of power is required. But a mains or battery car is needed for more than an hour's use. Professions targeted include doctors and lawyers.

Price and size of this item is expected to come down quickly making them feasible consumer products. Within two years, Mike Lloyd, managing director of Oxford-based Attica Cybernetics, the product distributor, says they are likely to cost around $2000.

Fibre optics links

AS a result of increasing demands placed upon global communications facilities, the establishment of fibre optic links between continents have been pursued. The first undersea fibre-optic communications link between the USA, Japan and Guam was put into service recently by AT&T and Kokusai Denshion Denwa (KDD) of Japan.

The latest undersea fibre optic cable, called the Pacific Link, can apparently accommodate the equivalent of 40,000 simultaneous calls and will be used to transmit voice, data and video.

The 8271 mile cable (over 13,000 kilometres) is said to be critical to a worldwide fibre optic network connecting three continents – Asia, North America and Europe. It is the result of a breakthrough mathematical formula known as the Harmarkar algorithm.

This was used to verify the design and routing plan for the Pacific region for the next 15 years. It was invented by AT&T Bell Laboratories mathematician Narendra Harmarkar in 1984.

In a similar development, the longest single length fibre optic cable of almost 100 kilometres has been laid in the sea between the Philippine islands of Cebu and Negros. Two hairlike optic fibres (the cable contains four) can carry 1920 telescope conversations and TV programs. Siemens Ltd is responsible for the development.

The Pacific Link consists of three pairs of glass fibres. Each pair transmits 280 million bits of information per second. Some 198 repeaters spaced about 43 miles apart are said to keep signals strong and clear. The Siemens cable does not require repeaters, providing an alternative to radio-relay and overland cable.

Industry News

Adrienne Lambert

After a stint as marketing manager for Financial Computing Services, Adrienne Lambert has been appointed dealer manager for Hypertec Pty Ltd. She has over 15 years experience in the computer industry.

★ ★ ★

Marconi Instruments Ltd of the UK has formed a wholly owned subsidiary company in Australia. The sales and service facility of Marconi Instruments Pty Ltd (formerly a division of GEC Australia) is now located at Lane Cove. The new address is Level 4, 15 Orion Road (PO Box 1390), Lane Cove NSW 2066. ☎ (02) 418 6044.

Industry News

Despite the statement in the May ETI that electronics consultant BIS Macintosh preferred the European GSM standard over the US standard for the introduction of digital cellular radio in Australia, it must be noted that the US only adopted a standard in the fourth week in January this year.

It must also be noted that the US standard permits overlaying digital cellular alongside the existing frequency band, making all equipment compatible for the US and Australia. This would enhance export opportunities for Australian companies.

The European standard, on the other hand, would require entirely parallel technology. It would reduce export prospects, and could affect the balance of payments through the import of expensive equipment.

★ ★ ★

MM Cables has appointed Henri Van Tienen wholesaler's manager. He was formerly commercial and engineering construction manager for Cable Makers Australia, one of the companies combined to form the MM Cables group late last year.

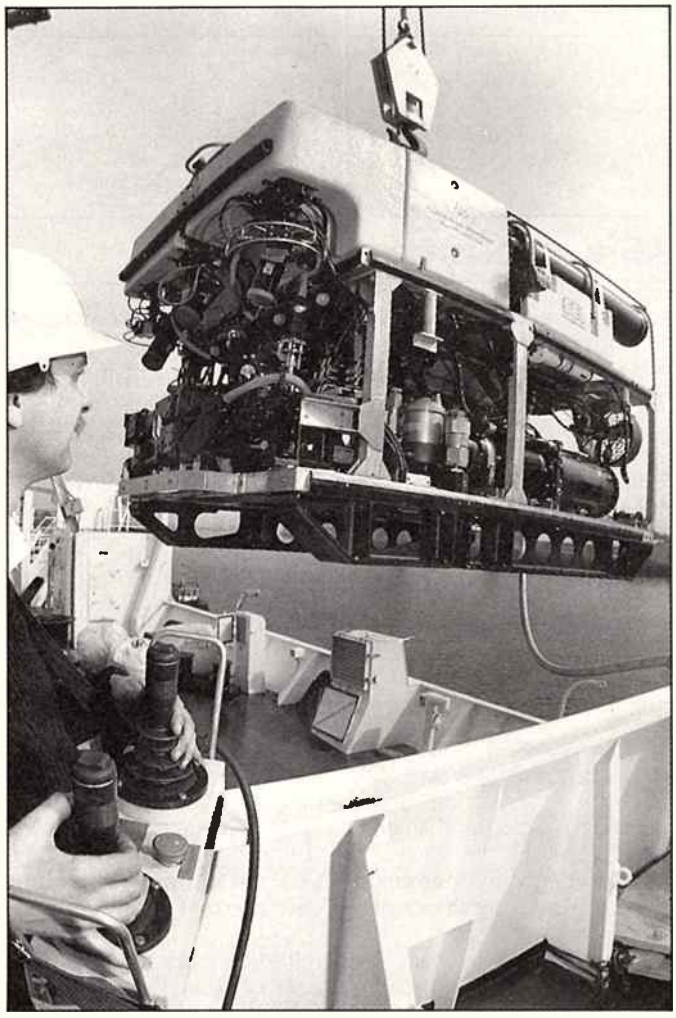
★ ★ ★

Ericsson has announced a $26m expansion program for its Broadmeadows plant in Melbourne. Part of the expansion is a workforce recruitment drive to up the size of its workforce by 200 people. Under the plan, Ericsson will also increase its manufacturing and R&D facilities.

★ ★ ★

Local power supply manufacturer, Setec Pty Ltd, has completed an impressive array of international approvals for a power supply they manufacture for Unisys. It meets all major safety requirements and EMI compliance.

Setec says it will design a product for sale in any country that a customer requests. They will even obtain all required approvals in order to ease the customer's burden. How nice.



Working down to depths of 2000m, this remotely operated vehicle (ROV) will be able to expose buried communications cables by using water jet equipment to cut through silt, sand, gravel and soils. After repairs it will then re-bury the cable.

The ROV 128, seen here aboard the $28 million cable ship Sir Eric Sharp, built for Cable and Wireless of London, will soon be at work on repair and maintenance duties on the PTAT system.

This is the first privately funded transatlantic fibre optic telecommunications cable linking Britain with the United States.

Ozone layer monitoring

BRITISH Aerospace (Space Systems) Ltd has completed assembly of ISAMS (Improved Stratospheric and Mesospheric Sounder) which will apparently provide data regarding the upper atmosphere, including the ozone layer.

ISAMS will help determine the extent of ozone layer depletion and also help define the role of the upper atmosphere in relation to climatic change. By facilitating greater understanding of these processes, it will improve the ability of scientists to assess the impact of human activities upon the atmosphere.

ISAMS was conceived by Oxford University and will be one of the largest, most complex scientific packages to be put in space by the UK. It will fly on NASA's Upper Atmosphere Research Satellite (UARS) due for launch by space shuttle in 1990.

Satellite images for sale

USING the north-east Australia satellite imagery system (NASIS), James Cook University in Queensland is offering for sale infra-red satellite data with the potential to pinpoint mineral deposits, monitor droughts and detect good fishing areas.

The system was developed by a consortium including the university, the Australian Institute of Marine Science, the Great Barrier Reef Marine Park Authority, CSIRO division of atmospheric administration and the Queensland Department of Geographic Information.

NASIS can access data free of charge from the US National Oceanographic and Atmosphere Administration (NOAA) polar-orbiting satellites NOAA-11 and NOAA-12. One passes over the same point every six hours, making them easy to use.

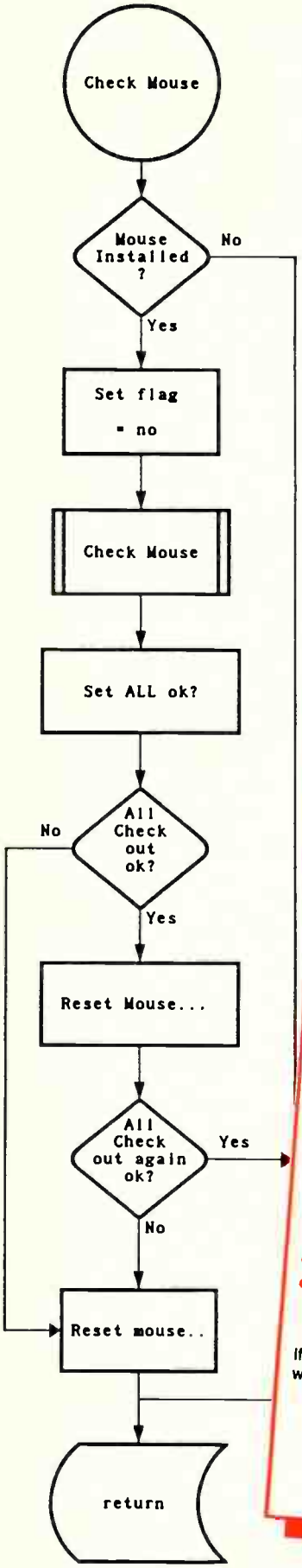
NOAA satellites can take five images of an area using the visible spectrum, near infra-red, mid infra-red and two far infra-red channels.

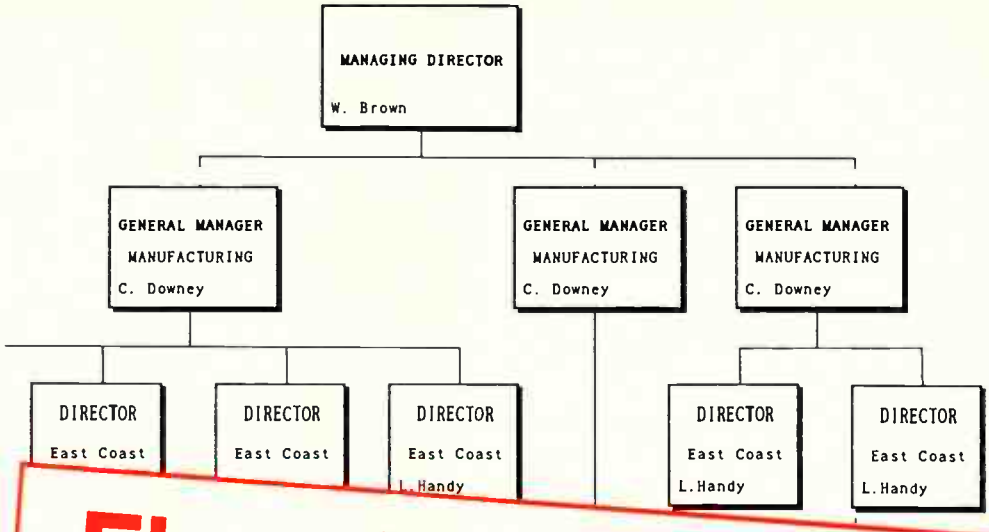
Different rates of temperature change can indicate the presence of large bodies of ore beneath the surface. Fishermen in NSW and Victoria use NOAA data from a similar centre in Melbourne to map ocean temperature changes to find warm areas where fish gather.

The AIMS is using the same kind of information to map ocean currents. This is also used in the study of reef ecology. The NASIS centre provides information not available from the other Melbourne centre.

Project manager, John Lilleyman, said the university was approaching mining companies, oceanographers, the fishing industry and a number of South Pacific island nations.

A mining company has already used the system to monitor sedimentary flow in the Fly River in PNG. And CSIRO in Alice Springs is using it for drought monitoring: thermal images can reveal vegetation patterns.





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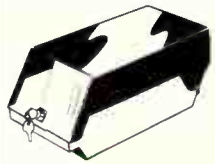

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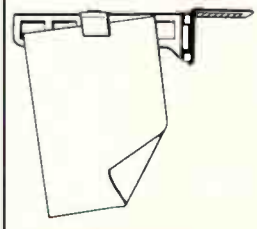

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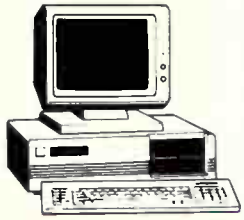

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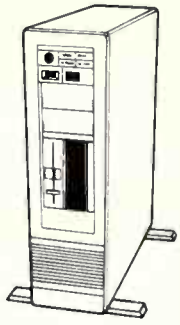

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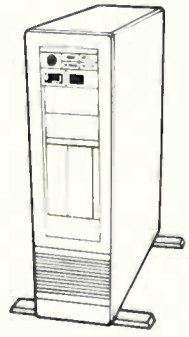

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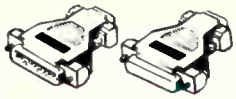

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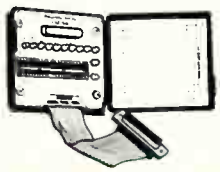

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X15651.....Male to Female
X15652...Female to Female
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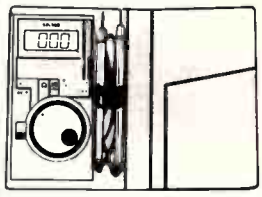

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- Auto/manual range select easy to operate
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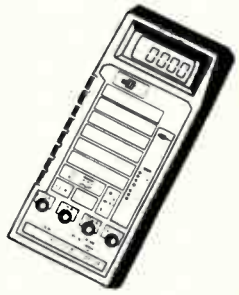
- Memory-comparative function available for allowance within ±5% f.s
- Warning sound for overload and conductance
- Dimension & Weight = 170 x 80 x 33mm, 260gram approx
- Data hold function for easy readout

Q11268.....$110



MULTIMETER (YF-2100)

- Large display 4 1/2 dgt 0.5" height LCD with maximum reading of 19999
- Automatic polarity."-" display for negative input
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- Over load display, the highest digit "1" or "-1" alone glows
- Power consumption 20mW approx.
- Dimension & weight = 162 x 86 x28mm and 200g approx

Q11266.....$199

ROD IRVING ELECTRONICS

Industry News

The Queensland Branch of Square D Australia has moved to new offices located at 113 Breakfast Creek Road, Newstead. It is the third move the company has made since its Brisbane branch was opened in 1979. For more, contact Col Graham, Square D Australia, ☎ (07) 252 8388.

★ ★ ★

Cooper Tools Pty Ltd has extended its national distribution of Weller and Xcelite products by adding ACD Elektron to long-time distributor the George Brown Group.

★ ★ ★

Scientific Devices Australia has been made exclusive representative in Australia for Datum Inc. of the USA. Datum produces an array of time and frequency products. Contact Scientific Devices Australia Pty Ltd, 2 Jacks Road, South Oakleigh Vic 3167. ☎ (03) 579 3622.

★ ★ ★

Award Software has appointed Energy Control International as its Australian and New Zealand representative. It is apparently recognised as a leading developer of system-level products that work with IBM's PC families. Award's Modular BIOS product line is used by major manufacturers around the world.

Award also provides full service design capabilities and technical support to customers for a range of specialised applications, including system diagnostics. Contact Energy Control P/L, 26 Boron Street, Sumner Park Qld 4074. ☎ (07) 376 2955.

COSSA chief retires

THE Director of the CSIRO Office of Space Science and Applications (COSSA), Dr Ken McCracken, will retire on medical grounds. Temporarily transferred to other duties, he commenced leave on May 31, 1989, prior to retirement.

Dr McCracken was appointed as the first director of COSSA in 1984. Under his leadership, COSSA has co-ordinated and developed space R and D within the CSIRO.

CSIRO and its collaborators, in both the public and private sectors, including educational institutions, have achieved access to data from experimental satellites like Japan's MOS-1, and have been accepted as participants in a number of international experiments which will involve several international satellites being launched over the next decade.

Almost five years after COSSA's establishment, numerous products designed and developed in the CSIRO are now manufactured and sold the world over by Australian industry.

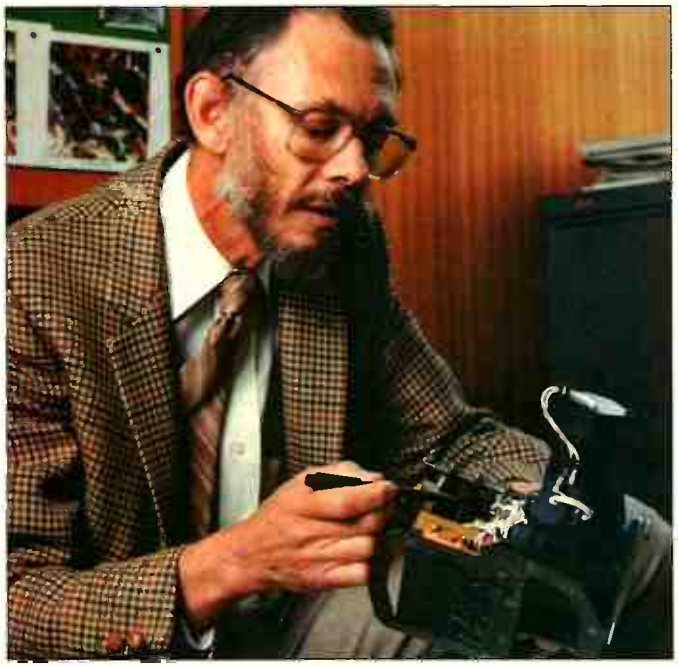
Satellite communications equipment and advanced remote sensing instruments and software have been the major focus of COSSA work. Instruments designed by the CSIRO and built by Australian industry will also be flown on the European Space Agency's ERS-1 and the USSR's Radioastron satellites.

Experience gained through this was crucial in securing $100m worth of space contracts arising from the purchase of the AUSSAT B satellites from the USA.

COSSA has also provided representation on International satellite planning bodies.

Prior to his appointment to COSSA, Dr McCracken had been Chief of two of the CSIRO minerals divisions and professor at the University of Adelaide. He had also led a major space program in the USA for eight years.

After training as a physicist at the University of Tasmania, he was subsequently on the faculty of the Massachusetts Institute of Technology (1959-62) and University of Texas (1962-66).



Dr Ken McCracken

During this later appointment he designed and built seven instruments flown on the Pioneer (6-9) and Explorer spacecraft.

He returned to a Chair in Physics at the University of Adelaide in 1966, and initiated investigations in X-ray astronomy using rockets launched from the Woomera rocket range.

This led to the first evidence of pulsing X-ray stars being obtained.

In 1970, Dr McCracken joined CSIRO and led the Division of Mineral Physics and Mineralogy in research into geophysics, mining, and mineral processing.

He also led innovative CSIRO/Australian Mineral Industries Research Association studies into the application of satellite remote sensing to mineral exploration.

This research has paid high dividends to the Australian mining industry. No fewer than eight major mining companies make comprehensive use of remote sensing systems.

Also in 1970, he helped initiate Australia's involvement in the US Landsat program.

Dr McCracken is a member of the Aerospace Industries Council and of the Australian Liaison Committee for Remote Sensing by Satellite (ALCORSS). This provides information to the Federal Government in its operation of the Australian Centre for Remote Sensing.

He has represented Australia at the UN Committee on the Peaceful Uses of Outer Space, and has long been an advocate of the benefits of spacecraft for communication and the management of the resources of our continent.

In praising his achievements, Dr R H Frater, Director of the CSIRO Institute of Information and Communications Technologies, said Dr McCracken's leadership qualities were recognised through the award of a CSIRO medal in 1988.

It has also been said that COSSA, under Ken McCracken's directorship, has acted as a potent stimulus to the development of space awareness and activity in Australia. This is due to his commitment to the benefits of space technology and his enormous knowledge of the field.

Dr Frater will now take direct responsibility for COSSA.

Amber sponsors jazz

IN order to send young jazz musicians to Germany this year, Amber Technology has launched a promotion in conjunction with the Conservatorium of Music Foundation.

Amber has produced a colourful line drawing of the inner workings of a Neumann microphone set against a black background. It has a Neumann logo at the front.

All proceeds of sales of the shirts, $29.95 each, will go to the Con's Jazz Department. Everyone buying a shirt also gets a ticket in a raffle to win a Neumann TLM 170 microphone valued at $2000.

Phobos probe problems

OF the two Soviet Phobos craft sent to Mars, one was lost through carelessness, and one was just lost. In September 1988, a programmer sent the craft an incorrect command. It did not respond to commands to communicate or return again.

The loss of the second one was similar, but there was no evidence that it was anyone's fault. It lost contact with its controllers while manoeuvring around one of Mars' two moons, Phobos.

The probe has had previous mishaps. Such accidents were a blow to the USSR's ambitious planetary science mission. The craft were to drop probelets onto Phobos' surface to see what it was made of. This would provide new information on the moons of Mars which appear to be from the earliest phase of the Solar System.

It has been suggested that the mission may have been too ambitious. Stories abound over disputes between scientists and engineers over the design of the craft and what could be expected of them.

Perhaps it was just beyond them. The craft were the first of a new design, so they cannot have been expected to be faultless. The difficulties they apparently had en route to Mars suggest changes are necessary if they are to be the backbone of the Soviet program for the next few decades.

An upgraded flight computer with enough initiative to look for its master's voice if contact is lost has been postulated. But the craft weren't total failures. They provided information on the Sun, the matter between the Earth and Mars, the Martian magnetic field in addition to pictures of the Martian surface and close-ups of the moon.

Grapevine boosts facilities

GRAPEVINE Studios of Adelaide, known for its work on jingles and voice-overs, has installed a Soundtrac in-line, 36/32 track audio console as part of its equipment upgrade.

Apparently the entire production control room has been completely rebuilt around it. The Soundtrac IL-3632 has boosted the studio's capabilities. It will now be able to tackle ambitious projects like feature film sound productions. For more information contact David Hudson, Amber Technology, PO Box 942, Brookvale NSW 2100. ☎ (02) 975-1211.

Industry News

Barry Turner, who has worked for Jands Customs Agents and has had experience with international shipping and customs, has been appointed shipping manager for Jands. He will be responsible for all incoming and outgoing international shipments.

Jands has said this will allow Jands' operation manager David Williams to concentrate more on stock levels, dealer enquiries and JBL product support.

Karen McLean, who, for many years worked for her father's business, McLeans Sound and Lighting, has joined Jands as a sales representative. She will mainly be concentrating on Jands NSW lighting dealers and sales for Jands dealer based products.

★ ★ ★

The first of a quarterly publication to be issued by four-time IR100 award winner the LeCroy Corporation will apparently give users and interested persons valuable information on product applications, new products, measurement hints, literature available and such like.

It is to be called "T and M News". For more information contact ETP-Oxford, 31 Hops Street, Ermington NSW 2115. ☎ (02) 858 5122. Or in Melbourne you can get in touch with them at 214 Berkely Street, Carlton Vic 3053. ☎ (03) 347 0733.

★ ★ ★

Recognising the key importance of high-temperature superconductivity, Hoechst AG and Siemens AG have entered into a joint research and development program in this field. Research will be application-oriented.

Activities are centred on seeking new superconducting substances and on manufacturing processes for conductor structures as well as on the further development of coating techniques. The agreement, which has been signed by both countries, will last initially until the end of 1990.

ARTHUR CUSHEN

JAMMING STATIONS REVITALISED

Arthur Cushen reveals some interesting snippets on the USSR's old jamming stations, published recently in Moscow's famous Pravda newspaper.

The ending of the Soviet jamming of Western broadcasts last year has resulted in the history of the jamming stations being published in Pravda, the Moscow newspaper.

The newspaper reported that for about 50 years there was a secret department at the USSR Ministry of Communications, which, in recent years, was known by the staff as the Krestyaninova Service. Nataliya Yevgenyevna Krestyaninova was for 25 years in charge of radio transmitting devices designed to create artificial interference to foreign radio stations throughout the USSR territory.

The practice of subversive radio broadcasting by one country to another began as long ago as the 1920s. Radio counter-measures began at about the same time. Thus, in Paris in 1923, radio transmitters installed on the Eiffel Tower were jamming Berlin radio. Austria tried to jam Nazi Germany's transmissions. In 1934 a station in Klaipeda was active against subversive broadcasts from Lithuania.

In 1937 an intergovernmental conference in Geneva, under the auspices of the League of Nations, drew up a convention on the use of radio broadcasting in the interests of peace. The articles of the international treaty confirmed, in particular, the right of every state to ban and immediately stop all broadcasts that might incite the citizens of the territory in question to act contrary to internal order and security. The convention was adopted by 22 countries. Among those who did not sign were Germany, Italy, Japan and the United States. Two years later a special service was created in the USSR to jam the "radio voices".

Communications experts were on duty around the clock in every union republic and in large cities, jamming foreign broadcasts. In Moscow, the control point was situated on Taganka and manned in four shifts. The operator might find the voice of Radio Liberty, for instance, on professional receivers and give a command by way of a direct link to the radio broadcasting station. Interference would then appear on the air.

Depending on current events and the political situation in the world, the centre received special instructions on which broadcasts to "kill" and which not to touch.

Today, 38 radio stations from 28 countries broadcast to the USSR. Radio Liberty ranks first in terms of the volume of broadcasts. It is on the air for 71 hours in every 24 hours; the Voice of America for 23 hours 45 minutes; Radio Beijing for 15 hours 35 minutes.

Some of the former jammers are now being used to relay radio broadcasts from all the union republics into the Moscow area, with 14 programs being available – 10 are of the first program from each of the Soviet Republics and four are the second programs from Ukraine, Azerbaijan, Uzbek and Kazakh.

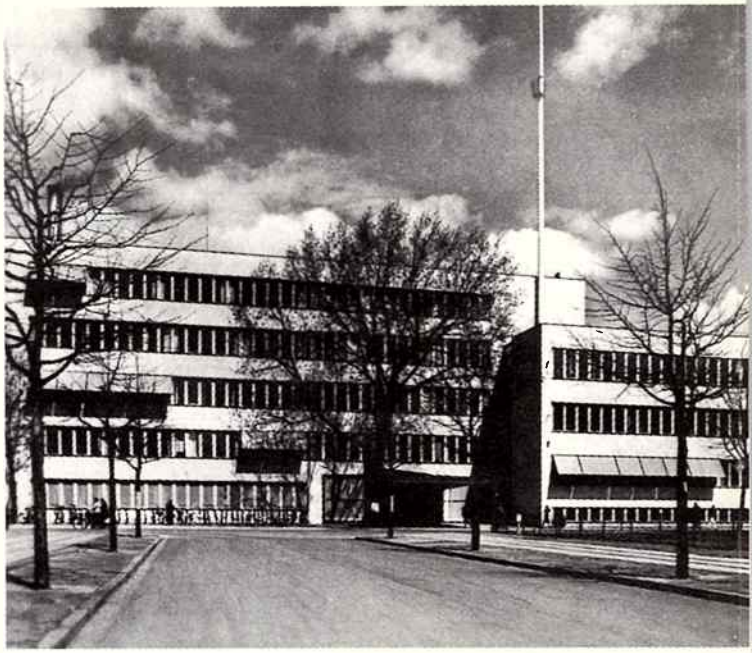
Higher power

AN increasing number of new transmitters put into operation in the past few weeks has been reported by the BBC. Three 100kW transmitters are to be installed at West Germany's Lampertheim and Biblis transmission centres for Radio Free Europe/Radio Liberty's broadcasts to Eastern Europe. Recently two 500kW transmitters were installed at the external service transmitting site of Radio Iran which carries broadcasts of Radio Tehran, adding to that country's extensive transmitting complex. Radio Portugal indicates that one 300kW transmitter is being installed at its transmitting centre. Broadcast of Yemen Radio from San'a was observed on four frequencies carrying the general Arabic program opening at 0300UTC on 4835, 5950, 6135 and 9780, indicating additional transmitters in use.

Additional co-operation in the Nordic area has been announced with Radio Norway carrying the broadcast of Radio Denmark during the next few months. The Oslo transmitters have some spare capacity on their 500kW units and they will be relaying Denmark in the future. Denmark, along with New Zealand, was famed for having the oldest transmitters on the air, but recently Denmark put into operation a 50kW unit. Denmark has a transmission to Australia 1000-1052UTC on 17740, and broadcasts in Danish except for a short English announcement at the opening of the transmission.

VOA upgrading

THE Voice of America has announced extensive up-grading of many of its overseas



The studios of Radio Denmark, Copenhagen, whose programs will

transmitting sites and the installation of new 500 kW transmitters.

The long term plan involves 108 transmitters. The first phase of this extensive upgrading of equipment has begun with the awarding of contracts for transmitters in Morocco. These will replace the existing low powered facilities near Tangier. There will be ten 500kW transmitters installed at the Tangier site and this will be followed by upgrading transmitters in Thailand, Sri Lanka and Botswana. Four 500kW transmitters, each from a different manufacturer, were tested in the United States and a Marconi – Cincinati Electronics Corporation tender was chosen. The transmitter contract also included additional equipment and the Tangier station is expected to commence operation in 1992.

VOA staff

IN the United States the Voice of America employs nearly 2000 people as writers, editors, producers, engineers and support staff who work together to create approximately 1200 hours of programming each week. Outside of the US, Voice of America has about 775 employees. These include people who work at correspondent bureaus, as well as those who work at VOA relay stations around the world.

soon be relayed by Radio Norway.

AROUND THE WORLD

NEW ZEALAND: Radio New Zealand International has a new schedule from September 3 which will be valid up to October 8 when New Zealand moves to Daylight Time. New Zealand has extended its daylight time by a further 5 weeks and this year it will be from the second Sunday in October to the third Sunday in March. The September schedule is 1830-2105, 2345-0145 and 0330-0730 on 15150, 17705kHz; 0900-1205 9850, 11780; on Saturday and Sunday the broadcasts are continuous between 0145-0330 on 15150 and 17705kHz.

SAIPAN: KYOI relays the program of the Christian Science Monitor World Service from Boston for reception in Australian 0800-1000UTC on 17855kHz. This broadcast is also carried by the new 500kW transmitter, WSHB at Cypress Creek, South Carolina which is using 9455kHz for the same transmission. Programs originate from WCSN Boston and are fed by satellite to WSHB and KYOI.

SPAIN: Spanish Foreign Radio at Madrid is using 15110 for English broadcasts 0000-0200, while the same program is available on 9630kHz. English is again heard 0500-0600 on 9630kHz, the new frequency of 15110 providing excellent reception.

SYRIA: Damascus now has a daily transmission to Australia 2105-2200UTC on 15095kHz. The same transmission is carried on 17710kHz while an earlier broadcast in English 2005-2100 is heard on both frequencies.

VATICAN: Vatican Radio, in its service to Australia in English, 2205-2225UTC, is now using 15105kHz to replace 6015kHz. Two other frequencies, 9615 and 11830kHz, carry the broadcast. The new frequency provides the stronger signal, but at times suffers from interference from Deutsche Welle broadcasting from Cologne. eti

This item was contributed by Arthur Cushen, 212 Earn St, Invercargill, New Zealand. He would be pleased to supply additional information on medium and shortwave listening. All times are quoted in UTC (GMT) which is 10 hours behind Australian Eastern Standard Time.

JOHN COULTER

PUTTING IT TO THE PEOPLE

Present environmental impact statement (EIS) and assessment procedures are totally inadequate, says John Coulter. He proposes more democratic ways of dealing with environmental and development issues.

This article continues the theme of looking at more rational ways of making decisions for or against major development proposals. The first one (see ETI, June, page 16) dealt with the failure of current economic indices to give the right signals so that rational decisions can be made. This one examines the inadequacy of the present environmental impact statement (EIS) and assessment procedures.

The Whitlam Government introduced a requirement for the preparation and assessment of EISs for certain major developments. The USA had already legislated this requirement and, since then, Australian states have progressively adopted the EIS procedure. When an EIS is required, the proposer of a development collects information on a number of relevant factors, sometimes predetermined by a department of environment, and presents them so as to make a case as to why the development is desirable. He must demonstrate how environmental impacts will be ameliorated and attempt to show, through the EIS, that the benefit outweighs the environmental (and social) cost.

When first conceived, the EIS was also supposed to cover the costs of not proceeding with the development (the No-go option) and alternative uses of the resource. If rational decisions are going to be made, these inclusions are necessary as one development usually precludes others and options are foreclosed. However, it places a very heavy, and I believe, unwarranted burden on the proposer. The consequences of all resource exploitation spread, like ripples on a pond, to the furthest part of the environment. Where these impacts are considered to become insignificant is a matter of individual judgement.

On the other hand, it also places the public in a very unsatisfactory position. Those responding to an EIS must consider the multitude of environmental issues in the context of this particular proposal. For the reasons just given, each respondent will find the EIS deficient in some or several respects. For example: how far should a specific coastal development proposal discuss greenhouse warming and sea-level rise; or, to what extent should a proposal to build a petrochemical plant canvass the alternative uses of both feedstock and product and the role of such alternative uses in adding to or reducing the release of greenhouse gases to the atmosphere?

The problem is caused by the failure of elected governments to democratically determine these threshold questions before specific proposals are put to environmental impact assessment. Governments tend not to set down in legislative form comprehensive policy on these matters. Support for certain directions for development tends to reside in individual minds at the more vague levels of bias, prejudice and preference.

An alternative may work something like this. Take coastal developments. There are a number of general matters shared to varying degree by all such proposals. These should be publicly examined and settled so that both proposers of specific developments and the public share a comprehensive, previously decided set of policies. The proposer need then address a far narrower range of issues; the EIS need be less extensive and cheaper and there would be greater certainty of the outcome of its review. The public would not be faced with having to mount opposition to a number of proposals which share the same threshold problems. Problems shared by coastal developments include: storm damage (including increased risk of damage and flooding as a consequence of greenhouse induced sea level rise); protection and/or maintenance of a frontal dune system; long shore sand drift and the problems of beach erosion and accretion; mangrove and seagrass protection and so on. Through the preparation of government prepared papers on these matters and public review of these stances a more workable process would be established. From such a process, those sites suitable for marina development and the general conditions which must apply would be known and those threshold conditions would not be in contention to particular proposals.

> *'It seems like government does not want to expose publicly its development biases'*

There have been a number of proposals to build a petrochemical plant in South Australia. Extensive EISs have been prepared but so far no plant has been seen. If government had just decided through the public processes I have outlined how the people of South Australia wanted the natural gas in the Copper Basin used, it's likely that there would have been general support for the turning of the ethane fraction into long-life plastic rather than merely burning it. The next stage would have been to determine what plastics should be made and by what processes. With that background the South Australian Government may well have sought tenders from petrochemical companies for a plant which already had wide support in the community. This procedure would also have the people of South Australia determining through a democratic and open process what and how they want one of their important resources used.

Some seven years ago, the government of South Australia began a public inquiry into how it might improve the quality and effectiveness of its environmental impact assessment process. I proposed to the inquiry a staged assessment of public policy along the lines summarised in this article. I believe it was accepted by the inquiry and recommended to government. It seems, however, that the government does not want to publicly expose, clarify and codify its development biases. Both the public and would-be developers are disadvantaged by this reticence. eti

Senator John Coulter is the spokesman for the Australian Democrats on Science and Technology.

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Without RAM
X18103.....$2,390
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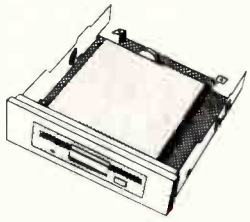

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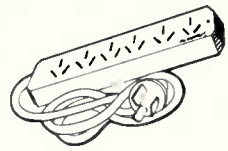

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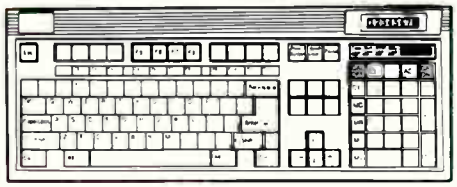

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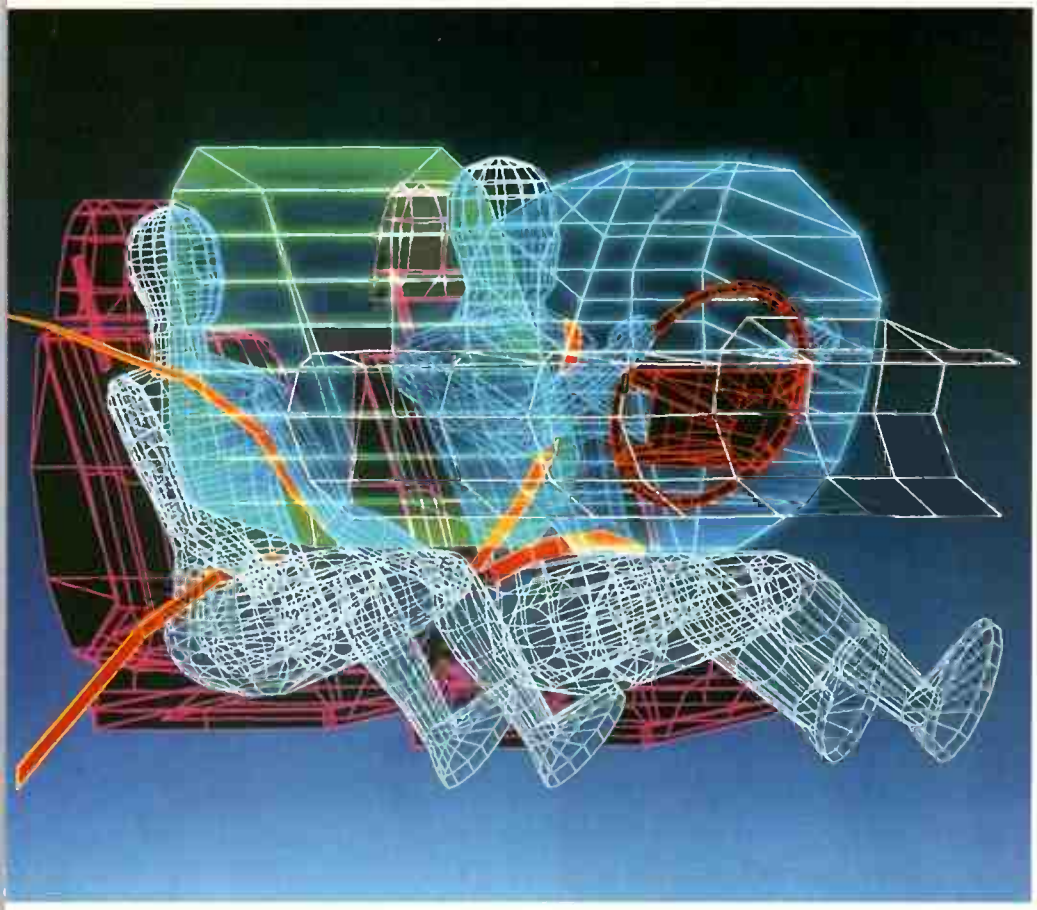
BRIAN WOODWARD

STAYING AI

Accidents will happen — but rest assured that car designers are doing their best to make sure you survive to tell the tale. By Brian Woodward.



Above: the driver's airbag, in conjunction with a specially designed seat-belt tensioner, are now standard features on all Mercedes Benz. Right: how about this for high tensile strength? This Mercedes is hanging by a single door lock.

LIVE

Accident statistics make dull reading. Horrific photos in newspapers, tragic reports on television and the pompous nonsense spoken by politicians all contribute to make us immune to the figures.

After all, they're statistics, not people.

But if the usual daily or holiday weekend statistics are boring – try these.

- In the period 1980-1988 the number of people who died on Australian roads exceeds 25,000.
- The second largest cause of death amongst 15-24 year olds is suicide. In 1986 alone, 361 Australians in this age group took their own lives. **But 1040 died in road crashes.**
- For Australians under the age of 45 **the most likely form of death** is a traffic accident. During 1986 1300 more Australians in this age group died on the roads than died from heart disease and 500 more than cancer.
- On an average Australian day **eight people will die** and 80 will be seriously injured in a road accident.

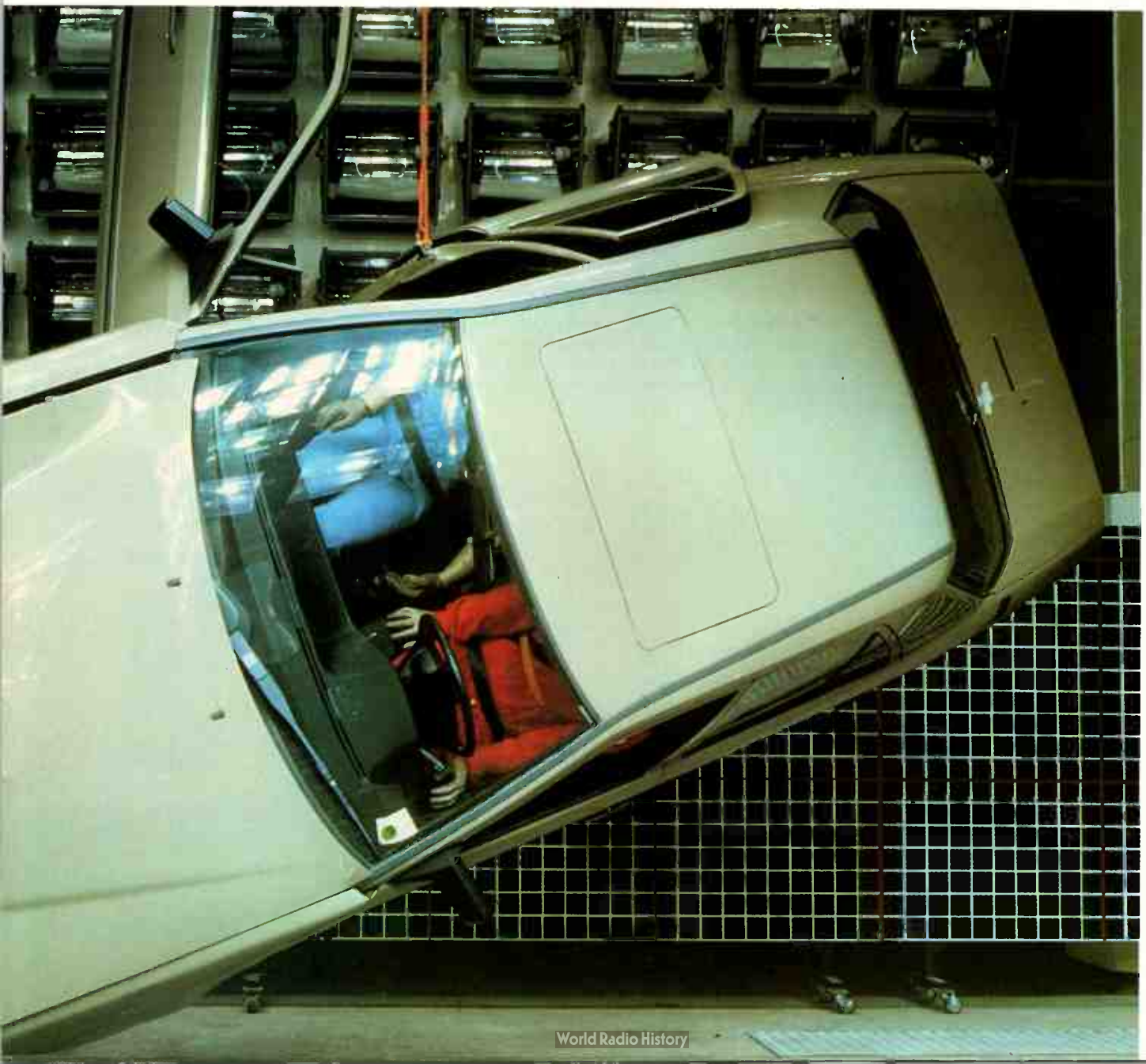
The causes of accidents are many and varied; traffic density, (up 185 percent since 1963), higher traffic speeds and greater driver pressure are a few.

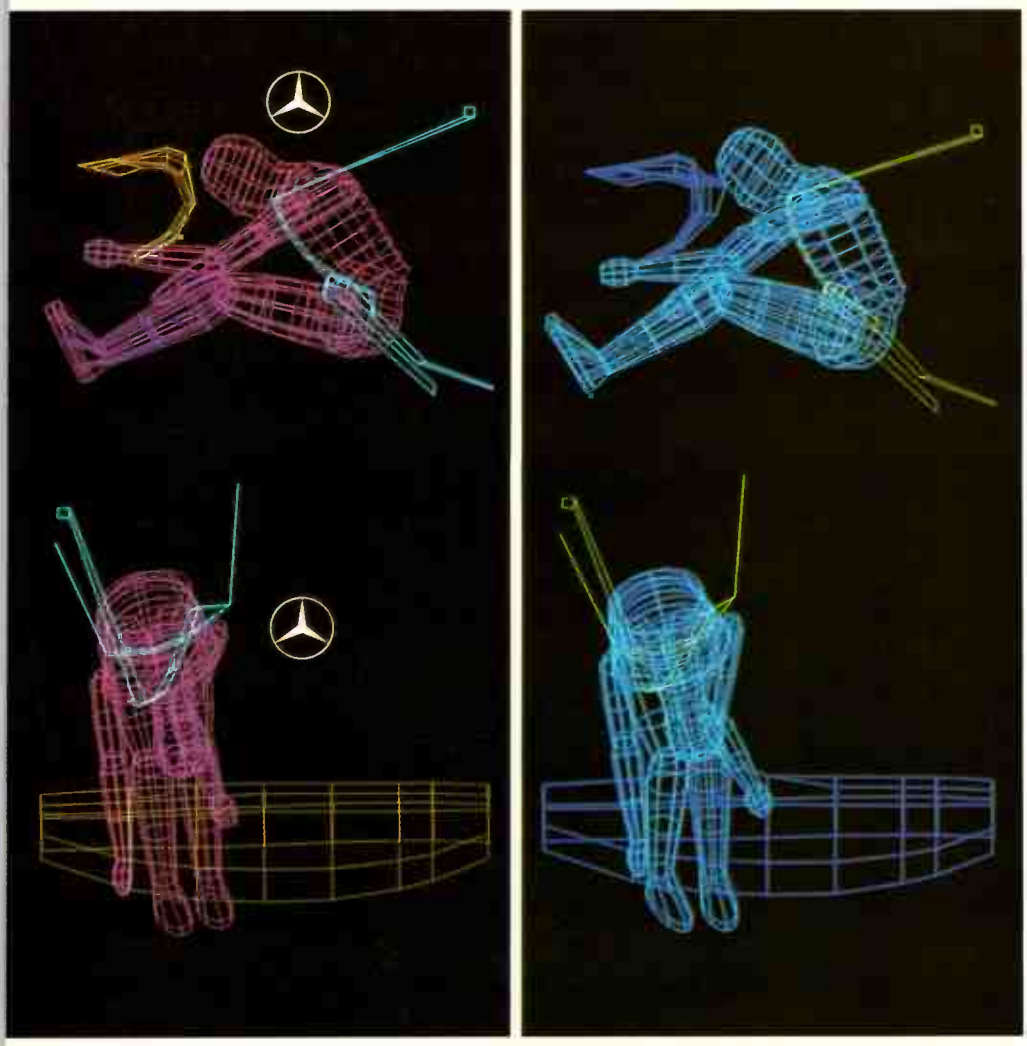
As tragic as the figures are, the ratio of road fatalities per 100,000 is actually lower than at any time since 1945 – 17:100,000. And the ratio of deaths per 10,000 vehicles is the lowest ever recorded at 3:10,000, as is the number of fatalities per 100 million kilometres travelled – 1.8:100 million kilometres.

Indeed, in the first quarter of 1989, New South Wales recorded the lowest rate of fatalities since 1945 – further improving on the 1988 figure.

Driver training

Things are improving. But why? One factor which remains unchanged throughout all of this is driver training – it is still woefully inadequate. Politicians hoping for another term in office are unwilling to impose a strict





Top: prevention of head impact is particularly important in the design of the dashboard. "Cockpit" type dashboards significantly increase the risk of injury, particularly to the front passenger. Bottom: most nose-first accidents involve offset crashes where only a small percentage of the car's front takes the impact. Mercedes Benz' chassis yoke overcomes this problem.

Staying alive

new training regime on the teenagers of their electorate. The driver's licence has become a right, not a privilege based on skill.

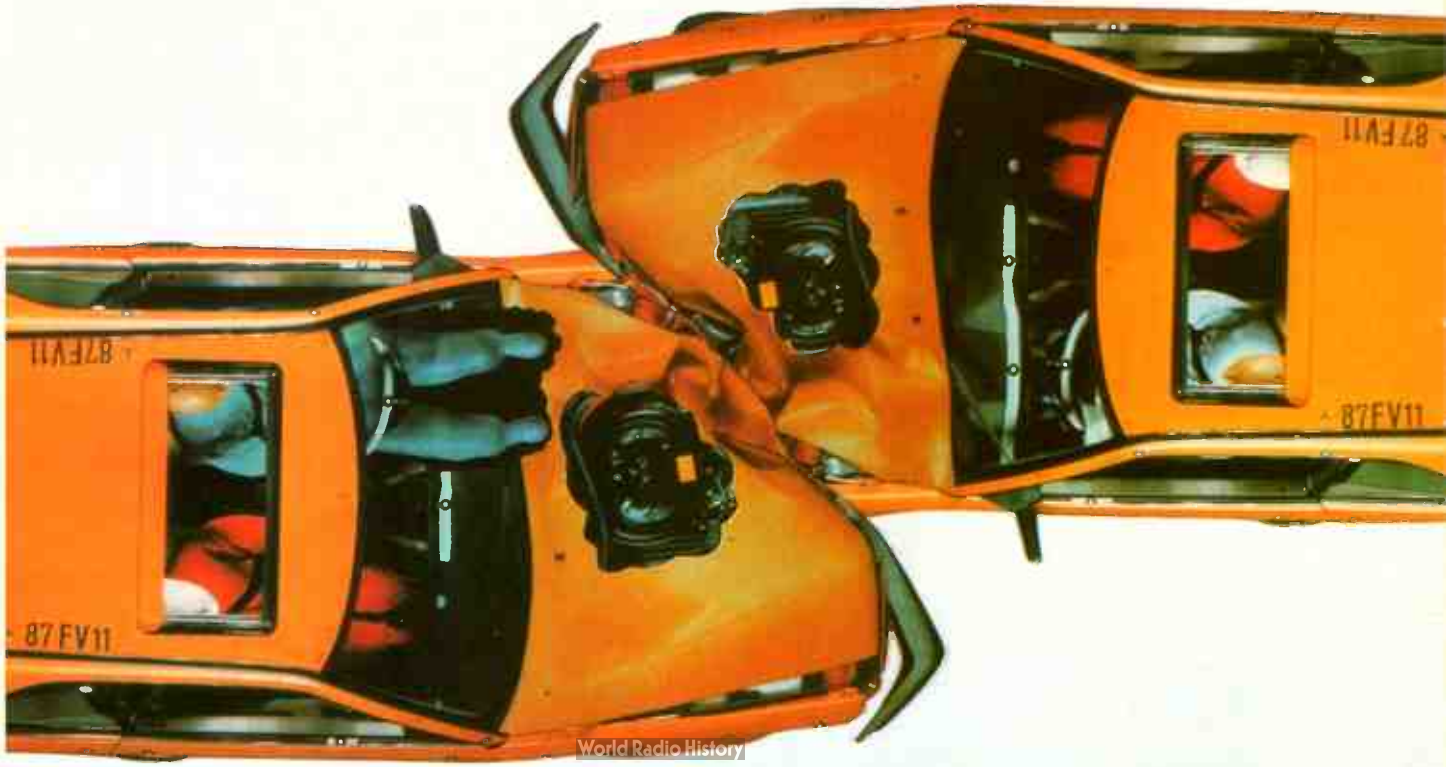
Instead of beating the electorate over the head, politicians have found it easier to legislate car makers into manufacturing cars which are safer. Seat belt wearing alone contributes greatly to the reduction in the road death toll, but independent work by manufacturers in making vehicles actively and passively safer has contributed as much again.

It didn't take car manufacturers long to realise that fear was a strong marketing tool; that doing something about car safety could prompt more people to consider buying that particular brand of car than unsuccessfully lobbying governments to lift the standard of driver training.

A pile of accident-damaged cars with XYZ Cars on the grilles is definitely bad PR. A strong advertising campaign pointing out the safety benefits of a car is good PR. The number of car companies seriously involved in accident injury minimisation programs through improved car design has reached the stage where almost all spend millions each year.

One of the companies at the forefront of car safety through good design is Mercedes Benz. The cost of research and the price of putting the results of this research into production is high – the cost of any Mercedes Benz is proof of this. Yet many Mercedes Benz-initiated safety developments are being licenced to other car makers – or copied.

One person who leads the world in motor vehicle design for occupant safety is Mercedes Benz's Ingo Kallina, a young engineer who has dedicated much of his working life to making cars safer.



There are two aspects to safety – active and passive. These can be readily defined as making the car responsive to driver commands (active) and predictably safe in the event of an accident (passive).

Central to the improvement of both is an elaborate computer system. In the case of active safety, Mercedes Benz has one of the most entertaining computers in the world. A test vehicle rests on servo hydraulic rams inside a projection sphere. Road conditions are generated and projected inside the sphere as a driver 'drives' the stationary car. As corners are turned, accelerator pressed or brakes activated the servo hydraulic rams tilt the car in a most realistic manner and the projected image reacts in real-time.

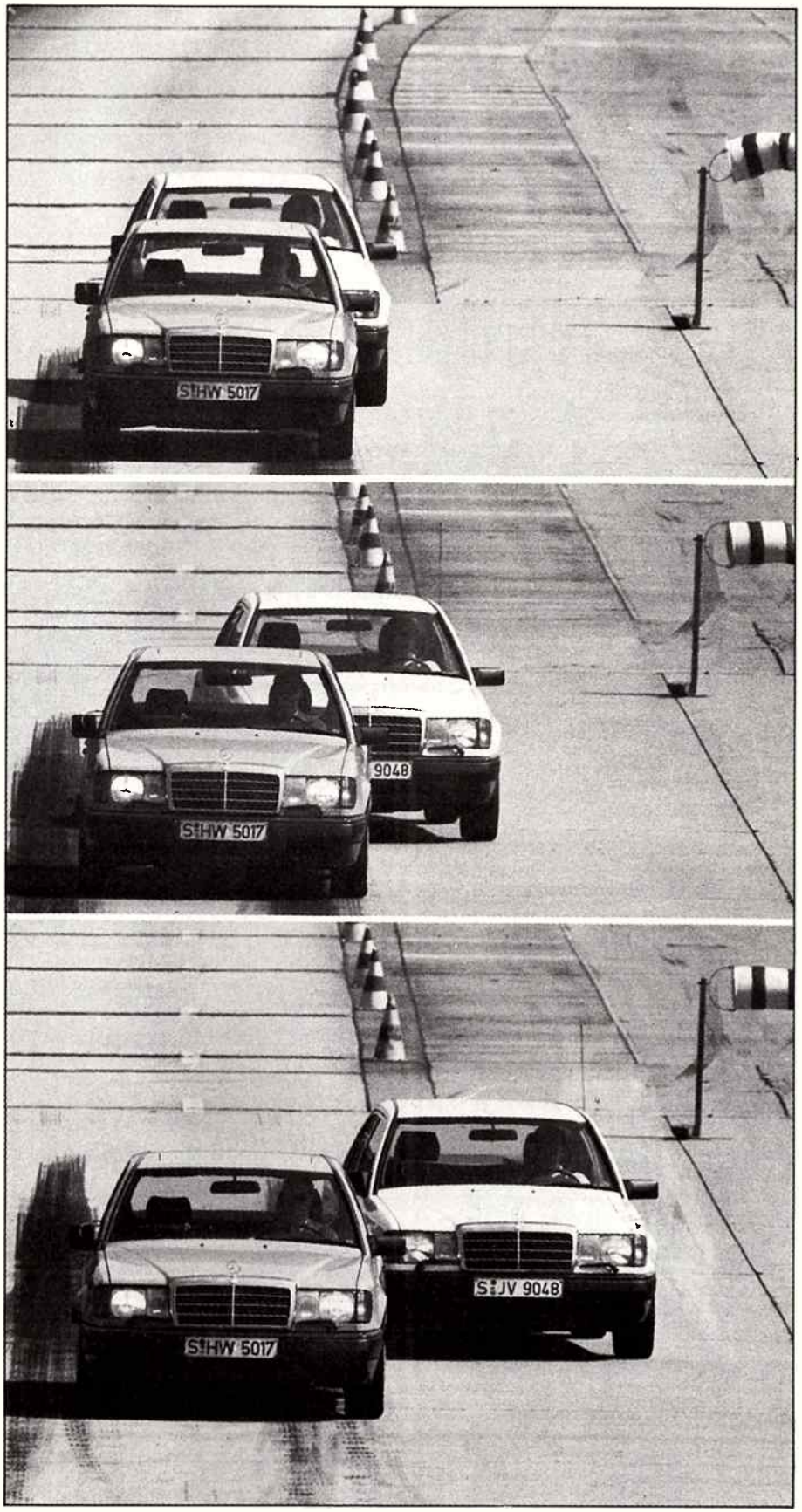
The information gathered from this computer is used to design vehicle dynamics which are more responsive, or vehicle characteristics which better inform the driver of vehicle conditions. For example, tyres are being developed which inform the driver of imminent slip and then lose grip progressively. Tyres with higher adhesion but little warning of slip may be acceptable on a race track, but they lull a driver into a false sense of security and then leave nothing in reserve in emergency.

Active suspension

One major development coming from the driving sphere is active suspension. Information is taken from sensors on the front shock absorbers of the car and the rear is informed of imminent change. Working from side to side as well, the nature of the car's shock absorbers can be changed according to steering wheel deflection and lateral load to keep the car flat when turning a corner. Eliminating body roll maintains an ideal relationship between the tyre's tread and the road.

Another research direction is in having a car with suspension which changes characteristics according to road speed and conditions. At low to cruising speeds on a smooth, relatively straight road, soft suspension is preferrable – the driver remains relaxed. But as bumps occur, or speed increases, the shock absorbers (more correctly called dampers) should become progressively stiffer. Ideally the car should also ride lower to the ground at higher speed for better aerodynamic efficiency. Also (in an ideal world) the suspension of a car should be self-levelling so that varying loads do not cause the car to ride nose-up. All of these features are present on the Mercedes Sports SL which will be released in Australia around May 1990.

Mercedes Benz has researched four wheel steering and found that the advantages of systems currently in production in Japan can be exceeded if the rear wheel steering is both automatic and intelligent. Research is currently underway with evaluation of a



Research into rear axle steering aims to balance out negative effects on the vehicle, such as side wind, without the driver having to intervene.

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system which detects a change in side wind and compensates automatically – normally a driver would have to correct the car's front wheel steering in a heavy cross wind.

But it is in the field of passive safety where the greatest challenges lie. The computer system used here (by every car manufacturer) has an elaborate CAD system. The software is capable of creating a body/frame design with known parameters of metal wall thickness and weld integrity. The vehicle created on the CAD systems's screen is then 'crashed' (with the calculations sometimes taking hours) and a deformed picture appears on the screen.

Four requirements

These tests are necessary because passive safety has four basic requirements. To create a strong, safe passenger cell, to restrain passengers, to prevent the components inside the cell from injuring passengers and, finally, to surround the cell with a predictable, progressively deformable 'brake'.

In an accident, the human body is subjected to massive deceleration. If that deceleration is too severe, then the seat belts will do almost as much damage as if they weren't used. Deceleration must be progressive.

Two of the essentials have already been achieved. Passenger restraint takes the form of seat belts. Research has shown that even correctly fitted seat belts extend dramatically in an accident. To cure this problem Mercedes Benz has developed a new type of seat belt with a modified inertia reel. When an accident is sensed, the inertia reel locks, as usual. At the same time a small pyrotechnic charge (explosive is a risky word to use for a device that is inside a car!) fires. The gas pressure developed operates a piston which reels the belt in still further, tightening it against the occupant and restraining him or her even more securely.

To further protect occupants from switches and knobs already designed to be soft to the human body, Mercedes Benz is now fitting air bags to some models and making them available as options on others. Airbags are large permeable woven bags stored inside the steering wheel hub and the dashboard. When an accident equivalent to hitting a rigid barrier at 20 km/h or more is sensed these inflate in around 25 to 30 milliseconds and cushion deceleration. The bang associated with inflation is not loud enough to harm hearing and with 500,000 already in service in Europe and the USA, Mercedes Benz claims there has not been one reported incident of an airbag 'falsing'.

As an example of the interaction between CAD design and practical testing (plus the essential element – analysis of real-life accidents) Mercedes Benz has changed the footwell design of its cars. Protecting the dummy in a test accident has proven relatively easy, but Mercedes Benz discovered that many real accident victims suffered breaks to feet and ankles. The reason for this that even a minor intrusion into the footwell loaded limbs already under great stress, breaking bones. The result is the installation of a deceleration foam under the carpet adding about 25 mm of protection. It works.

As well as being safe, suspension must be comfortable. Active suspension represents an optimal solution. The control system is designed to prevent side tilt during cornering.

Kallina is first to acknowledge that though computer simulation may be worthwhile, actually smashing expensive Mercedes Benzes into concrete walls is essential if the data gained on the screen is to be confirmed (and usually modified).

World-wide standards have been set by governments for crash barrier testing. The spectacular tests have received huge publicity, yet they prove little or nothing when related to real accidents. Most nose-first accidents involve "offset" crashes where only a small percentage of the car's front hits the other car or obstacle. It is relatively easy to achieve minimum safety cell penetration when the accident load is taken equally by the entire front of the vehicle. It is much harder when the same load is applied to 40 percent of the car's front.

Chassis Yoke

To overcome this situation Mercedes Benz has developed a chassis yoke which spreads the load over the side of the passenger cell and the very strong transmission tunnel. This way the accident intrusion into the passenger cell remains the same even if the car has to absorb accident load through only 40 percent of its frontal area.

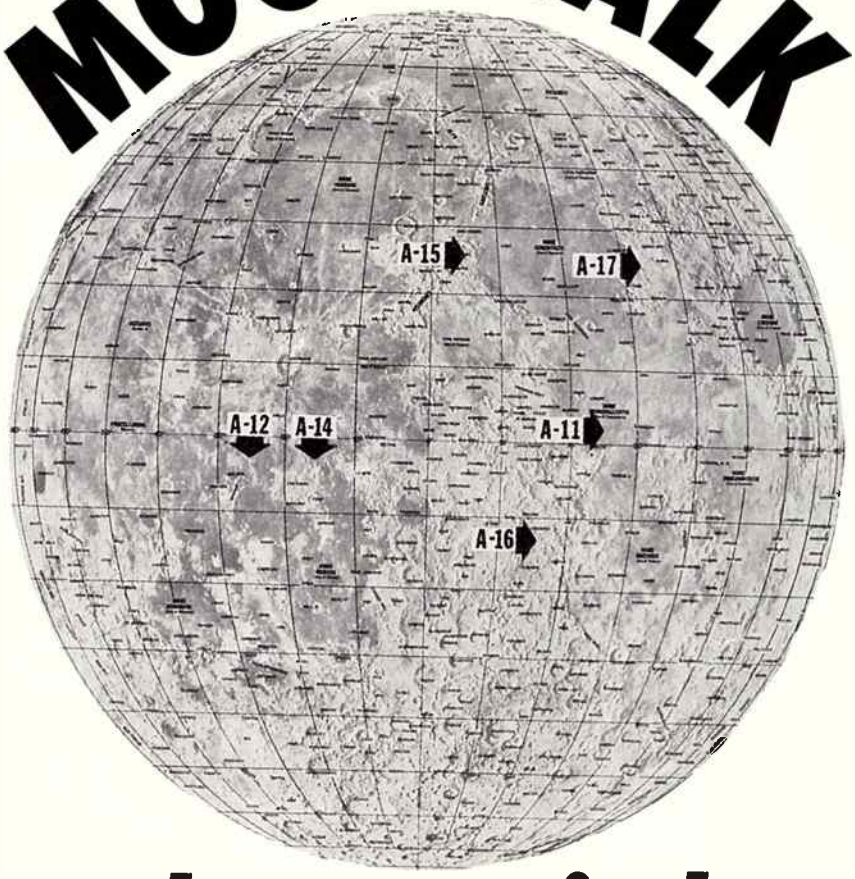
Keeping people alive in cars is an expensive business. The most important objective is to cushion the blow and prevent the human from decelerating too fast, or hitting protrusions within the passenger cell. Thus the passenger must be firmly restrained, the interior designed safely and the steel panels ouside the cell must deform progressively.

Unfortunately, the cost of repairing a safe car is often greater than repairing an unsafe one. Progressively deformable panels sacrifice themselves to save human life. Huge progress has been made by Mercedes Benz and other car makers, but, as Kallina says, "There is no way we can construct a car to cope with a catastrophe." Indeed, catastrophes can only be minimised by extensive driver training.

As an orthopeadic surgeon working with accident victims at Sydney's Concord hospital once said, "There is an element of risk in all technology, from a biro to a space shuttle. It is society's moral task to determine the acceptable level of safety."

Car makers like Mercedes Benz are raising the level of safety and reducing the number of needless road deaths. eti

MOONWALK



The twentieth anniversary

Kathryn Doolan takes us on an astronomical trip down memory lane.

TECHNOLOGY

"I believe that this nation should commit itself to achieving the goal before this decade is out – that of landing a man on the Moon and returning him safely to Earth. No single space project in this period will be more impressive to mankind or more important for the long range exploration of space; and none will be so difficult or expensive to accomplish." So said John F. Kennedy on 25 May, 1961.

This July will mark the twentieth anniversary of man's first landing on the Moon. Since Neil Armstrong's "One small step", there have been many changes in the American manned program and the NASA of 1989 bears little resemblance to the NASA of 1969. In the halls of NASA now, the Apollo Project is a cherished memory of a time when the President, Congress, media and the general public were all behind it. The Apollo 11 landing was seen to be demonstrating to the world the power of the United States' technological superiority – especially after the humiliating debacle of the Soviet Sputnik flight in 1957 and Yuri Gagarin's orbital flight in April, 1961.

The flight of Gagarin in particular posed a political problem for the new President, John F. Kennedy. The US space program was preparing for the first manned suborbital flight and it was galling to NASA to be beaten by the Soviets – especially after NASA had sent several chimpanzees into space. It was widely believed that NASA could have sent a man into space in March, 1961, but the top NASA officials were reluctant to commit themselves and it was not until May that an American was launched.

The flight of Alan Shepard was a turning point for the American space program. Bouyed by public acceptance of the flight, President Kennedy (in spite of the strenuous objections of his closest advisors) decided to launch the Americans on a program that would eventually see two astronauts on the moon. In retrospect, Kennedy's decision can be seen as an amazing gamble. In May, 1961, NASA's total manned spaceflight experience was fifteen minutes. At that time there had been no American orbital flight and NASA officials publicly admitted that they did not – know how they were going to meet Kennedy's goal in less than nine years.

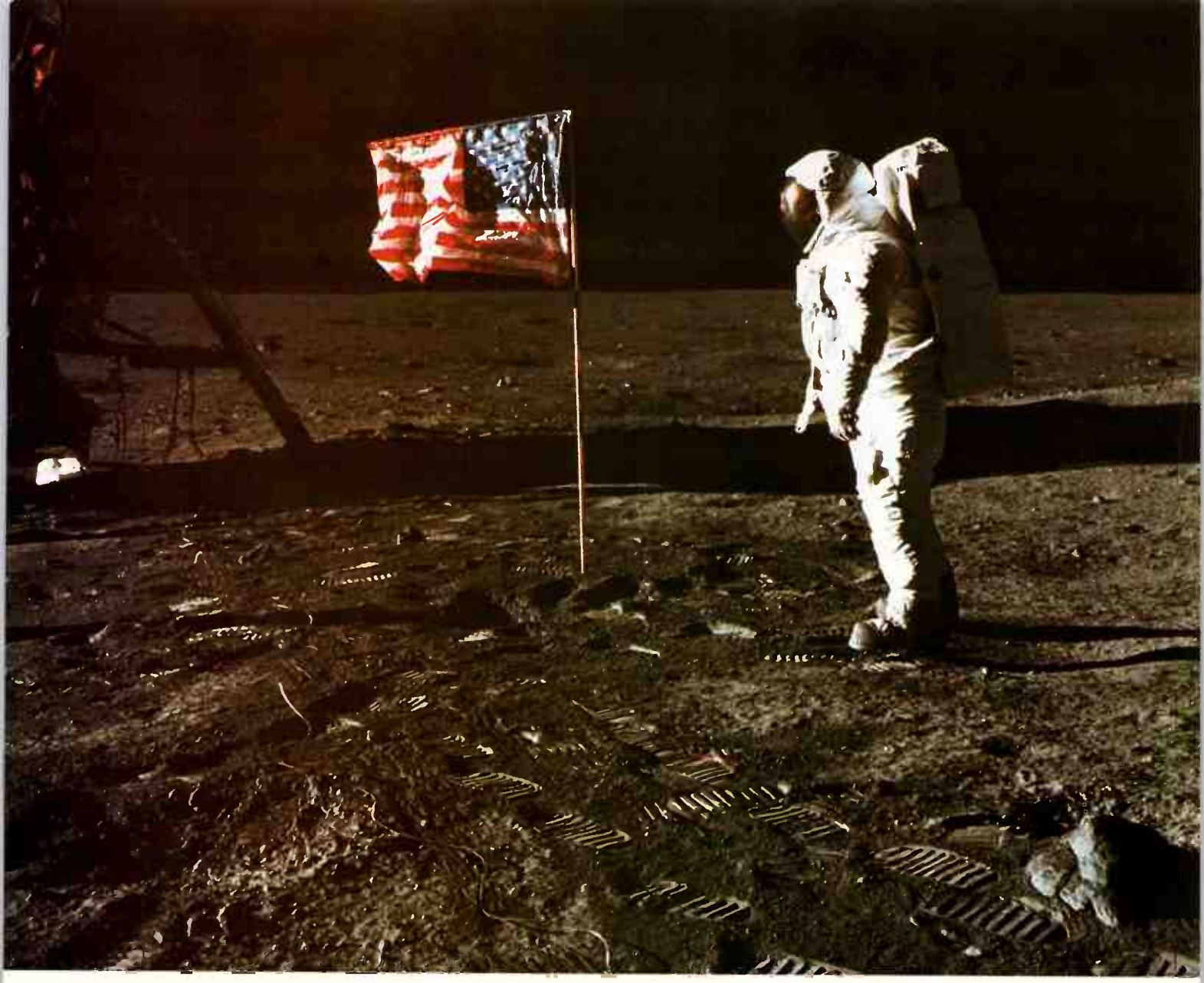
Now that the Americans had a goal, and a time in which to accomplish it, some serious thinking started. On the books were three different approaches:

1. Direct Ascent Mode,
2. Earth Orbit Rendezvous,
3. Lunar Orbit Rendezvous.

The Direct Ascent Mode involved building a large and powerful rocket. After launch it would travel directly to the Moon, land and eventually lift off from the lunar surface and return to Earth, all along dropping off segments of the rocket that were finished with. The main drawback to this was simply the cost of the rocket.

The Earth Orbit Rendezvous was the approach favoured by Werner Von Braun, the German rocket scientist who, by 1961, was in charge of building NASA's rockets. EOR involved launching two separate vehicles, which would rendezvous and both land on the Moon.

The last option was the Lunar Orbit Rendezvous. What this involved was the launching of one rocket, with a Lunar Excursion Module aboard. Once the rocket reached lunar orbit, two astronauts would descend to the lunar surface while a third astronaut waited above in the spacecraft which would return to Earth. Once the astronauts had finished on the surface they would rendezvous with the craft in lunar orbit, dump the moon craft and come home. Interestingly, this theory had been suggested by a Soviet mechanic, Yuri V Kondratyuk in 1916, when he suggested that the entire



Opposite page: photographic illustration of the nearside of the Moon showing the locations of the Apollo landing sites. They are: Apollo 11 — Sea of Tranquility: Apollo 12 — Ocean of Storms; Apollo 14 — Fra Mauro; Apollo 15 — Hadley-Apennines; Apollo 16 — Descartes and Apollo 17 — Taurus-Littrow. Above: astronaut Ed Aldrin Jnr of Apollo II poses on the lunar surface beside the deployed United States flag. Lunar Module Eagle is on the left.

spacecraft need not land.

In the early 1960s, a NASA engineer, John Houbolt, had independently come up with the same idea and tried to sell it to his superiors. A large political squabble broke out and Houbolt came under increasing pressure to drop the idea. Instead, he approached NASA administrators and eventually the Lunar Orbit Rendezvous method was chosen because it was the easiest and cheapest method.

After the completion of the Mercury program in the middle of 1963, there was a two year hiatus in manned spaceflight. The reason was the development of a bridging program that would give astronauts flight experience in long duration flights of up to fourteen days (which would be the duration of later Apollo flights). Experience was also needed in the area of Extra Vehicular Activity by astronauts. It had to be proved that astronauts could work outside their spacecraft in relatively safe conditions and get used to working in their unwieldy spacesuits. The most important activity that had to take place during the bridging program was the maneouvring and rendezvous of spacecraft in orbit-essential, as the Apollo program would rely on rendezvous to achieve its goals.

The name of this bridging program was Project Gemini and in March 1964, the first of the Gemini manned flights was launched with astronauts Gus Grissom and John Young on board. The purpose of Gemini Three was to flight-test the spacecraft and in so doing a first was achieved – the spacecraft was able to change orbits and be manoeuvred manually by the astronauts. The flight also gained notoriety when John Young smuggled a corned beef sandwich aboard!

The next flight, Gemini Four, in June 1965, was a four day flight – the longest US flight to date. It was also the flight in which the first US Extra Vehicular Activity took place. Astronaut Ed White exited the craft for twenty-two minutes, proving that men could work in space without too many problems. The one major problem on the flight was the trouble fellow astronaut Jim McDivitt had getting the reluctant White to come back into the spacecraft.

Gemini Five was to be a real endurance flight of eight days. The crew of Gordon Cooper and Pete Conrad had unofficially christened the flight "Eight Days or Bust" which hadn't gone down well with NASA administrators. Fortunately, all went well, apart from a fuel cell breakdown which led to the crew having to drift for most of the

Apollo II lift-off, July 1969. Aboard were astronauts Neil Armstrong, Michael Collins and Edwin E. Aldrin Jnr.

flight's duration. Some impressive Earth observation photography took place and the crew were found to be in good condition after they landed, which persuaded NASA officials to schedule a fourteen day flight later in 1965.

In October, the Gemini Six crew, Wally Schirra and Tom Stafford, were due to make the first manned rendezvous, docking with another spacecraft. However, before the launch, the target vehicle – an Agena stage on top of an Atlas rocket – failed to achieve orbit, leaving Gemini Six in the lurch. After some inspired planning by NASA and private industry engineers it was decided to have Gemini Six rendezvous with Gemini Seven during its two week marathon flight.

Gemini Seven launched on 4th December, 1965, on a fourteen day flight aimed mainly to observe how the human body adapted to prolonged weightlessness. Astronauts Frank Borman and Jim Lovell flew in lightweight suits to make them feel more comfortable in the cramped Gemini craft. During their flight, they conducted medical experiments on themselves and carried out an extensive scientific program.

Gemini Six was due to fly on 12 December and whilst the countdown went smoothly, the Titan rocket shut down 1.2 seconds after ignition leaving the astronauts on a bomb. Disobeying procedures Wally Schirra refused to eject from the rocket and his judgement was proved correct when the rocket stayed shut down. The problem was found to be a dustcap left on a fuel nozzle and once this was removed, the launch took place three days later. During Gemini Six's third orbit, its computer locked onto Gemini Seven and several hours later, the two spacecraft rendezvoused, with Gemini Six coming to within a foot of Gemini Seven. After more rendezvous activities, Schirra and Stafford headed for splashdown, but not before telling ground controllers that they had spotted a UFO over the North Pole being pulled by eight reindeer!

Borman and Lovell stayed up an extra three days, making this manned flight the longest so far. This record was broken in 1970 by the Soviets. The Gemini Seven crew were found to be in excellent physical condition, better than the Gemini Five crew after their flight.

After an eventful 1965, NASA planned to have an even busier 1966, with the Gemini program continuing and the hopeful start of the Apollo program. Gemini Eight was launched in March 1966, with the intention of achieving the first docking with an Agena target vehicle. However, after achieving the docking, the Gemini spacecraft spun widely out of control and astronauts Neil Armstrong and David Scott had to use the re-entry thrusters to regain control of the spacecraft. Once the spacecraft had stabilised, ground controllers ordered the crew to return to Earth, cutting short a planned four day flight.

The next flight, Gemini Nine, was marred by problems. The prime crew of Elliott See and Charlie Bassett were killed in January 1966 in a T38 training jet accident and the backup crew of Tom Stafford and Gene Cernan had to step in. An Agena target vehicle was launched and failed to orbit. Another target vehicle was launched but proved impossible to dock with after a protective shroud failed to budge, earning it the nickname of the "Angry Alligator". Instead, the crew flew around it and rendezvous skills were practiced. A spacewalk by Cernan had to be abandoned after the astronaut wore himself out attempting to use the backpack manoeuvring unit. After a flight of somewhat mixed results, Gemini Nine splashed down less than two-and-a-half miles from the recovery forces.

Gemini Ten was crewed by two astronauts who were to play a prominent role in the upcoming Apollo program. John Young and Mike Collins launced in July 1966 and it was hoped that a new space altitude record of 475 miles would be reached. Docking with the same Agena target used by Gemini Eight was achieved early in the mission and Mike Collins spacewalked over to the Agena and retrieved an experimental package that had been placed there to test the environment of space on man-made machinery. The only drawback to Collins' EVA had been when he let go of a camera that had been recording the details of his walk. Young then successfully used the Agena vehicle to boost the spacecraft to an altitude of 476 miles - a record at that time. After a successful flight, the crew landed less than three miles from

the aircraft carrier.

Gemini Eleven was launched on schedule in September 1966, with the launch window lasting just two seconds. The crew, Pete Conrad and Dick Gordon, docked with an Agena target craft and then were boosted to an altitude of 850 miles. Gordon attempted a spacewalk to tether the Gemini spacecraft and Agena target together, but, as with Cernan's spacewalk on Gemini Nine, he became exhausted after tethering the two craft together and was ordered back into Gemini. Other flight activities included the production of the first artificial gravity created in space, Earth observation photography and some medical experiments. A first for the Gemini program was the re-entry, which was computer controlled. All the astronauts had to do was watch the craft make a precision splashdown, telecast live on television.

The last flight of the Gemini program was Gemini Twelve which launched in November, 1966. The crew of Jim Lovell and Buzz Aldrin had barely lifted off when wreckers started demolishing their launch pad to make way for Apollo. The main activity of the flight was the five-and-a-half-hour spacewalk by Buzz Aldrin. Careful training in an underwater tank paid off when Aldrin performed some twenty assigned tasks such as plugging and unplugging connectors, bolts and screws. Aldrin proved that with adequate training, man could work in space and perform useful tasks. Other features of the flight included a docking with an Agena target, which was accomplished by backup charts and a slide rule when the computer failed, as well as the observation of a solar eclipse. The Gemini program ended when Gemini Twelve splashed down less than three miles from the recovery ships.

During the Gemini program, preparations were going all out for Apollo. Werner Von Braun's team down in Huntsville, Alabama, had designed two rockets – the Saturn One and the mighty Saturn Five. The Saturn One, which would be used for the Apollo Earth orbit flights, was 224 feet high and produced almost a million and a half pounds of thrust. It was powered by a cluster of H1 engines and had a restartable J2 engine. Saturn One rockets were used through the middle sixties to launch three Pegasus satellites which were used to determine whether micrometeroids would be a danger to Apollo spacecraft.

The Saturn Five rocket was simply a monster. A three stage rocket, it stood 363 feet high and, at liftoff, generated thrust of seven and a half million pounds. By the time of the first manned Apollo flight in January 1967, the Saturn Five had yet to be flight tested.

In early 1967, NASA faced a serious problem. In the preparations to meet Kennedy's deadline, a large amount of overconfidence had crept into the Apollo program. After the success of Mercury and Gemini, there was a feeling that the deadline would be met by early 1968 and NASA could continue with an ambitious post Apollo program. However, all was not well. Lieutenant General Sam Phillips, who was the Apollo Program Director, visited the factory where the Apollo spacecraft was being manufactured and after the visit wrote a devastating report on the shoddy workmanship and management that was taking place. This report was kept from the media, Congress and the White House. It would be revealed at a later date with terrible consequences.

On 27 January, 1967, the crew of Apollo One were undergoing a simulated launch in their spacecraft when, just moments before the test ended, a flash fire broke out in the craft. Less than a minute later the crew, comprising Gus Grissom, Ed White and Roger Chaffee were dead. The cause of the fire was an electrical short circuit which ignited combustible material which thrived in a 100% pure oxygen atmosphere. At the end of January 1967, the goal of having men on the moon by the decade's end looked very unlikely.

Immediately after the fire, NASA set up an investigative board to find out the cause of the fire and what could be done to ensure that another one did not happen. All up, over 1500 changes were suggested and NASA eventually adopted 1300 of them. Most were fire-related and a more serious approach was taken to crew safety including the installation of fire extinguishers, manufacture of fire-proof space suits and a mix of 60% oxygen and 40% nitrogen for the spacecraft whilst on the launch pad to cut down on fire risk.

Ed Aldrin walks on the surface of the Moon.

As can be expected, members of Congress demanded their own investigation and it was particularly nasty for NASA Administrator, James Webb. Webb had no prior knowledge of the Phillips Report and was hauled over the coals by then Senator Walter Mondale – an enemy of the space program. Webb was accused of lying, and cover ups involving the Apollo fire, but in the end he was cleared by other NASA testimony. The upshot of the hearings was that NASA was free to continue the Apollo program, but increased emphasis by Congressional watchdogs on safety ensured that NASA did put safety first and the Moon goal became a second priority.

Meanwhile, tests were still continuing with the Saturn rockets. In November 1967, the first Saturn Five rocket was launched and one witness stated that he wasn't sure whether the Saturn had launched or Florida had sunk. The main purpose of this launch, apart from testing the rocket, was the test of the Command Module heat shield and whether it could re-enter safely at Moon return velocity.

The first test of the Lunar Module was in January, 1968. During this flight the ascent and descent engines were fired twice to ensure that they would work in the vacuum of space. The last, unmanned Apollo test was a launch in April 1968 which tested all the Apollo hardware as well as investigating the "POGO" phenomenon – the serious oscillations that occurred during the launch phase and which were a worry to the spacecraft designers.

The Apollo Seven flight, which was to be the first manned flight, was scheduled for October, 1968. On this flight, the only real objectives were to test the Apollo spacecraft to see if it was spaceworthy. It would also provide an important psychological boost to the Apollo program after the fire.

The main area of test on Apollo Seven was to be the Command Module, the living and working quarters for any voyage to the Moon. The CM, as it was popularly known, was thirteen feet in diameter and eleven feet high, and was crewed by three astronauts. The CM had an extensive guidance and navigation system, which was powered by a large computer replacing the hand-held sextant and small computer that were used on Gemini. One of the features of the computer was that it could be used to assist in the manoeuvring of the spacecraft – useful in conserving fuel. Another feature was an extensive backup system. If something went wrong, there was

always a way to fix or replace it. There was no escape system within the CM; instead a solid rocket escape tower was provided and should something go wrong at the launch the spacecraft commander would pull an ejection handle and the CM would be separated from the rest of the rocket to make a safe landing.

Apollo Seven launched in October 1968, under the command of Mercury veteran Wally Schirra, along with Command Module Pilot Donn Eisele and Lunar Module Pilot Walt Cunningham (there was no LM on the flight). The crew were delighted with the spacecraft, which performed to perfection. A rendezvous took place with a spent Saturn rocket section and it showed that rendezvous with the Lunar Module could be achieved. Another first was the introduction of live television shows from space which gained the crew an Emmy Award for their comedic talents. One major problem arose when all crew members came down with the flu and they eventually flew re-entry without their helmets to ensure that they didn't burst their eardrums. Schirra later referred to the flight as an eleven day cold capsule! Apollo Seven landed in the Atlantic Ocean and was described as a 101% success as the crew had met mission objectives as well as several objectives that were not planned.

NASA had a small problem after Apollo Seven. Apollo Eight, due to launch in December 1968, was to test the Lunar Module in orbital flight. Due to a slippage in production of the LM, NASA officials decided that Apollo Eight would become the first manned flight to orbit the Moon. There was an ulterior motive to this decision as recent intelligence had suggested that the Soviets were about to attempt the same thing and, mindful of the propaganda coup that the Soviets would have, NASA decided to go for a Christmas flight. On 21 December, using the Saturn Five rocket for the first time in a manned flight, the Apollo Eight crew of Frank Borman, Jim Lovell and Bill Anders lifted off in a picture-perfect launch. On the journey to the Moon, Borman came down with space sickness but it was decided to continue the mission and on Christmas Eve 1968, Apollo Eight went into a sixty mile orbit around the Moon. During the ten orbits of the Moon, the astronauts made extensive photographic observations of future lunar landing sites and other features. On the last orbit of the Moon, there was a broadcast beamed back to Earth and the astronauts, in a stunning surprise, read the first chapter of the Bible which was heard in sixty four countries. After the successful firing of the Service Propulsion System, the Apollo Eight crew headed home, landing in the Pacific Ocean on 27 December, 1968.

The next flight, Apollo Nine, saw the debut of the Lunar Module. The LM, fondly referred to as "The Bug" was 23 feet high with its legs extended and had a diameter of 31 feet. The combined thrust of the ascent and descent stage came to nearly 14,000 pounds. Because the craft was manufactured to operate in the vacuum, it had no heat shield and its skin was so thin it could be punctured with a screwdriver or even a human fist. The object of the Apollo Nine flight was to flight test the LM and practice docking procedures with the Command Module. The flight was delayed due to astronauts being ill, but on 3 March, 1969, finally lifted off. The crew of Jim McDivitt, Dave Scott and Rusty Schweickart were allowed to name their spacecraft and descriptively named the Command Module "Gumdrop" and the Lunar Module "Spider". During the first two days of the flight, system checks took place and on the third day, McDivitt and Schweickart, in Spider, powered up the descent engine whilst it was docked with Gumdrop. This test cleared the way for Spider to fly some 115 miles away, jettison the descent stage and return to rendezvous with Gumdrop. This was completed successfully, and also tested successfully was the Apollo lunar spacesuit with its portable life support system backup. After a ten day flight, the crew landed safely in the Atlantic Ocean.

The crew of Apollo II. From left to right are: Neil Armstrong, Michael Collins and Edwin E. Aldrin Jnr.

The next flight, Apollo Ten, was originally to be the first to land on the Moon. However, NASA officials decided a full dress rehearsal was in order, so the landing was put back to July. The crew of Tom Stafford, John Young and Gene Cernan launched on 18 May on a flight that would take Stafford and Cernan to within nine miles of the lunar surface. The naming of the spacecraft caused a public storm, with the Command Module being christened "Charlie Brown" and the Lunar Module "Snoopy" after characters in the "Peanuts" comic strip. Actually, this was thought to be an inspired choice, as NASA used Snoopy to emphasise quality control throughout the Apollo program. The trip to the Moon was uneventful apart from the debut of a colour television camera to send shots of the Earth and the spacecraft back home. Once in lunar orbit, the two spacecraft separated and Snoopy descended to within nine miles of the surface. During this time, Stafford and Cernan made observations of the July landing site as well as several geological observations. After jettisoning the descent engine for the journey back to Charlie Brown, trouble stuck. Snoopy went gyrating out of control and only after several hairy minutes, was brought under control. The gyrations were thought to have been caused by a switch left in the wrong position. Once the crew's mission around the Moon ended, they proceeded back to Earth and on the way home carried out the important Sierra Hotel Alpha Victor Echo experiment, or, in other words, demonstrated that it is possible to shave in zero gravity! Apollo Ten splashed down in the Pacific Ocean, secure in the knowledge that it had cleared the way for the first lunar landing.

By the time of Apollo Eleven in July 1969, America was a changed country. The Vietnam War was sucking away millions of dollars and countless lives. Dissent had become commonplace with sometimes violent demonstrations a regular occurrence. Turmoil in ghettoes and political assassinations had made America in the late sixties an unpleasant place to be. Richard Nixon, who was now President, was hoping that the Apollo Eleven mission would take the country's attention from its domestic turmoil to space and, in the bargain, give him some political glory at John Kennedy's expense.

The crew for the Apollo Eleven mission had been named in January, 1969. Commanding the crew was Neil Armstrong who had previously flown on Gemini Eight; the Command Module Pilot was Mike Collins who had been "bumped" from the Apollo Eight crew due to surgery. The Lunar Module Pilot was Buzz Aldrin a Gemini veteran with experience in rendezvous and spacewalking activities. At first, it was assumed that Aldrin would step on the Moon first, but for reasons never explained it was announced that Armstrong would be the first man to step on the Moon.

Leading up to the launch of Apollo Eleven, some one million people travelled to Florida and on the morning of 16 July, 1969, man headed to the Moon. The journey was

uneventful and the crew concentrated mainly on "housekeeping" and television shows back to Earth. One problem was that the Soviets had sent a probe to the moon and it was unclear whether it was trying to steal Apollo's thunder and return a sample to Earth. There were worries that the probe could get in the path of Apollo and disturb its mission, but those fears were allayed when the probe crashed into the lunar surface.

On the 20th July, the Lunar Module "Eagle" separated from the Command Module "Columbia" and began its descent to the landing site in the Sea of Tranquility. All was going well until an alarm sounded. According to Mission Control, the landing computer had overloaded and was posing a threat to landing. Flight Controller Steve Bales told the crew to ignore it and it was at this time that Armstrong took manual control and landed the Eagle safely on the surface.

Several seconds after landing, Armstrong radioed back the first words from the Moon: "Houston, Tranquility Base here, the Eagle has landed". Once systems checks had been carried out, Mission Control gave the order for Armstrong and Aldrin to stay on the Moon, and prepare for the lunar walking activities.

Back on Earth, the news that Apollo Eleven had touched down created a storm of excitement the world over. My fondest memory of the day is that we were given the day off school to go home and watch the activities on television, and I'm not sure what delighted that six year old more, the day off school or the Moon Landing! The coverage by the media was extensive and only four countries did not see or know of the landing – Red China, North Vietnam, Albania and North Korea. The only person who didn't see the television coverage was Command Module Pilot Mike Collins orbiting alone above the lunar surface.

At Tranquility Base, Armstrong and Aldrin decided to forego their scheduled sleep period and immediately embarked on preparations for the moonwalk. After having a brief meal and suiting up, Armstrong left Eagle. As he descended down the ladder to the surface, he stopped briefly to turn on the television camera and once that was completed Neil Armstrong stepped down onto the lunar surface with the words "That's one small step for man, one giant leap for mankind". Armstrong then went on to describe the surface as fine and powdery and easy to kick about; after that he took several photographs and collected a contingency sample in case there was to be an emergency liftoff. Some fifteen minutes later, Aldrin stepped onto the surface to start the scientific experiments and ceremonial duties such as raising the American flag and receiving a somewhat maudlin telephone call of congratulations from President Richard Nixon. The scientific experiments included setting up a seismic measuring device which would record movement under the lunar surface, a laser reflector which would at a later date be used to measure the exact distance from the Earth to the Moon and a solar wind collector which was set up and which, once the moonwalk was completed, would be rolled up and brought back to Earth for analysis. After nearly two hours on the surface, Aldrin returned to the LM and helped put the boxes inside and the two men removed all the expendable rubbish by throwing it outside. Also thrown outside was the Apollo One patch and medals in honour

The plaque which the Apollo II astronauts left behind on the Moon in commemoration of the historic event.

of dead Soviet cosmonauts Gagarin and Komarov.

Eagle lifted off from the Moon nearly twenty hours after it first landed. Following the successful rendezvous with Columbia, Eagle was, on purpose, crashed into the lunar surface, to determine what would happen on the seismic measuring unit. The crash was recorded and in the words of one geologist the Moon "rang like a bell" for several hours after the crash.

The journey home from the Moon was uneventful but the splashdown was another story. Fearful that the astronauts may have been contaminated by Moon organisms, a three week quarantine was in force from the time Armstrong and Aldrin stepped off the Moon, and the unfortunate Collins had to be quarantined too. The astronauts splashed down safely, and were flown to a mobile quarantine facility on the aircraft carrier Hornet where they were greeted by President Nixon, (who, in coming weeks, would show what his opinions of NASA's programs meant).

With the successful conclusion of Apollo Eleven, there was a massive turn away from the space program by Congress, the White House and some sections of the media, who questioned the expenditure and lack of scientific input to the Apollo program. The severest cut came from the White House which ordered the cancellation of the Saturn Five production lines, three Apollo landing missions and a scaled back space station which would eventually become "Skylab".

After Apollo Eleven, there were another six flights to the Moon, with only one, Apollo Thirteen, not landing on the Moon. As the missions progressed, more ambitious landing sites were used and in the last three missions (Apollo 15, 16 and 17) a Lunar Rover was used to cover distances of up to five miles from the Lunar Module.

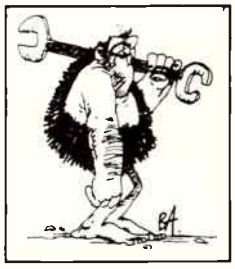
One of the more interesting aspects of the Apollo astronauts was the fact that only one scientist was assigned to a flight and eventually landed on the Moon. There was a large controversy from the scientific community that the astronauts sent to the Moon were test pilots with only a smattering of scientific training. It was only on the last Apollo mission (17) that an actual geologist was able to land on the Moon and make professional and correct judgements on the lunar surface. Until that time scientists had to literally "babysit" astronauts on the Moon, therefore reducing the time that could be spent in scientific investigations.

Looking back at the Apollo landings some twenty years later, it can be said that, if anything, the Apollo Program was a technological miracle. In less than nine years NASA progressed from suborbital flights to a manned Moon landing and by meeting President Kennedy's deadline showed that if the nation was willing to work on a started goal, that goal could be achieved.

This talk of having a space goal is still relevant today, as the United States space program is in desperate need of a substantial goal in space. It has been advised that the United States should not embark on a crash program like Apollo, but take it slowly and eventually build up to a large and long term space program. In her report "Leadership and America's Future in Space", Dr Sally Ride suggests that what is needed is an Apollo-type goal but that it should be taken slowly and given consideration as to what the next goal will be – a return to the Moon or a manned landing on Mars.

The Challenger tragedy in early 1986 showed both NASA and political leaders that the average American citizen is interested in space, but needs to be encouraged to support it – whether by a crash program or even just a high profile shuttle program, which encourages participation from the "ordinary" citizen. It is interesting to note that it took a disaster to give back the support to NASA that it had in Apollo days.

The last important lesson that was learned by Apollo was that we became more aware of our home planet and its uniqueness. The first image sent back by the Apollo Eight at Christmas, 1968, was a blue and brown oasis surrounded by the black of space. Earth is the only planet of its kind and mankind should make an effort to look after it. eti



TECHNOLOGY

THE INSIDIOUS SPIKE

Spikes and surges on data lines can play havoc with electronic data communications, ranging from computer networks to factory control systems — even electronic funds transfers. How do surges arise and how are they dealt with? By Paul Ripamonti.

Heat lightning, barely perceived by the operating personnel at a large chemical plant that sprawls over thousands of acres, wipes out over one hundred current transmitters used to furnish process control data to a central computer. The plant is down for five days. A funds transfer computer, from time to time, transfers dollar amounts that appear unrelated to instruction. The common villain? Transients – surges – spikes – call them what you like: chunks of electrogmagnetic energy; unwanted, usually unexpected, and all too often unprepared for!

A single surge can easily finish off an IC or a microprocessor, crippling an electronic or computer system. Or a series of surges can gradually degrade a device, giving rise to intermittent or unreliable operation, long before catastrophic failure.

Sources of surges

Surges result from the redistribution of electromagnetic energy. Such redistributions occur, for example, due to lightning discharges and switching of inductive loads, such as motors and transformers, on the electricity supply mains.

They also include the spark that leads from your fingertip on a dry, or not so dry, day – termed ESP or electrostatic discharge. Also included is NEMP, the acronym for Nuclear Electromagnetic Pulse. It is the super steep wavefront disturbance that results from a high altitude nuclear explosion.

Energy levels for all surge sources range from trivial to those of a direct lightning strike, which is, for most practical purposes, impossible to protect against. Fortunately, most surges result in circuit energy levels which lie in the mid-range, for which protective designs can be both reasonable and effective.

Most people think that for lightning to cause trouble, it has to strike something. Not so. All that is needed is a flash between two clouds and there is plenty of trouble for modern electronic purposes.

Why? Because the sudden change in electric field that occurs during a cloud-to-cloud discharge can typically be 40 to 50 volts per metre, one to two kilometres away from the flash. That massive redistribution of electric charge can induce a surge of say 40,000 volts on only a 1000 metre length of cable – which may be the very cable to which your equipment is connected.

Fortunately, most of the punch never reaches the ICs deep within a computer. There are several lines of defence between the energy source and its tender electronic target, including purposely selected surge protection.

The first level of surge protection, however, we usually get for free. It's there simply as a result of the "flashover" of wiring and connectors interposed between the surge and its possible victim. The flashover is normally about 6 kV and this is why surge tests use something like this figure as an upper limit.

This is a key issue in understanding the character and strength of surge waves actually reaching electronic circuits and systems.

Unlike lightning, switching transients are man-made. They result from the rapid release of energy stored as current flowing in inductors. These include air conditioning, refrigerators, the electric motors that provide the muscle in computer peripherals, fluorescent lights and the endless array of other electro-mechanical devices in factory, office and home for our modern technological society. Some of these devices can hit the ac line with a surge of tens of thousands of volts. A typical surge wave is shown in Figure 1.

The ac lines can transmit their spikes to data lines. The picture that emerges is of a high peak voltage operating through a high series impedance. The combination functions as a current source.

Transients, surges or spikes, although generated from a number of different sources, have common characteristics. These can be identified by the three parameters – amplitude, waveshape and frequency of occurrence.

However, the surges your computer must survive are a function not so much of the surge sources themselves, but of the characteristics of the networks to which the computer is connected. Certain surges, such as the already mentioned ESD, do generate signals that are more source dependent than load dependent.

Not surprisingly, then, surge signals found on computer data lines are all vastly different in character, even though the surge source may be identical. But let's look at what we are protecting.

Weak links in the chain

Data terminals and computer mainframes are failing, with increasing frequency from lightning-caused transient voltages (as well as from other sources) on communication lines. This is directly related to a higher degree of IC miniaturisation and increasing use of longer data lines. Even when acceptable shielding practices and grounding procedures are employed failures still occur.

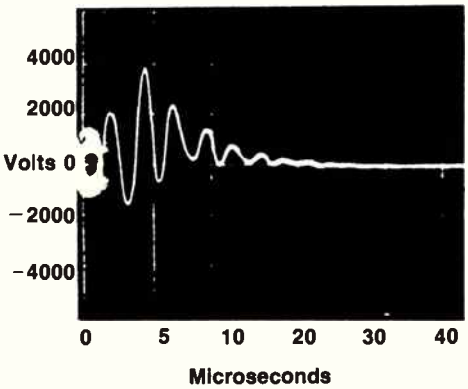


Figure 1. Typical surge signal or wave.

A successful method of suppressing transient voltages on datalines has been developed by PHR Computer Switching Pty Ltd. They are made in Australia and called Dataline Surge Suppressors.

The factors that make up the expected transients, surges and spikes along internal data lines were examined. The shortfalls of existing products were checked.

Efficiency in mechanical layout, economy, and, most importantly, effectiveness were finally thrown into the design arena. The result was a dual function product suitable for the protection of computer peripheral equipment via the data lines using RS232 format. (Other applications available on request).

Actual field trial results have shown the product to be reliable and, in some cases, able to enhance performance.

This product (patent applied for) is the only one approved by leading computer manufacturers. They are currently available from Digital Equipment Corporation, NCR Australia, and Honeywell Bull.

Further information is available from the manufacturer, PHR Computer Switching Pty Ltd on ☎ (02) 654-1737. Their motto is: "Every peripheral should have one."

TABLE 1
Minimum Failure Thresholds of CMOS and TTL

Device Type	Pulse Width					
	20μsec	2μsec	1μsec	0.2μsec	0.1μsec	.025μsec
55107	22V	16V		22V		
55109	326V	38V		60V		
5404			30V		50V	120V
54L30			20V		50V	90V

The increasing complexity of IC chips has dictated that each component on that chip be smaller with the result that the failure threshold is also quite low. Most ICs fail at transient energies below 100 microjoules. Failure threshold voltage levels of those devices have been reported by Van Keuren and are shown in Table 1.

The bipolar structured devices used for line drivers and receivers have been observed to fail at levels between 40 V and 100 V from lightning transients, with the drivers being generally less susceptible than the receivers. Factors relating to failure, in addition to device type, can include manufacture and lot.

A microphotograph of the failed area of a type SN1488 RS232 line driver is shown in Figure 2. The output resistor failed short and melted through to the metallised overlays. The failure area of type SN1489 RS232 line receiver is shown in Figure 3. Arc traces across the input resistor and its contacts can be seen as thin white lines. This device type must operate at levels of up to 25 V on computer equipment. However, it can fail at a level of only 40 V, which is readily produced from transient surges.

MOS and small area geometry semiconductors are particularly vulnerable to the effects of transient voltages. The work reported by Van Keuren illustrates how fragile CMOS and TTL devices can be. ESD failures of MOS microcircuits have been measured by Gallace and Pugol. Comparisons among several suppliers indicate that failure levels can be a function of manufacturing technique.

Protection

And now the tricky part. How do we protect these ever more sensitive ICs from the barrage of destructive surges coming down data/signal lines? Well, a number of protection devices have been developed to dissipate the energy in a surge, preventing it damaging devices beyond it. Surge suppression devices or protectors are highly non-linear. Some even exhibit negative resistance characteristics. Using them in conjunction with even a few linear components means that sometimes their performance is actually counter-intuitive. That is, they do the opposite of what you think they will.

Systems requiring surge protectors are often complex, with numerous input and output lines carrying protection. Surge protection design requires a firm understanding of ground systems, one of the most sophisticated engineering areas in electronic systems.

There are two basic types of protector: clamps and crowbars. Clamps simply impose a voltage limit. Crowbar devices exhibit steep negative resistance characteristics that result in them clamping transient voltages well below the "striking" potential of the device. Gas discharge tubes and metal-oxide varistors (MOVs) are examples of crowbar protection devices. Silicon transient voltage suppressors are an example of the clamp-type. They are rather like zener diodes.

The current-handling distinction between clamps and crowbars leads to important circuit design implications. Crowbars cope with extremly high surge currents, while clamps are generally less well-equipped to deal with them. But crowbars reflect a higher percentage of energy back into the circuit, while for a given surge current, clamps dissipate more energy on the spot.

Now, considering the chances of a direct lightning hit on an internal data line as very low, it is safe to assume that almost all transients and surges appearing at the peripheral port will have the cable as part of a high impedance source.

Comparisons

The designs of most surge suppressors available today have used this fact and incorporate either MOVs or silicon transient voltages suppressors. Let us now look at the suitability of these two completely different

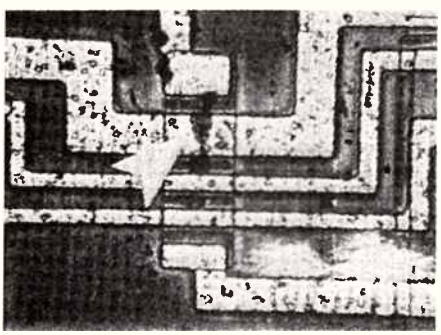


Figure 2. Failed SN1488 line driver.

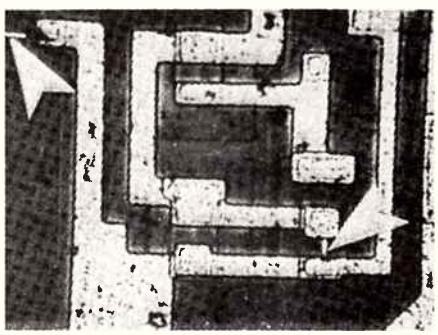


Figure 3. Failed SN1489 line receiver.

The insidious spike

components for use in dataline surge protectors.

Silicon PN junction transient voltage suppressors (STVSs) are characterised by their phenomenal surge handling capabilities, extremely fast response time and low series resistance. Unlike the zener diode, whose function is voltage regulation, the STVS is designed, manufactured, specified and tested for transient suppression.

Metal oxide varistors (MOVs), originally developed by Matsushita Electric, are normally classified as a non-linear resistor or a voltage dependent resistor. A MOV cannot be directly cross-referenced to an STVS even though the purpose and function of both are similar. They can in some applications be placed in the same points for electronic circuit protection, but each product is specified differently.

The MOV is a low-priced component capable of withstanding high current peaks of very short duration. It is better suited for the protection of electrical and electro-mechanical equipment against high level transients. That is, transformers, motors and relays, to the exclusion of fragile components.

The STVS is a remarkable clipper. Its excellent reliability ensures a very long service life and is better suited for the protection of electronic circuits which require the correct clamping for protection, ie transistors and ICs.

The clamping voltage is the maximum voltage a suppression device exhibits when subjected to a specific current pulse for a specified time interval. The clamping voltage is probably the single most important electrical characteristic for correct protection. The maximum clamping voltage must be known by the design engineer in order to provide effective protection in any transient environment. The graph below is a plot of the typical clamping voltages of a STVS and MOV for varying current pulses.

As the pulse current is increased, the higher resistance of the MOV becomes quite apparent. Also MOVs have a negative thermal co-efficient while STVS have a positive thermal co-efficient. It is easy to see why data sheets on MOVs do not specify a maximum clamping voltage.

The clamping time is the response time required for the device to react and clamp a voltage pulse to a specified level. The STVS has a theoretical response time of one picosecond. Depending on which MOV data sheet is availble for reference the reference time specified varies anywhere from one to fifty nanoseconds.

There are other characteristics that can be compared but it always comes out the same. It is also interesting to note that the failure mode for STVS is a short circuit which makes it easy to detect if activated beyond its capacity.

It must also be appreciated that surge suppression must take into account that the transients may be conducted common-mode (between all lines and ground), or in differential-mode (between lines).

Even considering all of this, the selection of the correct components, the ground circuitry and the component layout can still render the surge suppressor either totally reliable or useless. eti

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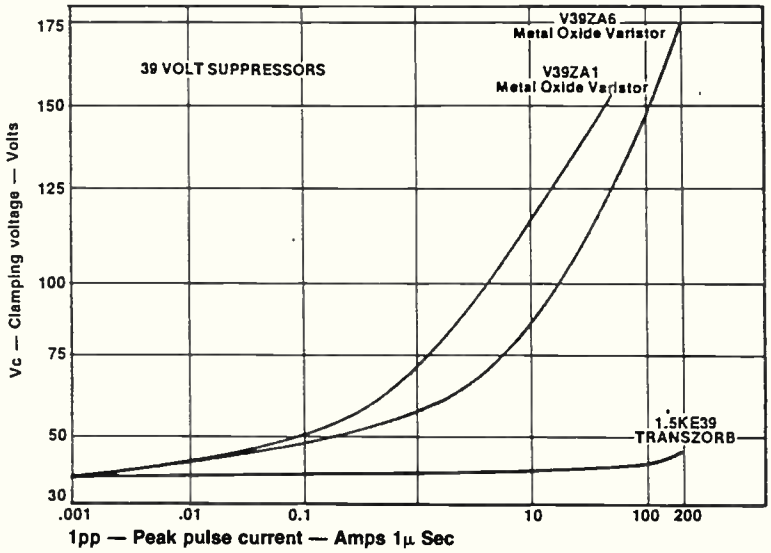
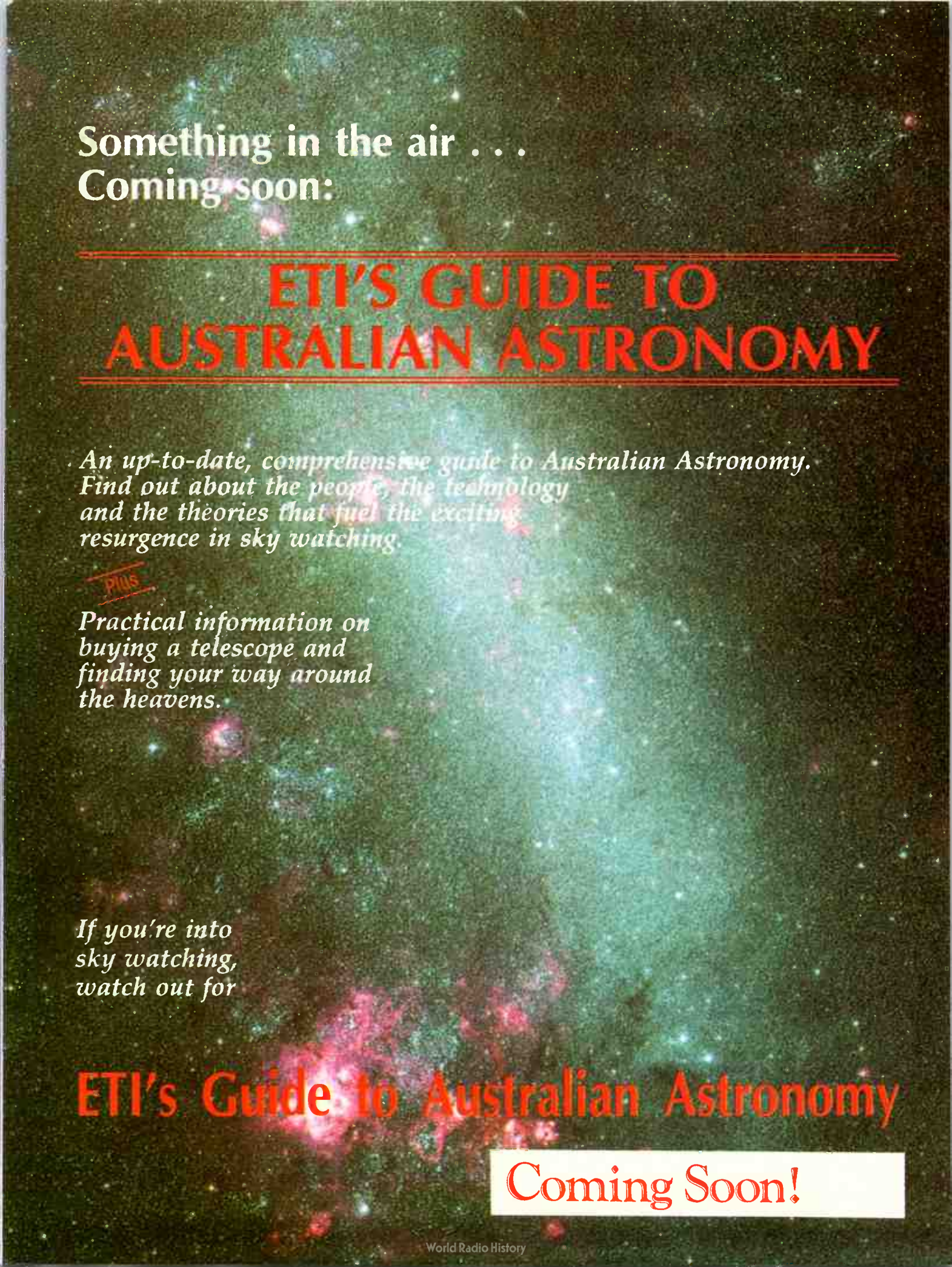


Figure 4. MOV and Transorb characteristics.



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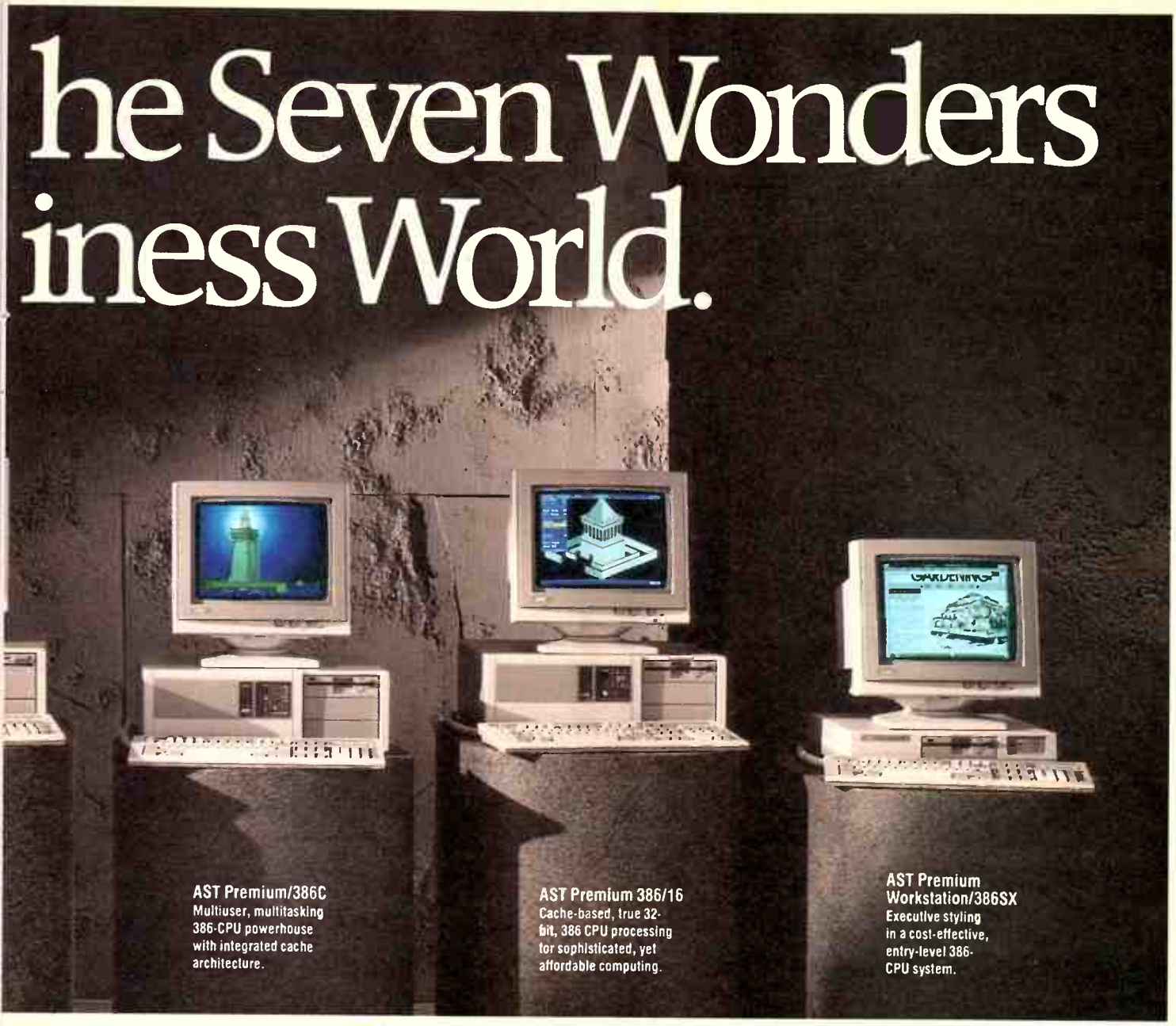

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TECHNOLOGY

David Smith thought that surely he could save some money on a personal computer by taking his holidays in Hong Kong and buying it there . . .

Buying a computer in Hong Kong

A CAUTIONARY TALE

After several years of hard work and never having a decent holiday, I was recommended to read a recent article in a local magazine about going to Hong Kong on a buying spree. The article was full of encouragement on buying a PC and the deals available there certainly sounded too good to be true; so, a trip was organised for a party of eight people departing on different days and flying with different airlines with the aim of meeting in Hong Kong. Each member of the group had the intention of purchasing a personal computer to bring back to Australia, and, as each member had varying requirements, we all went our own way to make a purchase.

Arrival blues

I was fortunate to have included in my travel package a limousine service provided for transport to my hotel on arrival. On arrival, the car was waiting, with the trip to the hotel taking about 20 minutes. I usually stay at Holiday Inns on my world trips and elected to do so this time. As it turned out, this proved itself to be one of the better chains to stay with.

Two of my colleagues arranged transport to their hotels with a local shuttle bus, which took 80 minutes to get organised and then another 90 minutes to get to their hotel, after a trip around Kowloon, stopping at every other hotel to drop off passengers! The other two each caught a taxi, the first taking about 30 hair-raising minutes at a cost of HK$35 (A$6) – very reasonable. The second chap was asked if it was his first trip to HK. He answered yes and accordingly it took 55 minutes to get to the same hotel at a cost of HK$120 (A$20). The driver then demanded a HK$20 tip to take the bags out of the cab and would not unlock the cab door until he was paid!

Don't ever complain about cabbies on Sydney's north shore again.

When travelling around HK there are a number of modes of transport, the best value being the underground railway which charges about HK$5.50 to go to HK Island and to the north of the new territory (Kowloon). From there you can walk to wherever you wish to go.

A word of caution about the underground. In peak traffic hours the local transport authority engages professional pushers to cram as many people, as quickly as possible, onto the trains – by way of a good shove in the back! On more than one occasion I was separated from my loved one by up to two trainloads of passengers! The moral to the story here is, don't go anywhere in the rush hour!

On the plus side is the low cost and the speed of getting from place to place. The ticket issuing is fully computerised and the tickets are reclaimed at the end of your journey. Make sure you have change for the machines.

The second best mode of transportation is to use the local Red Cabs and, as you might expect, it pays to be smart or you will be had for sure. Rule number one is to get the bell captain to write out in Chinese the address of where you wish to go on the back of a hotel card. Keep the card so that, on the return trip, the cab driver can read where to go back to.

Ask the bell captain the approximate cost and check this with the cab driver before departing (one enterprising driver quoted me HK$150 to go uptown to the Golden Building from downtown Kowloon, and, when questioned about the cost, reported that traffic would be very heavy at that time of day. When I complained and asked to stop the cab he tried to charge HK$32.50 to go around the block. I paid his flag fee of HK$6.50 begrudgingly and caught another cab – the cost: $HK20.50).

When it comes to tips, everybody has their hand out and the minimum to even get the time of day is HK$10; and should you be so rash as to ask a stranger, after he gets your $10 he will probably insist you see his cousin and buy an imitation Rolex or Gucci watch for about HK$350 (A$60). This sounds like a good deal, but remember the going price for these objects is about HK$90 for Australians and English and HK$250 for Americans! It appears that the Americans prefer not to waste their time spending three days bartering to find the HK$90 jobs.

Caveat emptor

Some wag once said that this Latin expression, which otherwise translates as "let the buyer beware", means "don't go into a cave unless it's empty"! I guess, when bears and lions roamed the Mediterranean in ancient days, such was good advice. It certainly applies in today's Hong Kong except, for caves, read shops.

In HK there are two types of traders: those who are members of the HK traders' association and display their little red Junk stickers, and those that are not. The publicity says that as a tourist you have protection against rip offs and the association will fight your cause. In practice, all these red Junk traders are concentrated around Nathan Road, the main shopping road and specifically close to the hotels.

The privilege for this protection is about 10%-20% higher prices (30% for Americans) than can be obtained from non-members. As an example, a Sony 330E camcorder will

cost about HK$790O from a Junk store and HK$57OO from a normal (non-member) store, and if you travel to the outskirts, as low as HK$55O for the same item.

When purchasing goods, remember to get a receipt and preferably pay by plastic credit card and keep the receipt for customs. There are two small traps in using plastic: firstly, you will be charged an additional 2.5% for Visa and 5.5% for Amex from the supplier, and, on return to Australia, you will generally get a less than favourable exchange rate than you thought.

Also, when changing Australian travellers' cheques you will have to chase around to get the best exchange rate, (i.e; in Australia at the time of my trip the rate was 6.9HK$ for each A$1. The best I could get in HK was 6.4HK$).

Of the many places to buy computers, the best found for my system (an 80386 tower VGA system) was the Golden Shopping Centre. After two days looking and talking you will find out that the Chinese have never heard of personalised, friendly, helpful service, and if you don't know about computer systems you will be largely HAD.

Service is the exception not the rule. As one trader pointed out, if I didn't like it there would be another 50,000 tourists arriving tomorrow to fill my place.

Traps and technology

Of the traps for players, the most likely one to fall into is in claimed performance speeds. These days, the Chinese claim the speed as being that reported by a benchmark test (usually the landmark speed test) and not the processor clock speed. Preferably, take you own test disk. On a system that reported 80 MHz on the dealer's software I tested at 25 MHz on my test software. Likewise, 33 MHz tested 25 mHz, 25 mHz tested 16 MHz and 16 MHz tested 12 MHz on an 80286 (AT) and 16 MHz tested 10 MHz on an 8088 (XT).

Of the advances in technology, it is now common practice to use voice coil hard disk drives which achieve about 25 ms seek time (take a benchmark like Coretest to check this out) instead of the standard stepper motor types with 65 ms seek time. This offers an improvement in performance of 3:1 on program and data load times. The current price for a 44 Mbytes voice coil drive is HK$35OO. Ensure that the drive is a known model and spares are available in Australia.

The hard disk controller types offered vary considerably and many dealers are shipping XT controllers in systems to reduce the price. The best types are, in the case of AT and 386 product, full 16-bit cards identified by double edge connectors. There are many types available here and selection depends on the type of system it is going into. If it is an AT, a standard interleaved type is best with the interleave set on the optimum performance of the computer. If it is a fast 386 system then a 1:1 interleave type can be used as the processor is fast enough to read in real time the next hard disk sector. Also available are hard disk controller cards with onboard caching of up to 1 Mbyte RAM. These can give superb performance to users of databases, but offer only limited performance improvement to other software.

Processor caching is also starting to become popular with up to 50% improvement in processor execution speeds. BIOS ROM RAM shadowing is also popular, the basis being that most BIOS ROMs are slow 200 ns devices, and as all device I/O (i.e: keyboard, screen, disk) is done with BIOS calls either directly or indirectly, a speed advantage is obtained by copying the BIOS ROM into fast (60 ns) RAM and executing it there.

The number of wait states is also a determining factor in processor performance. If the manufacturer uses slow DRAMs, wait states are introduced for reliable performance; with four wait states set, a reduction of up to 55% of speed will result.

As an additional factor, if the machine is a 386 system, ensure that only planar 32-bit memory boards are used or the memory buss design will again hinder performance.

A part of the processor board performance overlooked is the speed of the I/O buss. If slow cards are used, the buss speed could be as low as 6 MHz, which will slow peripheral transfers significantly over that of a 16 MHz buss. This is particularly important with hard disk and graphics systems where large amounts of data are transferred over this buss.

Try before you fly

Once you have got your system assembled, test it to ensure that what you ordered is what you have. If time permits, assemble it in your hotel room and give it a burn-in test as it is easier to have faults repaired in HK than to have to sort it out in Australia.

For shipping your computer, it is best to use the carton(s) provided and not to place it in suitcases, etc. On this issue, a word of warning! Our party of travellers averaged 30 kg each excess baggage. Those who flew with Qantas and British Airways were either not charged or charged only a nominal amount.

I flew with Cathay Pacific, with a connecting flight with Singapore Airlines to Australia. At HK I was charged HK$24OO excess baggage, supposedly booked all the way to Australia, a point which my wife and I double checked. On transfer in Singapore, Singapore Airlines removed our baggage and refused to issue a boarding pass until a further A$12OO was paid for the excess baggage to Australia again – a total of A$16OO for 7O kg excess baggage.

When I challenged the airline and indicated that I could strap the luggage (a computer and monitor) into a seat in first class for less, the response was less than cordial. My advice is to check before you go as to the policy of the airline regarding excess baggage. As pointed out, the Australian carriers appear to be well in front.

Customs with Customs

On the subject of Customs charges and declaration on re-entry to Australia, it is important to read the freely available Customs guide and declare everything, as the penalties are not worth it.

Typical ruses used when bringing goods back include the issue of false invoices by traders to underestimate the correct value and installing four to six hard disks into a computer and then filling up all the slots with cards and declaring the customs value to be only A$6OO instead of A$45OO. If you get through customs you are lucky. If you get a random inspection and get caught out, then you will suffer the consequences.

What it all cost

My system was a 25 MHz (real) 80386 system with coprocessor, 2 Mbyte of RAM, a 1.2M floppy, a 1.44M floppy, a VGA card and monitor with a 7OM voice coil hard disk. The cost? A$457O, plus 5.5% for putting it on my Amex – $252, plus freight – $16OO, plus duty and sales tax on arrival – $1446; a total of $7868.

The cost of a similar unit by chasing around in Australia? $557O – $23OO less, not including the cost of the holiday and extras for two people with accommodation at A$15O/day – $89OO.

My advice to all is to stay in Australia for your holiday and support your local dealer. He will do a lot more for you and your money.

eti

STUART CORNER

Transputers for communications terminals

THE use of transputers, the UK-developed parallel processing chips, could lead to the development of hand-held units which will provide both two way communications and precise postiion fixing anywhere on the globe.

Under a $US250,000 contract from Inmarsat, Inmos, the UK company which developed the transputer, will conduct a feasibility study. The study will investigate the possibilities of integrating Inmarsat's Standard C communications terminal with technology for position fixing based on two different satellite navigation systems: the US Global Positioning System (GPS) and the USSR's GLONAS system.

Phase 1 of the study will investigate the possible integration of Standard C facilities with GPS. Phase 2 will perform a similar evaluation for Standard C with GLONAS. The optional third phase will be to build a demonstration Standard C/GPS prototype.

Standard C terminals are briefcase-sized portable units with a dinner-plate-sized satellite antenna. They provide two way text messaging services over most points on the globe and are due to become commercially available this year. Inmarsat has already let the first contract for Standard C terminal manufacture to Danish electronics company, Thrane & Thrane. Australia's signatory to Inmarsat, OTC Ltd, says it plans to offer Standard C services from next year.

Standard C is expected to find wide use with long distance trucking companies, allowing truck drivers to be in constant touch with headquarters to relay schedules and to pick up details of consignments en route.

Inmos' applications engineering manager, Philip Mattos, claims the transputer is ideally suited to this type of embedded signal processing application. It will be able to replace several cards of hardware and custom ships used in conventional GPS receivers.

The Inmarsat system has its rivals, however. A US based company, Geostar Corporation, of Washington DC, claims it is planning to offer two way messaging and position fixing to within about 10 metres, from pocket-sized terminals with postage stamp-sized antennas. The service will not be fully operational until Geostar launches its own satellites in 1991-92. The company says it is also planning to include speech synthesised voice transmission capability into future applications.

Voice mail becomes video mail

VOICEMAIL systems allow voice messages to be stored in a central computer to be retrieved by the recipient at a later time, or automatically delivered by having the central computer telephone a predetermined number to relay the message. Now the technology has been adapted to include similar store and forward facilities for images.

The key to this facility is a video unit which attaches to an ordinary telephone line. It converts a still black and white image from the camera into sound signals which can be sent over the phone line. When these signals are fed to a similar unit at the other end of the line, they are converted back to an image and displayed on the screen as a still black and white picture. Resolution is not as good as normal video. The whole process takes about 5 seconds.

Sydney-based voicemail bureau operator, Connect International, is offering an image store and forward service using the Mitsubishi Visitel terminal which costs less than $1000. As well as providing a two way transfer of pictures, the company sees the technology as a good way to deliver video and voice information services. For example, the terminals could be located in hotel foyers to provide tourist information.

They could also be menu driven with the options being selected by the dial from the telephone. Voice cannot be transmitted at the same time as the image is being sent, but the company says this could be overcome by using two phone lines and two voicemail boxes simultaneously; one for voice and one for image.

25,000 telephone calls on a single link

BRITISH Telecom claims to have set a record in optical fibre transmission systems by carrying 25,000 telephone conversations simultaneously over a single pair of optical fibres. The demonstration was carried out not in a laboratory, but over a fully operational cable which links the UK mainland with the Isle of Man. This cable runs for 94 kilometres without repeaters and is believed to be the longest unrepeatered in-service fibre optic cable in the world. The Tasman 2 cable, which will come into service between Australia and New Zealand in 1991, will have repeaters every 100 kilometres. It is expected to carry 10,000 conversations per fibre pair.

BT's record has been achieved using frequency division multiplexing. In a conventional optical fibre cable, a laser light source with a very precise wavelength is used (1550 nanometres in the case of Tasman 2). This light source is switched on and off many millions of times per second to transmit data at the rate of several hundred megabits per second. In the BT trial several light signals of different wavelengths were transmitted over the fibre simultaneously.

Telephone radios are shocking

THE Australian Post and Telecommunications Union says that unauthorised telephone equipment could result in its members receiving fatal electric shocks. The problem stems from cheaply manufactured equipment, mainly telephones combined with radios, not approved by Telecom to be connected to its network. It is illegal to connect such equipment to a telephone line, but it is nevertheless legally imported and sold in Australia.

Faults in such equipment can cause the mains voltage to be fed into the telephone line, especially if the equipment has been designed for the US (which uses 110V mains), and has not been properly modified to operate safely at the higher voltages used in Australia.

Telecom says there have been instances where equipment in exchanges has been damaged, but reports no injuries to staff so far. However, linesmen working with exposed cables in holes in the ground would be at considerable risk from mains voltages.

Telecom says it has tried to get the government to restrict imports of such equipment, but without success. Since July this year,

responsibility for authorisation of equipment for connection to the Telecom network has gone to a new, independent regulatory body, Austel.

Huge demand for new networks

INDUSTRY and users are moving rapidly to exploit the high capacity of the emerging Fibre Distributed Data Interface standard (FDDI). FDDI is designed for computer to computer communications in local area network situations. It provides a capacity of 100 megabits per second over distances of up to 100 kilometres using a fibre optic ring. Two contra-rotating rings can double this capacity.

There were reported to be only 24 FDDI nodes operating in the US last year; this number is predicted to rise to 30,000 by 1993.

A US company, Simplenet Systems Inc, claims to have the first commercially available FDDI network for personal computers. The plug-in boards are compatible with IBM PC/AT systems. The company has reported high demand for the product. However, according to reports from the US, the costs of FDDI networks are too high for most organisations. They are resorting to installing FDDI backbones to link low speed-conventional local area networks rather than a complete FDDI system.

FDDI is particularly needed in the computer graphics area. Applications such as computer aided design and drafting generate enormous amounts of data and conventional local area networks operating at 10 megabits per second are not fast enough. Three of the major CAD workstation manufacturers: Prime Computer Inc, Apollo, and Sun Microsystems recently demonstrated interworking of their equipment over FDDI using an FDDI chip set developed by Advanced Micro Devices Inc of Sunnyvale, California. The same chip set is used in Simplenet's PC FDDI LAN.

Another US company, Fibrecom Inc, was recently awarded a contract to design FDDI networks for NASA's planned space station, Freedom. The company is subcontracted to IBM, which has overall responsibility for the station's data management systems under contract from the builder, McDonnell Douglas.

The FDDI standard is still under development. It is the responsibility of the US X3T9.5 Accredited Standards Committee and is reported to be about 75 percent complete. Existing products should be upgradable to the final standard, according to US commentators.

Cheap and getting cheaper

THE Overseas Telecommunications Commission (OTC) says it expects to lower its charges for international telephone calls later in the year. This was revealed in a submission by OTC to the Prices Surveillance Authority in January.

The PSA was ordered by the treasury to hold a public enquiry into OTC's pricing for international telephone calls after the debacle in December when OTC was found to have awarded pay rises in excess of those agreed in the Accord.

Treasury was concerned that these excessive rights might be reflected in increased charges for international telephone calls. According to OTC's submission this would be unlikely. OTC claimed that the total cost of providing the international telephone service was currently $815m per year. Of this, OTC said, 53% went to overseas carriers for calls made from Australia, 29% went to Telecom for the domestic portion of international phone calls. Only 5% of the total went on staff costs.

OTC predicted that its 1988/89 financial year, which ended on March 31, would be a record in revenue and profits. This was due to favourable foreign exchange rates, an increase in telephone traffic and a decrease in the corporate tax rate to 39%. OTC hoped to be able to announce tariff reductions in time for the inauguration of the new independent regulatory body Austel on July 1.

Comparisons of international telephone charges between different countries is a complex task. The Organisation for Economic Co-operation and Development (OECD) attempted to make comparisons using a common methodology in a paper published in September 1988.

According to the OECD, Australia came out very favourably. The OECD methodology calculated the average cost of international phone usage for all 24 OECD nations and compared this with costs in individual member nations. Australian costs rated 64.07% of average for business users and 66.78% of average for domestic callers. All other nations except Japan and the USA were in excess of 90% of average. Japan rated 89.71 and 80.32% of average for business and domestic calls respectively and the USA 68.40% and 61.95%.

There were few objections to OTC's prices made to the enquiry. The Australian Telecommunications Users Group (ATUG) reported that it had sought input from member organisations which were significant users of the international telephone service but few had responded. Those which did considered prices reasonable.

Second generation cordless phone

AT some time in the not too distant future it may be possible to carry a single, portable telephone handset which will serve as a cordless telephone in the home, a pager, a telephone to make calls from shopping complexes and airports, and a portable extension for the office PABX.

The distinction between mobile telephones, those which are designed to operate over a wide area and link into public telephone networks by radio, and cordless telephones, those which you use in the home and which operate only into your own personal radio base station, is becoming blurred.

A new generation of cordless/mobile telephones, known generically as CT2, is being introduced in Europe, and now in Australia, to provide communications for people on the move in limited areas such as shopping and industrial complexes and airports. In the UK, British Telecom is operating such a service under the name Phonepoint.

The subscriber has a small portable telephone handset which allows him or her to make but not receive calls within a few hundred metres of a base station. The phone could be used with a pager so that two-way contact is possible.

These base stations will be installed by British Telecom in large public complexes such as shopping centres and airports. Phonepoint telephones use much less power than mobile telephones and so are smaller and lighter. They are being touted by manufacturers as a low-cost alternative to mobile telephones and a vandal-proof alternative to payphones. If the various industry functions can reach agreement on standards, the one handset will service as the subscriber's access to a public CT2 base station, an office PABX and his own domestic telephone line in the same way as today's cordless telephone.

In Australia, Telelcom has yet to make a decision on whether to operate a public Phonepoint type of service, but one organisation has stolen a march on the public operator. Qantek, the recently formed information technology arm of Qantas Airways, is planning to install British Telecom's technology in major airports to keep head office staff in contact as they move around the country's airports. eti

Stuart Corner is a former editor of C in C News, and a regular writer on computers and communications.

ROGER HARRISON

ANSWERS & ARGUMENTS

This column is intended as a forum for exchange between you, the readers, and the magazine. Via this column I'll answer queries on projects, general questions on electronics and related subjects that may puzzle or concern you, engage in a little argument on topics of interest, or discuss subjects you might like raised. It's up to you! Short letters will be appreciated, long ones may be edited; if asking questions, confine your letter to one or two topics please. Send your letters to: Locked Bag 888, Rozelle, NSW 2039.

Project costs

What happened to the 'cost' at the end of the project Parts Lists?

P.P.,
Moe, Vic.

It's back. Next question!

Shed light on DSP?

Keep up the good work. How about a project or article on DSP (digital signal processing) chips and analogue processing. What about an updated lighting dimmer control desk?

S.E.,
North Haven, S.A.

Well, we might just be able to do something about digital signal processing and analogue processing. I've recently been discussing those very topics with a well-known semiconductor importer and we're looking at bringing you not only the odd article, but the odd practical project to back it all up. Keep reading!

A lighting dimmer control desk, eh? Got any suggestions on the sort of features and functions you'd like to see? Has anyone else?

Beginners' series—1

I find your magazine has a good mix of electronics for hobbyists, mixed with lists of new products and programs for computers. However, I would like to see a section for beginners, giving tutorials on digital electronics and analogue circuits.

P.P.
Gordonvale, Qld.

OK, so turn to Jack Middlehurst's "Building Blocks of Electronics" series, Part 1, elsewhere in this issue. Alright, so it doesn't cover digital, but first things first. A practical series on basic digital electronics we might be able to provide somewhat further down the track.

Beginners' series—2

Well, I think ETI's a great publication, especially the project building section plus instruments and programs and circuits.

What I would like to see again, though, is a run through of basic electronics for the beginner, even though we have the ORCAD/PCB software.

You have probably already done it, except I was not one of your readers then.

H.Z.,
Sydney University,
Department of Pharmacology,
Sydney, NSW.

See the previous letter!

Modem query

On page 75 of May (the Turbo Modem project) are the components on the Phylon module that are indicated as RAM really ROM? I believe that 27C64's are CMOS ROMs.

This may be confirmed by the fact that each component has written on it, Program volts = 12.5 V (look closely at the photo on page 79).

A.F.,
Florey, ACT.

You're quite right. My mistake. How could you misspell ROM? Believe me, it's simpler than you think!

More valves, please!

I enjoyed the May issue's article on valves, but how about taking it a step further and giving the valve lovers some technical information on valve amplifiers and the reasons why all the major musical amplifier manufacturers are still using valves – especially for guitar and bass amplifiers, in preference to solid state?

Also, a list of suppliers of valve-related components would be handy.

I notice that hi-fi manufacturer Luxman lists a valve preamp and power amplifier in its catalogue. Why, if they are supposedly outmoded?

N.W.,
Cooran, Qld.

Good grief! You see, there's actually a world-wide conspiracy among the capitalist ruling classes of the bourgeois western industrialist nations to suppress this superior technology and prevent the right-acting workers of the socialist world from rising out of the shackles of their imperialist past.

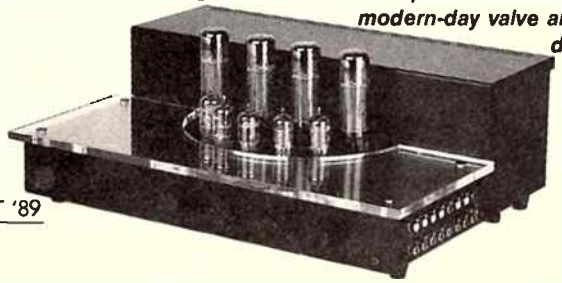
And that's probably as good an explanation as any.

A number of manufacturers don't think valve amplifiers are outmoded. There are British and American firms (even Japanese) creating new valve amplifier designs as I write and modern-day valve amplifiers are available on the shelves of some specialist local hi-fi dealers in Australia. But this isn't the place for a survey.

There are many reasons for the ascendancy of solid-state circuitry over vacuum tube technology – lower power consumption, size, manufacturing cost, increasing circuit complexity – the list goes on. But, that's not to say that valves are inappropriate in some applications.

Very soon, through the pages of ETI, you will be able to judge for yourself whether vacuum tube technology is superior or inferior, or merely more appropriate, better suited if you like, in given audio applications. We have an article in-hand and valve projects in support. But, be warned! You'll have to be resourceful in finding the required components because that capitalist conspiracy has ensured that the parts will be in scarce supply. And scarcity of supply in the capitalist world means higher cost. Marx wuz right!

Thus endeth the lesson for today (thank you, comrade Keating).



Audio Innovation's Series 500 25 watt/channel integrated amplifier — one of many modern-day valve amplifier designs.

BUILDING BLOCKS OF ELECTRONICS

Despite the advent of throw-away ghetto blasters and the difficulty of getting good service information, there are still many enthusiastic electronics hobbyists who want to understand circuits and, if possible, fix them, rather than simply be conspicuous consumers. Many readers like to build their own equipment anyway, as evidenced by the demand for the construction articles in this magazine. In addition, there is a growing group of people interested in valve-based circuits and many of these are being resurrected with loving care.

This series of articles, by Jack Middlehurst, is designed to describe the various analogue (i.e: non-digital) circuit blocks that you are likely to find in both modern and ancient electronic equipment. The main properties and the operations of each block will be discussed, emphasis being placed on predicting dc and signal levels. For many of the blocks, tables will be given of typical dc levels at various critical points in the circuit. This will be followed by simple tests that can be made to establish whether the block is operating satisfactorily.

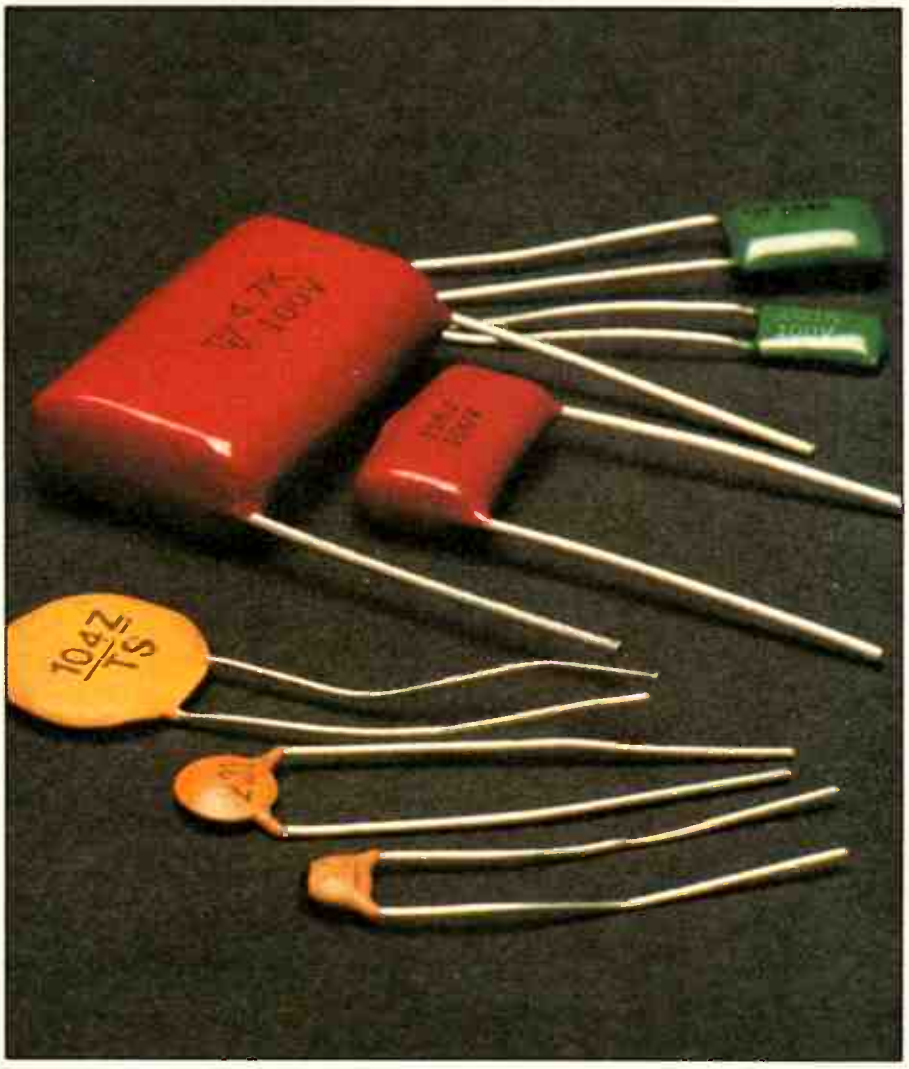
The tests will be based on the *ETI-195 Signal Injector/Tracer* described in this issue. This instrument has been designed so that reasonably accurate measurements can be made, at least at 1 kHz. It will be assumed that everybody has a Signal Injector/Tracer, and also owns a meter for measuring resistance, dc current, and ac and dc voltages. If you have such things as an AF and RF signal generator, an audio voltmeter or a CRO, so much the better.

It is not intended that the series be the complete 'how to design' circuit blocks, nor 'how to become a TV serviceman'. If you want to do either of these, a few years at the appropriate Institute, CAE, or University would be the solution. We will assume that all the designing has already been done. Understanding critical parts of the design is where this series aims to help. To begin, we will start by describing the simplest blocks.

Part 1

The simplest blocks

Every analogue circuit you'll meet will use capacitors and resistors, so let's start there!



A variety of non-polarised fixed capacitors you'll meet.

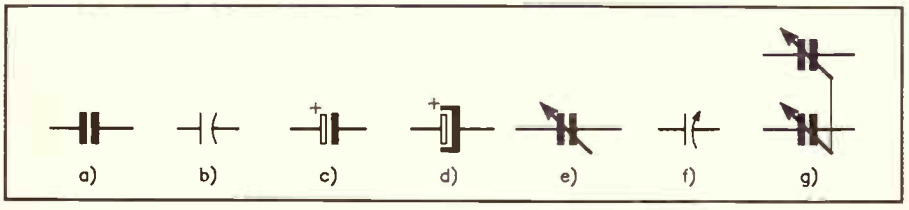


Figure 1.1. Symbols used to represent capacitors. (a) and (b) are the symbols for non-polarised units, (c) and (d) represent polarised types, e.g: electrolytic or tantalum, (e) and (f) are tuning capacitors, and (g) is a ganged tuning type (where several variable capacitors are mechanically coupled, usually on the one shaft).

Capacitors and resistors-radio and electronics would have gone nowhere without them! Figure 1.1 here shows the common symbols used for capacitors. The primary purpose of a capacitor is to pass ac and to prevent dc from flowing. For power supply filtering, large value electrolytic capacitors are used. To be effective they must have a low internal resistance and a low leakage current. Capacitors used for 'bypassing', that is for making the impedance between a particular point and earth as low as possible, have to have a low internal resistance and a low impedance at the frequency of operation.

Electrolytic and various forms of plastic capacitor are used at audio frequencies and polystyrene or ceramic at radio frequencies. Old radios used mica capacitors for radio frequencies and paper capacitors for audio frequencies. Capacitors used simply to pass a signal from one block to the next in a circuit have to have the same properties as a bypass capacitor operating at the same frequency.

Capacitors used for fixed tuning, e.g: those in IF (Intermediate frequency) transformers in superhet radios, have to have low loss at the frequency of operation and have to be stable with time and temperature. Polystyrene and special ceramic capacitors are used for this purpose. Again, older equipment uses mica capacitors. Variable capacitors used for tuning radio receivers have to remain stable when left in one position and must have a smooth variation of capacitance. Most mechanical types use air dielectric although some for use in transistor radios use plastic film dielectric. Often the tuning circuits of modern radios and TVs use matched diodes as the capacitors, the diodes having an anode-to-cathode capacitance that is voltage dependent.

If you think that a capacitor in a circuit may be faulty, there are a couple of tests that can be made before laying out the cash for a replacement. The first thing to do is either remove the capacitor for the circuit, or, if it is a large electrolytic in a valve circuit, for example, remove the leads connected to the capacitor so that it can be tested without the rest of the circuit interfering with the test. Next, measure the dc resistance between the two capacitor connections.

If the capacitor is a polarised type (i.e: has + and/or – marked on it in some way) then

you have to be careful how you use your meter to measure the resistance. If you have an ordinary dc meter, switch to the high resistance range and apply the negative lead of the meter to the positive lead of the capacitor and the positive lead of the meter to the negative capacitor lead. If you have an electronic meter (i.e: a digital voltmeter or a VTVM) then connect the positive lead of the meter to the positive lead of the capacitor and the negative lead of the meter to the negative lead of the capacitor.

With a usable capacitor, the meter should slowly rise to 100k or more, depending on the capacitance value. Capacitors of a few uF should be 1M or more; old, high voltage electrolytics can be as low as 100k and still be usable in valve circuits.

If the capacitor is not polarised, it does not matter which way round you connect the meter leads to it. The resistance should be infinite on ordinary meters and at least 10 M and preferably over 100M on digital meters.

If the capacitor passes the resistance test, the next step is to check its capacitance. If you have a capacitance meter, use it. If not, you can use the ETI-195 Signal Injector/Tracer. Connect up the circuit of Figure 1.2; for polarised types use a 6 V lantern battery or from two to four C cells in series for the battery. AA cells will work for capacitors up to about 10 uF but are useless for 100uF and above because of their high internal resistance. Make sure you have the + on the capacitor connected as shown in the figure.

For non-polarised capacitors, remove the battery and connect the bottom of R directly to earth. In either case use the resistance value shown in the accompanying Table for R. Switch the injector on and set its output to 300mV, measuring this with the signal tracer. Then use the tracer to read the output from the circuit. The capacitance can be calculated from the formula:

$$C = 159/R/\sqrt{((Ein/E)^2 - 1)}$$

where

C is the capacitance in uF
R is the resistance of the load resistor used, in Ohms
Ein is the Input voltage (0.3 in this case)
E is the output voltage

As an example, suppose you use a resistor of 10 ohms and get an output voltage of 0.1 Volts, the capacitance value is

$$159/10/\sqrt{((0.3/0.1)^2 - 1)} = 5.6uF.$$

For capacitors below 1 nF (1000 pF), the input capacitance of the tracer affects the answer, so a simple and sufficiently accurate method is to use a known capacitor of 1 nF with a resistor R of 10k, in which case the output voltage should be about 20 mV. Then put the unknown capacitor in parallel with the 1 nF capacitor and observe the increase in output voltage. If the output voltage rises by 5% to 21 mV, the capacitor is 5% of 1 nF, ie: 50 pF.

None of these measurements is a substitute for a direct measurement on a capacitance meter or an ac bridge, but they give a good indication of whether a capacitor's value has changed by a considerable amount.

Capacitors can develop some obscure faults, such as an increased internal resistance. If you find the capacitor tests OK but still does not work in the circuit, replace it with a new capacitor of the same type and capacitance. If this works, throw the old one away, first cutting off its leads to make sure you don't find it again and use it. If replacement with a new capacitor does not work, it is time to reconsider your diagnosis of the problem.

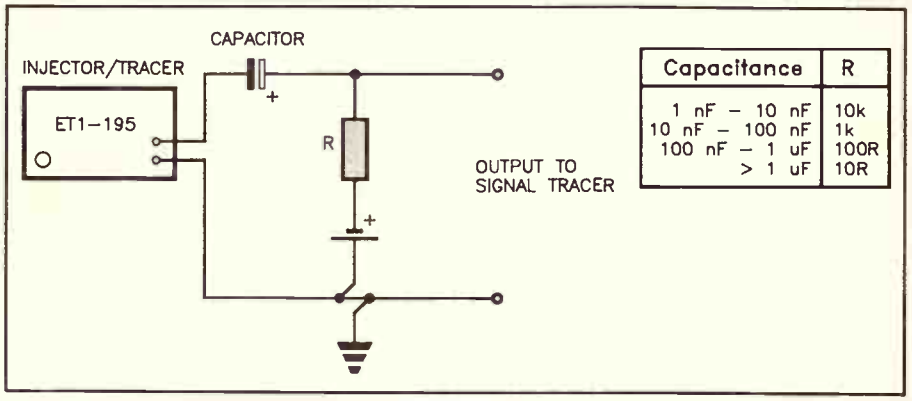
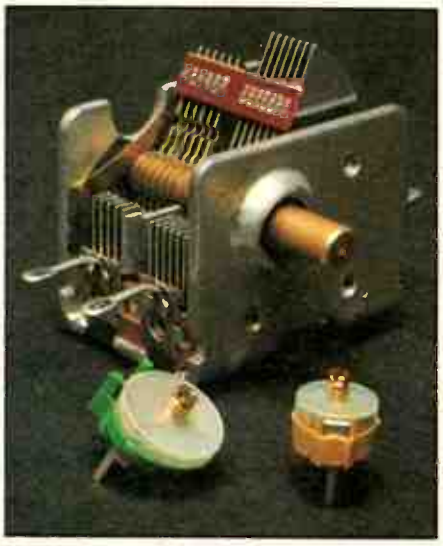


Figure 1.2. Circuit for measuring the capacitance of a capacitor using the ETI-195 injector/tracer.



A "tuning gang" variable capacitor.

Fixed resistors and two-terminal variable resistors

The symbols for fixed resistors are given in Figure 1.3a. Variable resistors that have only two connections are shown in Figure 1.3 b.

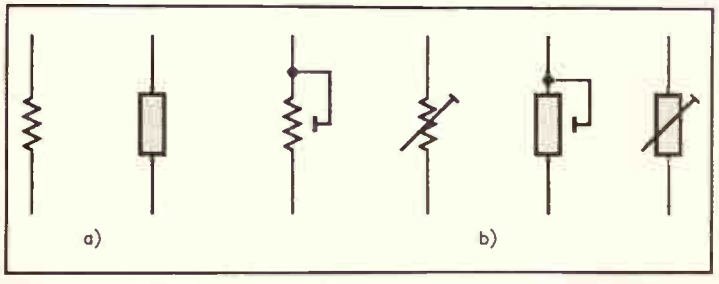


Figure 1.3. Symbols for (a) fixed resistors, and (b) two-terminal variable resistors.

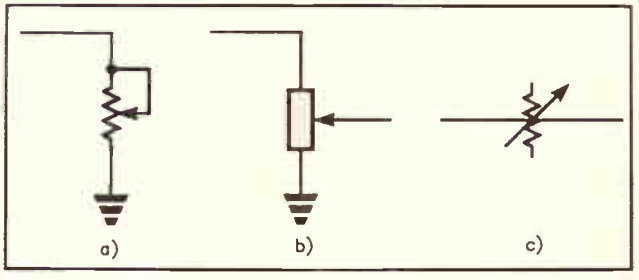
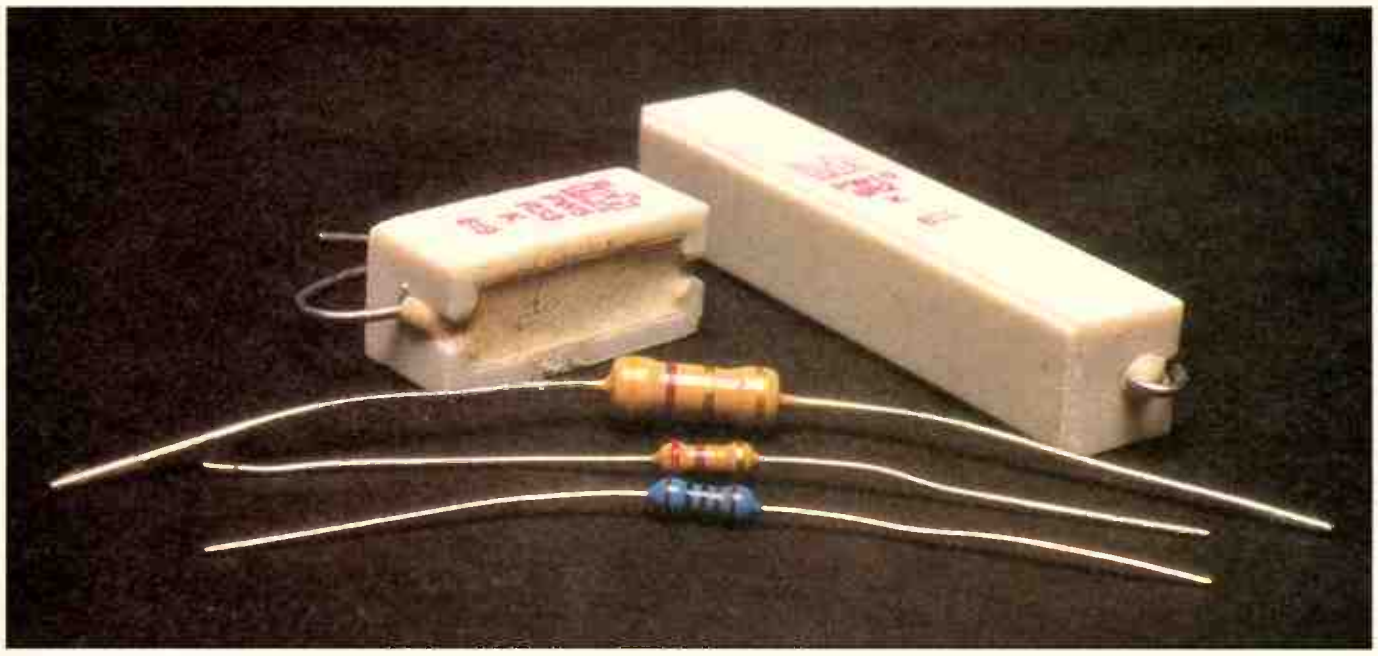


Figure 1.4. Symbols used for potentiometers (e.g: volume controls).



Typical fixed resistors you'll meet.

There are several properties of fixed resistors that we need to keep in mind:

1) the actual resistance value, which can be measured with an Ohmmeter,
2) the precision, usually 10%, 5%, 2%, or 1%,
3) the wattage rating,
4) the stability and
5) the inductance.

If high stability is needed, 1% metal film resistors are used. For more tolerant circuits, ordinary composition or carbon film resistors are quite adequate.

Elderly equipment often makes use of high wattage carbon composition resistors for which there are no modern replacements. If you have this trouble, use several resistors in parallel to get the required wattage, e.g: five 10k, 1 W resistors in parallel to replace a 2k, 5 W. Leave enough space between the resistors for air to flow which conducts away the heat. For all normal purposes the inductance of modern composition and all film resistors is low enough to be neglected. For some circuits the inductance has to be particularly low and this means that the usual types of wirewound resistors cannot be used. High powered low inductance resistors are made of wire that is wound in a particular way to minimise the inductance.

Three-terminal variable resistors

Originally called potentiometers, three-terminal variable resistors are universally known as 'pots' for short. They are used to produce dc or ac voltages that can be varied by manual control. Typical examples are the voltage control on a variable power supply and the volume control in a radio. Controls that are designed to be adjusted and then left set are often called 'trimpots'.

Figure 1.4 also shows three ways in which a volume control is drawn in circuit diagrams; (a) was common until about 1960, (b) is its modern equivalent. The symbol at (c) is used in professional diagrams, particularly where the circuit impedance is fixed. Figure 1.5 shows the three equivalent symbols for preset controls (trimpots).

For valve circuits the resistance of the volume control is commonly 1M, whereas most transistor circuits use 10k. This means that testing a volume control in a valve circuit presents more of a problem than testing one in a transistor circuit. The input impedance of the ETI-195 Signal Tracer is 680k, so when the tracer probe is put on the wiper terminal, it will load the 1M control and reduce the output. This effect is worst when the control is set to 0.5M, the output being reduced by 27% as the probe is applied. If you are simply looking to see whether there is a signal, this is no problem, but if you are trying to take measurements, this loading effect of the

A selection of pots and trimpots.

Typical polarised capacitors.

probe must be remembered.

Professional volume controls are called 'faders' and are invariably designed for a fixed circuit impedance, usually 600 Ohms or 12k for unbalanced faders and twice this for balanced ones. They often use non-inductively wound Constantan wire resistors. This has several side effects. Firstly the noise level generated within the resistors is low (0.4 uV for 600 Ohms with a 20 kHz bandwidth) compared to that from a 1M control (17 uV for the same bandwidth).

Secondly, the control will probably be a stepped switch, usually with 31 or 32 steps. This reduces the wiper noise that can become severe with rotary volume controls that have carbon elements. Thirdly, in the full-on position, the gain is not 1, but considerably less than 0.5, so when testing faders, the probe will not load them, but their output can be much lower than you expect.

Ganged controls, such as those in balanced (not stereo) circuits are often drawn as a box with an arrow going through it, with two input and two output leads, and with the impedance written in or near the box. The trick with these controls is that they often do not have an earth. Figure 1.6a shows the circuit of a typical professional fader and Figure 1.6b the circuit for a balanced unit. Note that each output terminal will (should!) be loaded by a resistor equal to the fader impedance. We will be dealing with balanced circuits later in the series.

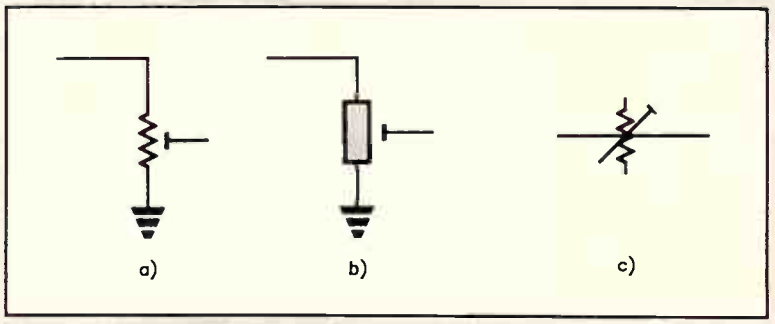


Figure 1.5. Symbols used for present volume controls (trimpots).

Stereo volume controls simply consist of two volume controls, as in Figure 1.4, mechanically ganged together, each control having its own earth. When testing these, the important requirement is equality of output from the two controls at any setting. Again, professionals use step type, constant resistance, ganged faders for stereo work. A volume control is tested by first measuring its resistance to make sure it hasn't changed from the marked value and, if this is correct, applying about 100 mV from the injector into the input and listening to the output using the tracer. Listen for a smooth change in ouput as the control is varied. With presets, simply check for correct input and output voltage levels. eti

Jack Middlehurst is a physicist, who has recently retired from the CSIRO where he worked on the physics and biophysics of biological membranes. He is now a programming consultant with Aguila Holdings Pty Ltd. His hobby has, for many years, been electronics, his particular interest being high fidelity audio.

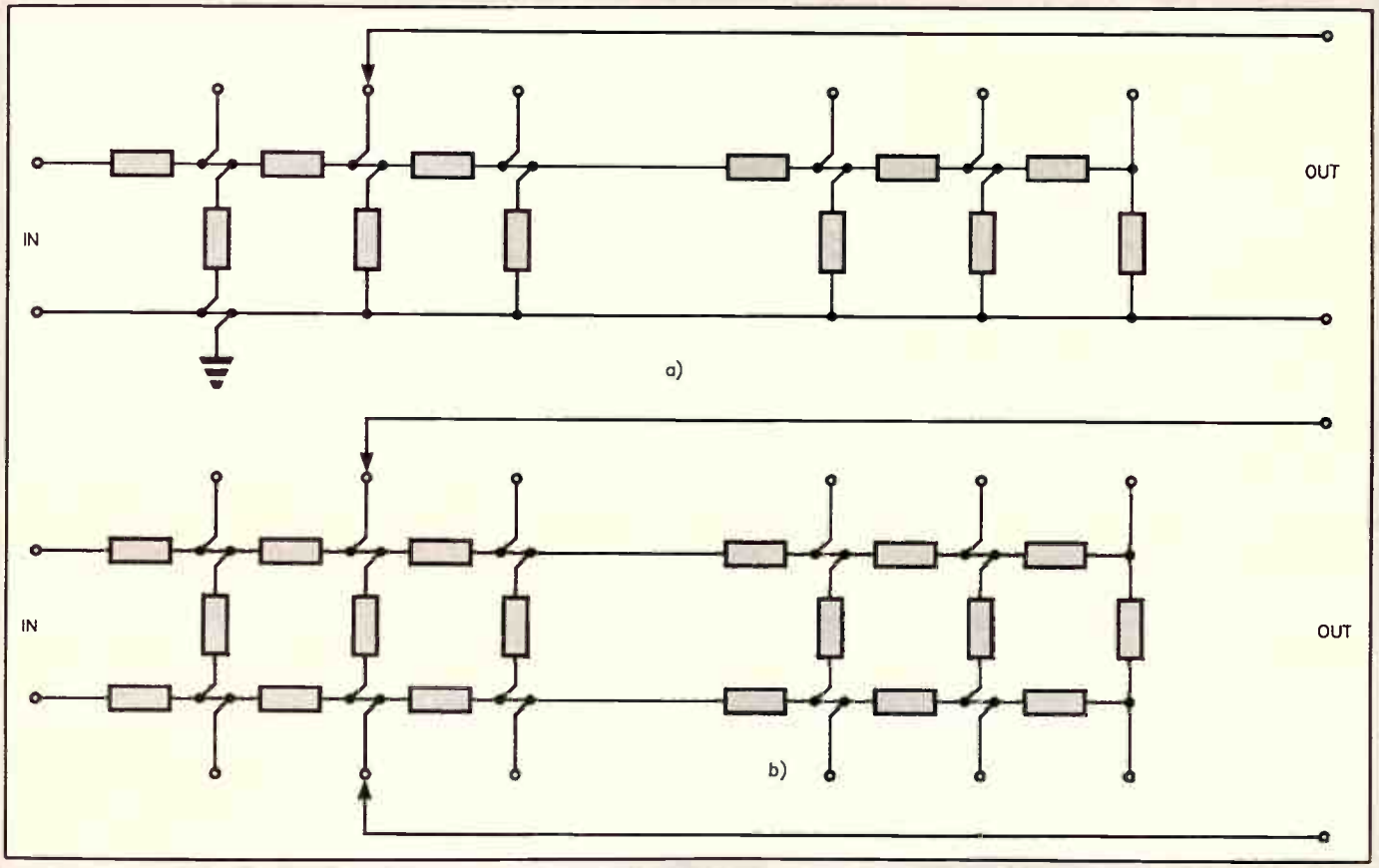


Figure 1.6. Circuits of step type "faders" — (a) unbalanced, (b) balanced.

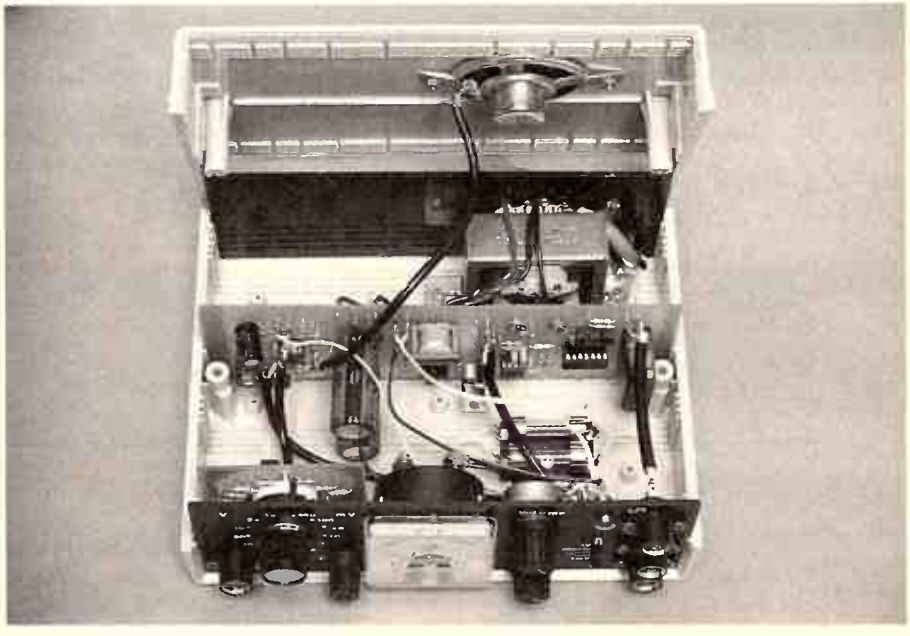
ELECTRONICS
ETI - 195

Every electronics lab or workshop — even if it's your kitchen table — should have one of these. It can be used to check components and circuits in both solid-state and valve equipment, whether factory-built or your own projects. By Jack Middlehurst.

The technique of signal tracing is almost as old as electronics itself. To test a piece of electronic equipment, each of its fundamental circuit blocks is first identified. Then, for each block in turn, a known signal is injected into its input and a signal tracer is used to measure the signal at its output. Lack of an output tells us that there is something wrong with that particular block, otherwise the ratio of output to input tells us its gain. In this way, faults in equipment can rapidly be traced to a particular circuit block which can then be studied in detail to locate the faulty component or components.

As well as being an extremely useful general testing instrument, the injector/tracer is intended to be used in conjunction with the series of articles called *Building Blocks of Electronics* that starts in this issue. This series is designed to help enthusiasts understand the way in which various complicated pieces of electronic equipment work by the simple process of dividing the circuit up into a set of standard blocks.

The articles give tables setting out the expected dc and signal levels at various points within these individual blocks. Armed with these values, the operation of most non-digital circuits can be checked with nothing



Build this signal injector/tracer

THE UNIVERSAL TROUBLESHOOTER

more expensive than a reasonable meter for measuring Volts, Ohms, and milliamps, and the signal injector/tracer. While its primary purpose is to check audio equipment, the injector/tracer can also be used on AM broadcast band and shortwave radios. It can also serve to measure the values of capacitors and inductors over quite a wide range.

SPECIFICATIONS ETI-195 SIGNAL INJECTOR/TRACER

Operating frequency	**1 kHz**
Injector square wave output	**100 mVp-p**
Square wave output impedance	**75 Ohms**
Sinewave output (adjustable)	**5 uV to 500 mV RMS**
Sinewave output impedance	**1 Ohm**
Tracer range (adjustable)	**1 mV to 100 V RMS FSD**
Tracer input impedance	**660k**

The injector

As the circuit diagram of Figure 1 shows, the signal injector itself consists of three simple blocks. The signal we are producing starts as a somewhat rounded square wave at 1 kHz generated in a CMOS phase shift oscillator using three CMOS inverters. CMOS is used because the peak-to-peak amplitude of the signal is automatically equal to the power supply voltage (8 V), avoiding the need for complicated stabilisers. This signal is fed to a CMOS inverter/squarer and emerges via a voltage divider as a 100 mV square wave at an impedance level of 75 Ohms. This output is for signal tracing radio frequency circuits.

The original 1 kHz signal is also divided by 57 and fed to a high Q band pass filter tuned to 1 kHz and having a gain of 7. This removes the harmonics and leaves us with a decent sinewave at 1 kHz of about 350 mV RMS. These parts of the circuit are run from a regulated +8 V power supply to assure both constant frequency and amplitude.

The sinewave is fed via an output level control to a low power amplifier with a gain of 11 and thence into half the primary of a small transformer using a turns ratio of about 4:1, giving an overall gain of about 2.5. The transformer allows us to have an output that is completely independent of earth, something essential for testing balanced audio stages. It also prevents earth loops while testing mains operated equipment.

The ouput from the transformer goes to a low impedance voltage divider so that the injector can provide 1 kHz sinewaves from about 500 mV, for testing power amplifiers, capacitors, and inductors, down to a few microvolts, for testing sensitive audio equipment. The maximum output is limited to 500 mV by the onset of overload of the output transformer.

The tracer

The signal tracer is required to do several different things. Firstly, it can be used for measuring audio signals over the frequency range 20 Hz to 20 kHz and the voltage range of about 50 uV to 100 V. It can also be used to listen to the audio signals so that moderate amounts of distortion can be detected. Finally, using a diode probe, rough measurements can be made on amplitude modulated IF (intermediate frequency) and RF (radio frequency) signals in AM radios, and the audio modulation can be heard. If a digital voltmeter is available, the strength of

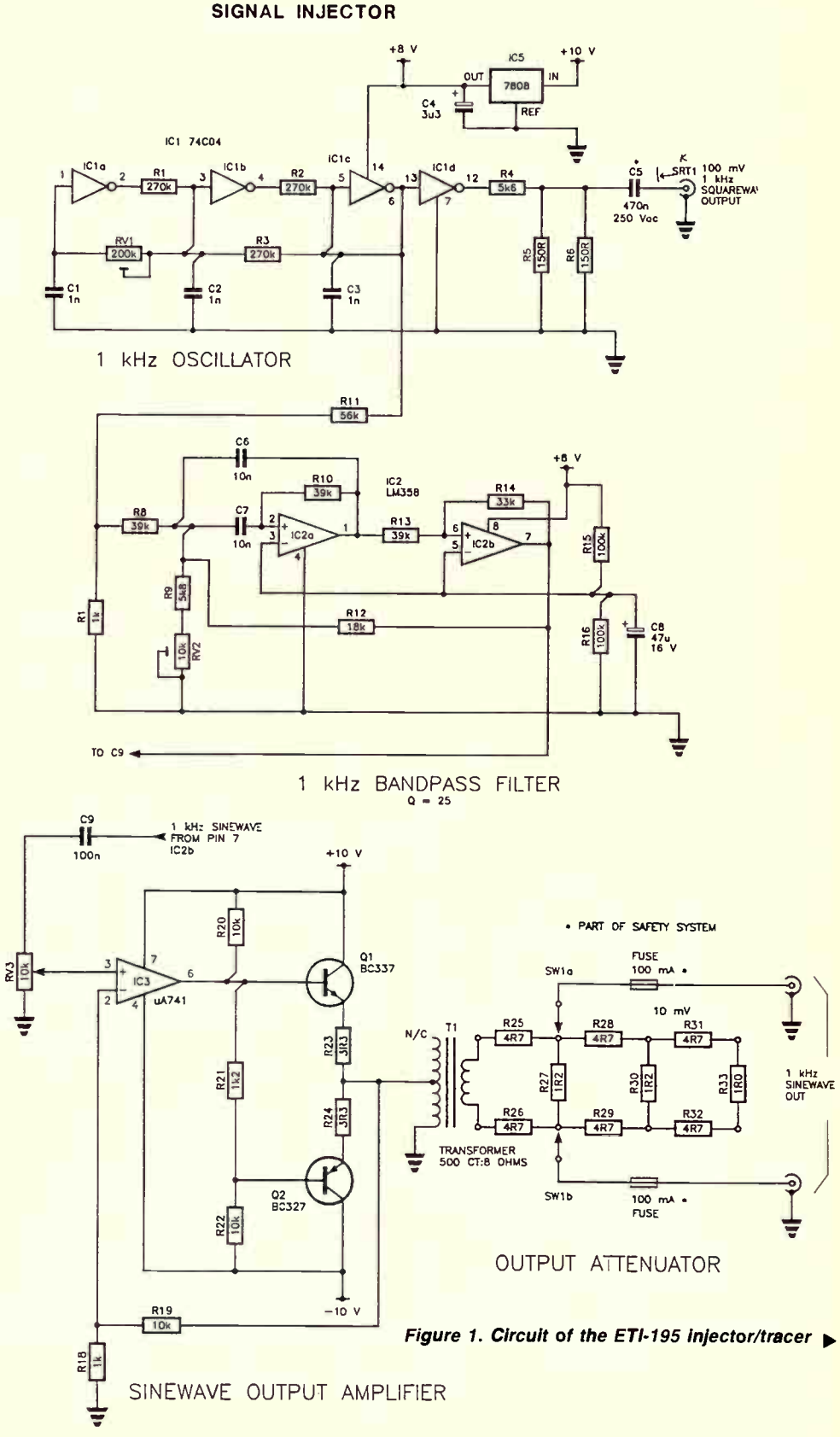
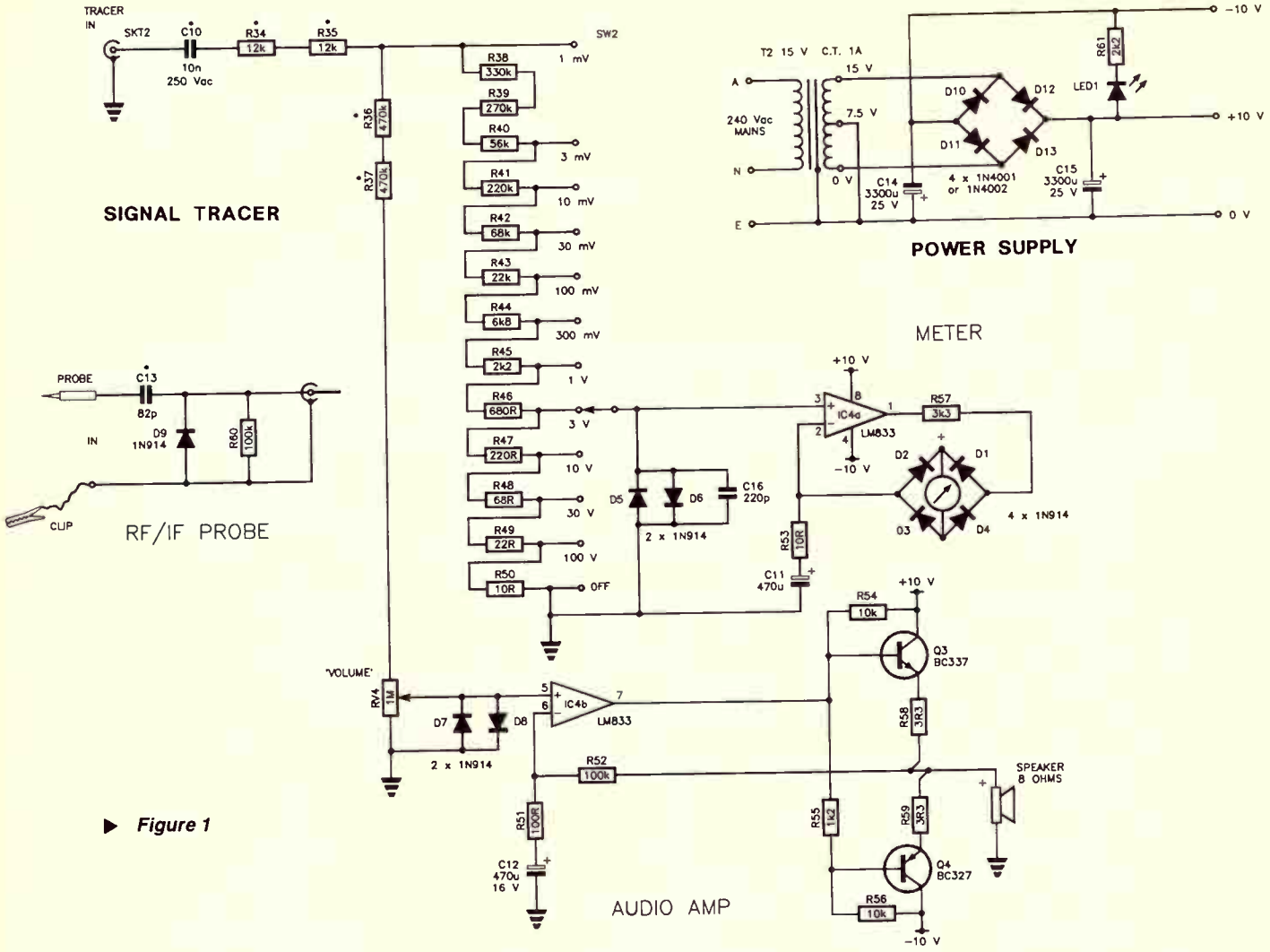


Figure 1. Circuit of the ETI-195 injector/tracer ▶



▶ *Figure 1*

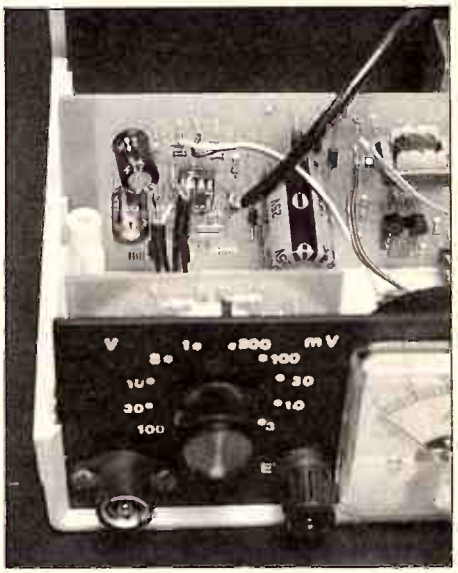
unmodulated RF/IF signals can be measured using this probe.

The tracer part of the instrument consists of half an LM833 twin low noise amplifier used in an ac current feedback circuit to produce an AF (audio frequency) voltmeter with a sensitivity of 1 mV full scale. A 100 uA meter is enclosed within four diodes in the feedback circuit. If the output current of the amplifier is positive, the current flows through D1, then the meter from + to -, and D3. If the current is negative, the current flows through D2, the meter from + to -, and D4.

So ac flows in the feedback resistors, but dc flows through the meter. The meter full scale current (100 uA) times R53 (10 Ohms) approximately sets the full scale reading of the instrument (1 mV). Capacitor C11 stabilises the operating conditions of the amplifier by making the gain at dc equal to 1, at the same time allowing the ac to flow through R53. R57 is included solely to reduce the likelihood of burning out the meter should a very high signal output overload the meter. It has no effect on the sensitivity of the instrument.

The meter amplifier is fed from a stepped attenuator so that the sensitivity can be changed in 1:3:10 steps from 1 mV to 100 V full scale. By using a meter with scales of 1 and 3.16 V full scale, resistors from the E12 range can be used in the stepped attenuator (3.16 is the square root of 10, so every second step changes the sensitivity by a factor of exactly 10). The two 12k, 1 W resistors are used for safety purposes, discussed below. C16 reduces the effects of RF pickup on the meter.

The other half of the LM833 is used in conjunction with a simple complementary output stage to drive a small loudspeaker so that the signal being traced can be listened to as well as measured. A separate volume control is used so that the sound level from the loudspeaker can be controlled independently of the meter reading. The signal amplitude is divided by two at the input to reduce the maximum voltage on the volume control.



Closeup view showing the input attenuator with the pc board mounted directly on the rear of the switch.

Safety

Since this is a measuring instrument, and accidents do happen, the design philosophy has been deliberately slanted quite heavily towards safety. The input probes are designed to withstand a maximum combined dc plus peak ac voltage of 600 V since you may want to measure the output signal on the anode of a valve. If the dc voltage is low, the maximum ac voltage on the input probes should not exceed 100 VRMS. It is not intended to have any of the output leads connected to high dc or ac voltages since they are designed to feed a signal into the input of amplifiers etc. However, we have tried to ensure that no harm will come to the operator or the instrument even if one of the probes or output leads should accidentally come in contact with the 240 V mains.

For this reason, the AF probe uses coaxial cable rather than ordinary shielded wire. The coax feeds into a 10 nF capacitor rated for continuous operation at 630 Vdc. This type of capacitor can withstand 240 Vac for long periods. The RF/IF probe also uses coax cable and has an 82 pF polystyrene capacitor also rated at 630 Vdc, and a diode load of only 100k. This acts as a high pass filter so that 240 Vac 50 Hz is reduced to less than 1 Vac at the diode, which is well within its rating.

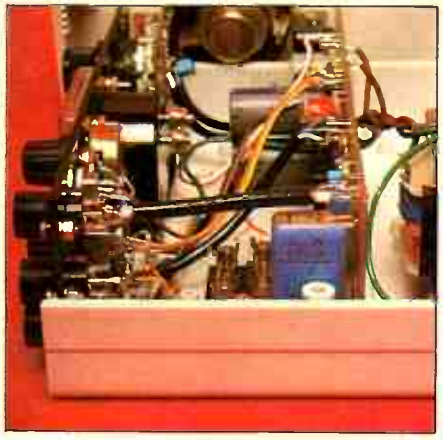
In addition to these precautions for the probes, as you can see in the main circuit, each amplifier is protected by high wattage resistors in series with its input, together with diodes from input to each. This limits the voltage at the amplifier input to about 0.3 VRMS even with the full 240 Vac on the probe and the instrument on the 1 mV range. Of course the meter will bang hard over against the full scale stop, but if you get the probe off the 240 V within a few seconds, no harm should be done. Since resistors have a voltage limit as well as a power limit, several resistors in series are used rather than a single resistor in critical parts of the input dividers.

The output leads present a different problem. The square wave output is protected by using a 470 nF (0.47 uF) capacitor rated for 250 Vac in series with it, but such a safety system is not practical with the sinewave output since the output impedance has to be so low that 1000 uF 240 Vac capacitors would be needed.

For this reason a 100 mA fuse has been included in each output lead of the sinewave output terminals. If the output probe is accidentally connected to 240 Vac, these fuses should save the operator, but they may not save the output transformer or the resistors in the output attenuator, since they may have time to burn out in the split second that it takes the fuse to blow.

Construction

Because the signal injector and the tracer are on the one printed circuit board, considerable care has been taken with the earthing arrangements so that the high current signals flowing to earth via the primary lead of the injector output transformer do not induce voltages in the input earth of the tracer. Similar care has been taken with the earth for the square wave output. In fact, six separate earth paths are used to keep the signal paths of the various parts of the circuit well separated. For this reason it is essential to use the printed board layouts shown in Figure 2.

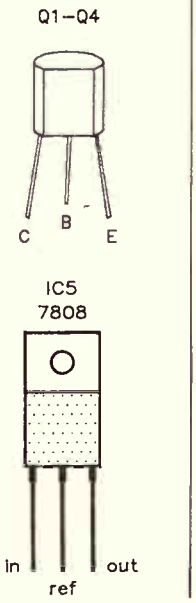


The "safety" capacitor on the output of the square wave generator (injector).

Before starting, make sure that you have all the components that are listed, and then visually check the two printed circuit boards (PCBs) for defects. Tiny gaps in copper traces can be bridged with solder, larger gaps will need to be bridged with fine wire and solder. Copper tracers that are touching (and shouldn't) can be carefully cut apart with a hobby knife, scalpel or similar sharp blade. If all is well, try the main PCB in the slots in the case to make sure that it is an easy fit. If not, some filing of the edges is necessary before you start mounting any components. Indeed it is worth while smoothing the edges of both PCBs anyway.

Begin with the main printed circuit board. First insert and solder the 22 PCB pins. The three pins for connection to the transformer secondary are mounted to protrude on the copper side of the board. Then make the link out of a piece of tinned copper wire and solder it in place. Then start mounting the components.

It is a good idea when installing components in PCBs to start with the smallest ones and work up in size. Doing it the other way can make the board unwieldy when you are trying to mount a diode on a board that insists on falling over because it has a



large electrolytic mounted way off-centre.

After mounting a set of about four components, do a close visual inspection of the soldered joints, preferably using a magnifying glass. If any joint is not absolutely perfect, redo it. This is a measuring instrument that you will need in good working order all the time. Perfection is the only way to ensure that it won't give up the ghost just when you need to use it most.

Be especially careful when mounting polarised components such as electrolytics, transistors, diodes, and ICs. Mounting any of these the wrong way round will destroy them. The main PCB has a small copper '1' next to each IC pad to show where pin number 1 of the ICs has to go.

After you have mounted everything and checked all the joints, check the whole thing again. Better still, get someone else to check it for you since, if you have made a mistake, you will probably make the same mistake again when checking it. If it passes this check, clean the copper side carefully using a toothbrush and methylated spirits, and, when the board is quite dry, spray it with clear PCB lacquer.

Next, start on the smaller board. This mounts directly on the input selector switch, so make sure that the switch fits, re-drilling the holes if necessary. The switch mounts on the component side of the board. The pins on the switch should go right through the PCB and protrude on the copper side. On this occasion it is alright to mount the switch first since it can be used to hold the PCB while you are soldering the other components. Note that this switch MUST have an insulated shaft assembly and that the PCB has a large area of earth conductor on it. This is to allow for the possibility of 240 Vac getting onto the input lead.

Once you have made sure that the switch fits, remove it and insert and solder the PCB pin near the earth terminal. This pin protrudes on the component side and has to be cut to about 5 mm. Then insert and solder the remaining two PCB pins to protrude on the copper side. Put the switch back and solder all of the switch pins. Mount the 10n/630 Vdc input capacitor with 3 mm of lead above the PCB since later the capacitor has to be bent out of the way of the coax input socket. Then mount all the resistors.

Mount the two 1N914 diodes and C16 on the copper side, directly from switch pin No 12 (which is earthed) to the moving arm contact. The shielded cable to the input of the tracer amplifier on the main board will connect to these points later. Again, check the board for correct assembly and check all soldered joints, then clean the board and spray the copper side with PCB lacquer. It doesn't matter if you get lacquer on the diodes.

Next comes the front panel. Mark out and carefully centre-punch all the holes according to Figure 3. When drilling the holes it pays to use an undersize drill first and then enlarge the hole to the correct size. For holes as large as 12 mm, use 6, 8, 10, and 12 mm drills in succession. In this way you get a round hole with the minimum chance of the drill catching and tearing the panel as it goes through.

The slot for the four-position switch is made by carefully drilling four 4 mm holes in a line and using a small square file to finish the slot. The positions of the four mounting holes for the meter depend on the particular meter that you buy, so they may differ from those in the diagram. When you are satisfied that the panel is ready, apply the rub-down lettering and follow this with a coat of clear PCB lacquer.

While the lacquer is drying, you can start mounting the loudspeaker onto the inside of the top of the case. The loudspeaker is located 70 mm from the right hand side of the lid and 50 mm from the front. First make up two small clamps from pieces of 1 mm scrap aluminium about 12 mm wide by 15 mm long, with a 2.5 m hole 6 mm from one end.

Then cut away part of one of the raised pieces of a PCB slot in the top of the case with a hobby knife or chisel to make room for the loudspeaker. After this, drill an array of 5 mm holes that let the sound out of the top panel. You can cover them by glueing cloth on the inside if you like; it will stop things falling into the loudspeaker if you are prone to putting small bits and pieces on top of test equipment. Then drill the two holes for the clamps and mount the loudspeaker.

After all that is finished, you can return to the front panel, mounting the four coax sockets, the four-position switch, the LED, RV3, RV4, the earth terminal, and the meter, in that order. In mounting RV3 and RV4, bend the locating tags out of the way or cut them off.

It may be necessary to elongate the 2.5 mm locator hole for the input selector switch to get the small PCB in position with its edges in line with those of the front panel. At this stage the input capacitor has to be bent out of the way of the input coax connector. Do not let the capacitor touch the 470k resistors next to it. This board will be held onto the front panel by the input switch.

Slip the knobs onto the three shafts and measure the length of shaft needed by each knob. Then remove RV3, RV4 and the selector swtich (with its PCB) from the front panel, and mark and cut the shafts to the correct length. Smooth the cut off ends with a file, then remount all three on the front panel. This time the input and earth connections on the PCB can be soldered. Solder a short piece of hookup wire from the bottom earth connections of the input coax socket to the input earth under R34 on the small PCB. Keep the wire well away from R34.

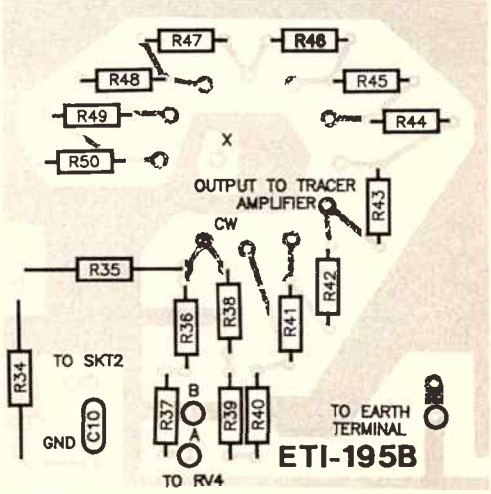
Now mount R25 and R33 on the four-position switch, keeping the lead length as short as possible. If you can get some 1/8 W resistors for these, so much the better. If not, use the physically smallest resistors that you can. Next, the fuse holders have to be mounted. These are rather bulky, so they are best mounted horizontally on the bottom of the case, near the output sockets. You can use nuts and bolts and/or Superglue.

Cut the hole for the cable clamp in the rear panel using a drill and then a file to get the final shape. Remove about 75 mm of the outer covering of the mains cable and shorten the active and neutral leads to about 50 mm, then connect them to the primary of the mains transformer, putting insulating tape over the joints when you are sure they are sound.

Mount the transformer in the back right hand corner of the box using self-tapping screws and with the 240 V connections facing the back of the box. Crimp or solder a spade tag to the end of the earth lead, then solder a 100 m piece of insulated wire to the centre tap of the secondary and put a spade tag on its other end. Now remove the right hand transformer mounting screw and put the screw through the two spade tags and then a star washer and screw the transformer down again. These leads constitute the main earthing system for the instrument, so take great care that the leads are sound and that there is a good contact with the mounting frame of the transformer via the star washer.

Connect three 150 mm pieces of insulated hookup wire, one each to the 0 V, 7.5 V, and 15 V tappings of the transformer secondary. Slip the main PCB into the first slot in the box that is just on the transformer side of half way from the front, with the components pointing towards the front of the case. Tightly twist or

Figure 2. Showing placement of components on the pc boards and details of the various off-board connections.



PARTS LIST — ETI-195 NOTE: All components marked with a asterisk (*) are especially designed as part of the safety system of this instrument. DO NOT substitute parts with lower voltage or lower wattage ratings!

SEMICONDUCTORS

D1-D9 ..... 1N914 or 1N4148
D10-D13 ..... 1N4002
LED1 ..... 5 mm red LED, with bezel
IC1 ..... 74C04
IC2 ..... LM358
IC3 ..... uA741, LM741 or similar
IC4 ..... LM833
IC5 7808
Q1 ..... BC337
Q2 ..... BC327
Q3 ..... BC337
Q4 ..... BC327

RESISTORS

all 1/4 W, 5% unless otherwise specified.

R1, R2, R3 ..... 270k
R4 ..... 5k6
R5, R6 ..... 150R
R7 ..... 1k
R8 ..... 39k, 1%
R9 ..... 5k6
R10 ..... 39k, 1%
R11 ..... 56k
R12 ..... 18k, 1%
R13 ..... 39k, 1%
R14 ..... 33k, 1%
R15 ..... 100k
R16 ..... 100k
R17 ..... not used!
R18 ..... 1k
R19, R20 ..... 10k
R21 ..... 1k2
R22 ..... 10k
R23, R24 ..... 3R3
R25, R26 ..... 4R7, 1/4 W #
R27 ..... 1R2, 1/4 W #
R28, R29 ..... 4R7 1/4 W #
R30 ..... 1R2, 1/4 W #
R31, R32 ..... 4R7, 1/4 W #
R33 ..... 1R0, 1/4 W #
R34, R35 ..... 12k, 1 W*
R36, R37 ..... 470k*
R38 ..... 330k, 1%*
R39 ..... 270k, 1%*
R40 ..... 56k, 1%*
R41 ..... 220k, 1%
R42 ..... 68k, 1%
R43 ..... 22k, 1%
R44 ..... 6k8, 1%
R45 ..... 2k2, 1%
R46 ..... 680R, 1%
R47 ..... 220R, 1%
R48 ..... 68R, 1%
R49 ..... 22R, 1%
R50 ..... 10R, 1%
R51 ..... 100R
R52 ..... 100k
R53 ..... 10R, 1%
R54 ..... 10k
R55 ..... 1k2
R56 ..... 10k
R57 ..... 3k3
R58, R59 ..... 3R3
R60 ..... 100k, 1/4 W #
R61 ..... 2k2
RV1 ..... 200k hor. trim.
RV2 ..... 10k hor. trim.
RV3 ..... 10k lin. pot.
RV4 ..... 1M log. pot.

or 1/8 W.
* see text

CAPACITORS

Capacitors marked * are part of the safety system and must not be altered in value or rating.

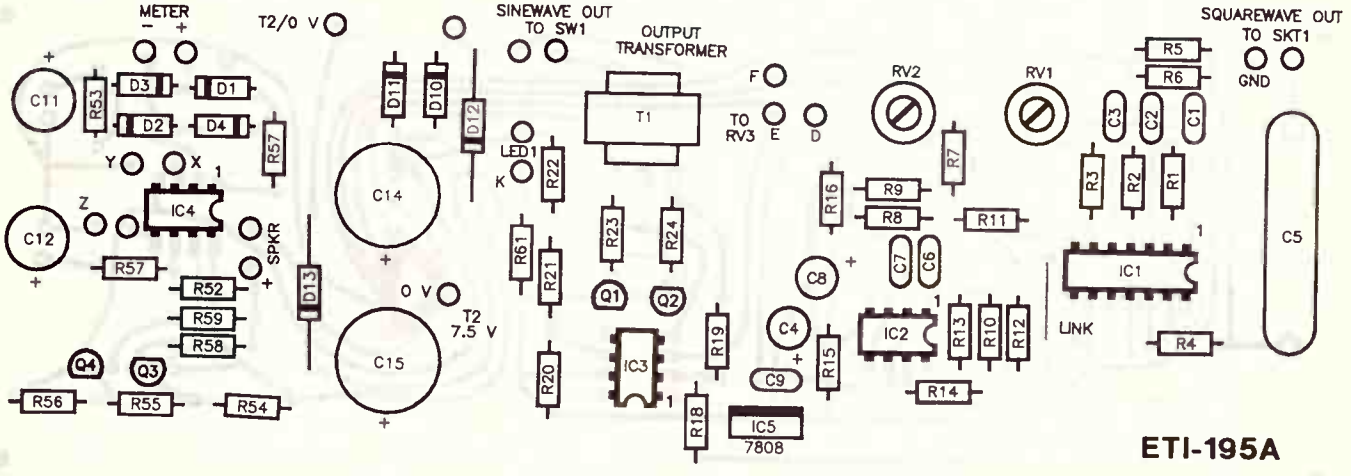
C1-C3 ..... 1n/100 V MKP or MKT
C4 ..... 3u3/16 V RB electro.
C5 ..... 470n (0.47u)/250 Vac WIMA MP3*
C6, C7 ..... 10n/50 V MKT
C8 ..... 47u/16 V RB electro.
C9 ..... 100n/50 V MKT
C10 ..... 10n/300 V WIMA MKS4*
C11, C12 ..... 470u/16 V RB electro.
C13 ..... 82p/630 V axial lead
C14, C15 ..... 3300u/25 V RB electro. #
C16 ..... 220p/50 V ceramic or MKP

MKP = metallised polypropylene
MKT = metallised polyester ("greencaps" may be used)
RB = pc-mount type
# 2500u/25 V may be used
* polystyrene

MISCELLANEOUS

ETI-195A and ETI-195B pc boards; T1 – audio transformer, ferrite cored 500 Ohms centre-tapped to 8 Ohms (e.g: Altronics M 0226); T2 – type 2155 mains transformer, 240 V to 15 V CENTRE-TAP, 1 A; SW1 – 2-pole 4-position slide switch, with mounting screws; SW2 – 1 pole 12 position rotary switch, with insulated shaft (by Alpha or Lorlin) (e.g: Rod Irving S13021, or Altronics S3021); 100 uA panel meter type SEW ST-45 or similar, scaled 0-100 and 0-31.6; Loudspeaker – 2.25" diameter, 8 Ohm; IC sockets – 3 x 8-pin, 1 x 14-pin; 25 x PCB pins; 4 x Belling-Lee type insulated coax sockets (e.g.: Rod Irving P10406); 4 or 5 x Belling-Lee type coax plugs (5 if optional earth lead is used – e.g: insulated) knobs; 1 x plastic instrument case 200 mm w x 70 mm h x 160 mm d; 2 x 3AG fuseholders; 2 x fuses, 100 mA 3AG; 1 x 4 mm panel terminal green or black; 4 m of light duty coax cable; 700 mm of twinlead shielded microphone cable; 120 mm of rainbow cable (10 or more wires); 600 mm of insulated hookup wire; 4 or 5 x spade tags (4 if a banana plug is used); 1 x banana plug (optional); 2 x crocodile/alligator clips (optional); 1 x mains cable clamp; 2 m of 240 V light duty mains cable with 3-pin mains plug; 14 x 2.5 mm bolts with nuts; 2 x self-tapping screws; 9 x 2.5 mm star washers.

Approx. Cost: $125-$135.



plait the three transformer leads and connect them to the ac input pins, the 7.5 V lead going to the pin between the two 3300u electrolytics.

Now make up five leads from the microphone cable. To make the description easier it will be assumed that the two wires in the cable are blue and white. It doesn't matter what the actual colours are, provided you are consistent with what you do with each coloured wire. The three types of lead ends to be made on the cables are shown in Figure 4. Make up the leads as follows:

Length	One end	Other end
65 mm	type A	type B
100 mm	type C	type C
150 mm	type A	type C
160 mm	type B	type C
190 mm	type B	type C

Now solder the A end of the 65 mm cable to the output of the small PCB, the white wire to the switch moving contact and the blue wire to pin 12 (earth) on the switch. Leave the other end of this lead for the moment. Connect one end of the 100 mm lead to the Output control, the braid to the anti-clockwise terminal, the white wire to the clockwise terminal, and the blue wire to the moving arm terminal.

Connect the A end of the 150 mm lead to the two pins at the bottom of the small PCB, the white wire to the 470k resistor pin and the blue wire to the earth. Connect the other end of this cable to the volume control, the white wire to the fully clockwise terminal and the blue wire to the fully anti-clockwise. After removing the lacquer from a 10 mm square section of the metal, solder the braid to the case of the volume control.

The 190 mm lead is now connected to the volume control with the braid soldered to the case, the white wire to the centre terminal and the blue wire to the anti-clockwise terminal (which already has one blue wire connected from the 150 mm lead). Solder the two 1N914 diodes from the centre terminal to the anti-clockwise terminal on the volume control, noting that the diodes are connected with opposite polarities.

Now peel the rainbow lead into five 120 mm long pieces of 'twin-lead'. Strip 3 mm of insulation from each of the two wires of one end of each twinlead. Then solder four twinleads to:

1. the LED, making a note of which colour wire is attached to the LED's positive connection;
2. the top two connections of the four-position switch;
3. the two output connections of this switch, and
4. the centre connections of the two sinewave output coax sockets.

The fifth twinlead has two spade tags soldered to it and these are then connected to the meter. All of these twinleads will need to be cut to length later. Strip 10 mm of one end of a 150 mm piece of insulated hookup wire and use the stripped end to connect the two earths on the sine wave output sockets. Leave this wire hanging for the moment.

Strip 10 mm of outer covering off each end of a 65 mm piece of coax cable, neatly twist the outer braids, and strip 5 mm of the inner insulation from the central conductor at each end. Solder one end of the lead to the square wave output coax socket, the braid going to the 'earth' connection on the socket. Leave the other end until later.

Now slip the front panel into place and start connecting the leads to the main PCB. With the front panel facing you, connect the leads in the following order:

1. The 'twinlead' from the sinewave output sockets goes to the right hand ends of the two fuseholders, so cut it to length first and then solder the two wires in place.
2. The lead from the output connections of the four-position switch goes to the left hand connections of the fuseholders.
3. The earth lead from the sinewave output coax sockets goes to the back of the pin between the two 3300u electrolytics on the main PCB (the CENTRE-TAP of the transformer goes to the front of this pin so solder the wire rapidly or you will unsolder the transformer wire).
4. The LED leads go to the two pins slightly below and to the left of the output transformer, the positive of the LED going to the lower pin.
5. The lead from the top of the four-position switch goes to the sinewave output pins on the main PCB.
6. The lead from the Output control goes to the set of four pins to the right of the output transformer, the white wire to the bottom right pin, the blue to the bottom left, and the braid to either of the top two pins.
7. The lead from the Volume control goes to the two pins to the left of IC4, the white wire to the right hand pin, the blue wire/braid to the left.
8. The 65 mm lead from the selector switch goes to the two pins just above IC4, the white wire to the right hand pin, the blue wire/braid to the left.
9. The B end of the 160 mm cable goes to

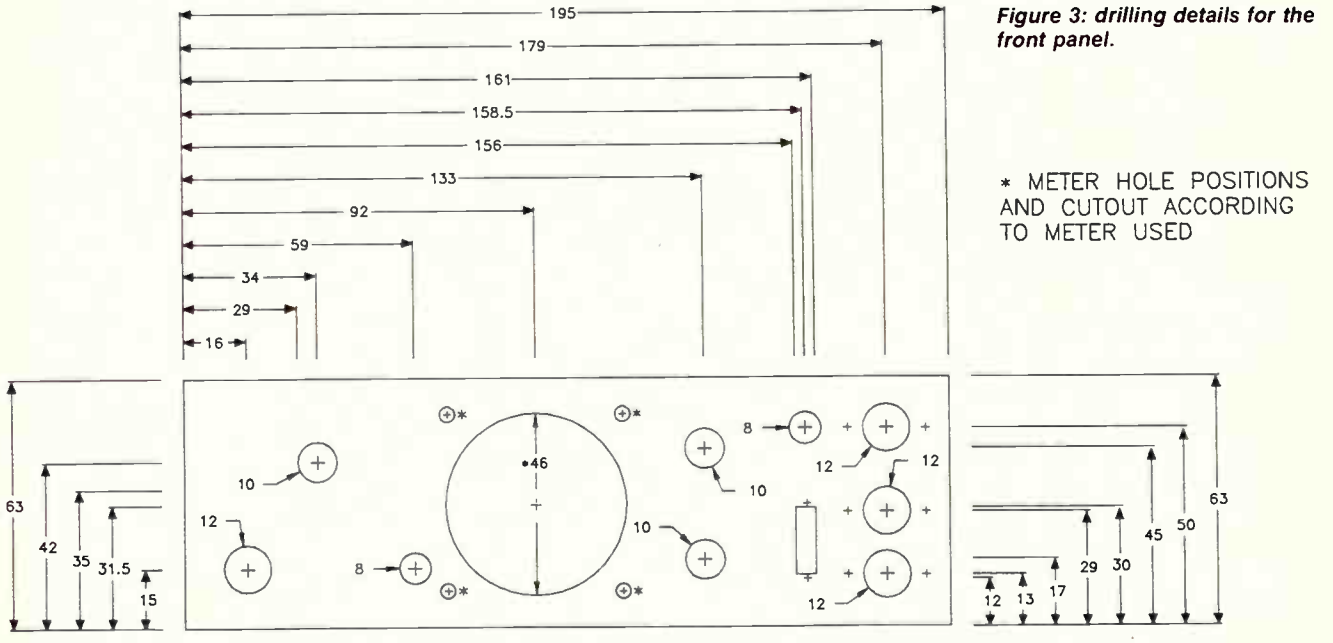


Figure 3: drilling details for the front panel.

the loudspeaker output pins to the right of IC4, the blue wire/braid going to the upper pin, the white wire to the lower (the other end of this cable doesn't go anywhere yet).
10. The meter leads go to the top pins above IC4, the positive to the centre pin, the negative to the left hand pin. The third pin is not connected.
11. The 65 mm coax cable connects to the square wave output pins, the braid going to the left hand pin, the centre conductor to the right.

Now connect the other end of the loudspeaker lead to the loudspeaker, the braid being soldered to the metal frame of the loudspeaker.

Probes and leads

If you use the probes shown in the photograph, first remove the plastic cap and metal prod, and drill out the hole in the handle of the probe to take the coax cable as a neat fit. Then remove the cover and braid from 20 mm of one end of a metre of coaxial cable, strip down the insulation from 5 mm of the central conductor, pass the cable down the handle of the probe until the 5 mm of conductor protrudes. Solder this to the blunt end of the metal prod and, when it has cooled, push the prod into the handle.

Then cover the prod end of the probe with the plastic cap provided until just the 4 mm spike protrudes. Slip a 30 mm piece of 6 mm shrink tubing over the cable and push it as far as it will go onto the handle end of the probe (about 12 mm). Using a hair dryer on its hottest setting, shrink the tubing onto the probe and coaxial cable. To finish the input probe, install a coax plug on the other end of the cable. The two output probes are made in a similar way.

The IF/RF probe also needs the probe handle drilled out to take the coaxial cable.

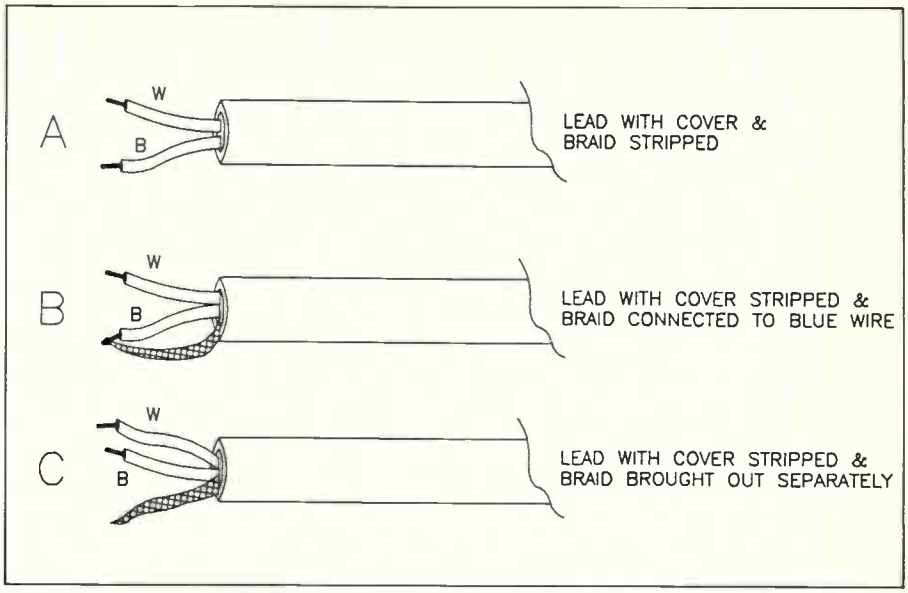
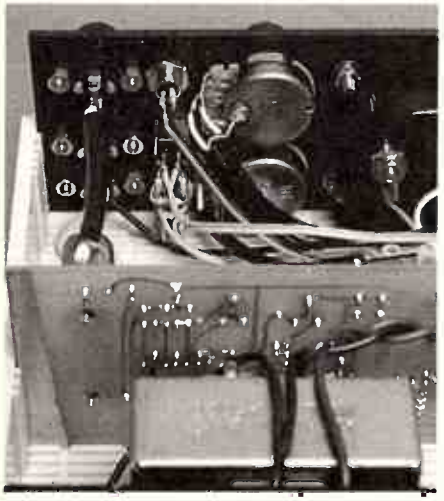
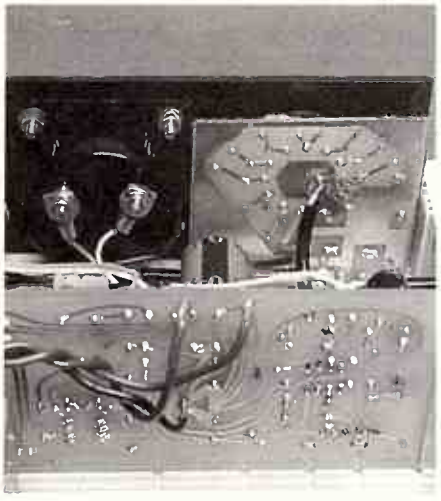


Figure 4. Three ways of preparing the end of the microphone cable.

Cut and strip the end of a 1 m length of coaxial cable as shown in Figure 5 and carefully solder C13, D9, and R60 as shown. Slip this assembly down the probe handle and solder the end of C13 to the blunt end of the prod. Slide the prod into the handle as for the input probe and apply 30 mm of shrink tube as before. Put a coaxial plug on the other end. Mark this probe in some way to distinguish it from the other three probes. Belling-Lee plugs were used (and sockets on the front panel). Details on how to cut and strip the coax and assemble these connectors is published in the Data Section of the Dick Smith Electronics Catalogue.

Two other simple leads can help to make life easier. One is a 1 m length of hookup wire with a coaxial plug on one end and a small crocodile/alligator clip on the other. This can be used to earth one of the sinewave output terminals when a balanced output is not needed. The other is a 1 m length of hookup wire, with a spade tag or banana plug (to go onto the earth terminal) on one end and a small clip on the other. This lead is used for earthing the injector/tracer to other equipment.





Two views behind the front panel, showing major component placement and interwiring. In the left hand picture you can see the resistors mounted on the rear of the sinewave output attenuator. In the picture at right, note the components mounted on the rear of the input attenuator pc board (D5-D6 and C16).

Testing

The next thing to do is to go and have a rest, then do a complete check of all the connections, not only against the description but against the circuit, to make sure that there are no errors.

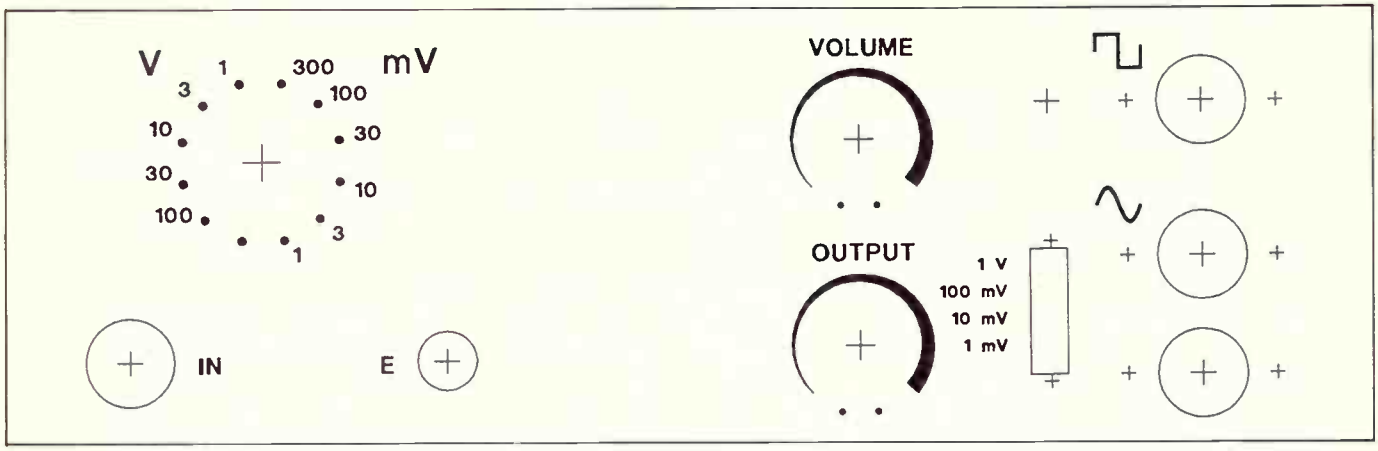
If you are quite happy that there are no blunders, turn the input switch to the blank position after 100 V, turn RV1 and RV2 to their mid positions, turn RV3 and RV4 fully anti-clockwise and put the four-position switch on 1 V.

Turn the power on while watching the LED. If it does not light up, turn off smartly and find out why. The most likely trouble is a short across the power supply. If the LED indicates that all is well with the power supply, rotate the input switch. In the 1 mV range it should indicate a noise level between 50 uV and 250 uV, depending on the stray magnetic field of the particular power transformer that you use.

Turn the selector back to the 100 mV range. Now connect the input probe to the square wave output and you should get a reading of about 35 mV. Turning up the volume control should produce a high pitched, rather annoying sound.

Turn the input selector to the 300 mV scale and the volume to zero, and connect the input probe to the centre of the top sinewave output coax socket and connect the centre of the bottom one to earth.

Artwork for a Scotchcal escutcheon to suit the project. Some suppliers may be able to sell you a Scotchcal escutcheon like this, or it may be supplied with kits (see Shoparound elsewhere in this issue). Scotchcal is easy to apply if you first soak it in water to soften the glue. Then wet the ready-drilled panel with a sponge, peel off the Scotchcal backing and place it on the panel. Being wet, you have time to move it precisely into position. Sponge away any bubbles from centre to edge. Let it dry before cutting out the holes with a sharp hobby knife.



Turning the output control up should give a reading of about 200 mV and turning up the volume should produce a much more pleasant sound from the loudspeaker. If it works to this stage, you can get on with the adjustments.

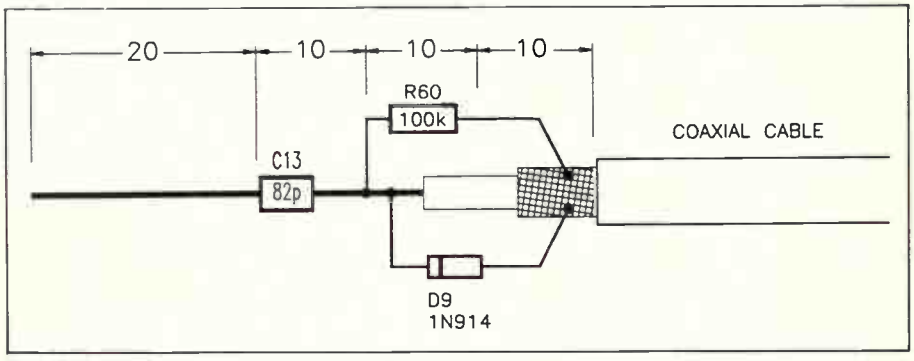


Figure 5. Layout of components in RF probe.

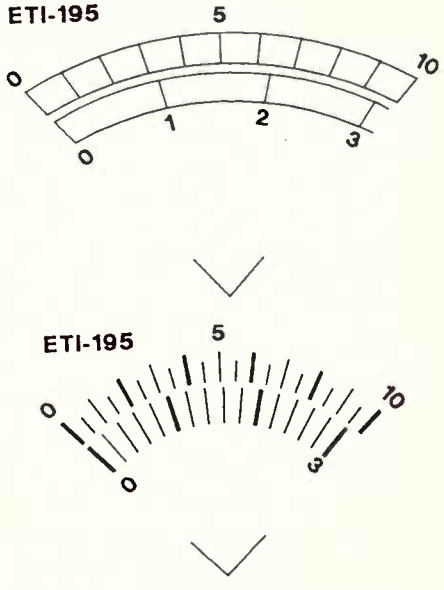
Adjustments

1. Frequency: if you have access to a frequency meter, connect it to the square wave output and measure the frequency, using RV1 to adjust for exactly 1 kHz. If you do not have a frequency meter but do have access to a piano, connect the input of the tracer to one of the sinewave output connectors and earth the other, then adjust the output level and volume controls to get a moderate sound output. Adjust RV1 until the frequency of the sound is the same as the note C", two octaves above middle C. If you do not have access to a frequency meter or a piano, simply set RV1 at mid position.

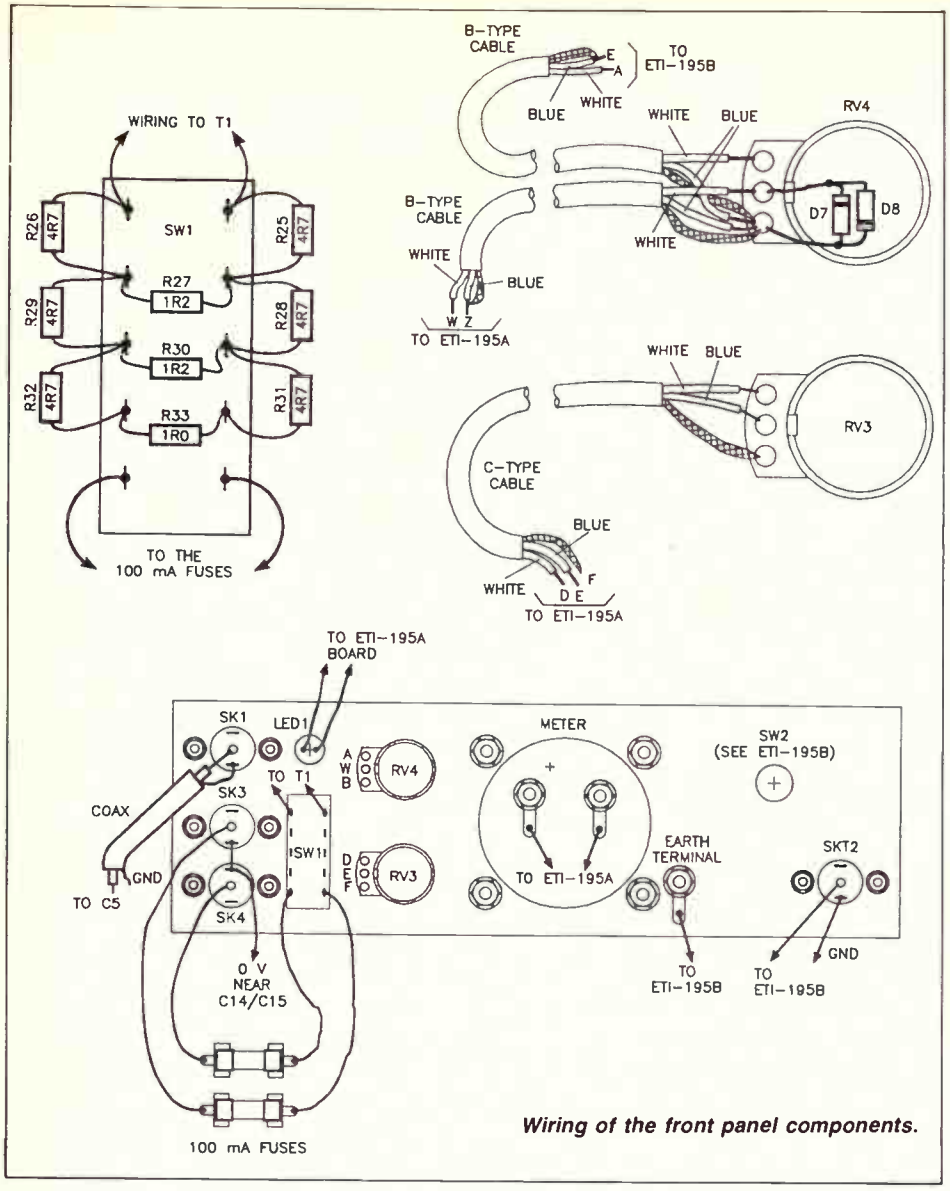
2. Sinewave purity: set the tracer to the 300 mV range and connect the tracer probe to one of the sinewave output connectors, earthing the other. With the output switch set to the 1 V range, and the output control set to give about 100 mV of signal, adjust RV2 for maximum output on the meter. Turning the output level control fully up should now produce somewhat more than 500 mV output.

That completes the construction and testing of the injector/tracer. You will find that it is quite a sensitive instrument so that even on the 30 mV scale, waving the probe near a 240 V mains cable will pick up the stray electric field and tell you if the power is on. The many ways in which it can be used are described in detail in the *Building Blocks of Electronics* series. eti

The probes were made from a pair of Coline brand meter probes (obtained from Geoff Wood Electronics in Sydney). These feature safety finger guards and pinpoint probe tips. The top one is shown without the probe shroud which prevents shorting between the probe end and adjacent contact points when using the probe.

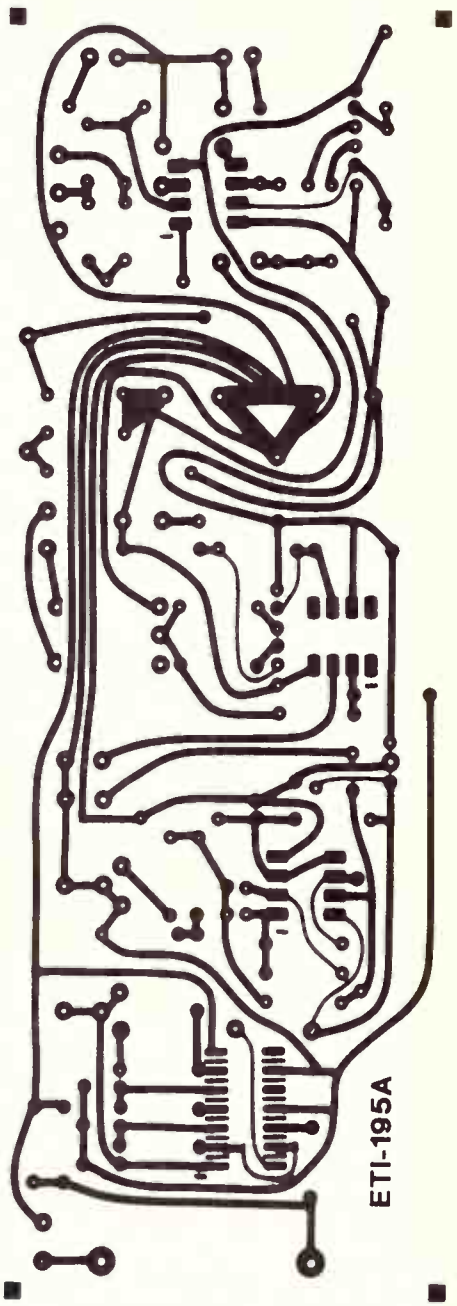


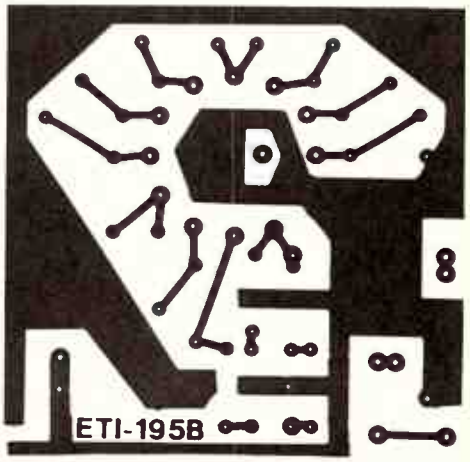
Meter scales for ST-45 (top) and MU-45 meters.

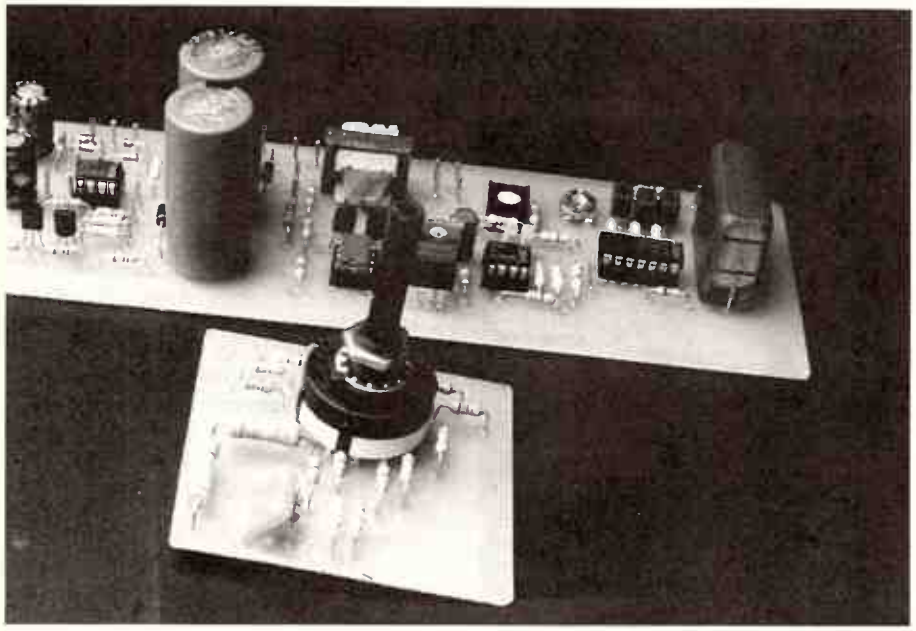


Wiring of the front panel components.

Full-size printed circuit board artwork for the Signal Injector/Tracer project.







View of the completed pc boards, before being assembled in the case and wired up.

A 16-BIT VGA CARD FOR YOUR PC-COMPATIBLE

ELECTRONICS
ETI – 1615

How would you like 800 x 600 pixel resolution graphics for your PC/XT/AT-compatible without breaking the bank or needing a university degree to build your own? Here it is — part 1 by Roger Harrison.

Graphics capability was long ago recognised as an important feature for personal computers. As the power and speed of processors developed, and the cost of memory dropped, graphics capability became a mandatory requirement to the extent that, with some personal computer systems, it's the graphics capability – and the software applications that exploit it – that defines whether it lives or dies.

When IBM introduced its celebrated PC in the early 1980s, it was sensible in making it an open architecture machine which permitted third-party suppliers to develop and market add-on cards that could be used to enhance the PC's functionality and performance. Suppliers of add-on cards have had a field day since then, considerably enhancing the popularity of the PC. Clones and compatibles also made their appearance, but that's another story!

IBM defined hardware and software standards for video adaptors, among other things, for use in differing applications. For example, the monochrome display adapter (MDA – just love those acronyms!) provided for a screen resolution of 720 by 350 pixels (a pixel is one little ▪ on your screen) in one colour and was meant for text-based applications (word processing, spreadsheets, etc). MDA has no graphics cabability.

To cover the requirements of graphics applications, the colour graphics adapter standard was introduced. This gave a 640 x 200 pixel resolution and limited colour selection. But, it made working in text-based applications difficult because of this limited resolution. Users were placed in a bit of a quandary. They were rescued, temporarily, by the release of the Hercules Graphics Card (HGC) which, with a resolution of 720 x 348 pixels, was acceptable in text-based applications while offering graphics capabilities. It had one major drawback – you got only one on-screen colour.

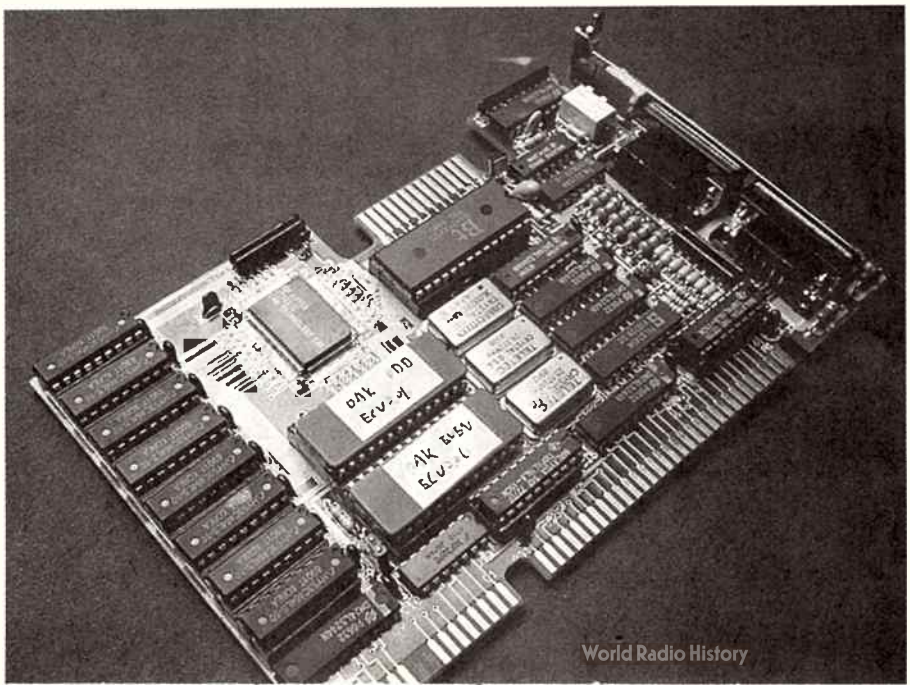
Salvation, for the moment, arrived with the Enhanced Graphics Adapter, offering a 640 x 350 pixel screen resolution – good enough for text applications – and a palette of 64 colours. However, EGA has a number of drawbacks. It doesn't produce a square pixel, so it's impossible for software developers to write applications featuring what-you-see-is-what-you-get (WYSIWYG – pronounced wyzzy-wig). The problem is more serious when it comes to working with printers, scanners and the like, much of which has square pixels. Thus, the limitations of the 64-colour palette and other software difficulties, limits EGA's usefulness.

Meanwhile, video monitors had to keep pace. Higher resolution requires faster scanning rates and more lines/inch down the screen. Special (expensive!) EGA monitors made their appearance, then multisync monitors, capable of accepting and displaying the various video standards. Their price had to keep pace with video adapter card prices, too – no use paying four times as much for the monitor as the adapter card cost!

The next solution was the video graphics array (VGA) standard which arose some two years ago and is hailed as the most versatile graphics standard to date. It was introduced by IBM as the graphics standard for their Personal System/2 range of computers. VGA boasts features which support a wide range of applications, including graphics, text (up to 132 columns across the screen) and imaging – things that were not available with previous video standards.

VGA provides a medium resolution of 640 x 480 pixels (which are square) and a 262,144-colour palette with up to 256 colours permitted simultaneously on-screen! And it sports software advantages not realised in the earlier standards. VGA solves many of the problems inherent in the earlier standards and allows backward compatibility so that you don't waste existing investment in software applications.

As things have progressed, one standard has surpassed its predecessor. Where once



The ETI-1615 Video Graphics Adapter.

CGA held sway in the marketplace, EGA has taken its place. Within a year or not much longer, VGA will become the erstwhile standard and EGA will be relegated to the position now occupied by CGA. Time to upgrade!

The advent of the VGA video specification has greatly expanded the scope of possibilities for both hardware and software developers using the Intel microprocessor bus architecture, as used in the IBM PC. There have even been some developers who have adapted the VGA system to other bus architectures. While IBM originally envisaged VGA to be implemented in their Microchannel architecture bus system, chip makers and add-on board designers enhanced it by providing some hardware backwards compatibility so that it could be used with the earlier XT and AT machines.

The first VGA controller chip sets hit the market late in 1987, US manufacturer Cirrus Logic Inc being first off the rank claiming volume production, although other manufacturers had released VGA chips in sample quantities.

Cirrus' early VGA product was a two-chip set; they released a development board in December 1987. Within six months, over half a dozen other chip and board makers had released VGA products. Quickly, single-chip VGA controllers made their appearance and now predominate. Chip makers producing VGA controllers now include US manufacturers OAK Technology and VLSI Technology, joined by Tseng Laboratories and Chips & Technologies from Asia.

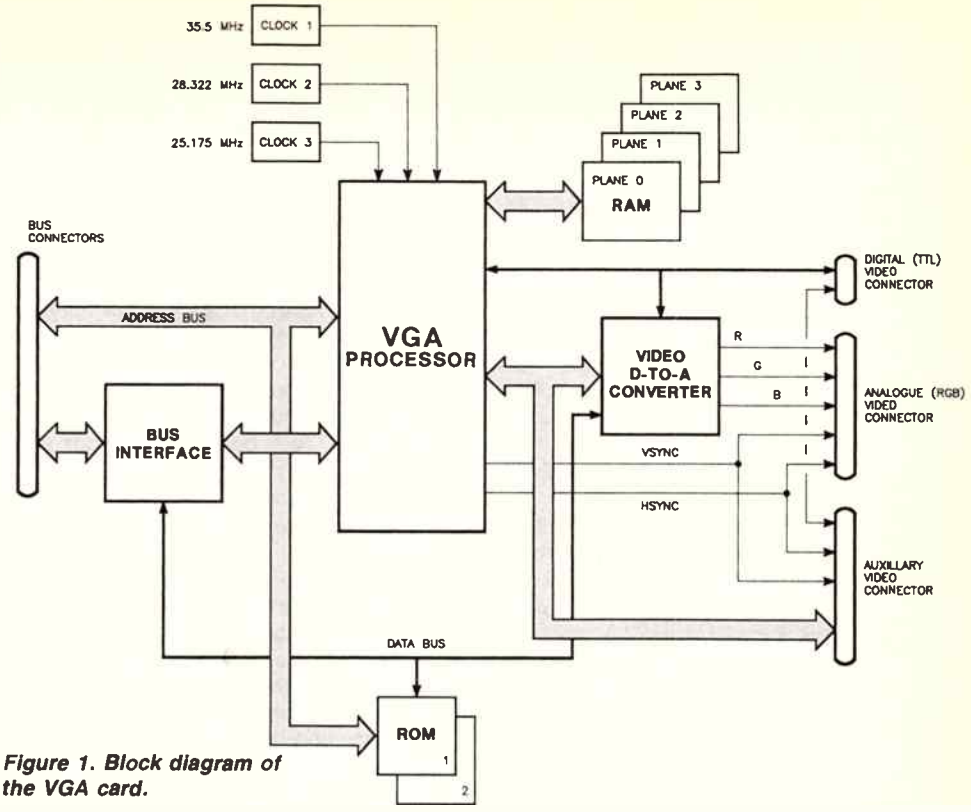


Figure 1. Block diagram of the VGA card.

Early VGA boards were aimed at the then huge market base of XT machines which employs an 8-bit data bus. While these worked in both XTs and ATs, the AT's 16-bit bus offered performance advantages that could not be exploited until 16-bit VGA chips were developed and became available. So, you'll find a combination of 8-bit and 16-bit VGA boards in the market, with the inevitable price differences. A 16-bit VGA board in an AT offers a performance increase of around 40 to 90 per cent, according to benchmark test reports.

VGA vs EGA

The original VGA specification developed by IBM Corporation solved a number of problems associated with the EGA system as well as adding some new features.

One of the major problems with the EGA specification is the complexity of the video memory interface and consequently the programming interface as well. This is due to the bit-plane architecture of the video memory. When programmers want to change the value of a 4-bit pixel they actually have to access four bytes of information, getting one bit from each byte. Of course there are hardware features in the EGA specification which enhance the performance of certain operations, and the video memory is not interleaved the way it is in the CGA specification, but applications which update the screen a lot can be affected by the extra overhead activity required.

The VGA, in addition to retaining compatibility with the older EGA and CGA modes, offers a 256 colour mode where each pixel is represented by one byte in lineally mapped display memory. Even though the standard resolution in this mode is only 320 x 200 is can be made to appear much higher by using line smoothing techniques. This is possible because of the greater number of simultaneously displayable colours. To create the illusion of shading in the EGA display requires pixel dithering, where dots of two or more colours are arranged in a pseudo random pattern in varying proportions to yield various shades when viewed from a distance.

In the VGA display each pixel can have any of 262, 144 discreet colours, so intensity and hue information can be directly encoded in each pixel. For this application the VGA produces a much cleaner image with much less software overhead, in spite of the reduced resolution. For line drawing applications the VGA supports the EGA architecture at 640 x 350, as well as an enhanced resolution of 640 x 480 with the same type of display memory mapping.

Project overview

The ETI-1615 Video Graphics Array (VGA) card is a video display adapter for the IBM PC/XT, the IBM PC/AT, the IBM PS/2 model 25/30 and similar IBM-compatible systems. It offers more functions than a conventional IBM VGA adapter and it also emulates the adapter standard for the IBM Monochrome Display Adapter (MDA), the monochrome Hercules Graphics board, the IBM Colour Graphics Adapter (CGA) and the IBM Enhanced Graphics Adapter (EGA). The features are summarised in the accompanying panel.

The circuitry is entirely contained on a half-card, with the mandatory edge connectors arrayed along the bottom and the video connectors on the rear edge of the card securing the metal slot card carrier which serves to hold the card in place.

This project has been made available coutesy of Brisbane-based semiconductor importer/distributor Energy Control International and is another of their technology demonstration projects. This concept has been devised by proprietor Ken Curry – projects designed to demonstrate the capabilities of emerging semiconductor technologies.

Energy Control International will have the project available in both kit and built-up form at a cost of $499 for the kit and $549 for the fully built-up unit ($449 ex-tax). Compared to other VGA cards of comparable

specification currently available, that's very good value for money!

Operating at dot clock rates of up to 35.5 MHz the chip set on which this video adapter card is based supports high resolution graphics mode for high-resolution variable frequency monitors. With a digital (TTL) colour monitor connected, a maximum of 16 out of 24 colours can be selected and displayed. For analogue monitors, the 256 colour graphics mode can display 256 out of 256K colours simultaneously through the external colour palette chip. So this leads us onto looking at the technical details involved in this VGA card.

A disk of software is provided with the project. It contains drivers for high resolution mode applications, such as Windows 2.0 and Windows/386, AutoCAD, GEM/3, Ventura, Framework II and Lotus 1-2-3, along with 132-column text mode applications, such as Wordstar 3.30 and Professional Release 4, and Word Perfect V/4.2.

Technical overview

A block diagram of the project is shown in Figure 1. The VGA processor, or controller, is the veritable heart of the system. Three clocks are required in order to meet the various video standards. The display memory, the RAM at top right, is organised in four planes, a total of 256K being provided on-board. The on-board ROM, shown at the bottom of the block diagram, provides for emulation of earlier video adapter standards. The bus interface provides data bus buffering and adaptation for the XT's 8-bit bus and the AT's 16-bit bus.

The VGA processor outputs directly to digital video monitors (TTL level signals), while the video D-to-A converter provides RGB (red-green-blue) analogue video output for analogue monitors. It is this video DAC which provides the major colour graphics features of the project.

So, the critical components are the VGA processor and the video DAC. The latter is a combination of RAM and D-A converter, which gives rise to the name that such devices are often called – RAMDAC. This takes colour data supplied from the VGA processor and re-maps it in a RAM, then converts this information from digital form to analogue form for output to the video monitor. Inmos, National Semiconductor, OAK Technology and Brooktree all make compatible RAMDACs for this application.

The VGA processor is a single-chip controller of which several manufacturers make compatible types: e.g: the OAK Technology's OTI-037 and VLSI Technology's VL82C037, which I'll refer to simply as the 037.

The 037 implements all the standard VGA features and adds even more enhancements such as higher graphics resolution and expanded alphanumeric display modes. Apart from the modes listed earlier, it can display 132 columns of alphanumeric characters in either 25 or 43 rows. In both of these modes the display memory is mapped the same as in the standard 80 x 25, the only difference being that the buffer is larger and there are fewer pages available in 132 x 43 character mode.

It can also display 16-colour graphics with a resolution of 800 x 600 pixels. The display memory in this mode is mapped the same as in the standard EGA graphics mode, except that each bit plane is 60K bytes long instead of 28K. All three of these modes require a faster video monitor than the standard analogue VGA monitor, and the 800 x 600 graphics mode requires 100 ns video DRAMs instead of the 120 ns type suitable for the other modes.

Either the OAK OTI-037 or the VLSI VL82C037 may be supplied with the project. These come in a 100-pin surface-mount flat-pack. For obvious practical reasons, kits will be supplied with this chip already mounted.

The RAMDAC supplied for this project is a Brooktree Bt476. It is compatible with the Inmos IMS176 and the OAK OTI-036. Internally, it features three 6-bit D-A converters, a 256-word colour palette RAM and RS-343A/RS-170 compatible video standard outputs.

I'll delve more into the technical details in Part 2.

Table 1

MODE (HEX)	Type	COLxROW	Colors	Pages	Map Addr (HEX)	CharBox
00	Text	40x25	16	8	B800	8x8
01	Text	40x25	16	8	B800	8x8
02	Text	80x25	16	8	B800	8x8
03	Text	80x25	16	8	B800	8x8
00*	Text	40x25	16	8	B800	8x14
01*	Text	40x25	16	8	B800	8x14
02*	Text	80x25	16	8	B800	8x14
03*	Text	80x25	16	8	B800	8x14
00+	Text	40x25	16	8	B800	9x16
01+	Text	40x25	16	8	B800	9x16
02+	Text	80x25	16	8	B800	9x16
03+	Text	80x25	16	8	B800	9x16
07	Text	80x25	2	8	B000	9x14
07+	Text	80x25	2	8	B000	9x16
04	APA	320x200	4	1	B800	8x8
05	APA	320x200	4	1	B800	8x8
06	APA	640x200	2	1	B800	8x8
0D	APA	320x200	16	8	A000	8x8
0E	APA	640x200	16	4	A000	8x8
0F	APA	640x350	2	2	A000	8x14
10	APA	640x350	16	2	A000	8x14
11	APA	640x480	2	1	A000	8x16
12	APA	640x480	16	1	A000	8x16
13	APA	320x200	256	1	A000	8x8
50	Text	132x25	16	8	B800	8x14
51	Text	132x43	16	5	B800	8x8
52	APA	800x600	16	1	A000	8x8

A word on monitors

This VGA card will drive digital and analogue video monitors including monochrome, colour, EGA, PS/2 and multi-frequency monitors.

Digital monitors receive data through a nine-pin connector. Each pin contains a different type of signal. Signals include red, green, blue, secondary red, secondary green, secondary blue, horizontal synchronisation, vertical synchronisation and ground. The signals are transmitted in one of two states: ON or OFF. Standard colour digital monitors have three electron guns at the rear of the screen. These guns, named red, green and blue, fire electrons at red, green and blue coloured phosphorous dots painted on the screen and the dot is illuminated.

When both a red signal and a secondary red signal are transmitted, the red gun fires with twice the number of electrons at the

FEATURES

Single chip VGA graphics controller for IBM PC/XT/AT compatible and PS/2 Model 25/30 systems
100% hardware compatible with IBM VGA in all modes
EGA, CGA, MDA and Hercules Graphics compatible through emulation
Flicker-free operation in all video modes
Fast host access to video memory
32-bit video RAM access
Supports both digital (TTL) and analogue monitors
D-type analogue and digital video connectors
800 x 600 pixel high-resolution graphics mode with 16 colours
Supports 132-column text mode
256 Kbytes memory configuration
35.5 MHz dot clock
Fully compatible with IBM BIOS

dot. The intensity of the light emitted by the phosphor, as interpreted by the human eye and brain, is directly proportional to the number of electrons hitting the single red dot. When the monitor is on, each dot is in one of three states: on, off or on intensely.

The greatest number of colours that digital monitors can display at one time is 64. The limit is imposed by the monitor design, not by the display adapter.

Analogue monitors receive data through a fifteen-pin connector. Each pin carries a different signal. Signals include red, green and blue; monitor signals zero, one and two; and vertical synchronisation, horizontal synchronisation and ground.

The standard analogue signal varies from zero to 1.0 volt. Theoretically, there are an infinite number of analogue signal levels that can be transmitted in this range. The digital-to-analogue converter on the VGA adapter converts the signal into analogue signals, and each phosphorous dot is illuminated to one of 256,000 intensities. But, the greatest number of colours the VGA display adapter can display at any one time is 256.

Supported screen formats are given in Table 1.

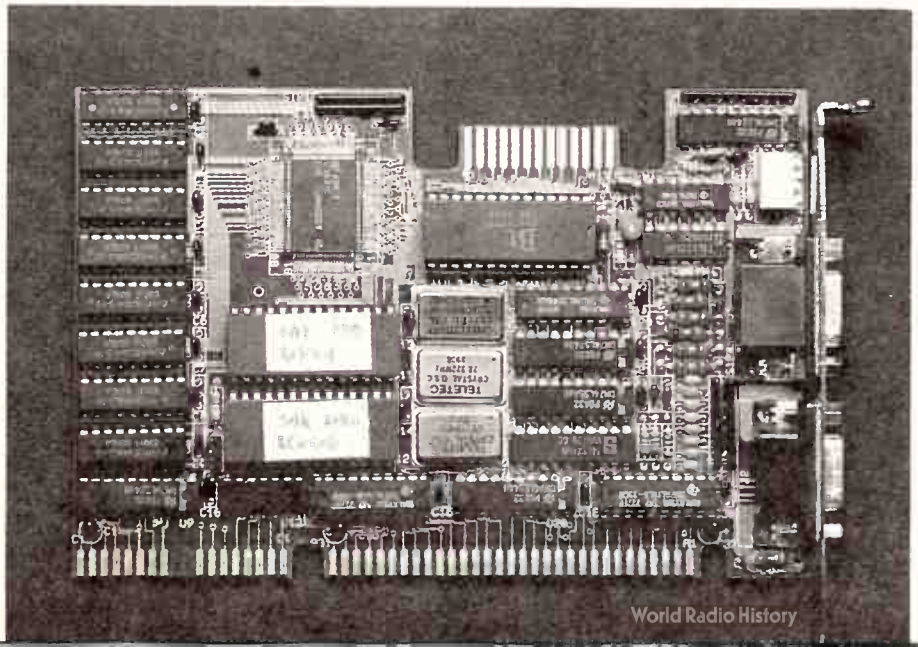
Constructing the VGA card

Rather than launching into a full circuit description at this stage, and knowing that you're probably champing at the bit to get stuck into this project, I have reversed the usual order of procedure with this project in describing its assembly first and leaving the circuit explanation till Part 2. In any case, you'll understand more about it once you've got a board to play with.

Despite the project's technological complexity, it's comparatively easy to assemble. The printed circuit board, of necessity, is a four-layer plated-through hole type, so for obvious reasons, we have not reproduced the artwork. Energy Control is supplying complete kits in any case, with all components.

The VGA controller comes soldered in place already as it's a surface-mount device. The board is solder-masked and has the component placement annotation silk-screened on the component side. The component overlay diagram here is a reproduction of the board's silk-screened annotation.

You will need a fine-pointed, temperature-controlled soldering iron and thin-guage (say, 22g) resin-cored solder. Not to mention a



steady hand and a keen eye! Needless to say, this is a project for experienced constructors.

First examine your board to familiarise yourself with the layout, IC orientation, etc. While there's a lot of circuitry on the board, it isn't particularly crammed. Some ICs are to be socketed (the RAM, EPROMs, RAMDAC, etc).

Best start by soldering all the resistors, RF chokes and capacitors in place. They should all sit right down on the board. Take care that bypass capacitors C2 to C9 don't lean towards the RAMs so that they won't foul the sockets.

Next, solder the D-type video connectors in place (but leave the metal slot card carrier aside for the moment). Now solder the TL431 current reference in place. Notice the orientation of the flat face of the package. Follow by soldering the three-pin jumper in place.

Now you can mount and solder all the IC sockets, taking particular care to get them right way round. Once you've done that, you should do a visual check of your work. You can check the 5 V rail for shorts, by checking with your multimeter between pins 28 and 14 of U21's (the RAMDAC) socket.

The three monolithic oscillators can be soldered in place next. Make sure you get them in the right order! Now tackle the ICs which can be soldered-in, as usual, taking care to place them the right way round. Solder the DIP switch in place next. It may be wise to have another visual check of your work and test the 5 V rail for shorts again.

With the DIP switch in place, the metal slot bracket can be secured to the D-connectors. Last of all, insert the socketed ICs.

In Part 2, you get to fire-up your project and learn more about its inner mysteries. eti

ETI-1615 PARTS LIST

SEMICONDUCTORS
U1-U8 ..... 4454-10 DRAM
U9, 7, 18, 20, 21 ..... 74LS244
U16 ..... 74ALS244
U10 ..... VL82C037, ITO-37 VGA chip
U11, U12 ..... 27128 EPROM
U13 ..... 74F32
U14, U24 ..... PAL16L8
U15 ..... BT476, OTI-036 RAMDAC
U19 ..... 74LS245
U22 ..... 74LS04
U23 ..... 74LS125
Q1 ..... TL431

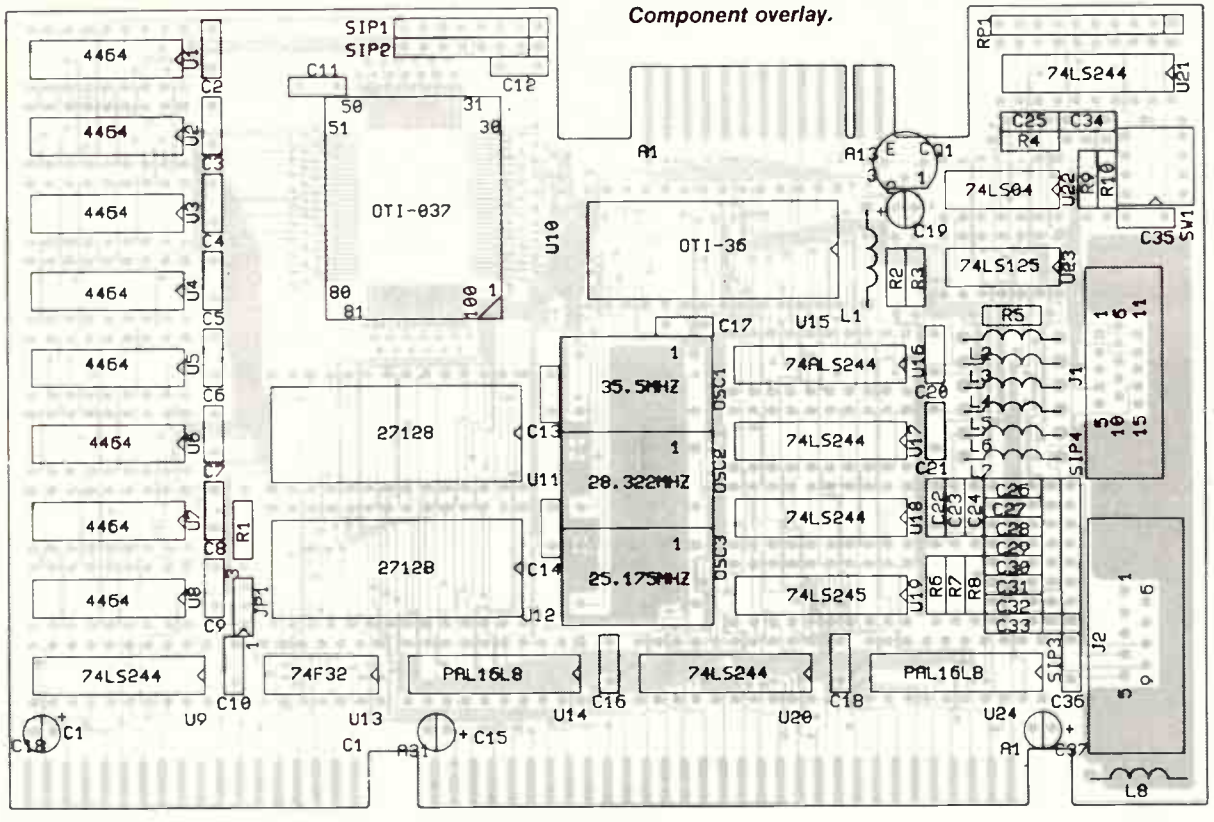
RESISTORS all 1/4 W, 5% unless noted
R1, 4, 9, 10 ..... 4k7
R2 ..... 1k
R3 ..... 365R, 2%
R5 ..... 22R
R6, 7, 8 ..... 100R
RP1 ..... 10-pin RP, 4k7
SIP1, 2, 3, 4 ..... 8-pin SIP, 22R

CAPACITORS
C1, 15, 37 ..... 10u/16 V tant.
C2-C14, 16-18, 20-22, 34-36 ..... 100n bypass
C19 ..... 22u/25 V tant.
C23, C24 ..... 270p ceramic
C25 ..... 47n ceramic
C26-33 ..... 27p ceramic

INDUCTORS
L1 ..... 5u1 H
L2-8 ..... 1u5 H

MISCELLANEOUS
J1 ..... 15-pin RA pc-mount D-socket
J2 ..... 9-pin RA pc-mount D-socket
JP1 ..... 3-pin jumper
OSC1 ..... 35.5 mHz
OSC2 ..... 28.322 mHz
OSC3 ..... 25.175 mHz
SW1 ..... 4-way DIP switch, RA pc-mount
printed circuit board; 8 x 18 pin DIL sockets; 2 x 20-pin DIL sockets; 3 x 28-pin DIL sockets; metal slot card carrier.
Cost: $499 kit, $549 (inc tax) built-up.

Component overlay.



ELECTRONICS

UPGRADING YOUR PC/AT COMPATIBLE

An application note from chip maker VLSI Technology shows how you can upgrade your PC/AT-compatible, such as the ETI-1613 Baby AT (Aug-Sept-Oct '88), with a 386SX-type processor. Vrooom!

Intel Corporation has introduced the 80386SX microprocessor and the 80387SX numeric coprocessor in order to combine the number of benefits of 80386 code compatibility and the cost reduction associated with 16-bit data bus microcomputer designs.

The 80386 and the 80387 use 32-bit internal and external data paths. The 386SX and 387SX have a 32-bit internal data bus and a 16-bit external data bus; in other respects they are equivalent. Here's a cost effective, low chip count circuit for integrating the SX circuits and one of VLSI Technology's state-of-the-art chip sets into a PC/AT-compatible computer.

Interfacing is required to achieve the maximum performance of the 386SX/387SX set in the original 286-based VLSI PC/AT-compatible chip set. The 386SX can operate

```
TITLE   386SX TO 286 STATUS
PATTERN P9-286.PAL
REVISION B
AUTHOR  AL WEIDNER
COMPANY VLSI PHOENIX, AZ.
DATE    10/25/88

CHIP    P9TO286          PAL16R6
;PIN#  1     2      3      4      5      6      7      8      9     10
     CLK2 MIO3   WRT3   CMD3   /ADS /RDY286 /BHE3 RST286  NC    GND
;PIN# 11    12     13     14     15     16     17     18     19    20
     /OE /BHE2  /SFAZ1 /S0    /S1    MIO    ADS2  SYSCLK RST386 VCC


EQUATIONS
/ADS2 := /(ADS*/ADS2)                    ;2ND PHASE OF ADS, WHETHER READY OR NO1

BHE2  = BHE3*ADS2 + BHE2*/ADS2           ;LATCHED /BHE

SFAZ1:= ADS2*RDY286                      ;1ST STAT PHASE, ALWAYS FOLLOWS ADS
                                         ; WHEN READY

/SYSCLK := SYSCLK + SFAZ1                ;INTERAL SYSCLK - SYNC EACH STATUS CYC.

/RST386 = /(RST286 + RST386*RST286       ;RESET TO TURN OFF ONLY DURING PHASE 2
        +   RST386*SYSCLK)

/MIO := /((ADS*MIO3)+(/ADS*MIO))         ;286 MIO, LATCHED BY ADS

S1    := ADS2*RDY286*/WRT3               ;286  S1, HELD FOR 2 PHASE STAT CYCLE
       + ADS2*RDY286*/CMD3*MIO3          ; 0 ALL OTHER TIMES
       + SFAZ1*S1

S0    := ADS2*RDY286*WRT3*MIO3           ;286 S0,  HELD FOR 2 PHASE STAT CYCLE
       + ADS2*RDY286*CMD3*WRT3           ; 0 ALL OTHER TIMES
       + ADS2*RDY286*/MIO3*/CMD3*/WRT3
       + SFAZ1*S0
```

Table 1. 386SX PAL equations.

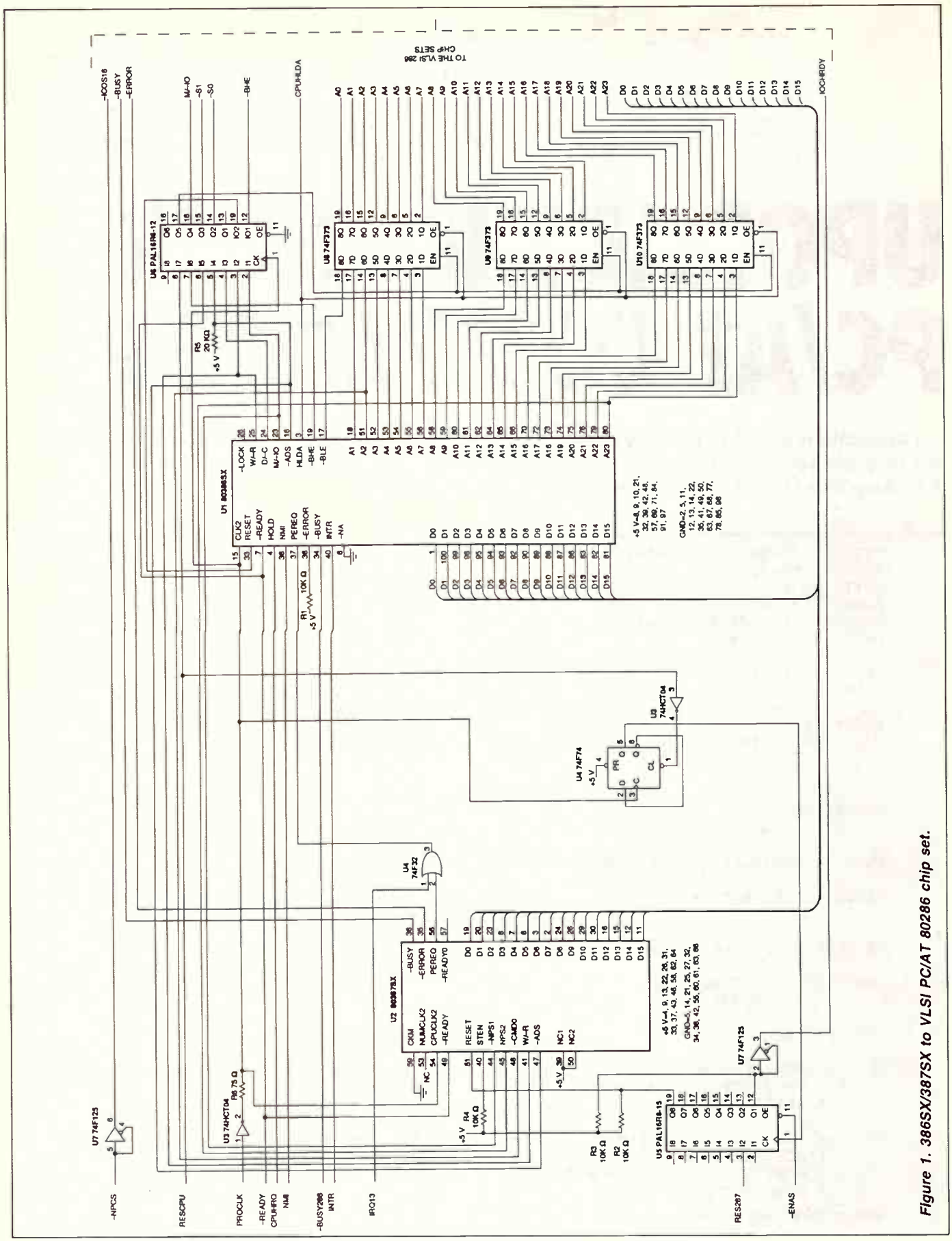


Figure 1. 386SX/387SX to VLSI PC/AT 80286 chip set.

```
TITLE 387SX INTERFACE PAL
PATTERN 387SX.PDS
REVISION B
AUTHOR  AL WEIDNER
COMPANY VLSI PHOENIX, AZ.
DATE    11/16/88

CHIP    387SX   PAL16R8
;PIN#
;1      2       3       4       5       6       7       8       9       10
CLK4    NC      RES287M NC      NC      NC      NC      NC      NC      GND
;11     12      13      14      15      16      17      18      19      20
/ENAS   IORDY   /Q5     /Q4     /Q3     /Q2     /Q1     /Q0     RES387  VCC

EQUATIONS

;6 BIT COUNTER - COUNTS WHEN RES287M IS HIGH, RESETS TO 0 WHEN RES287M IS LOW
;
Q0      := RES287M * /Q0
Q1      := RES287M * (Q1:+:Q0)
Q2      := RES287M * (Q2:+:(Q1*Q0))
Q3      := RES287M * (Q3:+:(Q2*Q1*Q0))
Q4      := RES287M * (Q4:+:(Q3*Q2*Q1*Q0))
Q5      := RES287M * (Q5:+:(Q4*Q3*Q2*Q1*Q0))

/IORDY  := RES287M * /(Q5*Q4*Q3*Q2)      ;PULLS IORDY (LOW) UNTIL CNT = 3Ch,
                                         ; THIS CAUSES RES287M TO STAY HIGH

/RES387 := /RES287M + Q5                 ;GENERATES THE 387SX RESET FOR 32 CLKS

;DESCRIPTION
; PULLS "IOCHRDY" TO HOLD THE CPU WHILE THE 387SX IS PERFORMING ITS RESET
; SEQUENCE.
; ALSO GENERATES A LONGER RESET (32 CLKS WIDE) TO THE 387SX
```

Table 2. 387SX PAL equations.

in either a pipelined mode or non-pipelined mode; but the non-pipelined mode causes significant performance deterioration.

This VLSI PC/AT-compatible 386SX interface has been designed to allow the maximum pipelined performance from the 386SX while fully utilising the coprocessing features of the 387SX. The addition of the 387SX greatly improves the system's numerical processing capability, required in many applications.

Technical considerations

The processor clock of the 386SX is 180 degrees out of phase with the clock supplied to the 286 by the PC/AT-compatible system. Additionally, the U4 flip-flop "Clear" input requires the inversion of the reset CPU (RESCPU) input. The two inverters (designated 74HCT04 in the circuit) provide the required signal conditioning.

The two buffers (U7) provide the tri-state outputs required in the PC/AT system for the 386SX interface. The D-type flip-flop, U4, provides the correctly timed clock signal for the 387SX's PAL. The U4 OR gate provides the 386SX with a PEREQ that remains active after an error condition, as indicated by IRQ13.

The control lines needed in the PC/AT-compatible system to control the status and I/O function differ from those supplied by the 386SX and 387SX. This conversion is accomplished for the 386SX by a PAL 16R6-12 (designated U6 in the schematic). The 387SX uses another PAL 16R8-15 (designated U5) to provide the correctly timed 387SX Reset.

The conversion equations for each PAL, reproduced here (Table 1 and Table 2) have been thoroughly evaluated, according to VLSI. They are commented and each describes the individual conversion that it implements.

Since the 386SX will be operating in the pipelined mode to achieve its maximum performance, the address lines generated will become valid sooner, and remain valid for a shorter period than the PC/AT-compatible system specification requires.

To guarantee correct worst-case timing specification performance of the PC/AT-compatible system, three 74LS373/74F373 octal latches (U8, U9 and U10), are used to hold the valid address values long enough to insure recognition by the PC/AT-compatible system.

This interface is compatible with all speed variations of the VLSI VL82CPCAT-QC, VL82CPCAT-16QC, VL82CPCPM-16QC, VL82CPCAT-20QC and VL82CPCPM-20QC PC/AT-compatible chip sets.

Practical considerations

This mod. could be wire-wrapped on a suitable piece of prototyping board then piggybacked to your motherboard and hard-wired in. For the experienced and adventurous hardware hacker only! Socket the 386SX and 387SX, for safety's sake. You can have your PALs programmed (cost, about $15) at Applix Computers which is located at Bexley in Sydney, ☎ (02) 758-2688. The 74F ("FAST") logic is sold by George Brown Electronics, among others. In lieu of 74F devices, use 74LS. eti

LCD depth sounder

THE Ray Jefferson LCD-600 depth sounder from Imark Communications Pty Ltd is a compact, 160 m depth sounder which utilises a 4" 3" Ultra Twist LCD screen to display the sea bottom, reefs and fish beneath the vessel. This is the most recent display available.

It weighs 1 kg and has 160 x 128 pixel resolution and a wide viewing angle. An Electro-luminescence back light is provided for night time viewing.

The LCD-600 has five depth ranges: 0-10, 0-20, 0-40, 0-80 and 0-160 (plus 0-320 on the 50 kHz version) metres. It also has three modes of operation. The first mode displays the seabed and water just like a chart recorder. The second mode displays the most recent portion of the soundings while the balance of the screen is used to display in large digital form the depth, the speed sweep, the boat speed, log and the surface water temperature.

The third mode displays a graph of the surface water temperature for the previous 15 minutes. The LCD-600 has a dual alarm facility, providing both a shallow and deep alarm. Settings for this area displayed on the LCD.

Five sweep speeds are also featured on the LCD-600, including a freeze frame which enables the screen to be frozen to allow careful study of the information and a synchronised speed which automatically synchronises the sweep speed with the boat speed.

It has a White Line feature which enables the operator to distinguish weed and fish near the ocean bottom from the seabed. In addition to this a zoom feature enables the operator to zoom in to view any 5 m section of the dispiayed range by halving the screen until the desired range is displayed across the entire screen.

The Liquid Crystal Display Sounder operates from a normal 12 V battery and draws only 600 milliamps. Dimensions are only 163mm x 210mm (W) x 56mm (D). Further information can be obtained from Imark Communications Pty Ltd, 167 Roden Street West Melbourne Vic 3003. ☎ (03) 329 5433.

READER INFO No. 258

Anti-static circuit board rack

TRACE Racks anti-static circuit board racks are now available for easy, convenient storing, carrying and processing of assembled or bare printed circuit boards.

Designed to protect ultra-sensitive MOS devices, the Model GFR-4, made of an electrically conductive plastic material, allows the stray static electricity to drain harmlessly to ground. The rack will not only provide protection against these static dischargers but will also resist nearly all solvents and acids. It withstands temperatures of 175°F, and comes in black.

Trace Racks are also available in two other models, the GFR-3 (blue polyproylene) and GFR-2 (red fibreglass reinforced plastic for temperatures to 400°F). These long-lasting racks provide full protection for circuit boards, yet cost less than conventional metal or wood racks.

All materials used will prevent staining, scratching, and other damage to bare or assembled circuit boards. The racks are self-draining and the circuit boards never touch the bottom. Detachable handles are optional.

For more information, write to TRACE RACKS, PO Box 970, El Segundo, California 90245, USA. ☎ 800-358-14000 (outside California) or (213) 772-3309.

READER INFO No. 259

New optical wavelength meter ▼

THE Anritsu Optical Wavelength Meter MF91A has been released by Alcatel-STC. It is said to be ideal for measuring the output power and wavelength of light emitting diodes and laser diodes used in optical fibre communication systems.

Three plug-in units provide coverage for all wavelengths from 400 to 1600 nanometres and power levels from −60 to +10 dBm (at 850 nanometres) can be measured. It has separate digital liquid crystal displays of wavelength and power. An IEEE 488 general purpose interface bus permits remote control of the MF91A for automatic testing applications.

For more, contact Alcatel-STC, Measuring Instruments, 58 Queensbridge Street, South Melbourne Vic 3205 ☎(03) 651 6666.

READER INFO No. 260

Electronic load

HEWLETT-Packard Australia has introduced two models of HP-IB (IEEE-488)-controlled dc electronic loads designed for testing power sources and power components.

The HP 6050A and HP 6060A, have a feature set directed toward power-supply testing, battery-performance evaluation and power-component testing, either in manual or automatic test environments.

Both are designed for technical applications in R and D labs, incoming and production test, and electronic-equipment service. Test applications include power-supply load-regulation tests, load-transient response tests, current/voltage/power cross-over characterisation and start-up delay measurements, among others.

An inbuilt HP-IB interface allows control and readback of all load functions. This one box single package integrated simplifies assembly within an automatic test system by combining functions that otherwise would require several individual units in one unit.

It is suitable for bench use. Both electronic loads have a front-panel LCD meter that shows voltage, current and power-input readings. A front-panel keypad apparently permits easy, repeatable control of the load when it is used manually.

The HP 6060A is a 300-W single-input self-contained electronic load, while the HP 6050A is an 1,800-W multiple-input electronic-load mainframe that can hold up to six individual plug-in modules.

Three load modules with different power ratings are available for the mainframe. They are the HP 60601A, rated at 150 W, the HP 60501A, rated at 300 W, and the HP 60504A, rated at 600 W.

For further details contact Hewlett-Packard Australia Ltd, 31-31 Joseph Street, Blackburn Vic 3130. ☎ (03) 895 2895.

READER INFO No. 261

Surface mount crystal

THE Watch Crystal or Tuning Fork Crystal is offered by Fox in a surface mount version. It is available on tape or reel and built to withstand high temperature soldering. Frequency tolerance is quoted as + – 20 ppm at 25 deg. C.

Details from Clarke and Severn Electronics, PO Box 129, St Leonards NSW 2065.

READER INFO No. 264

Radio communications analyser

THE MS55B Communications Analyser from Anritsu is said to provide all the test and measurement functions needed to maintain narrow band transceivers and radio telephone systems all in a single, portable unit.

It apparently covers a frequency range from 25 to 1000 MHz and can measure fundamental receiver and transmitter characteristics such as output power, frequency, FM deviation, sensitivity, signal to noise ratio and distortion.

The MS555B's inbuilt signal generator has excellent frequency stability and low residual noise, the company claims. A self-contained microprocessor provides optional automatic measurement and data printing.

An IEEE 488 optional interface is available to integrate the MS55B into a computer-controlled test system. Contact Alcatel-STC, Measuring Instruments, 58 Queensbridge Street, South Melbourne Vic 3205. ☎ (02) 925 7200.

READER INFO No. 263

Flat-cable assembly machine

SIEMENS now offers its customers a semi-automatic machine for producing flat-cable assemblies. The flat-cable is inserted manually into the pneumatic press. The connectors are then automatically fed in from the supply reel and attached.

This process is said to be suitable for medium to large quantities up to a maximum of 1220 attachments per hour. The device is apparently easy to use, and securely attaches female connectors per DIN 41651 and PC board connectors.

A further model of the press is available for the attachment of connectors where the pin count changes frequently. It is based on the same mode of operation but the connectors are fed from stacks in a turret.

For more, contact Siemens Components Department, 383 Pacific Highway, Artarmon NSW 2064 ☎ (02) 436 8711.

READER INFO No. 262

I/O, I/O it's off to . . .

PROCON Technology's PC-IO-XX series of digital I/O boards operate through the parallel printer adapter port on any IBM-PC or compatible. A total of fifteen I/O boards may be connected externally to the computer, providing 240 digital I/O points.

Within the range are long-life relay outputs (NR) suitable for general-purpose control applications and audio/video switching; and heavy duty relay outputs (DK) capable of switching 240 Vac at 10 A, and the latest solid-state relay outputs (DP) capable of switching 20 to 310 Vac at 1 A.

The digital input options include 12 or 24 volt ac or dc inputs, high-speed dc inputs and fully isolated TTL level inputs.

The latest addition to the range is the industrial version PC-IO-DK/I board which provides detachable screw terminals, plug-in relays and extended temperature operation.

IBM-PC software is supplied with each board.

Another software package, the PC-IC-XX, also from Procon, is said to facilitate the accumulation of input pulse counts automatically in background on the computer. That is, the computer may be doing other things while the inputs are being scanned and counted.

For further information contact Peter King, Procon Technology, PO Box 43, Essendon Vic 3040. ☎ (03) 336-4956.

READER INFO No. 257

PCB design system

THE new version of HP Printed Circuit Design System (HP PCDS 2.0) has been announced by Hewlett-Packard Australia. It apparently provides placement, routing and interactive capabilities especially suited for the design of dense two-sided surface-mount boards.

Among the new features are automatic placement on both sides of the board, and user-specified placement by device class on the selected side; support of metric, English or mixed units; the ability to flip board sides for viewing and checking plotting; differentiation of board sides through the use of coloured pads on each side and the ability to turn on/off part outlines and pads on each side.

Also included is routing to off-grid parts and SMD breakouts for higher completion rates; availability of multiple pads per part for more flexible design and simultaneous changes of all pad stacks; and user control of router-pad entry and length of pad approach for easier compliance with site-specific manufacturing constraints.

Real-time pan and zoom, a display port and additional display commands help designers orient themselves and provide quick movement around the board. Library-management functions have been enhanced to simplify library-part creation and management.

Improvements in part editing include dot and snapping grids, and automatic scaling.

The HP PCDS 2.0 automatic router adds rip-up and retry algorithms and an adaptive grid capability to the current look-ahead algorithm to improve completion rates for both through-hole and surface-mount designs.

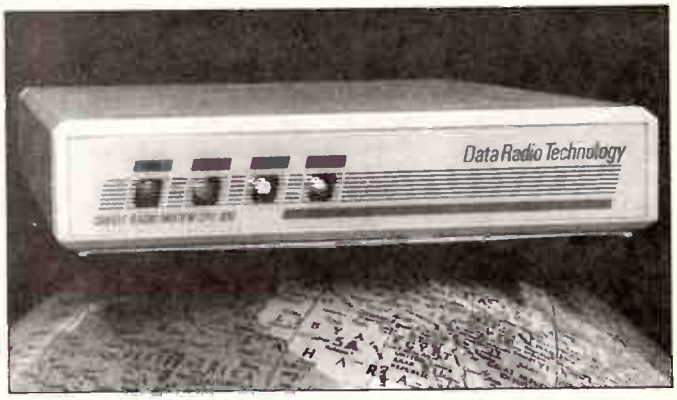
Combined with the new interactive graphics, this re-entrant router apparently gives designers maximum flexibility to make routing decisions. Adaptive gridding evidently provides routing to off-grid and variable-pitch components and eliminates the need to build a nonlinear grid.

In addition to this, the HP PCDS 2.0 router can automatically connect to buried whole or split planes.

For more information contact Hewlett-Packard Australia Ltd, 31-41 Joseph Street, Blackburn Vic 3130. ☎(03) 895 2895.

READER INFO No. 256

New radio data modem



DATA Radio Technology/GFS Electronics of Mitcham, Victoria, Australia, has recently released a new multi-featured version of their Smart Radio Modem, the Model CPU-100 Version 5.0.

DRT claims the release of this new version 5.0 hardware and its accompanying new Version 2.0 Block Exchange Compelled Sequence Protocol (BECSP) makes their latest CPU-100 a very powerful data communications tool for both HF and VHF/UHF radio system applications.

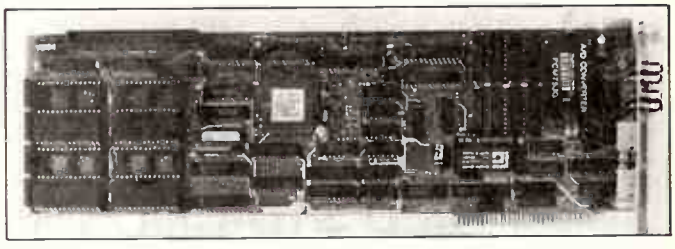
They even quote up to 500% higher throughput from their new version when it is compared with an X.25 type packet modem having the same link baud rate and packet size running on an HF radio system.

Features in the CPU-100 Version 5.0 include auto-ranging of the radio link baud rate; hardware watchdog timer; status display; an internally generated menu; user configurable Protocoless operating mode for baud rates up to 1200; carrier sense multi-access (CSMA) as well as other features.

Further information may be gathered from GFS Electronics, PO Box 97, Mitcham Vic 3132. ☎ (03) 873 3777.

READER INFO No. 255

Texas DSP prototyper



THE FB-320 Interactive DSP Software prototyping system for the Texas Instruments TMS320 family is now available from Energy Control International.

The system includes a Spectrum Signal Processing Inc TMS32020 or TMS320C25 board with 24K 16-bit words SRAM, Poly Forth, System Source Code and extensive software support.

It is compatible with the IBM PC XT/AT or close compatible with 128K RAM and DOS 2.0 or higher.

Other features include full range of addressing on the TMS320; an interactive, incremental programming environment; compact code; target compiler for ROMable programs; user-configurable target nucleus with hundreds of primitives and an extensive library of programmer aids and utilities.

For more information contact Energy Control International Pty Ltd, 26 Boron Street, Sumner Park, Brisbane Qld 4074. ☎ (07) 376 2955.

READER INFO No. 254

Fibre optic TDR

TECH-Rentals now have available the Tektronix OF 152 Fibre Optic TDR. It is apparently designed to meet the needs of engineers and technicians engaged in the installation and maintenance of fibre optic systems. The OF 152 will measure both signal loss and faults in cables up to 60 km in length.

It generates an optical signal at 1300 nm (multimode) and is capable of detecting losses in either fusion or connector splices at distances up to 60 km, with a resolution of 1m and an accuracy better than 0.5%.

The OF 152 comes complete with a built in XT recorder and a fibre optical interface cable with a Deutsch connector on one end. Provision for external DC operation and the unit's portability enables it to be used in the field or the workshop.

For further information contact your nearest Tech-Rentals outlet.

READER INFO No. 253

Execulog

EXECULOG, the electronic vehicle logbook, is apparently able to fit into any vehicle, is precisely calibrated to the vehicle's odometer (metric and imperial) with its own clock and calendar, and can be programmed for up to seven drivers and thirty-one distinct business purposes. It makes all the necessary calculations immediately and accurately, it is said.

The manufacturer says it slashes FBT costs, maximising tax deductions by producing documentary proof of vehicle usage. And it takes only one or two minutes to input the information.

It can cut staff costs by removing manual bookkeeping requirements and produces effective management reports for vehicle usage and costs.

Also, it is apparently easy to integrate output data into any existing fleet management software.

You initially enter all relevant details like number plate, vehicle type et al and then the potential drivers and business purposes. Execulog will remind the driver to press the start button. Readouts tell the driver to obtain receipts when expenses are recorded.

Further details are available from Tony Baxter, Marketing Director, Automotive Electronic Specialists Pty Ltd, Cnr Avenue and Crescent Roads, Camberwell Vic 3124. ☎ (03) 882 8305.

READER INFO No. 252

New HP oscilloscope

HEWLETT-Packard Australia has released the HP 54122T four-channel, 12.4-GHz digitising oscilloscope. It is the second major product in the HP 5412O-series of wideband oscilloscope.

The new digital sampling device is designed for use in the automated-production test environment. A four-range programmable step attenuator was added to each of the instruments' four channels.

It also has an inbuilt statistical analysis with histograms and can make quantitative and repeatable noise, jitter and eye-pattern measurements without an external controller.

All the HP 5412O-series oscilloscopes are said to provide the necessary statistical data for precise, consistent process control and present it in the form of time and voltage histograms.

The 12-bit converter provides up to 14 bits of resolution. This resolution, and matched IF filters for a low-noise floor, yield a sensitivity of down to 1 mV per division when the data is expanded.

For more details, contact Hewlett-Packard Australia, 31-41 Joseph Street, Blackburn Vic 3130. ☎ (03) 895 2895.

READER INFO No. 251

New Multisync monitors

THE NEC Multisync 2A is an ergonomically designed monitor. It is engineered for VGA and Super VGA resolutions; has a 14", direct etch screen which it is claimed delivers maximum contrast with minimum glare; analogue signal input; up-front user controls; dedicated signal cable and a tilt/swivel base. It also boasts a video bandwidth at 38 MHz.

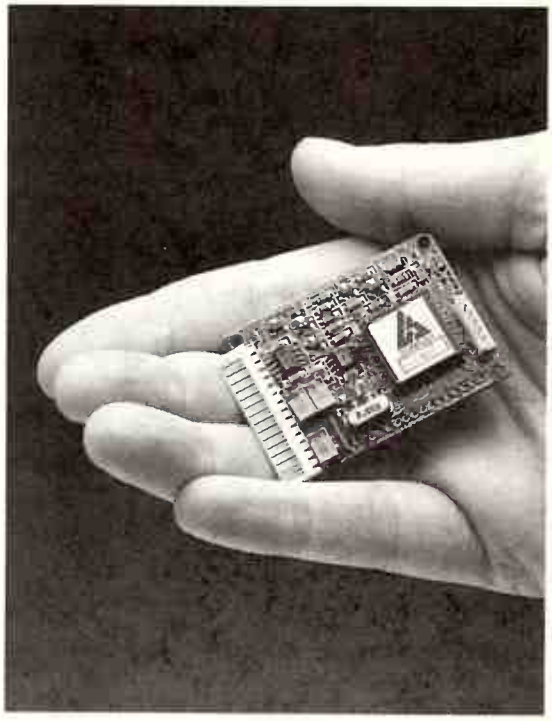
The Multisync 3D, the third generation colour monitor in the range, also supports the TTL graphics standards, including MDA, CGA and EGA. It is said to expand support for the newest analogue standards including VGA, 8514/A and the Apple Macintosh II Video Card.

It automatically scans all horizontal frequencies between 15.75 KHz and 38 KHz; has integral microprocessor, memory and digital controls; additional user programmable memory; and a 14", direct-etch screen.

In addition, it sports 0.28 mm dot pitch CRT and other features also common to the 2A. Video bandwidth is 45 MHz, and it has 1024 × 768 pixel resolution.

READER INFO No. 250

Sequential encoder/decoder



SAID to be one of the most versatile 5/6 tone sequential encoder/decoders manufactured, the GSA211O has been designed for Land Mobile Radio applications. It can be programmed with a standard RS232 link or with a traditional solder matrix.

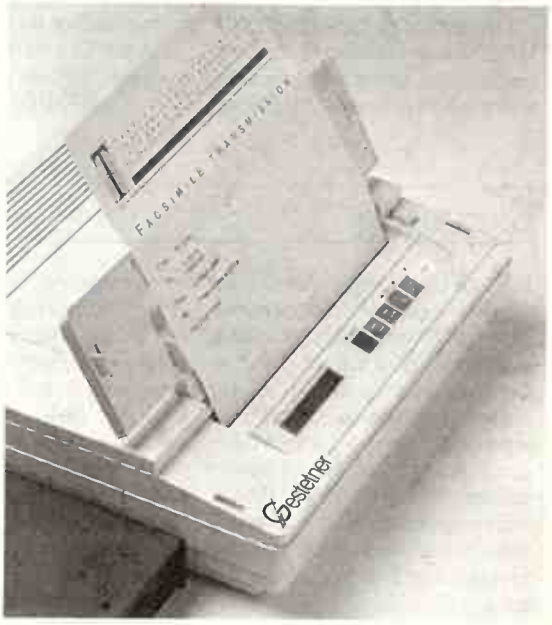
No special software or programming module is needed for serial programming; any dumb serial terminal will do. This facility has been added to allow control from a host microprocessor if desired.

A solder matrix is also provided.

The GSA211O provides considerable programming versatility. Eight international tone sets, five tone periods and auto acknowledge are some of the programmable features.

For further details contact GSA Technology Pty Ltd, 1 Hall Street, Hawthorn Vic 3122. ☎ (O3) 8227858. READER INFO No. 249

New Gestetner page printer



GESTETNER Lasers has announced the latest desktop page printer designed and manufactured in Australia – the GLC6OO. It apparently has the inbuilt capacity to handle text and full page graphics, barcoding and forms generation.

It will even print documents from two computers without changing connectors or software.

The Copyprinter 517O prints copies at prices as low as quarter of a cent per copy. It is easy to use, and can apparently handle memos, newsletters and circulars on different kinds of paper, in a combination of five colours and 12O copies a minute.

Gestetner's X9 fax machine is also said to be easy to use, has a portable terminal and provides a high quality return for your investment.

The 8ppm GLP8OO Scout PostScript laser printer uses a Canon SX laser engine and features 35 fonts, 2.O and 4.O Mbyte RAM options, an SCSI port for a 2O + Mbyte hard disc. This enables users to store bit-maps, downloadable outline fonts and user accessible files.

It has Appletalk, Parallel and RS232/422 communication protocols. Details from Gestetner Pty Ltd, 12 Rodborough Road, Frenchs Forest NSW 2086. ☎ (O2) 975 O555.

READER INFO No. 248

Sine/noise generator

BRUEL and Kjaer's new high-performance Sine/Noise Generator Type 1054 offers signal purity and accuracy over a 0.01 Hz to 2.54 MHz frequency range with a frequency resolution of 10 MHz.

For single, repetitive or continuous sweeps, the sweep rate is adjustable from 0.001 Hz/s to 2.54 MHz/s for linear sweeps, or 0.001 dec/s to 4.000 dec/s for logarithmic sweeps. Output levels from 1 mV to 5 V are selectable with better than –60 dB harmonic distortion.

An inbuilt compressor apparently provides 118 dB of "live" amplitude regulation, which is continuously displayed on the generator's front panel.

For frequently repeated tests, the generator stores nine sets of control panel settings internally for instant recall. It also includes narrow-band, white and pink noise.

For further information contact Bruel and Kjaer Australia Pty Ltd, 24 Tepko Rood, PO Box 177, Terrey Hills NSW 2084. ☎ (02) 450 2379.

READER INFO No. 247

New batteries

PREMIER Batteries now has a new range of high capacity rechargeable nickel cadmium cells. These apparently provide up to 40% increased capacity and are available in a number of popular sizes, including AA, Sub-C and D cells.

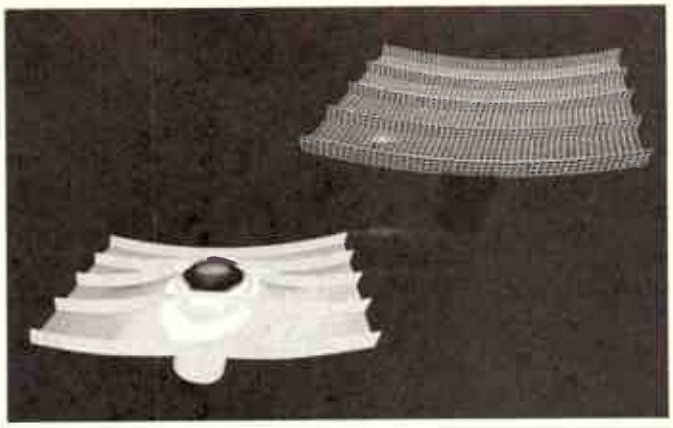
The new cells also feature a higher discharge current capability than the standard NiCad. They are also said to be suitable for rapid charging.

Premier offers them as single cells or in packs suitable for use in medical applications, broadcasting and communication equipment and the hobby market.

For further information contact Premier Batteries, Unit 7, 27 Childs Road, Chipping Norton NSW 2170. ☎ (02) 726 7701.

READER INFO No. 246

MSC/DYNA



MSC/DYNA is a new computer program designed for the analysis of highly nonlinear transient dynamic events like collisions. Applications include helicopter and aircraft crash-worthiness, assessment and simulation and analysis of bird strikes on aircraft.

Other applications include automotive crash simulation, ordinance design such as chamber and breach block interaction, response of structures to explosions, projectile impact and penetration modelling.

The program is fully integrated with modelling packages such as MSC/NASTRAN, I-DEAS, CAEDS, and PATRAN. It is designed to be compatible with current computer aided engineering environments from workstations to the largest computers.

Further information is available from Andrew Currie on ☎ (02) 283 2577.

READER INFO No. 245

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4	29	54	79	104	129	154	179	204	229	254	279	304	329
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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
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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	171	296	321	346
22	47	72	97	122	147	172	197	222	247	172	297	322	347
23	48	73	98	123	148	173	198	223	248	273	298	323	348
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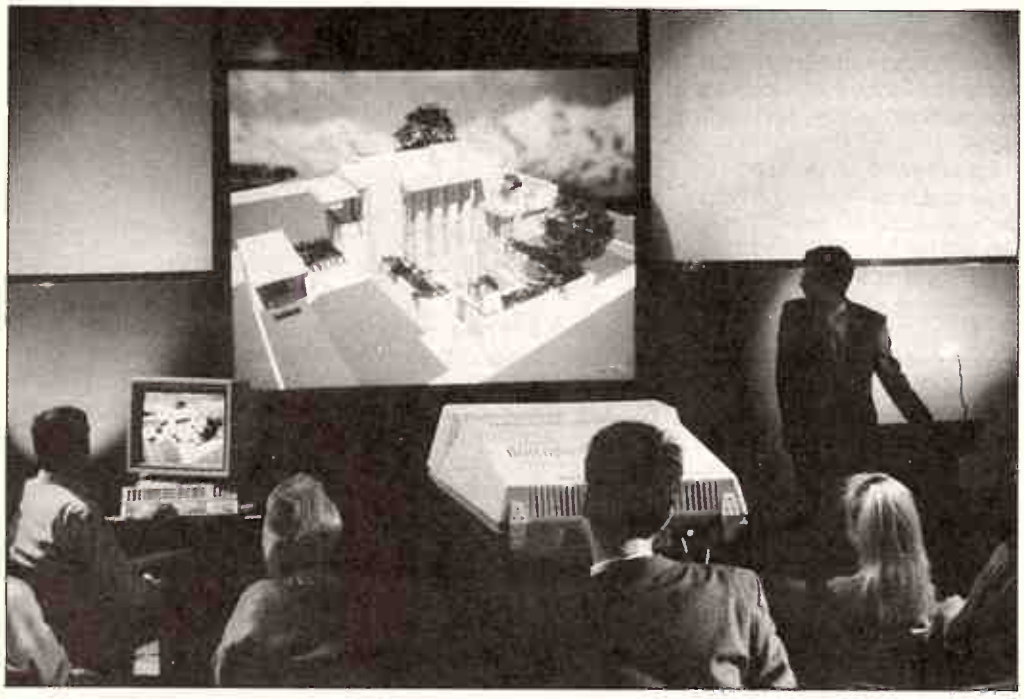
High-res video projector



THE Barcographics 1001 is claimed to be the ultimate in ultra-high resolution universal large screen projections systems. The projector can deliver the full resolution of a graphics workstation on screens of more than 8 m wide.

Barco claims it displays PC-based graphics at such high resolution that it reveals details a PC monitor cannot resolve. It is suited for applications involving CAD/CAM/CAE imaging, solid modelling, graphics art/animation, industrial design and process control.

Because of its range of screen sizes, it is also said to be ideal for applications requiring large group interactive analysis – medical imaging, simulation, educational/training and military command control environments.

For more information contact Peter Della Tolla, Trace Technology Pty Ltd, 200 Rouse Street, Port Melbourne Vic 3207.

READER INFO No. 244

New 60 W soldering station

TO give workshop and laboratory users the convenience of changing from the standard 60W iron to the ultra slimline 30W pencil with its own range of miniature tips a new station for the technician market has been released.

The required iron is selected by using the two positions switch at the front of the console. Heat up takes around one minute. Temperature setting need not be changed.

Apart from space saving on the bench the new double headed unit saves around 40% of the cost of a second station. Scope offers a factory upgrading service for owners of existing Scope stations.

For more, contact Scope Laboratories, 3 Walton Street, PO Box 63, Niddrie Vic 3042. ☎ (03) 338 1566.

READER INFO No. 243

Auto-insert slide switch

THE ASE/F series released by Augat/Alcoswitch is claimed to be the first auto-insertable slide switch. They are compatible with standard IC insertion equipment, and are the first slide switches featuring a process seal.

This allows them to be immersion cleaned in aqueous or solvent processes.

Dupont Rynite, a heat resistant polyester material was used to construct the all plastic DIP package. It apparently withstands surface mount processing and wave soldering.

Available in 1, 2, 4 and 6-pole versions, the new series comes with bifurcated, double-wipe contacts to provide dependable telecommunications grade switching.

The ASE/F series may be ordered with gold or silver plated contacts. The gold version has a contact rating 0.4VA at 28VDC; silver is rated at 300 mA 115 Vac. The minimum life expectancy is said to be 15,000 cycles.

Further details can be obtained from Augat Pty Ltd, Unit 21/26 Wattle Road, Brookvale NSW 2100. ☎ (02) 905 0533.

READER INFO No. 242

Electros from NSD

NSD has released a range of Giant brand radial ana axial electrolytic capacitors. The GRA series is said to be a compact capacitor designed for general use. They are apparently suitable for a range of applications requiring miniature radial type capacitors. They have a good operating life and popular ratings, the company claims.

The GAL series of miniature aluminium electrolytic capacitors are designed for tantalum capacitor replacement, hi-fi preamps and TV circuits.

GRT series miniature aluminium electrolytic capacitors are designed for a range of applications requiring miniature axial type capacitors.

For additional details contact Allan Farnell, Product Manager, NSD Australia, 205 Middleborough Road, Box Hill Vic 3128. ☎ (03) 890 0970. INFO No. 241

Atari robotics

INTENDED for the hobbyist and educational user, the Atari Robokit works on all Atari ST computers and consists of Robokit software, interface board and manual offering several projects to build.

Models can be built from Lego, Fischertechnik or other modelling materials like plastic or metal. They can contain battery powered motors, electromagnets, solenoids, microswitches, sensors for sound, light, touch or heat.

For more contact Atari Computers Pty Ltd, 376 Lane Cove Road, North Ryde NSW 2113. ☎ (02) 805 0344.

READER INFO No. 240

Kodak's battery range ▲

KODAK has released a new range of long-lasting batteries featuring the brand names 'Supralife' and 'Ultralife'.

The Kodak Ultralife 9 volt lithium high-tech battery offers a long shelf life and is said to be a good all round performer, especially in areas of temperatures between –40 and +70 deg. C.

Lithium's greater electrical potential produces higher voltages per cell. The Ultralife cell generates 3 volts per cell as opposed to 1.5 volts produced by the other most common types of power cell.

The Ultralife battery is ultrasonically welded in a polypropylene casing.

It is suitable for a range of medium to low drain 9 volt applications including radios, stereos, security alarm systems and remote controllers. Contact John Waddell, Kodak Product Manager, ☎ (03) 353 2392.

READER INFO No. 239

Flex signal processor

RANE is introducing a new line of products called the Flex Series Modular Signal Processors. Each module is a self-contained processing function packaged in the proposed Half-Rack format. This can be mounted vertically or horizontally using a minimum of 19" rack space.

The basic group of processors will include a variety of mixing functions; line splitters; crossovers; equalisers; filters; compressors and limiters; program meters; headphone amplifiers; output transformers and power supplies.

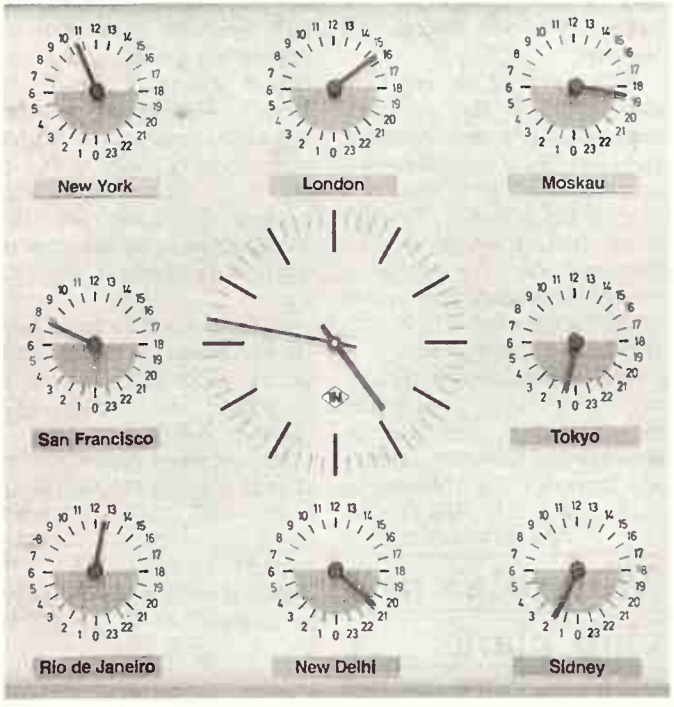
The first of the new units, the FAC-24 is based on current industry preferred 24 dB per octave crossover slopes while the second, the FAC-28, has Rane's exclusive proprietary 8th order Linkwitz-Riley slopes which provide a staggering 48 dB per octave rolloff.

The third of the new units, the FPE-13, is a three band full parametric EQ with overall bypass and overload LED. Similar in performance to the Rane FPE-15, the FPE-13 provides +12 and −20 dB boost and cut and 10Hz to 20KHz sweep range.

Additional information may be obtained from Peter Twartz, Jands Electronics Pty Ltd, 578 Princess Highway, PO Box 171, St Peters NSW 2044.

READER INFO No. 238

Universal time clock ▼



THESE clocks, recently released in Australia through Hertz Electronics, combine a 12-hour clock with eight 24-hour clocks in one housing.

For companies trading internationally, or just over different time zones, the 12-hour clock can be set to local time, and the others to corresponding times in capital cities of the user's choice.

The name of each city can be displayed under each clock face. Each 24-hour clock is half-shaded to clearly distinguish between day and night times.

The WZ9 Universal Time Clocks as they are called are available in two models; the WX9 Battery Clock and the WZ9 Secondary Clock. The battery powered model sells for around $1200. It can be installed just by hanging it on a wall.

The other sells for about $1600. It needs to be connected to a master-clock system, requiring a technician to install it.

For more information contact Hertz Electronics Pty Ltd, 539 Glenmore Road, Edgecliff NSW 2027. ☎ (02) 32 3029.

READER INFO No. 237

SEMICONDUCTOR WATCH

Roger Harrison looks at the latest available in semiconductors.

Ramtron signs agreement

THE research and development subsidiary of Ramtron Australia Ltd, Ramtron International Corporation, has signed a strategic technology co-development and licensed manufacturing agreement with The Seiko Epson Corporation of Japan.

Seiko will continue to pay Ramtron royalties for products produced using Ramtron's patented ferroelectronic technology.

It will also provide Ramtron with manufacturing capacity for Ramtron's own Ferroelectronic Random Access Memory (FRAM) products. Seiko Epson will have sales and distribution rights to specific FRAM products in Japan and South East Asia.

The agreement commits the companies to the joint development of an advanced high volume manufacturing process for sub-micron ferroelectronic complementary metal oxide semiconductors (CMOS).

Both companies will share rights to the jointly-developed technology, and each will design, manufacture and market their own products using the technology.

Unlike volatile memories which lose their data when power is lost, the FRAM can permanently retain information without power. It is said to combine the speed and ease-of-use of static random access memory (SRAM), the high density of dynamic random access memory (DRAM) and the non-volatility of read-only memory (ROM).

Ramtron's proprietary ferroelectronic technology, which is used to build FRAM, can be applied to microprocessors, application-specific integrated circuits (ASICs) and a wide range of other semiconductor devices with many applications from consumer electronics to defence systems.

For more information contact Ramtron Australia Ltd, 1st Floor, Lisgar House, 30 Carrington Street, GPO Box 3853, Sydney NSW 2001. ☎ (02) 262 1933.

READER INFO No. 276

Top-speed CMOS RISC chip

STUDIES of computer programs suggest that 20% of the commands are executed 80% of the time. This has led to the development of Reduced Instruction Set Computing (RISC) technology.

It differs from Complex Instruction Set Computing (CISC) by simplifying the instruction set. This leads to a quicker execution of commands.

The hardware and software for the MIPS RISC were developed in parallel. This way, according to the manufacturer, optimising compiler technology determines the hardware architecture rather than the software being written around the hardware.

Integrated Device Technology Inc, producers of the IDT79R3000, say their product is the highest performance CMOS RISC microprocessor available.

Their efficient pipelining aids in achieving an execution rate of one instruction per cycle. IDT claims. It has optimising compilers for C. Pascal, FORTRAN, Ada, PL/1 and Cobol and supports Unix System V.3 and Berkely 4.3 versions.

R2000 and R3000 are code compatible; it has a tightly coupled co-processor interface between CPU and Floating-Point Accelerator, with the FPA conforming with IEEE 754-1985. Write buffers enhance CPU performance by allowing memory writes during run cycles. R3000 is available in 12, 16.7, 20 and 25 MHz clock rates.

For further information contact IDT Inc's Australian representative. The George Brown Group, Marketing Division, 456 Spencer St, West Melbourne 3003. ☎ (03) 329 7500.

READER INFO No. 275

Motorola's new chip plant ▼

MOS 6, a new metal-oxide-silicon semiconductor fabrication facility in Mesa, Arizona, will apparently employ around 300 people and generate US$200 million in products per year, operating on a seven-day-a-week basis.

Company managers said Motorola will use MOS 6 primarily for the production of the one-megabit dynamic random access memories (DRAMs) and high density, semi-custom application-specific integrated circuits (ASICs).

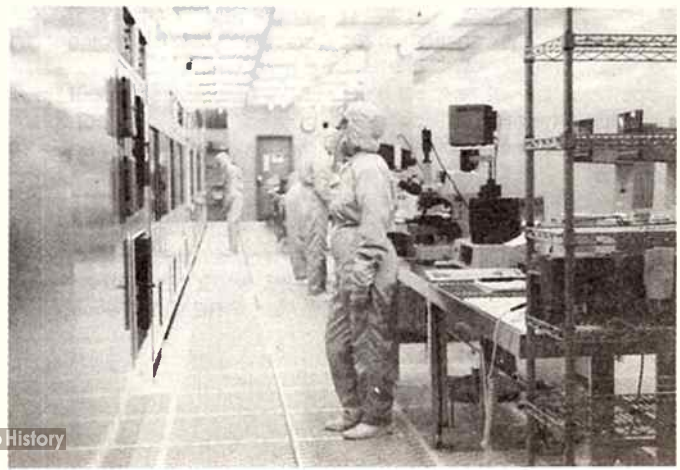
The DRAM memory products employ technology on license from Toshiba Corporation of Japan, a Motor Technology partner. Motorola will also manufacture its own proprietary memory products in the new facility.

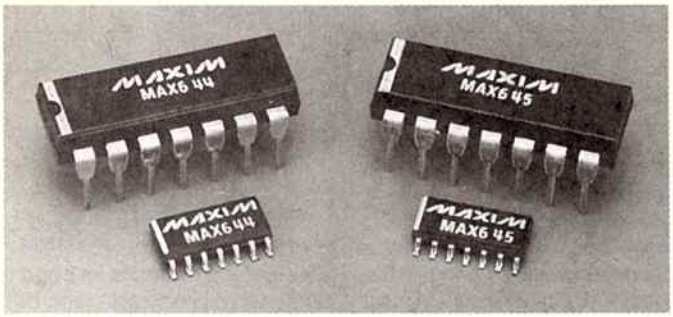
Motorola ASICs are high density, triple layer metal CMOS arrays apparently capable of containing over 100,000 logic gates on a single chip.

The memories and ASICs are part of a balanced portfolio of over 50,000 different semiconductor devices manufactured by the Semiconductor Products Sector, a business which generated $US2.8 billion in 1988.

Motorola officials said MOS 6 will also be dedicated to the fabrication of CMOS wafers six inches in diameter. They will be produced initially with 1.0 micron geometries.

READER INFO No. 274





Regulated +5 v from a single cell

FROM Maxim Integrated Products, the MAX644 generates a regulated +5 V supply when the available input voltage is quite low, like 1.3 V from a single cell battery.

It is guaranteed to start-up at voltages as low as 1.15 V and continues to operate below 1V as the battery discharges.

The MAX545 is optimised for marginally higher inputs, such as two alkaline cells or one lithium cell.

Both can supply 30-500 mA of output current with a maximum of external components. Typical conversion efficiency of 80% is apparently delivered.

Each device has a quiescent current standby mode in which the 5 V ouput can still supply low currents. They both have a low battery comparator output which goes low when the input battery voltage drops under 1.15 V.

A 'control' input, allowing either standby or high power mode to be activated by a switch or logic level, is also a feature of both devices, as is a "Power Ready" output which goes high when the 5 V output has reached its proper output level after power-up or termination of stand-by.

Applications include battery powered portable equipment, pagers, radios, telephones, remote sensing devices and hand held equipment. Both devices come in commercial, extended industrial and military temperature ranges. They are available in 14-lead plastic DIP, CERDIP and smal-outline (SO) packages.

For more detail, contact George Stockman, Marketing Manager, Veltek Pty Ltd, Burwood Vic 3125. ☎ (03) 288 7511.

READER INFO No. 273

IBM makes own CPU chips

AT IBM's Burlington, Vermont, semiconductor plant, 25 MHz 80386 microprocessor chips have been made under contract from Intel since January this year. They are being used in IBM's PS/2 Model 70 and 80 computers.

This is the first indication that anyone has been given "second source" rights to the 80386 chip. Although Intel and other manufacturers have, in the past, licensed other chip manufacturers, Intel had stopped this practice.

Observers believe it is the very close working relationship between the two companies which has resulted in this development.

READER INFO No. 272

Colour RAMDAC for VGA

COMPLETE pixel management and output driver for VGA and IBM PS/2 colour graphics is apparently provided by a colour palette RAM combined with triple 6-bit DAC on a single chip.

The ADV476 from Analog Devices makes up to 256 colours using its 256 × 18 colour look-up table. Pin- and software-compatible with the Inmos IMSG171, this IC is said to be well suited to high-resolution colour graphics, image processing, and CAE/CAD applications.

The system CPU can access different sections of the colour lookup table within the ADV476 Band alter the displayed colours. Video RGB outputs are directly RS-343 and RS-170 compatible without external buffering.

The CMOS device operates from 0 to +70 deg. C. Using a 5 V supply, it dissipates a low 800 mW maximum. The ADV476 is available for 35, 50 and 66 MHz clock rates.

Further information can be obtained from Parameters Pty Ldt, Centrecourt 25-27 Paul Street North, PO Box 261, North Ryde NSW. ☎ (02) 888 8777.

READER INFO No. 271

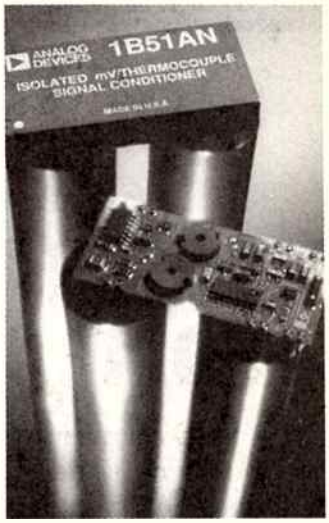
Thermocouple signal conditioner

ANALOGUE Devices' 1B51 is said to provide a complete, high-performance signal conditioning solution. It is designed for isolated interfacing of low-level and thermocouple signals to data acquisition system inputs.

It also includes a chopper stabilised amplifier, isolation circuitry and low-pass filter. It generates its own input-side power, providing true channel-to-channel isolation as well as auxiliary isolated power (6.2 V at 2 mA) for user input-related circuitry.

The 1B51 is resistor programmable for gains from 2 to 1000. Galvanic isolation to 1500 VRMS is provided via transformer coupling. Inputs are protected against continuous 240 VRMS faults.

A 3 Hz, three-pole active filter reduces line frequency noise with 60 dB normal mode rejection; CMR is 160 dB at maximum gain, AD claims. Zero-suppression (to null large input signal offsets), as well as open-input detection and



cold-junction compensation (needed for thermocouples) are easily implemented due to input stage's design.

Each 1B51 requires +13.6 to +18 V at 12 mA (quiescent) and is specified for performance from −40C.

For more information contact Parameters Pty Ltd, Centrecourt, 25-27 Paul Street North, PO Box 261, North Ryde NSW 2113 ☎ (03) 888 8777.

READER INFO No. 270

High speed HDLC

THE SAB 82525 from Siemens is said to offer a data transfer rate of 4 Mbits/s and is apparently regarded as having the highest performance of any device of this type currently available in the international market place.

The range of applications extends from the switching processor to patient monitoring. Siemens plans to sell around 300,000 HDLC controllers type SAB 825525/256 by 1990.

There is the HSCX, which supports two serial channels, and HSCX1 which supports only one. The HSCX is now presented as an 8-bit wide bus interface which is configurable for all microprocessor systems from Siemens /Intel and Motorola.

For more, contact Siemens Ltd, Communications Equipment Department, 544 Church Street, Richmond Vic 3121 ☎ (03) 420 7318 READER INFO No. 269

JIM TUCKER

PRINTER PROBLEMS — SOME SOLUTIONS

Computers were supposed to eliminate paper. Ha-ha! We now use reams of it! Jim Tucker continues our monthly column for PC users, and says printing should be easy, but . . .! Here are some answers and a free DOS program.

Take the simple act of printing. Please. All manner of things go wrong. The paper goes crooked and jams, the typeface goes into the wrong font, the ribbon fades, and the darn thing keeps printing across the paper perforations.

So, let's tackle a few of the problems which plague printers and see if we can find some solutions. Nothing too fancy. We'll assume you have a garden variety Epson compatible dot matrix.

We'll have to start with the printer manual. Some are good but most are understood only by gurus who live on mountain tops or the bloke in Tokyo who wrote it. Still, we'll suppose you have manoged to unpack your printer and plug it into the correct hole.

First of all, let's get the paper in the proper place. You need a little shelf for the printer (buy one or build one) so that the paper is stored properly. Once you get that right, paper jams will disappear – well, almost.

I'll assume you're starting with tractor feed paper. If you are buying a printer for the first time note that there are three types of tractors – those that move the paper before the platten, called *pushers* because the paper is literally pushed past the print area; those with the tractor after the print head, called *pullers*; and those that do both.

Pushers are, in some cases, the least effective way to move paper. Horses seem to work better in front of the wagon. However, my pusher has one advantage over pullers – it can pull the paper backwards. Pullers can't do this. It's not a feature everyone needs but very useful for printing graphics and letterheads with FLASHPRINT and other programs.

Those with tractor feeds before and after the print area give the best graphic alignment. You know, the lines of white space that appear in the middle of an image.

After you have loaded the paper see if your printer has a self-test function described amongst the gobbledegook in the manual. On most printers you hold down the paper feed button on the front panel as you switch on the machine. If all goes well the printer should begin printing the alphabet all by its intelligent self. You don't need your computer attached to do this. I do a self-test each time I load paper or change a ribbon. When you have proved that it prints, turn it off to stop the test.

Don't go dippy

Now we get down to the nitty-gritty. Somewhere in the printer you'll find tiny DIP switches which need to be set. I can't tell you where because every printer is different but you'll find out in the gobbledegook manual. On most modern printers you'll find a row of little switches below the front lift-up cover. Sometimes they are on the back panel. On old Epsons you have to unscrew the bottom panel to find them. Grrrrr!

The switches control the default values when you first switch on the printer – the typeface, the character set (for foreign languages), and the page length. If the switch is on the printer defaults to something, if the switch is off it defaults to something else. There's no half-way position.

I can't describe what they all do because the guys up north keep changing functions and positions, but here are some that I think are important.

Page length

Now here's a worry, for starters. The page length. Printers aren't metric. Most of them work in good old-fashioned inches. The DIP switch will give you a choice of two page sizes – 11 or 12 inches which is normally 66 or 72 lines per page. Your Aussie metric A4 paper is neither, it's 70 lines per page and there's no DIP switch setting for this. Arrghh!

If you want a simple solution you can buy 11-inch fan fold paper and make sure the DIP switch is in the correct position (66 lines per page). And make sure your printing program knows about it, too. If it was (most likely) written in the US it will assume an 11-inch or 66-line pages.

If you want to print on true A4 paper you will have to send a command from the computer to tell the printer you are printing 70 lines per page. On most Epson compatibles use FLASHSET(see "Free Offer" at end of column) to send the page length in lines from your PC. Try FLASHSET (27)C(70) for a standard A4 page. If your word processor (such as Wordstar) allows a printer initialisation string include it in the program.

Again, don't forget to tell your program the length of your page. In Wordstar you should type .PL70 (for page length 70) at the top of your document.

Ferkin commands

Printers move paper in bits of inches which are so small I call them jiffy ferkins. Printers use a stepping mirror which moves the paper a small increment each time it receives a pulse.

Older printers move the paper 1/72 inches for each pulse. Modern printers can do this but can also increment at 1/216 (72 times 3) of an inch. But life isn't easy. A jiffy ferkin on a 24-pin printer is 1/180 of an inch. Here's why expensive desk top publishing programs (Ventura, for instance) don't work on 24-pin printers. (Yes, Virginia, there are other reasons. But don't write now, I'll call you).

Actually, a real A4 page is 297 mm from top to bottom and that does not equal 10.6666 inches. The people who make true A4 fan fold paper cheat a bit – it's a few jiffy ferkins more or less than 297 mm between perforations.

Hop, skip and jump

There's an interesting DIP switch on my printer. When the switch is on the printer will skip six lines (one inch) when it reaches the bottom of a page (over the perforation). Trouble is, if you set it on and the program you are running also controls pages they don't get on too well. One guy skips, the other hops and the end result is a rather long jump with lots of white space. Experiment with your program before you turn the perforation DIP switch on.

Feed me a line

Your normal DOS program sends two bytes at the end of a line. One is a carriage return (ASCII 13) which sends the print head back to the left margin and the other is a line feed (ASCII 10) which moves the paper the required number of jiffy ferkins which is normally one-sixth of an inch.

Some fool, back in the stone age, decided the line feed was redundant and reckoned that every time his printer received a return it should also, automatically, perform a line feed. There are blessedly few programs which still assume this but even today you may find a DIP switch which tells the printer to do an automatic line feed every time it gets a return code from the computer. Only switch this on if your program does not send line feeds, else you will get two for the price of one (great for sending hard copy to magazine editors!).

Foreign tongues

Printers, alas, are non-metric and cannot cope with A4 size paper with a switch setting. Yet they can cope with umpteen foreign languages. For instance the # (hash) character is common in the United States. It's hardly ever used in Britain and the character on a UK keyboard is used for the pounds (currency) symbol instead. For currency, Sweden uses a character which looks like the sun, Japan has a Y for yen with two strokes through it and Spaniards print their question marks upside down.

Because printer makers want to sell machines everywhere from New York to Iceland there are normally a couple of DIP switches which let you choose an international character set. Unless you write to Reykjavik or need to print pounds instead of # you can leave this switch at the factory setting. On the other hand, if you really deal in sterling choose the UK character set.

Most people don't bother. For example, I recently received a quote for software from Britain which said the price was #49.

Enough about DIP switches. Just remember that these control some of the default setting on your printer. The machine will be normally supplied with US settings for 11-inch paper and will not need to be changed. If you make changes always do it with the printer switched off because the switch settings only become operative as the machine is switched on.

Who's in control?

Printers aren't all that dumb. In fact they are little computers in their own right. Inside the little beast you have a microprocessor, a program, and memory.

The printer's ROM (Read Only Memory) interprets each byte sent by the computer and decides what to do next. Send it a simple binary series of O1OOOOO1 (remember computers only know about zero and one) and it will print a capital A. Send it O1OOOO1O and you get the letter B. And so on.

Printing the letters of the alphabet is simply a matter of sending the correct code. But modern dot matrix printers can do much more – print italics, bold, different fonts and even change colours.

In your gobbledegook manual you'll find a section called something like Printer Control Commands. This is where most of us get into strife.

When the processor in your printer receives certain commands it changes its clothes. It turns on bold, underlines or prints italics, and so on. The manual tells you what the printer needs. Usually it's a sequence of code which begins with ESCAPE (ASCII 27) which simply alerts the printer that you are about to tell it something.

What follows is the code required by the printer. Modern dot matrix printers can handle hundreds of different codes.

Confusion reigns

At first glance the printer code described in the average manual looks like you need a degree in computing science just to get anything working. Not so. Let's examine a simple example and hopefully all will become clear.

My Panasonic printer manual says to print near letter quality, elite pitch mode, it needs the following code:

ESC + O
27,111 dec
1B,6F hex

Now these three lines all mean the same thing. What they are really saying is if you send ESC (which is the name for ASCII 27 decimal or 1B hex) you are telling the printer, "Here comes a command." The command follows: the lower case letter o (which is ASCIII 111 decimal or 6F hex). If we send that to the printer then presto! Near letter quality and elite (12 characters per inch).

Now I'll really try to make it simple. Forget the ESC nonsense. It's really only a name for the command and you cannot key that into a document and expect anything. And ignore the hexadecimal stuff. That's for programmers who have 16 fingers.

We'll look only at the decimal numbers and assume each number consists of three digits. If there are only two digits I'll add a leading zero. Why I'm doing this will be revealed later.

Here is a sample of Epson commands:

O27 O45 OO1	Turn on underline
O27 O45 OOO	Turn off underline
O27 O82 OO8	Select Japanese characters
O27 O82 OOO	Select USA characters
O27 O54	Select italics
O27 O55	Turn off italics

Remember, your printer manual will not show the leading zero, but I have a reason for this. Keep reading. There are hundreds of commands and you can combine them, of course. For instance, O27 O45 OO1 O27 O54 will turn on underline **and** italics.

How to send 'em

Golly, we still have another problem. We have a list of decimal numbers to send to the printer which we have gleaned from the manual but how do we include these in our program or document?

Well, if you write your own programs (which most sensible people do not) it's easy. But say you want to send the code for underlined italics from your word processor, spread sheet or whatever.

I have knocked together a thing called FLASHDEC (not much of a name, but it means it's flash and it sends decimal bytes) which is a memory resident program. It traps INT 17H (which is output to the printer) and converts a three digit number to ASCII. To send any decimal number as a byte, from any program that prints, simply precede the number with a left curly bracket. It even works from the Print Screen key. The rules are simple: Load FLASHDEC (from a batch file if you like) and precede the number with a left curly bracket. For instance, to turn on underlined italic, key this:

{{}027{{}045{{}001{{}027{{}054

You can put this printer code into anything that prints. This is not the ideal solution, of course. Your program's setup may have more sophisticated methods. And my curly bracket thing will certainly stuff up justification or line lengths in a word processor which will assume the code is going to be printed as it appears on the screen. But on the other hand, you could include the code on a line of its own and it would print as a blank line.

Another use: key the code as a DOS command and print the screen. It will certainly show you what happens. A quick and cheap way to test out printer commands before you include them in programs or documents.

Oh, and the reason for three digits? First of all, it keeps you organised so you know you have keyed the correct number. And it saved me writing another 100 lines of assembler code.

Free Offer

FLASHDEC.COM and FLASHSET are available free to ETI readers.

Simply send a DOS 5.25-inch 360K formatted disk to: Jim Tucker, PO Box 582, Blackwood, SA 5051 in a suitable mailer (available from Australia Post) with return postage. eti

TECHNOLOGY

THINK THIN, THINK INVISIBLE

Sound that can't be seen

The Technics audio-flat-panel speakers, released last year, have gathered accolades the world over in the short time since their launching. Indeed, Louis Challis waxed lyrical about the model SB-AFP10s last month. Roger Harrison reports on Technics' innovative speaker technology.

The concept of flat panel loudspeakers is not new. Quad pioneered the concept with its electrostatic panels in the 1960s. A few other manufacturers (but only a few!) have followed suit in the two decades since. More recently, US manufacturer, Magneplanar, introduced flat panel loudspeakers. They're not electrostatic, though. Rather, they consist of a "voice coil" laid on a flat diaphragm which is sandwiched between serried ranks of magnet pole pieces.

Loudspeakers with large, flat diaphragms have a number of advantages over loudspeakers which employ conventional cone or dome drivers. Firstly, a large, flat panel requires substantially less motion, or displacement, to produce comparatively high sound pressure levels. This means that such a loudspeaker comes closer to achieving true linear piston motion, resulting in lower distortion. Secondly, a flat panel does not behave as a point source radiator as conventional speakers do, which produce a spherical wavefront that suffers comparatively rapid attenuation owing to dispersion of the sound energy, while a flat panel's output closely approaches a plane wavefront. This has the advantage of suffering less dispersion loss and being less susceptible to irregularities in the frequency response caused by reflections from adjacent walls, ceiling and floor within a room.

Some ten years ago, Technics pioneered flat-faced speaker drive units when they introduced their honeycomb disc drivers, which employed a then revolutionary technology. The conical shape of conventional dynamic drivers was never a virtue of the design, but a necessity thrust upon the designers through the need to obtain a rigid moving surface with as little mass as possible and having low resonance characteristics – which meant using soft, pliant paper. The need for drivers with flat diaphragms was appreciated very early in loudspeaker development, but the problem of making material suitable for the application proved a major stumbling block. Cones were cheaper and easier to manufacture (for that matter, they still are!).

The cone on a conventional driver has two parts to its frequency response: the piston operating range, which covers usually the lower octave or two of the driver's response, and above that its modal operating range where the cone no longer acts as a rigid piston, sound energy radiating across the cone from the voice coil to the rim, creating a number of undesirable effects, including beaming (reduction in dispersion) and distortion. These partial vibrations on the cone's surface give rise to the term cone breakup, which designers often attempt to suppress with the crossover rolloff.

Additionally, the semi-enclosed air-filled cavity within the cone volume has a resonance effect known as front cavity effect which limits the upper frequency performance of conventional drivers.

The acoustic centre of a cone driver is located near the apex of the cone. Thus, to obtain a linear phase or time aligned loudspeaker using multiple cone drivers, the drivers must have their acoustic centres aligned, necessitating a stepped front to the loudspeakers which is constructionally complicated and introduces diffraction problems from the cabinet at higher frequencies. Various ploys to minimise this problem have been tried by manufacturers.

A rigid, flat diaphragm offers an inherently smoother frequency response, better dispersion and lower distortion. Additionally, the acoustic centre of flat diaphragm drivers is on the front surface, thus a linear phase system is easily achieved with the drivers all mounted on a plane surface.

Technics' honeycomb diaphragms provided a flat, lightweight piston with a wide frequency response using an axially symmetric honeycomb structure, with the honeycomb radiating from the centre, sandwiched between layers of thin metal foil. The design proved highly successful, delivered lower distortion and better dispersion and the technology was copied in various forms by a number of other Japanese manufacturers.

All this set the stage for flat panel driver development a decade on.

The goal

The engineers at Technics in Japan are working towards a long term goal, according to Technic's product manager in Australia, Gary Love. He told me that the philosophy at Technics is "...music is to be felt" and that their goal is to develop speakers that produce "...sound that can't be seen". The audio-flat-panel speaker technology is the first stage in achieving that, Gary said. Stage two is to produce speakers that mount in a wall, while the third stage is to make the speakers "invisible".

The traditional tower loudspeaker enclosure, about 300 mm or so wide by perhaps 300-400 mm deep and standing

The Technics SB-AFP10 loudspeaker. It stands tall and wide, but is very thin.

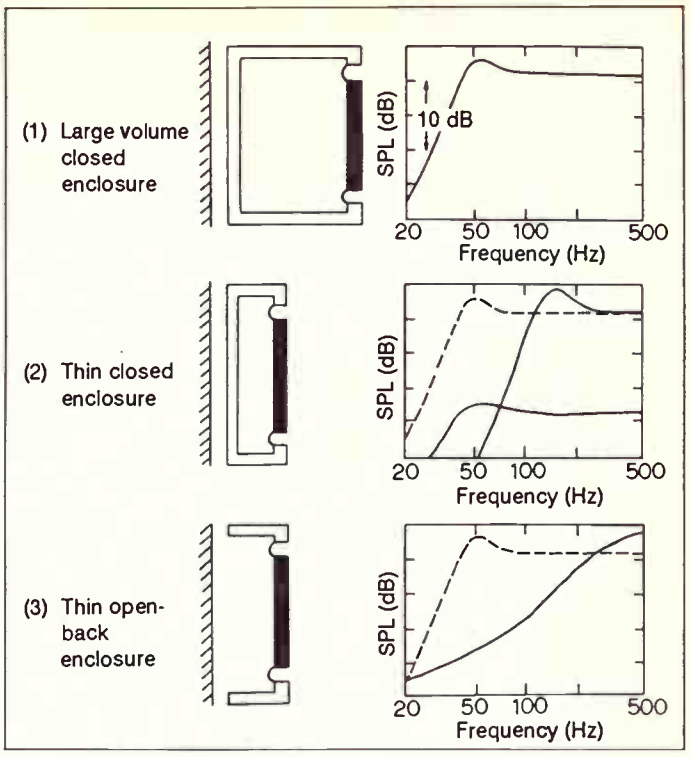


Figure 1. Typical frequency response curves obtained from a thin, closed enclosure and a thin open-backed enclosure are clearly inferior to a conventional large volume sealed enclosure.

perhaps 1.2-1.5 metres tall, definitely intrudes in the usual domestic listening room – be it lounge room, family room or whatever. While such systems are necessary to provide the appropriate wide frequency response, particularly the bass response, in a conventional 3-way or 4-way design, loudspeaker manufacturers have long sought ways to reduce the speaker cabinet volume or resorted to other types of systems to reduce the loudspeaker's intrusiveness. I discussed this at length in *Loudspeakers – Designing for the Future* in the June issue.

The approach the Technic design engineers took was to develop a flat diaphragm driver and mount it in a thin cabinet, to come up with the audio-flat-panel concept. Thin, flat speakers are inherently less intrusive in a room, and with further development of the concept, it's possible to see such speaker systems being incorporated into the wall of a room so that they blend architecturally, becoming a component of the room's structure, rather than a component of the room's decor.

The flat panel driver

The Technics engineers, clearly learning some lessons from their long experience with the flat honeycomb disc driver technology, and from the experience of other designers with flat panel speakers, set out to design a large flat panel driver that would achieve the sort of bass performance demanded, let alone desired.

It's a tall order, for to move as a piston the diaphram must be rigid, but it also must be light else too much power is required to drive it. The diaphragm must have high internal acoustic loss. This, together with high rigidity, are the two important characteristics of a large diaphragm if problems with partial vibrations are to be avoided.

Why not use the honeycomb sandwich metal foil structure so successfully employed in the honeycomb disc loudspeakers? Well, that's alright for the comparatively small structures employed in those drivers, but it lacks sufficient internal acoustic loss for use on large panels, according to Technics. So, they had to come up with some other sort of material.

Their solution is uncoventional, to say the least. The diaphragm they came up with is a sandwich of mica foam, mica sheet and paper pulp strengthened with a substance

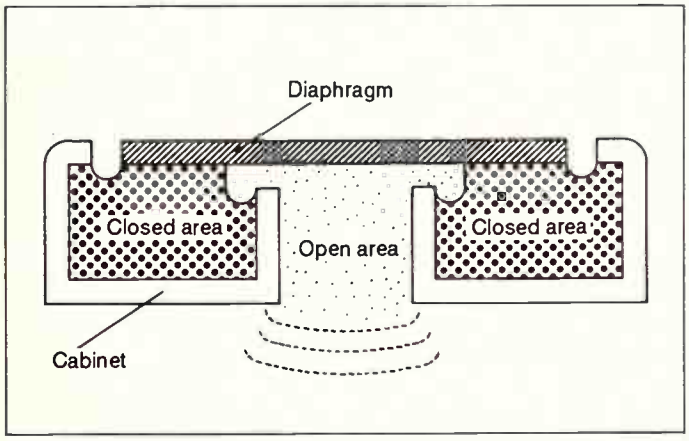


Figure 2. The Twin Cabinet principle, shown in cross-section.

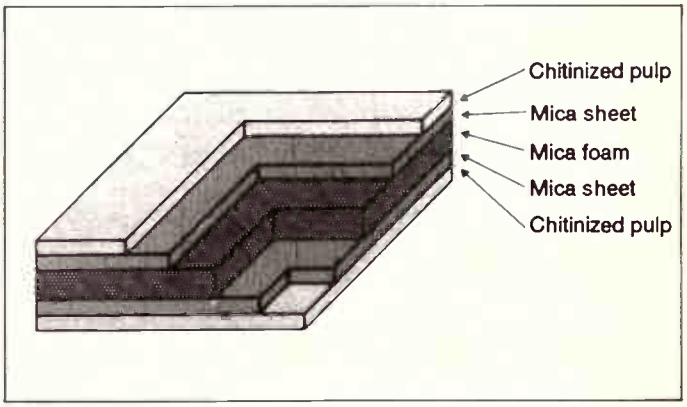


Figure 3. Showing the sandwich construction of the AFP woofer diaphragm.

Thinking thin

known as chitin, as illustrated in Figure 3.

Chitin is principally a "mucopolysaccharide", the tough substance which makes up crustaceans' shell (crabs, lobsters etc). It is similar to cellulose, the chief component of pulp. When added to pulp with a binder, chitin forms chemical bonds with the cellulose molecules during the paper making process resulting in a chitinised pulp. It has 20% greater rigidity and three times the internal loss of ordinary pulp, which makes it a highly desirable diaphragm material. This is used for the inner and outer surface layers of the driver's diaphragm (see Figure 3).

As pointed out in my introduction, a large area speaker diaphragm has advantages over a smaller area one. For a given frequency, acoustic power output is proportional to the diaphragm area and maximum displacement. For constant power applied to a given diaphragm area, the required peak displacement doubles each octave you move lower in frequency. This means that a driver with a small diaphragm must have a long throw to achieve adequate bass output. A driver with a large diaphragm area can deliver the same performance with much less displacement.

A speaker with a small diaphram called on to produce low bass at high output (high displacement), generates distortion when the inner and outer suspension systems and the voice coil itself exceed their range of linear movement. Thus, where circumstances permit, a large area diaphragm is more desirable for low frequency reproduction since it requires smaller displacement for equal output. Figure 4 compares the displacement versus sound pressure level at 50 Hz for two conventional woofers and Technics' AFP woofer.

At an SPL of 110 dB, the AFP woofer has a displacement of 1.0 mm; the 250 mm (8") diameter woofer has a displacement over ten times that! To equal the AFP driver's performance, you'd need a conventional cone woofer over one-and-half metres in diameter! The woofer developed for the AFP system speakers has a diaphram 280 mm wide by 780 mm tall. It is 9.5 mm thick. A low mid-range driver using the same technology was developed at the same time, having a diaphragm 114 mm wide by 300 mm high and 4 mm thick.

To permit linear (piston-like) operation over a wide frequency range, the tendency towards partial vibrations and thus diaphragm breakup must be overcome else distortion and colouration may result. If you drive a flat panel diaphragm in the middle, resonances are easily excited. You may remember a high school physics demonstration where sand or talc was sprinkled on a horizontal flat metal or glass plate, supported at its centre, set vibrating – resonating – by drawing a violin bow across its edge. The sand or talc would bounce about with the vibrations set up and settle in a characteristic pattern, showing up the nodal lines where the plate displacement was at a minimum. A variety of patterns may be generated in this way, each representing a distinct vibration mode.

Technics engineers used computer modelling and analysis to develop a four-point drive system which they say dramatically extends the frequency range of the flat panel drivers. This four-point drive system couples four voice coils to the diaphragm at the points which coincide with the natural resonance modes. The technique is illustrated in Figure 5, showing how both primary and secondary resonance modes are virtually eliminated with four-point drive when compared to single-point and two-point drive.

The assembly of four voice coils and their magnets behind the woofer diaphragm is shown in cross-section in Figure 6. The

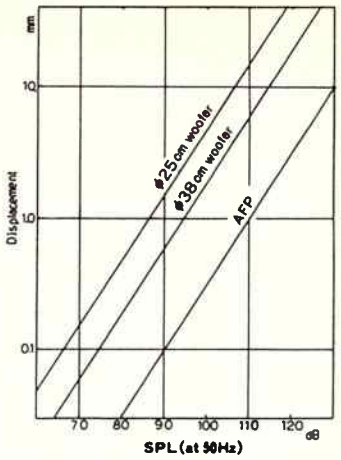


Figure 4. Comparison of displacement versus diaphragm area between two conventional woofers and the AFP woofer.

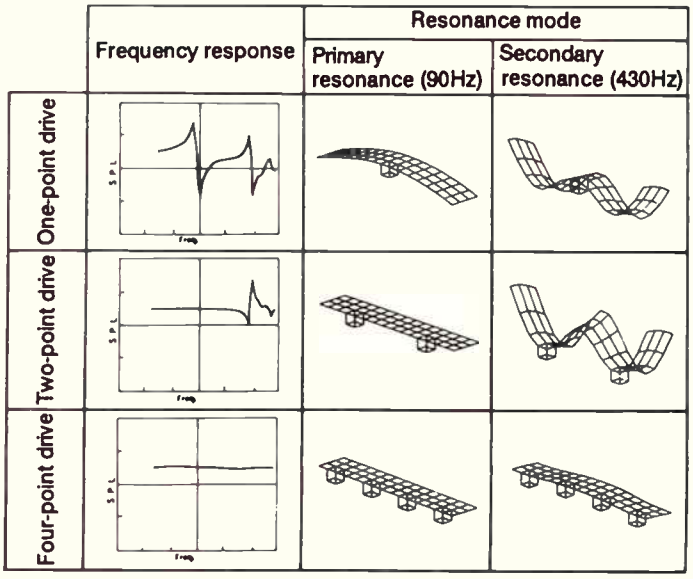
magnets are 120 mm diameter barium-ferrite; each voice coil is 45 mm in diameter constructed using flat, edgewise wrapped polyamide-fused wire. It's all mounted on a sturdy diecast aluminium frame.

The mid-low drivers are shown in cross-section in Figure 7. They use 75 mm diameter barium-ferrite magnets and 25 mm diameter voice coils.

Bass and the thin cabinet

Normally, we expect a large diaphragm driver and large cabinet volume to be required for adequate reproduction of the low bass end of the audible frequency range. But, as mentioned earlier, large, bulky speakers are often considered impractical. The obvious solution is to somehow shrink the cabinet dimensions.

So what happens when a large speaker is put into a closed, thin cabinet? Well, you find the bass resonance frequency rises, and thus the bass end rolloff – you get less bass. If the same driver is then mounted in a thin, open-



◀ ***Figure 5. Showing how four-point drive of a flat panel driver overcomes resonances and diaphragm breakup when compared to single-point and two-point drive.***

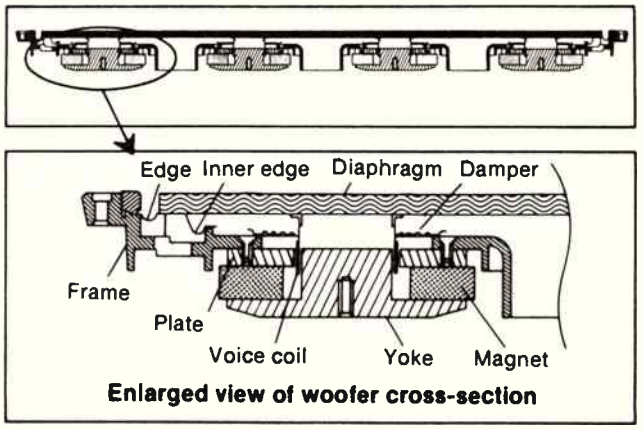


Figure 6. Cross-section of the AFP woofer drive system and an enlarged view of an individul drive unit.

backed cabinet, the front and rear radiation of the driver are essentially out of phase, the path between the front and rear of the cabinet being acoustically short and the bass frequencies tend to cancel, with substantial loss of bass response. All this is illustrated in Figure 1.

So, neither a closed nor open thin cabinet can deliver satisfactory bass response from a large diaphragm speaker. However, Technics engineers found that by incorporating aspects of both the closed and open designs in a single cabinet it was possible to compensate for the deficiencies of one with the other. This hybrid aproach, which Technics has dubbed the 'Twin Cabinets' system, is apparently the key to the success of their AFP speakers.

Figure 2 shows the principle of the Technics Twin Cabinet system. The open area behind the centre section of the diaphragm raises the compliance, prevents the undesirable raising of the bass resonance frequency, while at the same time increasing the acoustic distance between the front and rear preventing the effects of phase concellation we saw earlier. The two separate responses combine to produce a frequency response for the Twin Cabinet like that shown in Figure 8.

As you would expect, the design of the AFP cabinet required some considerable fine tuning – no less than 80 trial models were made before the Technics engineers' were satisfied.

The result is a speaker cabinet just 65 millimetres from front to back, yet it has the ability to reproduce the kind of low bass information found on today's digital recordings.

The AFP range

Technics has produced three loudspeakers in the AFP range. All are 4-way systems with similar frequency response rate at 35 Hz to 40 kHz (at -10 dB), but each has different power ratings.

The SB-AFP1000 is the top of the range. This stands 2.25 metres high by 2.2 metres wide. Rated at 600 W (DIN), it employs eight woofers, four mid-low drivers, four 80 mm flat diaphragm mid-high drivers and four 27 mm flat diaphragm tweeters. That's 20 drivers in all, per loudspeaker. It weighs 320 kg (including stand).

The SB-AFP100 uses four woofers, two mid-low drivers, two mid-high drivers and two tweeters. Ten speakers in all. It is rated at 300 W (DIN) and stands 2.25 metres tall by 1.2 metres wide. It weighs 170 kg (with stand).

The SB-AFP10 employs a modest complement of five speakers – two woofers and one each mid-low, mid-high and tweeter drivers. Rated at 150 W (DIN), it stands 1.2 metres high by one metre wide and weighs-in at 73.5 kg (with stand).

The quoted impedance of all three models is 6 Ohms, which is readily handled by today's amplifiers. The '1000 has a quoted sensitivity of 93 dB for 1 W at one metre, the '100 is 92 dB and the '10 is 90dB.

The mid-high driver and tweeter are unusual, too. The 80 mm diameter mid-high driver features a flat, circular diaphram with a sandwich construction using mica as the core material and mica surfaces coated with natural lacquer formed into a thin, film-like membrane. The magnet is a 1 kg-weight strontium type, housing a 50 mm diameter voice coil.

The 27 mm diameter tweeter has a diaphragm composed of a mica core material sandwiched between outer surfaces of diamond coated mica. It uses a 130 x 58 mm strontium magnet. Technics claims it has an upper frequency limit of 50 kHz. The mid-high driver and tweeter are shown in cross-section in Figure 9.

Without doubt, the first stage of Technics' plan has set the scene for what is to come. The day when music in the home is felt, not seen, is clearly within sight. eti

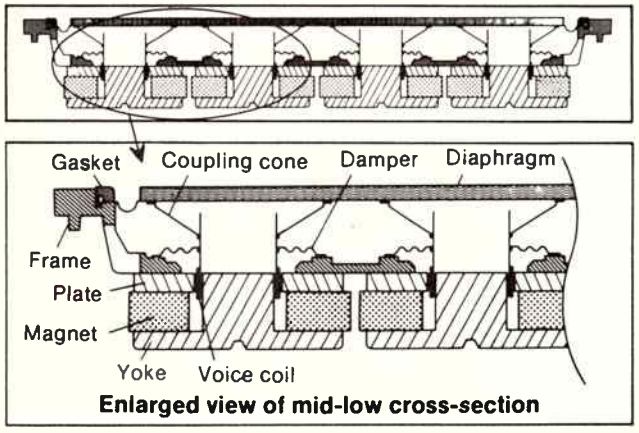


Figure 7. Showing a cross-section of the mid-low AFP driver.

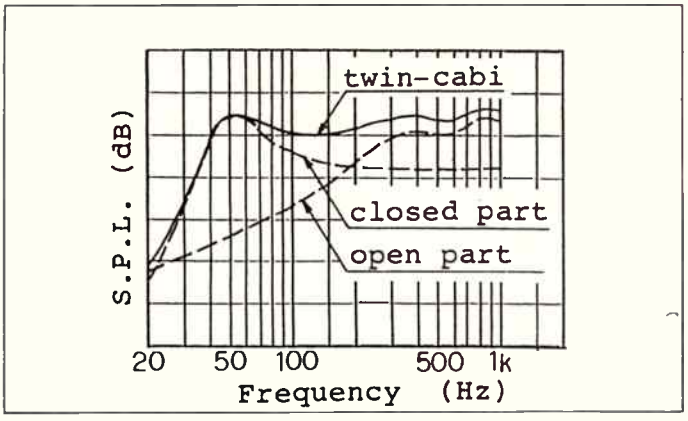
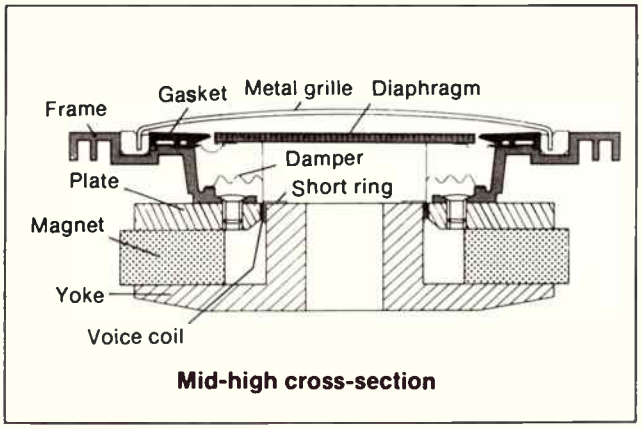


Figure 8. How the closed part and the open part of Technics' Twin Cabinet system combine to provide the required bass response.



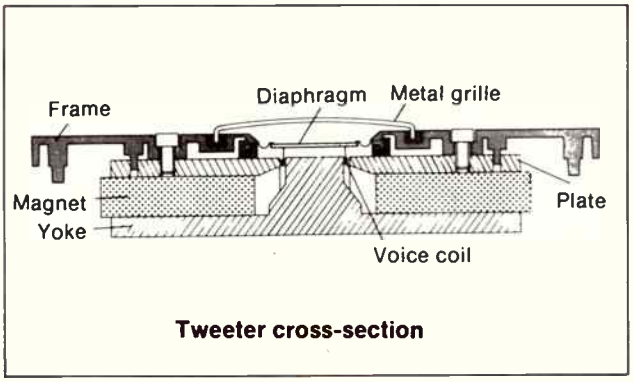


Figure 9. Cross-sections of the mid-high driver and tweeter employed in the AFP loudspeakers.

MANUFACTURING CAPACITY FOR SIEMENS

To further increase its strength in the local market and to assist its push into exports, Siemens Ltd recently underwent a major reorganisation. Its manufacturing facility was consolidated into the Bayswater (Victoria) site and Customer Service in Richmond with representatives in each of its branch offices.

Now that the reorganisation has been completed, Siemens has announced a new manufacturing policy: its manufacturing group must bid for and win up to 30% of its total volume from outside customers.

Companies subcontracting out their manufacturing requirements is a routine occurrence on the world market, even among direct competitors, and the Siemens worldwide group has a great deal of experience in this field. One is the Siemens/Philips joint agreement in the development of semiconductor technology. The concept is relatively new to Australia but Siemens has found that many companies are eager to subcontract out their manufacturing needs.

Automatic coil winding machines.

Manufacturing is important to Australia and New Zealand, with our balance of trade difficulties, but, according to Geoff Fagan, Siemens' manager, marketing communications, some local manufacturers or potential manufacturers would be better off subcontracting their activities to a well established manufacturing facility that has achieved a solid track record over a number of years. "Companies with limited capital and human resources often cannot afford to establish their own manufacturing facilities while continuing their R & D and expanding sales and marketing activities," he said. "Others may find they need manufacturing assistance as they try to fill a world niche market by exporting. Rapidly changing manufacturing technology may cause some firms to buy from us before they upgrade their own manufacturing equipment. So clearly there is a local market for our manufacturing services."

Siemens has played a leading role in Australian manufacturing for over 30 years and is backed by the worldwide expertise of its parent company which was founded in 1847 and has grown to 350,000 employees in 128 countries around the world. It is a major supplier of electrical, electronic and telecommunications equipment to Telecom Australia, State electricity commissions, business and industry.

In telecommunications, Siemens has fulfilled a number of big contracts for the upgrading of Telecom's national telecommunication network. This includes a multimillion dollar contract for pulse code modulation systems, designed and manufactured in Australia, and the optical fibre digital link between Darwin and Adelaide. The company also supplied Telecom with approximately 80,000

Commander 'S' Small Business Systems.

In the mining, manufacturing and chemical industries, it has been involved in major projects for electrical and electronic control equipment in a variety of operations. The giant dredgers at the SECV power stations in the Latrobe Valley, the stackers, reclaimers and conveyors in the Pilbarra iron ore area of West Australia and in the Queensland coal fields are almost exclusively controlled by Siemens electrics.

The largest project to date for Siemens is the SECV Loy Yang power station. As well as three 500 MW turbo-generators, it supplied the complete station cabling and electrical plant erection.

The company's involvement in the generation of electricity in Australia also includes gas turbines at Dry Creek in Adelaide and Jeeralang in the Latrobe Valley, turbo-alternators at Gladstone and Swanbank in Queensland, hydro-generators in Victoria and Tasmania, as well as the complete instrumentation in major power stations in New South Wales and Western Australia.

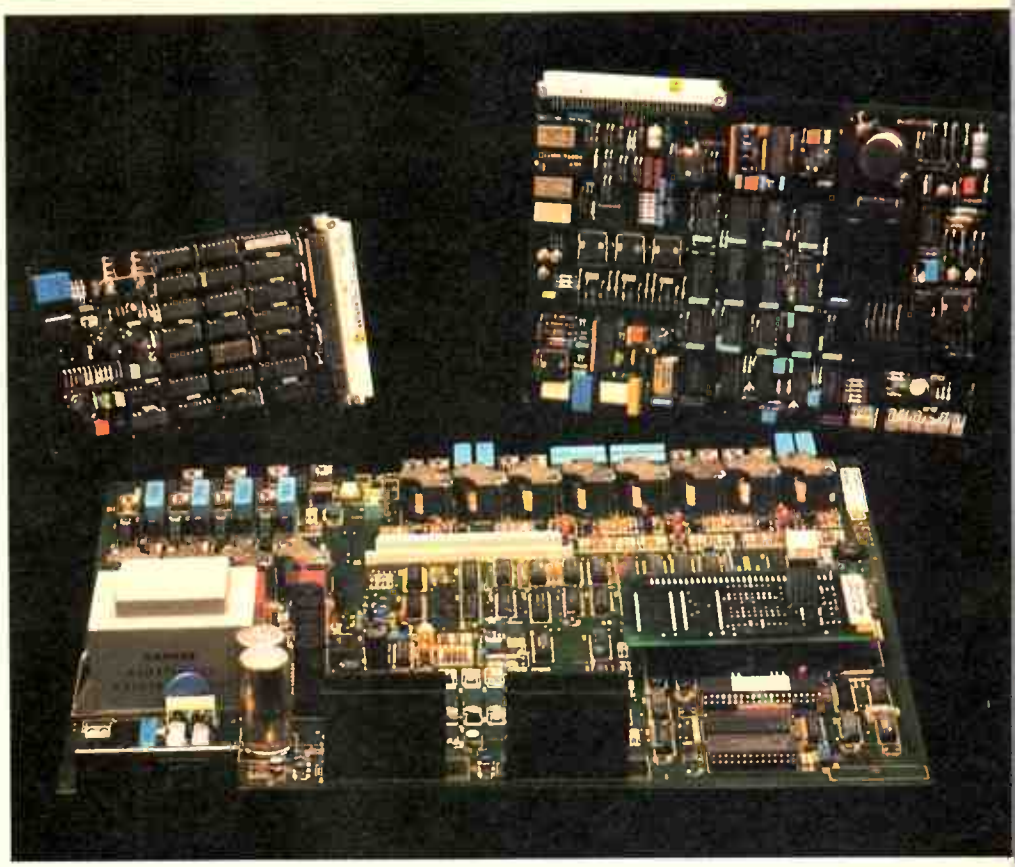
Many sporting venues in Australia are lit by Siemens floodlighting systems. These include Sydney Cricket Ground, Moonee Valley trotting track and VFL Park, Melbourne.

As part of the AMECON consortium, Siemens has also tendered to supply the electrical and electronic portions of the ANZAC frigates.

With this track record and with a corporate commitment to manufacturing, the company believes it is time to subcontract its capability. A major factor in Siemens having spare capacity is its commitment to remaining state-of-the-art in its production capability. "For example, we have recently commissioned a new surface-mounting device process line," explained Mr Fagan, "and this line can be loaded a lot more than at present. This situation is typical. When you install new equipment you are planning for the future. The equipment can not be fully utilised immediately for our in-house products alone."

The company believes there will be other benefits from this new policy. "There is the personal incentive for our manufacturing team to remain competitive," continued Mr Fagan. "The marketplace is the best measure of our efficiency. We can smooth out the cyclic peaks and valleys of our own products when we also manufacture products for different markets and, of course, we can achieve greater economy of scale by spreading our fixed costs over more products."

Siemens is offering its capability in three major areas – electronic module and system assembly and testing, electrical wiring and assembly and sheet metal production, including painting.



Typical electronic modules.

In the area of electronic module assembly and testing, the company has achieved flexibility in technologies, batch numbers and production techniques. The technologies cover leaded components and surface-mounted devices, integrated circuits and passives, including sophisticated automatic coil winding and analogue, digital and fibreoptic techniques.

Production batch numbers range from limited quantities as required in terminals and repeaters for fibreoptic telecommunications links, through to many thousands per annum for consumer durables such as office terminals or domestic telephones.

Techniques range from manual, through semi-automatic to fully-automatic assembly and testing. The test systems and software programs for testing are developed in-house.

In the area of electrical wiring and assembly, Siemens can supply systems for all industrial applications including mining, steel and aluminium processing, automobile factories, dockside container cranes, petrochemical complexes and food and drink processing.

The range of systems covers control systems to conventional switchboards with voltage levels from 12 V to 33 kV, motor control centres to programmable controller systems and switchgear from 3.3 kV to 33 kV.

The sheetmetal production varies from manual for small batch sizes to fully programmable rotating turret processing stations, welding from electric arc or inert gas to spot-welding and surface treatments from conventional wet-spray painting to the latest electrostatic powder coating and infra-red baking.

Siemens is committed to research development and design in Australia and has facilities in both its Richmond and Bayswater sites. In this area also it is interested in partnerships with other Australian firms.

During February, the managing director Klaus Lahr, co-hosted with Hans-Gerd Neglein, executive vice-president of Siemens AG in Munich, a seminar for an Australian business mission led by Senator Button, Federal Minister of Industry, Technology and Commerce. The company found that many innovative Australian firms admit that they lack crucial skills in design for mass production and in international marketing. These are skills that Siemens has learned well over the years. It was emphasised that Siemens' state-of-the-art-facilities in Melbourne are now available to those Australian firms.

"All they have to do is ask," confirmed Mr Fagan. "We are anxious to assess positively any reasonable proposal." eti

Siemens can be contacted on (03) 420 7111, fax (03) 420 7309.

THE DATAPLEX DPX-222 MODEM

With data communications users in full cry, the modem market is a very busy place. Australian manufacturer Dataplex is in there, mixing it with the rest of the competition. Jamye Harrison takes a look at a recent release.

The Dataplex DPX-222 modem sports the usual popular CCITT V21, V22 and V22bis communications standards along with Bell 103 and Bell 212A. So what is not usual about the new offering? First, let's set the scene.

The last two or three decades have seen the advent and maturity of a swag of computers, computing systems and their related technologies. Since the early eighties we've been graced with the presence of the ubiquitous IBM-PC and the ever-present Apple Macintosh.

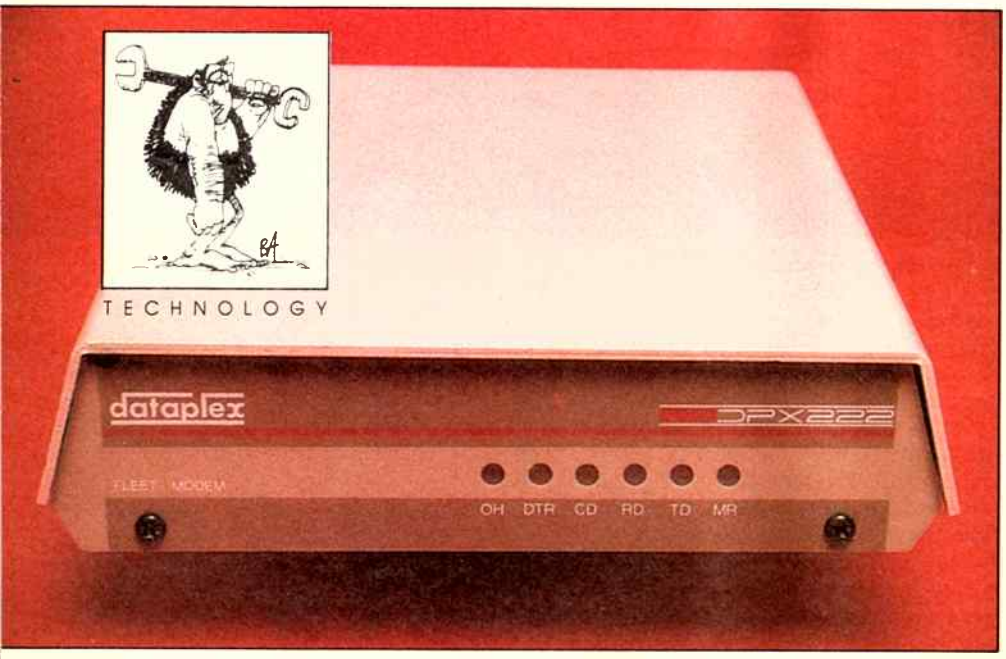
It seems that the computers themselves have hogged the lion's share of the limelight, though, at the expense of the great technological strides that have been made with a wide variety of peripherals. Don't get me wrong – computers are wonderful, they do deserve respect and market attention (as well as the $$$$$ they attract), but even comparatively humble peripherals can significantly extend and enhance the facility of a personal computer, much beyond the investment made.

What about the humble peripheral? You know, those things which let your computer print, talk, plot, scan and point.

Printers have now come of age since the days of the line printer or converted teletypes. Now we have among us ink-jet printers, 24-pin dot matrix printers and 600 dots-per-inch laser printers, all of which were not available a scant decade ago.

Fax cards, flat-bed scanners and modems have all enjoyed similar technological advances, along with consumer availability and affordability. Surely all these advances do not presently share their fair amount of the limelight. If you have a personal computer, no doubt you have one or two peripherals. Handy, aren't they? Your computer's like a car without wheels without them. Right? If you've never used a modem, quickly find someone who owns one. You'll discover a whole new world.

Got the picture? Right. On with the review...



The Dataplex DPX-222 modem is housed in a sturdy all-metal cabinet with all leads and connections via the rear panel. There are no front panel controls.

Where they're coming from

From purely a consumer's standpoint, what advances have set the "standards" in modem technology? For a complete answer to that, you'd better read *Modern Modem Technology* in the May and June issues. Briefly, the first consumer modems were acoustic coupler types where you put the phone handset in rubber cups and manually dialled and switched the modem. Clumsy, and crude. The next step was direct connect modems which plugged into the phone socket; but they still required manual dialling and switching in and out. Pretty quickly came software control and a swag of auto features, including auto-dialling, auto-hangup, auto speed selection etc, etc.

Today's modems require software control as a standard feature. No control command standards were set down, but the Hayes command set has become the de facto industry standard and is likely to remain so for many years to come. To be commercially viable, modems these days need Hayes compatibility. This command set has, I think, quite successfully unified the market – quite unlike the printer market where one printer's control language is definitely not compatible with another.

Secondly, advances in semiconductor technology, especially in the field of ASICs, has meant smaller, faster and more efficient modems can be made featuring a variety of functions and communications protocols.

Description

Physically similar in design to its predecessor, the DPX-224, the DPX-222 stands 53 mm high, 210 mm deep and 198 mm wide, making it about 60 per cent smaller than the 224. While it would be unfair to say it is modest in size compared to other modems on the market, the DPX-222, with its sturdy metal case, would easily survive the school of hard knocks, and would last any proud purchaser (physically, if not technologically) for many years to come – yes, it did survive our standard bench-drop test!

The modem's appearance is uncomplicated. It has six LED indicators on the front panel, leaving the serial port, phone line and telephone connections for the rear of the modem. Out of sight, out of mind.

No prizes for guessing its colour – yes, computer grey/beige. Safe, but boring! However, the physical design of the modem is pleasing overall, both functionally and aesthetically. Only one drawback presents itself. As you can see from the picture, the sides of the modem flare out and then taper back in towards the base creating an awkward shape if the modem were to be stacked or mounted in a crowded environment where straight sides would perhaps fit in better.

The inside of the modem shows some clever thinking – like the entirely enclosed Arlec transformer which supplies the main board with the necessary 6.5 V dc supply. This has been glued to the base of the modem. Why is this clever? This would have meant, during the approval stages with the ever-awkward Telecom, that the modem would have passed through approval much more easily than without a pre-packaged and approved trannie. The power supply and telephone line isolation are the two primary concerns of Telecom when approving a modem. (I note that the line isolation transformer is also sourced from Arlec).

The double-sided PTH pc board is a little larger than a standard IBM-PC half card and is well laid out. The silk-screen overlay proudly displays the message "Designed and built in Australia by Dataplex Pty Ltd." Unfortunately this is not as prominently displayed elsewhere on the modem, although it does rate a mention in the manual. A bit of self-salesmanship doesn't go astray; why hide it inside the product?

The DPX-222 uses the Exar 2400 chip set, discussed in *Modern Modem Technology* in the May and June issues. A Philips micro-controller IC looks after all the control functions (it is a second-sourced Intel device).

Operation

In use, the modem performs admirably. I used the modem in all modes, Bell included, and it came up tops every time. Setting the modem up was no easier or harder than before, although I did appreciate the fact that an external plug pack was not required; these are awkward at the best of times, when finding room for them on a power board and when the power jack at the modem inadvertently pops out.

As this is a software controlled modem, I will concentrate on the use of the modem in this sense.

The AT-command set (Hayes, AT stands for "attention") resident in the DPX-222 is very comprehensive and Dataplex has added some enhancements. The regular AT-commands perform as anticipated with few exceptions. The modem reliably returns the status of the phone line, (NO DIALTONE, BUSY, NO ANSWER, etc.) if required. This is useful when using the modem with an automated communications package such as Telix, Qmodem, Supercom and the like.

There has been many a time when other modems I have used did not operate dependably in this way. In fact, the Dataplex DPX-222 sensed and operated with the two different dial-tones we have available at our offices from the local exchange – the standard warble tone and the long, flat tone you find on some of the older exchanges.

As many of you will know, there are two ways to prematurely terminate a phone call on a Hayes compatible modem – send a "+ + + ATH" command or drop the DTR line. The DPX-222 did not perform reliably when given a + + + ATH command, but worked well when the DTR line was dropped. Fortunately, most communications packages give you the choice of using either method.

After fighting my way through the manual I found that the DPX-222 is capable of communicating in synchronous and asynchronous serial modes (for use with mainframes and minis). The extensive command set provides for some 27 S-registers, some of them bit mapped, giving the hard-core user good control over the modem and its functional features.

The AT&Hn command gives you access to any of three help menus, brief though they are. Extensive self-testing is also provided with the 222, including: local-analogue loopback, local digital loopback and remote digital loopback tests.

Ten telephone numbers can be stored in the modem's non-volatile memory – this can be useful, say, in a specialised environment where the modem is used with a remote data collector, or where certain numbers are to be dialled on a regular basis (as with networked bulletin boards).

A feature (or features) which especially impressed me about the DPX-222 were the extended AT*x commands Dataplex has added to the AT-command set. Although there are only four of these commands, it's good to see a company produce an industry standard and compatible product while not letting the sole requirement restrict their product development in terms of features.

Accessible with these commands are details of the modem's set-up, showing the user the current settings of the definable parameters. Also, you can set the modem to work in Asynchronous Overspeed Mode. In this mode, the 222 strips part of the stop bit of all asynchronous data. This allows the modem to operate at a greater speed than it would normally, if the conditions are right. The manual warns that this can occasionally cause problems with some equipment.

On power-up the Dataplex DPX-222 tests itself for a number of fault conditions. If any occur these are indicated in two ways. Firstly the MR (Modem Ready) light on the front panel will indicate a particular fault by flashing in a number of different ways. Probably a less cryptic way of finding out what fault, if any, has occurred would be to issue an AT*W command, which will return a result code relevant to the particular fault – this can then be looked up in the manual.

Documentation

While we are on the subject of the manual, as I hinted earlier, it is, in my mind, poorly written and presented. Especially so for the first-time modem user. While at least one to two paragraphs are devoted to each command the explanation is far from helpful and informative, both in terms of content and style. Although most of the information is there for a seasoned user, even he/she would find trouble in locating and understanding, at a glance, a particular detail.

Thankfully, there is a swag of communications packages both commercially available and in the public domain and shareware circles which assume little knowledge of the Hayes command set and allow operation of Hayes modems almost transparently.

On a lighter note, I had the pleasure, and in some ways Dataplex the disadvantage, of reviewing the modem during Sydney's wettest quarter on record. In my experience, the public switched telephone network (PSTN) exhibits poor data handling characteristics during unsettled, wet weather. (This is not based on any technical measurements or tests, just experience). Most of the software I use to drive my modems report the efficiency of file transfers expressed as a percentage. In poor weather I usually expect an efficiency of between about 78% and 86% at 2400 bps on the modem I use regularly. On the Dataplex I achieved typical efficiencies of 89% to 96%!

Conclusion

The Dataplex DPX-222 modem performs more than satisfactorily. (A colleague of mine once said the definition of satisfaction is the difference between expectation and realisation!).

The modem being capable of synchronous and asynchronous communication and operation on the PSTN and private leased lines means the DPX-222, along with its admirable performance, is ideal for a wide range of applications. I appreciate the quality and performance of such a modem in an Australian designed and built product. I also appreciate the price – $599.

Considering this, the modem is quite well priced. It represents fair value for money for the regular computer enthusiast or a small business, providing the potential buyer with a sturdy, reliable modem for which local technical support is provided.

All things considered, the Dataplex DPX-222 modem comes highly recommended. Pity about the documentation though. eti

DPX-222 modem kindly supplied for review by Dataplex Pty Ltd, 7-9 John St, Lilydale, Vic 3140. ☎ (03) 735-333.

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The DPX-222 is a full duplex, multi speed, sync/async modem that complies with CCITT and Bell standards from 300 to 2400bps in leased line and dial up applications.

It supports the Hayes "AT" command set, is suitable for both local and international calling and has its own non-volatile configuration storage.

With an on-line help facility, status and configuration screens, the DPX-222 is easy to use. There are no switches to set (fully soft strapped), and everything is documented and explained in a comprehensive users manual.

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HIGH PERFORMANCE

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INNOVATION

Temperature — heat and cold — is an important parameter in all manner of electronic systems. The same goes for many other applied science disciplines. Measuring temperature at one or several points doesn't give you the whole picture, however. 'Seeing' a thermal image goes much closer. Roger Harrison reviews a unique thermal imaging system new to Australia.

The Hughes Probeye thermal imaging video system

REVEALING GLIMPSES OF AN INVISIBLE WORLD

Measuring dc voltages at points in a circuit only reveals a limited view of what's happening, how a circuit is functioning. All you get is a static view. Where gross problems exist that affect that portion of the circuit, such a simple measurement will reveal the problem – not necessarily the source of the problem, though. An oscilloscope provides a more revealing picture of events in a circuit. A multi-channel oscilloscope will reveal even more – an overall image of the whole circuit's functioning, showing various inter-relations wherein all the major characteristics are apparent and more subtle problems can be seen virtually at a glance. Anything that shows an overall view of a system, or something approaching that, is a very powerful tool indeed.

Temperature is a very important parameter or characteristic of many natural objects, living or dead, and man-made systems or machines, too. In electronics, the heat characteristics of a system are a big determinant in reliability, as well as being an important parameter of functional operation. In thermal terms, taking spot temperature measurements tells you about as much as taking spot dc voltage measurements in terms of circuit operation, as explained above. Any instrument which gives you an overall view of an object's thermal characteristics is inevitably a much more powerful tool.

I was recently offered the opportunity to review a unique electronic instrument that has wide application in many technological fields – a video thermal imaging system, the Hughes TVS-7300. Such instruments, in the field of thermal test and measurement, can be likened to the multi-channel oscilloscope's position in electronics. But before I go into the details, it's necessary to set the scene.

Background

Temperature measurement using a thermometer – be it the liquid-in-glass type or an electronic instrument – can be likened to dc measurement with your multimeter. It reveals but a limited, static view of specific parts of the object or system you're looking at. But how do you measure temperature if you can't place a probe or thermometer on something? Answer – from its heat, or infrared radiation.

Infrared radiation involves electromagnetic radiation with wavelengths in the range from about one micrometre (a millionth of a metre) to one millimetre, that is, just longer than the wavelength range of visible light. Infrared radiation cannot be seen by the naked eye. It was discovered in 1800 by the astronomer, William Hershel.

Infrared detectors are based on either of two characteristics: (1) the generation of a change in voltage due to a change in detector temperature when infrared radiation is focussed on it, or (2) the generation of a change in voltage due to the interaction between infrared photons and electrons in the detector material.

Infrared imaging devices convert an otherwise invisible image into a visible image. The radiation used for imaging may simply be that emitted from objects in the scene being viewed, or from reflection of infrared radiation. The latter may come from sunlight (which contains a great deal of infrared radiation), or from a controlled source, such as a laser. Infrared imaging systems relying on radiation emitted from objects are called passive imagers, whereas if a controlled infrared source is used, they're called active imagers.

Active infrared imaging systems were developed in WWII for nighttime aerial

You can get a "macro" view, too. Here, the Hughes thermal video imaging system is looking inside a hybrid circuit in operation.

photo-reconnaissance. Passive infrared imaging systems appeared after the war. Since the early space exploration days, passive infrared imagers have been widely used in military, weather and Earth resources satellites.

Thermal imagers employ a single-element or multi-element detector array, or a thermally-sensitive surface. Early passive infrared thermal imagers used an oscillating mirror or a series of rotating mirrors to scan a scene, reflecting infrared radiation onto a single-element sensor. The sensor's output was then electronically processed and used to build up a picture line by line in a similar way that TV pictures are built up, hard copy being provided on, say, photographic film. Such systems have long been used in weather satellites. Multi-element arrays can be used to electronically scan a scene, subsequent processing of the image providing the required picture. Later, infrared-sensitive vidicons – TV camera tubes –were developed.

Since the advent of passive thermal imagers, it was realised they could provide a very powerful investigative and diagnostic tool in many fields – and that's exactly where they've found application – including military, medical, industrial, meteorological, aerospace, veterinary, ecological, agricultural and chemical fields.

Commercial infrared thermal imagers range from complex, fixed front ends for a sophisticated computer system signal processor with remote visual monitors, through small self-contained bench-type units, right down to portable devices with handheld, camera-like sensors.

The Hughes Probeye

The Hughes 7300 supplied for review is intended as a portable instrument and consists of, basically, four individual units: an infrared imaging 'camera' which may be handheld or mounted, a portable processing unit, a portable colour video monitor and combined 8 mm VCR, and a video printer. The video monitor/8mm VCR is manufactured by Sony and is one of their standard product lines. A portable Sony 8 mm video camcorder is also supplied as part of the kit, for recording views of the scene being imaged.

For portable measurements in the field, where the equipment is to be completely independent of a power source, only the imaging camera and processor unit are required, being battery-powered for such applications. A 240 Vac power supply is also included for mains operation. The video monitor/8 mm VCR and video printer are mains operated and are really adjuncts for viewing and recording images.

The unit supplied for review came from Tech-Rentals Pty Ltd who are specialists in renting test and measurement equipment. Its cost and application is such that few companies or institutions would consider outright purchase, but rental for a term is a viable proposition in a wide variety of applications.

The system represents the state-of-the-art in thermal detection equipment, according to the Hughes literature, and I can well believe it. The imaging camera itself is a remarkable piece of technology. To get adequate sensitivity and range, infrared detectors need to be kept cool. In the past this was done using low-temperature gas or liquid coolants and a special heat-exchanger system which makes the sensor heavy, bulky and not a little dangerous. The cooling system in the Hughes 7300 employs a thermo-electric cooling device – small, light weight and no dangerous liquids or gases.

The camera employs a 30-element detector array, the scanning system providing a spatial resolution of 214 elements per horizontal line and 140 lines vertically. Temperature range covered extends from -20 to +1500 degrees Celsius, with a quoted resolution of 0.1 Celsius degree. The scanning system provides a 30 Hz frame rate enabling flicker-free real-time imaging. The camera has an in-built 25 mm monochrome cathode ray tube viewfinder (just like the ones in video camcorders).

As a result of its innovative design, the camera can be operated in any attitude, so you can treat it much as you would an ordinary video camcorder. It is linked to the processor unit via a rather thick cable, which also supplies its power. Other features include a 20 x 27 degree field of view and interchangeable lenses and filters. An automatic calibration table selection is provided for use with the latter options.

The processor unit provides all the 'smarts', with sophisticated image processing, temperature measurement and on-screen graphics presentation capabilities. Hughes has been active in the infrared imaging field for a very long time and the 7300 certainly demonstrates their experience and skills gained in the field.

A high resolution 240 by 512 pixel IR video display is generated in colour. Display levels are programmable from a low of two right up to 128 levels, allowing you to choose extremely high spatial resolution, to highlight temperature changes on the target, or balance between the two. You have a

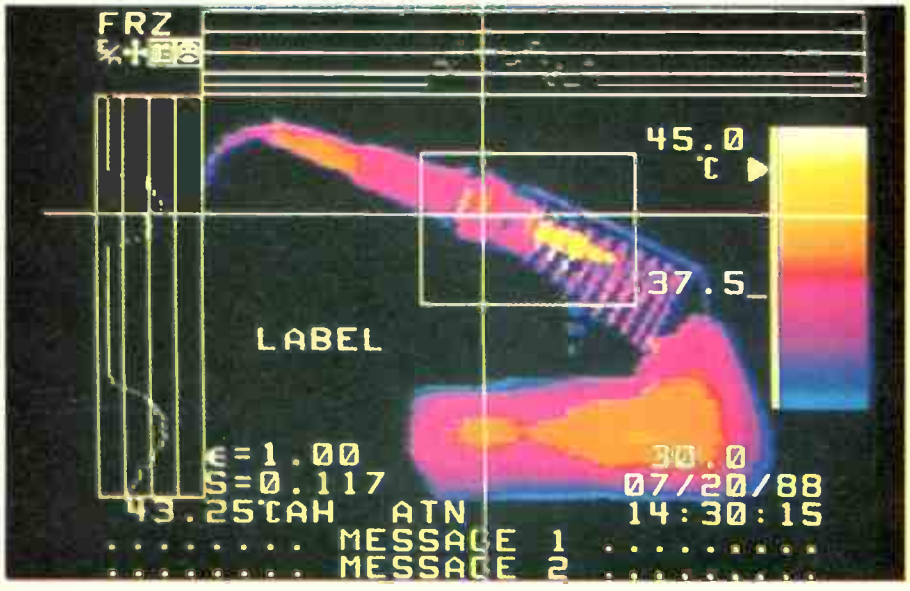
choice of three colour palettes, plus black and white (monochrome). Video outputs provided are: monochrome, RGB and composite colour. In the latter case, while the 7300 provides NTSC colour video (being American designed and manufactured), the unit supplied for review had a PAL colour video adaptor installed to suit the local market. All outputs are available simultaneously.

The processor has a keyboard on its front panel that includes a standard qwerty key set plus a numeric keypad, cursor keys and a set of function keys. The range of measuring features and functions provided include:

- Moveable crosspoint with on-screen display of temperature at any location within the image area.
- 240:1 angular field of view for temperature measurement crosspoint allows accurate temperature measurement over a distance as well as small targets.
- Crosspoint peak and low temperature hold functions.
- "A-scope" display of temperature gradient along movable X and Y cursor lines with optional background suppression selections.
- Adjustable area of interest rectangle with on-screen display of maximum, minimum and average temperature within the rectangle.
- Isotherm window to eliminate unwanted upper and/or lower temperature levels to remove unwanted background and highlight temperature levels of interest.
- Colour bar cursor marker indicates colour level of crosspoint temperature.
- Operator selects temperature readout in degrees Fahrenheit, Celsius or Kelvin.
- Temperature display to seven bits independent of number of levels programmed.
- Multi-mode automatic temperature tracking follows changing target temperatures without the need for operator input.
- Emissivity adjustment from 0.3 to 1.0 in 0.01 increments to ensure precise temperature display.

In addition, the image processing and display options include:

- Freeze-frame for prolonged study or photographic recording.
- Variable timed strobe for observation of repetitive processes or events.
- Radiometric functions are available during freeze or strobe.



This picture, taken directly from the video monitor screen, graphically demonstrates the range of capabilities of the system. It shows the thermal image of a temperature controlled soldering station in operation. The colour scale has been arranged so that blue represents the colder temperatures, ranging through pink and red for higher temperatures, the highest showing up as white.

The colour scale down the right of the screen shows the preset temperature range used in taking this image — 30-45 degrees Celsius. The small triangular cursor on this scale's left side, towards the top, shows the spot temperature at the junction of the screen cursor lines. The actual temperature is shown at bottom left of the screen — 43.25 degrees C. Other relevant parameters are shown above it. On the bottom right of the screen is the date and time.

The box depicts the area where the two gradient temperature profiles are taken, along the screen cursor lines; the vertical A-scan profile at the top of the screen. Note the space for two messages at the bottom of the screen. All this is very handy when making hard copies from the video printer.

- Image averaging function for increased sensitivity and random noise reduction (user selects 2 to 32 frames).
- Reverse video to invert temperature scale (black = hot).
- Spatial inversion control to mirror image for use with special installation requirements or optics.
- On screen display of time and date.
- Two lines of user programmable alphanumeric message lines.
- Label function to allow specific identification of details anywhere on the screen.
- On-screen confirmation of commands.
- Overlay blanking to suppress unwanted information from the display screen.

The accompanying photographs show the instrument's capabilities in more graphic detail. With all that under your belt, how easy is it to operate?

In use

Hughes claims the 7300 is extremely easy

The Hughes Model 7300 Probeye thermal imaging video system. In the right foreground is the camera; on the table to its left is the portable computer/processor unit. In the middle is the Sony colour monitor/8mm VCR and at left is the video printer unit. Sitting on this, viewed by the camera and seen on the monitor, you see a cup of hot coffee and a pack of frozen Hollandaise sauce.

to use, even for unskilled personnel. I can say, quite unequivocally, they're right. I would certainly have to rate as unskilled personnel. Tech-Rentals supplied two VHS video tapes, one detailing the features and functions of the instrument, the other detailing a variety of applications in a wide range of fields. These tapes were most informative. Additionally, we were given a short demonstration of how to set up and drive the 7300 by Ray Hancock of Innovative Technology in Sydney.

The documentation supplied includes a quick instruction card, the other documentation being much more comprehensive. As sophisticated as it is, it is possible to quickly learn how to use the instrument and obtain meaningful and useful images and measurements.

The processor unit, with battery pack attached, is quite easily carried with an over-shoulder strap. It's comfortable to carry, but relatively weighty. I wouldn't like to lug it around all day.

The accompanying screen photograph of the thermal image of a soldering station shows pretty well the extent of the instrument's display capabilities.

We were intrigued with its ability to resolve temperature differences down to one-tenth of a degree Celsius. It's tricky to attempt to verify this sort of thing. However, on one occasion we had the camera idly aimed at the grey metal box housing the electronic PABX for the telephone system in our office. Now, stuck on the front of this happens to be a cutout picture of the American humorist, Pee Wee Herman. The temperature span happened to be set over a narrow range about the day's ambient temperature and the image of the PABX case quite clearly showed the paper cutout to be a fraction lower in temperature!

We had a fascinating time taking thermal images of various objects, and each other. The latter exercise is fascinating, particularly people's faces; it is possible to clearly show patterns of blood flow beneath the skin's surface, and in real-time, too.

Looking at a pc board in operation, you can immediately pick out the power dissipation hot spots. The Probeye's application in test and measurement in electronics is immediately apparent.

The instrument comes packed in a set of sturdy road cases with generous foam padding inside which appears to offer completely adequate protection; it was entrusted to the care of a local courier for an across-Sydney excursion and survived without mishap – no fragile stickers included. Enough said?

The Hughes 7300 thermal video imaging system is a fascinating instrument and clearly an extraordinarily powerful tool with wide application in many fields. eti

Review unit supplied by Tech Rentals Pty Ltd, PO Box 621, Ringwood Vic 3134; offices in all state capitals. Note that Tech Rentals puts on free seminars on thermal imaging if you want to know more about the subject.

ELECTRONICS

ETI BUYERS' GUIDE

Readers who've been with us a while will remember this column from earlier years. For those who have only recently become readers, we're resurrecting *Shoparound* to let you know which firms are stocking kits for current projects published in the magazine, those firms stocking printed circuit boards, and companies that carry components used in projects we've published along with interesting and useful snippets of news about products and services of interest to electronics enthusiasts.

Electronics retailers and other suppliers are circulated with information on projects to be published in ETI some three months in advance of publication. This is then checked as close as possible to the date this column has to be prepared, but there is still a time lag, you will appreciate, of around six weeks before the magazine appears and many things can transpire in that time that may affect the availability of a particular component and thus the availability of a kit. This is something entirely beyond our control, and often beyond the suppliers' control. The information supplied in this column is as accurate as we can ascertain at the time of writing, so please understand if the situation is different by the time you check with suppliers.

This month, I'll cover details on some of the projects from the May, June and July issues, along with this issue's projects. Already, we understand, response to the May issue's feature project, the Turbo Modem, has been phenomenal, as has the response to the Digi-125 Audio Power Amp (ETI-1430) and the ETI-1623 I/O card. I guess we've hit it with a few popular projects!

ETI-1430 Digi-125 Audio Amp Module

First, there's an errata: Q4, on the circuit diagram (page 82), is shown as a BC557, when it should be a BC556. The Parts List on page 84 is correct.

The printed circuit board, as noted in the article, is available from Graham Dicker at PC Computers, 36 Regent St, Kensington SA 5068, (08) 332-6513. The board costs $4.95 singly, plus $2 post & handling, or $9 for a pair, plus $2 post and handling.

We hear that many constructors ask for a power supply pc board for this project, and many others require further applications and installation information. Well, we'll be dealing with those things in an article in an upcoming issue. Stay tuned!

The following retailers have indicated they stock the necessary components for this project: in Melbourne – All Electronic Components at 118-122 Lonsdale St, and The Electronic Component Shop at 289 Latrobe St (except for the 2 W resistors). Dick Smith Electronics indicate they stock the components in their stores around Australia and New Zealand, too.

ETI-299 VOX Relay

Also a May issue project, you should find components for this project widely stocked by electronics retailers. Specifically, however, the following retailers have indicated they stock all the necessary components, but do not carry it as a kit: Dick Smith Electronics stores throughout Australia and NZ, and in Melbourne – All Electronic Components at 118-122 Lonsdale St, and The Electronic Component Shop at 289 Latrobe St.

For printed circuit boards, try Acetronics, 112 Robertson Rd, Bass Hill NSW 2197, (02) 645-1241; RCS Radio, 651 Forest Rd, Bexley NSW 2207, (02) 587-3491; and All Electronic Components, 118-122 Lonsdale St, Melbourne (03) 662-1381.

ETI-1623 Input/Output Card

From numerous reader requests, computer add-on projects are popular at the moment, so this simple card should also prove a hit. To date, only Geoff Wood Electronics in Sydney has indicated they stock all the components, but they won't be stocking a kit.

Printed circuit boards for this project are available from Graham Dicker at PC Computers, 36 Regent St, Kensington SA 5068, (08) 332-6513.

ETI-1432 Audio Toolkit

A good project to keep on hand for that odd job. The components for this project can be found off-the-shelf at any electronics retailer. For printed circuit boards, try Acetronics, 112 Robertson Rd, Bass Hill NSW 2197, (02) 645-1241; RCS Radio, 651 Forest Rd, Bexley NSW 2207, (02) 587-3491; and All Electronic Components, 118-122 Lonsdale St, Melbourne (03) 662-1381.

ETI-789 Shortwave Receiver

Featured in July, this simple little receiver will astound constructors with its performance, especially now that the shortwave bands are jumping with activity because of the good conditions brought on by the sunspot cycle peak this year. All Electronics Components will be stocking it as

a kit – and they plan to have a working model on the counter for you to try before you buy ! They can supply pc boards, the Scotchcal panel and tuning gangs too, if you can source all the other components from your own stocks. Components are widely available from electronics retailers. RCS Radio in Bexley NSW and Acetronics in Bass Hill can also supply pc boards.

ETI-1624 PC Speed Display

A snazzy little project to jazz up the front panel of your PC/compatible. It has very few components, all generally available from electronics retailers. The pc board is obtainable for $7 plus $1 post and handling from the author, Mick Gulovsen, 14 Sutherland St, Glenroy Vic 3046. Mick can also supply full-built units for $29 plus $1 post and handling.

ETI-1615 VGA card

Featured in this issue, this in another "technology demonstration" project courtesy of Energy Control International, who are offering it in both kit and built-up form. Contact them at 26 Boron St, Sumner Park Qld 4074. (07) 276-2955.

ETI-195 Signal Injector/Tracer

Now here's a project that every enthusiast's work bench must have! And if you're following Jack Middlehurst's *Building Blocks of Electronics* series, it's essential. At time of going to press, we're yet to receive feedback about which retailers may be supplying kits, so check with your favourite supplier first, then ring around.

Most components specified for this project are obtainable from general electronics retailers. The Parts List details suppliers' catalogue numbers for particular components to help you locate them or equivalent types from other suppliers. The two probes were obtained from Geoff Wood Electronics in Sydney – (02) 428-4111, but for similar probes try Stewart Electronic Components in Melbourne (122 Lonsdale St) and RCS Radio, 651 Forest Rd Bexley in Sydney. Acetronics at Bass Hill in Sydney can also supply pc boards.

Enthusiasts' newsletter

Dick Smith Electronics is distributing a free newsletter though stores, called "Enthusiast Electronics". You can pick it up on the counter at any store – providing they have some left!

The issue we saw contained eight pages, the middle two-page spread containing some useful semiconductor data and applications circuits; one page was entitled "Product Premier", devoted to DSE's new range of 1989 digital multimeters, and another page was devoted to other new products. The newsletter boasts a Computer Page which, in our copy, discussed modems and bulletin boards and public domain software.

And there was a free sample offer! DSE is now stocking Remtek heatshrink tubing in several sizes and wants to know what sizes best suit customers' applications. A coupon on the back page of the newsletter gets you a free sample of Remtek heatshrink tubing, the second part of the coupon giving size ranges for feedback to help DSE choose what to stock.

The newsletter, to be released every four months, is looking for contributions. Write to: The Editor, Enthusiast Electronics, PO Box 321, North Ryde, NSW 2113. eti

TEST AND MEASUREMENT

An overview of the current state of instrumentation for test and measurement in electronic applications, by Roger Harrison.

One of the simplest RF instruments is the basic reflectometer/power meter, like this one from Captain Communications, designed for application in testing mobile cellular radio installations. It features a simple analogue meter with a scale calibrated in SWR and power to 5 W.

On electronic circuit or equipment development, maintenance and servicing, measurement as proof of performance, tracing of problems or adjustment of operation is the one essential. Measurement of a circuit's operational parameters or characteristics provides an insight into its operation that, more often than not, can be gained in no other way. Measuring instruments have been part and parcel of electronics throughout its evolution – from the first exploration of electrical phenomena, through radio and, later, electronics.

Today, there's a staggering breadth and variety of instruments, ranging from the humble pocket multimeter through to highly sophisticated automated instruments that can perform mathematical calculations and transformations on complex signals to reveal a wealth of subtle detail about them.

This feature is, of necessity, split across two issues because of the breadth and complexity of the whole field. Even so, its coverage will not include instruments designed primarily for application in the computer field – that would require a whole feature on its own!

A convenient place to start is with basic measurement – which, fundamentally, provides a view of circuit operation, commencing with the ubiquitous multimeter. From there, I'll go on to specific adaptations of unit quantity measurement – RF voltage and power, SWR, etc, frequency and period. Follwing this, and continuing the theme of viewing circuit operation, oscilloscopes and analysers come next. Stimulating a circuit or circuit element with a signal is also part and parcel of electronic test and measurement, so I'll be covering signal generators and circuit analysers later, plus a gaggle of gadgets that don't comfortably fit these categories.

Typical of low-cost handheld DMMs is this Dick Smith Electronics job, the Q-1445. Priced at $84.95, it features a 3.5-digit liquid crystal display, safety-yellow case, shrouded probe connectors and finger guards on the probes, five ac and dc voltage ranges from 200 mV to 1000Vdc (650 Vac), five ac and dc current ranges from 200 uA to 10 A, seven resistance ranges from 200 Ohms to 200M, plus audible continuity tester, and diode, transistor and battery testing functions.

Sprinkled throughout the text are illustrations of some equipment typical of the type and categories currently available. In addition, you will see a few panels with short profiles provided by some of the companies operating in this market. Next month, we'll conclude the two-part feature with a comprehensive list of companies offering instruments in this field. On with the show!

Multimeters

The multimeter remains the fundamental tool in electronic test and measurement. Analogue instruments, which once dominated the market, have been superseded by digital multimeters (DMMs) over the past decade. The handheld DMM now entirely dominates the basic instrument market and, boy, what a choice you get – a veritable smorgasbord of price, features, functions and performance!

The digital instrument revolution started in 1952 when Andy Kay in the USA unveiled the first digital voltmeter. Reportedly both the idea and the company formed around the idea, Non-Linear Systems, which took off like a rocket.

Today, digital voltmeters and multimeters are found not only in areas ranging from electronic engineering labs to electronics hobbyists' workshops, but in such diverse fields as process engineering, chemical and medical applications, and the aerospace and mining industries.

The digital conversion

Primarily, electronic measurement is concerned with measuring voltage. This is because the dc volt has a primary standard accurate to better than one part in one million. Digital readout or display of quantities has decided advantages, particularly the quantities we wish to measure in electronics.

When reading a quantity from an analogue meter scale, you have to interpret the reading. If it's not on a scale point you

When you get to higher-priced DMMs, you get some fancy features for your money, such as those this Soar 3.5-digit DMM boasts: like all-pushbutton operation, autoranging, true-RMS reading on ac, relative mode that displays only changes in readings, peak hold and data hold (store) functions, temperature measurement (with external probe) and a frequency counter.

Nilsen

Oliver J. Nilsen (Australia) commands a prominent position in Australian industry. Its activities are diverse and since its establishment in 1916, it has grown with an uncompromising committment to innovation, technical expertise, reliability, quality and service.

There are four operating groups within the company, each an independent entity with a dynamic and progressive profile in its area of specialisation.

The activities of the Electrical and Electronic Products Group include the design, manufacture and marketing of low voltage switchgear and high reliability industrial electronic products and systems.

The Instruments Group imports and markets a range of exclusive electrical and electronic instruments which have broad application to the industry.

The Engineering Contracting and Service Group supplies a wide range of services to industry and commerce, including electrical installations, service and the design and manufacture of switchboards.

Finally, there's the Materials Group. The two companies within the Materials Group design and produce a diverse range of components. The powder metal division designs and manufactures powder metal components and the ceramic division designs and manufactures components made from zirconium to form a unique ceramic called PSZ (partially stabilised zirconium).

The above operating groups are supported by a services group which provides property, financial and administrative services.

Nilsen employs 1200 hundred people, has assets totalling more than $55m and in 1987, achieved annual sales of $78m.

The Nilsen Instruments Group imports and markets a range of testing and measuring equipment for industry and many government departments including defence, education, communications and science.

Much of the equipment incorporates state-of-the-art technology and is held under exclusive franchise for Australasia from the world's leading instrumentation manufacturers. To service and market fully in Australasia, the group maintains sales offices in all the major Australian and New Zealand cities and employs a staff of 55.

The range of instruments includes apparatus for testing and commissioning electrical generators, circuit-breakers and transformers, test and development systems for sophisticated electronics manufacture and design, and instruments for research and educational applications. Quality assurance, routine testing, fault location and maintenance can all be carried out with the exact testing equipment to meet each need.

The demand for electronic testing equipment is ever-increasing. There have been exponential rates of growth in the application of electronics technology for everyday usage, from simple arcade games to highly complex digital communication equipment.

Nilsen-supplied electronic testing and measuring equipment is used in applications like security and surveillance systems, electronic control for industry machinery, computers and peripherals, navigational and defence surveillance equipment and radio and television transmitters and receivers.

have to interpolate – euphemism for an educated guess. Because of this, the accuracy of analogue meters varies across the scale, being best at full scale and worst around the zero end. You can readily read to within ±/– half a scale division which, on a 0 - 100 scale is ±/– 0.5% at full scale, but a ±/– 50% at the zero end! In addition, errors in the analogue movement mechanism plus parallax reading error contribute to full scale errors and error variation across the scale.

It's obvious that when you make a measurement and get a numerical readout the uncertainties are reduced and convenience enhanced. Errors can be reduced, too, and held constant across a reading range. To obtain a digital readout, the quantity – which is analogue in the real world – needs to be converted to a digital form. This is done by an analogue-to-digital (A-D) converter. Because the volt derives from an accurate fundamental standard, most other quantities are converted to a dc voltage and this, in turn, converted to digital form.

Accuracy is the primary consideration because one of the advantages of a digital instrument is the very high resolution possible, giving very high accuracy, provided that any appreciable sources of error can be avoided. The overall accuracy is determined by the A-D converter which means any sources of error here must be minimised or eliminated to ensure the required accuracy and stability.

The voltage arriving at the input of an A-D converter is rarely pure dc. Almost always there will be both hum and noise present.

Anritsu is a well-known name in test and measurement, so it's no surprise to see them enter the opto-electronics market with suitable instruments. This is their model MF91A optical wavelength meter — the equivalent of the DFM in RF measurement. The dual liquid crystal display also provides readout of power in watts, relative dBs or dBm. It sports plug-in front ends to cover differing wavelength ranges and a GPIB (IEEE-488) interface so that it may be hooked into a system, like so many other instruments these days.

Such unwanted signals are called series-mode noise. But, we want the A-D converter to ignore it, otherwise measurement accuracy is affected. An obvious solution is to use a low-pass filter to reject the series – mode noise, but you would require it to cut off at a few hertz or so, and this has the disadvantage that it slows down the measurement. Another solution is to integrate the signal to average out the series-mode noise. If the integration period is long enough, the average unwanted ac signal imposed on the dc to be measured will be almost zero and a good series-mode rejection is obtained.

Measurement speed is another important requirement. For run-of-the-mill bench applications, about two or three measurements per second is generally acceptable. Where instantaneous value readings are called for, and in automated or semi-automated measuring systems, 10, or even up to 100, readings per second may be required. Thus the speed of the A-D conversion may be a limitation.

As with their analogue predecessors, the more accurate the measurement is required to be, the more important it is that a DVM or DMM itself does not influence the signal being measured. A high input impedance ensures the instrument does not load the signal source. Also, care is taken to see that internal signals are not fed back to the signal source being measured. Such signals, called kick-back signals, appear as series-mode noise and may be difficult to reject.

Something different in RF test and measurement, this Fujisoku RF power meter and reflectometer features a 7-digit digital frequency meter (DFM).

Quite a number of A-D schemes have been developed over the years, but only three are generally used these days. The successive approximation technique offers rapid conversion for reading instantaneous value of input but has no inherent series-mode rejection capability.

The dual-slope or multi-ramp method is a simple integration technique requiring minimum circuitry and offering high noise rejection. Conversion time is relatively slow compared to that of the other methods, particularly if a readout of more than four digits is required.

The delta-pulse or pulse-width modulation technique combines the advantages of the above two methods while overcoming their limitations, providing a balance between high resolution precision measurements and high speed operation while exhibiting good noise immunity.

With successive approximation, a reading in millivolts can be obtained simply by the right choice of reference voltage. Measurement speed is quite fast, depending on the A-D converters' frequency. An analogue low-pass input filter or synchronous digital filter is essential to provide adequate series-mode rejection for precision of measurement. This effectively slows down the measurement speed.

The accuracy of this technique is only as good as the smallest converter steps and the stability and accuracy of the reference voltage. However, good 5-digit readout instruments using this technique are available, generally using additional error reduction circuitry to improve performance.

Dual slope integration is possibly the most widely-used technique, because some 10 years ago an IC manufacturer worked out how to put the whole A-D converter and display driver on a single chip, making low-cost handheld DMMs possible.

The technique involves ramping up the voltage on a capacitor from the input signal for a fixed period (fixed number of clock pulses), then discharging the capacitor against a reference voltage; the ramp-down period is then proportional to the input, its period being measured against the clock pulses. The resolution achievable depends on the clock speed; the more pulses you can count during ramp-down the better the resolution.

The multi-ramp or multi-slope technique is a refinement of this that provides greater accuracy. The ramp-up process is identical, but ramp-down is different. There is an initial fast (high slope) ramp-down for partial conversion, followed by a reduction in the reference voltage which slows the ramp-down, providing a more precise final result.

Dual-slope integration is a simple, effective measuring technique that can be implemented for minimal cost. Dual-slope DVM and DMM ICs are quite common and widely used in both handheld and benchtop instruments.

This technique can give very good series-mode noise rejection, particularly if the ramp-up period is one or more complete cycles of the mains frequency (20-100 ms for 50 Hz mains). The clock frequency can be quite low, and it's accuracy does not directly affect the measurement accuracy because only the one clock and counter are used.

For mains-operated instruments, the clock can be phase-locked to the mains to provide

Hewlett Packard

Hewlett-Packard is an international manufacturer of measurement and computation products and systems recognised for excellence in quality and support. The company's products and services are used in industry, business, engineering, science, medicine and education in over 70 countries. Founded in 1939, the company employs 93,000 people worldwide and had a revenue of almost $10 billion in its 1988 fiscal year.

Hewlett-Packard Australia, a locally-owned subsidiary of the parent company, was established in 1967. The company is headquartered in Blackburn, Victoria, with branches in all mainland states. Employing some 700 people, and with a revenue of A$226,000,000 in its 1988 fiscal year, Hewlett-Packard Australia was one of the first signatories to the Federal Government's Partnerships for Development program. In line with this program, Hewlett-Packard Australia has undertaken to invest A$70 million in local research and development to build the company's Australian exports to A$80 million annually by 1994. As a further committment to this country, Hewlett-Packard Australia is an equal partner in a new joint venture company with Telecom Australia, which provides our business community with a single source of integrated computing and telecommunications solutions.

It was 50 years ago that HP helped launch the test and measurement industry with the sale of eight audio oscillators to Walt Disney Studios, which enabled them to produce the innovative soundtrack for the film Fantasia.

Since then, the company has successfully produced a great many test and measurement product ranges from digital oscilloscopes, network analysers, signal generators, protocol analysers, spectrum analysers, board test systems and virtually every test and measurement product to suit the scientific, engineering and telecommunications industries.

In the early days of its 50 year history, the company began in a two-car garage in Palo Alto, California, that has now been listed as an historic monument and the official birthplace of Silicon Valley, and the world's electronics industry.

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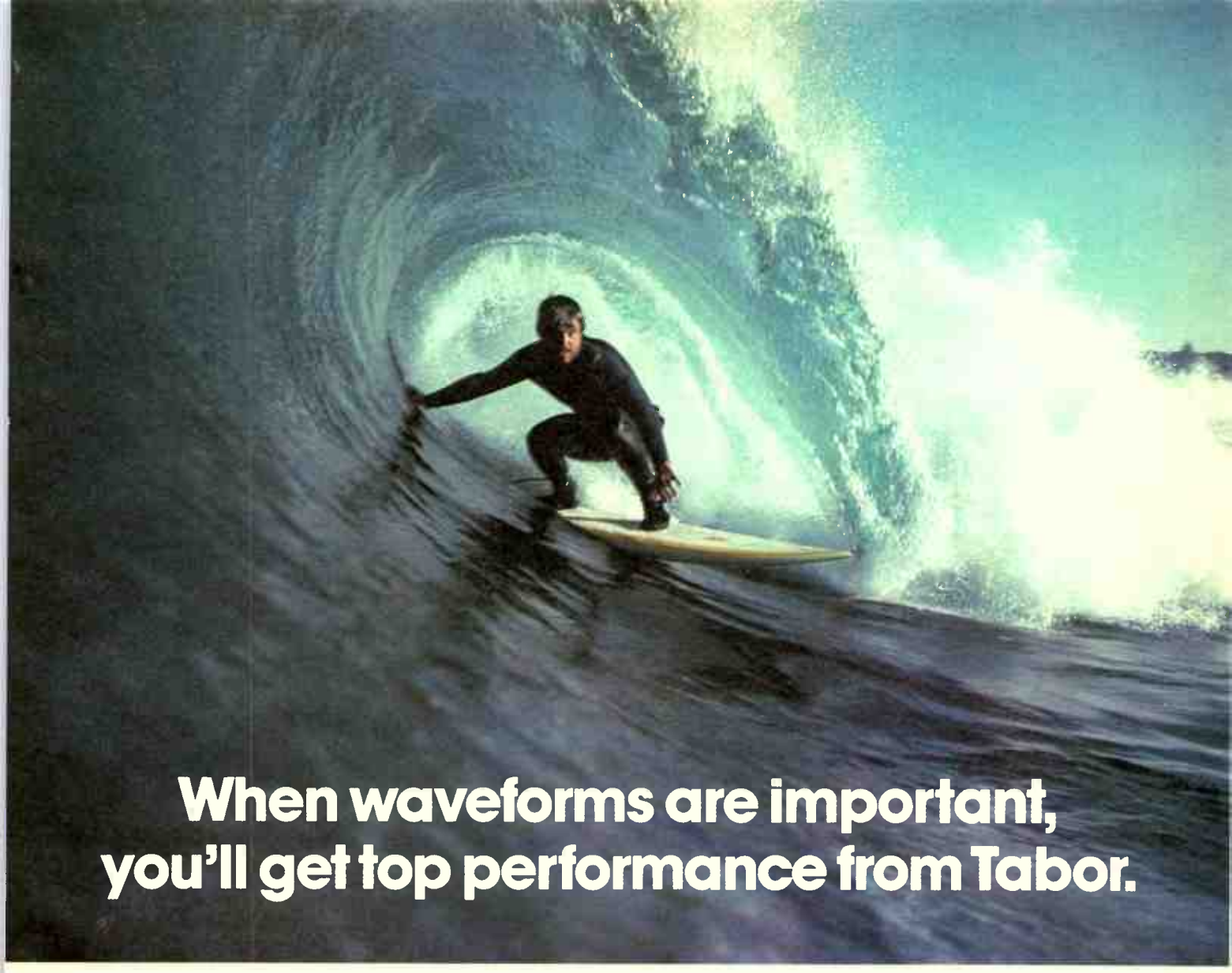

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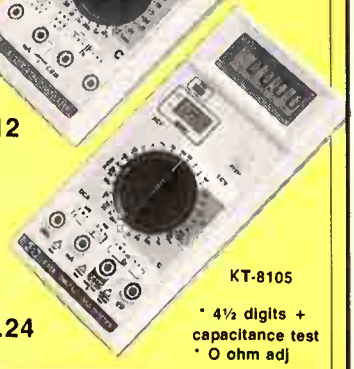

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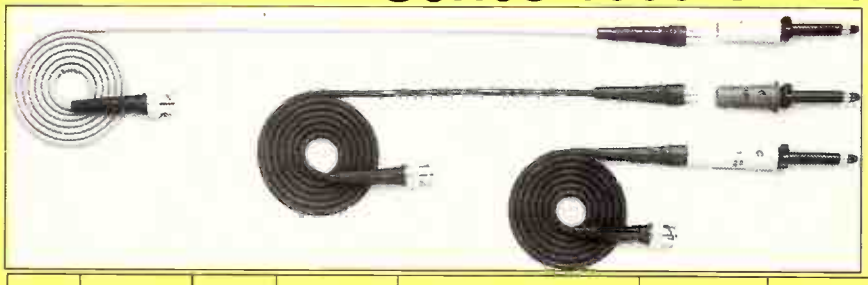

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READER INFO No. 25

greatly improved series-mode rejection of hum. The only factor influencing the accuracy is, in fact, the reference voltage. This, along with its very good series-mode rejection, makes the dual-slope system suitable for precision measurements to six or seven digits.

The main disadvantage is in its relatively slow speed. Also, the display is only updated after ramp-down and, if the wrong input range has been selected, no range changing can occur until after ramp-down which, in auto-ranging instruments, contributes to slowing down the measurement speed.

Readout accuracy can be affected by the fact that the input is only averaged during the up-slope period. During ramp-down, the input signal is disconnected and not measured at all. If any variation of the input signal occurs during this time, the instrument will not register it and hence, true averaging of the input signal does not occur. However, this is only of concern when precision beyond six digits is required.

The delta-pulse or pulse-width method is an integrating technique that enjoys the advantages of the above two systems without their disadvantages. The method has the same advantages as dual-slope, with good series-mode noise rejection and accuracy which depends primarily on the reference voltage. The A-D conversion is very rapid and continuous (dynamic integration) so that it can follow input variations to give true dc measurement. In addition, the display can vary from three digits to up to eight digits to suit a wide variety of applications. Despite being somewhat more complex than the dual-slope technique, it lends itself to large-scale integration.

Comparisons

All three techniques exhibit low kick-back signals as the input circuitry in each case is isolated from the digital measurement and display circuitry. Both the dual-slope and delta-pulse methods have inherently high input impedance. Some dual-slope instruments boast a one giga-ohm (1000 megohms) input impedance! The input impedance of a successive approximation A-D converter is not constant because of the switched input sampling and needs buffering.

The series-mode rejection of the dual-slope and delta-pulse methods is high, while successive approximation suffers from low series-mode rejection, requiring added filtering. As far as speed is concerned, successive approximation is inherently the fastest, but the requirement for series-mode filtering slows it down. Dual-slope and delta-pulse are medium speed methods, with

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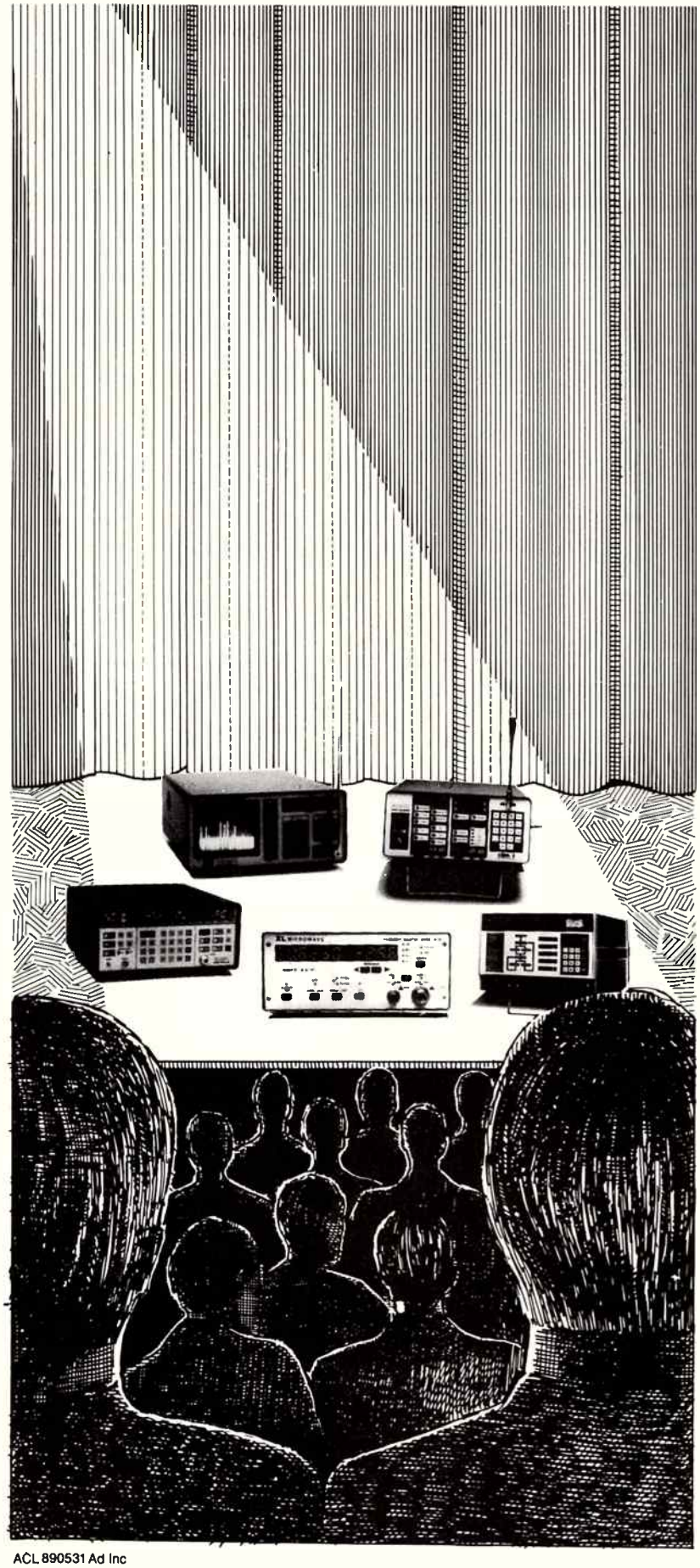

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Typical of bench-type digital frequency counters is this Philips PM 6669. It has a basic 120 MHz input with an additional UHF input that takes the upper frequency to 1.3 GHz. Features include high resolution reciprocal counting, a high stability mathematically temperature compensated crystal oscillator (MTCXO), eight measuring modes including pulse width, auto and selectable trigger modes, and IEEE-488 (GPIB) interface enabling it to be used as part of a system.

delta-pulse generally having the edge over dual-slope.

What's around

So-called budget analogue multimeters are available for under $20. They're serviceable but not as robust as their digital cousins. At this price, you would get an instrument with around 15 ranges, 2% full scale accuracy, and sensitivity of 2000 Ohms/volt. Typically, they have four dc and ac ranges, covering 10/50/250/1000 Vdc but only to 500 V on the top ac range. On ac current, typically you get ranges of 0.5 or 1.0 mA at the bottom with two or three ranges covering up to 250 mA or one amp on the top range. You get two or three resistance ranges covering 1000 Ohms on the lower range and 1M on the upper range. The scales are non-linear so accuracy is not good.

Analogue meters have the advantage that you get a feel of the proportion of a reading relative to the scale selected, so you can determine is your reading's in the right area if absolute numbers are not necessary. The costlier analogue meters usually offer greater ruggedness, plus more ranges and functions. If you're thinking of spending around $90-$100 on a multimeter, then handheld DMMs start to offer more than analogue meters in this price range.

Their shortcomings notwithstanding, many specialist instrument manufacturers still maintain a few analogue models in their catalogue range. Low cost handheld DMMs, generally 3.5-digit types, these days all feature liquid crystal displays and typically offer some 24 ranges, accuracy at least 10 or 20 times better than their analogue counterparts and the distinct advantage of dealing in numbers – no need to interpret a scale. Most provide additional features, such as transistor gain measurement, diode and battery check functions, for example. All of this for under a hundred dollars!

As the price begins to creep up, features and functions rapidly escalate – you get such goodies as auto-ranging, pushbutton function, mode selection, frequency measurement, capacitance measurement, display hold, peak hold, analogue bargraph display, etc. At around $200 – still in the low-cost bracket 4.5-digit DMMs appear.

The displays on many low-cost DMMs often offer comprehensive functional indications apart from the reading. As you go up in price, so the display generally gets more comprehensive.

Most low-cost DMMs offer four or five dc and ac voltage ranges, from 200 mV at the bottom ranging to 1000 Vdc at the top, 650 to 750 V on the top ac range. True RMS reading on non-sinusoidal waveforms began to be featured on handheld DMMs a little while ago.

Bench-type multimeters take over from here, the lower-cost ones generally starting with 4.5-digit displays, then ranging through 5.5, 6.5 to 7.5-digit displays. Some less common examples go beyond that. Generally, bench-type DMMs at the lower priced end offer more ranges and functions than their handheld little brothers, many being auto-ranging. Optional probes for high

voltage measurement, RF voltage measurement, temperature measurement, etc, are also offered with bench-type mulitmeters.

Accuracies from 0.01 to 0.001% are widely specified for bench DMMs, with resolutions down to 0.1 microvolt. A true RMS function is now widely offered on models even at the bottom price range, whereas it was an inclusion only on the more expensive models a few short years ago.

Automation

Automation of a variety of functions on a multimeter is desirable for the convenience offered and the elimination of ambiguity. Automatic zeroing and auto-polarity indication are included on virtually all DMMs available these days, while auto-ranging is becoming more and more common on handhelds and bench models alike.

When you short the input of a voltmeter, you expect the display to read zero. In a 3.5–digit DVM or DMM, with a maximum readout of 1999, a 0.05% of full-scale zero error is enough to give a 0001 display. To avoid this and maintain accuracy with low-value readings, a zero adjustment is necessary. Automating means you do not have to perform the operation manually every time you take a reading where zero error might matter.

Auto-ranging can greatly enhance the convenience of using a DMM. The object is to obtain a reading with the best resolution under all conditions. For example, on a 3.5-digit display, 150 mV should be displayed as 150.0, not 0150.

The ranges need to overlap, otherwise ranging jitter occurs at the transition between ranges. For example, without overlap, an input of 200 (mV, say) with slight variations would be displayed as a reading varying between 199.9, 0201, 0200, etc. In an autoranging unit, with the exception of the lowest range, each range has a lower limit set a little within the full scale of the next lowest range.

The coming trend with bench-type DMMs is system integration. The IEEE-488 system bus interface and RS-232 interface are being incorporated into more and more such instruments these days, allowing to be used in production testing applications, data logging and monitoring, as the front end of a computer-controlled system. Along with this development has come the incorporation of microprocessors into DMMs, offering more independence and specialised functions. It's a trend in every idea of test and measurement instrumentation, as you shall see.

Where a complete series of both unrelated and interdependent measurements is to be made in, say, production testing and alignment, or servicing and maintenance applications, equipment test and adjustment procedures can be set up and executed in an efficient manner, saving time and increasing productivity using such integrated systems. And results can be stored on floppy disk or as hard copy, providing an audit trail of procedures and performances.

Fluke handheld DMMs are widely held to be the top flight instruments. The models 25 and 27 are their top-of-the-line 3.5-digit instruments; they're comparatively expensive, but you get a lot for your money. They feature an analogue bargraph display beneath the large digital numerals, auto or manual range selection, full protection, sealed cases to withstand harsh environments and special EMI shielding which protects them from external interference. The 27 also features a "min-max" mode which stores the highest and lowest readings and a relative mode. All this and a 2-year warranty. Fluke and Philips merged last year.

Extensions

Multimeters serve the requirement of unit quantity measurement – ac and dc voltage, current and resistance, etc. In the communications field, specialised instruments serve the same purpose, where the measurement of RF voltage and power is specifically required, and the technology that serves for direct voltage and current measurement and derivatives at lower frequencies does not serve at RF.

Special techniques and devices are necessary, but the general technique is to convert RF quantities to a dc quantity and then measure and display that using conventional techniques.

Optical, or rather opto-electronic technology is now a rapidly developing field and similar problems and solutions apply as with RF. Optical measurement quantities are converted to a dc quantity, which is then measured electronically using conventional techniques. Optical power meters and reflectometers are now available, just like their counterparts in the RF area, but wavelength measurement substitutes for frequency measurement in optical applications.

Frequency and period measurement

Frequency measurement has been a concern to researchers, engineers, technicians and service personnel since the days of Heinrich Hertz and that practical fellow blamed for starting it all (electronics, that is), Marconi. As the technology of radio communications and broadcasting progressed, so the demand for greater and greater accuracy in frequency measurement demanded more and more sophisicated instruments and measurement techniques. Until digital counting techniques emerged from the laboratory in the 1950s, and for more than a decade after, analogue frequency measurement techniques dominated.

The basic requirement of frequency measurement, as in other unit quantity measurement, is to obtain a number to a given degree of accuracy. Analogue

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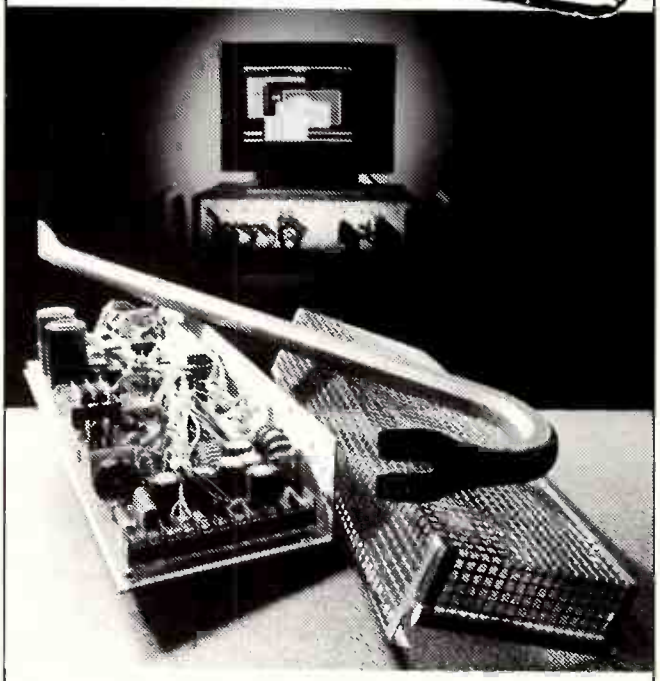

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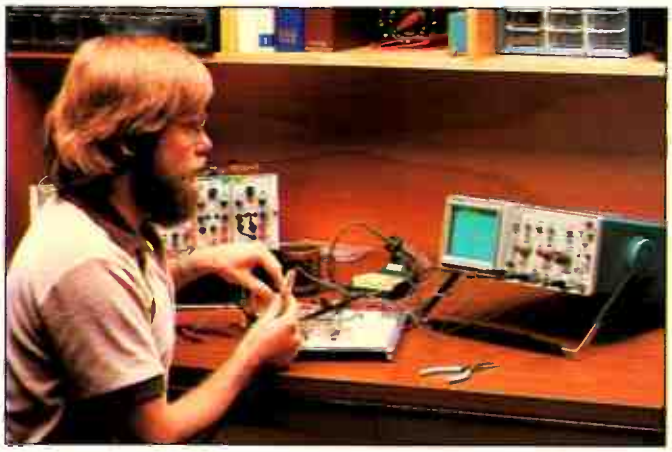


Basic! A multimeter, a low-cost dual-channel oscilloscope, a breadboard and not much else. (Picture courtesy Tektronix.)

For a mid-price range oscilloscope, you can do rather well with features, functionality and performance. Philips led the way two years ago with their model PM3055, then a 50 MHz instrument, now up-graded to 60 MHz. It is a dual-channel, dual-trace machine that features soft-touch pushbutton operation, microprocessor control and a panel layout that is quite different to that of other instruments in its class — you read it like a book — left to right, top to bottom. A great ergonomic improvement. It has an LCD panel showing all range and function settings and — best of all — a green auto pushbutton. Just hook up your probes, hit the auto button and it sets up the mode, attenuator and trigger settings to provide a proper display.

techniques inevitably require the reading and interpolation of a scale. When great accuracy is required, this results in relatively slow, cumbersome measurements. Hence, since the appearance of the digital frequency meter, which offers direct readout, it has been the preferred method of measuring frequency.

Since period in a waveform has an inverse relationship to its frequency, period measurement is simply added on in digital frequency measurement.

Over a decade ago, IC manufacturers incorporated the basic functional blocks of electronic frequency/period measurement and digital display into an IC, providing rapid acceleration of the development of high performance, portable and handheld instruments. With modern large scale integration techniques providing the building blocks, many instrument makers now offer direct readout frequency/period counters offering highly accurate measurements extending well into the gigahertz/nanosecond region for remarkably low cost. High grade laboratory instruments with temperature stabilised reference oscillators and low ageing rate components can provide results accurate to fractions of a cycle well into the gigahertz region, able to

hold their accuracy over very long periods.

Low cost 6- and 7-digit frequency counters are offered for simple frequency checking either with a pickup wand or probe or for in-line operation, connected in the antenna coax of a trasmitter installation. While conventional LED displays are still offered on many instruments, especially the lower cost models, LCD displays are appearing more and more; gas-discharge displays are also still widely in evidence, particularly on higher priced instruments.

So-called budget counters offer a 6- or 7-digit display and operation to, typically, 50 MHz. Next step up the ladder are 100 MHz and 500 MHz units, with the occasional 1 GHz and 2w GHz model tagging along. While switched range selection is still seen, auto-ranging has become very widespread, allowing essentially hands-off operation. Often, for UHF measurement, a separate input is provided with a built-in prescaler doing the initial division.

Resolutions down to 0.001 Hz on low frequency measurements, 100 kHz at the upper end, are typically offered on the lower cost models. Some offer difference frequency and/or period measurement with two inputs. Sensitivities of 10 mV are typical on many instruments, some models offering sensitivities down to 1 mV. Accuracy depends on a number of factors, but typically, across the model ranges available, you'll find it's around ±/−2 or ±/−1 count (last digit), plus the timebase error. Oven-controlled timebases are even offered on many comparatively lower cost models these days.

At the top end of the cost scale, a huge range of special functions is offered, along with 10- or 12-digit displays and, naturally, greater resolution and accuracy.

The microprocessor has quietly revolutionised the performance, functions and features offered in digital frequency/period counters in recent years. Incorporation of microprocessors allows reciprocal measurements which provide a much higher resolution than is possible with conventional directly-gated counters.

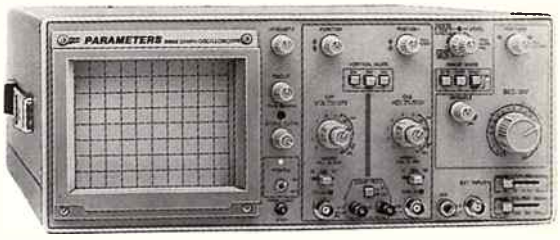
Microprocessors can simplify data handling, but paradoxically can reduce instrument speed. The counting process requires specialised operations – particularly triggering and scaling, best provided in dedicated form, so the micro is left to do the comparatively low speed serial operations. Conventional counters employ fixed gating periods to measure the incoming signal. Under microprocessor control and using reciprocal counting, where period is measured rather than number of events (frequency), counting is not limited to a fixed time interval. The measuring time can be continuously variable to obtain the required degree of measurement accuracy.

Pioneered by Philips, computing counting – as this is called – functions by calculating the frequency. An integral number of input cycles is divided by the time period over which they were counted during a specified time window. This requires some form of synchronising circuitry to ensure both input cycles and clock pulses are counted over exactly the same period. Each is gated and the start of counting occurs on the first input trigger point opening both gates. Both events are stored in counter registers which are accessible by the microprocessor which calculates the frequency and displays it in the appropriate notation with the required resolution. Resolution depends directly on the period of the clock pulse – the shorter the pulse period, the higher the resolution.

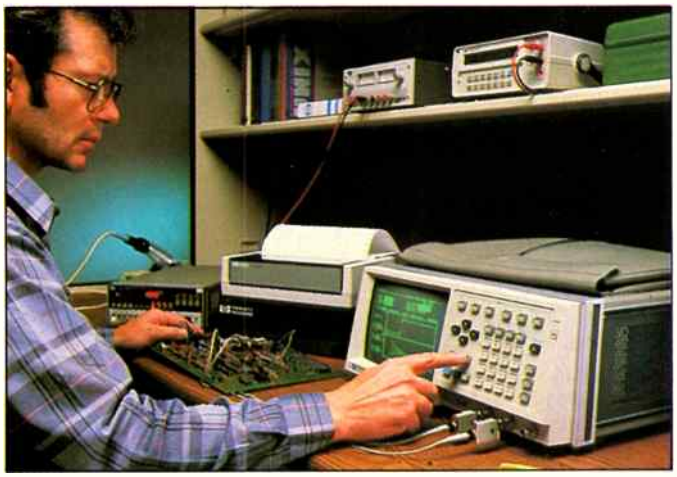
The inside view

Unit quantity measurements provide but a limited static view of any circuit or system under measurement. For a dynamic view, one must trace what's happening in or with a circuit in time, and for that role, the oscilloscope was developed.

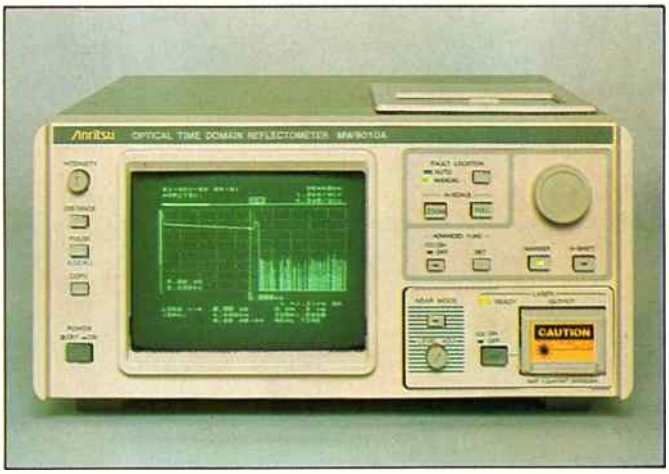
So versatile is the measurement of voltage versus time that the oscilliscope has become a fundamental tool in electronic test and measurement, alongside the multimeter. And it's a very versatile tool indeed. These days some models, admittedly more up-market types, can provide you with all the features and functions of a full-featured DMM, tool It is not uncommon to find oscilloscopes these days that can simultaneously measure and display the sort of quantities that it took three or four instruments to do in the past. And with



Where single-trace, single-channel 5 MHz or 10 MHz bandwidth oscilloscopes were once the bulk of low-cost CROs sold, these days it's been overtaken by the dual-channel, dual-trace 20 MHz instrument. Typical of many on the market, all generally priced well under $1000, is this Parameters 'scope, model 5502. It features a vertical bandwidth of 20 MHz, 150 mm rectangular CRT with illuminated inner-face graticule, 1 mV to 5 V per division vertical sensitivity, signal delay line so you can see the start of a trace after triggering, variable hold-off triggering, sweep magnification, and a channel 1 output. For twice the bandwidth and a few other features (like delayed sweep), you'll pay about 60% more; for three times the bandwidth (60 MHz) plus extras, you'll pay about double.



Sophisticated! Heart of the system here is a high performance progammable digitising oscilloscope with VDU-type screen, teamed with a printer and other programmable instruments forming part of a system. (Hewlett Packard photograph.)



Like a cross between an oscilloscope, computer and reflectometer, this top-of-the-line optical time domain reflectometer, model MW9010A from Anritsu, provides sophisticated fault analysis for optical fibre communications.

Test and measurement

a precision rivalling costly DMMs.

Many of today's oscilloscopes combine, in a single instrument, along with the usual CRO functions, the functions of a digital voltmeter (with simultaneous peak, average and RMS readout), dB meter and frequency and period counter. And you can often get a few fancy functions thrown in for good measure – like a fast Fourier transorm (FFT). Pretty smart!

The variety of styles, features and functions offered reflects the wide ranging demands of their applications. Bench instruments have been with us since the first commercially available CROs appeared. Portable instruments, better described as luggable bench CROs, flourished in the 1960s and now represent the greater portion of the market. Some boast battery operation for application in the field where independence of mains power is required.

Until recently, portable oscilloscopes suffered restricted specifications and functions, which limited their usefulness and application. But that is rapidly changing, where lightweight, truly portable – even handheld – units are now appearing.

While the classical vacuum technology cathode ray tube (CRT) has held sway as the basis of the oscilloscope since its inception, oscilloscopes featuring liquid crystal displays have appeared in recent years and seem set to become predominant in the portable oscilloscope market in the near future, judging by a number of new releases.

With conventional CROs, prices on basic instruments fell rapidly a few years ago, and while there's the occasional skirmish, prices have remained largely static.

Dual-channel, dual-trace oscilloscopes are by far the preferred type in the low to mid-price range instruments (from under $1000 to around $3000 or so), their versatility and usefulness far surpassing single-channel, single-trace models. Single-trace instruments these days are largely relegated to the very basic low cost, low bandwidth end of the market. eti

Opto-electronics is now an important and rapidly-growing field, hence test and measurement instruments to service the needs of this market are appearing regularly. For low-cost, unit quantity testing, this hand held digital optical power tester would be representative. Featuring a 4-digit liquid crystal display, it gives a readout in relative dB, absolute dBm, milliwatts, microwatts or nanowatts. It is used for checking connections, fibre cable quality, light source power meter, etc. It is distributed by Kingfisher International of Melbourne.

Billed as the best digital multimeter in the world, this is the Datron 1281. It features an 8.5-digit readout with 40-character menu display, self-calibration and programmability via its IEEE-488 interface. It also features a dc voltage range from 10 nV (!) to 1100 V, an ac voltage range from 100 nV to 1100 V, simultaneous display of frequency and true RMS ac volts, resistance measurement from one micro-ohm to two giga-ohms, ratio measurements, plus computation ability for offsets, scaling dBs and averaging. Distributed by Scientific Devices of Melbourne.

Other meters show half the picture

The new Fluke 45 has dual display versatility.

With 2 multifunction displays and 16 different measurement capabilities, the new Fluke 45 does virtually everything you want a meter to do.
And all for a suprisingly affordable price of around $1260 (ex tax) plus options.

FLUKE

The 5-digit, 100,000 count dual displays give you more information in less time - and with less effort. For example, measure the Vdc output of a power supply while measuring the Vac ripple. Or check the amplitude and frequency of an ac signal. From a single test connection!

And the Fluke 45 is designed to make complex measurements easier, with standard features like a 1MHz frequency counter, Min Max, Limits testing (Hi/Lo/Pass), Touch Hold™ and Relative modes. There are 21 different reference impedances for dB measurements; in the 2Ω to 16Ω ranges, audio power can be automatically displayed in watts.

Accuracy to get the job done right.

The Fluke 45 is a true rms meter, with 0.02% basic dc voltage accuracy and 100,000 count resolution on both displays. Basic dc current accuracy is 0.05%, making the 45 ideal for servicing 4-20mA current loops. Closed-case calibration simplifies the calibration process and increases uptime.

Even an RS-232 interface is standard

Connect the Fluke 45 to PC's, RS-232 printers and modems is as easy as attaching the cable. An IEEE-488.2 interface and rechargeable batteries are available as options.

FLUKE 45 DUAL DISPLAY MULTIMETER

Dual Display	Compare and Relative functions
True-rms voltage and current, including ac+dc	Min Max and Touch Hold® functions
0.02% basic dc voltage accuracy	Optional PC software for RS-232 applications
0.05% basic dc current accuracy	Optional IEEE-488.2 interface, battery pack
1 MHz frequency counter	One year warranty
RS-232 interface standard	
dB, with 21 reference impedances, and audio power calculations	

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READER INFO No. 36

ELECTRONICS

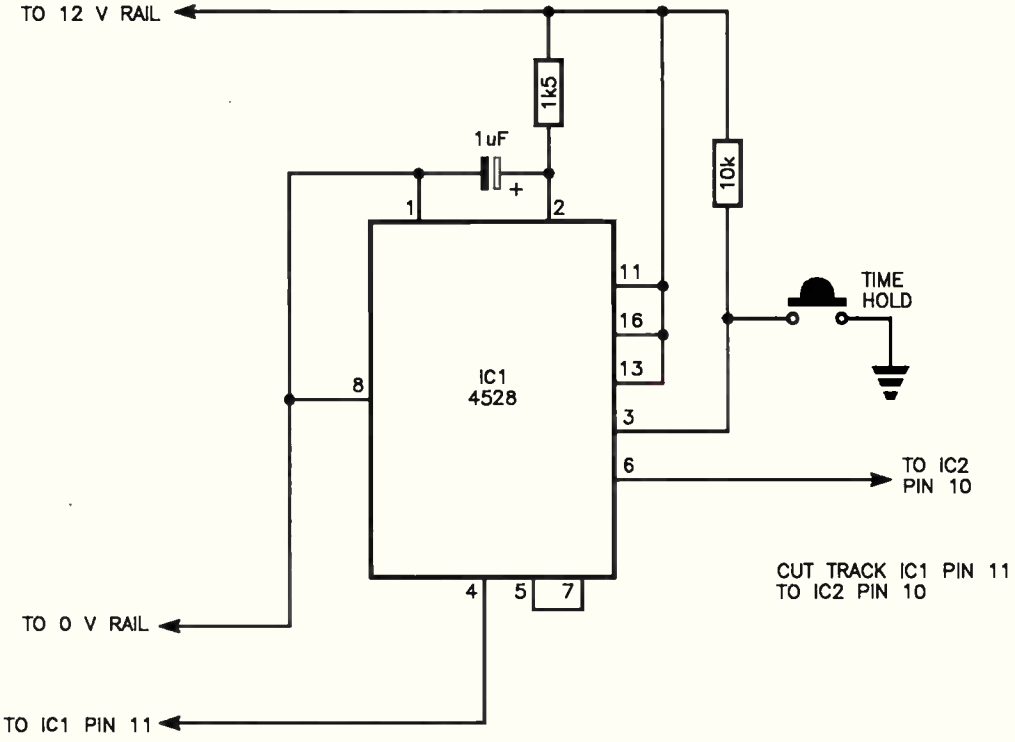
Circuits

50 Hz reference filter

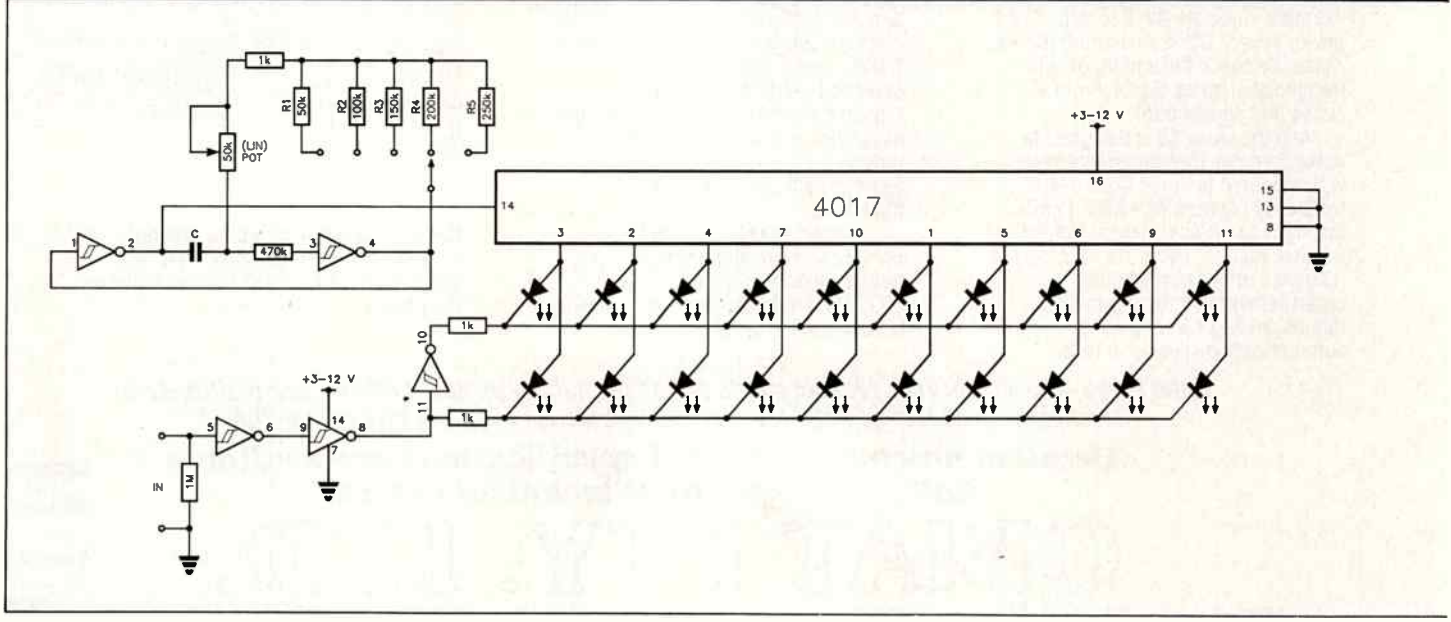
After building the ETI-564 clock I was disappointed to find that it didn't keep reasonably accurate time, so I added the circuit shown connected as a non-retriggerable mono stable between DIN11 of IC1 and DIN10 of IC2. The effect is to allow 50Hz to pass through while blocking any hash that may get through in between.

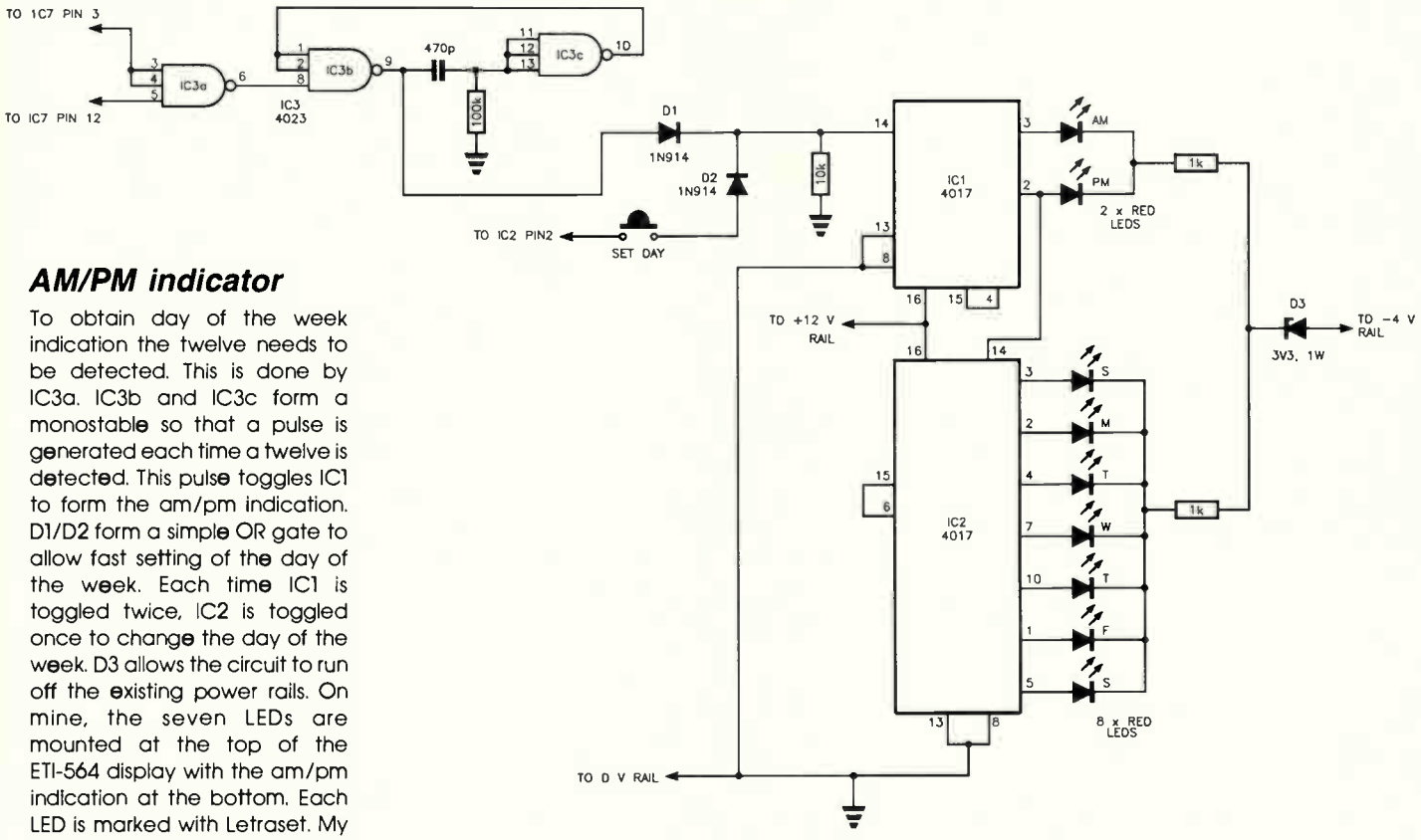
The clock now runs to within a few seconds of Telecom time over a period of months. The track must be cut between DIN11 of IC1 and DIN10 of IC2. The time hold was added to allow easier setting of the clock. The circuit was built on Veroboard and mounted where possible behind the main display.

G. Freeman,
Nairne, SA



WINNER





AM/PM indicator

To obtain day of the week indication the twelve needs to be detected. This is done by IC3a. IC3b and IC3c form a monostable so that a pulse is generated each time a twelve is detected. This pulse toggles IC1 to form the am/pm indication. D1/D2 form a simple OR gate to allow fast setting of the day of the week. Each time IC1 is toggled twice, IC2 is toggled once to change the day of the week. D3 allows the circuit to run off the existing power rails. On mine, the seven LEDs are mounted at the top of the ETI-564 display with the am/pm indication at the bottom. Each LED is marked with Letraset. My circuit was built on Veroboard and positioned where possible behind the main display. My clock sits on top of the television, mounted on two small feet.

G. Freeman,
Nairne, SA

Duty cycle logic probe

This probe can be used to check the duty cycle of a digital waveform in steps of 10% (which may be expanded) of total cycle. It may also be used to view more complex repeating digital waveforms. The waveform is displayed on two rows of LEDs that show the 'on time' top row, and the 'off time' bottom row. The two rows are sufficient to display the digital waveform as the rise and fall times are too fast to display anyway.

The circuit consists of:

1. An oscillator (2x1/6 40106 or similar Schmitt trigger inverter) that is used to synchronise the incoming waveform with the display via the rotary switch (coarse), and the potentiometer (fine) adjustments.
2. The display driver and decoder (4017).
3. 2 x 10 LED matrix (looks good with green rectangular LEDs)
4. The input buffer (2 x 1/6 40106).

NOTE: the oscillator frequency must be 10 times that of the incoming waveform frequency in order to display one cycle over the entire display. C and R are used to set the oscillator frequency. These may be varied depending upon frequency range required.

C = 1 uF – 100pF
R_1 = 50k
R_2 = 100k
R_3 = 150k
R_4 = 200k
R_5 = 250k
+ V = 3-12 V
1 = 0V

G. Katz,
Dee Why, NSW

BUFFOONERY

THINGS THAT GO BUMP . . .

The Lawrence Livermore Laboratory in the United States is a defence research facility of world renown. It is for this reason, no doubt, that it is involved in research on the probably ill-fated "Star Wars" Strategic Defence Initiative, a legacy left to the world by the now-departed actor of note and politician of regular personal habits, Ronald Raygun. It was this prestigious laboratory that came up with the X-ray laser.

X-rays are a form of very short wavelength radiation, as you may well know from your high school science class (that one when Abigail Williams, or whatever her name was, the school crowd pleaser, happened to be away and so your attention was not distracted from the lesson, or in the ladies' case, where your science teacher, generally known as 'Mathews the hunk", was on in-service training and the lesson was given by some relief teacher in drag...).

With lasers, the shorter you try to make the output wavelength, the more energy is required to pump up the lasing medium. So, you will realise it takes lots of energy to make an X-ray laser. So much, in fact, that the boys at the Lawrence Livermore Labs proposed an X-ray laser that required a small nuclear blast to provide the energy! They made one, too, it is reliably reported. Problem is, such lasers only work once.

Brilliant idea, chaps!

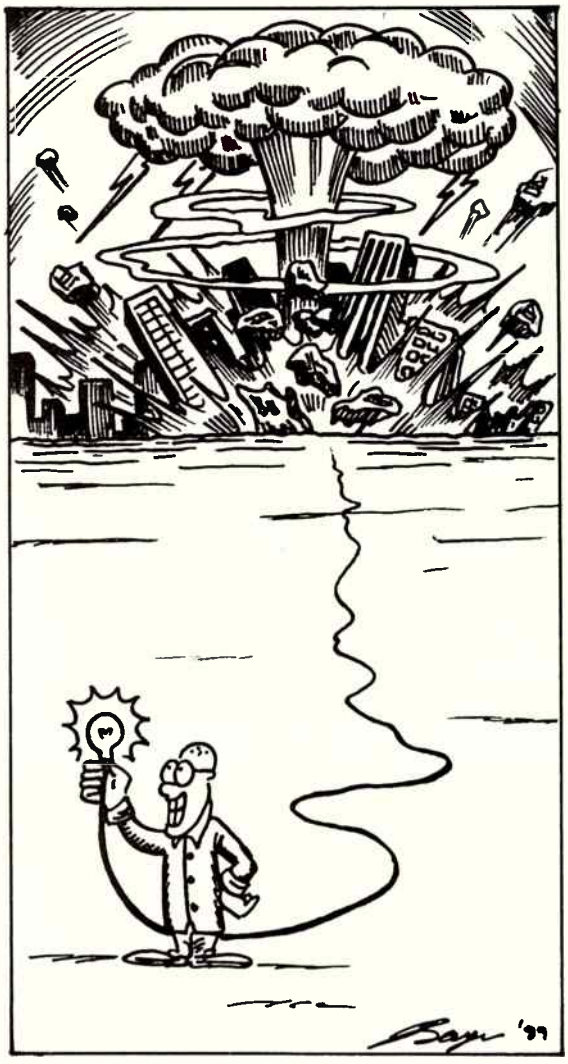
Well, it seems the same chaps at Lawrence Livermore are at it again. They've come up with an idea to harness nuclear fusion to generate electricity that circumvents all the efforts with Tokomaks and JETs and the like the world over, let alone the controversial cold fusion experiments so much in the news lately, saying that the technology is available here and now. They have seriously proposed using thermonuclear blasts because it is the only fusion power concept where the technology is proven and in hand today – quote, unquote.

Apparently, the scheme involves setting off a nuclear blast every twenty minutes inside a steel-lined (BHP – here's your chance!) underground cavity. Inside the cavity would be a fluoride salt of lithium and beryllium. The explosion would convert the salt into molten droplets and the heat from these would drive a steam turbine and generator. It would only require small explosions, we're told.

I can just imagine it. "What's that thumping sound, Harold?"

"It's only the power station, Martha. Nothing to worry about!"

eti



eti

Sound insights

Reviews:

SANSUI'S BAR SERIES

YAMAHA'S AST SYSTEM

Cover: JAMO CONCERT VIIs

THAT'S SUCCESS!

A new brand of audio cassettes being distributed in Australia looks set to follow earlier success in Europe. Roger Harrison takes a look at the That's Tape brand, distributed here by Atsui.

At the 1988 Perth Electronics Show last July, I was intrigued to run across an exhibitor, That's International, new to the PES, promoting a brand of audio cassettes unknown on the Australian market – That's Tape. I had seen references to the product in various European hi-fi journals, noting the fulsome praise being received. I chatted with the promoter on the stand who said that he was hopeful of organising national distribution in the following 12 months.

I heard no more until, on a recent trip to Melbourne, I met with Gary Furness of Atsui and was pleasantly surprised to learn that his company had a distribution agreement with That's International to distribute and promote That's audio tape range. Atsui is an Australian company, despite what the name might suggest, probably better known at this juncture as the distributor of Sansui audio products.

Gary gave me five samples of the That's tape being distributed here: two Type I (normal) tapes – FM-S and FX.XP, one Type II (chrome) tape – CDII 54T and two Type IV (metal) tapes – the MR.XP and the very new Suono, which had its world debut only last month.

That's Tape is made by Japanese electronic component manufacturer, Taiyo Yuden, which has no less than six factories in Japan and business offices in nine locations across seven countries around the world, including Asia, Europe and North America. The company was established in 1950 and is a major manufacturer of capacitors, hybrid circuits, ceramic-based components and ferrite products for electronics.

It's first That's tapes were launched in 1984, being Type I products; chrome (Type II) products were launched in 1985, to be followed by the Type IV metal tapes.

The company boasts that its tapes offer superior performance and, judging by the results of published test results overseas, it's a claim that seems to be substantiated in practice.

In 1986, the Swedish magazine *Hi-Fi Musik*, in a comparison review of 36 Type I tapes, gave That's FX first position in the general evaluation in which seven parameters were measured, ahead of the Sony HF-ES. That's FX gave a frequency response that rolled off above 20 kHz and a distortion of 1.0%, which compared closely with Denon's DX4 tape (1.0%), Fuji FR

New, top quality, audio cassette tapes for the Australian market — That's Tape distributed by Atsui, from Melbourne.

(1.1%) and the Sony (0.8%)

In 1988, That's Tape copped a string of presitigious gongs, it seems. The British audio journal *What Hi-Fi* voted That's MRX Pro chrome tape the best blank tape. Sweden's *Sound Information* gave it cassette of the year while the Swiss issue voted it best cassette amongst all chrome tapes tested, and West Germany's *Stereoplay* magazine said it broke all records in lab measurements. Another West German magazine, *Stereo*, in its annual tape test, gave MRX Pro highest marks.

And the list goes on. Earlier this year, *What Hi-Fi* voted That's FX tape as the best budget ferric tape presently available, giving it the 1989 award.

That's just-released top-line tape, the Suono, is dubbed a true designer's tape as Taiyo Yuden set out to design and manufacture "...the ideal functional design which meets all characteristics...beyond the sense of the conventional cassette tape..." They approached leading Italian industrial designer Mr G. Giugiaro, having set down the parameters important to the design of top quality tapes in any category: in tape characteristics – dynamic range, sensitivity and frequency response; in running characteristics – wow and flutter, azimuth accuracy and modulation noise; and in reliability – print-through, dropouts, erasability and distortion.

Suono is Italian for sound. That's claims the tape achieves unparalleled performance for an audio cassette, with significantly improved dynamic range, high output level and low noise. The cassette case is highly unusual, featuring an elliptically-shaped dome in the centre on both the top and bottom of the case, with variable thickness of the plastic case material. This is claimed to substantially reduce case resonance effects which give rise to tape modulation noise. The case material is a specially-formulated composite material.

Inside a cassette shell, the hubs and friction sheet require an appropriate rigidity for smooth rotation of the tape spool. The friction sheet normally has tiny embossed ridges to support the tape. In the Suono cassette, the ridges on the friction sheet are double-humped which increases rigidity of the friction sheet by a factor of some 1.8 times, Taiyo Yuden claims, which substantially reduces the wow and flutter component, particularly noticeable at the low frequencies.

One aim of the manufacturer in designing this tape was to make a tape having a dynamic range applicable to today's digital sources, particularly CD. For such applications, a tape needs high MOL and SOL figures and low bias noise. Taiyo Yuden came up with a tape formulation that employs nano-dynamic tactoid material of super-fine particles which gives very dense packing of the particles, combined with a special polymer binder.

According to the data supplied, That's Suono tape delivers a dynamic range at around 300 Hz of just over 90 dB, and about 92 dB at 1 kHz, a performance likely to outclass most other similar tapes on the market.

That's tapes will be a little more expensive than the competition, but they come with an absolute guarantee that the distributor will replace, quibble free, any tape if the customer is not fully satisfied.

There seems little doubt that we'll be hearing a lot more of That's tapes in the near – and distant – future. In the UK market, That's Tape claims to be the fastest growing brand. In 1986, one year after being launched there, it led just 3% of the market. In 1987, its toehold grew to a respectable 10% foothold. In 1988, That's Tape sales represented 30% of the market. eti

BOSE®

The Bose® 601™ Series III Direct/Reflecting® Loudspeaker System

Bose engineers have invested more than 25 years of ongoing research seeking one goal—re-creating the realism of a live performance.

The next best thing to hearing music live is hearing it through a Bose® Direct/Reflecting® speaker.

Drawing on the heritage of the internationally acclaimed Bose 901® speaker, the 601™ speaker gives you the best seat in the house—wherever you sit or stand.

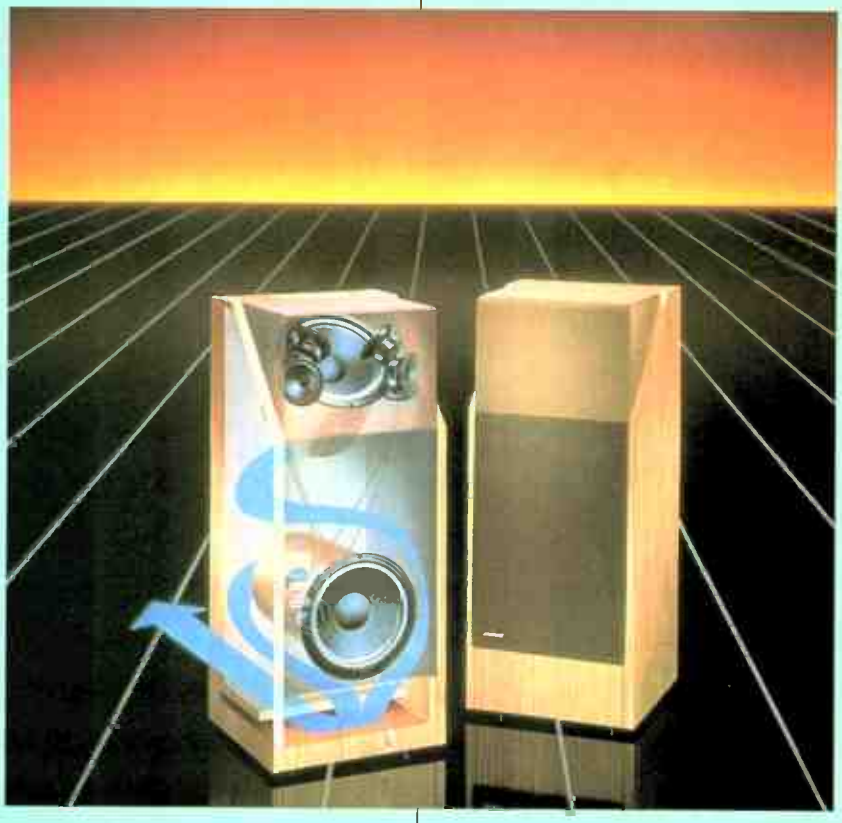
Through our extensive acoustical research into live sound, we learned that focusing on only one musical parameter such as frequency response and expecting realistic sound is like trying to create a lifelike painting by concentrating solely on colour. As with visual images, live sound has perspective, clarity and proportion.

We designed our speakers based on the natural combination of direct and reflected sound. The difference between listening to conventional speakers and Bose Direct/Reflecting® speakers is like the difference between viewing a movie on a television versus experiencing it in a theatre.

The 601 system brings a three dimensional sensation to music—giving the sound depth, height and width. In short, it seems to come alive!

In a live performance, the majority of sound reaches your ears after being reflected off the walls, floors and ceiling. With conventional speakers, you mainly hear only direct sound. Bose Direct/Reflecting® speakers add the missing elements of music by bringing you the natural combination of direct and reflected sound (see diagrams at right). The result is a lifelike soundstage that's practically like being there.

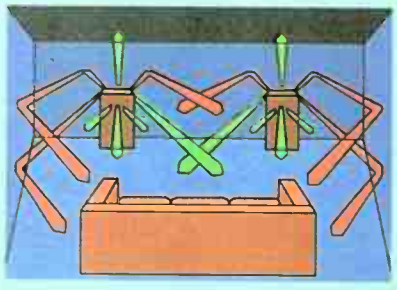
With most conventional speakers, you hear stereo in one or two parts of the room. Everywhere else, you hear primarily one speaker. The 601 system allows you to hear true stereo



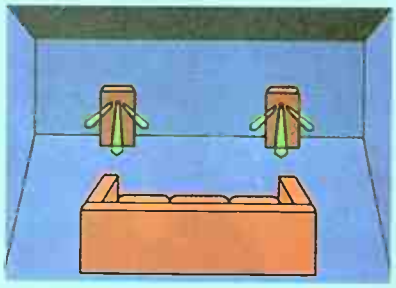
everywhere in the room—even when you are directly in front of one of the speakers.

The 601 system is the ideal cornerstone for a complete home entertainment system. It unleashes the full potential of your sound system, efficiently produces excellent sound and easily handles high power. This rare performance combination allows you to enjoy today's power-demanding sound sources such as digital audio at true-to-life volume levels.

The Bose 601 system also makes it possible to use your stereo system in a new way: as part of a total audio/video system. It is designed to produce greater realism with all video sound sources—especially stereo televisions, hi-fi VCRs and video disc players.



Bose 601 Direct/Reflecting® system.



Conventional speaker system.

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READER INFO No. 37

Videomovie camera competition

MARKETERS of JVC products in Australia have launched a campaign which gives each customer who purchases a JVC videomovie camera, or who has bought one in the past, a chance to win back the cost of their camera. It will be called the JVC "Best Home Video" competition.

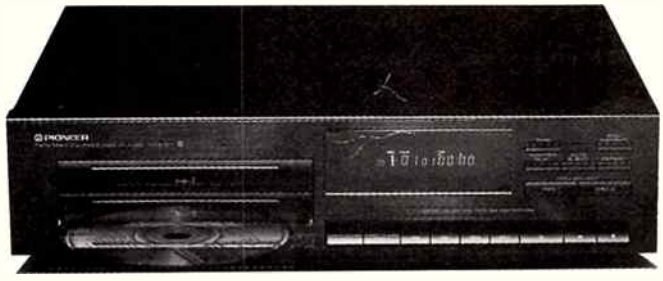
Each entrant will also receive a free JVC video tape. Five customers will receive money to the value of their videomovie cameras; these winners will also be entered in the prestigious world wide JVC Tokyo Video Festival.

The GR-A30EA, the latest member of the JVC line-up, is said to achieve a previously unattainable level of picture quality. It has completely automatic operation, with a flying erase head, high speed shutter and children's age insert.

It also features a full-range auto-focus, enabling the camera to focus on any subject at any distance from the lens with no additional manual macro setting.

For further details contact Hagemeyer (Australasia) B.V., ☎ (02) 750 3777.

READER INFO No. 265



The two-up CD player ▲

PIONEER'S new twin CD player, the PD-Z72T, is said to be a unique twin-tray two disc CD player which can hold and play two discs in any sequence, and allow one disc to be played while the other is loaded.

Once the twin trays are loaded the listener can either play each disc in normal sequence, with the machine selecting at random from both CDs or can pre-program to play from up to 24 tracks off the two discs.

The twin player can handle both album (12cm) and single (8cm) CDs. It also has twin digital-to-analogue converters and two oversampling digital filters to ensure top quality sound.

Further details from Paul Clarke or Robert Costello, Pioneer Electronics, ☎ (03) 580 9911.

READER INFO No. 266

Versatile amp ▲

DESCRIBED as the perfect amplifier for medium power applications, the HCA-500 is said to be ideal for surround sound, remote speakers, on-site monitoring of live recorders, and mobile DJ stage monitors.

Features include discrete circuitry (no integrated circuits); oversized power transformer for high current low impedance drive; gold plated RCA jacks, 1/4" phone jacks, 5-way terminals and front panel level controls.

A 19" rack mount is available. For more, contact Doug Osmond, NZ Marketing ☎ (02) 997 4666.

READER INFO No. 267

New Mirage speaker ▼

THE M-260 is the smallest in Mirage's '60' range of top-end speakers and, like others in this range, is constructed from high-density "Customwood". However, it uses a smaller bass/mid driver and a 19mm tweeter in lieu of the 25mm used in the M-360, M-460 and M-760.

The M-60's tweeter is a soft-dome, ferro-fluid cooled unit. This soft fabric dome is completely recessed within the plastic housing.

For further information contact Doug Osmond, NZ Marketing ☎ (02) 997 4666.

READER INFO No. 268

The Sansui brand name is back in the Australian audio market after a lapse of several years. Once known for its innovative, yet affordable products, Sansui seems set to be re-established with well-engineered, well-made and well-priced products. Roger Harrison reviews one of its newly-released systems, the 'Bar' series.

Unlike in Europe and Japan, midi sound systems have not made a great impact in the market in Australia. Several reasons have been advanced to explain this: accommodation in Japan and Europe in general is not as spacious as in Australia, hence midi sound systems with the 360 mm wide, generally slim-line components and smaller loudspeakers are more readily accepted where space is at a premium. Australia's houses, with their large lounge rooms, have the space to fit sound systems of more generous proportions, where they're regarded more as part of the furniture – hence, it is argued, the greater acceptance of traditional 430 mm-wide component systems and attendant medium-to-large volume 3-way loudspeakers which dominate sound system sales here. Funny thing though, Australians buy more big cars per head of population than the Europeans or Japanese. Maybe it's the influence of the great outdoors. Maybe it's just a belief in bigger is better.

There may be a marketing reason. By far the majority of sound equipment sold in Australia is priced below $899. It's hardly hi-fi, with perhaps some occasional exceptions. Such equipment is referred to as music centres in the trade. Price-wise, midi systems have fallen just above music centres, and, performance-wise, a lot of midi equipment has not been significantly better than music centres. A lot of midi systems were marketed through discount furniture and electrical goods chains. While genuine bargains were available, perhaps this didn't do much for the image of the midi sound system. So many hi-fi specialists refuse to stock midi systems on the

SANSUI'S 'BAR' SOUND SYSTEM

Sansui's 'Bar' series system is set to re-write the rule book for midi systems in Australia.

grounds of the down-market image and, in the past, the mediocre performance of much of it on offer.

Well, that is all about to change, if the Australian Sansui distributor, Atsui, has its way. Atsui, in spite of what the name might at first suggest, is an all-Australian company. It has spent the past two years quietly resurrecting the Japanese Sansui brand name through sound specialist stores around the country since the demise of Sansui's previous sole distributor here, Vanfi, in 1986.

Among a crop of new Sansui component hi-fi equipment releases earlier this year, Atsui launched the new 'Bar' series midi system which comes in two models – the 770 and the 970. The Bar series consists of separate components, plus speakers: these include an amplifier, equaliser, CD player, dual cassette deck, tuner and turntable. There are two power amp models – the A-E770 boasting 50 watts RMS per channel, and the A-E970 at 75 watts RMS per channel. Hence the two system models, although the cassette deck in the 770 is different to that in the 970 system. A 57-key multi-function infrafred remote controller comes with either system.

Cost depends on what you include in the system configuration. The 770 costs around $3000, the 970 around $4000. The system received for review was the 970, comprising the A-E970 amplifier, D-E970 dual cassette deck, CD-E770 CD player, T-E770 AM/FM stereo tuner, the G-E770 graphic equaliser and the S-U970 3-way loudspeakers.

Cosmetics

Each unit has smoothly sculpted front panel with a curved recess running the width of the bottom portion of the front panel containing the majority of controls and switches. All functions are clearly marked and easily accessible. The front panels are plastic while the cabinets and chassis are all metal. Colour is a metallic "dolphin" greeny-grey with a lustrous patina giving the equipment an elegant appearance.

All switches are of the push-push type, some having integral red LED indicators (e.g: the power switches, all the source switches on the amp, etc).

The graphic equaliser features a fluorescent bar graph display for each band in each channel. The dual cassette deck features a digital counter display and peak/average multi-colour bar graph level meter. The tuner features digital readout, function and time display, while the CD player features a fluorescent program, function, track and time display.

The loudspeakers are in a complementary wood-grain finish with black protective grilles.

The remote control features a specially-contoured shape to fit comfortably in the hand with the equipment controls down the top face, the master volume control being top-most. It's meant for two-handed operation and is comfortably held in either the left or right hand, according to your preference.

Specifications

The A-E970 amplifier is rated at 75 watts RMS output per channel, with no more than 0.05% total harmonic distortion across the 20 Hz to 20 KHz frequency range. The phono input sensitivity is quoted as 3.5 mV (50k input impedance), aux input sensitivity is given as 200 mV (47k). Frequency response is quoted as 10 Hz to 60 kHz +1 dB, -2 dB, while signal-to-noise ratio is 72 dB on phono and 95 dB on the other inputs. The digital processor section has a quoted dynamic range of 95 dB and a signal-to-noise ratio of 98 dB; frequency response is give as 10 Hz to 20 kHz.

The tuner has a 50 dB quieting sensitivity on FM quoted as 18 dBf (stereo) and a signal-to-noise ratio of 78 dB at 65 dBf. On AM, the sensitivity is quoted as 50 dB/m (loop aerial) and signal-to-noise ratio as 50 dB.

The D-E970 cassette deck has a stated wow and flutter of 0.08% (WRMS), which is very respectable, and a frequency response on metal tape of 30 Hz top 17 kHz. Dolby B, C noise reduction is included, yielding quoted signal-to-noise ratios of 64 and 74 dB respectively.

The G-E770 graphic equaliser has a quoted THD figure of only 0.01% and a signal-to-noise ratio of 110dB, which implies that the A-E970 amplifier sets the basic noise and distortion parameters of the system. Equaliser channels are centered on 63 Hz, 160 Hz, 400 Hz, 1kHz, 6.3 kHz and 16 kHz. Range is +/-10 dB.

The S-U970 three-way speaker system is rated at 90 watts RMS maximum input power, nominal impedance of 8 Ohms and has a quoted sensitivity of 90 dB for 1 W at one metre. Frequency response is given as 45 Hz to 20 kHz, but no level is quoted; crossover points are not quoted.

A closer look

The 970 Bar series system has a great many functions and features, but I'll just cover the most important ones here.

The A-E970 power amp includes a high performance digital signal processing system featuring a four-times oversampling digital filter with dual digital-to-analogue converters. Conveniently, it has three direct digital inputs – CD (optical), DAT and digital. The processor locks onto the incoming signal's sampling frequency, be it 32 kHz, 44.1 kHz or 48 kHz, so it's ready for any existing or upcoming digital source. Extra source inputs are provided, allowing audio from a video cassette recorder, for example.

The large volume control knob is a very convenient feature, and it sports a LED position indicator; it's a motor-driven potentiometer linked to the remote control. You can operate it manually too, of course.

The CD-E770 compact disc player has both audio and optical outputs. It also features memory programming allowing you to select the playing of up to 30 tracks on a disc in any sequence. A random play function plays the tracks on a disc in a random sequence. In addition, it has automatic music program searching, repeat playback and a CARS function that links with the cassette deck.

The CARS feature – computer assisted recording system – automatically scans for the highest peak in the CD tracks you've selected for taping and finds the correct recording level setting. Another feature of the CARS system is that it puts the CD player and cassette deck in perfect synchronisation: the disc is paused between tracks while the tape is reversed, ensuring there's no break in the music when you reach the end of a tape during recording. Pretty cunning, and very handy!

This feature is great for making party tapes where you want continuous music to be playing on the sound system, but you don't

want your precious CDs subjected to possible damage during the fun.

The T-E77O tuner includes the usual style of station memory system, but has a feature that very few other tuners on the market include: an advanced, three-mode programmable timer. This is a very versatile feature. Firstly, you can set up to seven on/off operations, precisely timed, for any of eight program sources (from the tuner, tape deck, CD player or whatever), daily or weekly. Great for time-shifting radio programs, just as you time-shift TV programs. Secondly, its wake-up call function allows you to precisely switch-in a program source at a given time with a gradual fade-up, rather than an abrupt turn on. Thirdly, it has a sleep function that turns off the system at a set time, gradually fading down the sound rather than abruptly cutting it off.

The versatility of the programmer allows you to switch program sources in and out according to a planned sequence. You can wake up to the sound of your favourite breakfast announcer, record something while you're out for the day (or night), play soothing music as you retire to bed, fading out after a preset time when you've fallen asleep, etc.

The D-E97O dual cassette deck provides dubbing from tape A to tape B, timer operation (from the tuner's timer, as just explained), Dolby HX-Pro noise reduction and a special feature called Megalo-Mix. This is just the thing for creating anthologies of favourite tracks or when compiling party tapes or tapes for the car. What it does is this: during recording, as one song is about to end, it gradually fades it out and gradually fades in the next to provide a seamless recording.

You can crossfade recordings like this from the CD player automatically, or with manual operation you can do the same with the songs recorded from the tuner, other tapes or records. A unique feature.

The seven-band graphic equaliser features five fixed equalisations: pops, classic, rock, car and headphone, each taking into account the differing emphasis required by both the source and the environment. Naturally, you can run it 'flat', too. Basically, it's a sophisticated tone control, with the added advantages of five fixed settings and up to five settings which can be determined by you and stored in memory.

The remote controller is comprehensive and versatile, with ten separate functions. The master volume control operates the amplifier's volume potentiometer with a motor drive, as explained earlier. There is a mute button to silence the system; for example, you operate the mute to answer a phone call or the front door. There are three controls to operate the tuner and a very comprehensive set of controls for the dual cassette deck. There are five source selection buttons and a complete set of controls each for the CD player and the graphic equaliser. A power button puts the whole system in standby. There are ten 'number' buttons for use in conjunction with the other function buttons.

The loudspeakers are a three-way system with a 230 mm polypropylene woofer in a rear-ported bass reflex cabinet.

A sound tryout

The system was given a thorough run-through with sources from the tuner, CD player and tape deck, playing a wide variety of material, ranging from classical through some pop music, blues and modern rock.

The A-E97O amplifier and S-U97O loudspeakers can certainly deliver plenty of volume, even in a large room. The whole system is simple and straightforward to operate, particularly when using the remote control. I didn't have the system long enough to work comprehensively through all the functions of the remote controller, so I was unable to discover how the number buttons are used. Apart from that, I found the remote controller a delight to use and a definite plus for the system.

Functionally, the unit is very good indeed. All operations behave as you would expect them to; there are no 'surprises'. The functional features of the cassette deck, CD player and tuner provide very good value for money. Personally, the equaliser didn't excite me, but I'm not really into that sort of thing anyway. If you are, no doubt you'll find it a versatile and useful item.

Sound-wise it gives a very creditable performance. If this were my system, at some later stage I would consider upgrading the loudspeakers. Like most hi-fi gear these days, the performance of the electronics inevitably surpasses that of the loudspeakers. If you're on a budget, perhaps the first thing to do would be to add a passive sub-woofer system. I like my bass and felt that the system had more to offer than the loudspeakers could deliver.

Certainly, you need to wind up the wick to get the most out of them. The equaliser can compensate partially, but needs to be used with a light hand to prevent boominess. On some sources I noticed a little mid-range edginess, but could not determine conclusively whether it was the particular recordings or the speakers.

Stereo imaging is quite good and the speakers do not show the evils of excessive presence so predominent in many sound systems in a similar class.

I would judge the Sansui 97O Bar series system to be very good value for money in functions, features and performance. The remote controller, the Megalo-Mix and CARS recording features and the three-mode programmable timer particularly set this system apart from its competitors. If you're on the lookout for a hi-fi system with comprehensive features and good performance, then I would recommend you give the Sansui Bar series system very serious consideration. eti

Review unit kindly provided by Atsui Pty Ltd, 1st Floor, The Biltmore, 152 Bridport St, Albert Park Vic 3206. ☎ (03) 699-1200.

State of the Art Hi-Fi Now in Australia

Sansui, widely recognised as leaders in Japanese Audio technology, will market their sensational new Bar Series 970/770 Hi-Fi midi-system in Australia as a result of boom sales achieved in the hi-tech-conscious Japanese domestic market.

The midi-system, consisting of 36 cm wide components as against the larger dimensions of full size audio gear, is designed primarily as a shelf type unit for smaller rooms, space restricted areas, or for owners desiring inconspicuous equipment.

Traditionally, midi-systems have equated with low budget, average performance Hi-Fi, but Sansui has changed all that with its Bar Series, now catering to the performance levels demanded by audiophiles.

Bar Series' ergonomic design combines the latest in Sansui engineering, such as the megalomix crossfader and CARS recording system to produce seamless, professionally mixed music tapes, or Sansui's graphic equaliser with electronic memory preset to Pops, Classic, Rock, Car and Headphone modes.

The Dolby HX-Pro double cassette deck automatically adjusts recording signals to combine low distortion with maximum output.

"The X-Balanced system operates independently of the ground, with what amounts to two amplifiers to handle negative and positive current. With a total harmonic distortion reading of 0.05 per cent and clean, crisply detailed music pouring from the speakers, it seems to work", says David Frith, Hi-Fi critic of The Sydney Morning Herald.

The Bar Series also features a 57 key multi-function remote control, 3 way speaker system, CD with optical digital output, advanced 3-mode programmable timer, direct digital sound switch and audio/video connections capacity.

Presented with sculptured control panels designed in "dolphin" metallic finish or black, Sansui Bar Series will be available from leading Hi-Fi specialist stores around Australia.

• Three models are available from $2899 depending on options required.

The Bar Series is covered by Sansui's exlusive 5 year warranty including CD laser head pick-up.

SANSUI

BAR SERIES

For your nearest authorised Sansui dealer, contact:
Atsui Pty Ltd (03) 699 1200
Fax (03) 696 4771

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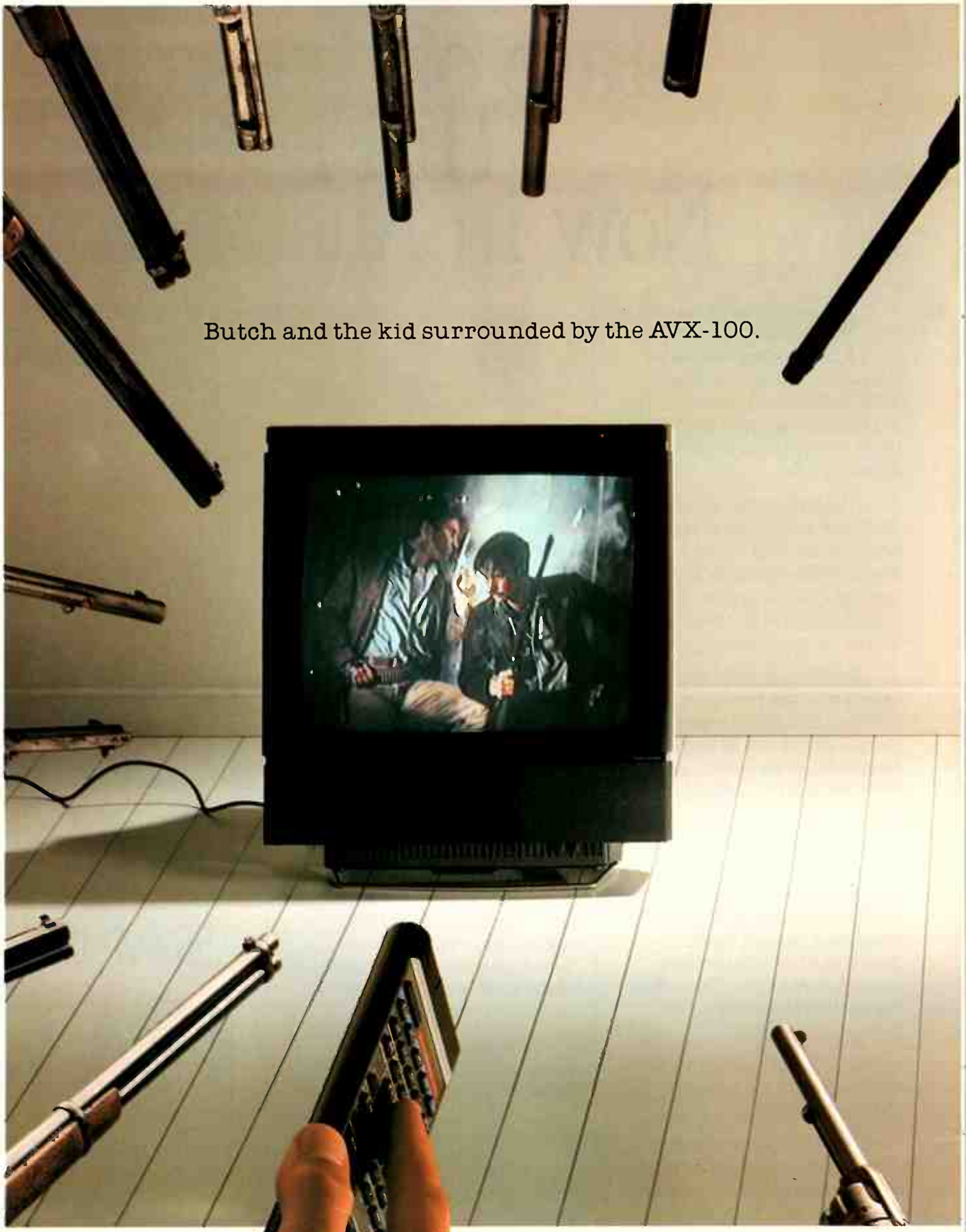

Saatchi YAM 052/B

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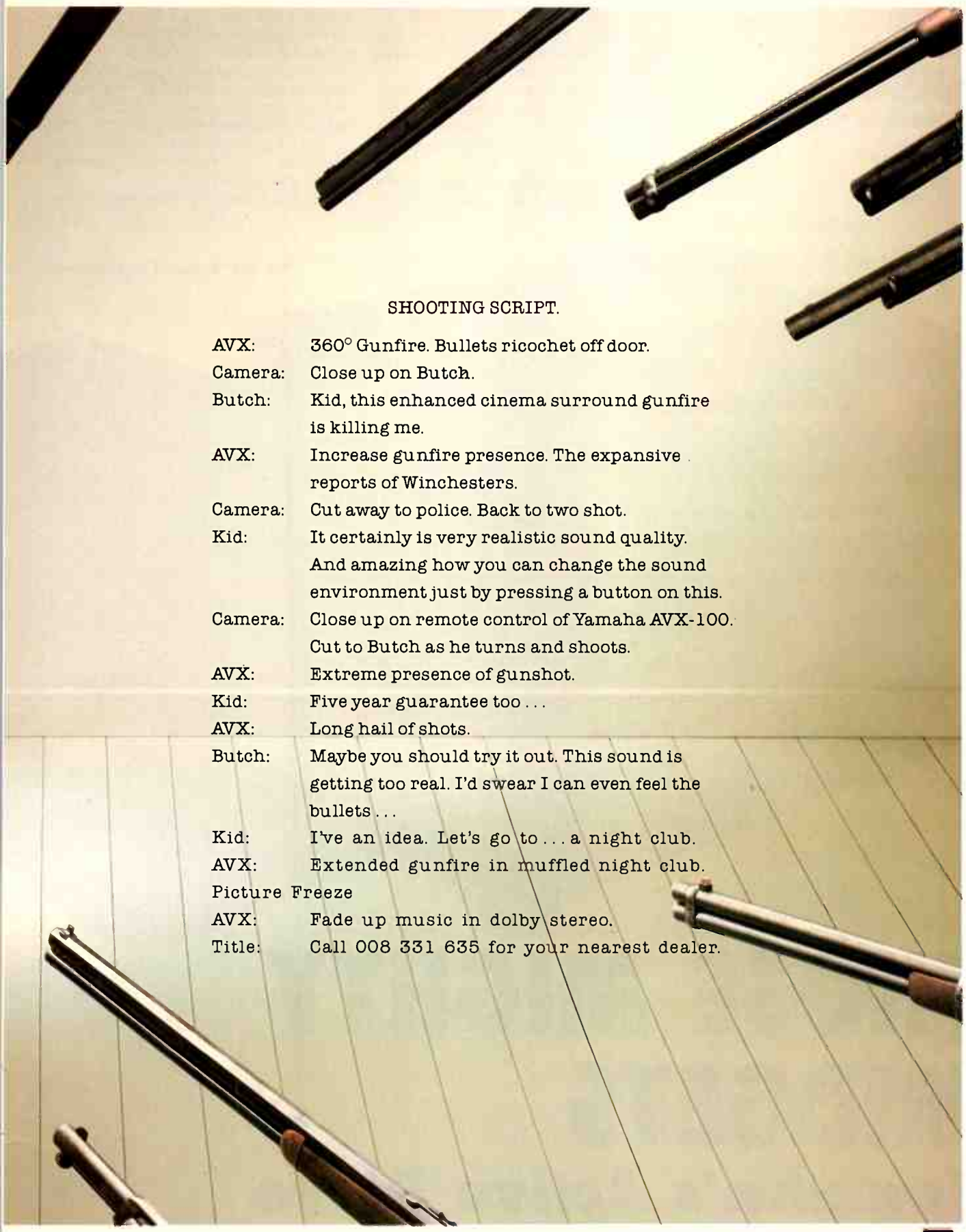


SHOOTING SCRIPT.

AVX:	360° Gunfire. Bullets ricochet off door.
Camera:	Close up on Butch.
Butch:	Kid, this enhanced cinema surround gunfire is killing me.
AVX:	Increase gunfire presence. The expansive reports of Winchesters.
Camera:	Cut away to police. Back to two shot.
Kid:	It certainly is very realistic sound quality. And amazing how you can change the sound environment just by pressing a button on this.
Camera:	Close up on remote control of Yamaha AVX-100. Cut to Butch as he turns and shoots.
AVX:	Extreme presence of gunshot.
Kid:	Five year guarantee too . . .
AVX:	Long hail of shots.
Butch:	Maybe you should try it out. This sound is getting too real. I'd swear I can even feel the bullets . . .
Kid:	I've an idea. Let's go to . . . a night club.
AVX:	Extended gunfire in muffled night club.
Picture Freeze	
AVX:	Fade up music in dolby stereo.
Title:	Call 008 331 635 for your nearest dealer.

YAMAHA

AUDIO – VIDEO AMPLIFIERS · 5 YEAR WARRANTY

Les Cardilini takes a look at the speaker system that leapfrogs both bookshelf and satellite speaker technologies.

The ability of loudspeakers to reproduce rich bass sound has traditionally depended on the size of the speaker box or enclosure.

Generally, the larger the speaker system, the better the bass responses has been the rule. Speaker systems no longer need to be big and bulky in order to deliver respectable levels of bass.

Satellite speaker systems, for example, with their characteristic lower visible profile in a room are also becoming quite popular. The typical satellite system comprises a centrally located woofer and a stereo pair of smaller speaker boxes deployed strategically in the listening room for mid-range and treble reproduction and stereo imaging. In theory at least, a distortion-free woofer is difficult to localise aurally and so can be placed virtually anywhere in the room without impairing stereo channel separation.

In a nutshell, bookshelf models and satellite

The AST-CIO sound stereo system.

THOSE MIGHTY MIDGETS

Yamaha's Active Servo Technology

speakers are physically smaller and less visually imposing systems which, despite their diminished profiles, do not necessarily compromise on bass response and stereo imaging, compared with larger, traditional speaker systems.

And now Yamaha has developed an even smaller speaker system that virtually leapfrogs both bookshelf and satellite speaker technologies. In fact the first model released here in recent months, the AST-S1, reportedly already proving to be very popular, can be used either as a small main or bookshelf system, or in Yamaha's new, Active Servo Technology (AST) mode which extends the bass response of these mighty midgets down to a body-pumping 28Hz.

Even when they are connected into a system as conventional speakers with a conventional amplifier, the Yamaha AST-S1s are impressive for their size. When operating with the AST power amplifier, however, one is tempted to look for a sub-woofer secreted somewhere in the room. The deep bass that extends perhaps an octave or more below the bottom end in typical conventional speaker systems is not only present when it is needed but is also clean and tight in the AST-S1, controlled rigourously by the AST amplifier. The performance of the diminutive AST-S1s has even compared seriously with the popular Yamaha NS-1000 monitors, four to five times their size.

The relatively tiny AST-1 speaker box measures only 188 millimetres wide, 297 millimetres high and 200 millimetres deep (7 3/8 inches, 11 11/16 inches by 9 1/16 inches). The box is magnetically shielded for safer use near colour TV sets and tapes and thus lends itself readily for use in integrated stereo and video systems.

At first, the AST-S1 has the appearance of being a two-way system, with its 16 centimetre (6 6/16 inches) diameter multirange driver and a soft-dome three centimetre (1 3/16 inches) tweeter. But the system is also designed to radiate from an open port or air-woofer.

Within a claimed overall frequency response of 20Hz to 20kHz for the Yamaha AST-S1 the air-woofer and the multi-range driver cross over at about 100Hz while the tweeter takes over at 2.5kHz and carries the frequency response through to around 20kHz. The AST-S1s are rated to provide a maximum, 112 decibels of Sound Pressure Level with a 1kHz test signal, measured on the centre-axis of the enclosure, at a distance of one metre.

The air-woofer in the AST-S1 operates on the Helmholtz resonator principle invented during the nineteenth century and is named after its discoverer.

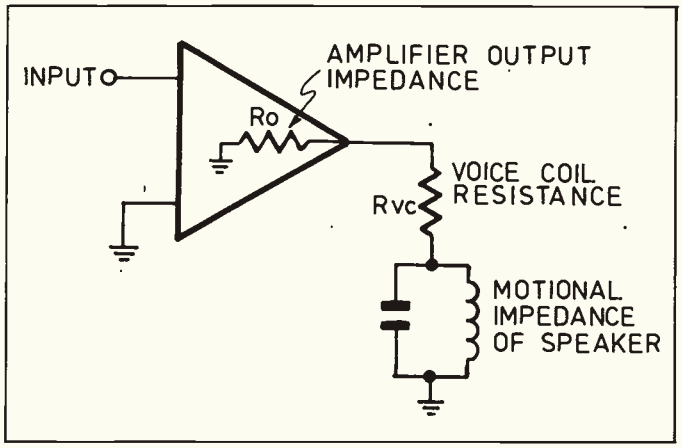
'The idea of having virtually zero impedance in the speaker system raises some interesting questions'

The Helmholtz principle can be demonstrated by blowing across the uncorked neck of a bottle to generate musical sounds (although this is hardly likely to be what Helmholtz intended). The larger the bottle the lower the pitch. In fact, if the AST-S1 could be turned inside out, like a sock, the AST speaker box might vaguely resemble a large bottle or whiskey jug. Who would have thought, then, that the favourite bass instrument of moonshining blue grass musicans in Kentucky would be the foundation of hi-fi and stereo speaker systems today?

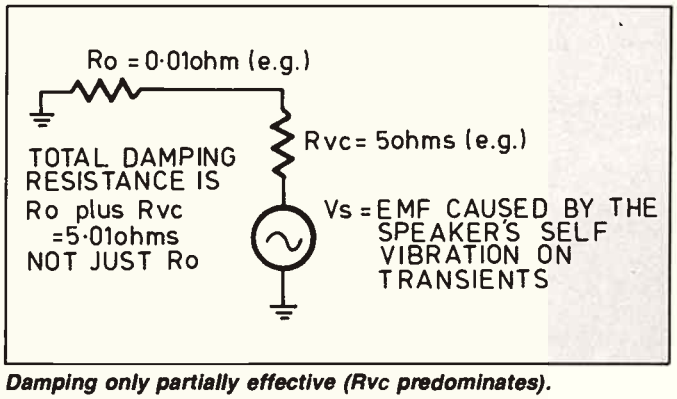
With the AST-S1, however, you do not have to nurse it tenderly and blow into the vent. The air inside the cabinet is moved by the bass driver cone and extends down and enhances the system's bass response by radiating sound from the opening of the neck, or duct, inside. The Helmholtz principle is used in many bass reflex systems.

But Helmholtz is only a part of Yamaha's Active Servo Technology. While the Helmholtz principle enhances the speaker's bass response acoustically, AST controls the speaker electronically by helping the AST amplifier to hold a very tight rein on the bass driver cone. The AST amplifier prevents the bass driver cone from overshooting during rapid transients, or vibrating on its own suspension instead of stopping virtually instantaneously to obey some characteristic of the music, for example. Unwanted cone vibration sets up sound waves that are not part of the music and typically causes a smearing or colouring of the sound.

Ordinarily, the ability of the amplifier to

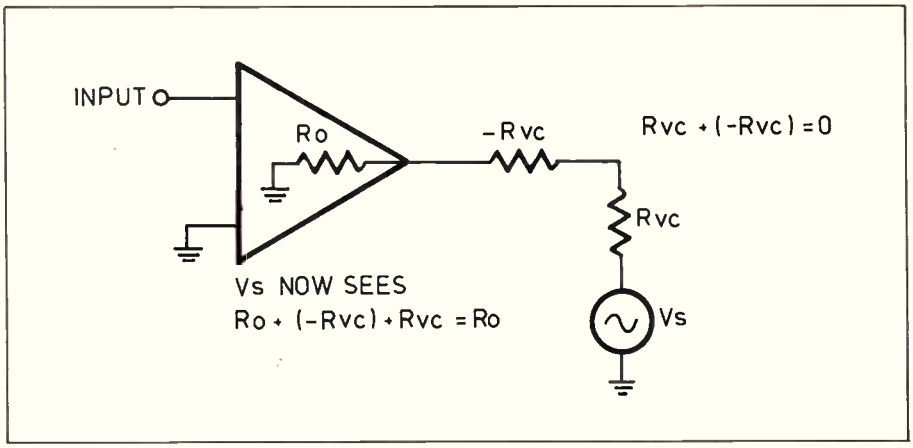


Ordinary amplifier circuit.



Damping only partially effective (Rvc predominates).

control this delinquent behaviour of speakers generally, is reflected in the damping factor of the system amplifier. Higher damping factors which at first appear attractive, however, are, for practical purposes, thwarted by the dc resistance of the speaker's own voice coil. As long as there remains significant resistance in the speaker circuit damping is less than totally effective. For example, an amplifier output impedance of, say, 0.01 ohms is of only academic interest as far as damping is concerned if it is in series with, and swamped by, a voice coil resistance of five ohms. This is where AST comes in.



Now Ro can critically damp involuntary cone motion on transients.

'At first, the AST-S1 has the appearance of being a two-way system'

In the AST system each pair of AST speakers is matched with the AST power amplifier by a small palm-sized plug-in module, or pod, supplied with that system. The module has no cords attached to it. It simply breaks into the circuit and enables the amplifier to adapt to the speaker system for which the module is designed. The circuit networks and negative feedback paths in the module, in effect, cancel the impedance of the bass driver's voice coil and the AST amplifier is then able to keep the bass speaker under control in a vice-like grip.

In effect, the AST amplifier tends to achieve an infinite damping factor by negating counter-productive, residual impedance in the speaker system and leads.

The idea of having virtually zero impedance in the speaker system also raises some interesting questions on the use of different kinds of speaker cables as AST circuitry is more or less fine-tuned to a particular set of speakers. But I digress.

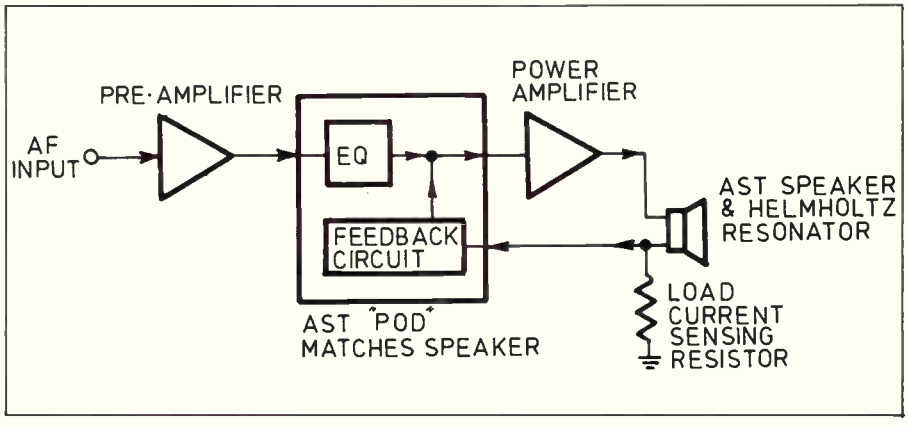
An AST system comprises a stereo pair of speakers with a unique matching AST module to plug into an AST amplifier. The Yamaha AST-A10 amplifier released with the AST-S1 speaker system is a power amplifier only and so a separate pre-amplifier or control amplifier is needed to complete the stereo system.

Alternatively, the AST-A10 amplifier might be connected to the Pre-Out or possibly the Tape Recording output connectors on a stereo integrating amplifier. Currently, the AST-A10 can be matched with Yamaha's AVC70T Natural Sound Audio/Video Control Amplifier, for a complete AST system.

Yamaha's AST is not simply a fashion feature in current models. A spokesperson for Yamaha pointed out that AST is here to stay. AST is considered to be such a significant development, in fact, that it will become a standard feature option in the majority of Yamaha systems and portables alike and will be featured in an increasing number of Yamaha products such as integrated amplifiers, receivers and portables.

AST also has compatibility. A new set of AST speakers, for example, could be fitted to either a later or earlier model AST amplifier simply by unplugging the AST module for the old speakers and plugging in the pack that would come with the new AST speaker system. Conversely, the AST module for a particular speaker system could be used with a different AST amplifier if required.

Recommended retail prices are $799.00 for the AST-A10 Amplifier, $999.00 for the AST-S1 Speakers and $999.00 for the AVS70 Four-Channel Audio/Video Control/-Preamplifier which also features S-Video inputs for use with S-VHS video systems. The AST-A10 is a power amplifier only and requires a pre-amplifier such as the AVC70 although an existing preamplifier should be suitable also. By the time we go to print, however, Yamaha should also have released its new, AST-capable stereo integrated amplifier Model AX 630 with a price tag of $699 rrp... More information: Yamaha Music Australia Pty Ltd, 17-33 Market Street, South Melbourne, Victoria 3205 (03) 699 2388. eti



Basic principle of AST system. Active Servo Technology equalisation and feedback are determined by the speaker characteristics.

COME TO THE CONCERT

The Australian Connection

Louis Challis takes his hat off to the latest Jamo speakers, the Concert VIIs.

It's funny but when you dig deep enough, it's remarkable how often you find an Australian connection in a new product which is acclaimed for its excellence. The Jamo Concert VIIs are just one case in many I've seen recently.

Jamo is Denmark's largest loudspeaker manufacturer, and has had a sizeable portion of the 'top end' loudspeaker market at its feet. Rather inexplicably, for the last few years it has put most of its marketing emphasis on the bottom end of the market and, in the process, I suspect, has lost some following.

Recently, the Jamo Concert Vs, which have some nice features, did much to improve their kudos, but they don't really offer all the panache that a real top-of-the-line speaker needs. Jamo had to offer some sort of revolutionary departure from their previous design philosophy and develop some practical advances to attract new buyers. As I soon found, the Concert VIIs are precisely the real advance that they sought and are attractive enough to entice you to go and audition them.

The concerts VIIs' speaker enclosures are deceptively tall and narrow with an unusual, cloth-covered, steel-framed speaker grill which neatly sits in a pair of slots on both sides at the top of the cabinet where it is nattily retained by magnets set into the panel.

With the panel removed, one finds what almost looks like a conventional array of tweeter and mid-range up at the top of the face, but, instead of a woofer at the bottom, you find only a neat base reflex port with an annular slot around its perimeter. Even after you look more closely to find the woofer you can't because it, or rather they, are hidden inside the cabinet.

Now, way back in December, 1976, Electronics Australia published an article on an exciting development by AWA's speaker design group on a new development in speaker technology called the Duplex Drive. Walter Barlow, the innovative speaker designer at AWA's Ashfield factory, had found that by coupling two bass speakers face to face (or rather cone to cone) in a standard enclosure, he could double the stiffness, double the mass of the cones, reduce the interaction of the cabinet's volume and achieve a significant downward extension of the lower cut off frequency of the cabinet. The low frequency harmonic distortion was reduced because of the push-pull characteristics, speaker linearity was enhanced and the speaker surrounds were less likely to suffer from damage. Even the august Australian Financial Review picked up the story and ran it, but AWA never really capitalised on the development and it had to wait for others, like Jamo in Demark, to pick up the ball and run with it.

Jamo, of course, went one better than AWA. They put the Barlow Duplex Drive into a Bass Pass Reflex System, where the front face (or actually the rear of one of the 200mm diameter speakers) looks into a small Bass Reflex enclosure tuned to 150Hz, whilst the other side of the pair looks into a somewhat larger Bass Reflex enclosure tuned to 30Hz. Hey Presto! They had a remarkably efficient and reasonably flat woofer frequency response from a relatively small enclosure which knocks rings off most of the much larger systems and quite a few commercial sub-woofers as well.

Here, of course, the Jamo design engineers' innovative flair really has come to the fore, for not only have they ported the two sides of the woofer enclosures to precisely the same frontal drive point on the cabinet (which is really neat) but they have also used the structural requirements of the two separate cabinet enclosures to stiffen up the cabinet so that peripheral stiffening problems are simultaneously resolved.

In order to optimise the limited operating

MEASURED PERFORMANCE OF JAMO CONCERT VII LOUDSPEAKERS

Frequency response				**35Hz to beyond 20kHz**	
Crossover frequencies				**150Hz & 3.4kHz**	
Sensitivity					
(for 90dB average at 2m)		**11.9V r.m.s. = 17.7 Watts (nominal into 8ohms)**			
Harmonic distortion		**100Hz**	**1kHz**	**6.3kHz**	
(for 96dB at 1m)					
	2nd	**−36.7**	**−56.8**	**−41.8**	**dB**
	3rd	**−36.6**	**−55.0**	**−40.2**	**dB**
	4th	**−39.8**	**−67.9**	**−44.0**	**dB**
	5th	**−38.1**	**−63.1**		**dB**
	THD	**2.6**	**0.24**	**1.4**	**%**
Input impedance		**100Hz/7kHz 4:1**			
On test	**100Hz**		**9.6**	**ohms**	
	1kHz		**13.2**	**ohms**	
	6.3kHz		**10.0**	**ohms**	
	Min at 140Hz		**6.0**	**ohms**	

Date: 9th April 1989

range of the low frequency woofer drive, the mid range driver has to cover an unusually wide range which extends from 150Hz all the way up to 3.5kHz. This performance has been neatly achieved by providing a separate, relatively large, sealed enclosure for the mid-range driver at the top of the cabinet.

The resulting response of the 160mm mid-range driver is remarkably smooth and only goes to show what you can do when you try hard enough with a good speaker. After a very satisfactory proving run in the Concert V system, Jamo has used the same 25mm SEAS Norwegian Super Alloy treble unit in the Concert VII. This tweeter has its first real resonance beyond 25kHz and so its effect is not really excited by program content.

The tweeter is protected from high level transients by a current limit on the crossover board, but the woofers and mid range are not provided with any form of protection, and most probably don't need it.

I opened up the cabinet and confirmed that the speakers are wired in very heavy OFC cable to minimise resistive losses and observed that the front panel boasts a one-piece heavy moulded plastic face constructed from what Jamo described as a Non-Colouration Compound (NCC). This uses concrete and resonance damping binder which is cast between two thin layers of vacuum moulded polystyrene.

Even the 'T' nut fixings are moulded into this assembly to reduce construction costs and the overall results from this system are surprisingly effective.

At the rear of the cabinet are two sets of gold plated binding parts instead of a single pair. This combination allows you to either 'bi-amp' or 'bi-wire' the speakers, or, if you prefer, to run conventional low resistance wiring and just bridge the pairs of terminals with links that are provided, or, if you choose, with one link and one resistor (in the range 1-3 ohms) so that you can slightly attenuate the tweeter's output.

The crossover is well designed and utilises the mechanical filter of the upper end of the woofer system's band pass response to provide the upper end of the woofer crossover response. The crossover utilises heavy duty air cored inductors with polyester high working voltage capacitors to provide a stable crossover performance which is not voltage sensitive.

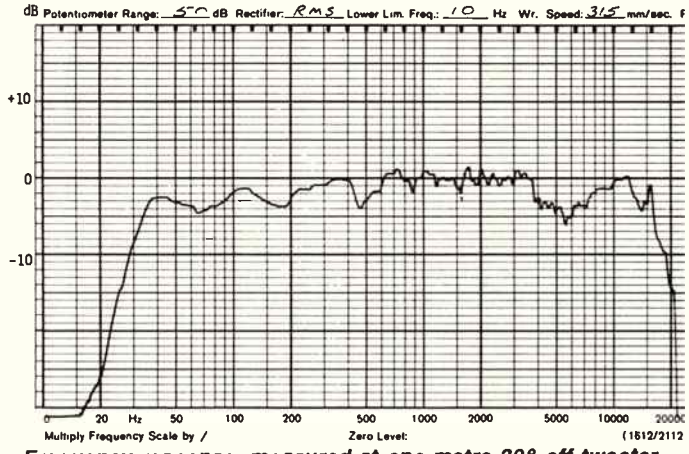
The four feet at the base of the enclosure are dual purpose and accept screw-in spikes on which the speakers can be more securely fixed into a timber floor (or on the carpet), if your wife (or mother) doesn't catch you

The pair of test speakers came to my office during my absence. When my staff unpacked them they noted that the back of one of the speaker cabinets had been slightly damaged during transit. It was only during the subsequent laboratory testing of this speaker that we noted a strange anomaly in its frequency response.

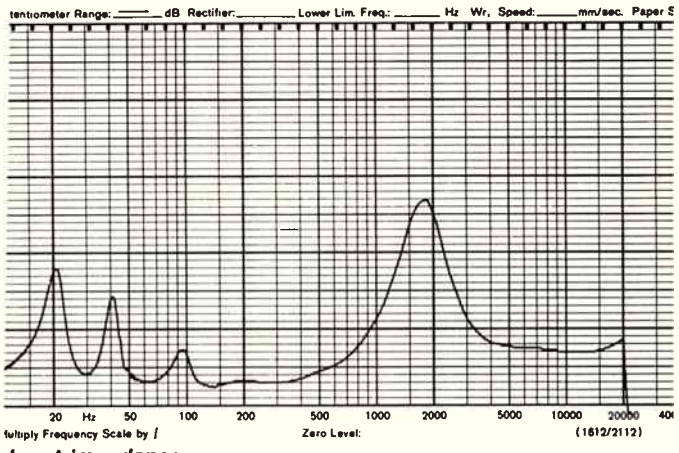
On closer examination I noted the presence of a very small indentation in the face of the tweeter, and this, as it transpired, was the cause of the anomaly. With the tweeter replaced by a new unit, I re-measured the frequency response of the speaker in my anechoic room and found that it was absolutely outstanding, and within ± 4dB all the way from 33Hz to well beyond 20kHz for the on-axis test. The bottom end was clearly something 'out of the box' and there are obviously very few other loudspeakers on the market, at even twice the price, that are capable of matching this.

Even the off-axis response is good, although at 30° off-axis the tweeter output drops off sharply above 16kHz, which is still quite acceptable and a real credit to the Norwegian tweeter designers at the SEAS factory.

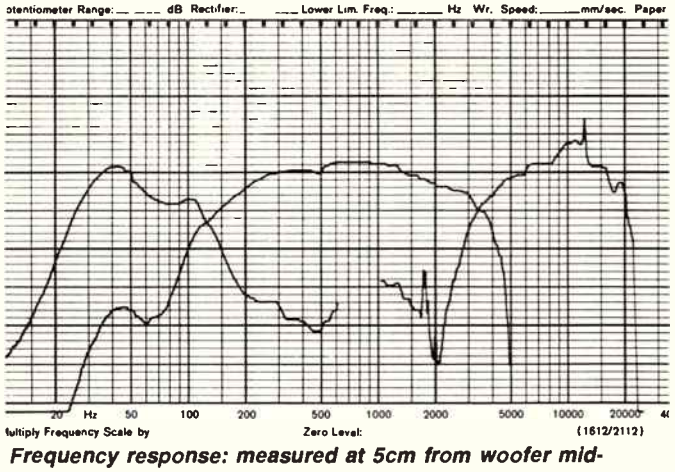
The polar responses of the enclosure reveal that even at 10kHz the – 6dB points are 90°



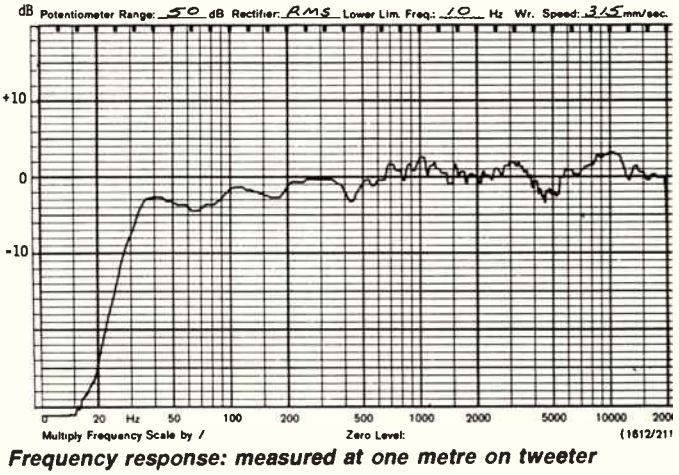
Frequency response: measured at one metre 30° off tweeter axis.



Input impedance.



Frequency response: measured at 5cm from woofer mid-range and tweeter. (Faulty tweeter.)



Frequency response: measured at one metre on tweeter axis.

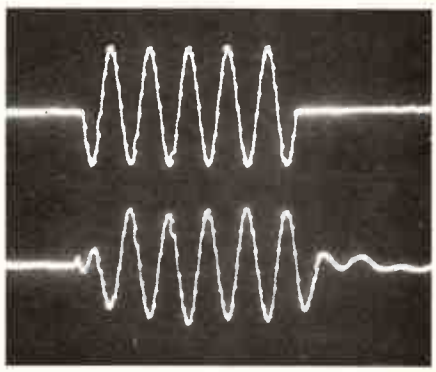
apart whilst the −3dB points are still 65° apart. All the polar responses are very smooth and the effects of contouring the cabinet edges and careful adjustment of the phase linear characteristics of the drivers in the cabinet have really been exceedingly well executed.

The distortion characteristics of the speaker are reasonable, but not as low as some of the other speakers we have seen recently, although the really good ones were, admittedly 10 times the price. Surprisingly, the distortion at 100Hz was much higher than I would have expected on the basis of my theoretical assessment.

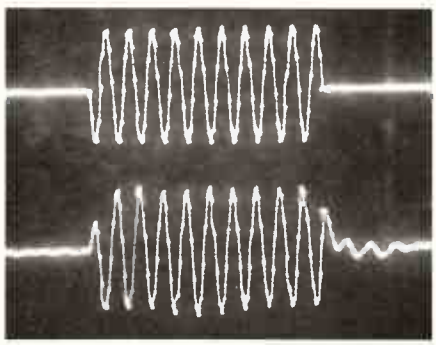
Dimensions:	**950mm high × 320mm deep × 285mm wide**
Weight:	**30kg each**
Price:	**$2,990 R.R.P.**

The input impedance curve reveals that the speaker is a true 6 ohm system with only minor resonances at 20Hz, 40Hz, 95Hz and one well defined peak of 26 ohms at 1.8kHz. With these characteristics the speaker system will cause no problems for an amplifier, but is not well suited for parallelling with other speakers unless your amplifier can handle impedances of less than 4 ohms.

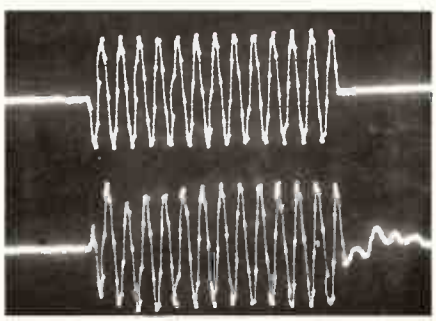
The phase response is exceptionally smooth and the designers have obviously achieved outstanding results by positioning the drivers at just the right position on the moulded panel face and by providing well designed crossover circuits.



Tone burst response at 100 Hz (20mS/div).



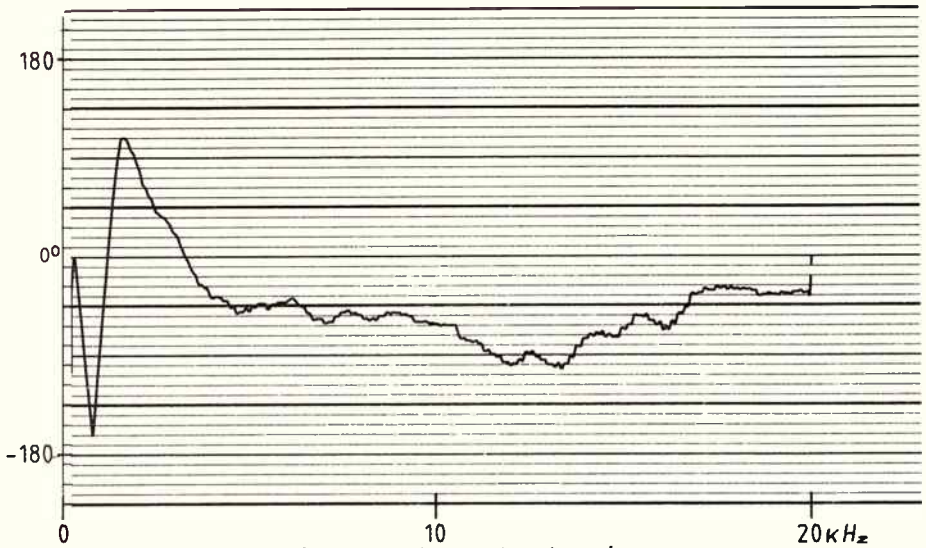
Tone burst response at 1kHz (2mS/div).



Tone burst response at 6.3kHz (0.5mS/div).

Note: upper trace is electrical input, lower trace is loudspeaker output.

Jamo Concert VIIs



Phase response: measured at two metres on tweeter axis.

The decay response spectra of the Jamo is undoubtedly one of the strongest attributes and neither the speakers nor the cabinets display any real trace of a significant response until well up to (and apparently beyond) 25kHz.

The low level resonances in the 300 to 600 micro-second range after the application of the test pulses are particularly low and very well controlled. Taken overall, this objective performance of the Jamo VIIs was exciting and indicative of a potentially outstanding subjective performance.

The subjective assessment lasted for a period of four weeks during which time I was able to play a wide range of my existing discs, tapes, records and even some hi-fi videos. Right from the start, the most outstanding feature of the Concert VIIs was thier bass response which rivalled any speaker I have ever brought into my home. They took the organ records and discs, the drums and the pre-recorded thunder and lightning (without the optical flashes) and reproduced the recorded signals with a level of fidelity which I found was quite outstanding.

There are many wonderful tests and tricks for finding out what makes a loudspeaker tick, but in the end your subjective impressions of the true to life quality of the speakers is of supreme importance; if you can't listen to and really enjoy the music for its own sake then all those high faluting tests are worth nought. At the moment of truth the Concert VIIs had to deliver the goods – and they did.

I started my subjective assessment with one of the most highly acclaimed CDs released in Australia in the last few months. The disc features the American Pianist Murray Perahia in one of the most masterful renditions of Schumann's Concerto for Piano and Orchestra (OP54), followed by Grieg's beautiful Concerto for Piano and Orchestra (OP16), with Sir Colin Davis conducting the Bavarian Radio Symphony Orchestra, (CBS Masterworks MK44899). Murray Perahia and the orchestra's presentation of the Schumann Concerto is unquestionably the most eloquent and powerful rendition I have yet heard. Three previous international pianists who have played this piece in concert in Sydney during the last 30 years, just fail to compare in their interpretations with Perahia's zest and dramatic virtuoso style of playing. Yet, as good as the Schumann piece is, I believe that the Grieg Concerto is eclipsed by Perahia's scintillating wizardry in the Adagio, repeated in the Allegro Moderato Molto e Morcato. The speakers came much closer to re-creating the concert hall ambience than I would have believed possible and I was left feeling quite jubilant because I felt I was experiencing a rare level of acoustical fidelity.

I went on to audition another exciting new disc featuring the brilliant violinist Cho-Liang Lin with Esa Pekka Salonen conducting the Philharmonic Orchestra in Sibelius's Concerto for Violin and Orchestra OP47 and the Swedish Radio Symphony Orchestra in Nielson's Concerto for Violin and Orchestra OP33 (CBS Masterworks MK 445348).

I believe that the Sibelius Concerto is one of his greatest works and Cho Liang Lin's rendition is flawless, but then so was the speaker's rendition of the music. The quality of the sound was very close to that which we all seek and with delightful poignancy. Seldom have I been able to enjoy a pre-recorded concert as much as I did the Sibelius' Violin Concerto, and the speakers' neutral true to life characteristics really came to the fore.

It is not easy for a speaker to produce precisely the original characteristics of the Concert Hall — in point of fact, it is obviously extremely difficult, if not impossible. Notwithstanding, the Concert VIIs came so close to achieving that accolade that I metaphorically took my hat off to them.

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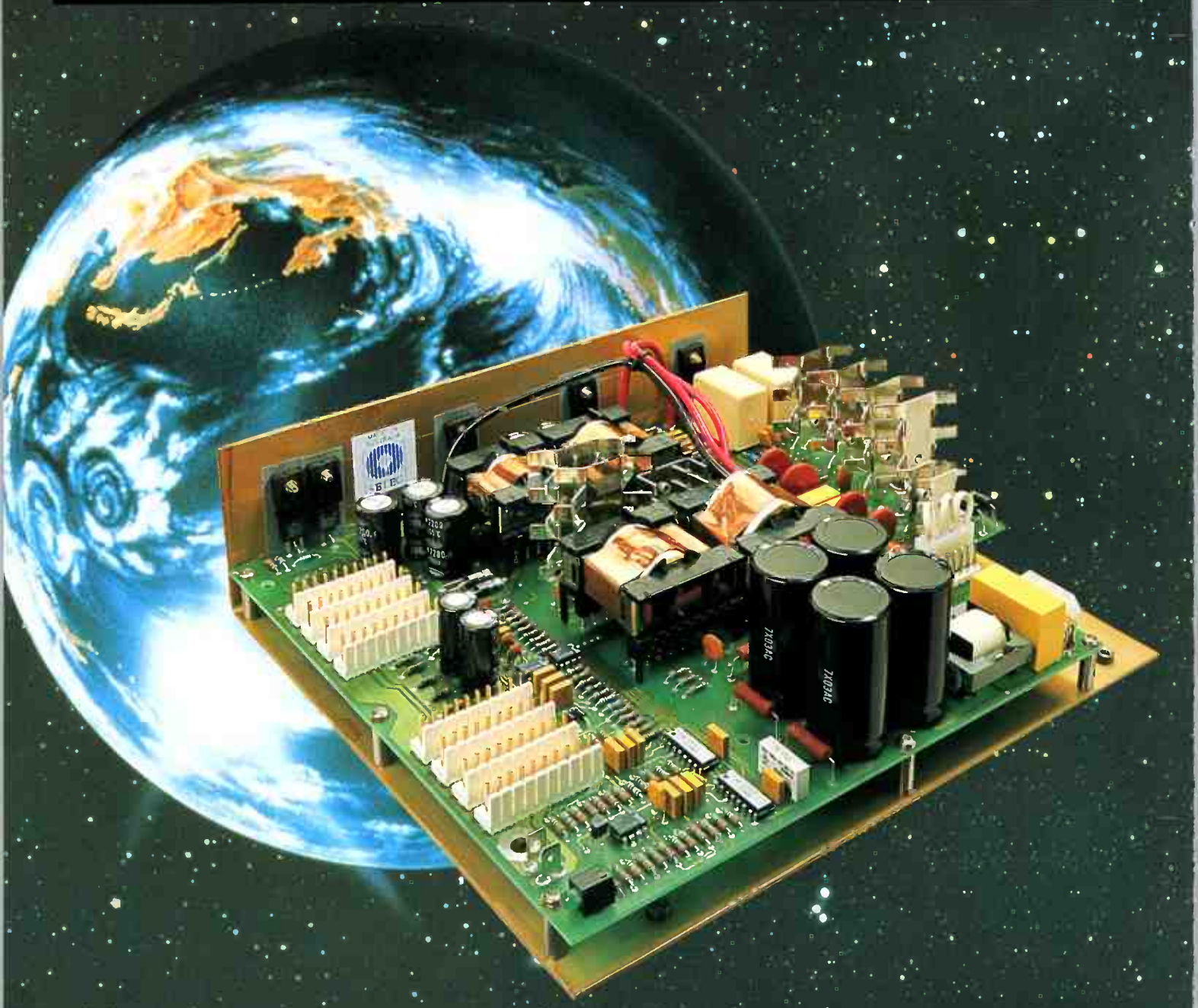

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